INSTALLATION RESTORATION PROGRAM

SITE INVESTIGATION REPORT

FINAL

151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

NOVEMBER 1997

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Environmental Restoration and Waste Management Programs
Oak Ridge, Tennessee 37831-7606
managed by MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the U.S. DEPARTMENT OF ENERGY under contract DE-AC05-84OR21400

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Submitted to:

AIR NATIONAL GUARD READINESS CENTER
ANDREWS AIR FORCE BASE

Submitted by:

HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM
MARTIN MARIETTA ENERGY SYSTEMS, INC.
Oak Ridge, Tennessee 37831

for the:

U.S. DEPARTMENT OF ENERGY

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ANGRC	Air National Guard Readiness Center
ARAR	Applicable or Relevant and Appropriate Requirements
AREFG	Air Refueling Group
ASTM	American Society of Testing and Materials
atm-m3/mole	Atmospheres - Cubic Meter Per Mole
AWQC	Aquatic Water Quality Criteria
BCE	Base Civil Engineering
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
BTOC	Below Top of Casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	CERCLA Information System
CES	Civil Engineering Squadron
CFR	Code of Federal Regulations
cfs	Cubic Feet Per Second
cm	Centimeter
CPsil-5	9-Meter Capillary Column
CRAVE	Carcinogen Risk Assessment Group Verification Endeavor
CWA	Clean Water Act
DD	Decision Document
DERA	Defense Environmental Restoration Account
DOD	Department of Defense
DOT	U.S. Department of Transportation
DQO	Data Quality Objectives
DWR	Division of Water Rights
EPA	Environmental Protection Agency
ES	Engineering-Science, Inc.
eV	Electron Volt
FFS	Focused Feasibility Study
FS	Feasibility Study
ft/day	Feet Per Day
ft/ft	Foot Per Foot
FTA	Fire Training Area
GC	Gas Chromatograph
gm/mol	Gram Per Mole
HAZWRAP	Hazardous Waste Remedial Action Program
HCL	Hydrochloric Acid
HEAST	Health Effects Assessment Summary Tables
HPLC	High Performance Liquid Chromatography
ID	Inside Diameter
IDL	Instrument Detection Limit
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IVR	Inhalation Unit Risk

LIST OF ACRONYMS
(continued)

K	Hydraulic Conductivity
K_d	Distribution Coefficient
K_{oc}	Organic Carbon Partition Coefficient
L water/day	Liters of Water Per Day
L/Kg	Liters Per Kilogram
m^3/day	Cubic Meters Per Day
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
mg/kg	Milligrams Per Kilogram
mg/kg-day	Milligrams Per Kilogram Per Day
mg/L	Milligrams Per Liter
ml	Microliter
mm	Micrometer
mL	Milliliter(s)
mm Hg	Millimeters of Mercury
mmol	Micromole
MS	Matrix Spike
MSD	Matrix Spike Duplicates
MSL	Mean Sea Level
MSLD	Mean Seal Level Datum
NA	Not Available
ND	Not Detected
NGB	National Guard Bureau
NM	Micrometer
NOAA	National Oceanic and Atmospheric Administration
NV	Not Verifiable
NYSDEC	New York State Department of Environmental Conservation
^oC	Degrees Centigrade
OU	Operable Unit
PA	Preliminary Assessment
PCBs	Polychlorinated Biphenyls
PHE	Public Health Evaluation
PI-5	Piezometer PI-5
PID	Photoionization Detector
POL	Petroleum, Oil, and Lubrication
PNA	Polynuclear Aromatics
PPMs	Priority Pollutant Metals
ppbv	Part(s) Per Billion, Volume Per Volume
ppmv	Part(s) Per Million, Volume Per Volume
PRG	Preliminary Remediation Goal
PSI	Pounds Per Square Inch
PVC	Polyvinyl Chloride

LIST OF ACRONYMS
(continued)

QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RAGS	Risk Assessment Guidance for Superfund
RD	Remedial Design
RFC	Reference Concentration
RFD	Reference Dose
RI	Remedial Investigation
RM	Remedial Measures
SAC	Strategic Air Command
SAP	Sampling and Analysis Plan
SI	Site Investigation
SLCAA	Salt Lake City Airport Authority
SLCIA	Salt Lake City International Airport
SLCWD	Salt Lake City Water Department
SPC	Soil Phytotoxic Concentration
SQC	Sediment Quality Criteria
SVOCs	Semivolatile Organic Compounds
SWDA	Safe Water Drink Act
TCE	Trichloroethylene
TCLP	Toxicity Characteristics Leachating Procedure
TDL	Toxic Dietary Level
TDS	Total Dissolved Solids
TOC	Top of Casing
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
UANG	Utah Air National Guard
UR	Under Review
USAF	United States Air Force
USDA	United States Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
WP	Work Plan
WQC	Water Quality Criteria

EXECUTIVE SUMMARY

A Site Investigation (SI) was conducted at the 151st Air Refueling Group of the Utah Air National Guard (Base), located at Salt Lake City International Airport, Salt Lake City, Utah. The SI was performed under National Guard Bureau's Installation Restoration Program (IRP). Objectives of the SI were to confirm the presence or absence of contaminants, preliminarily determine risk, and evaluate the potential for contaminant migration.

SI activities at the Base were conducted under the IRP at the following sites:

- Basewide - Background Soil Boring/Monitoring Wells and City Drain Canal
- Site 1 - Former Pesticide Dump
- Site 2 - Waste POL Fuel Spill
- Site 3 - Drum Burial Locations
- Site 4 - Fire Training Area 1
- Site 5 - Fire Training Area 2
- Site 6 - Ramp Washdown
- Site 7 - Oil Sludge Pond
- Site 8 - Building 10 Underground Storage Tank (UST)
- Site 9 - Building 40 UST
- Site 10 - Petroleum, Oils, and Lubricant (POL) facility

Sites 1 through 7 and the City Drain Canal were investigated October 1992 to March 1993. UST Sites 8 and 9 were investigated during this same time under the IRP program, but are addressed in other independent documents and are only briefly mentioned here. The Site 10 investigation was initiated under the IRP program in May 1994 but was not completed due to a health and safety incident. Investigation of the site is being completed by a different contractor. Additional soil borings were installed in October 1994 at Site 1. Additional monitoring wells were installed in August 1995 at Sites 1, 2, and 6, and at another background location, and these new wells (five total) and existing wells (12 total) were sampled. All of the site monitoring wells and background wells were sampled and analyzed for arsenic in 1995 and arsenic was found to be ubiquitous in, and indigenous to, shallow groundwater at the Base. Site descriptions, results of the investigations, and recommendations are summarized by site in the following paragraphs.

Basewide - Two background soil boring/monitoring wells were installed to determine background concentrations of organic compounds and metals in soil and groundwater.

The City Drain Canal is an unlined canal portion of the City Drain that affects shallow subsurface groundwater flow at the Base. Areas of the Base north and south of the canal discharge groundwater into the canal from the shallow aquifer. Storm drains at the Base collect and route overland flow that is ultimately discharged at several outfalls into the canal or pipeline of the City Drain. The canal was investigated to determine if contaminated ground/surface water at the Base was possibly impacting the canal media, or likewise, if canal media was impacting shallow groundwater at the Base.

Confirmation activities consisted of collecting six sediment samples and three surface water samples. The three surface water samples were collected adjacent to the sediment samples at locations where water enters or exits the canal.

Concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and ideno(1,2,3-cd)pyrene in sediment, at a sampling location near the west end of the canal and upstream of Base outfalls into the canal, exceeded human health criteria. The concentrations of arsenic, beryllium, and chromium exceeded human health criteria in all sediment samples. Seven metals, bis(2-ethylhexyl)phthalate, and heptachlor exceeded ecological criteria for sediment, indicating some potential concern for aquatic life.

Concentrations of benzene, dieldrin, antimony, arsenic, and cadmium exceeded human health criteria in surface water. Three metals and dieldrin exceeded ecological criteria for surface water, indicating some potential concern for aquatic life.

The source of sediment and water contamination in the City Drain Canal is probably cumulative. The primary origin of contamination may be from several upstream point sources and possibly from non-point sources. Groundwater contamination beneath the IRP sites does not appear to have reached the canal, based on the calculated groundwater flow rates at the sites and the suspected residence times and concentrations of the detected analytes.

The potential health concern for the canal is low to moderate.

No further characterization of canal media contamination is recommended. However, risks associated with the canal media should be considered by base personnel.

Site 1 - During the Preliminary Assessment (PA) the Former Pesticide Dump reportedly was located. No information existed on the amounts, contents, or dates of use.

Confirmation activities at the site consisted of 10 shallow soil borings and two shallow downgradient monitoring wells (one installed in 1993 and one installed in 1995).

Seven of the 10 soil borings were advanced after initial soil results indicated low levels of the pesticides chlordane and beta-BHC were present. Volatile organic compounds (VOCs) were analyzed in addition to pesticides and trichloroethene only was detected at the soil/water interface in one of the seven additional soil borings.

Concentrations of the pesticides and trichloroethene in soil did not exceed human health or ecological risk-based criteria.

Pesticides were not detected in groundwater. However, the concentrations of five VOCs in groundwater collected from the newly installed (1995) downgradient monitoring well exceeded human health criteria. The concentrations of tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, and vinyl chloride also exceeded maximum contaminant levels (MCLs) for water quality. The MCL is the most stringent human health criterion for 1,2-dichloroethene.

The lateral and vertical migration of the VOCs in groundwater are limited by the hydraulic properties of the shallow aquifer and the presence of an underlying clay layer. The presence of natural degradation daughter products indicates that intrinsic remediation of the chlorinated solvents is occurring.

Based on risk, the potential concern for Site 1 is low.

No further action is recommended for Site 1 pertaining to pesticides. The Site 1 area should be considered for further investigation of a potential source of chlorinated VOCs in groundwater.

Site 2 - The Waste POL Fuel Spill resulted from a 1987 bowser valve failure. The bowser stored waste oils, solvents, and fuel. The exact amount of the waste released is unknown. Most of the site is covered with asphalt and concrete.

Screening and confirmational activities at the site consisted of a soil gas survey, six shallow soil borings, and two shallow downgradient monitoring wells (one installed in 1993 and one installed in 1995).

Soil samples contained low levels of organic compounds and low to moderate levels of Total Recoverable Petroleum Hydrocarbons (TRPH). Concentrations of arsenic and beryllium slightly exceeded human health criteria in all site soil samples. However, these metals may be naturally occurring. Ecological criteria for soils were not exceeded.

Concentrations of nine organic compounds (primarily chlorinated solvents) in downgradient groundwater exceeded human health criteria. The concentrations of tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, and vinyl chloride also exceeded maximum contaminant levels (MCLs) for water quality. The MCL is the most stringent human health criterion for 1,2-dichloroethene. The concentration of trichloroethene increased between sampling events at the initial (1993) monitoring well installed at the site. The concentration of arsenic exceeded (both sampling events) its human health criterion and MCL in groundwater collected from the initial monitoring well installed at the Site.

Soil leaching appears to be limited at the site due to the high clay content of shallow subsurface soils and the presence of asphalt and concrete paving. The lateral and vertical migration of contaminants in groundwater are limited by the hydraulic properties of the shallow aquifer and the presence of an underlying clay layer. The presence of natural

degradation daughter products indicates that intrinsic remediation of the chlorinated solvents is occurring.

Based on risk, the potential concern for Site 2 is low.

A Remedial Investigation/Feasibility Study is recommended for Site 2.

Site 3 - A total of 10 crushed 55-gallon drums were unearthed from two drum burial locations at Site 3. The PA reported that the drums may have contained "off-spec" JP-4 jet fuel and waste solvents and that the contents of the drums may have been poured out prior to crushing. The site is covered by fill material and construction debris.

Confirmation activities at the site consisted of six shallow excavation soil samples, five shallow soil borings, one shallow upgradient monitoring well, and one shallow downgradient monitoring well.

Soil samples from the shallow excavations and soil borings contained relatively low levels of organic compounds and TRPH. The concentrations of organic compounds detected in soil did not exceed human health or ecological criteria.

Upgradient and downgradient groundwater contained low levels of chlorobenzenes, dichlorobenzenes, and dissolved petroleum constituent compounds. These compounds do not appear to be site-related; upgradient concentrations were higher than downgradient concentrations in groundwater from an initial sampling event and upgradient concentrations decreased and no organic compounds were detected in downgradient groundwater from a second sampling event. The concentration of 1,4-dichlorobenzene in upgradient groundwater slightly exceeded its human health criterion for both sampling events.

The groundwater flow rate at this particular site is relatively high based on the hydraulic properties of the shallow aquifer. However, natural attenuation of the low concentration compounds detected in groundwater should occur through the processes of advection, dispersion, dilution, and degradation before potential receptors are impacted. Vertical migration is impeded by the presence of an underlying clay layer.

Based on risk, the potential concern for Site 3 is low.

A no-further-action decision document is recommended for Site 3.

Site 4 - The Base operated Fire Training Area 1 from 1947 to 1972 and conducted exercises once per year. The normal practice was to ignite 300 to 500 gallons of fuel, extinguish it, and reburn to achieve a maximum 70-percent consumption. Occasionally, as much as 1,200 to 1,500 gallons of fuel and other types of flammable liquids reportedly were used, including varsol, kerosene, and solvents. The area was being used for Motor Pool parking during the SI field effort. The site is paved with asphalt.

Screening and confirmational activities at the site consisted of a soil gas survey, nine shallow soil borings, and one shallow downgradient monitoring well.

Soil samples contained relatively low levels of organic compounds and low to moderate levels of TRPH. The organic compounds commonly detected in soils at fire training areas were not detected in site 4 soils, which is inconsistent with the reported site history. Concentrations of arsenic and beryllium slightly exceeded human health criteria in all site soil samples. However, these metals may be naturally occurring. Ecological criteria in soils were not exceeded.

Downgradient groundwater contained very low concentrations of petroleum-related VOCs that did not exceed human health criteria. Arsenic was detected at concentrations in excess of its human health criterion and the MCL for two sampling events at the site.

Soil leaching appears to be limited at the site due to the high clay and native organic silt content of shallow subsurface soils and the presence of asphalt paving. The lateral and vertical migration of contaminants in groundwater are limited by the hydraulic properties of the shallow aquifer and the presence of an underlying clay layer.

Based on risk, the potential concern for Site 4 is low.

A no-further-action decision document is recommended for Site 4.

Site 5 - The Base operated Fire Training Area 2 from 1973 to 1975 and conducted exercises only two or three times using 150 gallons of JP-4 jet fuel for each burn. The site is covered by fill material and construction debris and has limited vegetation.

Screening and confirmational activities at the site consisted of a soil gas survey, seven shallow soil borings, and one shallow downgradient monitoring well.

Soil samples contained low levels of organic compounds consistent with fire training practices. The concentration of benzo(a)pyrene in a near-surface soil sample from one of the soil borings slightly exceeded its human health criterion. Ecological criteria for soils were not exceeded.

Initially, downgradient groundwater contained only 1,1-dichloroethane at a very minor concentration that did not exceed its human health criterion. No organic compounds were detected in groundwater from a second sampling event.

The potential for soil leaching may exist since the site is unpaved. However, the particular organic compounds detected at this site appear to be immobilized by the native organic rich soils due to adsorption.

Based on risk, the potential concern for Site 5 is low.

A no-further-action decision document is recommended for Site 5.

Site 6 - The Ramp Washdown area is located in a grassy area along the west edge of the aircraft parking apron (ramp). Numerous fuel and oil spills occurred on the ramp during the 1950s and 1960s. Aircraft reportedly leaked large quantities of oil that was washed off the ramp into the adjacent grassy area.

Confirmation activities consisted of 10 shallow soil borings and five shallow upgradient/downgradient monitoring wells (three installed in 1993; two in 1995).

Soil samples contained very low levels of organic compounds and TRPH. None of the concentrations of the organic compounds detected in soil exceeded human health criteria or ecological criteria. Very minor concentrations of xylenes and 1,4-dichlorobenzene that did not exceed human health criteria or MCLs were detected from a second sampling of one of the three initial (1993) monitoring wells installed at the site. The general lack of soil and groundwater contamination at the site implies that the reported fuel spills did not adversely impact these media or that the fuel hydrocarbons have degraded.

Based on risk, a potential concern is not indicated for Site 6.

A no-further-action decision document is recommended for Site 6.

Site 7 - The Oil Sludge Pond was in operation from the mid-1950s until 1972. It was used to dispose of waste petroleum products and possibly other wastes (e.g., solvents, paints, etc.). The area was being used for Motor Pool parking during the SI field effort. The site is covered by asphalt.

Screening and confirmational activities at the site consisted of a soil gas survey, 10 shallow soil borings, one shallow upgradient monitoring well, and one shallow downgradient monitoring well.

Most of the soil samples contained relatively low levels of organic compounds, with the exception of TRPH. Elevated concentrations of TRPH were detected in soil samples collected from two soil borings located at the center of the site. Comparative risk criteria were not available for TRPH. Concentrations of arsenic and beryllium slightly exceeded human health criteria in all site soil samples. However, these metals may be naturally occurring. Ecological criteria for soils were not exceeded.

Downgradient concentrations of chloroform and bis(2-ethylhexyl)phthalate exceeded human health criteria in groundwater from an initial sampling event; however, both of these compounds may be sampling artifacts. The most stringent human health criterion for bis(2-ethylhexyl)phthalate was the MCL. No organic compounds were detected in groundwater from a second sampling event at the site. Both the upgradient and downgradient concentrations of arsenic (both sampling events) exceeded the human health criterion and the MCL and upgradient concentrations were higher.

Soil leaching appears to be limited at the site due to the high clay and native organic silt content of shallow subsurface soils and the presence of asphalt paving. Elevated TRPH in soil appear to be degrading slowly. However, the TRPH appear to be immobilized by the native organic rich soils due to adsorption. The lateral and vertical migration of contaminants in groundwater are limited by the hydraulic properties of the shallow aquifer and the presence of an underlying clay layer.

Based on risk, the potential concern for Site 7 is low.

A no-further-action decision document is recommended for Site 7.

Sites 8 and 9 - The results for these sites are addressed in other, independent reports, and are only briefly mentioned in this document (ES, 1993; ES, 1994).

Site 10 - The POL facility (Site 10) was investigated in May 1994, after the initial investigations at the other nine sites and the City Drain Canal. A release of 3,500 gallons of mixed fuel and water was reported in the PA. However, the SI was terminated after the emplacement of three piezometers and four soil borings because of a fume exposure that caused adverse health effects to the site geologists and drilling crew during drilling.

The results of the preliminary soil borings indicated low to elevated levels of petroleum-related contamination in soil. Groundwater was not sampled and analyzed. The compound(s) that caused the adverse health effects in field personnel were not identified because the soil analytical results were inconclusive.

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SECTION 1
INTRODUCTION

The Department of Defense (DOD) has developed a program to identify and evaluate sites on DOD property where contamination may be present due to past spills or hazardous waste disposal practices. This program is the Installation Restoration Program (IRP) and its purpose is to identify the presence of hazardous contaminants and to control hazards to health, welfare, or the environment that may result from their presence.

The Air National Guard Readiness Center (ANGRC) headquartered in Washington, DC, manages the IRP for the Air National Guard (ANG) facilities throughout the country. The Martin Marietta Energy Systems, Inc. Hazardous Waste Remedial Actions Program (HAZWRAP) is assisting the ANGRC in identifying, investigating, and remediating environmental contamination through the IRP. Parsons Engineering Science, Inc. (Parsons ES) was assigned the task of investigating seven hazardous waste disposal/spill sites at the 151st Air Refueling Group (AREFG), Utah Air National Guard (UANG) Base, located at Salt Lake City International Airport (SLCIA), near Salt Lake City, Utah, hereinafter referred to as the Base. Parsons ES conducted a Site Investigation (SI) of the identified hazardous sites at the Base during the months of October, November, and December, 1992, and during the months of January, February, and March, 1993, to confirm or deny the presence of contaminants in soil and groundwater. Additional SI activities were also conducted at one to all of the seven hazardous sites on subsequent dates in 1994 and 1995. Three other sites potentially contaminated from petroleum releases were also investigated under the IRP program concurrently, or after, the primary 1992-93 SI field effort. The petroleum release sites are addressed in independent documents, were not included in this SI project scope, and are only briefly mentioned here.

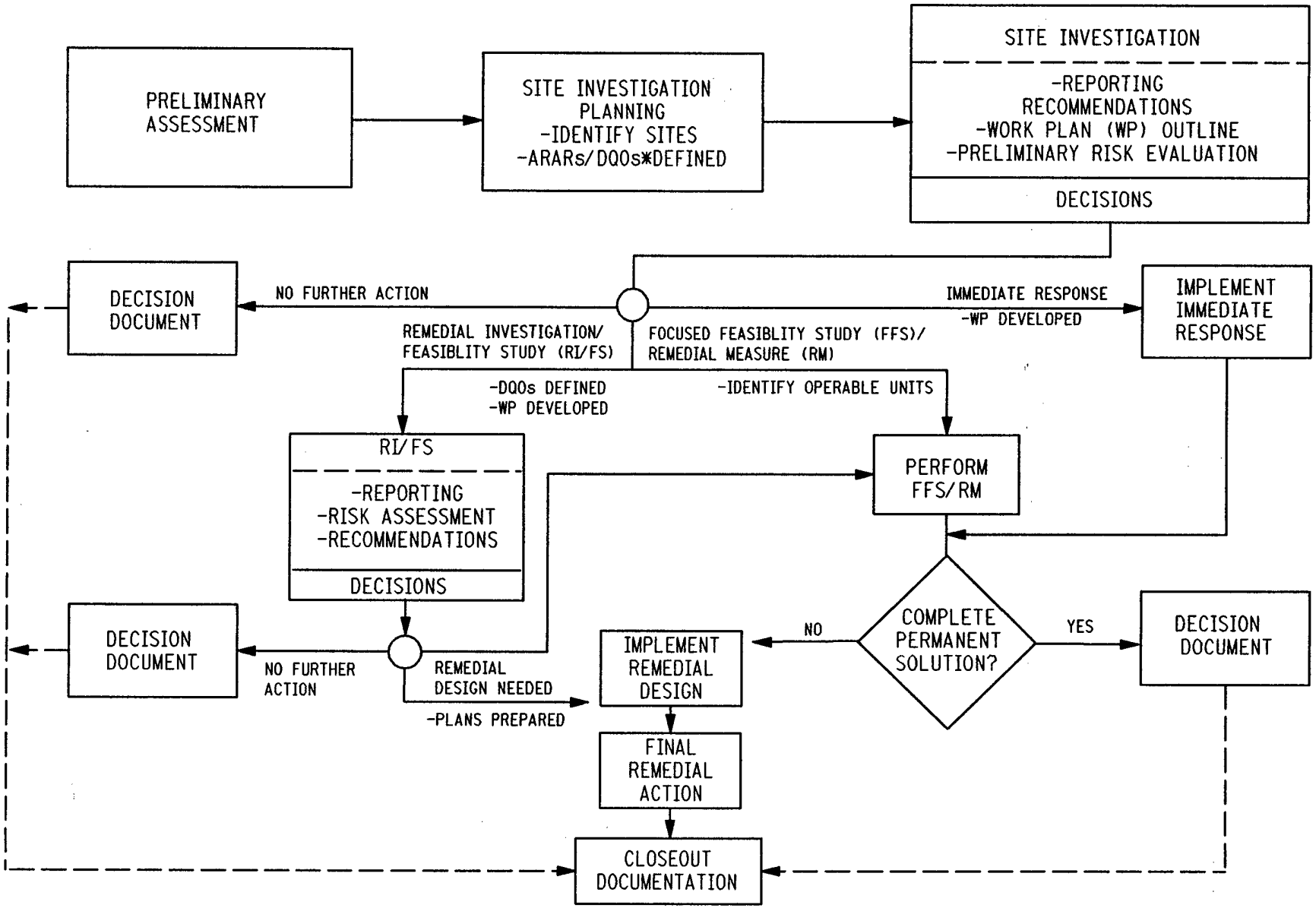
1.1 INSTALLATION RESTORATION PROGRAM

The IRP is an environmental program developed by DOD. The objectives of the IRP are to evaluate DOD installations and:

- Identify former waste, spill, storage, and disposal sites;
- Evaluate the nature and extent of contamination if present; and
- Initiate appropriate remedial action.

Figure 1.1 presents the IRP decision flow chart which illustrates the components of the IRP and the various decision points in the program.

IRP DECISION FLOW DIAGRAM



*ARARs-APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
DQOs-DATA QUALITY OBJECTIVES

FIGURE

FINAL

PARSONS ENGINEERING SCIENCE

1.1.1 Preliminary Assessment (PA)

A preliminary assessment (PA) is the initial step in the IRP process; it is the method used to identify areas which may be contaminated. The PA is conducted at DOD installations where hazardous wastes have been reportedly disposed/stored. The steps used in conducting a PA are as follow:

1. Conduct record search of past disposal practices.
2. Conduct interviews with employees.
3. Conduct a site inspection.
4. Determine further action:
   - No Further Action -- Decision Documents (DDs); or
   - Further Action -- Site Investigation (SI).

1.1.2 Site Investigation

The objectives of the SI are to:

- Confirm the presence/absence of contamination which may threaten human health or the environment;
- Identify the nature of contaminants;
- Provide some contamination quantification and preliminarily assess risk; and
- Provide a hydrogeological study of the Base.

Expanded objectives of this particular SI are to:

- Define the lateral extent of soil contamination in the source areas;
- Perform aquifer tests and quantify groundwater flow rates and velocities; and
- Evaluate the potential for contaminant migration.

The SI consists of field screening and confirmation activities and the preparation of a SI report. Initial field screening activities may include soil gas surveys in potential source areas and piezometer installation to determine local groundwater flow direction. Confirmation activities may include drilling soil borings and collecting soil samples in source areas, installing downgradient monitoring wells and collecting groundwater samples, and collecting surface water and sediment samples for chemical analysis. Following the laboratory analysis of field samples, the data are evaluated, and an SI report is prepared.

Successful completion of the SI will aid in the following:

- Completion of a hydrogeologic study;
- Further definition of the nature of contamination;
- Evaluation of the need for additional site characterization or an RI/FS;

- Implementation of Remedial Measures (RMs) if necessary;
- Elimination of non-hazardous sites from further investigation;
- Completion of DDs; and
- Establishment of priority for future IRP work.

Following the SI segment, each site will be recommended for:

- No further action (DD);
- A Focused Feasibility Study (FFS) and RMs;
- A Remedial Investigation and Feasibility Study (RI/FS); or
- Immediate remedial response.

1.1.3 Preliminary Risk Evaluation

A preliminary risk evaluation is conducted in conjunction with the SI. The purpose of the preliminary risk evaluation is to assess the need for immediate or subsequent remedial actions at a site to aid in project scoping necessary for the RI, or to support the preparation of a DD.

The preliminary risk evaluation identifies all known contaminant sources, routes of contaminant migration, and potential receptors. Risks are evaluated by reviewing state and federal limits, advisories, and recommended limits on contaminant concentrations in the affected media.

The results of the preliminary risk evaluation are used to determine further actions. If the preliminary risk evaluation identifies an imminent threat to human health or the environment, an FFS or RM may be necessary. Long-term or potential threats may require initiation of an RI/FS. No further action may be indicated if the preliminary risk evaluation concludes that no current or potential threat to human health or the environment is posed by contaminants. These decisions may be applied to the Base as a whole, or to individual operable units (OUs) or sites.

1.1.4 Remedial Investigation

If the SI confirms the presence of contamination at the Base, an RI will be conducted. The purpose of the RI is to further define the magnitude and extent of contamination and to evaluate the potential for contaminant migration. The RI may include the installation of additional monitoring wells, collection of additional soil, groundwater, surface water, and sediment samples, performance of aquifer tests or additional aquifer tests, and/or biota sampling. The data collected during the RI are used to perform a baseline public health evaluation (PHE). The PHE quantifies the risks to public health and the environment due to existing site conditions.

1.1.5 Feasibility Study (FS)

Following completion of the RI, an FS would be conducted to develop and evaluate alternatives for remediation of contamination at the Base. A range of alternatives would be developed for various media and source areas. The alternatives may include no action, off site or on site disposal, and treatment.

The remedial alternatives would be evaluated in terms of effectiveness, implementability, and cost. Each alternative would be compared to the remedial objectives for the site, and the alternatives would be compared to one another. The final objective of the FS is to provide information which is sufficient to support the selection of a remedial alternative.

1.1.6 Remedial Design/Remedial Action

Remedial Design/Remedial Action (RD/RA) follows the selection of a remedial alternative. The RD would be developed on the basis of the FS. The RD is a detailed design of the selected remedial action and includes all specifications and design drawings. The RD is used to implement the RA.

The RA is the implementation of the remedial alternative(s) selected for the Base. This action may include several technologies and may affect one or several media and source areas.

1.1.7 Focused Feasibility Study and Remedial Measures

An FFS is a feasibility study of one or more OUs. An OU may be a particular media, such as soil or groundwater, or may be one source, such as a waste lagoon or spill area. The purpose of the FFS is to develop a range of measures which may be employed to remediate contamination at the OU. These measures, termed remedial alternatives, are evaluated on technical, cost, and environmental considerations. The FFS is used to select the most appropriate remedial alternative for an OU, to prepare cost estimates, and to initiate the remedial design.

RMs may be taken to alleviate immediate threats to human health or the environment. RMs may be implemented for an OU; for example, a waste pile may be covered or fenced to prevent human or wildlife contact with hazardous substances.

FFSs and RMs may be initiated at any point in the IRP process if the need for an FFS or RMs becomes obvious. FFSs for several OUs may be combined to produce a FS for the entire Base.

1.1.8 Regulatory Involvement

Throughout all segments of the IRP, the ANGRC attempts to work closely with the U.S. Environmental Protection Agency (EPA) and the state regulatory agencies. The IRP encourages the early and continuous participation of federal and state regulatory agencies through meetings and review of work plans and reports. Installations considered for the IRP are prioritized under the Comprehensive Environmental Response, Compensation,

and Liability Act (CERCLA) also known as Superfund, with respect to health risks, hazard level, and Defense Environmental Restoration Account (DERA) funding availability.

1.2 BASE HISTORY

The UANG was founded on November 18, 1946. The UANG was originally a fighter-bomber unit, the 191st Fighter Squadron: its assigned mission has changed three times since its inception. The type of aircraft flown by the unit has changed seven times since its inception. The UANG has a two-fold mission, serving both the state and federal governments. Today the UANG consists of 16 units and is an integral part of the total U.S. Air Force (USAF) mission. Its units represent the Air Force Intelligence Command, the Air Force Combat Command, the Air Force Material Command, and the Air Force Mobility Command.

In August 1957, the 151st Consolidated Aircraft Maintenance Squadron and the 151st USAF Dispensary were formed. These units were responsible for care and maintenance of all aircraft, and for medical care of guardsmen, respectively.

In April 1961, the UANG was reorganized from a jet fighter to an air transport squadron, with C-97 stratofreighter aircraft.

In 1969, the 299th Communications flight unit was organized. The unit is currently active and provides full-period USAF support in radar control and surveillance services to aircraft operating within the Hill/Wendover/Dugway Range training complex.

In April 1978, the 151st AREFG became part of the Strategic Air Command (SAC) and began flying the KC-135 stratotanker. During the early 1980's, the 151st AREFG converted to KC-135E aircraft. These large aircraft are used to fuel other aircraft in flight. The air refueling planes participate in flight assignments in Europe as well as for the Pacific Tanker Task Force.

In 1986, the 151st Civil Engineering Flight was re-designated as the 151st Civil Engineering Squadron (CES). The CES is responsible for design, development, maintenance, and management of the physical plant and base facilities.

1.3 PROJECT SCOPE

The SI was performed at seven sites to confirm the presence or absence of contamination, determine the nature and extent (if possible) of any contaminants present, and evaluate the potential for contaminant migration. The SI was conducted during October, November, and December 1992, and January, February, and March 1993. A Work Plan (WP) (ES, 1992a) and Sampling and Analysis Plan (SAP) (ES, 1992b) describe the activities to be undertaken at the Base to meet the objectives of the SI. These objectives are previously discussed in Subsection 1.1.2.

1.4 SUMMARY OF PREVIOUS IRP INVESTIGATIONS

The only previous investigation performed at the Base under the IRP was a PA (HAZWRAP et al. 1989). The PA consisted of interviewing past and present base employees concerning the use, generation, and disposal of materials that were subsequently categorized as hazardous. A field survey was also conducted. The PA identified seven sites with a potential for contaminated soils and/or groundwater. The PA recommended that SIs be performed at Site 1 (Former Pesticide Dump), Site 2 (Waste petroleum, oil, and lubricant [POL] spill near Building 1527), Site 3 (Drum Burial), Site 4 (Fire Training Area 1), Site 5 (Fire Training Area 2), Site 6 (Ramp Washdown), and Site 7 (Oil Sludge Pond). In addition to these seven sites identified in the PA, three petroleum release sites (Sites 8, 9, and 10) were investigated. Locations of the sites are shown on Figure 1.2.

1.5 IRP SITE IDENTIFICATION AND DESCRIPTIONS

1.5.1 Site 1 - Former Pesticide Dump

The Former Pesticide Dump reportedly is located in an area south of 2nd Street between E and F Streets at the south portion of the Base. No information exists on the contents, amounts, or dates of operation. During the PA, the site reportedly was located. During the SI site visit, the exact location of the dump was not determined. At that time, no stressed vegetation was observed; however, the area had recently been graded.

1.5.2 Site 2 - Waste POL Fuel Spill near Building 1527

This site is adjacent to the southeast corner of Building 1527. A 200-gallon bowser was used by the 106th/109th Tactical Control Flight Aerospace Ground Equipment Shop to store waste oils, solvents, and fuel. In 1987, the bowser leaked due to a valve failure. The exact amount of waste released is unknown. The materials were cleaned up and placed in drums for disposal. Stained soil was observed during the PA performed in 1988, although no staining was observed during a 1990 "kick-off" site visit preliminary to the SI. Most of the site is now covered with asphalt and concrete.

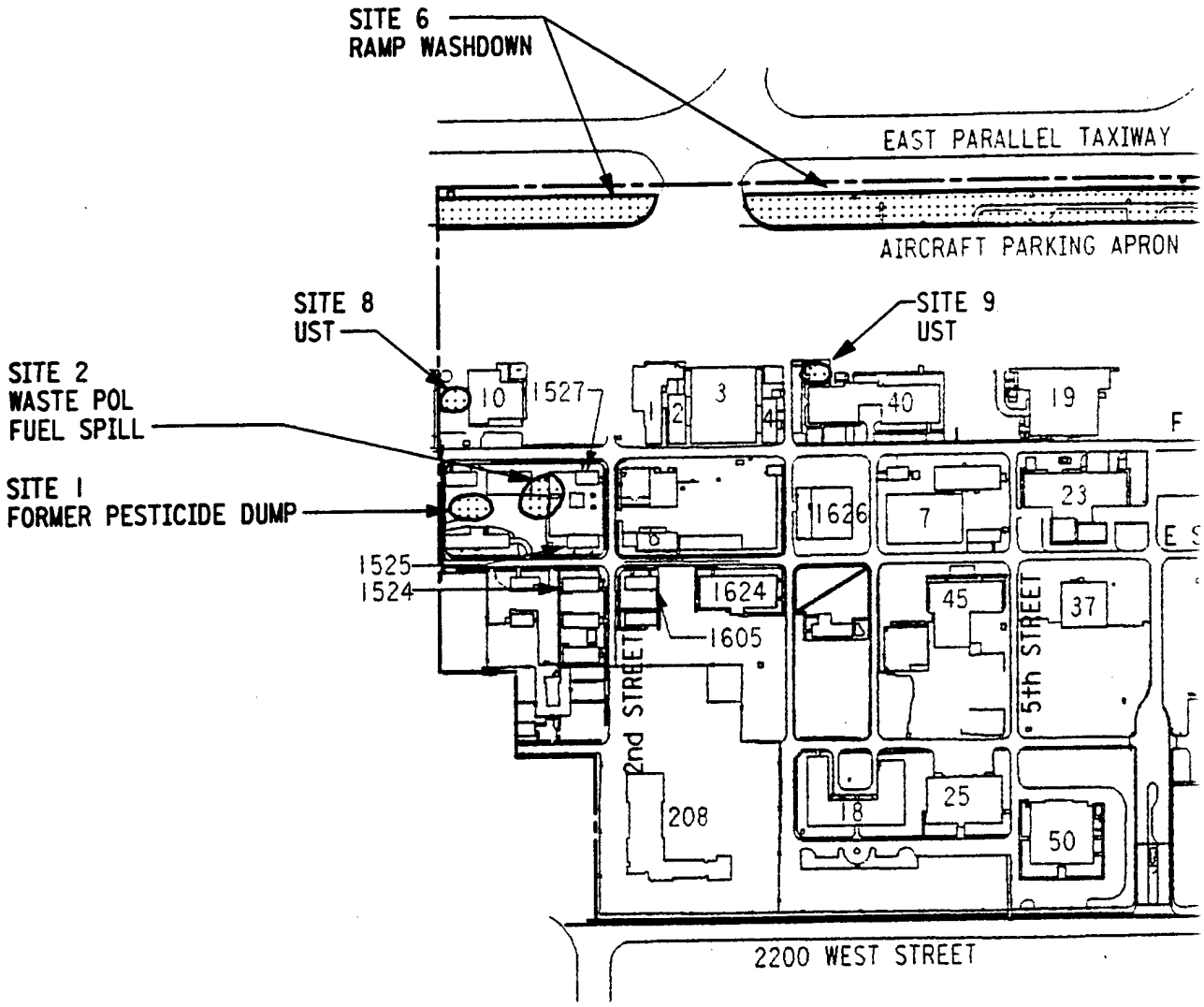
1.5.3 Site 3 - Drum Burial Locations

The area south of and adjacent to the existing Salt Lake City International Airport (SLCIA) fire training area (FTA) was reportedly used as a drum burial site. This site is located approximately 1,000 feet north of the corner of C Street and 9th Street, immediately south of the FTA. The PA reported that approximately six drums containing "off spec" JP-4 jet fuel and waste solvents were crushed by a bulldozer until flattened. It had not been determined whether the liquid contents of the drums were discharged into the FTA before the drums were crushed, or if the drums were full when crushed. Common practices and safety considerations by the equipment operator would be to pour the liquid contents out of the drum and allow the remaining drum contents to evaporate prior to crushing. Approximately 6 inches of fill material was

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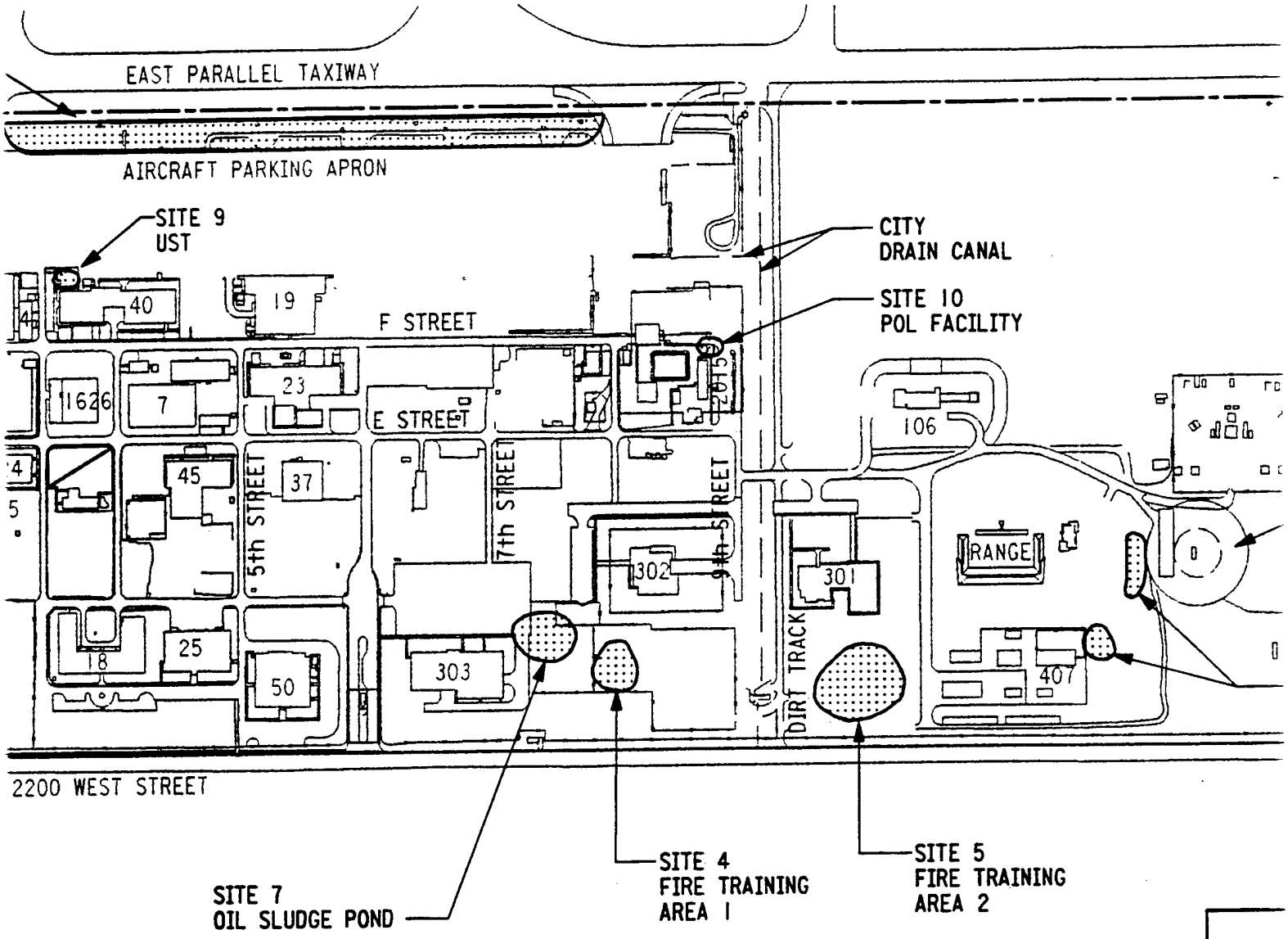
IF
LOC

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SALT LAKE CIT
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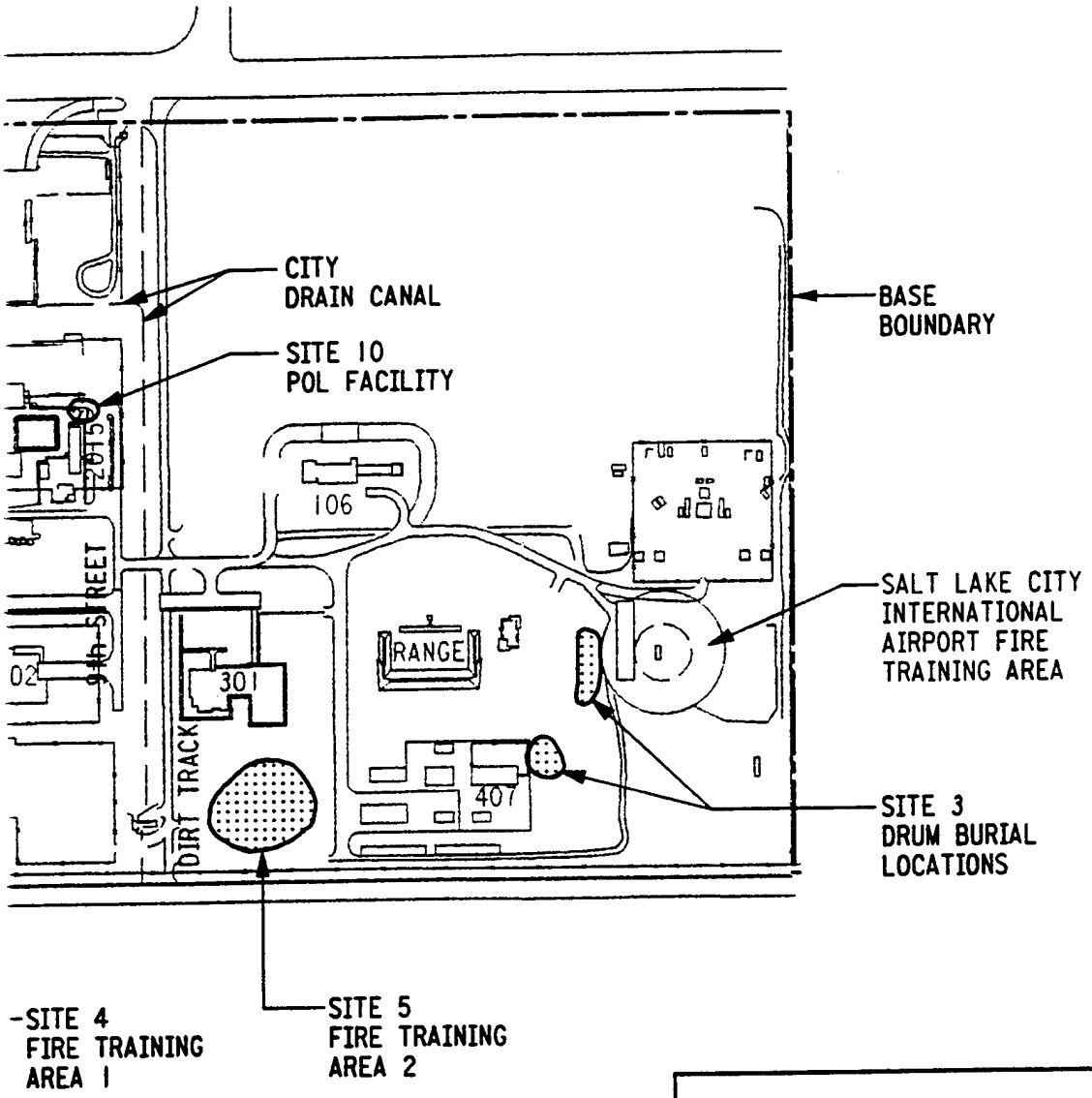
IRP SITE LOCATION MAP

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:
Drawing has been updated to show new construction as of August 1995 when field work concluded. The primary site investigation occurred in 1992-93.

IARD
ORT



LEGEND

FENCE

IRP SITE LOCATION

37 BUILDING AND BUILDING NUMBER

odated to show new construction
when field work concluded. The
tigation occurred in 1992-93.

FIGURE 1.2

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reportedly placed over the drums. During a 1990 "kick-off" site visit preliminary to the SI, no signs of contamination were apparent due to construction debris that covered the area.

1.5.4 Site 4 - Fire Training Area 1

The Base operated Fire Training Area 1 from 1947 to 1972 at a location approximately 350 feet northeast of the intersection of C Street and 7th Street. The Base was the sole user of this FTA and conducted exercises here once per year. During a 1990 "kick-off" site visit preliminary to the SI, the FTA could not be visually located because the area had recently been paved with asphalt. This area was being used for motor pool parking during the field effort in 1992 and 1993.

The normal fire training practice was to ignite 300 to 500 gallons of fuel, extinguish it, and reburn it to achieve a maximum 70-percent consumption. Occasionally, as much as 1,200 to 1,500 gallons of fuel and other types of flammable liquids were used, including varsol, kerosene, and solvents.

1.5.5 Site 5 - Fire Training Area 2

The Base operated Fire Training Area 2 from 1973 to 1975. This FTA was located approximately 400 feet northeast of the intersection of C Street and 9th Street. The Base was the sole user and conducted exercises only two or three times, using 150 gallons of JP-4 jet fuel for each burn. During the PA, the FTA was located using aerial photographs. During a 1990 SI "kick-off" site visit preliminary to the SI, the exact location was not identified because the area recently had been graded.

1.5.6 Site 6 - Ramp Washdown

This site is located in the grassy area along the west edge of the aircraft parking apron (ramp). Numerous fuel and oil spills have occurred on the ramp, especially during the 1950s and 1960s when the Base supported C-/KC-97, F-86, and C-124 aircraft. These aircraft leaked large quantities of oil, which was washed off the ramp into the adjacent grassy area. No vegetative stress was observed during a 1990 "kick-off" site visit preliminary to the SI.

1.5.7 Site 7 - Oil Sludge Pond

The Oil Sludge Pond was located approximately 150 feet northeast of the intersection of C Street and 7th Street. The location of the pond was determined from aerial photographs and Motor Pool blueprints. The pond was in operation from the mid-1950s until 1972. It was used to dispose of waste oil and possibly other wastes (e.g., solvents and paints). The site is located beneath the Motor Pool parking area and was reportedly closed prior to Motor Pool construction, according to construction specifications. Details of the closure are unknown. The site is currently covered by asphalt.

1.5.8 Site 8 - Building 10 USTs

In addition to the sites identified in the PA (Sites 1 through 7), potential fuel releases from two 2000-gallon underground storage tanks (USTs) located in an unpaved area south of the southeast corner of Building 10 were investigated February through March 1993 by Parsons ES [formerly Engineering-Science, Inc. (ES)]. Building 10 is the Base fire station and is located near the southern boundary of the Base west of F Street. The SI at Site 8 is referenced in ES (April, 1993). One tank was reported to have contained diesel fuel and the other tank JP-4. Based on the results of the SI, additional site investigation activities were conducted at Site 8 to further identify the extent of petroleum soil contamination (ES, July, 1994). The additional SI identified solvent related contamination at the site not previously detected. An additional phase of this investigation was then conducted to determine the extent of contamination in groundwater (same reference). As a result, Site 8 is being further investigated under an RI/FS phase. The on-going investigation at the site is not being conducted by Parsons ES. Specific data for Site 8 is not discussed further in this document, however, the location of the site is shown on Figure 1.2.

1.5.9 Site 9 - Building 40 UST

In addition to the sites identified in the PA (Sites 1 through 7), a potential fuel release from a 2000-gallon UST located in a grassy area at the southwest side of Building 40 was investigated February through March 1993 by Parsons ES. The tank was reported to have contained fuel oil. Additional site investigation was not required at Site 9. Specific data for Site 9 is not discussed further in this document, however, the location of the site is shown on Figure 1.2.

1.5.10 Site 10 - POL Facility

A release of a 3,500 gallon mixture of fuel and water was reported to have occurred at the Petroleum, Oils, and Lubricant (POL) facility, but the POL facility was not identified in the PA as a site for intrusive investigation. However, during the basewide screening phase of the primary SI (Sites 1 through 7), the borehole soils of a piezometer located in the POL were sampled and analyzed for organic compounds and metals resulting in the detection of soil contamination. The POL was later investigated in May 1994 under the IRP program and became Site 10. However, the SI at Site 10 was terminated after the emplacement of three piezometers and the advancement of four soil borings because of an adverse fume exposure to the site geologists and drilling crew while drilling the first soil boring. The analytical results of the preliminary Site 10 soil borings are provided in Section 4 of this document. A preliminary risk evaluation of Site 10 is not included due to incomplete investigation of the site and insufficient data. The location of the initial fuel release at the POL facility is shown on Figure 1.2 as Site 10. As of this writing, a continued investigation of Site 10 under an RI phase is being conducted by a different contractor.

SECTION 2
PHYSICAL AND ENVIRONMENTAL SETTING

2.1 FACILITY DESCRIPTION

2.1.1 Location

The 151st AREFG of the UANG is located in Salt Lake City, Salt Lake County, Utah. An index map of the State of Utah is shown as Figure 2.1. The Base is located on the northeast side of SLCIA. The airport property is owned by Salt Lake City. The Base property is leased from Salt Lake City Airport Authority (SLCAA), and is within the city limits. As shown in Figure 2.2, the Base and adjoining SLCIA airport property occupy and area of approximately 5 square miles. The ANG facilities alone occupy an area of approximately 130 acres. The Base and airport are situated on flat-lying sediments approximately 8 miles east-southeast of the present Great Salt Lake shoreline, and 1 mile west of the Jordan River. An inland estuary and marsh of the Great Salt Lake is present approximately 2 miles northwest of the Base. The man-made City Drain crosses the Base property and is a conveyance for storm runoff. The locations of these features are shown on the index map of Salt Lake County in Figure 2.3.

2.1.2 Land Uses

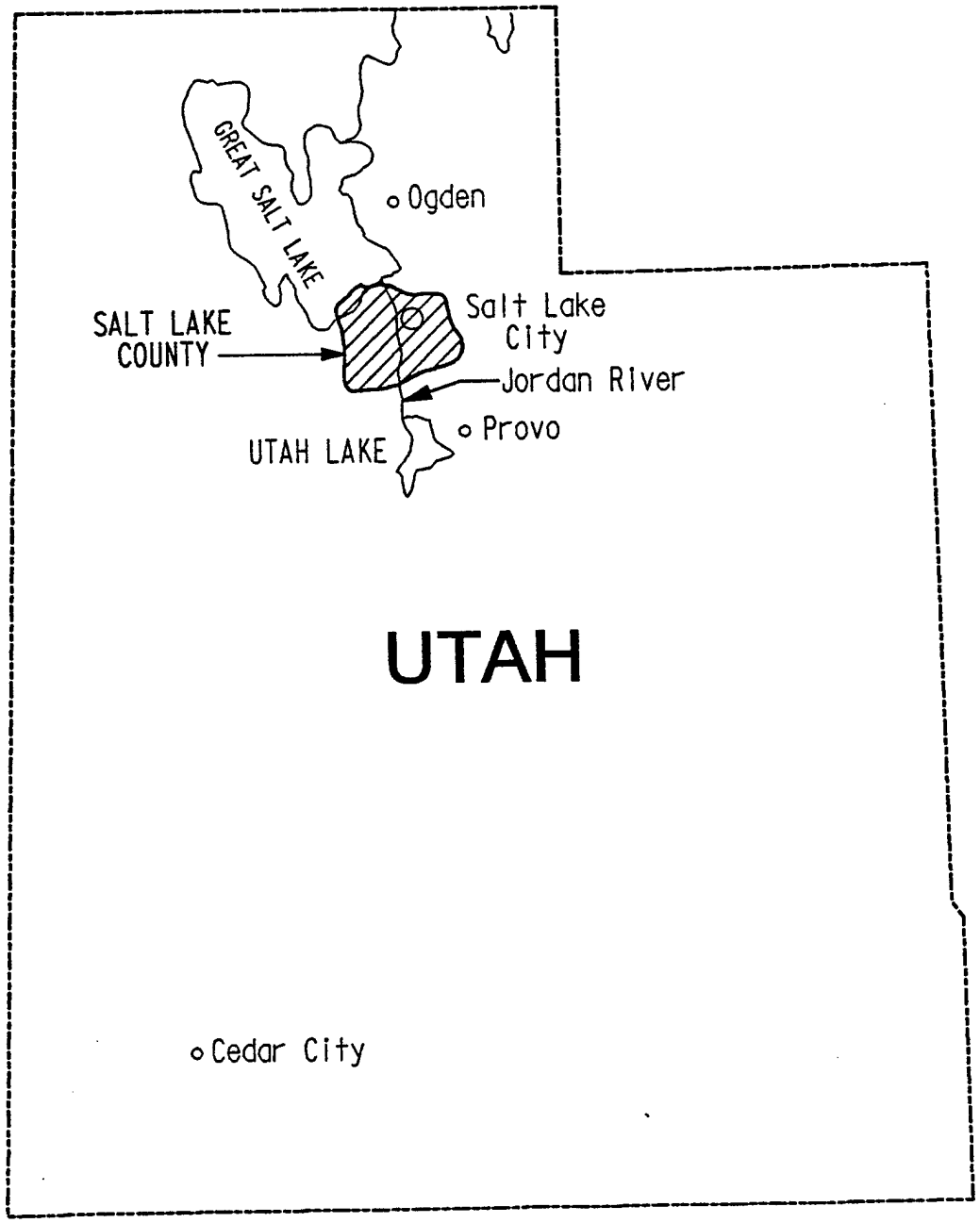
Land uses in the vicinity of the Base include limited agricultural, commercial, industrial, recreational, and residential. The area surrounding the Base consists of commercial airport operations to the west and south, manufacturing operations to the north, and residential neighborhoods to the east. Commercial airport operations are the SLCIA west of the Base, and General Aviation to the south. McDonnell Douglas manufacturing operations border the Base to the north. The residential area is moderately populated with persons who live in single-family homes and apartment complexes. The residential population within a 1,000-foot radial distance from the Base boundary is approximately 8,600 persons. This data was obtained from the 1990 census data for Salt Lake County, Utah Office of Planning and Budget, Department of Demographic/Economic Analysis. The Base population is 380 full-time personnel during the day, and approximately 1,650 part-time personnel on training weekends (ES, 1992b). These personnel do not reside at the Base.

2.1.3 Topography

The Base lies at an elevation ranging from 4,215 feet to 4,218 feet above mean sea level (MSL). As indicated by this elevation range, the Base and surrounding land are nearly flat, with only a few feet of relief. The Base lies on the gently undulating plain

FINAL

INDEX MAP OF UTAH

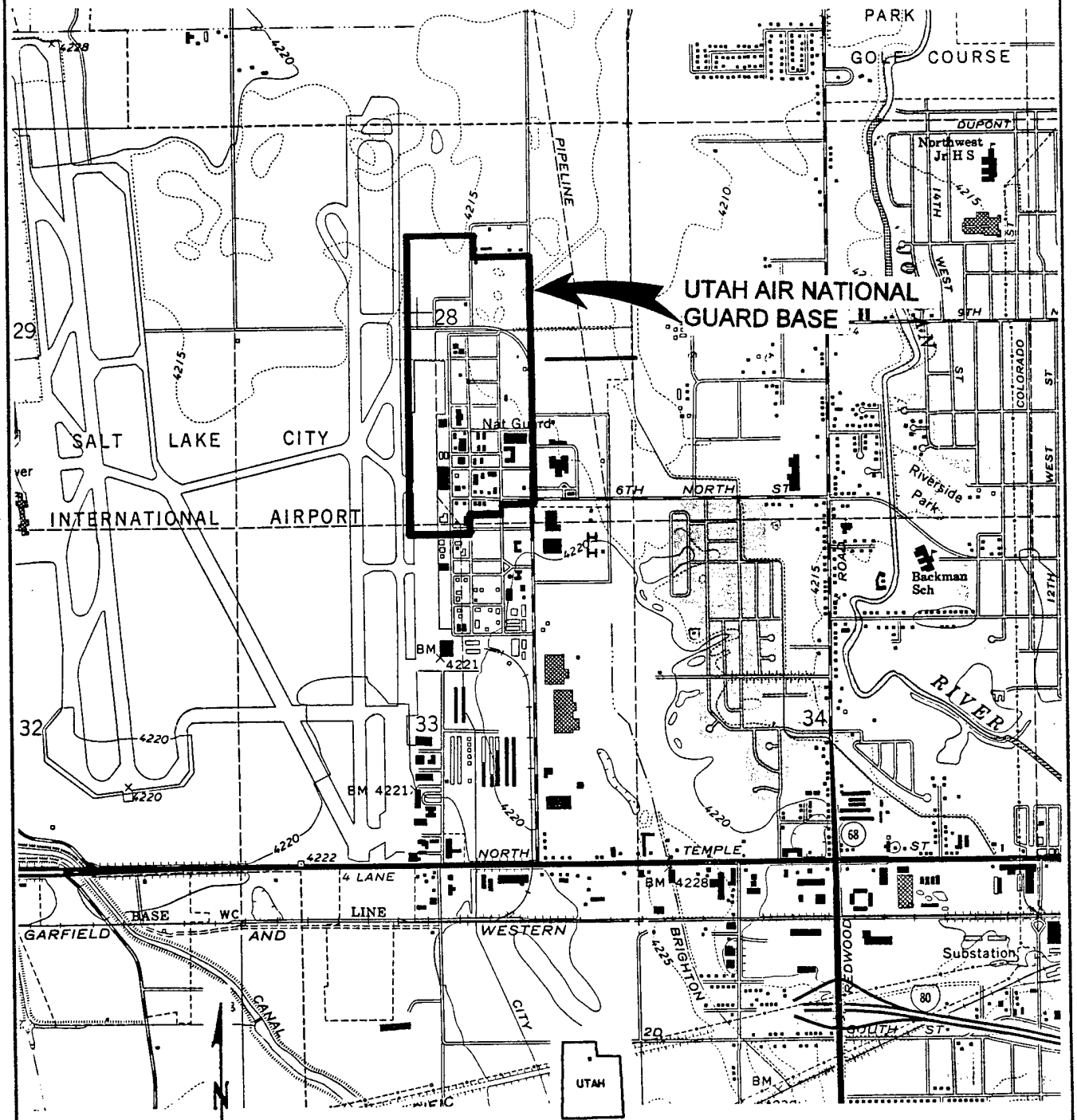


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FIGURE 2.1

LOCATION MAP

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



QUADRANGLE LOCATION

SALT LAKE CITY NORTH, UTAH
N4045-W11152.5/7.5

1963
PHOTOREVISED 1969 AND 1975
AMS 3665 IV SW-SERIES V897

Scale 1:24,000
CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 5-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

LEGEND:

Utah Air National Guard Property

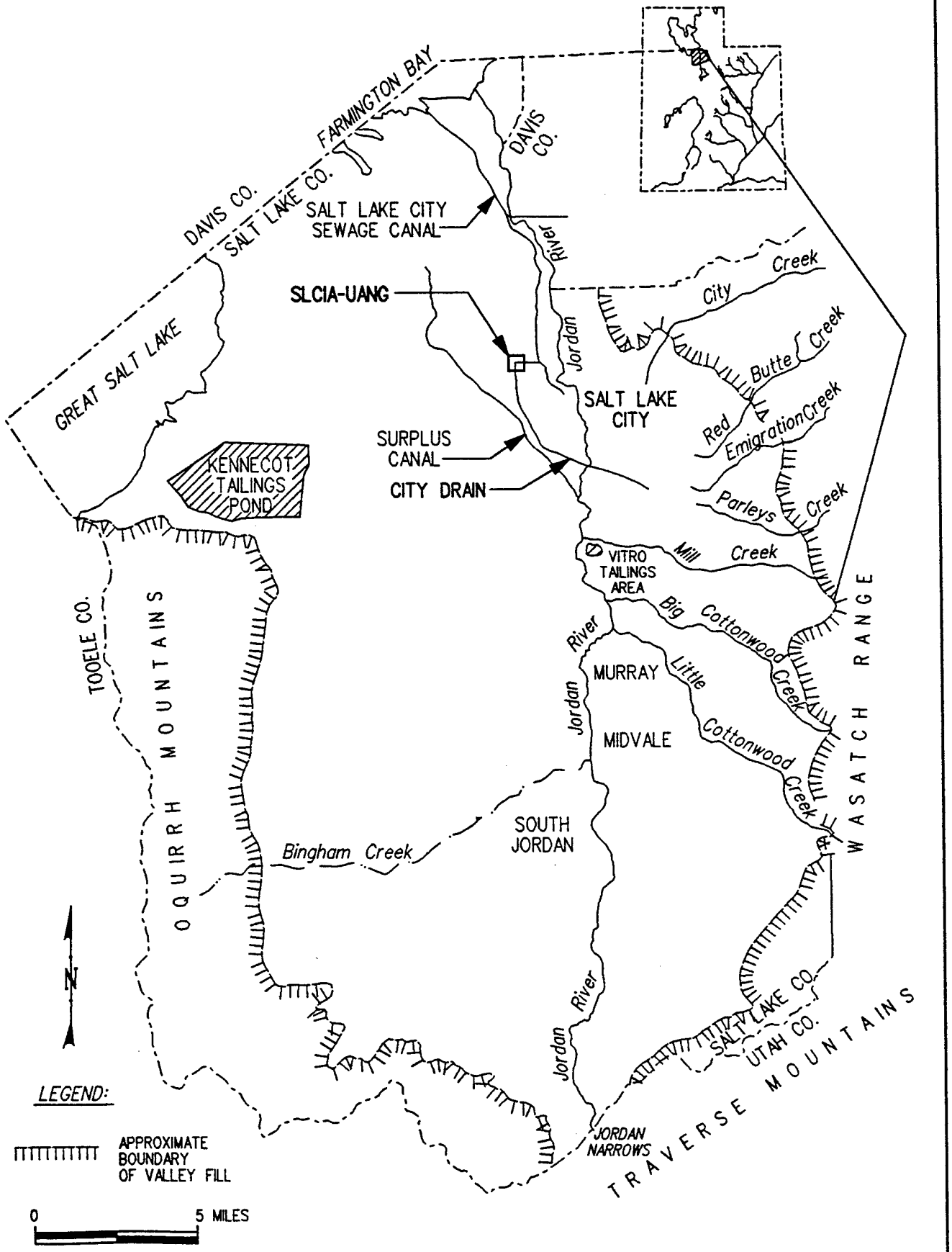
SOURCE: USGS, 1963

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FIGURE 2.2

FINAL

INDEX MAP OF FEATURES IN SALT LAKE COUNTY, UTAH



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FIGURE 2.3

southeast of the Great Salt Lake, and the low-lying topography is typical of a floodplain-lake plain. The Base is situated at the western edge of the Jordan River Bench at the margin of the 100-year floodplain. The Base and airport were threatened by rising lake levels in 1983-1984 from above-average precipitation. However, a decline in annual precipitation in 1985 and subsequent years reduced the potential flood threat.

2.1.4 Surficial Soils

According to the United States Department of Agriculture (USDA), Soil Conservation Service (1974), most of the surface soils at the Base consist of miscellaneous fill material or made-land (Figure 2.4). The surficial soil is a natural silty clay loam in the extreme northern end of the Base (USDA, 1974). Soil boring sampling in conjunction with the SI indicates that much of the surface soil in the northern portion of the Base is disturbed as a result of base practices, and could also be considered made-land or fill.

2.1.5 Stormwater Discharge - City Drain

Airport, Base, and industrial operations, including chemical plants, iron works, and water storage areas, are located along the City Drain south and upstream of the Base. The City Drain originates about 8 miles southeast of the Base in southern Salt Lake City, Utah (Figure 2.3). Many of these facilities, including the Base and airport, discharge surface runoff waters into the City Drain. The purpose of the City Drain is to convey runoff discharge and to dewater a shallow aquifer in this part of the Salt Lake Valley.

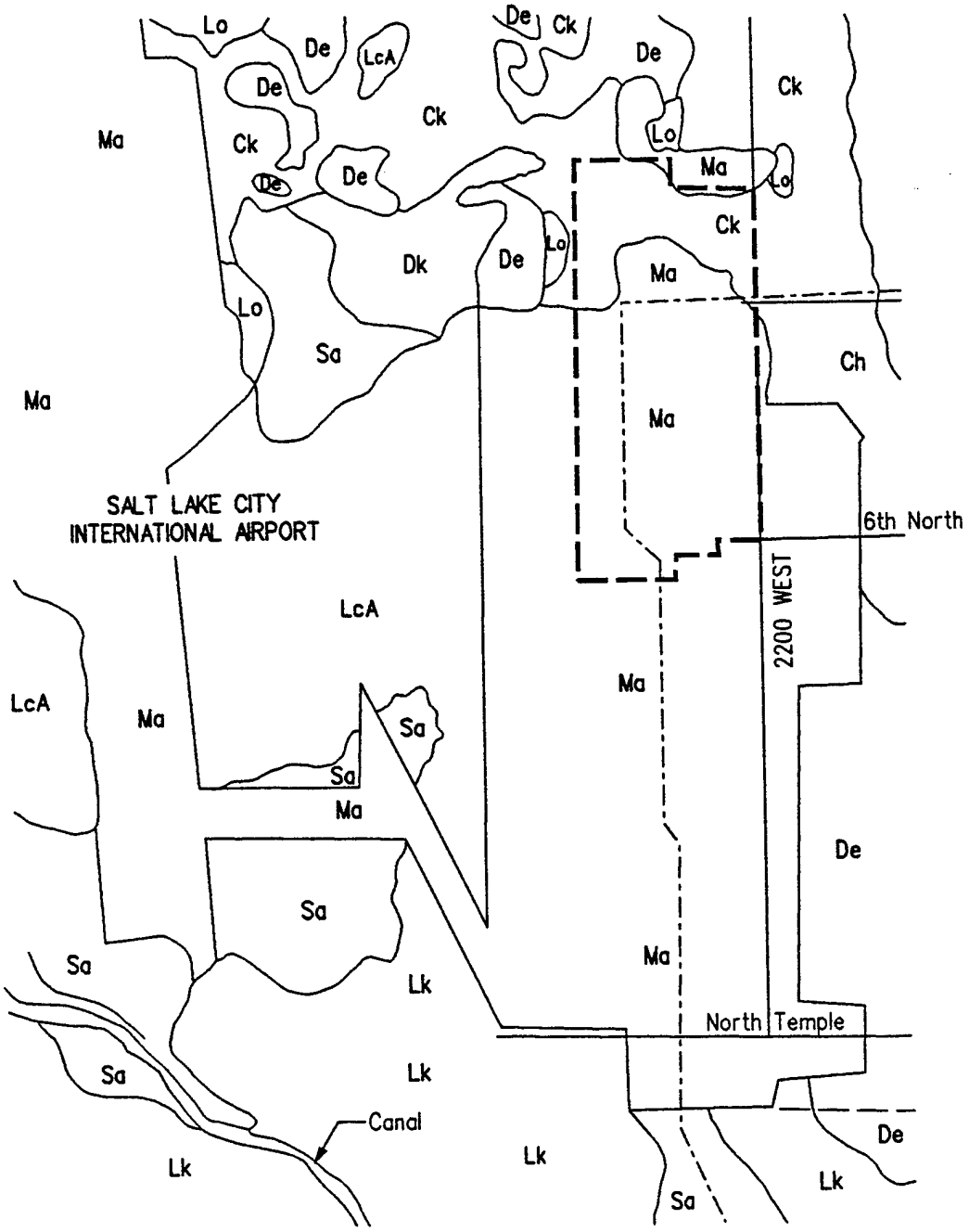
The City Drain is an open, unlined canal throughout most of its course upstream and downstream of the Base. However, the City Drain is channeled into a 60-inch culvert approximately 1.5 miles south of the Base boundary and continues north for about 0.5 mile beneath the Base proper until it resurfaces and discharges into a canal between the Petroleum, Oil, and Lube (POL) facility and Site 6. In the past, the culvert originated approximately 0.5 mile south of the Base, and the present additional one mile of pipeline was added. The locations of the canal, the POL, and Site 6 are shown in Figure 1.2. The canal, herein referred to as the City Drain Canal, makes a 90 degree bend west for 1,200 feet on base property, continues west for another 1,300 feet, then bends north for approximately 3 miles until it discharges into the Salt Lake City Sewage Canal. The sewage canal discharges into Farmington Bay, approximately 5 miles north of the junction of the sewage canal and the City Drain. Farmington Bay is a diked, freshwater (as opposed to saltwater) bay of the Great Salt Lake located approximately 8 miles north-northwest of the Base. The locations of these features are shown on the index map of Salt Lake County in Figure 2.3.

2.2 CLIMATE AND METEOROLOGY

The climate of the Salt Lake Valley area is semi-arid, characterized by moderately cold to cold winters, and hot summers. The mean annual temperature is 51.7 degrees Fahrenheit at the airport. The average July temperature is 97 degrees Fahrenheit, and the summer daytime relative humidity is below 30 percent. The average January temperature

SOILS MAP OF THE UANG AREA

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



LEGEND:

Ch - Chipman silty clay loam
Ck - Chipman silty clay loam, saline-alkali
De - Decker fine sandy loam
Dk - Decker loam, strongly saline-alkali
LcA- Lasil silt loam
Lk - Leland fine sandy loam
Lo - Loamy borrow pits
Ma - Made land
Sa - Saltair silty clay loam

SCALE 1:20,000

Base Boundary
City Drain

N

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FIGURE 2.4

is 37 degrees Fahrenheit. The percent possible sunshine is 66 percent, which is a measure of light intensity or incident solar radiation. These data were obtained from the National Weather Service (Weather Information Service, 1993).

Most precipitation at the airport occurs as rain during the months of February through May and August through November. During the winter months of December and January, precipitation is mostly in the form of snow. Precipitation is relatively light in June and July. The average yearly precipitation at the National Weather Service Field Office located at the SLCIA is 15.12 inches for the years 1931 through 1989 (Herbert et al., 1990). The average for the last 11 years on record is 16.10 inches for the years 1979-1990, with a standard deviation of 5.72 inches. Climatological data for 1987 are not included. The maximum yearly precipitation for these years was 24.26 inches in 1983, and the minimum yearly precipitation was 9.29 inches in 1988. The years 1988, 1989, and 1990 were drought years. These annual precipitation data are published by the National Oceanic and Atmospheric Administration (NOAA) in *Climatological Data* and are summarized in Table 2.1. Average yearly pan evaporation for two gaging stations at the Great Salt Lake is 78.5 inches for the period 1931-1976 (Waddell and Barton, 1980). This corresponds to surface water evaporation of approximately 55 inches using a pan coefficient of 0.7. The net evaporation is then approximately 40 inches per year using the average annual precipitation of 15.12 inches.

Record snowfall occurred in January 1993, during the SI field effort. The 30-year normal snowfall for January, beginning in 1929, is 13.7 inches. January snowfall for 1993 was 50.3 inches at the airport, exceeding the old record of 32.3 inches in 1937. Snowfall in December 1992 and February 1993 also exceeded normals for these months, but by much smaller margins (National Weather Service, Weather Information Service, 1993).

Average wind speed at the airport is 8.5 miles per hour. Prevailing winds are from the northwest to the southeast. Winds are sometimes from the southwest (National Weather Service, Weather Information Service).

2.3 SURFACE WATER HYDROLOGY

Salt Lake City obtains about 20 percent of its water supply from surface reservoirs in the Wasatch Mountain Range east of Salt Lake Valley. Another 65 percent is obtained from Wasatch Mountain Range canyon streams (see Figure 2.3). An additional 15 percent comes from springs and wells located in the southern and eastern parts of Salt Lake City (Waddell et al., 1987a). Water supply for the Base is provided by the Salt Lake City Water Department (SLCWD). Wastewater is also handled by SLCWD.

Surface water within a 1 mile radius of the Base consists of scattered minor wetlands and man-made drainage canals. On a regional scale, the primary surface features in the area of the Base are the Jordan River and Great Salt Lake. The Jordan River is located about 1 mile east of the Base, and the present Great Salt Lake shoreline is approximately 8 miles west-northwest of the Base (Figure 2.3).

TABLE 2.1
SALT LAKE CITY NATIONAL WEATHER FIELD OFFICE - AIRPORT
YEARS 1979 - 1986, 1988 -1989
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Year	Total Precipitation
1979	8.70
1980	17.19
1981	16.59
1982	22.86
1983	24.26
1984	21.55
1985	16.97
1986	19.40
1988	9.29
1989	10.87
1990	9.47
Average Precipitation	**16.10**
Standard Deviation	**5.72**

2.3.1 Jordan River

The Jordan River is a meandering river with a gentle gradient. It occupies an approximate 1-mile-wide 100-year floodplain in the center of the Utah and Salt Lake Valleys. Flooding is common in the lower reaches of the river during periods of high seasonal run-off. The origin of the river is the north end of Utah Lake in Utah Valley. The 50-mile course of the river is north through Salt Lake Valley from Utah Lake to Farmington Bay where it discharges into this freshwater (as opposed to saltwater) bay of the Great Salt Lake. The locations of these features are shown in Figures 2.1 and 2.3.

Inflow into the Jordan River is regulated by discharges from Utah Lake and upstream diversions; it varies considerably with the available water supply in Utah Lake, and with the other diversions. During the period from 1913 to 1977, the total inflow of Jordan River water to the Salt Lake Valley area averaged 265,200 acre-feet per year (Price and Jensen, 1985). The Jordan River is also fed by several Wasatch Range streams. At two stream flow gaging stations of the Jordan River, one approximately 3 miles south and one approximately 3 miles north of the Base, discharges average 145 cubic feet per second (cfs) and 141 cfs, respectively, for the period of record. Maximum recorded flows are 348 cfs and 384 cfs, respectively, and minimum recorded flows are 39 cfs and 0 cfs, respectively (Price and Jensen, 1985).

Jordan River water (including diversions to canals) is generally fresh to saline. Total dissolved solids (TDS) concentrations are commonly in the range of 500 to 1,500 milligrams per liter (mg/L) except in the reach between South Jordan and Murray, where TDS concentrations range from 1,000 to 2,000 mg/L (Price and Jensen, 1985). Most of the river water is diverted upstream from South Jordan and the higher TDS between this point and Murray reflect more highly mineralized irrigation return flows and groundwater inflow to the river. Downstream from the river's confluence with Little Cottonwood Creek in Murray, the dissolved solids concentration of the river again is in the 500 mg/L to 1,500 mg/L range, reflecting inflows of fresher water from Little Cottonwood and Big Cottonwood Creeks and other Wasatch Range streams (Price and Jensen, 1985). TDS in Wasatch Range streams generally range from 250 mg/L to 500 mg/L at the canyon mouths. The locations of the cities and creeks are shown on Figure 2.3.

2.3.2 Great Salt Lake

The Great Salt Lake is a briny, shallow, salt water lake with a dissolved solids concentration in excess of 100,000 mg/L (Price and Jensen, 1985). Arnow (1984) reported TDS as high as 250,000 mg/L in some areas of the lake. This concentration far exceeds dissolved solids concentrations in the oceans. Ninety percent of the TDS concentration by weight is sodium and chloride (Arnow, 1984). The Great Salt Lake is in a topographically closed basin and has no surface flow outlet; therefore, it is one of the saltiest bodies of water on earth due to evaporation. Surface flows that reach the lake through natural streams and manmade drains are generally saline. Principal contributors to the salinity of these surface flows are irrigation return flows, evapotranspiration, urban

and suburban runoff, and inflow of municipal and industrial (including mine drainage) effluents (Price and Jensen, 1985).

2.3.3 Local Basewide Hydrology and Surface Drainage

There are no existing streams, lakes, or ponds at the Base. The primary surface water feature at the Base is the City Drain Canal previously discussed in Subsection 2.1.5. The average discharge of the canal is estimated to be approximately 30 cfs to 40 cfs based on the cross-sectional area of the canal, and the surface water velocities observed during the SI. The canal drains the shallow aquifer at the Base, and as a result, affects shallow subsurface groundwater flow at the Base. The effects of the canal on groundwater flow are discussed later in Subsection 2.5.2.1.

Mechanisms of surface drainage at the Base are runoff to storms drains and infiltration into the subsurface soils. Storm drains at the Base collect overland flow that is routed, and ultimately discharged, by several outfalls into the City Drain culvert or City Drain Canal (Figure 2.5). Storm drains in nearby surrounding areas also collect surface water that is discharged to the City Drain. Surface retention and depression storage also may affect surface drainage at the Base. Surface retention includes depression storage. Rainwater retained in puddles and other depressions at the ground surface (depression storage), and the total part of storm precipitation retained on or above the ground surface (surface retention), may affect surface water infiltration and recharge into the shallow groundwater table. The rate of infiltration or infiltration capacity of the soils is dependent upon soil type, moisture content, and mainly soil porosity and permeability. Surface soils at the Base are predominantly made-land fill material. Some areas are natural silts and clays. The Soil Conservation Service (1974) gives an infiltration rate of 0.2 to 0.63 inches/hour for the natural silty clay loam that is present in the extreme north end of the Base and in adjacent areas east of the Base (Figure 2.4). Many of the Base IRP sites are covered with asphalt. This is the case at IRP Sites 2, 4, and 7 (see Figure 1.2). As discussed in Section 1, Sites 4 and 7 are now beneath the motor pool parking area. The asphalt pavement impedes infiltration of surface water at these sites. Since asphalt pavement covers much of the Base, the primary method of surface drainage at the Base appears to be surface runoff rather than soil infiltration.

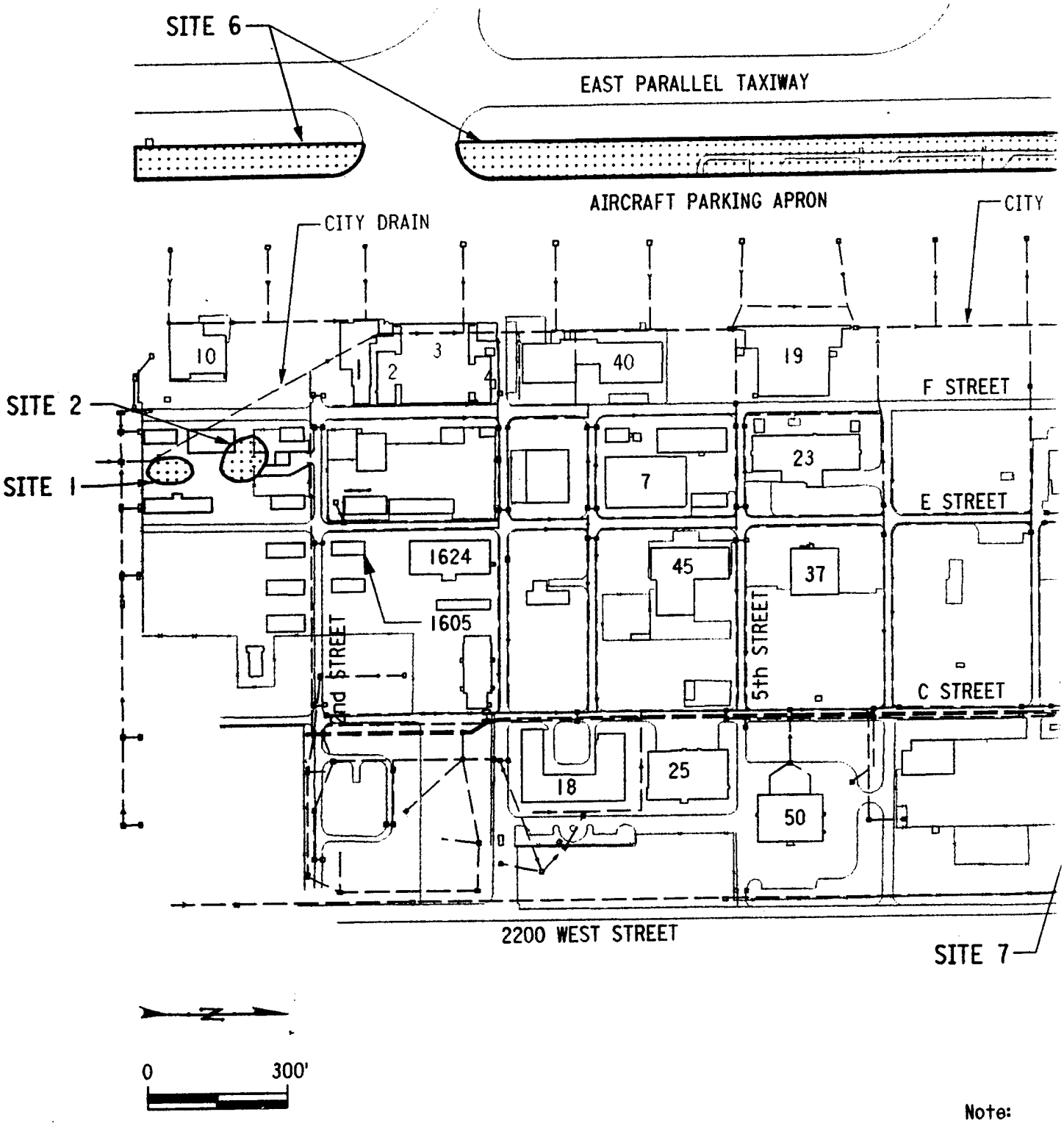
2.4 GEOLOGY AND HYDROGEOLOGY

2.4.1 Regional Geology and Hydrogeology

The Salt Lake Valley is a structural basin (graben) bounded on the east by the Wasatch Range (horst), an eastward tilted fault block, and the Wasatch Fault Zone at the western base of the Wasatch Range. The Oquirrh Mountains bound the valley to the west (see Figure 2.3). The horst and graben structure of the Wasatch Mountain Front and Salt Lake Valley is the result of Basin and Range extension along deep-seated, low-to mid-angle, normal faults. Utah's present mountains, although influenced by earlier events, are mostly the result of uplift and block-faulting which occurred in the last 25 million years (Hintze, 1973).

BASE STORM D

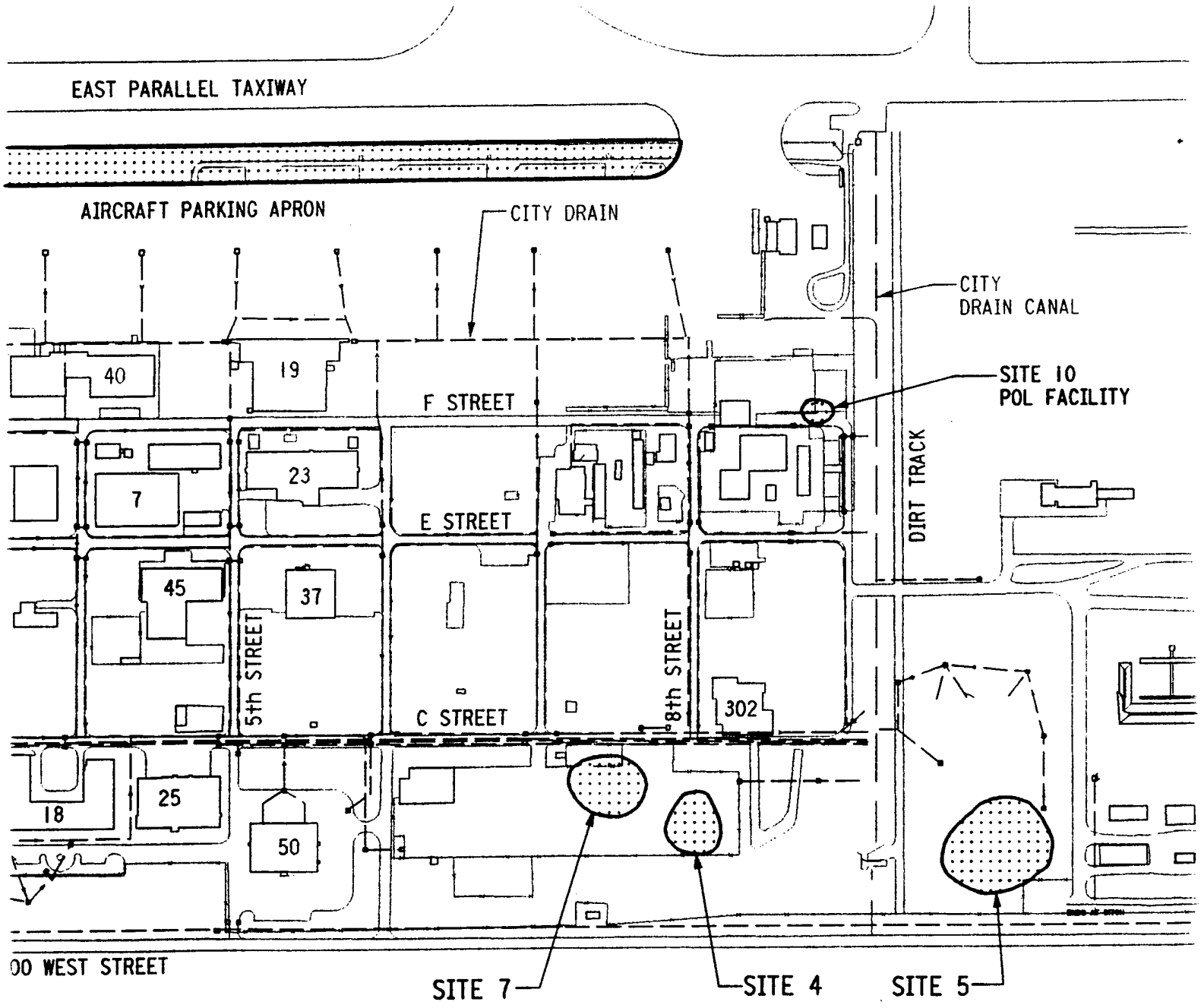
151st AREFG, UT
SALT LAKE CITY I
SALT LA



Note:
Arrows sh

BASE STORM DRAINAGE SYSTEM

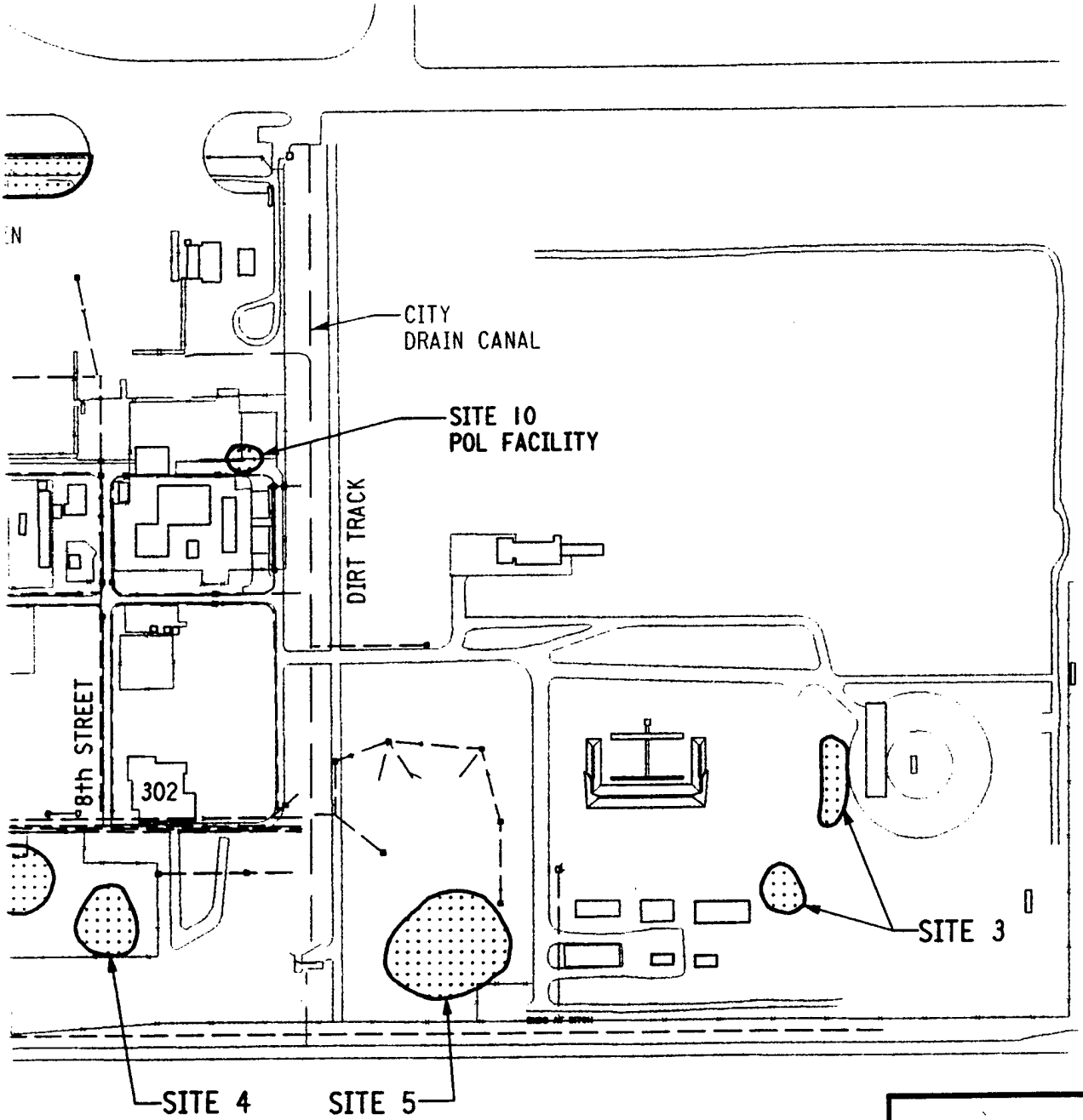
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



Note:
Arrows show the direction of flow.

AINAGE SYSTEM

AIR NATIONAL GUARD
RNATIONAL AIRPORT
ITY, UTAH



LEGEND

- STORM DRAIN PIPELINE
- COLLECTION POINT (GRATE)
- IRP SITE LOCATION

ne direction of flow.

FIGURE 2.5

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Salt Lake Valley topography has been shaped by ancient Lake Bonneville, by stream activity, and by alluvium eroded from the adjacent mountains (Davis, 1983). Lake Bonneville was the primary agent in shaping the present valley topography and alluvial geology. Lake Bonneville was the largest late Pleistocene pluvial (formed by high precipitation) lake in western North America. At its maximum, it covered 20,000 square miles and attained a depth of more than 1,000 feet in the area of the present Great Salt Lake (Hintze, 1973). Shorelines of the lake are a conspicuous feature along the mountain range and valley margins in northwestern Utah. Morrison (1966) reports at least ten sizable lake cycles (rises and falls) during the last 70,000 to 100,000 years that produced the shorelines and other features collectively attributed to Lake Bonneville.

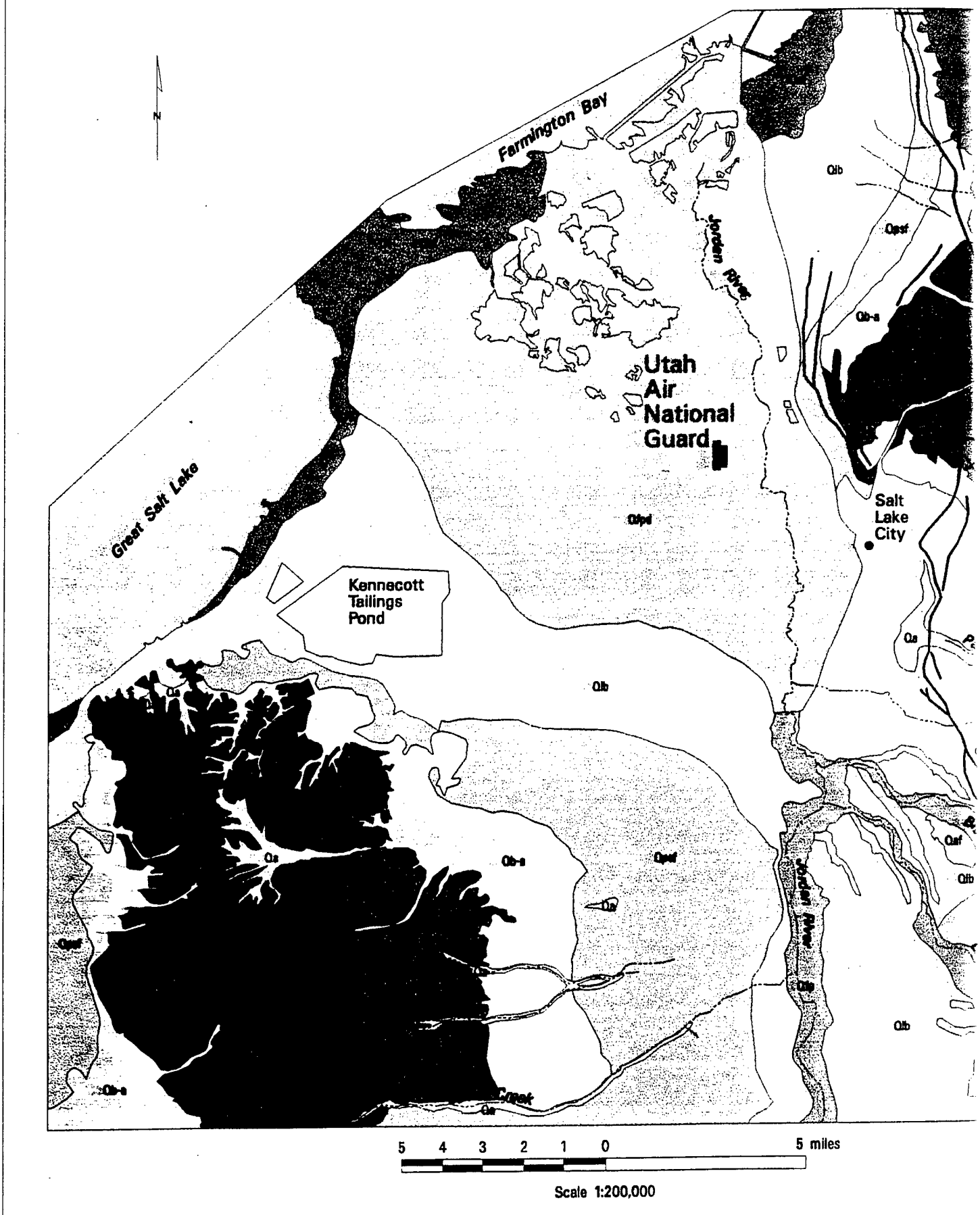
Flat-lying sediments form a gently undulating plain in the center of Salt Lake Valley. The Jordan River flows northward in the center of the valley from Utah Lake to the Great Salt Lake and has deposited fine-grained floodplain (overbank) deposits. From the confluence of Big Cottonwood Creek in Salt Lake City to the Great Salt Lake, the Jordan River formed a huge fan shaped floodplain and delta complex (Davis, 1983). The geologic map by Davis (1983) shows that the Base is located on the recent (Quaternary) Jordan River floodplain and delta complex. A digitized geologic map modified from Davis (1983) is shown in Figure 2.6.

The Salt Lake Valley structural basin is filled extensively with unconsolidated alluvium that locally attains vertical depths in excess of 2,000 feet (Hely et al., 1971). The unconsolidated valley fill is saturated with water to within a few hundred feet of the surface near the valley margins. The margins of the valley are the principal recharge areas and the level of saturated alluvium constitutes a deep unconfined aquifer. The approximate boundary of valley fill is shown in Figure 2.3. Local areas of the deep unconfined aquifer have perched water table zones resulting from interbedded deposits of low permeability. In some low-lying areas near the center of the valley, the alluvium is saturated to near-ground surface. The near-surface sediments in the center and north end of the valley form a shallow unconfined aquifer that is laterally extensive. Deep confined (artesian) principal aquifer(s) with variable hydrostatic head are present throughout the valley beneath the shallow unconfined aquifer. Water moves into the confined aquifer(s) from the marginally adjoining deep unconfined aquifer. A generalized hydrogeologic cross-section of the Salt Lake Valley aquifer system is provided in Figure 2.7.

2.4.1.1 Deep Confined Aquifer(s)

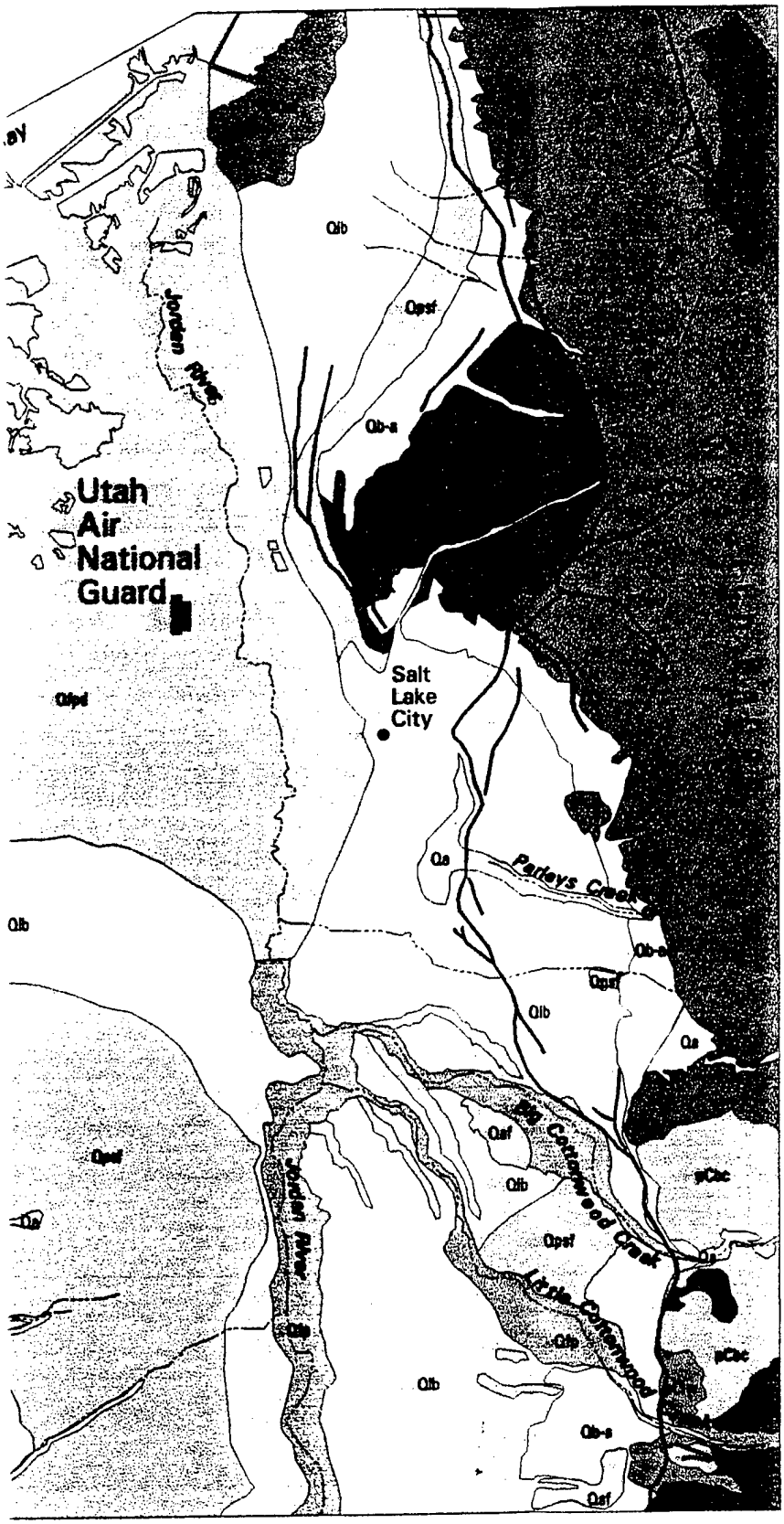
Deeper valley-fill deposits are comprised of continuous to discontinuous beds of clay, silt, sand, and gravel sediments that collectively form the confined artesian aquifer system (Hely et al., 1971). Overlying the deep confined principal aquifer(s) are interfingered deposits of clay, silt, and fine sand which form a confining layer that ranges from about 40 feet to 100 feet in thickness (Hely et al., 1971). The confining layers may be leaky; groundwater flows either up or down through these confining layers, depending on localized pumping demands and natural vertical groundwater gradients (Hely et al., 1971). The confining layer contains many beds of low permeability material that act

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N
Farmington Bay
Great Salt Lake
Jordan River
Utah
Air
National
Guard
Salt
Lake
City
Kennecott
Tailings
Pond
Qlb
Qlpd
Qa
Qlb-a
Qaf
Jordan River
Creek
5 4 3 2 1 0
5 miles
Scale 1:200,000

(1)

Generalized Geo
of Salt Lake City,



Modified from Davis (1983)

Explanation

Quaternary

- Qa Alluvial Deposits; stream alluvium, alluvial fans and loc
- Qsf Salt Flat; poorly drained soils with high silt, clay, and s
- Qfp Floodplains; floodplains along existing streams
- Qfpd Floodplain and Delta Complex; chiefly fine-grained and sediments
- Qaf Abandoned Floodplain and Stream Channel Deposits; ch silt; sand and gravel
- Qlb Provo Formation and Younger Lake Bottom Sediments; c and locally; offshore sand bars
- Qpsf Provo Formation and Younger Shore Facies; chiefly sanc beach deposits; bars, spits, and deltas
- Qb-a Bonneville and Alpine Formations; chiefly shore facies, a includes beach deposits; bars, spits, and deltas
- Qh Harkers Alluvium; unconsolidated and poorly sorted bou sand; silt, and clay deposited in pre-Lake Bonneville all

Tertiary

- Tqm Quartz Monzonite; Bingham and Little Cottonwood stoc
- Tw Wasatch Formation; conglomerate beds with lenses of s to coarse sandstone

Paleozoic

- PZwu Paleozoic undivided; consists of Cretaceous to Cambria sandstone; and shale in Wasatch Range
- PZou Paleozoic undivided; consists of Permian to Mississippia sandstone; and shale in Oquirrh Mountains

Precambrian

- pCbc Big Cottonwood Formation; quartzite, shale, and siltston
- pClw Little Willow Formation; schist
- pCf Farmington Canyon Complex; gneiss, schist, granite

- Contact
- Fault
- River or Stream

Generalized Geologic Map of Salt Lake City, Utah Area

Explanation

Quaternary

- Qa Alluvial Deposits; stream alluvium, alluvial fans and locally, mud flows
- Qsf Salt Flat; poorly drained soils with high silt, clay, and salt content
- Qfp Floodplains; floodplains along existing streams
- Qfpd Floodplain and Delta Complex; chiefly fine-grained and poorly-drained sediments
- Qaf Abandoned Floodplain and Stream Channel Deposits; chiefly mixtures of silt; sand and gravel
- Qlb Provo Formation and Younger Lake Bottom Sediments; clays, silts, and, and locally; offshore sand bars
- Qpsf Provo Formation and Younger Shore Facies; chiefly sand and gravel in beach deposits; bars, spits, and deltas
- Qb-a Bonneville and Alpine Formations; chiefly shore facies, and gravel; includes beach deposits; bars, spits, and deltas
- Qh Harkers Alluvium; unconsolidated and poorly sorted boulders, gravel, sand; silt, and clay deposited in pre-Lake Bonneville alluvial fans

Tertiary

- Tqm Quartz Monzonite; Bingham and Little Cottonwood stocks
- Tw Wasatch Formation; conglomerate beds with lenses of siltstone and fine to coarse sandstone

Paleozoic

- PZwu Paleozoic undivided; consists of Cretaceous to Cambrian limestone, sandstone; and shale in Wasatch Range
- PZou Paleozoic undivided; consists of Permian to Mississippian limestone, sandstone; and shale in Oquirrh Mountains

Precambrian

- pCbc Big Cottonwood Formation; quartzite, shale, and siltstone
- pClw Little Willow Formation; schist
- pCf Farmington Canyon Complex; gneiss, schist, granite

- Contact
- Fault
- River or Stream

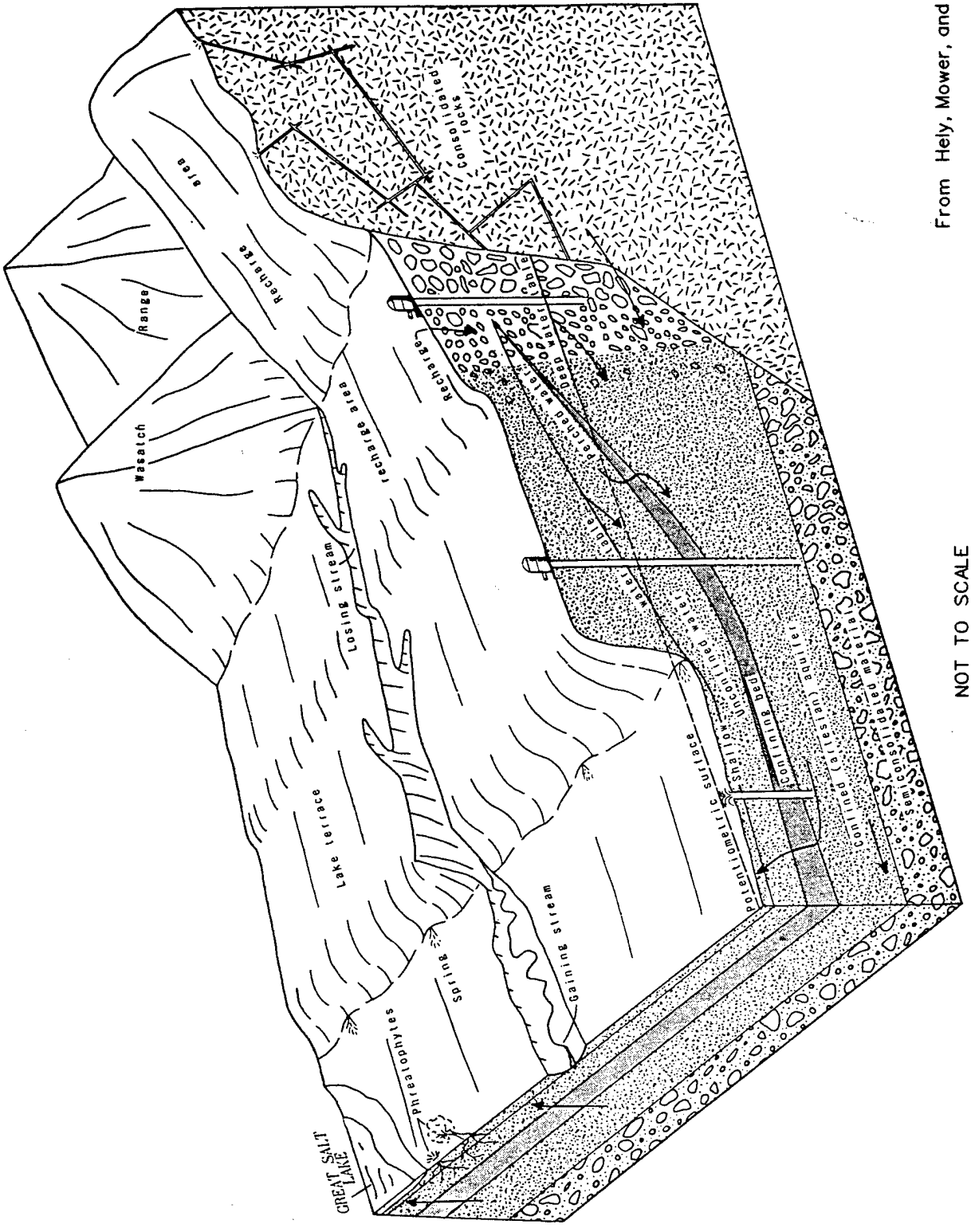
(1983)

(3)

FIGURE 2.6

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GENERALIZED HYDROGEOLOGIC CROSS-SECTION OF SALT LAKE VALLEY AQUIFIERS, UTAH


Wasatch Range
Bench
Bench
Consolidated rocks
Consolidated rocks
Lake terrace
Lake terrace
Losing stream
Losing stream
Recharge area
Recharge area
Recharge area

collectively as a single bed and retard the vertical movement of groundwater (Hely et al., 1971).

Five deep drilling logs for wells in a 0.5-square-mile area approximately 0.75 mile east of the Base, near the Jordan River, indicate the confining-layer thickness ranges from about 40 feet to 70 feet, with an average thickness of about 55 feet. The general sedimentary sequence in this area is a surface silt or clay to a depth of about 10 feet, sand from 10 feet to about 20 feet to 30 feet, and clay from 20 feet to 30 feet to depths ranging from 75 feet to 100 feet below land surface (BLS). Thereafter, the sequence is a series of interbedded sands and clays which is interpreted to be the principal confined artesian aquifer(s). The five wells were screened from about 200 feet to 400 feet BLS. The wells were all flowing wells at the time of construction (1942 to 1979) and the hydrostatic head ranged from 3 feet to 9 feet above land surface.

The deep drilling logs discussed above were obtained from a well survey conducted as part of the SI to gather information on hydrostratigraphy, water rights, and water uses in the vicinity of the Base. The survey showed 32 points of diversion within a 1-mile radius of the center of the Base. The on-line computer database of the State of Utah, Division of Water Rights (DWR), indicated that most of the water rights are for wells that are used for irrigation, stock watering and domestic purposes. Most of the wells are concentrated in the area east of the Base, are hydraulically cross-gradient of the Base, and have total depths that range from a minimum of 126 feet BLS to a maximum of 654 feet BLS. The location and description of the water rights within a 1-mile radius of the Base are included in Appendix A.

2.4.1.2 Shallow Unconfined Aquifer

Approximately 2 miles west of the Base, the shallow unconfined aquifer is about 40 feet to 50 feet thick, and is separated from the deeper confined aquifer(s) by approximately 50 feet of relatively impermeable deposits of clay, silt, and fine sand that constitute the confining layer (Waddell et al., 1987a). Due east of the Base the shallow unconfined aquifer consists of sand and is approximately 20 feet to 30 feet thick, as determined from the five deep well logs discussed above in Subsection 2.4.1.1.

2.4.2 Local Basewide Geology and Hydrogeology

The shallow subsurface unconsolidated deposits beneath the Base consist of fine-grained delta and floodplain sediments, and coarse-grained shoreline or stream channel sediments as indicated by Davis (1983). These deposits are approximately 20 feet thick beneath the Base and collectively constitute the shallow unconfined aquifer beneath the Base.

At the surface, the nearly flat lake and floodplain topography was conducive to the formation of swamps and marshes in the area. In the swampy and marshy areas, dark, highly organic, sediments accumulated. As a result, a black to dark gray organic silt and clay layer is present beneath most of the Base sites at a range of thicknesses. At some locations this organic layer is contacted at a depth of 3 feet and extends to a depth of 11

feet BLS. Generally, a layer of moderately well to well sorted, fine to coarse sand of granitic provenance (origin) is subjacent to the organic sediment. This sand is apparently detrital material derived from the igneous Little Cottonwood and Bingham stocks. These Tertiary age granitic intrusions are present in the Wasatch Range at the headwaters of Big and Little Cottonwood Canyons, approximately 16 miles southeast of the Base (Figures 2.3 and 2.6). These canyons appear to be the source of the stratigraphically lower (earliest deposition) sand sections of the shallow aquifer at the Base.

The granitic sand is continuous, and is mostly well sorted and generally coarse. The sand unit is a relatively higher energy deposit that formed within, or adjacent, to the delta complex. The sand was probably deposited as bifurcating streams of the delta lost energy and deposited their suspended loads and/or as coarser sediments were reworked by wave action near a shoreline. The lower energy dark organic silt was later deposited above the sand as the depositional environment changed.

In areas of the Base to the south and west, the dark organic silt and clay and granitic sand sedimentary sequence is absent. Here, the sedimentary deposits are primarily clay mixed with variable amounts of silt and sand, with discrete thin sand zones in some places. This lateral facies (characteristics of a sedimentary unit reflecting the conditions of its origin and differentiating it from adjacent units) change appears to be the interface of a lower energy deltaic and floodplain environment with a higher energy shoreline and/or stream channel depositional environment. The stratigraphically lower facies observed beneath the Base may be the result of interaction of higher energy delta complex discussed by Davis (1983) and very late-stage Lake Bonneville recession. The stratigraphically higher (later-deposition) fine-grained sediments result from lower energy floodplain-marsh-meandering stream deposition in the upper or late-stage delta complex.

The granitic sand, where present, is about 10 feet thick and vertically extends into a dark gray to greenish-gray clay layer at an average depth of about 20 feet BLS. The clay layer is laterally extensive in the subsurface beneath the Base and appears to be relatively impermeable. However, the thickness of the clay beneath the Base is unknown. This dark gray to greenish gray clay is interpreted to be the uppermost unit of the confining layer discussed by Waddell et al., (1987a) that separates the shallow unconfined aquifer from the deeper confined aquifer(s). As mentioned in Subsection 2.4.1.1, this confining clay layer is about 55 feet thick and is present at a depth of 20 feet to 30 feet BLS approximately 0.75 miles east of the Base.

Site-specific geology and hydrogeology, as determined through SI field activities, are discussed in Section 4.

2.5 GROUNDWATER HYDROLOGY

2.5.1 Regional Groundwater Hydrology

2.5.1.1 Groundwater Flow Characteristics

The regional groundwater flow direction within the shallow unconfined is northeasterly toward the Jordan River, except in the northwest part of the valley, in the area of the Base, where groundwater flow is generally toward the Great Salt Lake (Seiler and Waddell, 1984). Groundwater flow in the principal confined aquifer(s) is generally north-northwest for most of Salt Lake Valley (Waddell et al., 1987a). Groundwater movement in the confined aquifer(s) is generally toward the northwest and is upward leaking through the confining layer in the area of the Base; therefore, it discharges into the shallow unconfined aquifer or discharges into the Great Salt Lake (Waddell, et al., 1987a). Groundwater hydraulic head equipotentials of the principal confined aquifer range from 5 feet to 10 feet above land surface in the area of the Base (Marine and Price, 1964; Price, 1988), indicating an upward vertical hydraulic gradient. Therefore, the susceptibility of the deep, principal confined aquifer(s) being impacted by migration of contamination through the confining layer from the shallow unconfined aquifer is low. Waddell et al., (1987b) estimated subsurface groundwater flow to the Great Salt Lake to be 3,100 acre-feet during 1982.

2.5.1.2 Hydraulic Conductivity

Values of hydraulic conductivity used for the shallow unconfined aquifer in a digital model for Salt Lake Valley are given in Waddell et al., (1987b). The hydraulic conductivity used in the model for the area of the Base ranged from 0.6 feet per day to 1.25 ft/day. Using other digital model data from Waddell et al., (1987b), the vertical hydraulic conductivity through the confining layer in the area of the Base is estimated to be about 1×10^{-3} ft/day, assuming a confining layer thickness of 50 feet.

2.5.1.3 Groundwater Quality

Groundwater in the deep, principal confined aquifer(s) in the area of the Base contains between 500 and 1,000 mg/L of TDS and is principally a calcium-bicarbonate type water (Waddell et al., 1987a, Plate 1). Groundwater obtained from the deeper aquifers is used as a potable source of water because of the generally good water quality.

The shallow unconfined aquifer contains water of poor chemical quality with TDS ranges from 2,000 to 4,000 mg/L in the area of the Base (Waddell et al., 1987a, Plate 2). Groundwater in the shallow unconfined aquifer is not used for human consumption. Further west toward SLCIA groundwater in the shallow unconfined aquifer is characterized by higher TDS concentrations that range from 4,000 to 9,000 mg/L (Waddell et al., 1987a, Plate 2). The shallow unconfined aquifer also contains higher concentrations of sodium, chloride, and sulfate.

Elevated concentrations of arsenic are also common in shallow groundwater in the regional area of the Base. Published USGS chemical quality data for shallow

groundwater in the Salt Lake Valley indicate that arsenic in concentrated in shallow groundwater in the northern part of the valley, particularly south and west of the Base and SLCIA (USGS, 1983; and USGS, 1992). Based on this published data, levels of arsenic in the shallow unconfined aquifer range from 60 ug/L to 360 ug/L within a 3-mile radius of the Base. Concentrations of dissolved arsenic exceed 200 ug/L in several shallow wells further west of SLCIA. The possible origin of arsenic in this area has not been addressed. Vance (1995) suggests that arsenic is often concentrated by geogenic processes in soil and groundwater associated with acidic to intermediate volcanic rocks (granites), and that concentrations in related groundwater may exceed 50 ug/L. Other authors state that high arsenic concentrations in groundwater are common in the western United States (Welch, Lico, and Hughes, 1988). These are associated with sedimentary rocks or sediment derived from volcanic areas, geothermal systems, and gold and uranium mining districts. Parsons ES suspects that much of the arsenic in shallow groundwater in the area of the Base may result from deposition of sediments derived from weathering of granitic igneous rocks of the Wasatch Range, and therefore, the arsenic is probably associated with deposition of the delta complex discussed in subsection 2.4.2.

2.5.1.4 Groundwater Contamination

Groundwater in the Salt Lake Valley has been impacted by sources of organic and inorganic contamination. Contamination of the shallow unconfined aquifer and to a lesser extent the principal confined aquifer(s) by inorganic constituents and trace elements has occurred in two mine tailing sites within the regional area of the Base: the Kennecott tailings pond, approximately 7 miles west-southwest of the site, and the Vitro Chemical Co. tailings, approximately 6 miles south and upgradient (surface water and groundwater) of the Base. The locations of these tailings areas are shown in Figure 2.3. Concentrations of arsenic, cadmium, and iron in these areas exceed water quality criteria of the EPA (1977 and 1980) for domestic water supply (Seiler and Waddell, 1984).

Organic constituents exceeding recommended limits set by the EPA have been detected in wells screened in the shallow unconfined aquifer (Seiler and Waddell, 1984). The greatest concentrations occur in wells near landfills and tailings areas southwest of Salt Lake City, approximately 5 to 6 miles south and upgradient of the Base. Contamination of the principal confined aquifer system by organic chemicals has not been documented (Waddell et al., 1987a).

2.5.2 Local Basewide Groundwater Hydrology

2.5.2.1 Groundwater Flow Characteristics

Groundwater flow gradients across the Base were initially established in December, 1992, by installing basewide piezometers and measuring water levels. Groundwater flow directions were determined prior to the emplacement of IRP site monitoring wells. Groundwater gradients were later established in March, 1993, and again in July, 1995, from groundwater elevations in basewide piezometers and IRP site monitoring wells. Hydraulic gradients and flow directions changed between these dates indicating a

dynamic potentiometric surface. However, at all measuring times, groundwater flow was toward the City Drain Canal from areas of the Base to the north and south of the canal. The canal traverses the Base from east to west (Figure 1.2). Basewide and individual IRP site hydraulic gradients and flow directions are discussed in detail in Section 4.

The average south-to-north hydraulic gradient in the area of the Base south of the City Drain Canal was about 1.15×10^{-3} feet/feet (3.0 feet change in water elevation in a horizontal distance of 2,600 feet) from initial water levels measured in basewide piezometers. This is a water table slope of 0.115 percent. Approximately 3 months later in March, 1993, water levels in basewide piezometers and IRP site monitoring wells indicated only a slightly steeper south-to-north hydraulic gradient toward the City Drain Canal from this area of the Base.

The portion of the Base north of the City Drain Canal initially showed an average north-to-south hydraulic gradient of 0.94×10^{-3} ft/ft (1.5 feet change in water elevation in a horizontal distance of 1,600 feet), or a 0.094 percent slope, toward the City Drain Canal. Approximately 3 months later in March, 1993, water levels in basewide piezometers and IRP site monitoring wells indicated a much steeper north-to-south gradient toward the canal from the north end of the Base. The hydraulic gradient increased to 2.5×10^{-3} ft/ft, or a groundwater table slope of 0.25 percent, and the groundwater elevation increased about 3 feet in piezometers and monitoring wells. This may be due to a relatively greater influx of groundwater recharge from snowmelt into the subsurface at the north end of the Base, because the north end of the Base is not covered with asphalt. The groundwater elevation in basewide piezometers increased by an average of 2.17 feet during the 3 months between measurements.

In July, 1995, groundwater gradients and water levels were much the same as they were in December, 1992. Basewide potentiometric surface and groundwater gradient maps are shown in Section 4.2

Seasonal fluctuations of shallow groundwater water levels are caused by variations in recharge or discharge during different seasons of the year. Water levels generally rise during the winter and are highest in the spring when recharge by snowmelt and precipitation is greater than discharge. Conversely, water levels decline rapidly during the summer and are lowest in later summer or early fall when discharge by evapotranspiration and seepage is greater than recharge by precipitation. The typical seasonal water level fluctuations observed in the shallow aquifer beneath the Base follow this general pattern described above.

2.5.2.2 Hydraulic Conductivity from Slug Tests

The hydraulic conductivity of the shallow unconfined aquifer beneath the Base was estimated from slug tests at IRP site monitoring wells. Hydraulic conductivity values of the porous media near the screened interval of the monitoring wells show a wide range of variation, from a minimum of 0.17 ft/day in the southern portion of the Base to a maximum of 50.41 ft/day in the northern portion of the Base. The mean hydraulic

conductivity of 17 shallow monitoring wells installed at the Base during the SI is 8.37 ft/day with a standard deviation of 12.65. This range of values indicates the shallow aquifer has a high degree of heterogeneity in aquifer properties, with a difference in minimum and maximum hydraulic conductivity values of over two orders of magnitude. The subsurface hydraulic conductivity at the individual sites and methods of analysis are discussed in Section 4.

Hydraulic conductivity values for monitoring wells screened in the coarse granitic sand in areas of the Base north of the City Drain Canal are significantly higher than values obtained in monitoring wells screened in silt, sand, and clay at the southern areas of the Base. The mean hydraulic conductivity of four wells in the north portion of the Base is 24.25 ft/day with a standard deviation of 19.94. The mean hydraulic conductivity of 13 wells in the southern and western portions of the Base is 3.48 ft/day with a standard deviation of 2.00. This disparity in the values of hydraulic conductivity is not unusual considering the contrast in subsurface sediment types present at these areas of the Base, as discussed in Subsection 2.4.2. The values of hydraulic conductivity from slug tests at IRP site wells are significantly higher than the 0.6 ft/day to 1.25 ft/day range used in the digital model of Waddell et al., (1987b), discussed in Subsection 2.5.1.2.

2.5.2.3 Groundwater Quality

Groundwater samples from the IRP site monitoring wells were not analyzed for major cations and anions as per the SAP. However, specific conductance of groundwater samples collected from monitoring wells was measured. The mean field measured specific conductance of groundwater samples collected in February, 1993, was 1,536 microsiemens per centimeter (cm) which converts to approximately 983 mg/L TDS. The mean field pH of groundwater samples was 7.9. The mean field measured specific conductance of groundwater samples collected in August, 1995, was 7,602 microsiemens/cm (4,865 mg/L TDS) with a mean field pH of 7.89. Slightly higher pH values were obtained in groundwater from shallow wells screened in clay and silt. Slightly lower values were obtained in groundwater from shallow wells screened in sand. Elevated concentrations of arsenic were detected in groundwater samples collected from the IRP site monitoring wells. The distribution of dissolved arsenic in shallow groundwater at the Base is presented and discussed in Section 4. Regional groundwater quality pertaining to arsenic is discussed in Subsection 2.5.1.3. Site-specific groundwater quality results and site-specific hydrogeology, as determined through SI field activities, are discussed in Section 4.

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SECTION 3
FIELD INVESTIGATION PROGRAM

3.1 PROGRAM IMPLEMENTATION

The SI field effort was conducted by Parsons ES personnel under subcontract to HAZWRAP. The SI is part of the IRP managed by the ANGRC.

Field activities (Sites 1 through 7) were initiated at the Base on 23 October 1992 and were completed on 16 March 1993. Initially, basewide piezometers were installed in October 1992 (additional piezometers were installed in December 1992). Then, soil gas surveys were conducted in October and November 1992. Soil boring drilling and sampling were performed in December 1992. Monitoring wells were installed at the sites in January 1993, and groundwater was sampled in early February, 1993. Surface water and sediment sampling of the City Drain Canal was performed in late February 1993. Aquifer tests of site monitoring wells were also conducted in late February 1993 and early March 1993. Field work at the POL facility (Site 10), which was not part of the primary field effort discussed above, was initiated and terminated due to an exposure incident in May 1994. Also, seven additional soil borings were advanced at Site 1 in October 1994. In August, 1995, five additional monitoring wells were installed as part of the basewide SI of Sites 1 through 7. Groundwater from these new wells and the existing wells were sampled and analyzed for the same constituents that were analyzed in 1993.

Drilling services were provided by PC Exploration of Centerville, Utah, and Layne Environmental of Denver, Colorado. Land surveying was conducted by Bingham Engineering of Salt Lake City, Utah. Drum excavation, snow removal, and landscaping services were provided by Toxi-Tech Control Inc., of Salt Lake City, Utah. Laboratory analytical services were provided by ES-Berkeley Laboratory and DataChem Laboratories of Salt Lake City, Utah. All other activities were performed by Parsons ES.

3.2 CONTAMINANT SOURCE INVESTIGATIONS

A contaminant source investigation was performed at each of the SI sites to determine the presence/absence of soil and groundwater contamination in the source areas, and to define the lateral extent of soil contamination. The initial source investigations were conducted through soil gas surveys at five of the sites, and through soil and groundwater sampling at Sites 1 through 7. Surface water and sediment samples were also collected from the City Drain Canal as part of the basewide investigation activities. Field activities conducted at the Base during the SI are summarized in Table 3.1. The SI methods are discussed in detail in the following sections.

TABLE 3.1
SUMMARY OF FIELD ACTIVITIES
151st AREFG, UTAH AIR NATIONAL GUARD
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	Total Numbers of Activities									
Field Activity	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 10	Backgrnd/ Basewide	Total
BOREHOLE SOILS										
Soil Gas Survey Points	0	15	0	25	25	80	20	0	0	165
Soil Borings	10	6	5	9	7	10	10	4	2	63
Soil Samples	20	9	6	16	14	20	16	9	5	115
Field Duplicates	3	1	1	2	1	3	1	0	1	13
SHALLOW EXCAVATION SOILS										
Near Surface Soil Samples	0	0	6	0	0	0	0	0	0	6
SEDIMENTS										
City Drain Canal Samples	NA	NA	NA	NA	NA	NA	NA	NA	6	6
Field Duplicates	NA	NA	NA	NA	NA	NA	NA	NA	1	1
GROUNDWATER										
Piezometers	0	0	0	0	0	0	0	3	10	13
Monitoring Wells	2	2	2	1	1	5	2	0	2	17
Water Samples	3	3	4	2	2	8	4	0	3	29
Field Duplicates	0	1	1	0	1	0	0	0	0	3
SURFACE WATER										
City Drain Canal Samples	NA	NA	NA	NA	NA	NA	NA	NA	3	3
Field Duplicates	NA	NA	NA	NA	NA	NA	NA	NA	1	1
CONTAINERIZED SOILS										
Soil Cutting Samples	1	1(a)	0	1(a)	0	0	1(a)	1	0	3

(a) Containerized soils from Sites 2, 4, and 7 were combined for one chemical analysis.
NA - Not applicable

3.3 SOIL GAS SURVEY

3.3.1 Overview

Soil gas surveys were performed on Sites 2, 4, 5, 6, and 7 during the screening phase of the SI. The objectives of the surveys were to:

- Delineate the horizontal extent of subsurface contamination at Sites 2, 4, 5, 6, and 7;
- Determine the source area of contamination at each site; and
- Provide information for optimal placement of soil borings and monitoring wells.

This section contains a summary of sample collection methods and analytical procedures used in the soil gas surveys. The results of the soil gas surveys are presented in Section 4.

3.3.2 Sampling Methods

Soil gas surveys were conducted at Site 2 (15 points), Site 4 (23 points), Site 5 (25 points), Site 6 (78 points), Site 7 (20 points), and encompassed the supposed areal extent of each site as presented in the PA (HAZWRAP et al., 1989). Generally, an equidimensional grid with spacing that ranged from 25 feet to 50 feet was used at each site, depending on the size of the site. At site 6, the original proposed number of soil gas points was 122. However, some of the proposed points in the vicinity of a new taxiway at the north end of the ramp area were not sampled, since up to 7 feet of fill dirt had been placed and compacted and had been overlain with 12-18 inches of concrete. The Base personnel who had supervised installation of the new taxiway indicated that no odors or contaminated soils were observed during construction.

The soil gas surveys were conducted by driving hollow steel rods fitted with disposable steel probe tips into the subsurface at regular grid intervals. Before use, the steel tips were decontaminated to remove cutting oils by washing in a Liquinox™ solution, followed by tap water, methanol, and distilled water rinses, and air drying. The rods with tips were driven with a hammer drill to a depth of 4.5 feet BLS. A Teflon® tape-wrapped polyethylene fitting attached to a handheld vacuum pump via Tygon® tubing was installed into the above ground exposed tip of the steel rod. The probe system was purged, and a Tedlar® sampling bag was placed on the exhaust end of the hand-operated vacuum pump to obtain a soil gas sample. Prior to collection of each sample, the sample location, date, and time of collection were written on the outside surface of the sampling bag.

After collection of each sample, the probe assembly was dismantled, and the steel rods were decontaminated by removing soil from the interior of the sampling rod with a small diameter probe and by scrubbing the outside of rod with Liquinox™ detergent wash. This was followed by a tap water rinse and a final rinse with deionized water.

3.3.3 Analytical Procedure

A Photovac® 10S50 portable gas chromatograph (GC) was used as a field screening tool to analyze gaseous phase components in the soil. The Photovac® 10S50 GC was equipped with a 9-meter capillary column (CPsil-5) and a 1-meter pre-column/backflush system. The GC detector was a 10.6 electron volt photoionization detector (PID).

The GC output is in the form of a chromatogram. The chromatogram depicts the concentrations of organic compounds by differing peaks above a horizontal axis. The organic compounds are identified by their retention times after injection into the GC column and by the height or area of the curves. Each compound is indicated on the chromatogram by a characteristic curve and retention time. The curves of the specified compounds on the chromatograms are compared by the GC to the associated curves of the calibration standards to determine the concentrations in the soil gas samples.

Calibration of the GC was accomplished using commercially prepared gas standards supplied by Scott Specialty Gases and Byrne Specialty Gases. Scott Specialty Gases originally sent two standards which contained 1 part per million, volume per volume (ppmv) and 50 ppmv of six components: benzene, toluene, ethylbenzene, and meta-, ortho-, and para-xylenes. However, as determined later, the vendor mislabeled the standards. The 50-ppmv standard actually contained 1 ppmv of each of the six compounds and the 1-ppmv standard actually contained 50 ppmv of each component. This problem caused considerable confusion when a 5-ppmv trichloroethylene standard was made and mixed with the supposed 50-ppmv standards of benzene, toluene, ethylbenzene, and xylenes (BTEX) components. Due to the erroneously labeled standards from Scott Specialty Gases and the resulting chromatogram data, a field change order (field change no. 1) was submitted to and accepted by Martin Marietta's HAZWRAP that rescinded the requirement that soil gas samples be analyzed for trichloroethylene. Field change requests are provided in Appendix B. When new chromatograph data based on the Byrne Specialty Gases standards was reviewed, it became obvious that the Scott Specialty Gas standards had been mislabeled. When notified of the error, Scott Specialty Gases sent a new set of labels for the cylinders.

The field GC was calibrated daily after the internal oven had warmed to 30 degrees centigrade (°C). The calibration was accomplished by injecting a 5-microliter (ml) aliquot of the 1-ppmv standard and a 5-ml aliquot of the 50-ppmv standard into the GC. If a difference of 10 percent or greater was detected, the calibration standards were rerun until a result of less than 10 percent was noted.

Routine startup procedure included an instrument blank, syringe blanks, and machine blanks. Instrument blanks consisted of a 5-ml injection of ultra zero air [filtered air with hydrocarbon concentrations of less than 1 part per billion, volume per volume (ppbv)], and were used to gauge the stability of the instrument, flow balance, and column configuration. Syringe blanks consisting of injections of ambient air were used to check for background contamination. Machine blanks were used to check for contamination in the column, and check the flow balance of the carrier gas. In addition to blank samples,

sample duplicates were run periodically to check the reproducibility of results. When problems were detected, immediate corrective action was taken.

3.3.4 Calculations

Concentrations of BTEX components in the soil gas samples were calculated using the following method. A 5-ml volume of a 1 ppmv and 50 ppmv calibration standard was injected into the GC column to obtain a straight line calibration curve. Each component of the standards is retained in the column for a specific amount of time that is a function of the particular column and component. The amount of time required for the component to appear on the chromatogram following injection is called the retention time. Each chemical component has a unique retention time and curve shape for the particular GC column being used. The GC calculates the height or area under the curve in millivolt seconds, and the corresponding gas concentration in ppmv. Calibration standards are entered in the onboard computer by the GC operator. When a soil gas sample with an unknown concentration of a specified component is injected into the GC, the PID quantifies the concentration of the component based on the height or area of its curve. The height or area of the curve is related to the number of millivolt seconds, and the curve is compared to the calibration standards. The GC outputs the names of the components, retention times, curves in millivolt seconds, and concentrations of the components. Only the detected components from retention times for which the GC has been calibrated are reported.

As previously stated, a two-standard calibration was used for field GC analysis. The SAP (ES, 1992b) called for a triple-standard calibration. This requirement was amended to the two-standard calibration by a field change request to HAZWRAP. The reason for this change is detailed in a field change request form, field change no. 2, that is included in Appendix B. A two-standard calibration may not be quite as accurate or yield as much calibration range as the triple-standard calibration. Therefore, the detected soil gas concentrations of BTEX components below the 1 ppmv and above the 50 ppmv concentrations of the standards may not be completely accurate. A soil gas concentration of 0.5 ppmv was chosen as lower limit of accuracy for the individual components. If the concentrations of BTEX in soil gas samples were below 0.5 ppmv, the compounds were present, but were not quantified.

