1.0 EXECUTIVE SUMMARY

BACKGROUND AND APPROACH

The potential for migration of organic contaminants from Hill Air Force Base (AFB) into Layton community via ground water was identified in 1986 by Hill Air Force Base through Installation Restoration Program (IRP) studies. Hunter/ESE was contracted in 1987 by Hill AFB to perform a ground water investigation to characterize ground water contamination and its migration.

The investigation conducted by Hunter/ESE included the following studies to define the subsurface hydrogeology and the presence of volatile organic compounds (VOCs) in the ground water.

- o Literature Search:
  - Compilation of existing data and site background information.
- o Stratigraphic and Hydrogeologic Definition:
  - Borehole drilling and soil sample collection for stratigraphic control.
  - Laboratory soil classification tests of borehole samples for stratigraphic and aquifer definition.
  - Monitor well installation to monitor ground water chemistry and define the potentiometric surface.
  - Slug/bail tests for aquifer characterization.
- o Delineation of Organic Contamination:
  - Soil gas survey to aid in selection of monitor well locations.
  - Analysis of borehole soil samples for detection of organic compounds.
  - Two rounds of water quality sample collection and analysis for detection of VOCs.
  - Evaluation of agricultural field drain water sample analyses.
- o Inventory of Near-Surface Manmade Features:
  - Documentation of the location, depth, and construction materials for agricultural field drains, storm sewers, industrial and sanitary sewers, and domestic water lines. These features were evaluated as potential migration pathways for transport of organic compounds.

- Evaluation of analytical data for effluent of the Industrial Waste Treatment Plant (IWTP) and from the North Davis County (NDC) Sewer District for additional delineation of organic contamination.

o Preliminary Risk Assessment:

- Identification of indicator chemicals, migration pathways, environmental fate and transport, exposure pathways, potential receptors, exposure point concentrations, identification of applicable or relevant and appropriate requirements (ARARs) and risk characterization.

HYDROGEOLOGY

Four predominant lithologic units were identified during the investigation:

o poorly graded sand with silt (SP-SM)

o silty sand (SM)

o silt and silty clay (ML; CL-ML)

o lean clay (CL)

The stratigraphic sequences and predominant lithologies are indicative of a fluvially dominated deltaic system. The southern portion of Hill AFB and the northern areas of Layton are apparently south of the main distributary channel system related to the delta plain.

The deltaic deposits in the study area are characterized by alternating sequences of medium and fine grained deposits (sand and clay). Several fine-grained channels were encountered in the study area. These channels may represent off-shoots from the main distributary channel. The shallow water table aquifer underlying Hill AFB and northern Layton is an unconfined system. Depths to the water table range from 7.3 ft to 53.0 ft below ground surface. Water quality analysis indicates the ground water is generally a calcium magnesium bicarbonate (Ca^{+2} - Mg^{+2} - HCO_3^-) type.

Hydraulic conductivities in the water table aquifer system beneath the site were found to range from 1.2 ft/day to 42.8 ft/day. These values were based on results from preliminary aquifer testing (slug/bail tests) and grain size comparison of area soils as authorized in the statement of work. Utilizing

this data, preferential flow paths of the ground water were found to have relatively low horizontal hydraulic conductivity. In addition, the average linear ground water velocity ranged from 0.1 ft/day to 3.0 ft/day. The ground water flow direction in the study area is generally to the southwest becoming more southerly eastward in the study area.

MANMADE FEATURES

Near surface manmade features that exist in the study area may be acting as potential conduits for ground water flow. The features have been identified as sanitary and industrial sewer lines, storm drains, domestic and irrigation water lines, and agricultural field drains.

These features create a complex lattice or network of preferential flow paths in the upper portions of the water table aquifer and exist throughout the study area.

CONTAMINANT DISTRIBUTION

Low concentration levels of organic compounds were identified during the investigation. The compounds were detected in samples collected from ground water monitoring wells, agricultural field drains, sewer discharge lines, and soil gas.

