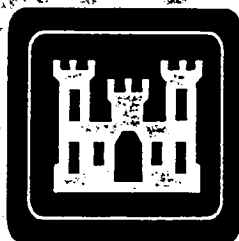

FINAL
USACE/OR/DACA62-1041

GROUNDWATER CHARACTERIZATION REPORT OF 1997 BASELINE DATA FOR THE HAZELWOOD INTERIM STORAGE SITE (HISS)

ST. LOUIS, MISSOURI

JUNE 1998



U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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prepared by

U.S. Army Corps of Engineers, St. Louis District Office, Formerly Utilized Sites Remedial Action Program

with technical assistance from

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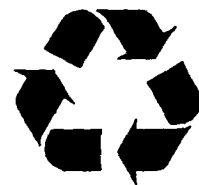


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LIST OF ACRONYMS

bgl	- below grade level
bgs	- below ground surface
BNI	- Bechtel National, Inc.
1,2-DCE	- 1,2-dichloroethene
ha	- hectares
HISS	- Hazelwood Interim Storage Site
MCL	- maximum contaminant level
MDNR	- Missouri Department of Natural Resources
meq/l	- milliequivalents per liter
mg/l	- milligrams per liter
pCi/l	- picocurie per liter
PCOC	- potential constituents of concern
RI	- remedial investigation
SAIC	- Science Applications International Corporation
SLAPS	- St. Louis Airport Site
SMCL	- secondary maximum contaminant level
SVOC	- semi-volatile organic compound
TCE	- trichloroethene
TDS	- total dissolved solids
TWG	- technical working group
µg/l	- micrograms per liter
USACE	- United States Army Corps of Engineers
USEPA	- United States Environmental Protection Agency
VOC	- volatile organic compound

1.0 INTRODUCTION

1.1 Purpose and Scope

This report has been prepared by Science Applications International Corporation (SAIC) to present the findings and interpretations of groundwater conditions at the Hazelwood Interim Storage Site (HISS), based on the 1997 baseline sampling and data collection effort. This new information is used in tandem with existing site hydrogeologic information to interpret site groundwater flow conditions, identify the distribution of potential constituents of concern (PCOCs), and compare the analytical data to regulatory and estimated background levels. The baseline groundwater sampling effort was performed by Bechtel National, Inc. (BNI) in July, August, and September 1997. This effort represented a comprehensive baseline sampling event for radiological and nonradiological constituents, and was a result of recommendations made by the groundwater Technical Working Group (TWG) associated with the site. The task and procedures of the sampling work and other site-related tasks were described in a September 1997 report entitled "Abbreviated Plan for Providing Baseline Sampling and Data Collection for Surface Water and Groundwater at the St. Louis Airport Site and the Hazelwood Interim Storage Site, St. Louis Missouri" (SAIC, 1997). The complete set of field and laboratory data of this sampling event has been provided to the United States Army Corps of Engineers (USACE) by BNI as a separate document.

A brief description of the site setting and previous groundwater sampling work is included in the remaining part of Chapter 1.0. The monitoring well network at HISS is discussed in Chapter 2.0. Chapter 3.0 contains an evaluation of potentiometric (groundwater surface) and groundwater chemistry data to identify groundwater regimes at HISS. The occurrence and distribution of radiological and nonradiological PCOCs in site groundwater, as well as a comparison of the 1997 baseline data to historical data, are contained in Chapter 4.0. An evaluation of compliance with the abbreviated sampling plan requirements for the recent groundwater sampling work is contained in Chapter 5.0. Conclusions regarding the hydrogeology and groundwater chemistry conditions at HISS are included in Chapter 6.0.

1.2 Site Setting

The HISS is located approximately one mile north of the St. Louis Airport at 9200 Latty Avenue (Figure 1-1). This 3.2 hectares (ha) (8 acres) site is near various industrial properties and is bounded to the north by Latty Avenue, to the east by Stone Container Company, to the south by an unoccupied field, and to the west by Futura Industries. Two large piles of covered contaminated soil occupy the central portion of HISS. The site is surrounded by security fencing. Coldwater Creek is located about 400 feet west of the site. The St. Louis Airport Site (SLAPS) is located approximately 0.75 mile to the south of HISS.

1.3 Previous Work

A total of 21 groundwater monitoring wells have been installed at HISS. These wells were installed in the time period of 1979 to 1992. Groundwater samples were collected from these wells during the same years. In the early 1990s, groundwater samples were collected from three or four wells at the site on an annual or quarterly (every three months) basis. Eighteen monitoring wells existed at HISS during the baseline sampling event. The 1997 baseline groundwater sampling event was the most comprehensive groundwater monitoring program conducted at the site.

Results of previous groundwater sampling efforts have been presented in various reports. A remedial investigation report (RI) was issued by BNI in 1994. The work was performed to determine the nature and extent of contamination in soil and groundwater, and to characterize the geologic and hydrogeologic features of HISS. Analytical results for radiological and chemical characterization surveys at HISS are summarized in the RI report and RI addendum, prepared by SAIC in 1995.

2.0 REVIEW OF MONITORING WELL NETWORK

The groundwater monitoring well network at HISS was reviewed and assessed to determine the composition of the monitoring well system and to identify its adequacy to monitor the identified groundwater zones beneath the site. HISS has had 20 wells completed in the upper stratigraphic units (less than 32 feet below ground surface [bgs]) and one deep well completed in the deep stratigraphic units. Three wells (HISS-3, HISS-4, and HISS-8) were closed in 1992, and two additional wells (HISS-2 and HISS-12) were closed in April 1998 after the 1997 baseline sampling event. The locations of the monitoring wells at HISS are shown on Figure 2-1. The boring logs and well construction records were not available for wells HISS-1 to HISS-8. A summary of the available well information is provided in Table 2-1.

The generalized stratigraphy beneath HISS is presented on Figure 2-2. The site stratigraphy is interpreted to be similar to the stratigraphy beneath SLAPS (SAIC, 1998). The stratigraphic profile is interpreted to consist of an upper loess zone (Unit 2) underlain by a clayey silt and clay zone (Unit 3). Beneath the clay zone is a clayey sand and gravel (Unit 4) on top of limestone bedrock (Unit 6). The Cherokee Shale bedrock (Unit 5) is interpreted to be absent beneath HISS. A continuous surficial fill layer (designated as Unit 1 at SLAPS) appears absent at HISS.

Monitoring wells HISS-1 through HISS-20 are or were completed to depths less than 32 feet below grade level (bgl). These intervals, based on boring logs available for HISS-9 through HISS-15, appear consistent with the stratigraphic Units 2 and 3T identified at SLAPS. These units are interpreted to have low hydraulic conductivity values (10^{-4} to 10^{-8} centimeters per second) as determined to occur at SLAPS (SAIC, 1998). No rubble or fill were identified on these boring logs. These shallow wells are completed in the upper hydrostratigraphic zone.

Monitoring well HISS-5D, the deepest on-site well, was drilled to a total depth of 97 feet bgl. The boring for this well encountered greenish-gray to olive-gray, medium, stiff, high plasticity clay from 50 to 82 feet bgl. This interval is interpreted to be the 3M unit found beneath SLAPS. A silty sand and gravel zone (Unit 4) was encountered from 89 to 95 feet bgs in this well. Well HISS-5D encountered limestone bedrock at a depth of 95 feet bgs. Well HISS-5D is exposed to the lower hydrostratigraphic zone at a depth of 87 to 97 feet bgl (Table 2-1). No wells are exposed to the bedrock beneath HISS.

Based on available site information and an understanding of the hydrogeologic setting at SLAPS, three main hydrostratigraphic zones are interpreted to occur in the non-lithified material beneath HISS. The upper hydrostratigraphic zone consists of Unit 2 and the top portion of Unit 3 (3T). The middle part of Unit 3 (plastic clay of 3M) forms the middle hydrostratigraphic zone and is interpreted to act as an aquitard. The lower hydrostratigraphic zone beneath the 3M unit is believed to consist of Units 3B (bottom of Unit 3) (clayey silt) and Unit 4 (clayey gravel). The underlying limestone bedrock probably exists as a separate hydrostratigraphic zone.

3.0 EVALUATION OF GROUNDWATER REGIMES

The groundwater regimes and their flow patterns at HISS are evaluated based on various hydrogeologic information including their potentiometric surface and groundwater chemistry. The chemical parameters evaluated in this section are principally naturally occurring cations and anions.

3.1 Potentiometric Surface

Potentiometric surface elevation data of June and September 1997, as collected and determined by BNI, are provided in Table 3-1. The depth to groundwater ranged between about 5 and 15 feet bgl in September 1997. The top of the saturated zone occurs in the low conductivity silts and clays of stratigraphic Units 2 and 3T. The potentiometric surface configuration of the upper zone groundwater using the September 1997 data is illustrated on Figure 3-1. A near-radial potentiometric surface contour pattern is interpreted at HISS. Groundwater data from the late 1980s and early 1990s also indicate a radial contour pattern. Wells HISS-1 and HISS-5 near the center of the site have the highest potentiometric surface with decreased surrounding groundwater elevations. This groundwater mound may be partially caused by perched saturated conditions. The groundwater surface elevation declines approximately 10 feet from well HISS-1 to well HISS-12 at the southern part of the site, and to a similar extent north of the site as observed in well HISS-18S. The potentiometric surface elevation directly west of the groundwater mound is unknown due to the absence of wells in this area. The area of central groundwater mound corresponds to a low wet area on the ground surface which collects some surface water runoff from the main covered soil pile. An average hydraulic gradient of about 0.015 existed in the upper zone using the September 1997 data. Groundwater movement is interpreted to be minimal in the upper zone materials.

Based on the September 1997 data, a vertical hydraulic head differential of 3.8 feet was measured at well cluster HISS-5/HISS-5D. A higher piezometric surface was measured in shallow well HISS-5, which indicates a downward vertical gradient potential at this location. The direction of groundwater movement in the lower zone is unknown based on available data.

3.2 Analysis of Groundwater Chemistry

Results of an aqueous mass balance comparison of major cations and anions that distinguish the dominant groundwater chemical constituents and illustrate the differing groundwater quality in the upper hydrostratigraphic zone and the lower hydrostratigraphic zone are contained in this section. Additionally, an analysis of nitrate-nitrogen, selenium, arsenic, and tritium concentrations in groundwater is performed to evaluate the hydrostratigraphic zones. These determinations were made based on a series of groundwater quality trend analyses conducted on the 1997 groundwater data for HISS. As previously explained in Section 2.0, the shallow wells that are completed above the 3M subunit are considered in the upper hydrostratigraphic zone, and well HISS-5D which is completed below the 3M subunit is considered in the lower hydrostratigraphic zone.

The concentrations of major dissolved cation and anion species present in groundwater samples from HISS are plotted on Figure 3-2. The cationic parameters include potassium (K) + sodium (Na), calcium (Ca), magnesium (Mg), and iron (Fe). The anionic parameters include chloride (Cl), alkalinity ($\text{HCO}_3 + \text{CO}_3$), sulfate (SO_4), and nitrate (NO_3). Aqueous concentrations are plotted in milliequivalents per liter (meq/l) to show sample composition relative to charge balances and the dominant constituents. The resulting graphic configuration (stiff diagrams) characterizes groundwater chemistry at each well location.

The stiff diagrams of the upper and lower zone groundwater samples from the 1997 baseline sampling are shown on Figure 3-2. The data for each sample were examined for charge balance based on the suite of major cation and anion concentrations. Overall, the determined cation/anion ratios range between 1.0 and 1.2 in all groundwater samples except for two well locations at HISS. It was decided that the groundwater quality data should be presented in its entirety to ensure thorough evaluation of data from all well locations, regardless of the degree of sample charge balance. An imbalance may suggest a change in the chemical composition of the groundwater due to some impact. The charge balance analysis for the HISS groundwater samples is provided in Table 3-2.

3.2.1 Upper Hydrostratigraphic Zone

The chemical character of groundwater in the upper zone is variable and cannot be characterized into an average overall composition. The complex nature of groundwater chemistry in this zone is apparently due to impacts to the upper zone from waste storage and other surficial activities.

The red-colored stiff diagrams on Figure 3-2 show the major cation and anion configuration for groundwater collected from wells completed in the upper zone. The overall basic cation and anion balance is shown for six wells as light red diagrams, such as for wells HISS-9 and HISS-18. The remaining upper zone wells (shown in dark red), such as wells HISS-1 and HISS-16, can be categorized as having some level of impact to water quality, either elevated sulfates, elevated calcium and nitrate, elevated sodium and chloride, or a combination of these parameters.

The most distinct upper zone groundwater characteristic is the elevated concentrations of calcium and nitrate. This pattern is typically correlated to high relative total dissolved solids (TDS) concentrations. The cause of this groundwater quality may be related to the release of nitric acid waste products that were neutralized by limestone or dolomite as part of the former off-site ore processing.