3.4 DECONTAMINATION PROCEDURES

Decontamination procedures for all drilling, soil and groundwater sampling, and monitoring well and piezometer installation consisted of steam cleaning all non-disposable sampling equipment, well risers, well screens, and end caps. The sampling equipment was further cleaned with a phosphate-free laboratory-grade detergent (Liquinox™) and potable water solution, rinsed with potable water, then rinsed with Fisher Scientific Optima® grade methanol, and finally rinsed with Fisher Scientific Optima® high-performance liquid chromatography (HPLC)-grade deionized water. The equipment was allowed to air dry, and was then wrapped in aluminum foil after drying

(Table 3.2). All decontamination fluids used during drilling and sampling were collected and drummed in labeled 55-gallon drums for later disposal.

To facilitate decontamination of equipment, a cleaning area was constructed by covering a 20-foot by 20-foot bermed area with Visqueen®, to catch any overspray. A 300-gallon capacity galvanized watering trough was placed in the center of the area and several Visqueen® covered saw-horses were placed in the galvanized trough. Augers, drill rods, and split-spoon samplers were then laid on several layers of Visqueen® on the saw-horses to prevent the items from contacting potential contaminated surfaces, and were then steam cleaned. Whenever measurable quantities of decontaminated water pooled in the decontamination area or galvanized trough, the water would be pumped into 55-gallon drums for later disposal. Decontamination of equipment was noted in the field log book during daily operations.

Drilling rigs, augers, and drill rods were thoroughly cleaned prior to beginning work on base as well as between each drill site. All well screen, riser, and end caps were steam cleaned and allowed to air dry. Once dry, they were wrapped in aluminum foil for storage. All bailers and downhole sampling equipment were decontaminated following the procedures set forth in the sampling and analysis plan (SAP) (ES 1992b). An oil/water interface probe and slope indicator used for measuring water levels in monitoring wells and piezometers were cleaned between each use following the standard decontamination procedures outlined above.

3.5 PIEZOMETER CONSTRUCTION, AND MONITORING WELL CONSTRUCTION, DEVELOPMENT, AND SAMPLING

3.5.1 Piezometer Construction

Ten piezometers were installed throughout the Base outside of the site source areas to determine the approximate groundwater flow direction. Groundwater levels in piezometers were used to guide upgradient and downgradient placement of monitoring wells at the sites.

The piezometers were installed with a truck-mounted Acker Soil-Max™ or Mobile B-57™ drilling rig using 6.25 inch inside diameter (ID) hollow-stem augers. The screen and riser were installed inside the auger flights to maintain the integrity of the borehole and ensure emplacement of an equally distributed filter pack in the annular space.

A typical piezometer construction diagram is shown in Figure 3.1. Specific construction details are referred to in Section 4. The piezometers were constructed of 1-inch ID Schedule 40 polyvinyl chloride (PVC) casing and screen. Each piezometer typically had a 5-foot section of 0.010-inch slotted screen and a 10-foot section of riser (if flush-mount). The tops of the screen were placed to approximately 10 feet BLS. The filter pack, composed of 20/40-grade (0.850 to 0.425 mm) washed silica sand, was placed to approximately 8 feet BLS. A 2-foot-thick bentonite seal was placed to approximately 6 feet BLS. A cement/bentonite (5% bentonite by weight) grout was placed from the top

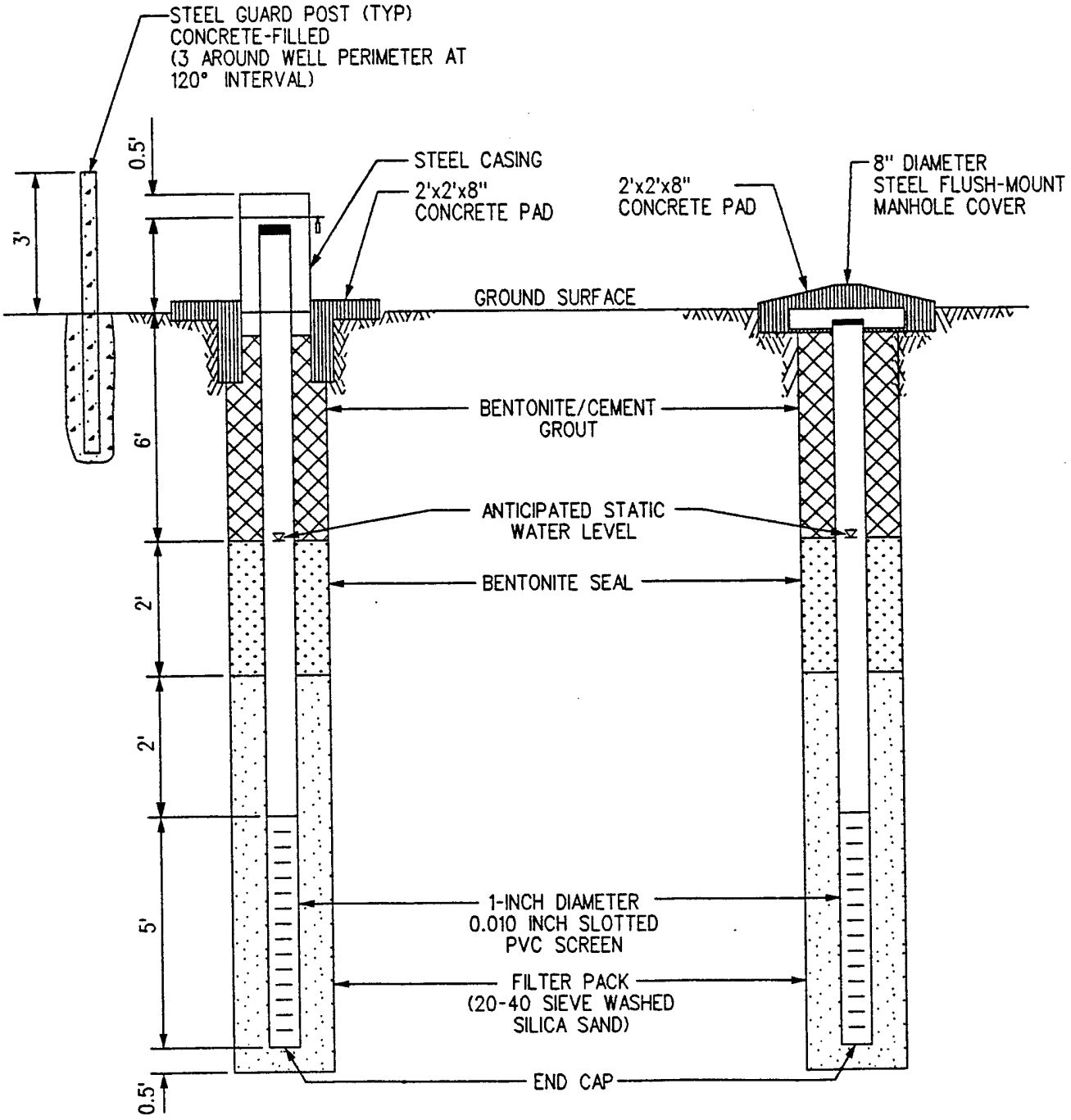
TABLE 3.2
SUMMARY OF DECONTAMINATION PROCEDURES FOR SAMPLING EQUIPMENT
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Wash and scrub with Liquinox™ detergent (laboratory grade).
Rinse with tap water.
Rinse with methanol(1).
Rinse with High Pressure Liquid Chromatography (HPLC) grade water(1).
Air dry.
Wrap in aluminum foil until used.

(1) Methanol and HPLC water was Fisher Scientific Optima grade.
Note: All metal sampling equipment was paint-free stainless steel or brass.
The Teflon™ bailers were decontaminated following the same procedures.

PIEZOMETER CONSTRUCTION DIAGRAM

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NOTE: THE DIMENSIONS SHOWN ARE TYPICAL FOR MOST AS-BUILT PIEZOMETER CONSTRUCTIONS. SEE TABLE F.1 APPENDIX F, FOR SPECIFIC CONSTRUCTION DETAILS. ACTUAL STATIC WATER LEVEL MAY VARY.

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FIGURE 3.1

of the bentonite seal to 6-inches BLS to seal the well from possible surface contamination.

Either a flush-mount 8-inch diameter steel manhole cover or a 6-foot-long, 4-inch square protective steel casing was installed at each piezometer for wellhead protection. Flush finishing was used for piezometers installed in high-traffic areas. The flush-completion risers were finished approximately 3 inches BLS, and a plastic locking cap was placed over the top of the riser. Piezometers with projecting finishes (above ground) have risers that extend approximately 2 feet above the land surface, and have a locking protective steel casing set 3.5 feet BLS that extends approximately 2.5 feet above the land surface. A 2-foot by 2-foot by 8-inch sloped concrete pad was set around each piezometer to secure the piezometer and promote drainage away from the wellhead. Three concrete-filled steel guard posts were placed around the steel protective casings of the above ground piezometers. (Figure 3.1).

Following installation, the piezometers were allowed to equilibrate for at least 48 hours before water levels were measured. The top-of-casing elevations, ground elevations, and coordinates of the piezometers were surveyed by a registered land surveyor.

During drilling, soil samples were collected with 2.5-inch diameter split-spoon samplers for soil description. Soils were classified with respect to type, grain size, mineralogy, color, etc. To provide a soil description in a consistent manner, a number of qualifiers were incorporated into an approved procedure for logging a soil boring. Consistency and relative density of the soils were determined from standard penetration tests [American Society for Testing and Materials (ASTM Test D-1586)] during drilling, and from field tests involving the relative ease of sample deformation when applying finger pressure. The distinction between silt and clay was based upon field tests such as a feel test and grit test. Plasticity at the inherent moisture content of the soils was determined by rolling the soil into 1/8-inch diameter threads. Grain-size determination of particle diameters followed the Wentworth (1922) system, as illustrated in Table 3.3. A description of sediment sorting employed the standards of Folk (1968). For consistent descriptions of soil color, the Munsell color chart based on Goddard et al. (1948) was used. Soil moisture was determined qualitatively by visual inspection, and was documented using the terms dry, damp, moist, and saturated.

3.5.2 Monitoring Well Construction and Development

Monitoring well boreholes were drilled using 6.25-inch ID hollow-stem augers. During drilling, continuous split-spoon soil samples were collected following standard penetration test procedures (ASTM Test D-1586) for lithologic evaluation. The soils were screened with a Microtip™ PID. Soil samples were collected in 40-ml glass vials with Teflon® lids and septa for field GC headspace analysis of BTEX. The monitoring well boreholes were placed downgradient (also upgradient at Sites 3 and 7) of the source sites, and were installed in clean sediments based on PID and field GC headspace

TABLE 3.3
CLASSIFICATION BASED ON WENTWORTH GRAIN SIZE SCALE (1)
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Exact size limits (mm.)	Approximate inch eqivalents (in.)	Sediments
256	<10	Boulder gravel
64-256	2.5-10	Cobble gravel
32-64	1.2-2.5	Very coarse pebble gravel
16-32	0.6-1.2	Coarse pebble gravel
8-16	0.3-0.6	Medium pebble gravel
4-8	0.15-0.3	Fine pebble gravel
2-4	0.08-0.15	Granule (or very fine pebble) gravel
1-2	0.04-0.08	Very coarse sand
0.5-1	0.02-0.04	Coarse sand
0.25-0.5	0.01-0.02	Medium sand
0.125-0.25	0.005-0.01	Fine sand
0.0625-0.125	0.002-0.005	Very fine sand
0.0039-0.0625	0.00015-0.002	Silt
Smaller than 0.0039	<0.00015	Clay (clay-size materials)

(1) Wentworth (1922).

screening results. Well borehole soil samples were not submitted to the laboratory for chemical analysis as per SAP.

The monitoring wells were constructed inside the drill augers to maintain the integrity of the boreholes during installation and to ensure that the filter pack was equally distributed in the annular space. The wells were constructed with new, decontaminated 2-inch ID Schedule 40 PVC casing, screen, and bottom caps. Each well has 10 feet of 0.010-inch slotted screen. A Schedule 40 PVC sediment trap with an end cap was placed on the bottom of each screen prior to installation. The tops of the screens were initially placed across the water table; it was anticipated that this length would allow for the detection of any floating product and would allow for fluctuation of water levels. However, as described in field change Request No. 7 (Appendix B), higher than anticipated static water levels encountered during the field effort required shorter well screens and less screen above the static water table to ensure an adequate seal. Also, water levels rose from the higher than normal precipitation as discussed in Section 2, so that when the monitoring wells were sampled in February, 1993, water levels were slightly above the screens in a few wells. Static water levels were low and were below the screen tops when the monitoring wells were resampled in August, 1995.

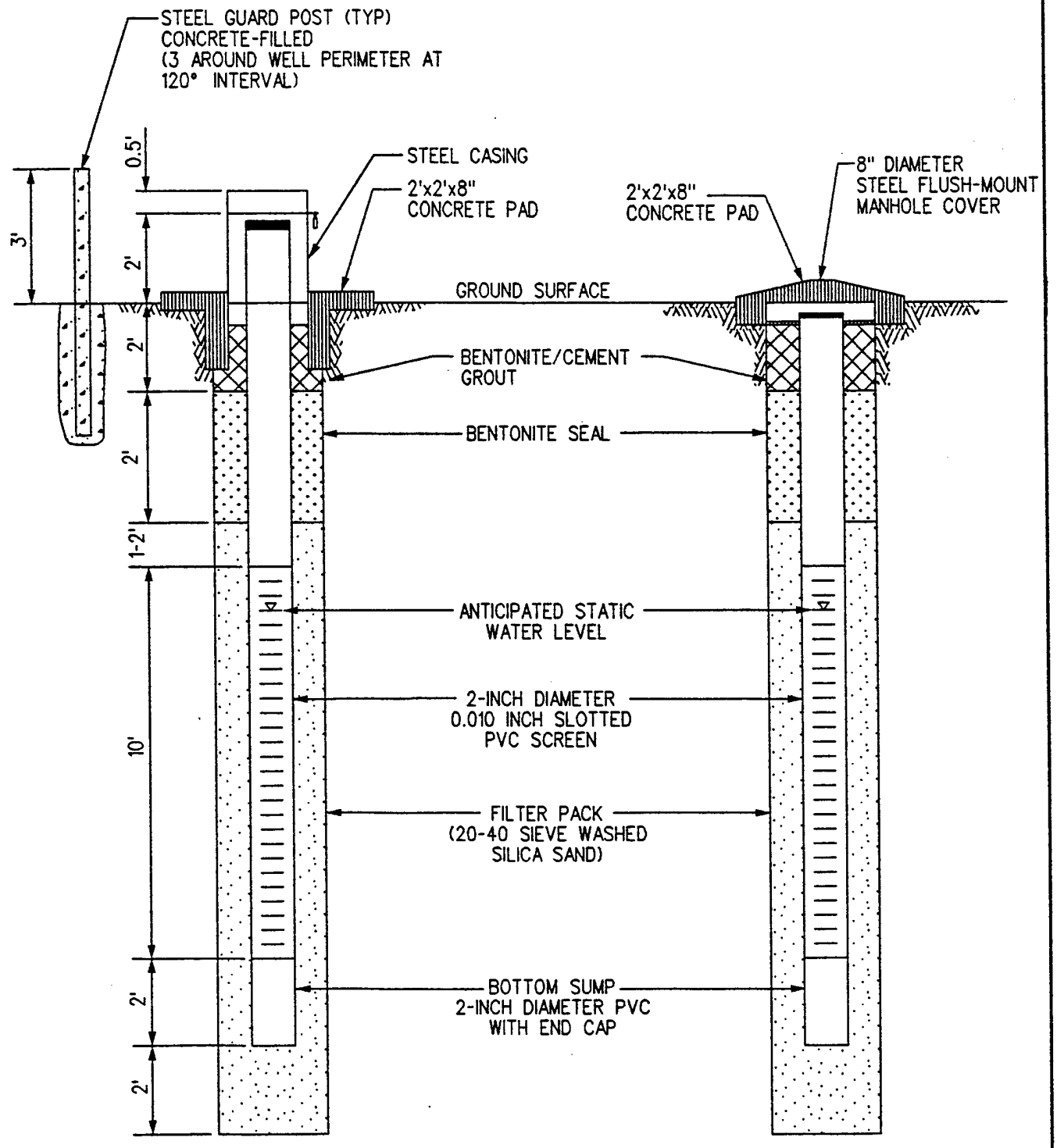
The monitoring wells were installed by suspending the riser and screen assembly inside the augers, and by placing the filter pack around the annular space from a depth of 1 foot to 2 feet below the screen to a height of 1 foot to 2 feet above the screen. The filter pack consisted of washed and graded silica sand that would pass through a No. 20 sieve but would be retained by a No. 40 sieve. The 20/40 grade silica sand was tremied into the borehole and was periodically tamped to make sure all void spaces were filled. A 2-foot-thick seal composed of bentonite pellets was placed above the filter pack. The bentonite seal was allowed to hydrate in place for 4 hours prior to placing a cement/bentonite grout above the seal to depth of approximately 6 inches BLS.

Monitoring wells at Sites 3 and 5 were completed above ground with approximately 2 feet of PVC riser projecting above the ground surface, and have 4-inch square locking protective steel casings set 1.5 feet BLS that extend approximately 2.5 feet above the land surface. The bottom of the casings are set in cement/bentonite grout. A 2-foot by 2-foot by 8-inch sloped concrete pad was placed around each monitoring well to secure the well and promote drainage away from the wellhead. The annular space between the risers and the protective casings was filled with peastone. Weep holes were drilled at the base of the protective casings for drainage. Three steel guard posts were erected in a triangular pattern around each projecting monitoring well. The bottoms of the posts were set at a depth to prevent frost heaving, and were filled with concrete to increase their stability. A typical monitoring well construction diagram is shown in Figure 3.2.

Monitoring wells at Sites 1, 2, 4, 6, and 7 were located in high-traffic areas and required flush-mount completions. These sites are in the ramp parking area for the Boeing KC-135E aircraft, in parking lots, the motor pool, and in other areas where it would be undesirable to have aboveground wells. Flush-mount monitoring wells were

MONITORING WELL CONSTRUCTION DIAGRAM

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NOTE: THE DIMENSIONS SHOWN ARE TYPICAL FOR MOST AS-BUILT MONITORING WELL CONSTRUCTIONS. SEE TABLE G.1 APPENDIX G, FOR SPECIFIC CONSTRUCTION DETAILS. ACTUAL STATIC WATER LEVEL MAY VARY.

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FIGURE 3.2

installed in the same manner as the above ground wells except that the PVC riser terminated at a depth of approximately 3 inches BLS and an 8-inch diameter flush-mount steel manhole cover was installed at the surface. The flush-mount manhole covers installed in the ramp area at Site 6 are 10 inches in diameter and are designed to withstand a pressure of 2,000 pounds per square inch (PSI).

Monitoring well development was initiated at least 48 hours after the wells had been installed. The static water levels and total depths of the monitoring wells, and the initial pH, temperature, and conductivity of groundwater were measured and recorded on monitoring well development forms. The wells were developed by surging with a 1.875-inch-diameter bailer. Groundwater and suspended sediment removed with the bailer were stored in 55-gallon drums for later disposal. The wells were developed until temperature, pH, and conductivity measurements had stabilized to within 10 percent of the previous observation for three consecutive measurements. Physical characteristics such as color, odor, and suspended solids were continually recorded during development. The duration of the development of each well, a calculation of the amount of water to be developed (5 casing volumes), and the actual volume removed from each well were recorded on the monitoring well development form. The original well development forms, along with purging and sampling forms are provided in Appendix C.

3.5.3 Groundwater Sampling

After development, the wells were allowed to equilibrate at least 24 hours prior to purging and sampling. Microtip™ PID readings, static water levels, total depths of the monitoring wells, and the initial pH, temperature, and conductivity of groundwater were measured and recorded on groundwater sampling forms. The monitoring wells were purged prior to collecting samples by removing a minimum of 3 to 5 well casing volumes. The pH, temperature, conductivity, and the physical characteristics of the groundwater were monitored and recorded during purging. A decontaminated Teflon® bailer and new polypropylene rope were used to purge each well.

Groundwater samples were collected from each monitoring well after purging using a second decontaminated Teflon® bailer and new polypropylene rope. The static water level was allowed to recover to at least 80% of the initial level before sampling. The pH, temperature, and conductivity of the groundwater samples were measured and recorded on the groundwater sampling forms. A bottom-emptying device on the bailers was used to reduce the potential for volatilization as the groundwater was transferred to sample containers. Priority pollutant metals samples were collected using a pressure bailer with a 4-micrometer (mm) metals filter.

Sample containers for volatile organic compounds (VOCs) analysis (40-ml glass vials with Teflon® lids and septa) were filled so that the meniscus extended slightly above the mouth of the vial leaving no apparent headspace or bubbles in the sample. The sample bottles obtained from the laboratory were preserved with hydrochloric acid (HCL), sulfuric acid (H2SO4), or nitric acid (HNO3). Table 3.4 presents a summary of the sample containers, preservatives, and holding times for the analytical methods.

TABLE 3.4
SUMMARY OF ANALYTICAL METHODS, SAMPLE CONTAINERS, SAMPLE PRESERVATION METHODS, AND HOLDING TIMES
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Analytical Parameters	Preparation/Analytical Method (SW846)	Preservation Method	Number of Containers and Type of Sample Container	Holding Times (1)
SOIL AND SEDIMENT SAMPLES				
Halogenated Volatile Organic Compounds	SW5030/8010	4°C	3" California ring sampler	14 days
Aromatic Volatile Organic Compounds	SW5030/8020	4°C	3" California ring sampler	14 days
Volatile Organic Compounds	SW5030/8240	4°C	3" California ring sampler	14 days
Semivolatile Organic Compounds	SW3540/8270	4°C	500-ml glass jar	(2)(3)
Pesticides and PCBs	SW3550/8080	4°C	500-ml glass jar	14/40 days(2)
Total Recoverable Petroleum Hydrocarbons	E418.1	4°C	500-ml glass jar	28 days
Total Petroleum Hydrocarbons	8015 mod.	4°C	500-ml glass jar	28 days
Priority-Pollutant Metals	(4)	4°C	500-ml glass jar	180 days (28 days for Hg)
WATER SAMPLES				
Halogenated Volatile Organic Compounds	SW5030/8010	HCl, 4°C	3,40-ml, glass VOA, Teflon Septum	14 days
Aromatic Volatile Organic Compounds	SW5030/8020	HCl, 4°C	3,40-ml, glass VOA, Teflon Septum	14 days
Volatile Organic Compounds	SW5030/8240	HCl, 4°C	2,40-ml, glass VOA, Teflon Septum	14 days
Semivolatile Organic Compounds	SW3510/8270	4°C	2,1-liter narrow mouth amber glass	(2)(5)
Pesticides and PCBs	SW3510/8080	4°C	2,1-liter narrow mouth amber glass	(2)(5)

TABLE 3.4-Continued
SUMMARY OF ANALYTICAL METHODS, SAMPLE CONTAINERS, SAMPLE PRESERVATION METHODS, AND HOLDING TIMES
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Analytical Parameters	Analytical Method	Preservation Method	Number of Containers and Type of Sample Container	Holding Times (1)
Total Recoverable Petroleum Hydrocarbons	E418.1	H2SO4, 4°C	2,1-liter narrow mouth amber glass	28 days
Priority-Pollutant Metals (filtered) (6)	(7)	HNO3, 4°C	1-liter polyethylene	180 days (28 days for Hg)

(1) All holding times are determined from date and time of collection. For GC methods, second-column confirmation must be completed within the stated holding time.
(2) Specified holding times recommended by Richard Westmorland (HAZWRAP), 12 April 1990, based on EPA validation guidelines.
(3) Extract within 14 days of collection, analyze within 40 days of extraction

(4) Analytical Methods for Priority Pollutant Metals (Soil and sediment)

Antimony SW3050/6010
Arsenic SW3050/7060
Beryllium SW3050/6010
Cadmium SW3050/6010
Chromium SW3050/6010
Copper SW3050/6010
Lead SW3050/7421
Mercury SW7471
Nickel SW3050/6010
Selenium SW3050/7740
Silver SW3050/6010
Thallium SW3050/7841
Zinc SW3050/6010

(5) Extract within 7 days of collection, analyze within 40 days of extraction
(6) Soluble metals
(7) Analytical Methods for Priority Pollutant Metals (Groundwater)

Antimony SW3010/6010
Arsenic SW7060
Beryllium SW3010/6010
Cadmium SW3010/6010
Chromium SW3010/6010
Copper SW3010/6010
Lead SW3020/SW7421
Mercury SW7470
Nickel SW3010/6010
Selenium SW7740
Silver SW3010/6010
Thallium SW3020/SW7841
Zinc SW3010/6010

3.6 SOIL BORINGS AND SAMPLING PROCEDURES

All soil borings were advanced with a truck-mounted drill rig using continuous-flight hollow-stem augers. The boreholes were sampled continuously to total depth; soil boring depths were dependent upon site-specific conditions. The boreholes were advanced to a depth corresponding to the static water level as per SAP. The water table generally varied from 5 to 8 feet BLS. An attempt was made to collect soil samples from native soils rather than collecting samples from post-release fill material. In some cases (e.g., at Site 2), the fill material/native soil contact was 3 feet BLS and the water table was approximately 5 to 6 feet BLS. Therefore, in some of the optional borings, only one bottom-hole soil sample coincident with the water table was selected for analysis, rather than the two samples proposed in the SAP (ES, 1992b). Also, the water table had risen by the time that many of the optional borings were drilled. Due to the rise in water levels, only one shallow soil sample collected at, or above, the water table was selected for chemical analysis.

Soil samples were collected continuously for soil description (following the protocol outlined in Subsection 3.5.1), VOC headspace screening, and chemical analysis using 24- or 30-inch-long, 2.5-inch-ID split-spoon samplers containing 3-inch-long stainless steel California ring-liners. After a soil sample was collected, the split-spoon sampler was taken apart, and the stainless steel liners were separated with a knife and screened for organic vapors with a PID. The liner with the highest PID reading observed during the screening process was capped for laboratory VOCs analysis by placing Teflon® tape and a plastic cap over the ends the ring liner. Soil from the adjacent liners was removed and placed in a stainless steel bowl. A small portion of this soil was transferred to a 40-ml glass vial with a Teflon® septum for field GC screening of BTEX components at the field trailer. In addition, a small portion of the soil was immediately retrieved for onsite PID headspace screening of organic vapors. PID screening in the field was accomplished using the following protocol:

- A portion of the soil was transferred to a glass jar immediately upon retrieval;
- The jar was covered with aluminum foil, capped with lid, and set aside for at least 10 minutes; and
- After 10 minutes the probe of the PID was inserted through the foil to obtain a reading.

The remaining soil in the bowl was composited with a stainless steel spoon and divided into quarters. Portions of the soil were gathered from two of the quartered sections and were placed in 500-ml glass sample jars. The process was then repeated until all of the sample jars required for laboratory chemical analyses had been completely filled to the top of the container. Analytical methods, sample containers, and holding times are summarized in Table 3.4.

Soil logging information and PID readings were recorded on soil boring forms. Generally, two soil samples from each boring were selected for laboratory chemical

analysis based on the results of PID and GC screening. In the absence of any evident contamination, one sample from near-surface native soil and one sample from a sampling interval near the water table were selected to be analyzed for the specified organic compounds. All soil samples were prepared for shipment using the procedures described in Subsection 3.9. Two soil samples were collected from one of the 10 basewide piezometers using the same methods described for the soil borings. This piezometer is located in the current Base POL Facility. Soil samples were collected to determine the presence or absence of soil contamination at the location of this piezometer as requested by HAZWRAP (A suspected fuel release at the POL Facility had been identified in the PA).

Boreholes were abandoned by slowly backing the augers out of the borings, minimizing the quantity of soil to be drummed for removal. The remaining void space left after removal of the augers was filled flush to the surface with cement/bentonite grout to prevent migration of soil contaminants through the borehole into groundwater. For permanent identification, a brass pin was placed in the grout at each soil boring location. Information on the brass pin included the boring location number (e.g., UANG-S7-SB1), the company (ES, now Parsons ES), and the date of installation.

3.7 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples were collected 11 and 12 February 1993 on base property from an open, unlined canal portion of the City Drain, referred to in this document as the City Drain Canal. Grab samples of canal water were collected on 11 February 1993 at a depth of approximately 1 to 2 feet below the water surface by lowering a clean bailer into the canal in a zone of low flow velocity. Sample bottles were filled by placing a Teflon® valve on the bottom of the bailer, emptying the contents of the bailer into the sample containers. The analytical methods, types of sample bottles, and preservatives, were the same as those shown in Table 3.4 for groundwater. The samples were prepared for shipment using the procedures described in Subsection 3.9.

City Drain Canal sediment samples were collected on 12 February at the locations of the canal water samples and at additional locations along the course of the canal. Sediments were collected near the edges of the canal in bottom sediments at a depth of approximately 1 foot using a decontaminated hand-held stainless steel hand auger. A portion of the sediments was removed from the auger bucket and was immediately placed into a 500-ml glass jar for laboratory VOCs analysis. The remaining sediment was placed into a decontaminated stainless steel mixing bowl, was composited, and was then placed into sample jars to complete the required suite of laboratory analyses. If additional sediment was needed to fill the required number of sample jars, a second bucket of sediment was obtained from the same vicinity and depth as the first bucket. The analytical methods, types of sample bottles, and preservatives, were the same as those shown in Table 3.4 for soil. The samples were prepared for shipment using the procedures described in Subsection 3.9.

3.8 SAMPLE NUMBERING SYSTEM

The establishment of a standard sample designation/labeling protocol is essential to ensure adequate quality assurance and quality control (QA/QC) with regard to the traceability of samples and their associated analytical data. Proper labeling allows for the tracking of samples from the time of sample collection, through analysis, and following project completion, should future data correlation be deemed necessary. The proper labeling of samples is also critical for ensuring that samples are analyzed within the required sample holding times as specified by the appropriate analytical methods.

Sample tracking was initiated in the field with the assignment of an identification number to each sample as it was collected. The field sample identification number consisted of four identifying symbols separated by hyphens. For example, a groundwater sample might be labeled:

UANG-S7-MW2-1

In this example UANG is a unique project symbol (Utah Air National Guard), S7 is the site (Site 7, Oil Sludge Pond), MW2 is the sampling location (monitoring well 2, or MW2), and the final 1 is the sequential number of the sampling round. Other sampling location descriptions include SB (soil boring), SS (surface soil), CW (canal water), and CS (canal sediment).

For soil borings only, the final numbers represent the sample interval from which the sample was collected. For example, UANG-S2-SB6-2-4 identifies a sample collected at Site 2 from soil boring 6 at a depth of 2 to 4 feet BLS.

The identification number was recorded on the sample label and the chain-of-custody forms described in Subsection 3.9.2. The number was also recorded in the field logbook, soil boring log, monitoring well soil boring and construction log, monitoring well development form, and groundwater sampling form, along with any additional comments relative to sample description and collection methodology.

QC samples were labeled as follows:

- Rinsate blanks were designated as RB and numbered sequentially (e.g., UANG-RB1, UANG-RB2, etc.).
- Trip blanks were designated as TB and numbered sequentially (e.g., UANG-TB1, UANG-TB2, etc.).
- Field blanks were designated as FB and numbered sequentially (e.g., UANG-FB1, UANG-FB2, etc.).
- Blind field duplicates were collected and designated by a fictitious sampling interval (e.g., if the duplicate was collected from the second depth interval in SB3, the first two sampled intervals may have been designated as 2-4 and 5-7, and the field duplicate of the 5-7 interval may have been labeled 9-11 or some other

fictitious interval). The true descriptions of the blind field duplicates were recorded in the field log book.

3.9 SAMPLE HANDLING AND CUSTODY

3.9.1 Sample Handling

All samples except soil and sediments analyzed for VOCs were placed in preserved, pre-cleaned (EPA Level III protocol) glass or plastic bottles for shipment to the laboratory. All bottles had Teflon® lined lids. The pre-cleaned, preserved bottles were obtained from Environmental Sampling Supply of Oakland California. The sample bottle caps were taped using polyethylene (or Teflon® for VOC samples) tape to ensure they would remain sealed during shipment.

Individual sample bottles were wrapped in bubble pack to prevent breakage during shipment. The wrapped bottles were placed into insulated shipping coolers with plastic bags of ice or Blue Ice®. A chain-of-custody form describing the contents of the cooler was placed in a sealed plastic bag and taped to the upper lid of the cooler. The shipping coolers were sealed to prevent leakage of melting ice and were affixed with signed and dated custody seals taped over opposite ends of the lid. The coolers were labeled in accordance with the U.S. Department of Transportation (DOT) regulations for transport as described in the 49 Code of Federal Regulations (CFR) Parts 171 through 177, and were shipped by Federal Express® for next day delivery to the laboratory.

3.9.2 Sample Custody

Proper sample custody procedures are needed to ensure that samples have been obtained from the locations stated and that they have reached the laboratory without alteration. All sample bottles were maintained in a locked storage area prior to use. Evidence of the sample traceability from collection to shipment, laboratory receipt, and laboratory custody was documented. A sample was considered to be in a person's custody if the sample was:

- In a person's actual possession;
- In view after being in a person's possession;
- Locked, so it cannot be tampered with, after having been in physical custody; or
- In a secured area, with access restricted to authorized personnel.

The field team leader was responsible for overseeing and supervising the implementation of proper sample custody procedures in the field. The team leader was also designated as the field sample custodian and was responsible for ensuring sample custody until the samples had been transferred to a courier.

Once the samples were received by the laboratory, a designated person was responsible for maintaining a file of all the original documents (e.g., chain of custody forms, traffic reports, special analytical services request forms, etc.) pertinent to sample custody and sample analysis protocol.

A chain-of-custody (COC) form accompanied the samples during shipment and throughout the laboratory handling process. When transferring samples, the individuals relinquishing and receiving the samples, signed, dated, and noted the time on the record. The laboratory maintained a file copy, and the completed original was returned to the project manager as a part of the final analytical report. This record is used to document sample custody transfer from the sampler to the laboratory. COCs are provided in Appendix D.

Shipments were sent by Federal Express® overnight, and air bills were kept as receipts of shipment. Air bills have been retained as part of the permanent documentation.

3.10 ANALYTICAL METHODS

A summary of the analyses performed by matrix and method for the site environmental samples, background and basewide (City Drain Canal) environmental samples, and field QA\QC samples, including SI-derived waste materials, is presented in Table 3.5.

EPA-published methods were used as the basis for all analyses for which such methods exist. The EPA methods are contained in Test Methods for Evaluation, Solid Waste, SW846, 3rd edition (1983b); or Methods for the Analysis of Water and Wastes, EPA 600/4-79-020 (1983c). Detected target compounds and detection limits by method are presented and discussed in Section 4.

3.11 QUALITY ASSURANCE AND QUALITY CONTROL

3.11.1 Quality Control Samples

During each sampling effort, a number of QC samples were collected and submitted for laboratory analysis. The number and frequency of the QC sample collection are given in Table 3.5. The types of QC samples that were collected, along with a brief description of each sample type, are outlined in the following sections. QC samples were collected in accordance with the guidelines contained in HAZWRAP/Department of Energy (HAZWRAP/DOE) documents 69R1 (1990a), 65R1 (1990b), and 100 (1990c).

3.11.1.1 Trip Blanks

Trip blanks accompanied environmental samples that were to be analyzed for VOCs. The trip blank analytical results serve as a baseline measurement of potential VOCs cross-contamination that environmental samples may have been exposed to in the field, during packaging and transport, and in laboratory storage prior to analysis.

Trip blanks originated at the laboratory and contained HPLC-grade water placed in 40-ml glass vials by the subcontracted laboratory. Two trip blanks were placed in coolers at the inception of each days field effort, and accompanied the environmental samples during sample collection at the sites. Trip blank vials were not opened in the field. The trip blanks and associated environmental samples were shipped to the

TABLE 3.5
SUMMARY OF ANALYSES PERFORMED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

		Environmental Samples										Field QA/QC Samples					Total Samples	
Matrix Analysis	Method (a)	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 10	Backgrnd/ Basewide	Subtotal	Field Duplicate(1)	Equipment Rinseate(2)	Trip Blanks(3)	Field Blanks(4)	MS/ MSD(5)	Soil	Water
BOREHOLE SOILS																		
Halogenated Compounds	SW8010	14	3	6	8	6	12	10	9	5	73	8	5	7	0	7	95	12
Aromatic Compounds	SW8020	14	3	6	8	6	12	10	9	5	73	6	5	7	0	7	93	12
Volatile Organic Compounds	SW8240	0	6	0	8	8	8	6	1	2	39	4	4	9	1	5	53	14
Semivolatile Organic Compound	SW8270	0	9	6	16	14	20	16	1	7	89	10	9	0	1	9	117	10
TRPH	E418.1	0	9	6	16	14	20	16	0	7	88	10	9	0	1	9	116	10
Total Petroleum Hydrocarbons	8015 mod.	0	0	0	0	0	0	0	8	0	8	0	0	0	0	1	10	0
Priority Pollutant Metals	SW3050(b)	0	8	0	16	0	0	16	0	7	47	5	4	0	1	5	62	5
Pesticides/PCB	SW8080	20	0	0	0	0	0	0	1	7	28	4	3	0	2	3	38	5
SEDIMENTS																		
Halogenated Compounds	SW8010	0	0	6	0	0	0	0	0	6	12	1	1	0	2	1	15	3
Aromatic Compounds	SW8020	0	0	6	0	0	0	0	0	6	12	1	1	0	2	1	15	3
Semivolatile Organic Compound	SW8270	0	0	6	0	0	0	0	0	6	12	1	1	0	2	1	15	3
TRPH	E418.1	0	0	6	0	0	0	0	0	6	12	1	1	0	2	1	15	3
Priority Pollutant Metals	SW3050(b)	0	0	0	0	0	0	0	0	6	6	1	1	0	2	1	9	3
Pesticides/PCB	SW8080	0	0	0	0	0	0	0	0	6	6	1	1	0	2	1	9	3
GROUNDWATER																		
Halogenated Compounds	SW8010	2	3	4	2	2	8	4	0	3	28	3	7	11	5	4	0	62
Aromatic Compounds	SW8020	2	3	4	2	2	8	4	0	3	28	3	7	11	5	4	0	62
Semivolatile Organic Compound	SW8270	0	3	4	2	2	8	4	0	3	26	3	5	0	6	4	0	48
TRPH	E418.1	0	0	0	0	0	0	2	0	3	5	0	2	0	2	1	0	11
Priority Pollutant Metals	SW3010(c)	0	3	0	2	0	0	4	0	3	12	1	3	0	5	3	0	27
Pesticides/PCB	SW8080	3	0	0	0	0	0	0	0	3	6	1	2	0	6	1	0	17
Arsenic	SW7060	2	NA	2	NA	1	5	NA	0	NA	10	1	NA	0	NA	1	0	13

TABLE 3.5-Continued
SUMMARY OF ANALYSES PERFORMED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

		Environmental Samples										Field QA/QC Samples					Total Samples	
Matrix Analysis	Method (a)	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 10	Backgrnd/ Basewide	Subtotal	Field Duplicate(1)	Equipment Rinseate(2)	Trip Blanks(3)	Field Blanks(4)	MS/ MSD(5)	Soil	Water
SURFACE WATER																		
Halogenated Compounds	SW8010	0	0	0	0	0	0	0	0	3	3	1	1	1	1	1	0	9
Aromatic Compounds	SW8020	0	0	0	0	0	0	0	0	3	3	1	1	1	1	1	0	9
Semivolatile Organic Compound	SW8270	0	0	0	0	0	0	0	0	3	3	1	1	0	1	1	0	8
TRPH	E418.1	0	0	0	0	0	0	0	0	3	3	1	1	0	1	1	0	8
Prioity Pollutant Metals	SW3010(c)	0	0	0	0	0	0	0	0	3	3	1	1	0	1	1	0	8
Pesticides/PCB	SW8080	0	0	0	0	0	0	0	0	3	3	1	1	0	1	1	0	8
CONTAINERIZED SOILS																		
TCLP	SW1311(d)	1	1(e)	0	1(e)	0	0	1(e)	1	0	3	0	0	0	0	1	5	0

(1) Field Duplicates-Collected at a frequency of 10% per matrix.

(2) Equipment Blanks-Collected at a frequency of 10% per matrix.

(3) Trip Blanks-One per shipment of samples for volatile organic analysis.

(4) Field Blanks-One per water type (HPLC-grade and municipal/potable) per field sampling event.

(5) Matrix Spike and Matrix Spike Duplicate-One MS/MSD was collected at a frequency of 10% per matrix type. Number in table is for MS/MSD sets (1MS/MSD=1MS and 1MSD).

(a) Series 1000-9000 Methods
Test Methods for Evaluating Solid Wastes, SW846, 3rd Edition, USEPA, November 1986.

(b) Preparation and analytical methods for prioity pollutant metals in soil/sediment: Sb, Be, Cd, Cr, Cu, Ni, Ag, Zn, by SW3050/6010; As by SW3050/7060, Pb by SW3050/7421, Hg by SW7470, Se by SW3050/7740, Tl by SW3050/7841.

(c) Preparation and analytical methods for prioity pollutant metals in groundwater and surface water: Sb, Be, Cd, Cr, Cu, Ni, Ag, Zn, by SW3010/6010; As by SW7060, Pb by SW3020/7421, Hg by SW7470, Se by SW7740, Tl by SW 3020/7841.

(d) Preparation for TCLP extract was SW1311. Analytical methods: volatile organics by SW8240, semi-volatile organics by SW8270, Hg by SW7470, and As, Ba, Cd, Cr, Cu, Ni, Ag, Zn, by Sw3010/6010.

(e) Sample was a composite of containerized soils at Sites 2, 4, and 7.

TRPH - Total Recoverable Petroleum Hydrocarbons

Note: Halogenated compounds and aromatic compounds are volatile organic compound analyses.

Note: Two soil samples from basewide piezometer PI-5 are included in the background/basewide totals for borehole soils.

laboratory in sealed containers. At the laboratory, trip blanks were stored with the associated environmental samples, and were analyzed with samples for VOCs. Trip blanks were inadvertently left out of the shipping container in one shipment. In this case, the trip blanks were shipped with the following day's samples.

3.11.1.2 Rinsate Blanks

Rinsate blanks were collected from sampling equipment (bailers, split-spoon samplers, auger bucket) when devices other than the sample containers were used for the collection of samples. The analytical results of rinsate blanks verify potential cross-contamination of environmental samples due to improperly decontaminated sampling equipment.

Rinsate blanks were obtained using certified optima HPLC-grade water from Fisher Scientific that was transported to the sample collection site, poured into the sampling device following equipment decontamination procedures, and was collected directly into the sample containers. The rinsate blanks were shipped to the laboratory with the environmental samples and were analyzed for the same parameters as the associated samples. One rinsate blank was collected per sampling event for every 10 environmental samples.

3.11.1.3 Field Blanks

Potable water field blanks were collected to verify a potential source of cross-contamination from water used to decontaminate drilling rig and sampling equipment. HPLC-grade water field blanks were collected to verify potential environmental cross-contamination introduced to samples on site. One sample from each event and each source of water was collected and analyzed. The potable water field blanks were tap water obtained from Vern and Carol's Airport Diner (on base). The environmental field blanks were collected by pouring certified optima HPLC-grade water from Fisher Scientific into sample containers in the field.

3.11.1.4 Field Duplicates

Analysis of duplicates provides statistical information relating to sample variability and serves as a check on the precision of any sample collection method as it pertains to the sampled area. Duplicate soil samples for analyses of semi-volatile organic compounds (SVOCs), total recoverable petroleum hydrocarbons (TRPH), pesticides and polychlorinated biphenyls, and metals were obtained from the same interval as the primary sample. The duplicate VOC sample was obtained from the ring-liner adjacent to the primary sample collected at that interval. When collecting samples for groundwater analysis, the duplicate was collected at the same time and from the same volume of water as the original.

Ten percent of all samples from each matrix for each event were collected in duplicate and were submitted for laboratory analysis. Field duplicates were labeled in a unique manner so that persons performing laboratory analyses were unable to distinguish the duplicates from the associated primary samples.

3.11.1.5 Matrix Spikes and Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) samples were collected to assess the accuracy and precision of the analytical data. MS/MSD samples were collected at a frequency of 10 percent per matrix per event. Three times as much soil and water was collected for the MS/MSD samples and associated environmental samples. The 40-ml glass vials for VOCs were filled first, and a composite of the remaining soil was packed into the remaining jars.

3.12 SURVEYING

All piezometers, monitoring wells, and soil borings were surveyed by a professional surveyor registered in the State of Utah. Ground elevations were measured to the nearest 0.1 foot. Elevations of the monitoring well risers (top of casing) were measured from a notch on the north side of the PVC riser to the nearest 0.01 foot. Coordinate locations were measured to the nearest 0.1 foot in Utah State Plane Coordinate system, and to the nearest 0.0001 second longitude and latitude.

3.13 ADDITIONAL PROCEDURES

3.13.1 Materials Certification

Documentation of all materials used in the SI were retained on site for future reference. Examples of the types of documentation retained are as follow:

- Sieve analysis of all filter pack material;
- Material certificates for all construction materials;
- Manufacturer and lot numbers for all calibration standards; and
- Certificates of analysis for materials used in sampling and decontamination procedures.

Material blanks were collected. Material blanks are samples of the construction materials used during the field effort that are archived for future reference. Material blanks are required for all of the applicable construction materials used on the project. The types of materials include: PVC pipe, well screen, filter pack material, drilling additives, bentonite, cement, and cement antifreeze compounds. Samples of each required material were collected and stored for future testing and analysis, if required.

3.13.2 Water Level Measurements

Measurements of water levels in piezometers and monitoring wells were gauged using electronic water level indicators. Two types were used. An Environmental Instruments Co. oil/water interface probe was used to measure the water levels in monitoring wells. A Slope Indicator Co., water level indicator (model 51453) was used to measure water levels in piezometers because of the smaller 1-inch diameter of the piezometers. Identical water levels in monitoring wells were obtained with both instruments as a check on calibration and accuracy.

3.13.3 Field Changes

All variances from procedures stipulated in the work plan (ES, 1992a) or sampling and analysis plan (ES, 1992b) and other planning/design documents were documented using the field change request form (Form 9). The HAZWRAP project manager for the SI approved all of the field changes that had a major impact on cost, schedule, and technical performance, prior to initiation of requested change. Signed and dated copies of the field change request forms are included in Appendix B.

3.14 SI-DERIVED WASTE MANAGEMENT

Following completion of the field activities at each site, the site was restored to pre-SI site conditions.

3.14.1 Soil Cuttings

Soil cuttings generated from the installation of piezometers and monitoring wells and the advancement of soil borings were containerized in drums at each site. The DOT approved 55-gallon drums were labeled according to their contents. Drums were completely filled with the soil cuttings from one or more soil borings or monitoring wells to reduce the amount of storage area required for the drums.

3.14.2 Decontamination Fluids

Decontamination fluids were collected daily and stored in 55-gallon drums. The contents of the drums were disposed into the sanitary sewer system following provision of the analytical data by the sanitary sewer pre-treatment coordinator.

3.14.3 Well Development and Purge Waters

The liquids derived from the purging and development of monitoring wells were collected in 55-gallon drums for proper disposal at a later date. The groundwater analytical reports were reviewed to determine if concentrations of contaminants exceeded limits set by the Safe Drinking Water Act (SDWA), or the Clean Water Act (CWA). The purge and well development fluids collected from the site monitoring wells were disposed into the sanitary sewer system by provision of the sanitary sewer pre-treatment coordinator if SDWA or CWA levels were not exceeded.

3.14.4 Hazardous Waste Disposal

The disposal of all SI-derived wastes were arranged by the Base Environmental Management Directorate, as outlined in the SAP (ES, 1992b). All disposal manifests were signed by the designated base personnel. The analytical results and method of disposal for the SI-derived soil cuttings are provided in Section 4.

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SECTION 4
SITE INVESTIGATION RESULTS

4.1 INTRODUCTION

4.1.1 Data Organization

This section presents the results of the SI conducted at the Base and initially discusses analytical QA/QC in Subsection 4.1. Most data are presented on a site-specific basis. Basewide activities which are not site-specific are discussed in Subsection 4.2. Subsections 4.3 through 4.10 present the SI results for Sites 1 through 7 and Site 10. Each site discussion presents screening, confirmation and optional site activities, and results of the field investigation and laboratory analyses. Field investigation results include geology and hydrogeology, groundwater flow calculations, soil contamination assessment, and groundwater contamination assessment. A summary and analysis of the basewide distribution of arsenic in shallow groundwater is contained in Subsection 4.11. Subsection 4.12 presents the analyses of SI-derived wastes. Groundwater analytical results of five additional monitoring wells installed in 1995 and the results of a second round of sampling of the 12 existing wells installed in 1993 are also included in the site by site discussions.

4.1.2 Laboratory Analytical QA/QC

Proper interpretation of laboratory analytical data requires consideration of QA/QC activities. All laboratory data in this section have been validated in accordance with HAZWRAP Level C requirements as presented in *Requirements for Quality Control of Analytical Data* (HAZWRAP, 1990b). This level of validation corresponds to EPA Level III QC.

Review of the analytical data indicates that most of these data are accurate, precise, and complete. However, during the data review, some analytical and laboratory QC problems were identified. In instances where the QC problems potentially affect the quality of the data, the affected samples have been qualified. Qualifier flags and symbols are defined as follows:

U - The compound was not present in the sample above the associated detection limit.

J - The concentration is estimated. The quantitative analysis is acceptable, but the value cannot be considered as absolutely accurate.

UJ - The compound was not detected in the sample, but the detection limit, which precedes the flag, is estimated.

R - Data are rejected and are unusable, and therefore are not reported. The only way to obtain useful data is to resample and reanalyze.

A complete description of the 1992-93 and 1994 data with the reasons for data qualification is contained in QA/QC report No.1 of Appendix E. A complete description of the 1995 data with the reasons for data qualification is contained in QA/QC report No.2 of Appendix E.

Review of the 1992-93 and 1994 data indicated that some analytical QC problems were identified with method preparation blanks, and the associated samples were qualified. Analytical results of the method preparation QA/QC blanks associated with the 1992-93 and 1994 environmental samples indicated the following potential sources of cross-contamination:

- The common laboratory contaminant acetone was detected in several method blanks analyzed with environmental samples. Affected samples that contained less than 10 times the concentration found in a blank are reported as not-detected. Samples that contained this compound at concentrations in excess of 10 times the concentrations detected in the associated method blanks were considered valid and are reported as detected in the results. If acetone was detected in analytical samples but not in associated blanks, the results also are reported.
- The common laboratory contaminants phthalates were detected in some of the method blanks analyzed with environmental samples. Affected samples that contained less than 10 times the concentration found in a blank are reported as not-detected. Samples that contained these compounds at concentrations in excess of 10 times the concentrations detected in the associated method blanks were considered valid and are reported as detected. If phthalates were detected in analytical samples but not in associated blanks, the results also are reported.

Review of the 1995 data indicated that some analytical QC problems were identified with laboratory and method preparation blanks, and the associated samples were qualified. Analytical results of the laboratory and method preparation QA/QC blanks associated with the 1995 environmental samples indicated the following potential sources of cross-contamination:

- Chloromethane and dichlorodifluoromethane were detected in one method blank analyzed with environmental samples. Three affected samples contained less than five times the concentration found in the blank, and thus, are reported as not-detected.
- The common laboratory contaminants phthalates were detected in some of the method blanks analyzed with environmental samples. Seven affected samples contained less than 10 times the concentration found in the blanks, and thus, are reported as not-detected.

- Seven different metals were detected in several laboratory and method blanks. Affected samples that contained less than five times the absolute value concentration found in a blank are reported as not-detected. Samples that contained metals at concentrations in excess of five times the concentrations detected in the associated method blanks were considered valid and are reported as detected.

4.1.3 Field Blank Analytical QA/QC

Some QC problems were identified with trip blanks, equipment rinsate blanks, and field blanks associated with the collection and handling of environmental samples. The analytical results of the field QA/QC blanks associated with the 1992-93 and 1994 environmental samples indicated the following potential sources of cross-contamination:

- Two trip blanks contained minor concentrations of VOCs; 1,1-dichloroethane was detected in one trip blank and dichloromethane was detected in another trip blank.
- Chloroform was detected in all but one of the rinsate blanks, diethylphthalate was detected in one rinsate blank, and 1,3-dichlorobenzene was detected in one rinsate blank.
- Chloroform was detected in all HPLC-grade deionized water field blanks and potable water field blanks analyzed for VOCs. Bromodichloromethane and dibromochloromethane were also detected in potable water field blanks. Ethylbenzene and di[illegible]lorobenzene were detected in one field blank, and 1,3-dichlorobenzene was detected in one field blank.

The analytical results of the field QA/QC blanks associated with the 1995 environmental samples indicated the following potential sources of cross-contamination:

- Several field QA/QC samples contained VOCs (both halogentated and aromatic) that affected only a limited number of environmental samples.
- Chromium and zinc were detected in a potable water field blank and chromium and nickel were detected in a rinsate blank that affected samples.

Analytical results of the trip blank, equipment rinsate blank, and field blank QA/QC samples and associated environmental samples are presented in the QA/QC reports in Appendix E. Based on the field QA/QC results, samples were qualified using the 5X or 10X rules.

4.1.4 Analytical Detection Limits

Two laboratories were used for the sample analyses: ES Berkeley Laboratory and DataChem Laboratories (ES Berkeley laboratory is no longer in service). All of the 1992-93 soil, sediment, and surface water analyses were performed by the ES Berkeley Laboratory. The 1992-93 groundwater samples, with the exception of a sample from background well BGMW1, were analyzed by ES Berkeley Laboratory. Additional soil samples collected in October 1994 at Site 1 and a limited number of soil samples

collected in May 1994 at Site 10 were analyzed by DataChem Laboratories. In 1995, the second round of groundwater samples, and soil samples collected at background well BGMW2, were analyzed by DataChem Laboratories.

The laboratories used the lowest attainable detection limits by method, based on their protocols, equipment, etc. However, the lowest detection limits were not always achieved as these limits are highly matrix dependent. Analysis was performed on all samples using USEPA SW-846 protocols which requires laboratories to establish the lowest practical quantitation/detection limits as defined in these methods. The contract required detection limits (CRDLs) defined and reported by DataChem on their original data forms are actually USEPA SW-846 practical quantitation limits. The term **detection limits** used throughout this section of the report for the presentation of organic analytical data is equivalent to the laboratory reported CRDLs, by definition. The CRDL as truly defined by USEPA Contract Laboratory Program (CLP) was not applicable or used in the UANG project requirements.

For metals, the lowest laboratory practical quantitation/detection limits (defined as method detection limits {MDLs}) were selected for final reporting. Therefore, the term **detection limits** used throughout this section of the report as applied to metals is the method detection limit, by definition.

There is an important difference in how the laboratories performed the analyses pertaining to sample dilution. ES Berkeley Laboratory applied the dilution equally to all of the target analytes for a given method, thereby raising the detection limits of an affected sample analysis by the factor of dilution. For example, if the dilution was 10, the detection limits of all analytes included in the method were increased by a factor of 10. DataChem Laboratories used separate dilutions for the individual analytes included in the method, based on their relative concentrations. The DataChem protocol established and maintained the lowest possible detection limits for analytes detected in the low concentration range.

4.2 BASEWIDE SCREENING AND SAMPLING ACTIVITIES

4.2.1 Groundwater Elevations and Flow Direction

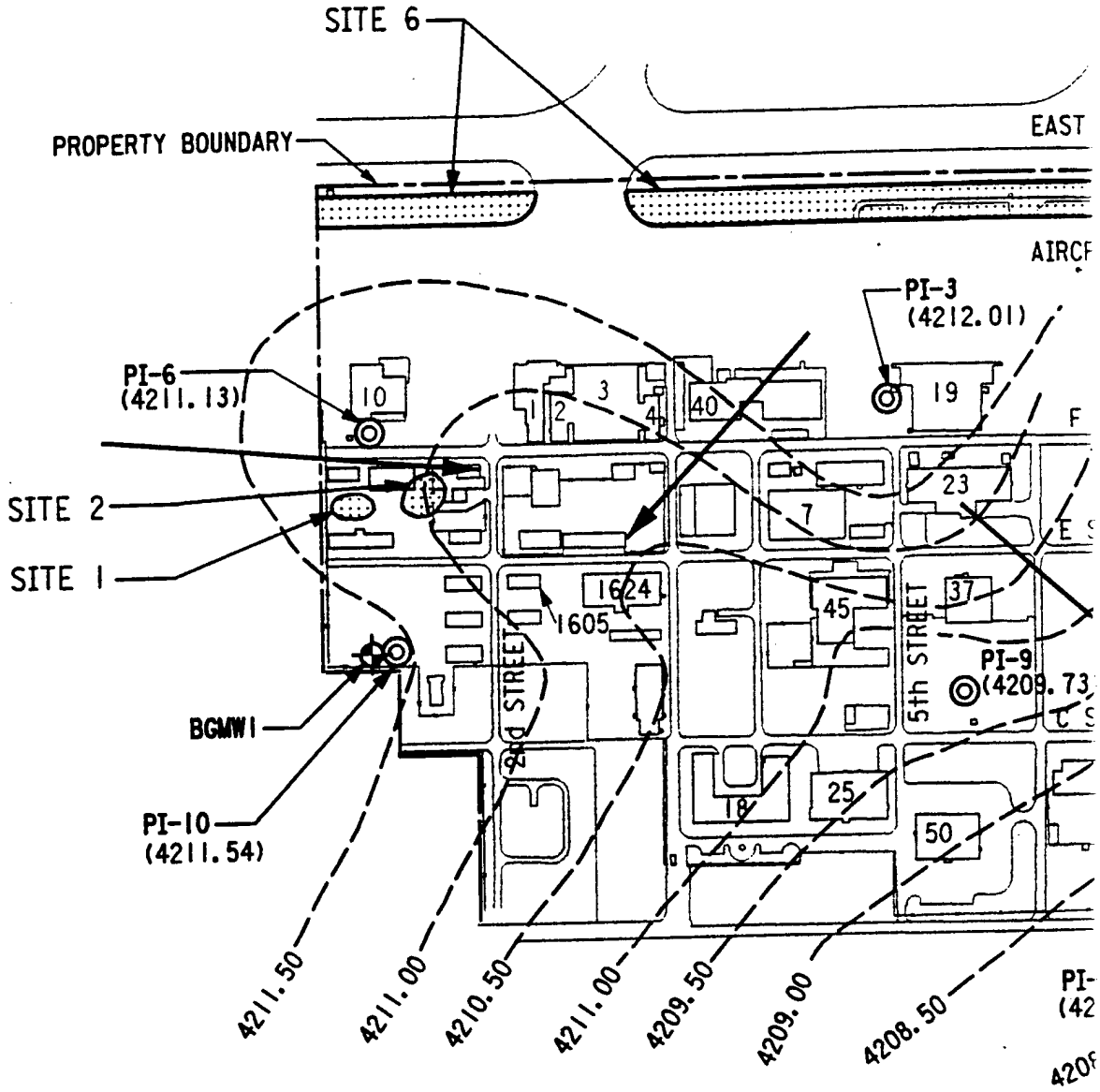
4.2.1.1 Piezometers - December 1992

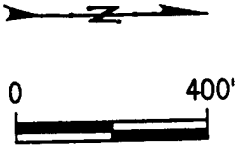
Ten shallow piezometers were installed basewide so that approximate groundwater flow directions at the sites could be determined for proper placement of upgradient and downgradient monitoring wells at the sites. With one exception, the piezometers are screened in the 10- to 15-foot BLS interval of the shallow aquifer. Piezometer construction details and screened intervals are provided in Table F.1, Appendix F. The piezometer soil boring logs with construction diagrams are also contained in Appendix F.

Water levels in piezometers were measured to establish the groundwater flow patterns across the Base. The piezometer locations, corresponding groundwater elevations, and resulting potentiometric surface and gradient are shown in Figure 4.1.

POTENTIOMETRIC SURFACE
FROM BASEW
28 DEC

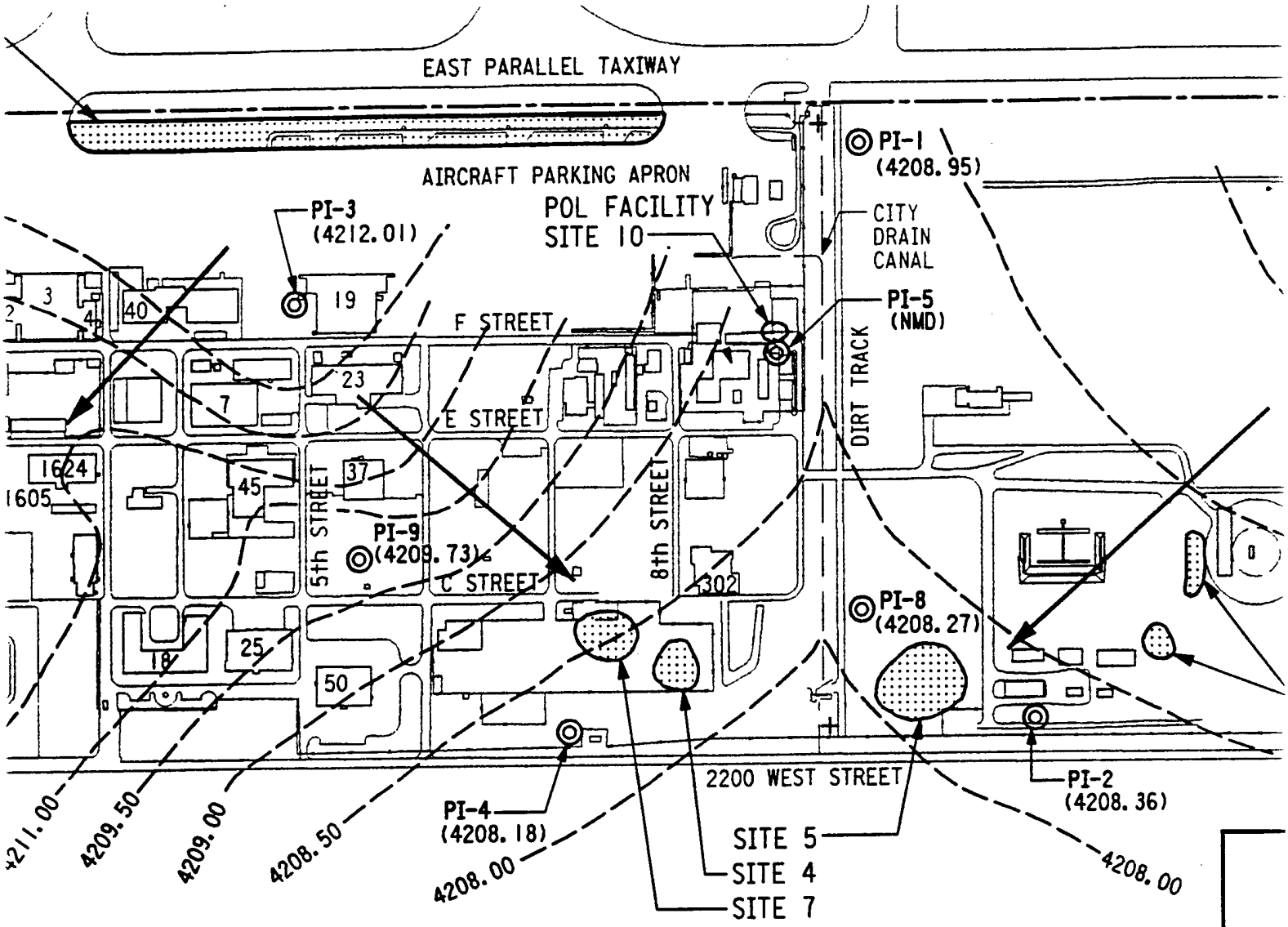
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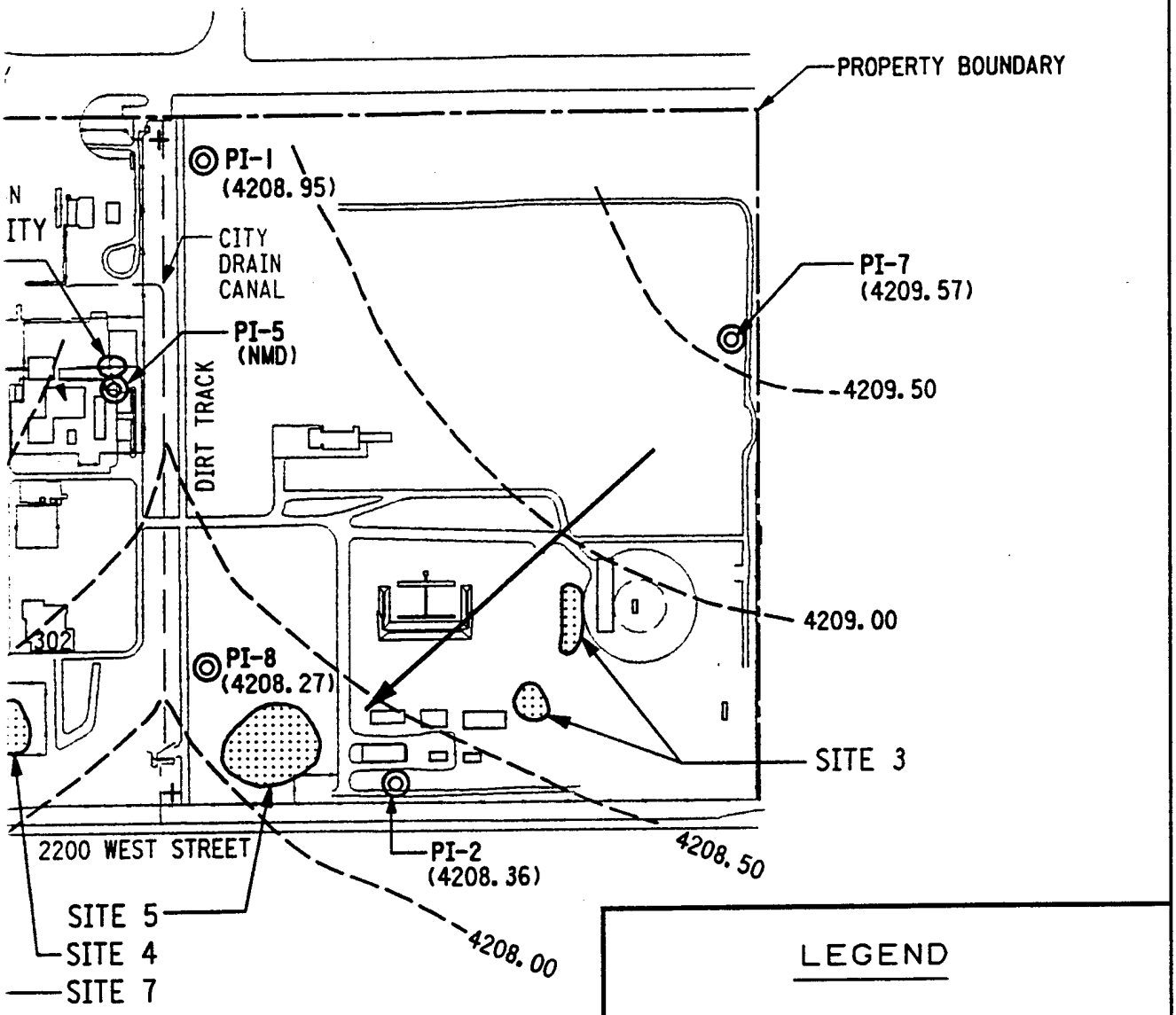
POTENTIOMETRIC SURFACE - GROUNDWATER GRADIENT MAP FROM BASEWIDE PIEZOMETERS 28 DECEMBER 1992

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



ATER GRADIENT MAP
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GUARD
IRPORT



LEGEND

PI-1 (4208.95)	PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)
BGMW1	BACKGROUND SOIL BORING/ MONITORING WELL LOCATION
4208.00	APPROXIMATE GROUNDWATER ELEVATION CONTOUR (ft-MSL)
	GROUNDWATER FLOW DIRECTION (12/92)
	IRP SITE LOCATION

FIGURE 4.1

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Groundwater elevations are tabulated in Table 4.1. Groundwater elevations in piezometers on 28 December 1992 showed the general gradient across the Base to be northeast in areas south of the City Drain Canal and southeast in areas north of the City Drain Canal. The inferred groundwater gradients indicate that shallow groundwater was discharging into the Canal, as shown in Figure 4.1.

4.2.1.2 Piezometers and Monitoring Wells - March 1993

In January 1993, 12 shallow monitoring wells were installed at the sites based on flow directions inferred from the 28 December 1992 water levels in basewide piezometers. One of the monitoring wells, BGMW1, is a background well. With one exception, the monitoring wells are approximately screened in the 5- to 15-foot interval of the shallow aquifer. Well construction details and screened intervals are provided in Table G.1, Appendix G. The monitoring well soil boring logs with construction diagrams and other pertinent information are also contained in Appendix G.

Water levels in basewide piezometers and site monitoring wells installed during the SI were measured 16 March 1993 to establish hydraulic gradients and flow directions for groundwater flow rate calculations at the sites. March 1993 corresponds to a period of groundwater recharge to the shallow aquifer that was increased by the melting of heavy winter snows. The piezometer and monitoring well locations, corresponding groundwater elevations, and resulting potentiometric surface and gradient are shown in Figure 4.2. Groundwater elevations are tabulated in Tables 4.1 and 4.2. Groundwater elevations on 16 March 1993 showed the general gradient across the Base to be northeast and northwest in areas south of the City Drain Canal, and south in areas north of the City Drain Canal. The inferred groundwater gradients indicate that shallow groundwater was discharging into the Canal, as shown in Figure 4.2.

4.2.1.3 Piezometers and Monitoring Wells- July 1995

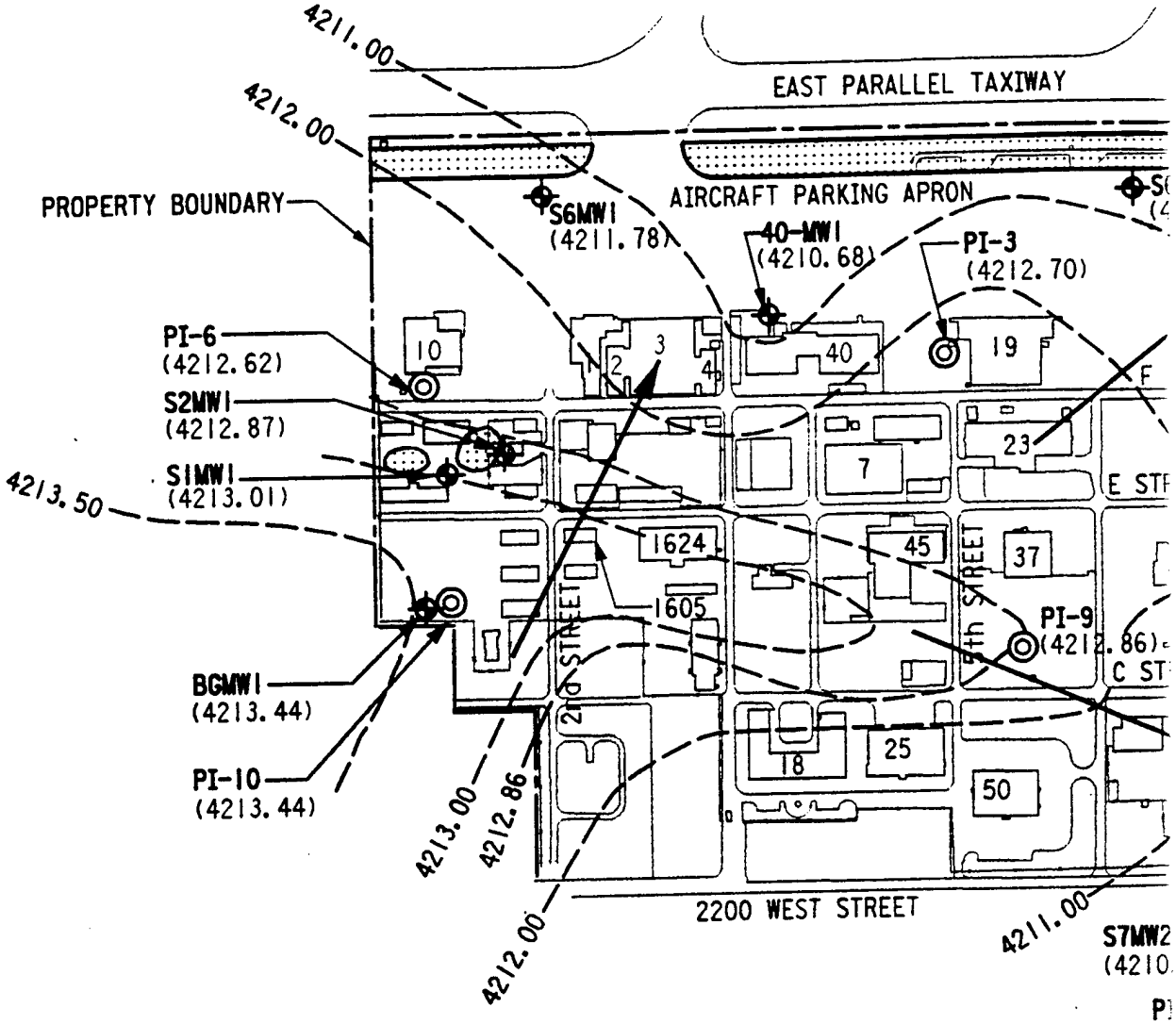
Due to the observed variations in groundwater flow direction between December 1992 and March 1993, a total of five additional shallow monitoring wells were installed at selected IRP sites to ensure adequate downgradient coverage. These five wells were installed in August 1995. One of the monitoring wells, BGMW2, is a background well. The monitoring wells are all approximately screened in the 4- to 14-foot interval of the shallow aquifer. Well construction details and screened intervals are provided in Table G.1, Appendix G. The monitoring well soil boring logs with construction diagrams and other pertinent information are also contained in Appendix G.

Water levels in basewide piezometers and site monitoring wells installed during the SI in 1992-93 were measured 19 July 1995 to establish groundwater gradients across the Base prior to the placement of the additional monitoring wells. July 1995 corresponds to a period of low groundwater elevation and gradient. The piezometer and monitoring well (12 existing and five new) locations, corresponding groundwater elevations, and resulting potentiometric surface and gradient are shown in Figure 4.3. Groundwater elevations are tabulated in Table 4.3. Groundwater elevations on 19 July 1995 showed the general

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POTENTIOMETRIC SURFACE
FROM BASEWIDE PIEZOMET
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SALT LAKE CITY
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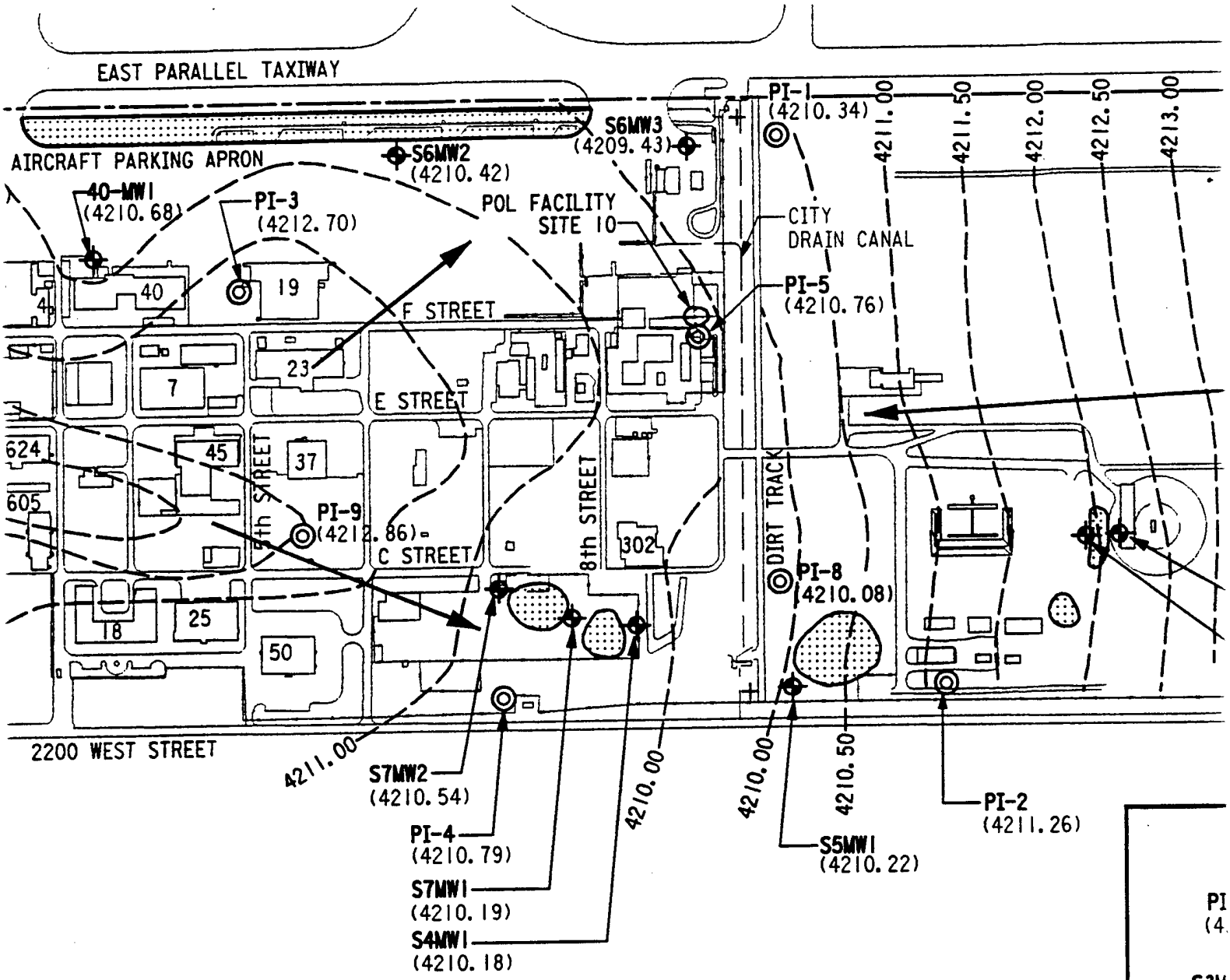
0 400'

NOTE: Groundwater contours are based on water levels in basewide piezometers and site monitoring wells. Site designations are denoted by monitoring wells, for exam S2MW1 is MW1 at Site 2.

40MW1 is a monitoring well from the Site 9 UST investigation (ES, 1993).

POTENTIOMETRIC SURFACE - GROUNDWATER GRADIENT MAP FROM BASEWIDE PIEZOMETERS AND MONITORING WELLS 16 MARCH 1993

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

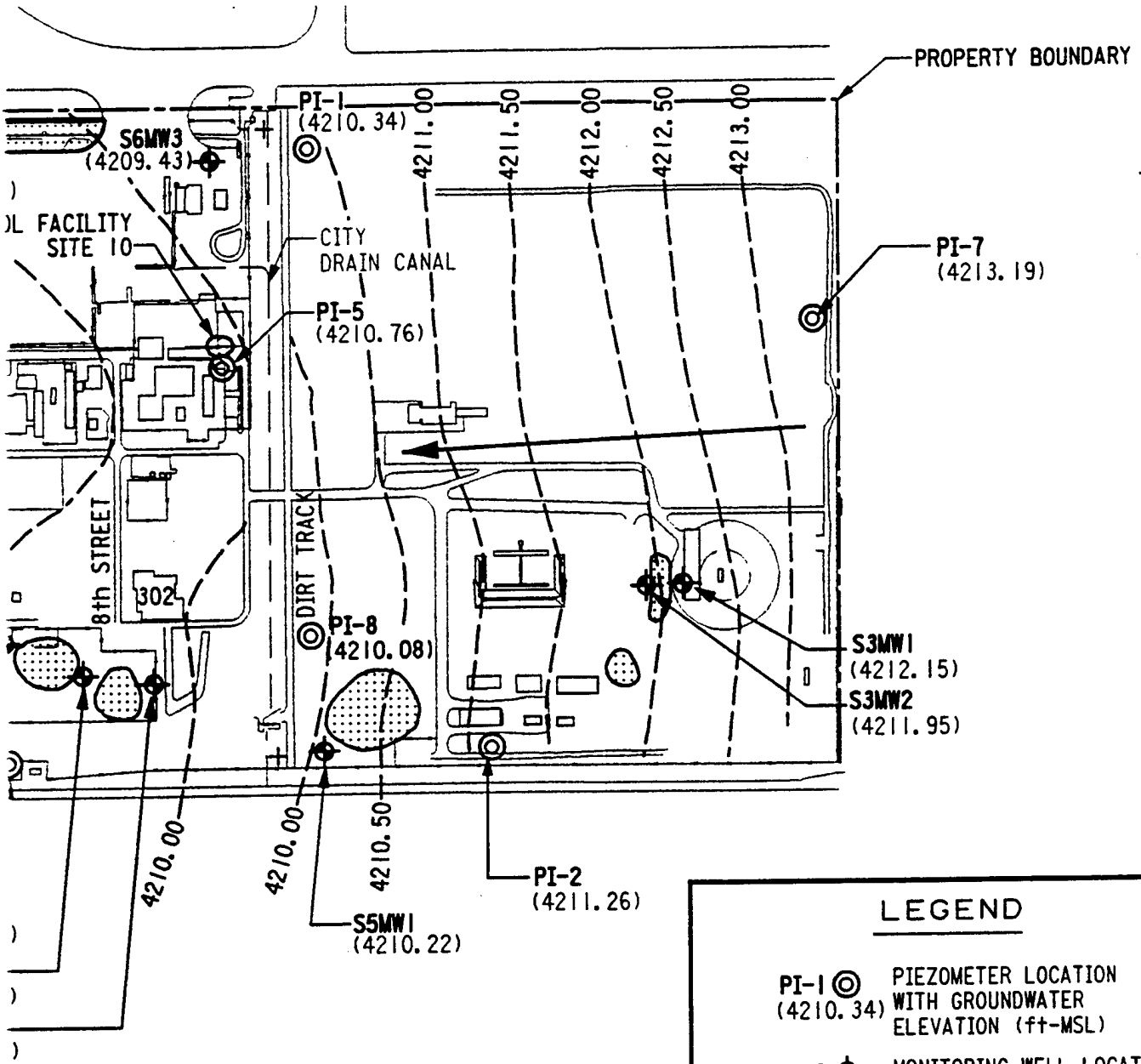


...urs are based on water levels in
...ers and site monitoring wells. Site
... denoted by monitoring wells, for example
...ite 2.

...oring well from the Site 9
... (ES, 1993).

ROUNDWATER GRADIENT MAP
AND MONITORING WELLS
1993

NATIONAL GUARD
ATIONAL AIRPORT
, UTAH



LEGEND

PI-1 (4210.34) — PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)

S3MW2 (4211.95) — MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)

4210.00 — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (ft-MSL)

GROUNDWATER FLOW DIRECTION (3/93)

IRP SITE LOCATION

FIGURE 4.2

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TABLE 4.1
GROUNDWATER ELEVATIONS FROM BASEWIDE PIEZOMETERS
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Station	Measuring Point (1) Elevation (feet above MSL)	Water Level Below Measuring Point (2) (feet)		Groundwater Elevation (feet above MSL)	
		28 December 1992	16 March 1993	28 December 1992	16 March 1993
PI-1	4214.68	5.73	4.34	4208.95	4210.34
PI-2	4212.56	4.20	1.30	4208.36	4211.26
PI-3	4217.28	5.27	4.58	4212.01	4212.70
PI-4	4214.79	6.61	4.00	4208.18	4210.79
PI-5	4214.29	NMD	3.53	NMD	4210.76
PI-6	4217.85	6.72	5.23	4211.13	4212.62
PI-7 (3	4219.57	10.00	6.38	4209.57	4213.19
PI-8 (3	4218.29	10.02	8.21	4208.27	4210.08
PI-9 (3	4220.04	10.31	7.18	4209.73	4212.86
PI-10	4218.83	7.29	5.39	4211.54	4213.44

MSL = Mean Sea Level
NMD = No Measurable Data
(1) Measuring Point = Top of PVC Casing (TOC)
(2) Below Measuring Point = Below Top of PVC Casing (BTOC)
(3) Above Ground Well Casing

TABLE 4.2
GROUNDWATER ELEVATIONS FROM MONITORING WELLS
16 MARCH 1993
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Station	Measuring Point Elevation (1) (feet above MSL)	Water Level Below Measuring Point (2) (feet)	Groundwater Elevation (feet above MSL)
BGMW1	4218.74	5.30	4213.44
S1MW1	4218.02	5.01	4213.01
S2MW1	4217.16	4.29	4212.87
S3MW1 (3)	4215.43	3.28	4212.15
S3MW2 (3)	4218.71	6.76	4211.95
S4MW1	4214.06	3.88	4210.18
S5MW1 (3)	4216.47	6.25	4210.22
S6MW1	4216.71	4.93	4211.78
S6MW2	4216.32	5.90	4210.42
S6MW3 (3)	4219.29	9.86	4209.43
S7MW1	4214.84	4.65	4210.19
S7MW2	4215.1	4.56	4210.54
40MW1 (4)	4217.76	7.08	4210.68

MSL = Mean Sea Level

(1) Measuring Point = Top of PVC Casing (TOC)

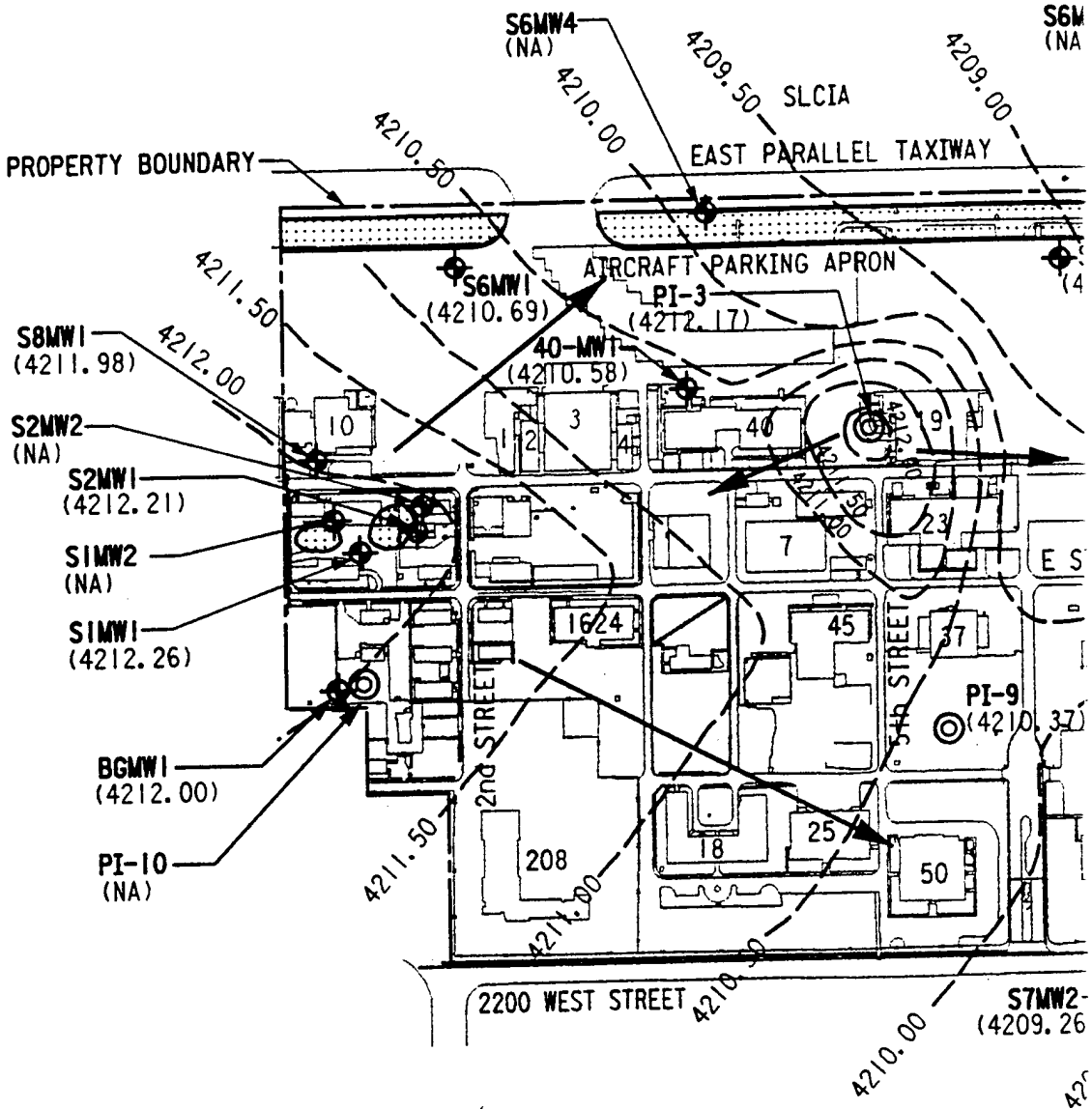
(2) Below Measuring Point = Below Top of PVC Casing (BTOC)

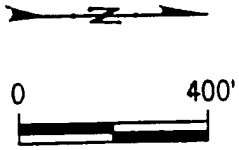
(3) Above Ground Well Casing

(4) Existing Monitoring Well from a UST Investigation (ES, 1993)

POTENTIOMETRIC SURFACE
FROM BASEWIDE PIEZOME
19 J

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SALT LAKE CITY
SALT L





NOTE:

Groundwater contours are based on water levels in basewide piezometers and site monitoring wells. Site designations are denoted by monitoring wells, for example S2MW1 is MW1 at Site 2.

40MW1 and S8MW1 are monitoring wells from the Site 8 & 9 UST investigations (ES, 1993).

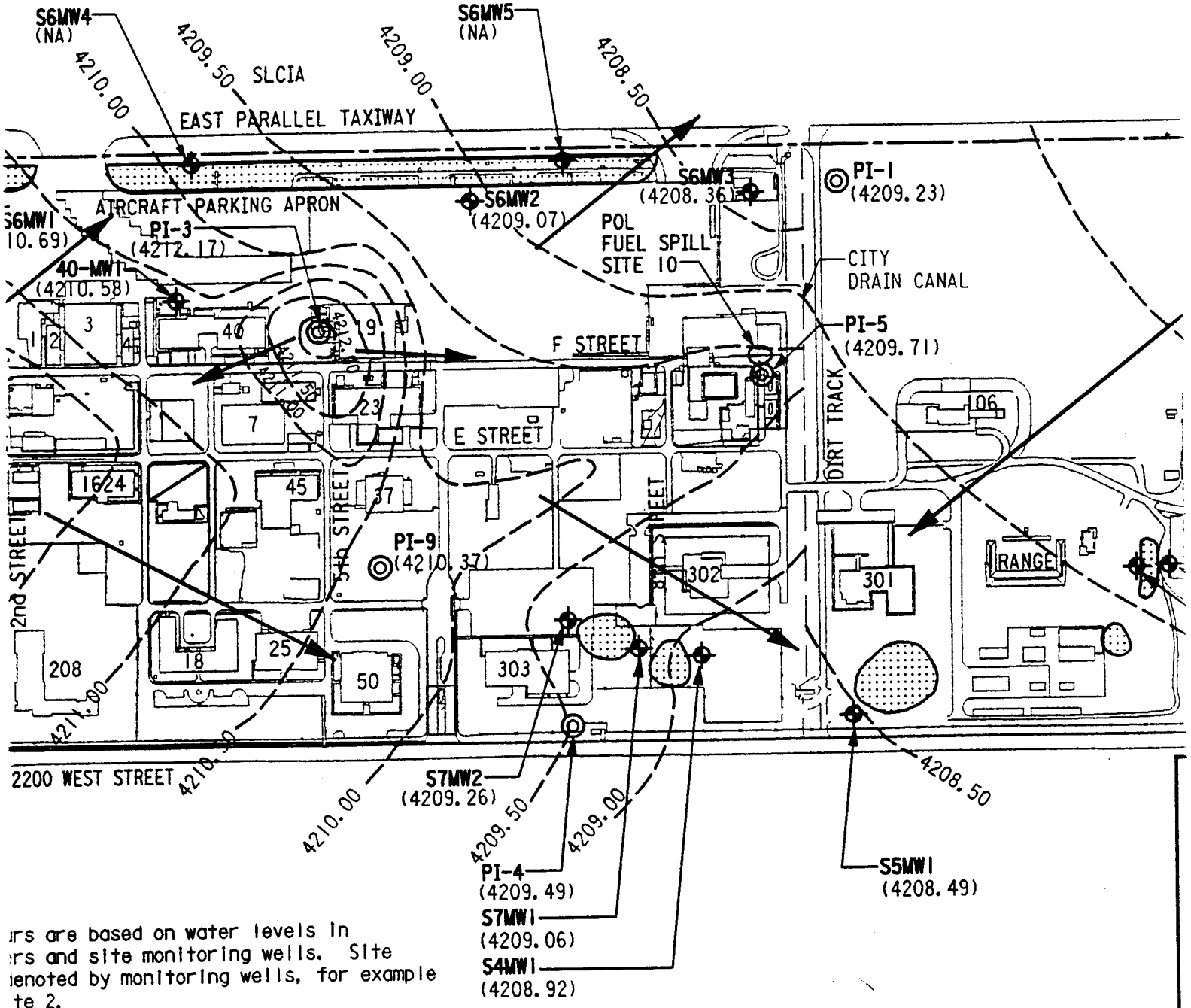
PI-2, PI-6 and PI-8 have been destroyed.

BGMW2, S1MW2, S2MW2, S6MW4, and S6MW5 were installed August 19

New construction as of August 1995 is shown.

POTENTIOMETRIC SURFACE - GROUNDWATER GRADIENT MAP FROM BASEWIDE PIEZOMETERS AND MONITORING WELLS 19 JULY 1995

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



irs are based on water levels in
irs and site monitoring wells. Site
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te 2.

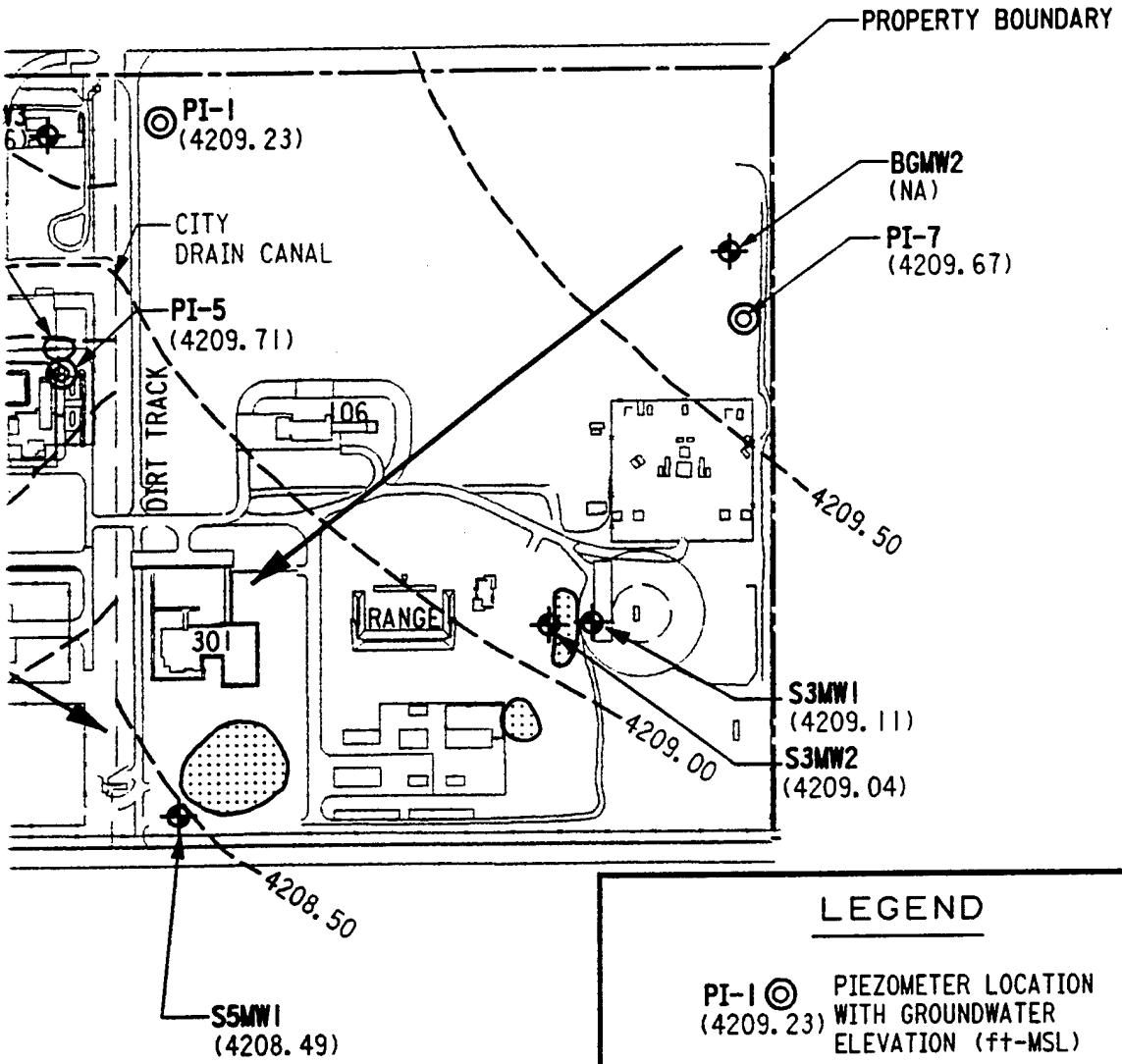
e monitoring wells from the Site 8 & 9
(ES, 1993).

3 have been destroyed.

/2, S6MW4, and S6MW5 were installed August 1995.

is of August 1995 is shown.

ER GRADIENT MAP
ITORING WELLS



LEGEND

PI-1 (4209.23) — PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)

S3MW2 (4209.04) — MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)

4210.00 — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (ft-MSL)

GROUNDWATER FLOW DIRECTION (7/95)

IRP SITE LOCATION

FIGURE 4.3

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TABLE 4.3
GROUNDWATER ELEVATIONS IN MONITORING WELLS AND PIEZOMETERS
19 JULY 1995
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Station	Measuring Point Elevation (1) (feet above MSL)	Water Level Below Measuring Point (2) (feet)	Groundwater Elevation (feet above MSL)
BGMW1	4218.74	6.74	4212.00
S1MW1	4218.02	5.76	4212.26
S2MW1	4217.16	4.95	4212.21
S3MW1 (3)	4215.43	6.32	4209.11
S3MW2 (3)	4218.71	9.67	4209.04
S4MW1	4214.06	5.14	4208.92
S5MW1 (3)	4216.47	7.98	4208.49
S6MW1	4216.71	6.02	4210.69
S6MW2	4216.32	7.25	4209.07
S6MW3 (3)	4219.29	10.93	4208.36
S7MW1	4214.84	5.78	4209.06
S7MW2 (4)	4215.59	6.33	4209.26
40MW1 (5)	4217.76	7.18	4210.58
S8MW1 (5)	4217.62	5.64	4211.98
PI-1	4214.68	5.45	4209.23
PI-3	4217.28	5.11	4212.17
PI-4	4214.79	5.30	4209.49
PI-5	4214.29	4.58	4209.71
PI-7	4219.57	9.90	4209.67
PI-9	4220.04	9.67	4210.37
PI-10	4218.83	NA	NA

MSL = Mean Sea Level

(1) Measuring Point = Top of PVC Casing (TOC)

(2) Below Measuring Point = Below Top of PVC Casing (BTOC)

(3) Above Ground Well Casing

(4) This wellhead was raised and re-surveyed after construction of a new parking lot

(5) Existing Monitoring Wells from UST Investigations (ES, 1993)

Note: PI-2, PI-6, and PI-8 have been destroyed since last measurement

gradient across the Base to be northeast and northwest in areas south of the City Drain Canal, and southeast in areas north of the City Drain Canal. This is the same general pattern observed in December 1992. An anomalous groundwater mound (high), showing some reverse gradient to the south, was present near PI-3. The origin of this mound is unknown, however; it could be attributed to an intrusion of water into the shallow subsurface from an unknown source and/or very low hydraulic conductivity of the sediments. The inferred groundwater gradients indicate that shallow groundwater was discharging (base flow) into the canal, as shown in Figure 4.3.

4.2.2 Confirmation Activities

4.2.2.1 Background Soil Boring/Monitoring Well(s)

Background soil and groundwater samples were collected at two hydraulically upgradient locations, BGMW1 and BGMW2. These media were sampled to provide data on background concentrations of these contaminants at the Base, in an area of the Base judged to be unaffected by activities involving hazardous substances. There was no indication of the use of hazardous substances, past or present, in the areas of BGMW1 and BGMW2. BGMW1 is located at the south end of the Base near PI-10 (Figure 4.1). BGMW2 is located at the northwest corner of the Base near PI-7 (Figure 4.3).

Two soil samples (December 1992) and two groundwater samples (one in February 1993 and one in August 1995) were collected from BGMW1 and were analyzed for VOCs, SVOCs, pesticides/PCBs, and priority pollutant metals (PPMs). The soil samples were also analyzed for TRPH. Field duplicates were not collected.

Three soil samples and one groundwater sample were collected (August 1995) from BGMW2 and were analyzed for VOCs, SVOCs, pesticides/PCBs, and priority pollutant metals (PPMs). The soil samples were also analyzed for TRPH. A field duplicate for soil was collected.

Well construction details for the background monitoring wells are provided in Table G.1, Appendix G. The well boring logs and construction diagrams are also provided in Appendix G. BGMW1 is screened from 4.85 feet to 14.85 feet BLS and BGMW2 is screened from 4.00 feet to 14.00 feet BLS. BGMW1 is screened primarily in clay, whereas, BGMW2 is screened primarily in coarse sand. Following development, the background wells were purged and sampled. Well development and sampling forms are provided in Appendix C.

4.2.2.2 City Drain Canal

The following activities were conducted at the City Drain Canal during the basewide confirmation phase of the SI:

- Collected and analyzed six sediment samples; and
- Collected and analyzed three surface water samples.

Canal water samples were collected 11 February 1993, and canal sediment samples were collected 12 February 1993. Sediment and surface water were sampled in areas of possible contamination to evaluate a potential hydrological and chemical connection between canal media and the Base. The sampling locations and pertinent features are shown on Figure 4.4.

Sediment sample CS1 and water sample CW1 were collected near a pump house. Surface drainage waters from catchment basins and runways of the SLCIA are occasionally discharged into the City Drain Canal at this location in accordance with a permit held by the Salt Lake City Corporation and issued by the Utah Division of Water Quality. Discharge occurs via two 12-inch-diameter pipes from the pump house and a 24-inch-diameter culvert at the west end of the canal. According to the environmental manager for SLCIA, the airport normally discharges to an area west of the airport.

Sediment sample CS6 and water sample CW2 were collected near the culvert that is the junction of the City Drain and the open, unlined, canal portion of the drain that is referred to on-base as the City Drain Canal.

Samples CS5 and CW3 were collected from the City Drain Canal at the east side of the Base near an oil/water separator. Additional sediment samples CS2, CS3, and CS4 were collected along the course of the Canal. Field duplicate samples were collected at the CW3 and the CS6 sampling locations.

4.2.3 Results of the Basewide Investigation

4.2.3.1 Background Soil Boring/Monitoring Well(s)

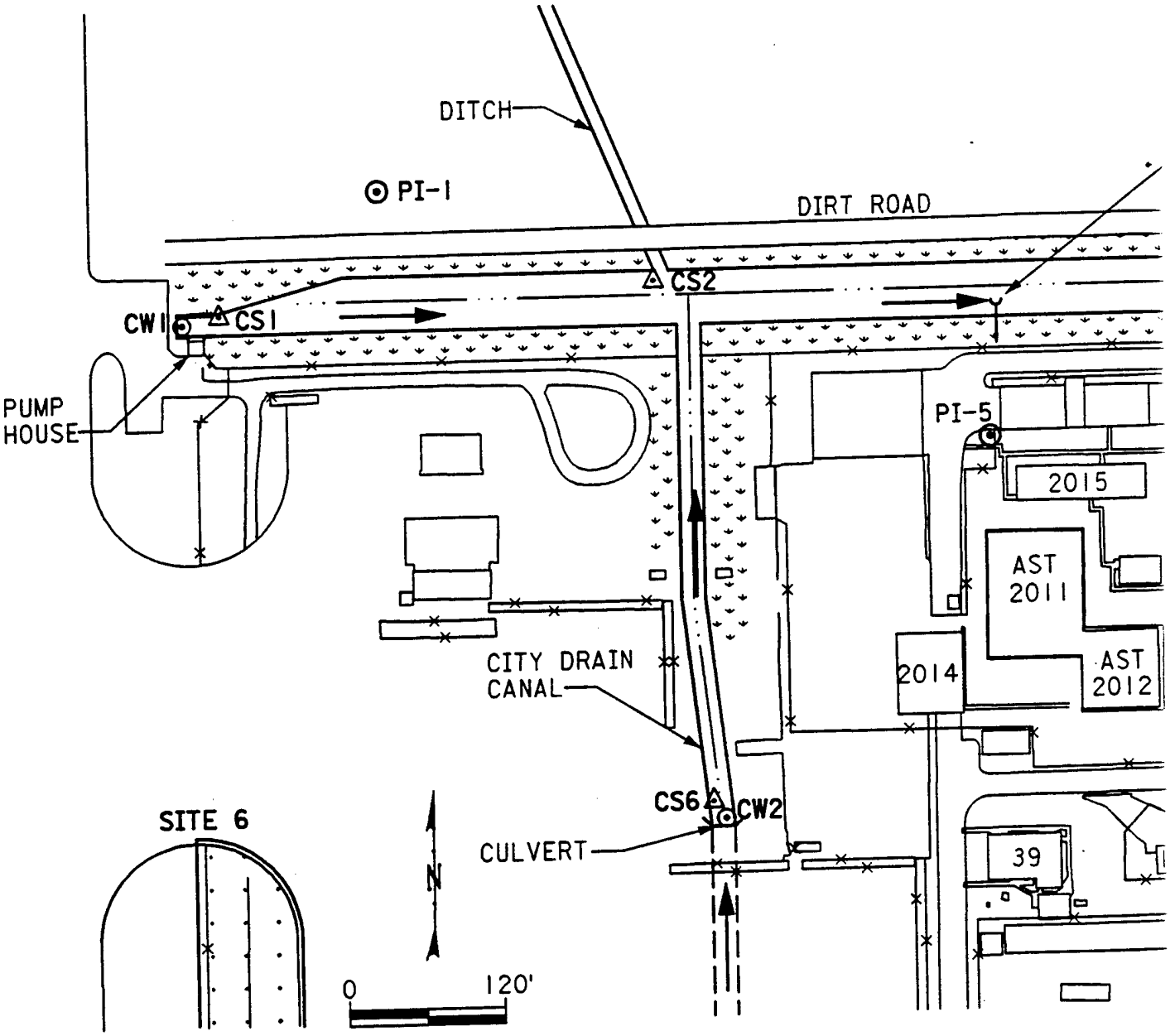
Soil. Background soil samples collected at BGMW1 (December 1992) and BGMW2 (August 1995) were analyzed for VOCs, SVOCs, pesticides/PCBs, TRPH, and the 13 PPMs. Target compounds of each of the analyses and the detection limits for the compounds are provided in Appendix H. These parameters are provided in Table H.1 for the BGMW1 analyses and in Table H.2 for the BGMW2 analyses. The analytical results of the BGMW1 and BGMW2 soil samples are provided in Tables 4.4 and 4.5, respectively. Only organic compounds that were detected are listed in the tables. For comparison, where concentrations of the detected compounds were below their respective detection limits in the other sampling interval(s), the detection limits are shown.

Toluene was the only VOC detected in background soil. It was present in the 0- to 2-foot BLS interval of BGMW1 at a concentration of 2.1 micrograms per kilogram (µg/kg). The background concentrations of all other VOCs were below detection limits.

The only SVOC detected in soil samples was bis(2-ethylhexyl)phthalate at a concentration of 130 µg/kg estimated from the 0- to 2-foot interval sample of BGMW1. In the 4- to 6-foot interval, the compound was not reported above the detection limit of 400 µg/kg. The background concentrations of all other SVOCs were below detection limits.

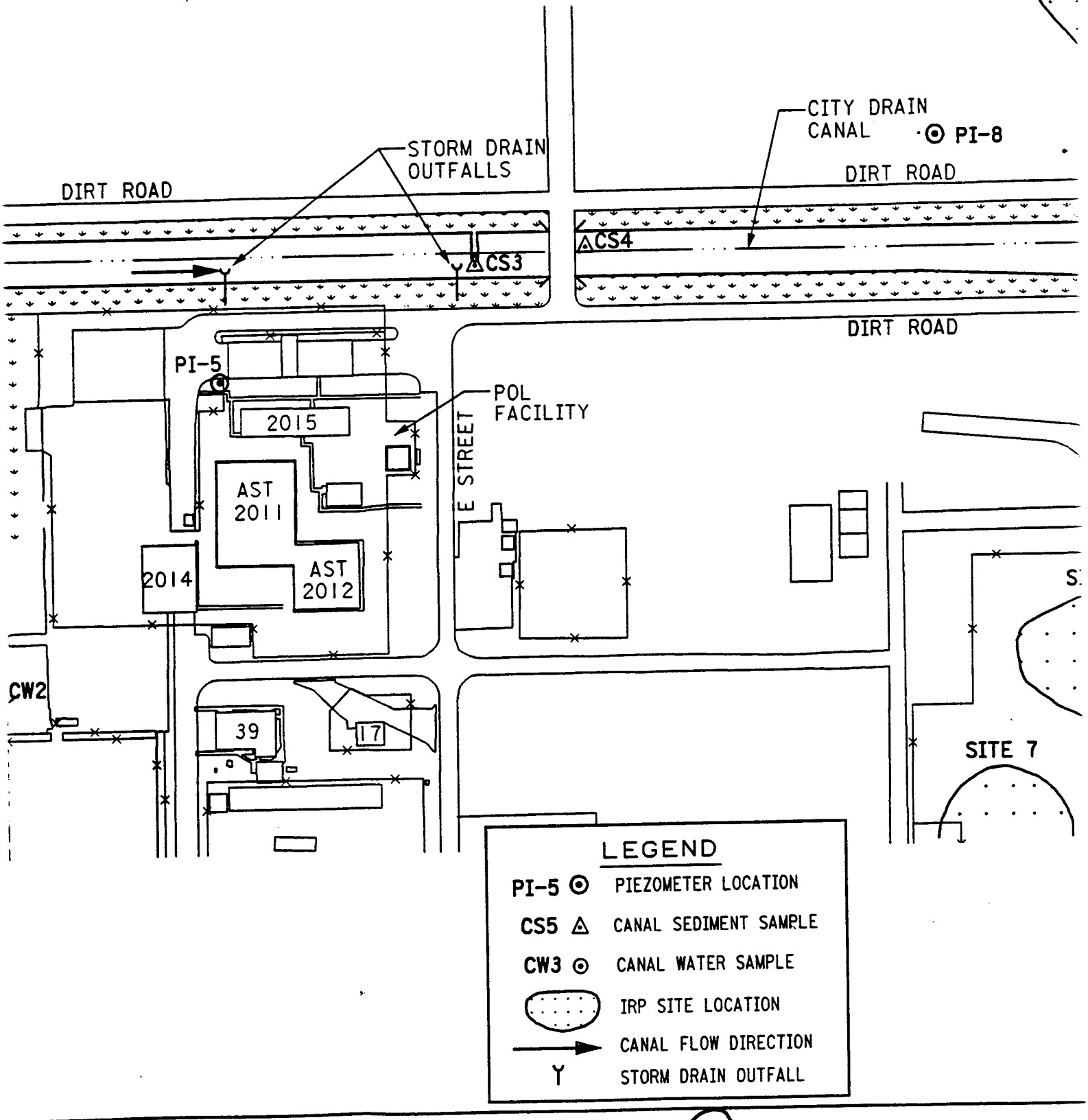
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CITY DRAIN CANAL
SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

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SALT LAKE CITY, UTAH



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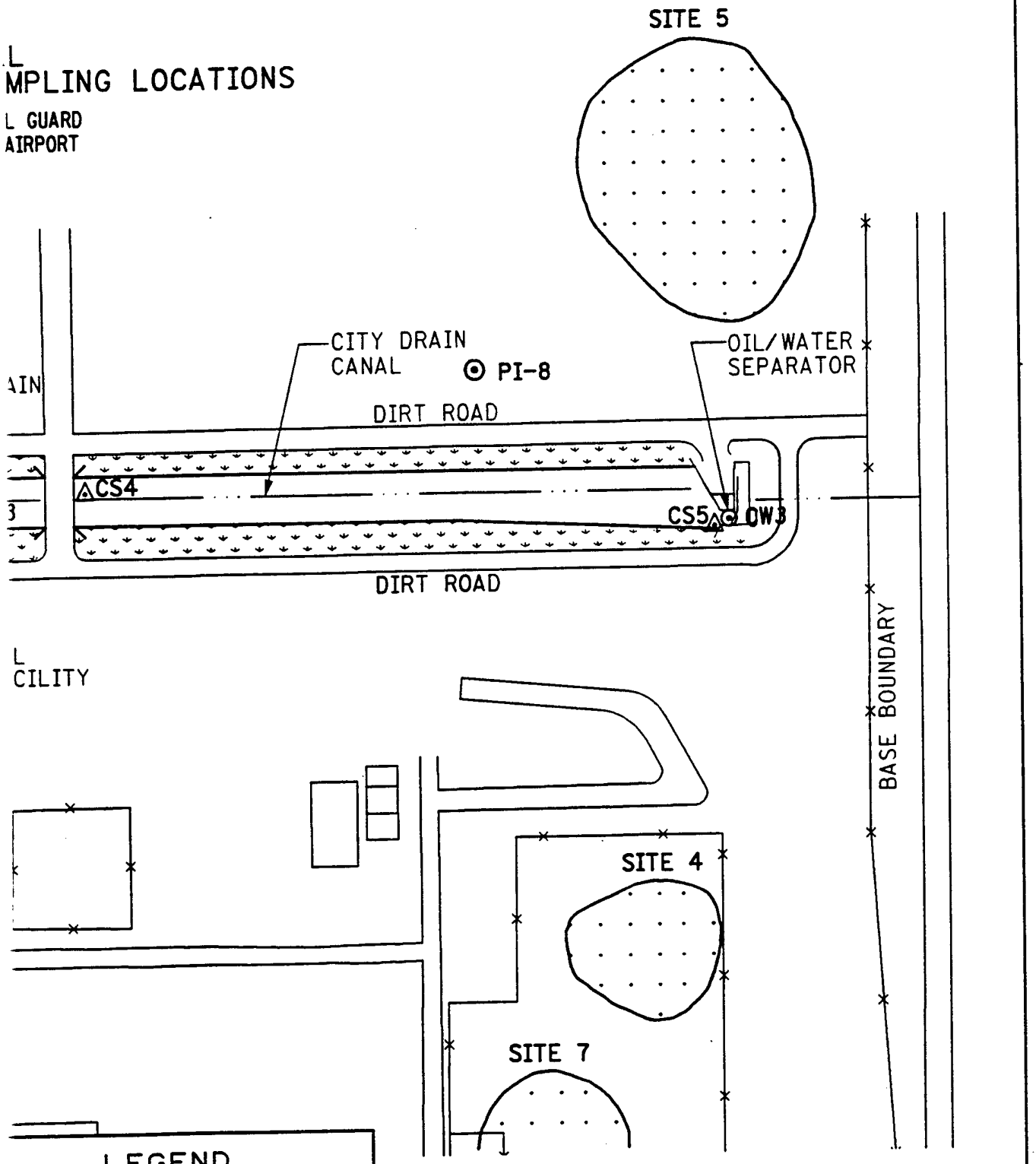


FIGURE 4.4

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TABLE 4.4
BACKGROUND SOIL BORING/MONITORING WELL BGMW1
ANALYTES DETECTED IN SOIL
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	BGMW1-0-2	BGMW1-4-6
VOCs (SW8010/8020) (µg/kg)*				
Dilution Factor	--	--	1	1
Toluene	5.4E+07 nc	2.0	2.1	2U
SVOCs (SW8270) (µg/kg)*				
Dilution Factor	--	--	1	1
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	130J	400U
Pesticides/PCBs (SW8080) (µg/kg)*				
Results	--	--	ND	ND
TRPH (E418.1) (mg/kg)*				
Results	na	10.0	11U	12U
PPMs (mg/kg)*				
Arsenic	0.366 c	2.0	***12.5J***	***4.8J***
Beryllium	0.149 c	0.33	***0.19J***	***0.36J***
Cadmium	135 c	1.0	0.27J	0.36J
Chromium	1,350 c	2.0	9.7J	9.5J
Copper	10,800 nc	2.0	8.2	28.1
Lead	na	2.0	22.6J	14.3J
Nickel	5,400 nc	3.0	6.0	8.0
Zinc	81,000 nc	1.0	25.2J	37.2J

***** **Analyses were performed by ES-Berkeley Laboratory.**
U **Compound not present at the detection limit shown.**
J **Concentration of the compound is estimated.**
ND **All analytes were not detected; see Table H.1of Appendix H for list of compounds and detection limits.**
Note: **Concentrations exceeding Preliminary Remediation Goals (PRGs) are shown in bold italics, nc - noncarcinogen, c - carcinogen, na - not available.**
Note: **The value 5.4E+07 is exponential notation for 54,000,000.**

TABLE 4.5
BACKGROUND SOIL BORING/MONITORING WELL BGMW2
ANALYTES DETECTED IN SOIL
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units	PRGs	Detection Limit	BGMW2-0-2	BGMW2-2-4	BGMW2-4-6	duplicate (a) BGMW2-6-8
VOCs (SW8010/8020) (µg/kg)**						
Results	--	--	ND	ND	ND	ND
SVOCs (SW8270) (µg/kg)**						
Results	--	--	ND	ND	ND	ND
Pesticides/PCBs (SW8080) (µg/kg)**						
Results	--	--	ND	ND	ND	ND
TRPH (E418.1) (mg/kg)**						
Results	--	10.0	12U	12U	12U	12U
PPMs (mg/kg)**						
Antimony	108 nc	2.1	4.4R	2.1R	2.1R	2.1R
Arsenic	0.366 c	0.09	***4.1J***	***3.7J***	***11J***	***8.4J***
Beryllium	0.149 c	0.03	***0.50***	***0.37***	***0.40***	***0.35***
Cadmium	135 c	0.08	0.22	0.26	0.30	0.22
Chromium	1,350 c	1.0	14U	11U	12U	12U
Copper	10,800 c	0.3	21J	21J	26J	26J
Lead	na	0.06	14J	9.8J	11J	9.8J
Mercury	81 nc	0.02	0.033	0.075	0.067	0.046
Nickel	5,400 nc	4.0	9.5U	6.9U	8.9U	7.5U
Selenium	1,350 nc	0.46	0.46U	0.46U	0.46U	0.46U
Silver	na	0.51	0.78	0.51U	0.51U	0.51U
Thallium	na	0.14	0.31J	0.20J	0.21J	0.14U
Zinc	81,000 nc	0.73	52.0	32.0	36.0	29.0

(a) **Blind duplicate of preceding sample interval BGMW2-4-6.**
****** **Analyses were performed by DataChem Laboratories.**
ND **All analytes were not detected; see Table H.2, Appendix H, for list of compounds and detection limits.**
U **Compound not present at the detection limit shown.**
J **Concentration of the compound is estimated.**
R **Data rejected.**
Note: **Concentrations exceeding Preliminary Remediation Goals (PRGs) are shown in bold italics, nc - noncarcinogen, c - carcinogen, na - not available.**

Pesticides/PCBs and TRPH were not detected above their respective method detection limits in any of the background soil samples. Therefore, background concentrations of these compounds are considered to be below detection limits.

Concentrations of PPMs in soils at BGMW1 and BGMW2 appear to be in the naturally-occurring range based on the analysis of soil samples from across the contiguous U.S. (USGS, 1984) and could be considered background.

The presence of toluene and bis(2-ethylhexyl)phthalate indicate that soils at BGMW1 do not represent organic-free background conditions. However, toluene and phthalates can be laboratory contaminants; although, they were not detected in associated method or field QA/QC blanks.

Groundwater. Two background groundwater samples from BGMW1 (February 1993 and August 1995) and one background groundwater sample from BGMW2 (August 1995) were analyzed for VOCs, SVOCs, pesticides/PCBs, TRPH, and the 13 PPMs. Target compounds of each of these analyses and the detection limits for the compounds are provided in Table H.2, Appendix H. The analytical results of the BGMW1 and BGMW2 groundwater samples are provided in Tables 4.6 and 4.7, respectively. Concentrations of all organic analytes were below method detection limits as shown in the tables. Therefore, the non-detection of organic analytes in the groundwater samples is considered to be representative of background conditions.

The analytical detection limits of the metals analyses for the February 1993 groundwater sample from BGMW1 were too high to evaluate background concentrations of metals (the analytical laboratory reported high TDS matrix interference). Therefore, non-detection results for metals in this particular groundwater sample are meaningless. For clarity, the detection limits for the metals analyses are provided in Table 4.6.

The metals arsenic, copper, and mercury were detected in groundwater collected from BGMW1 in 1995. The concentration of arsenic exceeded its Maximum Contaminant Level (MCL). Metals were not detected above the detection limits in groundwater collected from BGMW2. However, some of the metals were qualified "U" based on QA/QC blank results. Background concentrations of metals for the 1995 analyses are shown in Table 4.7. As presented and discussed in following Section 4 site by site discussions, arsenic is ubiquitous in groundwater at the Base in areas south of the City Drain Canal, and is probably naturally occurring as previously stated in Subsection 2.5.1.3.

Field measurements of specific conductance, pH, and temperature were made on the background groundwater samples at the time of sample collection in February 1993 and August 1995. These measurements and approximate TDS conversions are provided in Tables 4.8 and 4.9. Specific conductance at BGMW1 measured 1,098 microsiemens/cm and 1,977 microsiemens/cm between sampling events, respectively, and the pH measured 7.3 and 7.82. In 1995, specific conductance at BGMW2 measured greater than 20,000 microsiemens/cm with a pH of 7.03 (BGMW2 was installed in August, 1995).

TABLE 4.6
BACKGROUND - GROUNDWATER
ANALYTES DETECTED (February 1993)
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	BGMW1
VOCs (SW8010/8020) (µg/L)**	
Results	ND
SVOCs (SW8270) (µg/L)**	
Results	ND
TRPH (E418.1) (µg/L)**	
Results	100U
Pesticides/PCBs (SW8080) (µg/L)**	
Results	ND
PPMs (µg/L)**	
Antimony	200UJ
Arsenic	500UJ
Beryllium	10UJ
Cadmium	10UJ
Chromium	10UJ
Copper	20UJ
Lead	100UJ
Mercury	0.1U
Nickel	30UJ
Selenium	300UJ
Silver	20UJ
Thallium	500UJ
Zinc	20UJ

U Compound not present above the detection limit shown.
UJ Compound not detected, but the detection limit is estimated.
** Analyses performed by DataChem Laboratories.
ND All analytes were not detected, see Table H.2 for compounds and detection li

TABLE 4.7
BACKGROUND - GROUNDWATER
ANALYTES DETECTED (August 1995)
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	MCLs	Detection Limit	BGMW1	BGMW2
VOCs (SW8010/8020) (µg/L)**				
Results	--	--	ND	ND
SVOCs (SW8270) (µg/L)**				
Results	--	--	ND	ND
TRPH (E418.1) (µg/L)**				
Results	na	100.0	100UJ	100UJ
Pesticides/PCBs (SW8080) (µg/L)**				
Results	--	--	ND	ND
PPMs (µg/L)**				
Antimony	6	24.0	24U	60UJ
Arsenic	50	2.0	***250***	2.0UJ
Beryllium	na	0.63	0.63U	0.78U
Cadmium	5	1.0	0.97U	0.97UJ
Chromium	100	3.6	5.0U	3.6U
Copper	1,300	2.1	17.0	12U
Lead	15	4.4	4.8UJ	4.4UJ
Mercury	2	0.02	0.024J	0.02UJ
Nickel	100	11.0	11U	11U
Selenium	50	1.2	12U	60UJ
Silver	na	5.5	5.5U	5.5U
Thallium	2	1.2	1.2UJ	1.2UJ
Zinc	5,000	3.6	4.1U	3.6U

****** **Analyses performed by DataChem Laboratories.**
ND **All analytes were not detected; refer to Table H.2 for compounds and detection limits.**
U **Compound not present above the detection limit shown.**
J **Concentration of the compound is estimated.**
UJ **Compound not detected, but the detection limit is estimated.**
na **No MCL exists.**
Note: **Concentrations exceeding Maximum Contaminant Levels (MCLs) are shown in bold italic.**

TABLE 4.8
SPECIFIC CONDUCTANCE, pH, AND TEMPERATURE OF GROUNDWATER SAMPLES FROM SITE MONITORING WELLS FEBRUARY 1993 151st AREFG, UTAH AIR NATIONAL GUARD SALT LAKE CITY INTERNATIONAL AIRPORT SALT LAKE CITY, UTAH

Well	Specific Conductance (microsiemens/cm)	Total Dissolved Solids Concentration(mg/L) (1)	pH	Temp °C
BGMW1	1,098	703	7.3	8.1
S1MW1	1,793	1,148	8.6	10.5
S2MW1	1,802	1,153	8.0	9.5
S3MW1	1,797	1,150	7.4	7.0
S3MW2	1,762	1,128	7.4	8.2
S4MW1	478	305	7.8	8.4
S5MW1	1,750	1,120	7.6	9.1
S6MW1	1,728	1,106	8.1	13.5
S6MW2	1,836	1,175	8.4	11.1
S6MW3	1,684	1,078	7.4	8.9
S7MW1	1,114	713	8.0	10.7
S7MW2	1,589	1,017	7.8	9.4
Mean	1,536	983	7.8	9.5
Standard Deviation	420	269	0.4	1.7

(1) Estimated from conversion: 1 mmho/cm=1000 microsiemens/cm = 640 mg/L.

Note: Measurements were taken in the field at the time of sampling with a Hanna combination meter.

TABLE 4.9
SPECIFIC CONDUCTANCE, pH, AND TEMPERATURE OF GROUNDWATER SAMPLES FROM SITE MONITORING WELLS AUGUST 1995 151st AREFG, UTAH AIR NATIONAL GUARD SALT LAKE CITY INTERNATIONAL AIRPORT SALT LAKE CITY, UTAH

Well	Specific Conductance (microsiemens/cm)	Total Dissolved Solids Concentration (mg/L) (1)	pH	Temp °F
BGMW1	1,977	1,265	7.82	66.7
BGMW2	20,000	12,800	7.03	60.1
S1MW1	1,960	1,254	8.85	67.7
S1MW2	2,310	1,478	7.99	64.0
S2MW1	2,720	1,741	8.71	69.4
S2MW2	10,050	6,432	7.52	62.5
S3MW1	5,530	3,539	7.37	60.8
S3MW2	9,840	6,298	7.24	64.4
S4MW1	738	472	7.70	65.8
S5MW1	9,640	6,170	7.23	59.2
S6MW1	16,350	10,464	8.06	67.5
S6MW2	13,460	8,614	8.94	68.2
S6MW3	6,050	3,872	7.57	63.4
S6MW4	14,590	9,338	8.29	64.6
S6MW5	9,570	6,125	8.15	62.5
S7MW1	1,780	1,139	7.80	63.6
S7MW2	2,670	1,709	7.85	69.0
Mean	7,602	4,865	7.89	64.7
Standard Deviati	5,915	3,785	0.57	3.1

(1) Estimated from conversion: 1 mmho/cm=1000 microsiemens/cm = 640 mg/L.

Note: Measurements were taken in the field at the time of sampling with a Hydac combination meter.

4.2.3.2 City Drain Canal - Sediment Samples

Six sediment samples were collected from bottom sediments along the course of the City Drain Canal at a depth of approximately one-foot. These sediment samples and one field duplicate were analyzed for VOCs, SVOCs, TRPH, pesticides/PCBs, and PPMs. Target compounds included in each of these analyses and the detection limits of the compounds are included in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in Appendix E.

The analytical results of the Canal sediment samples are provided in Table 4.10. Only the compounds that were detected are included in the table. If the concentrations of the detected compounds are below their respective detection limits in other sediment samples, the detection limits for those samples are shown. Detection limits vary due to differing dilution factors and dry weight calculations. Preliminary Remediation Goals (PRGs) for sediment/soil are provided in the table. The basis and derivation of these health-based criteria are discussed in the Preliminary Risk Evaluation (Section 5). The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in sediments of the City Drain Canal are shown on Figure 4.5. Polynuclear aromatics (PNAs) [phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, ideno(1,2,3-cd)pyrene, and benzo(g,h,i)perylene] have been grouped together for presentation; the values shown on the figure represent the sum of the compounds in this group of SVOCs. The SVOC 2-methylnapthalene is listed separately on the figure. The SVOC bis(2-ethylhexyl)phthalate is shown as phthalates on the figure.

Organic compound concentrations are highest in sediment at locations where water enters or exits the City Drain Canal. The presence of organic compounds in sediment is most widespread near the pump house at CS1. Ten PNAs were detected in sediment at this location with an estimated total concentration of 7,230 µg/kg. Total xylenes were present at a concentration of 460 µg/kg. Bis(2-ethylhexyl)phthalate was detected at a concentration of 1,200 µg/kg estimated. TRPH were detected at a concentration of 900 mg/kg estimated.

Sediment sample CS6, collected near the 60-inch-diameter culvert of the City Drain where the unlined City Drain Canal begins, contained toluene at a concentration of 430 µg/kg, xylenes at a concentration of 710 µg/kg, PNAs (pyrene) at a concentration of 3,600 µg/kg estimated, bis(2-ethylhexyl)phthalate at a concentration of 7,200 µg/kg estimated, the pesticide 4,4-DDE at a concentration of 130 µg/kg, and TRPH at a maximum canal sediment concentration of 1,300 mg/kg estimated.

Sediment sample CS5, collected near the oil/water separator contained toluene at a concentration of 790 µg/kg, xylenes at a concentration of 1,800 µg/kg, 2-methylnapthalene at a concentration of 9,700 mg/kg estimated, and bis(2-ethylhexyl)phthalate at a concentration of 7,900 µg/kg estimated.

TABLE 4.10
CITY DRAIN CANAL - SEDIMENT
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	CS1	CS2	CS3	CS4
VOCs (SW8010/ 8020) (µg/kg)*						
Dilution Factor	--	--	100	5	100	5
Toluene	5.4E+07 nc	2.0	290U	21	310	13U
Xylenes (Total)	5.4E+08 nc	2.0	460	16	480	13U
SVOCs (SW8270) (µg/kg)*						
Dilution Factor	--	--	1	1	1	1
2-Methylnapthalene	na	330.0	470U	430U	470U	430U
Phenanthrene	na	330.0	350J	430U	470U	430U
Fluoranthene	1.08E+07 nc	330.0	690	430U	470U	430U
Pyrene	8.1E+06 nc	330.0	1100	430U	150J	430U
Benzo(a)anthracene	604 c	330.0	580	430U	470U	430U
Chrysene	19,9000 c	330.0	900	430U	120J	430U
bis(2-Ethylhexyl)phthalat	45,700 c	330.0	1200J	430U	860J	430UJ
Benzo(b)fluoranthene	627 c	330.0	***1200***	430U	470U	430U
Benzo(k)fluoranthene	1,330 c	330.0	360J	430U	470U	430U
Benzo(a)pyrene	87.7 c	330.0	***690***	430U	470U	430U
Ideno(1,2,3-cd)pyrene	379 c	330.0	***690***	430U	470U	430U
Benzo(g,h,i)perylene	na	330.0	670	430U	470U	430U
Pesticides/PCBs (SW8080) (µg/kg)*						
Dilution factor	--	--	10	10	10	10
Heptachlor	142 c	1.0	14U	28	14U	13U
4,4-DDE	1,880 c	1.3	18U	17U	18U	17U
TRPH (E418.1) (mg/kg)*						
Result	na	10.0	900J	40J	150J	40J

TABLE 4.10 - Continued
CITY DRAIN CANAL - SEDIMENT
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	CS6	duplicate (a) CS7	CS5
VOCs (SW8010/ 8020) (µg/kg)*					
Dilution Factor	--	--	100	100	100
Toluene	5.4E+07 nc	2.0	430	310U	790
Xylenes (Total)	5.4E+08 nc	2.0	710	310U	1800
SVOCs (SW8270) (µg/kg)*					
Dilution Factor	--	--	30	30	30
2-Methylnapthalene	na	330.0	15000U	16000U	9700J
Phenanthrene	na	330.0	15000U	16000U	27000U
Fluoranthene	1.08E+07 nc	330.0	15000U	16000U	27000U
Pyrene	8.1E+06 nc	330.0	3600J	4800J	27000U
Benzo(a)anthracene	604 c	330.0	15000U	16000U	27000U
Chrysene	19,900 c	330.0	15000U	16000U	27000U
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	7200J	6300J	7900J
Benzo(b)fluoranthene	627 c	330.0	15000U	16000U	27000U
Benzo(k)fluoranthene	1,330 c	330.0	15000U	16000U	27000U
Benzo(a)pyrene	87.7 c	330.0	15000U	16000U	27000U
Ideno(1,2,3-cd)pyrene	379 c	330.0	15000U	16000U	27000U
Benzo(g,h,i)perylene	na	330.0	15000U	16000U	27000U
Pesticides/PCBs (SW8080) (µg/kg)*					
Dilution Factor	--	--	1	1	1
Heptachlor	142 c	1.0	23U	23U	40U
4,4-DDE	1,880 c	1.3	130	46	52U
TRPH (E418.1) (mg/kg)*					
Results	na	10.0	1300J	1600J	R

TABLE 4.10 - Continued
CITY DRAIN CANAL - SEDIMENT
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (units)	PRGs	Detection Limit	CS1	CS2	CS3	CS4	CS5	CS6	duplicate (a) CS7
PPMs (mg/kg)*									
Antimony	108 nc	1.1	1.5UJ	1.2UJ	1.3UJ	1.3UJ	2.6UJ	1.4UJ	1.9J
Arsenic	0.366 c	2.0	***4.0***	***12.2***	***9.5***	***7.3***	***30.8***	***29.8***	***20.0***
Beryllium	0.149 c	0.33	***0.4J***	***0.75***	***0.48J***	***0.48J***	***0.76J***	***0.40J***	***0.39J***
Cadmium	135 nc	1.0	1.3	0.42UJ	1.6	0.53UJ	2.8	3.3	3.7
Chromium	1,350 nc	2.0	17.6J	19.9J	19.4J	15.4J	37.2J	52.2J	52.6J
Copper	10,800 nc	2.0	39.0	44.5	40.6	21.8	119	66.6	115
Lead	na	2.0	75.6J	36.2J	41.6J	20.2J	139J	568J	322J
Mercury	81 nc	0.02	0.11J	0.02UJ	0.02UJ	0.02UJ	0.04UJ	0.42J	0.36J
Nickel	5,400 nc	3.0	8.4	15.1	10.3	9.1	17.0	16.8	11.9
Selenium	1,350 nc	0.28	0.28UJ	0.49UJ	0.28UJ	0.43UJ	0.54J	4.8J	0.39J
Zinc	81,000 nc	1.0	97.4J	107J	117J	55.0J	316J	283J	383J

CS Canal sediment sample.

***** Analyses were performed by ES-Berkeley Laboratory.

U Compound not present at the detection limit shown.

J Concentration of the compound is estimated.

UJ Compound not detected, but the detection limit is estimated.

R Data rejected due to matrix interference, and not reported.

(a) Blind duplicate of analytical sample CS-6.

