EXECUTIVE SUMMARY

This report presents the results of the Phase II hydrogeologic survey at Hill Air Force Base (AFB), Utah which was accomplished under the U.S. Air Force Installation Restoration Program (IRP).

The IRP Phase II Field Survey was conducted after the completion of an IRP Phase I Records Search by Engineering Science (1982). Thirteen disposal sites at Hill AFB were evaluated which were rated and prioritized by contamination potential. Of these sites, the U.S. Air Force selected the four highest priority waste disposal areas for initial Phase II investigation. The four waste areas selected were: (1) Chemical Disposal Pits No. 1 & 2, (2) Landfill No. 3, (3) Berman Pond, and (4) Chemical Disposal Pit No. 3.

The project team consisted of personnel from three organizations. The Utah Biomedical Test Laboratory (UBTL) Division of the University of Utah Research Institute (UURI) provided the overall project management and laboratory analyses. Radian Corporation conducted the field hydrogeological investigation and interpretation of conditions. The Earth Science Laboratory (ESL) of UURI provided geophysical surveys of the waste sites.

The report is presented in two volumes. Volume I is the text of the final report and Volume II contains appendices supporting the investigation.

Location of Sites

Five separate areas were investigated during this study. They are: Chemical Disposal Pits Nos. 1 & 2, Landfill No. 3, Hill AFB Golf Course Area, Berman Pond, Chemical Disposal Pit No. 3. The general locations of these areas are shown on Figure S-1. The Golf Course area was included by the IRP Phase II team in order to examine potential groundwater recharge to the down slope waste sites at the Chemical Disposal Pits No. 1 & 2 and Landfill No. 3 areas.

Chemical Disposal Pits No. 1 & 2

Chemical Disposal Pits No. 1 & 2, located in the eastern portion of the base (Figure S-1) were used for dumping of liquid petroleum wastes from 1954 to 1973. The liquids were periodically burned. Oil has been detected on top of groundwater in two monitor wells located 200 to 300 feet from the pits. Previous chemical analyses of water samples showed high levels of COD, BOD and phenols. (U.S. Air Force Occupational and Environmental Health Laboratory, 1976)

Landfill No. 3

Landfill No. 3 (Figure S-1) was operated from 1947 through 1967. Large quantities of waste solvents, bottoms from solvent cleaning operations, and sludge from the base Industrial Wastewater Treatment Plant (IWTP) were placed in the landfill. The proximity of Landfill No. 3 to a previously studied Landfill No. 4 (Calscience Research, Inc., 1981; and U.S. Air Force Occupational and Environmental Health Laboratory, 1976) suggested that it may be contributing to the contamination observed near Landfill No. 4. Northwest of Landfill No. 3 is a fire protection training area. Although this area was not part of the present study, some data were indirectly developed for that area in the course of the Landfill No. 3 studies.

Golf Course Area

Construction of an 18-hole golf course on the east side of the base began in 1960 (Figure S-1). The facility is equipped with an irrigation system. The golf course is situated south of the waste disposal areas of Chemical Disposal Pits No. 1 & 2, Landfill Nos. 3 & 4 and is topographically about 50 feet higher than the disposal areas. The golf course is not a waste disposal area. As noted above, it was included in the survey by the IRP Phase II team in order to assess its hydrologic effect upon the down slope disposal areas.