3.2.2 Lower Hydrostratigraphic Zone

The chemical character of groundwater collected from the one lower zone well (HISS-5D) at HISS is shown as the blue-colored diagram on Figure 3-2. The cation configuration reflects

moderate concentrations of calcium with lower concentrations of potassium and sodium, magnesium, and iron. The dominant major anionic component is alkalinity. Sulfate and chloride are present at low concentrations. Nitrate was not detected in lower zone groundwater from well HISS-5D. Arsenic was detected at 37 micrograms per liter ($\mu\text{g/l}$) in the lower zone well. The character of groundwater in well HISS-5D is very similar to the average lower zone groundwater composition at SLAPS. The cation/anion relationships are nearly identical with a slightly higher TDS concentration at HISS.

The chemical character of groundwater in the lower hydrostratigraphic zone is also presented on a tri-linear plot of cations ($\text{Ca} + \text{Mg}$; $\text{Na} + \text{K}$) and anions ($\text{SO}_4 + \text{Cl}$; $\text{HCO}_3 + \text{CO}_3$) in all samples collected during the 1997 baseline sampling event. Shown in blue on Figure 3-3 are data from well HISS-5D of the lower zone.

3.2.3 Comparison of Upper Zone and Lower Zone Groundwater Chemistry

The difference between groundwater chemistry in the upper zone and lower zone at HISS is shown on Figure 3-3, a tri-linear plot of relative cation and anion concentrations. Wells completed in the upper zone (shown in red) plot as general clusters of anionic parameters. The distribution of cation and anion concentrations for well HISS-5D completed in the lower zone (shown in blue) is separated from the upper zone clusters.

The difference in upper and lower zone water quality is also presented on Figure 3-4, which show histograms of groundwater sample frequency versus groundwater sample concentration for nitrate-nitrogen, selenium, and arsenic. The vertical bars represent the number of samples included in the range of concentrations shown for each parameter and are color coded to indicate the groundwater source (upper or lower zone). The groundwater sample from the lower zone contained non-detectable concentrations of nitrate-nitrogen and selenium. Groundwater samples from the upper zone contained elevated concentrations of both parameters (exceeding 700 milligrams per liter [mg/l] of nitrate-nitrogen and exceeding 350 $\mu\text{g/l}$ of selenium). The absence of these parameters in the lower zone indicates limited downward migration from the upper zone, likely due to a barrier (3M unit) to vertical groundwater flow.

Arsenic concentrations above 30 $\mu\text{g/l}$ were only detected in groundwater collected from well HISS-5D, the only lower zone well, and a single upper zone well (HISS-19S) (Figure 3-4). The relatively high arsenic concentration detected in well HISS-19S (144 $\mu\text{g/l}$) appears anomalous compared to other upper zone groundwater quality data. The presence of arsenic in groundwater at HISS is likely related to natural conditions.

Additional evidence supporting the existence of distinct upper and lower hydrostratigraphic zones are the tritium data collected from five well locations at HISS. Tritium was detected in groundwater samples from four upper zone wells (HISS-13, HISS-15, HISS-17S, and HISS-20S) and one lower zone well (HISS-5D) ranging between 0.08 picocurie per liter (pCi/l) and 139 pCi/l . The lower zone sample contained the lowest tritium value of 0.08 pCi/l . The

upper zone samples contained tritium concentrations ranging from 30.5 to 139 pCi/l with the highest value in well HISS-17S.

Tritium is a Hydrogen-3 isotope with a half-life of 12.3 years. It is produced in the atmosphere by natural processes and is brought to the earth's surface by precipitation. Additional tritium was introduced into the atmosphere during nuclear weapons testing in the 1950s and 1960s. Sufficient tritium was added to the global water cycle to make pre-1950 water distinguishable from post-1950 water. Higher concentrations of tritium are indicative of relatively young water which has not had as much time to allow for tritium decay. Lower concentrations of tritium may be indicative of relatively older water that has undergone longer residence times, greater amounts of tritium decay, or has not received tritium from man-made sources. Tritium concentrations of two or more orders of magnitude exist between upper zone and lower zone groundwater samples at HISS. These results indicated that groundwater in the upper zone is recent (less than 50 years old) and the groundwater in the lower zone is older (at least 50 years). Rapid water recharge to the upper zone is evident with this data. The varied tritium concentrations also suggest no or limited hydraulic communication between the hydrostratigraphic zones. More uniform tritium concentrations would be expected to exist if significant groundwater mixing between zones was occurring.

3.2.4 Summary

Based on the 1997 baseline groundwater chemical analyses, the upper and lower hydrostratigraphic groundwater zones in the non-lithified material beneath HISS have distinct groundwater chemistry. These zones appear to have negligible hydraulic communication and are interpreted to be separated by the 3M aquitard unit and/or other low conductivity units beneath HISS. Groundwater in the upper zone is mainly characterized by high calcium and nitrate or high sodium/potassium and chloride concentrations, as well as relatively high tritium concentrations. Groundwater in the lower zone is characterized by a high alkalinity signature with low relative concentrations of sulfate, chloride, and tritium; the absence of detectable nitrate-nitrogen and selenium; and elevated arsenic.

The lower zone groundwater data of 1997 do not indicate impacts from upper zone groundwater or site-related activities. Nitrate-nitrogen and selenium concentrations in groundwater at HISS indicate that localized groundwater impact appears limited to the upper zone. Although elevated arsenic is present in the lower zone groundwater at HISS, it is probably indigenous to the native substrate and occurs at natural background concentrations as determined for SLAPS (SAIC, 1998).

4.0 OCCURRENCE OF GROUNDWATER CONTAMINANTS

The type, occurrence, and distribution of groundwater contaminants at HISS are identified and evaluated in this section. Constituents that are known or suspected to occur in groundwater at HISS based on historical information and groundwater data are initially considered to be analytes of interest. An assessment to determine PCOCs in site groundwater is then made based mainly on their detection in historical groundwater data. The occurrence and distribution of the determined PCOCs is discussed using the 1997 baseline data. A comparison of the PCOCs to historical groundwater data is also presented to help define any changes to chemical concentrations in site groundwater occurring over time.

4.1 Potential Constituents of Concern

4.1.1 Radionuclides

Various radionuclides and their daughter products were associated with HISS waste storage and handling activities. The radionuclides identified in Table 4-1 were consistently part of historic groundwater analyses and are identified as analytes of interest. The following radioisotopes were analyzed in collected groundwater samples: total uranium, actinium-227, thorium-227, thorium-228, thorium-230, thorium-232, protactinium-231, radium-226, radium-228, and lead-210. These radionuclides were chosen because of their potential presence in the former ore processing material or in the generated waste stored at HISS from SLAPS.

Radionuclide PCOCs are identified based on detections in groundwater and exceedances of regulatory action and/or estimated background levels. Total uranium is a PCOC since it has consistently exceeded its United States Environmental Protection Agency (USEPA) maximum contaminant level (MCL) in groundwater at numerous well locations. Radium-226 and thorium-230 may be considered PCOCs due to their historical detection in site groundwater with an occasional background exceedance; however, the detected concentrations of these two radionuclides for the last several years have been below the MCL for radium and estimated background values for both radionuclides. Therefore, only total uranium is considered a PCOC in this report. Total uranium and its associated regulatory action level and estimated background value are provided in Table 4-2.

4.1.2 Non-Radionuclides

The same suite of metals and inorganics identified as analytes of interest at SLAPS are used for HISS. The following inorganics have been included as analytes of interest due to their presence in the uranium ore processing and associated waste streams and residues: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, nitrate, potassium, selenium, silver, sodium, sulfate, vanadium, and zinc (Table 4-1).

Based on previous detections in existing groundwater analytical data and current regulatory action levels, the metals of interest were reduced to the following elements: aluminum, arsenic, barium, calcium, chromium, iron, manganese, nitrate, and selenium. Aluminum, calcium, and iron were eliminated as PCOCs due to their natural background presence in both the upper and lower hydrostratigraphic zones. Arsenic, barium, and chromium were detected historically at interpreted natural background concentrations below their MCLs. Based on historical data, the concentrations of manganese have varied from non-detectable to up to about 5,800 µg/l. While most wells contained manganese below its secondary maximum contaminant level (SMCL) of 50 µg/l, groundwater samples from several wells have had elevated concentrations which appear to exceed natural background values. Manganese is, therefore, considered a PCOC based on available data. Nitrate (as nitrogen) and selenium were detected at concentrations exceeding their MCLs in groundwater at numerous locations at HISS and are also considered PCOCs. Based on the analytical results, manganese, nitrate, and selenium are the non-radionuclide analytes considered as PCOCs for groundwater at HISS.

Groundwater at HISS was also analyzed for priority pollutant volatile organics, semi-volatile organics, pesticides, and herbicides during the 1980s and early 1990s. Trichloroethene (TCE) is identified as a PCOC due to its historical and recent presence in wells HISS-9 and HISS-17S, although the source of this compound may not be related to previous or existing site operations. The compound 1,2-dichloroethene (1,2-DCE), a transformation product of TCE, was detected in well HISS-9 in 1997 at a concentration significantly below its MCL. This volatile organic compound (VOC) is not considered a PCOC in groundwater at HISS.

4.2 Distribution of PCOCs in Groundwater

The distribution of PCOCs in groundwater based on the 1997 baseline sampling results is described in this section. Groundwater chemistry data of the HISS 1997 baseline sampling was compared to USEPA MCLs (October 1996) and estimated background concentrations in four major categories: radionuclides, VOCs and semi-volatile organic compounds (SVOCs), metals, and inorganic constituents. The Missouri Department of Natural Resources (MDNR) MCLs for the determined PCOCs are the same as the USEPA standards. The baseline data were provided with laboratory and review qualifications. In this analyses, the data are reported in consideration of the "review qualifier."

4.2.1 Radiological Data

The distribution of total uranium in groundwater at HISS as of September 1997 is illustrated on Figure 4-1. Total uranium was detected above its MCL of 20 µg/l in 4 wells and above its estimated local background concentration of less than 5 µg/l in 5 additional wells at HISS. These total uranium concentrations ranged from 6.3 µg/l in well HISS-17S to 129 µg/l in well HISS-6. The highest total uranium concentrations were detected in the north-central part of the site. Groundwater samples from numerous upper zone wells around the perimeter of the site contained total uranium concentrations below its MCL or estimated background value. A total uranium concentration of less than 1.5 µg/l was detected in the sample from deep well HISS-5D. The

Detection of total uranium in groundwater samples is partially influenced by the Eh and pH of the groundwater. Groundwater with a lower Eh or pH may have more detectable uranium due to its increased solubility in a reducing or acidic environment. No other radionuclides were detected at concentrations above their MCLs in site groundwater.

4.2.2 Nonradiological Data

Concentrations of manganese ranged between 4 and 3,090 $\mu\text{g/l}$ in the 1997 baseline sampling data. The distribution of dissolved manganese appears to have no distinguishable pattern. The highest concentration was detected in the groundwater sample from off-site well HISS-19. Only trace to low concentrations of manganese were measured in wells (such as HISS-5 and HISS-7) located in the center part of HISS. Groundwater samples from 10 wells at HISS contained manganese above its SMCL of 50 $\mu\text{g/l}$, including deep well HISS-5D. The remaining 11 wells at HISS have manganese concentrations below its MCL and the estimated upper zone background concentration of 25 $\mu\text{g/l}$ (BNI, 1998). The cause of this inorganic in local groundwater at elevated concentrations is unknown and may not be related to previous or current site activities.

Dissolved nitrate and selenium were detected above their respective MCLs and estimated background values. Nitrate was detected in 11 wells above its MCL of 10 mg/l (Figure 4-2). These nitrate concentrations ranged from 22 mg/l in wells HISS-2 and HISS-5 to 729 mg/l in HISS-20S. Three additional wells contained groundwater with nitrate concentrations exceeding the estimated background value of two mg/l. Selenium was detected in groundwater from 9 wells above its MCL of 50 $\mu\text{g/l}$. Selenium concentrations ranged from 81 $\mu\text{g/l}$ in well HISS-12 to 386 $\mu\text{g/l}$ in well HISS-20S (Figure 4-3). Four additional wells have elevated selenium above its estimated background concentration of five $\mu\text{g/l}$. Non-detectable concentrations of nitrate and selenium were measured in the groundwater from lower zone well HISS-5D. The widespread presence of nitrate and selenium in upper zone groundwater appear to be related to site activities.

Groundwater samples collected from site wells were analyzed by USEPA Method 8260 for VOCs and USEPA Method 8270 for SVOCs. TCE was the only organic compound detected above its MCL. Dissolved TCE was detected above its MCL of five $\mu\text{g/l}$ in groundwater from two wells located on the western site boundary. Monitoring well HISS-9 contained 400 $\mu\text{g/l}$, and well HISS-17S contained 120 $\mu\text{g/l}$ of TCE. TCE was not detected in the groundwater sample from lower zone well HISS-5D. This organic compound may not be related to previous government activities at HISS because its presence is common in many industrial settings.