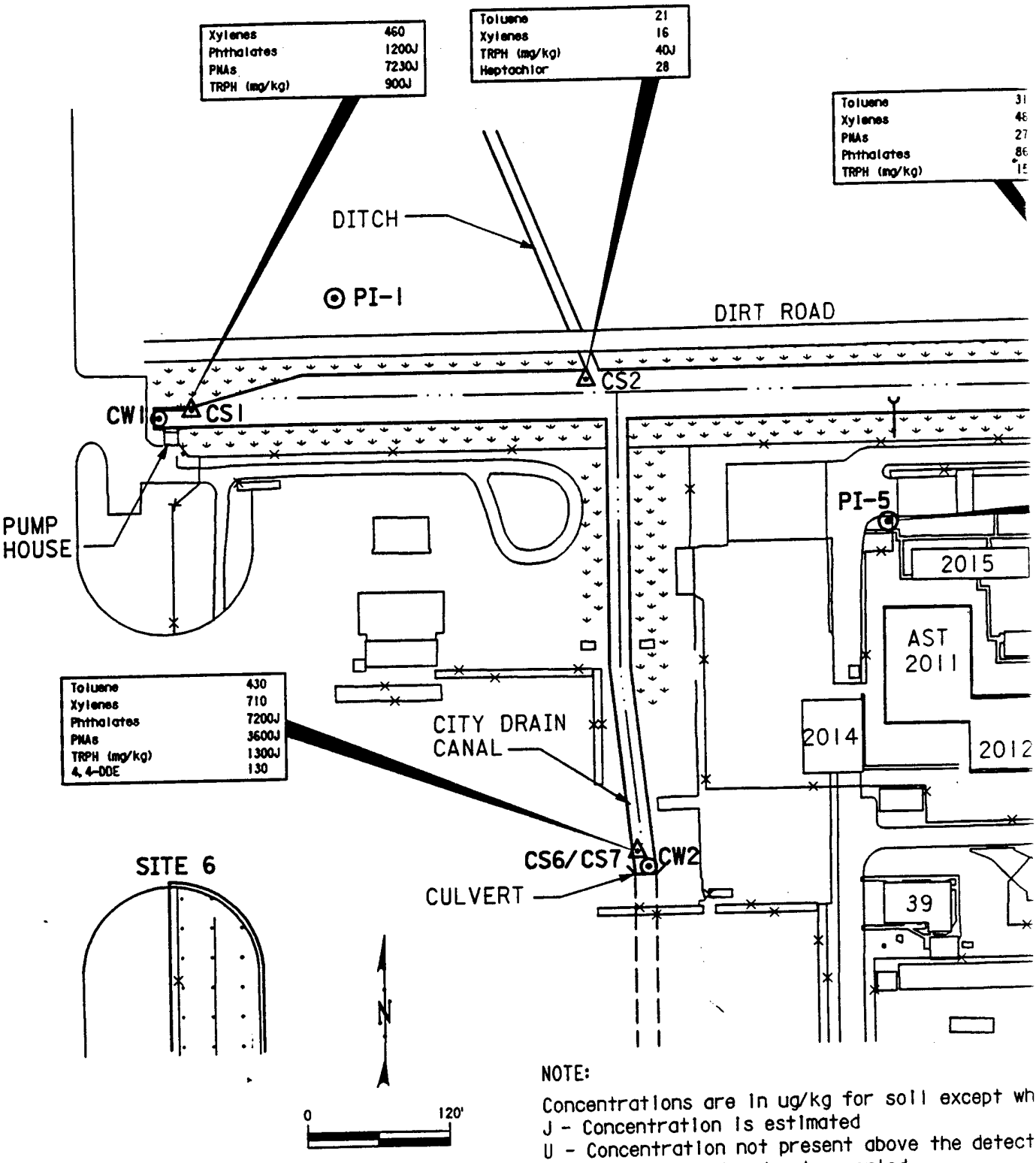
Note: Concentrations exceeding Preliminary Remediation Goals (PRGs) are shown in bold italics, nc - noncarcinogen, c - carcinogen, na - not available.

Note: PRG values greater than five digits are in scientific notation.

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NOTE:

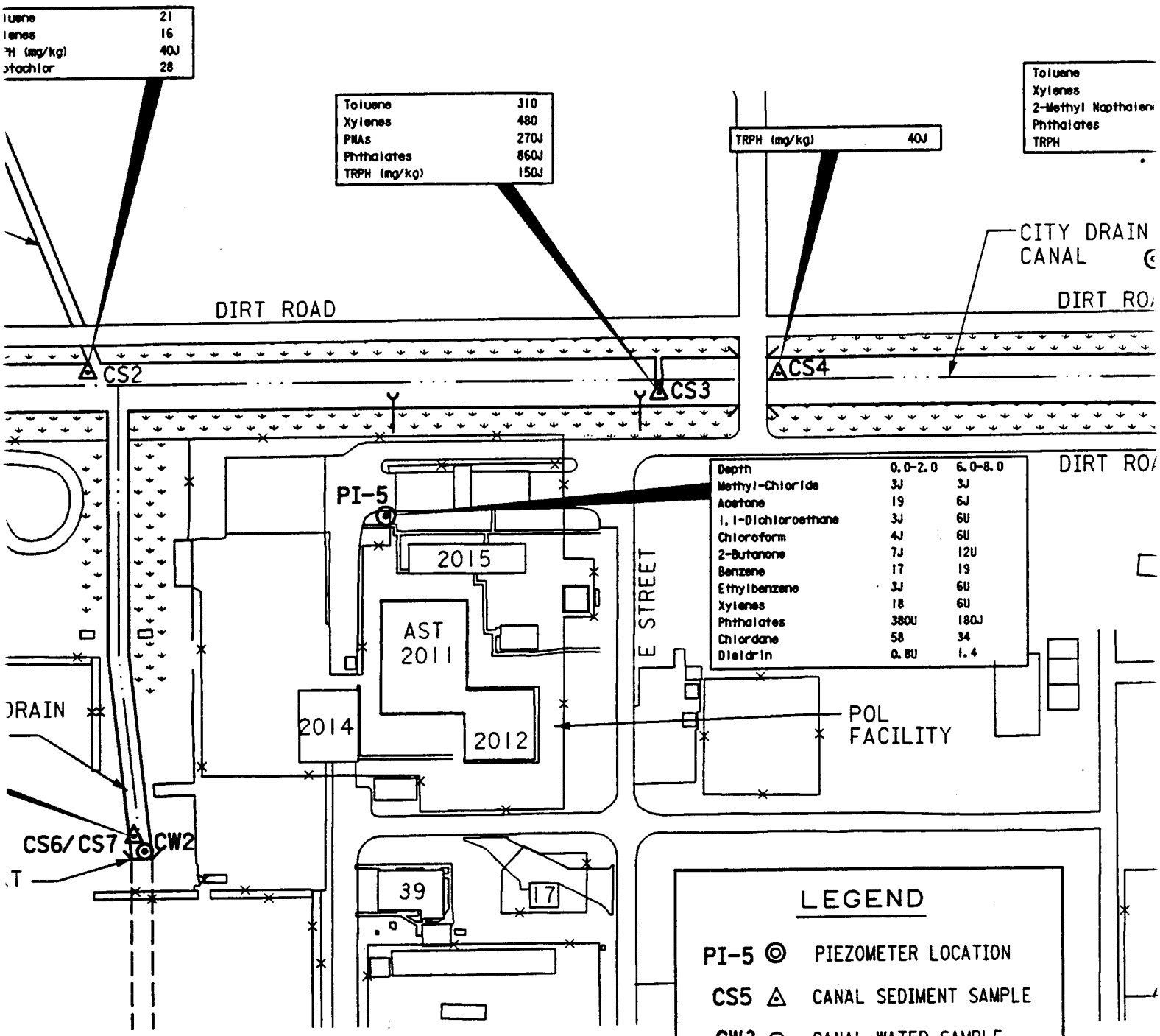
Concentrations are in ug/kg for soil except wh
J - Concentration is estimated
U - Concentration not present above the detect
R - Data rejected and not reported

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(1)

ORGANIC COMPOUNDS DETECTED IN SEDIMENT SAMPLES FROM THE CITY DRAIN CANAL AND SOIL IN PI-5

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:

Concentrations are in ug/kg for soil except where noted.
J - Concentration is estimated
U - Concentration not present above the detection limit
R - Data rejected and not reported

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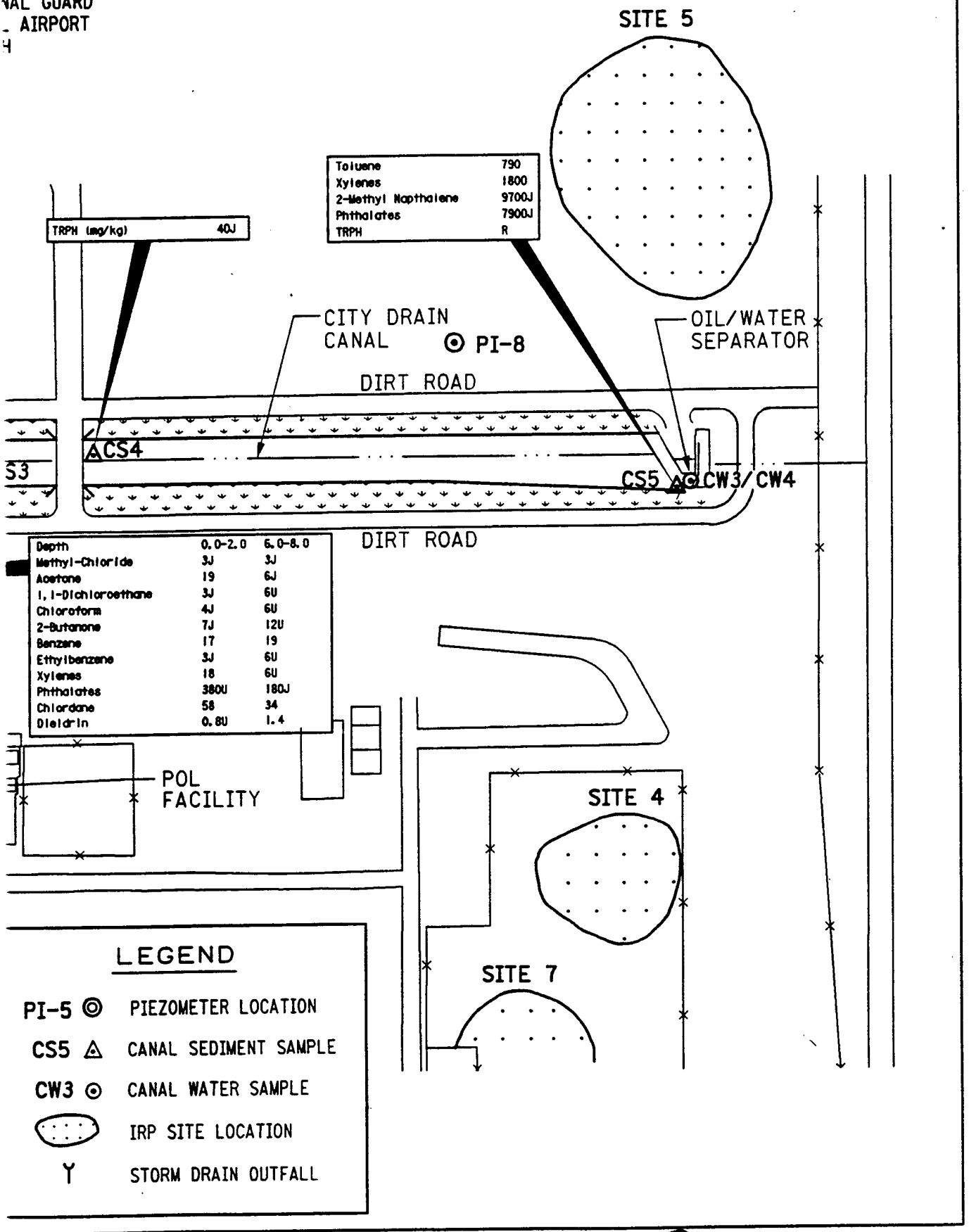


FIGURE 4.5

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Canal sediment samples CS2, CS3, and CS4 were collected along the course of the City Drain Canal and contained relatively lower concentrations of organic compounds. Sediment sample CS2 contained toluene and xylenes at concentrations of 21 µg/kg and 16 µg/kg, respectively, the pesticide heptachlor at a concentration of 28 µg/kg, and TRPH at a concentration of 40 mg/kg estimated. Sediment sample CS3 contained toluene and xylenes at concentrations of 310 µg/kg and 480 mg/kg, respectively, pyrene and chrysene at estimated concentrations of 150 µg/kg and 120 µg/kg, respectively, bis(2-ethylhexyl)phthalate at a concentration of 860 µg/kg estimated, and TRPH at 150 mg/kg estimated. Only TRPH were detected in sediment sample CS4, at a concentration of 40 mg/kg estimated.

Metals. Metals detected in sediment samples from the City Drain Canal exhibit a wide range of concentrations (Table 4.10). For the purposes of comparison and graphical presentation, and to better visualize the location and spatial distribution of the relatively higher metals concentrations in canal sediment, a site-specific comparative value concentration for each individual metal was established. The comparative value is defined as the mean plus one standard deviation of the total canal sediment sample population for a particular metal. This methodology is not intended to select contaminants of concern or to imply risk. The mean plus one standard deviation comparative values for metals consistently detected in canal sediment are presented in Table 4.11. The duplicate sample (CS7) of CS6 was included in the mean. Concentrations of the selected metals at a given sample location that are higher than their comparative values are depicted on Figure 4.6.

Seven metals (arsenic, beryllium, chromium, copper, lead, nickel, and zinc) were present in all seven samples at concentrations above the method detection limit, and mean plus one standard deviation comparative values were determined for these metals. Cadmium was detected in five samples and a comparative value was also determined for this metal. Because selenium and mercury were detected in only three samples, comparative values for these metals were not determined and concentrations of these metals are not shown on Figure 4.6. Concentrations of antimony, thallium, and silver were below the analytical method detection limits for all canal sediment environmental samples. Antimony was detected in the field duplicate CS7.

At the sediment sample location CS6/CS7, the concentrations of seven of the eight metals depicted on Figure 4.6 are higher than the canal-specific mean plus one standard deviation comparative values for these respective metals. Arsenic was present at a concentration of 29.8 mg/kg, cadmium at 3.7 mg/kg, chromium at 52.6 mg/kg estimated, lead at 568 mg/kg estimated, nickel at 16.8 mg/kg, zinc at 383 mg/kg estimated, and copper at 115 mg/kg. The values depicted on Figure 4.6 represent the maximum concentration of the individual metals from either CS6 or CS7. Selenium and mercury were also detected in CS6/CS7 at canal sediment maximum concentrations of 4.8 mg/kg estimated and 0.42 mg/kg estimated, respectively (Table 4.10).

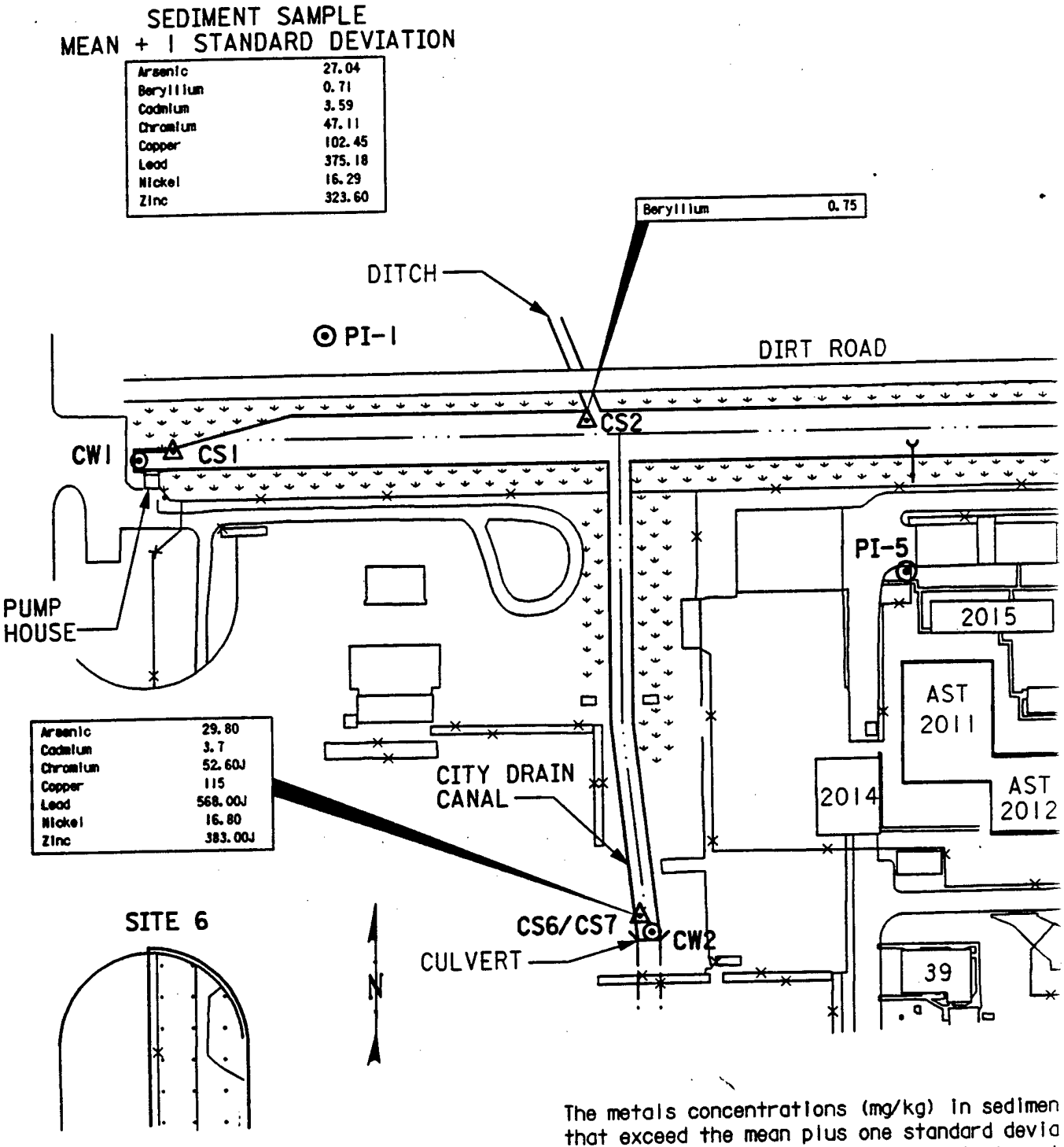
TABLE 4.11
CITY DRAIN CANAL
MEAN AND STANDARD DEVIATION OF METALS DETECTED IN SEDIMENTS
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter	Range (mg/kg)	Mean	Std. Dev.	Mean + Std. Dev	# of Samples
Arsenic	4.00-30.80	16.23	10.81	27.04	7
Beryllium	0.39-0.80	0.53	0.18	0.71	7
Cadmium	1.3-3.70	2.54	1.05	3.59	5
Chromium	15.40-52.60	30.61	16.50	47.11	7
Copper	21.80-119.00	63.79	38.66	102.45	7
Lead	20.20-568.00	171.80	203.38	375.18	7
Nickel	8.40-17.00	12.66	3.63	16.29	7
Zinc	55.00-316.00	194.06	129.54	323.60	7

Note: The mean and standard deviation were not calculated for selenium and mercury because these metals were not detected in enough samples.

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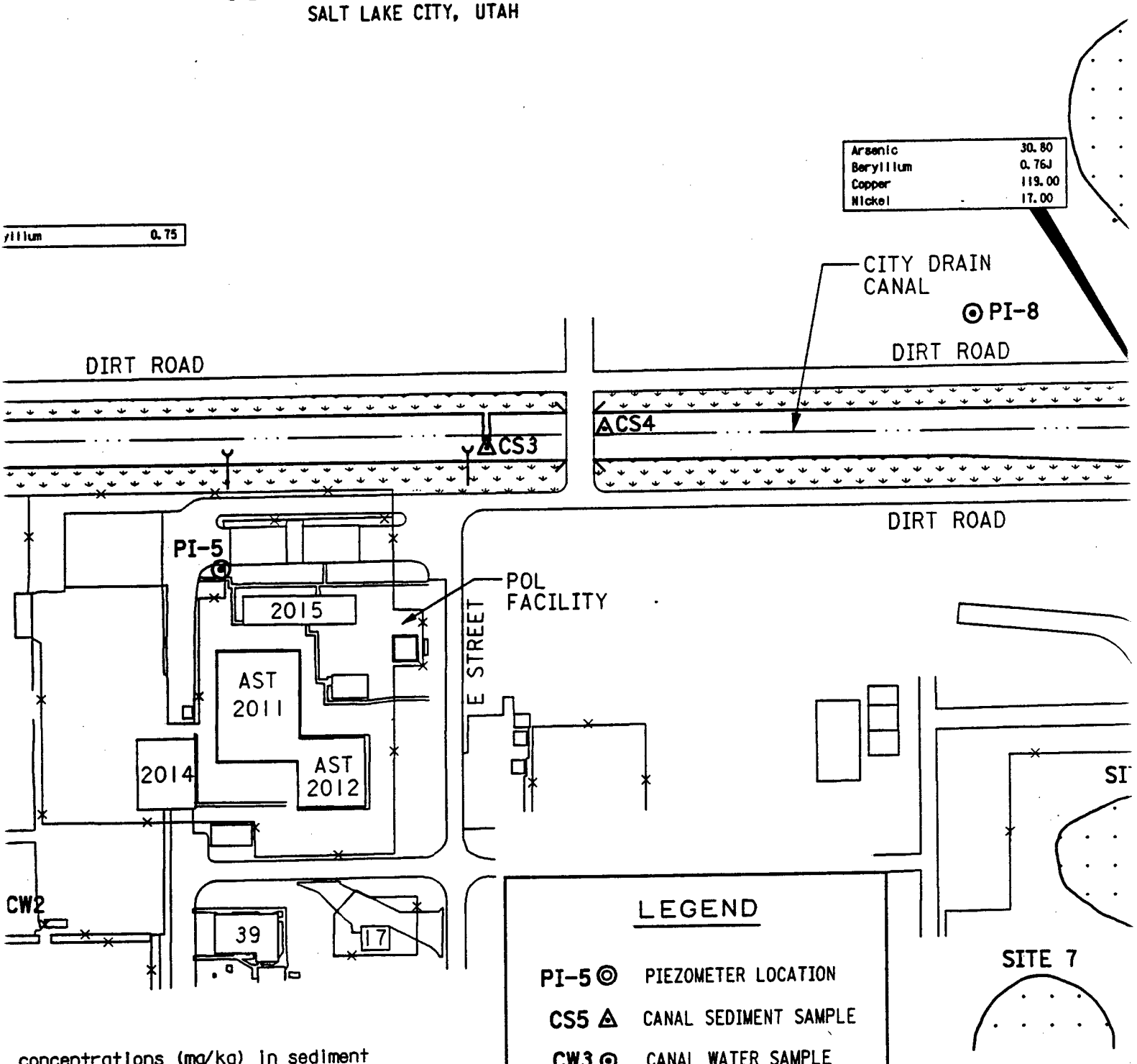


The metals concentrations (mg/kg) in sedimen
that exceed the mean plus one standard devia
of the total sample population for that part
metal at the site are shown.

J - Concentration is estimated

METALS DETECTED IN SEDIMENT SAMPLES FROM THE CITY DRAIN CANAL

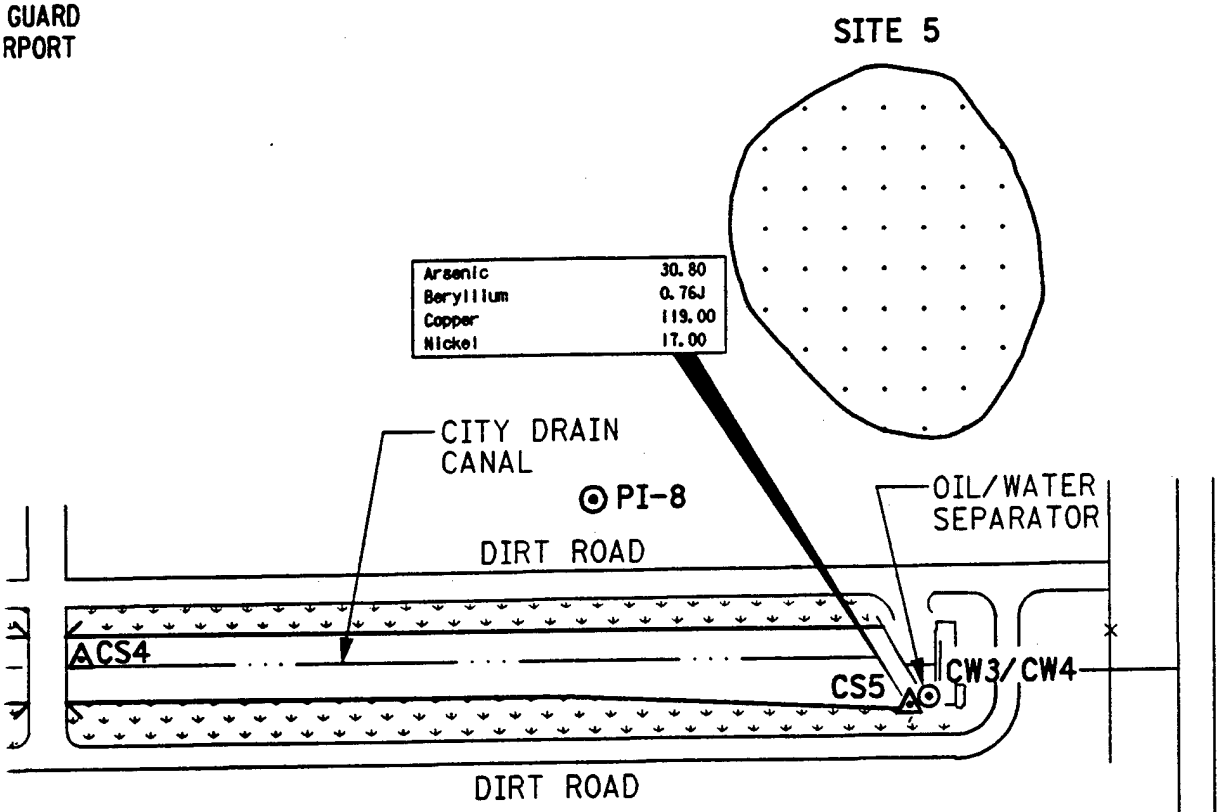
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SALT LAKE CITY, UTAH



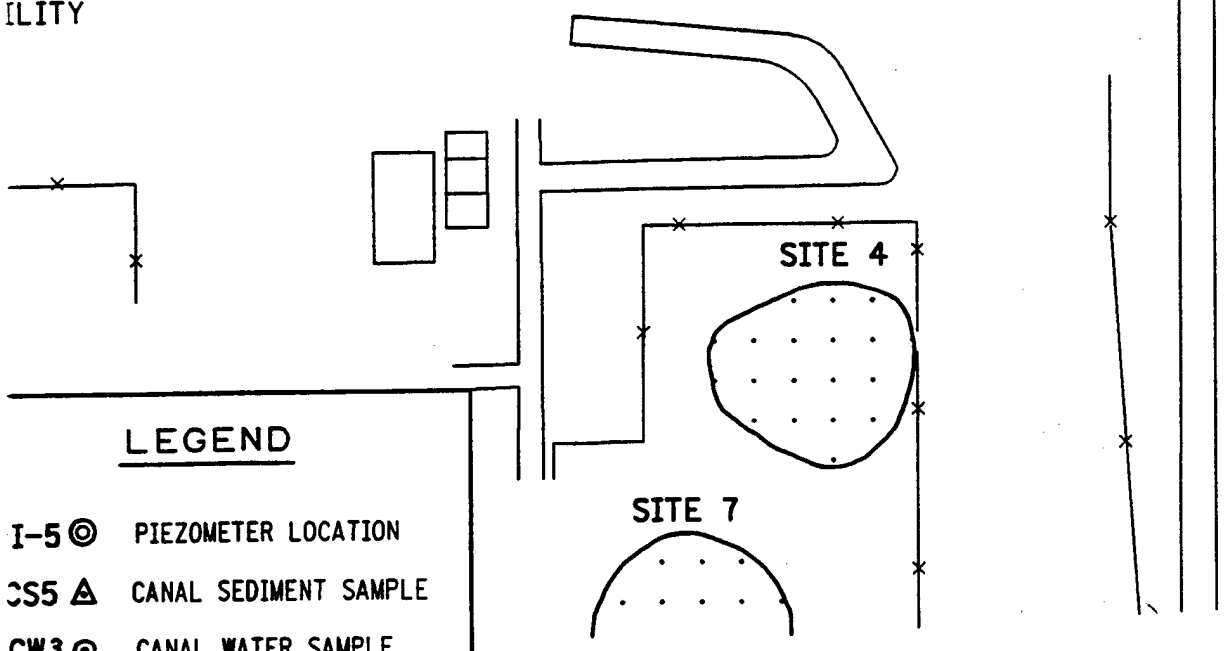
concentrations (mg/kg) in sediment
d the mean plus one standard deviation
al sample population for that particular
he site are shown.

tration is estimated

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LEGEND

I-5 ◎ PIEZOMETER LOCATION
CS5 △ CANAL SEDIMENT SAMPLE
CW3 ⊙ CANAL WATER SAMPLE
IRP SITE LOCATION
STORM DRAIN OUTFALL

FIGURE 4.6

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In sediment sample CS5, the concentrations of arsenic, beryllium, copper, and nickel are higher than their comparative values, at concentrations of 30.8 mg/kg, 0.76 mg/kg estimated, 119 mg/kg, and 17 mg/kg, respectively. Lead was also present at a concentration of 139 mg/kg estimated.

Sediment sample CS2 contained beryllium at a concentration of 0.75 mg/kg, which is higher than the canal-specific comparative value of 0.71 mg/kg for this metal.

4.2.3.3 City Drain Canal - Surface Water Samples

Three canal water samples were collected at locations where water enters or exits the City Drain Canal. These samples and one field duplicate were analyzed for VOCs, SVOCs, pesticides/PCBs, TRPH, and PPMs. Target compounds included in each of the analyses and the detection limits for the compounds are included in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in Appendix E.

The analytical results for compounds detected in the City Drain Canal water samples are provided in Table 4.12. If the concentrations of the detected compounds are below their respective detection limits in other surface water samples, the detection limits for those samples are shown. The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in canal water are shown on Figure 4.7. Canal water sample CW1 was collected near the pump house at the location of sediment sample CS1, which is upstream of any base outfalls into the canal. The VOCs 1,1,1-trichloroethane, trichloroethene, and toluene were detected in CW1 at concentrations of 4.2 µg/L, 1.5 µg/L, and 3.1 µg/L, respectively. The SVOCs phenol, 2-methylnapthalene, and 4-nitrophenol were detected at the estimated concentrations of 1 µg/L, 1 µg/L, and 2 µg/L, respectively.

Canal water sample CW2 was collected near the 60-inch-diameter culvert of the City Drain where the unlined City Drain Canal begins. Benzene, toluene, and xylenes were present in this canal water sample at concentrations of 1.3 µg/L, 3.6 µg/L, and 4.5 µg/L, respectively. 2-Methylnapthalene was detected at a concentration of 3 µg/L estimated. The pesticide 4,4-DDD was detected at a concentration of 0.17 µg/L.

Canal water sample CW3, collected at the oil/water separator contained several organic compounds in minor concentrations. The VOCs 1,1,1-trichloroethane, benzene, toluene, and xylenes were detected at concentrations of 2.6 µg/L, 1.1 µg/L, 3.5 µg/L, and 5.1 µg/L, respectively. The SVOCs phenol, 1,3-dichlorobenzene, and napthalene were each detected at the estimated concentration of 2 µg/L. The pesticide dieldrin was detected at a concentration of 0.021 µg/L estimated in this sample, and was detected at a concentration of 0.031 µg/L estimated in a duplicate sample (CW4). The pesticide aldrin was detected in the duplicate sample CW4 at a concentration of 0.042 µg/L estimated.

Metals. Six metals were present above the method detection limit in canal water sample CW1 and three metals were present above the method detection limit in CW2 and

TABLE 4.12
CITY DRAIN CANAL - SURFACE WATER
ANALYTES DETECTED
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Parameter (method) (units)	MCLs	Detection Limit	CW1	CW2	CW3	duplicate (a) CW4
VOCs (SW8010/8020) (µg/L)*						
Dilution Factor	--	--	1	1	1	1
1,1,1-Trichloroethane	200	1.0	4.2	1.0U	2.6	4.0
Trichloroethene	5	1.0	1.5	1.0U	1.0U	1.4
Benzene	5	1.0	1.0U	1.3	1.1	1.0U
Toluene	1,000	2.0	3.1	3.6	3.5	2.4
Xylenes (Total)	10,000	2.0	2.0U	4.5	5.1	2.0U
SVOCs (SW8270) (µg/L)*						
Dilution Factor	--	--	1	1	1	1
Phenol	na	10.0	1J	10U	2J	1J
1,3-Dichlorobenzene	na	10.0	10U	10U	2J	2J
Napthalene	na	10.0	10U	10U	2J	1J
2-Methylnapthalene	na	10.0	1J	3J	10U	2J
4-Nitrophenol	na	25.0	2J	25U	25U	25U
Pesticides/PCBs (SW8080) (µg/L)*						
Dilution Factor	--	--	1	1	1	1
Dieldrin	na	0.02	0.02UJ	0.02U	0.021J	0.031J
Aldrin	na	0.04	0.04UJ	0.04U	0.04U	0.042J
4,4-DDD	na	0.11	0.11UJ	0.17	0.11U	0.11UJ
TRPH (E418.1) (mg/L)*						
Results	na	1.0	1U	1U	1U	1U

TABLE 4.12 - Continued
CITY DRAIN CANAL - SURFACE WATER
ANALYTES DETECTED
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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

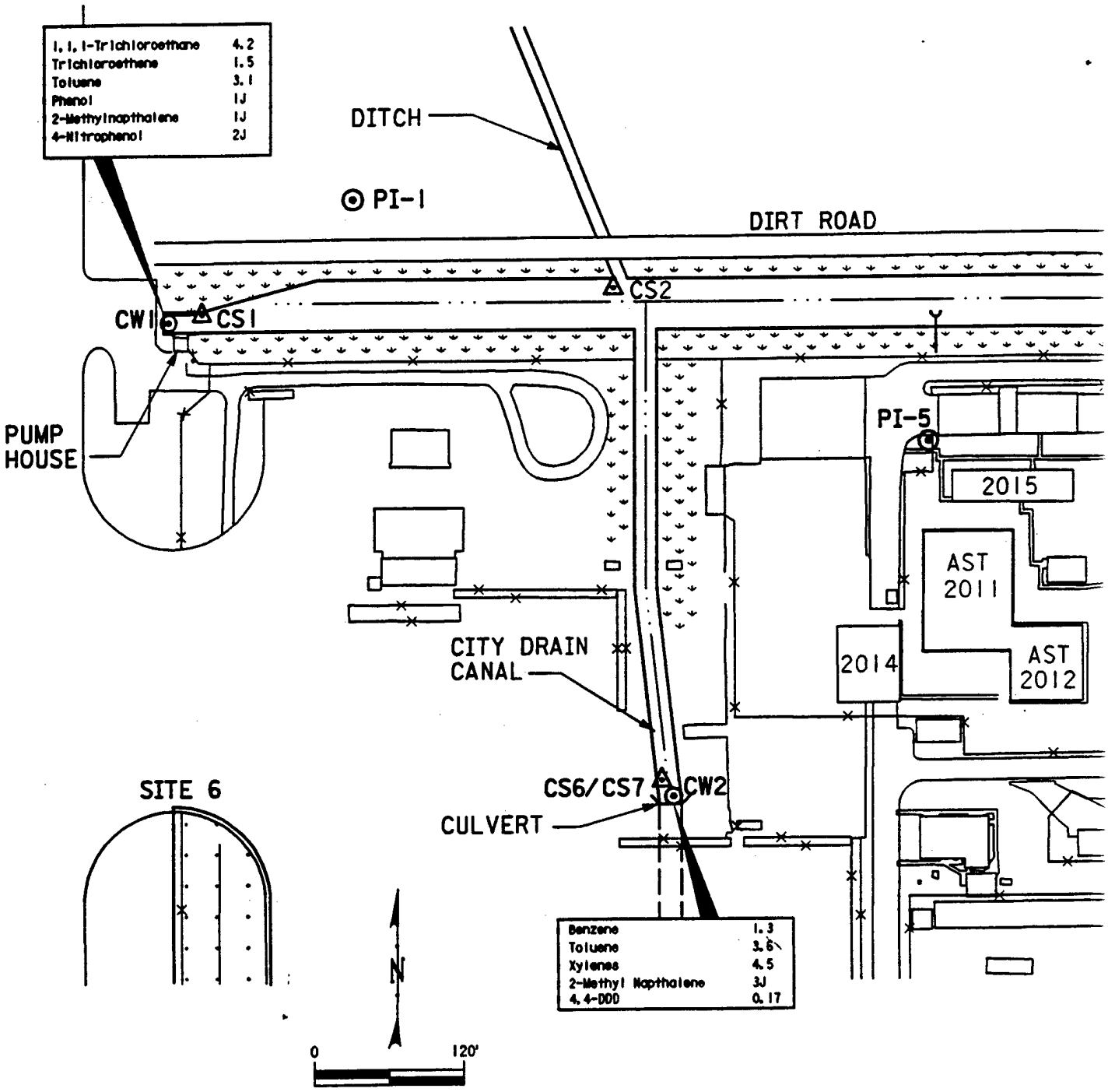
Parameter (method) (units)	MCLs	Detection Limit	CW1	CW2	CW3	duplicate (a) CW4
PPMs (µg/L)*						
Antimony	6	11.0	***25.7J***	11.0UJ	***13.8J***	***19.0J***
Arsenic	50	1.0	***83.5J***	***108J***	***63J***	***86.5J***
Cadmium	5	1.0	1.0J	1.0U	1.3UJ	1.0U
Chromium	100	2.0	3.0UJ	3.0UJ	2.7UJ	4.8UJ
Copper	1,300	2.0	15.4J	17.5J	11.4UJ	12.6J
Lead	15	2.2	7.3UJ	2.2J	2.4UJ	5.0UJ
Nickel	100	3.0	4.3J	3.0UJ	3.0UJ	3.0UJ
Selenium	50	1.0	6.5J	1.0UJ	1.9J	7.4J
Zinc	5,000	1.0	8.8UJ	9.8UJ	9.8UJ	10.7UJ

CW Canal Water Sample
(a) Blind duplicate of sample CW3
***** Analyses were performed by ES-Berkeley Laboratory.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
na No MCL exists.
Note: Concentrations exceeding Maximum Contaminant Levels (MCLs) are shown in bold italic.

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ORGANIC COMPOUNDS DETECT
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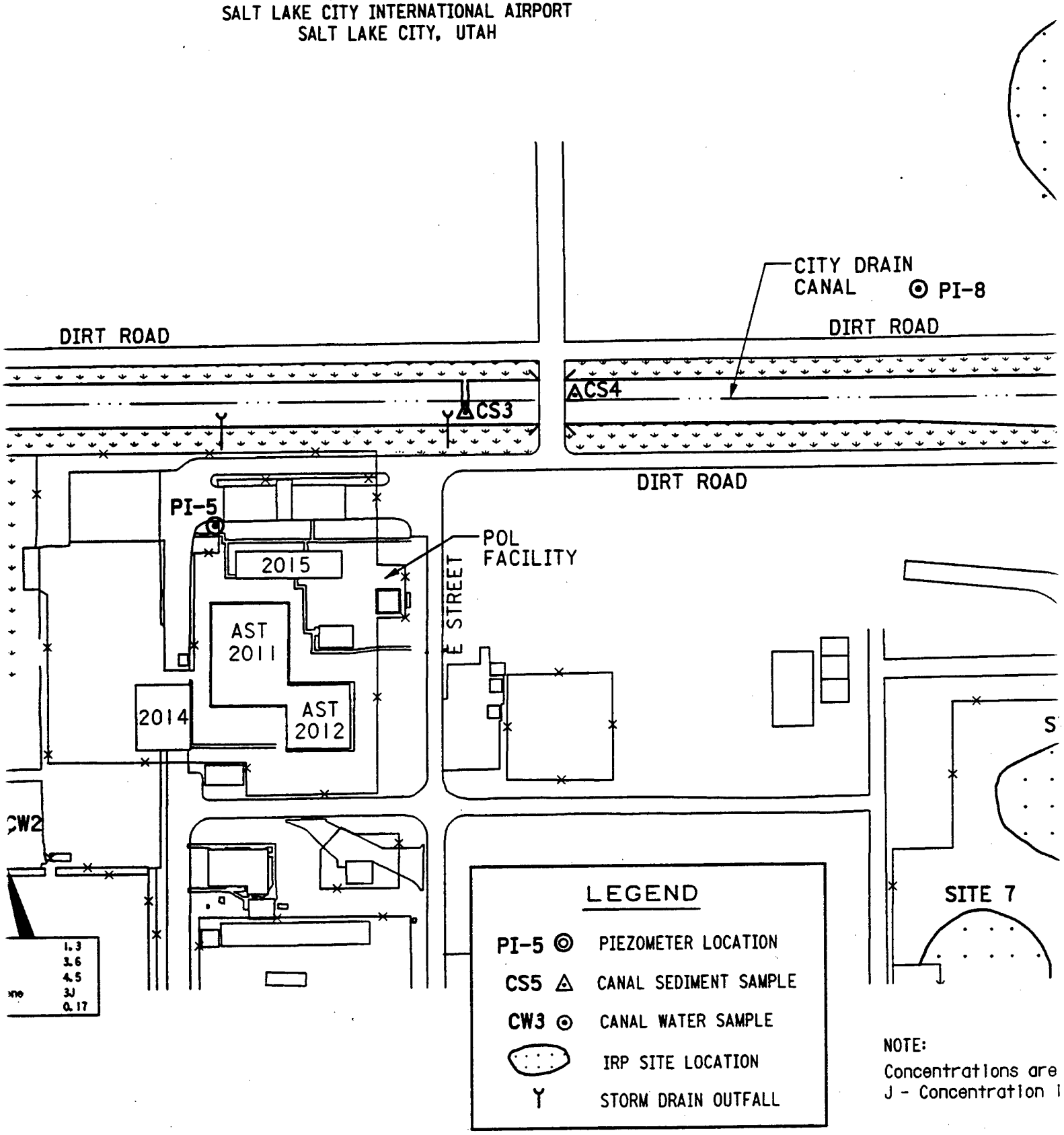


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(1)

RGANIC COMPOUNDS DETECTED IN SURFACE WATER SAMPLES FROM THE CITY DRAIN CANAL

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SALT LAKE CITY, UTAH



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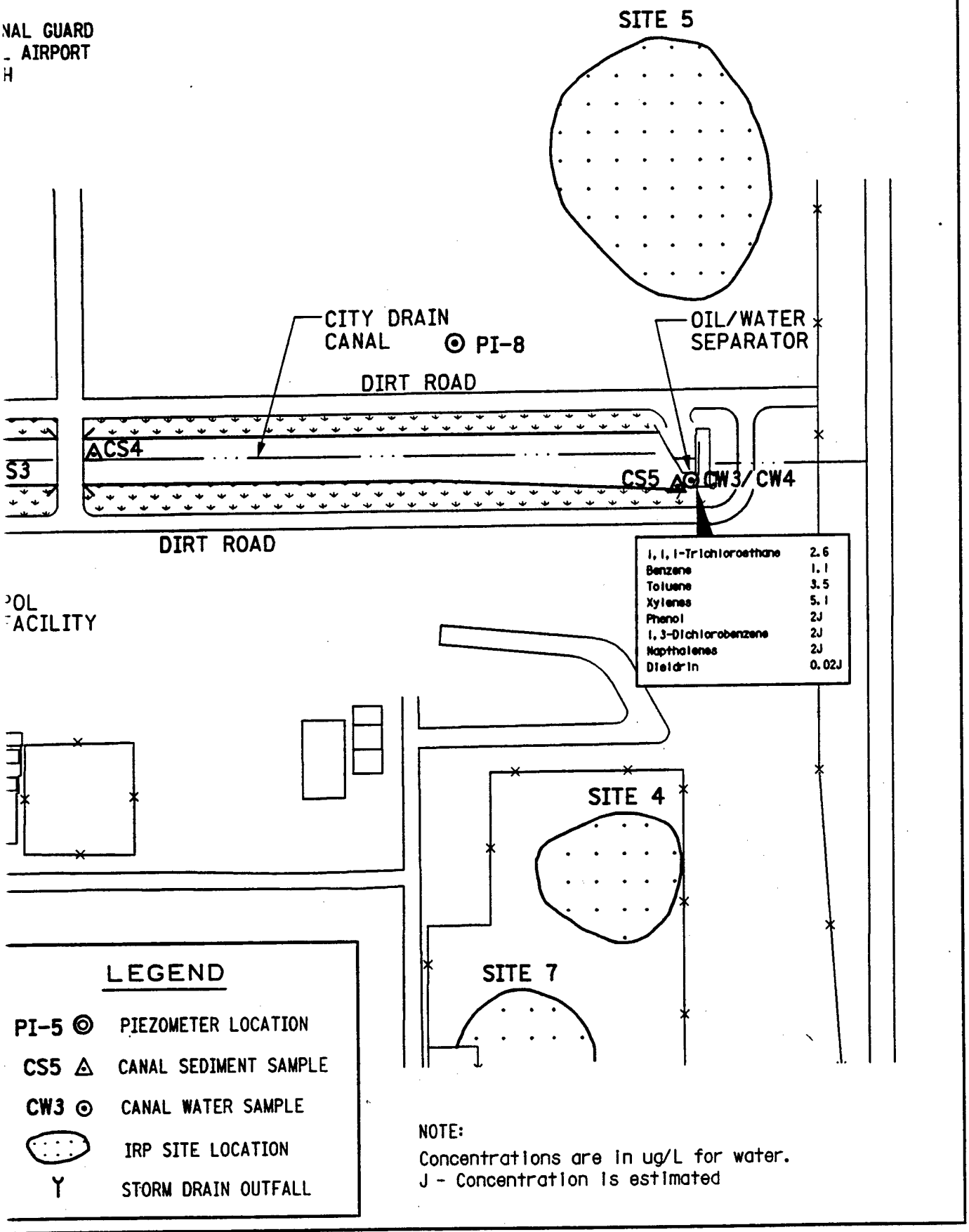


FIGURE 4.7

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CW3, as shown in Table 4.12. The locations of the samples and the concentrations of these metals are depicted on Figure 4.8. Antimony, arsenic, cadmium, copper, nickel, and selenium were detected at the estimated concentrations of 25.7 µg/L, 83.5 µg/L, 1 µg/L, 15.4 µg/L, 4.3 µg/L, and 6.5 µg/L, respectively, in CW1. Arsenic, copper, and lead were detected at estimated concentrations of 108 µg/L, 17.5 µg/L, and 2.2 µg/L, respectively, in CW2. Antimony, arsenic, and selenium were detected at estimated concentrations of 13.8 µg/L, 63 µg/L, and 1.9 µg/L, respectively, in CW3. These metals were also detected in the duplicate sample CW4 at similar concentrations. Concentrations of antimony and arsenic exceeded MCLs as noted in Table 4.12. A discussion of health-based and ecological comparative criteria is provided in the preliminary risk evaluation (Section 5).

4.2.3.4 Piezometer (PI-5) - Soil Samples

The area of piezometer PI-5, located in the Base POL facility, was suspected to be contaminated. Consequently, two soil samples from the PI-5 soil boring were collected in October 1992 for chemical analysis. The soil samples were analyzed for VOCs, SVOCs, pesticides/PCBs, PPMs, and TRPH. Target compounds included in each of the analyses and the detection limits for the compounds are included in Table H.1, Appendix H.

The analytical results for compounds detected in the two soil samples are provided in Table 4.13. The piezometer soil boring log and construction diagram are provided in Appendix F.

Organic Compounds. Concentrations of organic compounds detected in the PI-5 soil boring are shown on Figure 4.5. Benzene was detected in both sampling intervals of the piezometer soil boring. Benzene, ethylbenzene, and xylenes were detected in clayey sand at the 0- to 2-foot interval at concentrations of 17 µg/kg, 3 mg/kg estimated, and 18 µg/kg, respectively. Benzene was detected at a concentration of 19 µg/kg in fine sand at the 6- to 8-foot interval. The VOCs 1,1-dichloroethane, chloroform, and 2-butanone were present at estimated concentrations of 3 µg/kg, 4 µg/kg, and 7 µg/kg, respectively, in clayey sand at the 0- to 2-foot level. The SVOC bis(2-ethylhexyl)phthalate was reported at a concentration of 180 µg/kg estimated in the 6- to 8-foot sampling interval. The pesticide chlordane was detected in both sampling intervals. Chlordane was detected at a concentrations of 58 µg/kg in the shallow sampling interval and 34 µg/kg in the deeper sampling interval. The pesticide dieldrin was also detected in the 6- to 8-foot interval at a concentration of 1.4 µg/kg. TRPH were not detected in the soil samples.

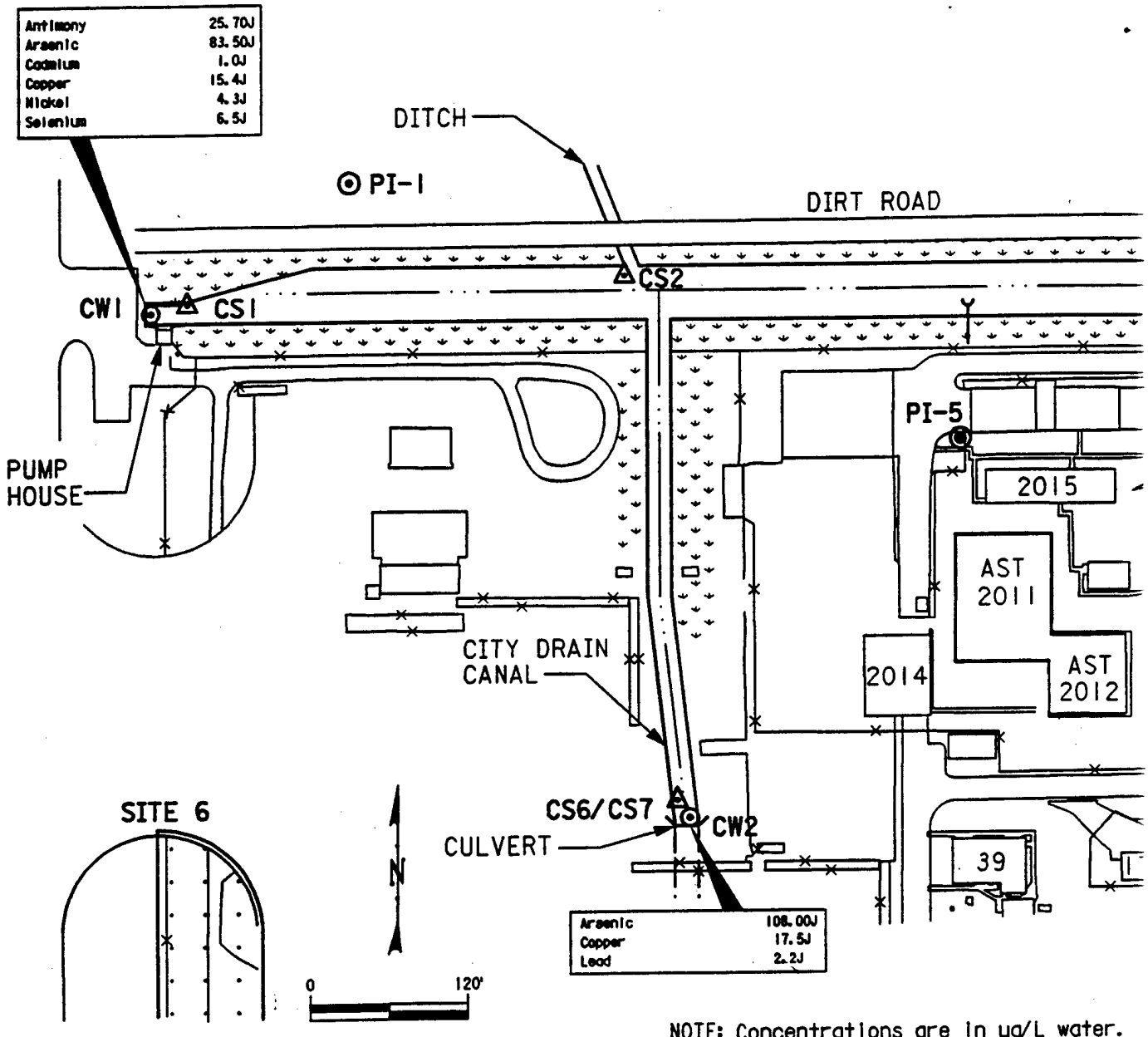
The common laboratory contaminants methylene chloride and acetone were detected in both soil samples. However, these compounds were not detected in an associated method blank. A trip blank did not accompany these samples to the laboratory.

Metals. The metals arsenic, beryllium, chromium, copper, lead, nickel, and zinc were detected in both soil samples from PI-5 at the concentrations shown in Table 4.13.

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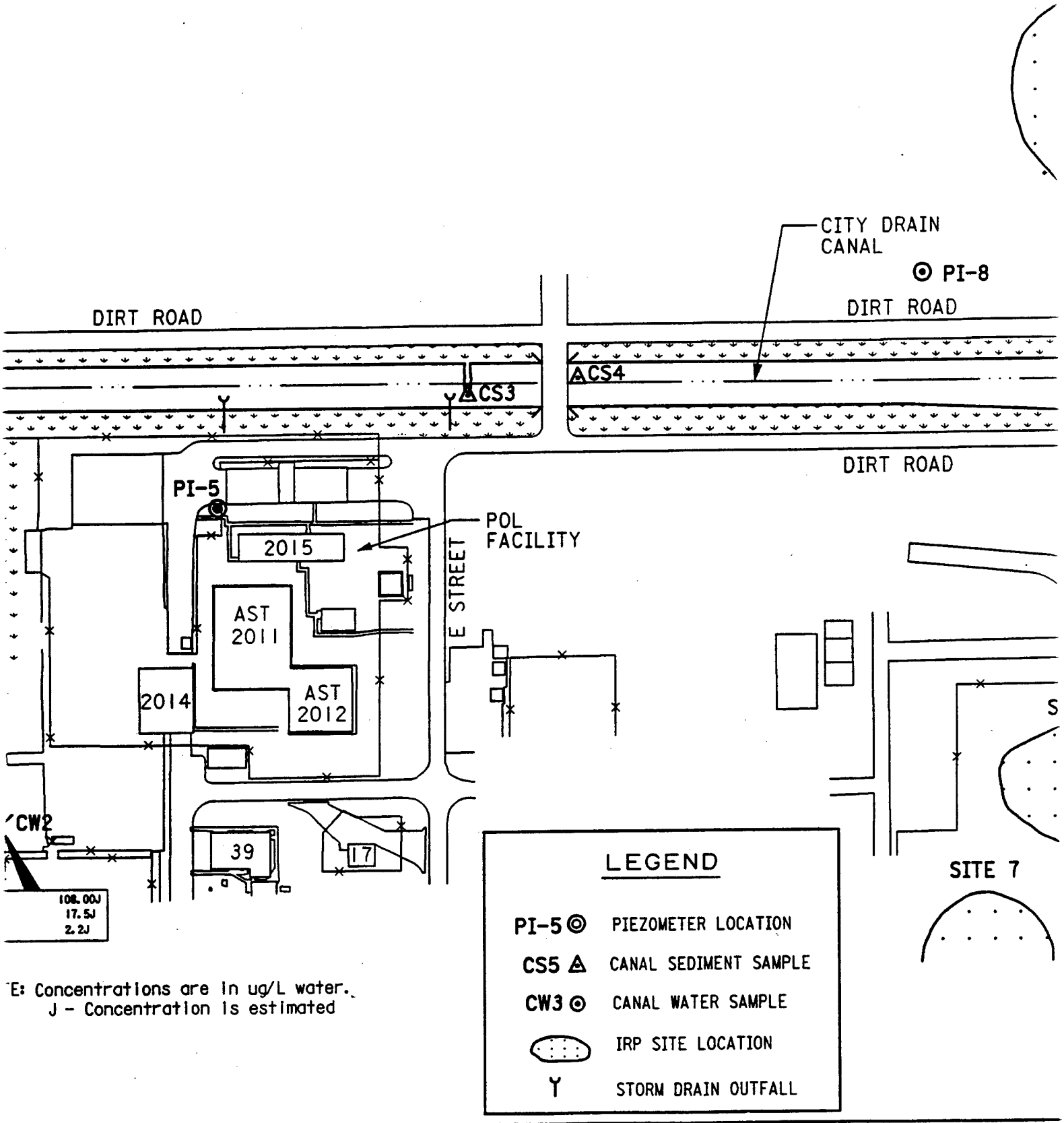
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NOTE: Concentrations are in ug/L water.
J - Concentration is estimated

METALS DETECTED IN SURFACE WATER SAMPLES FROM THE CITY DRAIN CANAL

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SALT LAKE CITY, UTAH



E: Concentrations are in ug/L water.
J - Concentration is estimated

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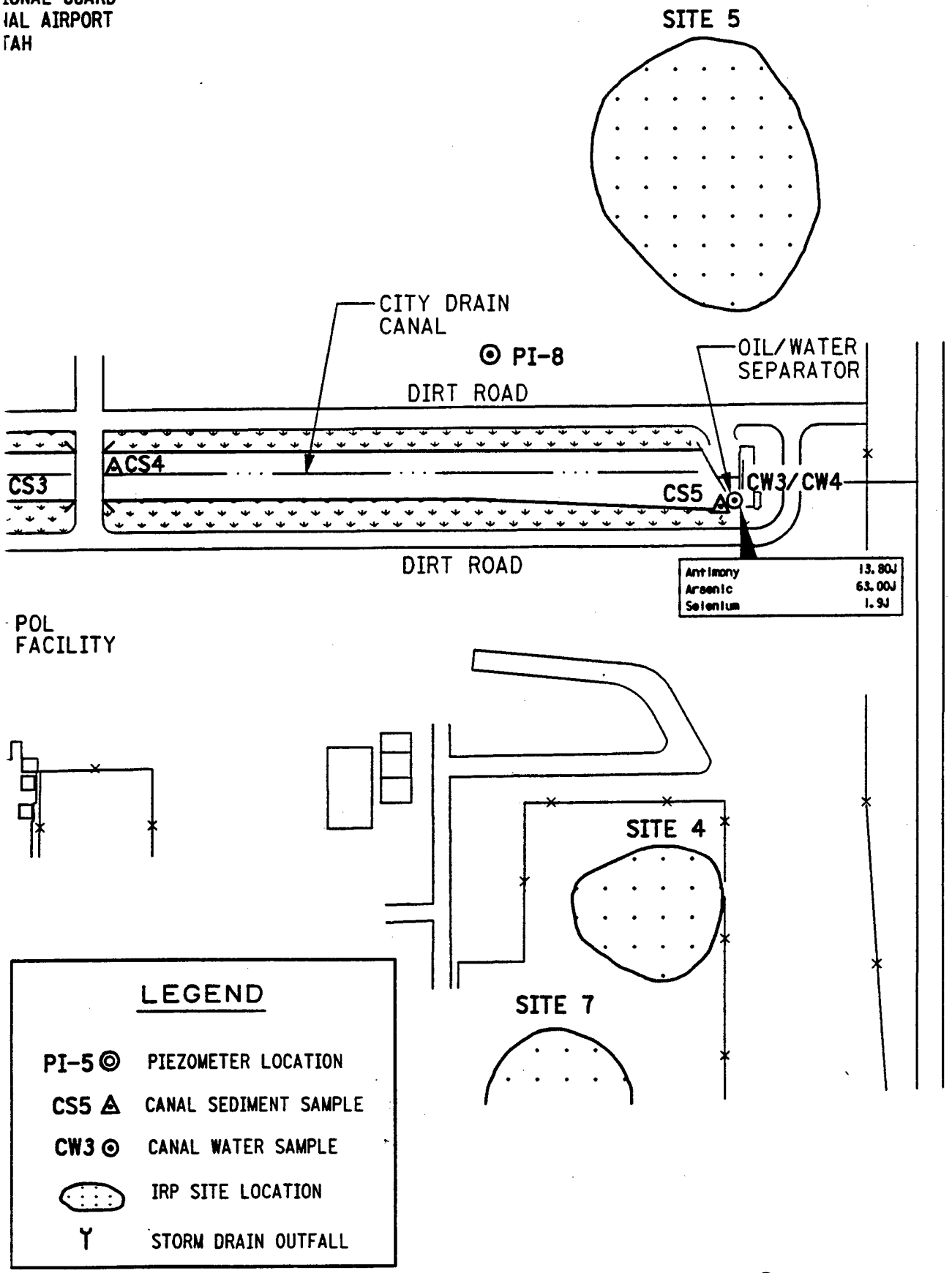


FIGURE 4.8

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TABLE 4.13
PIEZOMETER PI-5 SOIL BORING - ANALYTES DETECTED
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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	PI-5-0-2	PI-5-6-8
VOCs (SW8240) (µg/kg)*				
Dilution Factor	--	--	1	1
Methylene Chloride	58,300 c	5.0	3J	3J
Acetone	2.7E+07 nc	10.0	19J	6J
1,1-Dichloroethane	2.7E+07 nc	5.0	3J	6U
Chloroform	1.05E+05 nc	5.0	4J	6U
2-Butanone	1.62E+08 nc	10.0	7J	12UJ
Benzene	22,100 c	5.0	17	19.0
Ethylbenzene	2.7E+07 nc	5.0	3J	6U
Total Xylenes	5.4E+08 nc	5.0	18	6U
SVOCs (SW8270) (µg/kg)*				
Dilution Factor	--	--	1	1
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	380U	180J
Pesticides/PCB's (SW8080) (µg/kg)*				
Dilution Factor	--	--	1	1
Chlordane	492 nc	4.70	58.0	34.0
Dieldrin	40 c	0.70	0.80U	1.4
TRPH (E418.1) (mg/kg)*				
Result	na	10.0	12U	12U
PPMs (mg/kg)*				
Arsenic	0.366 c	2.0	***15.3J***	***7.9J***
Beryllium	0.149 c	0.33	***0.40J***	***0.33J***
Chromium	1,350 nc	2.0	13.9J	11.8J
Copper	10,800 nc	2.0	17.2J	22.3J
Lead	na	2.0	12	13.2
Nickel	5,400 nc	3.0	9.7J	7.6J
Zinc	81,000 nc	1.0	45.2J	41.2J

U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
* Analyses were performed by ES-Berkeley Laboratory.
Note: Concentrations exceeding Preliminary Remediation Goals (PRGs) are shown in bold italic
nc - noncarcinogen, c - carcinogen, na - not available.

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4.3 SITE 1 - FORMER PESTICIDE DUMP

4.3.1 Field Program

4.3.1.1 Screening Activities

There were no site-specific screening activities conducted at Site 1 during the screening phase of the SI. Piezometers were installed basewide, as discussed in Subsection 4.2.1, and are not site specific. A soil gas survey was not conducted at this site during the screening phase of the SI since pesticides are not volatile.

4.3.1.2 Confirmation and Optional Activities

The following activities were conducted during the confirmation/optional phase of the Site 1 SI:

- Advanced 10 soil borings;
- Selected and analyzed 20 soil samples;
- Installed two downgradient monitoring wells; and
- Collected and analyzed three groundwater samples.

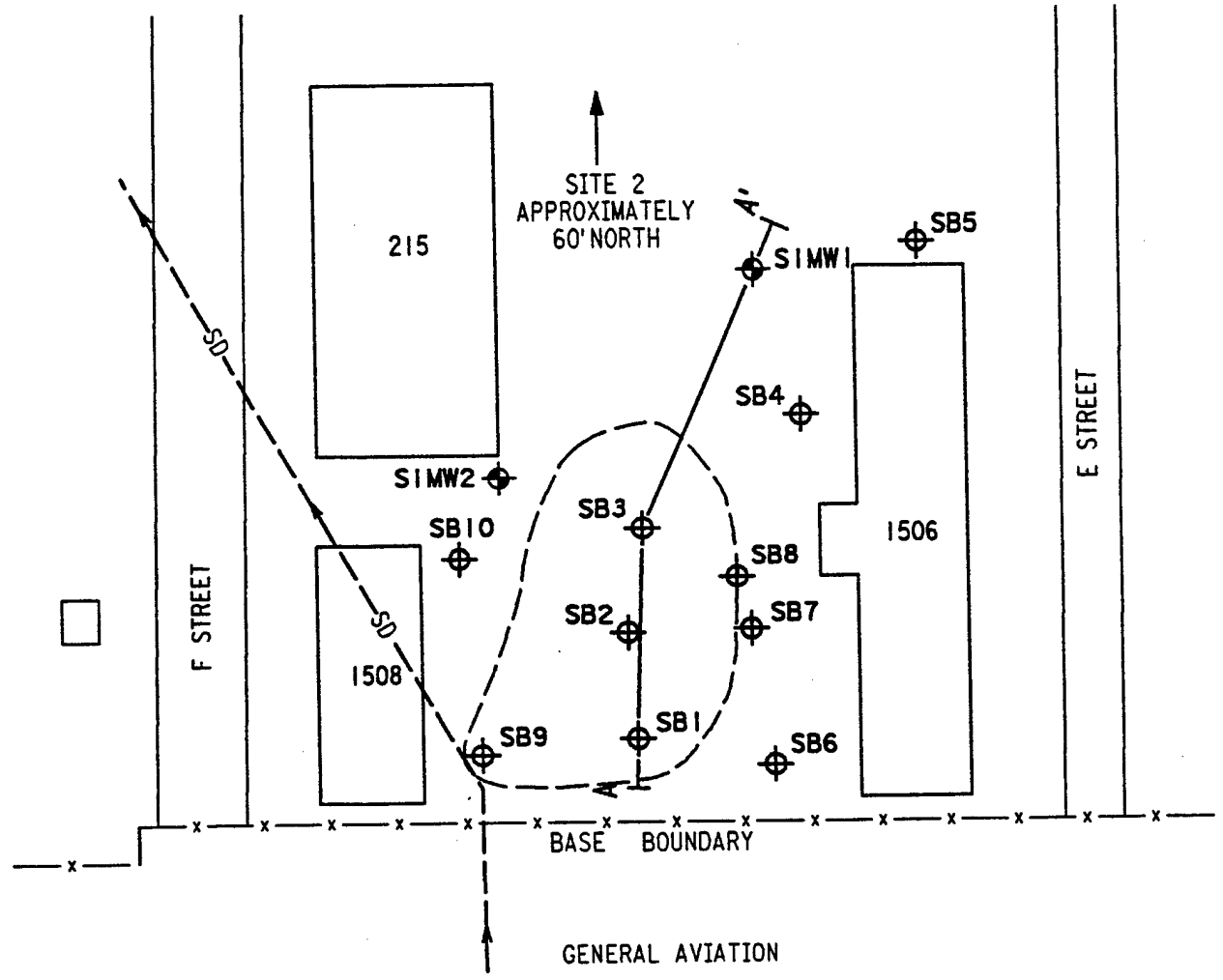
The locations of the soil borings at Site 1 were selected after evaluating the results of the PA and the area of contamination proposed in the SAP for Site 1. In December 1992, three confirmational soil borings were placed in locations of possible soil contamination. Seven additional soil borings were installed at the site in October 1994, subsequent to submission of the Internal Draft SI Report. The seven borings were placed near the doorways and garage doors of Buildings 1506 and 1508. Pertinent site features and the locations of the soil borings are shown on Figure 4.9.

Two soil samples from each of the 10 soil borings were selected for chemical analyses and were packaged for laboratory analysis; COCs are provided in Appendix D. The deepest sample selected was based on the proximity to the water table. Groundwater was encountered during drilling at a depth of approximately 5 feet to 6 feet BLS. Headspace screening results, sampling intervals, and the unconsolidated sediments of each boring were recorded. Detailed soil descriptions are provided on the soil boring logs in Appendix G.

One hydraulically downgradient monitoring well, S1MW1, was installed in January 1993, north-northeast of the soil borings and a second hydraulically downgradient monitoring well, S1MW2, was installed in August 1995, northwest of the soil borings at the locations shown in Figure 4.9. S1MW1 is screened from 5.35 feet to 15.35 feet BLS and S2MW2 is screened 4.0 to 14.0 feet BLS. Both wells are screened in clay and sand. Construction details for the Site 1 monitoring wells are provided in Table G.1 of Appendix G. The monitoring well boring logs and construction diagrams are also provided in Appendix G. Following development, the monitoring wells were purged and sampled, and the samples were analyzed for specified chemical constituents. Well development and sampling forms are provided in Appendix C.

SOIL BORING, MONITORING WELL, AND GEOLOGICAL CROSS-SECTION LOCATIONS - SITE 1

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SALT LAKE CITY, UTAH



LEGEND

- SOIL BORING
- MONITORING WELL
- SD — CITY DRAIN
- x — FENCE
- 1 — BUILDING & BUILDING NUMBER
- SITE LOCATION (based on soil results)

N

0 50'

NOTE:

SIMW1 was installed January 1993.
SIMW2 was installed August 1995.

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FIGURE 4.9

4.3.2 Results of Site Investigation

4.3.2.1 Geology and Hydrogeology

A geological cross-section of Site 1 stratigraphy, at the location shown on Figure 4.9, is presented as Figure 4.10. Site 1 is underlain by a silty clay or silty sand, clay, sand, and clay depositional sequence. The upper 4 feet of stratigraphy below fill contains discontinuous layers of clayey silt, silty clay, and silty sand. A thin lens of organic silt is present near the surface at soil boring SB2. The deposits are predominantly olive-gray clay with areas that are mottled olive-gray and olive-brown from 4 feet to a depth of approximately 9 feet BLS. A gray silty sand that coarsens with depth is present at 9 feet to 14 feet BLS at monitoring well S1MW1. A dark greenish-gray clay is present below the sand layer to the lowest sampling depth of 16.5 feet at S1MW1. The upper 4 feet of stratigraphy at Site 1 is typical of alluvial sediments deposited by meandering streams in a marsh-floodplain environment. The lower clay and sand appear to be the result of deltaic deposition.

Basewide groundwater levels were measured on 28 December 1992, 16 March 1993, and 19 July 1995 to determine hydraulic gradients and groundwater flow directions at the sites (Figures 4.1, 4.2, 4.3). Extrapolated groundwater contour maps of the Site 1 area for these respective dates are provided as Figures 4.11, 4.12, and 4.13. The purpose of the 28 December 1992 and 19 July 1995 measurements was to establish groundwater flow directions prior to well placement. The purpose of the 16 March 1993 round of groundwater measurements was to establish hydraulic gradients and flow directions for groundwater flow rate calculations at the sites. This was the only instance when all of the site monitoring wells and basewide piezometers were measured on the same day during the primary 1992-93 investigation of Sites 1 through 7. As shown in Figure 4.12, the groundwater flow direction at Site 1 was to the west-northwest on this date. The west-northwest flow direction on 16 March 1993 represents a change from the more northerly flow direction at the site inferred from the 28 December 1992 groundwater gradient (Figure 4.11). The groundwater flow direction also was to the northwest on 19 July 1995 prior to placement of the new downgradient monitoring well S1MW2 (Figure 4.13). For a comparison of groundwater levels in basewide piezometers and monitoring wells see Tables 4.1, 4.2, and 4.3. The variation in groundwater elevations, hydraulic gradients, and flow directions among these dates is probably due to the shallow aquifer's response to seasonal groundwater recharge and discharge. Therefore, the local hydraulic flow conditions at this site and the other sites is considered to be seasonally variable.

4.3.2.2 Groundwater Flow Calculations

As stated above, 16 March 1993 groundwater levels were measured to evaluate groundwater flow rates at the sites. However, since only one monitoring well, S1MW1, was installed at Site 1 in 1993, the site-specific hydraulic gradient and groundwater flow rate across this particular site were not determined. The second downgradient monitoring well, S1MW2, was not installed until 1995. The hydraulic conductivity (K) of the clay and sand in the screened interval of S1MW1 was estimated from a slug test at the well to

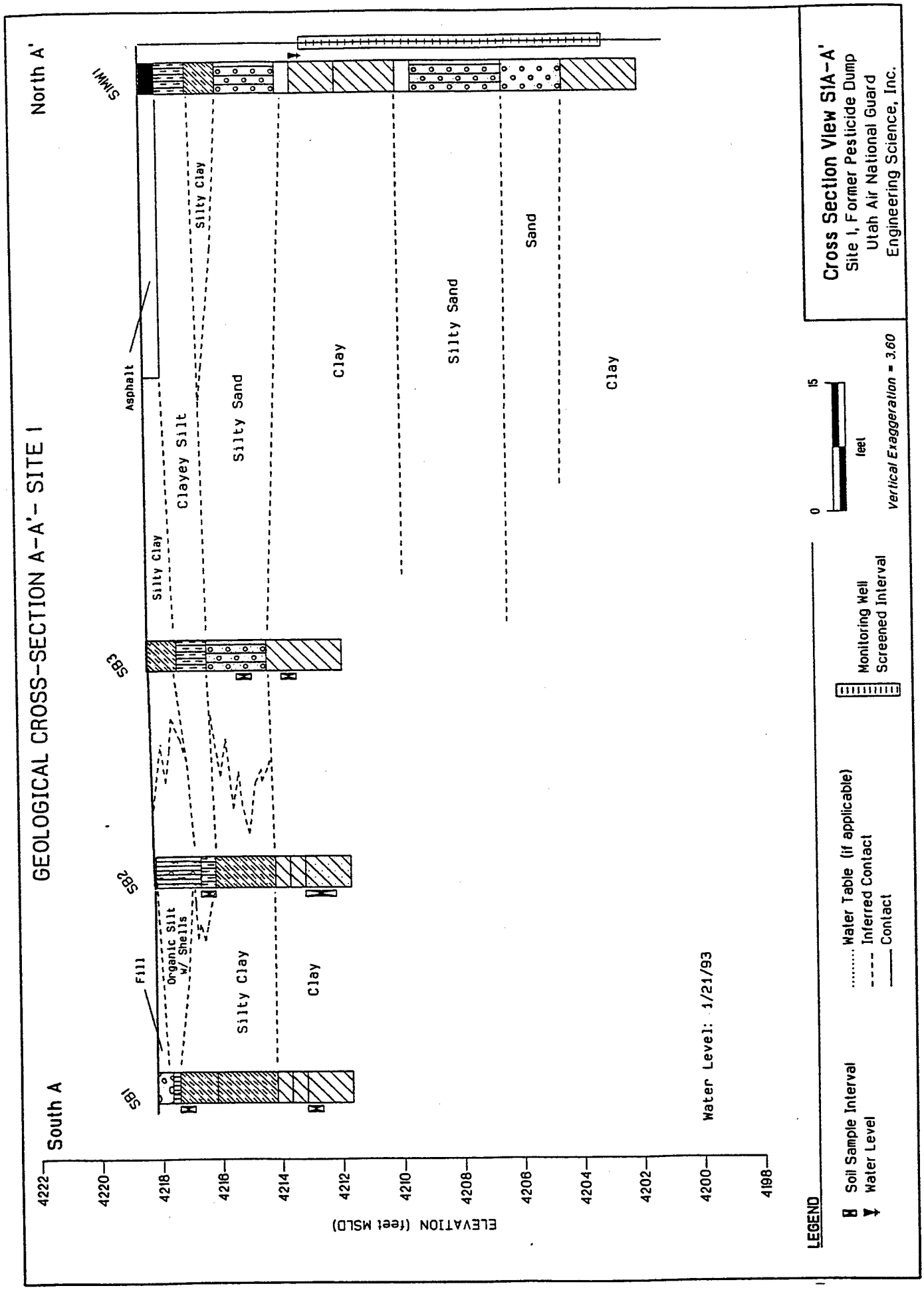
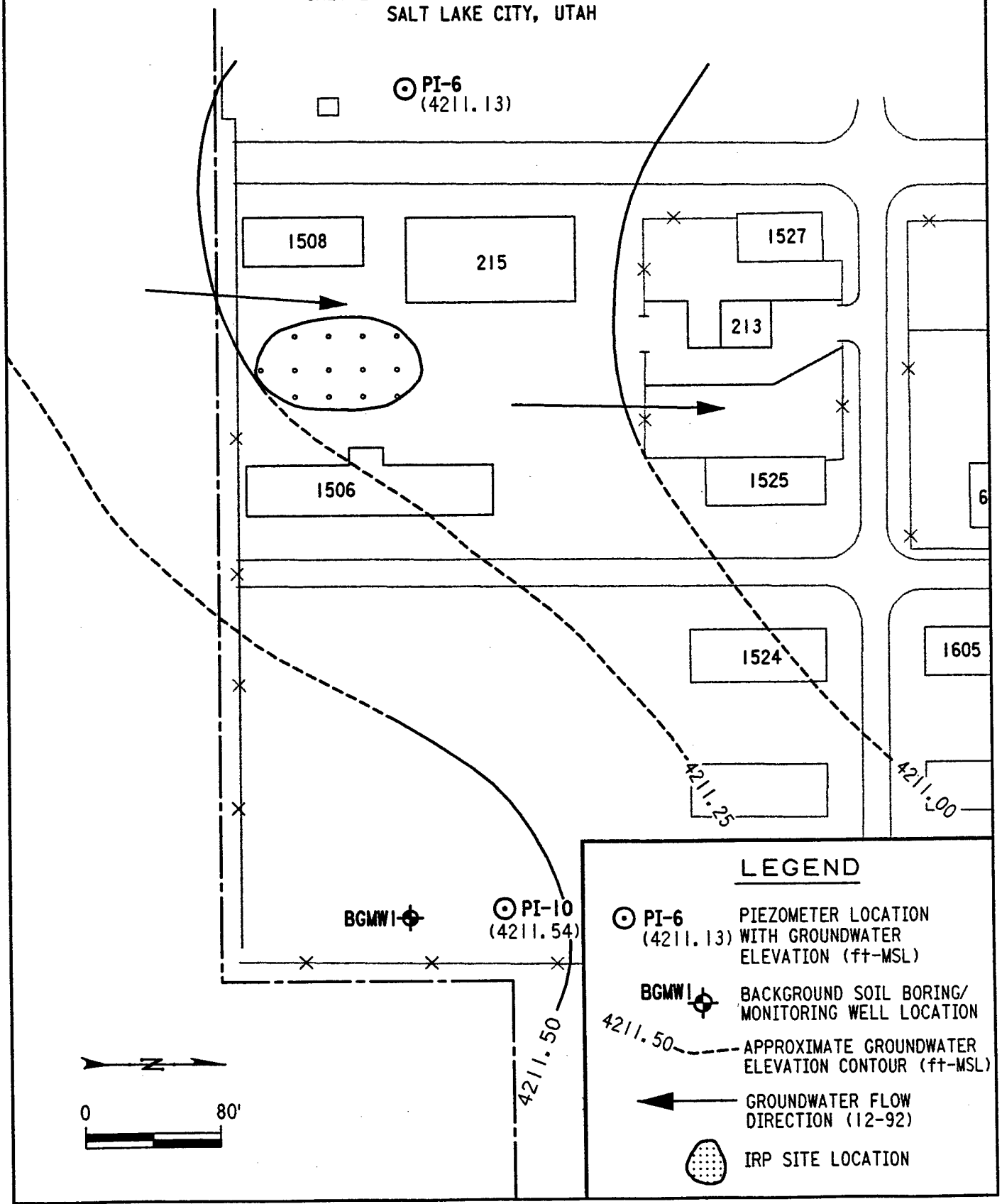

GEOLOGICAL CROSS-SECTION A-A'- SITE 1
North A'
South A
SMW1
SB3
SB2
SB1
Asphalt
Fill
Organic Silt w/ Shells
Silty Clay
Clayey Silt
Silty Sand
Clay
Silty Sand
Sand
Clay
Silty Clay
Clay
Water Level: 1/21/93
ELEVATION (feet MSLD)
4222
4220
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well Screened Interval
0
15
feet
Vertical Exaggeration = 3.60
Cross Section View S1A-A'
Site 1, Former Pesticide Dump
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.10

GROUNDWATER GRADIENT MAP - SITE 1
28 DECEMBER 1992

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SALT LAKE CITY, UTAH

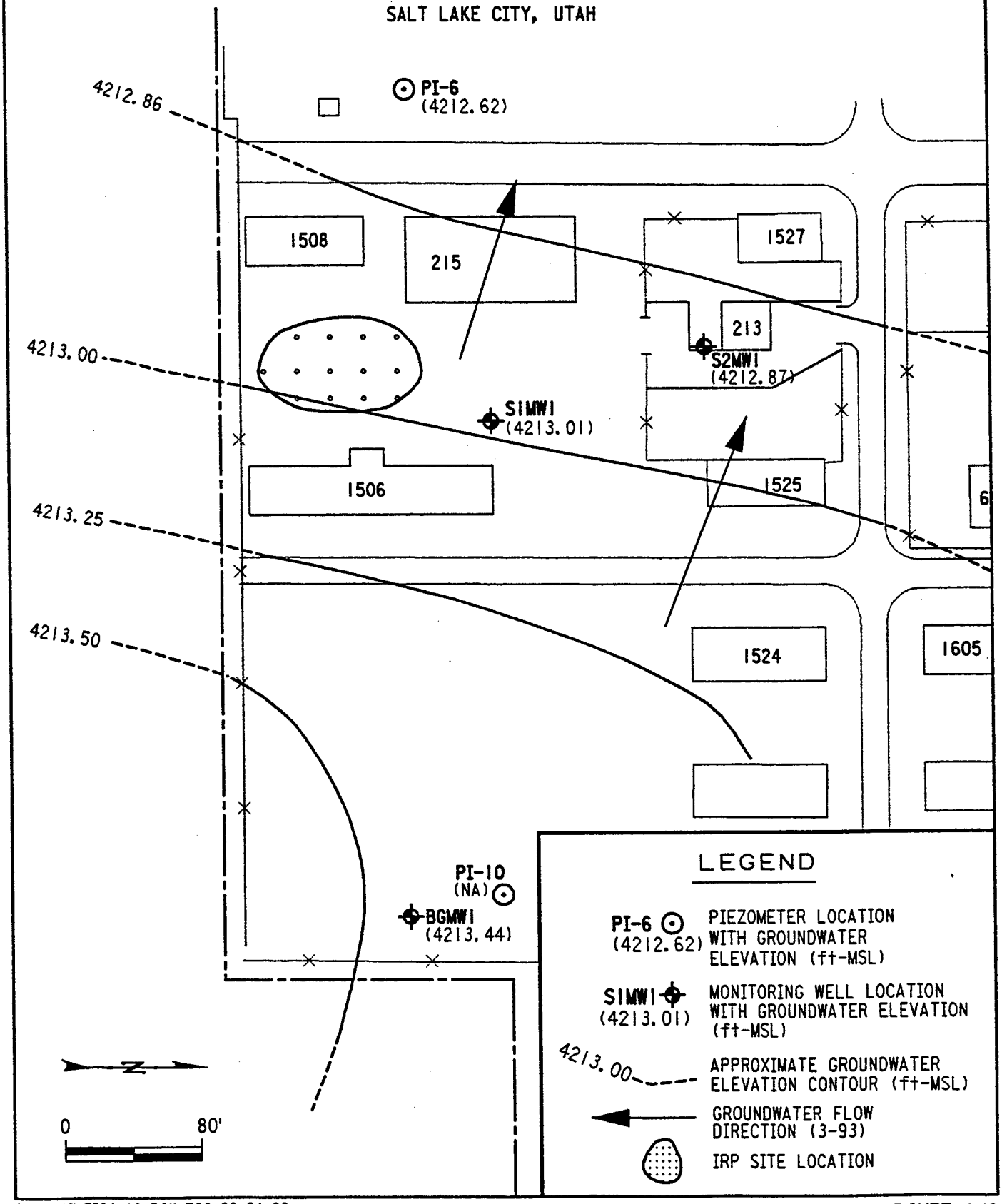


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FIGURE 4.11

GROUNDWATER GRADIENT MAP - SITE 1
16 MARCH 1993

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SALT LAKE CITY, UTAH



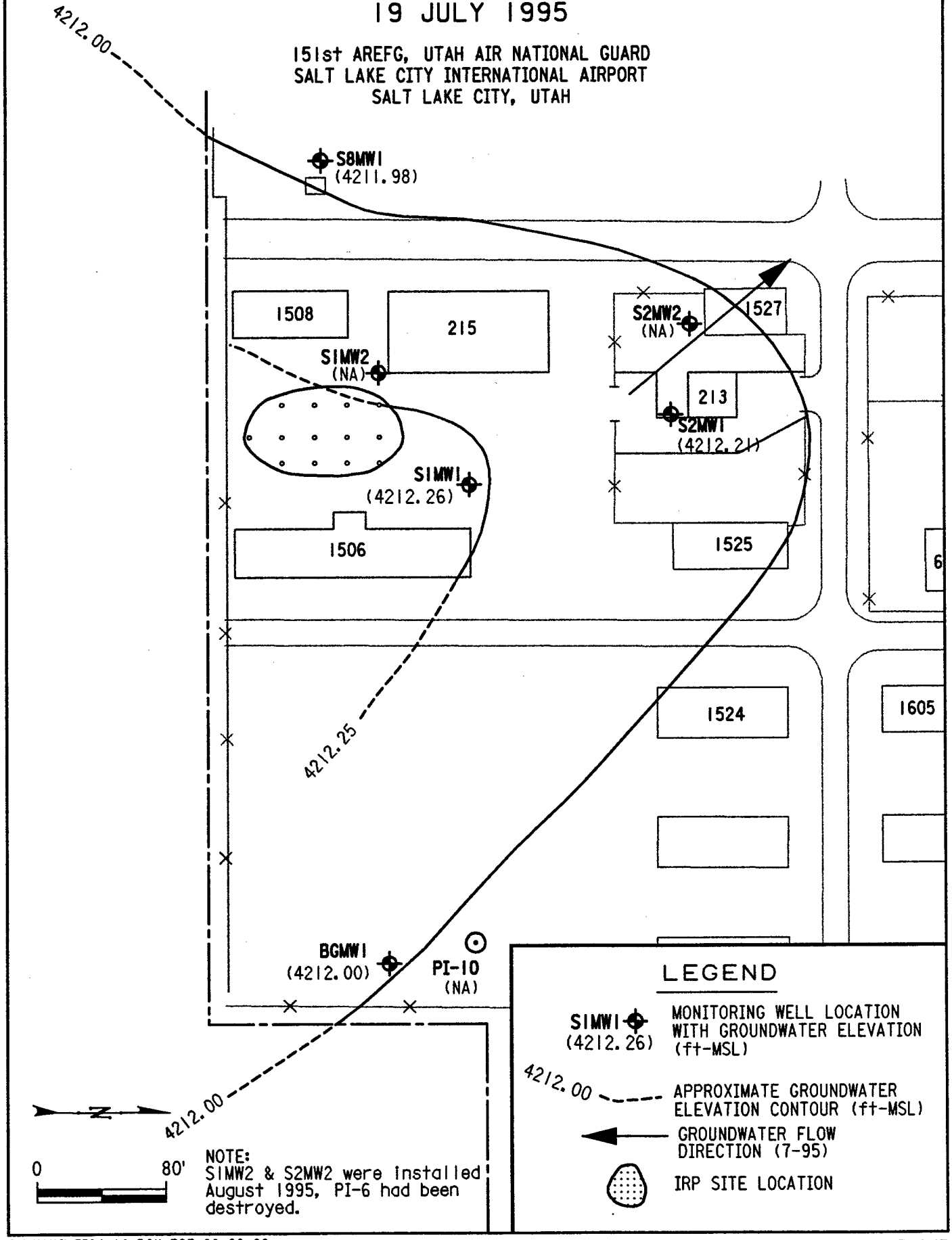
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FIGURE 4.12

FINAL

GROUNDWATER GRADIENT MAP - SITE 1
19 JULY 1995

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C:\UANG\FIG4-13.DGN R05 06.06.96

FIGURE 4.13

be 3.3 ft/day. The hydraulic conductivity of the clay and sand in the screened interval of S1MW2 was estimated from a slug test at the well to be 5.34 ft/day. Slug test methods and results are presented and discussed in Appendix I. Hydraulic conductivity values are given in Table I.1 of Appendix I.

4.3.2.3 Soil Contamination Assessment

Soil samples were collected from three initial and seven additional soil borings at Site 1. Analytical soil samples were not collected from the monitoring well borehole as per SAP. The locations of the analytical samples within the 2-foot or 2.5-foot sampling intervals of the three initial soil borings and the types of soil from which the analytical samples were collected are shown in the geological cross-section (Figure 4.10) and the soil boring logs in Appendix G.

Two samples from each of the three initial soil borings and one field duplicate were analyzed for pesticides/PCBs. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Two soil samples from each of the seven additional soil borings and two field duplicates were analyzed for Pesticides/PCBs and VOCs. VOCs were analyzed because soil gas headspace readings were detected during field screening of soils. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.2, Appendix H. Complete QA/QC information for the analytical data and the results of the field QA/QC samples are provided in QA/QC report No. 1, Appendix E.

The analytical results for compounds detected in Site 1 soil samples are provided in Table 4.14. If concentrations were below their respective detection limits in other soil samples, the detection limits are shown in the table. The detection limits vary slightly for the ES Berkeley Laboratory data due to matrix effects and dry weight calculations. Soil PRGs are provided in the table. The basis and derivation of these health-based criteria are discussed in the Preliminary Risk Evaluation (Section 5). The findings of the detected compounds are discussed below.

Organic Compounds. Concentrations of pesticides detected in Site 1 soils are shown on Figure 4.14. Pesticides were detected in the three initial confirmational soil borings advanced at the site in December 1992. Chlordane was detected at a concentration of 32 µg/kg in silty clay at the 0- to 2-foot interval of SB1. Beta BHC was detected at a concentration of 2.7 µg/kg in clay at the 4- to 6.5-foot interval of this soil boring. Beta BHC was also detected at the concentrations of 10 µg/kg and 16 µg/kg in clay at the 4- to-6.5-foot sampling intervals of SB2 and SB3, respectively.

No pesticides/PCBs were detected in soil samples collected from the seven additional soil borings advanced at the site in October 1994. However, the VOC trichloroethene was detected at the soil/water interface at a concentration of 4.4 µg/kg in the 5-to 7-foot sampling interval of SB9.

TABLE 4.14
SITE 1 - SOIL BORING
ANALYTES DETECTED
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Parameter (method) (units)	PRGs	Detection Limit	SB1-0-2	SB1-4-6.5	SB2-0-2	SB2-4-6.5	SB3-2-4	SB3-4-6.5	duplicate (a) SB3-6.5-8.5
VOCs (SW8010/8020) (µg/kg)*									
Dilution Factor	--	--	1	1	1	1	1	1	1
Trichloroethene	58,200 c	1.0	NA	NA	NA	NA	NA	NA	NA
Pesticides/PCBs (SW8080) (µg/kg)*									
Dilution Factor	--	--	1	1	1	1	1	1	1
Beta BHC	356 c	2.0	2.3U	2.7	2.3U	10	2.4U	16	2.4U
Chlordane	492 c	4.7	32	5.9U	5.4U	6.1U	5.6U	6.6U	5.6U

Parameter (method) (units)	PRGs	Detection Limit	SB4-3.5-5.5	SB4-7.5-9.5	SB5-1-3	SB5-5-7	SB6-1-3	duplicate (a) SB6-3-5	SB6-5-7	SB7-1-3
VOCs (SW8010/8020) (µg/kg)**										
Dilution Factor	--	--	1	1	1	1	1	1	1	1
Trichlorethene	58,200 c	0.5	1U	1U	1U	1U	1U	1U	1U	1U
Pesticides/PCBs (SW8080) (µg/kg)**										
Dilution Factor	--	--	1	1	1	1	1	1	1	1
Beta BHC	356 c	1.7	1.7U	1.7U	1.7U	1.7U	1.7U	1.7U	1.7U	1.7U
Chlordane	492 c	4.7	17U	17U	17U	17U	17U	17U	17U	17U

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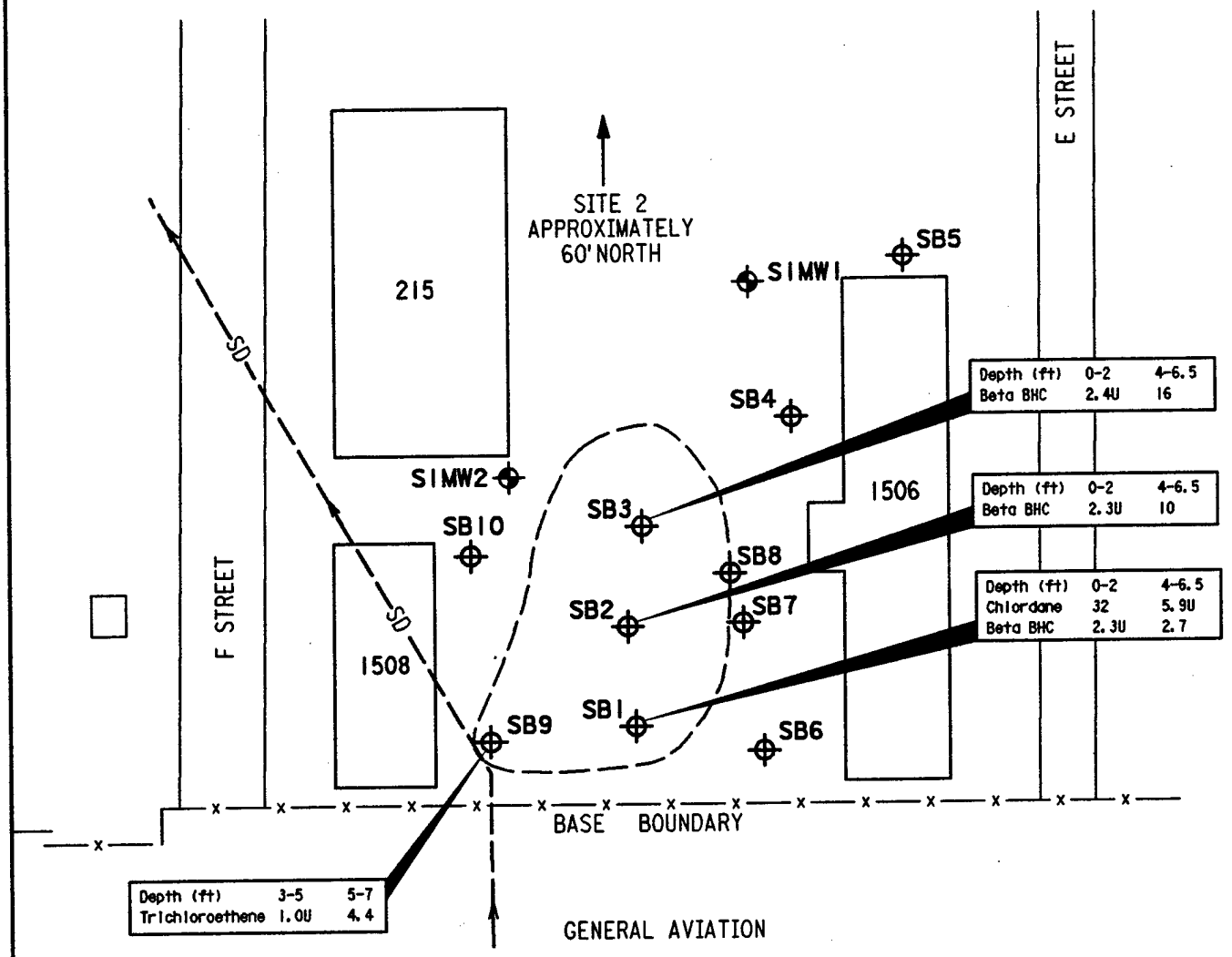
TABLE 4.14 - Continued
SITE 1 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
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SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB7-5-7	SB8-1-3	SB8-5-7	duplicate (a) SB8-7-9	SB9-3-5	SB9-5-7	SB10-1-3	SB10-5-7
VOCs (SW8010/8020) (µg/kg)**										
Dilution Factor	--	--	1	1	1	1	1	1	1	1
Trichloroethene	58,200 c	0.5	1U	1U	1U	1U	1U	4.4	1U	1U
Pesticides/PCBs (SW8080) (µg/kg)**										
Dilution Factor	--	--	1	1	1	1	1	1	1	1
Beta BHC	356 c	1.7	1.7U	1.7U	1.7U	1.7U	1.7U	1.7U	1.7U	1.7U
Chlordane	492 c	4.7	17U	17U	17U	17U	17U	17U	17U	17U

(a) Blind duplicate from preceding sample interval.
***** Analyses were performed by ES-Berkeley Laboratory.
****** Analyses were performed by Datachem Laboratories.
NA Not analyzed.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
Note: No soil Preliminary Remediation Goals (PRGs) exceeded; c - carcinogen

FINAL

ORGANIC COMPOUNDS DETECTED IN SOIL
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LEGEND

- SOIL BORING
- MONITORING WELL
- FENCE
- BUILDING & BUILDING NUMBER
- SITE LOCATION

N

0 50'

NOTE:
Concentrations are in ug/kg for soil.
U - concentration not present above detection limit shown

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FIGURE 4.14

4.3.2.4 Groundwater Contamination Assessment

One groundwater sample was collected in February 1993 from monitoring well S1MW1 and was analyzed for pesticides/PCBs. A field duplicate groundwater sample from the well was also collected and analyzed for these analytes. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

In August 1995, groundwater samples were collected from monitoring well S1MW1 and newly installed S1MW2 and were analyzed for pesticides/PCBs. In addition, the samples were also analyzed for VOCs and arsenic. Arsenic was analyzed at this non-metals site and all other sites for this second round of sampling to provide background information on arsenic concentrations in this area thought not to be affected by metals contamination and to evaluate the basewide distribution of arsenic in shallow groundwater. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.2, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 2, Appendix E.

Field measurements of specific conductance, pH, and temperature were made on the samples at the time of sample collection. These measurements are provided in Tables 4.8 and 4.9.

Analytical results of the groundwater samples collected at Site 1 are provided in Tables 4.15 and 4.16. MCLs are also provided in the tables for compounds detected at the site. MCLs for all compounds detected during the SI are listed in Table 5.3 of the preliminary risk evaluation (Section 5). The findings are discussed below.

Organic Compounds. No pesticides/PCBs were detected in the groundwater samples collected from the Site 1 monitoring wells as indicated on Figure 4.15 and the tables. However, solvent-related VOCs were detected in groundwater collected from S1MW2 at the concentrations shown in Table 4.16. The chlorinated VOCs 1,2-dichloroethene, trichloroethene, tetrachloroethene, and vinyl chloride, detected at concentrations of 400 µg/L estimated, 37 µg/L estimated, and 4.3 µg/L, respectively, exceeded MCLs.

4.3.3 Site 1 - Conclusions

Low levels of pesticides were detected in three soil borings at the center of the site (Figure 4.14). This confirmed that the site was located during the PA and that only small amounts of pesticide were disposed. The concentrations of pesticides and the single detection of trichloroethene in soils were compared to PRGs. No health-based PRGs were exceeded. Therefore, a potential concern is not indicated for soil at this site.

Pesticides/PCBs were not detected in groundwater samples collected from the February 1993 and August 1995 sampling events at Site 1. Based on the non-detection of pesticide/PCBs and the locations of the site monitoring wells with respect to groundwater

TABLE 4.15
SITE 1 - GROUNDWATER
ANALYTES DETECTED (February 1993)
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Parameter (method) (units)	MCLs	Detection Limit	S1MW1	duplicate (a) S1MW2
Pesticides/PCBs (SW8080) (µg/L)*				
Results	--	--	ND	ND

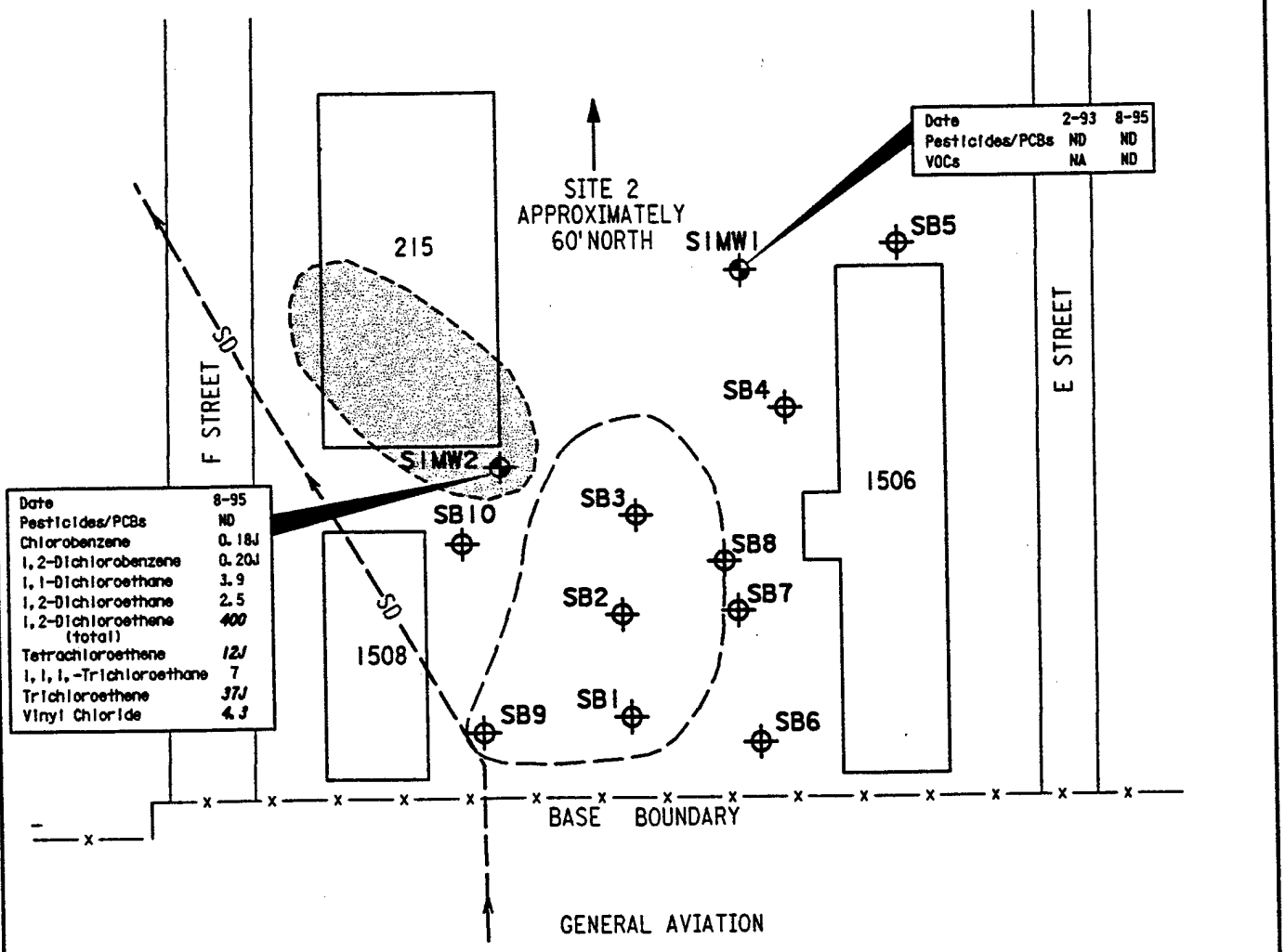
(a) Blind duplicate of S1MW1.
* Analyses were performed by the ES Berkeley Laboratory.
ND All analytes were not detected; refer to Table H.1 of Appendix H for compounds and de

TABLE 4.16
SITE 1 - GROUNDWATER
ANALYTES DETECTED (August 1995)

Parameter (method) (units)	MCLs	Detection Limit	S1MW1	S1MW2
VOCs (SW8010/8020) (µg/L)**				
Dilution Factor	--	--	1	1:1 to 1:20
Chlorobenzene	100	0.5	0.50U	0.18J
1,2-Dichlorobenzene	600	0.5	0.50U	0.20J
1,1-Dichloroethane	na	0.5	0.50U	3.9
1,2-Dichloroethane	5	0.5	0.50U	2.5
1,2-Dichloroethene (total)	70	0.5	0.50U	***400J***
Tetrachloroethene	5	0.5	0.50U	*12J*
1,1,1-Trichloroethane	200	0.5	0.50U	7.0
Trichloroethene	5	0.5	0.59U	***37J***
Vinyl Chloride	2	0.5	0.50U	***4.3***
Pesticides/PCBs (SW8080) (µg/L)**				
Results	--	--	ND	ND
Arsenic (SW7060) (µg/L)**				
Results	50	89.0	***310***	***130***

** Analyses were performed by the DataChem Laboratories.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
na No MCL exists.
ND All analytes were not detected; refer to Table H.2 of Appendix H for compounds and de
Note: Concentrations exceeding Maximum Contaminant Levels (MCLs) are shown in bold ital
Note: The MCL for 1,2-Dichloroethene is for the cis isomer, no MCL exists for 1,2-DCE total.

ORGANIC COMPOUNDS DETECTED IN GROUNDWATER
SITE 1
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NOTE:

Concentrations (ug/L) exceeding MCLs are shown in bold italic.
J - concentration is estimated
ND - not detected above detection limits
NA - not analyzed

N

0 50'

LEGEND

- SOIL BORING
- MONITORING WELL
- FENCE
- BUILDING & BUILDING NUMBER
- SITE LOCATION
- APPROXIMATE EXTENT OF VOCs EXCEEDING MCLs

flow directions observed at the site, the absence of pesticide/PCBs in groundwater appears to be confirmed.

The chlorinated VOCs 1,2-dichloroethene (total), tetrachloroethene, trichoroethene, and vinyl chloride were detected in the newly installed downgradient monitoring well, S1MW2, in excess of MCLs (Figure 4.15). However, the risks associated with contaminated groundwater at Site 1 are considered to be low, as discussed in the Preliminary Risk Evaluation (Section 5). The concentration of 1,2-dichloroethene was over 10 times greater than that of trichloroethene. The presence of the trichloroethene degradation products 1,2-dichloroethene and vinyl chloride indicates that intrinsic remediation is occurring and also suggests that the chlorinated VOCs may have resided in shallow groundwater downgradient of the site for some time. The natural attenuation pathway is probably anaerobic reductive dehalogenation whereby the chlorinated solvents act as terminal electron acceptors and native organic hydrocarbons are utilized as bacterial substrate. However, further analytical characterization would be necessary to evaluate potential natural degradation pathways and to determine decay rates and mass loss.

The source of the chlorinated VOCs detected in downgradient groundwater at Site 1 is not clear. The only VOC detected in soil at the site was trichloroethene and it was detected in soil at or below the water table at the far southwest corner of the site near a bend in the City Drain pipeline (Figure 4.14). The presence or absence of VOCs within the site area or upgradient of the site was not confirmed since only downgradient monitoring wells were installed at the site. Therefore a source within the site area or an upgradient source for these compounds could exist. Chlorinated VOCs were detected in groundwater in the area of Site 8, which borders Site 1 to the west (ES, 1993; ES, 1994). VOCs detected at S1MW2 also may be related to the generally widespread VOCs groundwater contamination present in the Site 8 area (refer to subsection 1.5.8 for the discussion of this area). Arsenic detected in groundwater at the site (Table 4.16) appears to be representative of background conditions for this metal in this area of the base. Elevated concentrations of arsenic in shallow groundwater are essentially ubiquitous at the Base as discussed in subsection 4.11. Also, where arsenic is available in the soil/water system, it is very soluble and mobile under reducing conditions (i.e., low Eh). The redox potential of groundwater is characteristically reducing when anaerobic de-chlorination of solvents is occurring.

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4.4 SITE 2 - WASTE POL FUEL SPILL

4.4.1 Field Program

4.4.1.1 Screening Activities

The following activity was conducted at Site 2 during the screening phase of the SI:

- Performance of a soil gas survey.

A soil gas survey was conducted to determine the potential source area and approximate extent of soil contamination for optimal placement of soil borings.

Soil gas samples were collected at 15 points during the Site 2 soil gas survey. A grid pattern with a 25-foot spacing between points was established for the survey. Soil gas samples were collected at a depth of approximately 4.5 feet BLS at all of the sampling locations. The sampling point locations with total BTEX concentrations and corresponding benzene fractions are identified on Figure 4.16. The coordinate system shown on Figure 4.16 identifies the specific soil gas point designation and location. Analytical results are presented in Table 4.17.

Soil gas samples from points B1, B2, C1, and D2, contained total BTEX concentrations of 133.2 ppmv, 126 ppmv, 63.9 ppmv, and 61.8 ppmv, respectively. Because benzene was the primary BTEX compound present at these sample locations, benzene concentrations are shown in relation to total BTEX on Figure 4.16. Soil gas samples from points A1 and B4 contained BTEX compounds, but the compounds were present at less than the 0.5 ppmv quantification limit of the GC calibration. The sample from B3 contained 0.8 ppmv ethylbenzene. Benzene was detected at B3, but at less than the 0.5 ppmv quantification limit. No BTEX were detected in any sample from the remaining points. The soil gas survey results indicated the possibility of a source area of BTEX contamination in the west-southwest section of the survey grid, near points B1, B2, C1, and D2.

4.4.1.2 Confirmation and Optional Activities

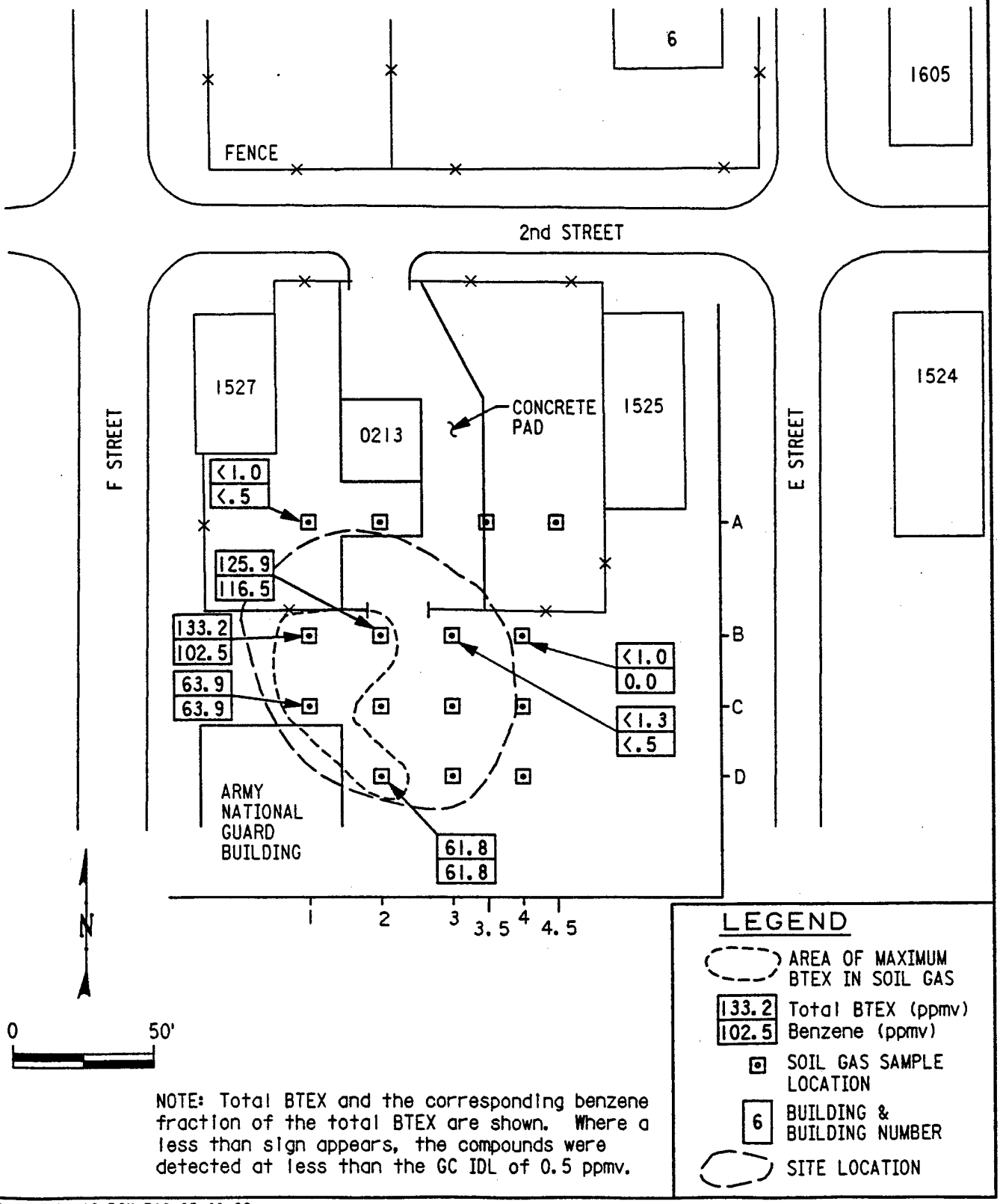
The following activities were conducted during the confirmation/optional phase of the Site 2 SI:

- Advanced six soil borings;
- Selected and analyzed nine soil samples;
- Installed two downgradient monitoring wells; and
- Collected and analyzed three groundwater samples.

The locations of three confirmational soil borings were selected after evaluating the results of the soil gas survey. The borings were placed in locations of possible soil contamination, as indicated by elevated concentrations of VOCs in soil gas samples. Three optional soil borings were placed as indicated by visual observation and elevated headspace readings from GC and PID screening of the soil samples collected during

SOIL GAS SURVEY RESULTS - SITE 2

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NOTE: Total BTEX and the corresponding benzene fraction of the total BTEX are shown. Where a less than sign appears, the compounds were detected at less than the GC IDL of 0.5 ppmv.

C:\UANG\FIG4-16.DGN R10 05.30.96

FIGURE 4.16

TABLE 4.17
SITE 2 - SOIL GAS SURVEY RESULTS
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Point	Benzene ppm v	Toluene ppm v	Ethylbenzene ppm v	Xylenes ppm v	Total BTEX ppm v
A1	<0.5	ND	<0.5	ND	<1.0
A2	ND	ND	ND	ND	ND
A3.5	ND	ND	ND	ND	ND
A4.5	ND	ND	ND	ND	ND
B1	102.5	ND	21.1	9.6	133.2
B2	116.5	ND	5.6	3.9	126
B3	<0.5	ND	0.8	ND	<1.3
B4	ND	ND	<0.5	<0.5	<1.0
C1	63.9	ND	ND	ND	63.9
C2	ND	ND	ND	ND	ND
C3	ND	ND	ND	ND	ND
C4	ND	ND	ND	ND	ND
D2	61.8	ND	ND	ND	61.8
D3	ND	ND	ND	ND	ND
D4	ND	ND	ND	ND	ND

ND - Not detected (BTEX compounds were not observed on chromatograms).
<0.5-BTEX compounds observed on original chromatograms but were not quantified.

drilling of the confirmational borings. The optional soil borings were placed to evaluate the areal extent of apparent soil contamination at the site (Field change No. 9, Appendix B). The locations of the soil borings and pertinent site features at Site 2 are shown on Figure 4.17. The soil borings were drilled sequentially beginning with soil boring SB1.

Two soil samples from each of the three confirmational soil borings and one soil sample from each of the three optional soil borings were selected for chemical analyses and were packaged for laboratory analysis. COCs are provided in Appendix D. Only one bottom-hole soil sample from the optional borings was selected for analysis due to reasons outlined in Subsection 3.6. Soil samples were selected for analysis based on the results of headspace screening and proximity to the water table. Groundwater was encountered during drilling at a depth of approximately 5 feet to 6 feet BLS. Headspace screening results, sampling intervals, and the unconsolidated sediments of each boring were logged and recorded. Detailed soil descriptions are provided on the soil boring logs in Appendix G. A correlation of the soil BTEX results of field GC screening versus the analytical laboratory is provided in Appendix J.

One hydraulically downgradient monitoring well, S2MW1, was installed in January 1993, north-northeast of the soil borings and a second hydraulically downgradient monitoring well, S2MW2, was installed in August 1995, northwest of the soil borings at the locations shown in Figure 4.17. S2MW1 is screened in the interval 5.27 feet to 15.27 feet BLS primarily in clay. S2MW2 is screened 4.0 feet to 14.0 feet BLS in clay and sand. Construction details for the Site 2 monitoring wells are provided in Table G.1, Appendix G. The monitoring well boring logs and well construction diagrams are also provided in Appendix G. Following development, the monitoring wells were purged and sampled, and the samples were analyzed for the specified chemical constituents. Well development and sampling forms are provided in Appendix C.

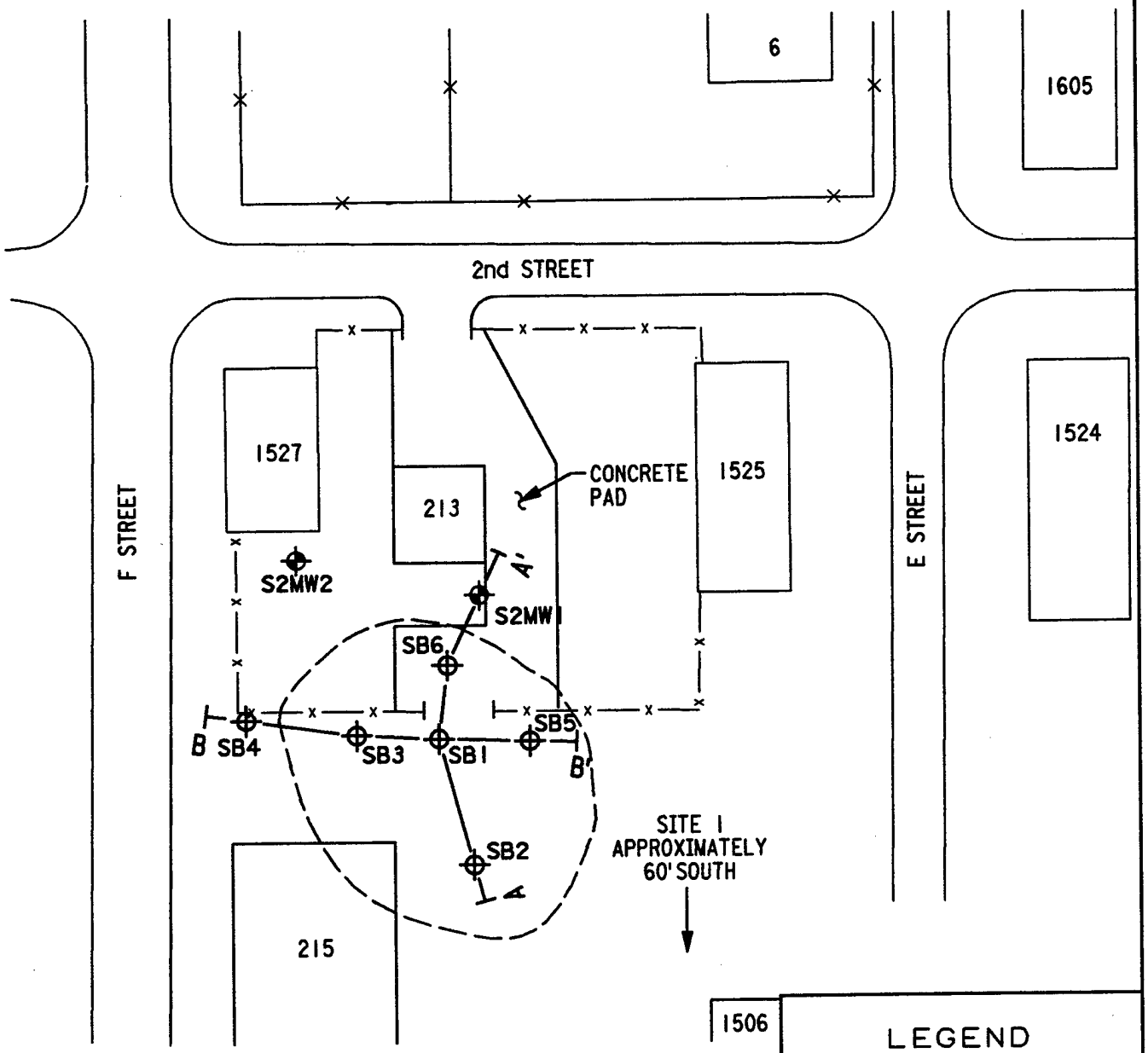
4.4.2 Results of Site Investigation

4.4.2.1 Geology and Hydrogeology

Geological cross-sections of Site 2 stratigraphy, at the locations shown on Figure 4.17, are presented as Figures 4.18 and 4.19. Site 2 is primarily underlain by a sandy clay. The sandy clay deposit is mottled olive and olive-brown to a depth of 5 feet at the west side of the site near SB4, is mostly gray from 5 feet to 9 feet, and is then greenish-gray with an increase in sand content to a maximum sampling depth of 16 feet BLS. Sand, gravel, and clay fill material is present at varying thickness beneath the asphalt and concrete surface cover. Discontinuous layers of silt, clay, and silty sand interfinger in the upper 5 feet to 8 feet of the natural depositional sequence. Due to lateral variation in the sediments, the stratigraphy is difficult to correlate between boreholes. A discrete sand lens is present beneath clay at soil borings SB5 and SB6 at a depth of 8 feet. The upper 10 feet of alluvial stratigraphy at Site 2 is typical of sediments deposited by meandering streams in a floodplain. The extensive sandy clay at depth is probably the result of deltaic deposition.

SOIL BORING, MONITORING WELL, AND GEOLOGICAL CROSS-SECTION LOCATIONS - SITE 2

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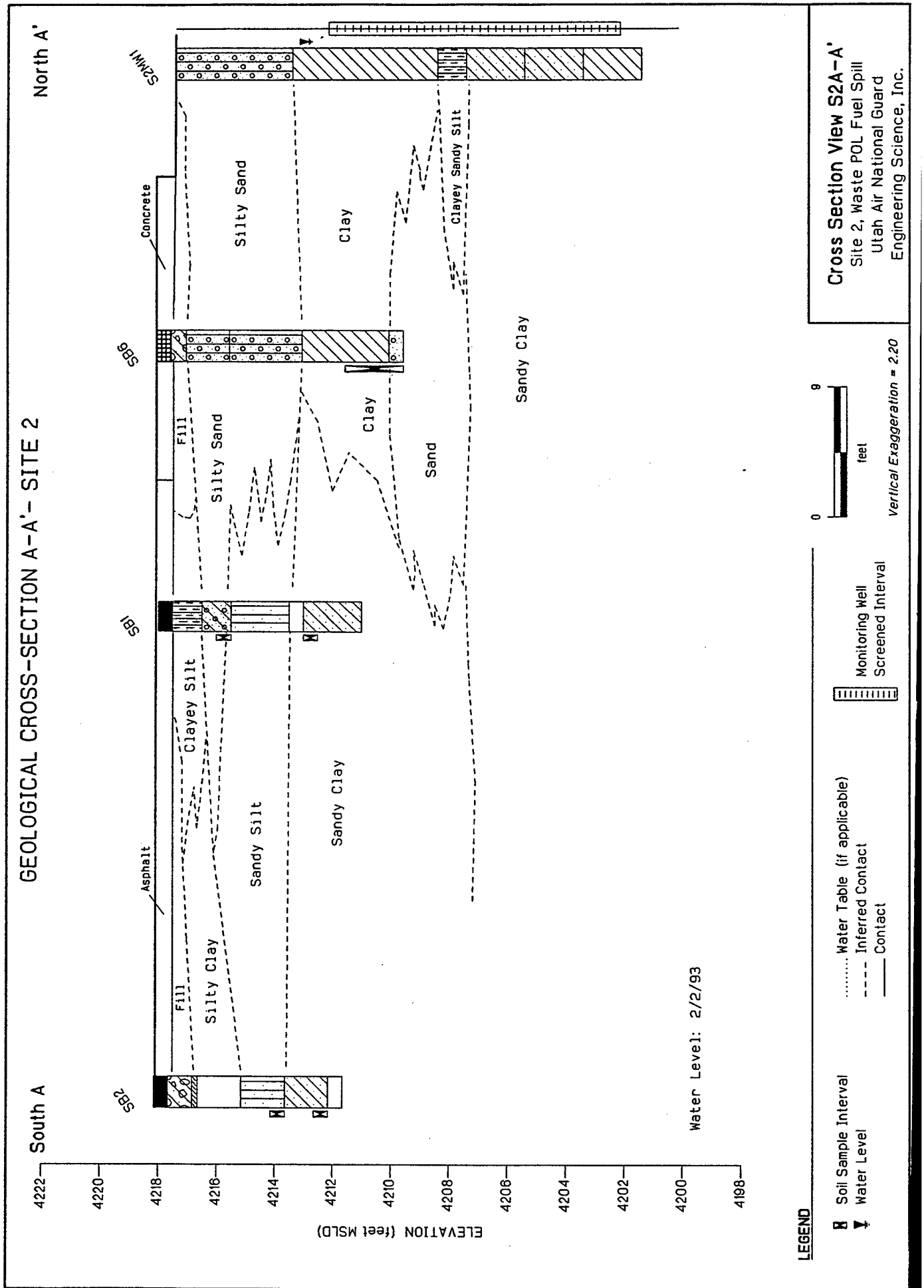

GEOLOGICAL CROSS-SECTION A-A'- SITE 2
South A
North A'
S2MW1
SB6
SB1
SB2
Concrete
Asphalt
Fill
Silty Sand
Clay
Clayey Sandy Silt
Sandy Clay
Fill
Silty Sand
Clay
Sand
Fill
Silty Clay
Clayey Silt
Sandy Silt
Sandy Clay
Water Level: 2/2/93
ELEVATION (feet MSLD)
4222
4220
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval
0
8
feet
Vertical Exaggeration = 2.20
Cross Section View S2A-A'
Site 2, Waste POL Fuel Spill
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.18

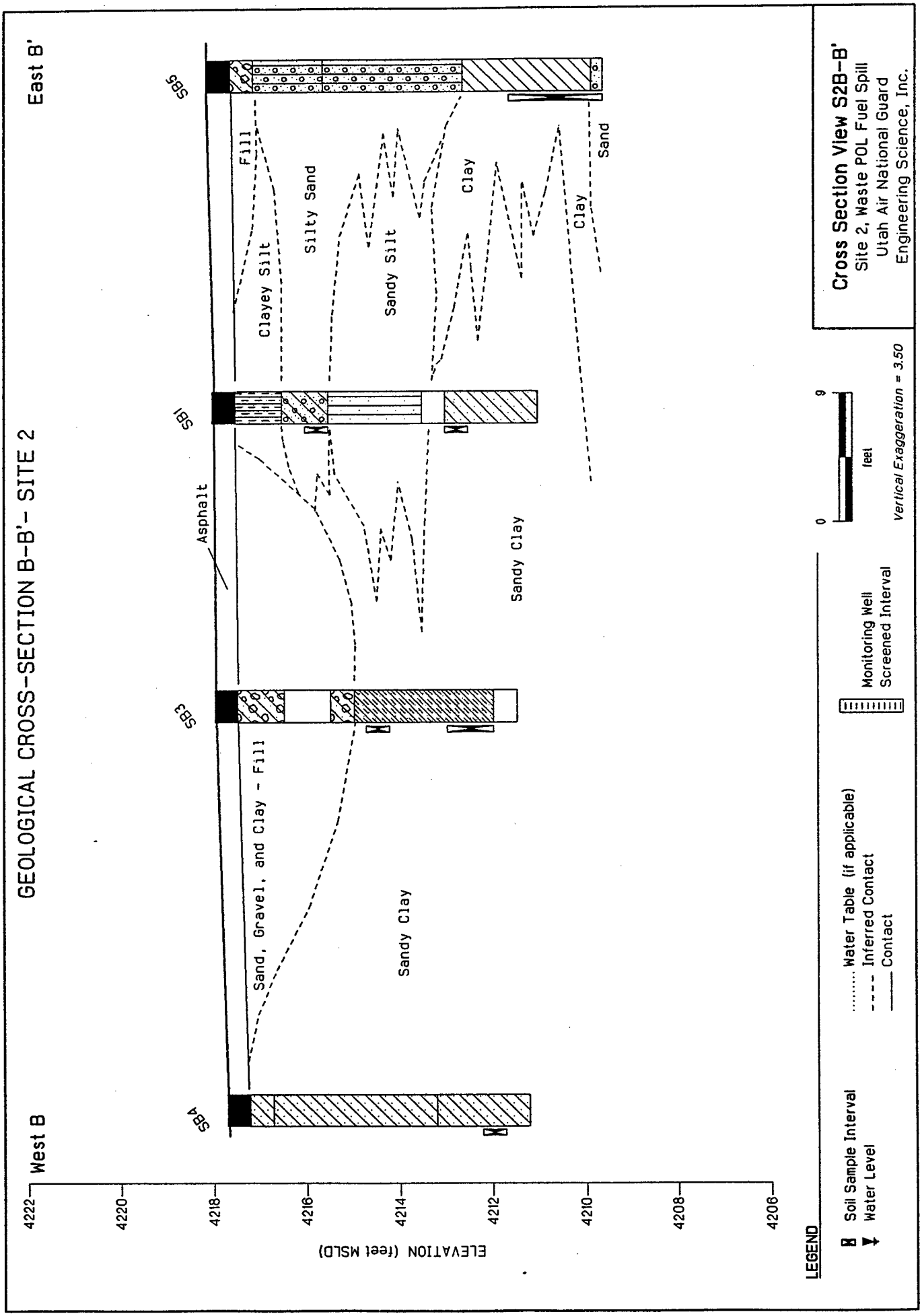

GEOLOGICAL CROSS-SECTION B-B'- SITE 2
West B
East B'
SB5
SB1
SB3
SB4
Fill
Clayey Silt
Silty Sand
Sandy Silt
Clay
Clay
Sand
Asphalt
Sandy Clay
Sand, Gravel, and Clay - Fill
Sandy Clay
ELEVATION (feet MSLD)
4222
4220
4218
4216
4214
4212
4210
4208
4206
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval
0
9
feet
Vertical Exaggeration = 3.50
Cross Section View S2B-B'
Site 2, Waste POL Fuel Spill
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.19

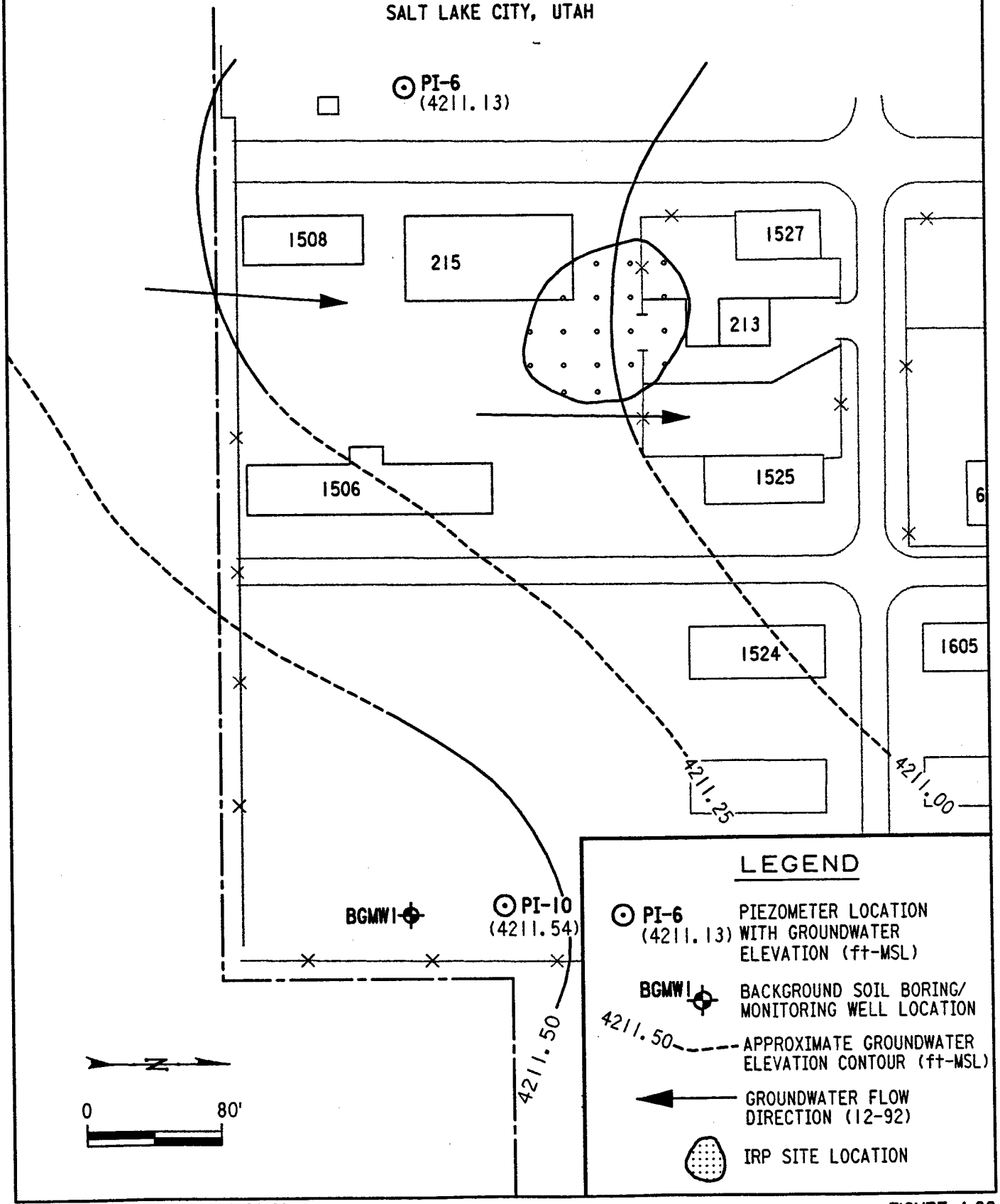
Basewide groundwater levels were measured on 28 December 1992, 16 March 1993, and 19 July 1995 to determine hydraulic gradients and groundwater flow directions at the sites (Figures 4.1, 4.2, 4.3). Extrapolated groundwater contour maps of the Site 2 area for these respective dates are provided as Figures 4.20, 4.21, and 4.22. The purpose of the 28 December 1992 and 19 July 1995 measurements was to establish groundwater flow directions prior to well placement. The purpose of the 16 March 1993 round of groundwater measurements was to establish hydraulic gradients and flow directions for groundwater flow rate calculations at the sites. March 1993 was the only instance when all of the site monitoring wells and basewide piezometers were measured on the same day during the primary 1992-93 investigation of Sites 1 through 7. As shown in Figure 4.21, the groundwater flow direction at Site 2 was to the west-northwest on this date. The west-northwest flow direction on 16 March 1993 represents a change from the more northerly flow direction at the site inferred from the 28 December 1992 groundwater gradient (Figure 4.20). The groundwater flow direction also was to the northwest on 19 July 1995 prior to placement of the new downgradient monitoring well S2MW2 (Figure 4.22). For a comparison of groundwater levels in basewide piezometers and monitoring wells see Tables 4.1, 4.2, and 4.3. The variation in groundwater elevations, hydraulic gradients, and flow directions among these dates is probably due to the shallow aquifer's response to seasonal groundwater recharge and discharge. Therefore, the local hydraulic flow conditions at this site and the other sites is considered to be seasonally variable.