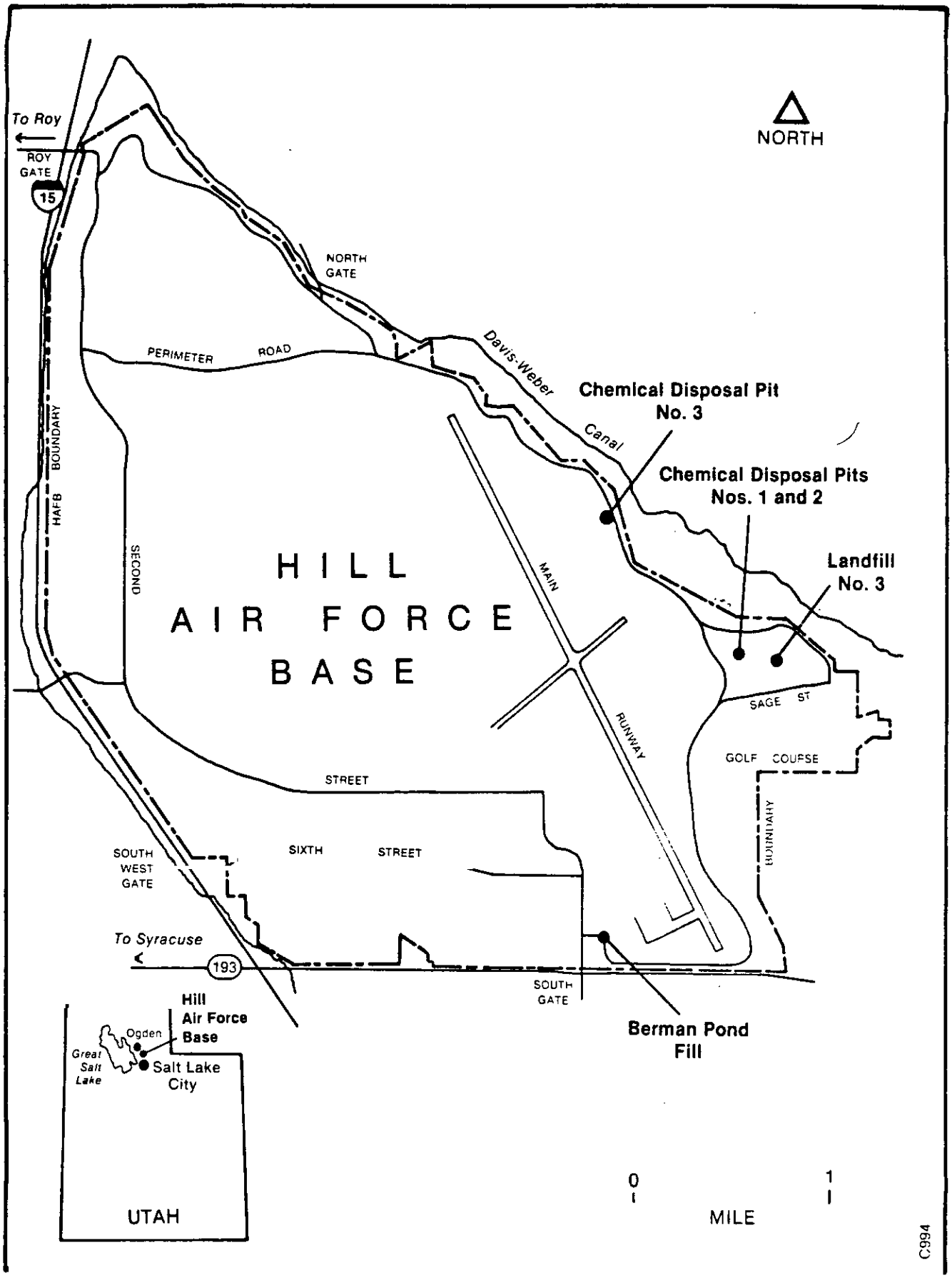

Figure S-1. Study Area and Waste Site Locations.

Berman Pond

Berman Pond was operated as an unlined evaporation pond for industrial wastewaters, including electroplating wastes, from 1940 to 1956. The site, located at the southern end of the base, has been filled and regraded (Figure S-1). No site-specific data on the subsurface geology and groundwater in the Berman Pond area were available prior to this investigation.

Chemical Disposal Pit No. 3

Chemical Disposal Pit No. 3, located on the northeastern border of Hill AFB (Figure S-1), was used from 1967 to 1975 for disposal of large quantities of sludges bottoms from a TCE solvent recovery unit. The area is also reported to have received bottoms from plating operations during the 1940's. The exact location of the pit was not evident. No studies had been performed in the area, and no evidence of contaminant discharge off-base from the pit has been reported.

Type and Number of Tests Conducted

A variety of techniques were employed in the Hill AFB Survey. They include three geophysical techniques (electrical resistivity, ground magnetics and self-potential measurements), soil coring and analysis as well as sampling for water analysis from monitor wells, lysimeters and piezometers installed as part of the project. In addition, water samples were collected from selected existing monitor wells. Table S-1 summarizes the field program and sampling. Table S-2 summarizes the pollutant analyses.

Based upon the IRP Phase II Field Survey findings, the following results can be derived.

Geophysical Results

Chemical Disposal Pits No. 1 & 2. Resistivity data have mapped a rather continuous clay layer at depths between 30 and 50 feet, beneath Chemical Pits No. 1 & 2, in contrast to much thicker sand and gravels to the west and north which could permit migration to the west and north of pollutants from the chemical pits. Ground magnetic data mapped a broad

Table S-1

Summary of Field Program Techniques and Sampling Methods

	Data Review	Electrical Resistivity	Ground Magnetics	Self-Potential	Soil Coring	Monitor Wells	Piezometers	Lysimeters
Chemical Disposal Pits Nos. 1 & 2	X	X	X	X	X	X		
Landfill No. 3	X	X	X			X		
Golf Course Area	X	X				X		
Berman Pond	X	X	X		X	X		X
Chemical Disposal Pit No. 3	X	X		X	X		X	X

Table S-2.