In summary, based on historical and the 1997 baseline groundwater sampling results, the five PCOCs in the shallow groundwater at HISS are total uranium, manganese, nitrate, selenium, and TCE.

4.3 Comparison of Historical Data

Comparisons of the 1997 baseline groundwater sampling data to available historic data for determined PCOCs are made in this section of the report. Some variations in concentrations over

time in collected groundwater samples may be related to or caused by varied groundwater sampling techniques or changes in subsurface conditions such as groundwater turbidity and groundwater surface elevation. In addition, this evaluation may also compare filtered samples for "dissolved" concentrations to historical unfiltered samples for "total" concentrations.

4.3.1 Radiological Data

Total uranium concentrations detected in groundwater samples from wells HISS-1, HISS-5S, HISS-6, and HISS-16 of the 1997 baseline sampling exceeded the uranium MCL of 20 $\mu\text{g/l}$ (Table 4-3). The concentration of total uranium was approximately double in the baseline groundwater samples from well HISS-1 (34 $\mu\text{g/l}$) compared to 17 $\mu\text{g/l}$ in 1984. Similarly, the total uranium in recent samples from wells HISS-6 and HISS-16 are the highest concentrations detected in these two wells. A lower total uranium concentration was recently detected in the well HISS-5 sample at 40 $\mu\text{g/l}$ compared to 113 $\mu\text{g/l}$ in 1991.

Although radium and thorium species are not considered PCOCs in groundwater at HISS, some information of their historical occurrence are provided. No historical or baseline groundwater samples from HISS contained radium-226 concentrations exceeding its MCL of 20 pCi/l. Groundwater samples from all HISS wells had lower radium-226 concentrations in 1997 compared to 1992 results, except for wells HISS-16 and HISS-20S. A summary of radium-226 concentrations in groundwater at HISS is presented in Table 4-4. No HISS groundwater samples analyzed for thorium-230 have exceeded 1.0 pCi/l since 1993. No USEPA MCL has been established for this radionuclide. The baseline groundwater samples contained lower thorium-230 concentrations compared to 1992 sampling results. A summary of thorium-230 concentrations in groundwater at HISS is presented in Table 4-5.

4.3.2 Nonradiological Data

A comparison of previously detected manganese concentrations (1988 to 1989) from wells HISS-1 to HISS-15 and the 1997 baseline data indicate lower manganese concentrations in the recent sampling event (Table 4-6). Relatively low concentrations of about 30 $\mu\text{g/l}$ were previously measured in wells HISS-5 and HISS-6. Lower, yet similar, values of manganese were measured in groundwater from these locations in 1997.

In the 1997 baseline data, groundwater from 11 wells at HISS exceeded the MCL of nitrate (10 mg/l). Limited historical data from only four wells are available for comparison of nitrate concentrations over time (Table 4-7). The concentration of nitrate in well HISS-13 is lower in the recent sample (517 mg/l) compared to 880 mg/l in 1995. Historical and the recent nitrate concentrations of wells HISS-15 and HISS-17S are similar. A higher nitrate concentration was recently detected in the well HISS-20S sample compared to previous results.

Nine groundwater analyses from the 1997 baseline sampling exceeded the selenium MCL of 50 $\mu\text{g/l}$ at HISS. A maximum concentration of 386 $\mu\text{g/l}$ was detected at well HISS-20S. This recent value is higher compared to 134 $\mu\text{g/l}$ reported in this well in 1989. Higher recent

selenium concentrations were noted in wells HISS-2, HISS-7, HISS-17S, and HISS-20S samples compared to previous results. Selenium concentrations are lower in nine of the baseline samples relative to the 1989 results. These selenium values in HISS groundwater are presented in Table 4-8.

Groundwater samples from two wells (HISS-9 and HISS-17S) in 1997 had detectable concentrations of TCE. The highest TCE concentration of 400 $\mu\text{g/l}$ was detected at well HISS-9. No historical groundwater data from this well are available. The baseline groundwater sample from well HISS-17S has a higher concentration of TCE from 3 $\mu\text{g/l}$ in 1989 to 120 $\mu\text{g/l}$ in 1997. The 1997 concentrations exceed the MCL of five $\mu\text{g/l}$ for TCE.

4.4 Summary

Using historical and the 1997 baseline data, groundwater in the upper hydrostratigraphic zone beneath HISS contains elevated concentrations of total uranium, nitrate, and selenium. Elevated manganese in site and off-site wells is also detected, although its cause is unknown. No new PCOCs were detected compared to previous data. TCE concentrations were also recently detected in HISS groundwater, consistent with previous results. The occurrence of TCE is believed to be not related to previous or existing site activities. No PCOCs (except manganese) were detected in the lower hydrostratigraphic zone (well HISS-5D) at HISS.

Concentrations of total uranium in the 1997 baseline data are both higher and lower at different locations compared to previous results. Some higher concentrations of nitrate and selenium were recently detected at certain locations compared to historical data. The recent high concentrations at some locations may suggest a local influx of PCOCs into parts of the shallow groundwater system at HISS.

5.0 EVALUATION OF ABBREVIATED SAMPLING PLAN REQUIREMENTS

SAIC has reviewed the "Abbreviated Plan for Providing Baseline Sampling and Data Collection for Surface Water and Groundwater at the St. Louis Airport Site and the HISS Site" (Baseline Sampling), dated September 1997. The Baseline Sampling Plan was compared to the actual field data collected and to groundwater laboratory analyses made available to SAIC. Some concerns about the baseline data may be resolved by examining the original laboratory data reports and field logs. Future work by the USACE and SAIC will address these issues by providing analytically verified and complete data sets. Our comments about the groundwater sampling work and associated laboratory data are as follows:

1. No laboratory analytical methods or analytical reports were supplied with the baseline data report. The methods specified in the Baseline Sampling Plan are assumed to have been followed by the laboratory, as well as quality control procedures and requirements such as holding time and instrument calibration.
2. Specific detection limits given in the Baseline Sampling Plan were not always achieved in the reported analytical data. The specific detection limit of 0.2 $\mu\text{g/l}$ was not achieved for most VOCs analyses. The alkalinity detection limit of one mg/l was not achieved. The actinium-227 detection limit of 1 pCi/l and the protactinium-231 detection limit of 50 pCi/l were not achieved. The detection limits of the plan may have been modified based on the used analytical method.
3. Certain compounds were reported as having a detection by the laboratory but are qualified with a "U" (indicating the parameter was not detected) by the review qualifier. For example, copper for well HISS-14 was reported as 7.4 $\mu\text{g/l}$ with a laboratory detection limit of 0.6 $\mu\text{g/l}$ and a sample quantitation limit of 1.4 $\mu\text{g/l}$. No laboratory qualifier was entered, but the reviewer qualified the data with a "U."
4. No information regarding the data validation review was provided for the baseline data. Therefore, SAIC is unable to confirm the validity of the data qualifiers supplied in the analytical data.
5. The analytical results for bromoform, 2-chloroethylvinyl, ether, benzidine, bis(2-chloroisopropyl)ether, and 1,2-diphenolhydrazine were not provided in the baseline data report. The analyses were specified in the Baseline Sampling Plan.
6. Analytical results of any split samples or other water samples collected by the MDNR or USEPA were not evaluated as part of this report.

6.0 CONCLUSIONS

Based on existing hydrogeologic information, historical groundwater quality data, and the findings of the 1997 baseline groundwater sampling event at HISS, the following conclusions have been drawn regarding hydrogeology and groundwater chemistry at the site.

1. Three main hydrostratigraphic zones are interpreted to exist in the non-lithified material beneath HISS. The upper stratigraphic zone consists of an upper loess zone (Unit 2) and a silty clay zone (Unit 3T). The middle hydrostratigraphic zone is defined by the 3M clay unit which appears to act as an aquitard and is approximately 32 feet thick. Based on current data, the lower hydrostratigraphic zone beneath the 3M unit consists of stratigraphic Units 3B and 4 (clayey silt and clayey gravel). The underlying limestone bedrock is interpreted to be a separate hydrostratigraphic zone. Shale bedrock is believed to be absent beneath HISS.
2. At the time of the baseline sampling, 17 monitoring wells were completed in the upper hydrostratigraphic zone and one deep well was completed in the lower hydrostratigraphic zone. The upper zone wells are interpreted to penetrate stratigraphic Units 2 and 3T. Well HISS-5D was drilled to a total depth of 97 feet bgl and is interpreted to monitor the lower hydrostratigraphic zone. Two upper zone wells were closed after the baseline sampling event.
3. The 1997 groundwater surface measurements indicate a radial groundwater contour pattern at HISS. Groundwater surface elevations decline from the central part of the site. Groundwater movement is interpreted to be minimal in the low conductivity saturated materials. The area of central groundwater mound corresponds to a low wet area on the ground surface. A downward vertical gradient potential or hydraulic head differential existed at well cluster HISS-5/HISS-5D.
4. The chemical composition (cation/anion relationships) of the upper and lower groundwater zones are distinguished and similar to the compositions observed at SLAPS. The upper zone groundwater is mainly characterized by high calcium, nitrate, and chloride concentrations, and a very low arsenic content. The lower zone groundwater as determined from well HISS-5D has elevated alkalinity and arsenic with very low concentrations of sulfate, chloride, and nitrate.
5. The identified groundwater PCOCs in the upper groundwater zone at HISS are total uranium, manganese, nitrate, selenium, and TCE. Of these PCOCs, only manganese has been detected at elevated concentrations in the lower zone groundwater.
6. Total uranium was detected above its MCL in four upper zone wells and above its estimated background concentration in five additional upper zone wells. No other radionuclides were detected at elevated concentrations above MCLs in site groundwater in 1997.

7. Elevated manganese was detected in baseline groundwater samples from numerous site and off-site wells above its SMCL and estimated background values. Manganese concentrations exceeded its SMCL in 10 wells, including lower zone well HISS-5D. The cause of elevated manganese in site and off-site groundwater may not be entirely related to site activity.
8. Dissolved nitrate and selenium were detected above their respective MCLs and estimated background concentrations in upper zone groundwater. Nitrate was detected above its MCL in 11 wells. Selenium was detected above its MCL in groundwater from nine wells. The highest concentrations of these two inorganics were detected in several wells in 1997. The presence of nitrates and selenium in the upper zone groundwater appears to be related to site activities.
9. Dissolved TCE was detected above its MCL in groundwater from two wells located along the western site boundary. This organic compound may not be related to government activities at HISS because its presence is common in many industrial settings. A very low concentration of 1,2-DCE, a transformation compound, was also detected in groundwater at one well in 1997.

7.0 REFERENCES

Bechtel National, Inc. (BNI); 1994; *Remedial Investigation Report for the St. Louis Site, St. Louis, Missouri*; DOE/OR/21949-280; January.

BNI; 1998; *Summary and Analysis of the 1997 Baseline Groundwater Sampling Data for the St. Louis North County Sites*; January.

Science Applications International Corporation (SAIC); 1995; *Remedial Investigation Addendum for the St. Louis Site*; DOE/OR/ 21950-132; September.

SAIC; 1997; *Abbreviated Plan for Providing Baseline Sampling Data and Data Collection for Surface Water and Groundwater at the St. Louis Airport Site and the Hazelwood Interim Storage Site, St. Louis, Missouri*; September.

SAIC; 1998; *Groundwater Characterization Report of 1997 Baseline Data for the St. Louis Airport Site, St. Louis, Missouri*; May.

United States Environmental Protection Agency, Office of Water; 1996; *Drinking Water Regulations and Health Advisories*; October.