4.4.2.2 Groundwater Flow Calculations

Using downgradient monitoring well S1MW1 at Site 1 as an upgradient well for Site 2, the calculated groundwater flow rate and groundwater velocity across Site 2 were determined from 16 March 1993 groundwater levels between monitoring wells S1MW1 and S2MW1, as shown on Figure 4.23. The average hydraulic gradient (i) shown on the figure is established in the direction of groundwater flow perpendicular to hydraulic head equipotentials at the wells, and was approximately 0.14 foot change in head (dh) in a horizontal distance (dl) of 85 feet, or 1.65×10^{-3} ft/ft (i=dh/dl). The hydraulic conductivity (K) of the sandy clay in the screened interval of S2MW1 was estimated from a slug test at the well to be 0.17 ft/day. The hydraulic conductivity of the clay and sand in the screened interval of S1MW1 is 3.3 ft/day. Therefore, the average hydraulic conductivity of the saturated porous media beneath the site is estimated to be 1.74 ft/day or the average of the values obtained at the two monitoring wells. The average saturated thickness (b) of the shallow aquifer at this site was estimated to be about 15.40 feet, based on 16 March 1993 groundwater levels. Using Darcy's Law (q=Kib), the above parameters yield a groundwater volumetric flow rate (q) per unit width of saturated aquifer thickness of 4.41×10^{-2} cubic foot per day per foot (ft^3/day/ft) between the wells on 16 March 1993. The corresponding groundwater velocity (v) is estimated from the equation (v=Ki/n) and the parameters given above to be approximately 0.01 ft/day, assuming an effective porosity (n) of 30 percent. Hydrogeological data and calculations are presented in Tables I.1 and I.2, Appendix I. Field methods, methods of analysis, slug

GROUNDWATER GRADIENT MAP - SITE 2
28 DECEMBER 1992

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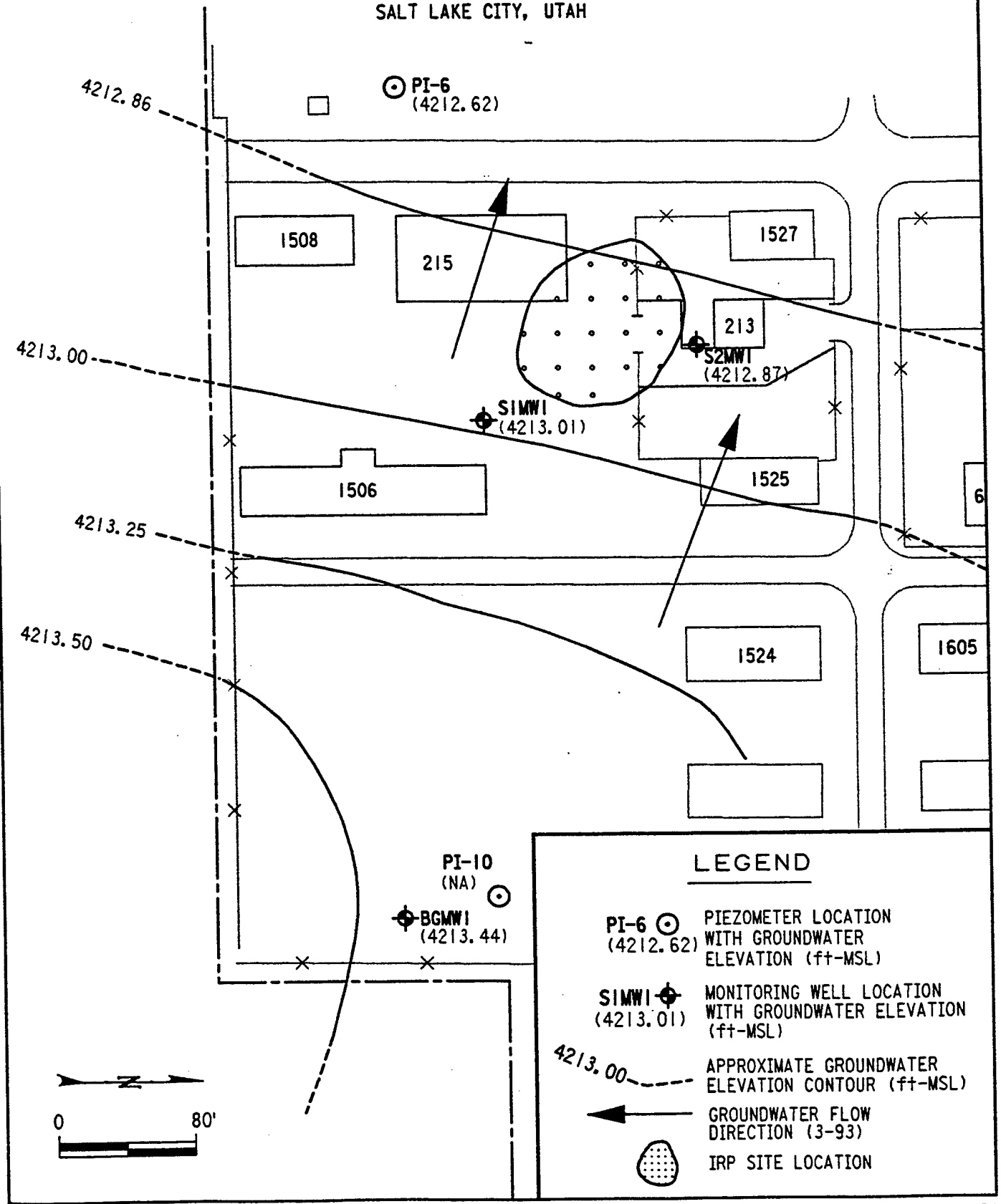


C:\UANG\FIG4-20.DGN R04 06.04.96

FIGURE 4.20

GROUNDWATER GRADIENT MAP - SITE 2
16 MARCH 1993

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

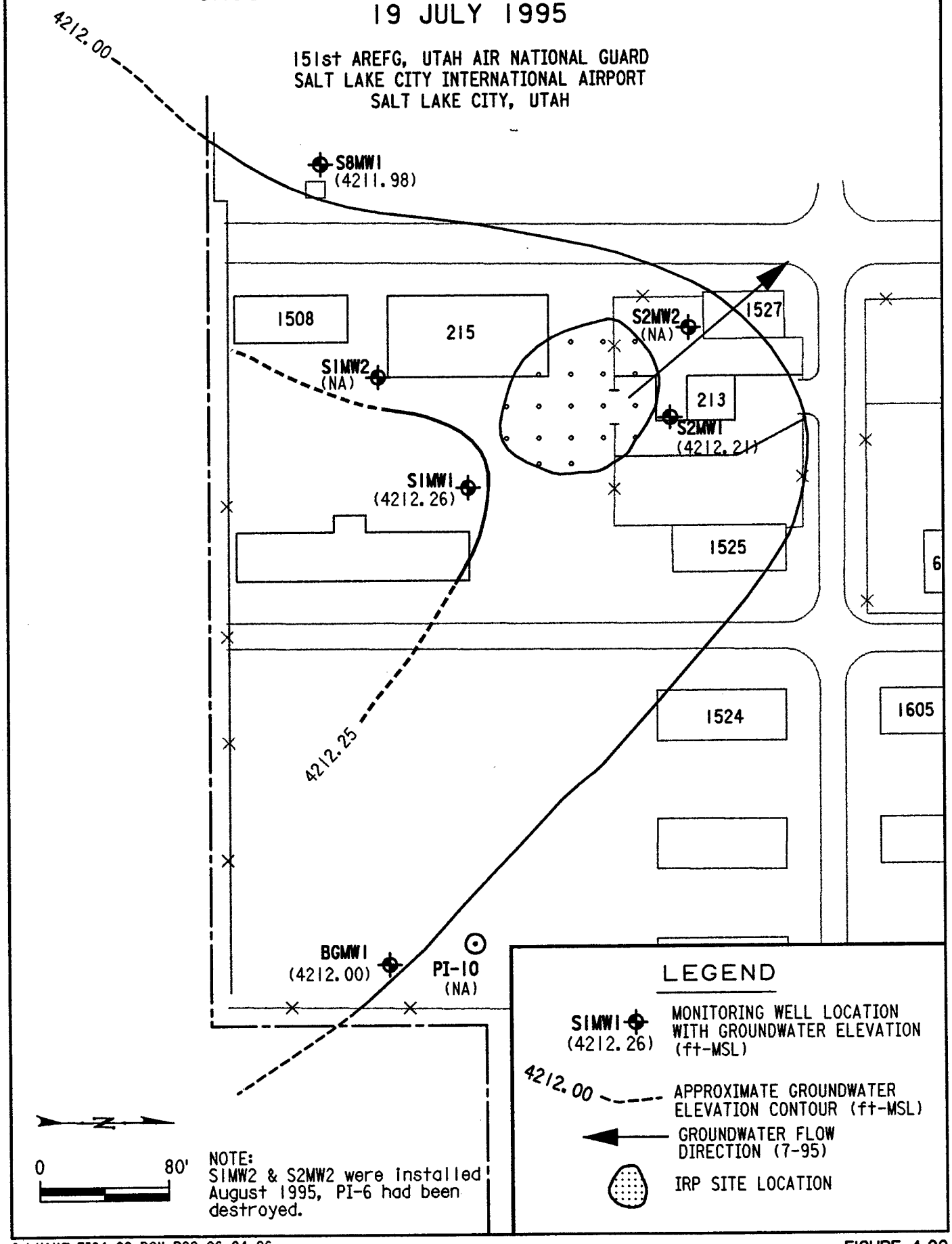


C:\UANG\FIG4-21.DGN R02 06.04.96

FIGURE 4.21

GROUNDWATER GRADIENT MAP - SITE 2
19 JULY 1995

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SALT LAKE CITY, UTAH



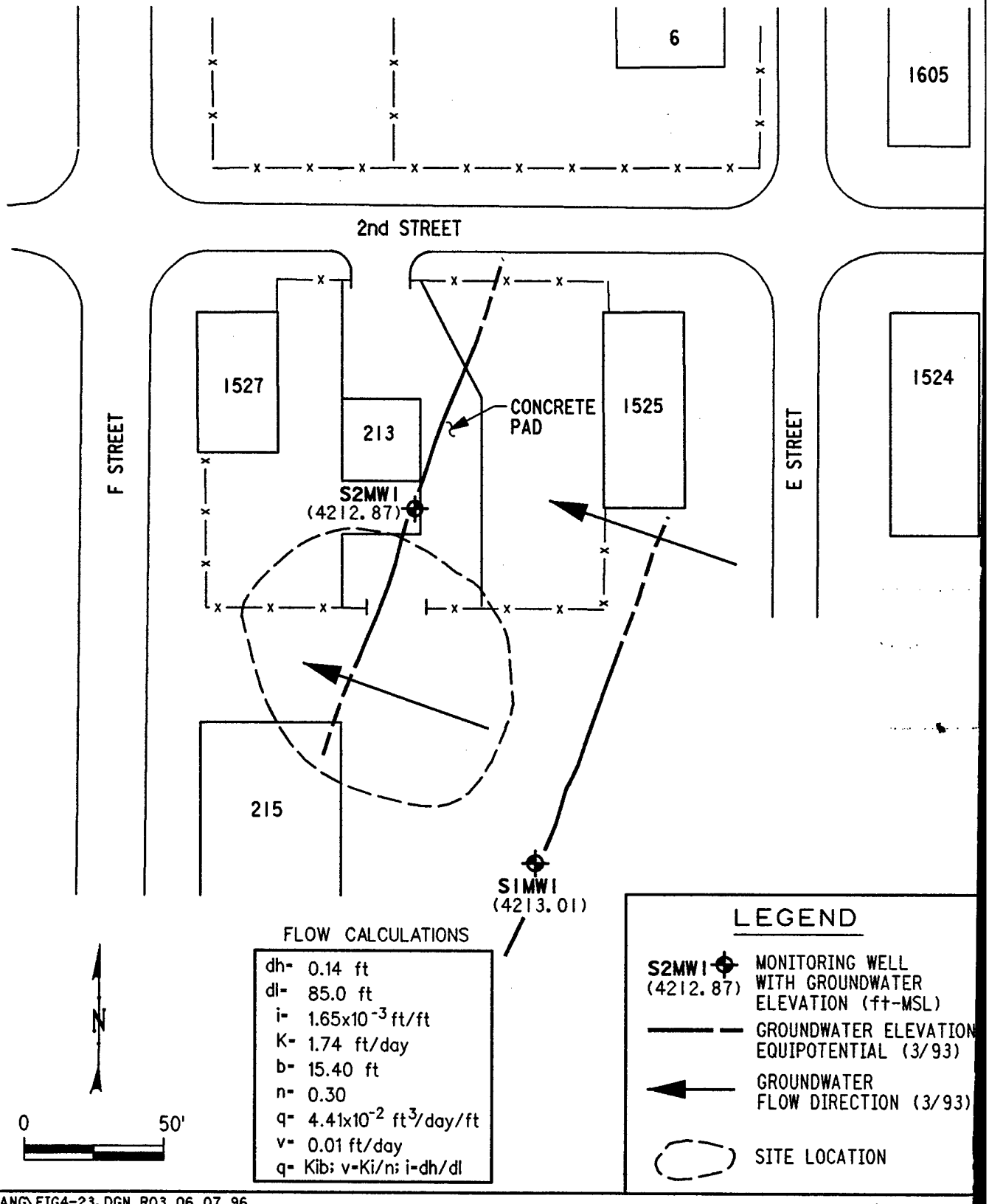
C:\UANG\FIG4-22.DGN R02 06.04.96

FIGURE 4.22

FINAL

GROUNDWATER FLOW RATE AND VELOCITY - SITE 2
16 MARCH 1993

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SALT LAKE CITY, UTAH



C:\UANG\FIG4-23.DGN R03 06.07.96

FIGURE 4.2

test results, and a detailed description and evaluation of hydraulic conductivity, flow rates, and velocities are also contained in Appendix I.

An extensive dark gray or black to greenish-gray clay layer is present beneath the sites at the Base at an average depth of about 20 feet. The clay is considered to be an impervious aquifer boundary layer for hydraulic conductivity and groundwater flow rate calculations.

4.4.2.3 Soil Contamination Assessment

Soil samples were collected from six borings at Site 2. The locations of the analytical samples and the types of soil from which the analytical samples were collected are shown in the geological cross-sections of Figures 4.18 and 4.19 and the soil boring logs in Appendix G. The soil samples and one field duplicate were analyzed for VOCs, SVOCs, PPMs, and TRPH. Target compounds included in each of the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in Appendix E.

The analytical results for compounds detected in Site 2 soil samples are provided in Table 4.18. If concentrations were below their respective detection limits for these detected compounds in other soil samples, the detection limits are shown in the table. The detection limits vary due to differing dilution factors, matrix effects, and dry weight calculations. Field duplicates are shown after their associated samples in Table 4.18. Soil PRGs are provided in the table. The basis and derivation of these health-based criteria are discussed in the Preliminary Risk Evaluation (Section 5). The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 2 soils are shown on Figure 4.24. PNAs (phenanthrene, fluoranthene, pyrene, chrysene, and fluorene) have been grouped together for presentation; the values shown on the figure represent the sum of the compounds in the group. Bis(2-ethylhexyl)phthalate is shown as phthalates on Figure 4.24. PNAs and phthalates are included in the SVOC suite of analyses.

Chlorinated VOCs were detected in soils at soil borings SB2, SB5, and SB6 in the eastern half of the site. Tetrachloroethene (SB5), trichloroethene (SB5 and SB6), cis-1,2-dichloroethene (SB5 and SB6), and total 1,2-dichloroethene (SB2) were detected at the concentrations shown in Table 4.18. The maximum concentration of these solvent-related compounds is for cis-1,2-dichloroethene, with a concentration of 45 mg/kg in clay and sand at the 6.5- to 8.5-foot sampling interval in SB5. This depth coincides with the soil/water interface.

Petroleum-related organic compounds resulting from a probable waste fuel spill were detected in sandy clay at both sampling intervals in SB3. BTEX constituents were detected in the sampling intervals ranging from 2.5 feet to 6.5 feet. The maximum BTEX concentration was total xylenes at a concentration of 20,000 µg/kg. The location of soil

TABLE 4.18
SITE 2 - SOIL BORING
ANALYTES DETECTED
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SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limits	SB1-0.5-2.5	SB1-5.0-7.5	SB2-2.5-4.5	SB2-4.5-6.5	SB3-2.5-4.5	SB3-4.5-6.5	duplicate(a) SB3-6.5-8.5
VOCs (SW8240) (µg/kg)*									
Dilution Factor	--	--	1	1	1	1	125	1	1
Acetone	2.7E+07 nc	10	28	20U	40U	20U	1500UJ	40U	40U
1,2-Dichloroethene (Total	NA	5	6U	7U	3UJ	4J (6)	770U	7UJ	6UJ
Chloroform	1.05E+05 nc	5	6U	7U	3J	6U	770U	7U	6U
Benzene	22,100 c	5	6U	7U	6U	6U	770U	6J	3J
Toluene	5.4E+07 nc	5	6U	7U	6U	6U	230J	5J	3J
Ethylbenzene	2.7E+07 nc	5	6U	7U	7	6U	770U	100J	48
Total Xylenes	5.4E+08 nc	5	6U	7U	6U	6U	20000	43J	16
SVOCs (SW8270) (µg/kg)*									
Dilution Factor	--	--	1	1	1	1	10	1	1
2-Methylnapthalene	na	330	400U	440U	410U	400U	4800	450U	730
Phenanthrene	na	330	400U	440U	410U	400U	1100J	58J	260J
Fluoranthene	1.08E+07 nc	330	400U	440U	410U	400U	500J	450U	88J
Pyrene	8.1E+06 nc	330	400U	440UJ	410UJ	400UJ	740J	450UJ	270UJ
Chrysene	19,900 c	330	400U	440U	410U	400U	4100U	450U	120J
bis(2-Ethylhexyl)Phthalat	45,700 c	330	190J	440U	410U	400U	4100UJ	190J	190J
Fluorene	1.08E+07 nc	330	400U	440U	410U	400U	4100U	450U	55J
TRPH (E418.1) (mg/kg)*									
Results	na	10	70	13U	17	12U	1300	63	700

TABLE 4.18 - Continued
SITE 2 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limits	SB4-4.5-6.5	SB5-6.5-8.5	SB6-6.5-8.5
VOCs (SW8010/8020) (µg/kg)*					
Dilution Factor	--	--	1	1	2
cis-1,2-Dichloroethene	2.7E+07 nc	1	1.3U	45	35
Tetrachloroethene	1,230 c	1	1.3U	7.8	2.6U
Trichloroethene	5,820 c	1	1.3U	6.6	3.3
SVOCs (SW8270) (µg/kg)*					
Dilution Factor	--	--	1	1	1
2-Methylnapthalene	na	330	430U	530U	430U
Phenanthrene	na	330	430U	530U	430U
Fluoranthene	1.08E+07 nc	330	430U	530U	430U
Pyrene	8.1E+06 nc	330	430U	530U	430U
Chrysene	19,900 c	330	430U	530U	430U
bis(2-Ethylhexyl)phthalate	45,700 c	330	430U	530U	430U
Fluorene	1.08E+07 nc	330	430U	530U	430U
TRPH (E418.1) (mg/kg)*					
Results	na	--	13U	16U	13U

TABLE 4.18 - Continued
SITE 2 - SOIL BORING
ANALYTES DETECTED
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SALT LAKE CITY, UTAH

Parameter (units)	PRGs	Detection Limits	SB1-0.5-2.5	SB1-5-7.5	SB2-2.5-4.5	SB2-4.5-6.5	SB3-2.5-4.5	SB3-4.5-6.5	duplicate(a) SB3-6.5-8.5
PPMs (mg/kg)*									
Arsenic	0.366 c	2	***22.9J***	***40.8J***	***18.4J***	***11.3J***	***15.2J***	***9.0J***	***4.5J***
Beryllium	0.149 c	0.33	***0.63***	***0.76***	***0.52J***	***0.47J***	***0.47***	***0.77***	***0.27J***
Cadmium	135 c	1	0.20UJ	0.22UJ	0.21UJ	0.22UJ	0.17UJ	0.24UJ	0.18UJ
Chromium	1,350 c	2	15.2J	22.3J	13.5J	13.9J	14.6J	22.8J	5.2J
Copper	10,800 nc	2	30.0	42.2	33.1	28.0	22.0	35.1	11.3
Lead	na	2	25.2	31.4	16.9	18.8J	39.3	25.8	15.0
Nickel	5,400 nc	3	11.7	17.0	12.2	10.4	9.8	15.2	5.4
Thallium	na	0.39	R	0.49J	0.50J	0.48J	R	0.71J	R
Zinc	81,000 nc	1	58.0J	85.3J	57.4J	50.6J	54.2J	78.1J	29.5J

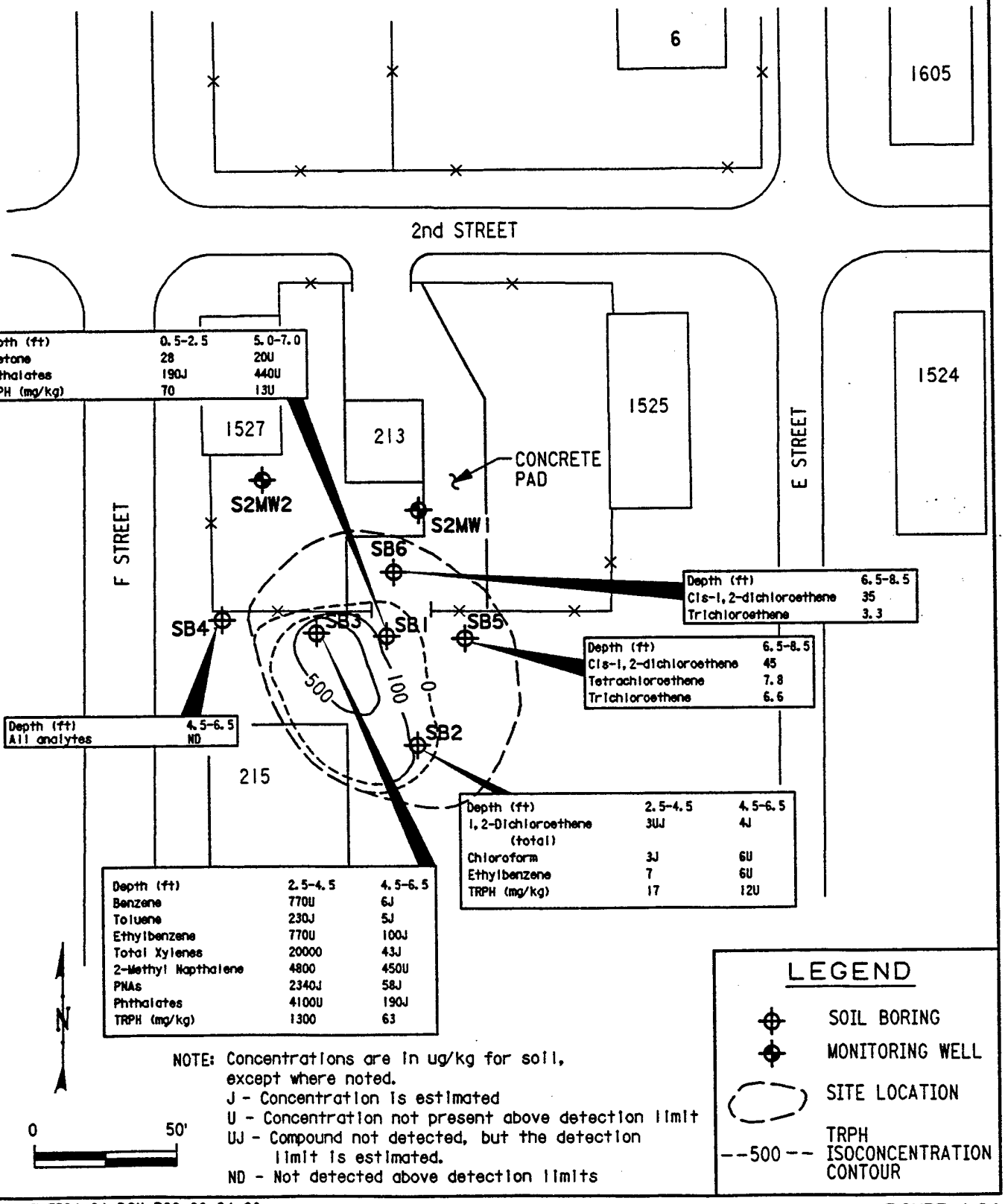
TABLE 4.18 - Continued
SITE 2 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (units)	PRGs	Detection Limits	SB4-4.5-6.5	SB5-6.5-8.5	SB6-6.5-8.5
PPMs (mg/kg)*					
Arsenic	0.366 c	2	NA	***18.6J***	***44.0J***
Beryllium	0.149 c	0.33	NA	***1.3***	***0.36J***
Cadmium	135 c	1	NA	0.72J	0.59
Chromium	1,350 c	2	NA	32.3J	11.9J
Copper	10,800 nc	2	NA	50.2	51.9
Lead	na	2	NA	39.1J	5.3J
Nickel	5,400 nc	3	NA	25.8	24.0
Thallium	na	0.39	NA	0.97UJ	0.70UJ
Zinc	81,000 nc	1	NA	122J	47.0J

(a) Blind duplicate sample
***** Analyses were performed by ES-Berkeley Laboratory.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
R Data rejected.
NA Not analyzed; the analytical laboratory did not perform metals analysis on this sample though requested on the COC.
Note: Concentrations exceeding Preliminary Remediation Goals (PRGs) are shown in bold italics, nc - noncarcinogen, c - carcinogen, na - not available.
Note: PRG values greater than five digits are in scientific notation.

ORGANIC COMPOUNDS DETECTED IN SOIL WITH ISOCONCENTRATIONS OF TRPH - SITE 2

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NOTE: Concentrations are in ug/kg for soil, except where noted.
J - Concentration is estimated
U - Concentration not present above detection limit
UJ - Compound not detected, but the detection limit is estimated.
ND - Not detected above detection limits

boring SB3 coincides with the area that exhibited higher benzene soil gas concentrations, as seen by comparing Figures 4.16 and 4.24. However, BTEX contamination of soil at SB3, and at the site in general, is minimal. Therefore, benzene (116.5 ppm maximum) soil gas concentrations at the site appear to represent separate gaseous-phase benzene that was not adsorbed to soil particles.

SVOCs (2-methylnapthalene, phenanthrene, fluoranthene, and pyrene) were detected in sandy clay at the 2.5- to 4.5-foot sampling interval in SB3 at the concentrations given in Table 4.18. Concentrations of these SVOCs were also detected in the field duplicate sample (SB3-6.5-8.5) from the 4.5- to 6.5-foot interval, but were absent in the primary sample from this depth except for a phenanthrene concentration of 58 µg/kg estimated. PNAs were detected only in soil samples from SB3. A maximum site TRPH concentration of 1,300 mg/kg was detected for in the 2.5- to 4.5-foot sampling interval at SB3. The 4.5- to 6.5-foot interval at SB3 contained TRPH at a concentration of 63 mg/kg in the primary sample and 700 mg/kg in the duplicate.

The SVOC bis(2-ethylhexyl)phthalate was detected in silty sand at the 0.5- to 2.5-foot interval of SB1 and in sandy clay at the 4.5-to 6.5 foot interval of SB3 at the concentration of 190 µg/kg estimated. TRPH were also detected in silty sand at a concentration of 70 mg/kg in the same sample interval of SB1. All analytes were below the method detection limits for the soil sample from SB4.

Acetone was detected in the near-surface sampling interval at SB1 and is reported since the concentration exceeds 10 times the concentration in an associated method blank.

In summary, organic soil contamination related to probable fuel and solvent spill(s) was localized at the site, and organic compound concentrations were highest at the center of the site in soil borings SB1, SB3, SB5, and SB6.

Metals. Metals detected in soil samples at Site 2 exhibit a wide range of concentrations (Table 4.18). The concentrations of most metals at Site 2 were slightly higher than concentrations in background soil samples collected from BGMW1 and BGMW2 (Tables 4.4 and 4.5). However, background values for means of comparison could not be adequately established with this limited number of background soil samples. Therefore, for the purposes of comparison and graphical presentation, and to better visualize the location and spatial distribution (at what depths and in what stratigraphic units) of the relatively higher metals concentrations in site soil, a site-specific comparative value concentration for each individual metal was established. The comparative value is defined as the mean plus one standard deviation of the total site soil sample population for that particular metal. This methodology is not intended to select contaminants of concern or to imply risk. Comparative values for the metals consistently detected at the site are presented in Table 4.19, and concentrations of the metals at a given sample location that are higher than their comparative values are depicted in Figure 4.25. Concentrations of the metals that are lower than their comparative values in other sampling intervals of the same soil boring are also shown on the figure for comparison. One soil sample per borehole was collected from soil borings SB4, SB5, and SB6.

TABLE 4.19
SITE 2 - MEAN AND STANDARD DEVIATION OF METALS DETECTED IN SOIL
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

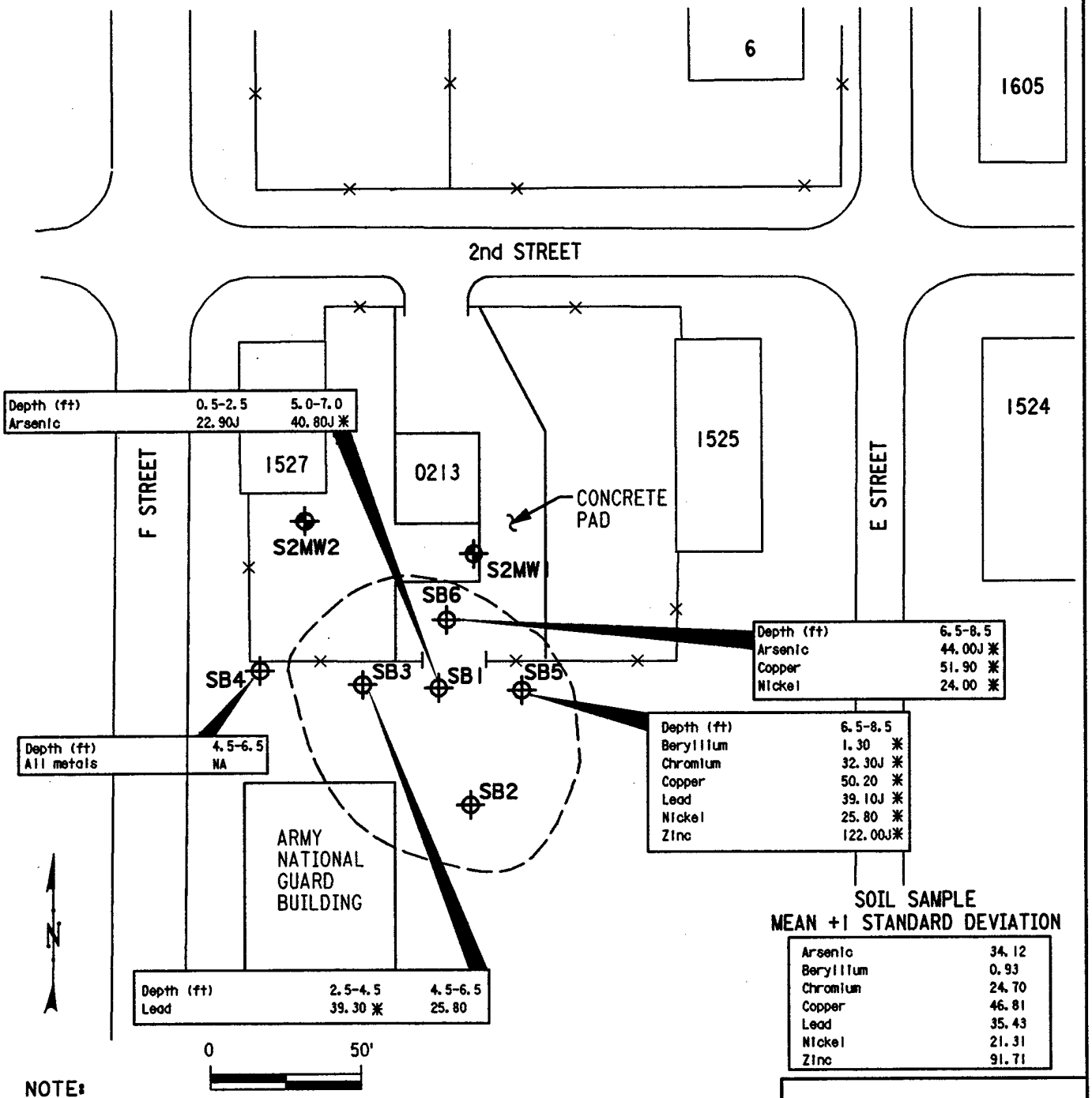
Parameter	Range (mg/kg)	Mean	Std. Dev.	Mean + Std. Dev	# of Samples
Arsenic	4.50-44.00	20.52	13.60	34.12	9
Beryllium	0.27-1.30	0.62	0.31	0.93	9
Chromium	5.20-32.30	16.86	7.84	24.70	9
Copper	11.30-51.90	33.76	13.05	46.81	9
Lead	5.30-39.30	24.09	11.34	35.43	9
Nickel	5.40-25.80	14.61	6.70	21.31	9
Zinc	29.50-122.00	64.68	27.03	91.71	9

Note: The mean and standard deviation were not calculated for cadmium and thallium because these metals were not detected in enough samples.

FINAL

METALS DETECTED IN SOIL
SITE 2

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



SOIL SAMPLE
MEAN +1 STANDARD DEVIATION

Arsenic	34.12
Beryllium	0.93
Chromium	24.70
Copper	46.81
Lead	35.43
Nickel	21.31
Zinc	91.71

NOTE:

The metals concentrations (mg/kg) in soils that exceed the mean plus one standard deviation of the total sample population for that particular metal at the site are shown with an asterisk. Concentrations of these metals in other sampling intervals (if applicable) of the same boring are shown for comparison.

J - Concentration is estimated
NA - Not Analyzed for metals

LEGEND

- SOIL BORING
- MONITORING WELL
- SITE LOCATION

C:\UANG\FIG4-25.DGN R05 05.30.96

FIGURE 4.25

Seven metals (arsenic, beryllium, chromium, copper, lead, nickel, and zinc) were detected in all analyzed samples and one duplicate at concentrations exceeding the method detection limit, and mean plus one standard deviation comparative values were determined for these metals. Thallium was present in only four samples and cadmium was present in two samples. Therefore, comparative values for these metals were not determined and their concentrations are not shown on Figure 4.25. Cadmium was present in a concentration similar to the concentration in background soil at BGMW1. Thallium was not detected in soil at BGMW1. Concentrations of antimony, selenium, mercury, and silver were below analytical method detection limits for all site soils. Data for antimony are unusable for seven of the nine samples from Site 2. Data for selenium are unusable for the samples collected at SB5 and SB6. Data for thallium were unusable for three samples. These data and the reason for rejection are provided in Table E.1.2, QA/QC Report No. 1, Appendix E.

The concentrations of six of the seven metals depicted on Figure 4.25 are higher than the site-specific mean plus one standard deviation comparative values for these metals in the only sampling interval at SB5. Beryllium was present at a concentration of 1.3 mg/kg, chromium at 32.3 mg/kg estimated, copper at 50.2 mg/kg, lead at 39.1 mg/kg estimated, nickel at 25.8 mg/kg, and zinc at 122 mg/kg estimated (Table 4.19). These metal concentrations were detected in clay and sand at the 6.5- to 8.5-foot interval in SB5.

The concentrations of arsenic, copper, and nickel are higher than their comparative values in SB6, at concentrations of 44 mg/kg estimated, 51.9 mg/kg, and 24 mg/kg, respectively. These concentrations were detected in clay and sand at the 6.5- to 8.5-foot interval in SB6.

The concentration of lead is higher than its comparative value at a concentration of 39.3 mg/kg in the 2.5- to 4.5-foot interval in SB3. A lead concentration of 25.8 mg/kg detected in the 4.5- to 6.5-foot interval of this soil boring is shown on Figure 4.25 for comparison, although the concentration is lower than the site-specific mean plus one standard deviation comparative value for lead. Both sampling intervals were in sandy clay.

The concentration of arsenic is higher than its comparative value at a concentration of 40.8 mg/kg estimated in the 5- to 7-foot interval in SB1. The sample was collected in sandy clay. The estimated arsenic concentration of 22.9 mg/kg detected in the 0.5- to 2.5 foot interval in SB1 is shown on Figure 4.25 for comparison, although this concentration is lower than the site-specific comparative value for this metal.

Soil boring SB2 samples did not contain metal concentrations that are higher than the comparative values for the range of individual metals at the site.

Overall, metals in Site 2 soils were relatively low, based on metals concentrations in background soil, other sites at the Base, and the averages and general ranges of these metals in the contiguous United States (USGS,1984). Metals concentrations were the

highest and most prevalent at soil borings SB5 and SB6. This coincides with the soil borings where soils were slightly impacted by solvent-related VOCs. However, these metals concentrations do not necessarily indicate that site soils are impacted from the spill, but rather, may reflect the variation of naturally-occurring levels resulting from depositional and hydrogeochemical processes. The soil samples from SB5 and SB6 were collected from clay and sand at the same depth interval near the soil/water interface.

4.4.2.4 Groundwater Contamination Assessment

One groundwater sample was collected in February 1993 from monitoring well S2MW1 and was analyzed for VOCs, SVOCs, and PPMs. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

In August 1995, groundwater samples were collected from monitoring well S2MW1 and newly installed S2MW2 (S2MW2 was installed in August 1995) and were analyzed for VOCs, SVOCs, and PPMs. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.2, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 2, Appendix E.

Field measurements of specific conductance, pH, and temperature were made on the groundwater samples at the time of sample collection in February 1993 and August 1995. These measurements and approximate TDS conversions are provided in Tables 4.8 and 4.9. Specific conductance at S2MW1 measured 1,802 microsiemens/cm and 2,720 microsiemens/cm between sampling events, respectively, and the pH measured 8.0 and 8.71. In August 1995, specific conductance at S2MW2 measured 10,050 microsiemens/cm with a pH of 7.52.

Analytical results of the Site 2 groundwater samples are provided in Tables 4.20 and 4.21. MCLs are also provided in the table. MCLs for all compounds detected during the SI are listed in Table 5.3 of the preliminary risk evaluation (Section 5). The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 2 groundwater are shown on Figure 4.26. Four VOCs, apparently related to solvent spills, were detected in a groundwater sample collected in February 1993 from S2MW1. The compounds cis-1,2-dichloroethene, tetrachloroethene, and trichloroethene, were detected at concentrations of 320 µg/L, 41 µg/L, and 370 µg/L, respectively. These concentrations exceeded MCLs. The MCLs for cis-1,2-dichloroethene, tetrachloroethene, and trichloroethene are 70 µg/L, 5 µg/L, and 5 µg/L, respectively, as shown in Table 4.20. 1,1-Dichloroethane was detected at a concentration of 7.1 mg/L estimated. These solvent-related VOCs are the same compounds that were detected in soil samples at the soil/water interface at soil borings SB5 and SB6. SVOCs were not detected above their detection limits.

TABLE 4.20
SITE 2 - GROUNDWATER
ANALYTES DETECTED (February 1993)
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	MCLs	Detection Limits	S2MW1
VOCs (SW8010/8020) (µg/L)*			
Dilution Factor	--	--	10
1,1-Dichloroethane	na	1.0	7.1J
cis-1,2-Dichloroethene	70	1.0	***320***
Tetrachloroethene	5	1.0	***41***
Trichloroethene	5	1.0	***370***
SVOCs (SW8270) (µg/L)*			
Results	--	--	ND
PPMs (µg/L)*			
Antimony	6	11.0	11U
Arsenic	50	1.0	***134J***
Cadmium	5	1.0	1.7UJ
Chromium	100	1.0	4.8UJ
Copper	1,300	2.0	18.9J
Mercury	2	0.03	0.03UJ
Nickel	100	3.0	3.0UJ
Selenium	50	1.0	2.8J
Thallium	2	2.0	5.2UJ
Zinc	5,000	1.0	3.7UJ

***** **Analyses performed by the ES-Berkeley Laboratory.**
na **No MCL exists.**
ND **All analytes were not detected; refer to Table H.1 for compounds and detection limits.**
U **Compound not present above the detection limit shown.**
J **Concentration of the compound is estimated.**
UJ **Compound not detected, but the detection limit is estimated.**
Note: **Concentrations exceeding Maximum Contaminant Levels (MCLs) are shown in bold**

TABLE 4.21
SITE 2 - GROUNDWATER
ANALYTES DETECTED (August 1995)
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SALT LAKE CITY, UTAH

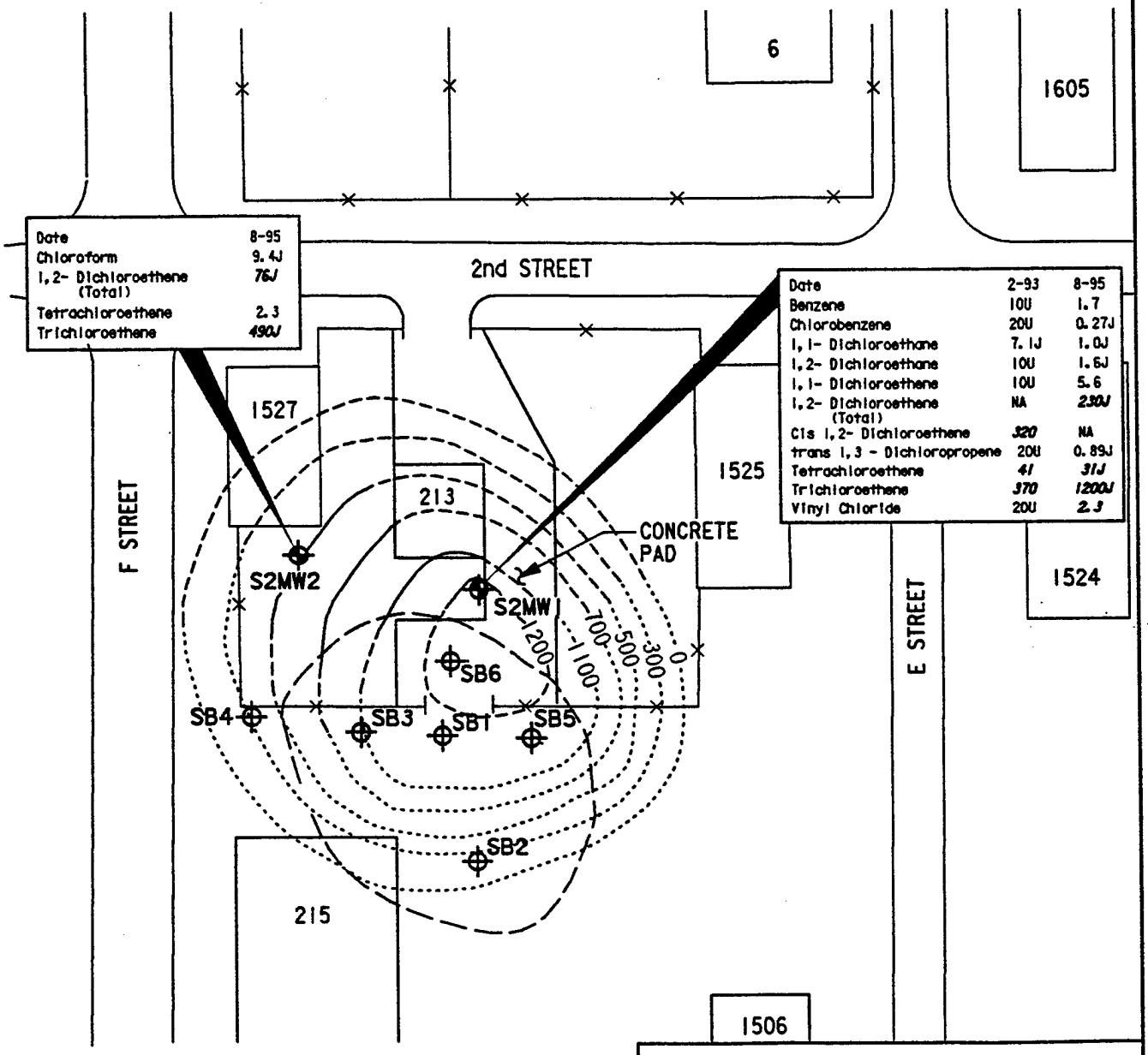
Parameter (method) (units)	MCLs	Detection Limits	S2MW1	S2MW2	duplicate (a) S2MW3
VOCs (SW8010/8020) (µg/L)**					
Dilution Factor	--	--	1:1 to 1:500	1:1 to 1:20	1:1 to 1:20
Benzene	5	0.5	1.7	0.50U	0.50U
Chlorobenzene	100	0.5	0.27J	0.50U	0.50U
Chloroform	100	0.5	0.50U	9.4J	10J
1,1-Dichloroethane	na	0.5	1.0J	0.50U	0.50U
1,2-Dichloroethane	5	0.5	1.6J	0.50U	0.50U
1,1-Dichloroethene	7	0.5	5.6	0.50U	0.50U
1,2-Dichloroethene (total)	70	0.5	***230J***	***76J***	59J
trans 1,3 - Dichloropropene	na	0.5	0.89J	0.50U	0.50U
Tetrachloroethene	5	0.5	***31J***	2.3	2.1J
Trichloroethene	5	0.5	***1200J***	***490J***	***480J***
Vinyl Chloride	2	0.5	***2.3***	0.50U	0.50U
SVOCs (SW8270) (µg/L)**					
Results	--	--	ND	ND	ND
PPMs (µg/L)**					
Antimony	6	24	24U	24U	24U
Arsenic	50	2.0	***240***	6.6	6.9J
Cadmium	5	0.97	0.97U	0.97U	0.97U
Chromium	100	3.6	5.1U	4.4U	3.8U
Lead	15	4.4	4.8UJ	3.5UJ	3.7UJ
Copper	1,300	2.1	20.0	6.5	5.1
Mercury	2	0.02	0.02UJ	0.049J	0.056J
Nickel	100	11.0	11U	11U	11U
Selenium	50	1.2	12U	12U	12U
Thallium	2	1.2	1.2UJ	1.2UJ	1.2UJ
Zinc	5,000	3.6	22U	13U	8.9U

(a) Blind duplicate of MW2.
****** Analyses performed by DataChem Laboratories.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
na No MCL exists.
ND All analytes were not detected; refer to Table H.2 for compounds and detection limits.
Note: Concentrations exceeding Maximum Contaminant Levels (MCLs) are shown in bold italic.
Note: The MCL for 1,2-Dichloroethene is for the cis isomer, no MCL exists for 1,2-DCE total.

FINAL

ORGANIC COMPOUNDS DETECTED IN GROUNDWATER WITH ISOCONCENTRATIONS OF TRICHLOROETHENE - SITE 2

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Date	8-95
Chloroform	9.4J
1,2- Dichloroethene (Total)	*76J*
Tetrachloroethene	2.3
Trichloroethene	*490J*

Date	2-93	8-95
Benzene	10U	1.7
Chlorobenzene	20U	0.27J
1,1- Dichloroethane	7.1J	1.0J
1,2- Dichloroethane	10U	1.6J
1,1- Dichloroethene	10U	5.6
1,2- Dichloroethene (Total)	NA	*230J*
Cis 1,2- Dichloroethene	*320*	NA
trans 1,3 - Dichloropropene	20U	0.89J
Tetrachloroethene	*41*	*31J*
Trichloroethene	*370*	*1200J*
Vinyl Chloride	20U	*2.3*

N

NOTE:

Concentrations (ug/L) exceeding MCLs are shown in bold italic.
J - Concentration is estimated
U - Concentration not present above detection limit

0 50'

LEGEND

- SOIL BORING
- MONITORING WELL
- SITE LOCATION
- 700 ---- ISOCONCENTRATION CONTOUR OF TRICHLOROETHENE EXCEEDING THE MCL (8-95), dashed where inferred, dotted where possible

C:\UANG\FIG4-26.DGN R06 06.10.96

FIGURE 4.26

Chlorinated VOCs were again detected in a groundwater sample collected in 1995 from S2MW1 (VOCs were resampled in November 1995 due to problems with the August laboratory analyses). The compounds tetrachloroethene, trichloroethene, 1,2-dichloroethene (total) and vinyl chloride were detected at concentrations of 31 µg/L estimated, 1,200 µg/L estimated, 230 µg/L estimated, and 2.3 µg/L, respectively, as shown on Figure 4.26 and Table 4.21. Concentrations of these compounds exceeded MCLs as shown in the table. There is no MCL for 1,2-dichloroethene (total) as shown in Table 5.3 of Section 5, so the MCL for cis 1,2-dichloroethene was applied. Isoconcentration contours of 1,2-dichloroethene for the 1995 sampling event are shown on Figure 4.27. The compounds, 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, benzene, chlorobenzene, and trans 1,3-dichloropropene were also detected in this groundwater sample at the concentrations shown in Table 4.21. As shown on Figure 4.26 and Table 4.21, VOCs were also detected in a groundwater sample collected from the newly installed monitoring well S2MW2, but at lower concentrations. Tetrachloroethene, trichloroethene, 1,2-dichloroethene (total), and chloroform were detected in this sample. The estimated concentrations of trichloroethene and 1,2-dichloroethene exceeded the MCL. SVOCs were not detected above their detection limits.

In summary, the concentration of trichloroethene in groundwater increased at S2MW1 between the sampling events in 1993 and 1995. Also, vinyl chloride was detected in S2MW1 from the 1995 sampling event. However, as shown on Figure 4.26, the detection limit for vinyl chloride was significantly higher for the 1993 analyses, due to dilution.

Metals. Concentrations of metals detected in Site 2 groundwater are shown on Figure 4.28. The metals arsenic, copper, and selenium were detected above method detection limits in a groundwater sample collected in February 1993 from S2MW1. Arsenic, detected at a concentration of 134 µg/L estimated exceeded its MCL. The MCL for arsenic is 50 µg/L as shown in Table 4.20.

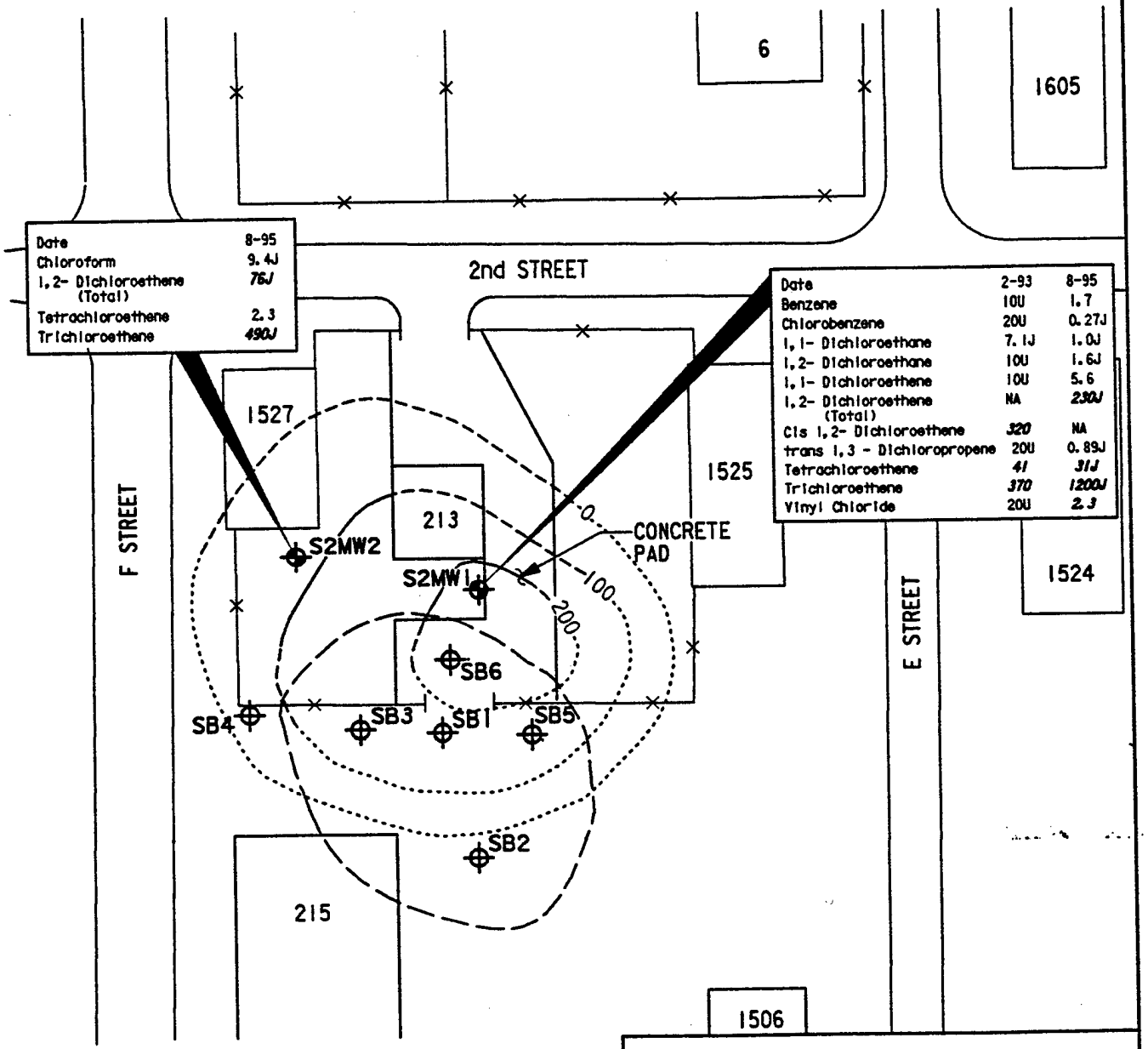
The metals arsenic and copper were detected in a groundwater sample collected in August 1995 from S2MW1. Concentrations are shown on Figure 4.28 and Table 4.21. Arsenic, detected at a concentration of 240 µg/L, exceeded its MCL. The metals arsenic, copper, and mercury were detected in a groundwater sample collected from the newly installed monitoring well, S2MW2. Arsenic was detected at a concentration of 6.6 µg/L. This was the lowest concentration of arsenic detected in shallow groundwater south of the City Drain Canal (refer to Subsection 4.11 for a presentation of arsenic in shallow groundwater).

The elevated dissolved arsenic in groundwater at Site 2 probably does not originate from the leaching of shallow Site 2 soils. The concentrations of arsenic in site soils are not much higher than concentrations detected in the background soil samples (Tables 4.4, 4.5, and 4.18), and, concentrations of arsenic in shallow groundwater are elevated basewide as discussed in subsection 4.11.

FINAL

ORGANIC COMPOUNDS DETECTED IN GROUNDWATER WITH ISOCONCENTRATIONS OF 1,2-DICHLOROETHENE - SITE 2

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NOTE:
Concentrations (ug/L) exceeding MCLs are shown in bold italic.
J - Concentration is estimated
U - Concentration not present above detection limit

N

0 50'

LEGEND

- SOIL BORING
- MONITORING WELL
- SITE LOCATION
- 100 ---- ISOCONCENTRATION CONTOUR OF 1,2-DICHLOROETHENE EXCEEDING THE MCL (8-95), dashed where inferred, dotted where possible

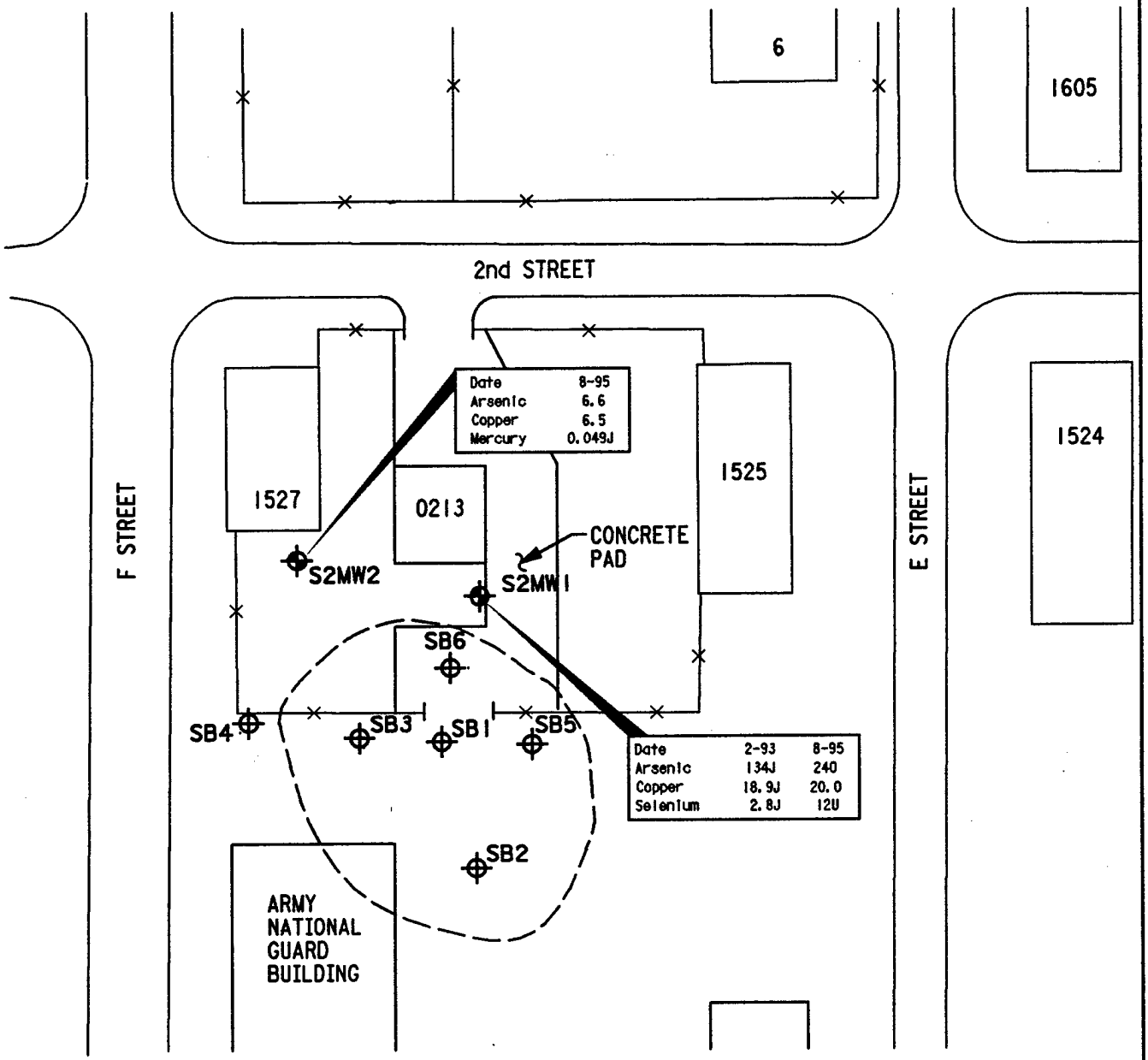
C:\UANG\FIG4-27.DGN ROS 06.12.96

FIGURE 4.27

FINAL

METALS DETECTED IN GROUNDWATER
SITE 2

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SALT LAKE CITY, UTAH



NOTE:
Concentrations are in ug/L for groundwater.
J - Concentration is estimated
U - Concentration not present above detection limit

C:\UANG\FIG4-28.DGN R06 05.30.96

FIGURE 4.28

4.4.3 Site 2 - Conclusions

Organic soil contamination related to a 1987 bowser leak was localized at the site. BTEX, TRPH, and PNAs related to a probable waste fuel spill were detected in soil samples collected from soil boring SB3 (Figure 4.24). Chlorinated VOCs possibly related to a solvent spill were present in the northeastern portion of the site. However, only bottom-hole samples were collected and these samples were collected at the soil/water interface. The compounds trichloroethene, tetrachloroethene, and cis-1,2-dichloroethene were detected in soil at SB5 and SB6. Of these compounds, cis-1,2-dichloroethene was detected at the highest concentration, which indicates that natural degradation is likely occurring. The concentrations of organic compounds were compared to PRGs that are discussed in detail in Section 5. No health-based PRGs for organic compounds were exceeded; therefore, a potential concern is not indicated for soil at this site. However, a PRG was not available for TRPH. The State of Utah does not have established CERCLA clean-up standards for soils and evaluates clean-up on a case-by-case basis.

Overall, metals in Site 2 soils were relatively low, based on metals concentrations in background soil, other sites at the Base, and the averages and general ranges of these metals in the contiguous United States (USGS,1984). Relatively higher site-specific metals concentrations were detected in soil samples from SB5 and SB6 and were collected from clay and sand at the soil/water interface (Figure 4.25). Concentrations of arsenic and beryllium exceeded the most stringent human health criteria for soil in all Site 2 soil samples. However, the established human health PRGs for these metals were below method detection limits and are impractical given the occurrence of these metals in natural soils.

Downgradient groundwater at Site 2 contained chlorinated VOCs. Concentrations of trichloroethene and 1,2-dichloroethene were elevated in both downgradient wells and the concentration of trichloroethene increased at S2MW1 between the sampling events in 1993 and 1995 (Figure 4.26). The presence of the tetrachloroethene and trichloroethene degradation products 1,2-dichloroethene and vinyl chloride indicates that intrinsic remediation is occurring and also suggests that the chlorinated VOC contamination may pre-date the 1987 bowser leak (Figure 4.27). The natural attenuation pathway is probably anaerobic reductive dehalogenation whereby the chlorinated solvents act as terminal electron acceptors and the fuel hydrocarbons and/or native organic material are utilized as bacterial substrate. However, further analytical characterization would be necessary to evaluate potential natural degradation pathways and to determine decay rates and mass loss at field scale. Concentrations of organic compounds were compared to MCLs. The concentrations of tetrachloroethene, trichloroethene, and cis-1,2-dichloroethene exceeded MCLs for one or both sampling events. However, the risks associated with contaminated groundwater at Site 2 are considered to be low, as discussed in the Preliminary Risk Evaluation (Section 5).

Concentrations of arsenic exceeding the MCL were detected (both sampling events) in groundwater collected from S2MW1. However, arsenic in groundwater appears to be indigenous to the shallow aquifer and probably is not related to the leaching of site soils. The concentrations of arsenic in site soils are not much higher than concentrations detected in the background soil samples and elevated concentrations of arsenic in shallow groundwater are essentially ubiquitous at the Base. Also, where arsenic is available in the soil/water system, it is very soluble and mobile under reducing conditions (i.e., low Eh). The redox potential of groundwater is characteristically reducing when anaerobic dechlorination of solvents is occurring.

The groundwater flow direction, hydraulic gradient, and flow rate at the site are subject to change (Figures 4.20, 4.21, and 4.22). Groundwater flow was north to northwest during the field effort. Based on the observed flow directions, the two downgradient monitoring wells were optimally placed in the prevailing direction of groundwater flow. The groundwater velocity was calculated to be 0.01 ft/day in March 1993. Under the March 1993 conditions, it would take groundwater nearly six years to move 20 feet downgradient. The bowser leak at Site 2 occurred in 1987.

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4.5 SITE 3 - DRUM BURIAL LOCATIONS

4.5.1 Field Program

4.5.1.1 Screening Activities

There were no site-specific screening activities conducted at Site 3 during the screening phase of the SI. A soil gas survey was not conducted at this site during the screening phase of the SI because potential contamination at Site 3 was anticipated to be localized in the vicinity of the buried drums.

4.5.1.2 Confirmation and Optional Activities

The following activities were conducted during the confirmation/optional phase of the Site 3 SI:

- Collected and analyzed six soil samples from shallow drum burial excavations;
- Advanced five soil borings;
- Selected and analyzed six soil samples;
- Installed one upgradient monitoring well;
- Collected and analyzed two upgradient groundwater samples;
- Installed one downgradient monitoring well; and
- Collected and analyzed two downgradient groundwater samples.

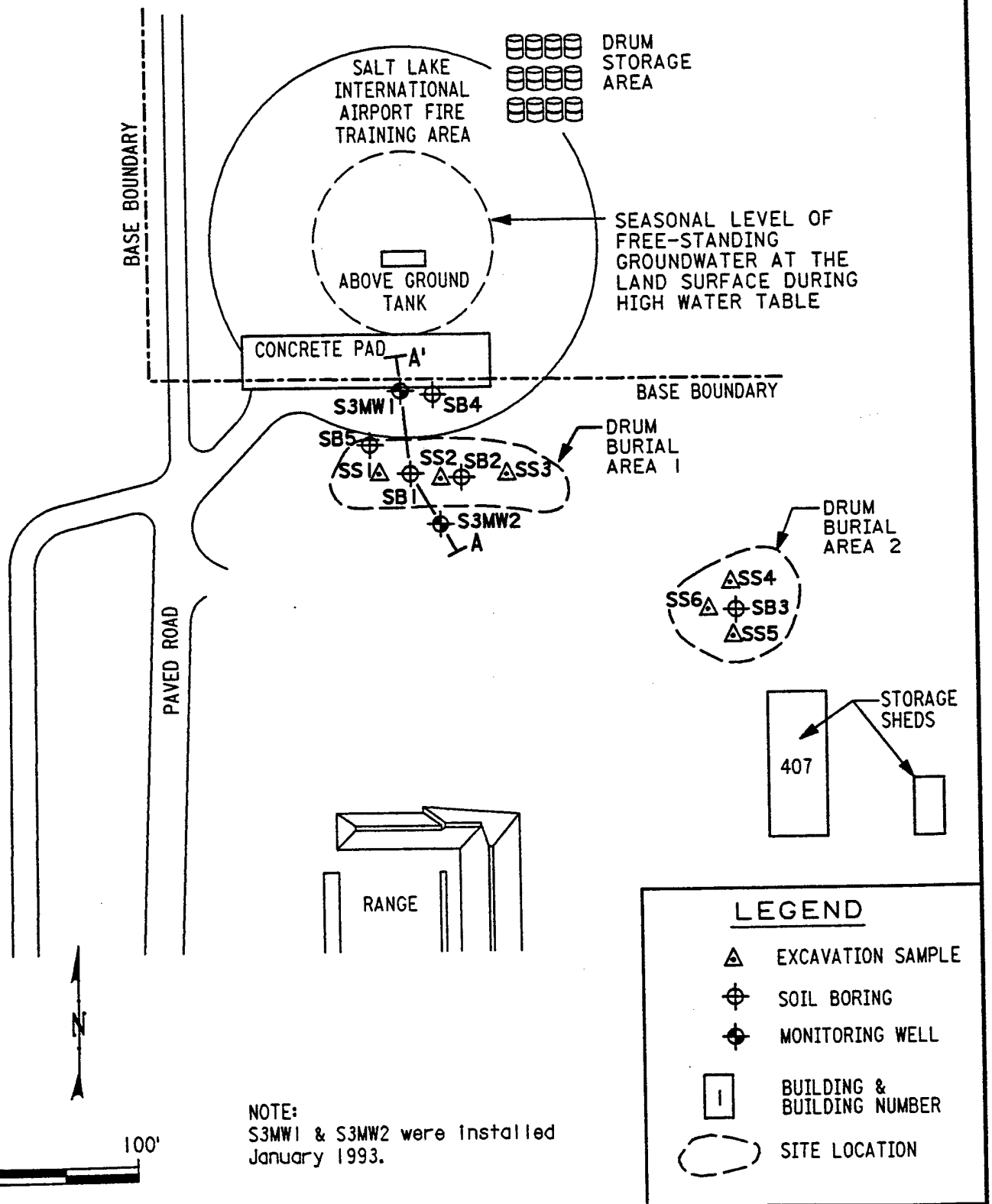
Six soil samples were collected from the drum burial excavations at the locations shown in Figure 4.29. Sampling depths were approximately 1 to 2 feet BLS. Ten 55-gallon crushed barrels were located with a metal detector and were unearthed in a shallow trench at Drum Burial Area. Four 55-gallon crushed barrels were located and unearthed at the location designated as Drum Burial Area 2. Contents of the drums, if any, were not known, but may have been petroleum products and waste solvents, as indicated in the PA (HAZWRAP, et al., 1989).

Four confirmational soil borings and one optional soil boring were advanced at the two drum burial locations after soil sampling of the shallow excavations. The soil borings, placed in areas of possible contamination, are shown in Figure 4.29. Soil Borings SB1, SB2, and SB5 were placed at Drum Burial Area 1. Soil boring SB3 was placed at Drum Burial Area 2. Soil boring SB4 was placed north (upgradient) of Drum Burial Area 1 to evaluate possible contamination from the SLCIA FTA that could be impacting UANG Site 3 soils or groundwater. The soil borings were drilled sequentially beginning with soil boring SB1.

One to two soil samples from each of the five soil borings were selected for chemical analyses based on the results of headspace screening and proximity to the water table. COCs are provided in Appendix D. Only one bottom-hole soil sample from four of the five soil borings was selected for analysis due to reasons discussed in Subsection 3.6. Groundwater was shallow at the site and was generally encountered during drilling at a

SOIL BORING, MONITORING WELL, AND GEOLOGICAL CROSS-SECTION LOCATIONS - SITE 3

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depth of approximately 5 to 6 feet BLS, depending upon the land surface elevation which was variable. Headspace screening results, sampling intervals, and the unconsolidated deposits of each boring were logged and recorded. Detailed soil boring logs are provided in Appendix G. A correlation of the soil BTEX results of field GC screening versus the analytical laboratory is provided in Appendix J.

One upgradient monitoring well and one downgradient monitoring well were installed in January 1993, at the locations shown on Figure 4.29. The upgradient well (S3MW1) was installed north of the soil borings and south of the SLCIA FTA. McDonnel-Douglas manufacturing operations are located approximately 500 feet north of the FTA. This monitoring well was placed immediately south of the FTA to evaluate potential upgradient impacts on Site 3 groundwater. The well is screened in the interval from 5.13 feet to 15.13 feet BLS. The downgradient monitoring well (S3MW2) was installed south of the soil borings and is screened in the interval from 8.74 feet to 18.74 feet BLS. Both wells are screened primarily in coarse granitic sand. Construction details for the Site 3 monitoring wells are provided in Table G.1, Appendix G. Well soil boring logs with well construction diagrams are also provided in Appendix G. Following development, the monitoring wells were purged and sampled, and the samples were analyzed for specified chemical constituents. Well development and sampling forms are provided in Appendix C.

4.5.2 Results of Site Investigation

4.5.2.1 Geology and Hydrogeology

A geological cross section of Site 3 stratigraphy, at the location shown in Figure 4.29, is presented as Figure 4.30. Site 3 is underlain primarily by an organic silt and clay that grades to sand with depth. The upper 1- to 6-feet of soil material is a sand, gravel, and silt fill that includes mixed debris in some areas. This fill extends to a maximum depth of 6 feet at S3MW2. A continuous layer of organic black silt and clay is present beneath the made-land fill to a depth of approximately 5 feet BLS, depending on the soil boring elevation. A 3-foot-thick lens of dark gray to olive-gray clay containing gastropod (snail) shells is present beneath the organic silt at SB3. Discontinuous layers of clayey silt, silty clay, and silty sand are subjacent (adjacent and below) to the organic silt layer to a depth of about 10 feet BLS, depending on soil boring elevation. At approximately 10 feet BLS, the silt and clay grade to a coarse gray sand. This coarse sand is highly permeable and extends to a depth of about 20 feet BLS where it terminates at a clay layer. The sand is composed of well-sorted quartz, mica, feldspar, and ferromagnesian (iron and magnesium rich) silicate minerals of granitic provenance (origin). The natural depositional sequence of the upper 8 feet at the site is indicative of organic sediment accumulation in a low- energy marsh-floodplain depositional environment. The coarse sand was deposited in a relatively high-energy depositional environment, possibly in a channel or near-shore area within or adjacent to the delta discussed in Subsections 2.4.1 and 2.4.2.

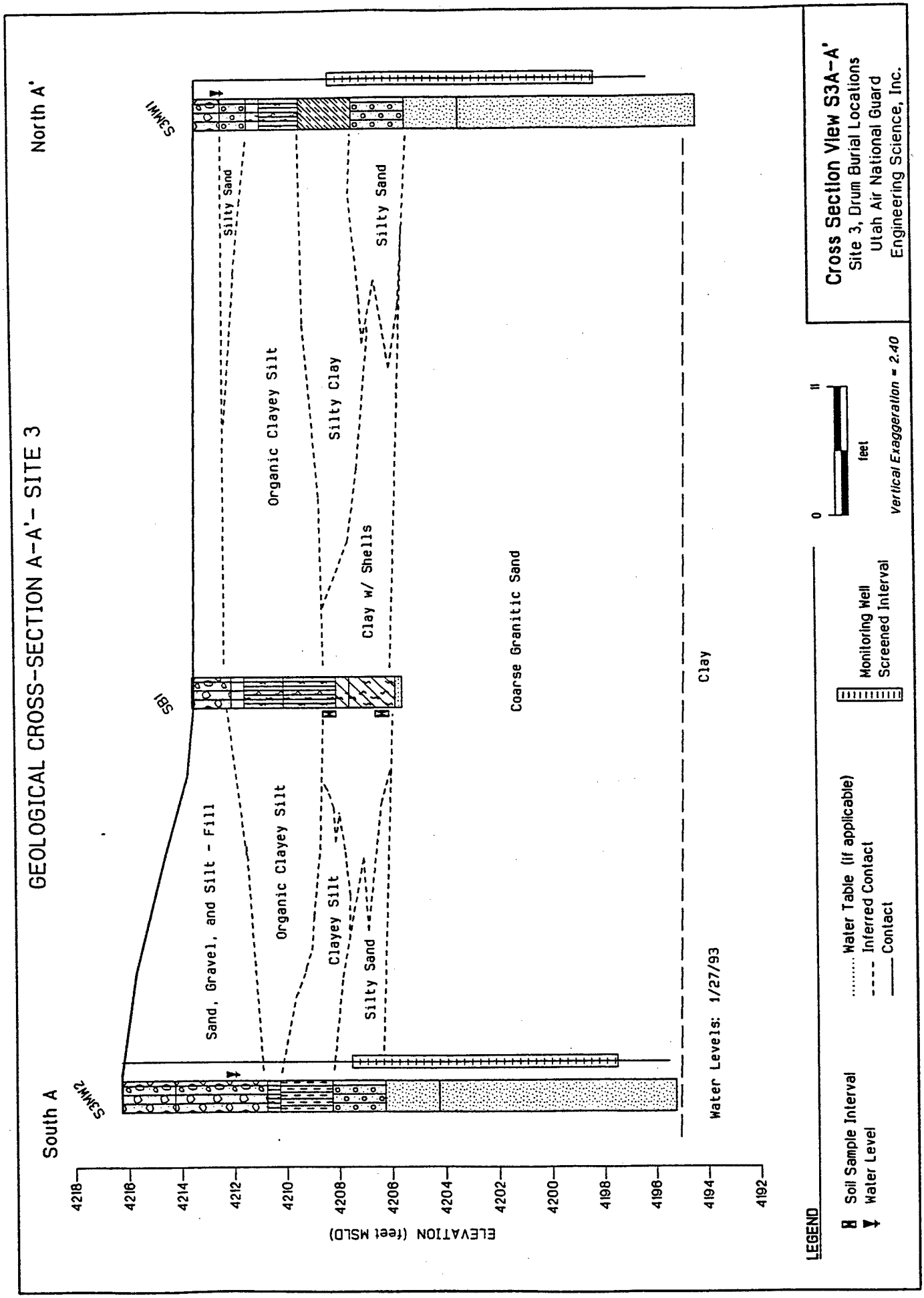

GEOLOGICAL CROSS-SECTION A-A'- SITE 3
North A'
South A
SBM1
SBM2
SB1
Silty Sand
Organic Clayey Silt
Silty Clay
Silty Sand
Clay w/ Shells
Sand, Gravel, and Silt - Fill
Organic Clayey Silt
Clayey Silt
Silty Sand
Coarse Granitic Sand
Clay
Water Levels: 1/27/93
ELEVATION (feet MSLD)
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
4196
4194
4192
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval
0
1"
feet
Vertical Exaggeration = 2.40
Cross Section View S3A-A'
Site 3, Drum Burial Locations
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.30

Basewide groundwater levels were measured on 28 December 1992, 16 March 1993, and 19 July 1995 to determine hydraulic gradients and groundwater flow directions at the sites (Figures 4.1, 4.2, 4.3). Extrapolated groundwater contour maps of the Site 3 area for these respective dates are provided as Figures 4.31, 4.32, and 4.33. The purpose of the 28 December 1992 and 19 July 1995 measurements was to establish groundwater flow directions prior to well placement. The purpose of the 16 March 1993 round of groundwater measurements was to establish hydraulic gradients and flow directions for groundwater flow rate calculations at the sites. March 1993 was the only instance when all of the site monitoring wells and basewide piezometers were measured on the same day during the primary 1992-93 investigation of Sites 1 through 7. As shown in Figure 4.32, the groundwater flow direction at Site 3 was to the south on this date. The southerly flow direction on 16 March 1993 represents a change from the southeasterly flow direction at the site inferred from the 28 December 1992 groundwater gradient (Figure 4.31). The groundwater flow direction also was southeasterly on 19 July 1995 (Figure 4.33). For a comparison of groundwater levels in basewide piezometers and monitoring wells see Tables 4.1, 4.2, and 4.3. The variation in groundwater elevations, hydraulic gradients, and flow directions among these dates is probably due to the shallow aquifer's response to seasonal groundwater recharge and discharge. Therefore, the local hydraulic flow conditions at this site and the other sites is considered to be seasonally variable.

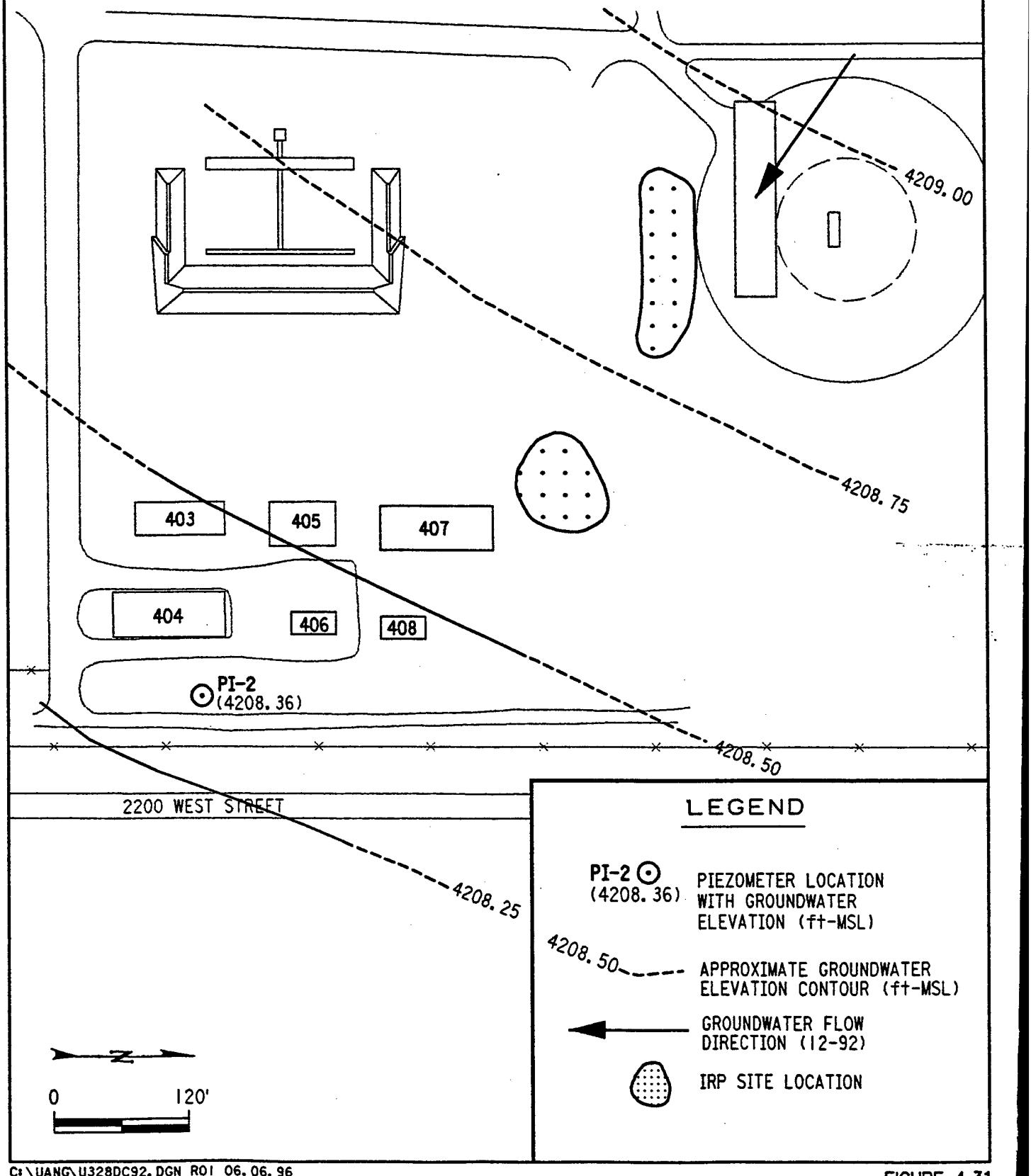
4.5.2.2 Groundwater Flow Calculations

The calculated groundwater flow rate and flow velocity across the site were determined from 16 March 1993 groundwater levels between monitoring wells S3MW1 and S3MW2, as shown on Figure 4.34. The average hydraulic gradient (i) shown on the figure is established in the direction of groundwater flow perpendicular to hydraulic head equipotentials at the wells, and was approximately 0.20 feet (dh) in 100 feet (dl), or 2.0 x 10^{-3} ft/ft (i=dh/dl). The hydraulic conductivity (K) of the coarse sand in the screened interval of S3MW1 was estimated from a slug test at the well to be 23.4 ft/day. The hydraulic conductivity of the coarse sand in the screened interval of S3MW2 is 50.4 ft/day. The average hydraulic conductivity of the porous media beneath the site is considered to be the average of the two values at the wells or 36.9 ft/day. Using Darcy's equation (q=Ki/b), the above parameters yield a volumetric flow rate (q) per unit width of saturated aquifer thickness of 1.37 ft^3/day/ft between the wells at the site on 16 March 1993, considering a saturated aquifer thickness (b) of approximately 18.5 feet. The corresponding groundwater velocity (v) is estimated from the equation (v=Ki/n) and the parameters given above to be approximately 0.25 ft/day, assuming an effective porosity (n) of 30 percent. Hydrogeological data and calculations are presented in Tables I.1 and I.2, of Appendix I. Field methods, methods of analysis, slug test results, and a detailed description and evaluation of hydraulic conductivity, flow rates, and velocities are also contained in Appendix I.

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GROUNDWATER GRADIENT MAP - SITE 3
28 DECEMBER 1992

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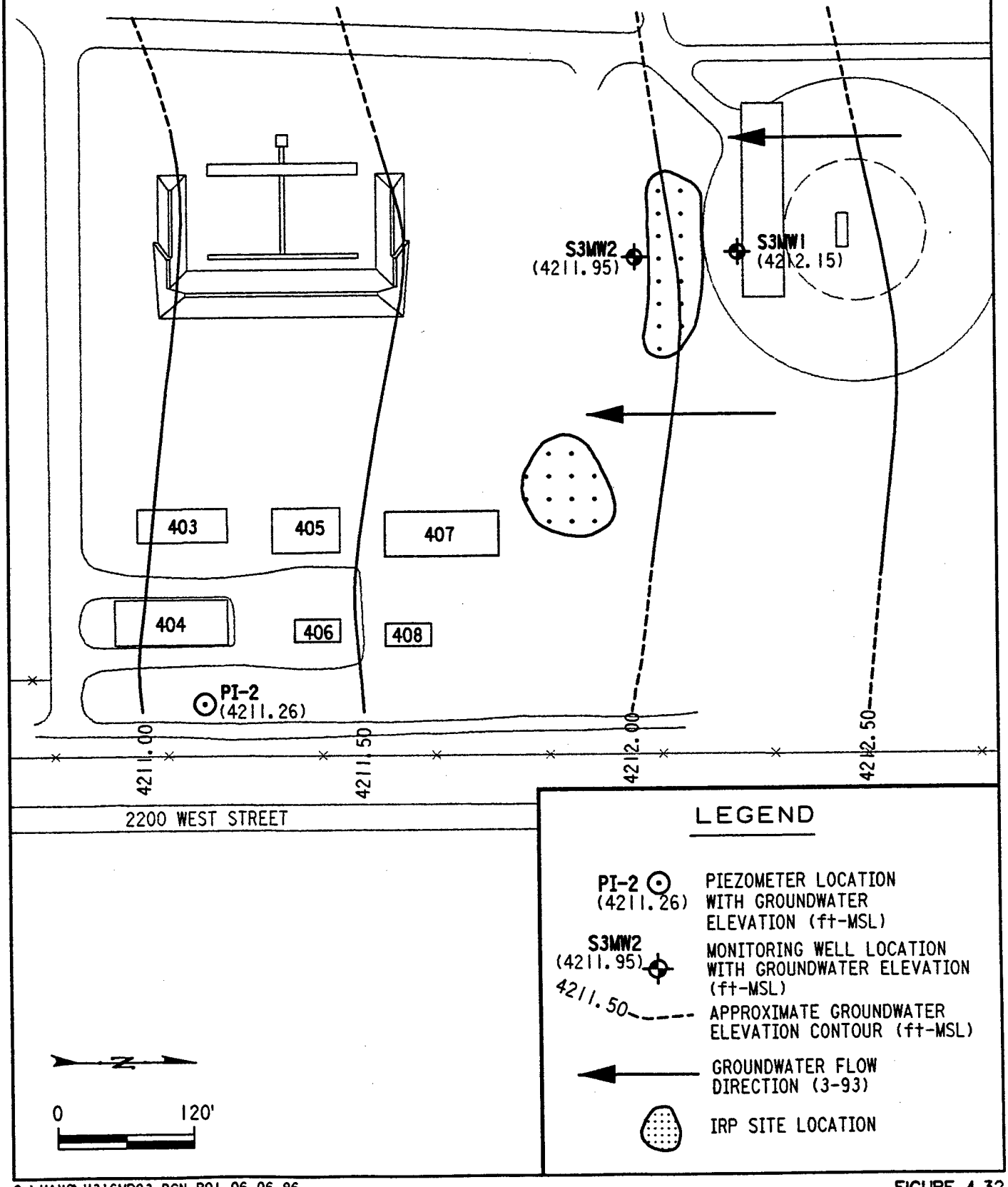
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FIGURE 4.31

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GROUNDWATER GRADIENT MAP - SITE 3
16 MARCH 1993

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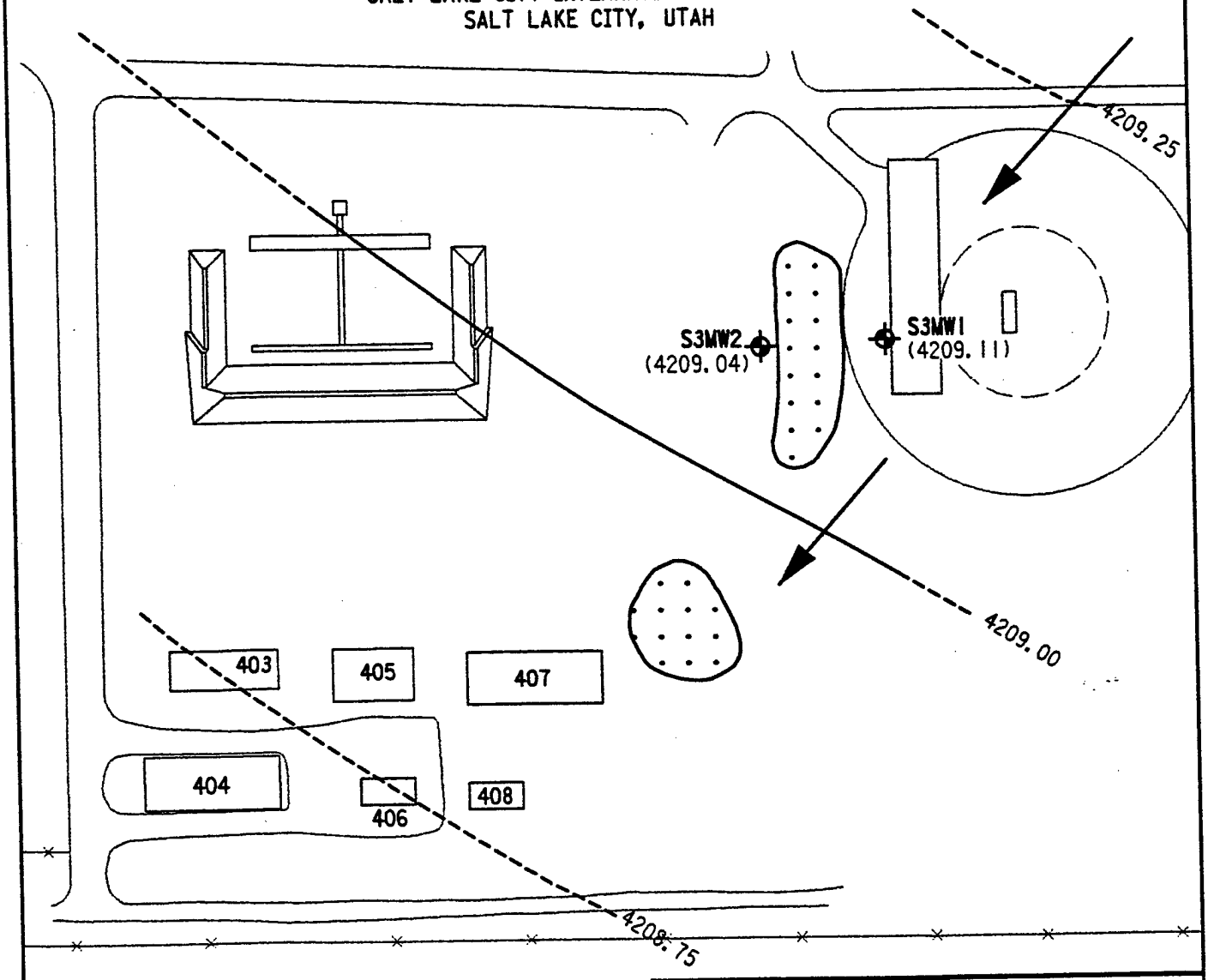


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FIGURE 4.32

GROUNDWATER GRADIENT MAP - SITE 3
19 JULY 1995

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SALT LAKE CITY, UTAH

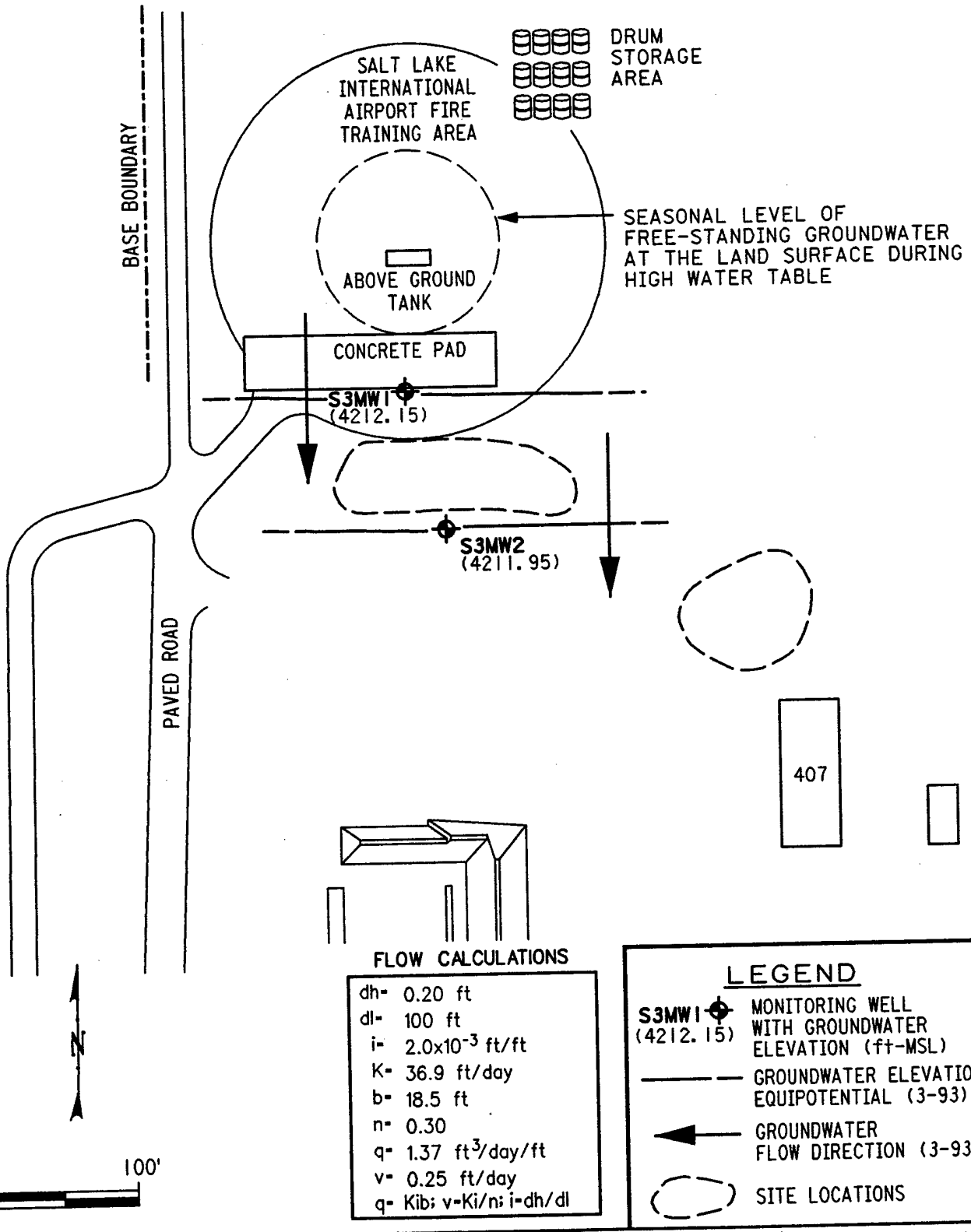


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FIGURE 4.33

GROUNDWATER FLOW RATE AND VELOCITY - SITE 3
16 MARCH 1993

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FIGURE 4.34

4.5.2.3 Soil Contamination Assessment

All of the soil samples from the excavation areas and the five soil borings, including one field duplicate, were analyzed for VOCs, SVOCs, and TRPH. Target compounds included in each of the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided QA/QC Report No. 1 in Appendix E.

The analytical results for compounds detected in Site 3 shallow excavation soil samples are provided in Table 4.22. The analytical results for compounds detected in Site 3 soil boring samples are provided in Table 4.23. Soil PRGs are provided in the table. The basis and derivation of these health-based criteria are discussed in the Preliminary Risk Evaluation (Section 5). The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 3 soils are shown on Figure 4.35. The PNAs (pyrene and chrysene) have been grouped together for presentation; the values shown on the figure represent the sum of the two compounds. The PNA phenanthrene is shown separately since it was detected in only one sample. Diethylphthalate and bis(2-ethylhexyl)phthalate are each separately shown as phthalates on Figure 4.35. PNAs and phthalates are included in the SVOC suite of analyses.

Three soil samples were collected from a shallow excavation trench at Drum Burial Area 1. Soil sample SS2 contained minor estimated concentrations of pyrene, chrysene, bis (2-ethylhexyl) phthalate, and TRPH as shown on the figure and Table 4.22. Soil samples SS1 and SS3 contained TRPH only, at concentrations of 14 mg/kg. These compounds present in near-surface soil at Drum Burial Area 1 were also detected at minor estimated concentrations in soils at Drum Burial Area 2. In addition, diethylphthalate was detected at SS6 at a concentration of 95 µg/kg estimated. TRPH were present at a maximum site concentration of 60 mg/kg at SS4. All of the shallow excavation soil samples were collected in near-surface fill material and debris.

For subsurface soil, only soil boring SB1 in Drum Burial Area 1, contained concentrations of organic compounds above the method detection limit. The 4- to 6-foot interval in SB1 contained phenanthrene at a concentration of 580 µg/kg and N-nitrosodiphenylamine at a concentration of 260 µg/kg estimated. TRPH were present at 50 mg/kg (Figure 4.35 and Table 4.23). These compounds were present in organic silt and clay at this sampling interval. These compounds were not detected at the method detection limits in clay at the 6- to 8-foot interval in SB1. At Drum Burial Area 2, the duplicate sample SB3-6-8 of the 4- to 6-foot interval in soil boring (SB3) contained bis(2-ethylhexyl)phthalate at a concentration of 160 µg/kg estimated in organic silt. The locations of the analytical samples within the 2-foot sampling intervals of SB1 are shown on the geological cross-section and the soil boring logs.

TABLE 4.22
SITE 3 - NEAR SURFACE SOIL
ANALYTES DETECTED
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Parameter (method) (units)	PRGs	Detection Limit	SS1	SS2	SS3	SS4	SS5	SS6
VOCs (SW8010/8020) (µg/kg)*								
Results	--	--	ND	ND	ND	ND	ND	ND
SVOCs (SW8270) (µg/kg)*								
Dilution Factor	--	--	1	1	1	1	1	1
Diethylphthalate	2.16E+08 nc	330.0	390U	390U	400U	400U	430U	95J
Pyrene	8.1E+06 nc	330.0	390U	85J	400U	120J	430U	230J
Chrysene	19,000 c	330.0	390U	69J	400U	83J	430U	240J
bis(2-Ethylhexyl)phthalate	4,570 c	330.0	390U	240J	400U	88J	100J	430U
N-Nitrosodiphenylamine	1.31E+05 c	330.0	390U	390U	400U	400U	430U	430U
Phenanthrene	na	330.0	390U	390U	400U	400U	430U	430U
TRPH (E418.1) (mg/kg)*								
Results	na	10.0	14	18	14	60	50	13U

SS Shallow excavation soil sample

***** Analyses were performed by ES-Berkeley Laboratory.

ND All analytes were not detected; refer to Table H.1, Appendix H, for compounds and detection li

U Compound not present above the detection limit shown.

J Concentration of the compound is estimated.

Note: No soil Preliminary Remediation Goals (PRGs) were exceeded, nc - noncarcinogen, c - carcinog na - not available.

Note: PRG values greater than five digits are in scientific notation.

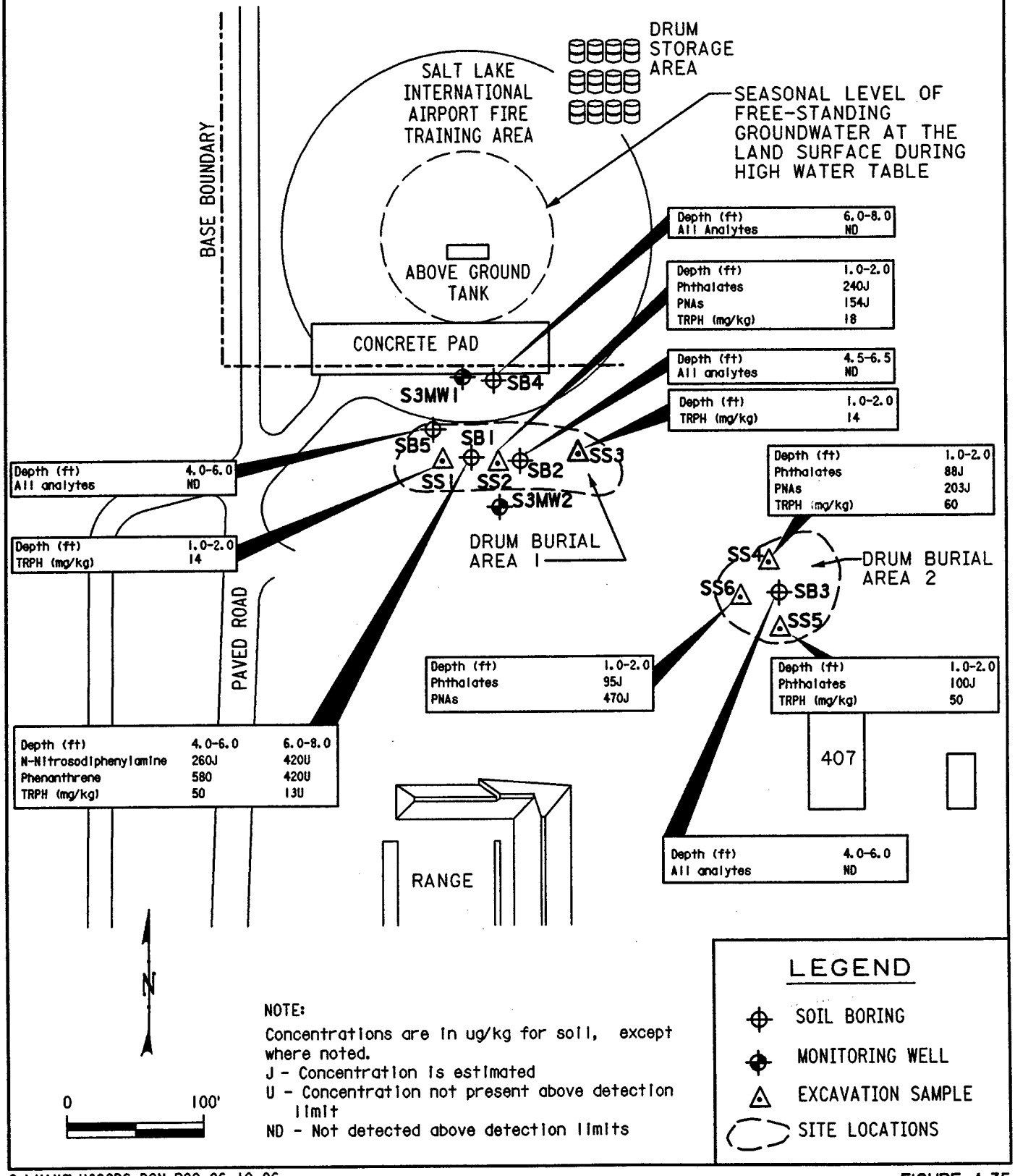
TABLE 4.23
SITE 3 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB1-4-6	SB1-6-8.5	SB2-4.5-6.	SB3-4-6	SB3-6-8 duplicate (a)	SB4-6-8	SB5-4-6
VOCs (SW8010/8020)(µg/kg)*									
Results	--	--	ND	ND	ND	ND	ND	ND	ND
SVOCs (SW8270)(µg/kg)*									
Dilution Factor	--	--	1	1	1	1	1	1	1
Diethylphthalate	2.16E+08	330.0	420U	420U	400U	520U	520U	400U	410U
Pyrene	8.1E+06 n	330.0	420U	420U	400U	520U	520U	400U	410U
Chrysene	19,900 c	330.0	420U	420U	400U	520U	520U	400U	410U
bis(2-Ethylhexyl)phthalat	4,570 c	330.0	420U	420U	400U	520U	160J	400U	410U
N-Nitrosodiphenylamine	1.31E+05	330.0	260J	420U	400U	520U	520U	400U	410U
Phenanthrene	na	330.0	580	420U	400U	520U	520U	400U	410U
TRPH (E418.1) (mg/kg)*									
Results	na	10.0	50	13U	12U	10U	16U	12U	10U

(a) Blind duplicate sample of the preceding interval.
***** Analyses performed by ES-Berkeley Laboratory.
ND All analytes were not detected; refer to Table H.1 of Appendix H for compounds and detection limits.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
Note: No soil Preliminary Remediation Goals (PRGs) were exceeded, nc - noncarcinogen, c - carcinogen, na - not available.
Note: PRG values greater than five digits are in scientific notation.

ORGANIC COMPOUNDS DETECTED IN SOIL
SITE 3

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:
Concentrations are in ug/kg for soil, except where noted.
J - Concentration is estimated
U - Concentration not present above detection limit
ND - Not detected above detection limits

VOCs were not detected in Site 3 soils. This suggests that the crushed barrels contained limited quantities, if any, of petroleum products or solvents. Conversely, the burn by-products pyrene, chrysene, and phenanthrene were detected in near-surface soils.

In summary, organic compounds were present and localized in shallow near-surface fill material at the drum burial excavations. The only organic compound contamination in natural, undisturbed sediment occurred in organic silt at the 4- to 6-foot interval in SB1.

4.5.2.4 Groundwater Contamination Assessment

Groundwater samples and one field duplicate were collected from the two monitoring wells at Site 3 in February 1993. At the time the wells were sampled, groundwater levels had risen substantially at this site, and basewide, as discussed previously in Subsections 2.5.2.1 and 3.5.2. As shown on Figure 4.30, the level of groundwater was only about 3 feet BLS at S3MW1 just prior to groundwater sampling. At the time of sampling, monitoring well S3MW1 was hydraulically upgradient of the soil-contaminated area at Drum Burial Area 1 and monitoring well S3MW2 was downgradient of this area. Both wells were downgradient of the SLCIA FTA and the McDonnel-Douglas manufacturing operations located north of the FTA. The two groundwater samples and one duplicate were analyzed for VOCs and SVOCs. Target compounds included in each of the analyses and the detection limits for the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

In August 1995, monitoring wells S3MW1 and S3MW2 were resampled and analyzed for VOCs and SVOCs. In addition, the groundwater samples were analyzed for arsenic. Arsenic was analyzed at this non-metals site and all other sites for this second round of sampling to provide background information on arsenic concentrations in this area not affected by metals contamination and to evaluate the basewide distribution of arsenic in shallow groundwater. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.2, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 2, Appendix E.

Field measurements of specific conductance, pH, and temperature, were made at the time of sample collection. These data for 1993 and 1995 are provided in Tables 4.8 and 4.9, respectively. Specific conductance measured 1,797 microsiemens/cm and 5,530 microsiemens/cm for these respective dates at monitoring well S3MW1. The corresponding pH values were 7.4 and 7.37. Specific conductance measured 1,762 microsiemens/cm and 9,840 microsiemens/cm for these respective dates at S3MW2, with corresponding pH values of 7.4 and 7.24.

Analytical results of the Site 3 groundwater samples are provided in Tables 4.24 and 4.25. MCLs for the detected analytes are also provided in the table. The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 3 groundwater are shown on Figure 4.36. Dichlorobenzenes are grouped together for presentation; the values shown on the figure represent the sum of the compounds. Chlorobenzene and dichlorobenzenes were detected by Methods SW8010 and SW8020 for volatile organics. Dichlorobenzenes were also detected by the analytical method for SVOCs, SW8270. The results depicted on Figure 4.36 for chlorobenzene and dichlorobenzenes are the greatest values reported by the separate methods. The slight variation in these results are due to analytical procedures and methods.

The groundwater sample collected in February 1993 from upgradient monitoring well S3MW1 contained chlorobenzene at a concentration of 36 µg/L (method 8010), dichlorobenzenes at a total concentration of 14.4 µg/L estimated (method 8020), and toluene at a concentration of 0.27 µg/L estimated. The sample collected from downgradient well S3MW2 contained chlorobenzene at a concentration of 0.37 µg/L estimated (method 8020), dichlorobenzenes at total concentration of 10 µg/L estimated (method 8270), ethylbenzene at a concentration of 0.46 µg/L estimated, and toluene at a concentration of 0.27 µg/L estimated. None of the concentrations of the detected compounds exceeded MCLs. MCLs, if applicable, are listed in Table 5.3 of the preliminary risk evaluation (Section 5).

Some of these compounds were also detected in groundwater samples collected in 1995 from S3MW1 and S3MW2 (VOCs were resampled in November at S3MW1 due to problems with the August laboratory analyses). Chlorobenzene was detected at a concentration of 19 µg/L (method 8010) and dichlorobenzenes were detected at a total concentration of 7.5 µg/L estimated (method 8020) in the sample collected from S3MW1 (Figure 4.36 and Table 4.25). Concentrations of these compounds did not exceed MCLs. Organic compounds were not detected in the sample collected from S3MW2.

In summary, chlorobenzene and dichlorobenzenes were detected at higher concentrations in the upgradient monitoring well, S3MW1, than in the downgradient well, S3MW2, and concentrations decreased in groundwater between sampling events. These compounds were not detected in site soils. Chlorobenzene and dichlorobenzenes are moderately to tightly adsorbed to soil, and thus do not readily leach to groundwater (Howard, 1989). Therefore, chlorobenzene and dichlorobenzenes present in groundwater at Site 3 do not appear to have leached from Site 3 soils, suggesting an upgradient source of groundwater contamination.

Chlorobenzenes as a group are used as chemical intermediates in manufacturing processes, solvents, and degreasers. 1,4-dichlorobenzene is commonly used as a polyphenylene sulfide resin production intermediate (Merck, 1989).

TABLE 4.24
SITE 3 - GROUNDWATER
ANALYTES DETECTED (February 1993)
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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	MCLs	Detection Limit	S3MW1	S3MW2	duplicate (a) S3MW3
VOCs (SW8010) (µg/L)*					
Dilution Factor	--	--	1	1	1
Chlorobenzene	100	1.0	36.0	1.0U	40.0
1,2-Dichlorobenzene	600	1.0	4.8	1.0U	5.1
1,3-Dichlorobenzene	na	1.0	0.72J	1.0U	0.73J
1,4-Dichlorobenzene	75	1.0	7.6	1.0U	7.9
VOCs (SW8020) (µg/L)*					
Dilution factor	--	--	1	1	1
Ethylbenzene	700	2.0	2.0U	0.46J	2.0U
Toluene	1,000	2.0	0.27J	0.27J	0.24J
Chlorobenzene	100	2.0	33.0	0.37J	32.0
1,2-Dichlorobenzene	600	4.0	5.7	0.55J	5.4
1,3-Dichlorobenzene	na	4.0	1.1J	4.0U	1.2J
1,4-Dichlorobenzene	75	4.0	7.6	0.50J	7.6
SVOCs (SW8270) (µg/L)*					
Dilution Factor	--	--	1	1	1
Phenol	na	10.0	10U	10U	4J
1,4-Dichlorobenzene	75	10.0	7J	6J	10U
1,2-Dichlorobenzene	600	10.0	4J	4J	10U
4-Methylphenol	na	10.0	10U	10U	2J

(a) Blind duplicate of MW1.
***** Analyses were performed by the ES-Berkeley Laboratory.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
na No MCL exists.
Note: No Maximum Contaminant Levels (MCLs) were exceeded.

TABLE 4.25
SITE 3 - GROUNDWATER
ANALYTES DETECTED (August 1995)
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SALT LAKE CITY, UTAH

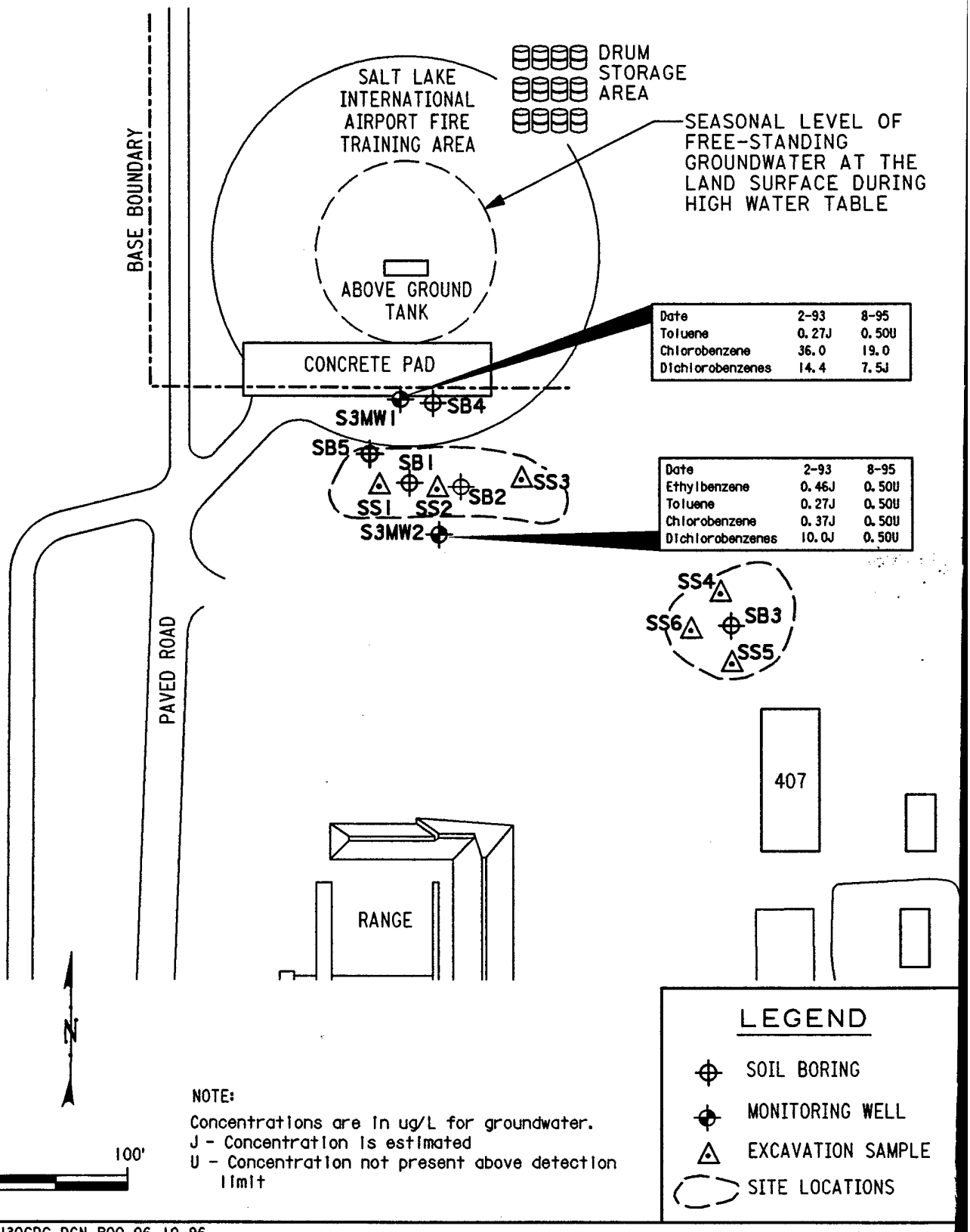
Parameter (method) (units)	MCLs	Detection Limit	S3MW1	S3MW2
VOCs (SW8010/8020) (µg/L)**				
Dilution Factor	--	--	1	1
Chlorobenzene	100	0.5	19	0.50U
1,2-Dichlorobenzene	600	0.5	2.3J	0.50U
1,3-Dichlorobenzene	na	0.5	0.62J	0.50U
1,4-Dichlorobenzene	75	0.5	4.6J	0.50U
SVOCs (SW8270) (µg/L)**				
Dilution Factor	--	--	1	1
1,4-Dichlorobenzene	75	10.0	3.3J	10U
Arsenic (SW7060) (µg/L)**				
Results	50	2.0	7.1J	5.3J

****** **Analyses were performed by Datachem Laboratories.**
U **Compound not present above the detection limit shown.**
J **Concentration of the compound is estimated.**
na **No MCL exists.**
Note: **No Maximum Contaminant Levels (MCLs) were exceeded.**

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ORGANIC COMPOUNDS DETECTED IN GROUNDWATER
SITE 3

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NOTE:
Concentrations are in ug/L for groundwater.
J - Concentration is estimated
U - Concentration not present above detection limit

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FIGURE 4.3

4.5.3 Site 3 - Conclusions

Organic compounds were localized in shallow near-surface fill material at the drum burial excavations (Figure 4.35). VOCs were not detected in site soils. Apparently, the drums were emptied of their contents prior to burial or the VOCs volatilized or have since degraded. The semivolatile PNA burn by-products pyrene, chrysene, and phenanthrene were detected at minor concentrations in near-surface fill material and construction debris at the two drum burial areas. The only organic compound contamination in natural, undisturbed sediment occurred in organic silt at the 4- to 6-foot interval in SB1. The PNA burn by-products detected in near-surface soil at the site may be the result of aerial fall-out related to fire training practices at the SLCIA FTA (the FTA is now no longer in use). Concentrations of organic compounds were compared to PRGs and none of these health-based risk criteria were exceeded; therefore, a potential concern is not indicated for soils at this site.

Upgradient and downgradient groundwater at Site 3 contained minor concentrations of chlorobenzene, dichlorobenzenes, and BTEX compounds that do not appear to be site related. Chlorobenzene and dichlorobenzenes were detected at higher concentrations in the upgradient monitoring well, S3MW1, than in the downgradient well, S3MW2, and concentrations decreased in groundwater between sampling events in 1993 and 1995 (Figure 4.36). Dichlorobenzenes, and chlorobenzene to a lesser extent, are moderately to tightly adsorbed to soil, and do not readily leach to groundwater (Howard, 1989). These compounds were not detected in site soils, suggesting an upgradient source of groundwater contamination. The concentrations of the organic compounds detected in site groundwater did not exceed MCLs. The risks associated with contaminated groundwater at Site 3 are considered to be low.

The groundwater flow direction, hydraulic gradient, and flow rate at the site are subject to change (Figures 4.31, 4.32, and 4.33). Groundwater flow was south to southwest during the field effort, toward the City Drain Canal. The upgradient and downgradient monitoring wells were adequately placed with respect to the observed groundwater flow directions. The groundwater velocity was calculated to be 0.25 ft/day in March 1993. Under the March 1993 conditions, it would take groundwater nearly 11 years to reach the City Drain Canal.

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4.6 SITE 4 - FIRE TRAINING AREA 1

4.6.1 Field Program

4.6.1.1 Screening Activities

The following activity was conducted at Site 4 during the screening phase of the SI:

- Performance of a soil gas survey.

A soil gas survey was conducted to determine the potential source area and approximate extent of soil contamination for optimal placement of soil borings.

Soil gas samples were collected at 23 points during the Site 4 soil gas survey. An equidimensional grid pattern with a 25-foot spacing between points was established at the site for the survey. Soil gas samples were collected at approximately 4.5 feet BLS at all of the sampling locations. The sampling point locations with total BTEX concentrations and corresponding toluene fractions are identified in Figure 4.37. Soil gas analytical results are presented in Table 4.26.

Most of the soil gas samples from points B2 and B3, C2 through C5, D2 through D4, and E2 through E4 exhibited significant detectable total BTEX concentrations that ranged from a high of 555.2 ppmv at D3 to a low of 9.8 ppmv at E4. Toluene was the predominant BTEX compound present at these sample locations. Soil gas samples from D5 and E5 contained total BTEX concentrations of 2.3 ppmv and 0.6 ppmv, respectively. No BTEX compounds were detected in any sample from the north row (row A) or west column (column 1) of the soil gas grid (Figure 4.37). The soil gas survey results indicated a source area of BTEX contamination in the area of the soil gas grid described above. These concentrations circumscribed an area of about 5,000 square feet (ft^2) of potential BTEX soil contamination.

4.6.1.2 Confirmation and Optional Activities

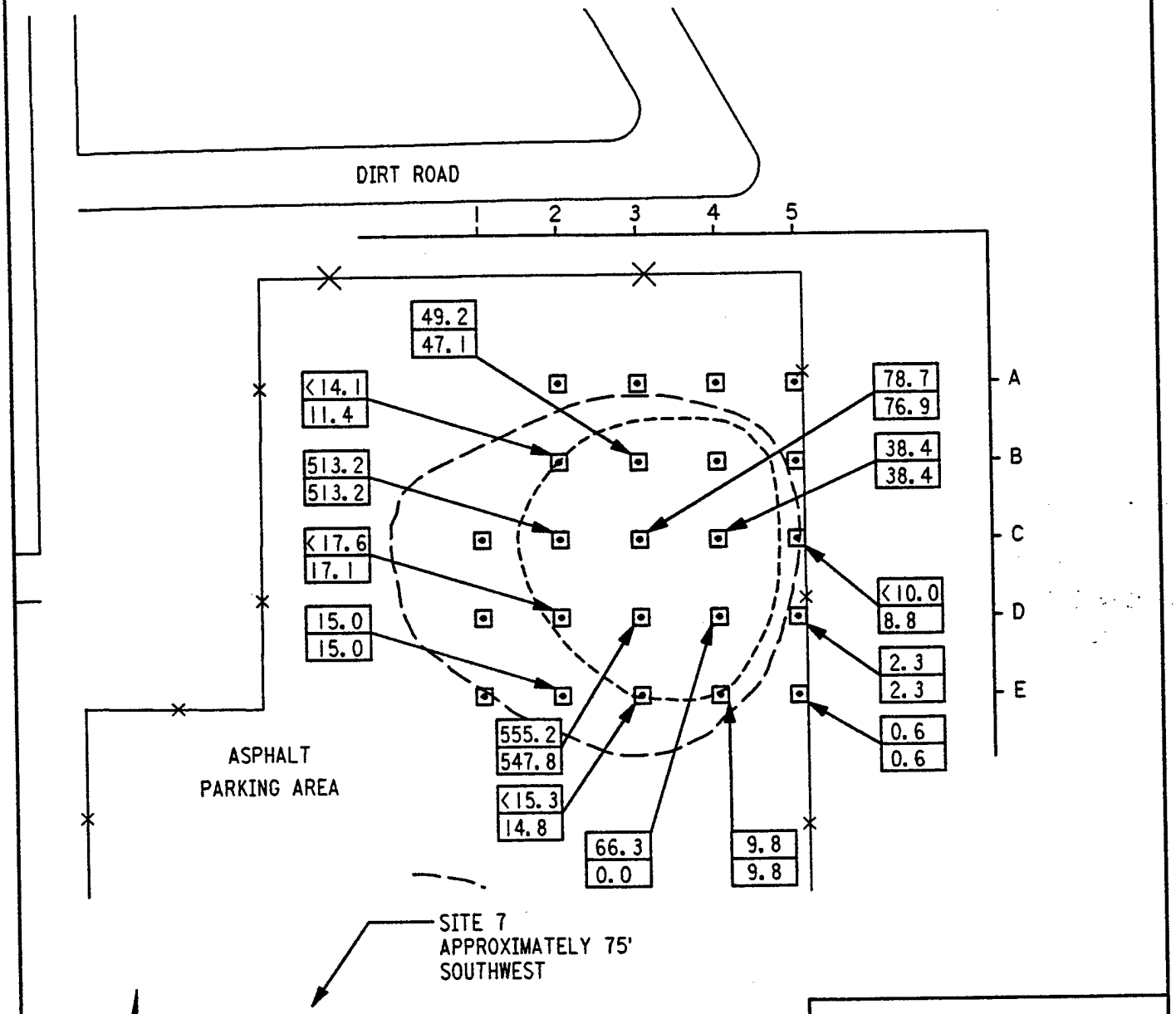
The following activities were conducted during the confirmation/optional phase of the Site 4 SI:

- Advanced nine soil borings;
- Selected and analyzed 16 soil samples.
- Installed one downgradient monitoring well; and
- Collected and analyzed two groundwater samples.

The locations of four confirmational soil borings were selected after evaluating the results of the soil gas survey conducted during the screening phase. The soil borings were placed in locations of possible soil contamination, as indicated by elevated concentrations of VOCs in soil gas samples. Five optional soil borings were placed as indicated by visual observation and elevated headspace readings from GC and PID screening of samples collected during drilling of the initial borings. The optional soil borings were placed to evaluate the areal extent of possible contamination at the site. The

SOIL GAS SURVEY RESULTS - SITE 4

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NOTE: Total BTEX and the corresponding toluene fraction of the total BTEX are shown. Where a less than sign appears, the compounds were detected at less than the GC IDL of 0.5 ppmv.

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FIGURE 4.37

TABLE 4.26
SITE 4 - SOIL GAS SURVEY RESULTS
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SALT LAKE CITY, UTAH

Point	Benzene ppm v	Toluene ppm v	Ethylbenzene ppm v	Xylenes ppm v	Total BTEX ppm v
A1	NA	NA	NA	NA	NA
A2	ND	ND	ND	ND	ND
A3	ND	ND	ND	ND	ND
A4	ND	ND	ND	ND	ND
A5	ND	ND	ND	ND	ND
B1	NA	NA	NA	NA	NA
B2	2.2	11.4	ND	<0.5	<14.1
B3	ND	47.11	ND	2.07	49.18
B4	ND	ND	ND	ND	ND
B5	ND	ND	ND	ND	ND
C1	ND	ND	ND	ND	ND
C2	ND	513.2	ND	ND	513.2
C3	ND	76.9	1.8	ND	78.7
C4	ND	38.4	ND	ND	38.4
C5	ND	8.8	<0.5	0.7	<10.0
D1	ND	ND	ND	ND	ND
D2	ND	17.1	<0.5	ND	<17.6
D3	ND	547.8	0.9	6.5	555.2
D4	66.3	ND	ND	ND	66.3
D5	ND	2.3	ND	ND	2.3
E1	ND	ND	ND	ND	ND
E2	ND	15	ND	ND	15
E3	ND	14.8	<0.5	ND	<15.3
E4	ND	9.8	ND	ND	9.8
E5	ND	0.6	ND	ND	0.6

ND Not detected (BTEX compounds were not observed on chromatograms)

NA Not Analyzed

<0.5-BTEX compounds were observed on original chromatograms but were not quantified.

locations of the soil borings at Site 4 are shown on Figure 4.38. The soil borings were drilled sequentially beginning with soil boring SB1.

Two soil samples from each of the nine soil borings were selected for analysis based on the results of headspace screening and proximity to the water table. COCs are provided in Appendix D. Groundwater was initially encountered at a depth of approximately 7 to 8 feet BLS during drilling in early December 1992. Groundwater was encountered at a depth of 6 to 7 feet BLS while drilling optional soil borings, approximately 2 weeks to 3 weeks later. Apparently, the water level increased in response to seasonal groundwater recharge during this time interval. Headspace screening results, sampling intervals, and the unconsolidated deposits of each boring were logged and recorded. Detailed soil descriptions are provided in the soil boring logs in Appendix G. A correlation of the soil BTEX results of field GC screening versus the analytical laboratory is provided in Appendix J.

One downgradient monitoring well, S4MW1, was installed at the location shown in Figure 4.38. The well is screened in the interval from 5.35 feet to 15.35 feet BLS in clay, silt, and sand. Construction details for the Site 4 monitoring well are provided in Table G.1, Appendix G. A well soil boring log with a construction diagram are also provided in Appendix G. Following development, the monitoring well was purged and sampled, and the sample was analyzed for the specified chemical constituents. Well development and sampling forms are provided in Appendix C.

4.6.2 Results of Site Investigation

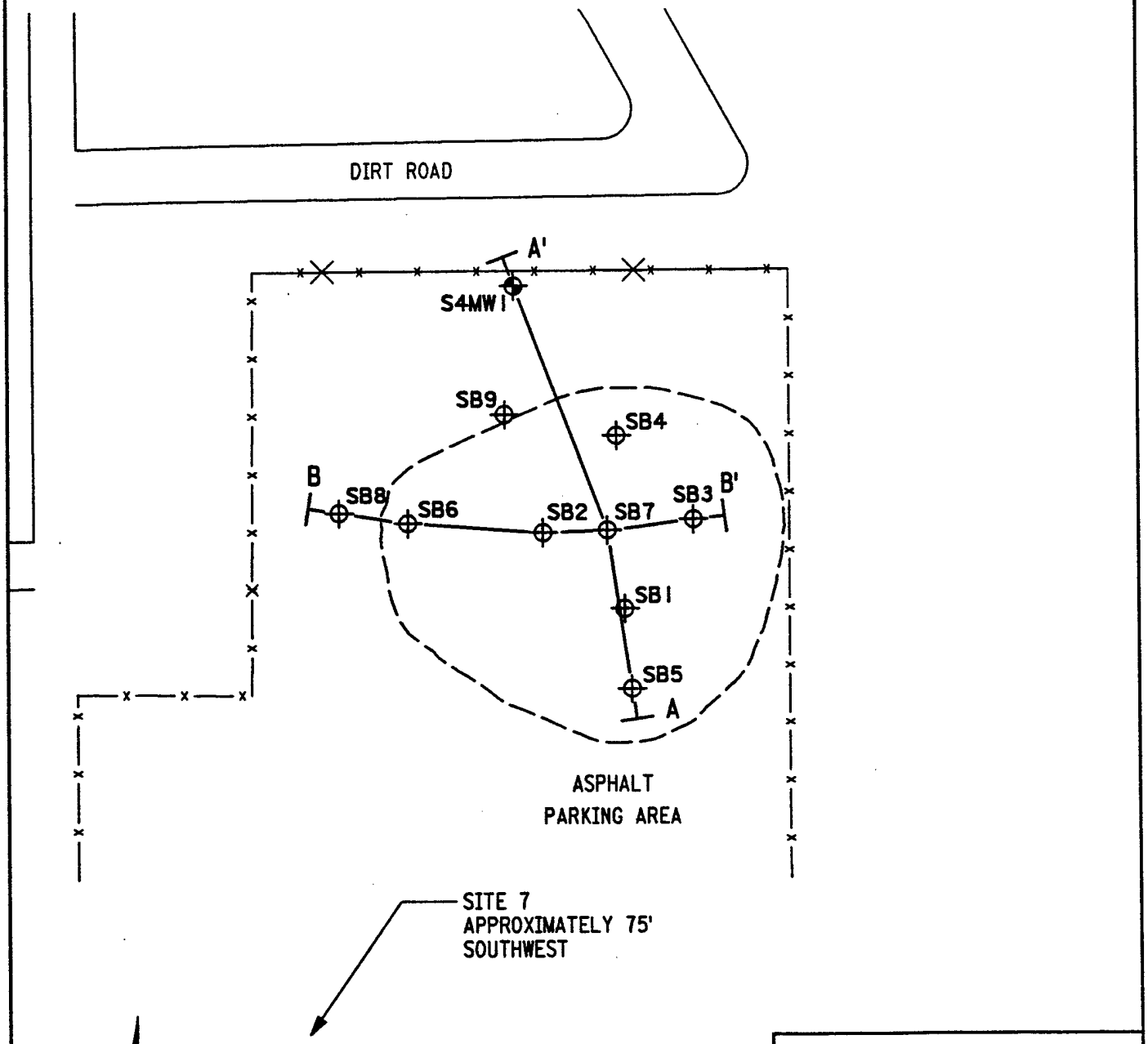
4.6.2.1 Geology and Hydrogeology

Geological cross-sections of Site 4 stratigraphy, at the locations shown in Figure 4.38, are presented as Figures 4.39 and 4.40. Site 4 is underlain by a clay or silt, organic silt, clay or silt, silty sand, and sand depositional sequence. The upper 1- to 2-feet of made-land material beneath asphalt is a sand, clay, and gravel fill that covers the entire site. The 2- to 4-foot depth BLS is primarily discontinuous interfingering greenish-gray or olive-gray clay, clayey silt, and silty clay. From 4 feet BLS, a relatively continuous layer of black to dark gray organic silt and silty clay is present to a maximum depth of approximately 7 feet BLS. These layers contain gastropod shells, plant roots and rhizomes (root hairs), and peat material. The organic silt appears to be a marsh or swamp deposit. Beneath the organic deposit are discrete 2-foot-thick lenses of sandy clay, and discontinuous layers of clayey silt, silty clay, and silty sand. Due to the lateral variation in sediments, these alluvial units are difficult to correlate between boreholes. At an average depth of approximately 9 feet BLS, a gray fine to medium sand is present. The sand is comprised of quartz, feldspar, mica, and ferromagnesian silicate minerals of granitic provenance. The sand terminates at a clay layer at approximately 20 feet BLS. The stratigraphically lower sand was deposited in a relatively higher-energy depositional environment. The upper 9 feet of the depositional sequence superjacent (adjacent and above) to the sand is typical of lower energy meandering stream-marsh-floodplain deposition.

FINAL

SOIL BORING, MONITORING WELL, AND GEOLOGICAL CROSS-SECTION LOCATIONS - SITE 4

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NOTE:
S4MW1 was Installed January 1993.

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FIGURE 4.38

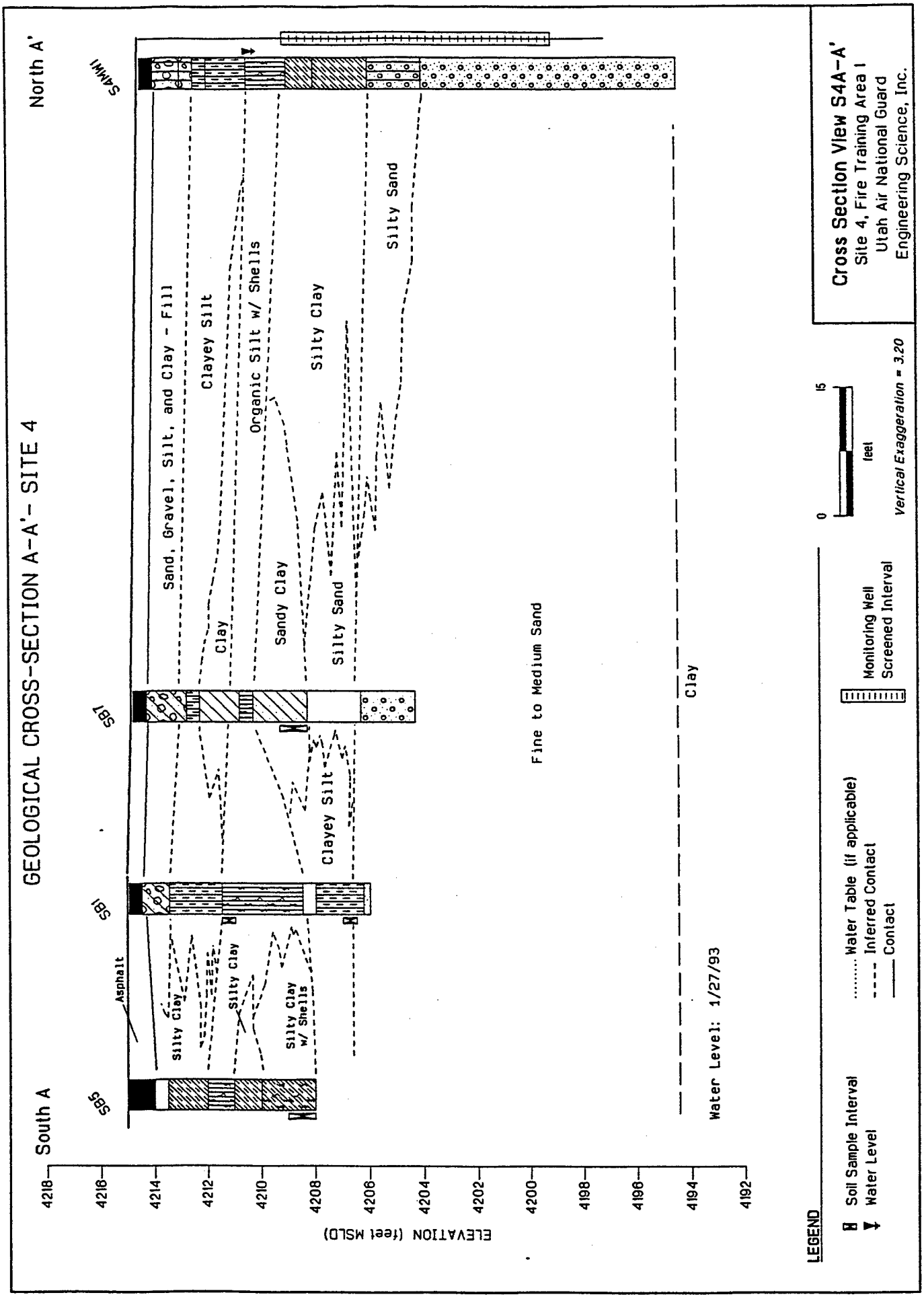

GEOLOGICAL CROSS-SECTION A-A'- SITE 4
South A
North A'
SB5
SB1
SB3
SB4
Asphalt
Silty Clay
Silty Clay
Silty Clay w/ Shells
Sand, Gravel, Silt, and Clay - Fill
Clayey Silt
Clay
Organic Silt w/ Shells
Sandy Clay
Silty Clay
Silty Sand
Clayey Silt
Silty Sand
Fine to Medium Sand
Clay
Water Level: 1/27/93
ELEVATION (feet MSLD)
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
4196
4194
4192
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval
0
15
feet
Vertical Exaggeration = 3.20
Cross Section View S4A-A'
Site 4, Fire Training Area I
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.39

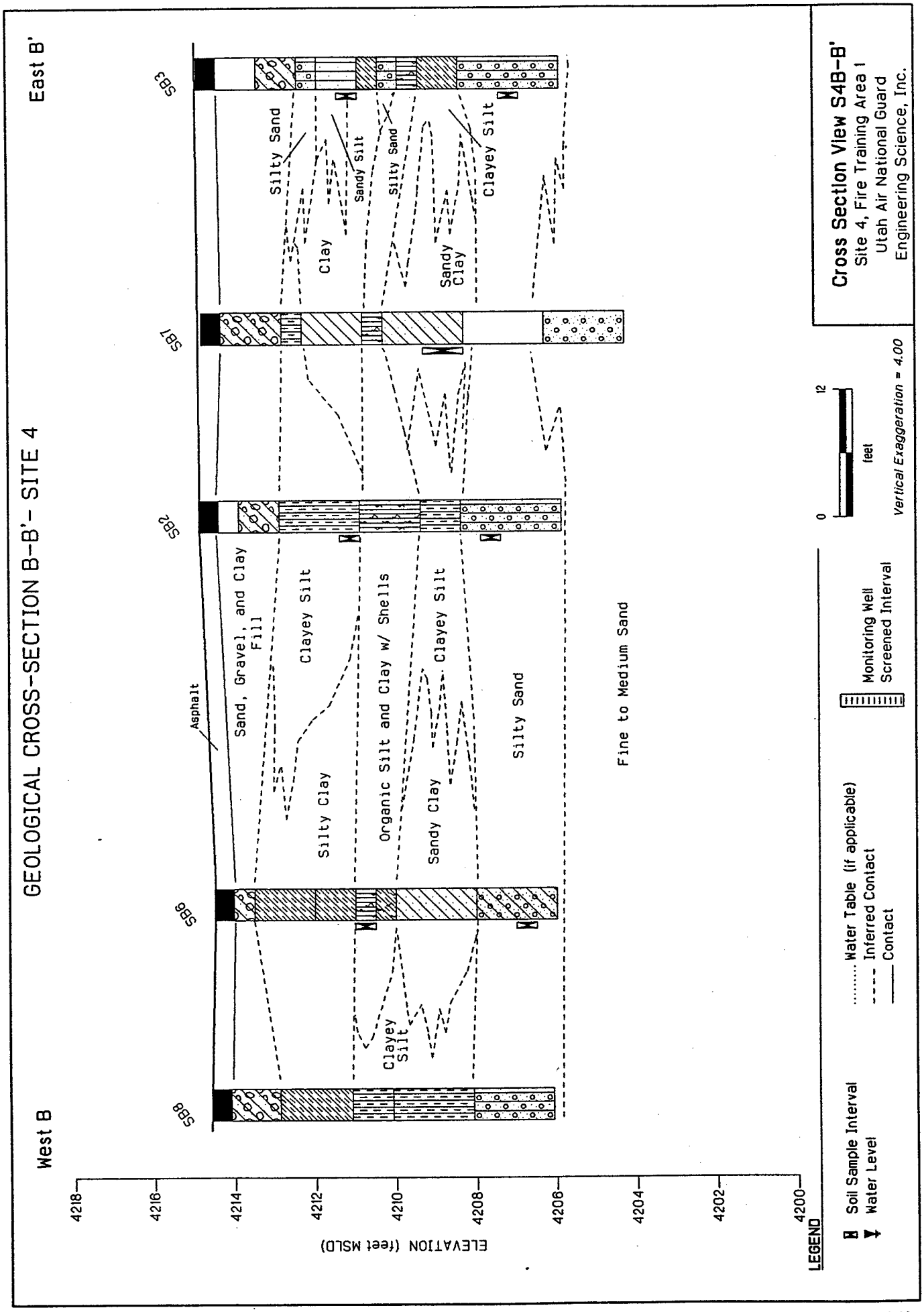

GEOLOGICAL CROSS-SECTION B-B'- SITE 4
West B
East B'
SB3
SB1
SB2
SB6
SB8
Asphalt
Sand, Gravel, and Clay Fill
Clayey Silt
Silty Clay
Organic Silt and Clay w/ Shells
Sandy Clay
Clayey Silt
Silty Sand
Fine to Medium Sand
Clayey Silt
Silty Sand
Clay
Sandy Silt
Silty Sand
Sandy Clay
Clayey Silt
ELEVATION (feet MSLD)
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval
0
12
feet
Vertical Exaggeration = 4.00
Cross Section View S4B-B'
Site 4, Fire Training Area 1
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.40

Basewide groundwater levels were measured on 28 December 1992, 16 March 1993, and 19 July 1995 to determine hydraulic gradients and groundwater flow directions at the sites (Figures 4.1, 4.2, 4.3). Extrapolated groundwater contour maps of the Site 4 area for these respective dates are provided as Figures 4.41, 4.42, and 4.43. The purpose of the 28 December 1992 and 19 July 1995 measurements was to establish groundwater flow directions prior to well placement. The purpose of the 16 March 1993 round of groundwater measurements was to establish hydraulic gradients and flow directions for groundwater flow rate calculations at the sites. March 1993 was the only instance when all of the site monitoring wells and basewide piezometers were measured on the same day during the primary 1992-93 investigation of Sites 1 through 7. As shown in Figure 4.42, the groundwater flow direction at Site 4 was to the north on this date. The northerly flow direction on 16 March 1993 does not indicate much of a change from the north-northeasterly flow direction at the site inferred from the 28 December 1992 groundwater gradient (Figure 4.41). The groundwater flow direction also was north-northeasterly on 19 July 1995 (Figure 4.43). For a comparison of groundwater levels in basewide piezometers and monitoring wells see Tables 4.1, 4.2, and 4.3. The variation in groundwater elevations, hydraulic gradients, and flow directions among these dates is probably due to the shallow aquifer's response to seasonal groundwater recharge and discharge. Therefore, the local hydraulic flow conditions at this site and the other sites are considered to be seasonally variable.