Summary of Pollutant Analyses - Ranges Detected

Water Analysis	Chem. Pits Nos. 1 & 2	Landfill No. 3	Golf Course Area	Berman Pond	Chem. Pit No. 3	Units
TOC	2-15	1-14	2-3	2-18	4-190	mg/L
TOX	90-950	30-280	70	60-2,800	40-180,000	µg/L
Oil & Grease	<5-76	<5	<5-6	<5		mg/L
Phenol	<10-1,200	<10-50	70-390	<10-30	<10-15,300	µg/L
MBAS		<0.1-0.4	<0.1-0.2			mg/L
TDS	340-840	320-2900	80-1,000			mg/L
Cyanide		<10	<10	<10	<10	µg/L
Sulfate	<5-45	21-480	8-130			mg/L
Arsenic		<5-28	<5-<10			µg/L
Barium	<100	<100	<100	<100	<100	µg/L
Beryllium		<10	<10	<10	<10	µg/L
Cadmium	<10-10	<10-20	<10	<10	<10-100	µg/L
Chromium		<50	<50	<50	<50	µg/L
Copper		<20	<20			µg/L
Iron	<100-18,000	<100-2,100	<100-200	<100	<100	µg/L
Lead		<10-<20	<10-<20			µg/L
Manganese	140-1,600	<20-1,700	<20-440	<20-70	<20-2,400	µg/L
Mercury		<0.2-<10	<0.2-<10			µg/L
Zinc	200-320	30-90	30-230	<10-40	<10-540	µg/L
601 (1)	<1-34,000	<1-490	<1	<1-1,400	<1-610,000	µg/L
602 (2)	<1-25,000	<1-37	<1-3	<1-2		µg/L
GC/MS (3)						
ICAP (4)						
Conductance	580-1,300	390-4500	100-1,800	250-840	80-3,300	µmho/cm
Calcium	52-180	50-300	10-100	18-110	13-280	mg/L
Magnesium	26-31	12-130	1-51	7-14	9-130	mg/L
Sodium	27-49	38-490	13-200			mg/L
Potassium	4-8	2-19	<1-26			mg/L
Carbonate	18-44	<1-68	10-52			mg/L
Bicarbonate	200-520	220-530	20-470			mg/L
Chloride	50-79	48,1,000	14,230			mg/L
Fluoride	0.2-0.3	0.3-0.5	0.2-1.3			mg/L
Nitrate	<0.02-0.61	<0.02-3.3	0.5-5.4			mg/L
Hardness	250-580	240-1,300	29-420			mg/L
Silica	11-29	10-18	2-16			mg/L

(1) Volatile halocarbons
(2) Volatile aromatics
(3) GC/MS screening for organics, see text for details
(4) ICP screening for metals, see text for details

Table S-2. (Continued)

Summary of Pollutant Analyses - Ranges Detected

Water Analysis	Chem. Pits Nos. 1 & 2	Landfill No. 3	Golf Course Area	Berman Pond	Chem. Pit No. 3	Units
TOC	3,000-23,000			630,6,000	470-18,000	µg/L
TOX	<5-11			>5->6	>5->6	µg/L
Oil & Grease	<5-370			<5-12		mg/L
Phenol	<10-380			<10-43		µg/L
Cyanide				<10-<11	<10-<13	µg/L
Beryllium				<4	>4-49	µg/L
Cadmium				<4-17	<4-510	µg/L
Chromium				<20-230	<20-270	µg/L
Moisture	1.5-19			2.1-9.1	2-22	%

area (200 by 400+ feet) of metal trash and debris which includes the two pits. Erratic self-potential values suggest electrochemical reactions are continuing within the soil in the disturbed area mapped by the magnetics. The differential oxidation of iron barrels and other metallic trash in contact with near surface waters is the most likely source of the erratic voltage measurements.

Landfill No. 3. Electrical resistivity data indicate clay and sandy clay generally less than 30 feet deep beneath the eastern 70% of Landfill No. 3. Higher resistivities (75 ohm-meters) south of the top-of-slope indicate clay layers are more than 60 feet deep. Ground magnetic data indicate the presence of fill and magnetic trash throughout the Landfill No. 3 area.

Golf Course Area. One resistivity line suggests that a clay layer is present at shallow (10-30 feet) depth beneath much of the Golf Course Area. At Base Well No. 4, near the intersection of Sage Street and Perimeter Road, the clay layer appears to be deeper (30 feet or more) and dipping to the north.

Berman Pond. The Berman Pond fill is indicated by apparent resistivities less than 100 ohm-meters in contrast to much higher values (200 to 1000 ohm-meters) corresponding to undisturbed sands to the south. No substantial (5 feet thick or more) laterally extensive clay layer is present within 60-80 feet of the surface at Berman Pond. Ground magnetic survey data confirm the presence of much magnetic debris within the fill and further substantiate the outline of the landfill area.