FIGURES

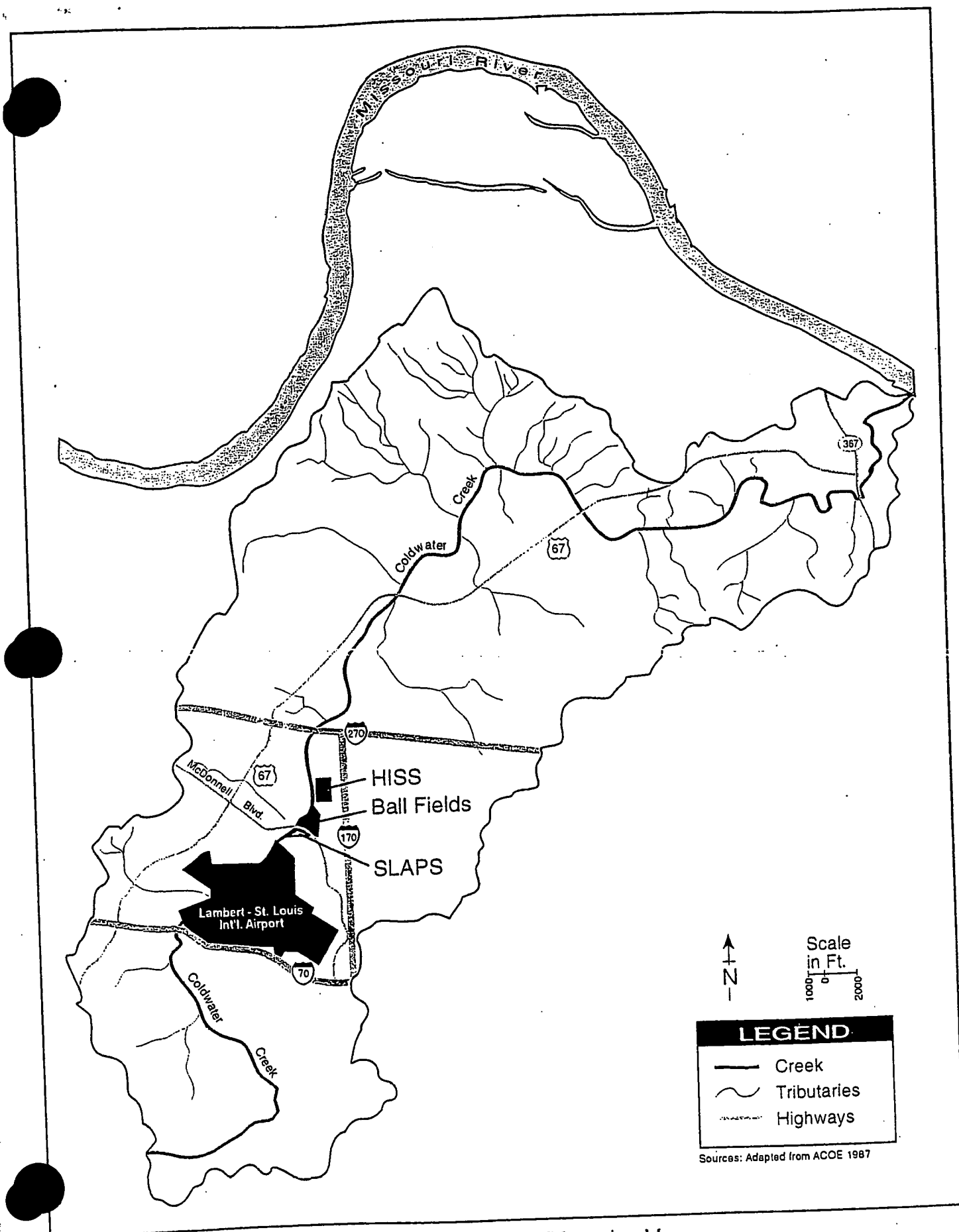


Figure 1-1. SLAPS/HISS Location Map

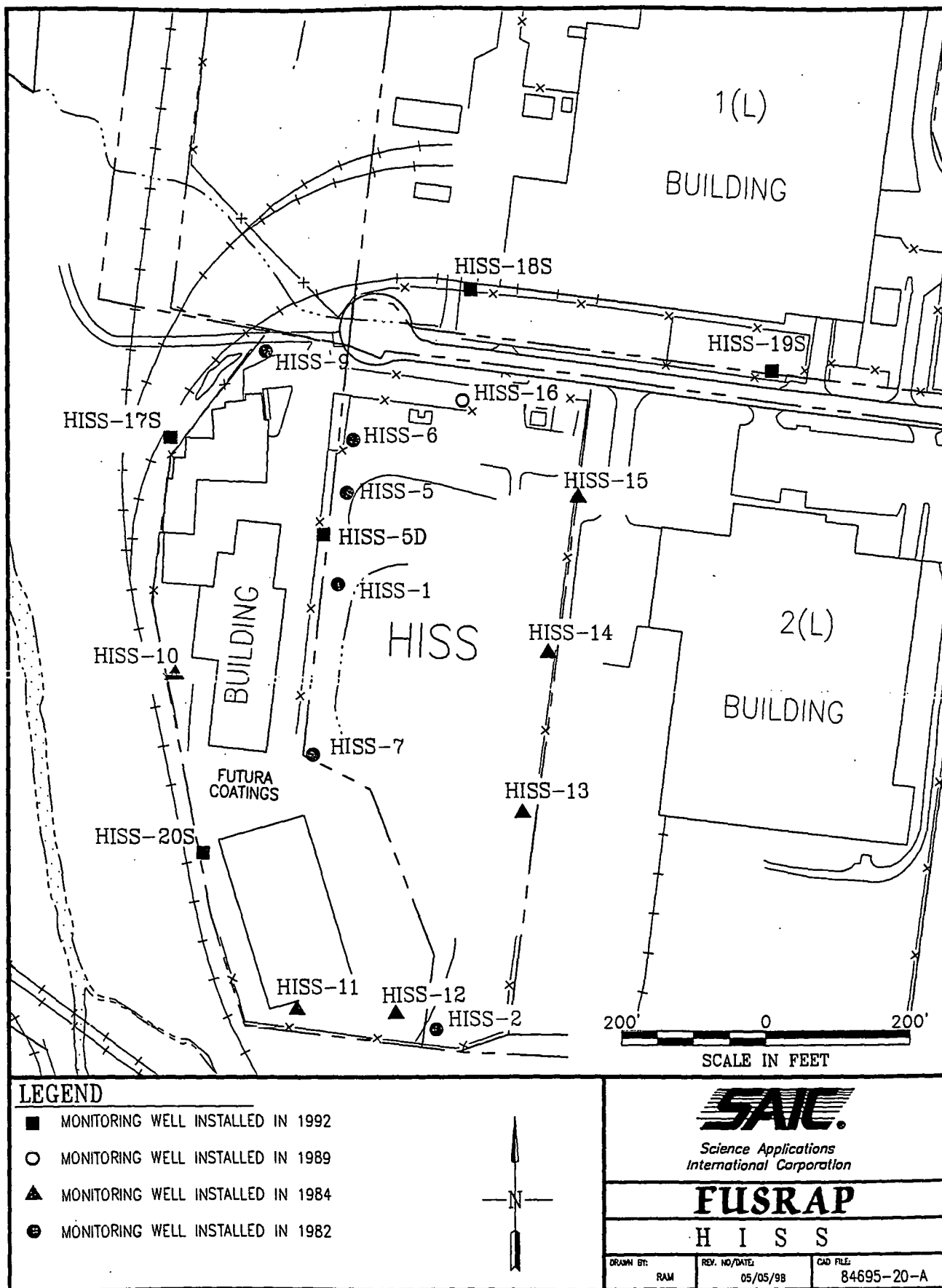


Figure 2-1
HISS Monitoring Well Location Map


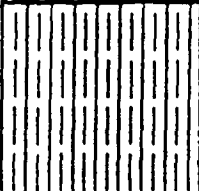






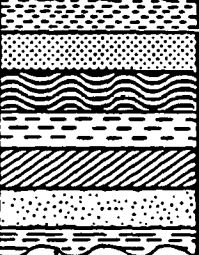
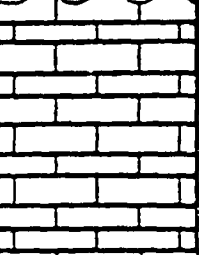
Hydro-Geologic Unit	Period	Epoch	Formation	Columnar Section	Approximate Thickness (ft)	Description
UPPER GROUNDWATER SYSTEM	QUATERNARY	RECENT	FILL		0-14	UNIT 1 Fill – Sand, silt, clay, concrete, rubble Topsoil – Organic silts, clayey silts, wood, fine sand. (Absent at HISS)
			LOESS (CLAYEY SILT)		11-32	UNIT 2 Clayey silts, fine sands, mottled with frequent iron oxide staining, scattered roots, and organic material. Occasional fossils. Low to moderate plasticity.
		PLEISTOCENE/HOLOCENE	LACUSTRINE SERIES:		19-75	UNIT 3 Silty clay with scattered organic blebs and peat stringers. Moderate plasticity. Moist to saturated. (3T)
			SILTY CLAY		9-27	
			VARVED CLAY		0-8	(3M)
			CLAY		0-26	Dense, stiff, moist, plastic clay. (3M)
			SILTY CLAY*		10-29	Similar to upper silty clay. Probable unconformity with highly plastic clay. (3B)
			CLAYEY & SANDY GRAVEL		0-6	UNIT 4 Glacial clayey gravels, sands, and sandy gravels. Mostly chert.
LOWER GROUNDWATER SYSTEM	PENNSYLVANIAN		PENNSYLVANIAN (Undifferentiated)		0-35	UNIT 5 BEDROCK, cycles of silty clay/shale, lignite/coal, sandstone, and siltstone. Erosionally truncated by glaciolacustrine sequences. (Absent at HISS)
			ST. GENEVIEVE (?) LIMESTONE		10+	UNIT 6 BEDROCK, hard, white to olive, well cemented limestone with interbedded shale laminations.

FIGURE 2-2
GENERALIZED STRATIGRAPHIC COLUMN FOR HISS AREA
(Modified from Bechtel 1994)

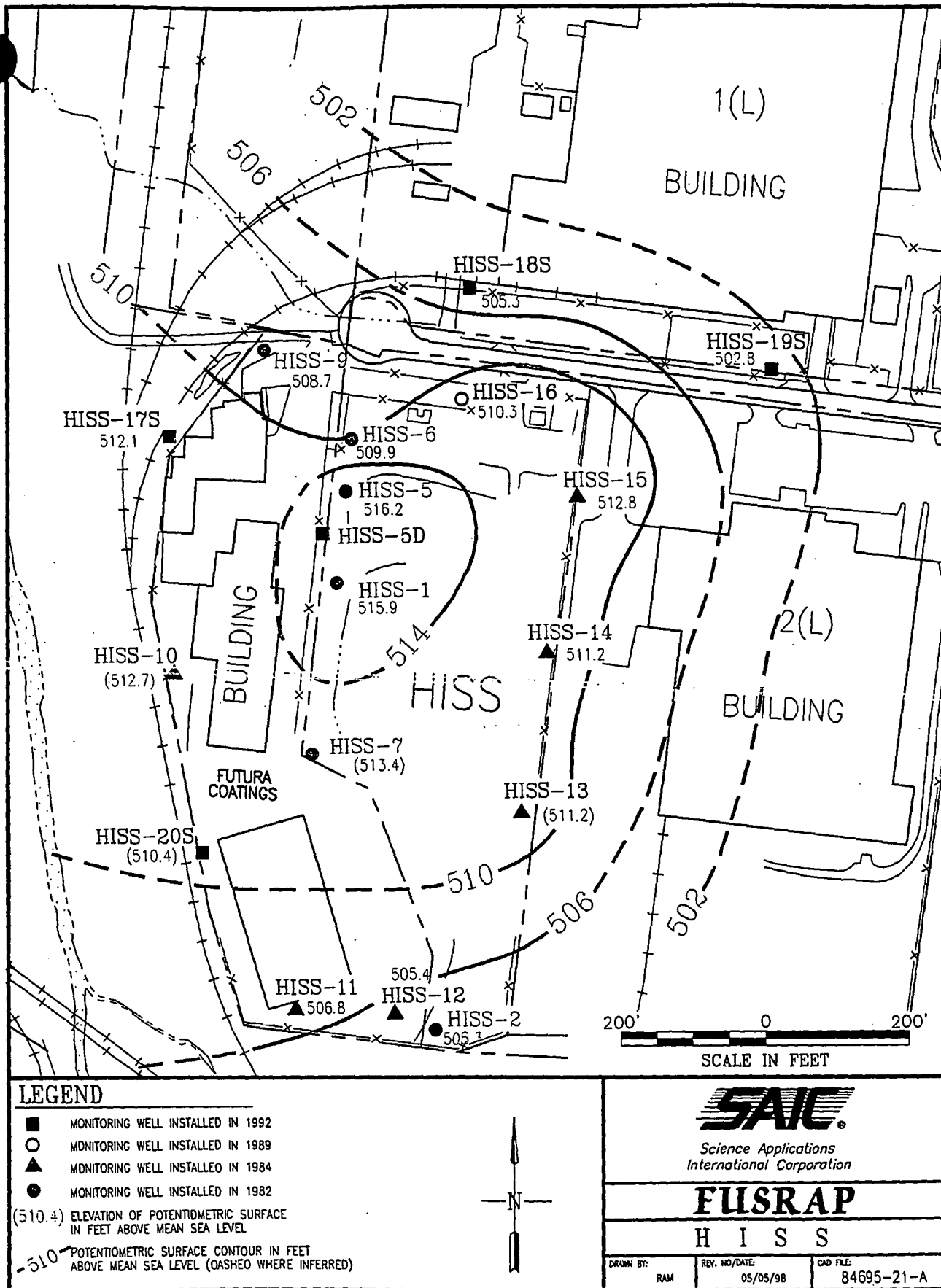


Figure 3-1
Potentiometric Surface Map of Shallow
Groundwater at HISS (9/97)