4.6.2.2 Groundwater Flow Calculations

The calculated groundwater flow rate and flow velocity across the site were determined from 16 March 1993 groundwater levels between monitoring wells S4MW1 and S7MW1, as shown in Figure 4.44. The downgradient monitoring well (S7MW1) at Site 7 was used as an upgradient well for Site 4 groundwater flow calculations. Because the measured hydraulic gradient across Site 4 between monitoring wells S4MW1 and S7MW1 was very minimal, shallow groundwater was essentially not flowing beneath the site at this time. The hydraulic conductivity of the silty clay, silty sand, and sand in the screened interval of monitoring well S4MW1 was estimated from a slug test at the well to be 1.44 ft/day. The hydraulic conductivity of the porous media in the screened interval of monitoring well S7MW1 is 1.13 ft/day and is discussed in Subsection 4.9.2.2. The average hydraulic conductivity used in the Site 4 calculations is 1.29 ft/day, which is the average of the hydraulic conductivity values obtained at the two monitoring wells. Values of hydraulic conductivity are given in Table I.1 of Appendix I. Calculations of hydraulic gradient, groundwater flow rate, and groundwater velocity across the site are given in Table I.2 of Appendix I. Slug test results and a description of methods are also contained in Appendix I.

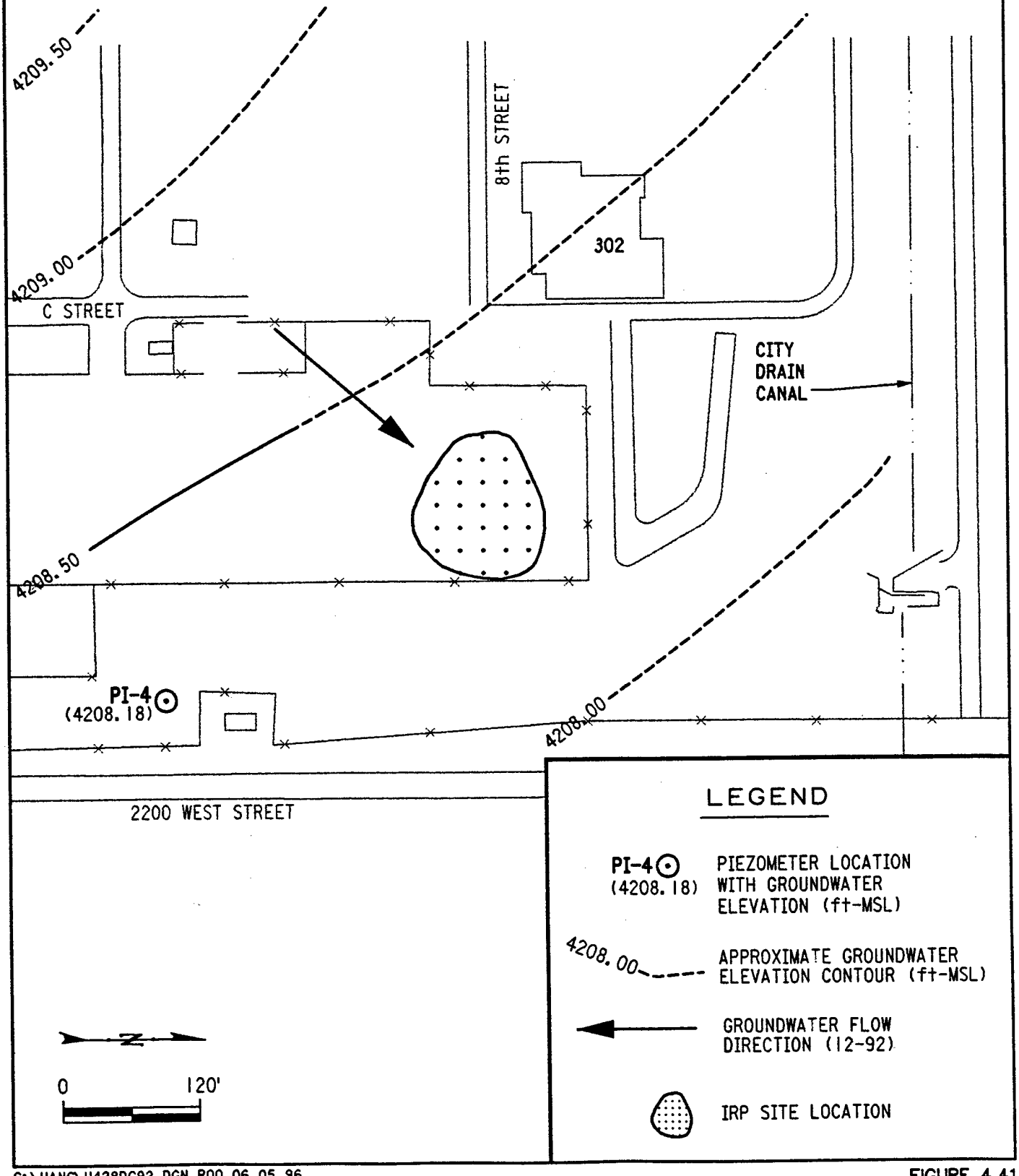
4.6.2.3 Soil Contamination Assessment

Soil samples were collected from nine soil borings at Site 4. The locations of the analytical samples and the types of soils from which the analytical samples were collected are shown in the geological cross-sections of Figures 4.39 and 4.40 and the soil

FINAL

GROUNDWATER GRADIENT MAP - SITE 4
28 DECEMBER 1992

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SALT LAKE CITY, UTAH

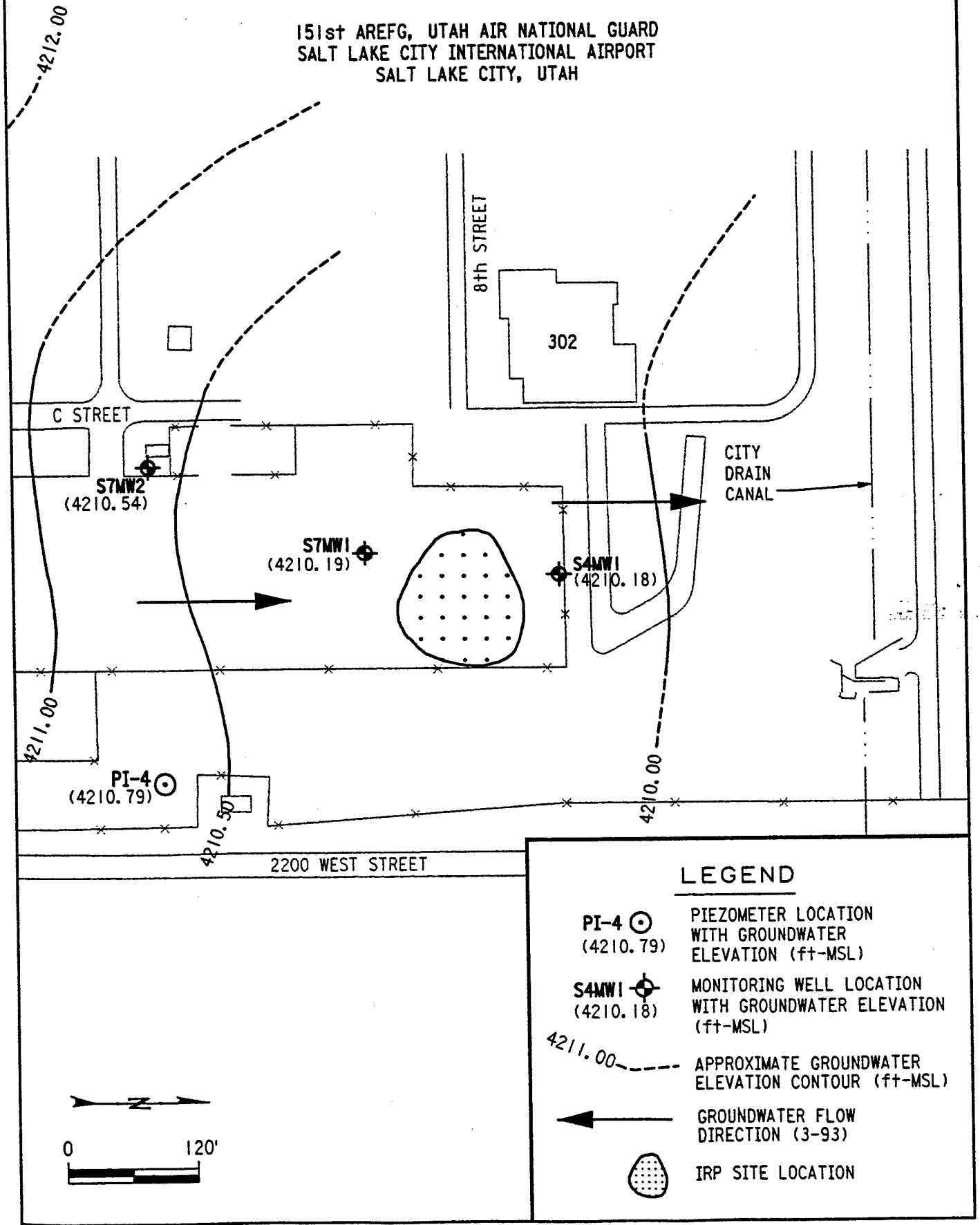


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FIGURE 4.41

GROUNDWATER GRADIENT MAP - SITE 4
16 MARCH 1993

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SALT LAKE CITY, UTAH



LEGEND

- PI-4 (4210.79) — PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)
- S4MW1 (4210.18) — MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)
- 4211.00 ---- APPROXIMATE GROUNDWATER ELEVATION CONTOUR (ft-MSL)
- ← GROUNDWATER FLOW DIRECTION (3-93)
- IRP SITE LOCATION

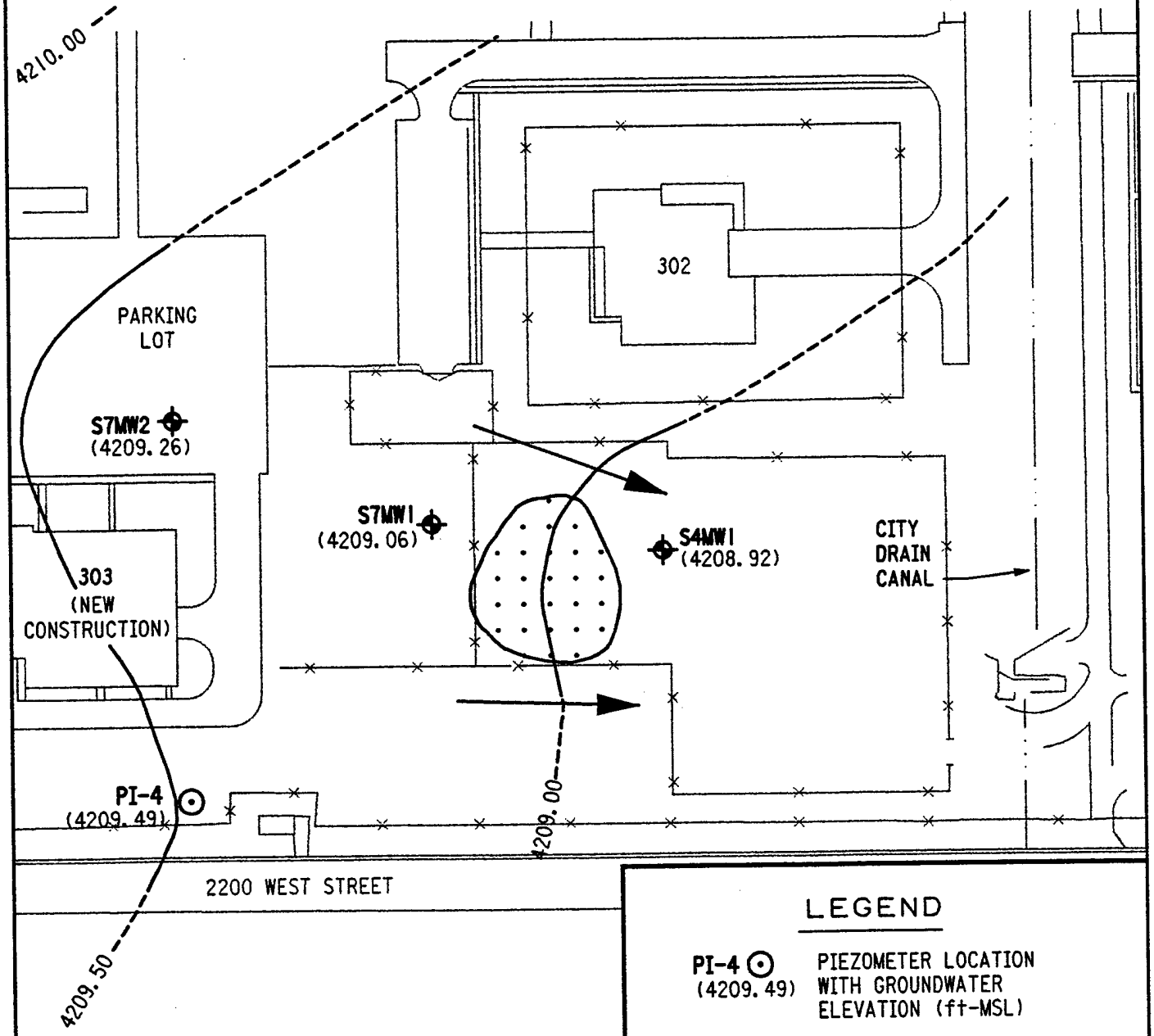
C:\UANG\U416MR93.DGN R02 06.07.96

FIGURE 4.42

FINAL

GROUNDWATER GRADIENT MAP - SITE 4
19 JULY 1995

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



LEGEND

PI-4 (4209.49) — PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)

S4MW1 (4208.92) — MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)

4209.00 — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (ft-MSL)

GROUNDWATER FLOW DIRECTION (7-95)

IRP SITE LOCATION

N

0 120'

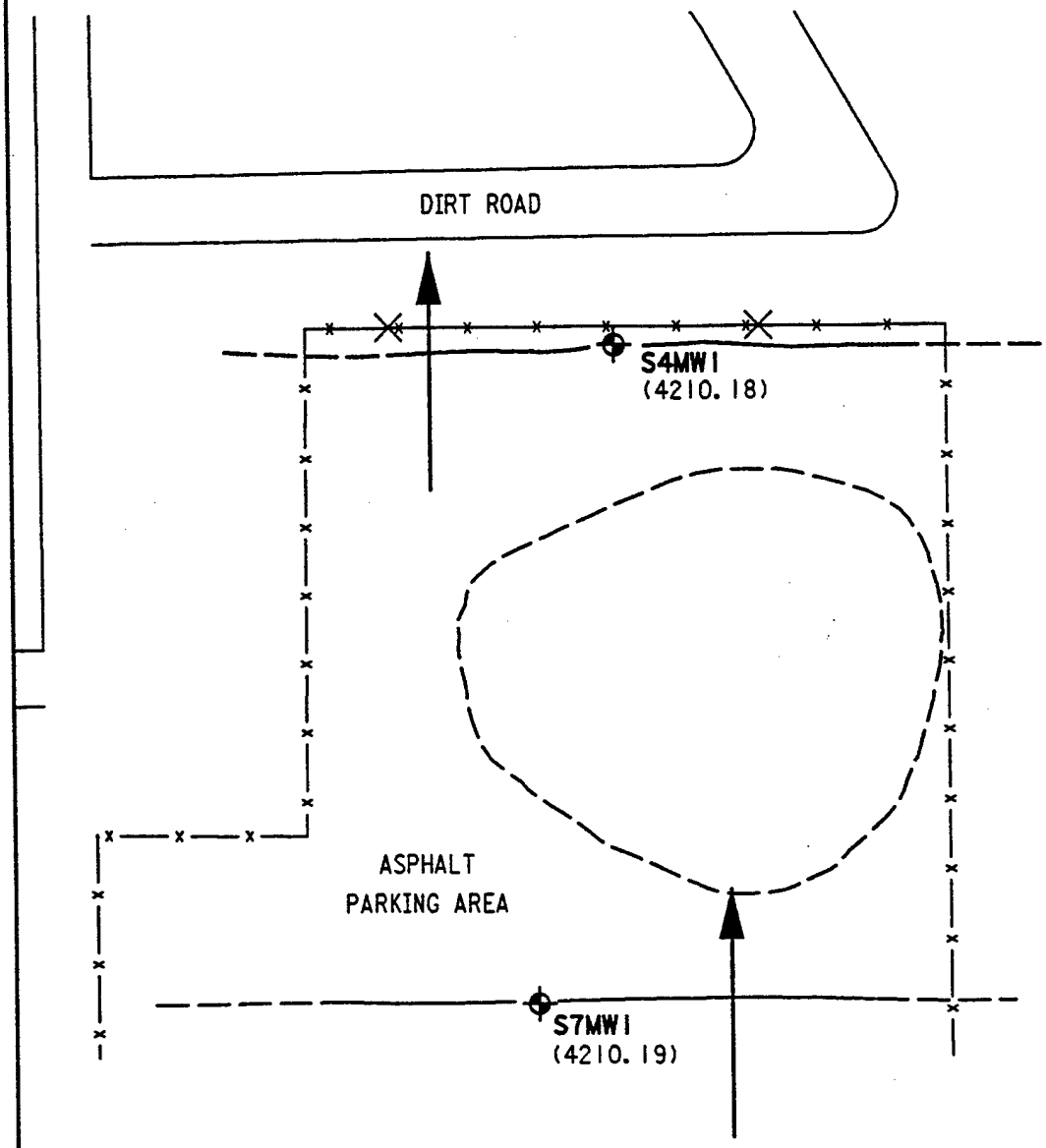
NOTE:
This site plan configuration is updated to incorporate new construction after the 1992-93 site investigation

C:\UANG\U419JL95.DGN R01 06.06.96

FIGURE 4.43

GROUNDWATER FLOW RATE AND VELOCITY - SITE 4
16 MARCH 1993

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH





0 50'

FLOW CALCULATIONS

dh=	0.01 ft
dl=	180 ft
i=	5.56×10^{-5} ft/ft
K=	1.29 ft/day
b=	15.5 ft
n=	0.30
q=	1.11×10^{-3} ft^3/day/ft
v=	2.39×10^{-4} ft/day

q= Kib; v=Ki/n; i=dh/dl

LEGEND

- S4MW1 (4210.18) — MONITORING WELL WITH GROUNDWATER ELEVATION (ft-MSL)
- GROUNDWATER ELEVATION EQUIPOTENTIAL (3-93)
- GROUNDWATER FLOW DIRECTION (3-93)
- SITE LOCATION

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FIGURE 4.44

boring logs in Appendix G. The soil samples and two field duplicates were analyzed for VOCs, SVOCs, PPMs, and TRPH. Target compounds included in each of the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

The analytical results for compounds detected in Site 4 soil samples are provided in Table 4.27. If concentrations were below their respective detection limits for these compounds in other soil samples, the detection limits for the individual analyses are shown in the table. The detection limits for the individual compounds vary due to matrix effects and dry weight calculations. Field duplicates are shown after their associated samples in the table. Soil PRGs are provided in the table. The basis and derivation of these health-based criteria are discussed in the Preliminary Risk Evaluation (Section 5). The findings for each group of detected compounds are discussed below.

Organic Compound. Concentrations of organic compounds detected in Site 4 soils are shown on Figure 4.45. Diethylphthalate and di-n-butylphthalate are each individually shown as phthalates on the figure. 2,4-Dimethylphenol is shown as phenols.

The highest concentration of organic compounds at the site occurred in the first sampling interval at soil borings SB1, SB2, and SB3. These soil boring locations coincide with the areas that exhibited higher toluene soil gas concentrations, as seen by comparing Figures 4.37 and 4.45. However, BTEX contamination of soil at these soil borings, and at the site in general, is minimal. Therefore, toluene (547.8 ppm maximum) soil gas concentrations at the site appear to represent separate gaseous-phase toluene that was not adsorbed to soil particles.

Organic compounds at soil borings SB1, SB2, and SB3 that exhibit the highest concentrations are phthalates and phenol. Diethylphthalate was detected at a concentration of 1,800 µg/kg in organic silt at the 2.5- to 4.5-foot interval in SB1. 2,4, Dimethylphenol was found at a concentration of 1,200 µg/kg estimated in clayey silt at the 2.5- to 4.5-foot interval in SB2. This interval also contained a maximum site TRPH concentration of 1,600 mg/kg. However, the 6.5- to 9-foot interval of SB2 contained only 10 mg/kg estimated TRPH. The 2.5- to 4.5-foot interval in SB3 contained di-n-butylphthalate at a concentration of 140 µg/kg estimated. The organic silt in the 2.5- to 4.5-foot interval in SB4 also contained di-n-butylphthalate at a concentration of 120 µg/kg estimated. Minor concentrations of BTEX compounds were detected in the sampling intervals of soil borings SB1 through SB4 as shown on Figure 4.45.

The other soil borings at Site 4 contained minimal TRPH (SB5, SB6, and SB7), or all the analytes were not detected above the analytical method detection limits (SB8 and SB9).

The concentration of acetone exceeded 10 times the concentration in an associated laboratory method blank for the analysis of a sample from SB1, and thus, is reported as a detected concentration. Methylene chloride was detected for several of the analyses and

TABLE 4.27
SITE 4 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (u	PRGs	Detection Limit	SB1-2.5-4.5	SB1-6.5-9	SB2-2.5-4.5	SB2-6.5-9	SB3-2.5-4.5	SB3-6.5-9	SB4-2.5-4.5	SB4-6.5-9	duplicate (a) SB4-9.0-11
VOCs (SW8240) (µg/kg)*											
Dilution Factor	--	--	1	1	1	1	1	1	1	1	1
Methylene Chloride	85,300 c	5.0	4J	7U	3J	6U	6U	6U	9U	6U	2J
Acetone	2.7E+07 nc	10.0	58	10U	16U	13U	12U	13U	19U	12U	15U
2-Butanone	.62E+08 n	10.0	14U	13U	3J	13U	12U	13U	17U	3J	13U
Carbon Disulfide	2.7E+07 nc	10.0	14U	13U	16U	13U	12U	13U	17U	12U	2J
Toluene	5.4E+07 nc	5.0	2J	7U	7J	2J	4J	3J	9U	3J	5J
Ethylbenzene	2.7E+07 nc	5.0	7U	7U	25J	6U	6U	6U	9U	6U	6U
Total Xylenes	5.4E+08 nc	5.0	2J	7U	40J	6U	6U	6U	9U	6U	6U
SVOCs (SW8270) (µg/kg)*											
Dilution Factor	--	--	1	1	5	1	1	1	1	1	1
2,4-Dimethylphenol	5.4E+06 nc	330.0	460U	440U	1200J	420U	380U	420U	560U	410U	420U
Diethylphthalate	.16E+08 n	330.0	1800	440U	2600U	420U	380U	420U	560U	410U	420U
Di-n-Butylphthalate	2.7E+07 nc	330.0	460U	440U	2600U	420U	140J	420U	120J	410U	540
TRPH (E418.1) (mg/kg)*											
Results	na	10.0	14U	13U	1600	10J	12U	13U	10U	12U	13U

TABLE 4.27 - Continued
SITE 4 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB5-5-7	duplicate (a) SB5-7-9	SB6-2.5-4.5	SB6-6.5-8.5	SB7-4.5-6.5	SB8-0.5-2.5	SB8-4.5-6.5	SB9-2.5-4.5	B9-4.5-6.
VOCs (SW8010/8020) (µg/kg)*											
Dilution Factor	--	--	1	1	1	1	1	1	1	1	1
Toluene	.4E+07 n	1.0	1U	1U	1U	1U	1U	2.6U	2.5U	2.5U	2.5U
Ethylbenzene	2.7E+07n	1.0	1U	1U	1U	1U	1U	2.6U	2.5U	2.5U	2.5U
Total Xylenes	5.4E+08n	1.0	1U	1U	1U	1U	1U	2.6U	2.5U	2.5U	2.5U
SVOCs (SW8270) (µg/kg)*											
Dilution Factor	--	--	1	1	1	1	1	1	1	1	1
2,4-Dimethylphenol	.4E+06 n	330.0	520U	550U	480U	410U	410U	430U	420U	410U	420U
Diethylphthalate	2.16E+08 n	330.0	520U	550U	480U	410U	410U	430U	420U	410U	420U
Di-n-Butylphthalate	.7E+07 n	330.0	520U	550U	480U	410U	410U	430U	420U	410U	420U
TRPH (E418.1) (mg/kg)*											
Results	na	10.0	60	17U	80	10U	16	13U	13U	10U	13U

TABLE 4.27- Continued
SITE 4 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (units)	PRGs	Detection Limit	SB1-2.5-4.5	SB1-6.5-9	SB2-2.5-4.5	SB2-6.5-9	SB3-2.5-4.5	SB3-6.5-9	SB4-2.5-4.5	SB4-6.5-9.0	duplicate (a) SB4-9.0-11.0
PPMs (mg/kg)*											
Antimony	108 nc	1.1	R	R	1.8UJ	1.4UJ	1.3UJ	1.4UJ	2.0UJ	1.4UJ	1.4UJ
Arsenic	0.366 c	2.0	***6.8J***	***4.2J***	***45.3J***	***5.7J***	***21.3J***	***129J***	***37.3J***	***17.1J***	***11.4J***
Beryllium	0.149 c	0.33	***0.56J***	***0.63***	***1.1***	***0.41J***	***0.44J***	***0.68***	***0.74J***	***0.46J***	***0.43J***
Cadmium	135 nc	1.0	0.23UJ	0.21UJ	0.82J	0.24UJ	0.22UJ	0.24UJ	0.79J	0.23UJ	0.23UJ
Chromium	1,350 nc	2.0	15.9J	18.6J	32.9	11.1	12.3	18.7	17.2	13.1	11.7
Copper	10,800 nc	2.0	24.9	30.4	57.8	20.3	23.4	37.8	103	26.4	41.2
Lead	na	2.0	21.7	25.4	102	16.1	17.9	38.9	99.2	18.8	18.2
Mercury	81 nc	0.02	0.02UJ	0.02UJ	0.04J	0.02UJ	0.02UJ	0.02UJ	0.03UJ	0.02UJ	0.02UJ
Nickel	5,400 nc	3.0	13.0	13.9	20.7	8.9	9.4	13.5	46.2	10.5	9.4
Thallium	na	0.39	R	R	0.50UJ	0.40UJ	0.36UJ	0.39UJ	0.72J	0.38UJ	0.38UJ
Zinc	81,000 nc	1.0	50.1J	76.7J	106J	44.8J	46.9J	59.0J	48.4J	53.5J	53.8J

TABLE 4.27- Continued
SITE 4 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

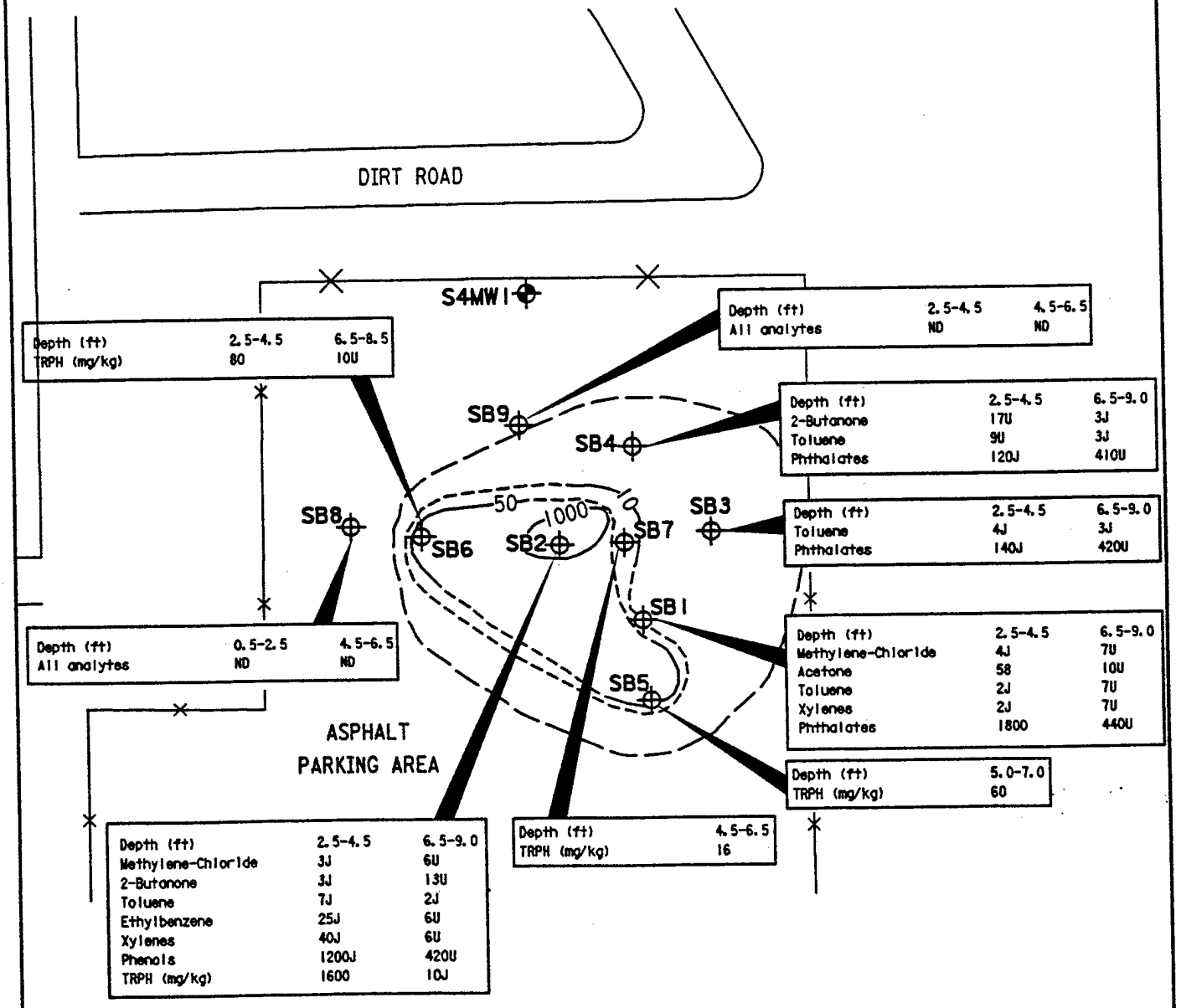
Parameter (uni	PRGs	Detection Limit	SB5-5-7	uplicate (a) SB5-7-9	SB6-2.5-4.5	SB6-6.5-8.5	SB7-4.5-6.5	SB8-0.5-2.5	SB8-4.5-6.5	SB9-2.5-4.5	SB9-4.5-6.5
PPMs (mg/kg)*											
Antimony	108 nc	1.1	1.8UJ	2.6J	1.7UJ	1.4UJ	1.5UJ	2.9J	1.3UJ	2.8J	1.8UJ
Arsenic	0.366 c	2.0	***4.7J***	***4.7J***	***25.7J***	***35.9J***	***5.8J***	***59.6J***	***8.2J***	***11.9J***	***7.5J***
Beryllium	0.149 c	0.33	***0.38J***	***0.36J***	***0.84***	***0.43J***	***0.34J***	***0.79***	***0.21J***	***0.53J***	***0.39J***
Cadmium	135 nc	1.0	0.30UJ	0.33UJ	0.28UJ	0.24UJ	0.24UJ	0.64	0.29J	0.46J	0.46J
Chromium	1,350 nc	2.0	7.7	6.3	17.2	11.6	10.1	20.0J	8.6J	14.1J	10.7J
Copper	10,800 nc	2.0	29.4	35.8	50.2	28.8	14.6	36.6	15.8	33.4	21.6
Lead	na	2.0	15.9	14.0	49.1	17.1	16.1	12J	7.5J	5.8J	5.5J
Mercury	81 nc	0.02	0.02UJ	0.02UJ	0.02UJ	0.02UJ	0.02UJ	0.02UJ	0.02UJ	0.02UJ	0.02UJ
Nickel	5,400 nc	3.0	8.1	7.4	17.1	9.5	7.5	16.4	7.2	12.6	9.1
Thallium	na	0.39	0.50UJ	0.93UJ	0.84UJ	0.72UJ	0.70UJ	0.7UJ	0.69UJ	0.65UJ	0.66UJ
Zinc	81,000 nc	1.0	42.2J	41.1J	74.0J	52.7J	38.4J	76.5J	31.5J	62.2J	46.6J

(a) Blind duplicate from the preceding sampling interval.
***** Analyses performed by ES-Berkeley Laboratory.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
R Data are rejected and were not reported.
Note: Concentrations exceeding Preliminary Remediation Goals (PRGs) are shown in bold italics, nc - noncarcinogen, c - carcinogen na - not available.
Note: PRG values greater than five digits are in scientific notation.

FINAL

ORGANIC COMPOUNDS DETECTED IN SOIL WITH ISOCONCETRATION OF TRPH - SITE 4

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:

Concentrations are in ug/kg for soil, except where noted.
J - Concentration is estimated
U - Concentration not present above detection limit
ND - Not detected above detection limits

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FIGURE 4.45

is reported since it was not detected in associated method blanks. However, both acetone and methylene chloride still could be lab contaminants. These compounds would not likely be associated with the contaminants detected in Site 4 soils that have suspected residence times of 20+ years.

In summary, most contamination at Site 4 occurred at the center of the site and was present in silt and organic silt beneath fill at the 2.5- to 4.5-foot intervals of the soil borings. Organic compounds associated with petroleum were present at minor concentrations in subsurface soils at Site 4. One exception was the TRPH concentration of 1,600 mg/kg at SB2. Not detected were the PNA semivolatile burn by-products that would be expected at a fire training area that reportedly was used as extensively as Site 4. According to Howard (1989), these chemicals have a high propensity to sorb to organic matter in soil, and as a result, would be expected to be more persistent in the subsurface than the other petroleum constituents detected in Site 4 soils. Since phthalates (common lab contaminants) were not detected in method blanks or field blanks, their presence in site soils may be related to the disposal of plastics, resins, or varnishes. Phthalates are generally used as plasticizers and are associated with plastics manufacturing (Howard, 1989).

Metals. Metals detected in soil samples at Site 4 exhibit a wide range of concentrations (Table 4.27). The concentrations of most metals at Site 4 were generally higher than concentrations in background soil samples collected from BGMW1 and BGMW2 (Tables 4.4 and 4.5). However, background values for means of comparison could not be adequately established with this limited number of background soil samples. Therefore, for the purposes of comparison and graphical presentation, and to better visualize the location and spatial distribution (at what depths and in what stratigraphic units) of the relatively higher metals concentrations in site soil, a site-specific comparative value concentration for each individual metal was established. The comparative value is defined as the mean plus one standard deviation of the total site soil sample population for that particular metal. This methodology is not intended to select contaminants of concern or to imply risk. Comparative values for the metals consistently detected at the site are presented in Table 4.28, and concentrations of the metals at a given sample location that are higher than their comparative values are depicted in Figure 4.46. Concentrations of these metals that are below their comparative values in other sampling intervals of the same soil boring are also shown on the figure for comparison.

Seven metals (arsenic, beryllium, chromium, copper, lead, nickel, and zinc) were present above the method detection limit in all analyzed samples and two field duplicates, and mean plus one standard deviation comparative values were determined for these metals. Cadmium was present in six samples and a mean plus one standard deviation comparative value was determined for this metal. Antimony was only present in three samples, and mercury and thallium were only detected in one sample. Consequently, mean plus one standard deviation comparative values for these metals were not determined. However, these metals were not detected in background soil at BGMW1. Concentrations of selenium and silver were below the analytical method detection limits

TABLE 4.28
SITE 4 - MEAN AND STANDARD DEVIATION OF METALS DETECTED IN SOIL
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

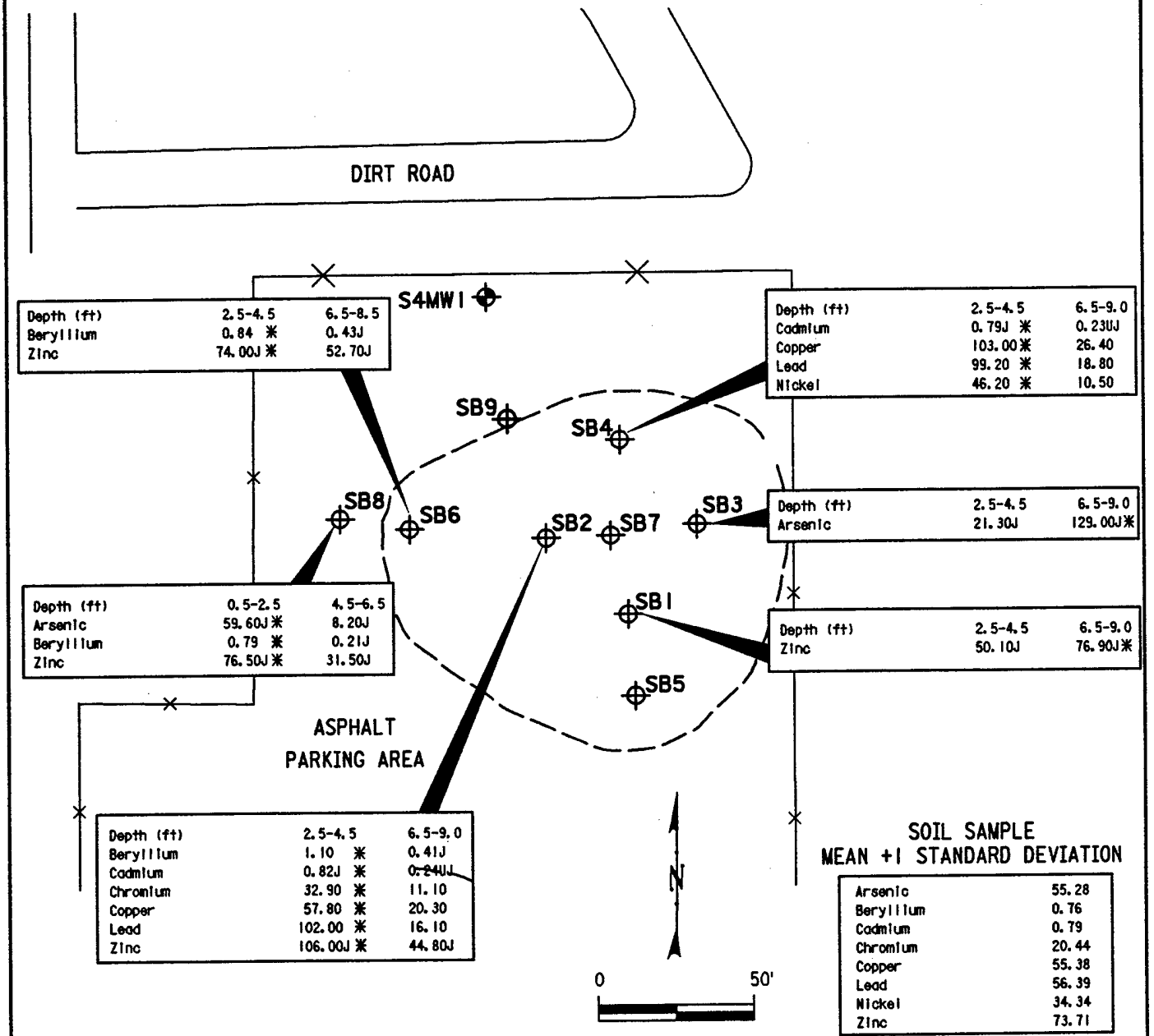
Parameter	Range (mg/kg)	Mean	Std. Dev.	Mean + Std. Dev	# of Samples
Arsenic	4.20-129.00	24.56	30.72	55.28	18
Beryllium	0.21-1.10	0.54	0.22	0.76	18
Cadmium	0.29-0.82	0.58	0.21	0.79	6
Chromium	6.30-32.90	14.32	6.12	20.44	18
Copper	14.60-103.00	35.08	20.30	55.38	18
Lead	5.5-102.00	27.84	28.55	56.39	18
Nickel	7.20-46.20	18.19	16.15	34.34	18
Zinc	31.50-106	55.80	17.91	73.71	18

Note: Mean and standard deviation were not calculated for antimony, mercury, and thallium because these elements were not detected in enough samples to determine the mean standard deviation.

FINAL

METALS DETECTED IN SOIL
SITE 4

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:

The metals concentrations (mg/kg) in soils that exceed the mean plus one standard deviation of the total sample population for that particular metal at the site are shown with an asterisk. Concentrations of these metals in other sampling intervals of the same boring are shown for comparison.

J - Concentration is estimated
UJ - Compound not detected, but the detection limit is estimated

LEGEND

- SOIL BORING
- MONITORING WELL
- SITE LOCATION

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FIGURE 4.46

for all site soils. Data for selenium (SB8 and SB9), thallium (SB1), and antimony (SB1) were unusable. These data and the reason for rejection are provided in Table E.1.2, QA/QC Report No. 1, Appendix E.

The concentrations of six of the eight metals depicted on Figure 4.46 are higher than the site-specific mean plus one standard deviation comparative value for that particular metal in the first sampling interval of SB2. Beryllium was present at a concentration of 1.1 mg/kg, cadmium at 0.82 mg/kg estimated, chromium at 32.9 mg/kg, copper at 57.8 mg/kg, lead at 102 mg/kg, and zinc at 106 mg/kg estimated. These metal concentrations were in clayey silt at the 2.5- to 4.5-foot interval in SB2. The concentrations of these metals in silty sand at the 6.5- to 9.0-foot interval of this soil boring were much lower and are below the comparative values. These concentrations are shown on Figure 4.46 for comparison. Concentrations of these metals between the two sampling intervals show a significant range given the three feet of soil that separates the analytical sample locations within these sampling intervals of SB2.

The concentrations of cadmium, copper, lead, and nickel are equal to or are higher than the mean and standard deviation comparative values for these metals in the first sampling interval of SB4, at concentrations of 0.79 mg/kg estimated, 103 mg/kg, 99.2 mg/kg, and 46.2 mg/kg, respectively. These concentrations were detected in organic silt at the 2.5- to 4.5-foot interval in SB4. The concentrations of these metals in silty sand at the 6.5- to 9.0-foot interval of this soil boring were lower and are below the comparative values.

Concentrations of arsenic, beryllium, and zinc are higher than their mean and standard deviation comparative values in the 0.5- to 2.5-foot interval in SB8, at concentrations of 59.6 mg/kg estimated, 0.79 mg/kg, and 76.5 mg/kg estimated, respectively. The sample was collected in fill material or silty clay. The concentrations of these metals at the 4.5- to 6.5-foot interval of this soil boring were lower and are below the comparative values.

Concentrations of beryllium and zinc are higher than their mean and standard deviation comparative values in the 2.5- to 4.5-foot interval in SB6, at concentrations of 0.84 mg/kg and 74 mg/kg estimated, respectively. The sample was obtained in organic silt. The concentrations of these metals in silty sand at the 6.5- to 8.5-foot interval are below the comparative values.

The concentration of arsenic is higher than the mean and standard deviation comparative value in the 6.5- to 9.0-foot interval in SB3, at a concentration of 129 mg/kg estimated. The native soil is silty clay at this sampling interval. The concentration of this metal in silt at the 2.5- to 4.5-foot interval is below the comparative value.

The concentration of zinc is higher than the mean and standard deviation comparative value in the 6.5-to 9-foot interval in SB1, at a concentration of 76.7 mg/kg estimated. The sample was collected in clayey silt. The concentration of this metal in silty clay at the 2.5- to 4.5-foot interval is below the comparative value.

Samples from soil borings SB5, SB7, and SB9 did not contain metal concentrations that are higher than the comparative values for the ranges of individual metals at the site.

The contrast in metals concentrations at the separate sampling intervals within each of the soil borings is substantial. All metals concentrations that are higher than the site-specific comparative values for these metals were unique to only one of the two sampling intervals of the individual soil borings. Therefore, the sitewide occurrence of higher metals concentrations appears to be localized and limited to specific depth intervals and sediments.

In summary, metals were most prevalent and concentrations were higher at only one of the two sampling intervals of soil borings SB1, SB2, SB3, SB4, and SB6. However, these metal concentrations do not necessarily indicate that the soils have been impacted by Base practices, but rather, may reflect the variation of naturally-occurring levels resulting from depositional and hydrogeochemical processes. For instance, soil at SB8 exhibited comparatively higher metal concentrations for three metals, but organic chemicals were not detected. Soil boring SB8 is considered to be outside of the area impacted by organic contamination.

4.6.2.4 Groundwater Contamination Assessment

One groundwater sample was collected in February 1993 from the downgradient monitoring well S4MW1. The groundwater sample was analyzed for VOCs, SVOCs, and PPMs. Target compounds included in each of the analyses and the detection limits for the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

In August 1995, groundwater from S4MW1 was resampled and analyzed for VOCs, SVOCs, and PPMs. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.2, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 2, Appendix E.

Field measurements of specific conductance, pH, and temperature were made on the samples collected from S4MW1 at the time of sample collection. These measurements are provided in Tables 4.8 and 4.9. Specific conductance measured a relatively low 478 microsiemens/cm in February 1993 and again measured a low 738 microsiemens/cm in August 1995. This specific conductance is significantly out of range relative to the other groundwater samples collected from monitoring wells at the Base, but is considered to be accurate since the values were essentially duplicated. The specific conductance of groundwater in this well at the time of well development, approximately one week prior to sampling (1993), was also nearly the same as the conductance of the sample. The pH of the samples were 7.8 and 7.7, respectively, between the sampling events.

Analytical results of the groundwater samples collected from S4MW1 are provided in Tables 4.29 and 4.30. MCLs for the detected analytes are shown in the tables. The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 4 groundwater are shown on Figure 4.47. Two VOCs, toluene and total xylenes, were detected in the groundwater sample collected in February 1993 from monitoring well S4MW1. Toluene and total xylenes were present at the concentrations of 0.7 µg/L estimated and 7.7 µg/L, respectively. These concentrations did not exceed MCLs as shown in Table 4.29.

No organic compounds were detected in the groundwater sample collected in August 1995 from S4MW1.

Metals. Only arsenic was present above the method detection limit in the groundwater sample collected in February 1993, as depicted on Figure 4.48. The concentration of 71.2 µg/L estimated exceeded the MCL.

Arsenic, chromium, and copper were detected in the groundwater sample collected in August 1995 from S4MW1. The arsenic concentration of 90 µg/L again exceeded the MCL.

Dissolved arsenic in downgradient groundwater is probably not related to leaching of arsenic from Site 4 soils. Arsenic was detected at a maximum soil concentration of 129 mg/kg in the 6.5- to 9-foot interval of SB3. The depth of this soil sample corresponds to a level below the water table at the time of groundwater sampling. This may indicate that the soil beneath the water table is a source of arsenic, or that the deeper soil is being impacted by the widespread arsenic in shallow groundwater. Elevated levels of arsenic in shallow groundwater occur in the regional area of the Base and the Base proper as discussed in subsection 2.5.1.3 and subsection 4.11.

4.6.3 Site 4 - Conclusions

Petroleum associated organic compounds and phthalates were present at minor concentrations in subsurface soils at Site 4. Organic compounds primarily were detected in silt and organic silt beneath fill at the 2.5- to 4.5-foot intervals of SB1, SB2, and SB6 (Figure 4.45). The highest concentration of an organic compound was TRPH at 1,600 mg/kg (SB2). PNAs were not detected, but would be expected at this fire training area where abundant native organic material is available as an adsorptive medium. The complete absence of PNAs is not consistent with the site history. The reported fire training practice was to ignite 300 to 500 gallons of fuel, extinguish it, and reburn it to achieve a maximum 70-percent consumption. Occasionally, as much as 1,200 to 1,500 gallons of fuel and other types of flammable liquids were used, including varsol, kerosene, and solvents. Considering this reported fire training regimen and the fate and transport characteristics of PNAs in organic rich soils, PNAs should be more prevalent and persistent than the other petroleum constituents detected in Site 4 soils. Concentrations of organic compounds were compared to PRGs and none of these health-

TABLE 4.29
SITE 4 - GROUNDWATER
ANALYTES DETECTED (February 1993)
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	MCLs	Detection Limit	S4MW1
VOCs (SW8010/8020) (µg/L)*			
Dilution Factor	--	--	1
Toluene	1,000	2.0	0.7J
Xylenes (Total)	10,000	2.0	7.7
SVOCs (SW8270) (µg/L)*			
Results	--	--	ND
PPMs (µg/L)*			
Arsenic	50	1.0	***71.2J***
Chromium	100	2.0	2.9UJ
Copper	1,300	2.0	10.6UJ
Lead	15	2.2	2.7UJ
Zinc	5,000	1.0	6.9UJ

***** Analyses performed by the ES-Berkeley Laboratory.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
ND All analytes were not detected; refer to Table H.1 for compounds and detection limits.
Note: Concentrations that exceed Maximum Contaminant Levels (MCLs) are shown in bold italic.

TABLE 4.30
SITE 4 - GROUNDWATER
ANALYTES DETECTED (August 1995)
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

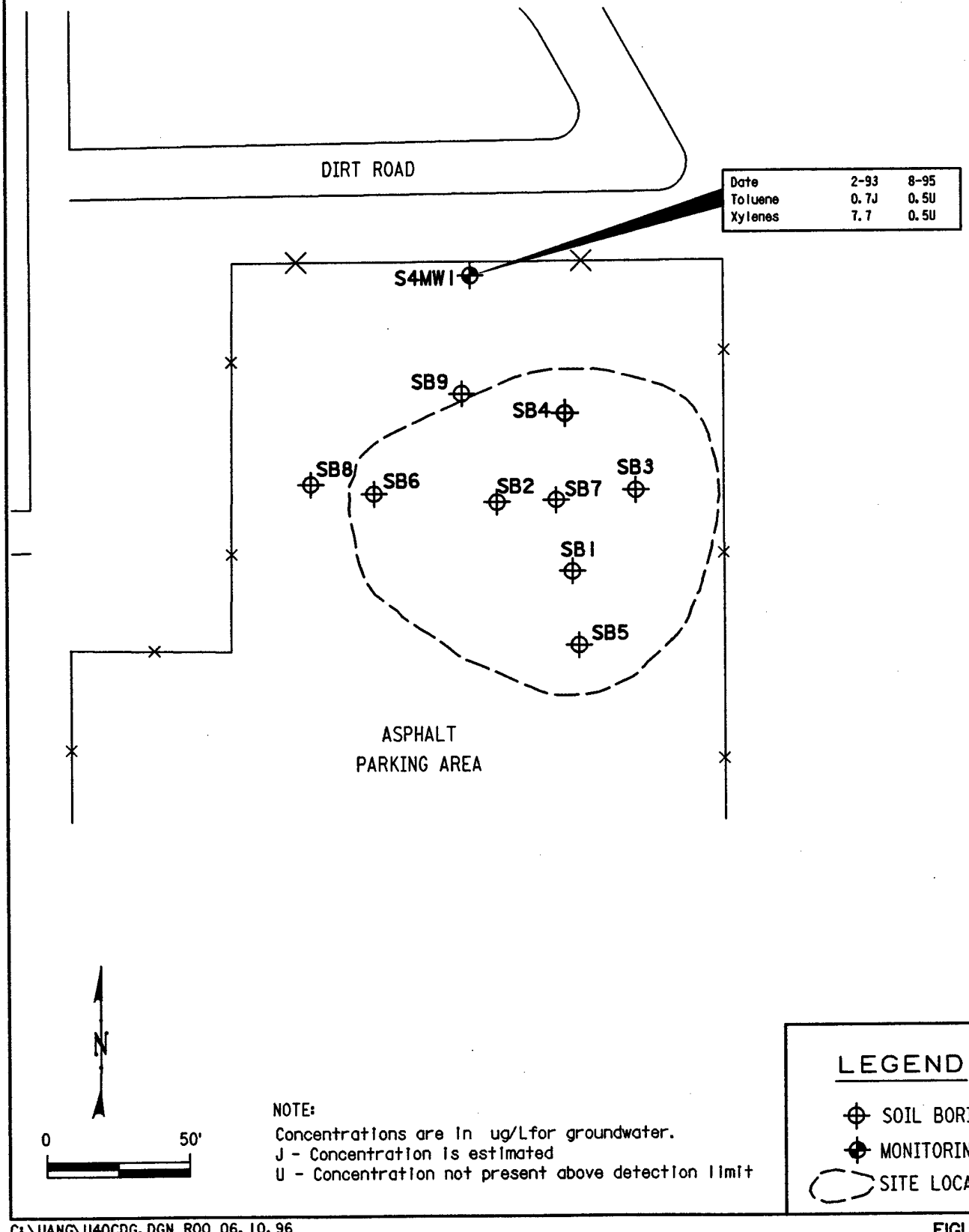
Parameter (method) (units)	MCLs	Detection Limit	S4MW1
VOCs (SW8010/8020) (µg/L)**			
Results	--	--	ND
SVOCs (SW8270) (µg/L)**			
Results	--	--	ND
PPMs (µg/L)**			
Antimony	6	24.0	44U
Arsenic	50	2.0	***90***
Beryllium	na	0.63	0.63U
Cadmium	5	1.0	0.97U
Chromium	100	3.6	4.5
Copper	1,300	2.1	2.7
Lead	15	4.4	0.88UJ
Mercury	2	0.02	0.02UJ
Nickel	100	11.0	11U
Selenium	50	1.2	1.2U
Silver	na	5.5	5.5U
Thallium	2	1.2	1.2UJ
Zinc	5,000	3.6	3.6U

****** Analyses performed by the DataChem Laboratories.
ND All analytes were not detected; refer to Table H.2 for compounds and detection limit
na No MCL exists.
U Compound not present above the detection limit shown.
UJ Compound not detected, but the detection limit is estimated.
Note: Concentrations that exceed Maximum Contaminant Levels (MCLs) are shown in bol

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ORGANIC COMPOUNDS DETECTED IN GROUNDWATER
SITE 4

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

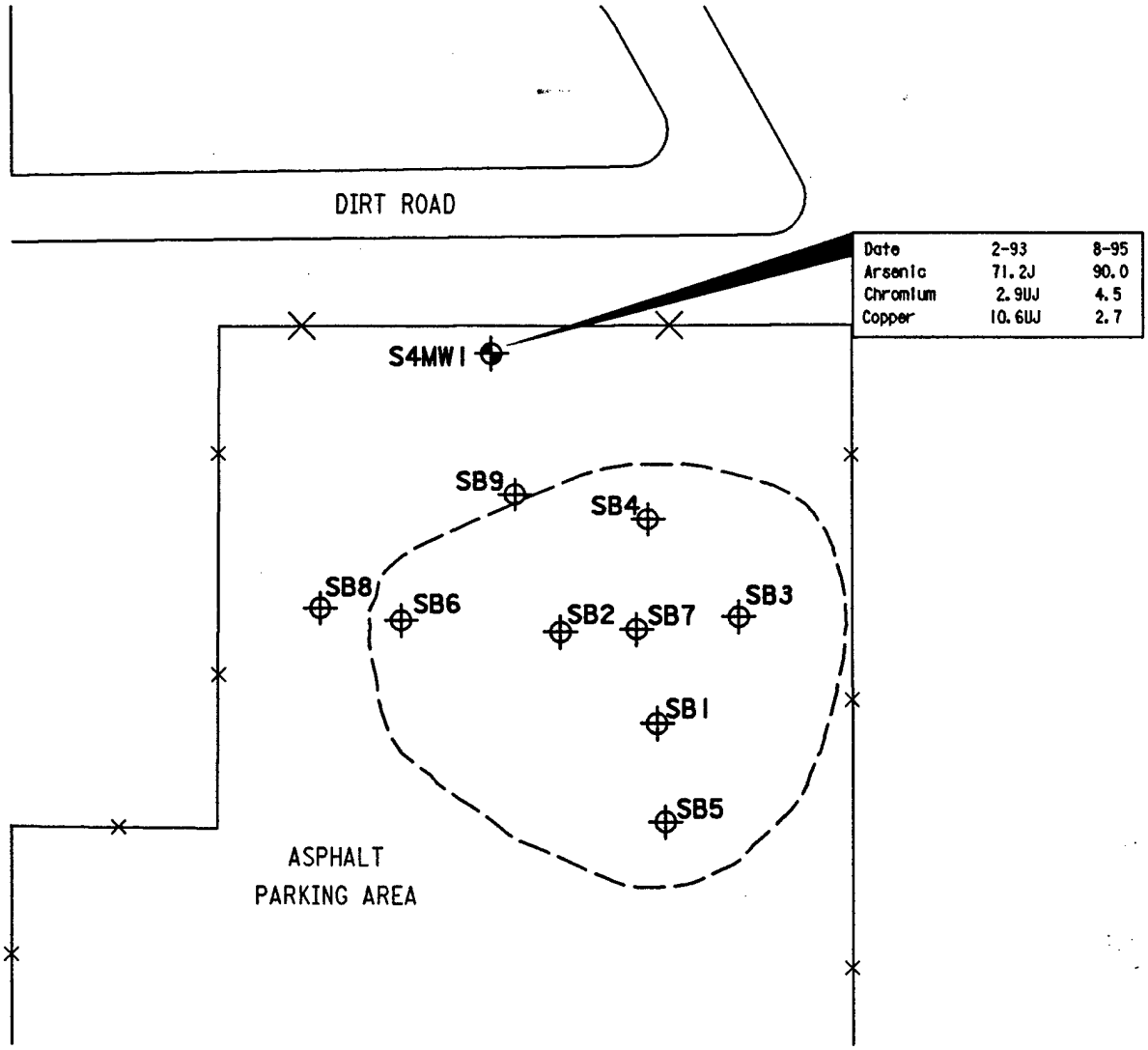


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FIGURE 4.47

METALS DETECTED IN GROUNDWATER
SITE 4

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



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FIGURE 4.4

based risk criteria were exceeded. A PRG was not available for TRPH. The potential concern for soil contamination at this site is considered to be low.

Site-specific higher concentrations of metals in soil were detected at the center of the site, but were also present outside of the area impacted by organic contamination. This may indicate that the metals present in site soil are depositional and that metals at the site may be naturally occurring. Concentrations of arsenic and beryllium exceeded the most stringent human health risk criteria in all Site 4 soil samples. However, the established human health PRGs for these metals were below method detection limits and are impractical given the occurrence of these metals in natural soils.

Toluene and xylenes were the only organic compounds detected in Site groundwater (Figure 4.47). Minor concentrations of these compounds were detected in 1993 and no MCLs were exceeded. Neither compound was detected in the 1995 sampling event.

Concentrations of arsenic exceeding the MCL were detected (both sampling events) in groundwater collected from S4MW1 (Figure 4.48). However, the arsenic detected in downgradient groundwater does not appear to be related to the leaching of Site 4 soils. The highest arsenic concentration in soil occurred at a deeper level below the water table. This may indicate that the deeper site soils are a source of arsenic, or that the soil at this depth is being impacted by the generally widespread arsenic detected in shallow groundwater basewide.

The groundwater flow direction, hydraulic gradient, and flow rate at the site are subject to change (Figures 4.41, 4.42, and 4.43). Groundwater flow was north to northeast during the field effort, toward the City Drain Canal. Based on the observed flow directions, the downgradient monitoring well was adequately placed in the prevailing direction of groundwater flow. In March 1993, groundwater was essentially not flowing between the two monitoring wells used for calculation because of the flat hydraulic gradient.

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4.7 SITE 5 - FIRE TRAINING AREA 2

4.7.1 Field Program

4.7.1.1 Screening Activities

The following activity was conducted at Site 5 during the screening phase of the SI:

- Performance of a soil gas survey.

A soil gas survey was conducted to determine a possible source area and the approximate extent of soil contamination for optimal placement of soil borings.

Soil gas samples were collected at 25 points during the Site 5 soil gas survey. An equidimensional grid pattern with a 50-foot spacing between points was established at the site for the survey. Soil gas samples were collected at approximately 4.5 feet depth BLS at all of the sampling locations. The sampling point locations with total BTEX concentrations and corresponding toluene fractions are identified in Figure 4.49. Analytical results are presented in Table 4.31.

Soil gas samples from Site 5 exhibited minimal BTEX concentrations. Toluene was almost exclusively the only BTEX compound detected at Site 5 sampling locations. Soil gas samples at A2, B1 through B5, C2 through C5, D2, and E1 and E4 contained some total BTEX concentrations. These concentrations range from a maximum of 2.7 ppmv at B1 to less than 0.5 ppmv at five of the soil gas points. The soil gas survey results were inconclusive in delineating a source area of BTEX contamination in the area of the soil gas grid at Site 5.

4.7.1.2 Confirmation and Optional Activities

The following activities were conducted during the confirmation/optional phase of the Site 5 SI:

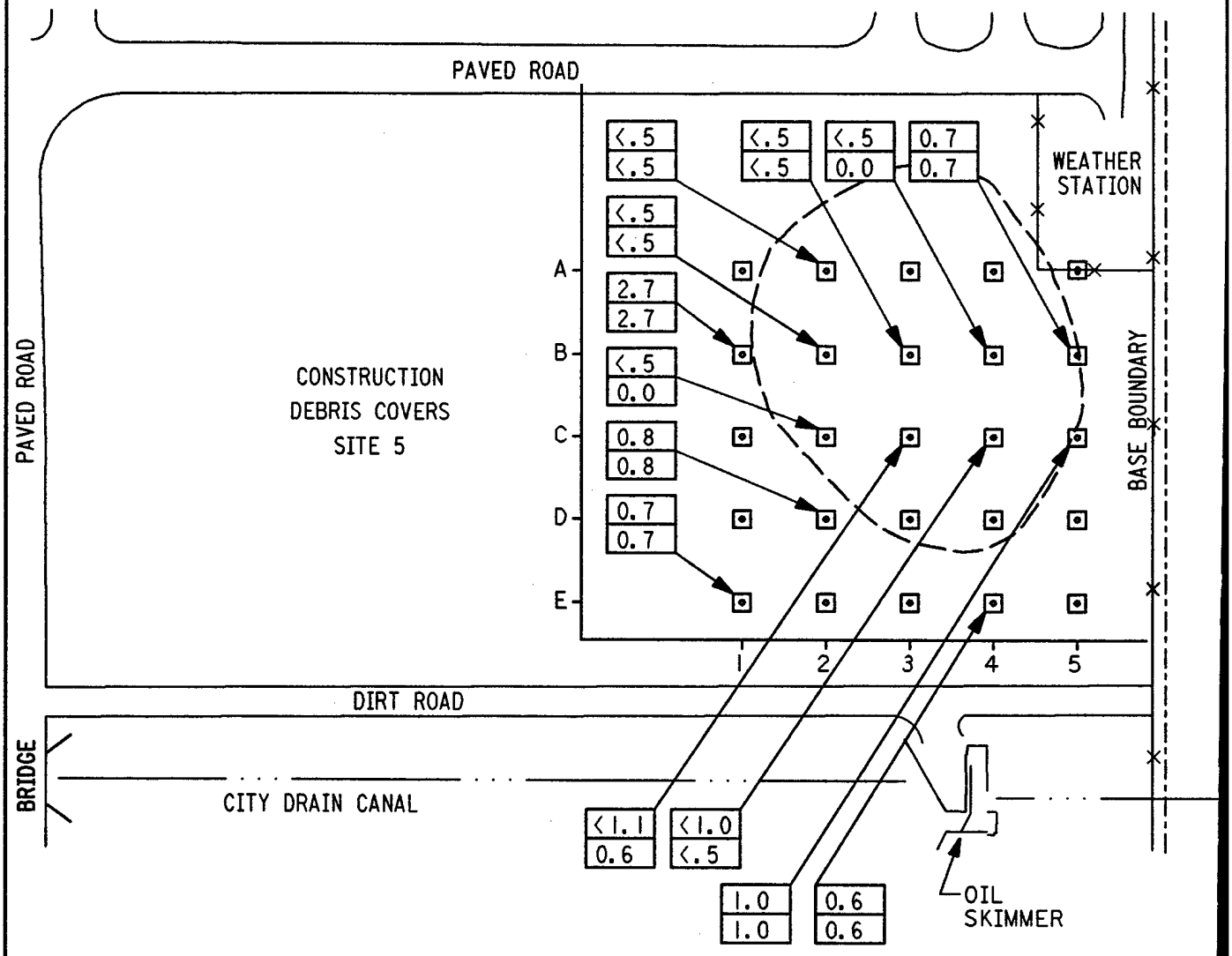
- Advanced seven soil borings;
- Selected and analyzed 14 soil samples;
- Installed one downgradient monitoring well; and
- Collected and analyzed two groundwater samples.

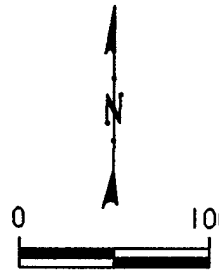
Results of the soil gas survey at Site 5 did not indicate an area of elevated VOC contamination. Therefore, to obtain optimal coverage of the site, seven soil borings were located to form a north to south and an east to west transect across the site. The soil borings (four confirmational and three optional) were placed to evaluate the areal extent of possible soil contamination at the site. Figure 4.50 shows the locations of the soil borings at Site 5. The soil borings were drilled sequentially beginning with soil boring SB1.

Two soil samples from each of the seven soil borings were selected for analysis based on the results of headspace screening and proximity to the water table; COCs are provided in Appendix D. Only minor VOC headspace concentrations were detected in

SOIL GAS SURVEY RESULTS - SITE 5

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH





NOTE: Total BTEX and the corresponding toluene fraction of the total BTEX are shown. Where a less than sign appears, the compounds were detected at less than the GC IDL of 0.5 ppmv.

LEGEND

- 2.7 / 2.7 — Total BTEX (ppmv) / Toluene (ppmv)
- SOIL GAS SAMPLE LOCATION
- FENCE
- SITE LOCATION

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FIGURE 4.4

TABLE 4.31
SITE 5 - SOIL GAS SURVEY RESULTS
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

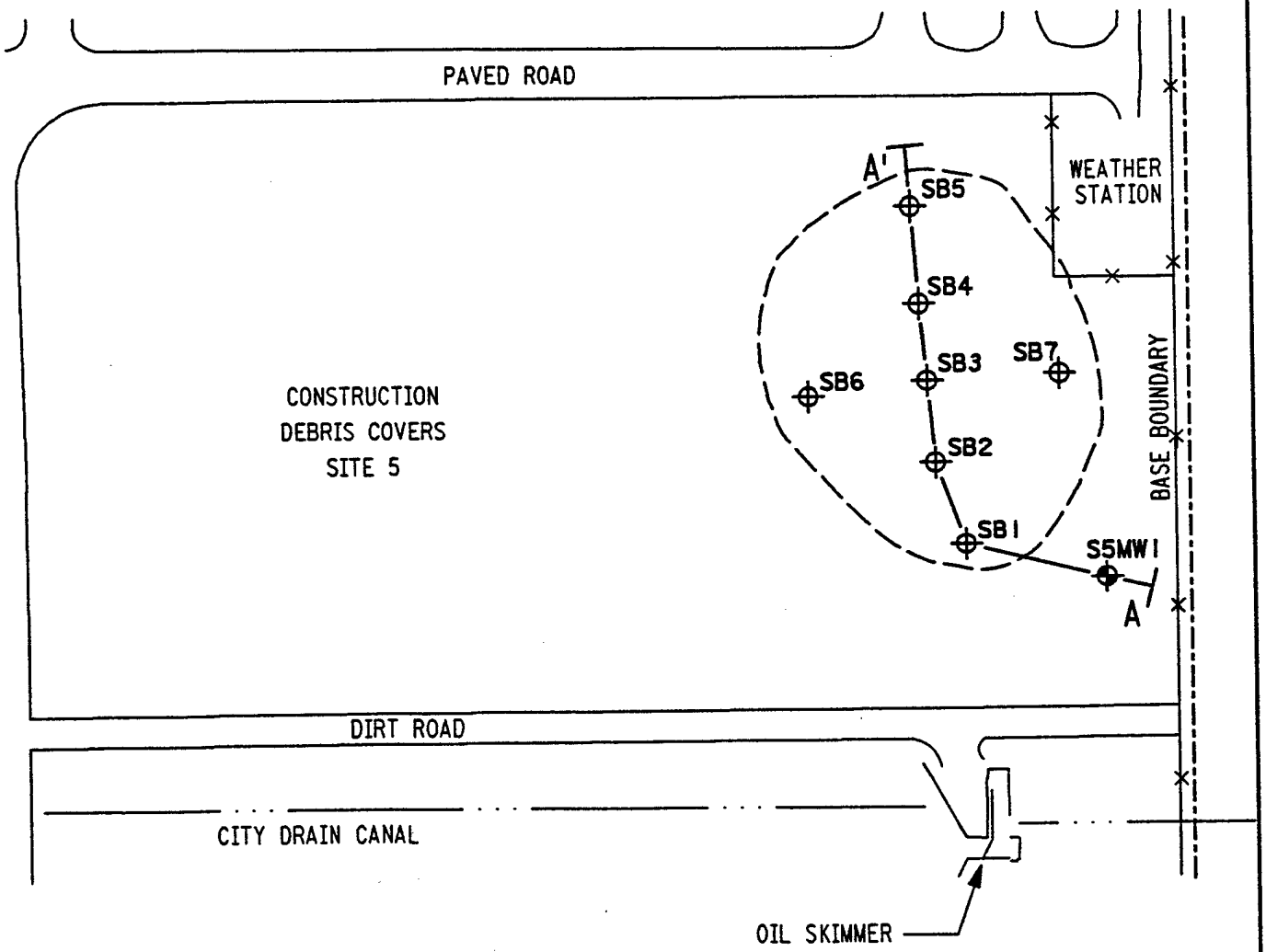
Point	Benzene ppm v	Toluene ppm v	Ethylbenzene ppm v	Xylenes ppm v	Total BTEX ppm v
A1	ND	ND	ND	ND	ND
A2	ND	<0.5	ND	ND	<0.5
A3	ND	ND	ND	ND	ND
A4	ND	ND	ND	ND	ND
A5	ND	ND	ND	ND	ND
B1	ND	2.7	ND	ND	2.7
B2	ND	<0.5	ND	ND	<0.5
B3	ND	<0.5	ND	ND	<0.5
B4	<0.5	ND	ND	ND	<0.5
B5	ND	0.7	ND	ND	0.7
C1	ND	ND	ND	ND	ND
C2	<0.5	ND	ND	ND	<0.5
C3	<0.5	0.6	ND	ND	<1.1
C4	ND	<0.5	<0.5	ND	<1.0
C5	ND	1	ND	ND	1
D1	ND	ND	ND	ND	ND
D2	ND	0.8	ND	ND	0.8
D3	ND	ND	ND	ND	ND
D4	ND	ND	ND	ND	ND
D5	ND	ND	ND	ND	ND
E1	ND	0.7	ND	ND	0.7
E2	ND	ND	ND	ND	ND
E3	ND	ND	ND	ND	ND
E4	ND	0.6	ND	ND	0.6
E5	ND	ND	ND	ND	ND

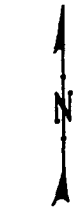
ND - Not detected (BTEX compounds were not observed on chromatograms).
<0.5 - BTEX compounds were observed on chromatograms but were not quantified.

FINAL

SOIL BORING, MONITORING WELL, AND GEOLOGICAL CROSS-SECTION LOCATIONS - SITE 5

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH







NOTE:
S5MW1 was installed January 1993.

LEGEND

- SOIL BORING
- MONITORING WELL
- FENCE
- SITE LOCATION (based on soil results)

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FIGURE 4.50

samples collected during drilling. Groundwater was encountered during drilling at a depth of approximately 7 feet BLS. Sampling intervals, headspace screening results, and the unconsolidated sediments of each boring were logged and recorded. Detailed soil boring descriptions are provided on the soil boring logs in Appendix G. A correlation of the soil BTEX results of field GC screening versus the analytical laboratory is provided in Appendix J.

One downgradient monitoring well, S5MW1, was installed in January 1993, at the location shown in Figure 4.50. The well is screened in the interval from 5.08 feet to 15.08 feet BLS. Well construction details for the Site 5 monitoring well are provided in Table G.1, Appendix G. A well soil boring log with a construction diagram is also provided in Appendix G. Following development, the monitoring well was purged and sampled, and the sample was analyzed for the specified chemical constituents. Well development and sampling forms are provided in Appendix C.

4.7.2 Results of Site Investigation

4.7.2.1 Geology and Hydrogeology

A geological cross-section of Site 5 stratigraphy, at the location shown in Figure 4.50, is presented as Figure 4.51. Site 5 stratigraphy consists of a silty sand, organic silt and clay, sandy or clayey silt, silty sand, and sand, sedimentary sequence beneath fill. The upper 3 feet of material is disturbed soil that is primarily a sand, silt, and clay, with variable amounts of gravel. Beneath the fill is a pale-yellow to olive silty sand approximately 2 feet thick. Below the silty sand is a 1-foot to 5-foot-thick organic black to dark gray silt and clay that contains gastropod shells, roots, and peat material. The organic silt and clay is about 3 feet thick at S5MW1, pinches to about 1 foot thick at SB1, SB2, and SB3; and thickens to about 3 feet to 5 feet at SB4 and SB5. This organic layer is not present at soil borings SB6 and SB7. Lenses of clayey silt and sandy silt are present beneath the organic layer at soil borings SB1, SB2, SB3, and SB4. At a depth of approximately 6 feet to 8 feet BLS an olive-gray silty sand is present at most of the soil boring locations. This silty sand grades into an olive-gray to dark gray fine to coarse sand at a depth of 8 to 10 feet. The sand is comprised of quartz, feldspar, mica, and ferromagnesian silicate minerals of granitic provenance. The sand vertically terminates at a clay layer at an approximate depth of 20 feet BLS. The stratigraphically lower sand was deposited in a relatively higher-energy depositional environment. The upper 9 feet to 10 feet of silt, clay, and silty sand is typical of lower-energy meandering stream-floodplain-marsh deposition.

Basewide groundwater levels were measured on 28 December 1992, 16 March 1993, and 19 July 1995 to determine hydraulic gradients and groundwater flow directions at the sites (Figures 4.1, 4.2, 4.3). Extrapolated groundwater contour maps of the Site 5 area for these respective dates are provided as Figures 4.52, 4.53, and 4.54. The purpose of the 28 December 1992 and 19 July 1995 measurements was to establish groundwater flow directions prior to well placement. The purpose of the 16 March 1993 round of groundwater measurements was to establish hydraulic gradients and flow directions for

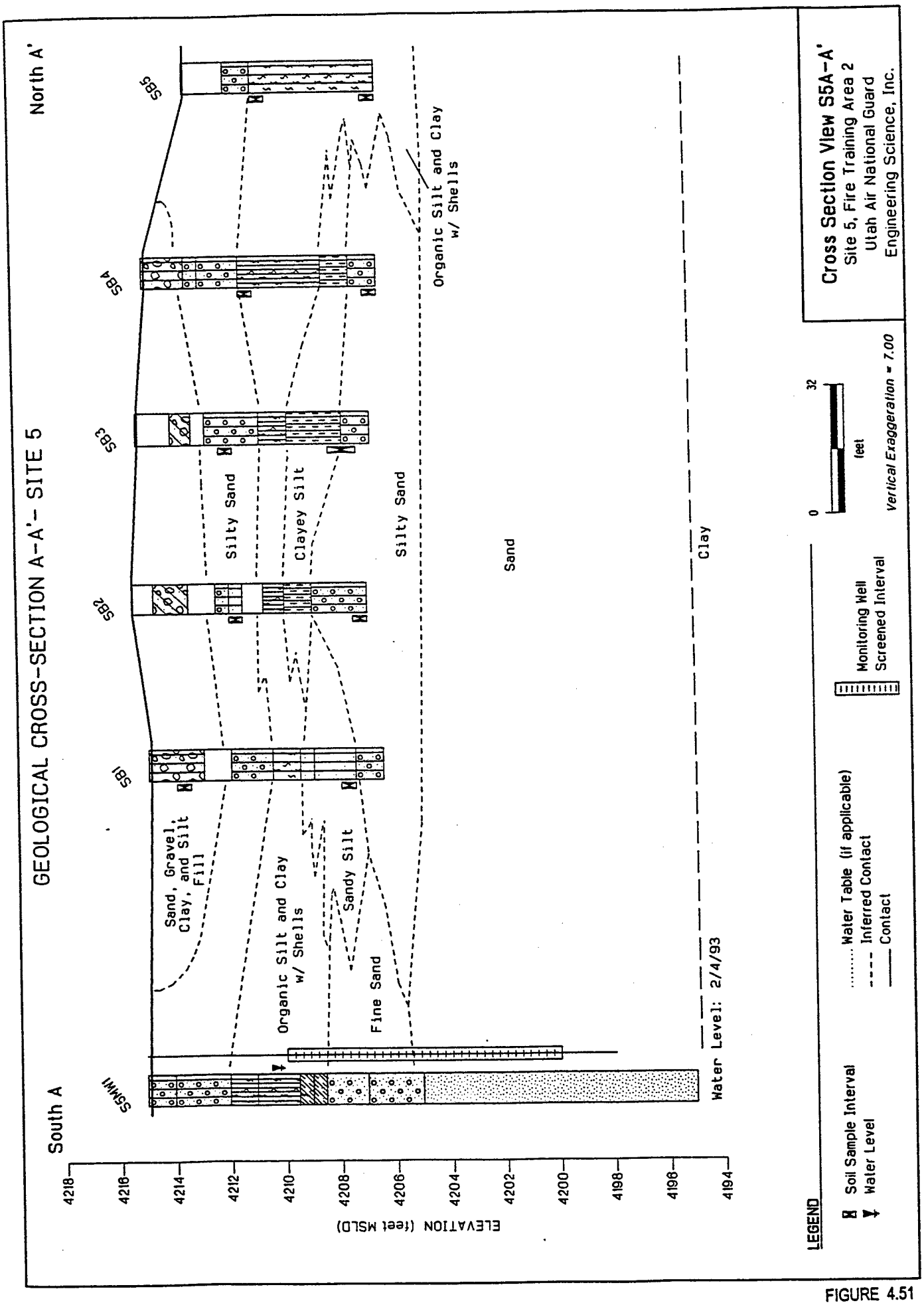
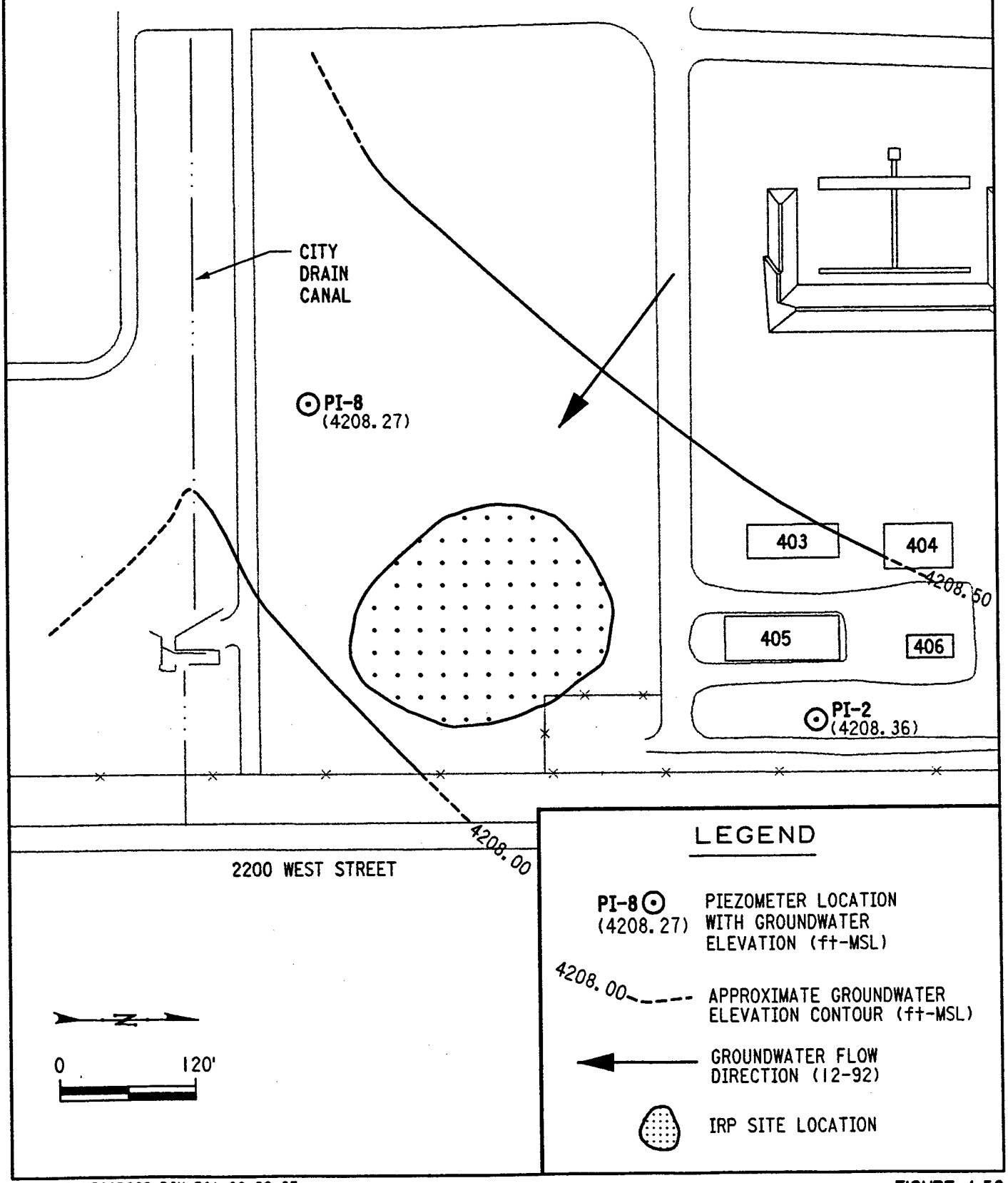

GEOLOGICAL CROSS-SECTION A-A'- SITE 5
South A
North A'
SB5
SB4
SB3
SB2
SB1
SSMW1
Sand, Gravel, Clay, and Silt Fill
Organic Silt and Clay w/ Shells
Sandy Silt
Fine Sand
Silty Sand
Clayey Silt
Silty Sand
Organic Silt and Clay w/ Shells
Sand
Clay
Water Level: 2/4/93
ELEVATION (feet MSLD)
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
4196
4194
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well Screened Interval
0
32
feet
Vertical Exaggeration = 7.00
Cross Section View S5A-A'
Site 5, Fire Training Area 2
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.51

FINAL

GROUNDWATER GRADIENT MAP - SITE 5
28 DECEMBER 1992

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



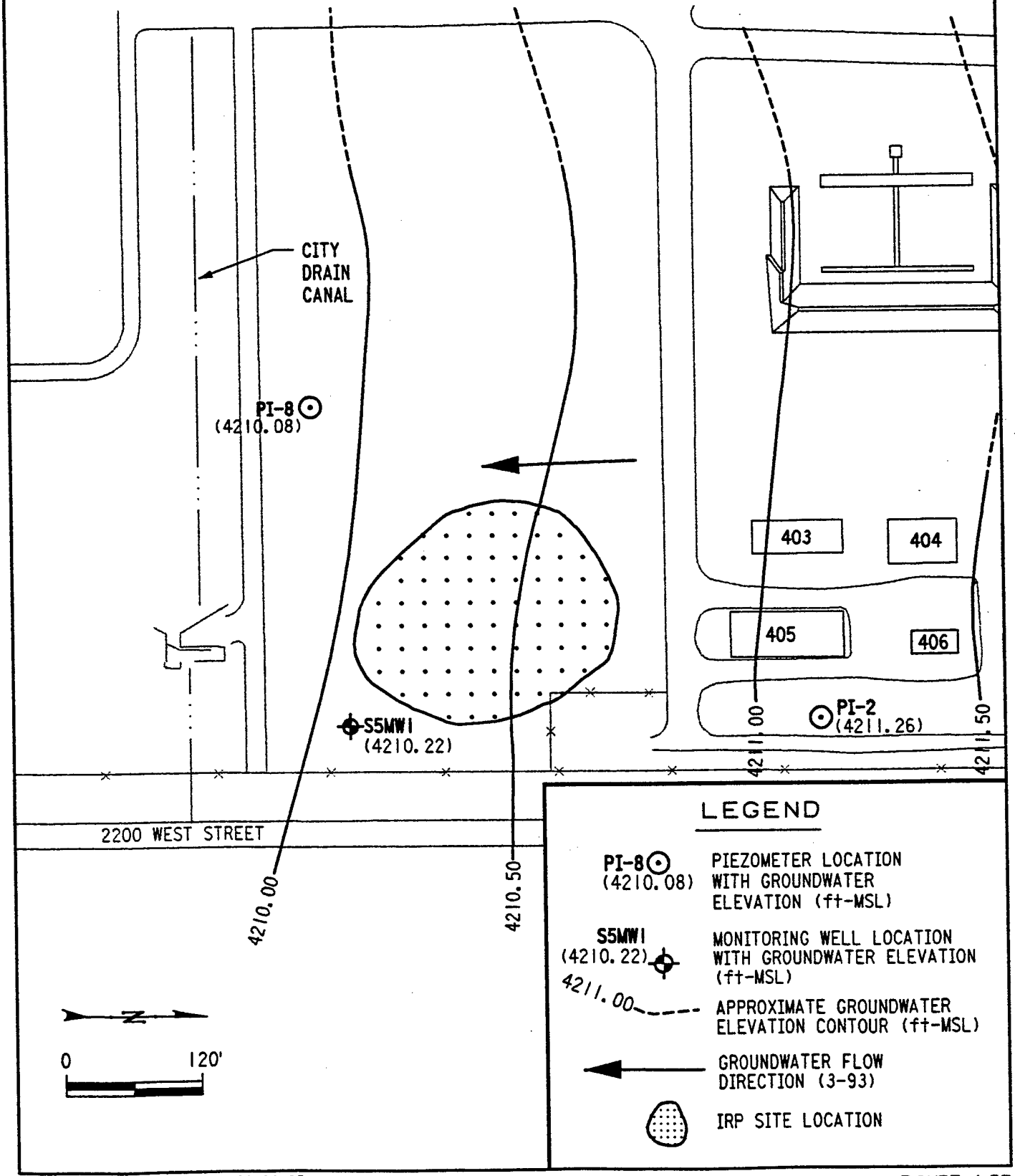
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FIGURE 4.52

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GROUNDWATER GRADIENT MAP - SITE 5
16 MARCH 1993

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



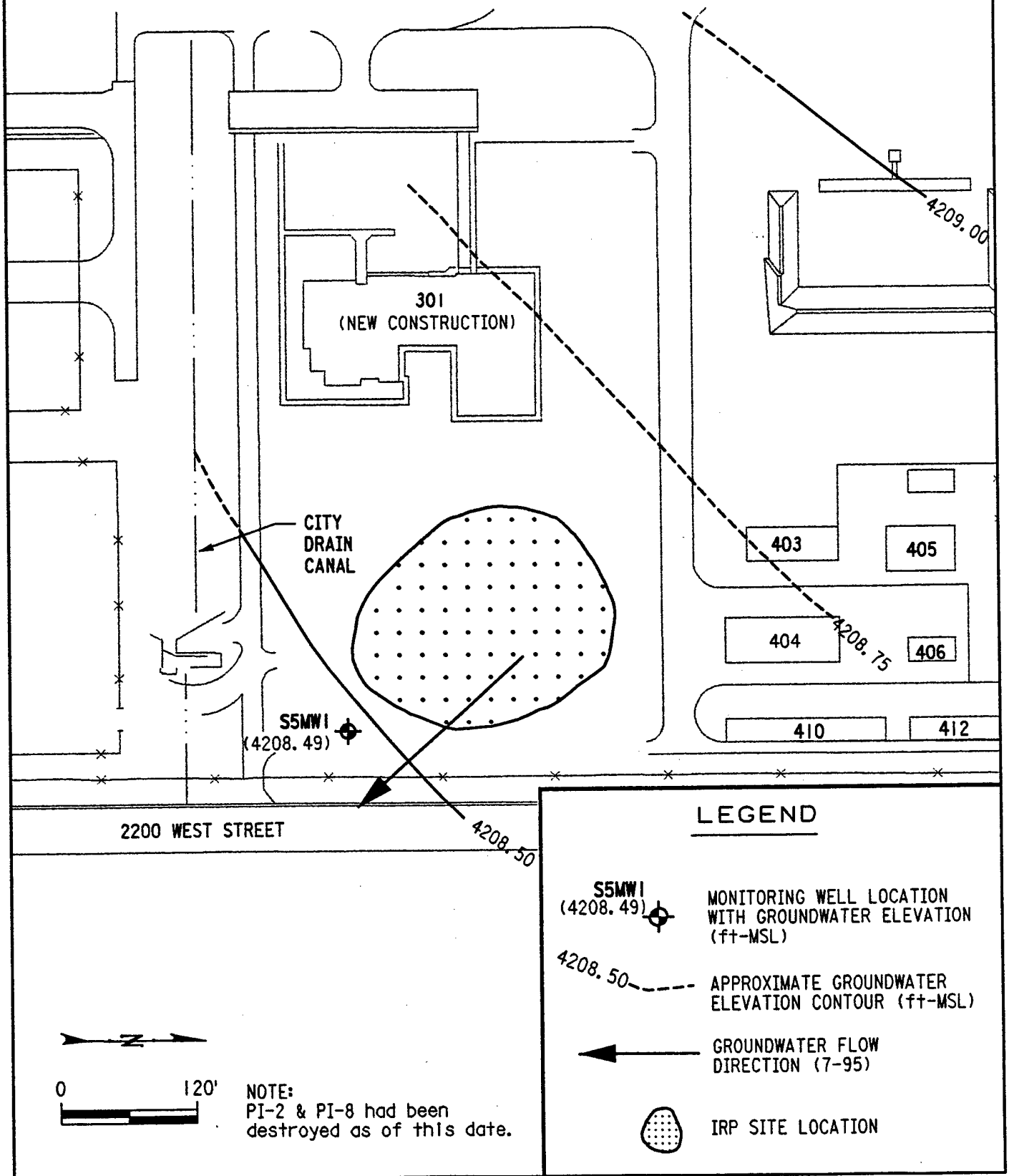
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FIGURE 4.53

FINAL

GROUNDWATER GRADIENT MAP - SITE 5
19 JULY 1995

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



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FIGURE 4.54

groundwater flow rate calculations at the sites. March 1993 was the only instance when all of the site monitoring wells and basewide piezometers were measured on the same day during the primary 1992-93 investigation of Sites 1 through 7. As shown in Figure 4.53, the groundwater flow direction at Site 5 was to the south on this date. The southerly flow direction on 16 March 1993 represents a change from the southeasterly flow direction at the site inferred from the 28 December 1992 groundwater gradient (Figure 4.52). The groundwater flow direction also was southeasterly on 19 July 1995 (Figure 4.54). For a comparison of groundwater levels in basewide piezometers and monitoring wells see Tables 4.1, 4.2, and 4.3. The variation in groundwater elevations, hydraulic gradients, and flow directions among these dates is probably due to the shallow aquifer's response to seasonal groundwater recharge and discharge. Therefore, the local hydraulic flow conditions at this site and the other sites is considered to be seasonally variable.

4.7.2.2 Groundwater Flow Calculations

The calculated groundwater flow rate and velocity at Site 5 were not established because only one monitoring well (S5MW1) was installed at this site. The hydraulic conductivity of the silt and sand in the screened interval of S5MW1 was estimated from a slug test at the well to be 21.28 ft/day. However, based on this hydraulic conductivity and the observed groundwater gradients at this portion of the Base, the rate of groundwater flow at Site 5 is anticipated to be relatively high. Values of hydraulic conductivity are provided in Table I.1, Appendix I.

4.7.2.3 Soil Contamination Assessment

Soil samples were collected from seven soil borings at Site 5. The locations of the analytical samples and the types of soils from which the analytical samples were collected are shown on the geological cross-section of Figure 4.51 and the soil boring logs in Appendix G. The soil samples and one field duplicate were analyzed for VOCs, SVOCs, and TRPH. Target compounds included in each of the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

The analytical results for organic compounds detected in Site 5 soil samples are provided in Table 4.32. The detection limits shown vary slightly due to matrix effects and dry weight calculations. Field duplicates are shown after their associated samples in the table. Soil PRGs are also provided in the table. The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 5 soils are shown on Figure 4.55. PNAs [phenanthrene, pyrene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, fluoranthene, benzo(a)pyrene, ideno(1,2,3-cd)pyrene, and benzo(g,h,i,)perylene] have been grouped together for presentation; the values shown on the figure represent the sum of the compounds in the group. Di-n-butylphthalate and

TABLE 4.32
SITE 5 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
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SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB1-0-2	SB1-6-8.5	SB2-2-4	SB2-6-8.5	SB3-2-4	SB3-6-8.5	duplicate (a) SB3-8.5-11.0	SB4-2-4
VOCs (SW8240) (µg/kg)*										
Dilution Factor	--	--	1	1	1	1	1	1	1	1
Methylene Chloride	85,300 c	5.0	2J	3J	6U	7U	6U	7U	7U	7U
Acetone	2.7E+07 nc	10.0	11U	13U	14	4J	3J	5J	5J	7J
Carbon Disulfide	2.7E+07 nc	10.0	11U	13U	1J	13U	11U	13U	13U	13U
2 - Butanone	1.62E+08 n	10.0	11U	13U	4J	13U	11U	13U	13U	13U
4-Methyl-2-pentanone	1.35E+07 n	10.0	11U	13U	2J	13U	11U	13U	13U	13U
Toluene	5.4E+07 nc	5.0	6	6U	6	7U	6U	3J	4J	10J
Total Xylenes	5.4E+08 nc	5.0	3J	6U	3J	7U	6U	7U	7U	7U
SVOCs (SW8270) (µg/kg)*										
Dilution Factor	--	--	1	1	1	1	1	1	1	1
Phenanthrene	na	330.0	370U	420U	380U	420U	49J	430U	430U	100J
Pyrene	8.1E+06 nc	330.0	110J	420U	380U	420UJ	120J	430U	430U	150J
Chrysene	19,900 c	330.0	370U	420U	380U	420U	74J	430U	430U	430U
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	370UJ	420U	380U	420U	51J	430U	120J	430U
Benzo(b)fluoranthene	630c	330.0	370U	420U	380U	420U	110J	430U	430U	430U
Benzo(k)fluoranthene	1,330 c	330.0	370U	420U	380U	420U	130J	430U	430U	430U
Fluoranthene	1.08E+07 n	330.0	370U	420U	380U	420U	84J	430U	430U	94J
TRPH (E418.1) (mg/kg)*										
Results	na	10.0	50	13U	20	10U	80	13U	13U	200

TABLE 4.32 - Continued
SITE 5 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB4-6-8.5	SB5-1-3	SB5-5-7	SB6-1-3	SB6-5-7	SB7-1-3	SB7-5-7
VOCs (SW8240, 8010/8020) (µg/kg)*									
Dilution Factor	--	--	1	1	1	1	1	1	1
Methylene Chloride	85,300 c	5.0	2J	7.3U	9.5U	5.8U	8.3U	5.8U	6.6U
Acetone	2.7E+07 nc	10.0	3J	NA	NA	NA	NA	NA	NA
Carbon Disulfide	2.7E+07 nc	10.0	13U	NA	NA	NA	NA	NA	NA
2-Butanone	1.62E+08 nc	10.0	13U	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	1.35E+07 nc	10.0	13U	NA	NA	NA	NA	NA	NA
Toluene	5.4E+07 nc	2.0	3J	2.0U	2.0U	2.3U	3.3U	2U	2U
Total Xylenes	5.4E+08 nc	2.0	2J	2.0U	2.0U	2.8	7.4	2U	2U
TRPH (E418.1) (mg/kg)*									
Results	na	10.0	13U	15U	19U	12U	17U	65J	13U

TABLE 4.32 - Continued
SITE 5 - SOIL BORING
ANALYTICAL DATA SUMMARY
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SALT LAKE CITY, UTAH

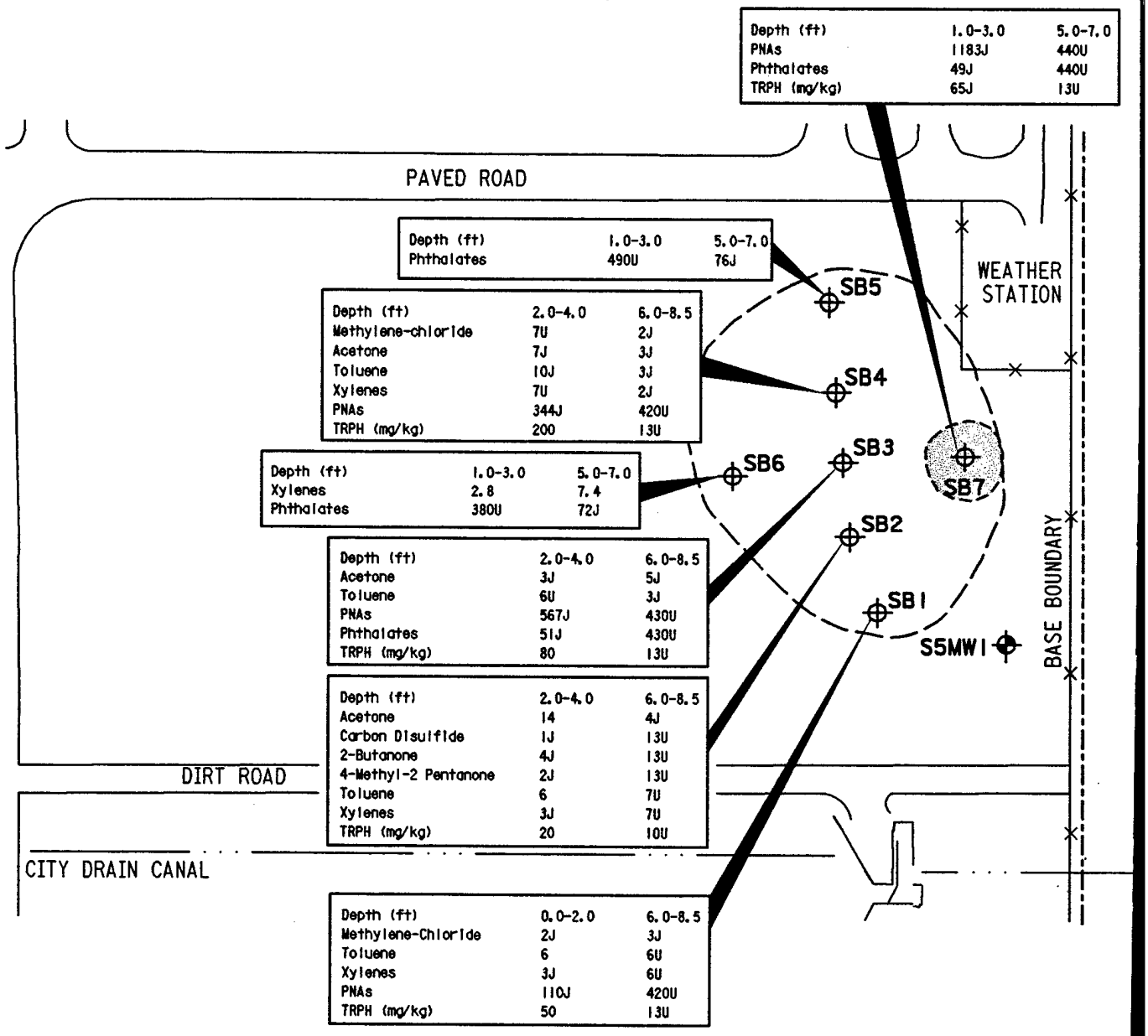
Parameter (method) (units)	PRGs	Detection Limit	SB4-6-8.5	SB5-1-3	SB5-5-7	SB6-1-3	SB6-5-7	SB7-1-3	SB7-5-7
SVOCs (SW8270) (µg/kg)*									
Dilution Factor			1	1	1	1	1	1	1
Phenanthrene	na	330.0	420U	490U	630U	380U	540U	130J	440U
Pyrene	8.1E+06 n	330.0	420UJ	490U	630U	380U	540U	270J	440U
Chrysene	19,900 c	330.0	420U	490U	630U	380U	540U	140J	440U
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	420U	490U	630U	380U	540U	380U	440U
Benzo(b)fluoranthene	630 c	330.0	420U	490U	630U	380U	540U	150J	440U
Benzo(k)fluoranthene	1,330 c	330.0	420U	490U	630U	380U	540U	380U	440U
Fluoranthene	1.08E+07 n	330.0	420U	490U	630U	380U	540U	160J	440U
Di-n-Butylphthalate	2.7E+07 n	330.0	420U	490U	76J	380U	72J	49J	440U
Benzo(a)pyrene	90 c	330.0	420U	490U	630U	380U	540U	***100J***	440U
Ideno(1,2,3-cd)pyrene	380 c	330.0	420U	490U	630U	380U	540U	86J	440U
Benzo(g,h,i)perylene	na	330.0	420U	490U	630U	380U	540U	98J	440U

(a) Blind duplicate from the preceding sample interval.
***** Analyses performed by the ES-Berkeley Laboratory.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
NA Method SW8010/8020 did not include these compounds.
Note: Concentrations exceeding Preliminary Remediation Goals (PRGs) are shown in bold italics, nc - noncarcinogen, c - carcinogen, na - not available.
Note: PRG values greater than five digits are in scientific notation.

FINAL

ORGANIC COMPOUNDS DETECTED IN SOIL
SITE 5

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NOTE:
Concentrations are in ug/kg for soil, except where noted.
J - Concentration is estimated
U - Concentration not present above detection limit

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FIGURE 4.5

bis(2-ethylhexyl)phthalate are separately shown as phthalates on Figure 4.55. PNAs and phthalates are included in the SVOC suite of analyses.

Organic compounds were detected in at least one sampling interval in all seven soil borings. PNAs were detected in the shallower sampling interval of soil borings SB1, SB3, SB4, and SB7, in fill, silty sand, organic silt and clay, and fill, respectively. A site maximum total PNA concentration of 1,183 µg/kg estimated was detected in sand, silt, and gravel fill material at SB7. Phenanthrene, pyrene, chrysene, benzo(b)fluoranthene, fluoranthene, benzo(a)pyrene, ideno(1,2,3-cd)pyrene, and benzo(g,h,i,)perylene, were all detected at the estimated concentrations shown in Table 4.32. Phenanthrene, pyrene, chrysene, benzo(b) and (k)fluoranthene, and fluoranthene were present in silty sand at SB3, at the estimated concentrations of 49 µg/kg, 120 µg/kg, 74 µg/kg, 110 µg/kg, 130 µg/kg, and 84 µg/kg, respectively. Phenanthrene, pyrene, and fluoranthene were present at the estimated concentrations of 100 µg/kg, 150 µg/kg, and 94 µg/kg, respectively, in organic silt and clay at SB4. Pyrene was also detected at a concentration of 110 µg/kg estimated at SB1.

bis(2-Ethylhexyl)phthalate was detected in the 2 -to 4-foot interval of SB3 at a concentration of 51 µg/kg estimated. Di-n-butylphthalate was detected at estimated concentrations of 76 µg/kg in the 5- to 7-foot sampling interval of SB5, 72 µg/kg in the 5- to 7-foot sampling interval of SB6, and 49 mg/kg in the 1- to 3-foot sampling interval of SB7.

Other compounds detected were the VOCs toluene, xylenes, carbon disulfide, 2-butanone, and 4-methyl 2-pentanone, at the minor concentrations shown in Figure 4.55 and Table 4.32. A maximum site TRPH concentration of 200 mg/kg was detected in organic silt and clay at the 2- to 4-foot sampling interval of SB4.

Minor concentrations of acetone were detected in soil samples from soil borings SB2, SB3, and SB4, and methylene chloride was detected in soil samples from soil borings SB1 and SB4. These compounds were not detected in associated laboratory method blanks.

In summary, detected organic compounds at Site 5 were widespread but concentrations were minor. PNAs were the primary compounds detected in soil. The PNAs detected in Site 5 soils appear to be burn by-products related to the past fire training practices at the site.

4.7.2.4 Groundwater Contamination Assessment

One groundwater sample was collected in February 1993 from the downgradient monitoring well, S5MW1. The groundwater sample was analyzed for VOCs and SVOCs. Target compounds included in each of the analyses and the detection limits for the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

In August 1995, S5MW1 was resampled and analyzed for VOCs and SVOCs. The sample was also analyzed for arsenic. Arsenic was analyzed at this non-metals site and all other sites for this second round of sampling to provide background information on arsenic concentrations in this area not affected by metals contamination and to evaluate the basewide distribution of arsenic in shallow groundwater. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.2, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 2, Appendix E.

Field measurements of specific conductance, pH, and temperature were made on the groundwater samples from S5MW1 at the time of sample collection. These measurements are provided in Tables 4.8 and 4.9. Specific conductance measured at 1,750 microsiemens/cm in February 1993 and measured 9,640 microsiemens/cm in August 1995. The pH was 7.6 and 7.23, respectively.

Analytical results of the groundwater samples collected from S5MW1 are provided in Tables 4.33 and 4.34. The findings are discussed below.

Organic Compounds. Only one organic compound was detected in groundwater collected from the monitoring well at Site 5, as shown on Figure 4.56. The VOC 1,1-dichloroethane was detected at a concentration of 1 µg/L (February 1993). This compound was not detected in Site 5 soils so its origin in groundwater is not known.

4.7.3 Site 5 - Conclusions

Minor concentrations of BTEX compounds, PNAs, and TRPH were detected in site soils (Figure 4.55). Some or all of these compounds were present at all site soil borings, indicating that organic contamination though detected at minor concentrations, is widespread at the site. PNAs were the primary compounds detected in soil. The PNAs detected in Site 5 soils appear to be burn by-products related to the past fire training practices at the site. The concentration of benzo(a)pyrene in the near-surface soil sample from SB7 slightly exceeded its carcinogenic human health PRG. However, the risks associated with contaminated soil at this site are considered to be low, as discussed in the Preliminary Risk Evaluation (Section 5).

Groundwater at Site 5 contained only one organic compound. Initially, 1,1-dichloroethane was detected at a minor concentration of 1 ug/L in groundwater from the single downgradient monitoring well installed at the site (Figure 4.56). This concentration did not exceed an MCL. No organic compounds were detected in the second sampling event in 1995. Based on the location of the downgradient monitoring well with respect to groundwater flow directions observed at the site, the general lack of groundwater contamination at the site appears to be confirmed. The detection of 1,1-dichloroethane in groundwater is not consistent with the organic compounds detected in site soil. Perhaps, the origin of the 1,1-dichloroethane is the City Drain Canal. Although shallow groundwater beneath the site is observed to flow toward the canal and provides

TABLE 4.33
SITE 5 - GROUNDWATER
ANALYTES DETECTED (February 1993)
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Parameter (method) (units)	MCLs	Detection Limit	S5MW1
VOCs (SW8010/8020) (µg/L)*			
Dilution Factor	--	--	1
1,1-Dichloroethane	na	1.0	1.0
SVOCs (SW8270) (µg/L)*			
Results	--	--	ND

* Analyses performed by the ES Berkeley Laboratory.
na No MCL exists.
ND All analytes were not detected; refer to Table H.1 for compounds and reporting limits.

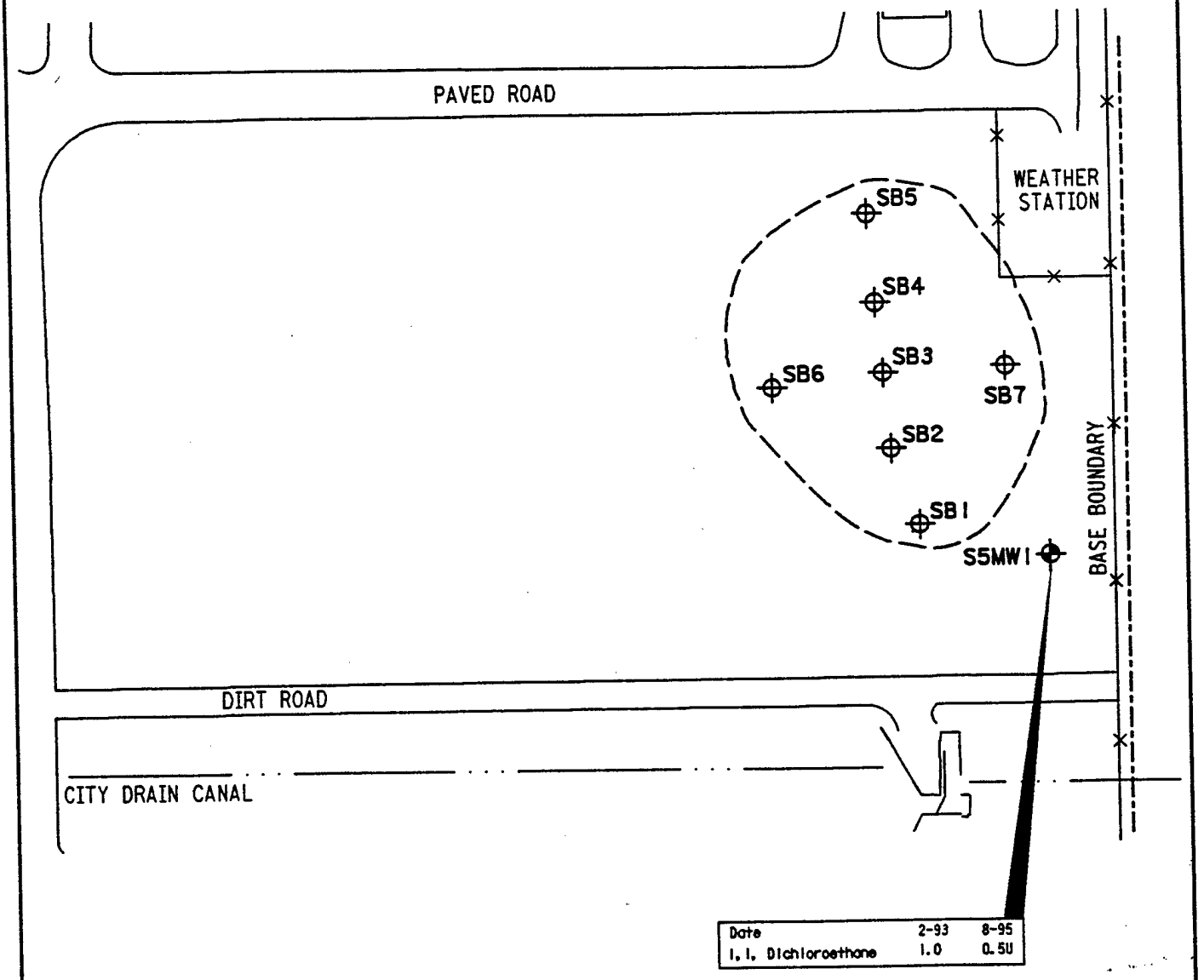
TABLE 4.34
SITE 5 - GROUNDWATER
ANALYTES DETECTED (August 1995)

Parameter (method) (units)	MCLs	Detection Limit	S5MW1	duplicate (a) S5MW2
VOCs (SW8010/8020) (µg/L)**				
Results	--	--	ND	ND
SVOCs (SW8270) (µg/L)**				
Results	--	--	ND	ND
Arsenic (SW7060) (µg/L)**				
Results	50	2.0	2.0UJ	6.6J

(a) Blind duplicate of MW1.
** Analyses performed by DataChem Laboratories.
ND All analytes were not detected; refer to Table H.2 for compounds and detection limits.
U Compound not present above the detection limit shown.
UJ Compound not detected, but the detection limit is estimated.
Note: No Maximum Contaminant Levels (MCLs) were exceeded.

ORGANIC COMPOUNDS DETECTED IN GROUNDWATER
SITE 5

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base flow to the canal, occasional high water stages from outfall discharges into the canal could result in a narrow band of reverse gradient and flow.

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4.8 SITE 6 - RAMP WASHDOWN

4.8.1 Field Program

4.8.1.1 Screening Activities

The following activity was conducted at Site 6 during the screening phase of the SI:

- Performance of a soil gas survey.

A soil gas survey was conducted to determine a possible source area and the approximate extent of soil contamination for optimal placement of soil borings.

Soil gas samples were collected at 80 points during the Site 6 soil gas survey along a grass strip adjacent to the aircraft parking apron ramp. An equidimensional grid pattern with 50-foot spacing between points was established at the site for the survey. Soil gas samples were collected at approximately 4.5 feet BLS at all of the sampling locations. The sampling locations showing total BTEX concentrations and corresponding toluene fractions are identified in Figure 4.57. Analytical results are presented in Table 4.35.

Soil gas samples obtained along the grass strip adjacent to the aircraft parking ramp contained minor BTEX concentrations. Toluene was almost exclusively the BTEX compound present at Site 6 sampling locations. Only soil gas samples at B1, B4, B14, B24, and B34 contained BTEX compound concentrations above the 0.5 ppm quantification limit. The total BTEX concentration at these point locations ranged from a minimum value of 0.6 ppmv at B14 to a maximum value of 2.0 ppmv at B34. Another 20 soil gas points showed measurable peaks on the GC, but contained BTEX at less than the 0.5 ppm quantification limit of the GC calibration. The soil gas survey results were inconclusive in establishing a contaminant source area of BTEX along the grass strip areas at Site 6.

4.8.1.2 Confirmation and Optional Activities

The following activities were conducted during the confirmation/optional phase of the Site 6 SI:

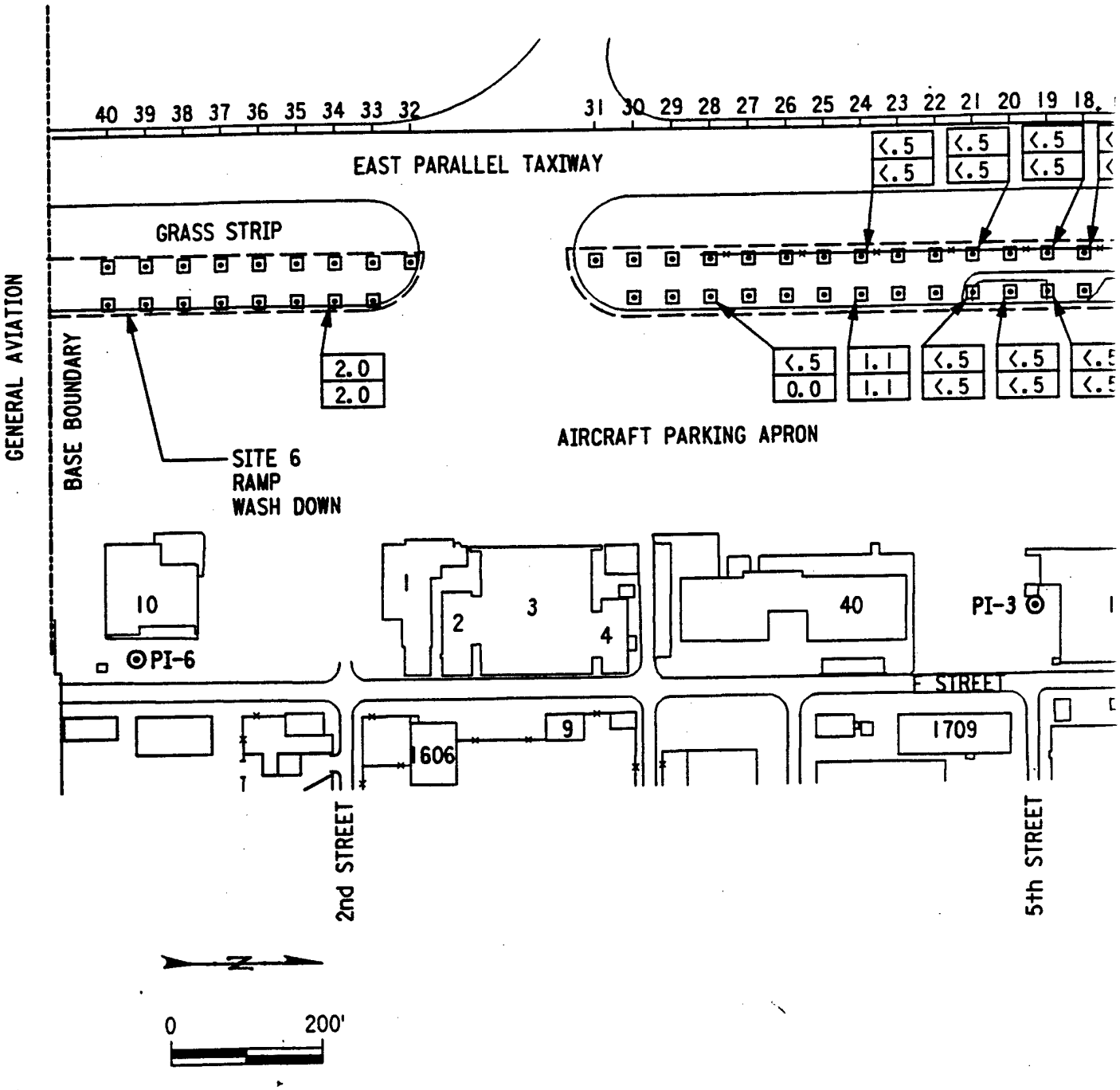
- Advanced 10 soil borings;
- Selected and analyzed 20 soil samples;
- Installed five downgradient monitoring wells; and
- Collected and analyzed eight groundwater samples.

Results of the soil gas survey at Site 6 did not indicate a distinct area of elevated VOCs to aid in the placement of soil borings. Therefore, ten confirmational soil borings were located at 100-foot intervals beginning at the north end of the grass strip area. The soil borings were placed to evaluate the extent of possible contamination at the site. Figure 4.58 shows the locations of the soil borings at Site 6. Soil borings SB1, SB2, SB5, SB7, and SB9 are in close proximity to the soil gas locations that exhibited

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SOIL GAS SURVE

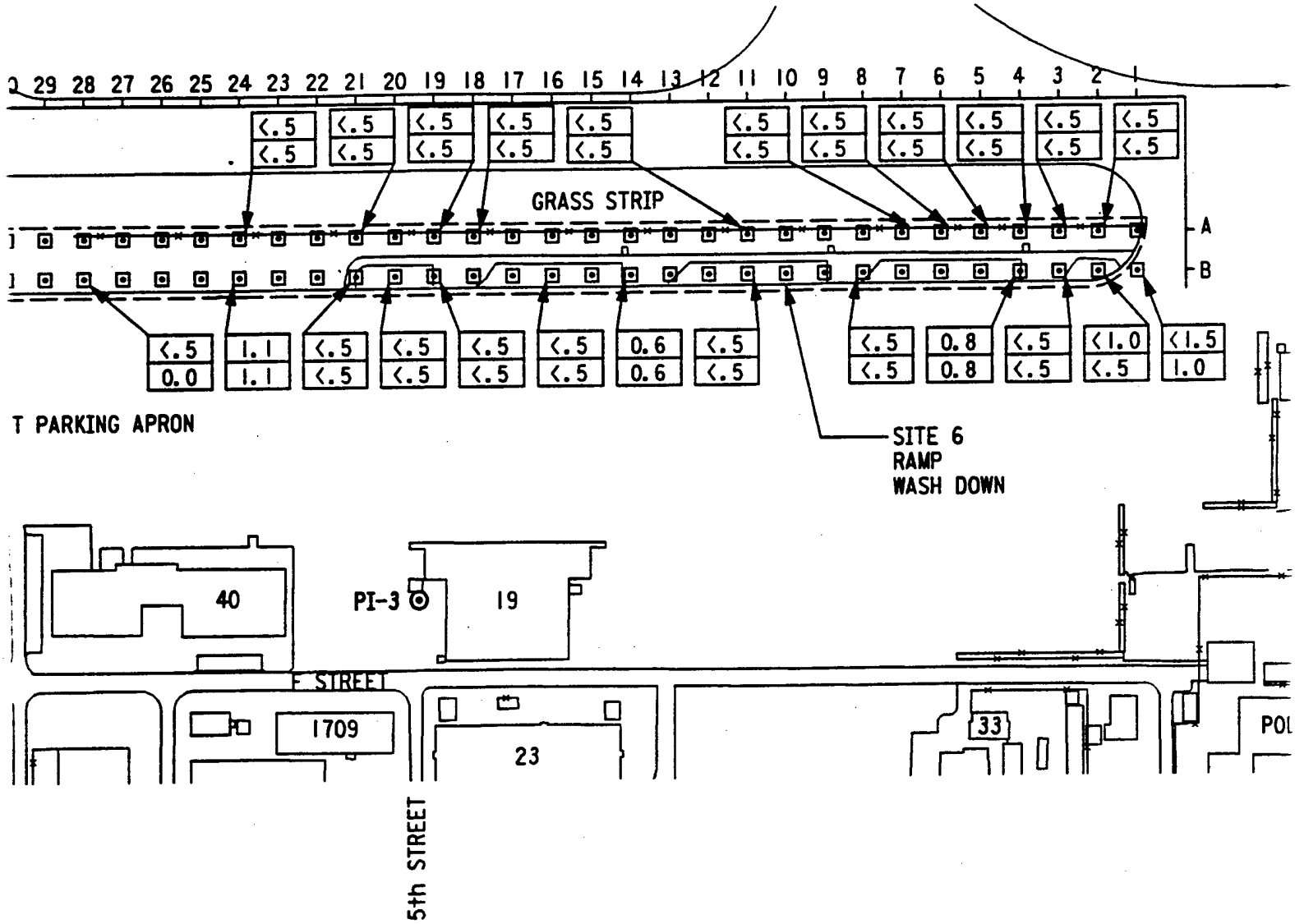
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NOTE: Total BTEX and the corresponding toluene fraction of the total BTEX are shown. Where a less than sign is shown, the compounds were detected at less than the GC IDL of 0.5 ppmv.

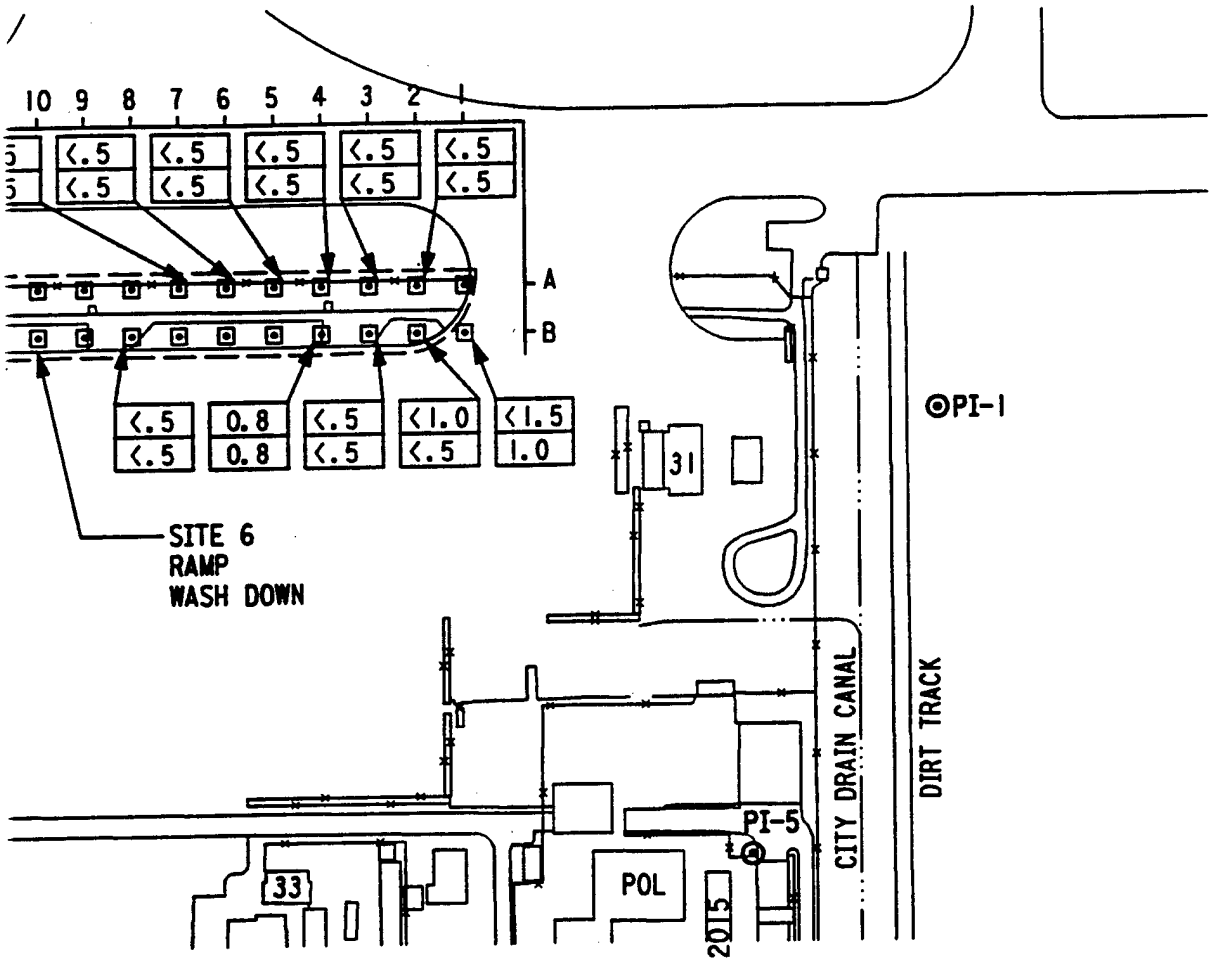
SOIL GAS SURVEY RESULTS - SITE 6

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SITE 6



LEGEND

- 2.0 / 2.0 — Total BTEX (ppmv) / Toluene (ppmv)
- SOIL GAS SAMPLE LOCATION
- FENCE
- 6 — BUILDING & BUILDING NUMBER
- SITE LOCATION

FIGURE 4.57

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TABLE 4.35
SITE 6 - SOIL GAS SURVEY RESULTS
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SALT LAKE CITY, UTAH

Point	Benzene ppm v	Toluene ppm v	Ethylbenzene ppm v	Xylenes ppm v	Total BTEX ppm v
A1	ND	ND	ND	ND	ND
A2	ND	<0.5	ND	ND	<0.5
A3	ND	<0.5	ND	ND	<0.5
A4	ND	<0.5	ND	ND	<0.5
A5	ND	<0.5	ND	ND	<0.5
A6	ND	<0.5	ND	ND	<0.5
A7	ND	<0.5	ND	ND	<0.5
A8	ND	ND	ND	ND	ND
A9	ND	ND	ND	ND	ND
A10	ND	ND	ND	ND	ND
A11	ND	<0.5	ND	ND	<0.5
A12	ND	ND	ND	ND	ND
A13	ND	ND	ND	ND	ND
A14	ND	ND	ND	ND	ND
A15	ND	ND	ND	ND	ND
A16	ND	ND	ND	ND	ND
A17	ND	ND	ND	ND	ND
A18	ND	<0.5	ND	ND	<0.5
A19	ND	<0.5	ND	ND	<0.5
A20	ND	ND	ND	ND	ND
A21	ND	<0.5	ND	ND	<0.5
A22	ND	ND	ND	ND	ND
A23	ND	ND	ND	ND	ND
A24	ND	<0.5	ND	ND	<0.5
A25	ND	ND	ND	ND	ND
A26	ND	ND	ND	ND	ND
A27	ND	ND	ND	ND	ND
A28	ND	ND	ND	ND	ND
A29	ND	ND	ND	ND	ND
A30	ND	ND	ND	ND	ND
A31	ND	ND	ND	ND	ND
A32	ND	ND	ND	ND	ND
A33	ND	ND	ND	ND	ND
A34	ND	ND	ND	ND	ND
A35	ND	ND	ND	ND	ND
A36	ND	ND	ND	ND	ND
A37	ND	ND	ND	ND	ND
A38	ND	ND	ND	ND	ND
A39	ND	ND	ND	ND	ND
A40	ND	ND	ND	ND	ND

TABLE 4.35 (con't.)
SITE 6 - SOIL GAS SURVEY RESULTS

Point	Benzene ppm v	Toluene ppm v	Ethylbenzene ppm v	Xylenes ppm v	Total BTEX ppm v
B1	<0.5	1	ND	ND	<1.5
B2	ND	<0.5	ND	<0.5	<1.0
B3	ND	<0.5	ND	ND	<0.5
B4	ND	0.8	ND	ND	0.8
B5	ND	ND	ND	ND	ND
B6	ND	ND	ND	ND	ND
B7	ND	ND	ND	ND	ND
B8	ND	<0.5	ND	ND	<0.5
B9	ND	ND	ND	ND	ND
B10	ND	ND	ND	ND	ND
B11	ND	<0.5	ND	ND	<0.5
B12	ND	ND	ND	ND	ND
B13	ND	ND	ND	ND	ND
B14	ND	0.6	ND	ND	0.6
B15	ND	ND	ND	ND	ND
B16	ND	<0.5	ND	ND	<0.5
B17	ND	ND	ND	ND	ND
B18	ND	ND	ND	ND	ND
B19	ND	<0.5	ND	ND	<0.5
B20	ND	<0.5	ND	ND	<0.5
B21	ND	<0.5	ND	ND	<0.5
B22	ND	ND	ND	ND	ND
B23	ND	ND	ND	ND	ND
B24	ND	1.1	ND	ND	1.1
B25	ND	ND	ND	ND	ND
B26	ND	ND	ND	ND	ND
B27	ND	ND	ND	ND	ND
B28	<0.5	ND	ND	ND	<0.5
B29	ND	ND	ND	ND	ND
B30	ND	ND	ND	ND	ND
B31	NA	NA	NA	NA	NA
B32	NA	NA	NA	NA	NA
B33	ND	ND	ND	ND	ND
B34	ND	2	ND	ND	2
B35	ND	ND	ND	ND	ND
B36	ND	ND	ND	ND	ND
B37	ND	ND	ND	ND	ND
B38	ND	ND	ND	ND	ND
B39	ND	ND	ND	ND	ND
B40	ND	ND	ND	ND	ND

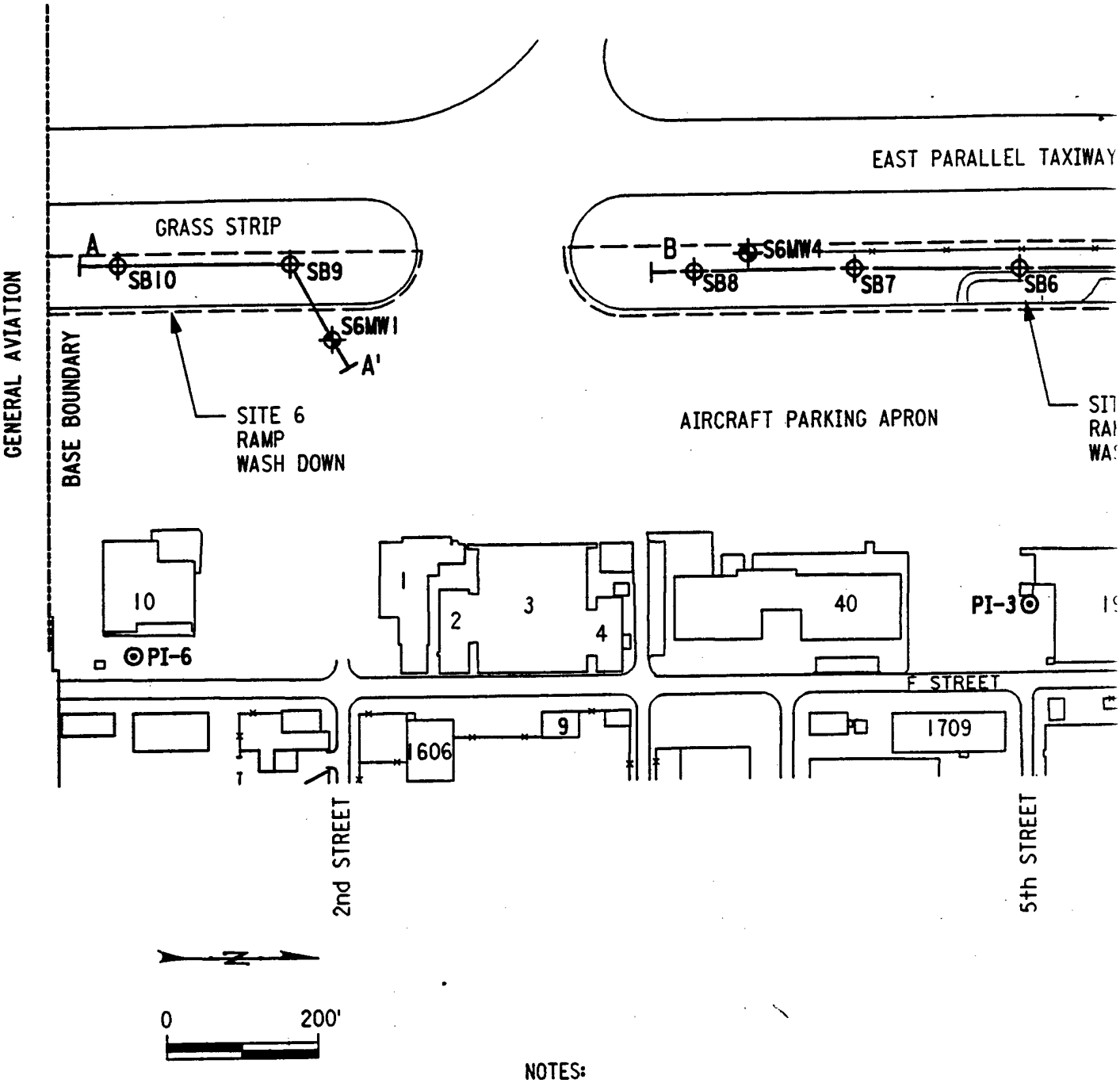
ND - Not detected (BTEX compounds were not observed on chromatograms).