Chemical Disposal Pit No. 3. Five dipole-dipole resistivity lines defined a complex resistivity distribution at Chemical Disposal Pit No. 3 which was interpreted to be a major slump feature. Clay layers are present west of the pits, but are broken and discontinuous within the slump block. Multiple pathways for contaminant migration thus appear to be present at this site.

Hydrogeologic Results

Chemical Disposal Pits No. 1 & 2 and Chemical Disposal Pit No. 3 have affected the largest downgradient groundwater areas by past disposal activities at the Base. Their disposal areas are much smaller than Landfill No. 3. No shallow groundwater was encountered at Berman Pond. Follow-on investigations will be required to fully evaluate the extent of contamination.

In the case of Chemical Disposal Pit No. 3, the approximate lateral extent of downgradient groundwater impact could encompass 14 acres between the Base boundary and the Davis Weber Canal. Migration east of the canal is a possibility because it is also located on a slump complex. The volume of groundwater impacted could not be reliably computed due to the numerous pathways for potential contaminant migration through the slump feature and the absence of downgradient hydrogeologic data. The thicknesses of the flow paths in the aquifers at the pit range from fractions of a millimeter along the slump fault planes to greater than 23 feet in the sand zones, with significant changes over short distances.

Contaminated soil outside Chemical Disposal Pits No. 1 & 2 was due to waste fluids migrating along the top of the groundwater surface, as evidenced by oil slicks at two nearby monitor wells (W-4 and 80-20) to the west. The lateral extent and thickness of the oil slick is unknown. The migration of the waste products from the pits is primarily to the nortwest with a probably secondary component to the north. The main groundwater flow goes to the Northwest.

Conclusions and Recommendations

The objectives of the initial IRP Phase II Field Investigation were met and information gaps identified. During the course of the investigation, it was found that a variety of hydrogeological conditions exist at the Base. All of the sites tasked for investigation were located and contamination was detected in groundwater in the vicinity of most of the waste sites. The Base Golf Course Area was investigated to determine its potential hydrologic impact on nearby Landfill No. 3 and Chemical Disposal

Pit Nos. 1 and 2. General site conclusions and recommendations are provided for each area as follows on Table S-3. Additionally, preliminary information on Landfill No. 4 (located next to Landfill No. 3) was developed during this study and warrants a brief comment in Table S-3.

Table S-3. Hill AFB IRP Phase II Investigation General Site Status

1. Chemical Disposal Pits Nos. 1&2: The sites were located and a plume was identified. The plume was also found to extend beyond the area of current monitor well control. Local hydrogeologic conditions were defined to include an underlying shallow clay and the identification of an aquifer under the clay. Downgradient and off-site conditions beyond present data are unknown. Field investigations will be required to define the plume and downgradient hydrogeologic conditions. Any remedial action design would have to consider the present sites and plume identified.

2. Landfill No. 3: A contamination plume was detected but not completely defined downgradient of the landfill. The local hydrogeology has been defined to include the underlying clay and the identification of an aquifer under the clay. Field investigations will be required to define the plume downgradient.

3. Golf Course: Groundwater was found below the golf course which can contribute groundwater underflow to the topographically lower disposal areas. Available information suggests that any remedial action at the topographically lower disposal areas should address the effects of groundwater underflow.

4. Landfill No. 4: Some monitor wells installed prior to this investigation are believed to be screened across the shallow and lower aquifers; in addition, some of these wells with either partial construction and/or entire casing are perforated. Therefore, it is recommended that the well construction data and screened horizons be evaluated to assess the usefulness of these wells as monitor wells under the remedial actions program. This assessment would also include the identification of locations of other monitor wells.

5. Berman Pond. Based upon present data, the approximate areal extent of the pond has been identified, local hydrogeology has been determined and the absence of shallow perched groundwater has been confirmed. Two deep aquifers at depths greater than 90 feet were found. If leachate is being generated at the pond, it would not be the result of groundwater intrusions but would be predominantly from infiltration of precipitation and possible leakage from utility water lines. Chemical analyses from the shallow lysimeters and deep monitor wells indicate contamination in groundwater, but due to the complexity of hydrogeologic conditions, the impact of Berman Pond on the groundwater is uncertain and cannot be reliably stated. Additional field investigation would be needed to define any impact on the local groundwater systems and assesses the potential for continued generation of leachate from the pond area.

6. Chemical Disposal Pit No. 3: Disposal pit location was determined. The local hydrogeology was determined and the occurrence of solvents in a perched shallow groundwater system was detected. Additional solvents were detected upgradient of the pit(s). The source of these solvents is unknown. Downgradient and off-site conditions are unknown. Additional field investigation is recommended to identify other source(s) of solvents and to assess the extent of impacts.