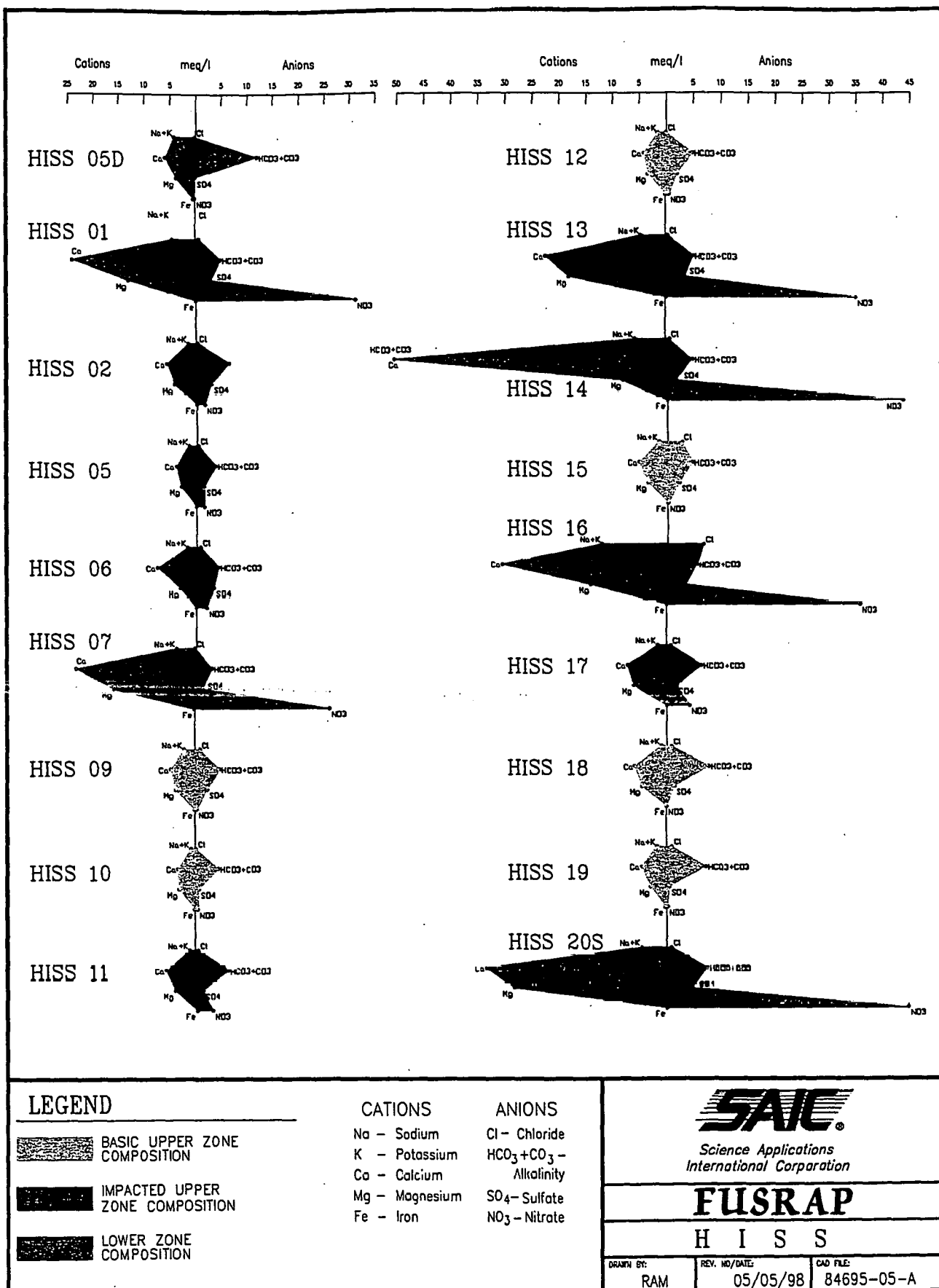
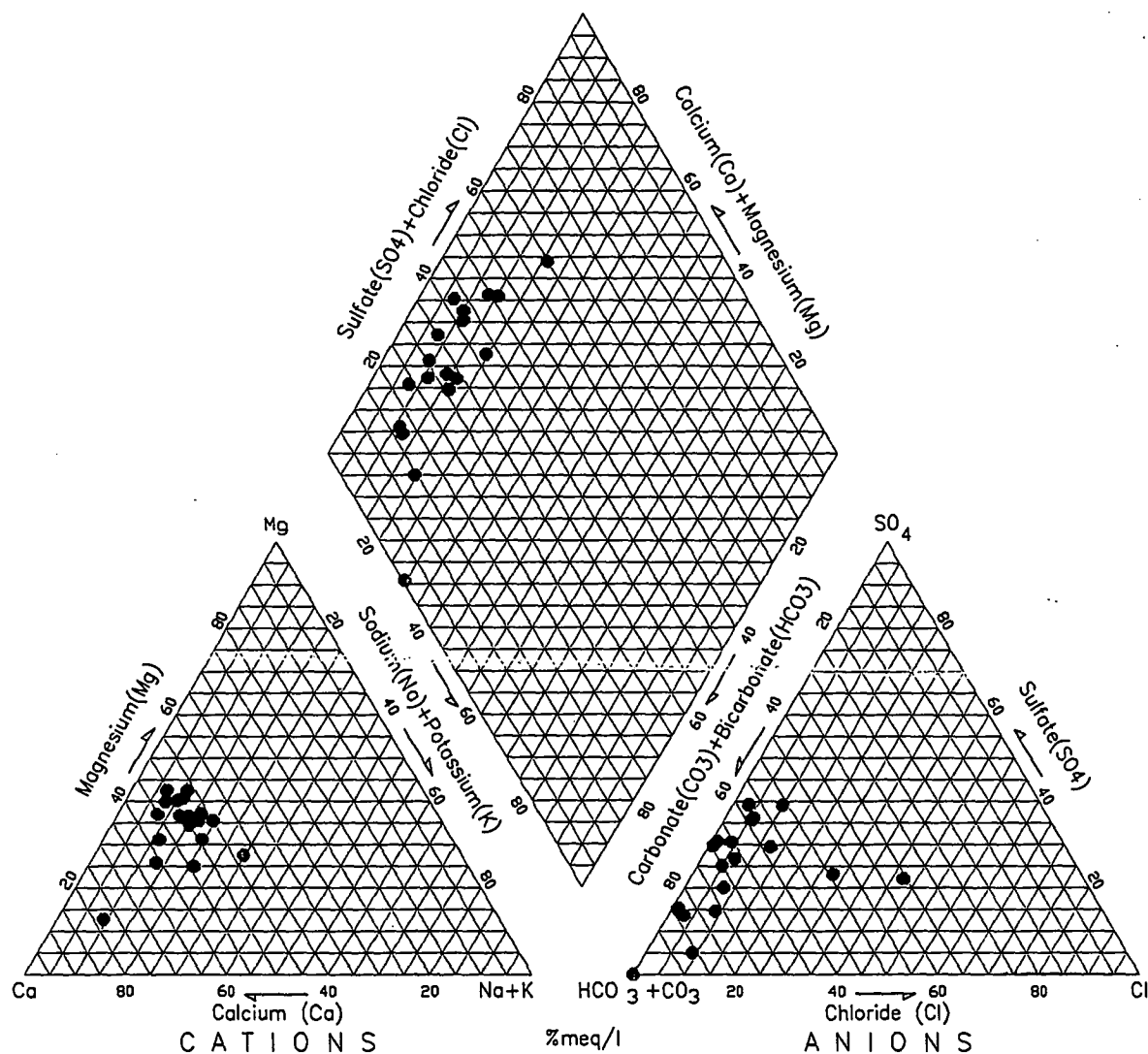


Figure 3-2
Groundwater Chemical Composition
of Upper and Lower Zones

HISS Groundwater Data



LEGEND:

- UPPER HYDROSTRATIGRAPHIC ZONE GROUNDWATER
- LOWER HYDROSTRATIGRAPHIC ZONE GROUNDWATER

SAIC

Science Applications
International Corporation

FUSRAP

H I S S

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RAM

REV. NO. / DATE:
05/05/98

CAD FILE:
84695-06-A

Figure 3-3
Tri-Linear Plot of Major Ionic Species
for Upper and Lower Zones

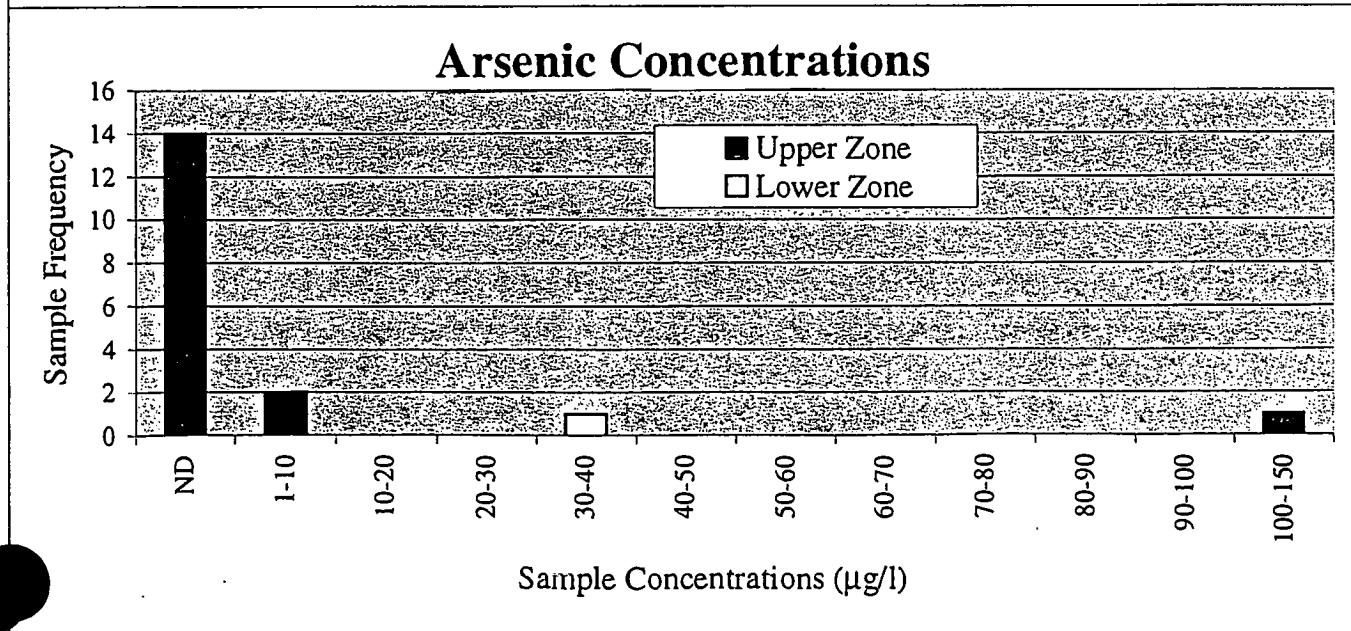
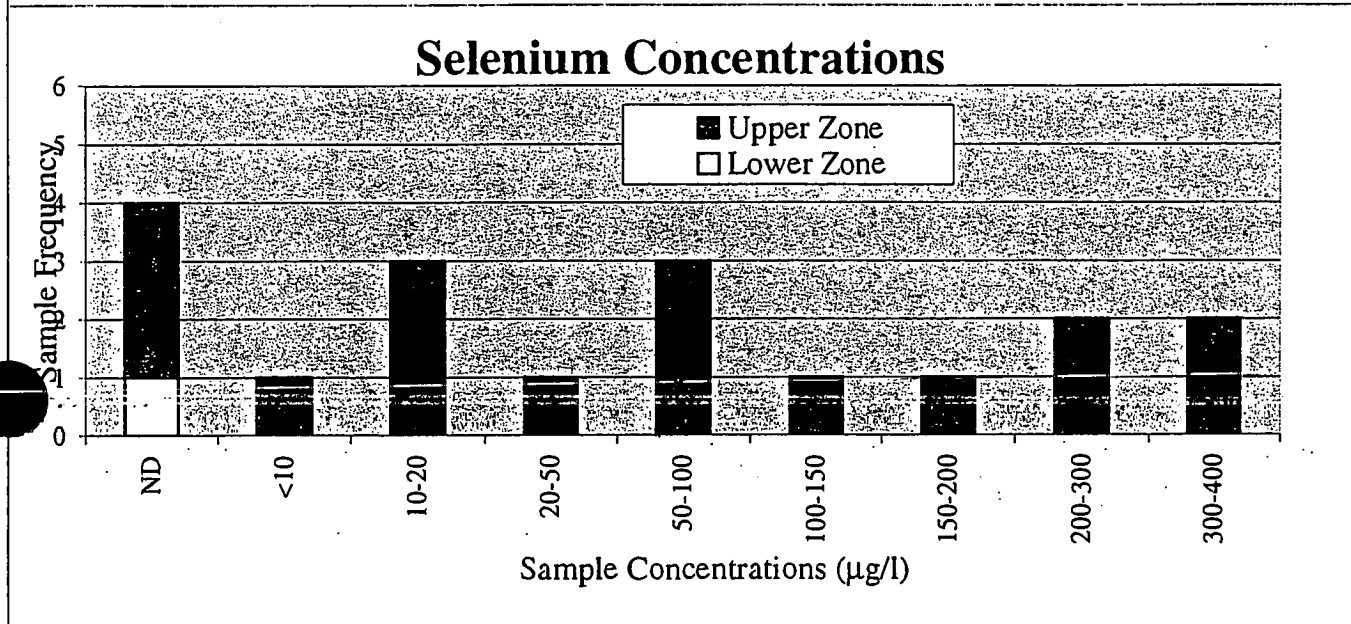
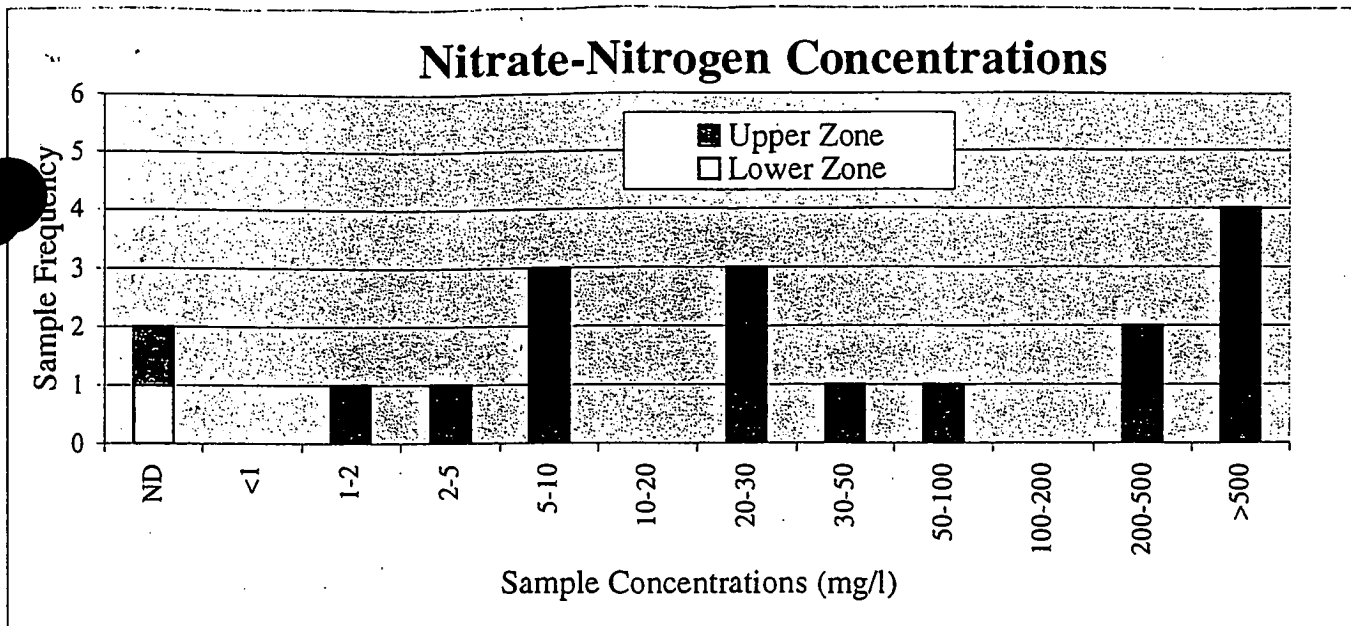