Trichloroethylene (TCE) was the only compound detected in ground water samples for which concentrations exceeded the United States Environmental Protection Agency (EPA) drinking water maximum contaminant level (MCL) of 5.0 micrograms per liter (ug/l). Concentrations of TCE exceeded the MCL in only two samples. One sample was collected from well ESE-W6 where the concentration of TCE equaled 9.4 ug/l. The other was detected at 6.7 ug/l in a pre-purged sample collected from well ESE-W2 (Sample ID# ESE-W28). ESE-W2 is located near the western boundary of the study area.

Chemical constituents detected in agricultural field drains exceeding EPA MCLs and proposed MCLs for drinking water include the following:

- Benzene
- 1,2-Dichloroethane
- Trans-1,2-Dichloroethene
- TCE

Chemical analysis characterizing the effluent in an industrial sewer line downgradient of the IWTP at Hill AFB indicates releases into the line exceeding the permit limit of 1.92 parts per million (ppm)/day of total toxic organic compounds. However, Hill AFB has upgraded its IWTP, and since March 1988 has met effluent limits for total toxic organic compounds. The following compounds, among others, were detected in the analyses:

- Benzene
- Methyl Ethyl Ketone
- Methylene Chloride
- Toluene
- Trichloroethanes
- Dichloroethanes
- Ethyl Benzene

The soil gas analyses indicate relatively low concentrations of trichloroethylene, methylene chloride, trans-1,2-dichloroethene, and benzene. These detections were located primarily downgradient of Ponds 1, 3, and Berman Pond. South of Hill AFB there were only sporadic detections of methylene chloride. Soil gas analysis detected relatively high levels of toluene in soil gas throughout the study area. However, electrical tape used in the sampling procedure may have contaminated the samples with toluene. The soil gas analyses for toluene may be unreliable. Toluene was only very sporadically detected in ground water and field drain samples.

The VOCs detected in the study area can be organized into four major classes: 1) halomethanes; 2) chlorinated aliphatics; 3) monocyclic aromatics; and 4) ketones.

Physical and chemical properties of contaminants will influence distribution in both the saturated and unsaturated soil environment. Properties such as partition coefficient (K_{OW}) and aqueous solubility will influence how readily a contaminant leachs into the aqueous phase (soil moisture).

Specific gravity of a contaminant influences the downward leaching rate and determines whether it floats or sinks in an aquifer once it reaches the water table. Vapor pressure and the Henry's Law Constant (H) for a

contaminant determine volatilization rate at the surface. Volatilization becomes a less important factor with depth.

Chlorinated ethanes and ethylenes (chlorinated aliphatics) are the primary compounds of interest in this investigation. These compounds are moderately to highly soluble (aqueous solubility ranges from 200 milligrams per liter (mg/l) to 8.69×10^3 mg/l), and the affinity for sorption on mineral surfaces or naturally occurring organic carbon is moderate to high (log K_{OW} ranges from 1.23 to 2.88), increasing with increased chlorine content. In ground water, the ethanes and ethylenes will undergo a complex series of dehalogenation reactions. A compound may form a number of degradation products depending upon the reaction mechanism.

Analysis of samples collected from eight monitor wells in the study area indicated low level organic contamination. Compounds detected at quantifiable levels in ground water samples included: chloroform (0.50 to 4.41 ug/l), chloromethane (1.93 to 3.64 ug/l), 1,1-dichloroethane (0.80 to 1.50 ug/l), 1,2-dichloroethane (0.1 ug/l), 1,1-dichloroethylene (0.20 ug/l), methylene chloride (3.0 to 3.41 ug/l), 1,1,1-trichloroethane (0.3 to 5.28 ug/l), and TCE (1.2 to 6.73 ug/l). The volatile organic carbon compounds, chloroethane, 2-chloroethylvinyl ether, chloromethane, and methylene chloride, were detected in the trip blank.

Analyses of six soil samples from selected locations were analyzed and no organic compounds were detected above EPA Contract Laboratory Program (CLP) established quantification limits. Methylene chloride was detected in a lean clay at a depth of 40 ft, but possible equipment contamination makes the reading suspect.