<0.5-BTEX compounds were observed on original chromatograms but were not quantified.

NA - Not analyzed

SOIL BORING, GEOLOGICAL CROSS-S

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NOTES:

S6MW1, S6MW2, and S6MW3 were installed January 1993.

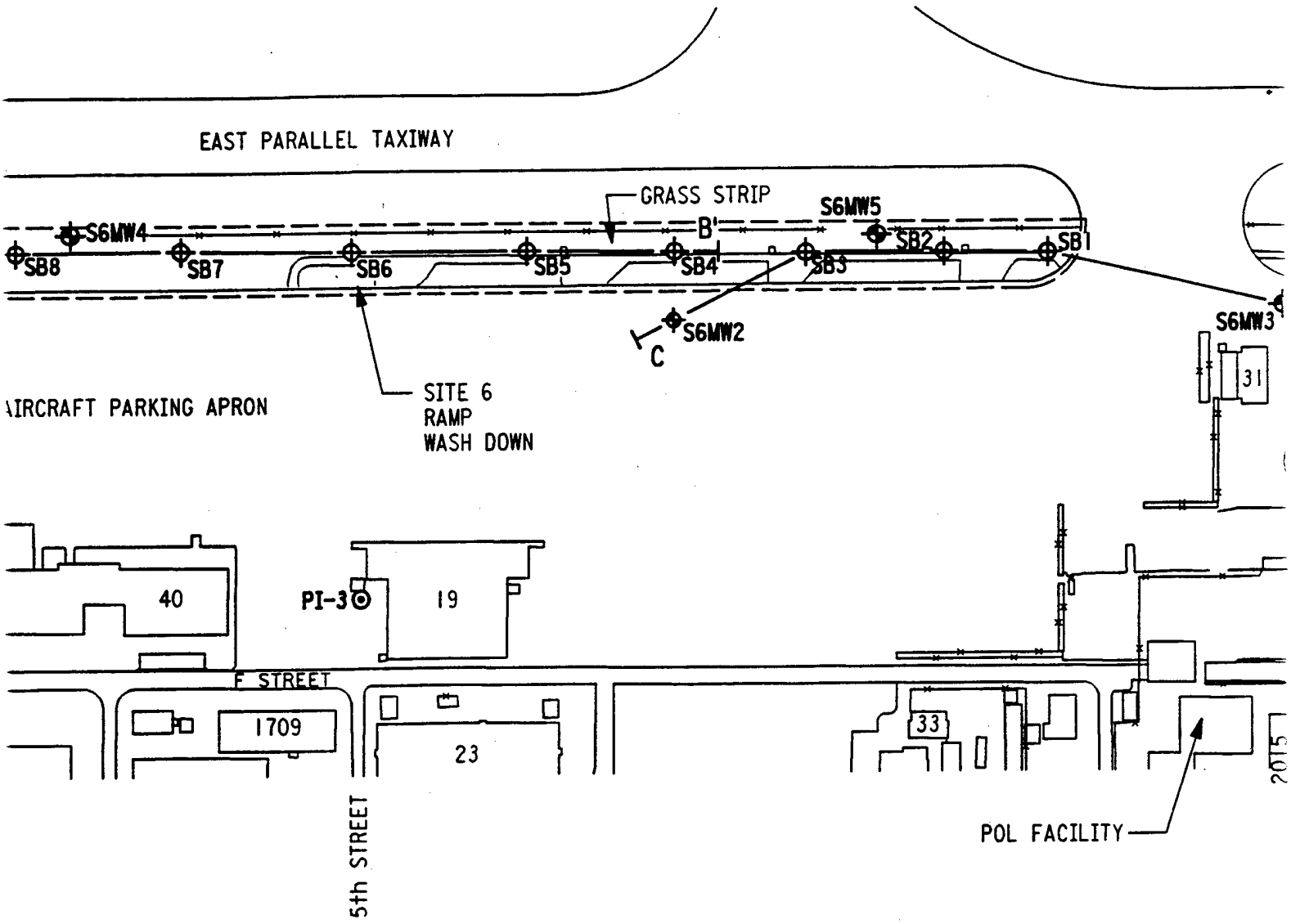
S6MW4 and S6MW5 were installed August 1995.

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(1)

SOIL BORING, MONITORING WELL, AND GEOLOGICAL CROSS-SECTION LOCATIONS - SITE 6

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and S6MW3
January 1993.

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August 1995.

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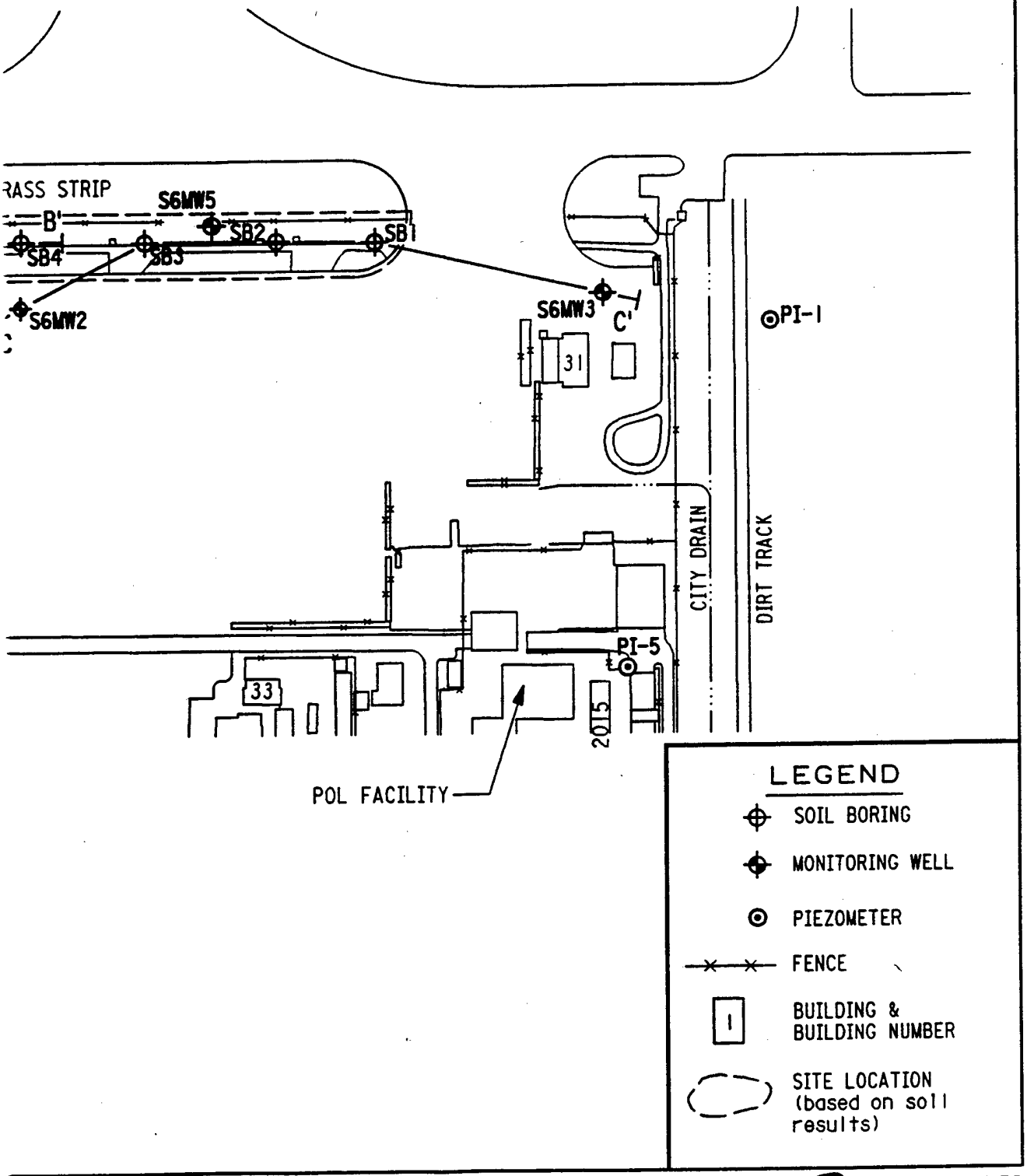


FIGURE 4.58

3

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quantifiable total BTEX. The soil borings were drilled sequentially beginning at soil boring SB1.

Two soil samples from each of the 10 soil borings were selected for chemical analyses based on the results of headspace screening and proximity to the water table; COCs are provided in Appendix D. Groundwater was encountered during drilling at a depth of approximately 5 to 7 feet BLS. Headspace screening results, sampling intervals, and the unconsolidated deposits of each boring were logged and recorded. Detailed soil boring descriptions are provided in the boring logs, Appendix G. A correlation of the soil BTEX results of field GC screening versus the analytical laboratory is provided in Appendix J.

In January 1993, three monitoring wells, S6MW1, S6MW2, and S6MW3, were installed hydraulically downgradient of the chain of soil borings in the direction of groundwater flow. In August 1995, two additional monitoring wells, S6MW4 and S6MW5, were installed hydraulically downgradient of the chain of soil borings in the direction of groundwater flow.

Monitoring wells S6MW1, S6MW2, S6MW3, S6MW4, and S6MW5 are screened in the interval from 5.24 feet to 15.24 feet BLS, 5.26 feet to 15.26 feet BLS, 4.75 feet to 14.75 feet BLS, 4.0 feet to 14.0 feet BLS, and 3.5 feet to 13.5 feet BLS, respectively. Well construction details for the Site 6 monitoring wells are provided in Table G.1, Appendix G. Well soil boring logs with construction diagrams are also provided in Appendix G. Following development, the monitoring wells were purged and sampled, and the samples were analyzed for the specified chemical constituents. Well development and sampling forms are provided in Appendix C.

4.8.2 Results of Site Investigation

4.8.2.1 Geology and Hydrogeology

Geological cross-sections of Site 6 stratigraphy, at the locations shown on Figure 4.58, are presented as Figures 4.59, 4.60, and 4.61. Site 6 is underlain by layers of sediment that are mixtures of sand, silt, and clay, and layers that are purely sand, silt, or clay. Some of the silts and clays have high organic content. Overall, the deposits are predominantly fine (silt and clay). The sediments beneath Site 6 exhibit a higher degree of stratification than those observed beneath the other sites at the Base. Sediment layers present beneath the site show lateral facies changes (clay grading to silt grading to sand) over the distance of approximately 2,500 feet that separate soil boring SB10 to the south and monitoring well S6MW3 to the north. As a result, specific sediment layers are difficult to correlate due to the variation in alluvium. The upper 10- to 12-feet of alluvial stratigraphy at Site 6 is typical of floodplain and meandering stream deposition. The clays and sands at depth are probably the result of deltaic deposition.

Basewide groundwater levels were measured on 28 December 1992, 16 March 1993, and 19 July 1995 to determine hydraulic gradients and groundwater flow directions at the sites (Figures 4.1, 4.2, 4.3). Extrapolated groundwater contour maps of the Site 6 area for

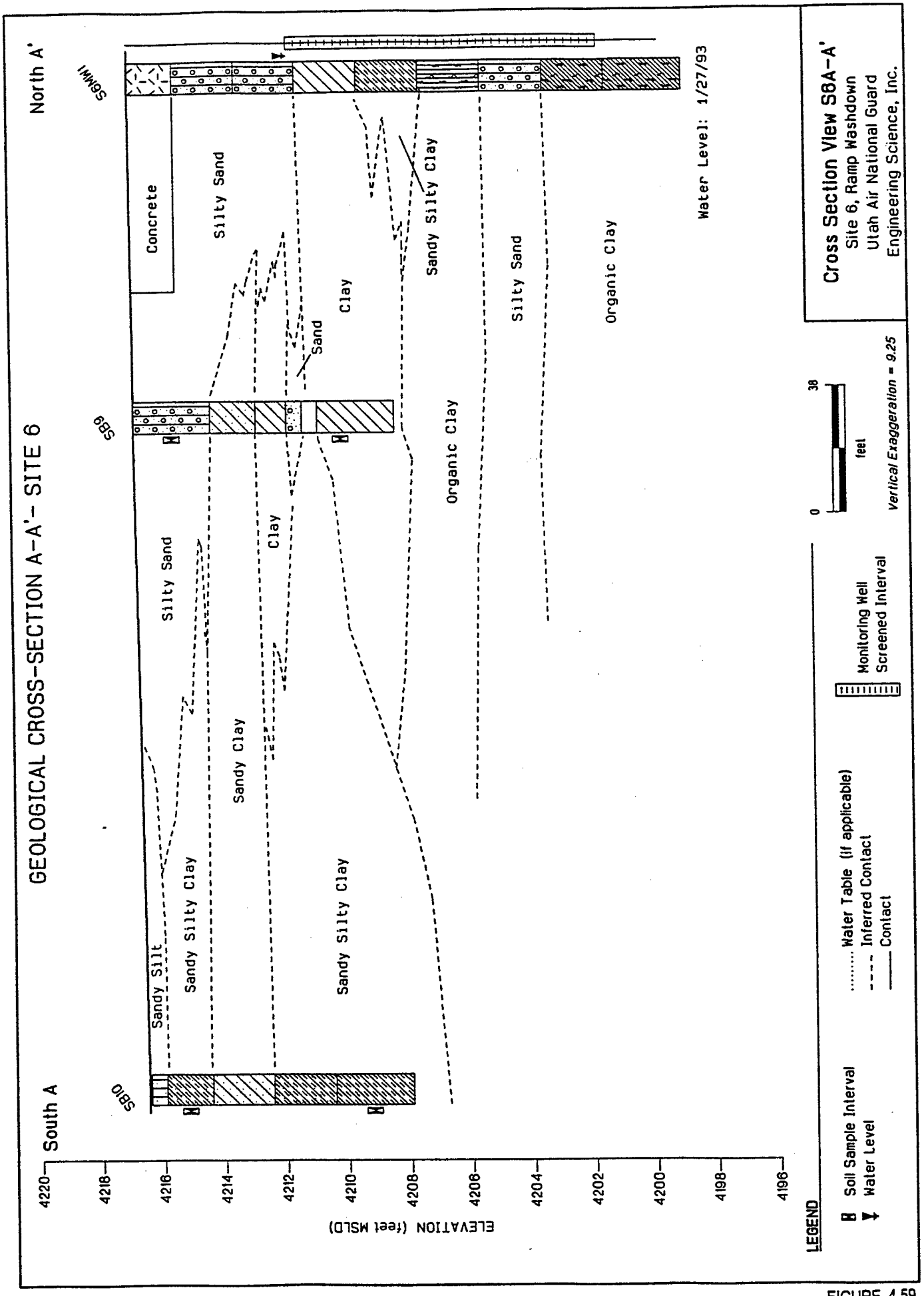

GEOLOGICAL CROSS-SECTION A-A'- SITE 6
South A
North A'
SB10
SB9
S6MW1
Concrete
Silty Sand
Clay
Sand
Sandy Silty Clay
Silty Sand
Organic Clay
Sandy Silt
Sandy Silty Clay
Sandy Clay
Clay
Sandy Silty Clay
Organic Clay
Water Level: 1/27/93
Cross Section View S6A-A'
Site 6, Ramp Washdown
Utah Air National Guard
Engineering Science, Inc.
0
38
feet
Vertical Exaggeration = 9.25
Monitoring Well
Screened Interval
Water Table (if applicable)
Inferred Contact
Contact
LEGEND
Soil Sample Interval
Water Level
ELEVATION (feet MSLD)
4220
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
4196

FIGURE 4.59

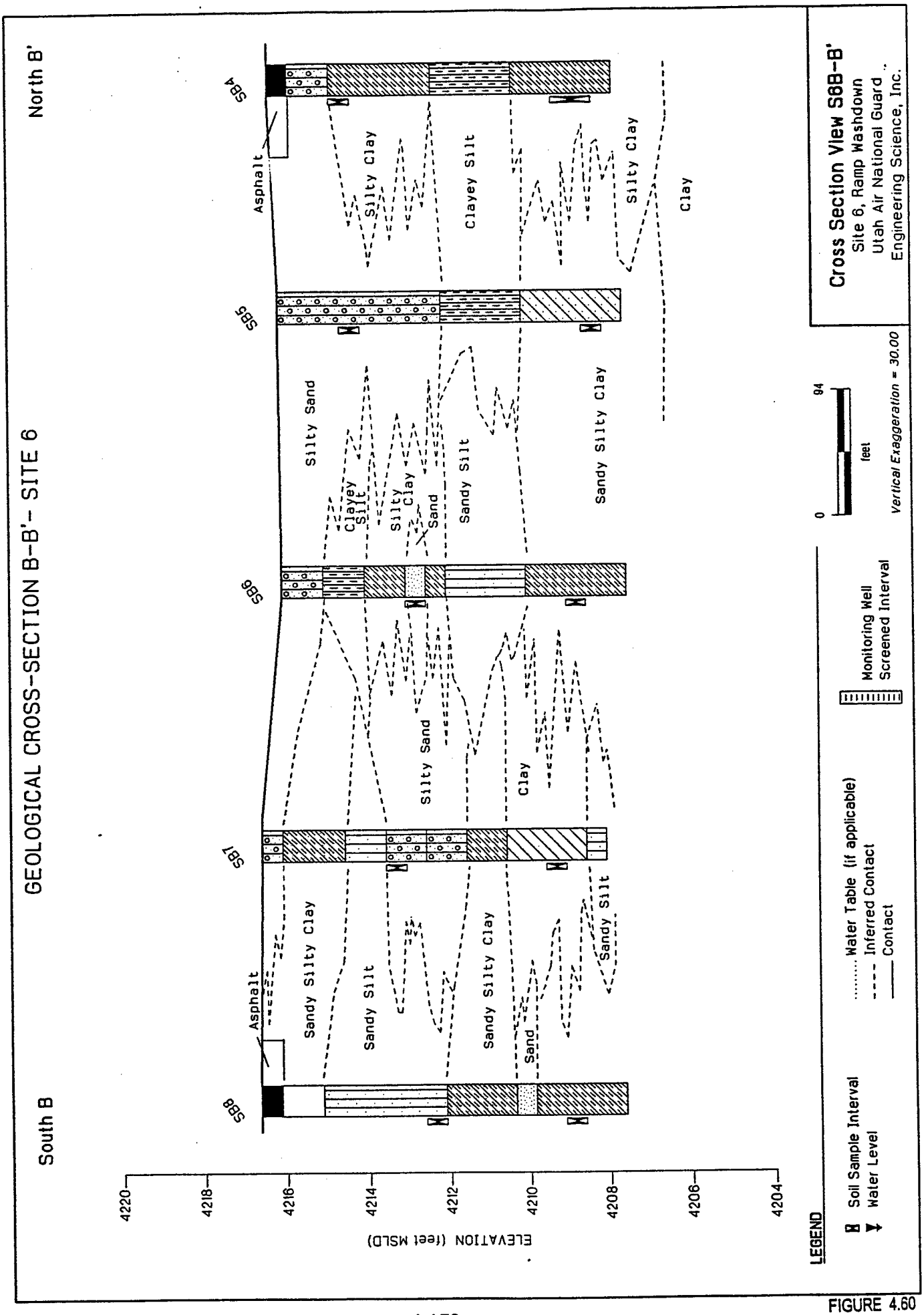

GEOLOGICAL CROSS-SECTION B-B'- SITE 6
South B
North B'
SB8
SB7
SB6
SB5
SB4
Asphalt
Asphalt
Sandy Silty Clay
Sandy Silt
Sandy Silty Clay
Sand
Silty Sand
Clay
Silty Sand
Clayey Silt
Silty Clay
Sand
Sandy Silt
Sandy Silty Clay
Silty Clay
Clayey Silt
Silty Clay
Clay
4220
4218
4216
4214
4212
4210
4208
4206
4204
ELEVATION (feet MSLD)
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval
0
94
feet
Vertical Exaggeration = 30.00
Cross Section View S6B-B'
Site 6, Ramp Washdown
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.60

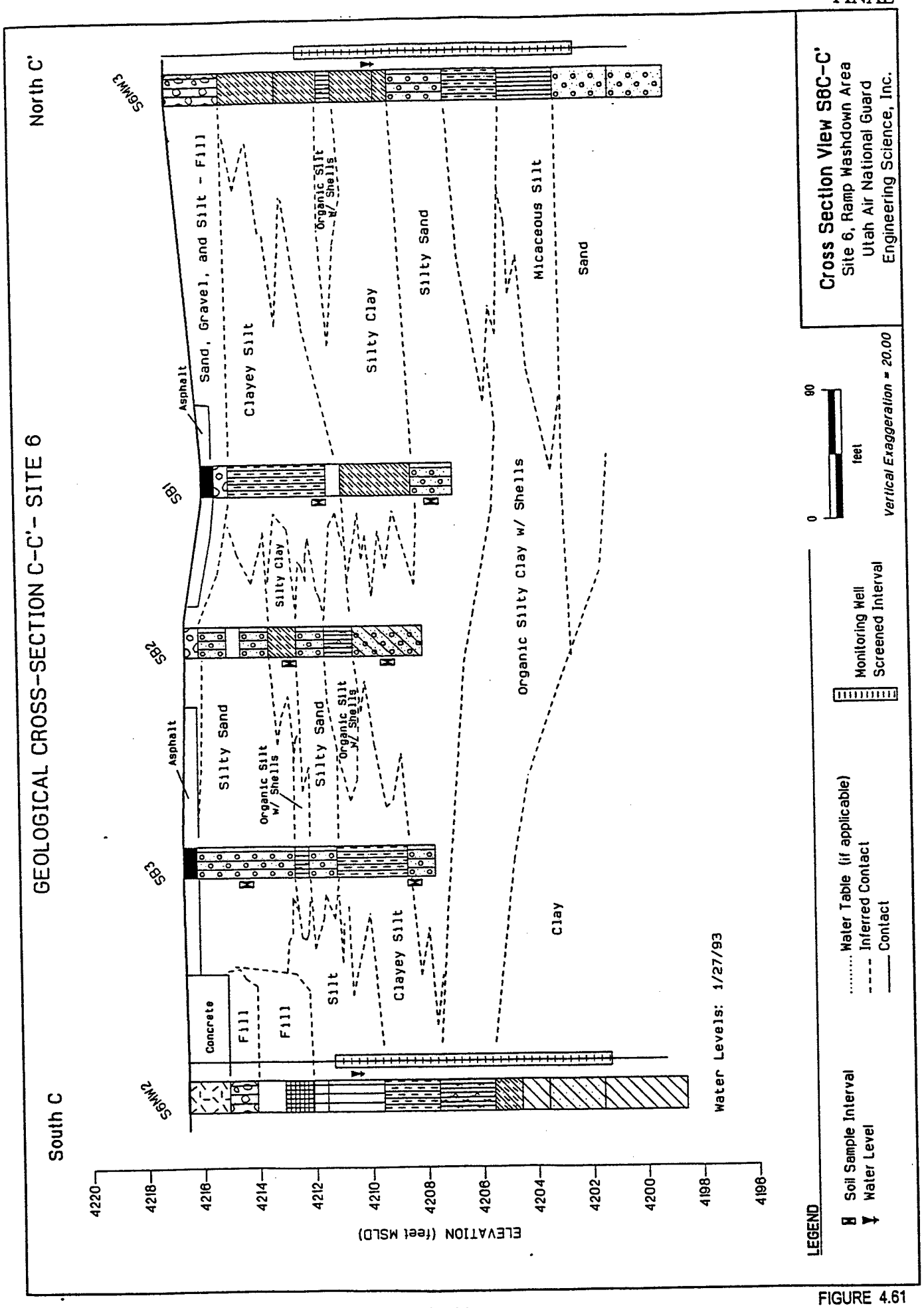

GEOLOGICAL CROSS-SECTION C-C'- SITE 6
South C
North C'
Cross Section View S6C-C'
Site 6, Ramp Washdown Area
Utah Air National Guard
Engineering Science, Inc.
Vertical Exaggeration = 20.00
0
90
feet
S6MW3
S6MW2
SB1
SB2
SB3
Asphalt
Concrete
Fill
Sand, Gravel, and Silt - Fill
Clayey Silt
Silty Clay
Silty Sand
Organic Silt w/ Shells
Micaceous Silt
Sand
Organic Silty Clay w/ Shells
Clay
Silt
Water Levels: 1/27/93
ELEVATION (feet MSLD)
4220
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
4196
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval

FIGURE 4.61

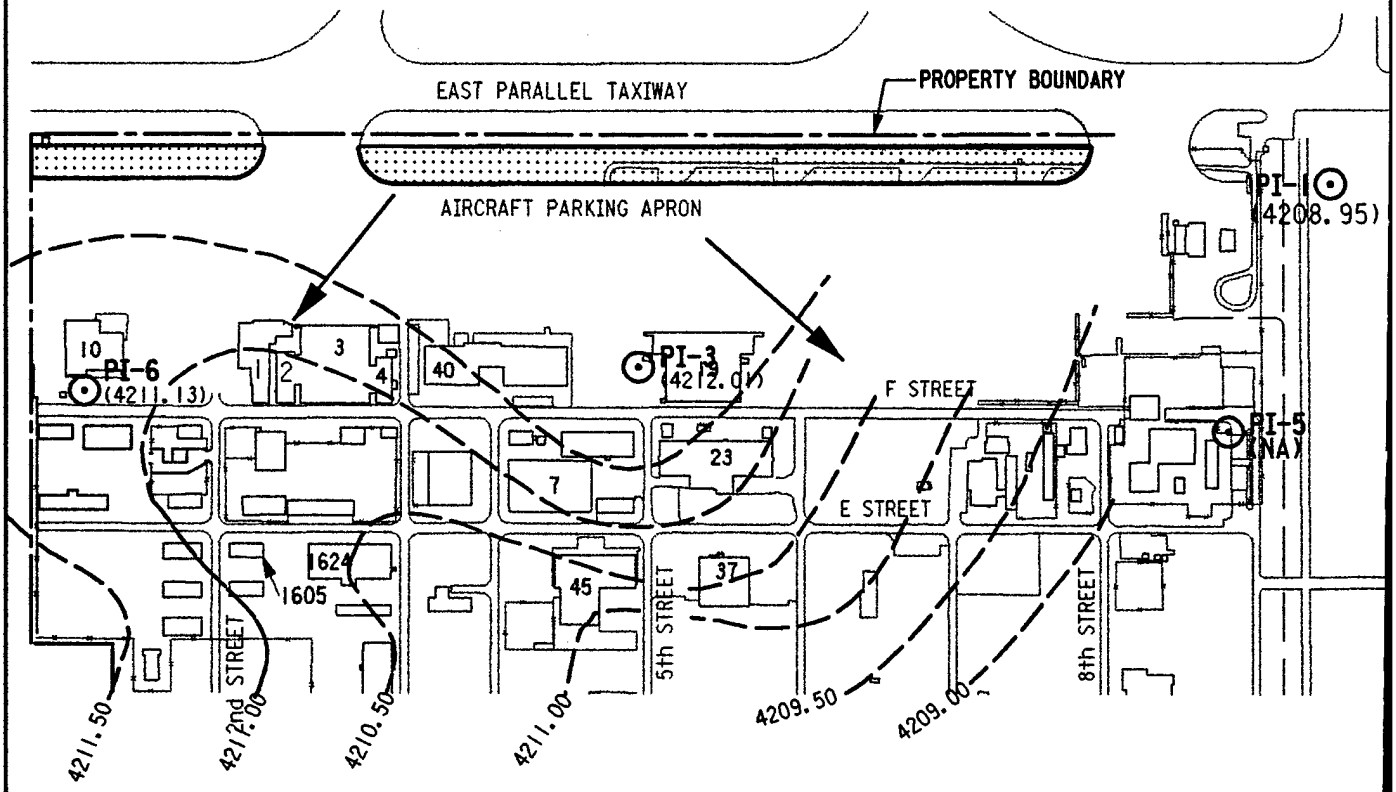
these respective dates are provided as Figures 4.62, 4.63, and 4.64. The purpose of the 28 December 1992 and 19 July 1995 measurements was to establish groundwater flow directions prior to well placement. The purpose of the 16 March 1993 round of groundwater measurements was to establish hydraulic gradients and flow directions for groundwater flow rate calculations at the sites. March 1993 was the only instance when all of the site monitoring wells and basewide piezometers were measured on the same day during the primary 1992-93 investigation of Sites 1 through 7. As shown in Figure 4.63, the general groundwater flow direction at the site was to the west-northwest on 16 March 1993. This is an apparent groundwater gradient reversal from the general east-northeast flow direction inferred from the potentiometric surface and groundwater gradient for 28 December 1992 (Figure 4.62). If real, this change in groundwater gradient and reversal of groundwater flow direction at the site may have resulted from a rapid response of the shallow aquifer to groundwater recharge from above-normal winter precipitation. The inferred east-northeast flow direction in Figure 4.62 could also result from a data gap in groundwater levels at this far west end of the Base (a piezometer was not placed in this area as per the SAP). The inferred groundwater flow direction on 19 July 1995 was northwest prior to placement of the new downgradient monitoring wells S6MW4 and S6MW5 (Figure 4.64), which is the same as the 16 March 1993 flow direction.

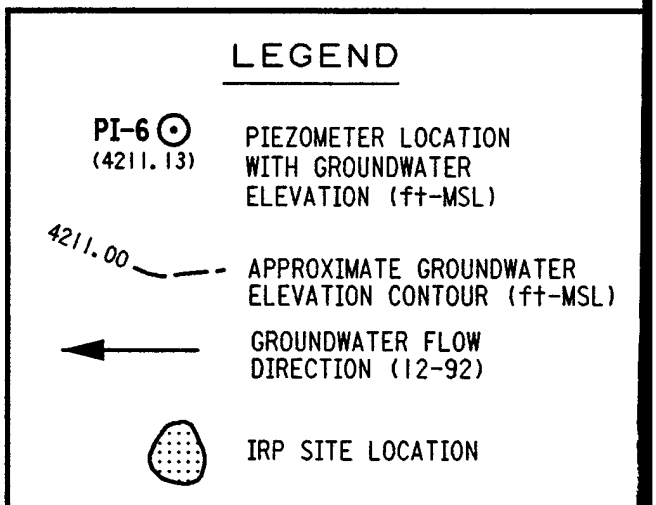
4.8.2.2 Groundwater Flow Calculations

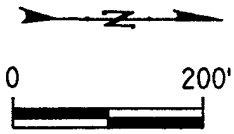
The calculated groundwater flow rate and velocity across the north end of the site were determined from the 16 March 1993 groundwater levels between monitoring wells S6MW2 and S6MW3. As shown on Figure 4.65, the hydraulic gradient (i) is established in the direction of groundwater flow perpendicular to hydraulic head equipotentials at the wells and was approximately 0.99 feet (dh) in 650 feet (dl), or 1.52×10^{-3} ft/ft (i=dh/dl). The hydraulic conductivity (K) of the silt and clay in the screened interval of S6MW2 was estimated from a slug test at the well to be 2.04 ft/day. The hydraulic conductivity of the sand, silt, and clay in the screened interval of S6MW3 is 5.0 ft/day. An average hydraulic conductivity of the porous media between these wells is 3.52 ft/day. The average saturated thickness of the shallow between wells was estimated to be 13.75 feet. Using Darcy's Law (q=Kib), these parameters yield a volumetric flow rate (q) per unit width of saturated aquifer thickness of 7.36×10^{-2} ft^3/day/ft between these wells at the north end of the site on 16 March 1993. The corresponding groundwater velocity (v) is estimated from the equation (v=Ki/n) and the parameters given above to be approximately 0.02 ft/day, assuming an effective porosity (n) of 30 percent. The hydraulic gradient and flow rate were not established between monitoring wells S6MW1 and S6MW2 because the flow direction was variable; and thus, there was not a direct perpendicular flow path between the wells (Figure 4.63.) Hydrogeological data and calculations are presented in Tables I.1 and I.2, of Appendix I. Field methods, methods of analysis, slug test results, and a detailed description and evaluation of hydraulic conductivity, flow rates, and velocities are also contained in Appendix I.

GROUNDWATER GRADIENT MAP - SITE 6
28 DECEMBER 1992

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SALT LAKE CITY, UTAH







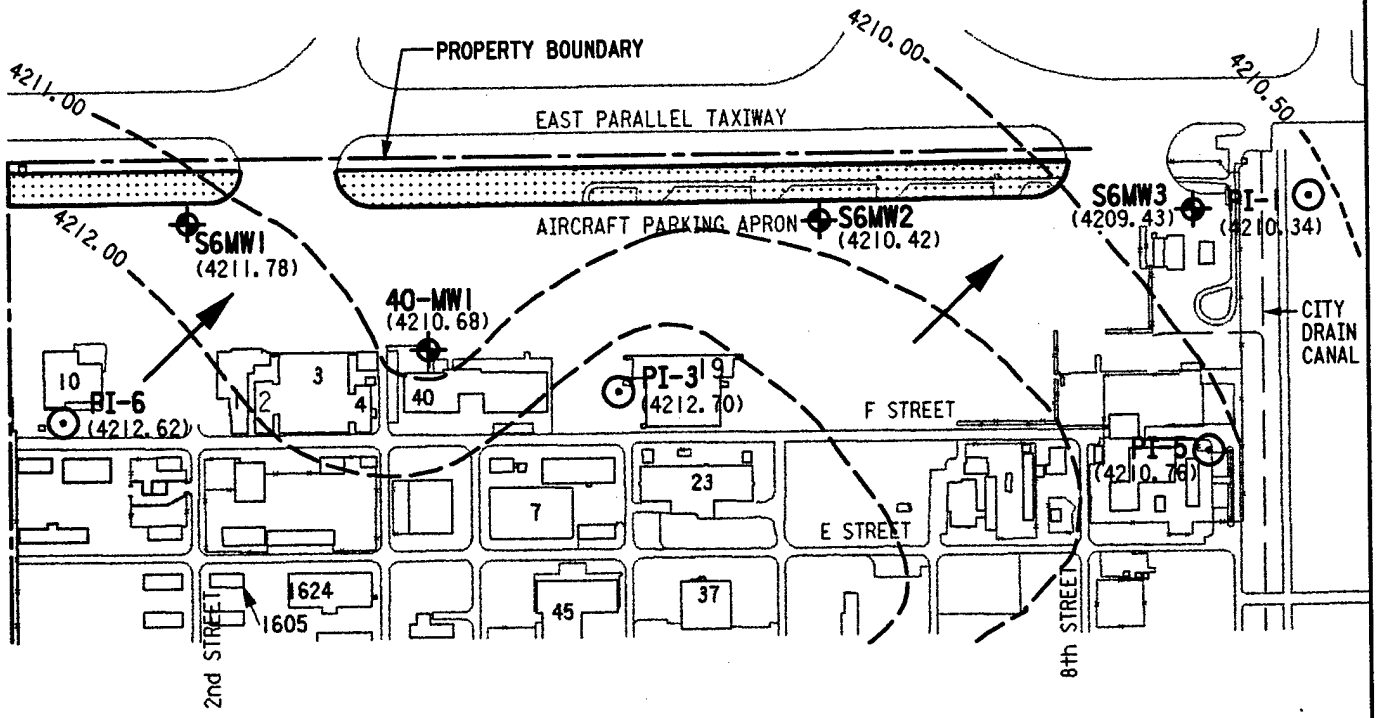
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FIGURE 4.6

FINAL

GROUNDWATER GRADIENT MAP - SITE 6
16 MARCH 1993

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SALT LAKE CITY, UTAH



LEGEND

PI-6 (4212.62) — PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)

S6MW1 (4211.78) — BACKGROUND SOIL BORING/ MONITORING WELL LOCATION

4211.00 — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (ft-MSL)

GROUNDWATER FLOW DIRECTION (3-93)

IRP SITE LOCATION

N

0 200'

NOTE:
40-MW1 is a Monitoring Well from the Site 9 UST Investigation (ES, 1993)

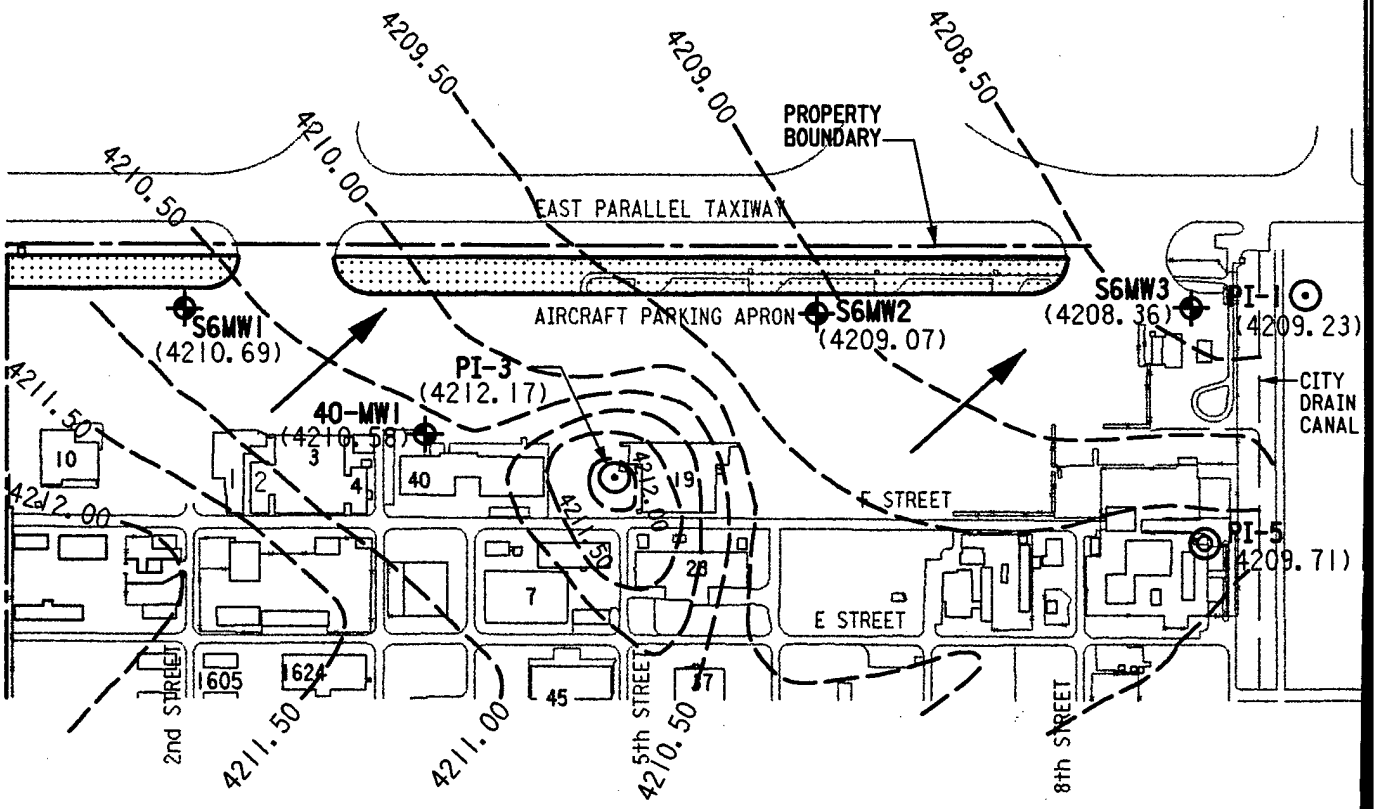
C:\UANG\U616MR93.DGN R02 06.07.96

FIGURE 4.63

FINAL

GROUNDWATER GRADIENT MAP - SITE 6
19 JULY 1995

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:
S6MW4 & S6MW5 were installed August 1995.

40-MW1 is a Monitoring Well from the Site 9 UST Investigation, (ES, 1993)

N

0 200'

LEGEND

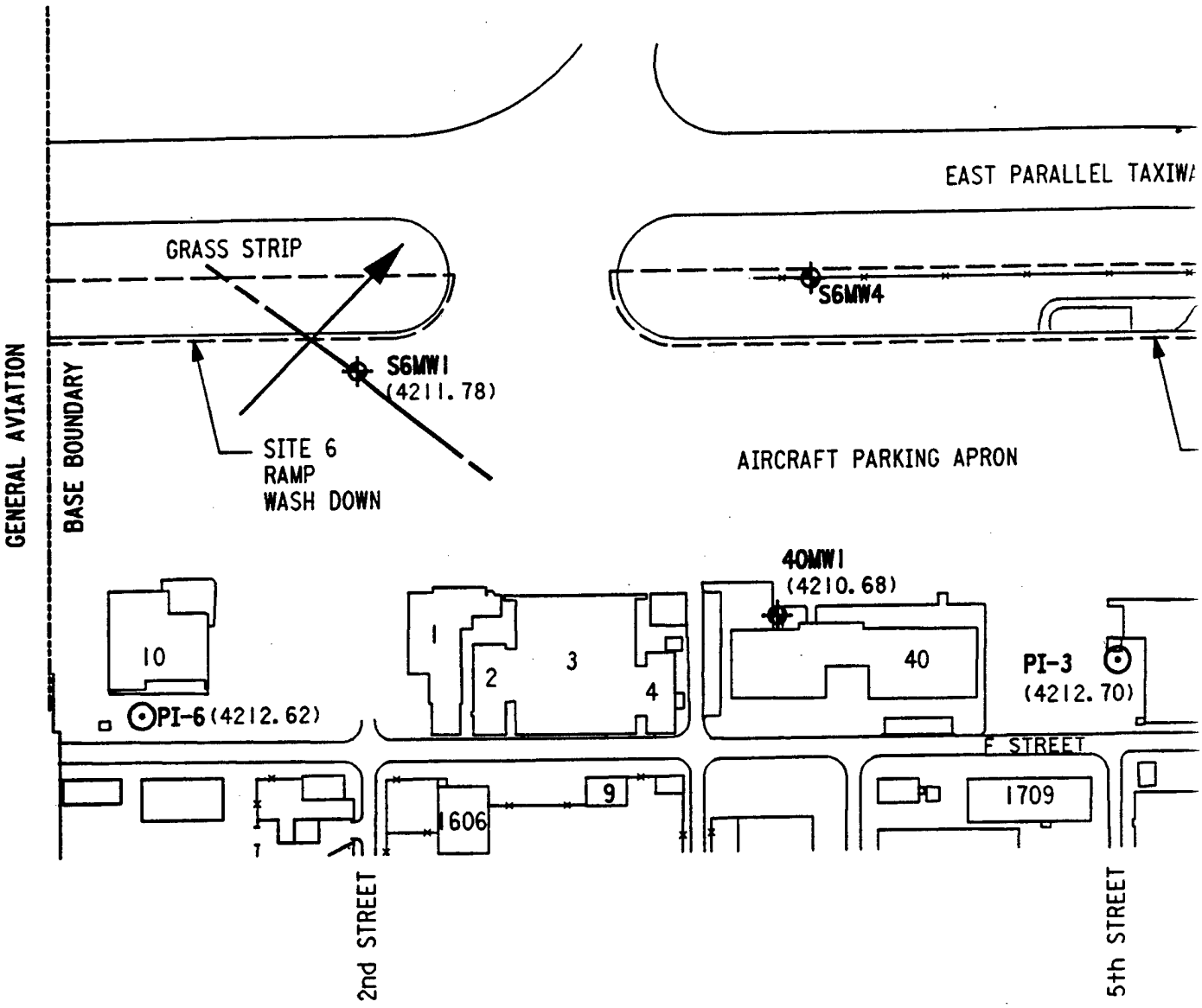
- PI-1 (4209.23) — PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)
- S6MW1 (4210.69) — BACKGROUND SOIL BORING/ MONITORING WELL LOCATION
- 4210.50 — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (ft-MSL)
- GROUNDWATER FLOW DIRECTION (7-95)
- IRP SITE LOCATION

C:\UANG\U619JL95.DGN R02 06.07.96

FIGURE 4.6

GROUNDWATER FLOW
16

151st AREF
SALT LAKE
SA



NOTE:

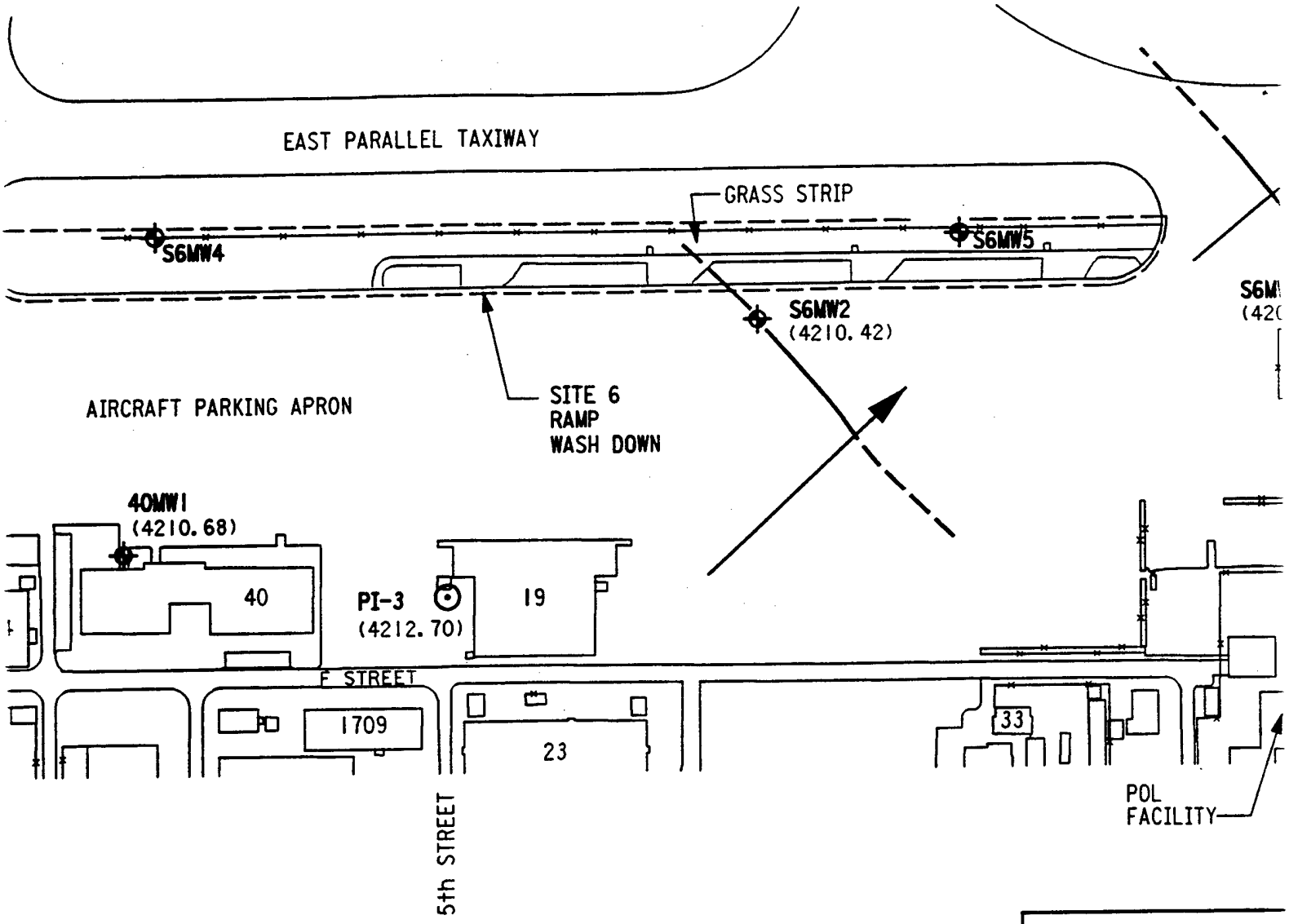
40MW1 is an existing monitoring well from the Site 9 UST investigation (ES, 1993).

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(1)

GROUNDWATER FLOW RATE AND VELOCITY AT SITE 6
16 MARCH 1993

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



FLOW CALCULATIONS

dh-	0.99 ft
dl-	650 ft
i-	1.52×10^{-3} ft/ft
K-	3.52 ft/day
b-	13.75 ft
n-	0.30
q-	7.36×10^{-2} ft^3/day/ft
v-	0.02 ft/day
q-	Kib; v-Ki/n; i-dh/dl

PI-5 (4210.76) ⊙ PIEZOMET WITH GRO ELEVATIO

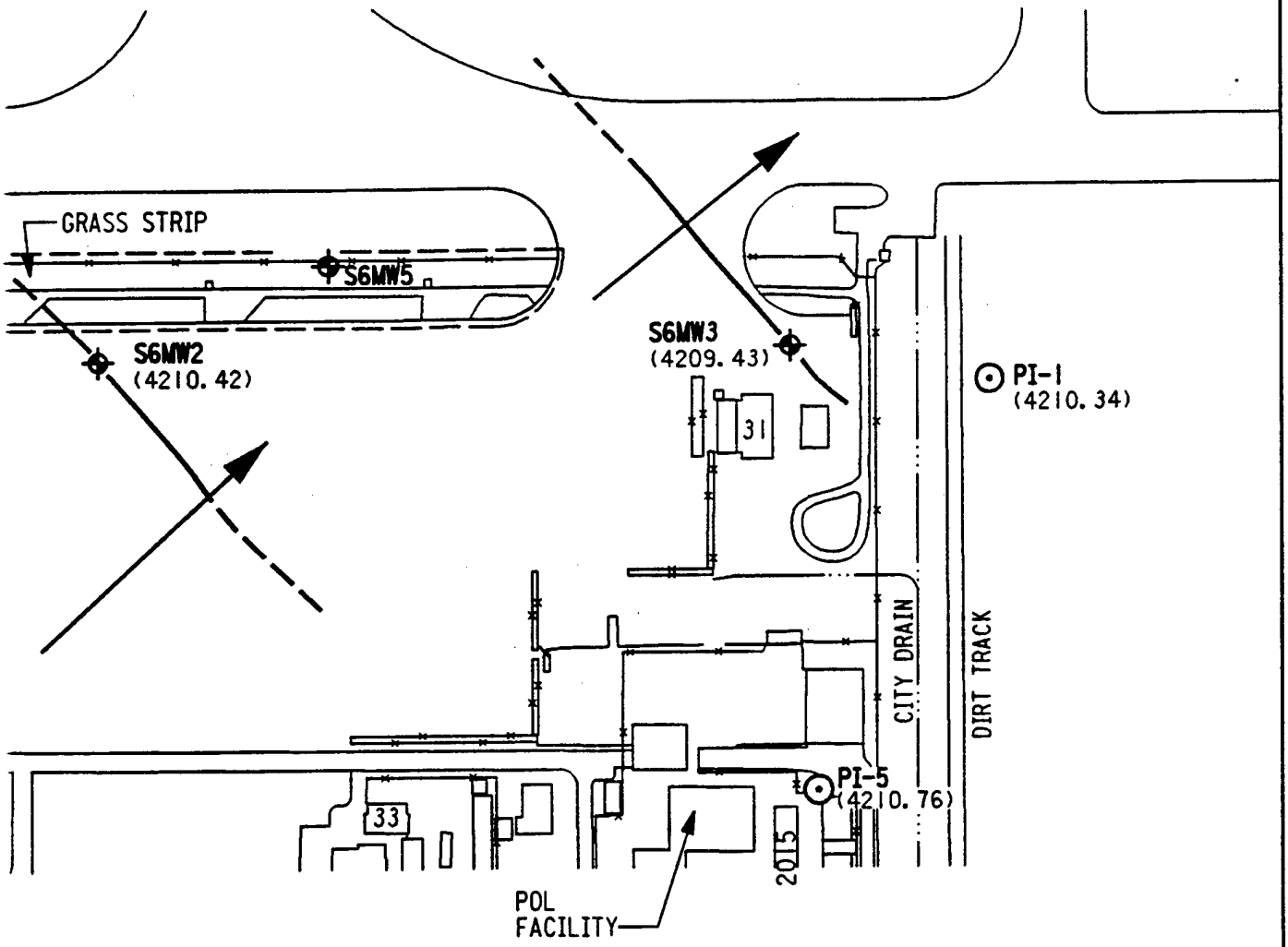
S6MW2 (4210.42) ⊕ MONITORI WITH GRO ELEVATIO

NOTE:

40MW1 is an existing monitoring well from the Site 9 UST investigation (ES, 1993).

) VELOCITY AT SITE 6
1993

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FLOW CALCULATIONS

dh=	0.99 ft
dl=	650 ft
i=	1.52×10^{-3} ft/ft
K=	3.52 ft/day
b=	13.75 ft
n=	0.30
q=	7.36×10^{-2} ft^3/day/ft
v=	0.02 ft/day

q= Kib; v=Ki/n; i=dh/dl

LEGEND

- PI-5 (4210.76) ⊙ PIEZOMETER WITH GROUNDWATER ELEVATION (ft-MSL)
- S6MW2 (4210.42) ⊕ MONITORING WELL WITH GROUNDWATER ELEVATION (ft-MSL)
- GROUNDWATER FLOW DIRECTION (3/93)
- GROUNDWATER ELEVATION EQUIPOTENTIAL (3/93)
- SITE LOCATION

FIGURE 4.65

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4.8.2.3 Soil Contamination Assessment

Soil samples were collected from 10 soil borings at Site 6. The locations of the analytical samples and the types of soil from which the analytical samples were collected are shown in the geological cross-sections of Figures 4.59, 4.60, and 4.61. Twenty soil samples and three field duplicates from the borings were analyzed for VOCs, SVOCs, and TRPH. Target compounds included in each of the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC blanks are provided in Appendix E.

The analytical results for compounds detected in Site 6 soil samples are provided in Table 4.36. The detection limits shown vary slightly due to matrix effects and dry weight calculations. Field duplicates are shown after their associated samples in the table. The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 6 soils are shown on Figure 4.66. Diethylphthalate and bis(2-ethylhexyl)phthalate are separately shown as phthalates on the figure.

The presence of organic compounds in Site 6 soils was minimal. The BTEX compounds toluene, ethylbenzene, and xylenes were detected only in the 2.5- to 4.5 foot interval of SB1, at estimated concentrations of 5 µg/kg, 2 µg/kg, and 5 µg/kg, respectively. Diethylphthalate was present in silty sand at the 6.5- to 9-foot interval of SB1 at a concentration of 56 µg/kg estimated. A maximum site TRPH of 15 mg/kg also occurred at this interval in SB1. bis(2-Ethylhexyl)phthalate was detected at a concentration of 18 µg/kg estimated in silty sand at the 6- to 8.5-foot interval of SB2 and at a concentration of 32 µg/kg estimated in sandy silty clay at the 6- to 8.5-foot interval of SB6. Diethylphthalate was present at a concentration of 550 µg/kg in sandy silt at the 2.5- to 4.5-foot interval of SB8. The PNA pyrene was detected in near surface silty sand at a concentration of 52 µg/kg estimated in the 0- to 2-foot interval of SB9. Soil samples from soil borings SB3, SB4, SB5, SB7, and SB10 did not contain any of the organic compounds discussed above.

Acetone was detected at minor concentrations in the soil samples collected at soil boring SB1 and was not detected in an associated laboratory method blank.

In summary, concentrations of VOCs, PNAs, and phthalates were very minor in Site 6 soils, and the presence of these compounds at detectable concentrations in soil is spotty and isolated.

4.8.2.4 Groundwater Contamination Assessment

Groundwater samples were collected in February 1993 from monitoring wells S6MW1, S6MW2, and S6MW3. At the time of sampling, the three monitoring wells at Site 6 are thought to have been hydraulically downgradient of the grass strip area where the soil borings are located. However, as discussed in Subsection 4.8.2.1, the inferred groundwater gradient at the site was reversed as of 16 March 1993. The samples were

TABLE 4.36
SITE 6 - SOIL BORING
ANALYTES DETECTED
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SALT LAKE CITY, UTAH

Parameter (method) (unit	PRGs	Detection Limit	SB1-2.5-4.5	SB1-6.5-9	SB2-2-4	SB2-6-8.5	SB3-0.5-2.5	SB3-6.5-9	SB4-0-2	SB4-6-8.5	duplicate(a) SB4-8.5-11
VOCs (SW8240) (µg/kg)*											
Dilution Factor	--	--	1	1	1	1	1	1	1	1	1
Acetone	2.7E+07 nc	10.0	5J	4J	12U	12U	12U	13U	12U	14U	14U
Toluene	5.4E+07 nc	5.0	5J	6U	6U	6U	6U	6U	6U	7U	7U
Ethylbenzene	2.7E+07 nc	5.0	2J	6U	6U	6U	6U	6U	6U	7U	7U
Total Xylenes	5.4E+08 nc	5.0	5J	6U	6U	6U	6U	6U	6U	7U	7U
SVOCs (SW8270) (µg/kg)*											
Dilution Factor	--	--	1	1	1	1	1	1	1	1	1
Diethylphthalate	2.16E+08 n	330.0	370U	56J	390U	390U	400U	420U	400U	460U	450U
Pyrene	8.1E+06 nc	330.0	370U	400UJ	390U	390U	400U	420U	400U	460U	450U
bis(2-Ethylhexyl)phtha	45,7000 c	330.0	370U	400U	390U	18J	400U	420U	400U	460U	450U
TRPH (E418.1) (mg/kg)*											
Results	na	10.0	11U	15	12U	10U	12U	13U	12U	10U	10U

TABLE 4.36 - Continued
SITE 6 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB5-0-2	SB5-6-8.5	SB6-2-4	SB6-6-8.5	uplicate (a) SB6-8.5-11	SB7-2-4	SB7-6-8.5	SB8-2.5-4.5
VOCs (SW8010/8020) (µg/kg)*										
Dilution Factor	--	--	1	1	1	1	1	1	1	1
Toluene	.4E+07 n	1.0	1U	1U	1U	1U	1U	1U	1U	1U
Ethylbenzene	.7E+07 n	1.0	1U	1U	1U	1U	1U	1U	1U	1U
Total Xylenes	5.4E+08nc	1.0	1U	1U	1U	1U	1U	1U	1U	1U
SVOCs (SW8270) (µg/kg)*										
Dilution Factor	--	--	1	1	1	1	1	1	1	1
Diethylphthalate	2.16E+08 n	330.0	400U	420U	350U	450U	430U	370U	470U	550
Pyrene	.1E+06 n	330.0	400U	420U	350U	450U	430U	370U	470U	390U
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	400U	420U	350U	32J	430U	370U	470U	390U
TRPH (E418.1) (mg/kg)*										
Results	na	10.0	10U	13U	11U	14U	13U	15U	10U	10U

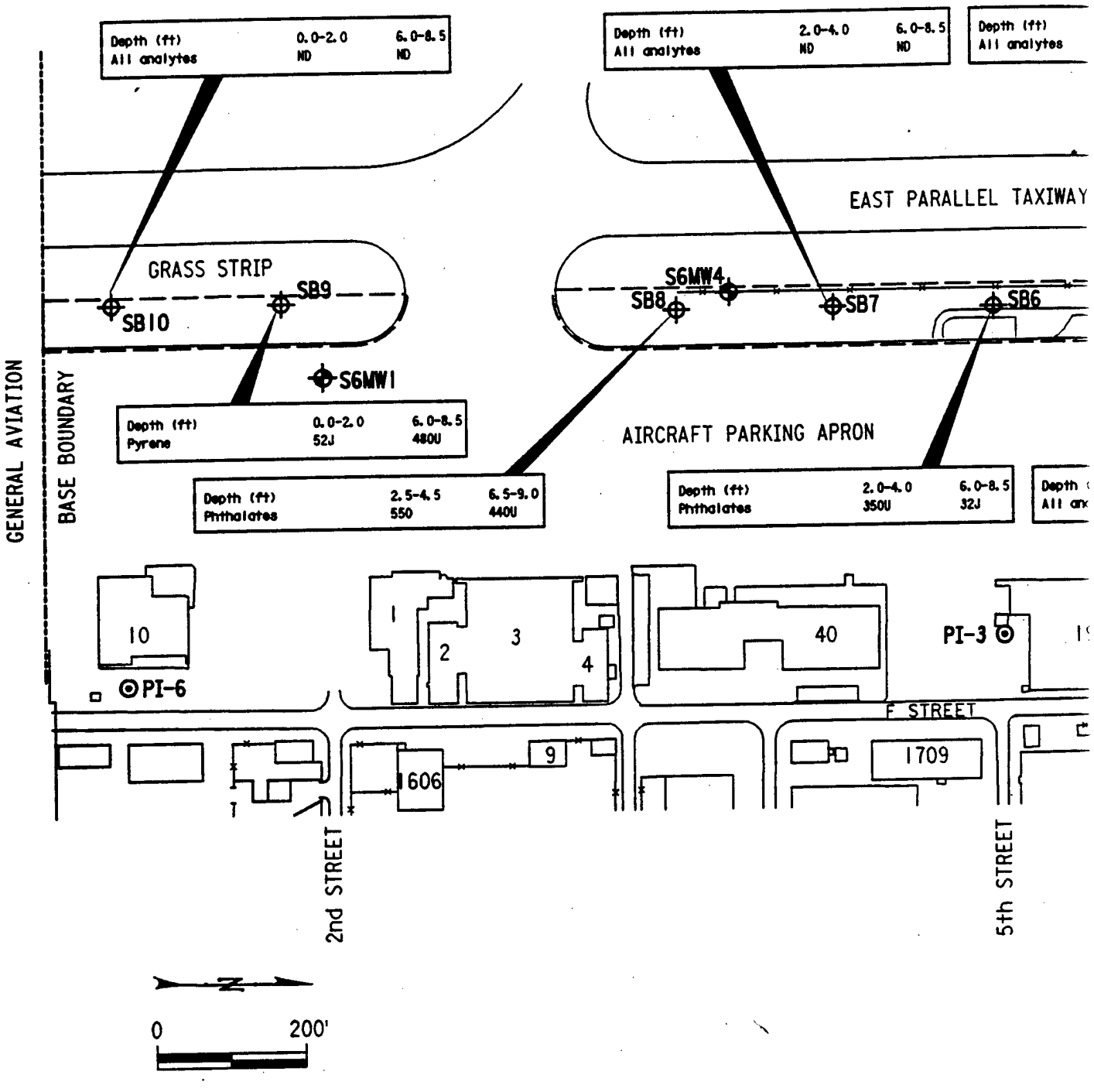
TABLE 4.36 - Continued
SITE 6 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB8-6.5-9	SB9-0-2	SB9-6-8.5	duplicate(a) SB9-8.5-11	SB10-0-2	SB10-6-8.5
VOCs (SW8010/8020) (µg/kg)*								
Dilution Factor	--	--	1	1	1	1	1	1
Toluene	5.4E+07 nc	1.0	1U	1U	1U	1U	1U	1U
Ethylbenzene	2.7E+07 nc	1.0	1U	1U	1U	1U	1U	1U
Total Xylenes	5.4E+08 nc	1.0	1U	1U	1U	1U	1U	1U
SVOCs (SW8270) (µg/kg)*								
Dilution Factor	--	--	1	1	1	1	1	1
Diethylphthalate	2.16E+08 nc	330.0	440U	390U	480U	460U	390U	430U
Pyrene	8.1E+06 nc	330.0	440U	52J	480U	460U	390U	430U
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	440U	390U	480U	460U	390U	430U
TRPH (E418.1) (mg/kg)*								
Results	na	10.0	13U	12U	15U	10U	10U	10U

(a)	Blind duplicate from preceding sample interval.
*	Analyses performed by the ES-Berkeley Laboratory.
na	Not available.
U	Compound not present above the detection limit shown.
J	Concentration of the compound is estimated.
UJ	Compound not detected, but the detection limit is estimated.
Note:	No soil Preliminary Remediation Goals (PRGs) were exceeded; nc - noncarcinogen, c - carcinogen,

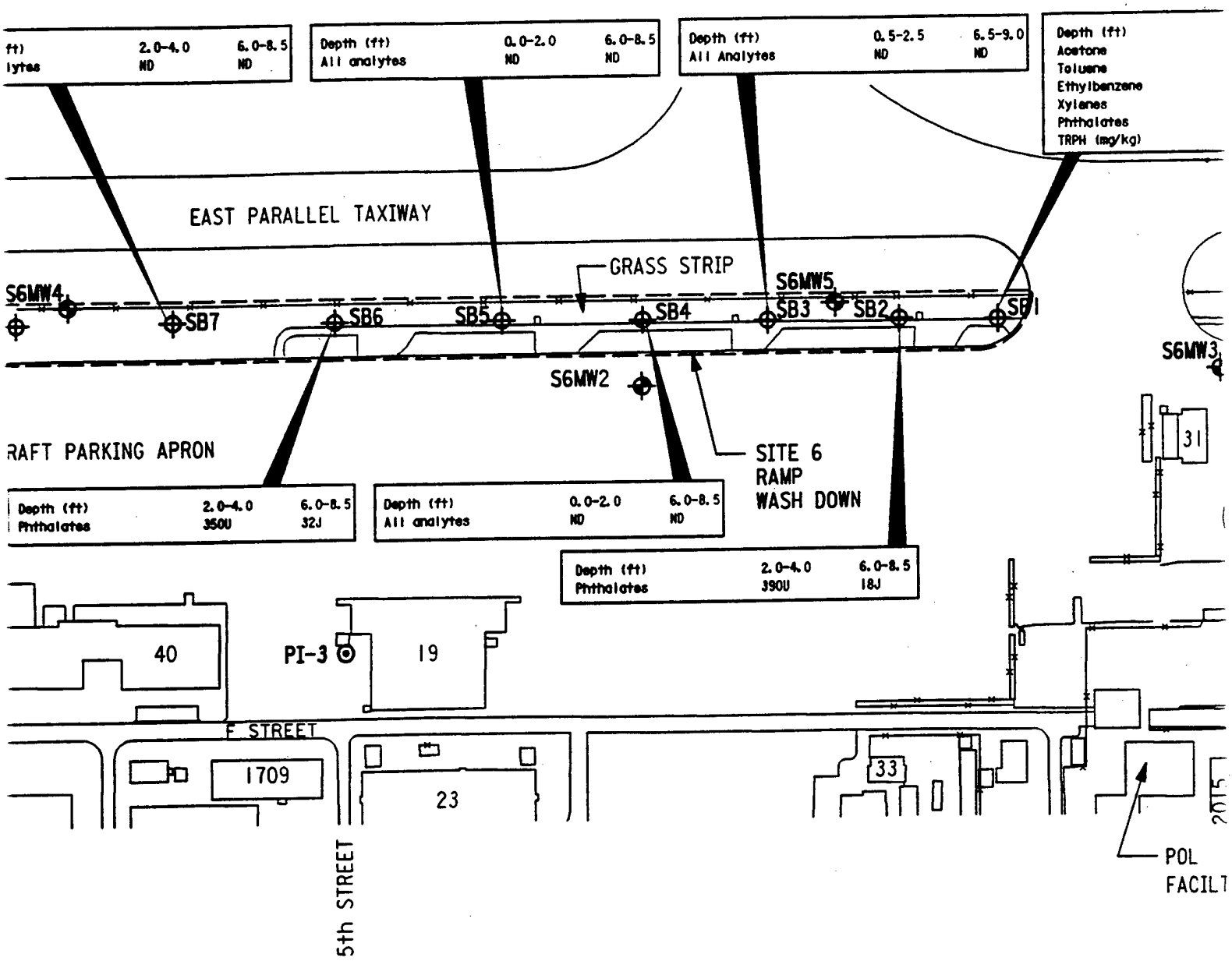
ORGANIC COMPOUNDS DI

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SALT LAKE CITY
SALT LA



ORGANIC COMPOUNDS DETECTED IN SOIL - SITE 6

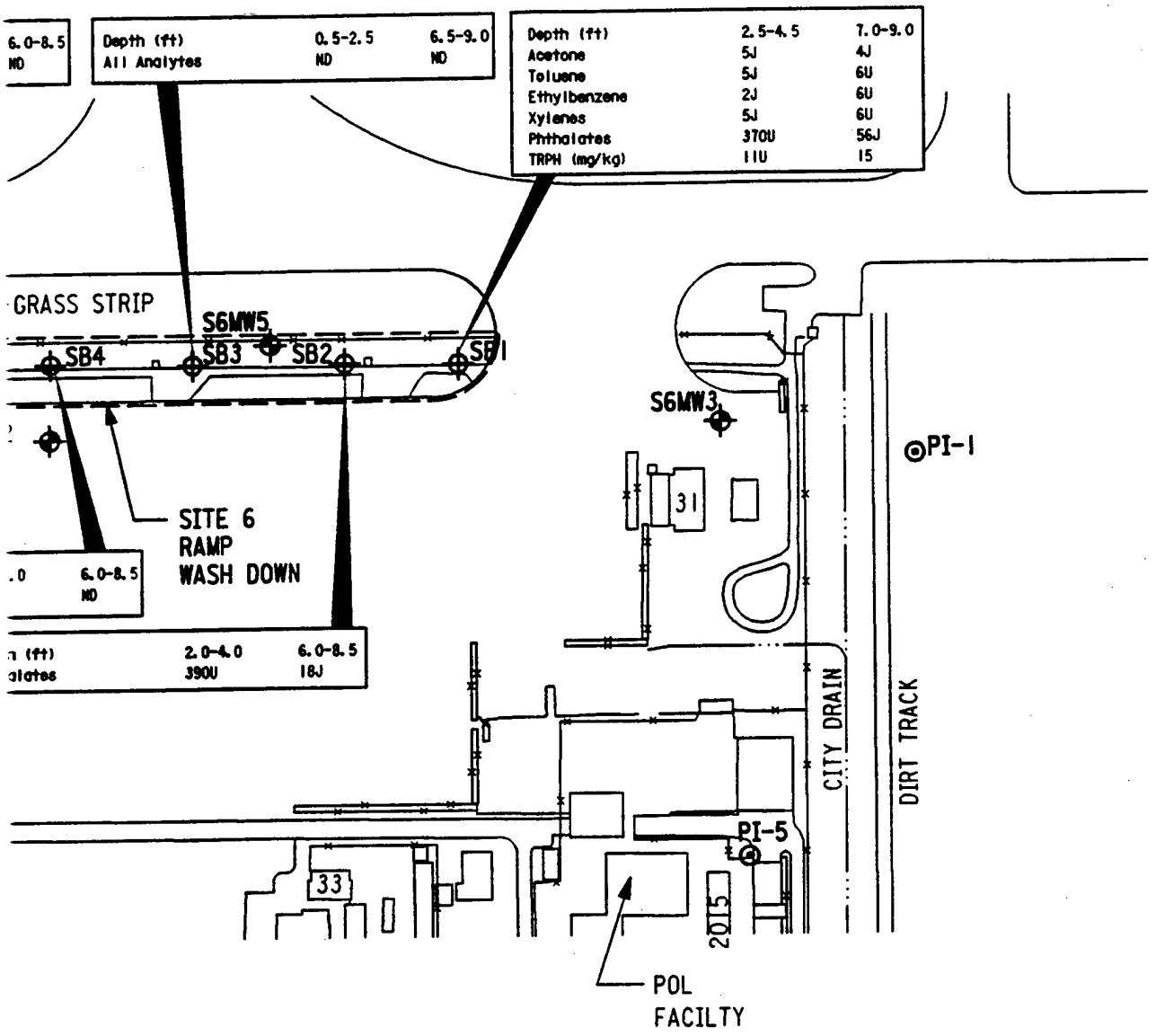
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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE: Concentrations are in ug/kg for soil, except where noted.
J - Concentration is estimated
U - Concentration not present above detection li
ND - Not detected above detection limits

N SOIL - SITE 6

GUARD
AIRPORT



LEGEND

- SOIL BORING
- MONITORING WELL
- BUILDING & BUILDING NUMBER
- SITE LOCATIONS

NOTE: Concentrations are in ug/kg for soil, except where noted.
J - Concentration is estimated
U - Concentration not present above detection limit
ND - Not detected above detection limits

FIGURE 4.66

3

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analyzed for VOCs and SVOCs. Target compounds included in each of the analyses and the detection limits for the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

In August 1995, groundwater samples were collected from monitoring wells S6MW1, S6MW2, and S6MW3, and newly installed monitoring wells S6MW4 and S6MW5. The samples were analyzed for VOCs, SVOCs, and arsenic. These wells were resampled in November 1995 for arsenic only due to improper laboratory analysis (the water from the August 1995 sampling was not retained by the lab). Arsenic was analyzed at this non-metals site and all other sites for this second round of sampling to provide background information on arsenic concentrations in this area not affected by metals contamination and to evaluate the basewide distribution of arsenic in shallow groundwater. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.2, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 2, Appendix E.

Field measurements of specific conductance, pH, and temperature were made on each sample at the time of sample collection. These measurements are provided in Tables 4.8 and 4.9. In February 1993, specific conductance measured 1,728 microsiemens/cm, 1,836 microsiemens/cm, and 1,684 microsiemens/cm at S6MW1, S6MW2, and S6MW3, respectively. The corresponding pH of the samples were 8.1, 8.4, and 7.4. Specific conductance measured significantly higher in Site 6 monitoring wells when sampled in August 1995, with a range of 6,050 microsiemens/cm to 16,350 microsiemens/cm. The pH ranged from 7.57 to 8.94.

Analytical results of the groundwater samples collected at Site 6 are provided in Tables 4.37 and 4.38. The findings are discussed below. Arsenic detected at the site (Table 4.38) is considered to be representative of background conditions for this metal in this area of the base.

Organic Compounds. Organic compounds were detected above the method detection limits in only one groundwater sample from the Site 6 monitoring wells, as shown on Figure 4.67 and the tables. Total xylenes and 1,4-dichlorobenzene were detected at low estimated concentrations at S6MW3 from the August 1995 sampling event.

4.8.3 Site 6 - Conclusions

The detection of organic compounds in Site 6-Ramp Washdown soils were isolated and concentrations were very minor (Figure 4.66). Concentrations were compared to PRGs and none of these health-based risk criteria were exceeded.

Groundwater at Site 6 was sampled and analyzed twice for VOCs and SVOCs. For the 1993 sampling event, none of these analytes were detected in groundwater collected from S6MW1, S6MW2, and S6MW3 (Figure 4.67). Two additional monitoring wells,

TABLE 4.37
SITE 6 - GROUNDWATER
ANALYTES DETECTED (February 1993)
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Parameter (method) (units)	MCLs	S6MW1	S6MW2	S6MW3
VOCs (SW8010/8020) (µg/L)*				
Results	--	ND	ND	ND
SVOCs (SW8270) (µg/L)*				
Results	--	ND	ND	ND

* **Analyses were performed by the ES-Berkeley Laboratory.**
ND **All analytes were not detected; refer to Table H.1 for list compounds and detection limits.**

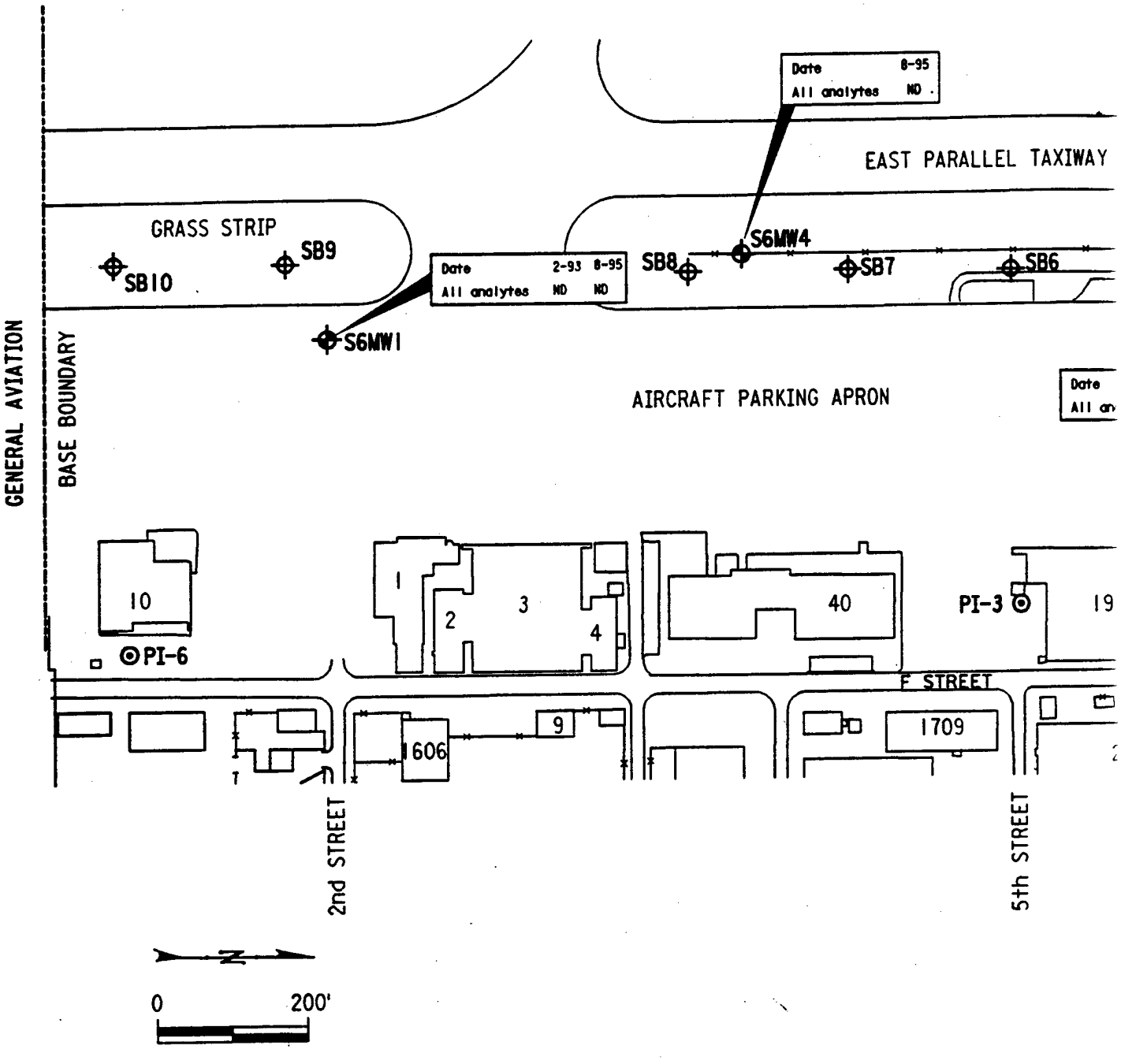
TABLE 4.38
SITE 6 - GROUNDWATER
ANALYTES DETECTED (August 1995)

Parameter (method) (units)	MCLs	Detection Limit	S6MW1	S6MW2	S6MW3	S6MW4	S6MW5
VOCs (SW8010/8020) (µg/L)**							
Dilution Factor	--	--	1	1	1	1	1
1,4-Dichlorobenzene	75	0.5	0.50U	0.50U	0.18J	0.50U	0.50U
Xylenes (total)	10,000	0.5	0.50U	0.50U	0.33J	0.50U	0.50U
SVOCs (SW8270) (µg/L)**							
Results	--	--	ND	ND	ND	ND	ND
Arsenic (SW7060) (µg/L)**							
Results	50	2.0	***190J***	*45J	***140J***	***91J***	***340J***

* **These arsenic concentrations are from November 1995 resampling.**
** **Analyses were performed by DataChem Laboratories.**
U **Compounds not present at the detection limit shown.**
J **Concentration of the compound is estimated.**
ND **All analytes were not detected; refer to Table H.2 for list compounds and detection limits.**
Note: **Concentrations exceeding Maximum Contaminant Levels (MCLs) are shown in bold italic.**

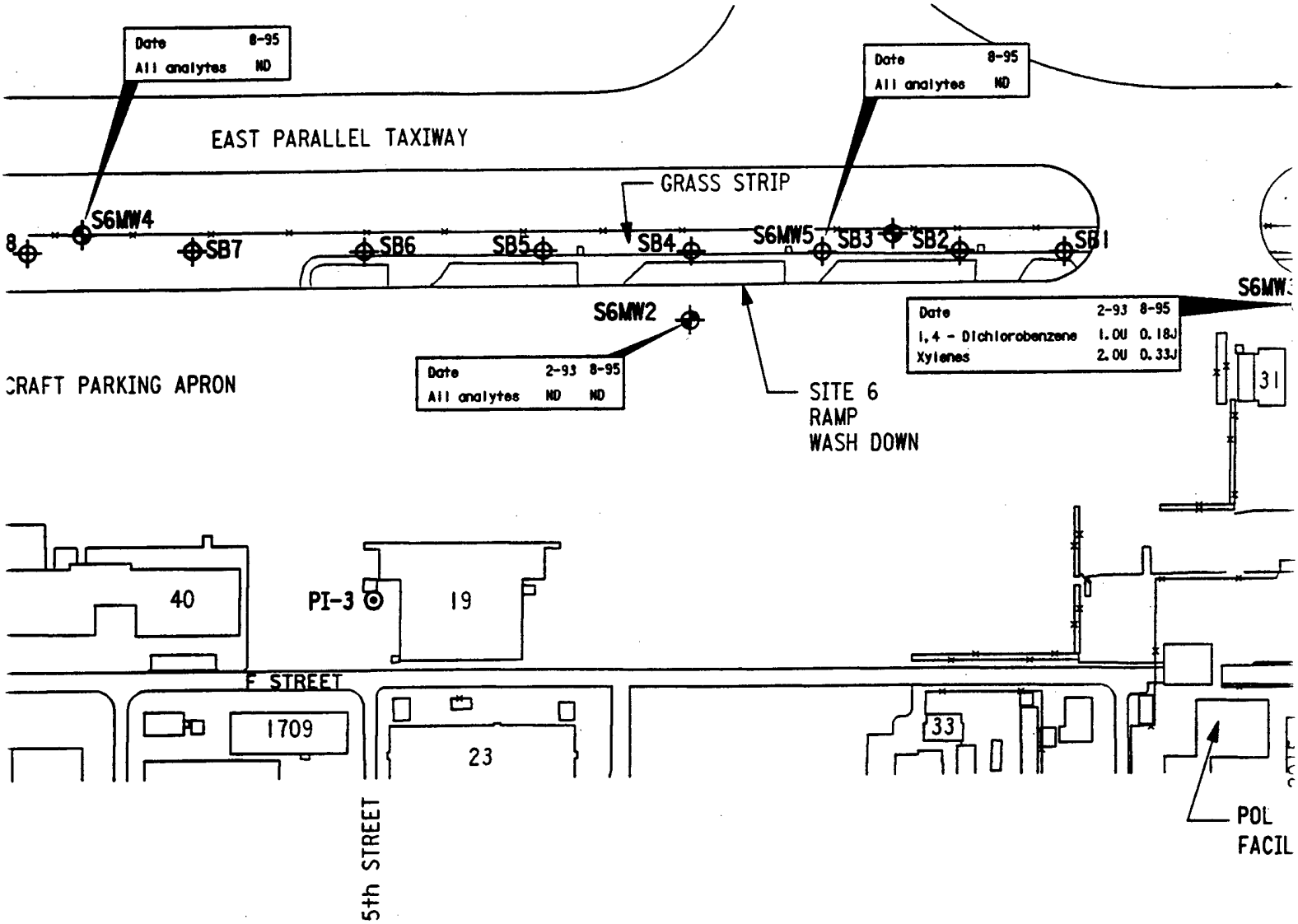
ORGANIC COMPOUNDS DETEC

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SALT LA



ORGANIC COMPOUNDS DETECTED IN GROUNDWATER - SITE 6

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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

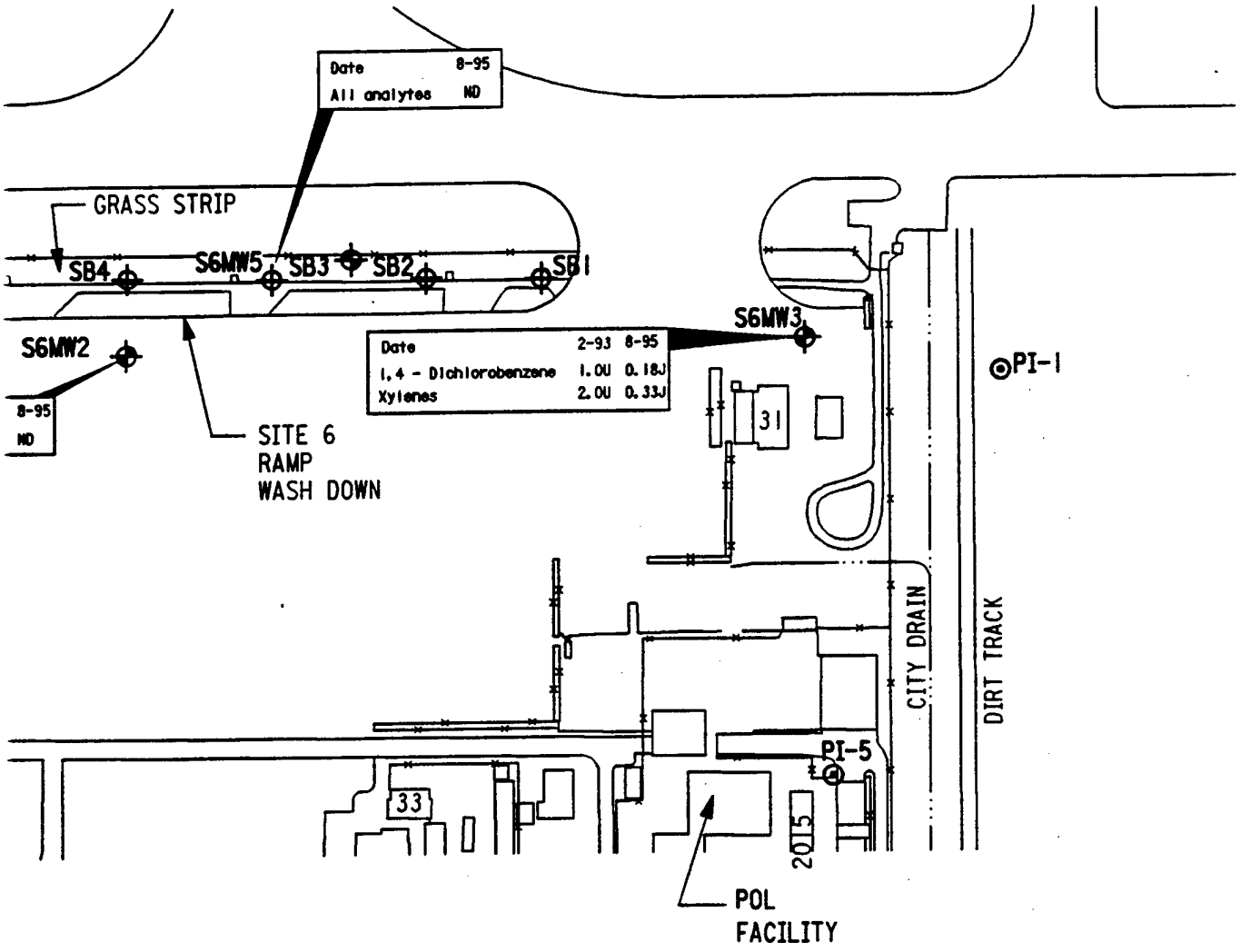


NOTE:

Concentrations are in ug/L for groundwater.
ND - Not detected above detection limits
J - Concentration is estimated
u - Concentration not present above the detection l

N GROUNDWATER - SITE 6

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UTAH



LEGEND

- SOIL BORING
- MONITORING WELL
- BUILDING & BUILDING NUMBER
- SITE LOCATIONS

NOTE:

Concentrations are in ug/L for groundwater.
ND - Not detected above detection limits
J - Concentration is estimated
u - Concentration not present above the detection limit

FIGURE 4.67

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S6MW4 and S6MW5, were installed in 1995 and all five wells were sampled. Very low concentrations of 1,4-dichlorobenzene and xylenes were detected in groundwater collected from S6MW3. The general lack of soil and groundwater contamination at the site implies that the reported fuel spills did not adversely impact these media and/or that the fuel hydrocarbons have degraded. Arsenic was also analyzed in the 1995 sampling event to evaluate background concentrations of this metal. Concentrations of arsenic exceeding MCLs were detected in four of the five samples. The presence of arsenic at this non-metals site supports the conclusion that dissolved arsenic is generally ubiquitous in shallow groundwater at the Base and is indigenous to the shallow aquifer.

The groundwater flow direction, hydraulic gradient, and flow rate at the site are subject to change (Figures 4.62, 4.63, and 4.64). The prevailing flow direction at the site was later determined to be to the west-northwest, which means that S6MW1, S6MW2, and S6MW3 were installed upgradient of the site. Monitoring wells S6MW4 and S6MW5 were installed downgradient of the site in the prevailing direction of groundwater flow. The groundwater velocity at the north end of the site was of 0.02 ft/day in March 1993. Under the March 1993 conditions it would take groundwater approximately 13 to 14 years to move 100 feet downgradient.

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4.9 SITE 7 - OIL SLUDGE POND

4.9.1 Field Program

4.9.1.1 Screening Activities

The following activity was conducted at Site 7 during the screening phase of the SI:

- Performance of a soil gas survey.

A soil gas survey was used to determine a possible source area and the approximate extent of soil contamination for optimal placement of soil borings.

Soil gas samples were collected at 20 points during the Site 7 soil gas survey. An equidimensional grid pattern with a 25-foot spacing between points was established for the survey. Soil gas samples were collected at approximately 4.5 feet BLS at all of the sampling locations. The sampling points with total BTEX concentrations and corresponding benzene fractions are identified in Figure 4.68. Analytical results are presented in Table 4.39.

Soil gas samples from Site 7 exhibited minimal BTEX concentrations, with benzene showing the highest concentration at the sampling locations. Soil gas sample A3 contained only benzene at a concentration of 1.9 ppmv. Toluene was the only other detectable BTEX component and was present at concentrations of 0.75 ppmv and 1.7 ppmv in samples A1 and C4, respectively. Five other sampling locations exhibited toluene peaks on the original chromatograms, but at some value below the 0.5 ppmv quantification limit of the GC calibration. The soil gas survey did not delineate a point source area of BTEX contamination at Site 7, although, BTEX components were detected at the periphery of the survey grid.

4.9.1.2 Confirmation and Optional Activities

The following activities were conducted during the confirmation/optional phase of the Site 7 SI:

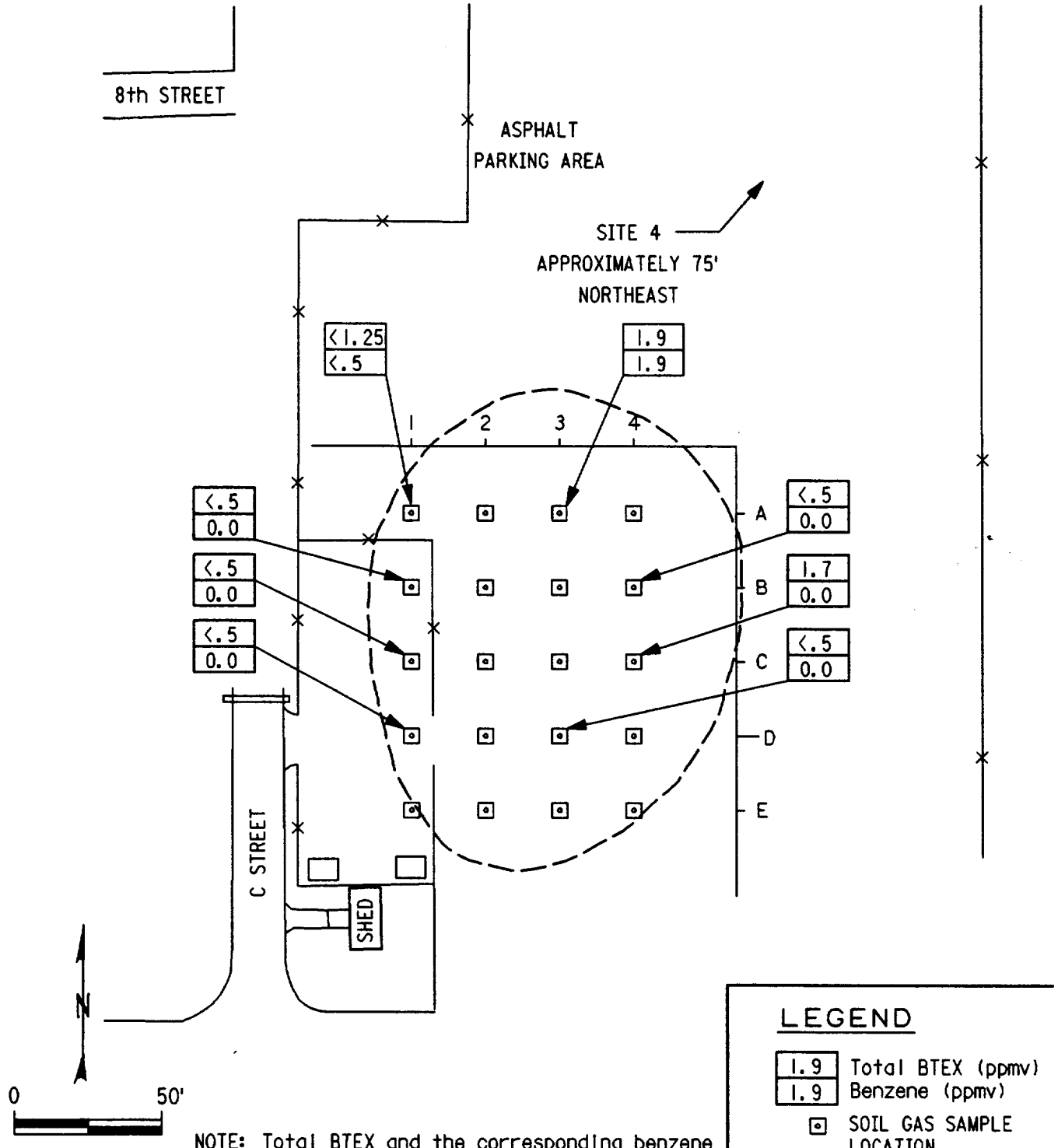
- Advanced 10 soil borings;
- Selected and analyzed 16 soil samples;
- Installed one downgradient monitoring well;
- Collected and analyzed two downgradient groundwater samples;
- Installed one upgradient monitoring well; and
- Collected and analyzed two upgradient groundwater samples.

Results of the soil gas survey at Site 7 did not indicate a specific area of elevated BTEX contamination. Initially, three confirmational soil borings (SB1, SB2, and SB3), were advanced sequentially north to south in the center of the soil gas grid to ascertain the presence of contamination. Soil boring SB1 was placed near soil gas point A3 where 1.9 ppmv benzene was detected. Evidence of hydrocarbon staining and elevated

FINAL

SOIL GAS SURVEY RESULTS - SITE 7

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NOTE: Total BTEX and the corresponding benzene fraction of the total BTEX are shown. Where a less than sign appears, the compounds were detected at less than the GC IDL of 0.5 ppmv.

LEGEND

- 1.9 / 1.9 — Total BTEX (ppmv) / Benzene (ppmv)
- SOIL GAS SAMPLE LOCATION
- FENCE
- SITE LOCATION

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FIGURE 4.6

TABLE 4.39
SITE 7 - SOIL GAS SURVEY RESULTS
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Point	Benzene ppm v	Toluene ppm v	Ethylbenzene ppm v	Xylenes ppm v	Total BTEX ppm v
A1	<0.5	0.75	ND	ND	<1.25
A2	ND	ND	ND	ND	ND
A3	1.9	ND	ND	ND	1.9
A4	ND	ND	ND	ND	ND
B1	ND	<0.5	ND	ND	<0.5
B2	ND	ND	ND	ND	ND
B3	ND	ND	ND	ND	ND
B4	ND	ND	ND	<0.5	<0.5
C1	ND	<0.5	ND	ND	<0.5
C2	ND	ND	ND	ND	ND
C3	ND	ND	ND	ND	ND
C4	ND	1.7	ND	ND	1.7
D1	ND	<0.5	ND	ND	<0.5
D2	ND	ND	ND	ND	ND
D3	ND	ND	ND	<0.5	<0.5
D4	ND	ND	ND	ND	ND
E1	ND	ND	ND	ND	ND
E2	ND	ND	ND	ND	ND
E3	ND	ND	ND	ND	ND
E4	ND	ND	ND	ND	ND

ND-Not detected (BTEX compounds were not observed on chromatograms).
<0.5-BTEX compounds observed on original chromatograms but were not quantified.

headspacereadings during screening of soil boring samples indicated that the soils beneath Site 7 were contaminated at soil boring locations SB1 and SB2. Seven additional (optional) soil borings were eventually placed to evaluate the extent of contamination at the site. Figure 4.69 shows the locations of the soil borings at Site 7. The soil borings were drilled sequentially beginning with SB1.

One or two soil samples from each of the ten soil borings were selected for chemical analyses based on the results of headspace screening and proximity to the water table; COCs are provided in Appendix D. Groundwater was encountered at a depth of approximately 7 to 8 feet BLS during initial drilling in early December 1992. Groundwater was encountered at a depth of 5 to 6 feet BLS while drilling optional soil borings, approximately 2 weeks to 3 weeks later. Apparently, the water level increased in response to seasonal groundwater recharge. Due to the rise in water levels and the presence of near-surface fill material only one bottom-hole soil sample from the later, optional soil borings was selected for chemical analysis (see Subsection 3.6 for discussion). Headspace screening results, sampling intervals, and the sediment types of each boring were logged and recorded. Detailed soil boring descriptions are provided in the soil boring logs, Appendix G. A correlation of the soil BTEX results of field GC screening versus the analytical laboratory is provided in Appendix J.

One downgradient monitoring well, S7MW1, and one upgradient well, S7MW2, were installed at the locations shown in Figure 4.69. Monitoring well S7MW1 is screened in the interval from 5.26 feet to 15.26 feet BLS and monitoring well S7MW2 is screened in the interval from 4.84 feet to 14.84 feet BLS. Well construction details for Site 7 monitoring wells are provided in Table G.1, Appendix G. Well soil boring logs with well construction diagrams are also provided in Appendix G. Following development, the monitoring wells were purged and sampled, and the samples were analyzed for the specified chemical constituents. Well development and sampling forms are provided in Appendix C.

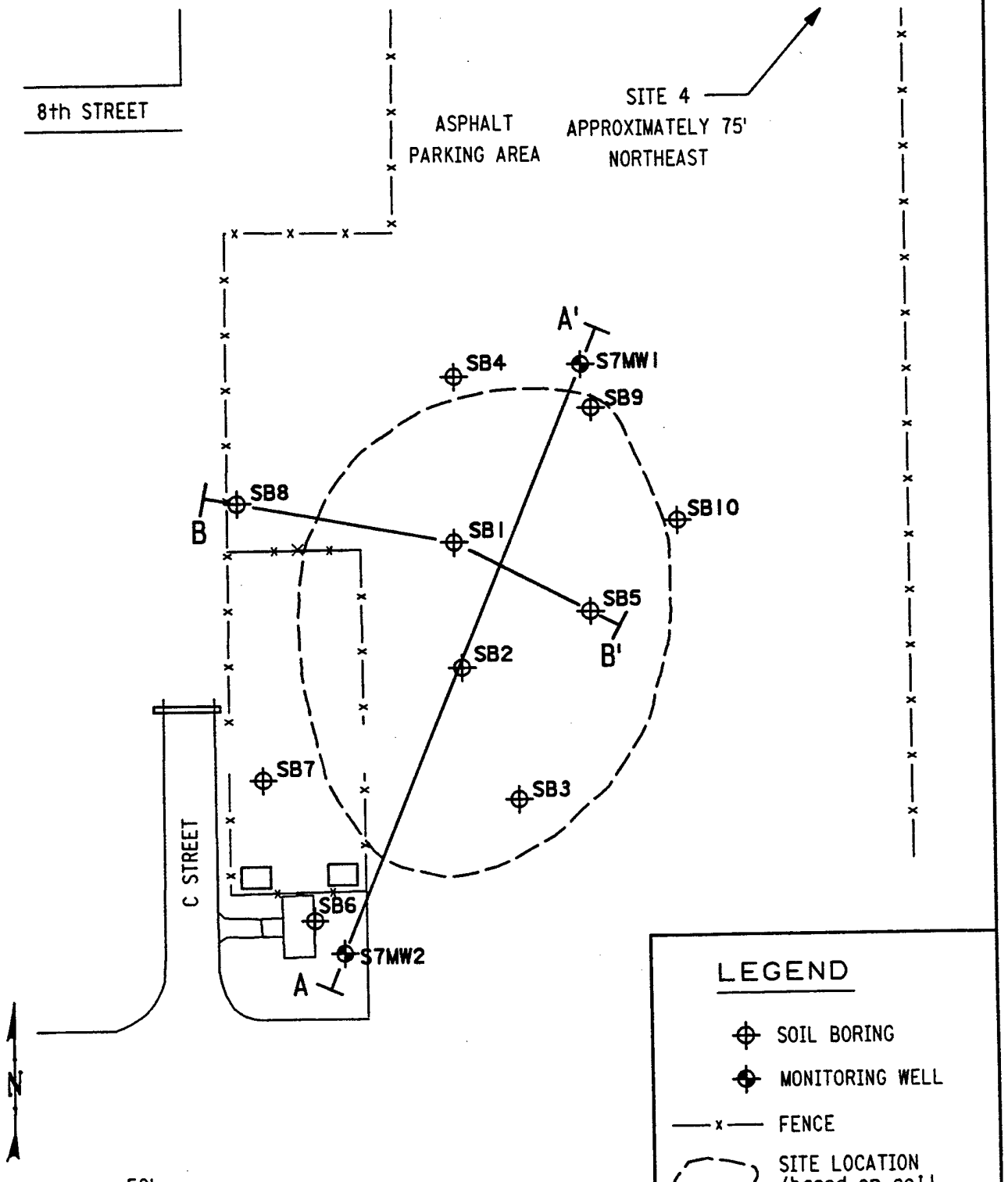
4.9.2 Results of Site Investigation

4.9.2.1 Geology and Hydrogeology

Geological cross-sections of Site 7 stratigraphy, at the locations shown in Figure 4.69, are presented as Figures 4.70 and 4.71. Site 7 is underlain by a clayey sand and silty sand, organic silt, and sand, depositional sequence. The upper 2 feet of material is a sand, clay, silt, and gravel fill. From 2 feet BLS extending to 4 feet BLS, a discontinuous greenish-gray, olive, or gray, clayey sand or silty sand is present. A small lens of sandy silt is interbedded in clayey sand at this depth at SB2. At 4 feet BLS, a layer of black organic silt or dark gray silt and clay of variable thickness is present to an average depth of about 9 feet. The layer extends to a depth of 11 feet at S7MW1. This organic deposit contains gastropod shells, plant roots and rhizomes, and peat material. The organic silt appears to be a marsh or swamp deposit. A small lens of silty sand approximately 2-feet-thick is interbedded in the organic layer at a depth of 6- to 8-feet BLS. At approximately 8 to 11 feet BLS, the black organic silt and clay grades to a gray fine to coarse sand. The

SOIL BORING, MONITORING WELL, AND GEOLOGICAL CROSS-SECTION LOCATIONS - SITE 7

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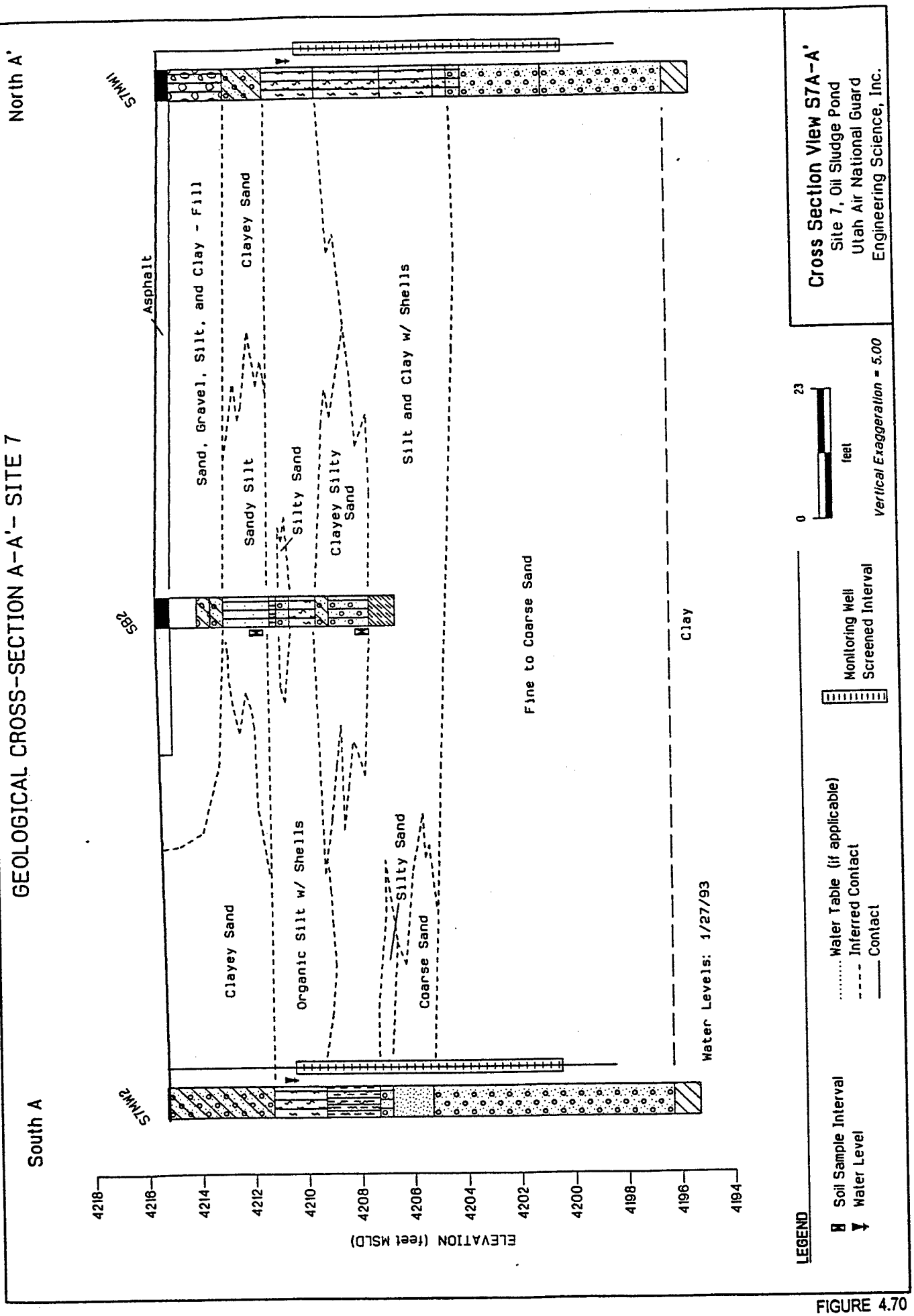

GEOLOGICAL CROSS-SECTION A-A'- SITE 7
South A
North A'
STMW1
STMW2
SB2
Asphalt
Sand, Gravel, Silt, and Clay - Fill
Clayey Sand
Sandy Silt
Silty Sand
Clayey Silty Sand
Silt and Clay w/ Shells
Fine to Coarse Sand
Clay
Clayey Sand
Organic Silt w/ Shells
Silty Sand
Coarse Sand
Water Levels: 1/27/93
ELEVATION (feet MSLD)
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
4196
4194
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval
0
23
feet
Vertical Exaggeration = 5.00
Cross Section View S7A-A'
Site 7, Oil Sludge Pond
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.70

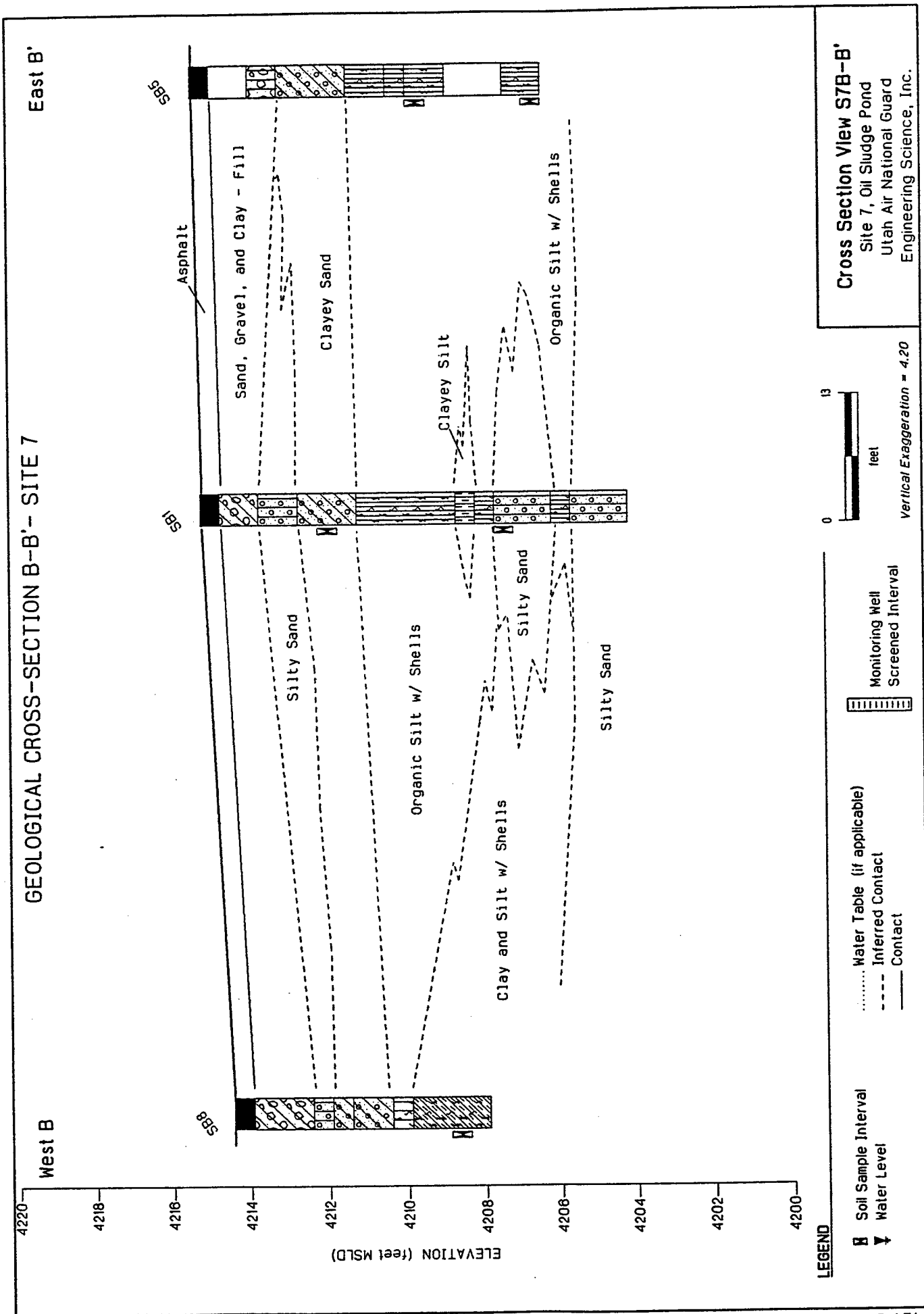

GEOLOGICAL CROSS-SECTION B-B'- SITE 7
West B
East B'
SB8
SB1
SB6
Asphalt
Sand, Gravel, and Clay - Fill
Clayey Sand
Clayey Silt
Organic Silt w/ Shells
Silty Sand
Organic Silt w/ Shells
Silty Sand
Clay and Silt w/ Shells
Silty Sand
ELEVATION (feet MSLD)
4220
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
LEGEND
Soil Sample Interval
Water Level
Water Table (if applicable)
Inferred Contact
Contact
Monitoring Well
Screened Interval
0
13
feet
Vertical Exaggeration = 4.20
Cross Section View S7B-B'
Site 7, Oil Sludge Pond
Utah Air National Guard
Engineering Science, Inc.

FIGURE 4.71

sand is comprised of quartz, feldspar, mica, and ferromagnesian silicate minerals of granitic provenance. This sand terminates at a clay layer at approximately 20 feet BLS.

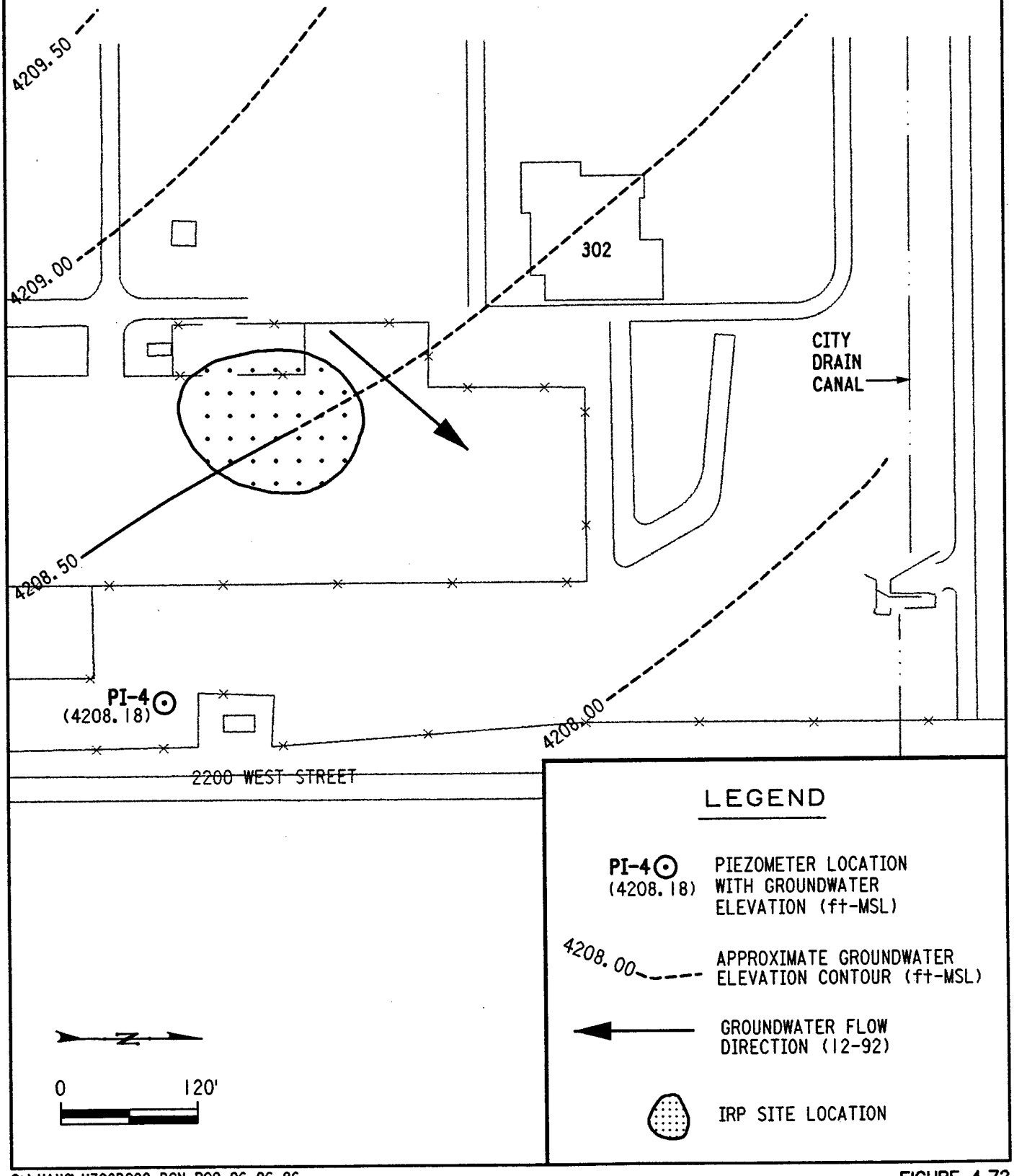
Basewide groundwater levels were measured on 28 December 1992, 16 March 1993, and 19 July 1995 to determine hydraulic gradients and groundwater flow directions at the sites (Figures 4.1, 4.2, 4.3). Extrapolated groundwater contour maps of the Site 7 area for these respective dates are provided as Figures 4.72, 4.73, and 4.74. The purpose of the 28 December 1992 and 19 July 1995 measurements was to establish groundwater flow directions prior to well placement. The purpose of the 16 March 1993 round of groundwater measurements was to establish hydraulic gradients and flow directions for groundwater flow rate calculations at the sites. March 1993 was the only instance when all of the site monitoring wells and basewide piezometers were measured on the same day during the primary 1992-93 investigation of Sites 1 through 7. As shown in Figure 4.73, the groundwater flow direction at Site 7 was to the north on this date. The northerly flow direction on 16 March 1993 does not indicate much of a change from the north-northeasterly flow direction at the site inferred from the 28 December 1992 groundwater gradient (Figure 4.72). The groundwater flow direction also was north-northeasterly on 19 July 1995 (Figure 4.74). For a comparison of groundwater levels in basewide piezometers and monitoring wells see Tables 4.1, 4.2, and 4.3. The variation in groundwater elevations, hydraulic gradients, and flow directions among these dates is probably due to the shallow aquifer's response to seasonal groundwater recharge and discharge. Therefore, the local hydraulic flow conditions at this site and the other sites is considered to be seasonally variable.

4.9.2.2 Groundwater Flow Calculations

The calculated groundwater flow rate and velocity across the site were determined from 16 March 1993 groundwater levels between monitoring wells S7MW1 and S7MW2, as shown in Figure 4.75. The hydraulic conductivity (K) of the silt and fine sand in the screened interval of S7MW1 was estimated from a slug test at the well to be 1.13 ft/day. The hydraulic conductivity of the silt and sand in the screened interval of S7MW2 was estimated from a slug test at the well to be 5.52 ft/day. Average hydraulic conductivity of the porous media between these two wells is 3.33 ft/day. However, shallow subsurface groundwater flow directly downgradient of Site 7 is reduced by the relatively lower hydraulic conductivity of the porous media in the vicinity of S7MW1 and S4MW1 farther north. As shown on Figure 4.75, the hydraulic gradient (i) across Site 7 is established in the direction of groundwater flow perpendicular to hydraulic head equipotentials at the wells and was approximately 0.35 feet (dh) in 210 feet (dl) or 1.67×10^{-3} ft/ft (i=dh/dl). Using Darcy's Law (q=Kib), the volumetric flow rate (q) per unit width of saturated aquifer thickness was 8.34×10^{-2} ft^3/day/ft between the wells on 16 March 1993. The corresponding groundwater velocity (v) is estimated from the equation (v=Ki/n) and the parameters above to be approximately 0.02 ft/day, assuming an effective porosity (n) of 30 percent. Hydrogeological data and calculations are presented in Tables I.1 and I.2, of Appendix I. Field methods, methods of analysis, slug test results, and a

GROUNDWATER GRADIENT MAP - SITE 7
28 DECEMBER 1992

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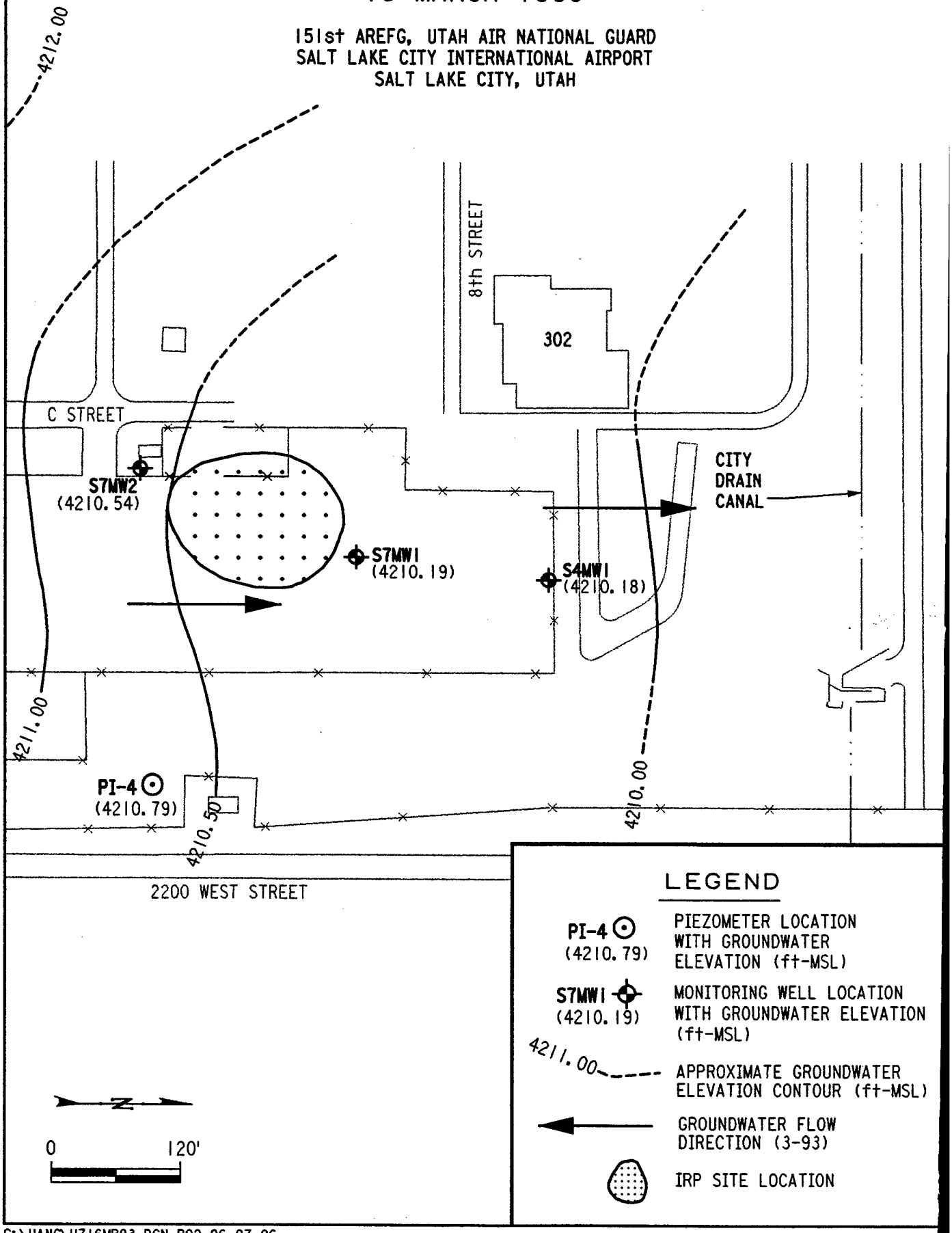


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FIGURE 4.72

GROUNDWATER GRADIENT MAP - SITE 7
16 MARCH 1993

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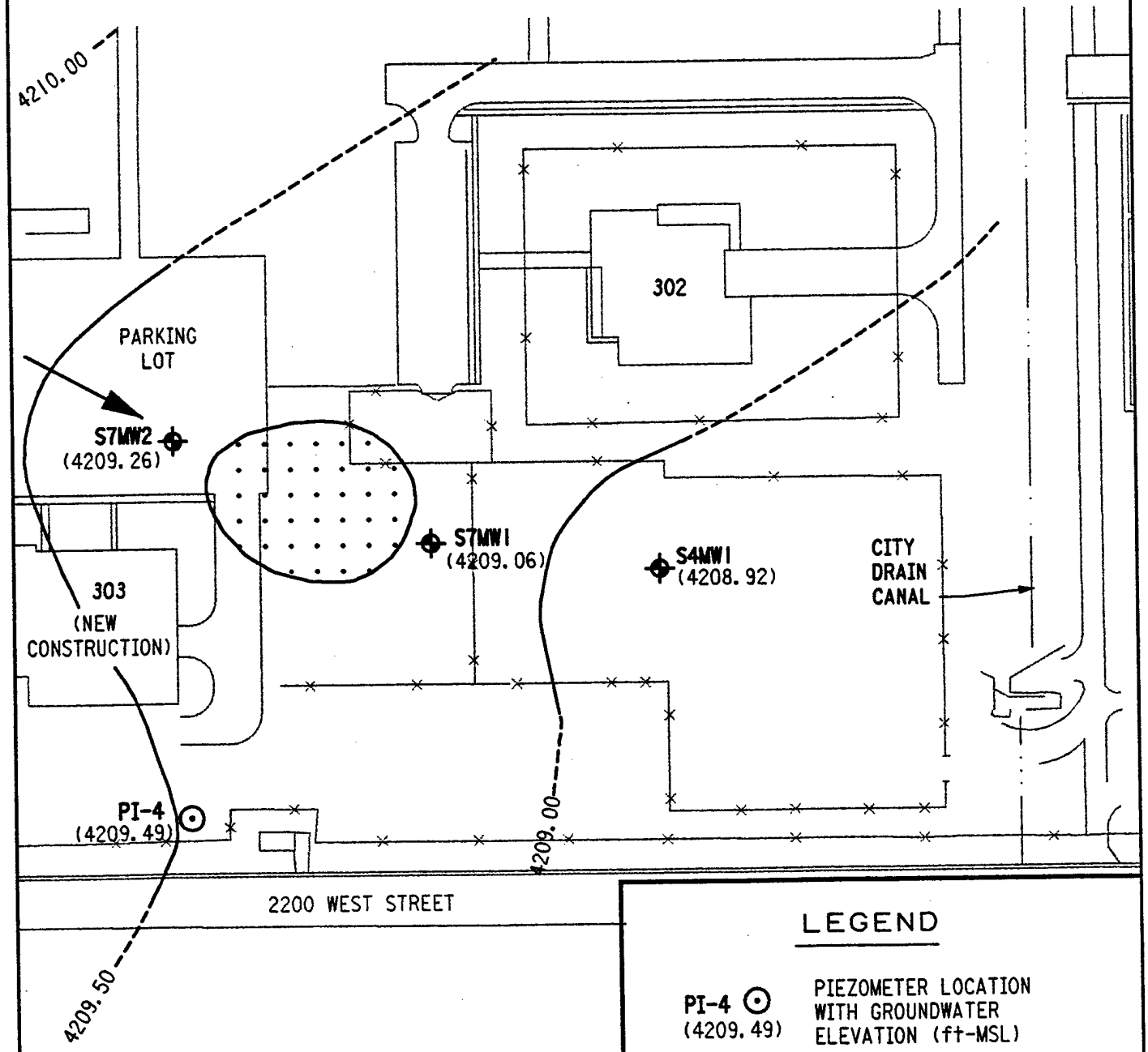


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FIGURE 4.7

GROUNDWATER GRADIENT MAP - SITE 7
19 JULY 1995

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LEGEND

- PI-4 (4209.49) — PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)
- S7MW1 (4209.06) — MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION (ft-MSL)
- 4209.00 — APPROXIMATE GROUNDWATER ELEVATION CONTOUR (ft-MSL)
- GROUNDWATER FLOW DIRECTION (7-95)
- IRP SITE LOCATION

N

0 120'

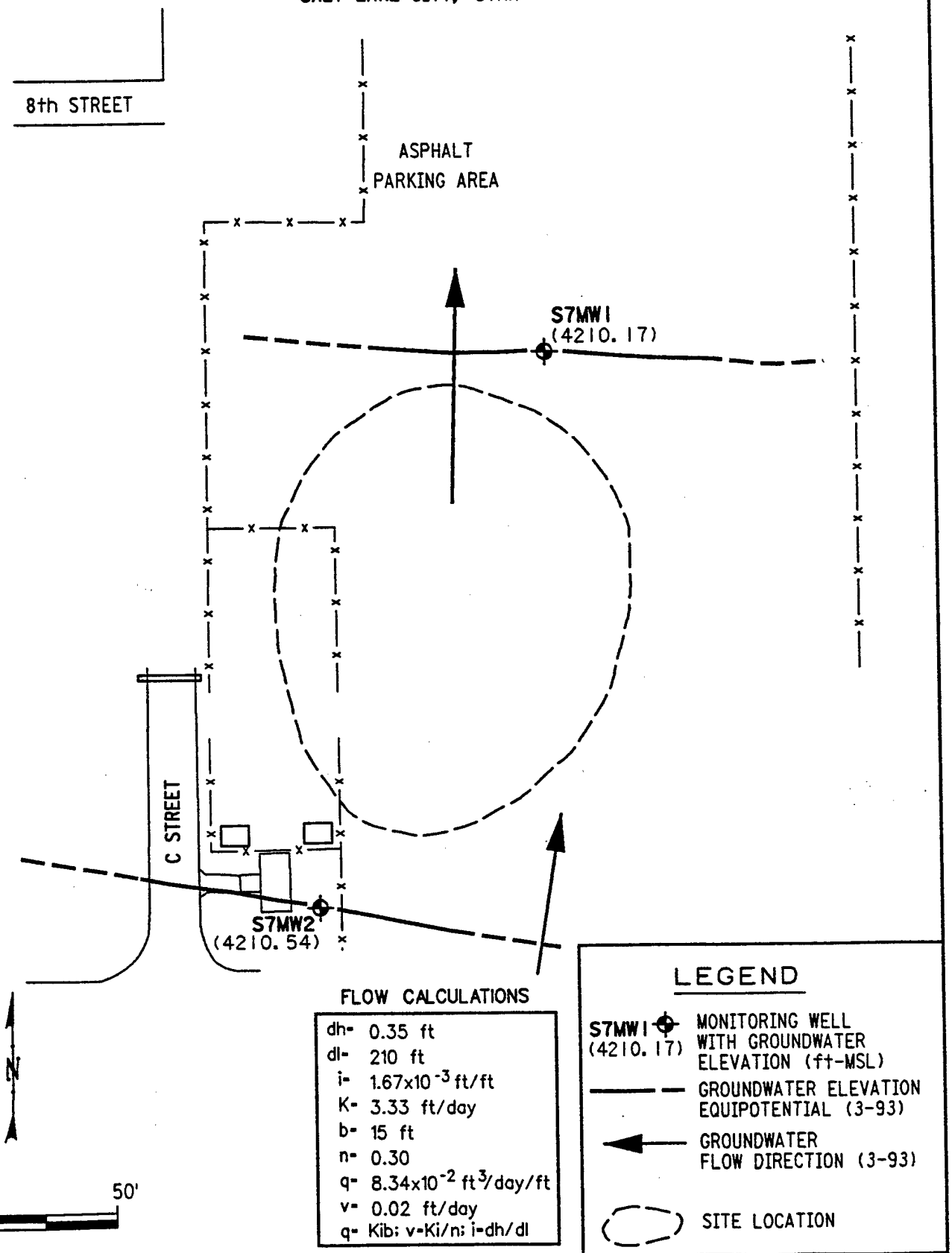
NOTE:
This site plan configuration is updated to incorporate new construction after the 1992-93 site investigation

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FIGURE 4.74

GROUNDWATER FLOW RATE AND VELOCITY - SITE 7
16 MARCH 1993

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SALT LAKE CITY, UTAH



FLOW CALCULATIONS

dh=	0.35 ft
dl=	210 ft
i=	1.67×10^{-3} ft/ft
K=	3.33 ft/day
b=	15 ft
n=	0.30
q=	8.34×10^{-2} ft^3/day/ft
v=	0.02 ft/day
q=	Kib; v=Ki/n; i=dh/dl

LEGEND

- S7MW1 (4210.17) — MONITORING WELL WITH GROUNDWATER ELEVATION (ft-MSL)
- GROUNDWATER ELEVATION EQUIPOTENTIAL (3-93)
- GROUNDWATER FLOW DIRECTION (3-93)
- SITE LOCATION

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FIGURE 4.75

detailed description and evaluation of hydraulic conductivity, flow rates, and velocities are also contained in Appendix I.

4.9.2.3 Soil Contamination Assessment

Soil samples were collected from 10 soil borings at Site 7. The locations of the analytical samples and the types of soil from which the samples were collected are shown in the geological cross-sections of Figures 4.70, and 4.71 and the soil borings logs in Appendix G. Sixteen soil samples and one field duplicate were analyzed for VOCs, SVOCs, TRPH, and PPMs. Target compounds included in each of the analyses and the detection limits of the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC blanks are provided in Appendix E.

The analytical results for compounds detected in Site 7 soil samples are provided in Table 4.40. If concentrations were below their respective detection limits for these compounds in other soil samples, the detection limits are shown in the table. The detection limits shown vary due to differing dilution factors and dry weight calculations. Field duplicates are shown after their associated samples in the table. The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 7 soils are shown on Figure 4.76. The PNAs (fluorene, phenanthrene, fluoranthene, and pyrene) have been grouped together for presentation; the values shown on the figure represent the sum of the compounds in the group. bis(2-Ethylhexyl)phthalate is shown as phthalates. Napthalene and 2-methylnapthalene are shown separately.

Organic compound concentrations are highest and/or most widespread at the center of the site in both sampling intervals of soil borings SB1, SB2, and SB3. Toluene, ethylbenzene, and xylenes were detected at respective concentrations of 450 µg/kg estimated, 5,200 µg/kg, and 30,000 µg/kg in clayey sand at the 2.5- to 4.5-foot interval of SB1. Ethylbenzene and xylenes were also present at lower concentrations in silty sand at the 7- to 9-foot interval of SB1. Naphthalene was detected at the estimated concentrations of 1,900 µg/kg and 440 µg/kg in the first and second sampling intervals of SB1, respectively. 2-Methylnapthalene was detected at the estimated concentrations of 3,000 µg/kg and 960 µg/kg in the first and second sampling intervals of SB1, respectively. A maximum site TRPH concentration of 11,500 mg/kg was present in the shallower (first) sampling interval of SB1. TRPH was detected at 2,200 mg/kg in the deeper (second) sampling interval.