Figure 3-4. Distribution of nitrate-nitrogen, selenium, and arsenic groundwater concentrations at HISS.

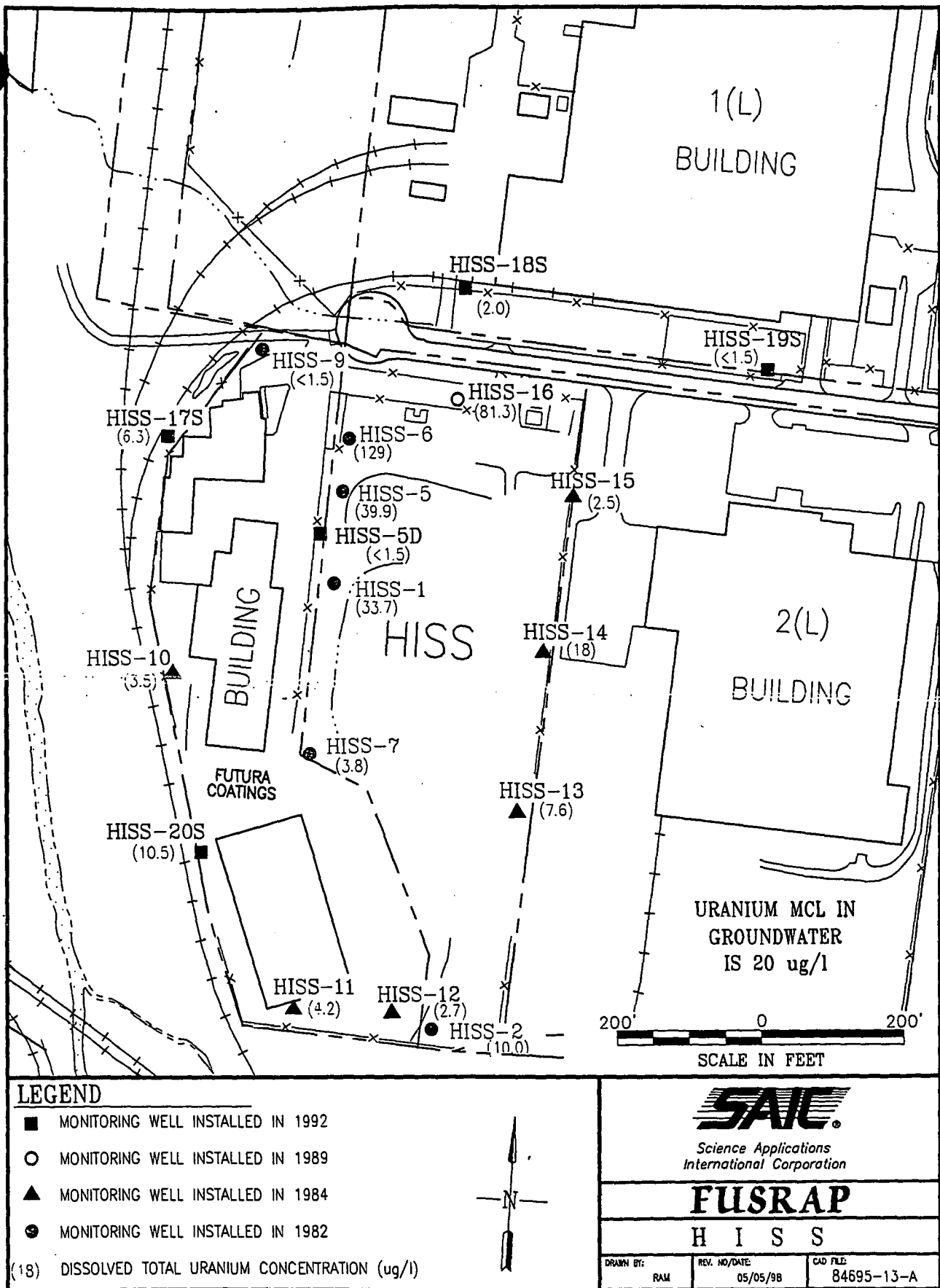
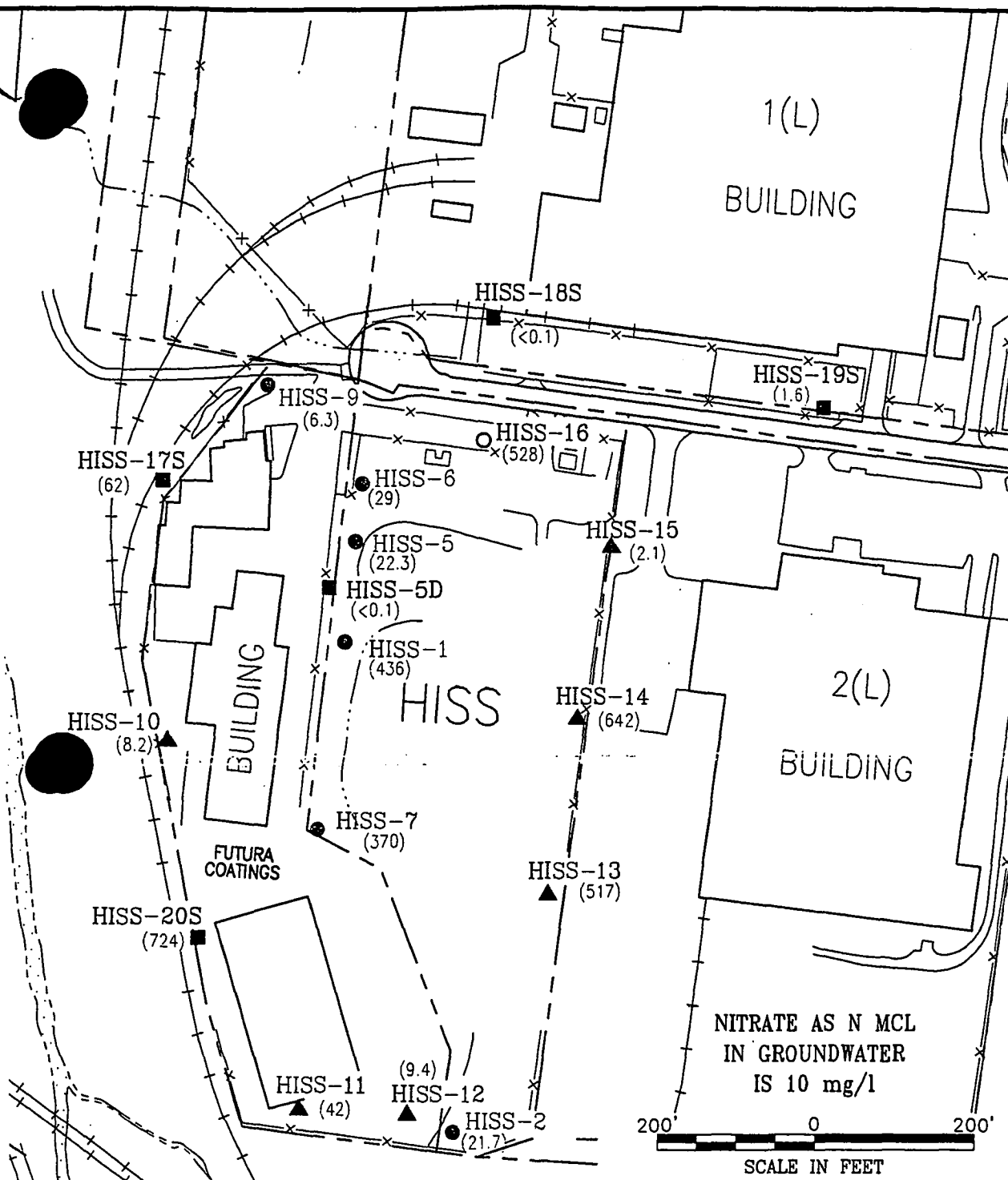


Figure 4-1
1997 Total Uranium Concentrations
in Groundwater



LEGEND ■ MONITORING WELL INSTALLED IN 1992 > MONITORING WELL INSTALLED IN 1989 ▲ MONITORING WELL INSTALLED IN 1984 ▽ MONITORING WELL INSTALLED IN 1982 ○) MEASURED NITRATE AS N CONCENTRATION (mg/l)		 Science Applications International Corporation		
		FUSRAP		
		H I S S		
		DRAWN BY: RAM	REV. NO./DATE: 05/05/98	CAD FILE: 94695-22-A