Benzene and toluene were detected at the estimated concentrations of 15 µg/kg and 18 µg/kg, respectively, in sandy silt at the 2.5- to 4.5-foot interval of SB2, but were not detected above the method detection limits in the clayey silty sand at the 6.5 -to 9-foot interval of SB2. Ethylbenzene and xylenes were detected at concentrations of 150 µg/kg and 990 µg/kg, respectively, in the sandy silt at the 2.5 -to 4.5-foot interval of SB2. Ethylbenzene and xylenes were also present at lower concentrations in the clayey silty

TABLE 4.40
SITE 7 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB1-2.5-4.5	SB1-7-9	SB2-2.5-4.5	SB2-6.5-9	SB3-2.5-4.5	SB3-6.5-9
VOCs (SW8240) (µg/kg)*								
Dilution Factor	--	--	50	5	5	5	5	1
Methylene Chloride	85,300 c	5.0	1500U	31U	31U	31U	31U	6J
Acetone	2.7E+07 nc	10.0	3100UJ	500U	63U	63U	100U	30U
Benzene	22,100 c	5.0	1500U	31U	15J	31U	31U	8U
Toluene	5.4E+07 nc	5.0	450J	31U	18J	31U	15J	8U
Ethylbenzene	2.7E+07 nc	5.0	5200	97	150	33	23J	8U
Total Xylenes	5.4E+08 nc	5.0	30000	190	990	90	70	2J
SVOCs (SW8270) (µg/kg)*								
Dilution Factor	--	--	10	10	1	1	1	1
Napthalene	1.08E+07 n	330.0	1900J	440J	230J	350J	400U	520U
2-Methylnapthalene	na	330.0	3000J	960J	670	900	400U	520U
Fluorene	1.08E+07 n	330.0	4100U	4100U	44J	410U	400U	520U
Phenanthrene	na	330.0	4100U	4100U	180J	240J	400U	520U
Fluoranthene	1.08E+07 n	330.0	4100U	4100U	49J	74J	400U	520U
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	4100UJ	4100UJ	340J	590	84J	82J
Pyrene	8.1E+06 nc	330.0	4100U	4100U	410U	270J	400UJ	520UJ
TRPH (E418.1) (mg/kg)*								
Results	na	10.0	11500	2200	5200	2400	12U	16U

TABLE 4.40 - Continued
SITE 7 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB4-4.5-6.5	SB5-4.5-6.5	SB5-6.5-9	SB6-4-6	SB7-1-3	SB7-5-7
VOCs (SW8010/8020) (µg/kg)*								
Dilution Factor	--	--	1	1	1	1	1	1
Methylene Chloride	85,300 c	5.0	1U	1U	1U	1U	6.2U	7.0U
Acetone	2.7E+07 nc	10.0	NA	NA	NA	NA	NA	NA
Benzene	22,100 c	5.0	1U	1U	1U	1U	1.2U	2U
Toluene	5.4E+07 nc	1.0	1U	4.5	1U	1U	2.5U	2U
Ethylbenzene	2.7E+07 nc	1.0	1U	1U	1U	1U	2.5U	2U
Total Xylenes	5.4E+08 nc	1.0	1U	1U	1U	1U	2.5U	2U
SVOCs (SW8270) (µg/kg)*								
Dilution Factor	--	--	1	1	1	1	1	1
Napthalene	1.08E+07 nc	330.0	500U	470U	460U	470U	410U	460U
2-Methylnapthalene	na	330.0	500U	470U	460U	470U	410U	460U
Fluorene	1.08E+07 nc	330.0	500U	470U	460U	470U	410U	460U
Phenanthrene	na	330.0	500U	470U	460U	470U	410U	460U
Fluoranthene	1.08E+07 nc	330.0	500U	470U	460U	470U	410U	460U
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	500U	470U	460U	470U	410U	460U
Pyrene	8.1E+06 nc	330.0	500U	470U	460U	470U	410U	460U
TRPH (E418.1) (mg/kg)*								
Results	na	10.0	10U	60	14U	10U	12U	14U

TABLE 4.40 - Continued
SITE 7 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	PRGs	Detection Limit	SB8-4.5-6.5	SB9-2.5-4.5	SB9-4.5-6.5	duplicate (a) SB9-8.5-9.5	SB10-4.5-6.5
VOCs (SW8010/8020) (µg/kg) *							
Dilution Factor	--	--	1	1	1	1	1
Methylene Chloride	85,300 c	5.0	7.5U	6.0U	7.2U	5.9U	6.8U
Acetone	2.7E+07 nc	10.0	NA	NA	NA	NA	NA
Benzene	22,100 c	5.0	1.5U	1.2U	1.4U	1.2U	1.4U
Toluene	5.4E+07 nc	1.0	3U	2.4U	2.9U	2.4U	2.7U
Ethylbenzene	2.7E+07 nc	1.0	3U	2.4U	2.9U	2.4U	2.7U
Total Xylenes	5.4E+08 nc	1.0	3U	2.4U	2.9U	2.4U	2.7U
SVOCs (SW8270) (µg/kg)							
Dilution Factor	--	--	1	1	1	1	1
Napthalene	1.08E+07 nc	330.0	490U	390U	480U	390U	450U
2-Methylnapthalene	na	330.0	490U	390U	480U	390U	450U
Fluorene	1.08E+08 nc	330.0	490U	390U	480U	390U	450U
Phenanthrene	na	330.0	490U	390U	480U	390U	450U
Fluoranthene	1.08E+07 nc	330.0	490U	390U	480U	390U	450U
bis(2-Ethylhexyl)phthalate	45,700 c	330.0	490U	390U	480U	390U	450U
Pyrene	8.1E+06 nc	330.0	490U	390U	480U	390U	450U
TRPH (E418.1) (mg/kg) *							
Results	na	10.0	15U	12U	35	12U	13U

TABLE 4.40 - Continued
SITE 7 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (units)	PRGs	Detection Limit	SB1-2.5-4.5	SB1-7-9	SB2-2.5-4.5	SB2-6.5-9	SB3-2.5-4.5	SB3-6.5-9
PPMs (mg/kg)*								
Antimony	108 nc	1.1	R	R	R	R	R	R
Arsenic	0.366 c	2.0	***8J***	***3.3J***	***9.1J***	***2.3J***	***13.6J***	***5.2J***
Beryllium	0.149 c	0.33	***0.63***	***0.39J***	***0.58***	***0.86***	***0.61***	***0.92***
Cadmium	135 nc	1.0	0.20UJ	0.19UJ	0.20UJ	0.21UJ	0.20UJ	0.26UJ
Chromium	1350 nc	2.0	17.5J	12.6J	17.1J	21.3J	17.3J	21.0J
Copper	10,800 nc	2.0	30.6	23.3	29.3	43.7	23.9	57.7
Lead	na	2.0	35.2	15.0	33.3	24.5	25.1	31.3
Nickel	5,400 nc	3.0	13.2	9.6	12.1	18.3	11.7	18.0
Zinc	81,000 nc	1.0	64.6J	43.2J	61.6J	88.1J	55.8J	87.2J

Parameter (units)	PRGs	Detection Limit	SB4-4.5-6.5	SB5-4.5-6.5	SB5-6.5-9	SB6-4-6	SB7-1-3	SB7-5-7
PPMs (mg/kg)*								
Antimony	108 nc	1.1	1.7UJ	1.6UJ	1.6UJ	1.5UJ	1.1UJ	1.5UJ
Arsenic	0.366 c	2.0	***5.1J***	***11.8J***	***14.7J***	***4.9J***	***6.7***	***3.2J***
Beryllium	0.149 c	0.33	***0.33J***	***0.59J***	***1.3***	***0.25J***	***0.52***	***1.1***
Cadmium	135 nc	1.0	0.28UJ	0.27UJ	0.27UJ	0.26UJ	0.39UJ	0.33UJ
Chromium	1350 nc	2.0	5.7	10.9	30.4	5.1	13.5J	25.4J
Copper	10,800 nc	2.0	29.3	45.0	83.6	15.7	23.7	43.0
Lead	na	2.0	11.6	21.9J	41.3	10.5	24.1J	28.2J
Nickel	5,400 nc	3.0	9.2	12.2	24.9	4.3J	9.7	19.6
Zinc	81,000 nc	1.0	33.5J	55.4J	132J	23.5J	52.4J	113J

TABLE 4.40 - Continued
SITE 7 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

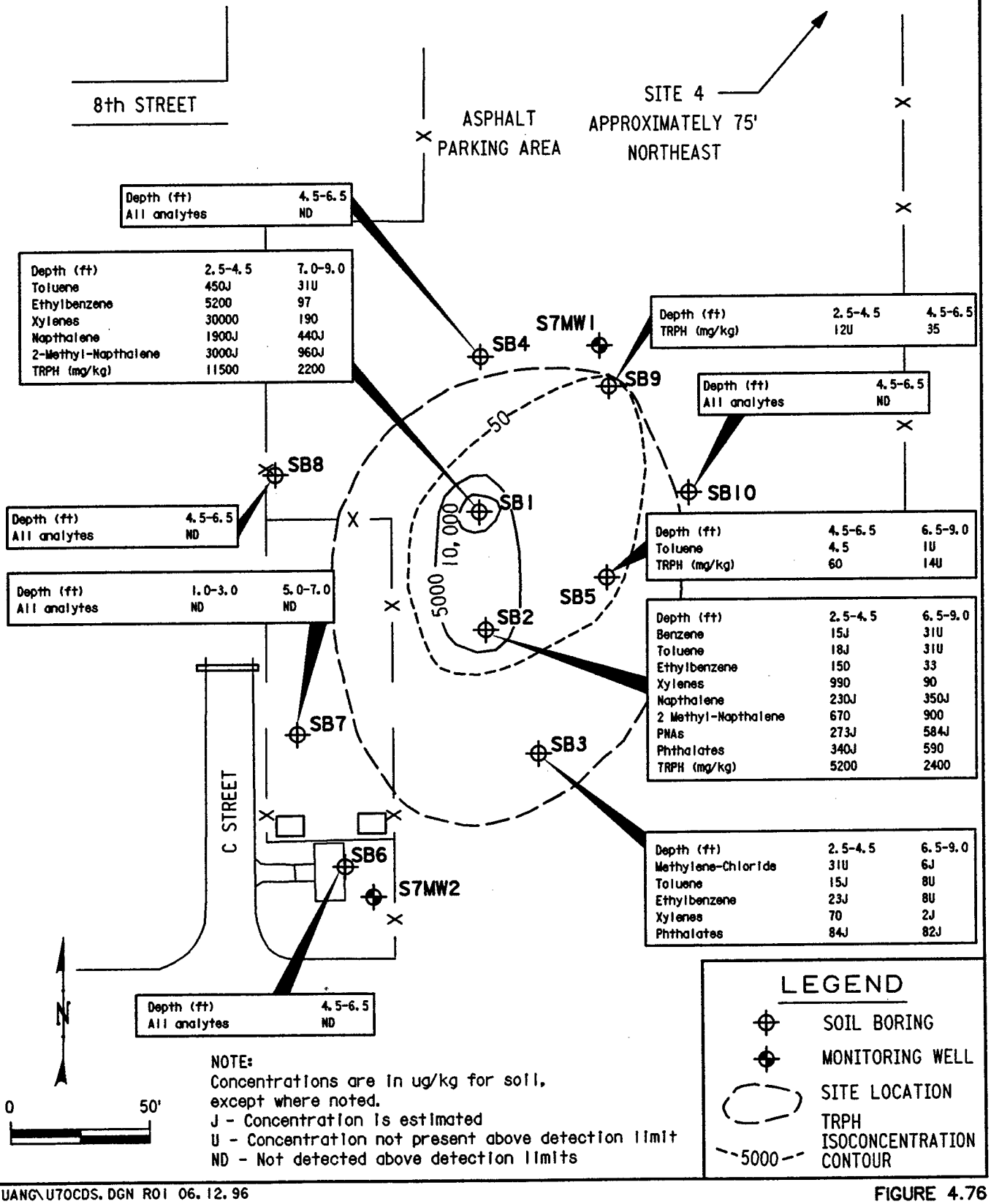
Parameter (units)	PRGs	Detection Limit	SB8-4.5-6.5	SB9-2.5-4.5	SB9-4.5-6.5	duplicate (a) SB9-8.5-9.5	SB10-4.5-6.5
PPMs (mg/kg)*							
Antimony	108 nc	1.1	2.2J	1.4UJ	1.8UJ	1.4UJ	2.8UJ
Arsenic	0.366 c	2.0	***6.9J***	***10.5J***	***11.7J***	***10.2J***	***8.3J***
Beryllium	0.149 c	0.33	***0.52J***	***0.42J***	***0.53J***	***0.39J***	***0.54J***
Cadmium	135 nc	1.0	0.29UJ	0.41J	0.33J	0.30J	0.58J
Chromium	1350 nc	2.0	10.4	12.7J	20.0J	11J	15.8J
Copper	10,800 nc	2.0	31.3	20.5	25.5	19.1	16.8
Lead	na	2.0	15.4	6.3J	7J	6J	25.8J
Nickel	5,400 nc	3.0	9.9	8.6	13.7	7.9	9.8
Zinc	81,000 nc	1.0	51.6J	44.8J	58.7J	41J	48.6J

***** Analyses were performed by ES-Berkeley Laboratory.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
NA Method SW8010/8020 did not include acetone.
R Data are rejected and were not reported.
(a) Blind duplicate of sample SB9-2.5-4.5.
Note: Concentrations exceeding Preliminary Remediation Goals (PRGs) are shown in bold italics, nc - noncarcinogen, c - carcinogen, na - not available.
Note: PRG values greater than five digits are in scientific notation.

FINAL

ORGANIC COMPOUNDS DETECTED IN SOIL WITH ISOCONCENTRATIONS OF TRPH - SITE 7

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:
Concentrations are in ug/kg for soil, except where noted.
J - Concentration is estimated
U - Concentration not present above detection limit
ND - Not detected above detection limits

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FIGURE 4.76

sand at the 7- to 9-foot interval of SB2. Naphthalene was detected at the estimated concentrations of 230 µg/kg and 350 µg/kg in the first (shallow) and second (deep) sampling intervals of SB2, respectively. 2-Methylnapthalene was also detected at 670 µg/kg and 900 µg/kg in the first and second sampling intervals of SB2, respectively. PNAs were detected at the estimated total concentrations of 273 µg/kg and 584 µg/kg in the first and second sampling intervals, respectively, of SB2. Phthalates were also detected at the concentrations of 340 µg/kg estimated and 590 µg/kg in the first and second sampling intervals of SB2, respectively. TRPH were present in the first sampling interval of SB2 at a concentration of 5,200 mg/kg, and at concentration of 2,400 mg/kg in the second sampling interval.

Toluene and ethylbenzene were detected at the estimated concentrations of 15 µg/kg and 23 µg/kg, respectively, in silt at the 2.5- to 4.5-foot interval of SB3, and were not detected above the method detection limits in the organic silt and clay at the 6.5- to 9-foot interval of SB3. Xylenes were detected at 70 µg/kg in silt at the 2.5- to 4.5-foot interval of SB3 and were detected at 2 µg/kg estimated in the organic silt and clay at the 6.5- to 9-foot interval of SB3. bis(2-Ethylhexyl)phthalate was detected at the estimated concentrations of 84 µg/kg and 82 µg/kg in the first and second sampling intervals of SB3, respectively. TRPH were not present above the method detection limit in either sampling interval of SB3.

Relatively low concentrations of TRPH were present in the first sampling interval of SB5 and in the second sampling interval of SB9. TRPH were detected at 60 mg/kg in organic silt at the 4.5- to 6.5-foot interval of SB5, and were detected at 35 mg/kg in clayey silt at the 4.5- to 6.5-foot interval of SB9. Toluene was detected at a concentration of 4.5 µg/kg in the 4.5- to 6.5-foot interval of SB5.

Organic compounds were not detected above the method detection limits at soil borings SB4, SB6, SB7, SB8, and SB10.

In summary, organic compounds related to the disposal of petroleum products were detected at minor concentrations in Site 7 soils. However, elevated concentrations of TRPH were present in soil samples at soil borings SB1 and SB2. Organic contamination was most prevalent at the 2.5- to 4.5-foot level, but extended to a maximum sampling depth of 9 feet BLS in the center of the site at SB1, SB2, and SB3.

Metals detected in soil samples at Site 7 exhibit a wide range of concentrations (Table 4.40). The concentrations of most metals at Site 7 were higher than background concentrations detected in soil samples from BGMW1 and BGMW2 (Tables 4.4 and 4.5). However, background values for means of comparison could not be adequately established with this limited number of soil samples. Therefore, for the purposes of comparison and graphical presentation, and to better visualize the location and spatial distribution (at what depths and in what stratigraphic units) of the relatively higher metals concentrations in site soil, a site-specific comparative value concentration for each individual metal was established. The comparative value is defined as the mean plus one standard deviation of the total site soil sample population for that particular metal. This

methodology is not intended to select contaminants of concern or to imply risk. Comparative values for the metals consistently detected at the site are presented in Table 4.41, and concentrations of the metals at a given sample location that are higher than their comparative values are depicted in Figure 4.77. Lesser concentrations of these metals that are below their comparative values in the other sampling interval (if applicable) of the same soil boring are also shown for comparison.

Seven metals (arsenic, beryllium, chromium, copper, lead, nickel, and zinc) were detected above the method detection limits in all analyzed samples, and mean plus one standard deviation comparative values were determined for these metals. Cadmium was detected in four samples and antimony was detected in only one sample. Therefore, comparative values for these metals were not determined. Concentrations of thallium, selenium, mercury, and silver were below the analytical method detection limits for all site soils. Data for selenium are unusable for samples collected at SB9 and SB10. Data for antimony are unusable for samples collected at SB1, SB2, and SB3. These data and the reason for rejection are provided in Table E.1.2, QA/QC Report No.1, Appendix E.

Concentrations of all seven metals depicted on Figure 4.77 are higher than the site-specific mean plus one standard deviation comparative value for that particular metal in the second sampling interval at SB5. Arsenic was present at a concentration of 14.7 mg/kg estimated, beryllium at 1.3 mg/kg, chromium at 30.4 mg/kg, copper at 83.6 mg/kg, lead at 41.3 mg/kg, nickel at 24.9 mg/kg, and zinc at 132 mg/kg estimated. These metal concentrations are in organic silt at the 6.5- to 9-foot interval of SB5. Concentrations of these metals in organic silt at the 4.5- to 6.5-foot interval of this soil boring are shown on Figure 4.77 for comparison. None of the metals concentrations in the first sampling interval of this soil boring were higher than the mean plus standard deviation comparative values for these metals at the site. Metals concentrations detected in the two sampling intervals show a significant range, considering the 2.5 feet of soil that separates the sampling locations within these sampling intervals of SB5.

The concentrations of arsenic, beryllium, copper, and zinc are higher than their mean and standard deviation comparative values at SB3, at concentrations of 13.6 mg/kg estimated, 0.92 mg/kg, 57.7 mg/kg, and 87.2 mg/kg estimated, respectively. The arsenic concentration was detected in silt at the 2.5- to 4.5-foot interval of SB3. The beryllium, copper, and zinc concentrations were in organic silt and clay at the 6.5- to 9-foot interval of SB3.

Concentrations of beryllium, lead, nickel, and zinc are higher than their standard deviation comparative values at SB2, at concentrations of 0.86 mg/kg, 33.3 mg/kg, 18.3 mg/kg, and 88.1 mg/kg estimated, respectively. The lead concentration was detected in sandy silt at the 2.5- to 4.5-foot interval of SB2. The beryllium and zinc concentrations were in clayey silty sand at the 6.5- to 9-foot interval of SB2.

The concentrations of beryllium, chromium, nickel, and zinc are higher than their mean and standard deviation comparative values in the 5- to 7-foot interval of SB7, at concentrations of 1.1 mg/kg, 25.4 mg/kg estimated, 19.6 mg/kg, and 113 mg/kg

TABLE 4.41
SITE 7 - MEAN AND STANDARD DEVIATION OF METALS DETECTED IN SOIL
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

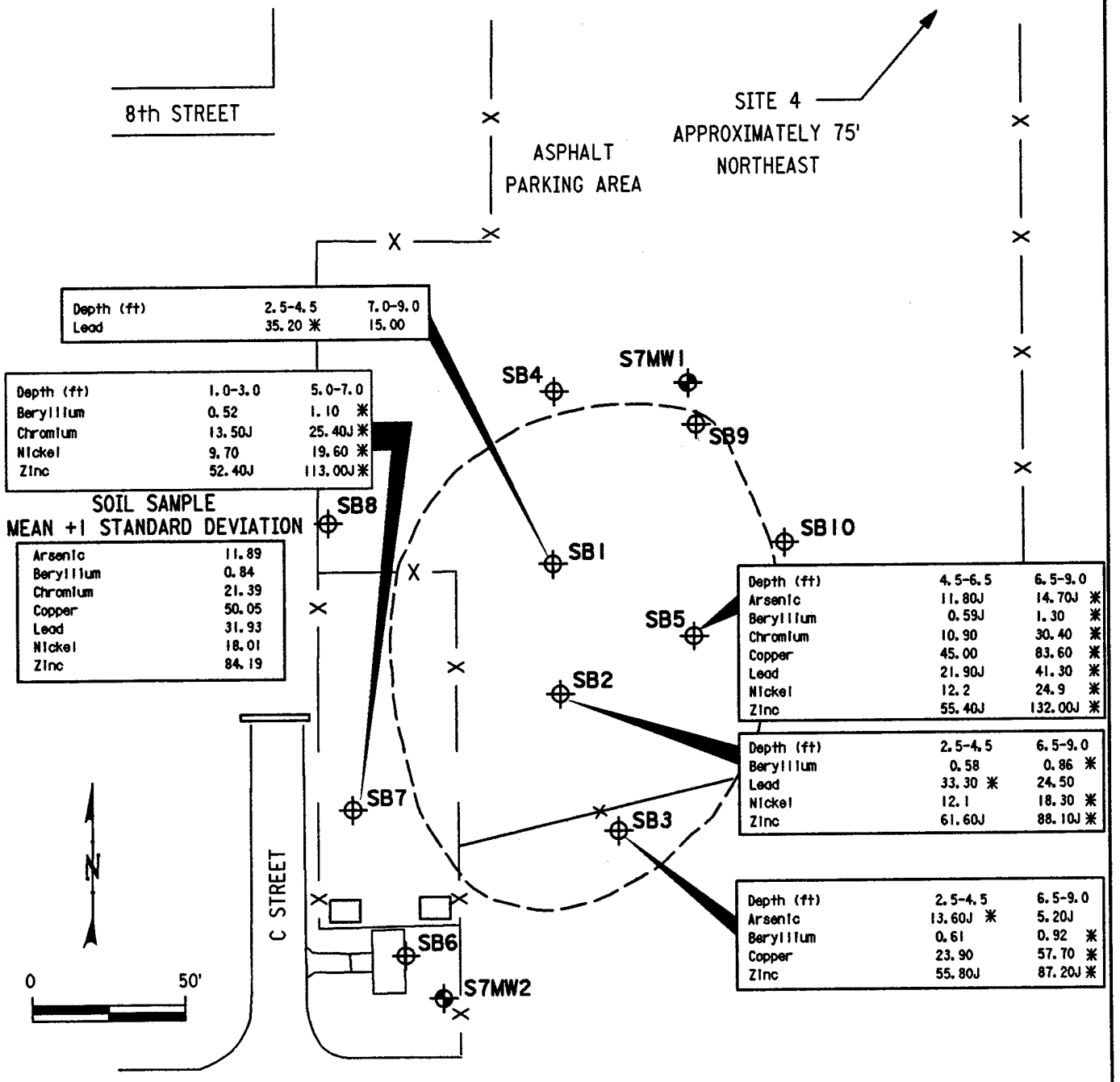
Parameter	Range (mg/kg)	Mean	tandard Deviatio	ean + Standard De	# of Samples
Arsenic	2.30-14.70	8.06	3.83	11.89	16
Beryllium	0.25-1.30	0.57	0.27	0.84	16
Chromium	5.10-30.40	14.88	6.51	21.39	16
Copper	15.70-83.60	32.24	17.81	50.05	16
Lead	6.00-41.30	21.38	10.55	31.93	16
Nickel	4.30-24.90	12.49	5.52	18.01	16
Zinc	23.50-132.00	57.98	26.21	84.19	16

Note: Mean and standard deviation were not calculated for antimony and cadmium because these metals were not detected in enough samples to determine these values.

FINAL

METALS DETECTED IN SOIL
SITE 7

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:

SOILS

The metals concentrations (mg/kg) in soils that exceed the mean plus one standard deviation of the total sample population for that particular metal at the site are shown with an asterisk. Concentrations of these metals in other sampling intervals (if applicable) of the same boring are shown for comparison.

J - Concentration is estimated

LEGEND

- SOIL BORING
- MONITORING WELL
- SITE LOCATION

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FIGURE 4.77

estimated, respectively. The sample was collected in organic silt, and sand. Lead is higher than the mean and standard deviation comparative value in the 2.5- to 4.5-foot interval of SB1, at a concentration of 35.2 mg/kg. The native soil is clayey sand at this depth.

Soil borings SB4, SB6, SB8, SB9, and SB10 did not contain metal concentrations that were higher than the site-specific comparative values for the range of individual metals at the site.

In contrast to Site 4, concentrations of metals in Site 7 soils that are higher than their site-specific comparative values were not unique to only one of the two sampling intervals of the individual soil borings. For instance, comparatively higher metals concentrations were found in both sampling intervals of SB2 and SB3. Therefore, the occurrence of higher metals concentrations in Site 7 soils does not appear to be limited to specific depth intervals and sediments.

Site-specific higher metals concentrations in soils at Site 7 do not necessarily coincide with soils that had more widespread organic compound contamination. For instance, soil at SB7 contained relatively higher metals concentrations but organic compounds were not detected above method detection limits. Likewise, the highest and/or most widespread metals concentrations at Site 7 were at the 6.5- to 9-foot interval of SB5, a soil horizon not impacted by organic contamination. Therefore, metals in site soils may be naturally occurring, and concentrations may reflect "*in situ*" variation in the depositional environment rather than impact from base disposal practices.

Overall, metals concentrations in site soils were relatively low considering this area was used as a dump to dispose of used waste products.

4.9.2.4 Groundwater Contamination Assessment

Groundwater samples were collected in February 1993 from the two monitoring wells at Site 7. Monitoring well, S7MW1, was hydraulically downgradient of the contaminated soil area and monitoring well, S7MW2, was hydraulically upgradient of the site. The samples were analyzed for VOCs, SVOCs, and PPMs. Target compounds included in each of the analyses and the detection limits for the compounds are provided in Table H.1, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 1, Appendix E.

In August 1995, monitoring wells S7MW1 and S7MW2 were resampled and analyzed for VOCs, SVOCs, and PPMs. Target compounds included in the analyses and the detection limits of the compounds are provided in Table H.2, Appendix H. Complete QA/QC information for the analytical data and the results of the QA/QC samples are provided in QA/QC Report No. 2, Appendix E.

Field measurements of specific conductance, pH, and temperature, were made at the time of sample collection. These data for 1993 are provided in Table 4.8 and for 1995 are provided in Table 4.9. Specific conductance measured 1,114 microsiemens/cm and 1,780 microsiemens/cm for these respective dates at monitoring well S7MW1. The

corresponding pH values were 8.0 and 7.80. Specific conductance measured 1,589 microsiemens/cm and 2,670 microsiemens/cm for these respective dates at S7MW2, with corresponding pH values of 7.8 and 7.85.

Analytical results of the groundwater samples collected from S7MW1 and S7MW2 are provided in Tables 4.42 and 4.43. The findings for each group of detected compounds are discussed below.

Organic Compounds. Concentrations of organic compounds detected in groundwater at Site 7 are shown on Figure 4.78. As shown on the figure, the VOCs chloroform, ethylbenzene, and toluene, and the SVOC bis(2-ethylhexyl)phthalate, were detected at concentrations of 3.2 µg/L, 0.5 µg/L estimated, 1.3 µg/L estimated, and 43 µg/L, respectively, in the groundwater sample collected in February 1993 from the downgradient monitoring well, S7MW1. The concentration of bis(2-ethylhexyl)phthalate exceeded the MCL of 6 µg/L as shown in Table 4.42. Toluene was detected at an estimated concentration of 0.9 µg/L in the groundwater sample collected in February 1993 from the upgradient monitoring well, S7MW2.

No organic compounds were detected in groundwater samples collected in August 1995 from S7MW1 and S7MW2 (Figure 4.78 and Table 4.43).

The toluene, ethylbenzene, and bis(2-ethylhexyl)phthalate originally detected in downgradient groundwater during sampling in 1993 could have been related to site soil leaching. The SVOC bis(2-ethylhexyl)phthalate can be a sampling artifact or laboratory contaminant but was not detected in associated field QA/QC samples or method blanks. Chloroform may be a sampling artifact since chloroform was detected in an associated rinsate blank (see QA/QC Report No. 1, Appendix E). The minor toluene detected at S7MW2 during sampling in 1993 was present hydraulically upgradient of the contaminated soil areas.

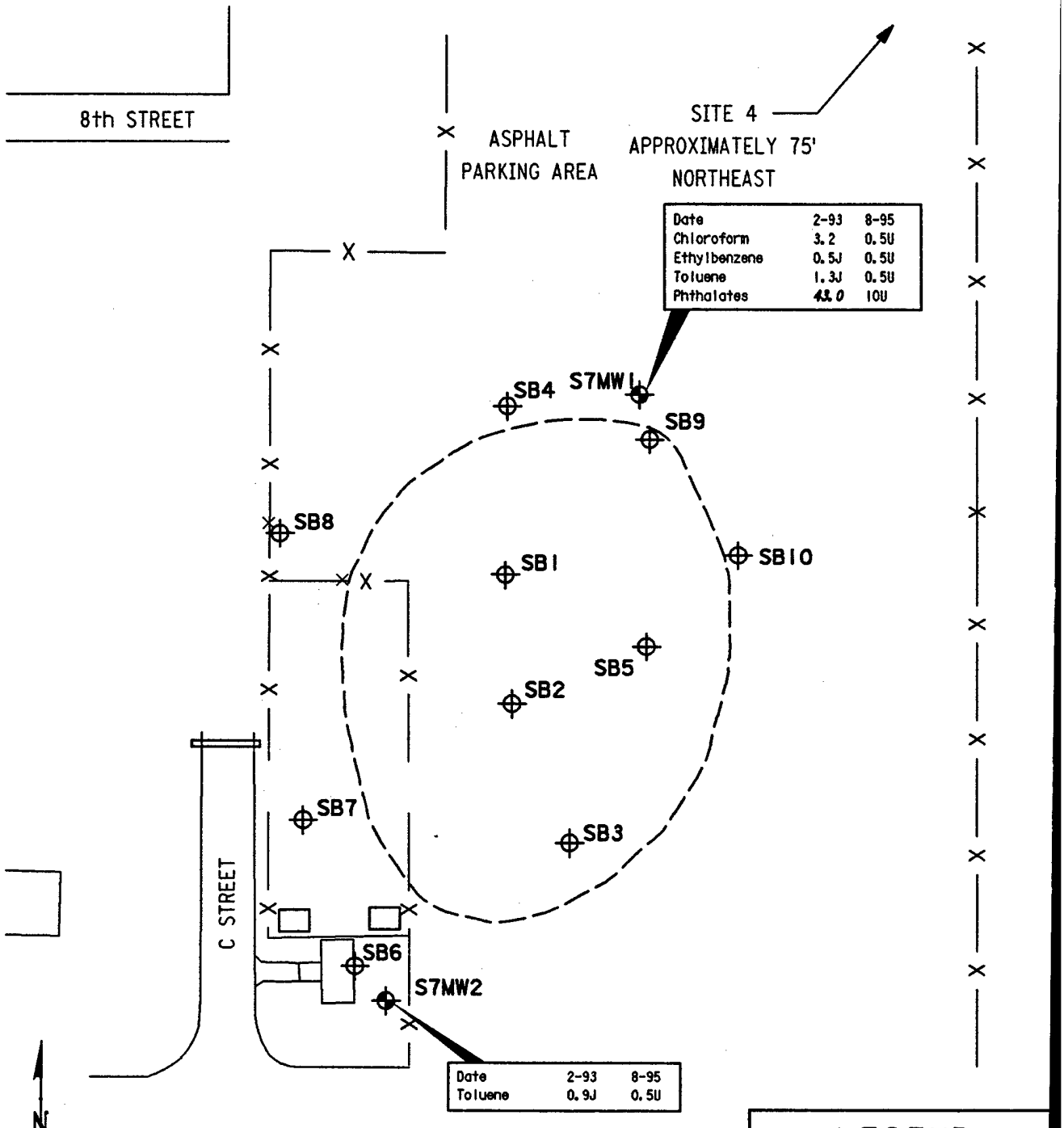
Metals. The metals arsenic and selenium were detected in groundwater samples collected in February 1993 from the Site 7 monitoring wells. Concentrations of these metals are shown on Figure 4.79. Arsenic concentrations of 52.5 µg/L estimated in the sample from monitoring well S7MW1 and 57.3 µg/L estimated in the sample from monitoring well S7MW1 exceeded the arsenic MCL of 50 µg/L. Selenium was detected at 2.2 µg/L estimated at S7MW2.

Arsenic and copper were detected in groundwater samples collected in August 1995 (Figure 4.79 and Table 4.43). Arsenic concentrations of 74 µg/L in the sample from S7MW1 and 270 µg/L in the sample from S7MW2 exceeded the MCL for arsenic. Copper was detected at 11 µg/L at S7MW2.

Arsenic was present in site soils at concentrations that were similar to the concentrations in background soil samples, and may be naturally occurring. Therefore, the dissolved arsenic concentrations in shallow groundwater are probably not related to soil leaching at the site. Also, dissolved arsenic concentrations were nearly the same (1993), or higher (1995), in groundwater samples from upgradient monitoring well

ORGANIC COMPOUNDS DETECTED IN GROUNDWATER
SITE 7

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:
Concentrations (ug/L) exceeding MCLs are shown in bold italic.
J - Concentration is estimated
U - Concentration not present above the detection limit

LEGEND
- SOIL BORING
- MONITORING WELL
- SITE LOCATION

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FIGURE 4.7

TABLE 4.42
SITE 7 - GROUNDWATER
ANALYTES DETECTED (February 1993)
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	MCLs	Detection Limit	S7MW1	S7MW2
VOCs (SW8010/8020) (µg/L)*				
Dilution Factor	--	--	1	1
Chloroform	100	5.0	3.2	1.0U
Ethylbenzene	700	5.0	0.5J	2.0U
Toluene	1,000	5.0	1.3J	0.9J
SVOCs (SW8270) (µg/L)*				
Dilution Factor	--	--	1	1
bis(2-Ethylhexyl)phthalate	6	10.0	***43***	10U
PPMs (µg/L)*				
Arsenic	50	1.0	***52.5J***	***57.3J***
Chromium	100	2.0	2.0U	2.3UJ
Copper	1,300	2.0	7.3UJ	9.3UJ
Lead	15	2.2	4.9U	2.2U
Mercury	2	0.03	0.03UJ	0.03UJ
Nickel	100	3.0	3.0UJ	3.0UJ
Selenium	50	1.0	2.0UJ	2.2J
Zinc	5,000	1.0	3.4UJ	4.4UJ

***** **Analyses performed by the ES-Berkeley Laboratory.**
U **Compound not present above the detection limit shown.**
J **Concentration of the compound is estimated.**
UJ **Compound not detected, but the detection limit is estimated.**
Note: **Concentrations that exceed Maximum Contaminant Levels (MCLs) are shown in bold italics.**

TABLE 4.43
SITE 7 - GROUNDWATER
ANALYTES DETECTED (August 1995)
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

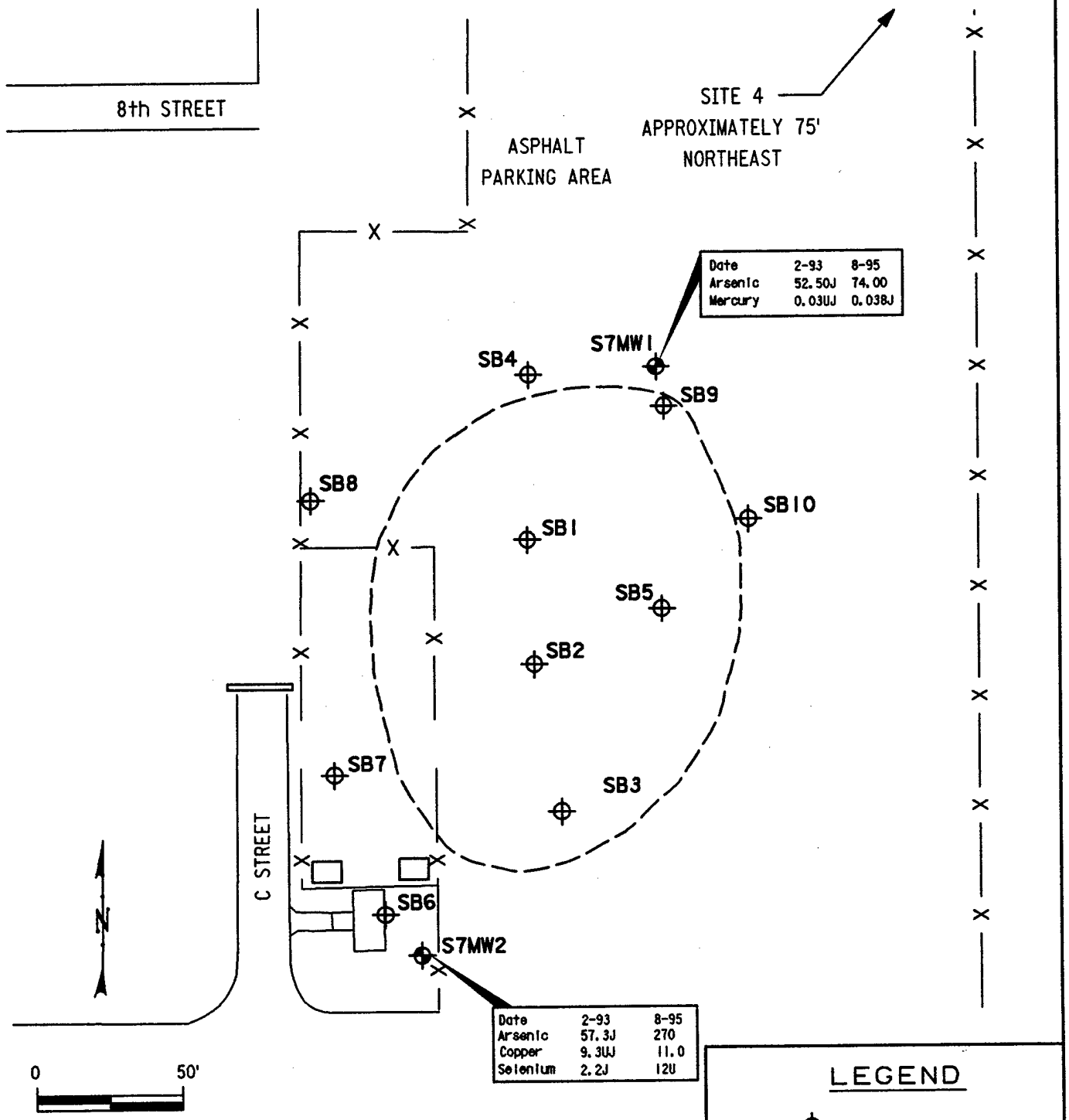
Parameter (method) (units)	MCLs	Detection Limit	S7MW1	S7MW2
VOCs (SW8010/8020) (µg/L)**				
Results	--	--	ND	ND
SVOCs (SW8270) (µg/L)**				
Results	--	--	ND	ND
TRPH (E418.1) (µg/L)**				
Results	na	100.0	100UJ	100UJ
PPMs (µg/L)**				
Antimony	6	24.0	24U	24U
Arsenic	50	2.0	***74***	***270***
Beryllium	na	0.63	0.63U	0.63U
Cadmium	5	1.0	0.97U	0.97U
Chromium	100	3.6	3.6U	3.6U
Copper	1,300	2.1	2.1U	11.0
Lead	15	4.4	0.88UJ	1.8UJ
Mercury	2	0.02	0.038J	0.02UJ
Nickel	100	11.0	11U	11U
Selenium	50	1.2	12U	12U
Silver	na	5.5	5.5U	5.5U
Thallium	2	1.2	1.2UJ	1.2UJ
Zinc	5,000	3.6	3.6U	6.8U

****** Analyses performed by DataChem Laboratories.
ND All analytes were not detected; refer to Table H.2 for compounds and detection limits.
na No MCL exists.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Not detected, but the detection limit is estimated.
Note: Concentrations that exceed Maximum Contaminant Levels (MCLs) are shown in bold italic.

FINAL

METALS DETECTED IN GROUNDWATER
SITE 7

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH



NOTE:
Concentrations are in ug/Lfor groundwater.
J - Concentration is estimated
U - Concentration not present above the detection limit
UJ - Not detected, but the detection limit is estimated

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FIGURE 4.79

S7MW2 compared to groundwater from downgradient well S7MW1. This suggests that neither the upgradient nor the downgradient dissolved arsenic is site-related. If groundwater were impacted from the leaching of site soils dissolved arsenic concentrations in downgradient groundwater would be expected to be higher than concentrations in upgradient groundwater. The groundwater flow direction at the site is northerly toward the City Drain Canal throughout the year (Figures 4.1, 4.2, 4.3, and 4.55). Elevated levels of arsenic in shallow groundwater occur in the regional area of the Base and the Base proper as described in subsection 2.5.1.3 and subsection 4.11.

4.9.3 Site 7 - Conclusions

Organic compounds reportedly disposed in this former oil sludge pond were detected at minor concentrations in site soils (Figure 4.76). However, elevated concentrations of TRPH (maximum 11,500 mg/kg) were present in soils at the 2.5- to 4.5-foot sampling interval of SB1 and SB2. Organic contamination was most prevalent at the 2.5- to 4.5-foot level, but extended to a maximum sampling depth of 9 feet BLS in the center of the site at SB1, SB2, and SB3. Concentrations of organic compounds were compared to PRGs and none of these health-based risk criteria were exceeded. However, a PRG was not available for TRPH and the State of Utah does not have CERCLA clean-up standards for soils. Therefore, the potential clean-up standard for TRPH in site soils would be evaluated on a case-by-case basis. The presence of TRPH at higher concentrations implies that intrinsic biological remediation of these aliphatic chain hydrocarbons is progressing slowly in site soils (the oil sludge pond was last used in 1972). Perhaps competing native organic carbon and/or depleted oxygen are limiting the rates of aerobic biodegradation. Although degradation may be progressing slowly, the TRPH appear to be immobilized in the organic rich soils due to adsorption.

Many of the site-specific higher metals concentrations in soils at Site 7 do not coincide with soils that were impacted by organic compound contamination (Figure 4.77). This may indicate that the metals present in site soil are depositional and that metals at the site may be naturally occurring. Concentrations of arsenic and beryllium exceeded the most stringent human health risk criteria in all Site 7 soil samples. However, the established human health PRGs for these metals were below method detection limits and are impractical given the occurrence of these metals in natural soils.

The VOCs chloroform, ethylbenzene, and toluene, and the SVOC bis(2-ethylhexyl)phthalate, were detected in the initial 1993 sampling event at downgradient monitoring well, S7MW1 (Figure 4.78). The concentration of bis(2-ethylhexyl)phthalate exceeded its MCL. A minor toluene concentration was detected in 1993 at upgradient monitoring well, S7MW2. No organic compounds were detected in groundwater samples collected in August 1995 from S7MW1 and S7MW2. This indicates that groundwater contamination at the site has diminished and implies that the chloroform and phthalate detected in 1993 may have been laboratory or sampling artifacts. Downgradient groundwater was also analyzed for TRPH in 1995 and TRPH were not detected. Therefore, TRPH detected in site soils does not appear to be leaching to groundwater.

Concentrations of arsenic exceeding the MCL were detected (both sampling events) in groundwater collected from both the upgradient and downgradient monitoring wells, and concentrations were higher in the upgradient well. Therefore, the dissolved arsenic does not appear to be site-related. Generally, dissolved arsenic concentrations exceeding MCLs were detected in shallow groundwater basewide.

The groundwater flow direction, hydraulic gradient, and flow rate at the site are subject to change (Figures 4.72, 4.73, and 4.74). Groundwater flow was north to northeast during the field effort, toward the City Drain Canal. The upgradient and downgradient monitoring wells were adequately placed with respect to the observed groundwater flow directions. The groundwater velocity was calculated to be 0.02 ft/day in March 1993. Under the March 1993 conditions it would take groundwater beneath Site 7 approximately 80 years to discharge into the City Drain Canal.

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4.10 SITE 10 - POL FACILITY

4.10.1 Field Program

As mentioned previously, the POL facility was not included in the original field program for the IRP SI, and was not identified in the PA as a site for intrusive investigation (only Sites 1 through 7 were identified as potential hazardous sites). However, due to the 3,500 gallon fuel and water mixture spill that occurred at the POL facility and confirmed soil contamination in basewide piezometer PI-5, the POL facility was preliminarily investigated for potential contamination.

4.10.1.1 Screening Activities

The following activity was conducted at Site 10 during the screening phase of the SI:

- Installed three site-specific piezometers.

Piezometers were installed to determine the site-specific groundwater gradient for optimal placement of upgradient and downgradient monitoring wells.

4.10.1.2 Confirmation and Optional Activities

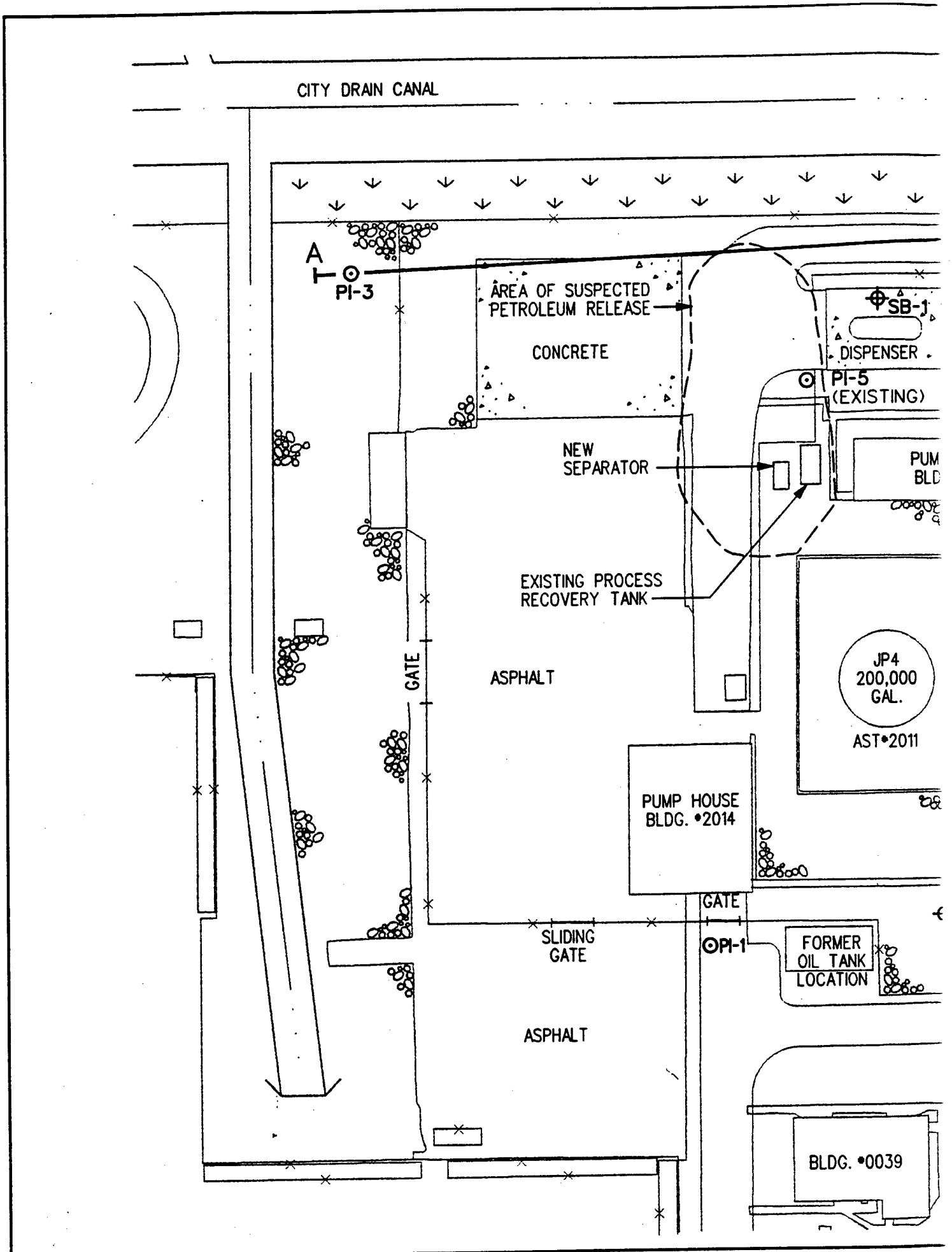
The following activities were conducted during the confirmation/optional phase of the Site 10 SI:

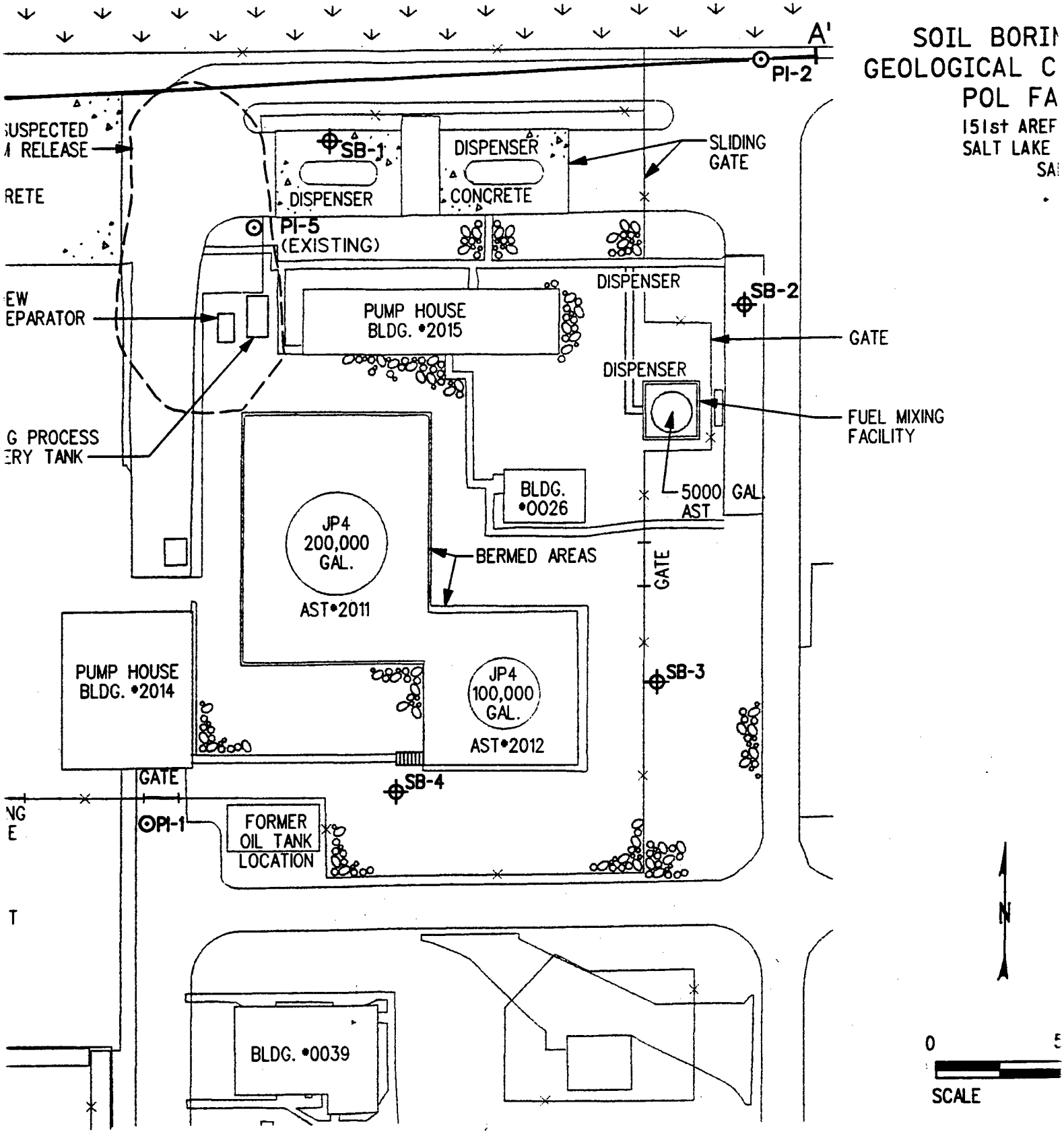
- Advanced four soil borings; and
- Selected and analyzed 9 soil samples.

Fifteen confirmational soil borings were to be advanced in the POL facility near the 3500-gallon fuel and water mixture spill, fuel tanks, and dispensers, to evaluate the extent of possible soil contamination in these areas. However, only four soil borings were completed at the site due to an adverse vapor exposure incident at the first boring drilled (SB1). Field work at this site commenced in May 1994, much later than the October 1992 date for the primary investigation of Sites 1 through 7 and the City Drain Canal. The locations of the four soil borings and three piezometers at Site 10 are shown in Figure 4.80. The soil borings completed at the site are located near the dispenser islands and in the southeastern portion of the site. Soil borings that were proposed to be advanced in the area of the process recovery tank fuel/water mixture release were not completed by Parsons ES due to the exposure incident. Investigation of the site is being continued under an RI phase by a different contractor.

Two to three soil samples from each of the four soil borings were selected for chemical analyses based on the results of headspace screening and proximity to the water table; COCs are provided in Appendix D. Groundwater was encountered during drilling at a depth of approximately 5 feet BLS. Headspace screening results, sampling intervals, and the unconsolidated deposits of each boring were logged and recorded. Detailed soil boring descriptions are provided in the soil boring logs, Appendix G.

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CITY DRAIN CANAL
A
PI-3
AREA OF SUSPECTED PETROLEUM RELEASE
SB-1
DISPENSER
CONCRETE
PI-5 (EXISTING)
NEW SEPARATOR
PUM BLD
EXISTING PROCESS RECOVERY TANK
GATE
ASPHALT
JP4 200,000 GAL.
AST•2011
PUMP HOUSE BLDG. •2014
GATE
SLIDING GATE
PI-1
FORMER OIL TANK LOCATION
ASPHALT
BLDG. •0039



SOIL BORI
GEOLOGICAL C
POL FA
151st AREF
SALT LAKE
SA

SOIL BORING, PIEZOMETER, AND GEOLOGICAL CROSS-SECTION LOCATIONS
POL FACILITY - SITE 10
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

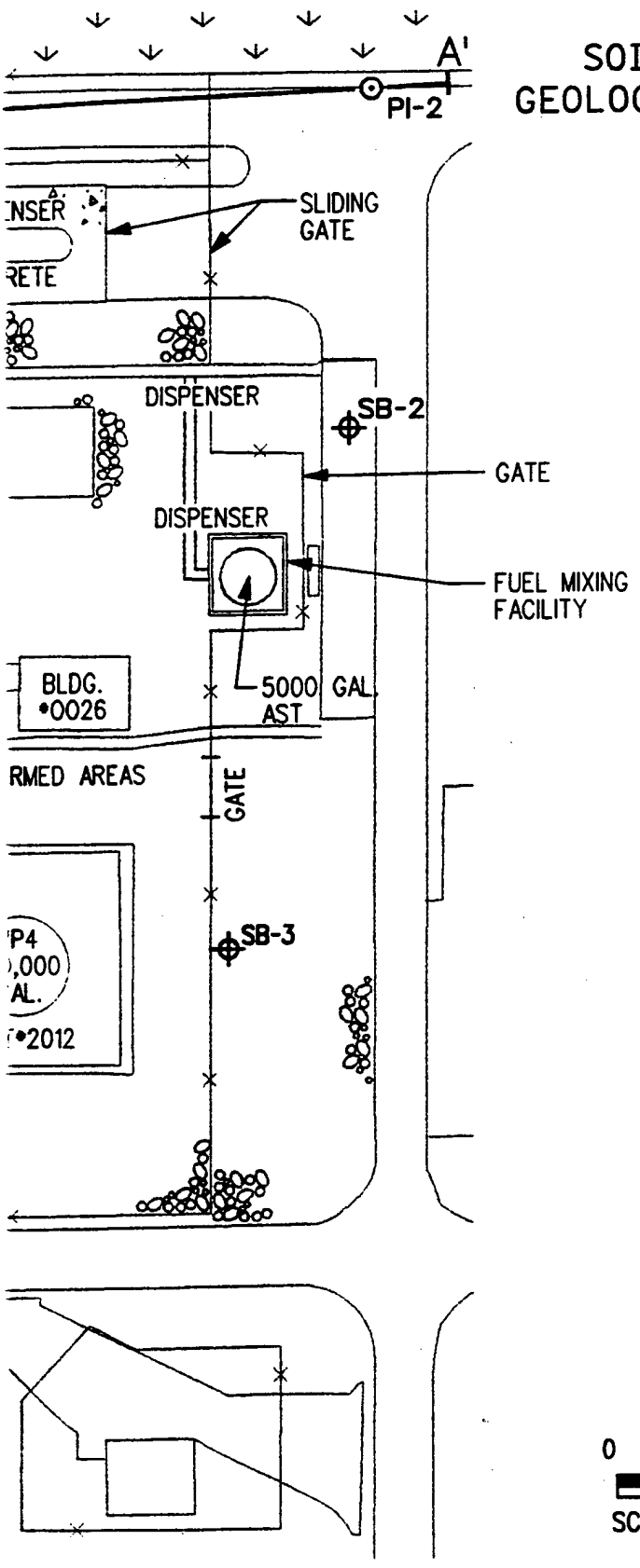


FIGURE 4.80

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4.10.2 Results of Site Investigation

4.10.2.1 Geology and Hydrogeology

A geological cross-section of Site 10 stratigraphy, at the location shown in Figure 4.80, is presented as Figure 4.81. Site 10 is underlain by a clayey sand or clay, organic silt, and sand depositional sequence. The upper 2 feet of material is generally a sand and gravel fill. Beneath fill is a gray clayey sand or dark gray organic-rich silt extending to 3 or 4 feet BLS. Gray clay and silt are primarily present beneath the organic silt. Poorly sorted to well sorted gray to olive sand of granitic origin is present at a depth of approximately 8-to 9-feet BLS. Gray or greenish-gray clay or silt is interbedded in the sand at some locations. The interbedded clay or silt sequence extends to a depth of 15 feet BLS, which is the greatest depth of drilling at the site.

4.10.2.2 Groundwater Flow Calculations

Groundwater levels in site piezometers were not measured. Therefore, the site-specific hydraulic gradient in May 1994 was not established. Also, the calculated groundwater flow rate and velocity across the site were not determined because site monitoring wells were not installed. However, existing data on basewide groundwater gradients shows the flow direction at the site to be north toward the City Drain Canal (Figures 4.1, 4.2 and 4.3).

4.10.2.3 Soil Contamination Assessment

Soil samples were collected from four soil borings at Site 10. The locations of the analytical samples and the types of soil from which the samples were collected are shown on the soil borings logs in Appendix G. Eight soil samples were analyzed for VOCs and total petroleum hydrocarbons (TPH). One soil sample from the sampling interval that caused the adverse health effects was analyzed for VOCs, SVOCs, and Pesticides/PCBs.

Analytical results for the Site 10 soil samples are provided in Table 4.44. If concentrations were below their respective detection limits for these compounds in other soil samples, the detection limits are shown in the table. The findings are discussed below.

Organic Compounds. Concentrations of organic compounds detected in Site 10 soils are shown on Figure 4.82. Petroleum related contamination was detected in soil borings SB1, SB2, and SB3. Detected concentrations were highest at SB1, located north of the northernmost dispenser island, and at SB2, located north of the eastern dispenser near the fuel mixing tank. Xylenes were detected at concentrations of 340 µg/kg estimated and 98 µg/kg estimated in the 2- to 4-foot and 6- to 8-foot sampling intervals, respectively, of soil boring SB1. Ethylbenzene was also detected in the 6- to 8-foot interval at a concentration of 34 µg/kg. TPH (gasoline fraction) were detected at concentrations of 12.1 mg/kg and 35.4 mg/kg estimated in the 2- to 4-foot and 6- to 8-foot sampling intervals, respectively, of SB1. Only benzene, at a concentration of 1.4 µg/kg estimated was detected in a sample obtained from sand in 8- to 10-foot interval of SB1. This result was unexpected since the split-spoon core from the 6- to 8-foot interval

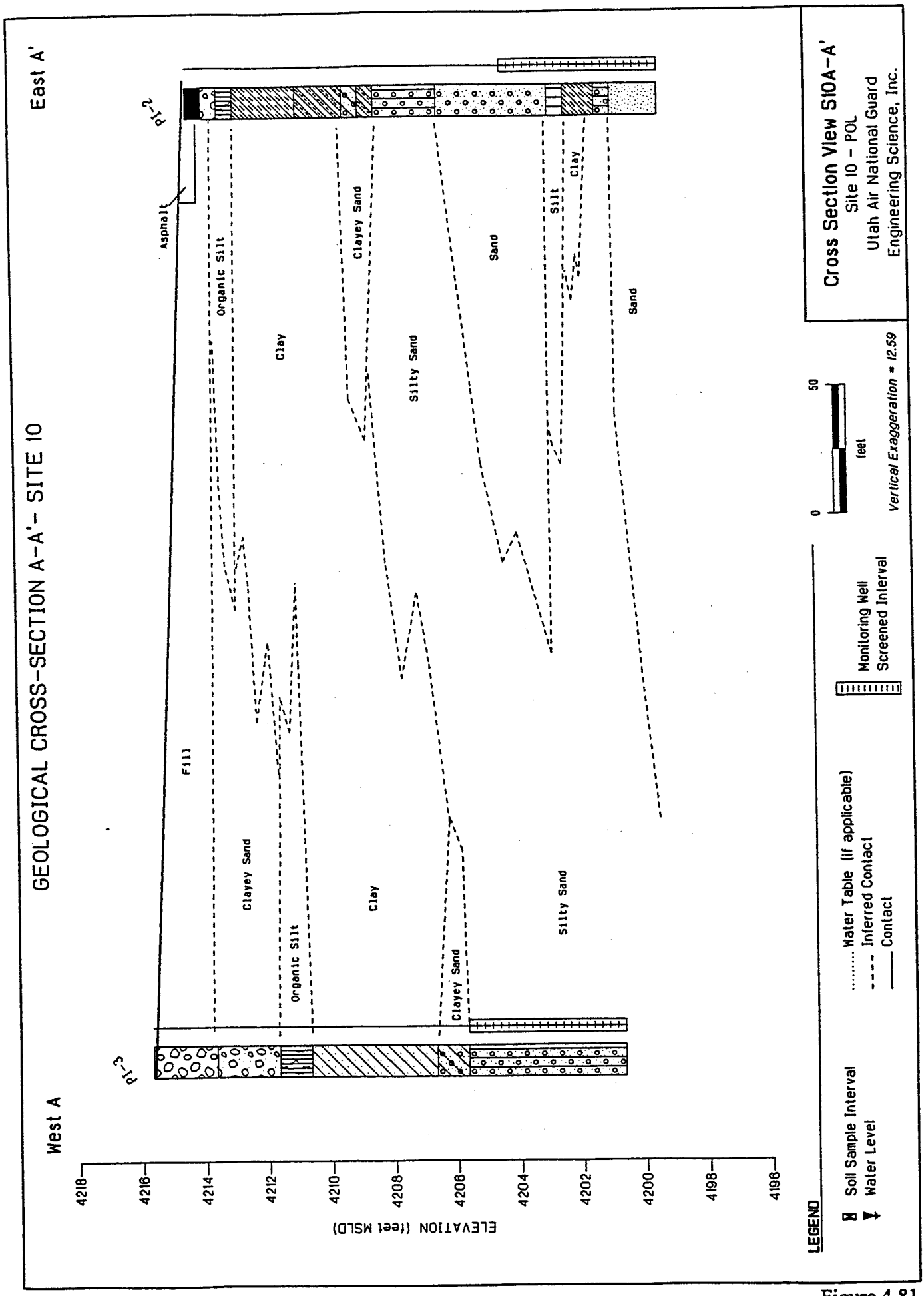

GEOLOGICAL CROSS-SECTION A-A'- SITE 10
West A
East A'
Asphalt
Fill
Organic Silt
Clayey Sand
Clay
Organic Silt
Clayey Sand
Silty Sand
Clay
Clayey Sand
Sand
Silt
Clay
Sand
Silty Sand
ELEVATION (feet MSLD)
4218
4216
4214
4212
4210
4208
4206
4204
4202
4200
4198
4196
Cross Section View S10A-A'
Site 10 - POL
Utah Air National Guard
Engineering Science, Inc.
Vertical Exaggeration = 12.59
0
50
feet
Monitoring Well
Screened Interval
Water Table (if applicable)
Inferred Contact
Contact
LEGEND
Soil Sample Interval
Water Level

Figure 4.81

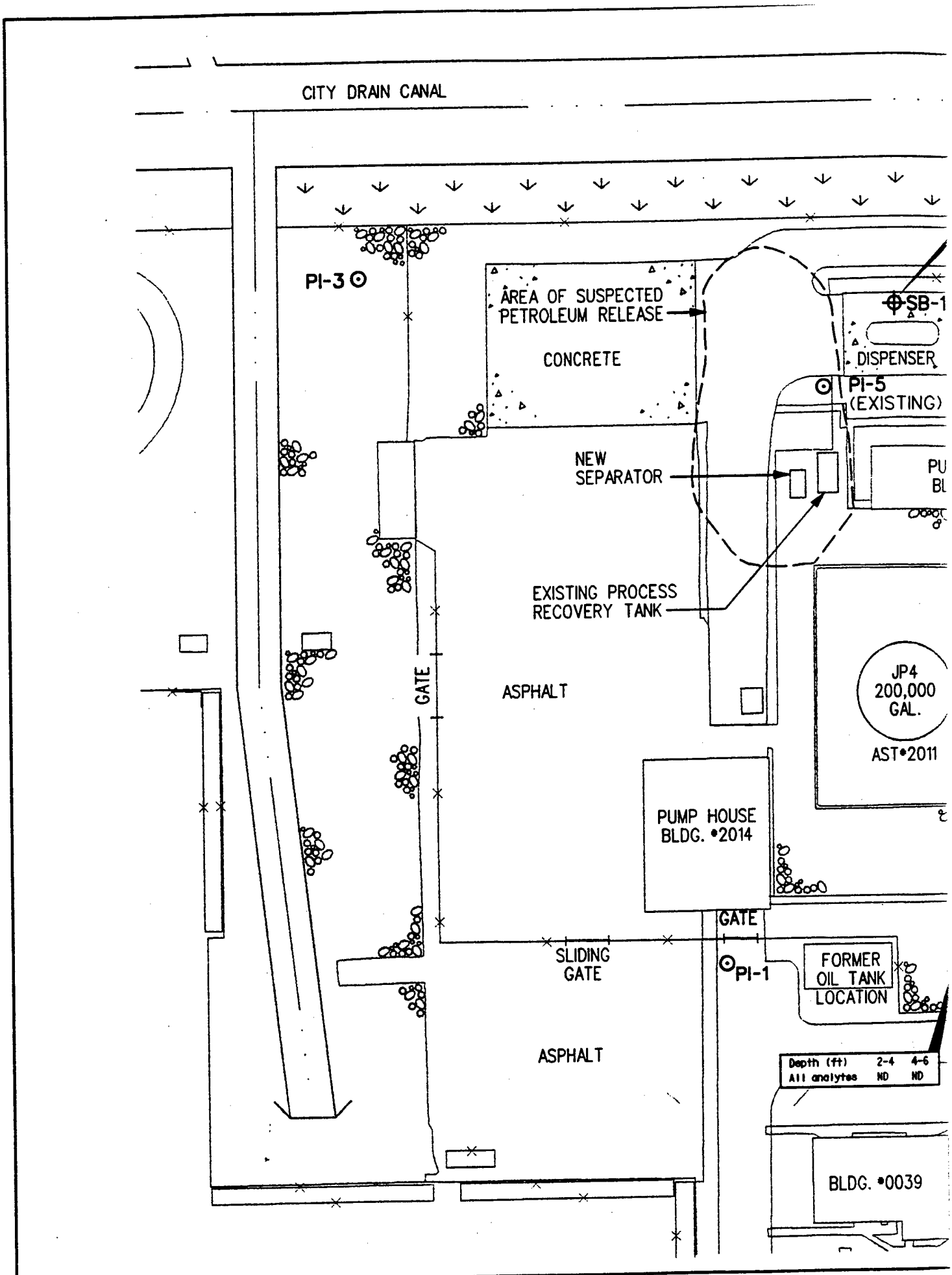
TABLE 4.44
SITE 10 - SOIL BORING
ANALYTES DETECTED
151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Parameter (method) (units)	Detection Limit	SB1-2-4	SB1-6-8	SB1-8-10*	SB2-2-4	SB2-4-6
VOCs (SW8010/8020) (µg/kg)**						
Dilution Factor	--	50	5	1	1	1000
Benzene	1.0	50U	5U	1.4J	1U	1000U
Toluene	1.0	50U	5U	5UJ	1U	1000U
Ethylbenzene	1.0	50U	34	5UJ	1U	1000U
Total Xylenes	1.0	340J	98J	5UJ	1U	7400J
TPH (8015 Mod.) (mg/kg)**						
Diesel Results	10.0	10U	10U	NA	10U	1400
Gasoline Results	1.0	12.1	35.4J	NA	2.56	353

Parameter (method) (units)	Detection Limit	SB3-1-3	SB3-3-5	SB4-2-4	SB4-4-6
VOCs (SW8010/8020) (µg/kg)**					
Dilution Factor	--	1	1	1	1
Benzene	1.0	1U	1U	1U	1U
Toluene	1.0	1U	1U	IU	1U
Ethylbenzene	1.0	1U	1U	1U	1U
Total Xylenes	1.0	1U	1U	1U	1U
TPH (8015 Mod.) (mg/kg)**					
Diesel Results	10.0	20	20	10U	10U
Gasoline Results	1.0	1U	0.99	1U	1U

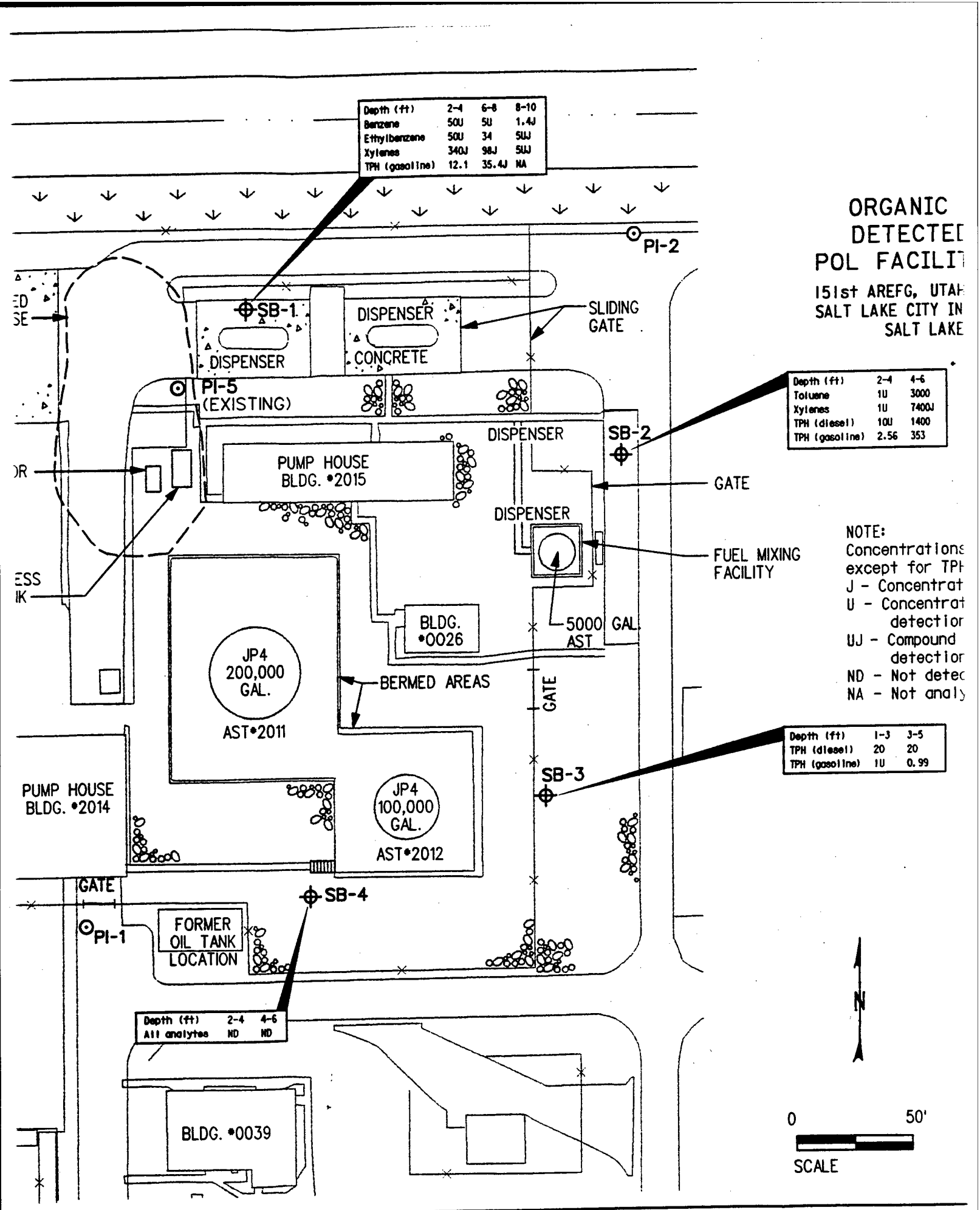
* This sample was also analyzed by method SW8270 and SW8080 and no analytes were detected.
** Analyses performed by Datachem Laboratories.
U Compound not present above the detection limit shown.
J Concentration of the compound is estimated.
UJ Compound not detected, but the detection limit is estimated.
NA Not analyzed.

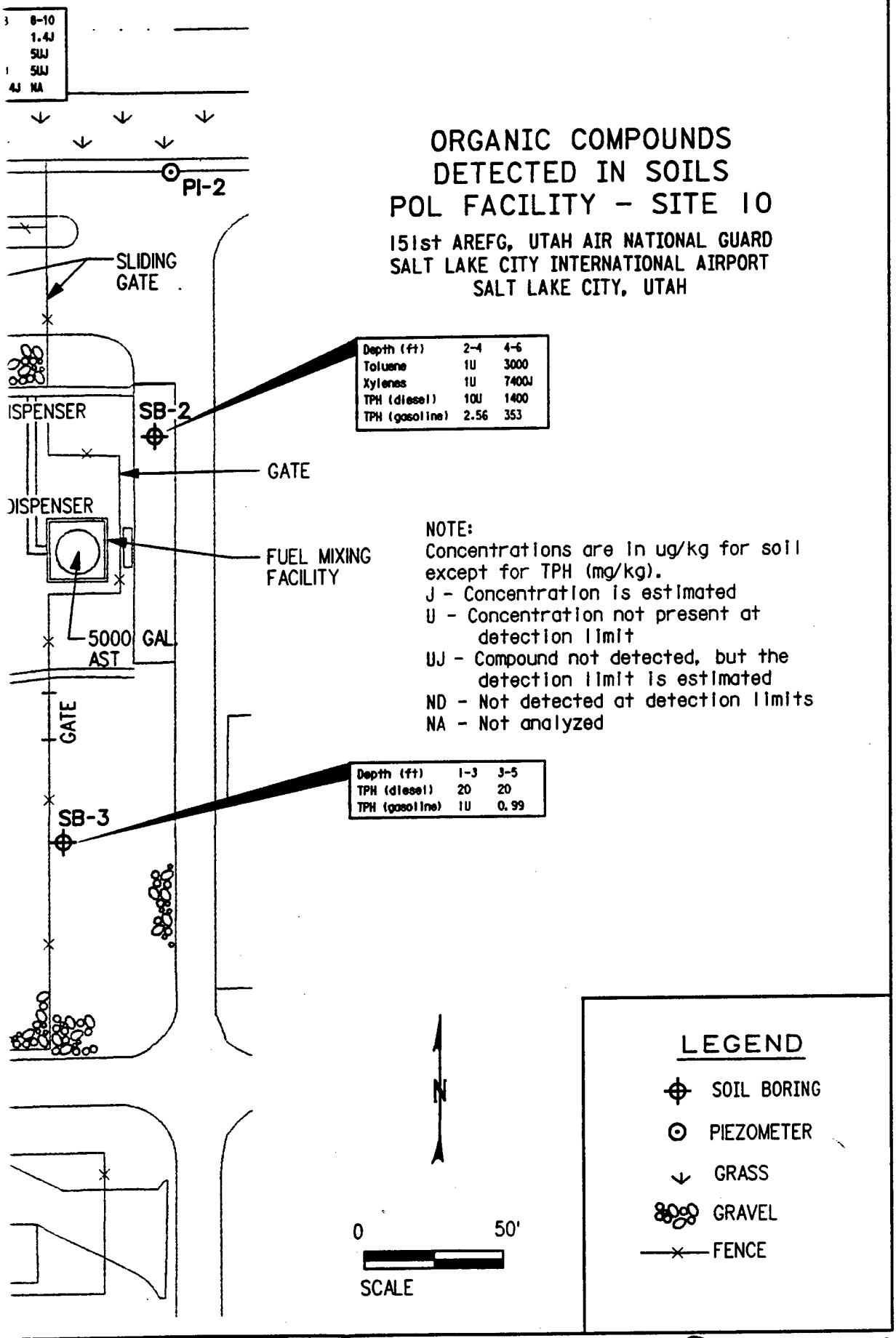
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(1)


ORGANIC
DETECTED
POL FACILITY
151st AREFG, UTAH
SALT LAKE CITY IN
SALT LAKE
Depth (ft) 2-4 6-8 8-10
Benzene 50U 5U 1.4J
Ethylbenzene 50U 34 5UJ
Xylenes 340J 98J 5UJ
TPH (gasoline) 12.1 35.4J NA
Depth (ft) 2-4 4-6
Toluene 1U 3000
Xylenes 1U 7400J
TPH (diesel) 10U 1400
TPH (gasoline) 2.56 353
Depth (ft) 1-3 3-5
TPH (diesel) 20 20
TPH (gasoline) 1U 0.99
Depth (ft) 2-4 4-6
All analytes ND ND
NOTE:
Concentrations
except for TPH
J - Concentrat
U - Concentrat
detectior
UJ - Compound
detectior
ND - Not detec
NA - Not analy
SB-1
SB-2
SB-3
SB-4
PI-1
PI-2
PI-5
(EXISTING)
DISPENSER
DISPENSER
CONCRETE
SLIDING
GATE
PUMP HOUSE
BLDG. *2015
DISPENSER
GATE
DISPENSER
FUEL MIXING
FACILITY
BLDG.
*0026
5000 GAL.
AST
JP4
200,000
GAL.
AST*2011
BERMED AREAS
GATE
PUMP HOUSE
BLDG. *2014
JP4
100,000
GAL.
AST*2012
GATE
FORMER
OIL TANK
LOCATION
BLDG. *0039
N
0
50'
SCALE



ORGANIC COMPOUNDS DETECTED IN SOILS POL FACILITY - SITE 10

151st AREFG, UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

NOTE:
Concentrations are in ug/kg for soil except for TPH (mg/kg).
J - Concentration is estimated
U - Concentration not present at detection limit
UJ - Compound not detected, but the detection limit is estimated
ND - Not detected at detection limits
NA - Not analyzed

FIGURE 4.82

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was the core that caused the adverse health effects in field personnel. Therefore, the soil analytical results of this sampling interval are considered to be inconclusive as to the cause of the adverse health effects. TPH (gasoline fraction) were detected at a concentration of 2.56 mg/kg in the 2- to 4-foot sampling interval of SB2. Toluene and xylenes were detected at concentrations of 3,000 µg/kg and 7,400 µg/kg estimated, respectively, in the 4- to 6-foot sampling interval of SB2. Diesel and gasoline fractions of TPH were also detected in this interval at concentrations of 1,400 mg/kg and 353 mg/kg, respectively.

TPH were detected in both sampling intervals of soil boring SB3. TPH (diesel fraction) were detected at concentrations of 20 mg/kg in the 1- to 3-foot interval and 3- to 5-foot interval of SB3. TPH (gasoline fraction) were also detected at a concentration of 0.99 mg/kg in the 3- to 5-foot interval. No analytes were detected in soil samples collected from SB4.

4.10.2.4 Groundwater Contamination Assessment

Monitoring wells that were proposed to be installed at the site were not completed due to the exposure incident at soil boring SB1. Therefore, groundwater at Site 10 has not been sampled and analyzed for potential contamination. Parsons ES suspects that the vapors associated with the 8- to 10-foot sampling interval of SB1 may have resulted from contaminated groundwater in this saturated sandy zone.

4.10.3 Site 10 - Conclusions

Petroleum related contamination from spills was detected in soil in three of the four preliminary soil borings advanced at the POL facility, confirming a release. The results of the analyses were inconclusive in identifying potential chemicals that may have caused the adverse health effects in field personnel. The preliminary soil analytical results were not compared to any health criteria or clean-up levels. Monitoring wells were not installed prior to termination of work at the site.

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4.11 BASEWIDE DISTRIBUTION OF ARSENIC IN GROUNDWATER

4.11.1 Rationale for Basewide Sampling of Arsenic

Analytical metals data for groundwater collected in February 1993 showed arsenic concentrations in shallow groundwater to be in excess of MCLs at the sites analyzed for PPMs; Sites 2, 4 and 7. Background concentrations at BGMW1 could not be evaluated due to detection limits that were too high to be of practical use. Based on these elevated concentrations of arsenic, groundwater for the second sampling event in August 1995, at all of the sites (metals and non-metals), was analyzed for dissolved arsenic. Arsenic was analyzed at the non-metals sites (Sites 1, 3, 5, and 7) and the two background wells for this second round of sampling to provide background information on arsenic concentrations in areas thought not to be affected by metals contamination and to evaluate the basewide distribution of arsenic in shallow groundwater. The rationale for analyzing arsenic in groundwater at all possible sampling locations was to determine if arsenic concentrations were elevated in background; and then, whether dissolved arsenic detected in excess of MCLs at Sites 2, 4, and 7 is site-related, or is indigenous to the shallow aquifer.

4.11.2 Results of Basewide Sampling of Arsenic

The concentrations of arsenic in groundwater at all 17 IRP monitoring wells for the 1995 sampling event are provided in Table 4.45. The data indicate that concentrations of dissolved arsenic in shallow groundwater primarily are elevated basewide and that arsenic is essentially ubiquitous at the Base. The mean concentration was 129 µg/L (the MCL is 50 µg/L). However, the higher concentrations of arsenic are constrained to sites in areas of the Base south and west of the City Drain Canal. The canal traverses west to east in the north portion of the Base (Figures 4.1, 4.2, and 4.3). The shallow aquifer sediments in these areas south and west of the canal have relatively higher clay content. Concentrations of dissolved arsenic in groundwater at Sites 3 and 5 and background well BGMW2 located north of the canal, were much lower or were below detection limits. This north portion of the Base is characterized by aquifer sediments that have relatively high sand content and high hydraulic conductivity. Also, pH of the groundwater was lower (Table 4.45). These factors, as well as redox reactions, Eh-pH phase stability, the presence of iron, solution kinetics, and ion exchange may affect the chemical nature, mobility, and concentration of this very labile (chemically unstable) metal. A discussion of the fate and transport characteristics of arsenic is contained in subsection 6.11.2.1.

Based on the concentrations of dissolved arsenic distributed in shallow groundwater at the Base, groundwater at Sites 2, 4, and 7 does not appear to have been impacted by Base activities. Rather, arsenic in groundwater at these sites and basewide appears to be indigenous to the shallow aquifer.

TABLE 4.45
ARSENIC CONCENTRATIONS, SPECIFIC CONDUCTANCE, pH, AND K OF GROUNDWATER SAMPLES FROM SITE MONITORING WELLS AUGUST 1995 151st AREFG, UTAH AIR NATIONAL GUARD SALT LAKE CITY INTERNATIONAL AIRPORT SALT LAKE CITY, UTAH

Well	Arsenic (µg/L)	Specific Conductance (microsiemens/cm)	pH	Hydraulic Conductivity (*K*) (ft/day)
BGMW1	250	1,977	7.82	4.26
BGMW2	<2UJ	20,000	7.03	1.91 (1)
S1MW1	310	1,960	8.85	3.30
S1MW2	130	2,310	7.99	5.34
S2MW1	240	2,720	8.71	0.17
S2MW2	6.6	10,050	7.52	3.42
S3MW1	7.1J	5,530	7.37	23.4 (1)
S3MW2	5.3J	9,840	7.24	50.41 (1)
S4MW1	90	738	7.70	1.44
S5MW1	<2UJ	9,640	7.23	21.28 (1)
S6MW1*	190J	19,980	8.30	4.28
S6MW2*	45J	14,400	8.68	2.04
S6MW3*	140J	6,300	7.42	5.00
S6MW4*	91J	13,680	8.41	2.34
S6MW5	340J	9,570	8.15	7.06
S7MW1	74	1,780	7.80	1.13
S7MW2	270	2,670	7.85	5.52
Mean	129	7,832	7.89	8.37
Standard Deviati	117	6,299	0.56	12.65

U Compound not present at the detection limit shown.

UJ Not detected, but the detection limit is estimated.

J Concentration of the compound is estimated.

* These arsenic concentrations are from November 1995 resampling.

(1) These wells are located at the north end of the Base and are screened in coarse granitic sands.

Note: Specific Conductance and pH were measured in the field at the time of sampling.

4.12 INVESTIGATION DERIVED WASTE ANALYSIS

4.12.1 Soil Samples and Related Cuttings

Soil samples and related cuttings from the soil borings, monitoring wells, and piezometers were retained in 55-gallon drums. Containerized soils from the monitoring wells and 10 piezometers were screened for organic vapors using a PID to verify that the VOC concentrations were less than 10 ppm and were then disposed of by Base personnel at a designated disposal area.

Soil analytical results of environmental samples collected from the soil borings were reviewed with the Base Environmental Coordinator. Composite soil samples of soil cuttings from Sites 1, 2, 4, 7, and 10, were collected for toxicity characteristic leaching procedure (TCLP) analysis. Tetrachloroethene and two metals were detected in the TCLP extract obtained from the soil cuttings. Results of these analyses are provided in Table 4.46. Based on these results, the soils were properly disposed by base personnel at a designated area.

4.12.2 Decontamination Fluids

Decontamination fluids were collected in 55-gallon drums. After review of the analytical reports with the Base Environmental Coordinator, the water was disposed into the sanitary sewer system by provision of the sanitary sewer pre-treatment coordinator.

4.12.3 Well Development and Purge Waters

Water derived from development and purging of monitoring wells was collected in 55-gallon drums for disposal at a later date. After review of the analytical reports with the Base Environmental Coordinator, the water was disposed into the sanitary sewer system by provision of the sanitary sewer pre-treatment coordinator if the concentrations of contaminants did not exceed SDWA or CWA levels. Drummed water exceeding SDWA or CWA levels was retained and properly disposed by appropriate Base personnel.

TABLE 4.46
ANALYSIS OF TCLP EXTRACT OF SOIL CUTTINGS FROM SOIL BORINGS AT SITES 1, 2, 4, 7, AND 10 151st AREFG UTAH AIR NATIONAL GUARD SALT LAKE CITY INTERNATIONAL AIRPORT SALT LAKE CITY, UTAH

Parameter (prepatory method) (units)	Site 1	Sites 2,4,7	Site 10
ORGANIC COMPOUNDS (SW1311) (µg/L)			
Vinyl chloride	0.39U	1.7U	0.39U
1,1-dichloroethene	0.36U	1.2U	0.36U
Chloroform	0.22U	1.8U	0.22U
1,2-dichloroethane	0.29U	2.4U	0.29U
2-butanone	1.3U	3.8U	1.3U
Carbon tetrachloride	0.28U	1.5U	0.28U
Trichloroethene	0.27U	1.3U	0.27U
Benzene	0.14U	1.6U	0.14U
Tetrachloroethene	0.37J	1.5U	0.31J
Chlorobenzene	0.16U	1.3U	0.16U
O-Cresol	NA	50U	NA
P-Cresol	NA	50U	NA
1,4-dichlorobenzene	NA	44U	NA
2,4-dinitrotoluene	NA	57U	NA
Hexachlorobenzene	NA	19U	NA
Hexachloro-1,3-butadiene	NA	9U	NA
Hexachloroethane	NA	16U	NA
Nitrobenzene	NA	19U	NA
Pentachlorophenol	NA	36U	NA
Pyridine	NA	50U	NA
2,4,5-Trichlorophenol	NA	50U	NA
2,4,6-Trichlorophenol	NA	27U	NA
TCLP METALS (SW1311) (mg/L)			
Arsenic	0.5U	0.5U	0.5U
Barium	1.2	0.02U	0.96
Cadmium	0.02	0.01U	0.01U
Chromium	0.02U	0.02U	0.02U
Lead	0.1U	0.10U	0.1U
Mercury	0.001U	0.0002U	0.001U
Selenium	0.3U	0.30U	0.3U
Silver	0.02U	0.02U	0.02U

U - Compound not present above the detection limit shown.
J - Concentration of the compound is estimated.
NA - Not Analyzed

SECTION 5
PRELIMINARY RISK EVALUATION

5.1 INTRODUCTION

The preliminary risk evaluation for the UANG Base was performed using data collected during the SI. These previously presented data include the site history (Section 1); demographic, land use, climatic, and geologic information (Section 2); and the results of the investigative program, including contaminant concentrations and geologic and hydrogeologic information (Section 4). The objectives of the preliminary risk evaluation are to provide qualitative information on the potential risks to human and environmental receptors due to the release or threat of release of hazardous substances from the sites; to aid in identifying additional data needed to complete a quantitative risk assessment during the RI; and to provide information for the determination that no further action is required if risks to human and environmental receptors are not identified.

The results of the investigations described in the previous sections were used to identify chemicals of concern, chemical concentrations within the release, general release characteristics, the affected environmental media, and exposed or potentially-exposed human or environmental receptors.

The initial steps of the preliminary evaluation were to:

- Summarize the available chemical sampling data;
- Establish criteria for selecting chemicals that are or may be related to the sites and that may have an adverse affect on human health or the environment in the concentrations present, and then, select a group of chemicals for further evaluation;
- Review the factors that affect migration of selected chemicals, and identify and evaluate the potential human and environmental receptors;
- Evaluate the potential toxicities associated with exposure to the selected chemicals by human or environmental receptors; and
- Identify potential hazards to human or environmental receptors that may have been affected by the migration of contaminants along identified pathways.

Because the SI is a screening phase of the investigation, the purpose of which is to confirm or deny the presence of contamination, the potential for data gaps exists. Therefore, detailed calculations to quantify risks to human health and the environment, which might be associated with a risk assessment, were not performed. Instead, a

qualitative approach was taken in which all potential receptors and exposure pathways were evaluated, and the potential importance of each exposure pathway was ascertained based on a comparison with standards or criteria and an evaluation of the likelihood of pathway completion. This risk evaluation was based on existing site information concerning migration pathways, the location and types of contaminants present, and the location of current and possible future receptors. Conservative assumptions were employed to ensure that potential exposure pathways were not excluded from consideration.

The preliminary evaluation assumes that no current or future remediation is to be performed at the site. This is referred to as the no-action alternative. This assumption is made to determine the need for remediation.

5.2 CHEMICALS OF CONCERN

The potential chemicals of concern were selected based on an evaluation of the available information on the hazards of substances at the Base. Data used in the selection of chemicals were compiled from the SI field work performed at the Base by Parsons ES. Summaries of the collected data are given in Section 4. Data that did not meet QC criteria were not used in the preliminary risk evaluation. Data qualifiers are also described in Section 4.

Analytical data were reviewed by media (i.e., groundwater, soil, surface water, and sediment) to identify potential chemicals of concern at Sites 1 through 7, the City Drain Canal, and piezometer PI-5. Site 10 is not included in the evaluation because of the incomplete investigation of the site and insufficient data. Chemicals that were not detected in any samples from a site in a particular media were eliminated from further evaluation. TRPH were also eliminated from further analysis because TRPH are an indicator of multiple petroleum compounds. This preliminary risk evaluation focuses on the fuel-related components of TRPH which were analyzed for separately. Soil gas information was not used in the risk evaluation because of its inherent uncertainty in both chemical identification and quantification.

Based on this analysis, the following compounds were evaluated as chemicals of potential concern:

Metals:

- antimony
- arsenic
- beryllium
- cadmium
- chromium
- copper
- lead
- mercury
- nickel
- thallium
- selenium
- zinc

Volatile Organic Compounds:

- acetone
- benzene
- 2-butanone

- carbon disulfide
- chlorobenzene
- 1,3-dichlorobenzene
- 1,2-dichlorobenzene
- 1,4-dichlorobenzene
- 1,1-dichloroethane
- 1,1-dichloroethene
- 1,2-dichloroethene (total)
- chloroform
- cis-1,2-dichloroethene
- 1,2-dichloropropane
- trans 1,3-dichloropropene
- ethylbenzene
- methylene chloride
- 4-methyl-2-pentanone
- tetrachloroethene
- toluene
- trichloroethene
- 1,1,1-trichloroethane
- xylenes (total)
- vinyl chloride

Semivolatile Organic Compounds:

- benzo(a)anthracene
- benzo(b)fluoranthene
- benzo(k)fluoranthene
- benzo(a)pyrene
- benzo(g,h,i)perylene
- bis(2-ethylhexyl)phthalate
- chrysene
- diethylphthalate
- 2,4-dimethylphenol
- di-n-butylphathalate
- fluoranthene
- fluorene
- ideno(1,2,3-cd)pyrene
- 2-methylnapthalene
- 4-methylphenol
- napthalene
- 4-nitrophenol
- n-nitrosodiphenylamine
- phenanthrene
- phenol
- pyrene

Pesticides/PCBs:

- aldrin
- beta-BHC
- chlordane
- dieldrin
- 4,4-DDE
- 4,4-DDD
- heptachlor

The potential chemicals of concern were not detected at all sites or in all media.

5.3 ENVIRONMENTAL FATE AND TRANSPORT

An evaluation of the environmental fate and transport of the selected chemicals of concern for UANG can help determine the potential for migration in the environment and the potential for exposure to the contaminants. The environmental fate and transport of contaminants is dependent upon the physical and chemical properties of the compounds, the environmental transformation processes affecting them, and the media through which they migrate. In this section, the chemical and physical properties of the chemicals of concern are presented and the relevance of these properties to environmental fate and transport is discussed. In addition, mechanisms of chemical migration into air, groundwater, and surface water and processes of biotransformation and bioaccumulation are discussed in relation to the environmental fate and transport of the chemicals of concern.

5.3.1 Chemical and Physical Properties of the Chemicals of Concern

Physical and chemical properties of the chemicals of concern will affect the extent to which they may migrate through the environment. Table 5.1 summarizes several of these properties for many of the selected potential chemicals of concern.

TABLE 5.1
RELEVANT PHYSICAL AND CHEMICAL PROPERTIES
OF INDICATOR CHEMICALS OF CONCERN a/
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Indicator Chemical	CAS[b/] Nubmer	Fish BCF[c/] (L/kg)	Water Solubility[d/] (mg/L)	Vapor Pressure[d/] (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Koc (ml/g)
Acetone	67-64-1	-	1.00E+06	2.70E+02	2.06E-05	2.2
Aldrin	309-00-2	28	1.80E-01	6.00E-06	1.60E-05	96,000
Antimony	7440-36-0	1	-	1.00E+00	-	-
Arsenic	7440-38-2	44	-	0.00E+00	-	-
Benzene	71-43-2	5.2	1.75E+03	9.52E+01	5.59E-03	83
Benzo(a)anthracene	56-55-3	-	5.70E-03	2.20E-08	1.16E-06	1,380,000
Benzo(a)pyrene	50-32-8	-	1.20E-03	5.60E-09	1.55E-06	5,500,000
Benzo(b)fluoranthene	205-99-2	-	1.40E-02	5.00E-07	1.19E-05	550,000
Benzo(ghi)perylene	191-24-2	-	7.00E-04	1.03E-10	5.43E-08	1,600,000
Benzo(k)fluoranthene	207-08-9	-	4.30E-03	5.10E-07	3.94E-05	550,000
Beryllium	7440-41-7	19	-	0.00E+00	-	-
Beta-BHC	58-89-9	130	7.8	1.60E-04	7.85E-06	1,080
Bis(2-ethylhexyl)phthalate	117-81-7	-	0.285	1.32@200C	3.61E-07	5,900
2-Butanone (MEK)	78-93-3	0	2.68E+05	7.75E+01	2.74E-05	4.5
Butyl benzyl phthalate	85-68-7	47	2.90E+00	8.60E-06	-	-
Cadmium	7740-43-9	81	-	0.00E+00	-	-
Chlorobenzene	108-90-7	10	4.66E+02	1.17E+01	3.72E-03	330
Chloroform	67-66-3	3.75	8.20E+03	1.51E+02	2.87E-03	31
Chromium	7440-47-3	16	-	0.00E+00	NR	-
Chrysene	218-01-9	-	1.80E-03	6.30E-09	1.05E-06	200,000
Copper	7440-50-8	200	-	1 @ 1628 C	NR	-
Carbon disulfide	75-15-0	15.8	1.70E+03	3.60E+02	1.33E-02	354.8
Chlordane	57-74-9	14,000	5.60E-01	1.00E-05	9.63E-06	140,000
4,4-DDD	72-54-8	-	1.00E-01	1.89E-06	7.96E-06	770,000
4,4-DDE	72-55-9	51,000	4.00E-02	6.50E-06	6.80E-05	440,000
1,1-Dichloroethane	75-34-3	13.5	5.06E+03	2.34E+02	1.90E-01	30.2
1,1-Dichloroethene	75-35-4	2.13	6.40E+03	5.91+02	1.90E-01	150

TABLE 5.1 (continued)
RELEVANT PHYSICAL AND CHEMICAL PROPERTIES
OF INDICATOR CHEMICALS OF CONCERN a/
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Indicator Chemical	CAS[b/] Nubmer	Fish BCF[c/] (L/kg)	Water Solubility[d/] (mg/L)	Vapor Pressure[e/] (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Koc (ml/g)
1,2-Dichloroethene (total)	-	-	-	-	7.59E-03	-
cis-1,2-Dichloroethene	156-59-2	1.6	3.50E+03	2.08E+02	7.59E-03	49
1,2-Dichloropropane	78-87-5	10	2.80E+03	5.00E+01	2.94E-03	51.3
trans-1,3-Dichloropropene	10061-02-6	7	2.80E+03	1.24E+03	1.80E-03	26
1,2-Dichlorobenzene	95-50-1	56	1.00E+02	1.00E+00	1.93E-03	1,700
1,3-Dichlorobenzene	541-73-1	56	1.23E+02	2.28E+00	3.59E-03	1,700
1,4-Dichlorobenzene	106-46-7	56.2	9.06E+01	4.00E-01	4.45E-03	158.5
1,2-Dichloroethane (EDC)	107-06-02	1.2	8.52E+03	6.40E+01	9.78E-04	14
2,4-Dimethylphenol	105-67-9	151.4	7.87E+03	9.80E-02	1.70E-05	117.5
Dieldrin	60-57-1	4760	1.95E-01	1.78E-07	4.58E-07	1,700
Diethyl phthalate	84-66-2	117	8.96E+02	3.50E-03	1.14E-06	142
Di-n-butyl phthalate	84-74-2	-	1.30E-01	1.00E-05	2.82E-07	170,000
Ethylbenzene	100-41-4	37.5	1.52E+02	7.00E+00	6.43E-03	1,100
Fluoranthene	206-44-0	1,150	2.06E-01	5.00E-06	6.46E-06	38,000
Fluorene	86-73-7	1,300	1.69E+00	7.10E-04	6.42E-05	7,300
Heptachlor	76-44-8	15,700	1.80E-01	3.00E-04	8.19E-04	12,000
Indeno(1,2,3-cd)pyrene	193-39-5	-	5.30E-04	1.00E-10	6.86E-08	1,600,000
Lead	7439-92-1	49	-	0.00E+00	-	-
Mercury	7439-97-6	5500	0.28µmol	2.00E-03	-	-
Methylene Chloride	75-09-2	5	1.94E+04	4.40E+02	2.69E-03	8.7
2-Methylnaphthalene	91-57-6	-	NS	6.81-02	-	-
4-Methylphenol	106-44-5	0	3.10E+04	1.10E-01	1.10E-06	500
4-Methyl-2-pentanone	108-10-1	2.4	1.70E+04	1.50E+01	1.49E-05	6.2
Napthalene	91-20-3	-	3.30E+01	2.30E-01	1.15E-03	-
Nickel	7440-02-0	47	-	0.00E+00	-	-
4-Nitrosodiphenylamine	86-30-6	218.7	3.51E+01	1.00E-01	6.60E-04	575.4
Phenanthrene	85-01-8	2,630	1.00E+00	6.80E-04	1.59E-04	14,000

TABLE 5.1 (continued)
RELEVANT PHYSICAL AND CHEMICAL PROPERTIES
OF INDICATOR CHEMICALS OF CONCERN a/
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Indicator Chemical	CAS[b/] Nubmer	Fish BCF[c/] (L/kg)	Water Solubility[d/] (mg/L)	Vapor Pressure[d/] (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Koc (ml/g)
Phenol	108-95-2	1.4	9.30E+04	3.40E-01	3.97E-07	26.9
Pyrene	129-00-0	-	1.32E-01	2.50E-06	5.04E-06	38,000
Selenium	7782-49-2	16	NS	< 0.001	-	-
Tetrachloroethylene	127-18-4	31	1.50E+02	1.78E+01	2.59E-02	364
Thallium	7440-28-0	-	-	0.00E+00	-	-
Toluene	108-88-3	10.7	5.35E+02	2.81E+01	6.37E-03	300
Total Petroleum Hydrocarbons (TPH)	-	-	-	-	-	-
Trichloroethylene	79-01-6	10.6	1.10E+03	5.79E+01	9.10E-03	126
1,1,1-Trichloroethane	71-55-6	5.6	1.50E+03	1.23E+02	1.44E-02	152
Xylenes	1330-20-7	-	1.98E+02	1.00E+01	7.04E-03	240
Zinc	7440-66-6	47	-	0.00E+00	-	-
Vinyl Chloride	75-01-4	7	2.70E+03	2.66E+03	5.60E-02	56

a/	Source: EPA, 1986b or National Library of Medicine, 1991, unless otherwise stated.
b/	CAS: Chemical Abstract Service.
c/	Source: U.S. EPA, 199la.
d/	Measured in temperature range 20-30°C unless otherwise noted; exponential notation values (i.e., 3.4E-01 is 0.34)
mg/L	Milligrams per liter
mm Hg	Millimeters of mercury
atm-m^3/mole	Atmosphere-cubic meter per mole
ml/g	Milliliters per gram
Koc	Organic carbon partition coefficient
NR	Not relevant
L/kg	Liters per kilogram
NS	Not Soluble
µmol	Micromole
BCF	Bioconcentration factor

The water solubility of a substance is a critical property affecting environmental fate. Highly soluble chemicals can be rapidly leached from wastes and soils and are generally mobile in groundwater. Solubilities can range from less than 1 mg/L to totally miscible. The solubility of chemicals which are not readily soluble in water may become enhanced in the presence of organic solvents (e.g., toluene), which themselves are more soluble in water. Volatilization of a compound will depend on its vapor pressure, water solubility, and air diffusion coefficient. Highly water-soluble compounds generally have lower volatilization rates from water unless they also have high vapor pressures. Vapor pressure, a relative measure of the volatility of chemicals in their pure state, ranges from roughly 0.001 to 760 millimeters of mercury (mm Hg) for liquids. The Henry's Law Constant, which combines vapor pressure with solubility, is more appropriate than vapor pressure alone for estimating releases from water to air for compounds having Henry's Law Constants. Compounds with Henry's Law Constants greater than 10^{-3} atmospheres - cubic meter per mole (atm-m^3/mole) can be expected to readily volatilize from water; those with values ranging from 10^{-3} to 10^{-5} atm-m^3/mole are associated with possibly significant but not facile volatilization, while compounds with values less than 10^{-5} atm-m^3/mole will only volatilize from water to a limited extent.

The organic carbon partition coefficient (K_{oc}) reflects the propensity of a compound to adsorb to organic matter found in soil. The normal range of K_{oc} values is 1 to 107 milliliters per gram (ml/g), with higher values indicating greater sorption potential. Chemicals which have a strong tendency to adsorb to organic matter (i.e., chemicals with high K_{oc}s) will move more slowly in the environment than chemicals with low K_{oc}s.

5.4 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of exposures to the chemicals of potential concern that are present at, or migrating from, a site. A completed exposure pathway is comprised of the following four elements:

- A source and mechanism for chemical release;
- An environmental transport medium;
- An exposure point; and
- A human or environmental receptor and a feasible route of exposure at the exposure point.

A pathway is not complete unless each of these elements is present.

The media into which chemicals migrate can affect the types of exposures that could occur. For example, a very volatile chemical is likely to be released into air, and thus, inhalation exposures may occur. Mechanisms of chemical migration are discussed below to help identify potential exposure pathways.

There are several mechanisms by which chemicals may migrate from source locations at the Base. Contaminated soil, sediment, groundwater, and surface water can

act as sources of contaminant migration. Migration of contaminants into the air can occur via fugitive dust emissions and volatilization. Migration into groundwater can occur by percolation of rainfall with subsequent leaching and transport. Migration into surface water can occur from surface runoff, and groundwater discharge. The migration of organic chemicals may be altered by biotransformations which may enhance or inhibit transport. The movement of inorganic compounds is dependent on physical/chemical characteristics and processes such as pH, ionic charge, and adsorption.

5.4.1 Pathways of Human Exposure

Potential pathways of exposure to chemicals of concern at each of the sites under consideration at the Base (Sites 1 through 7, the City Drain Canal, and piezometer PI-5) are summarized in Table 5.2. Demographic and land use information presented in Section 2 was used in developing exposure pathways. A general discussion of potential pathways at UANG is presented in the following paragraphs for each medium of concern.

5.4.1.1 Air

Contaminated surface soils and dry sediments are considered as potential sources for release into air via fugitive dust generation and volatilization. Base personnel and local residents are considered potential receptors who could be exposed to contaminants through inhalation or through dermal contact with contaminated airborne dust. The probability of pathway completion is dependent on the distance from the source and whether the receptors are located downwind. The potential for pathway completion is reduced if the site is paved or vegetated.

Subsurface soils would not be expected to act as a release source for the air pathway unless they were uncovered. This could potentially occur if construction activities, including trenching or excavation conducted in conjunction with utility replacement, were to take place.

5.4.1.2 Soils

Contaminated surface soils act as a source for dispersion via tracking, surface runoff, and wind dispersion. Base personnel are the most likely receptors under current conditions because there is no residential population on the Base. If in the future, the property were to change ownership and the land use were to change, local residents and children would become potential receptors. Similar to the air pathway, exposure to contaminated subsurface soils would not be expected to occur except during construction activities. Receptors could be exposed to contaminants in soils via incidental ingestion and dermal contact. The probability for pathway completion decreases if the site is paved or densely vegetated.

5.4.1.3 Groundwater

Leaching acts as a release mechanism for transporting contaminants from soils into groundwater. Currently, two aquifers have been identified: a shallow unconfined aquifer and a deeper confined aquifer (see Section 2 and 4). Hydraulic head information

TABLE 5.2
MATRIX OF POTENTIAL HUMAN EXPOSURE PATHWAYS
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Transport Medium	Release Source and Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route (s)
Air	Affected soils/fugitive dust generation, volatilization	Utah ANGB and areas downwind	Base personnel, residents downwind construction workers	Inhalation, dermal contact
Soils	Affected soils/tracking runoff, wind dispersion	Surface soils and subsurface soils	Base personnel, local residents, children	Ingestion, dermal contact
Groundwater	Affected soils, groundwater/site leaching	Base and local supply wells	Base personnel, local residents, children	Ingestion, inhalation, dermal contact
Surface water	Affected soils, groundwater, seepage, runoff, tracking, aerial deposition	City Drain Canal, Salt Lake City Sewer Drain, Farmington Bay	Base personnel, local residents, children	Ingestion, dermal contact

suggests that an extensive confining layer between aquifers allows for only upward groundwater migration between aquifers. Therefore, the shallow aquifer is likely to be the only aquifer impacted by site contaminant leaching.

Neither aquifer is used as a water source at the Base. Therefore, it is unlikely that Base personnel or local residents would be exposed to contaminated groundwater. The likelihood of future pathway completion depends on the existence of a continuing source for groundwater contamination, the existence of a conduit for downward vertical migration of contaminants from the shallow aquifer to the deeper ones, and the installation of shallow potable groundwater wells.

5.4.1.4 Surface Water

Surface water drainage at UANG is through the City Drain, which is an open and unlined canal along much of its course at the Base. Contaminants may be transported into the City Drain or to downgradient surface waters through surface runoff carrying contaminated soils or sediments, or seepage of contaminated groundwater into the City Drain Canal. On the Base, personnel could be exposed to contaminants in the storm drainage system through incidental contact. Under present conditions, local residents, including children, are not expected to be exposed to contaminants in storm drainages because access to the Base is restricted. Exposures could occur in the future however, if access became less restricted. Local residents could be potentially exposed to contaminants in surface water in the Salt Lake City Sewage Canal or downstream at Farmington Bay. Residents could be exposed via recreational activities including fishing or swimming at Farmington Bay.

5.4.1.5 Sediments

Pathways for exposure to sediments are similar to exposure to surface water. Contaminated soils, surface waters, and groundwaters may serve as sources for sediment contamination. Contaminants may be released through groundwater seepage, runoff, and tracking. Currently, Base personnel could be exposed to contaminated sediments in the City Drain Canal and local residents, including children, could be exposed to sediments in Salt Lake City Sewage Canal or Farmington Bay. If the Base property were to change ownership and the land use were to change, local residents could be exposed to sediments in surface drainages within the currently restricted access area.

5.4.2 Pathways of Ecological Exposure

In this section, a description of the environment is provided, followed by a pathway analysis which includes identification of potential receptor organisms.

5.4.2.1 Description of the Environment

The Base is located southeast of the Great Salt Lake. The Base lies in an area of hydrologic and biotic transition between upland habitat to the south and wetlands on the edge of the Great Salt Lake to the north and west. A variety of habitat types occur

between the uplands and the Great Salt Lake, including saline flats and playas, saline meadows, saline marshes, and open waters (SLCIA, 1991).

The Base and the SLCIA consist of runways, terminals, and other developed areas that provide limited wildlife habitat. The industrial and residential areas located east of the Base also have limited wildlife value. Native vegetation in these areas has been removed and replaced with either introduced landscaped plants or weedy opportunistic (ruderal) species. Some lands within and west of SLCIA are used for agriculture and livestock grazing (SLCIA, 1991). Lands northwest of the SLCIA are largely undeveloped and serve as wildlife habitat.

A description of the wildlife, vegetation and water quality in vicinity of the Base is presented in the following paragraphs. Information on threatened and endangered species is also provided.

Terrestrial and Aquatic Wildlife

The wetlands and upland habitats north and west of the Base support numerous animals such as rodents, muskrat, and other small mammals; songbirds; and many waterfowl (SLCIA, 1991). Raptors such as hawks, eagles, osprey, and owls hunt in the area and many over-winter here. Mammals such as rabbits, ground squirrels, and mice are an important food source for these raptors. During the warm months, amphibians such as tiger salamander and frogs, and reptiles such as leopard, collared, and short-horned lizards, are active and breeding. Species of concern that may be found in the vicinity of the Base include the federally listed endangered bald eagle and peregrine falcon and State species of concern including the short-eared owl, burrowing owl, snowy plover, and long-billed curlew.

The Great Salt Lake area provides important habitat for millions of migrating birds and is considered to be a major node on the north-south flyway in western North America (SLCIA, 1991). Approximately 8 miles north of the Base, the state has designated 8,725 acres as a waterfowl refuge called the Farmington Bay Waterfowl Management Area. Waterfowl species found in the Great Salt Lake area include ducks, geese, swans, grebes, and coots; shorebirds such as sandpipers and avocets; and wading birds such as herons and egrets.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service (USFWS) has identified two endangered species present in the SLCIA area: the bald eagle and peregrine falcon. In 1988, over 100 eagles were observed in the Jordan River area. Bald eagles are not known to nest in northern Utah, but are wintering residents (SLCIA, 1991). These birds are likely to forage for carp, waterfowl, and occasionally small mammals in the wetlands and open waters in vicinity of the Base. Peregrine falcons are known to nest in towers constructed by wildlife managers around the Great Salt Lake (SLCIA, 1991). One of the towers is

located about 2 miles from the Base and some falcons are known to forage in the SLCIA area. The falcons prey on upland and wetland birds.

Vegetation

The diversity of wetland and upland habitat types contributes greatly to the richness of the plant life as well as the animal life. The types of vegetation in the SLCIA area are described below for each habitat type in progression from wetlands to uplands (SLCIA, 1991):

- **Open Water** - supports predominantly submerged and microscopic vegetation such as filamentous algae, duckweed, and single-celled algae such as diatoms.
- **Saline Marsh** - includes cattails, bulrushes, rushes, spike rush, water parsnip, water hemlock, water cress, and pond weed.
- **Saline Flats and Playas** - vegetative cover includes inkweed, iodine bush, pickleweed, and saltgrass.
- **Saline Meadow** - supports Baltic rush, saltgrass, and salt-tolerant wet meadow grasses and herbs.
- **Saline Plains** - are upland habitat for salt grass, greasewood, shadscale, rabbitbush, indian paintbrush, thistles, and gumweed.

Water Quality

The Base lies within the floodplain of the Jordan River, an area of poor natural drainage, that is classified as wetlands. The developed areas on the Base and the SLCIA are drained by a network of ditches, drains, and canals with levees. The City Drain Canal bisects the Base and collects surface runoff and groundwater seepage that is discharged to the brackish ponds and marshes bordering the Great Salt Lake to the northwest.

A monitoring study conducted as part of an environmental assessment for expansion of the SLCIA found high concentrations of oil and grease, deicing chemicals, and other pollutants in the City Drain Canal (SLCIA, 1991). This contamination was reported to be related to urban drainage, agricultural runoff, and municipal and industrial discharges. In 1985, SLCIA constructed a detention basin and skimming device to remove oil and grease and other pollutants. However, during the SI an oil sheen was observed on the water surface of the canal on several occasions. Also, several bird species, including mallards, wood ducks, herons, kingfishers, and an osprey, were observed in and along the canal.

5.4.2.2 Receptor Organisms

Receptor organisms were identified by a biological resource group based on those organisms likely to be present at the Base. Receptor organisms were categorized as wildlife, aquatic life, or vegetation.

Ecological receptors may be exposed to chemical contaminants through direct or indirect pathways. Direct pathways would include direct contact with or ingestion of contaminated media such as soil, sediment, or water. No direct pathways were identified for groundwater although groundwater discharge may contribute to contamination in other media. Indirect pathways include those in which an animal consumes other previously contaminated organisms. If exposure pathways between contaminated media and receptor organisms are not complete, contaminants do not constitute an environmental risk.

Exposure media and routes may differ between various organisms due to their physiological and behavioral differences. For example, fish-eating birds may be exposed to contaminants by consuming fish that have bioaccumulated contaminants from surface water and sediments; whereas, seed-eating birds may be exposed to contaminants from seeds that have assimilated contaminants through plant uptake from soil or by direct contact with soils through incidental ingestion of soil while foraging. Receptors are identified by media in the following paragraphs.

Soils

Terrestrial animals at the site may be directly or indirectly exposed to contaminants in the soil. Direct dermal contact with the contaminated soil and incidental ingestion of soil could occur among burrowing animals, or among dust-bathing animals such as many bird species. In general, information for quantifying and evaluating the toxicity of dermal exposures to wildlife is limited. Relatively more information is available on exposure via ingestion (Gough et al., 1979; Micromedex, Inc., 1993; CH2M Hill, 1989). Small mammals may ingest soil while grooming. Herbivorous animals such as rabbits and seed-eating birds may ingest soil while feeding on plants and seeds, respectively. Indirect exposure to soil contaminants may occur through ingestion of soil-dwelling invertebrates (e.g., earthworms) or grasses and other plants which may bioaccumulate contaminants.

Plants may be directly exposed to contaminants in soil via uptake through their roots. The evaluation of potential effects on plants is often difficult because chemical uptake is known to vary among plant species and plant tissues. However, plant phytotoxic criteria for agriculturally important species are relatively well documented (EPA, 1983; Gough et al., 1979).

Groundwater

Groundwater constituents were not subject to ecological risk screening in this evaluation because this medium was considered a potential contaminant source rather than a physical medium capable of supporting biological communities. Under current use conditions, the shallow aquifer at the site is not used for purposes such as irrigation or livestock watering. Generally, the saline characteristics of the shallow groundwater make

it unsuitable for these uses. Furthermore, the majority of plant roots are not expected to reach the depth of groundwater (approximately 5 feet).

Surface Water and Sediment

Aquatic organisms such as fish may be directly exposed to contaminants in surface water and sediments through ingestion or direct contact with chemicals. Many chemicals are known to bioconcentrate in aquatic organisms. Aquatic organisms which bioaccumulate contaminants may also function as a source of contamination when utilized as a food by terrestrial wildlife. Omnivorous mammals such as raccoons, or raptors such as eagles, may be exposed through this pathway.

Most terrestrial wildlife are dependent, to some extent, on surface water as a source of water. Animals may be exposed to contaminants through direct ingestion or dermal contact when drinking water.

Benthic (bottom-dwelling) aquatic organisms may be continuously exposed to contaminants in sediment. Wading birds and other animals may also be exposed to contaminants from direct contact with sediment while foraging for food. In addition, rooted aquatic plants may be exposed to sediment contaminants through root uptake.

5.5 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to weigh available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects. Primary factors influencing the level of concern about a particular substance include its inherent toxicity, inherent bioaccumulation and/or biomagnification characteristics, and its persistence in the environment. For some chemicals of potential concern, this information has been processed through the scientific and political communities to develop standards, criteria, or other guidelines for the exposure of humans or other receptors to chemicals in various media.

In this section, a discussion of toxicity screening criteria is provided for both human and environmental receptors.

5.5.1 Human Health Screening Criteria

Human health screening criteria consist of pertinent chemical-specific standards which have been promulgated under specific laws, or developed using risk-based guidelines. Each of these criteria types are discussed in this section and presented in Table 5.3.

5.5.1.1 Promulgated Standards

Available standards for drinking water, which are used as screening criteria for groundwater, include MCLs promulgated under the Safe Drinking Water Act (SDWA)

TABLE 5.3
HEALTH SCREENING RISK CRITERIA
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Risk-based PRG a/ Water (mg/L) Carc	Water (mg/L) Non-Carc	Soil (mg/kg) Carc	Soil (mg/kg) Non-carc	MCL b/c/ (mg/L)	Non-Zero MCLG c/d/ (mg/L)
Acetone	NA	3.65E+00	NA	2.70E+04	NA	NA
Aldrin	1.05E-06	1.10E-03	3.80E-02	8.20E+00	NA	NA
Antimony	NA	1.46E-02	NA	1.08E+02	0.006	0.006
Arsenic	4.86E-05	1.10E-02	3.66E-01	8.10E+01	0.05	NA
Barium	NA	2.56E+00	NA	1.89E+04	2	20
Benzene	6.16E-04	NA	2.21E+01	NA	0.005	NA
Benzo(a)anthracene	8.02E-05	NA	6.04E-01	NA	NA	NA
Benzo(a)pyrene	1.16E-05	NA	8.77E-02	NA	0.0002	NA
Benzo(b)fluoranthene	8.33E-05	NA	6.27E-01	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Benzo(k)flouranthene	1.76E-04	NA	1.33E+00	NA	NA	NA
Beryllium	1.98E-05	1.83E-01	1.49E-01	1.35E+03	NA	NA
Beta-BHC(beta lindane)	9.73E-06	NA	3.56E-01	NA	NA*	NA*
bis(2-Ethylhexyl)phthalate	6.07E-03	7.30E-01	4.57E+01	5.40E+03	0.006	NA
2-Butanone	NA	2.47E+00	NA	1.62E+05	NA	NA
Cadmium	3.60E-06	1.83E-02	NA	1.35E+02	0.005	0.005
Carbon disulfide	NA	2.76E-02	NA	2.70E+04	NA	NA
Chlordane	6.54E-05	2.19E-03	4.92E-01	1.62E+01	0.002	NA
Chlorobenzene	NA	5.17E-02	NA	5.40E+03	0.1	0.1
Chloroform	2.76E-04	3.65E-01	1.05E+02	2.70E+03	0.1	NA
Chromium III	NA	3.65E+01	NA	2.70E+05	0.1	0.1
Chromium VI	4.63E-07	1.83E-01	NA	1.35E+03	NA	NA
Chrysene	2.65E-03	NA	1.99E+01	NA	NA	NA
Copper	NA	1.46E+00	NA	1.08E+04	1.3	1.3
4,4-DDD	3.55E-04	NA	2.67E+00	NA	NA	NA
4,4-DDE	2.50E-04	NA	1.88E+00	NA	NA	NA
Di-n-butylphthalate	NA	3.65E+00	NA	2.70E+04	NA	NA
1,2-Dichlorobenzene	NA	MA	NA	NA	0.6	0.6
1,3-Dichlorobenzene	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	3.54E-03	2.22E+00	2.67E+01	NA	0.075	0.075
1,1-Dichloroethane	NA	1.01E+00	NA	2.70E+04	NA	NA
1,2-Dichloroethane	2.94E-04	2.50E-01	NA	NA	0.005	NA
1,1-Dichloroethene	6.78E-05	3.29E-01	1.07E+00	2.50E+03	0.007	0.007
cis-1,2-Dichloroethene	NA	3.65E-01	NA	2.70E+03	0.07	0.07
1,2-Dichloroethene (Total)	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	1.25E-03	1.11E-02	9.41E+00	NA	0.005	NA
trans-1,3-Dichloropropene	1.50E-06	1.10E-02	3.56E+00	8.20E+01	NA	NA
Dieldrin	5.31E-06	1.83E-03	4.00E-02	1.35E+01	NA	NA
Diethylphalate	NA	2.92E+01	NA	2.16E+05	NA	NA

TABLE 5.3 (continued)
HEALTH SCREENING RISK CRITERIA
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Risk-based PRG a/ Water (mg/L) Carc	Water (mg/L) Non-Carc	Soil (mg/kg) Carc	Soil (mg/kg) Non-carc	MCL b/c/ (mg/L)	Non-Zero MCLG c/d/ (mg/L)
2,4-Dimethylphenol	NA	7.30E-01	NA	5.40E+03	NA	NA
Heptachlor	3.95E-06	1.80E-02	1.42E-01	1.37E+02	0.0004	NA
n-Nitrosodiphenylamine	1.73E-02	NA	1.31E+02	NA	NA	NA
Ethylbenzene	NA	1.58E+00	NA	2.70E+04	0.7	0.7
Fluoranthene	NA	1.46E+00	NA	1.08E+04	NA	NA
Fluorene	NA	1.46E+00	NA	1.08E+04	NA	NA
Indeno(1,2,3-cd)pyrene	5.03E-05	NA	3.79E-01	NA	NA	NA
Lead	NA	NA	NA	NA	0.015	NA
Mercury	NA	1.10E-02	NA	8.10E+01	0.002	0.002
Methylene chloride	6.22E-03	1.73E+00	8.53E+01	1.62E+04	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	NA	1.98E-01	NA	1.35E+04	NA	NA
4-Methylphenol	NA	1.83E-01	NA	1.35E+03	NA	NA
Naphthalene	NA	1.46E+00	NA	1.08E+04	NA	NA
Nickel	NA	7.30E-01	NA	5.40E+03	0.1	0.1
4-Nitrophenol	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Phenol	NA	2.19E+01	NA	1.62E+05	NA	NA
Pyrene	NA	1.10E+00	NA	8.10E+03	NA	NA
Selenium	NA	1.83E-01	NA	1.35E+03	0.05	0.05
Tetrachloroethene	1.43E-03	3.65E-01	1.23E+01	2.70E+03	0.005	NA
Thallium	NA	NA	NA	NA	0.002	0.0005
Toluene	NA	9.65E-01	NA	5.40E+04	1	1
1,1,1-Trichloroethane	NA	1.51E+00	NA	2.43E+04	0.2	0.2
Trichloroethene	2.55E-03	NA	5.82E+01	NA	0.005	NA
Xylene (Total)	NA	7.30E+01	NA	5.40E+05	10	10
Zinc	NA	1.10E+01	NA	8.10E+04	5	NA
Vinyl Chloride	4.48E-05	NA	3.37E-01	NA	0.002	0.002

a/PRG = Preliminary Remediation Goal
b/MCL = Maximum Contaminant Level
c/40 CFR parts 141.61-141.63 (7-1-1993 edition)
d/MCLG = Maximum Contaminant Level Goal
mg/L = milligrams per liter
mg/kg = milligrams per kilogram
NA = not available
Carc = Carcinogen; Non-carc = Noncarcinogen
* The gamma lindane MCL and MCLG are 0.0002 mg/L.
Note: The PRG values shown are in exponential notation (i.e., 5.82E+01 is 58.2).

and SDWA non-zero maximum contaminant level goals (MCLGs). The State of Utah has adopted these federal standards for water quality. Neither MCLs or MCLGs are available for all chemicals of potential concern, nor are promulgated standards available for soils and sediments. Therefore, risk-based guidelines were calculated using available toxicity information as described in the following paragraphs.

5.5.1.2 Risk-Based PRGs for Carcinogens

For chemicals that exhibit carcinogenic effects, most authorities recognize that one or more molecular events can evoke changes in a single cell or a small number of cells that can lead to tumor formation. This is the nonthreshold theory of carcinogenesis which purports that any level of exposure to a carcinogen can result in some finite possibility of generating the disease. Generally, regulatory agencies assume the non-threshold hypothesis for carcinogens in the absence of information concerning the mechanisms of action for the chemical (EPA 1989).

EPA's Carcinogen Risk Assessment Group Verification Endeavor (CRAVE) has developed slope factors (i.e., dose-response values) for estimating excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. The carcinogenic slope factors can be used to estimate the lifetime excess cancer risk associated with exposure to a potential carcinogen. Risks estimated using slope factors are considered unlikely to underestimate actual risks, but they may overestimate actual risks. Excess lifetime cancer risks are generally expressed in scientific notation and are probabilities. An excess lifetime cancer risk of $1x10^{-6}$ (one in one million), for example, represents the probability that an individual will develop cancer as a result of exposure to a carcinogenic chemical over a 70-year lifetime under specified exposure conditions. EPA (1990) has suggested developing remedial alternatives for cleanup of Superfund sites using total excess lifetime cancer risks ranging from 10^{-4} (one in ten thousand) to 10^{-6}.

Slope factors are developed based on epidemiological or animal bioassay data for a specific route of exposure, either oral or inhalation. For some chemicals, sufficient data are available to develop route-specific slope factors for inhalation and ingestion. For chemicals with only one route-specific slope factor but for which carcinogenic effects may also occur via another route, the available value may be used to evaluate risks associated with both potential routes of exposure.

There are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. EPA has proposed a system for characterizing the overall weight of evidence for a chemical's carcinogenicity based on the availability of animal, human, and other supportive data (EPA, 1986a). The weight-of-evidence classification is an attempt to determine the likelihood that an agent is a human carcinogen and thus qualitatively affects the estimation of potential health risks. Three major factors are considered in characterizing the overall weight of evidence for carcinogenicity: (1) the quality of evidence from human studies and (2) the quality of evidence from animal studies, which are combined into a characterization of the overall

weight of evidence for human carcinogenicity; and (3) other supportive information which is assessed to determine whether the overall weight of evidence should be modified. EPA's final classification of the overall weight of evidence includes the following five categories:

Group A - - Human Carcinogen

This category indicates that there is sufficient evidence from epidemiological studies to support a casual association between an agent and cancer.

Group B - - Probable Human Carcinogen

This category generally indicates that there is at least limited evidence from epidemiological studies of carcinogenicity to humans (Group B1) or that, in the absence of adequate data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C - - Possible Human Carcinogen

This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D - - Not Classified

This category indicates that the evidence for carcinogenicity in animals is inadequate.

Group E - - No evidence of Carcinogenicity to Humans

This category indicates that there is no evidence for carcinogenicity in at least two adequate animal tests in different species, or in both epidemiological and animal studies.

Several of the selected chemicals of concern have been classified as potential carcinogens by EPA, and each of these has also been assigned a carcinogenicity weight-of-evidence category. Slope factors and weight-of-evidence categories are listed in Table 5.4 for the potential chemicals of concern. The information was obtained from the Integrated Risk Information System (IRIS) (EPA, 1993) or the Health Effects Assessment Summary Tables (HEAST) (EPA, 1992). IRIS is a computerized library of current information that is updated on a continuous basis. It contains health risk assessment information on chemicals that have undergone a detailed review of toxicity data by work groups composed of EPA scientists from several agency program offices and represents

TABLE 5.4
CHEMICAL TOXICITY INFORMATION
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Chem Class (a)	Tox Class (b)	CAG (c)	Oral Exposure Route RfD (d) (mg/kg-d)	Oral Exposure Route SF (d) (kg-d/mg)	Inhalation Exposure Route RfC (d) (mg/cu m)	Inhalation Exposure Route IUR (d) (cu m/g)
Acetone	v	nc	D	1.00E-01	NA	nr	NA
Aldrin	t	c	B2	3.0E-05	1.70E+01	NA	4.90E-03
Antimony	m	nc	nr	4.00E-04	NA	nr	NA
Arsenic	m	c	A	3.00E-04	1.75E+00 (f)	nr	4.30E-03
Barium	m	nc	nr	7.00E-02	NA	5.00E-04	NA
Benzene	v	c	A	ur	2.90E-02	ur	8.30E-06
Benzo(a)anthracene	s	c	B2	nr	1.06E+00 (g)	nr	2.47E-04 (g)
Benzo(a)pyrene	s	c	B2	nr	7.30E+00	nr	1.70E-03
Benzo(b)fluoranthene	s	c	B2	nr	1.02E+00 (g)	nr	2.38E-04 (g)
Benzo(g,h,i)perylene	s	nc	D	nr	NA	nr	NA
Benzo(k)flouranthene	s	c	B2	nr	4.82E-01 (g)	nr	1.14E-04 (g)
Beryllium	m	c	B2	5.00E-03	4.30E+00	nr	2.40E-03
Beta-BHC(beta lindane)	t	c	C	NA	1.8E+0	NA	5.30E-04
bis(2-Ethylhexyl)phthalate	s	c	B2	2.00E-02	1.40E-02	nr	nr
2-Butanone	v	nc	D	6.00E-01	NA	1.00E+00	NA
Cadmium	m	c	B1	5.00E-04	nr	ur	1.80E-03
Carbon disulfide	v	nc	nr	1.00E-01	NA	1.00E-02	NA
Chlordane	t	c	B2	6.00E-05	1.30E+00	nr	3.70E-04
Chlorobenzene	v	nc	D	2.00E-02	NA	2.00E-02	NA
Chloroform	v	c	B2	1.00E-02	6.10E-03	ur	2.30E-05
Chromium III	m	nc	nr	1.00E+00	NA	ur	NA
Chromium VI	m	c	A	5.00E-03	nr	ur	1.40E-02
Chrysene	s	c	B2	nr	3.21E-02 (g)	nr	7.48E-06 (g)
Copper	m	nc	D	4.00E-02	NA	nr	NA
4,4-DDD	t	c	B2	NA	2.40E-01	NA	NA
4,4-DDE	t	c	B2	NA	3.40E-01	NA	NA
Di-n-butylphthalate	s	nc	D	1.00E-01	NA	nv	NA
1,2-Dichlorobenzene	s	nr	nr	NA	NA	NA	NA
1,3-Dichlorobenzene	s	nr	nr	NA	NA	NA	NA
1,4-Dichlorobenzene	s	c	C	nr	2.40E-02	8.00E-01	nr
1,1-Dichloroethane	v	c	C	1.00E-01	nr	5.00E-01	nr
1,2-Dichloroethane	v	c	B2	nr	nr	9.00E-02	2.60E-05
1,1-Dichloroethene	v	nc	C	9.00E-03	6.00E-01	NA	5.00E-05
cis-1,2-Dichloroethene	v	nc	D	1.00E-02	NA	nr	NA
1,2-Dichloroethene (Total)	v	nc	nr	NA	NA	NA	NA
1,2-Dichloropropane	v	c	B2	nr	6.80E-02	4.00E-03	nr
trans-1,3-Dichloropropene	v	c	B2	3.00E-04	1.80E-01	NA	4.30E-03
Dieldrin	t	c	B2	5.00E-05	1.60E+01	nr	4.60E-03
Diethylphalate	s	nc	D	8.00E-01	NA	nr	NA
2,4-Dimethylphenol	s	nc	nr	2.00E-02	NA	nr	NA

TABLE 5.4 (continued)
CHEMICAL TOXICITY INFORMATION
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SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Chem Class (a)	Tox Class (b)	CAG (c)	Oral Exposure Route RfD (d) (mg/kg-d)	Oral Exposure Route SF (d) (kg-d/mg)	Inhalation Exposure Route RfC (d) (mg/cu m)	Inhalation Exposure Route IUR (d) (cu m/g)
Heptachlor	t	c	B2	5.0E-04	4.50E+0	NA	1.3.0E-03
n-Nitrosodiphenylamine	s	c	B2	nr	4.90E-03	nr	nr
Ethylbenzene	v	nc	D	1.00E-01	NA	1.00E+00	NA
Fluoranthene	s	nc	D	4.00E-02	NA	nr	NA
Fluorene	s	nc	D	4.00E-02	NA	nr	NA
Indeno(1,2,3-cd)pyrene	s	c	B2	nr	1.69E+00 (g)	nr	3.94E-04
Lead	m	c	B2	nr	nr	nr	nr
Mercury	m	nc	D	3.00E-04	NA	3.00E-04	NA
Methylene chloride	v	c	B2	6.00E-02	7.50E-03	3.00E+00	4.70E-07
2-Methylnaphthalene	s	nr	nr	nr	NA	nr	NA
4-Methyl-2-pentanone	v	nc	nr	5.00E-02	NA	8.00E-02	NA
4-Methylphenol	s	c	C	5.00E-03	nr	nv	nr
Naphthalene	s	nc	D	4.00E-02	NA	nr	NA
Nickel	m	c	A	2.00E-02	nr	nr	2.40E-04
4-Nitrophenol	s	nr	nr	nr	nr	nr	nr
Phenanthrene	s	nc	D	nr	NA	nr	NA
Phenol	s	nc	D	6.00E-01	NA	nv	NA
Pyrene	s	nc	D	3.00E-02	NA	nr	NA
Selenium	m	nc	D	5.00E-03	NA	nr	NA
Tetrachloroethene	v	c	nr	1.00E-02	5.20E-02	nr	5.80E-07
Thallium	m	nr	nr	nr	NA	nr	NA
Toluene	v	nc	D	2.00E-01	NA	4.00E-01	NA
1,1,1-Trichloroethane	v	nc	D	9.00E-02	NA	1.00E+00	NA
Trichloroethene	v	c	nr	ur	1.10E-02	ur	1.70E-06
Xylene (Total)	v	nc	D	2.00E+00	NA	nv	NA
Zinc	m	nc	D	3.00E-01	NA	nr	NA
Vinyl Chloride	v	nc	A	NA	1.90E+00	NA	NA

(a) m = metals, s = semi-volatiles, t = pesticides, v = volatiles
(b) nc = noncarcinogen; c = carcinogen; nr = unable to assess carcinogenic potential
(c) CAG = EPA Carcinogen Asessment Group
(d) From IRIS (EPA, 1993). When IRIS values wer unavailable, HEAST (EPA 1992b) was used.
RfD= reference dose, SF= slope factor, RfC = reference concentration, IUR = inhalation unit risk
nr= not reported, ur= under review, nv= non verifiable
(e) The RfD for copper was calculated from a value of 1.3 mg/L, cited in HEAST
(f) The slope factor for arsenic is calculated from an oral unit risk of 5.0E-05 (l/ug)
(g) The slope factor (or unit risk) for this chemical was derived by multiplying the slope factor (or unit risk) for benzo(a)pyrene by a relative potency factor, as follows: chrysene, 0.0044; benzo(b)fluoranthene, 0.14; benzo(k)fluoranthene, 0.066; indeno(1.2.3-cd)pyrene, 0.232; and benzo(a)anthracene, 0.145

NA = not available

EPA concensus. HEAST is also a EPA database but has not undergone the rigorous peer-review process.

At the UANG sites, the risk-based screening criteria for carcinogens are based on the pathways shown as examples for residential site use in *Risk Assessment Guidance for Superfund (RAGS): Human Health Evaluation Manual: Part B "Development of Preliminary Remediation Goals"* (EPA, 1991f). For water, assumed exposure routes include direct ingestion of drinking water and inhalation of volatiles from household use. For soil, age-averaged direct ingestion is the assumed exposure route. A target concentration, or preliminary remediation goal (PRG), can be calculated by setting a target risk level and assuming residential exposure variables. For this initial calculation of PRGs, all of the default parameters in RAGS Part B were used (EPA, 1991f).

For carcinogens in water:

Risk = Risk due to ingestion + Risk due to inhalation

PRGs for residential use of water are calculated using the following equation (EPA, 1991f):

$$C = \frac{TR \times BW \times AT \times 365 \text{ days/year}}{EF \times ED \times [SF_o \times IR_w + (SF_i \times K \times IR_a]}$$

Where:

C	=	chemical concentration in water (mg/L)
TR	=	target excess individual lifetime cancer risk (unitless); 10^{-6}
SF_i	=	inhalation cancer slope factor $(mg/kg\text{-}day)^{-1}$; chemical-specific
SF_o	=	oral cancer slope factor $(mg/kg\text{-}day)^{-1}$; chemical-specific
BW	=	adult body weight (kg); 70 kg
AT	=	averaging time (years); 70 yrs
EF	=	exposure frequency (days/year); 350 days/yr
ED	=	exposure duration (years); 30 yrs
IR_w	=	daily water ingestion rate (L water/day); 2 L/day
IR_a	=	daily indoor inhalation rate (m^3/day); 15 m^3/day
K	=	volatilization factor (unitless); 0.0005 x 1000 L/m^3 (Andelman, 1990)

For this assessment, risk from inhalation is assumed to be relevant only for chemicals which easily volatilize. Thus, the risk equation incorporates a water to air concentration relationship that is applicable only to chemicals with a Henry's Law Constant of greater than 1 x 10^{-5} atm-m^3/mol and a molecular weight of less than 200 grams per mole (gm/mol). This is a screening process only. Some chemicals that do not meet this criteria may still have potential risks associated with volatilization. If the oral or inhalation slope factor is not available, the risk for that exposure is ignored or equated to zero. PRGs for carcinogens in water are shown on Table 5.3.

PRGs for residential use of soils are calculated using the following equation (EPA, 1991f):

$$C = \frac{TR \times AT \times 365 \text{ days/year}}{SF_o \times 10^{-6} \text{ kg/mg} \times EF \times IF_{soil/adj}}$$

Where:

C	=	chemical concentration in soil (mg/kg) or PRG for soil
TR	=	target excess individual lifetime concern risk (unitless); 10^{-6}
AT	=	averaging time (years); 70 years
SF_o	=	oral cancer slope factor $(mg/kg\text{-}day)^{-1}$; chemical specific
EF	=	exposure frequency (days/year); 350 days/year
$IF_{soil/adj}$	=	age-adjusted ingestion factor (mg-year/kg-day; 114 mg-year/kg-day (EPA, 1991f)

Resulting PRGs for carcinogens in soil are shown on Table 5.3.

5.5.1.3 Risk-Based PRGs for Systemic Effects

For chemicals that exhibit systemic (e.g., noncarcinogenic) effects, many authorities consider organisms to have repair and detoxification capabilities that must be exceeded by some critical concentration (threshold) before the health effect is manifested. For example, an organ can have a large number of cells performing the same or similar functions that must be significantly depleted before the effect on the organ is seen. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without an appreciable risk of adverse effects.

Health criteria for chemicals exhibiting noncarcinogenic effects for use in risk assessment are generally developed using EPA reference doses (RfDs) or reference concentrations (RfCs) developed by the RfD/RfC Work Group for oral and inhalation exposures, respectively. In general, the RfD/RfC is an estimate of an average daily exposure to an individual (including sensitive individuals) below which there will not be an appreciable risk of adverse health effects. The RfD/RfC is derived using conservative safety factors (e.g., to adjust from animals to humans and to protect sensitive subpopulations) to ensure that it is unlikely to underestimate the potential for adverse noncarcinogenic effects to occur. The purpose of the RfD/RfC is to provide a benchmark against which the sum of other doses (e.g., those projected from human exposure to various environmental conditions) might be compared. Doses that are significantly higher than the RfD/RfC may indicate an inadequate margin of safety could exist for exposure to that substance and that an adverse health effect could occur.

EPA has developed RfDs and RfCs for many of the potential chemicals of concern identified at the Base. In addition, the chemicals of concern may affect different target organs in the body. RfDs and RfCs, together with critical toxic effects, are listed in Table 5.4 for the potential chemicals of concern. Values were obtained from IRIS or HEAST.

Human health-based PRGs for toxicants (i.e., noncarcinogenic) can be estimated from RfDs. The criteria are an estimate of the daily exposure an individual (including sensitive individuals) can experience without appreciable risk of health effects during a lifetime. Criteria are shown on Table 5.3 and were calculated using EPA methodology (EPA 1991f), as shown below for water and soils:

$$C_{water} = \frac{THI \times BW \times AT \times 365\ days/yr}{EF \times ED \times [1/RfD_o \times IR_w + (1/RfD_i \times K \times IR_a]}$$

Where:

C_{water} = chemical concentration in water (mg/L) or PRG for water
THI = target hazard index (unitless); 1.0
RfD_i = inhalation chronic reference dose (mg/kg-day); chemical-specific
RfD_o = oral chronic reference dose (mg/kg-day); chemical-specific
BW = adult body weight (kg); 70 kg
AT = averaging time (years); 30 yrs
EF = exposure frequency (days/year); 350 days/yr
ED = exposure duration (years); 30 yrs
IR_w = daily water ingestion rate (L water/day); 2 L/day
IR_a = daily indoor inhalation rate (m^3/day); 15 m^3/day
K = volatilization factor (unitless); 0.0005 x 1000 L/m^3 (Andelman, 1990)

$$C_{soils} = \frac{THI \times AT \times 365\ days/yr}{[1/RfD_o \times 10^{-6}\ kg/mg \times EF \times IF_{soil\text{-}adj}]}$$

Where:

C_{soils} = chemical concentration in soil (mg/kg) or soil PRG
THI = target hazard index (unitless); 1.0
RfD_o = oral chronic reference dose (mg/kg-day); chemical-specific
$IF_{soil\text{-}adj}$ = age-adjusted ingestion factor (mg-yr/kg-day); 114 mg-yr/kg-day (USEPA, 1991a)
EF = exposure frequency (events/year); 350 days/yr
BW = body weight (kg); 70 kg
AT = averaging time (year); 30 yrs

5.5.2 Environmental Criteria

Available chemical-specific standards, criteria, and guidance for the protection of plants and animals are identified in Table 5.5 and discussed in this section for the chemicals of potential concern. Criteria are discussed below for surface water, sediment, and soil.

EPA water quality criteria for the protection of aquatic life are the maximum recommended concentrations in water to protect aquatic life against acute and chronic exposure effects. These criteria are developed to be protective of most aquatic species, and therefore, protect fish, aquatic invertebrates, and plants. For chemicals of potential

TABLE 5.5
ECOLOGICAL SCREENING CRITERIA
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Chronic Water Quality Criteria a/ (mg/L)	Sediment Quality Criteria b/ (mg/kg)	Soil Phytotoxic Concentration c/ (mg/kg)	Toxic Dietary Level d/ (mg/kg)
1,1,1-Trichloroethane	NA	NA	NA	10300
1,1-Dichloroethane	NA	NA	NA	1,120
1,1-Dichloroethene	11 f/	NA	NA	NA
1,2-Dichlorobenzene	0.76	0.12	NA	500
1,2-Dichloroethane	20	NA	NA	13400
1,2-Dichloroethene (total)	11 f/	NA	NA	NA
cis-1,2-Dichloroethene	11 f/	NA	NA	NA
1,2-Dichloroporpane	5.7 f/	NA	NA	1900
1,3-Dichlorobenzene	0.76	NA	NA	500
1,4-Dichlorobenzene	0.76	0.12	NA	500
2,4-Dimethylphenol	NA	NA	NA	NA
2-Butanone	NA	NA	NA	54000
2-Methylnaphthalene	2.12 f/	NA	NA	5000
4-Methyl-2-pentanone	5.3	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA
Acetone	NA	NA	NA	112000
Aldrin	NA	0.084	NA	2.5
Antimony	1.6	NA	NA	7000
Arsenic	0.048 f/	5	300	112
Benzene	5.3	NA	525	3800
Benzo(a)anthracene	NA	1.2	NA	NA
Benzo(a)pyrene	NA	1.2	NA	1000
Benzo(b)fluoranthene	NA	1.2	NA	NA
Benzo(g,h,i)perylene	NA	1.2	NA	NA
Benzo(k)fuoranthene	NA	1.2	NA	NA
Beryllium	0.0053 f/	NA	50	500
Beta - BHC	NA	0.0006	NA	76
Bis(2-ethylhexyl)phthalate	0.003	1.2	NA	30600
Cadmium	0.0011 e/	0.8	3	500
Carbon Disulfide	NA	NA	NA	600
Chlordane	0.0000043	0.00006	NA	200
Chlorobenzene	0.05 f/	NA	NA	NA
Chloroform	1.2	NA	NA	800
Chromium	0.0011	26	1000	500
Chrysene	NA	Na	NA	100
Copper	0.0012 e/	19	250	2000
4,4-DDD	NA	≤0.5	NA	1507

TABLE 5.5 (continued)
ECOLOGICAL SCREENING CRITERIA
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Chronic Water Quality Criteria a/ (mg/L)	Sediment Quality Criteria b/ (mg/kg)	Soil Phytotoxic Concentration c/ (mg/kg)	Toxic Dietary Level d/ (mg/kg)
4,4-DDE	NA	≤0.5	NA	249
Di-n-butylphthalate	0.003	1.2	NA	12000
Dieldrin	0.0000019	0.09	NA	37
Diethylphthalate	0.003	1.2	NA	9000
Ethylbenzene	32	NA	190000	3500
Fluoranthene	3.9 f/	10.2	NA	2000
Fluorene	NA	1.2	NA	NA
Heptachlor	3.80E-06	0.0003	NA	6
Indeno(1,2,3-cd)pyrene	NA	1.2	NA	NA
Lead	0.0032 e/	27	1000	800
Mercury	0.00012	0.11	1	800
Methylene Chloride	NA	NA	NA	2100
N-Nitrosodiphenylamine	NA	NA	NA	NA
Naphthalene	0.62	1.2	NA	4.9
Nickel	0.16	22	50	5,000
Phenanthrene	NA	1.2	NA	1700
Phenol	2.5	NA	NA	414
Pyrene	NA	1.2	NA	2700
Selenium	0.0035	NA	5	3
Tetrachloroethene	0.84	NA	NA	25600
Thallium	0.04 f/	NA	2	750
Toluene	17 f/	NA	NA	7500
Trichloroethene	21 f/	NA	NA	25640
Xylenes	NA	NA	NA	4300
Zinc	0.11	85	500	5000

a/ Source: EPA, 1988 and Zarba, 1987
b/ Source: EPA, 1991a, b, c, d, e, and New York State Dept. of Envir. Conservation, 1989
c/ Source: EPA 1983; Gough et al., 1979; Clements Associates, 1985; and Sax, 1987
d/ Concentrations in the diet that cause toxic effects to the receptor species (rat, mouse, etc.)
Sources include: Gough et al., 1979; Micromedex, Inc., 1993
e/ Criteria based on an assumed hardness of 100 mg/L
f/ Lowest observed effect level
mg/L = milligrams per liter
mg/kg = milligrams per kilogram
NA = not available

concern without promulgated water quality criteria, values were selected from the literature that seemed to best apply to conditions at the Base. For purposes of applying criteria for protection of aquatic life, the City Drain Canal is considered to be a freshwater environment. A hardness value of 100 mg/L was used to calculate hardness-dependent criteria for certain metals in surface water. No hardness data were available for the City Drain Canal, therefore, a value of 100 was assumed. If the actual hardness of the City Drain Canal water is greater than 100 mg/L, then the hardness dependent criteria would increase.

The EPA has not established sediment quality criteria to protect benthic organisms or aquatic life from sediment contaminants. Therefore, the following sources were used: EPA-proposed sediment criteria for five chemicals (EPA, 1991a-e) and New York State Department of Environmental Conservation (NYSDEC) proposed sediment criteria for metals and organic compounds established to protect aquatic life and wildlife that rely extensively on aquatic biota as food sources (NYSDEC, 1989).

Chemicals of potential concern in soil were evaluated for risk to vegetation and wildlife. EPA soil guidelines have been established for protecting plants from phytotoxic effects. A primary source for these guidelines is *Hazardous Waste Land Treatment* (EPA, 1983). Where USEPA soil guidelines were unavailable, similar threshold information was acquired from the technical literature, including agricultural soil guidelines for evaluating risks to general vegetation types.

There are no promulgated or established criteria relating specific chemical concentrations in soils directly to toxic effects on wildlife species. There are, however, toxicological testing data that relate known chemical dosages in either food or water to acute and chronic effects on specific species. These dosage values are used as screening reference points. However, dosage values cannot be used as absolute measurements of risk because the sophisticated site measurements required to credibly apply the dosage data (e.g., proportion of a species' annual diet derived from the site) involve analyses of food chain dynamics, and are beyond the scope of this study. The risk screening criteria for soil that were used in this evaluation are presented in Table 5.5.

5.6 RISK SCREENING

In this section, maximum concentrations of chemicals of potential concern were compared with appropriate criteria to provide an estimation as to whether the contaminants pose a potential human health or environmental risk. Only chemicals that were detected were evaluated. The method is intended as a preliminary screening tool rather than a detailed evaluation of risks posed by contaminants at the site. For clarity, each of the seven sites, the City Drain Canal, and piezometer PI-5 are evaluated separately.

Health and environmental criteria may consist of promulgated standards or PRGs as discussed previously. For the risk evaluation, the most conservative or stringent nonzero PRGs were compared to chemical concentrations. MCLs, nonzero MCLGs, proposed MCLs, and criteria calculated from RfDs and slope factors were used to evaluate the potential for adverse effects to human health from potential residential exposure to contaminated surface and groundwater. Where soil and sediment were the media of concern, maximum detected concentrations were compared to the most stringent of the health-based PRGs calculated from RfDs or slope factors. These criteria consider exposure through incidental ingestion of soil under a residential scenario. For surface water, maximum concentrations were compared to Aquatic Water Quality Criteria (AWQC) where available.

Potential for ecological risk was evaluated at each site and the City Drain Canal. Ecological risk screenings were conducted for the following physical media and biological groups:

- Soil and vegetation;
- Soil and wildlife;
- Surface water and aquatic life; and
- Sediment and aquatic life.

The maximum chemical concentrations measured in each physical medium were compared to the risk screening criterion for that medium. If the maximum chemical concentration exceeded the lowest applicable criterion and exposure pathways were completed, then it was assumed that there was a potential for ecological risk at that site.

5.6.1 Preliminary Human Health and Ecological Evaluation - Site 1

Site 1 is identified as a former pesticide dump. The general vicinity of the site was determined during the PA (HAZWRAP, et al., 1989). Visual inspection during the site visit did not reveal stressed vegetation, primarily because the site is paved with gravel.

Initially, six soil samples and a groundwater sample (downgradient) were collected and analyzed for pesticides and pesticides were detected in soil only. During further investigation of the site, 14 additional soil samples and two groundwater samples (both downgradient) were collected and analyzed for pesticides, VOCs, and arsenic, and VOCs

and arsenic were detected in soil and groundwater. As stated in subsection 4.3.2.4, arsenic was analyzed to evaluate its background concentration at this non-metals site, and therefore, is not considered to be a chemical of potential concern in the risk evaluation for Site 1.

5.6.1.1 Human Health Screening

The probability of pathway completion or receptor exposure from the soil and air route of transmission are low for current uses because most of the site is paved with gravel and trichloroethene and one of the pesticides were detected at depth. If in the future, construction activities are initiated then the probability of soils pathway completion will be higher. However, no human health criteria were exceeded (Table 5.6). The groundwater ingestion, inhalation, and dermal contact pathways have a low probability of completion because there are no potable water wells on the Base. If in the future the land use changes and groundwater wells are installed, there will be a low probability of pathway completion; however, it is unlikely that the shallow aquifer would be used as a water source.

Five of the chemicals of potential concern detected in groundwater samples collected from the two sampling events at Site 1 exceeded the most stringent groundwater criteria (Table 5.7). Values shown in Table 5.7 are the maximum of the two sampling events.

1,2-Dichloroethane, tetrachloroethene, trichloroethene, and vinyl chloride exceeded their respective carcinogenic PRGs. Comparison criteria are not available for 1,2-dichloroethene (total), so the criteria for cis 1,2-dichloroethene were applied. The concentration of 1,2-dichloroethene (total) exceeded the MCL for cis 1,2-dichloroethene as the most stringent criterion. Tetrachloroethene, trichloroethene, and vinyl chloride also exceed their less stringent respective MCLs.

Based on these findings, a potential future health concern is indicated for Site 1 if, in the future, direct contact with contaminated soil or groundwater occurs or the shallow aquifer is used for a potable water source. However, pathway completion is unlikely.

5.6.1.2 Ecological Risk Screening

Because Site 1 is covered with gravel there is little potential for current ecological complete pathways. If in the future site conditions change, the potential for complete pathways will increase. However, there is no expected adverse ecological effects since none of the chemicals of potential concern exceed the ecological screening criteria (Table 5.8).

5.6.2 Preliminary Human Health and Ecological Evaluation - Site 2

Site 2 is the location of a waste POL fuel spill near the southeast corner of Building 1527. An undetermined amount of waste oils, solvents, and fuel was released due to a valve failure on a bowser in 1987. The spilled materials were salvaged and drummed for disposal. In 1988, during the PA, stained soils were observed; however, no soil

TABLE 5.6
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS AT SITE 1
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)	Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
Chlordane	0.032	Carc PRG	4.92E-01	NO
Beta-BHC	0.016	Carc PRG	3.56E-01	NO
Trichoroethene	0.0044	Carc PRG	5.82E+01	NO

a/ Lowest soil PRG chosen as conservative estimate.
Carc PRG = Carcinogenic Preliminary Remediation Goal for soils
mg/kg = milligrams per kilogram

TABLE 5.7
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM GROUNDWATER CONTAMINANT CONCENTRATIONS AT SITE 1
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/L)	Criteria Type a/	Value (mg/L)	Criteria Exceeded?
1,2-Dichlorobenzene	0.00020 J	MCL	6.00E-01	NO
1,1-Dichloroethane	0.0039	NC PRG	1.01E+00	NO
1,2-Dichloroethane	0.0025	Carc PRG	2.94E-04	YES
1,2-Dichloroethene (total)	0.4 J	MCL	7.00E-02	YES
1,1,1-Trichloroethane	0.007	MCL	2.00E-01	NO
Chlorobenzene	0.00018 J	NC PRG	5.17E-02	NO
Tetrachloroethene	0.012 J	Carc PRG	1.43E-03	YES
Trichloroethene	0.037 J	Carc PRG	2.55E-03	YES
Vinyl Chloride	0.0043	Carc PRG	4.48E-05	YES

a/ Lowest groundwater criteria For human health selected as a conservative estimate of risk.
mg/L = milligrams per liter
J = The value reported is an estimated concentration.
NC PRG = Noncarcinogenic Preliminary Remediation Goal for groundwater
Carc PRG = Carcinogenic Preliminary Remediation Goal for groundwater
MCL = Maximum Contaminant Level

TABLE 5.8
COMPARISON OF MAXIMUM SOIL CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA AT SITE 1
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)	Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
Chlordane	0.032	TDL	2.00E+02	NO
Beta-BHC	0.016	TDL	7.60E+01	NO
Trichloroethene	0.0044	TDL	2.56E+04	NO

a/ Lowest soil criteria for ecological receptors selected as a conservative estimate.
TDL = Toxic Dietary Level
mg/kg = milligrams per kilogram

discoloration was observed in 1990. Site 2 is covered with both asphalt and sparse vegetation.

Nine soil samples, and three groundwater samples (all downgradient) from two sampling events, were collected and analyzed for VOCs, SVOCs, and metals at Site 2. The soil samples were also analyzed for TRPH.

5.6.2.1 Human Health Screening

The probability of pathway completion or receptor exposure from the soil and air route of transmission are low for current uses because most of the site is paved. If in the future the pavement is removed or construction activities are initiated, the soil and air pathways would have a higher probability of completion. The groundwater ingestion, inhalation, and dermal contact pathways have a low probability of completion because there are no potable water wells on the Base. If in the future the land use changes and groundwater wells are installed, there will be a low probability of pathway completion; however, it is unlikely that the shallow aquifer would be used as a water source.

For the soil samples, arsenic and beryllium exceeded their respective carcinogenic PRGs, the most stringent health based soil criteria (Table 5.9). Comparison criteria are not available for 1,2-dichloroethene (total), 2-methylnaphthalene, lead, phenanthrene, and thallium.

Ten of the chemicals of potential concern detected in groundwater samples collected from the two sampling events at Site 2 exceeded the most stringent groundwater criteria (Table 5.10). Values shown in Table 5.10 are the maximum of the two sampling events. cis-1,2-Dichloroethene exceeded its MCL and 1,2-dichloroethane, 1,1-dichloroethene, arsenic, benzene, chloroform, tetrachloroethene, trans 1,3- dichoropropene, trichloroethene, and vinyl chloride exceeded their respective carcinogenic PRGs.

TABLE 5.9
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS AT SITE 2
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
1,2-Dichloroethene (total)	0.004	J	NA	--	--
2-Methylnaphthalene	4.8		NA	--	--
Acetone	0.028		NC PRG	2.70E+04	NO
Arsenic	44	J	Carc PRG	3.66E–01	YES
Benzene	0.006	J	Carc PRG	2.21E+01	NO
Beryllium	1.3		Carc PRG	1.49E–01	YES
Bis(2-ethylhexyl)phthalate	0.19	J	Carc PRG	4.57E+01	NO
Cadmium	0.72	J	NC PRG	1.35E+02	NO
Chloroform	0.003	J	NC PRG	1.05E+02	NO
Chrysene	0.12	J	Carc PRG	1.99E+01	NO
Chromium	32.3	J	NC PRG	1.35E+03	NO
cis-1,2-Dichloroethene	0.045		NC PRG	2.70E+03	NO
Copper	51.9		NC PRG	1.08E+04	NO
Ethylbenzene	0.1	J	NC PRG	2.70E+04	NO
Fluoranthene	0.5	J	NC PRG	1.08E+04	NO
Flourene	0.055J		NC PRG	1.08E+04	NO
Lead	39.3		NA	--	--
Nickel	25.8		NC PRG	5.40E+03	NO
Phenanthrene	1.1	J	NA	--	--
Pyrene	0.74	J	NC PRG	8.10E+03	NO
Tetrachloroethene	0.0078		Carc PRG	1.23E+01	NO
Thallium	0.71	J	NA	--	--
Toluene	0.23	J	NC PRG	5.40E+04	NO
Trichloroethene	0.0066		Carc PRG	5.82E+01	NO
Xylenes	20		NC PRG	5.40E+05	NO
Zinc	122	J	NC PRG	8.10E+04	NO

a/ **Lowest soil PRG chosen as conservative estimate.**
NA = **Not Available**
NC PRG = **Noncarcinogenic Preliminary Remediation Goal for soils**
Carc PRG = **Carcinogenic Preliminary Remediation Goal for soils**
J = **The value reported is an estimated concentration.**
mg/kg = **milligrams per kilogram**

TABLE 5.10
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM GROUNDWATER CONTAMINANT CONCENTRATIONS AT SITE 2
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/L)		Criteria Type a/	Value (mg/L)	Criteria Exceeded?
1,1-Dichloroethane	0.0071	J	NC PRG	1.01E+00	NO
1,2-Dichloroethane	0.0016	J	Carc PRG	2.94E-04	YES
1,1-Dichloroethene	0.0056		Carc PRG	6.78E-05	YES
1,2-Dichloroethene (total)	0.23	J	NA	--	--
Arsenic	0.24	J	Carc PRG	4.86E–05	YES
Benzene	0.0017		Carc PRG	6.16E-04	YES
Chlorobenzene	0.00027	J	NC PRG	5.17E-02	NO
Chloroform	0.010	J	Carc PRG	2.76E-04	YES
Copper	0.02		MCL	1.30E+00	NO
cis-1,2-Dichloroethene	0.32		MCL	7.00E–02	YES
Mercury	0.000056	J	MCL	2.00E-03	NO
Selenium	0.0028	J	MCL	5.00E–02	NO
Tetrachloroethene	0.041		Carc PRG	1.43E–03	YES
trans 1,3-Dichloropropene	0.00089	J	Carc PRG	1.50E-06	YES
Trichloroethene	1.2		Carc PRG	2.55E–03	YES
Vinyl Chloride	0.0023		Carc PRG	4.48E-05	YES

a/ **Lowest groundwater criteria For human health selected as a conservative estimate of risk.**
mg/L = **milligrams per liter**
J = **The value reported is an estimated concentration.**
NC PRG = **Noncarcinogenic Preliminary Remediation Goal for groundwater**
Carc PRG = **Carcinogenic Preliminary Remediation Goal for groundwater**
MCL = **Maximum Contaminant Level**

Arsenic, tetrachloroethene, trichloroethene, and vinyl chloride also exceed their less stringent respective MCLs. Comparison criteria are not available for 1,2-dichloroethene (total).

Based on these findings, a potential future health concern is indicated for Site 2 if, in the future, direct contact with contaminated soil or groundwater occurs or the shallow aquifer is used for a potable water source. However, pathway completion is unlikely.

5.6.2.2 Ecological Risk Screening

Because most of Site 2 is covered with asphalt and concrete, exposure of wildlife and vegetation to possible soil contaminants would be limited under current conditions. If use of the site changes in the future, potential for pathway completion may increase.

None of the chemicals of potential of concern detected in soils at Site 2 exceed the minimum risk screening criteria for wildlife and plants (Table 5.11). Therefore, adverse effects on the environment are not predicted. Comparison criteria are not available for 1,2-dichloroethene (total).

TABLE 5.11
COMPARISON OF MAXIMUM SOIL CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA AT SITE 2
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
1,2-Dichloroethene	0.004	J	NA	--	--
2-Methylnaphthalene	4.8		TDL	5.00E+03	NO
Acetone	0.028		TDL	1.12E+05	NO
Arsenic	44	J	TDL	1.12E+02	NO
Benzene	0.006	J	SPC	5.25E+02	NO
Beryllium	1.3		SPC	5.00E+01	NO
Bis(2-ethylhexyl)phthalate	0.19	J	TDL	3.06+04	NO
Cadmium	0.72	J	SPC	3.00E+00	NO
Chloroform	0.003	J	TDL	8.00E+02	NO
Chromium	32.3	J	TDL	5.00E+02	NO
Chrysene	0.12	J	TDL	1.00E+02	NO
Copper	51.9		SPC	2.50E+02	NO
cis-1,2-Dichloroethene	0.045		NA	--	--
Ethylbenzene	0.1	J	TDL	3.50E+03	NO
Fluoranthene	0.5	J	TDL	2.00E+03	NO
Lead	39.3		TDL	8.00E+02	NO
Nickel	25.8		TDL	5.00E+01	NO
Phenanthrene	1.1	J	TDL	1.70E+03	NO
Pyrene	0.74	J	TDL	2.70E+03	NO
Tetrachloroethene	0.0078		TDL	2.56E+04	NO
Thallium	0.71	J	SPC	2.00E+00	NO
Toluene	0.23	J	TDL	7.50E+03	NO
Trichloroethene	0.0066		TDL	2.56E+04	NO
Xylenes	20		TDL	4.30E+03	NO
Zinc	122	J	SPC	5.00E+02	NO

a/ **Lowest soil criteria for ecological receptors selected as a conservative estimate.**
NA = **Not Available**
TDL = **Toxic Dietary Level**
SPC = **Soil Phytotoxic Concentration**
J = **The value reported is an estimated concentration.**

mg/kg = **milligrams per kilogram**

5.6.3 Preliminary Human Health and Ecological Evaluation - Site 3

Site 3 is the burial site of at least 14 drums that contained "off-spec" JP-4 and waste solvents. Apparently, the drum contents were discharged at an unknown location prior to flattening the drums. Approximated 6 to 21 inches of material was placed over the drums.

Six near-surface soil samples, six soil boring samples, and four groundwater samples (two upgradient and two downgradient) from two sampling events, were collected at Site 3 and were analyzed for VOCs and SVOCs. All soil samples were also analyzed for TRPH. Groundwater collected in the second sampling event was also analyzed for arsenic to evaluate the background concentrations of this metal at this non-metals site. Therefore, arsenic is not considered as a chemical of potential concern in the risk evaluation for Site 3.

5.6.3.1 Human Health Screening

The probability of pathway completion or receptor exposure from the soil and air route of transmission are moderate for current and future uses because the site is not paved. The groundwater ingestion, inhalation, and dermal contact pathways have a low probability of completion because there are no potable water wells on the Base. If in the future the land usage changes and groundwater wells are installed, there will be a low probability of pathway completion; however, it is unlikely that the shallow aquifer would be used as a water source. Groundwater may, however, ultimately discharge to the City Drain Canal which flows to Farmington Bay, a nearby recreation area.

None of the chemicals of potential concern detected in soils exceeded the most stringent health-based soil criteria (Table 5.12). However, no comparison value is available for phenanthrene.

Of the chemicals of potential concern detected in groundwater samples collected from the two sampling events at Site 3, only 1,4-dichlorobenzene exceeded (by two times) the most stringent criteria, the carcinogenic PRG (Table 5.13). 1,3-Dichlorobenzene does not have a comparison criteria available. The values shown in Table 5.13 are the maximum the two sampling events.

Based on the criterion exceedance of only one chemical of potential concern in groundwater, there is only a slight potential health concern at Site 3 for future potential groundwater users. However, pathway completion is unlikely.

5.6.3.2 Ecological Risk Screening

Site 3 is lightly vegetated, but provides a wildlife habitat of limited quality since the site is disturbed.

A comparison of the soil data to the ecological risk screening criteria established for this evaluation indicates that none of the screening criteria were exceeded (Table 5.14). No comparison criteria are available for N-nitrosodiphenylamine. Habitat is limited, so

TABLE 5.12
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS AT SITE 3
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)	Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
Bis(2-ethylhexyl)phthalate	0.24 J	Carc PRG	4.57E+01	NO
Chrysene	0.24 J	Carc PRG	1.99E+01	NO
Diethylphthalate	0.095 J	NC PRG	2.16E+05	NO
N-Nitrosodiphenylamine	0.26 J	Carc PRG	1.31E+02	NO
Phenanthrene	0.58	NA	--	--
Pyrene	0.23 J	NC PRG	8.10E+03	NO

a/ Lowest soil PRG chosen as conservative estimate.
NA = Not Available
NC PRG = Noncarcinogenic Preliminary Remediation Goal for soils
Carc PRG = Carcinogenic Preliminary Remediation Goal for soils
J = The value reported is an estimated concentration.
mg/kg = milligrams per kilogram

TABLE 5.13
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM GROUNDWATER CONTAMINANT CONCENTRATIONS AT SITE 3
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/L)		Criteria Type a/	Value (mg/L)	Criteria Exceeded?
1,2-Dichlorobenzene	0.0057		MCL	6.00E–01	NO
1,3-Dichlorobenzene	0.0012	J	NA	--	--
1,4-Dichlorobenzene	0.0079		Carc PRG	3.54E–03	YES
4-Methylphenol	0.002	J	NC PRG	1.83E–01	NO
Chlorobenzene	0.036		NC PRG	5.17E–02	NO
Ethylbenzene	0.00046	J	MCL	7.00E–01	NO
Phenol	0.004	J	NC PRG	2.19E+01	NO
Toluene	0.00027	J	NC PRG	9.65E–01	NO

a/ Lowest groundwater criteria for human health selected as a conservative estimate of risk.
mg/L = milligrams per liter
J = The value reported is an estimated concentration.
NA = Not Available
NC PRG = Noncarcinogenic Preliminary Remediation Goal for groundwater
Carc PRG = Carcinogenic Preliminary Remediation Goal for groundwater
MCL = Maximum Contaminant Level

TABLE 5.14
COMPARISON OF MAXIMUM SOIL CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA AT SITE 3
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
Bis(2-ethylhexyl)phthalate	0.24	J	TDL	30600	NO
Chrysene	0.24	J	TDL	100	NO
Diethylphthalate	0.095	J	TDL	9000	NO
N-Nitrosodiphenylamine	0.26	J	NA	--	--
Phenanthrene	0.58		TDL	1700	NO
Pyrene	0.23	J	TDL	2700	NO

a/ Lowest soil criteria for ecological receptors selected as a conservative estimate.
NA = Not Available
mg/kg = milligrams per kilogram
J = The value reported is an estimated concentration.
TDL = Total Dietary Level

potential risks are not anticipated. The available data suggest that there is not a potential risk from the chemicals of potential concern detected in soils at Site 3.

5.6.4 Preliminary Human Health and Ecological Evaluation - Site 4

Site 4, FTA 1, was used for training exercises once per year from 1947 to 1972. Normal practice was to burn 300 to 500 gallons of fuel, extinguish, and reburn for 70 percent consumption; however, on occasion as much as 1,200 to 1,500 gallons was used. The exact location of the FTA could not be determined since the site is paved with asphalt and is used for motor pool parking.

Sixteen soil samples, and two groundwater samples (both downgradient) from two sampling events, were collected and analyzed for VOCs, SVOCs, and metals. The soil samples were also analyzed for TRPH.

5.6.4.1 Human Health Screening

The probability of pathway completion or receptor exposure from the soil and air route of transmission are low for current uses because Site 4 is paved. However if in the future, the pavement is removed or construction activities are initiated, the probability of pathway completion would increase. The groundwater ingestion, inhalation, and dermal contact pathways have a low probability of completion because there are no potable water wells on the Base. If in the future the land usage changes and groundwater wells are installed, there will be a low probability of pathway completion, however, it is unlikely that the shallow aquifer would be used as a water source. Groundwater discharges into the City Drain Canal which eventually flows to Farmington Bay where recreational use occurs.

Of the chemicals of potential concern detected in soils, two exceeded the most stringent health-based soil criteria (Table 5.15). Arsenic and beryllium exceeded their carcinogenic PRGs. Comparison criteria are not available for lead.

In groundwater samples collected from the two sampling events at Site 4 only arsenic exceeded its carcinogenic PRG (Table 5.16). The value shown in Table 5.16 is the maximum of the two sampling events. Arsenic also exceeded its less conservative MCL.

Based on some exceedance of criteria, a slight potential human health concern exists if, in the future, direct contact with contaminated soil or groundwater occurs or the shallow aquifer is used as a water source. However, pathway completion is unlikely.

5.6.4.2 Ecological Risk Screening

Under current conditions at Site 4, wildlife and vegetation receptors would not be exposed to soil contaminants because the area is paved. If the pavement is removed or disturbed during future activities at the site, then the soil exposure route may become complete. However, none of the detected chemicals of potential concern in soils at Site 4 exceeded the minimum risk screening criteria for soils (Table 5.17). A screening criterion value is not available for 2,4-dimethylphenol.

TABLE 5.15
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS AT SITE 4
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
2-Butanone	0.003	J	NC PRG	1.62E+05	NO
2,4-Dimethylphenol	1.2	J	NC PRG	5.40E+03	NO
Acetone	0.058		NC PRG	2.70E+04	NO
Antimony	2.9	J	NC PRG	1.08E+02	NO
Arsenic	129	J	Carc PRG	3.66E–01	YES
Beryllium	1.1		Carc PRG	1.49E–01	YES
Cadmium	0.82	J	NC PRG	1.35E+02	NO
Carbon Disulfide	0.002	J	NC PRG	2.70E+04	NO
Chromium	32.9		NC PRG	1.35E+03	NO
Copper	103		NC PRG	1.08E+04	NO
Diethylphthalate	1.8		NC PRG	2.16E+05	NO
Di-n-butylphthalate	0.54		NC PRG	2.70E+04	NO
Ethylbenzene	0.025	J	NC PRG	2.70E+04	NO
Lead	102		NA	--	--
Mercury	0.04	J	NC PRG	8.10E+01	NO
Methylene Chloride	0.004	J	Carc PRG	8.53E+01	NO
Nickel	46.2		NC PRG	5.40E+03	NO
Thallium	0.72	J	NA	--	--
Toluene	0.007	J	NC PRG	5.40E+04	NO
Xylenes	0.04	J	NC PRG	5.40E+05	NO
Zinc	106	J	NC PRG	8.10E+04	NO

a/ **Lowest soil PRG chosen as conservative estimate.**
NA = **Not Available**
NC PRG = **Noncarcinogenic Preliminary Remediation Goal for soils**
Carc PRG = **Carcinogenic Preliminary Remediation Goal for soils**
J = **The value reported is an estimated concentration.**
mg/kg = **milligrams per kilogram**

TABLE 5.16
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM GROUNDWATER CONTAMINANT CONCENTRATIONS AT SITE 4
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/L)	Criteria Type a/	Value (mg/L)	Criteria Exceeded?
Arsenic	0.0712 J	Carc PRG	4.86E–05	YES
Chromium III	0.0045	MCL	1.0E-01	NO
Copper	0.0027	MCL	1.3E+00	NO
Toluene	0.0007 J	NC PRG	9.65E–01	NO
Xylenes	0.0077	MCL	1.00E+01	NO

a/ Lowest groundwater criteria for human health selected as a conservative estimate of risk.
mg/L = milligrams per liter
J = The value reported is an estimated concentration.
NC PRG = Noncarcinogenic Preliminary Remediation Goal for groundwater
Carc PRG = Carcinogenic Preliminary Remediation Goal for groundwater
MCL = Maximum Contaminant Level

TABLE 5.17
COMPARISON OF MAXIMUM SOIL CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA AT SITE 4
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
2-Butanone	0.003	J	TDL	54000	NO
2,4-Dimethylphenol	1.2	J	NA	--	--
Acetone	0.058		TDL	112000	NO
Antimony	2.9	J	TDL	7000	NO
Arsenic	129	J	TDL	112	NO
Beryllium	1.1		SPC	50	NO
Cadmium	0.82	J	SPC	3	NO
Carbon Disulfide	0.002	J	TDL	600	NO
Chromium	32.9		TDL	500	NO
Copper	103		SPC	250	NO
Diethylphthalate	1.8		TDL	9000	NO
Di-n-butylphthalate	0.54		TDL	12000	NO
Ethylbenzene	0.025	J	TDL	3500	NO
Lead	102		TDL	800	NO
Mercury	0.04	J	SPC	1	NO
Methylene Chloride	0.004	J	TDL	2100	NO
Nickel	46.2		SPC	50	NO
Thallium	0.72	J	SPC	2	NO
Toluene	0.007	J	TDL	7500	NO
Xylenes	0.04	J	TDL	4300	NO
Zinc	106	J	SPC	500	NO

a/ **Lowest soil criteria for ecological receptors selected as a conservative estimate.**
NA = **Not Available**
TDL = **Total Dietary Level**
SPC = **Soil Phytotoxic Concentration**
mg/kg = **milligrams per killogram**
J = **The value reported is an estimated concentration.**

At Site 4, no ecological risk would be predicted because no exposure pathways exist and chemical concentrations are below comparison criteria.

5.6.5 Preliminary Human Health and Ecological Evaluation - Site 5

Site 5, FTA 2, was used only two or three times between the years 1973 to 1975. One hundred and fifty gallons of JP-4 fuel was used for each burn. The location of FTA 2 was determined using aerial photographs during the PA; however, in 1990 the exact location of the FTA could not be identified due to recent grading.

Fourteen soil samples, and two groundwater samples (downgradient) from two sampling events, were collected and analyzed for VOCs and SVOCs. The soil samples were also analyzed for TRPH. Groundwater collected in the second sampling event was also analyzed for arsenic to evaluate the background concentrations of this metal at this non-metals site. Therefore, arsenic is not considered as a chemical of potential concern in the risk evaluation for Site 5.

5.6.5.1 Human Health Screening

The probability of pathway completion or receptor exposure from the soil and air route of transmission are moderate for current and future uses because the site is not paved. The groundwater ingestion, inhalation, and dermal contact pathways have a low probability of completion because there are no potable water wells on Base. If in the future the land usage changes and groundwater wells are installed, there will be a low probability of pathway completion, however, it is unlikely that the shallow aquifer would be used as a water source.

From site 5, groundwater flows directly to the south into the City Drain Canal. The canal eventually discharges into Farmington Bay where recreational use occurs.

Of the chemicals of potential concern detected in soils, benzo(a)pyrene was detected at a concentration slightly higher than the most stringent health-based soil criteria, the carcinogenic PRG (Table 5.18). Comparison criteria are not available for benzo(g,h,i)perylene and phenanthrene.

In groundwater samples from the two sampling events, only 1,1-dichloroethane was detected. The detected concentration of 0.001 mg/L does not exceed the noncarcinogenic PRG (1.0 mg/L) as the most conservative criterion.

Based on these findings, a potential health concern is not indicated at Site 5.

5.6.5.2 Ecological Risk Screening

No ecological criteria were exceeded at Site 5 (Table 5.19). However, comparison criteria are not available for 4-methyl-2-pentanone, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and ideno(1,2,3-cd)pyrene. Potential soil exposure pathways exist for vegetation and wildlife at Site 5. However, available habitat is limited. Therefore, a potential environmental concern is not indicated.

TABLE 5.18
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS AT SITE 5
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)	Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
2-Butanone	0.004 J	NC PRG	1.62E+05	NO
4-Methyl-2-pentanone	0.002 J	NC PRG	1.35E+04	NO
Acetone	0.014	NC PRG	2.70E+04	NO
Benzo(a)pyrene	0.1 J	Carc PRG	9.00E–02	YES
Benzo(b)fluoranthene	0.15 J	Carc PRG	6.30E–01	NO
Benzo(g,h,i)perylene	0.098 J	NA	--	--
Benzo(k)fluoranthene	0.13 J	Carc PRG	1.33E+00	NO
Bis(2-ethylhexyl)phthalate	0.12 J	Carc PRG	4.57E+01	NO
Carbon Disulfide	0.001 J	NC PRG	2.70E+04	NO
Chrysene	0.14 J	Carc PRG	1.99E+01	NO
Di-n-butylphthalate	0.076 J	NC PRG	2.70E+04	NO
Fluoranthene	0.16 J	NC PRG	1.08E+04	NO
Ideno(1,2,3-cd)pyrene	0.086 J	Carc PRG	3.80E–01	NO
Methylene Chloride	0.003 J	Carc PRG	8.53E+01	NO
Phenanthrene	0.13 J	NA	--	--
Pyrene	0.27 J	NC PRG	8.10E+03	NO
Toluene	0.01 J	NC PRG	5.40E+04	NO
Xylenes	0.0074	NC PRG	5.40E+05	NO

a/ **Lowest soil PRG chosen as conservative estimate.**
NA = **Not Available**
NC PRG = **Noncarcinogenic Preliminary Remediation Goal for soils**
Carc PRG = **Carcinogenic Preliminary Remediation Goal for soils**
J = **The value reported is an estimated concentration.**
mg/kg = **milligrams per kilogram**

TABLE 5.19
COMPARISON OF MAXIMUM SOIL CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA AT SITE 5
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
2-Butanone	0.004	J	TDL	54000	NO
4-Methyl-2-pentanone	0.002	J	NA	--	--
Acetone	0.014		TDL	112000	NO
Benzo(a)pyrene	0.1	J	TDL	1000	NO
Benzo(b)fluoranthene	0.15	J	NA	--	--
Benzo(g,h,i)perylene	0.098	J	NA	--	--
Benzo(k)fluoranthene	0.13	J	NA	--	--
Bis(2-ethylhexyl)phthalate	0.12	J	TDL	30600	NO
Carbon Disulfide	0.001	J	TDL	600	NO
Chrysene	0.14	J	TDL	100	NO
Di-n-butylphthalate	0.076	J	TDL	1200	NO
Fluoranthene	0.16	J	TDL	2000	NO
Ideno(1,2,3-cd)pyrene	0.086	J	TDL	--	--
Methylene Chloride	0.003	J	TDL	2100	NO
Phenanthrene	0.13	J	TDL	1700	NO
Pyrene	0.27	J	TDL	2700	NO
Toluene	0.10	J	TDL	7500	NO
Xylenes	0.0074		NA	4300	NO

a/ **Lowest soil criteria for ecological receptors selected as a conservative estimate.**
TDL = **Noncarcinogenic Preliminary Remediation Goal for soils**
SPC = **Soil Phytotoxic Concentration**
NA = **Not Available**
mg/kg = **milligrams per kilogram**
J = **The value reported is an estimated concentration.**

5.6.6 Preliminary Human Health and Ecological Evaluation - Site 6

Site 6 is a grassy area along the west edge of the flight ramp that served as a wash-down ramp. The site received fuel and oil surface runoff from the flight ramp during the 1950s and 1960s when the Base used aircraft that leaked large quantities of oil.

Twenty soil samples, and eight groundwater samples (all downgradient) from two sampling events, were collected and analyzed for VOCs and SVOCs. The soil samples were also analyzed for TRPH. Groundwater collected in the second sampling event was also analyzed for arsenic to evaluate the background concentrations of this metal at this non-metals site. Therefore, arsenic is not considered as a chemical of potential concern in the risk evaluation for Site 6.

5.6.6.1 Human Health Screening

The probability of pathway completion or receptor exposure from the soil and air route of transmission are moderate for current uses because the site area is grassy. However, vegetation can effectively limit fugitive dust generation and volatilization. Additionally, site access is restricted. If in the future site access is changed or construction activities are initiated, then the potential for pathway completion would increase. The groundwater ingestion, inhalation, and dermal contact pathways have a low probability of completion because there are no potable water wells on Base. If in the future the land usage changes and groundwater wells are installed, the groundwater pathway would be completed; however, it is unlikely that the shallow aquifer would be used as a water source. Groundwater may, however, ultimately discharge to the City Drain Canal which flows to Farmington Bay, a nearby recreation area.

Of the chemicals of potential concern detected in soils, none exceeded their respective health-based comparison criteria (Table 5.20).

In groundwater samples from the two sampling events, only 1,4-dichlorobenzene and xylenes were detected. The detected concentrations of 0.00018 mg/L and 0.00033 mg/L estimated for 1,4-dichlorobenzene and xylenes, respectively, do not exceed their most stringent health-based criteria; the carcinogenic PRG (0.00354 mg/L) for 1,4-dichlorobenzene and the MCL (10 mg/L) for xylenes.

Based on these findings, a potential health concern is not indicated for Site 6.

5.6.6.2 Ecological Risk Screening

Potential soil exposure pathways exist for vegetation and wildlife at Site 6. However, the maximum concentrations do not exceed the minimum risk evaluation criteria (Table 5.21). Therefore, a potential ecological concern is not indicated for Site 6.

5.6.7 Preliminary Human Health and Ecological Evaluation - Site 7

Site 7 is a oil sludge pond that was operated from the mid-1950s until 1972. The oil sludge pond was the disposal site of waste oil and possibly solvents and paints. The pond's closure details are unknown. Site 7 is currently covered with asphalt.

TABLE 5.20
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS AT SITE 6
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
Acetone	0.005	J	NC PRG	2.70E+04	NO
Bis(2-ethylhexyl)phthalate	0.032	J	Carc PRG	4.57E+01	NO
Diethylphthalate	0.55		NC PRG	2.16E+05	NO
Ethylbenzene	0.002	J	NC PRG	2.70E+04	NO
Pyrene	0.052	J	NC PRG	8.10E+03	NO
Toluene	0.005	J	NC PRG	5.40E+04	NO
Xylenes	0.005	J	NC PRG	5.40E+05	NO

a/ Lowest soil PRG chosen as conservative estimate.
NC PRG = Noncarcinogenic Preliminary Remediation Goal for soils
Carc PRG = Carcinogenic Preliminary Remediation Goal for soils
J = The value reported is an estimated concentration.

TABLE 5.21
COMPARISON OF MAXIMUM SOIL CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA AT SITE 6
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
Acetone	0.005	J	TDL	112000	NO
Bis(2-ethylhexyl)phthalate	0.032	J	TDL	30600	NO
Diethylphthalate	0.55		TDL	9000	NO
Ethylbenzene	0.002	J	TDL	3500	NO
Pyrene	0.052	J	TDL	2700	NO
Toluene	0.005	J	TDL	7500	NO
Xylenes	0.005	J	TDL	4300	NO

a/ Lowest soil criteria for ecological receptors selected as a conservative estimate.
TDL = Toxic Dietary Level
J = The value reported is an estimated concentration.

Sixteen soil samples, and four groundwater samples (two upgradient and two downgradient) from two sampling events, were collected and analyzed for VOCs, SVOCs, and PPMs. The soil samples, and groundwater samples from the second sampling event, were also analyzed for TRPH.

5.6.7.1 Human Health Screening

The probability of pathway completion or receptor exposure from the soil and air route of transmission are low for current uses because Site 7 is paved. However, if in the future the land usage or site access is changed, then the potential for soil and air pathway completion would increase. The groundwater ingestion, inhalation, and dermal contact pathways have a low probability of completion because there are no potable water wells on Base. If in the future the land usage changes and groundwater wells are installed, the pathway would be complete; however, it is unlikely that the shallow aquifer would be used as a water source. Groundwater may eventually discharge into the City Drain Canal, which flows to Farmington Bay, a recreation area.

Arsenic and beryllium concentrations in the soils exceeded their most stringent human health criteria, the carcinogenic PRGs (Table 5.22). Criteria are not available for 2-methylnaphthalene, lead, and phenanthrene.

Of the chemicals of potential concern detected in the groundwater samples, bis(2-ethylhexyl)phthalate exceeded its MCL and chloroform and arsenic exceeded their carcinogenic PRG values (Table 5.23). Arsenic also exceeded its less stringent MCL.

Although current pathways are not complete, some criteria exceedance in soils and groundwater indicates a slight potential human health concern if land use changes in the future. However, future pathway completion for groundwater is unlikely.

5.6.7.2 Ecological Risk Screening

Under current conditions at Site 7, wildlife and vegetation receptors would not be exposed to soil contaminants because the area is paved. If the pavement is removed or disturbed during future activities at the site, then the soil exposure route may become complete.

None of the chemicals of potential concern detected in soils exceeded their respective screening criteria (Table 5.24). However, criteria were not available for fluorene.

At Site 7, no ecological risk is predicted because completed exposure pathways to vegetation and wildlife do not exist and no criteria are exceeded.

5.6.8 Preliminary Human Health and Ecological Evaluation - The City Drain

A canal segment of the City Drain, referred to in this document as the City Drain Canal, is the primary surface water feature at the Base. The City Drain originates about 8 miles southeast of the Base in southern Salt Lake City, Utah. Throughout much of its course upstream and downstream of the Base, the City Drain is an open and unlined canal. The City Drain enters a 60-inch diameter pipeline approximately 1.5 miles south

TABLE 5.22
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS AT SITE 7
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
2-Methylnaphthalene	3	J	NA	--	--
Antimony	2.2	J	NC PRG	1.08E+02	NO
Arsenic	14.7	J	Carc PRG	3.66E-01	YES
Benzene	0.015	J	Carc PRG	2.21E+01	NO
Bis(2-ethylhexyl)phthalate	0.59		Carc PRG	4.57E+01	NO
Beryllium	1.3		Carc PRG	1.49E-01	YES
Cadmium	0.58	J	NC PRG	1.35E+02	NO
Chromium	30.4		NC PRG	1.35E+03	NO
Copper	83.6		NC PRG	1.08E+04	NO
Ethylbenzene	5.2		NC PRG	2.70E+04	NO
Fluorene	0.044	J	NC PRG	1.08E+04	NO
Fluoranthene	0.074	J	NC PRG	1.08E+04	NO
Lead	41.3		NA	--	--
Methylene Chloride	0.006	J	Carc PRG	8.53E+01	NO
Naphthalene	1.9	J	NC PRG	1.08E+04	NO
Nickel	24.9		NC PRG	5.40E+03	NO
Phenanthrene	0.24	J	NA	--	--
Pyrene	0.27	J	NC PRG	8.10E+03	NO
Toluene	0.45	J	NC PRG	5.40E+04	NO
Xylenes	30		NC PRG	5.40E+05	NO
Zinc	132	J	NC PRG	8.10E+04	NO

a/ **Lowest soil PRG chosen as conservative estimate.**
NA = **Not Available**
NC PRG = **Noncarcinogenic Preliminary Remediation Goal for soils**
Carc PRG = **Carcinogenic Preliminary Remediation Goal for soils**
J = **The value reported is an estimated concentration.**
mg/kg = **milligrams per kilogram**

TABLE 5.23
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM GROUNDWATER CONTAMINANT CONCENTRATIONS AT SITE 7
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/L)		Criteria Type a/	Value (mg/L)	Criteria Exceeded?
Arsenic	0.0573	J	Carc PRG	4.86E–05	YES
Bis(2-ethylhexyl)phthalate	0.043		MCL	6.00E–03	YES
Chloroform	0.0032		Carc PRG	2.76E–04	YES
Copper	0.011		MCL	1.30E+00	NO
Ethylbenzene	0.0005	J	MCL	7.00E–01	NO
Mercury	0.000038	J	MCL	2.00E-03	NO
Selenium	0.0022	J	MCL	5.00E–02	NO
Toluene	0.0013	J	NC PRG	9.65E–01	NO

a/ **Lowest groundwater criteria for human health selected as a conservative estimate of risk.**
mg/L = **milligrams per liter**
J = **The value reported is an estimated concentration.**
NC PRG = **Noncarcinogenic Preliminary Remediation Goal for groundwater**
Carc PRG = **Carcinogenic Preliminary Remediation Goal for groundwater**
MCL = **Maximum Contaminant Level**

TABLE 5.24
COMPARISON OF MAXIMUM SOIL CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA AT SITE 7
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
2-Methylnaphthalene	3	J	TDL	5000	NO
Antimony	2.2	J	TDL	7000	NO
Arsenic	14.7	J	TDL	112	NO
Benzene	0.015	J	SPC	525	NO
Beryllium	1.3		SPC	50	NO
Bis(2-ethylhexyl)phthalate	0.59		TDL	30600	NO
Cadmium	0.58	J	SPC	3	NO
Chromium	30.4		TDL	500	NO
Copper	83.6		SPC	250	NO
Ethylbenzene	5.2		SPC	3500	NO
Fluorene	0.044	J	NA	--	--
Fluoranthene	0.074	J	TDL	2000	NO
Lead	41.3		TDL	800	--
Methylene Chloride	0.006	J	TDL	2100	NO
Naphthalene	1.9	J	TDL	4.9	NO
Nickel	24.9		SPC	50	NO
Phenanthrene	0.24	J	TDL	1700	NO
Pyrene	0.27	J	TDL	2700	NO
Toluene	0.45	J	TDL	7500	NO
Xylenes	30		TDL	4300	NO
Zinc	132	J	SPC	500	NO

a/ **Lowest soil criteria for ecological receptors selected as a conservative estimate.**
NA = **Not Available**
TDL = **Toxic Dietary Level**
SPC = **Soil Phytotoxic Concentration**
mg/kg = **milligrams per kilogram**
J = **The value reported is an estimated concentration.**

of the Base boundary, and continues north for about 0.5 mile beyond the Base property boundary until it discharges from a culvert into the City Drain Canal near the current Base POL Facility. The Base discharges surface runoff waters into the pipeline and canal. The City Drain discharges downstream into the Salt Lake Sewage Canal which discharges 5 miles north of this junction into Farmington Bay.

Six sediment and three surface water samples were collected from the City Drain Canal and were analyzed for VOCs, SVOCs, PPMs, pesticides/PCBs, and TRPH.

5.6.8.1 Human Health Screening

The potential for current pathway completion or receptor exposure on Base to incidental ingestion, dermal contact, or inhalation of volatile contaminants in surface water or sediments in the City Drain Canal is low because access to the site is restricted. However, downstream in the City Drain or in the Salt Lake City Sewage Canal or Farmington Bay, city sewer workers, residents, children, and recreational users of surface waters may be exposed to surface waters and sediments. However, these water sources are not used as a drinking water supply.

In City Drain Canal sediment, arsenic, benzo(a)pyrene, benzo(b)fluoranthene, beryllium, and indeno(1,2,3-cd)pyrene exceeded their soil carcinogenic PRG (Table 5.25). No criteria are available for 2-methylnaphthalene, benzo(g,h,i)perylene, lead, and phenanthrene.

Of the chemicals of potential concern in surface water, antimony, arsenic, cadmium, benzene, and dieldrin exceed the most stringent human health criteria (Table 5.26). Arsenic and antimony also exceed their less stringent respective MCLs. No criteria were available for 1,3-dichlorobenzene, 2-methylnaphthalene, and 4-nitrophenol.

Pathway completion potential onsite is low and it is unlikely that downstream concentrations at the Salt Lake City Sewage Canal or Farmington Bay would be as high due to natural processes such as dilution, degradation, and uptake. In addition, the comparison of sediment concentrations to residential soil ingestion criteria is conservative, since any exposure would be less frequent and of limited duration. However, criteria exceedance indicates that the City Drain Canal may present some risk to human health under specific exposure scenarios.

5.6.8.2 Ecological Risk Screening

Direct exposure of aquatic life to contaminants in surface water and sediment is expected to occur, particularly in downstream areas such as Farmington Bay, a diked freshwater bay of the Great Salt Lake. Potential indirect exposure of wildlife could also result through consumption of contaminated aquatic life.

Of the chemicals of potential concern detected in surface water, concentrations of arsenic, copper, dieldrin, and selenium exceed water quality criteria for the protection of aquatic life (Table 5.27). Criteria are not available for 1,1,1-trichloroethane, 4-nitrophenol, xylenes, aldrin, and 4,4-DDE.

TABLE 5.25
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM CITY DRAIN CANAL SEDIMENT CONTAMINANT CONCENTRATIONS
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
2-Methylnaphthalene	9.7	J	NA	--	--
4,4-DDE	0.13		Carc PRG	1.88E+0	NO
Antimony	1.9	J	NC PRG	1.08E+02	NO
Arsenic	30.8		Carc PRG	3.66E–01	YES
Benzo(a)anthracene	0.58		Carc PRG	6.04E–01	NO
Benzo(a)pyrene	0.69		Carc PRG	8.77E–02	YES
Benzo(b)fluoranthene	1.2		Carc PRG	6.27E–01	YES
Benzo(g,h,i)perylene	0.67		NA	--	--
Benzo(k)fluoranthene	0.36	J	Carc PRG	1.33E+00	NO
Beryllium	0.76	J	Carc PRG	1.49E–01	YES
Bis(2-ethylhexyl)phthalate	7.9	J	Carc PRG	4.57E+01	NO
Cadmium	3.7		NC PRG	1.35E+02	NO
Chromium	52.6	J	NC PRG	1.35E+03	NO
Chrysene	0.9		Carc PRG	1.99E+01	NO
Copper	119		NC PRG	1.08E+04	NO
Fluoranthene	0.69		NC PRG	1.08E+04	NO
Heptachlor	0.028		Carc PRG	1.42E-01	NO
Ideno(1,2,3-cd)pyrene	0.69		Carc PRG	3.79E–01	YES
Lead	568	J	NA	--	--
Mercury	0.42	J	NC PRG	8.10E+01	NO
Nickel	17		NC PRG	5.40E+03	NO
Phenanthrene	0.35	J	NA	--	--
Pyrene	4.8	J	NC PRG	8.10E+03	NO
Selenium	4.8	J	NC PRG	1.35E+03	NO
Toluene	0.79		NC PRG	5.40E+04	NO
Xylenes	1.8		NC PRG	5.40E+05	NO
Zinc	383	J	NC PRG	8.10E+04	NO

a/ **Lowest soil PRG chosen as conservative estimate.**
NA = **Not Available**
NC PRG = **Noncarcinogenic Preliminary Remediation Goal for soils**
Carc PRG = **Carcinogenic Preliminary Remediation Goal for soils**
J = **The value reported is an estimated concentration.**
mg/kg = **milligrams per kilogram**

TABLE 5.26
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM CITY DRAIN CANAL WATER CONTAMINANT CONCENTRATIONS
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/L)		Criteria Type a/	Value (mg/L)	Criteria Exceeded?
1,1,1-Trichloroethane	0.0042		MCL	200E–01	NO
1,3-Dichlorobenzene	0.002	J	NA	--	--
2-Methylnaphthalene	0.003	J	NA	--	--
4-Nitrophenol	0.002	J	NA	--	--
4,4-DDD	0.00017		Carc PRG	3.55E-04	NO
Aldrin	0.000042	J	Carc PRG	1.05E-06	NO
Antimony	0.0257	J	Carc PRG	1.46E–02	YES
Arsenic	0.108	J	Carc PRG	4.86E–05	YES
Benzene	0.0013		Carc PRG	6.16E–04	YES
Cadmium	0.001	J	Carc PRG	3.60E-06	YES
Copper	0.0175	J	MCL	1.30E+00	NO
Dieldrin	0.000031		Carc PRG	5.31E–06	YES
Naphthalene	0.001	J	NC PRG	1.46E+00	NO
Nickel	0.0043	J	MCL	1.00E–01	NO
Phenol	0.002	J	NC PRG	2.19E+01	NO
Selenium	0.0074	J	MCL	5.00E–02	NO
Toluene	0.0036		NC PRG	9.65E–01	NO
Trichloroethene	0.0015		Carc PRG	2.55E–03	NO
Xylenes	0.0051		MCL	1.00E+01	NO

a/ **Lowest surface water human health criteria used as a conservative estimate of risk.**
NA = **Not Available**
mg/L = **milligrams per liter.**
MCL = **Maximum Contaminant Level**
NC PRG = **Noncarcinogenic Preliminary Remediation Goal for water**
Carc PRG = **Carcinogenic Preliminary Remediation Goal for water**
J = **The value reported is an estimated concentration.**

TABLE 5.27
COMPARISON OF MAXIMUM CITY DRAIN CANAL WATER CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/L)		Criteria Type a/	Value (mg/L)	Criteria Exceeded?
1,1,1-Trichloroethane	0.0042		NA	--	--
1,3-Dichlorobenzene	0.002	J	WQC	0.76	NO
2-Methylnaphthalene	0.003	J	WQC	2.12	NO
4-Nitrophenol	0.002	J	NA	--	--
4,4-DDD	0.00017		NA	--	--
Aldrin	0.000042	J	NA	--	--
Antimony	0.0257	J	WQC	1.6	NO
Arsenic	0.108	J	WQC	0.048	YES
Benzene	0.0013		WQC	5.3	NO
Cadmium	0.001	J	WQC	0.0011	NO
Copper	0.0175	J	WQC	0.0012	YES
Dieldrin	0.000031		WQC	0.0000019	YES
Naphthalene	0.001	J	WQC	0.62	NO
Nickel	0.0043	J	WQC	0.16	NO
Phenol	0.002	J	WQC	2.56	NO
Selenium	0.0074	J	WQC	0.0035	YES
Toluene	0.0036		WQC	17	NO
Trichloroethene	0.0015		WQC	21	NO
Xylenes	0.0051		NA	--	--

a/ **Lowest applicable criteria for surface water.**
NA = **Not Available**
WQC = **Water Quality Criteria for protection of aquatic life (EPA 1988).**
mg/L = **milligrams per liter**
J = **The value reported is an estimated concentration.**

Nine chemicals exceeded the sediment quality criteria [arsenic, bis(2-ethylhexyl)phthalate, cadmium, chromium, copper, lead, mercury, zinc, and heptachlor (Table 5.28)]. Screening criteria are not available for 2-methylnaphthalene, antimony, beryllium, chrysene, toluene, selenium, and xylenes.

The available surface water and sediment data suggest a potential for risks to aquatic life in the City Drain Canal. However, the sources of contaminants that pose potential risk cannot be determined with available information. There are several potential sources of the contaminants detected in City Drain Canal surface water and sediment. In addition, upstream (surface water) and upgradient (groundwater) concentrations have not been established. Finally, the canal is not a viable fishery.

5.6.9 Preliminary Human Health and Ecological Evaluation - Piezometer PI-5

Piezometer PI-5 was installed at the north end of the current Base POL facility which is located just south of the City Drain Canal. The area of the piezometer is covered with 3 to 5 inches of pebbles and cobbles. The surrounding property is paved.

Two soil samples were collected from the piezometer soil boring and were analyzed for VOCs, SVOCs, pesticides/PCBs, and PPMs.

5.6.9.1 Human Health Screening

Direct human exposure to the piezometer soil is unlikely due to a 3 to 5 inch layer of pebbles. However, in soil, arsenic and beryllium exceeded their carcinogenic PRG soil values (Table 5.29). Comparison criteria are not available for lead.

Based on these results, there is little current human health risk from piezometer PI-5 soil due to the incomplete pathway. However, if in the future the area is excavated, the risk could increase.

5.6.9.2 Ecological Risk Screening

Under current conditions at piezometer PI-5, wildlife and vegetation receptors would not be exposed to soils because the area is covered with 3 to 5 inches of pebbles.

None of the chemicals detected in the soil exceed the ecological criteria (Table 5.30).

Based on these findings at piezometer PI-5, no ecological risk would be predicted because no pathways exist and chemical concentrations are below comparison criteria.

5.7 UNCERTAINTY

There are several categories of uncertainties associated with this preliminary risk evaluation. All risk evaluations involve the use of assumptions, judgment, and imperfect data to varying degrees. Uncertainty in a risk evaluation may arise for many reasons, including:

- Limited environmental chemistry sampling and analysis;

TABLE 5.28
COMPARISON OF MAXIMUM CITY DRAIN CANAL SEDIMENT CONTAMINANT CONCENTRATIONS WITH ECOLOGICAL CRITERIA
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type	Value (mg/kg)	Criteria Exceeded?
2-Methylnaphthalene	9.7	J	NA	--	--
4,4-DDE	0.13		SQC	0.5	NO
Antimony	1.9	J	NA	--	--
Arsenic	30.8		SQC	5	YES
Benzo(a)anthracene	0.58		SQC	1.2	NO
Benzo(a)pyrene	0.69		SQC	1.2	NO
Benzo(b)fluoranthene	1.2		SQC	1.2	NO
Benzo(g,h,i)perylene	0.67		SQC	1.2	NO
Benzo(k)fluoranthene	0.36	J	SQC	1.2	NO
Beryllium	0.76	J	NA	--	--
Bis(2-ethylhexyl)phthalate	7.9	J	SQC	1.2	YES
Cadmium	3.7		SQC	0.8	YES
Chromium	52.6	J	SQC	26	YES
Chrysene	0.9		NA	--	--
Copper	119		SQC	19	YES
Fluoranthene	0.69		SQC	10.2	NO
Heptachlor	0.028		SQC	0.0003	YES
Ideno(1,2,3-cd)pyrene	0.69		SQC	1.2	NO
Lead	568	J	SQC	27	YES
Mercury	0.42	J	SQC	0.1	YES
Nickel	17		SQC	22	NO
Phenanthrene	0.35	J	SQC	1.2	NO
Pyrene	4.8	J	SQC	1.2	NO
Selenium	4.8	J	NA	--	--
Toluene	0.79		NA	--	--
Xylenes	1.8		NA	--	--
Zinc	383	J	SQC	85	YES

mg/kg = milligrams per kilogram
SQC = Sediment Quality Criteria
NA = Not Available
J = The value reported is an estimated concentration.

TABLE 5.29
COMPARISON OF HUMAN HEALTH CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS FROM PIEZOMETER PI-5
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
1,1-Dichloroethane	0.003	J	NC PRG	2.70E+04	NO
2-Butanone	0.007	J	NC PRG	1.62E+05	NO
Acetone	0.019		NC PRG	2.70E+04	NO
Arsenic	15.3	J	Carc PRG	3.66E–01	YES
Benzene	0.019		Carc PRG	2.21E+01	NO
Beryllium	0.4	J	Carc PRG	1.49E–01	YES
Bis(2-ethylhexyl)phthalate	0.18	J	Carc PRG	4.57E+01	NO
Chloroform	0.004	J	NC PRG	1.05E+02	NO
Chlordane	0.058		NC PRG	4.92E–01	NO
Chromium	13.9	J	NC PRG	1.35E+03	NO
Copper	22.3	J	NC PRG	1.08E+04	NO
Dieldrin	0.0014		Carc PRG	4.00E-02	NO
Ethylbenzene	0.003	J	NC PRG	2.70E+04	NO
Lead	13.2		NA	--	--
Methylene Chloride	0.003	J	Carc PRG	8.53E+01	NO
Nickel	9.7	J	NC PRG	5.40E+03	NO
Xylenes	0.018		NC PRG	5.40E+05	NO
Zinc	45.2	J	NC PRG	8.10E+04	NO

a/ Lowest soil PRG chosen as conservative estimate.
mg/kg = milligrams per kilogram
NC PRG = Noncarcinogenic Preliminary Remediation Goal for soils
Carc PRG = Carcinogenic Preliminary Remediation Goal for soils
J = The value reported is an estimated concentration.
NA = Not Available

TABLE 5.30
COMPARISON OF ECOLOGICAL CRITERIA WITH MAXIMUM SOIL CONTAMINANT CONCENTRATIONS FROM PIEZOMETER PI-5
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Chemical	Maximum Concentration (mg/kg)		Criteria Type a/	Value (mg/kg)	Criteria Exceeded?
1,1-Dichloroethane	0.003	J	TDL	1120	NO
2-Butanone	0.007	J	TDL	54000	NO
Acetone	0.019		TDL	112000	NO
Arsenic	15.3	J	TDL	112	NO
Benzene	0.019		SPC	525	NO
Beryllium	0.4	J	SPC	50	NO
Bis(2-ethylhexyl)phthalate	0.18	J	SPC	30600	NO
Chloroform	0.004	J	SPC	800	NO
Chlordane	0.058		TDL	200	NO
Chromium	13.9	J	TDL	500	NO
Copper	22.3	J	SPC	250	NO
Dieldrin	0.0014		TDL	37	NO
Ethylbenzene	0.003	J	TDL	3500	NO
Lead	13.2		TDL	800	NO
Methylene Chloride	0.003	J	TDL	2100	NO
Nickel	9.7	J	SPC	50	NO
Xylenes	0.018		TDL	4300	NO
Zinc	45.2	J	SPC	500	NO

a/ **Lowest soil PRG chosen as conservative estimate.**
mg/kg = **milligrams per kilogram**
TDL = **Toxic Dietary Level**
SPC = **Soil Phytotoxic Criteria**
J = **The value reported is an estimated concentration.**
NA = **Not Available**

- Use of maximum rather than upper (95th percentile) confidence interval for chemical concentration values;
- Choice of models or evaluation of toxicological data in dose-response quantification;
- Assumptions concerning exposure scenarios and population distributions for both human and environmental receptors; and
- Assumptions regarding future site conditions and land uses.

Uncertainty may be magnified in the evaluation through any combination of these variables.

In risk evaluations, procedures are designed to be conservative in order that they may screen for risks that require additional study. The net effect of combining numerous conservative assumptions is that the final estimates of risk may be greatly overestimated but will provide a guide for use in future studies, such as the RI, that more specifically estimate risks.

Environmental chemistry sampling and analysis error can stem from errors inherent in the sampling and analysis procedures, from a failure to take an adequate number of samples to arrive at sufficient areal resolution, from sampling and/or analysis errors, or from the heterogeneity of the matrix being sampled. One of the most effective ways of minimizing procedural or systematic error is to subject the data to a strict quality control review. Even with all data rigorously quality assured; however, there is still error inherent in all analytical procedures. Because of these limitations, it may not be possible to definitively determine if a sample is truly representative of site conditions. Some chemicals detected in soils and groundwater may not be related to Base practices. For example, metals were retained in the risk evaluation because background samples were not sufficient to reliably establish background concentrations; however, apparent risks from metals may stem from naturally-occurring concentrations. Similarly, other chemicals such as phthalate esters and PNAs can be ubiquitous in the environment or sampling artifacts. If this were the case, apparent risks from these chemicals would not be site related.

The chemicals that were not detected in soils, groundwater, surface water, or sediment at the sites were not evaluated for risk in this preliminary risk evaluation. It is possible that some chemicals may pose a risk at levels below method detection limits. This may tend to underestimate risks.

In almost all risk evaluations, the largest source of uncertainty is in the development of comparison criteria. The use of maximum concentrations rather than average concentrations tends to overestimate risks. For human health, the use of residential exposure assumptions provide an extremely conservative approach to developing comparison criteria. A qualitative risk assessment conducted using site-specific exposure information may indicate that criteria exceedance is not indicative of actual risk. For the environmental evaluation, toxicity thresholds vary considerably for different species.

Because criteria are not available for all individual species, criteria for surrogate species must often be used. To compensate for this uncertainty conservative assumptions are used. This is necessary to account for data gaps and gaps in toxicity information, and the great difference among species in contaminant uptake, bioaccumulation, and biomagnification of chemicals of concern. The resulting assessment, therefore, tends to overestimate risks.

Human health toxicity criteria for evaluating long-term exposures, such as RfDs or cancer slope factors, are based on concepts and assumptions which bias an evaluation in the direction of overestimation of health risk. These uncertainties are compensated for by using upper bounds for cancer slope factors for carcinogens and safety factors for RfDs for noncarcinogens. At best, the dose-response assumptions used in risk evaluation provide a rough but plausible estimate of the upper limit of risk. That is, it is not likely that the true risk would be much more than the estimated risk, but it could very well be considerably lower, even approaching zero.

In addition, there are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. EPA's weight-of-evidence classification provides information which can indicate the level of confidence or uncertainty in the carcinogenicity data obtained from studies in humans or experimental wildlife. Some of the uncertainties in the hazard evaluation are further compensated for by assuming that animal carcinogens behave as human carcinogens.

There are also inherent uncertainties in identifying exposure scenarios for evaluation and in determining the exposure parameters that are combined with toxicological information to estimate risk. For example, there are uncertainties regarding assumptions in estimating the likelihood that an individual or environmental receptor would come into contact with chemicals of concern originating at the site, the concentration of chemicals in the environmental medium of concern, and the period of time over which such exposures might occur. In general, use of conservative assumptions in estimating exposure-point concentrations and estimating chemical intakes will result in a conservative evaluation. In this evaluation, a residential exposure scenario was used to develop human health criteria which may over estimate potential risks.

Finally, because comparison criteria are not available for all chemicals of concern, certain potential health risks may be underestimated.

5.8 SUMMARY OF THE PRELIMINARY RISK EVALUATION

Based on the preliminary risk analysis, which included an evaluation of potential pathway completion and a comparison of maximum detected concentrations to screening criteria, none of the seven sites (1 through 7) nor the City Drain Canal and piezometer PI-5 appear to pose a significant potential threat to human health or the environment (Table 5.31). Chemicals of potential concern equal or exceed human health criteria at Sites 2, 3, 4, 5, 7, the City Drain Canal, and piezometer PI-5. However, current pathways are not complete and a future residential scenario on which comparison criteria are based is

TABLE 5.31
RISK EVALUATION SUMMARY
151st AREFG UTAH AIR NATIONAL GUARD
SALT LAKE CITY INTERNATIONAL AIRPORT
SALT LAKE CITY, UTAH

Site	Potential Concern	Reason
1	Low	Five organics in groundwater exceeded human health criteria, but pathway completion is unlikely. No ecological criteria were exceeded.
2	Low	Two metals (arsenic and beryllium) in soil and nine organics and one metal (arsenic) in groundwater exceeded human health criteria, but pathway completion is unlikely. No ecological criteria were exceeded.
3	Low	Only one organic (1,4-dichlorobenzene) slightly exceeded (2x) its conservative human health criterion in groundwater, but the pathway is not complete. No ecological criteria were exceeded.
4	Low	Two metals (arsenic and beryllium) in soil and one metal (arsenic) in groundwater exceeded human health criteria, but pathway completion is unlikely. No ecological criteria were exceeded.
5	Low	Benzo(a)pyrene was detected slightly above its human health criterion level in soils, but pathway completion is unlikely. No ecological criteria were exceeded.
6	Low	No criteria were exceeded; pathway completion is unlikely.
7	Low	Two metals (arsenic and beryllium) exceeded human health criteria in soils and two organics [bis(2-ethylhexyl)phthalate and chloroform] and one metal (arsenic) exceeded human health criteria in groundwater, but pathway completion is unlikely. No ecological criteria were exceeded.
City Drain Canal	Low to Moderate	Three PNAs and two metals exceeded their human health criteria in sediment; dieldrin, benzene, and three metals exceeded human health criteria in surface water. Nine chemicals [seven metals, bis(2-ethylhexyl)phthalate, and heptachlor] exceeded their sediment ecological criterion. Three metals and dieldrin exceeded ecological surface water quality criteria. The contamination source(s) is unknown and upstream background has not been established. Pathway completion is unlikely since the canal is not a drinking water source or a viable fishery.
Piezometer (PI-5)	Low	Two metals (arsenic and beryllium) in soil exceeded their human health criterion, but pathway completion is unlikely. No ecological criteria were exceeded.

unlikely. Ecological criteria are exceeded by chemical concentrations at the City Drain Canal, but aquatic habitat is unsuitable for a fishery and pathway completion probability is low. Also, the source(s) of contamination at the City Drain Canal is unknown. Finally, some of the chemicals of concern exceeding criteria levels may be sampling artifacts (chloroform and bis(2-ethylhexyl)phthalate), or may be naturally-occurring (metals).

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SECTION 6
SUMMARY AND CONCLUSIONS

6.1 INTRODUCTION

This section presents the conclusions of the SI on a site-specific and general basis. The objectives of the SI are reviewed in Subsection 6.1. In Subsections 6.2 through 6.8, the contamination of soil and groundwater and site-specific hydrogeology at Sites 1 through 7, are assessed. The preliminary results of Site 10 soil contamination are discussed in Subsection 6.9. Sediment and surface water contamination, and the hydrology and possible sources of contamination of the City Drain Canal, are assessed in Subsection 6.10. A general summary of the basewide stratigraphy, groundwater quality, and hydrogeology, and a general assessment of soil and groundwater contamination are presented in Subsection 6.11. An analysis of the fate and transport characteristics of chemicals of concern detected in soil and groundwater also is contained in Subsection 6.11.

6.1.1 Restatement of Objectives

The objectives of the SI were to:

- Confirm the presence/absence of contamination which may threaten human health or the environment;
- Identify the nature of the contaminants;
- Provide some contamination quantification and preliminarily determine risk, and;
- Provide a hydrogeological study of the Base.

The expanded objectives of this particular SI were to:

- Define the lateral extent of soil contamination in source areas;
- Perform aquifer tests and quantify groundwater flow rates and velocities; and
- Evaluate the potential for contaminant migration based on fate and transport characteristics of the contaminants and aquifer properties.

The objectives of the SI were met and results are summarized and concluded in the following site-by-site and general discussions.

6.2 SITE 1 - FORMER PESTICIDE DUMP

6.2.1 Conclusions

6.2.1.1 Soil Contamination

Low levels of pesticides were detected in the three initial soil borings advanced at the center of the site in December 1992. This confirmed that the site was located during the PA and that only small amounts of pesticide were disposed. Beta-BHC was detected in soil samples from all three soil borings and chlordane was detected in one sample. In all three borings Beta-BHC was detected at the deeper 4- to 6-foot sampling interval. Chlordane was detected in a near-surface sample.

Pesticides were not detected in soil samples collected from the seven additional soil borings advanced at the site in October 1994. However, trichloroethene was detected at a minor concentration at the soil/water interface in one of the additional soil borings located at the southwest corner of the site.

The extent of pesticide soil contamination at Site 1 has been adequately defined.

None of the concentrations of detected compounds in soils exceeded human health or ecological criteria. Therefore, a potential human health or ecological concern is not indicated for soil at this site.

6.2.1.2 Groundwater Contamination

A total of three groundwater samples from two downgradient monitoring wells at Site 1 were analyzed for pesticides/PCBs. No pesticides/PCBs were detected in the samples. Two of the three samples were collected from a second sampling event at the site and were also analyzed for VOCs and arsenic. Halogenated VOCs were detected in a sample collected from the new downgradient monitoring well installed at the site in August 1995. Elevated concentrations of arsenic were detected in both samples but the presence and concentrations of arsenic at the site are considered to be representative of background conditions.

Based on the non-detection of pesticide/PCBs for two sampling events and the locations of the site monitoring wells with respect to groundwater flow directions observed at the site, the absence of pesticide/PCBs in groundwater appears to be confirmed. The extent of halogenated VOCs in groundwater at the site has not been completely defined and the presence or absence of halogenated VOCs within the site area or upgradient of the site was not confirmed since only downgradient monitoring wells were installed. Therefore, a source within the site area or an upgradient source for these compounds could exist. Halogenated VOCs were detected in groundwater in the area of Site 8, which borders Site 1 to the west (ES, 1993; ES, 1994). VOCs detected in groundwater at Site 1 also may be related to the groundwater contamination present in the Site 8 area.

Concentrations of five halogenated VOCs in downgradient groundwater exceeded the most stringent human health criteria. The concentrations of tetrachloroethene, trichloroethene, 1,2-dichloroethene, and vinyl chloride also exceeded MCLs for water quality. Completion of exposure pathways from the groundwater route of transmission is not likely since the shallow aquifer is not used as a water source and it is unlikely that it would be used as a water source in the future. If however, direct human contact with groundwater were to occur, the groundwater route of transmission would be completed.

6.2.2 Groundwater Hydrology

Groundwater flow conditions at Site 1 have been adequately defined. However, the flow direction, hydraulic gradient, and flow rate are subject to change. The groundwater flow direction at the site was to the north on 28 December 1992, and was to the northwest on 16 March 1993 and 19 July 1995. The hydraulic gradient in the vicinity of the site increased between December 1992 and March 1993.

The groundwater flow rate and flow velocity were not calculated at Site 1 due to the lack of sufficient site-specific hydraulic gradient data. Hydraulic conductivities of the clay and sand in the screened intervals of the downgradient monitoring wells were 3.3 ft/day and 5.34 ft/day.

6.3 SITE 2 - WASTE POL FUEL SPILL

6.3.1 Conclusions

6.3.1.1 Soil Contamination

Soil samples were collected from six soil borings at Site 2. Site soils contained relatively low levels of organic compounds, low to moderate levels of TRPH, and metals. VOCs related to a probable solvent spill were present in the eastern half of the site. The compounds trichloroethene, tetrachloroethene, and cis-1,2-dichloroethene were detected in soil at this part of the site. Relatively higher BTEX, TRPH, and PNAs related to a probable bowser waste fuel leak in 1987 were detected in soil samples from one soil boring near the center of the site. Overall, metals concentrations at the site were low, but were most prevalent and were relatively higher at the northeastern part of the site. However, metals in Site 2 soils may be naturally occurring. Elevated concentrations of gaseous-phase benzene were detected in soil gas samples at the southwestern portion of the site.

The extent of organic compound soil contamination at Site 2 has not been completely defined (the extent of contamination is defined as the non-detection of organic compounds in soil); but, contamination is localized in the center of the site and does not appear to be widespread. The lateral extent of soil contamination has been defined to the west and has nearly been defined to the south. Samples from two soil borings at the northeastern part of Site 2 contained detectable concentrations of organic compounds. This suggests that the lateral extent of soil contamination has not been completely defined at this perimeter of the site. However, only bottom-hole samples were collected from the

soil borings at the northeastern part of the Site and these sample were collected at the soil/water interface. Therefore, soil at this depth may have been impacted by solvent-related contamination in groundwater. Soil contamination at the site extends vertically from below fill to the deepest sampling depth of 8.5 feet BLS. This depth approximately coincides with the deepest level of groundwater observed during the SI field effort. The water table at the site appears to fluctuate seasonally and rises to a shallower depth.

Concentrations of arsenic and beryllium exceeded the most stringent human health criteria for soil in all Site 2 soil samples. However, the established human health PRGs for these metals were below method detection limits and are impractical given the occurrence of these metals in natural soils (USGS, 1984). The concentrations of arsenic in soil ranged from 4.5 mg/kg to 44 mg/kg. The concentrations of beryllium ranged from 0.27 mg/kg to 1.3 mg/kg. The PRGs for arsenic and beryllium are 0.366 mg/kg and 0.149 mg/kg, respectively. Completion of exposure pathways from the soil route of transmission is not likely because most of the site is paved and the soil contamination poses a low current or future threat to human health or the environment. Ecological criteria for soils at Site 2 were not exceeded.

6.3.1.2 Groundwater Contamination

Downgradient groundwater at Site 2 contained VOCs and some metals. The solvent-related compounds dichloroethenes, dichloroethanes, tetrachloroethene, trichloroethene, and vinyl chloride, and minor concentrations of benzene, chlorobenzene, and trans 1,3-dichloropropene, were detected in site groundwater. The concentrations of trichloroethene were elevated in both downgradient wells and increased between sampling events in groundwater collected from the initial monitoring well installed at the site. The presence of trichloroethene degradation products indicates that intrinsic remediation is occurring and that degradation will likely continue in the future. Elevated concentrations of arsenic were detected (both sampling events) in groundwater collected from the initial monitoring well installed at the site. However, the arsenic in groundwater appears to be indigenous to the shallow aquifer and probably is not related to the leaching of site soils.

The geometric extent of confirmed groundwater contamination at the site has not been completely defined.

Concentrations of nine organic compounds (primarily halogenated VOCs) and arsenic in downgradient groundwater exceeded the most stringent human health criteria. The concentrations of tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, vinyl chloride, and arsenic also exceeded MCLs for water quality. Completion of exposure pathways from the groundwater route of transmission is not likely since the shallow aquifer is not used as a water source and it is unlikely that it would be used as a water source in the future. If however, direct human contact with groundwater were to occur, the groundwater route of transmission would be completed.

6.3.1.3 Groundwater Hydrology

Groundwater flow conditions at Site 2 have been adequately defined. However, the flow direction, hydraulic gradient, and flow rate are subject to change. The groundwater flow direction at the site was northerly on 28 December 1992, and was northwesterly on 16 March 1993 and 19 July 1995. Hydraulic gradients at the site also changed for the same time periods.

The groundwater flow rate at Site 2 was relatively low based on field-measured hydraulic conductivity and 16 March 1993 groundwater levels. The estimated hydraulic gradient at the site was 1.65×10^{-3} ft/ft. The average saturated hydraulic conductivity of the sandy clay beneath the site was determined to be 1.74 ft/day. This yielded a groundwater velocity of 0.01 ft/day, assuming an effective porosity of 30 percent. Under these conditions (March was a period of recharge to the shallow aquifer), it would take groundwater nearly six years to move 20 feet downgradient. The bowser leak at Site 2 occurred in 1987. However, likely heterogeneities in aquifer properties downgradient, seasonal and cyclic variation in hydraulic gradient and flow direction, accuracy of field methods for measuring hydraulic conductivity, and an assumption of effective porosity make this flow velocity and travel time an approximation.

6.4 SITE 3 - DRUM BURIAL LOCATIONS

6.4.1 Conclusions

6.4.1.1 Soil Contamination

Soil samples were collected from the five soil borings and two shallow excavations at Site 3. Site soils contained relatively low levels of organic compounds and TRPH; metals were not analyzed. VOCs were not detected in site soils. Apparently, the drums were emptied of their contents prior to burial or the VOCs volatilized or have since degraded. The semivolatile PNA burn by-products pyrene, chrysene, and phenanthrene were detected at minor concentrations in near-surface fill material and construction debris at the two drum burial areas. Organic compound contamination in native soil was only detected at one soil boring location: phenanthrene, N-nitrosodiphenylamine, and TRPH were present at minor concentrations in organic silt at a depth of 4- to 6-feet. Site 3 is south and adjacent to the SLCIA FTA. The PNA burn by-products detected in near-surface soil at the site appear to be the result of aerial fall-out related to practices at the FTA. The FTA is no longer in use.

The extent of subsurface soil contamination at Site 3 has been adequately defined (the extent of contamination is defined as the non-detection of organic compounds in soil). The extent of near-surface soil contamination resulting from the FTA has not been completely defined. However, the radius of the aerial fall-out could be extensive. Organic compound contamination at Site 3 appears to be localized in the upper 1 to 2 feet of near-surface soil.

None of the concentrations of detected compounds in soil exceeded human health criteria or ecological criteria. Therefore, a potential human health or ecological concern is not indicated for soil at this site.

6.4.1.2 Groundwater Contamination

Upgradient and downgradient groundwater at Site 3 contained minor concentrations of chlorobenzene, dichlorobenzenes, and BTEX compounds that do not appear to be site related. Upgradient concentrations of these organic compounds were higher than downgradient concentrations for both groundwater sampling events and no organic compounds were detected in downgradient groundwater from the second sampling event in 1995. Also, upgradient concentrations diminished between sampling events. Dichlorobenzenes, and chlorobenzene to a lesser extent, are moderately to tightly adsorbed to soil, and do not readily leach to groundwater (Howard, 1990). They are moderately volatile and have low to moderate solubility in water. These compounds were not detected in site soils, indicating an upgradient source of groundwater contamination. The SLCIA FTA and a drum storage area are located immediately north and hydraulically upgradient of the site. McDonnell Douglas plant operations are located north of the FTA.

Based on the two sampling events and the locations of the site monitoring wells with respect to groundwater flow directions observed at the site, the presence and then diminishing concentrations of contamination has been confirmed and the downgradient extent of groundwater contamination appears to be adequately defined.

For both sampling events, the concentration of 1,4-dichlorobenzene in upgradient groundwater slightly exceeded its human health criterion, but did not exceed the water quality MCL. A slight potential health concern exists for future potential groundwater users. However, it is unlikely that the shallow aquifer would be used as a water source, and the completion of exposure pathways from the groundwater route of transmission is not likely.

6.4.1.3 Groundwater Hydrology

Groundwater flow conditions at Site 3 have been adequately defined. However, the flow direction, hydraulic gradient, and flow rate are subject to change. The groundwater flow direction at the site was to the southeast on 28 December 1992, was to the south on 16 March 1993, and was again southeast on 19 July 1995. Hydraulic gradients at the site also changed for the same time periods. The hydraulic gradient increased significantly in March 1993. Based on observed flow patterns, groundwater currently beneath Site 3 would ultimately discharge to the City Drain Canal, which eventually flows to Farmington Bay.

The groundwater velocity at site 3 was significantly higher than the velocity at the other IRP sites based on field-measured hydraulic conductivity and 16 March 1993 groundwater levels. The average saturated hydraulic conductivity of the coarse granitic sand beneath the site was determined to be 36.9 ft/day. The hydraulic gradient at the site

was 2.0 x 10^{-3} ft/ft. This yielded a groundwater velocity of 0.25 ft/day, assuming an effective porosity of 30 percent. Under these conditions (March was a period of recharge to the shallow aquifer), groundwater beneath the site would discharge into the City Drain Canal in approximately 11 years. However, likely heterogeneities in aquifer properties downgradient, seasonal and cyclic variation in hydraulic gradient and flow direction, accuracy of field methods for measuring hydraulic conductivity, and an assumption of effective porosity make this flow velocity and travel time an approximation.

6.5 SITE 4 - FIRE TRAINING AREA 1

6.5.1 Conclusions

6.5.1.1 Soil Contamination

Soil samples were collected from nine soil borings at Site 4. Site soils contained relatively low levels of VOCs and SVOCs, low to moderate levels of TRPH, and metals. Volatile BTEX compounds, diethylphthalate, di-n-butylphthalate, and 2,4-dimethylphenol were present at the center of the site. Elevated concentrations of gaseous-phase toluene were also detected in soil gas samples at the center of the site. In contrast, toluene in site soils was minimal. The PNA burn by-products were not detected in soil, but would be expected for this site which reportedly was used extensively as a fire training area. PNAs have high organic carbon partition coefficients and are very persistent in organic soils. Organic soils are ubiquitous in the shallow subsurface at the site. Site-specific higher concentrations of metals were detected at the center of the site, but were also present outside of the area impacted by organic contamination. This may indicate that the metals present in site soil are depositional and that metals at the site may be naturally occurring.

The extent of soil contamination at Site 4 has almost been completely defined (the extent of contamination is defined as the non-detection of organic compounds in soil). The lateral extent of soil contamination has been defined to the west and north and has nearly been defined to the south and east. Organic compounds were not detected in samples from the northernmost and westernmost soil borings. A sample from the southernmost soil boring at the site contained only minor detectable TRPH. The easternmost soil boring contained minimal toluene and phthalate. This indicates that the lateral extent of soil contamination also has been practically defined at the southern and eastern perimeter of the site. Contamination is localized in the center of the site and does not appear to be widespread. Subsurface soil contamination (organic compounds) was almost exclusively present in silt, and organic silt and clay, at the 2.5- to 4.5-foot intervals of the soil borings. The 4.5-foot depth corresponds to the approximate level of the fluctuating water table.

Concentrations of arsenic and beryllium in soil exceeded the most stringent human health criteria in all Site 4 soil samples. However, the established human health PRGs for these metals were below method detection limits and are impractical given the occurrence of these metals in natural soils (USGS, 1984). The concentrations of arsenic in soil

ranged from 4.2 mg/kg to 129 mg/kg. The concentrations of beryllium ranged from 0.21 mg/kg to 1.1 mg/kg. The PRGs for arsenic and beryllium are 0.366 mg/kg and 0.149 mg/kg, respectively. Completion of exposure pathways from the soil route of transmission is unlikely because the site is paved and the soil contamination poses a low current risk to human health or the environment. If the pavement is removed, the probability of pathway completion would increase. Ecological criteria for soils at Site 4 were not exceeded.

6.5.1.2 Groundwater Contamination

Groundwater at Site 4 contained minor concentrations of VOCs, and some metals. For the 1993 sampling event, toluene and total xylenes were detected at minor concentrations in a groundwater sample collected from the single downgradient monitoring well installed at the site. No organic compounds were detected in groundwater from the second sampling event in 1995. The toluene and xylenes originally present in downgradient groundwater may be related to the leaching of these compounds from site soils. Elevated arsenic concentrations were detected in groundwater from both sampling events at the site. However, arsenic in groundwater does not appear to be related to former base activities and probably is indigenous to the shallow aquifer.

Based on the two sampling events and the location of the single site monitoring well with respect to groundwater flow directions observed at the site, the initial presence then later absence of contamination has been confirmed and the downgradient extent of groundwater contamination appears to be adequately defined.

The concentration of arsenic in downgradient groundwater exceeded its most stringent human health criterion as well as the MCL for water quality for both sampling events. However, completion of exposure pathways from the groundwater route of transmission is not likely because the shallow aquifer is not used for a potable water source.

6.5.1.3 Groundwater Hydrology

Groundwater flow conditions at Site 4 have been adequately defined. The groundwater flow direction at the site was northerly or slightly northeasterly at all three measuring times indicating that the flow direction at the site was essentially constant. However, hydraulic gradients and flow rates are subject to change. At all measuring times, shallow groundwater flow was toward the City Drain Canal, which is about 400 feet north of the site.

Groundwater was essentially not flowing at the site on 16 March 1993 due to a flat hydraulic gradient. The estimated hydraulic gradient at the site was 5.56×10^{-5} ft/ft using the downgradient well at Site 7 as and upgradient well for Site 4. The average hydraulic conductivity of the silt, clay, and sand beneath the site was 1.29 ft/day. This yielded a groundwater velocity of 2.4×10^{-4} ft/day, assuming an effective porosity of 30 percent. Under the 16 March 1993 hydraulic gradient, it would take groundwater nearly 10 years to move 1 foot downgradient. However, this travel time is based on the hydraulic

gradient at this particular time. A better approximation of the average flow velocity and travel time would be based on the seasonal and cyclic variation in hydraulic gradient and flow direction.

6.6 SITE 5 - FIRE TRAINING AREA 2

6.6.1 Conclusions

6.6.1.1 Soil Contamination

Soil samples were collected from seven soil borings at Site 5. Site soils contained low levels of organic compounds and TRPH; metals were not analyzed. Minor concentrations of BTEX compounds, PNAs, bis(2-ethylhexyl)phthalate, and TRPH were detected in site soils. Some or all of these compounds were present at all site soil borings, indicating that organic compound contamination though detected at minor concentrations, is widespread at the site. Semivolatile PNAs were the primary organic compounds detected in site soils. The PNAs appear to be burn by-products related to the past fire training practices at the site.

The extent of soil contamination at Site 5 has not been completely defined. The lateral extent of soil contamination has not been defined since all of the soil borings contained detectable, though minor, concentrations of organic compounds. However, the probability of detectable concentrations of organic compounds being present laterally outside of the established site configuration, in excess of concentrations that were found within the site, is not likely. Organic contamination was most prevalent in the shallow subsurface at depths ranging from 1 foot to 4 feet BLS, but also was detected at the deepest sampling depth of 6.5- to 8.5-feet BLS. The groundwater level at the site fluctuated between approximately 4 feet to 7 feet BLS during the field effort.

The concentration of benzo(a)pyrene in a near-surface soil sample from one of the seven soil borings at the site slightly exceeded its human health criterion. Completion of exposure pathways from the soil route of transmission is moderate for current and future uses because the site is not paved. Ecological criteria for soils at Site 5 were not exceeded, and a potential ecological concern is not indicated because of limited habitat at the site.

6.6.1.2 Groundwater Contamination

Downgradient groundwater at Site 5 contained only one VOC. Initially, 1,1-dichloroethane was detected at a concentration of 1 ug/L in a groundwater sample from the single monitoring well installed at the site. No organic compounds were detected in groundwater from the second sampling event.

Based on the two sampling events and the location of the single site monitoring well with respect to groundwater flow directions observed at the site, the presence then absence of contamination has been confirmed with the single downgradient monitoring well installed at the site.

The concentration of 1,1-dichloroethane in groundwater did not exceed human health criteria, so a potential health concern is not indicated for this site.

6.6.1.3 Groundwater Hydrology

Groundwater flow conditions at Site 5 have been adequately defined. The groundwater flow direction at the site was to the southeast on 28 December 1992, was to the south on 16 March 1993, and was again to the southeast on 19 July 1995. At all three synoptic measuring times, groundwater flow was toward the City Drain Canal, which is about 150 feet south of the site. The general hydraulic gradient in the vicinity of the site changed among these measuring times. Therefore, the flow direction, hydraulic gradient, and flow rate are subject to change.

The groundwater velocity was not calculated at Site 5 due to the lack of sufficient site-specific hydraulic gradient data. However, the velocity should be relatively high based on the hydraulic conductivity (21.28 ft/day) obtained from the sand in the screened interval of the site monitoring well and the observed basewide hydraulic gradients in the vicinity of Site 5.

6.7 SITE 6 - RAMP WASHDOWN

6.7.1 Conclusions

6.7.1.1 Soil Contamination

Soil samples from the 10 soil borings at Site 6 contained low levels of organic compounds and TRPH; metals were not analyzed. Minor concentrations of BTEX compounds, phthalates, a PNA, and TRPH were detected in site soils. However, detectable concentrations of these compounds in soils were isolated. Organic compounds were not detected in any soil samples collected from nearly half of the site soil borings. Phthalates were the primary organic compounds detected in site soils. The presence of phthalates is anomalous based on site history, considering that phthalates are not components or degradation products of airplane fuels. Therefore, the phthalates detected in site soils may be laboratory or sampling artifacts.

Soil contamination at Site 6 was thought to be limited to the long, narrow grass strip area adjacent to the parking apron. Based on the limited and isolated contamination present at the site, the extent of contamination is considered to be completely defined.

None of the concentrations of detected compounds in Site 6 soils exceeded human health or ecological criteria. Therefore, a potential human health or ecological concern is not indicated for this site.

6.7.1.2 Groundwater Contamination

Groundwater at Site 6 was sample and analyzed twice for VOCs and SVOCs. In 1993, none of these analytes were detected in groundwater collected from three downgradient monitoring wells installed at the site. Two additional downgradient monitoring wells were installed in 1995 and all five wells were sampled. In addition to

the organic analytes, arsenic was analyzed in the second sampling event. Very low concentrations of 1,4-dichlorobenzene and xylenes were detected in groundwater from one of the initial wells installed in 1993. The general lack of soil and groundwater contamination at the site implies that the reported fuel spills did not adversely impact these media or that the fuel hydrocarbons have degraded. Arsenic was analyzed in the second sampling event to evaluate background concentrations of this metal, and elevated concentrations of arsenic were detected. The presence of arsenic at this non-metals site supports the conclusion that dissolved arsenic is generally ubiquitous in shallow groundwater at the Base and is indigenous to the shallow aquifer.

Based on the two sampling events and the installation of two additional downgradient monitoring wells, the presence or absence of groundwater contamination at the site has been confirmed.

No organic compound concentrations in groundwater exceeded human health criteria; therefore, a potential health concern is not indicated for this site.

6.7.1.3 Groundwater Hydrology

Groundwater flow conditions at Site 6 have been adequately defined. The groundwater flow direction at the site was east-northeast on 28 December 1992 and was west-northwest on 16 March 1993 and 19 July 1995. This indicated a reversal of gradient and flow direction at this extreme west side of the Base among these measuring times. However, the west-northwest flow direction appears to be the prevailing direction of flow at the site. If so, the three initial monitoring wells were installed upgradient of the site and the two additional wells are downgradient of the site.

The groundwater velocity at Site 6 was relatively low based on field-measured hydraulic conductivity and 16 March 1993 groundwater levels. An estimated hydraulic gradient at the north end of the site was 1.52×10^{-3} ft/ft. The average hydraulic conductivity of the saturated sand, silt, and clay at the north end of the site was 3.52 ft/day. This yielded a groundwater velocity of 0.02 ft/day, assuming an effective porosity of 30 percent. Under these conditions, it would take groundwater approximately 13 to 14 years to move 100 feet downgradient if the groundwater flow direction and hydraulic gradient were constant.

6.8 SITE-7 - OIL SLUDGE POND

6.8.1 Conclusions

6.8.1.1 Soil Contamination

Soil samples were collected from 10 soil borings at Site 7. Site soils contained relatively low levels of organic compounds, low to high levels of TRPH, and metals. Organic compound contamination in soil appears to be primarily petroleum related. Minor concentrations of BTEX compounds, phthalates, PNAs, and napthalenes were detected in soils. Some or all of these compounds were present in samples collected from soil borings located at the center of the site. Elevated concentrations of TRPH were also

detected in soil samples from two soil borings located at the center of the site. The presence of TRPH at higher concentrations implies that intrinsic remediation of these hydrocarbons is progressing slowly in site soils (the Oil Sludge Pond was last used in 1972). Perhaps competing native organic carbon and/or depleted oxygen are limiting the rates of aerobic biodegradation. Although degradation may be progressing slowly, the TRPH appear to be immobilized in the organic rich soils due to adsorption. Site-specific higher concentrations of metals were detected at the center of the site, but were also present outside of the area impacted by organic contamination. This indicates that the metals present in site soil are depositional and that metals at the site may be naturally occurring.

The extent of soil contamination at Site 7 has almost been completely defined (the extent of contamination is defined as the non-detection of organic compounds in soil). The lateral extent of soil contamination has been defined to the west, south, and north and has nearly been defined to the east. Organic compounds were not detected in samples from the westernmost, southernmost, and northernmost soil borings. A sample from the easternmost soil boring at the site contained only minor detectable TRPH and toluene. This indicates that the lateral extent of soil contamination also has been practically defined at the eastern perimeter of the site. Subsurface soil contamination was most prevalent beneath fill at the 2.5- to 4.5-foot interval of the soil borings, but extends to a maximum sampling depth of 9 feet BLS at the center of the site.

Concentrations of arsenic and beryllium exceeded human health criteria for soil in all Site 7 soil samples. However, the established human health PRGs for these metals were below method detection limits and are impractical given the occurrence of these metals in natural soils (USGS, 1984). The concentrations of arsenic in soil ranged from 2.3 mg/kg to 14.7 mg/kg. The concentrations of beryllium ranged from 0.25 mg/kg to 1.3 mg/kg. The PRGs for arsenic and beryllium are 0.366 mg/kg and 0.149 mg/kg, respectively. TRPH concentrations detected in soils at the center of the site were elevated (maximum concentration of 11,500 mg/kg). However, no risk-based comparative criteria were available for TRPH. Completion of exposure pathways from the soil route of transmission is not likely because the site is paved and the soil contamination poses a low current risk to human health or the environment. If the pavement is removed, the probability of pathway completion would increase. Ecological criteria for soils at Site 7 were not exceeded.

6.8.1.2 Groundwater Contamination

Upgradient groundwater at Site 7 contained a minor concentration of a VOC and some metals. Downgradient groundwater at the site contained minor concentrations of VOCs, an SVOC, and some metals. A total of four groundwater samples from two sampling events (1993 and 1995) were collected. Toluene was detected in a groundwater sample collected from the upgradient monitoring well in the first sampling event. Chloroform, toluene, ethylbenzene, and bis(2-ethylhexyl)phthalate were detected in a groundwater sample collected from the downgradient monitoring well in the first

sampling event. In addition to the organic analytes mentioned above, TRPH was analyzed in the second sampling event, and no organic compounds including TRPH were detected. The organic compounds originally present in downgradient groundwater could have been related to the leaching of site soils, but the toluene in upgradient groundwater was not site related based on observed groundwater flow patterns at the site. Elevated concentrations of arsenic were detected in both upgradient and downgradient groundwater from both sampling events. Therefore, dissolved arsenic in groundwater does not appear to be site related since concentrations in upgradient groundwater were higher than downgradient concentrations and concentrations in site soils were relatively low. Arsenic in groundwater probably is indigenous to the shallow aquifer and is not related to the leaching of site soils.

Based on the observed groundwater flow directions at the site, the initial presence then later absence of groundwater contamination at the site has been confirmed and the extent of groundwater contamination at the site has been adequately defined.

Concentrations of two organic compounds and one metal in groundwater at Site 7 exceeded human health criteria. The concentration of chloroform in downgradient groundwater exceeded the human health PRG; however, chloroform appears to be a sampling artifact. The concentration of bis(2-ethylhexyl)phthalate in downgradient groundwater exceeded the water quality MCL, which was also the most stringent human health criteria for this compound. However, since bis(2-ethylhexyl)phthalate was not detected in the second sampling event, this SVOC also appears to have been a sampling artifact. The concentration of arsenic in both upgradient and downgradient groundwater exceeded the human health PRG and the MCL for both sampling events. Completion of exposure pathways from the groundwater route of transmission is unlikely because the shallow aquifer is not used as a potable water source.

6.8.1.3 Groundwater Hydrology

Groundwater flow conditions at Site 7 have been adequately defined. The groundwater flow direction at the site was northerly or slightly northeasterly at all three measuring times indicating that the flow direction at the site was essentially constant. However, hydraulic gradients and flow rates are subject to change. At all three measuring times, groundwater flow was toward the City Drain Canal, which is about 600 feet north of the site.

The groundwater velocity at Site 7 was relatively low based on field-measured hydraulic conductivity and 16 March 1993 groundwater levels. An estimated hydraulic gradient at the site was 1.67×10^{-3} ft/ft. The average saturated hydraulic conductivity of the silt, clay, and sand beneath the site was 3.33 ft/day. This yielded a groundwater velocity of 0.02 ft/day, assuming and effective porosity of 30 percent. Under these conditions, it would take groundwater beneath Site 7 approximately 80 years to discharge into the City Drain Canal. However, this travel time is based on the hydraulic gradient at this particular measurement. A better approximation of the average flow velocity and

travel time would be based on the seasonal and cyclic variation in hydraulic gradient and flow direction.

6.9 SITE 10 - POL FACILITY

6.9.1 Conclusions

6.9.1.1 Soil Contamination

A site investigation of a reported fuel/water spill, fuel tanks, and dispensers in the POL facility was initiated in May 1994, approximately one year subsequent to the investigation of Sites 1 through 7. Soil samples were collected from four soil borings prior to terminating the work due to a fume exposure incident that caused adverse health effects in drilling personnel. Therefore, investigation of the site was not completed. The preliminary results of the SI indicated that three of the four soil borings were petroleum contaminated. The analytical results of soil obtained from the 8- to 10-foot sampling interval that caused the adverse health effects were inconclusive (only a minor concentration of benzene was detected). Groundwater was encountered during drilling at a depth of approximately 5 feet BLS. As of this writing, a continued investigation of the site under an RI phase is being performed by a different contractor.

6.9.1.2 Groundwater Contamination

Monitoring wells that were proposed to be installed at the site were not completed due to potential health risks.

6.9.1.3 Groundwater Hydrology

In contrast to the other sites, three piezometers were installed during a screening phase at Site 10 to determine the site-specific groundwater flow direction prior to placement of monitoring wells. However, groundwater levels in Site 10 piezometers were not measured. Therefore a site-specific hydraulic gradient, groundwater flow direction, and groundwater flow velocity were not determined.

6.10 CITY DRAIN CANAL

6.10.1 Conclusions

6.10.1.1 City Drain Canal - Sediment

Six sediment samples were collected on 12 February 1993 at separate locations along the course and within the channel of the City Drain Canal. The samples contained low to moderate levels of organic compounds, and metals. Slightly elevated concentrations of TRPH were present in two sediment samples. Toluene, xylenes, bis(2-ethylhexyl)phthalate, numerous PNAs, 2-methylnapthalene, and pesticides were detected in the sediment samples at variable concentrations. One to all of these compounds were present in the each of the sediment samples. The highest concentrations of organic compounds in sediments occurred where water enters and exits the canal: near the pump house and associated culvert, near the culvert of the City Drain and the City Drain Canal,

and near the oil/water separator. Moderate to high concentrations of metals were also detected in sediment samples at these locations, with one exception; the location near the pump house. Lead (568 mg/kg) was particularly elevated at the sampling location near the culvert where the City Drain discharges into the unlined City Drain Canal. The culverts of the City Drain and the pump house are upstream of any base outfalls into the canal.

Concentrations of three organic compounds and two metals in sediment exceeded human health criteria. Sediment collected at the west end of the City Drain Canal near the pump house contained concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and ideno(1,2,3-cd)pyrene that exceeded the human health PRGs. These organic compounds were detected only at this location. Concentrations of arsenic and beryllium, in all sediment samples, exceeded human health PRGs. Completion in this medium is unlikely at the Base because the area is restricted. However, there is a potential concern for downstream receptors due to possible incidental contact with surface water and sediment. Seven metals, bis(2-ethylhexyl)phthalate, and heptachlor exceeded ecological criteria for sediment in the City Drain Canal, indicating some potential concern for aquatic life.

6.10.1.2 City Drain Canal - Surface Water

Three surface water samples collected on 11 February 1993 at locations where water enters and exits the City Drain Canal contained low concentrations of organic compounds, and metals. Minor concentrations of halogenated VOCs, BTEX compounds, SVOCs, and one pesticide were detected in the water samples. Trichloroethene, 1,1,1-trichloroethane, toluene, and three SVOCs were detected in a water sample collected at the west end of the City Drain Canal near the pump house. Benzene, toluene, total xylenes, and 2-methylnapthalene were detected in an upstream water sample collected near the culvert of the City Drain and the City Drain Canal. A downstream water sample collected near the oil/water separator at the eastern end of the City Drain Canal, near the base boundary, contained 1,1,1-trichloroethane, benzene, toluene, xylenes, three SVOCs, and the pesticide dieldrin. Some to all of the metals (arsenic, antimony, cadmium, selenium, copper, and nickel) were detected in the water samples.

Concentrations of one organic compound, one pesticide, and three metals in water exceeded human health criteria. The concentrations of benzene in canal water samples from the upstream and downstream locations exceeded the human health PRG. The pesticide dieldrin exceeded its PRG in the downstream water sample collected near the oil/water separator. Dieldrin has an extremely high bioconcentration factor in fish, indicating that this compound will bioaccumulate in aquatic organisms. The concentrations of arsenic and antimony exceeded their respective PRGs in the water sample collected near the pump house and the water sample collected near the oil/water separator. The concentration of arsenic also exceeded its PRG in the sample collected at the upstream location near the culvert. The concentration of cadmium exceeded its PRG in the sample collected near the pump house. Pathway completion in this medium is unlikely at the Base because this area is restricted to the public. There is a moderate

potential concern for downstream receptors due to possible incidental contact with surface water. However, downstream concentrations should be lower due to the natural processes of dilution, degradation, and uptake. Three metals and dieldrin exceeded ecological criteria for surface water in the City Drain Canal, indicating some potential concern for aquatic life.

6.10.1.3 City Drain Hydrology and Contamination Source

The main functions of City Drain are to de-water the shallow unconfined aquifer and convey storm/surface water runoff at the northern part of Salt Lake Valley. Therefore, the City Drain upstream of the Base could be impacted by the natural discharge of contaminated groundwater into the drain from the shallow aquifer or from contaminated surface water runoff. At the Base, the City Drain Canal acts as a sink for shallow groundwater flow. During the SI field effort, the inferred groundwater gradient and flow direction in the shallow aquifer was always toward the canal. However, groundwater contamination beneath nearby IRP sites (Sites, 3, 4, 5, and 7) does not appear to have impacted the canal based on the residence times, low organic contaminant concentrations, and groundwater flow velocities. Likewise, since shallow groundwater flow is toward the canal, contamination in the canal media does not appear to have adversely impacted the IRP sites.

The sources of sediment and water contamination in the City Drain Canal are not known. However, contamination of canal media at the Base is probably cumulative and appears to have been a "community effort". The primary origin of contamination may be from several upstream point sources and possibly from non-point sources. There may be several potential upstream contributors but specific upstream discharges to the City Drain were not researched or documented and were beyond the scope of this investigation.

6.11 GENERAL CONCLUSIONS

6.11.1 Soils

Shallow subsurface soils and sediments beneath the base IRP sites generally exhibit complex stratigraphy and a high degree of heterogeneity. The deposits are continuous to discontinuous silts, clays, organic silts, and sands extending below the shallow water table (5 feet to 8 feet BLS) to the maximum drilling depth of 20 feet BLS. Organic-rich silt is present near the water table in the shallow subsurface beneath most of the sites. The organic soil has a propensity to adsorb organic compounds.

The overall contamination of soil at the sites ranging from near surface sediments down to the fluctuating water table is minimal and is generally defined. Only one organic compound exceeded human health criteria; the PNA benzo(a)pyrene was slightly in excess of the most stringent human health PRG in one near-surface soil sample obtained from a soil boring at Site 5. The metals arsenic and beryllium were in excess of the most stringent human health PRGs for all soil samples analyzed for metals including the two background wells. However, the PRGs for arsenic and beryllium are impractically low. Elevated TRPH were present in soil samples from two soil borings at Site 7; however,

comparative risk criteria were not available for TRPH. Ecological criteria were not exceeded in soil at any of the sites preliminarily evaluated for risk. In conclusion, the risk to human health and the environment from contaminated soils at the sites is low, and any perceived risk from exceedence of comparative criteria in soils probably is overestimated because of the conservative risk assessment approach used. The fate and transport characteristics of the compounds exceeding human health criteria in soils are discussed in the following paragraphs.

6.11.1.1 Fate and Transport - Soil

The potential mobility of organic compounds in soil is related to the organic carbon partition coefficient (K_{oc}) of the compound and the amount of organic carbon in soil. The semivolatile compound benzo(a)pyrene is a high molecular weight PNA with a high K_{oc} and low volatility in soils. Due to its high molecular weight and high K_{oc}, the compound has a strong tendency to adsorb and resist movement through soil; therefore, it is not likely to leach into groundwater at Site 5. The fate and transport of the TRPH constituents is dependent on the properties of the individual constituents. Downward migration of TRPH constituents into soil and groundwater may be important. Under favorable conditions biodegradation is rapid. Hydrocarbon degradation is limited in environments with few degrading organisms, low pH, low air permeability and depleted oxygen, and high salinity (Oak Ridge National Laboratory, 1989). Based on the observed soil environment at Site 7, which has elevated TRPH, the biodegradation of TRPH may be limited. However, the potential for leaching at the site is mitigated by the asphalt surface and the TRPH appear to be immobilized in the clay and organic rich soils due to adsorption.

The metals arsenic and beryllium are persistent in soil and are not degraded. Environmental fate processes may transform arsenic into various forms. Soluble forms of arsenic tend to be quite mobile in water, while less soluble species adsorb to soil (ATSDR, 1991). Soils can contain arsenic as a result of adsorption onto clays, iron oxides, aluminum hydroxide, and organic material (Versar, 1979). In the upper reaches of the soil column, organic material typically dominates adsorption, while at greater depths, iron oxyhydroxides play the principal adsorptive role (Vance, 1995). Arsenic may also form sulfides and may be present as an element in sulfide ore deposits. In nature, beryllium is present in much greater concentrations in soils than in water (ATSDR, 1991). Beryllium is tightly adsorbed to most types of soils because it displaces divalent cations that share common sorption sites. Consequently, beryllium has limited mobility in soil and is not likely to leach to groundwater. Therefore, beryllium in soils at Sites 2, 4, and 7 is not likely to leach to groundwater. Although the soil concentrations of arsenic are low, the potential for leaching of arsenic to groundwater at these sites does exist based on its variable fate and transport characteristics. However, Sites 2, 4, and 7 are currently paved. The pavement should effectively impede the infiltration of water, and thus, the leaching of arsenic into groundwater at these sites.

6.11.2 Groundwater

The overall intrinsic quality of groundwater in the shallow aquifer at the Base appears to be poor. The mean TDS of groundwater samples obtained from 12 site monitoring wells in February 1993 was estimated from conversion of specific conductivity to be approximately 1,000 mg/L. The mean TDS of groundwater samples obtained from 17 site monitoring wells in August 1995 was estimated from conversion to be approximately 7,600 mg/L. The difference in specific conductance between these two measuring times may be partly due to the different sampling instruments used rather than actual physical difference. The mean field-measured pH of groundwater samples from wells were 7.8 and 7.9, respectively, for these dates. Groundwater samples were not analyzed for major cations and anions or other standard water quality parameters. Therefore, the baseline water quality of shallow groundwater at the base IRP sites has not been characterized. This may be necessary to determine the groundwater class for groundwater protection of the shallow unconfined aquifer at the Base (R317-6 of the Utah Administrative Code, 1994). There are no shallow domestic wells screened in the shallow unconfined aquifer within a 1-mile-radius of the Base.

The overall contamination of groundwater at the sites was low, with the exception of Sites 1 and 2. Concentrations of the VOCs tetrachloroethene, trichloroethene, 1,2-dichloroethene, and vinyl chloride exceeded water quality MCLs and the more stringent human health PRGs in downgradient groundwater at Sites 1 and 2. The SVOC bis(2-ethylhexyl)phthalate exceeded the water quality MCL as the most stringent human health criterion in downgradient groundwater at Site 7, but is thought to have been a sampling artifact. Arsenic exceeded its water quality MCL and the more stringent human health PRG at the metals sites; Sites 2, 4, and 7. Arsenic exceeded these criteria in both upgradient and downgradient groundwater at Site 7, and upgradient concentrations were higher. All 17 monitoring wells (metals sites, non-metals sites, and background wells) were analyzed for arsenic in the second sampling event to provide information on the background concentrations of this metal, and arsenic concentrations exceeded MCLs at 11 of the wells. Based on these results, arsenic appears to be indigenous to shallow groundwater at the Base. In conclusion, the overall risk to human health and the environment from contaminated groundwater at the sites is low, and the apparent risk from exceedence of comparative criteria in groundwater probably is overestimated because of the conservative risk assessment approach used. Ecological criteria were not evaluated for groundwater. The fate and transport characteristics of the compounds exceeding human health and/or water quality criteria in groundwater are discussed in the following paragraphs.

6.11.2.1 Fate and Transport - Groundwater

The mobility of compounds in groundwater is controlled by the processes of advection, dispersion, diffusion, and retardation. Advection is the actual velocity of groundwater flow. Dispersion, diffusion, and retardation affect the pattern and velocity of solute movement in relation to advection. Hence, the rate of migration of a particular

compound may be less than or greater than advection only. Generally, migration is slower than advection due to retardation. Retardation in soil/groundwater systems is related to the distribution coefficient (K_d) for the solute within the soil. Potential solutes in groundwater have a wide range of soil-solute specific distribution coefficients. The K_d for an organic compound in a soil is merely the K_{oc} for that compound times the percent organic carbon in the soil. Therefore, organic soils retard the migration of organic compounds with higher K_{oc}s. Because of large surface areas and numerous ion-exchange sites, clays have the largest K_d values for specific inorganic solutes. Cations are more strongly absorbed than anions. A particular organic compound or metal's rate of migration is slower with larger values of K_d due to retardation.

The fate and transport of organic compounds or metals that exceeded MCLs and PRGs in groundwater at the sites cannot be quantified due to insufficient data, but can be qualified based on the chemical properties of the confirmed analytes and observed aquifer properties.

The VOCs tetrachloroethene and trichloroethene detected in Site 1 and Site 2 groundwater are both moderately mobile in groundwater. They are only slightly soluble and have low K_{oc}s. Since both of these compounds are only somewhat soluble in water and are substantially denser, they tend to sink to the bottom of the aquifer when they occur as a separate free-phase (Howard, 1990). However, the concentrations of these compounds detected in site groundwater are indicative of dissolved phase. Due to the low K_{oc}s of the compounds, retardation is not an important factor affecting migration. Vertical migration (in the short term and in a homogeneous soil) from a point release may be more significant than lateral migration because of the high specific gravity of these compounds. The rates of biodegradation of these compounds depend on environmental conditions. Under both aerobic and anaerobic pathways these compounds undergo progressive dehalogenation, and will ultimately degrade to innocuous carbon dioxide, water, and chloride ions depending on the environmental conditions (Dragun, 1988). Tetrachloroethene and trichloroethene have half-lives in groundwater ranging from 10.7 months to 4.5 years (Howard, et al., 1991). The residence time of these compounds in site groundwater is unknown. Based on the fate and transport characteristics of these compounds and the relatively low rate of groundwater flow at Sites 1 and 2, the lateral migration of these spill-related compounds in site groundwater is expected to be limited. The vertical migration of these compounds at Site 2 would be impeded by the presence of a clay confining layer that subtends the shallow aquifer.

The VOCs 1,2-dichloroethene and vinyl chloride detected in Site 1 and 2 groundwater are likely degradation daughter products derived from the dehalogenation of trichloroethene, and much of the trichloroethene is probably degraded tetrachloroethene. Based on the constituents detected in site groundwater and their concentrations, trichloroethene has degraded to 1,2-Dichloroethene and 1,2-Dichloroethene has then degraded to 1,2-dichloroethane and/or vinyl chloride. The half-life of 1,2-dichloroethene in groundwater is 56 to 132 days and the half-life of vinyl chloride is 2 months to 7.9 years (Howard, et al., 1991). Both 1,2-Dichloroethene and vinyl chloride are more

mobile in soil/groundwater systems than tetrachloroethene and trichloroethene; these compounds have lower K_{oc}s, are more soluble, and have lower specific gravities. However, the migration of 1,2-dichloroethene and vinyl chloride in groundwater should be limited by the relatively low rate of groundwater flow at these sites.

The SVOC bis(2-ethylhexyl)phthalate detected in downgradient groundwater at Site 7 is only slightly mobile in groundwater. This compound is non-soluble and has a relatively higher K_{oc}. Therefore, it has a strong tendency to adsorb to soil, suggesting retardation in soil/groundwater at the site may be important. The upper one-third of sediment in the saturated zone at Site 7 appears to have high organic content. The lower two-thirds is granitic sand with abundant quartz. The abundance of quartz (silica) in the sand limits retardation (Fetter, 1988). Biodegradation of the compound is slight. Howard et al. (1991) report a half-life in groundwater of 10 days to 1 year for this compound. Based on the fate and transport characteristics of bis(2-ethylhexyl)phthalate and the relatively low rate of groundwater flow at Site 7, migration of this compound should be limited.

Arsenic was detected in groundwater at Sites 1, 2, 4, 6, and 7, and a background well at concentrations above its MCL and most stringent human health PRG. Elemental arsenic is extremely persistent in groundwater and is not degraded; however, environmental processes transform arsenic into mobile and immobile forms. Toxicities of the various forms of arsenic can be expected to be different. The mobility of arsenic is usually controlled by redox reactions, pH, biological activity, and adsorption/desorption reactions (Vance, 1995). The most commonly recognized adsorption reactions involve ion exchange between charged adsorption sites (clays) and charged soluble ions. Stable soluble forms are the high oxidation state arsenate oxyanions. In the presence of ferric iron, arsenate is immobilized in groundwater under normal pH and oxidizing conditions (Vance, 1995). However, arsenic adsorbed to ferric hydroxides in sediment can be released from the geologic substrate when exposed to groundwater that is chemically reducing. If reduced, arsenic can be quite mobile. The presence of iron in groundwater at the Base and reliable redox potential have not been determined.

Dissolved arsenic in groundwater beneath the Base may be derived from the weathering of granitic igneous rocks of the Wasatch Range and probably results from the deltaic deposition of these metal-bearing sediments and subsequent adsorption/desorption reactions. Also, possible sources of arsenic contamination such as metal ore concentrating processes and pesticides may be impacting shallow groundwater in the regional area of the Base. Mine tailings are prevalent in Salt Lake Valley. Arsenic, as a component of particular pesticides, may enter streams and groundwater through waste disposal or through non-point source agricultural drainage (Hem, 1985). Elevated concentrations of arsenic have been detected in groundwater in the northern part of Salt Lake Valley, primarily south and west of the Base and SLCIA (USGS, 1983; and USGS, 1992).

6.11.3 Hydrogeology

The hydrostratigraphic units in the vicinity of the Base consist of an approximately 20-foot-thick (beneath and to the east of the Base) to 50-foot-thick (west of the Base) shallow unconfined aquifer, confining layer, and a deeper confined aquifer system that is used for groundwater production. The confining layer that separates the shallow and deeper aquifers is comprised of a 50- to 60-foot-thick sequence of interbedded fine-grained sediments. In the regional area of the Base, the potentiometric surface (total hydraulic head) in the confined aquifer system is higher than the hydraulic head in the shallow aquifer. This indicates an upward leaking hydraulic gradient through the confining layer from the confined aquifer(s) to the shallow aquifer. Therefore, the susceptibility of the confined aquifer system being impacted by downward migration of contamination through the confining layer from the shallow aquifer is very low.

The shallow aquifer beneath the Base exhibits a high degree of heterogeneity in aquifer properties with a difference in minimum and maximum hydraulic conductivity values of over two orders of magnitude. This variability in the hydraulic conductivity could effect contaminant migration rates. The hydraulic conductivity of the aquifer and hydraulic gradient are significantly higher at the north end of the Base, north of the City Drain Canal. At this northern portion of the Base the aquifer media is a coarse granitic sand. Consequently, the advective rate of contaminant migration is expected to be greater. The hydraulic conductivity and hydraulic gradient are relatively low south of the City Drain Canal. At this portion of the Base the aquifer media is primarily a clay with intercalated sand and silt, and the advective rate of contaminant migration is expected to be less. The rate of contaminant migration also would be affected by dispersion, diffusion, retardation, and biodegradation. The general abundance of native organic material in the soil/groundwater system should impede the migration of contaminants with higher organic carbon partition coefficients.

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SECTION 7
RECOMMENDATIONS

7.1 INTRODUCTION

This section presents the recommendations of the SI on a site-specific and general basis. Site-specific recommendations for Sites 1 through 7 and Site 10 are presented in Subsections 7.2 through 7.9. Recommendations concerning contaminated media in the City Drain Canal are made in Subsection 7.10. A comprehensive water quality recommendation is given in Subsection 7.11. A summary of the conclusions and recommendations is contained in Subsection 7.12.

7.2 SITE 1 - FORMER PESTICIDE DUMP

7.2.3 Recommendations

Based on the results of the pesticides/PCBs data, risk evaluation, and hydrogeological conditions at the site, a no further action decision is recommended for Site 1 pertaining to pesticides. However, the Site 1 area should be considered for further investigation of a potential source of chlorinated VOCs in groundwater.

7.3 SITE 2 - WASTE POL FUEL SPILL

7.3.2 Recommendations

An RI/FS is recommended to further characterize groundwater contamination at Site 2. The following actions should be performed as a site RI/FS.

- Identify a potential remedial method concept based on existing site data in the event that remediation becomes necessary. Conduct additional RI/FS activities to support the selection of the identified remedial method.
- Further define the geometric extent of groundwater contamination.
- Analyze sampled media for additional specific protocol parameters so that the fate and transport of the groundwater contaminants can be modeled.
- Perform aquifer tests for hydraulic conductivity at additional monitoring wells and use downhole flow velocity meters to evaluate the vertical distribution of hydraulic conductivity.
- Further define seasonal flow patterns and hydraulic gradients.

- Further identify potential receptors based on the RI/FS characterization and assess the potential impacts of groundwater contamination on receptors.
- Based on the results of additional soil and groundwater data, re-evaluate and/or refine the identified remedial method and conceptual model and develop alternatives for remediation if necessary. Since the degradation or chlorinated VOCs appears to be occurring at the site, the risk is low, and time is not critical, additional site characterization should include the evaluation of intrinsic remediation as a viable alternative.

In addition to the above RI/FS activities, the following action should be initiated.

- Limit construction activities at the site and do not remove existing pavement to prevent direct human contact with contaminated shallow subsurface soils/groundwater and to mitigate infiltration and the potential leaching of soil contaminants to groundwater.

7.4 SITE 3 - DRUM BURIAL LOCATIONS

7.4.2 Recommendations

Based on the results of the analytical data, risk evaluation, and hydrogeological conditions at the site, a no-further-action decision document is warranted for Site 3. The following recommendations should be considered to support a DD:

- Sample the upgradient site monitoring well once more to confirm that concentrations of groundwater contamination migrating on-site form and off-site source are continuing to diminish.

If concentrations increase or exceed human health criteria, alternatives should be evaluated to abate and mitigate the further on-site migration of groundwater contamination.

7.5 SITE 4 - FIRE TRAINING AREA 1

7.5.2 Recommendations

Based on the results of the analytical data, risk evaluation, and hydrogeological conditions at the site, a no-further-action decision document is recommended for Site 4. However, the following action should be initiated.

- Limit construction activities at the site and do not remove existing pavement to prevent direct human contact with contaminated shallow subsurface soils and to mitigate infiltration and the potential leaching of soil contaminants to groundwater.

7.6 SITE 5 - FIRE TRAINING AREA 2

7.6.2 Recommendations

Based on the results of the analytical data, risk evaluation, and hydrogeological conditions at the site, a no-further-action decision document is recommended for Site 5.

7.7 SITE 6 - RAMP WASHDOWN

7.7.2 Recommendations

Due to only minor organic contamination in soil and groundwater at the site and the non-exceedance of human health or ecological risk-based criteria, a no-further-action decision document is recommended for Site 6.

7.8 SITE-7 - OIL SLUDGE POND

7.8.2 Recommendations

Based on the results of the analytical data, risk evaluation, and hydrogeological conditions at the site, a no-further-action decision document is warranted for Site 7. However, the following action should be initiated:

- Limit construction activities at the site and do not remove existing pavement to prevent direct human contact with contaminated shallow subsurface soils and to mitigate infiltration and the potential leaching of soil contaminants (primarily TRPH) to groundwater.

In addition, the following recommendation should be considered concerning TRPH.

- Evaluate alternatives for the remediation of elevated TRPH in site soils if deemed necessary by the regulatory agencies. In Utah, TRPH is evaluated on a case-by-case basis. Alternatives may include bioventing or excavation and removal. Specific field and laboratory tests would have to be conducted on site soil to determine the feasibility of "in-situ" bioremediation as a viable alternative.

7.9 SITE 10 - POL FACILITY

7.9.2 Recommendations

There are no recommendations concerning this site since investigation of the site is being completed under an RI phase by a different contractor.

7.10 CITY DRAIN CANAL

7.10.2 Recommendations

Sampling of canal media was included in the basewide activities; the objective was to evaluate the chemical and physical relationships between canal media and the soil and groundwater at IRP sites. Based on the apparent lack of connection between contamination of the canal media and contamination beneath the IRP sites, no further

characterization of the sediment and surface water in the canal is recommended. However, moderate health and ecological risk associated with the confirmed contamination in these canal media should be recognized and considered by Base and SLCAA personnel.

7.11 COMPREHENSIVE RECOMMENDATION

The following recommendation is made for further basewide action prior to, or during, an RI/FS phase:

- Evaluate water quality for groundwater classification and protection levels by establishing the baseline water quality and TDS of groundwater in the shallow aquifer. This would be accomplished by sampling all existing site monitoring wells and analyzing for major cations and anions and other standard water quality parameters. In addition, the redox potential and dissolved oxygen content of the groundwater should be accurately measured.

7.12 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Overall, soil contamination was minor at the Sites and poses a low threat to human health or the environment. The lateral extent of organic compound contamination in soil was generally defined at all of the sites.

The presence or absence of contamination in groundwater at all of the sites was confirmed. Groundwater contamination at the Sites was minor, with the exception of Sites 1 and 2. Based on risk, groundwater beneath all the Sites (including Sites 1 and 2) poses a low threat to human health or the environment. Solvent-related VOCs were present in groundwater at Sites 1 and 2 at concentrations in excess of MCLs and/or PRGs. However, the presence of natural degradation daughter products in groundwater indicates that intrinsic remediation of the chlorinated solvents is occurring at these sites. An upgradient source of groundwater contamination is indicated for Site 3. The concentration of 1,4-dichlorobenzene in upgradient groundwater at Site 3 slightly exceeded the most stringent human health PRG for both the 1993 and 1995 sampling events. However, the concentrations of 1, 4-dichlorobenzene and other low concentration constituents diminished between sampling events. In 1995, no analytes were detected in downgradient groundwater at Site 3. The concentration of bis(2-ethylhexyl) phthalate exceeded the MCL in downgradient groundwater at Site 7 for the 1993 sampling event. The MCL was the most stringent human health criterion for this SVOC. This common sampling artifact was not detected in groundwater in 1995 indicating that it may have been a sampling artifact or lab contaminant when detected in 1993.

Elevated concentrations of dissolved arsenic were found to be essentially ubiquitous in shallow groundwater at the Base. Arsenic appears to be indigenous to the aquifer matrix.

Soil leaching appears to be limited at the Sites due to a high clay and native organic silt content in shallow subsurface soils. Infiltration and potential leaching also should be

effectively impeded by the asphalt and/or concrete paving present at Sites 2, 4, and 7. The lateral migration of contaminants in groundwater at Sites 1, 2, 4, 6, and 7 is limited by the hydraulic properties of the shallow aquifer. The groundwater flow rate at Site 3 is relatively high based on the hydraulic properties of the shallow aquifer. However, natural attenuation of the low concentration contaminants should occur through the processes of advection, dispersion, diffusion, and degradation before potential receptors are impacted. The vertical migration of groundwater contamination at all of the Sites is impeded by the presence of a significant clay layer that underlies the shallow aquifer.

The Site 1 area should be considered for further investigation of a potential source of chlorinated VOCs in groundwater. No further action is recommended concerning pesticides at this site.

Based on the analytical results, risk assessment, and hydrogeological conditions at Sites 3, 4, 5, 6, and 7, no-further-action decision documents are recommended for these sites.

The performance of an RI/FS is recommended for Site 2.

Construction activities should be limited in the future at Sites 2, 4, and 7 to prevent human contact with contaminated soils and/or groundwater at these sites and to mitigate potential leaching. Construction activities at Sites 3, 5, and 6 should be curtailed until decision documents have been published and approved. However, construction activities at IRP sites at any time in the future should be conducted with consideration to the potential risk (confirmed and unforeseen) associated with the sites.

Contamination of surface water and sediment in the City Drain Canal was detected in excess of human health PRGs and ecological criteria for several chemicals and the moderate health and ecological risk associated with the canal media should be considered by Base and SLCAA personnel. Apparent upstream point-sources and non-point-sources of contamination have impacted canal media. Groundwater contamination beneath the IRP sites does not appear to have reached the canal based on data obtained during the SI. Further characterization of City Drain Canal contamination is not recommended.

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SECTION 8
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