Figure 4-2
1997 Nitrate Concentrations
in Groundwater

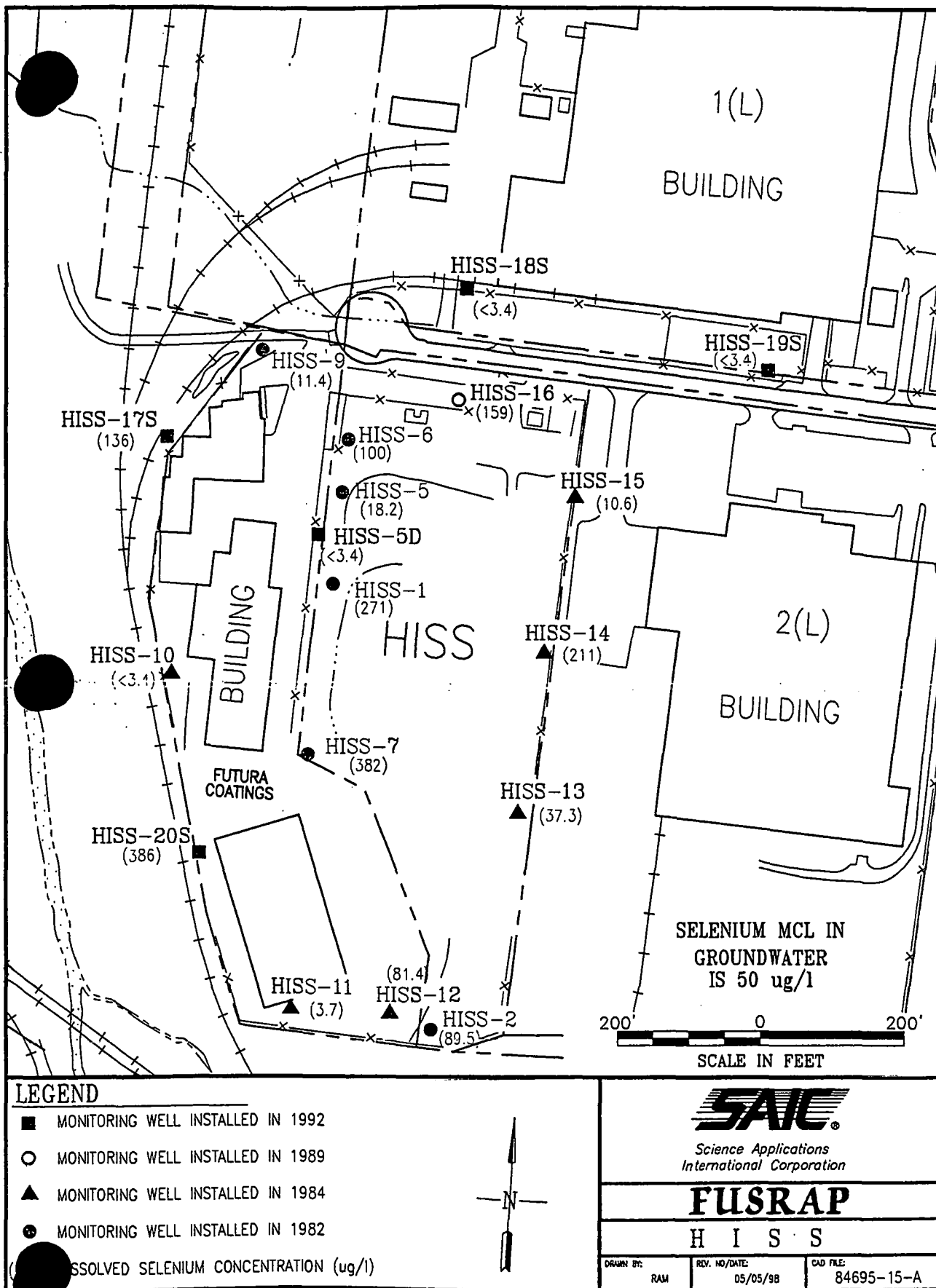


Figure 4-3
1997 Selenium Concentrations
in Groundwater

TABLES

TABLE 2-1

HISS Monitoring Well Summary Data

Well Information		Construction Parameters			Open Intervals				Monitored Stratigraphic Unit(s)
ID No.	Ground Elevation (feet MSL)	Type PVC or Steel	Diameter (inches)	Grout Depth (feet bgs)	Screen		Sand Pack		
					Top (bgs)	Bottom (bgs)	Top (bgs)	Bottom (bgs)	
HISS-1		PVC						25	2 & 3T ?
HISS-2		PVC						32.2	2 & 3T ?
HISS-3		PVC	Closed 7/92					21.6	2 & 3T ?
HISS-4		PVC	Closed 7/92					22	2 & 3T ?
HISS-5		PVC						21.1	2 & 3T ?
HISS-5D	518.5	Stainless Steel	4	87	90.0	95.0	87	97	3B & 4
HISS-6		PVC						20	2 & 3T ?
HISS-7		PVC						20	2 & 3T ?
HISS-8		PVC	Closed 7/92						2 & 3T ?
HISS-9	517.3	PVC	2	19.4	21.4	26.1	19.4	28.5	2 & 3T
HISS-10	517.2	PVC	2	14.1	16.6	21.3	14.1	25.0	2 & 3T
HISS-11	515.7	PVC	2	12.7	15.6	20.3	12.7	23.8	2 & 3T
HISS-12	517.5	PVC	2	9.8	12.1	16.8	9.8	20.0	2 & 3T
HISS-13	521.7	PVC	2	10	12.8	17.5	10.0	25.0	2 & 3T
HISS-14	520.4	PVC	2	9.3	11.6	21.3	9.3	30.0	2 & 3T
HISS-15	515.9	PVC	2	10.3	12.2	16.9	10.3	20.5	2 & 3T
HISS-16	514.3	Fiberglass	2	7	10.4	20.6	7	21	2 & 3T
HISS-17S	514.7	Stainless Steel	4	8	9.6	19.6	8	20	2 & 3T
HISS-18S	514.6	Stainless Steel	4	5	7.0	17.0	5	17	2 & 3T
HISS-19S	517.5	Stainless Steel	4	12	14.0	24.0	12	24	2 & 3T
HISS-20S	515.1	Stainless Steel	4	12	14.0	24.0	12	24	2 & 3T

Notes: Blank space indicates no information available.
 ? - Assumed Interpretation

Table 3-1 Potentiometric Surface Elevations of Site Monitoring Wells at HISS (in feet above mean sea level)		
Well ID	June 1997	September 1997
HISS-1	516.3	515.9
HISS-2	510.8	505.3
HISS-5	516.5	516.2
HISS-5D	NA	512.4
HISS-6	510.0	509.9
HISS-7	514.1	513.4
HISS-9	509.2	508.7
HISS-10	513.0	512.7
HISS-11	507.7	506.8
HISS-12	511.0	505.4
HISS-13	512.2	511.2
HISS-14	512.9	511.2
HISS-15	512.8	512.8
HISS-16	510.8	510.3
HISS-17S	511.3	512.1
HISS-18S	505.5	505.3
HISS-19S	503.1	502.8
HISS-20S	509.2	510.4

Notes:

NA - Not Available.

Potentiometric surface measurements taken by BNI.

Wells HISS-3, -4, and -8 were closed in 1992.

TABLE 3-2

Charge Balance Analysis of Groundwater at HISS

Well Locations:	HISS-1		HISS-2		HISS-5		HISS-5D		HISS-6		HISS-7		HISS-9		HISS-10		HISS-11	
Parameter	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l
Sodium (Na)	108.0	4.70	39.0	1.70	31.9	1.39	82.6	3.64	37.0	1.61	77.3	3.36	46.4	2.02	18.8	0.82	34.3	1.49
Potassium (K)	1.3	0.03	0.9	0.02	0.6	0.01	17.2	0.44	1.5	0.04	0.8	0.02	0.9	0.02	0.2	0.0	0.4	0.01
Calcium (Ca)	483.0	24.10	118.0	5.89	79.9	3.99	117.0	5.84	150.0	7.49	459.0	22.90	92.9	4.64	68.3	3.41	122.0	6.09
Magnesium (Mg)	159.0	13.08	53.4	4.39	36.2	2.98	45.3	3.77	38.7	3.18	188.0	15.47	44.7	3.68	38.0	3.13	53.5	4.40
Iron (Fe)	0.0	0.0	0.0	0.0	0.0	0.0	9.8	0.35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chloride (Cl)	17.8	0.50	5.7	0.16	14.7	0.41	2.1	0.06	32.7	0.92	9.1	0.26	39.6	1.12	7.1	0.20	4.6	0.13
Bicarbonate (HCO ₃)	293.0	4.80	384.0	6.29	231.0	3.79	736.0	12.06	269.0	4.41	219.0	3.59	302.0	4.95	277.0	4.54	366.0	6.00
Carbonate (CO ₃)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sulfate (SO ₄)	142.0	2.96	138.0	2.87	73.5	1.53	0.0	0.0	165.0	3.44	81.7	1.70	122.0	2.54	36.0	0.75	52.9	1.10
Nitrate (NO ₃)	1,930.9	31.14	96.1	1.55	98.8	1.59	0.0	0.0	128.4	2.07	1,638.6	26.43	27.9	0.45	36.3	0.59	186.4	3.01
Total Dissolved Solids	3,135 mg/l		835 mg/l		566 mg/l		1,011 mg/l		822 mg/l		2,673 mg/l		676 mg/l		482 mg/l		820 mg/l	
Ion Balance (Cations/Anions)	1.1		1.1		1.1		1.2		1.1		1.3		1.1		1.2		1.2	
Well Locations:	HISS-12		HISS-13		HISS-14		HISS-15		HISS-16		HISS-17S		HISS-18S		HISS-19S		HISS-20S	
Parameter	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l
Sodium (Na)	34.6	1.51	112.0	4.87	146.0	6.35	39.5	1.72	284.0	12.35	40.7	1.77	21.7	0.94	45.7	1.99	114.0	4.96
Potassium (K)	0.4	0.01	1.8	0.05	2.5	0.06	0.5	0.01	9.1	0.23	0.7	0.02	1.2	0.03	0.9	0.02	1.6	0.04
Calcium (Ca)	84.8	4.23	474.0	23.65	1,070.0	53.39	112.0	5.59	645.0	32.19	155.0	7.73	125.0	6.24	101.0	5.04	712.0	35.53
Magnesium (Mg)	41.4	3.41	233.0	19.17	106.0	8.72	47.1	3.88	181.0	14.89	79.8	6.57	58.3	4.80	38.9	3.20	365.0	30.04
Iron (Fe)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.01	9.3	0.33	0.1	0.0
Chloride (Cl)	3.7	0.10	12.4	0.35	13.7	0.39	97.8	2.76	259.0	7.31	27.8	0.78	35.5	1.00	29.9	0.84	29.5	0.83
Bicarbonate (HCO ₃)	320.0	5.24	323.0	5.29	299.0	4.90	288.0	4.72	362.0	5.93	409.0	6.70	498.0	8.16	454.0	7.44	469.0	7.69
Carbonate (CO ₃)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sulfate (SO ₄)	109.0	2.27	175.0	3.64	85.3	1.78	108.0	2.25	180.0	3.75	90.2	1.88	75.6	1.57	21.1	0.44	233.0	4.85
Nitrate (NO ₃)	41.6	0.67	2,289.6	36.93	2,843.1	45.86	9.3	0.15	2,338.3	37.72	273.2	4.41	0.0	0.0	7.1	0.11	3,228.4	52.07
Total Dissolved Solids	636 mg/l		3,621 mg/l		4,566 mg/l		702 mg/l		4,258 mg/l		1,076 mg/l		815 mg/l		708 mg/l		5,153 mg/l	
Ion Balance (Cations/Anions)	1.1		1.0		1.3		1.1		1.1		1.2		1.1		1.2		1.1	

Notes:

mg/l - milligrams per liter

meq/l - milliequivalents per liter; millimoles of solute x valence/liter

Table 4-1

Analytes of Interest for Groundwater at HISS

Radiological Constituent	Inorganic Chemical Constituent	
Actinium-227	Aluminum	Manganese
Lead-210	Antimony	Molybdenum
Proactinium-231	Arsenic	Nickel
Radium-226	Barium	Nitrate
Radium-228	Beryllium	Potassium
Thorium-227	Boron	Selenium
Thorium-228	Cadmium	Silver
Thorium-230	Calcium	Sodium
Thorium-232	Chromium	Sulfate
Total Uranium	Cobalt	Vanadium
Organic Chemical Constituent	Copper	Zinc
	Iron	
	Lead	
	Magnesium	
Volatile Organics		
Semi-Volatile Organics		

Table 4-2 Potential Radiological and Chemical Constituents of Concern with Regulatory and Estimated Background Values for Groundwater at HISS		
Constituent	EPA MCL (ug/l)	Estimated Background* (ug/l)
Radiological		
Total Uranium	20	Upper Zone - <5; Lower Zone - <1.5
Inorganic		
Manganese	50 (SMCL)	Upper Zone - <25; Lower Zone - <215
Nitrate	10,000	<2,000
Selenium	50	<5
Organic Chemical		
Trichloroethene	5	<5

Notes:

EPA MCL - Environmental Protection Agency Maximum Contaminant Level
 (USEPA Office of Water "Drinking Water Regulations and Health Advisories," October 1996)

SMCL - Secondary Maximum Contaminant Level

* Estimated background concentrations of constituents are based on historical and 1997 baseline data collected from suspected background wells at HISS and nearby SLAPS. Estimated concentrations are for dissolved constituents.

Table 4-3
Historical Concentrations of Total Uranium in Groundwater at HISS (1984-1997)

Concentrations in ug/l

Well ID	1984*	1985*	1986*	1987*	1988*	1989*	1990*	1991*	1992*	1993*	1994*	1995*	1996*	1997
HISS-1	16.9	--	--	--	--	--	--	--	--	--	--	--	--	33.7
HISS-2	14.1	4.2	--	--	--	--	--	--	--	--	--	--	--	10.0
HISS-3	26.8	8.3	--	--	--	--	--	--	--	closed	closed	closed	closed	closed
HISS-4	42.3	18.3	--	--	--	--	--	--	--	closed	closed	closed	closed	closed
HISS-5	11.3	--	--	--	--	--	80.3	112.7	--	--	--	--	--	39.9
HISS-5D	--	--	--	--	--	--	--	--	0.1	--	--	--	--	<1.5
HISS-6	94.4	101	46.5	56.3	70.4	116	67.6	56.3	65.8	--	--	--	--	129
HISS-7	18.3	--	--	--	--	--	4.8	14.1	6.5	--	--	--	--	3.8
HISS-8	40.8	--	--	--	--	--	--	--	--	closed	closed	closed	closed	closed
HISS-9	--	36.1	<4.2	<4.2	<4.2	<4.2	<4.2	8.5	3.2	--	--	--	--	<1.5
HISS-10	--	4.4	8.5	5.6	5.6	7	<4.2	9.9	6.8	--	--	--	--	3.5
HISS-11	--	<4.2	7	5.6	7	8.5	<4.2	14.1	5.9	--	--	--	--	4.2
HISS-12	--	<4.2	5.6	7	8.5	6.3	5.6	12.7	6.6	--	--	--	--	2.7
HISS-13	--	<4.2	11.3	11.3	11.3	6.7	7	12.7	8.3	8.2	8.9	8.9	8.5	7.6
HISS-14	--	11.1	--	--	--	--	8.5	12.7	11.8	--	--	--	--	18
HISS-15	--	<4.2	7	4.2	8.5	7	<4.2	12.7	4.1	1.8	2	1.8	2.7	2.5
HISS-16	--	--	--	--	--	--	31	11.3	16.5	8.7	16.2	34.6	36.1	81.3
HISS-17S	--	--	--	--	--	--	--	--	6.5	4.4	6	5.2	5.4	6.3
HISS-18S	--	--	--	--	--	--	--	--	11.4	--	--	--	--	2.0
HISS-19S	--	--	--	--	--	--	--	--	3	--	--	--	--	<1.5
HISS-20S	--	--	--	--	--	--	--	--	4.1	9.1	10.5	11.3	12.1	10.5

Notes:

-- Data not available.

* Yearly averaged data.

Wells HISS-3, -4, and -8 were closed in 1992.

All results reported to the nearest 0.1 ug/l for concentrations below 100ug/l.

The detection limit for 1997 results is 1.5 ug/l.

The EPA MCL for total uranium is 20 ug/l.

Historic data from BNI (1994) and SAIC (1995).

Historic data (1984-1996) may be "total" concentrations from unfiltered sample analyses.

Historical Concentrations of Radium-226 in Groundwater at HISS (1984-1997)

Concentrations in pCi/l

Well ID	1984*	1985*	1986*	1987*	1988*	1989*	1990*	1991*	1992*	1993*	1994*	1995*	1996*	1997
HISS-1	0.7	--	--	--	--	--	--	--	--	--	--	--	--	0.2
HISS-2	0.4	0.5	--	--	--	--	--	--	--	--	--	--	--	0.1
HISS-3	2.7	0.6	--	--	--	--	--	--	--	--	--	--	--	0.1
HISS-4	3.2	0.1	--	--	--	--	--	--	--	closed	closed	closed	closed	closed
HISS-5	0.3	--	--	--	--	--	--	--	--	closed	closed	closed	closed	closed
HISS-5D	--	--	--	--	--	--	0.6	0.2	--	--	--	--	--	<0.1
HISS-6	1.5	0.8	0.7	1.2	1.8	1.6	1	1	0.9	--	--	--	--	0.8
HISS-7	1.6	--	--	--	--	--	1	1	3.1	--	--	--	--	0.4
HISS-8	0.2	--	--	--	--	--	1	1	1.3	--	--	--	--	0.6
HISS-9	--	0.4	0.2	0.2	0.6	0.6	--	--	--	closed	closed	closed	closed	closed
HISS-10	--	0.2	0.1	0.2	0.4	0.3	0.4	1	8.9	--	--	--	--	0.1
HISS-11	--	0.3	0.4	0.2	1	0.7	0.2	1	4.5	--	--	--	--	<0.1
HISS-12	--	0.4	0.4	0.5	1.3	0.7	0.5	3	4.9	--	--	--	--	0.2
HISS-13	--	0.1	0.3	0.3	0.6	0.7	0.6	1	2.9	--	--	--	--	<0.1
HISS-14	--	1.1	--	--	--	--	0.6	2	2.3	0.5	0.5	0.2	0.4	0.3
HISS-15	--	0.3	0.4	0.4	0.8	1.2	0.8	3.5	0.9	--	--	--	--	0.8
HISS-16	--	--	--	--	--	--	0.8	0.8	5.6	0.4	0.3	0.4	0.3	0.2
HISS-17S	--	--	--	--	--	--	0.4	2.3	4.7	1.7	2.4	1.3	1.9	2.6
HISS-18S	--	--	--	--	--	--	--	--	0.4	0.2	0.3	0.2	0.3	0.3
HISS-19S	--	--	--	--	--	--	--	--	0.4	--	--	--	--	0.2
HISS-20S	--	--	--	--	--	--	--	--	0.5	--	--	--	--	0.4
									0.4	0.5	0.7	0.6	1.1	0.7

Notes:

-- Data not available.

* Yearly averaged data.

Wells HISS-3, -4, and -8 were closed in 1992.

All results reported to the nearest 0.1 pCi/l.

The detection limit for 1997 results is 0.1 pCi/l.

The EPA MCL for Radium-226 is 20 pCi/l.

Historic data from BNI (1994) and SAIC (1995).

Historic data (1984-1996) may be "total" concentrations from unfiltered sample analyses.

Table 4-5

Historical Concentrations of Thorium-230 in Groundwater at HISS (1984-1997)

Concentrations in pCi/l

Well ID	1984*	1985*	1986*	1987*	1988*	1989*	1990*	1991*	1992*	1993*	1994*	1995*	1996*	1997
HISS-1	0.9	--	--	--	--	--	--	--	--	--	--	--	--	<0.1
HISS-2	8.7	0.8	--	--	--	--	--	--	--	--	--	--	--	<0.1
HISS-3	3.4	0.2	--	--	--	--	--	--	--	closed	closed	closed	closed	closed
HISS-4	0.8	3.6	--	--	--	--	--	--	--	closed	closed	closed	closed	closed
HISS-5	106.8	--	--	--	--	--	0.5	1	--	--	--	--	--	<0.1
HISS-5D	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.1
HISS-6	2.2	5.5	2.6	2.9	24	5	3.7	7.7	4.5	--	--	--	--	<0.1
HISS-7	1.6	--	--	--	--	--	0.7	3	1.4	--	--	--	--	<0.1
HISS-8	0.8	--	--	--	--	--	--	--	0.3	closed	closed	closed	closed	closed
HISS-9	--	0.2	0.6	0.2	0.2	0.2	0.2	1	2.7	--	--	--	--	<0.1
HISS-10	--	0.2	0.7	0.3	0.7	0.1	0.2	0.7	2.7	--	--	--	--	<0.1
HISS-11	--	0.9	1.3	0.8	1.5	0.7	0.4	4	3.4	--	--	--	--	<0.1
HISS-12	--	0.4	2	0.8	2.3	2.3	2	5	3	--	--	--	--	<0.1
HISS-13	--	0.3	1	0.3	0.6	0.9	0.7	2	7.8	<0.1	0.1	0.4	0.2	<0.1
HISS-14	--	0.2	--	--	--	--	0.8	6	1.7	--	--	--	--	<0.1
HISS-15	--	0.5	1.3	0.8	5.7	8.6	11	35.8	5.4	0.1	0.2	0.2	0.4	<0.1
HISS-16	--	--	--	--	--	--	0.5	3.1	1.9	0.8	0.9	0.5	0.5	<0.1
HISS-17S	--	--	--	--	--	--	--	--	<0.2	<0.1	<0.1	<0.1	0.2	<0.1
HISS-18S	--	--	--	--	--	--	--	--	<0.3	--	--	--	--	<0.1
HISS-19S	--	--	--	--	--	--	--	--	<0.3	--	--	--	--	<0.1
HISS-20S	--	--	--	--	--	--	--	--	0.2	<0.1	0.1	0.3	0.6	<0.1

Notes:

-- Data not available.

* Yearly averaged data.

Wells HISS-3, -4, and -8 were closed in 1992.

All results reported to the nearest 0.1 pCi/l.

The detection limit for 1997 results is 0.1 pCi/l.

There is no established EPA MCL for Thorium-230.

Historic data from BNI (1994) and SAIC (1995).

Historic data (1984-1996) may be "total" concentrations from unfiltered sample analyses.

Table 4-6 Historical Concentrations of Manganese in Groundwater at HISS (1989 and 1997) Concentrations in ug/l		
Well ID	1989	1997
HISS-01	152	64.1
HISS-02	754	132
HISS-03	5754	closed
HISS-04	1678	closed
HISS-05	30	1.5
HISS-05D	--	606
HISS-06	26	<0.3
HISS-07	80	9.4
HISS-08	670	closed
HISS-09	249	190
HISS-10	16	4.8
HISS-11	27	19.8
HISS-12	18	<0.3
HISS-13	26	<0.3
HISS-14	48	126
HISS-15	839	160
HISS-16	--	11.4
HISS-17S	--	79.3
HISS-18S	--	227
HISS-19S	--	3090
HISS-20S	--	178

Notes:

-- Data not available.

Wells HISS-3, -4, and -8 were closed in 1992.

All results reported to the nearest 0.1 ug/l for concentrations below 100 ug/l.

The sample quantitation limit (SQL) for 1997 results is 0.3 ug/l.

The EPA SMCL for manganese is 50 ug/l.

Historic data from BNI (1994) and SAIC (1995).

Historic data (1989) may be "total" concentrations from unfiltered sample analyses.

Table 4-7

Historical Concentrations of Nitrate in Groundwater at HISS (1994-1997)

Concentrations in mg/l

Well ID	1994	1995	1996	1997
HISS-01	--	--	--	436
HISS-02	--	--	--	21.7
HISS-03	closed	closed	closed	closed
HISS-04	closed	closed	closed	closed
HISS-05	--	--	--	22.3
HISS-05D	--	--	--	<0.1
HISS-06	--	--	--	29.0
HISS-07	--	--	--	370
HISS-08	closed	closed	closed	closed
HISS-09	--	--	--	6.3
HISS-10	--	--	--	8.2
HISS-11	--	--	--	42.1
HISS-12	--	--	--	9.4
HISS-13	985	880	878	517
HISS-14	--	--	--	642
HISS-15	<0.1	<0.1	1.9	2.1
HISS-16	--	--	--	528
HISS-17S	--	50.9	53	61.7
HISS-18S	--	--	--	<0.1
HISS-19S	--	--	--	1.6
HISS-20S	--	1.1	2.3	729

Notes:

-- Data not available.

Wells HISS-3, -4, and -8 were closed in 1992.

All analyses performed on unfiltered samples. Filtered sample not available.

All results reported to the nearest 0.1 mg/l for concentrations below 100 mg/l.

The sample quantitation limit (SQL) for 1997 results is 0.1 to 100 mg/l,
depending on detected concentration.

The EPA MCL for nitrate is 10 mg/l.

Historic data from BNI (1994) and SAIC (1995).

Historic data (1994-1996) may be "total" concentrations from unfiltered sample analyses.

Table 4-8 Historical Concentrations of Selenium in Groundwater at HISS (1989 and 1997) Concentrations in ug/l		
Well ID	1989	1997
HISS-01	407	271
HISS-02	77	89.5
HISS-03	82	closed
HISS-04	147	closed
HISS-05	121	18.2
HISS-05D	--	<3.4
HISS-06	120	99.6
HISS-07	150	382
HISS-08	120	closed
HISS-09	120	11.4
HISS-10	120	<3.4
HISS-11	95	3.7
HISS-12	85	81.4
HISS-13	146	37.3
HISS-14	--	211
HISS-15	94	10.6
HISS-16	--	159
HISS-17S	96.5	136
HISS-18S	--	<3.4
HISS-19S	--	<3.4
HISS-20S	134	386

Notes:

-- Data not available.

Wells HISS-3, -4, and -8 were closed in 1992.

All results reported to the nearest 0.1 ug/l for concentrations below 100 ug/l.

The sample quantitation limit (SQL) for 1997 results is 3.4 ug/l.

The EPA MCL for selenium is 50 ug/l.

Historic data from BNI (1994) and SAIC (1995).

Historic data (1989) may be "total" concentrations from unfiltered sample analyses.