Quality Assurance/Quality Control (QA/QC) samples collected during the Layton field program permit an evaluation of analytical data accuracy. Three types of field QA/QC samples were prepared and analyzed: 1) trip blanks; 2) equipment blanks; and 3) duplicate samples. Two compounds were detected in significant concentrations in trip blanks for the April 1988 sampling round: chloromethane and methylene chloride. Oil and grease were detected in the December 1987 sample round in both the trip and equipment

blanks. Chromium was detected in the April 1988 sample round equipment blank. Detections of these constituents in these particular sampling rounds should be viewed with skepticism until verified by future sampling events.

A number of the constituents were reported at or near the Method Detection Limit (MDL). The repeated occurrence of these compounds at or near the MDL within each sample source supports their actual presence in the environment and discounts the possibility of field sampling or analytical error. In addition, many of the compounds were detected at concentrations between the MDL and the Practical Quantification Level (PQL). Values reported within this range are indicative of the compound being present, but with limited quantification.

If a compound is detected in a number of sample analyses (i.e., five detections out of seven analyses), this is significant and should be viewed as real, even if the concentration was near the MDL or below the PQL. On the other hand, one detection out of seven analyses, especially at a low concentration near the MDL, should be viewed with caution until verified. Concentrations of organic analytes at levels up to several times the detection limit should be viewed with caution and require verification.

MIGRATION OF ORGANIC COMPOUNDS

Three potential migration pathways for organic compounds exist in the study area:

- Preferential flow paths in the ground water aquifer;
- Preferential flow paths along storm and sanitary sewer lines; and
- Preferential flow paths along agricultural field drains.

Wells displaying the most detected compounds, although at relatively low concentrations, are ESE-W2, ESE-W4, ESE-W6 and ESE-W7. ESE-W2 and ESE-W7 may indicate migration of organic compounds out of the study area within preferred flow paths of the shallow unconfined aquifer. ESE-W6 and ESE-W7 are completed adjacent to the NDC sewer line that receives industrial effluent from the IWTP on Hill AFB. ESE-W4 is located near a storm drain which receives runoff from the southern area of the base.

Numerous potential sources for the introduction of organic compounds to the ground water exist off-base and on Hill AFB. Many of the compounds detected are solvents commonly used by many types of businesses, such as dry cleaners, gas stations, and vehicle maintenance shops. Potential off-base sources (not prioritized) have been identified as:

- Abandoned dry cleaner at intersection of Utah Highway 193 and 400 West Street in Layton;
- Texaco station on Utah Highway 193 near I-15 Interchange;
- Circle K, located on Utah Highway 193 and 1510 East, Clearfield;
- Phillips 66, located on Utah Highway 193 and 400 West, Layton;
- Utah Department of Transportation Maintenance Shop and Storage Yard, south of Pond 3 on the north side of Utah Highway 193;
- Herbicides and pesticides applied by farmers in the area and at Desarose Greenhouse;
- Septic tank leach fields;
- Farm activities (storage of oil and fuels, equipment maintenance, etc.); and
- Channelization of irrigation water containing potential contaminants.

Some of these facilities possess underground storage tanks for gasoline and diesel fuel. The types of chemical compounds detected in the field drains and nearby monitoring wells are generally not associated with fuel oil or gasoline petroleum hydrocarbons or their degradation products. Solvents used to clean such tanks may, however, contribute to the local contamination problem.

TCE has been is known to be used to clean septic tank leaching systems. The use and extent of septic leach fields in the study needs to be further documented. Additional evaluation of potential off-base sources is required before the extent and migration of contaminants of concern can be clarified.

The chemical composition of the tar paper surrounding the open joints in the older field drains, and that of the new polyethylene pipe currently used for field drains, were evaluated as potential sources of organic compounds. It

was determined through contact with the pipe manufacturer and through Hunter/ESE geochemists that neither material could introduce the type of organic compounds detected in the shallow ground water in the study area. The Air Force had the tar paper analyzed and found no organic compounds.

Two factors lead to the preliminary conclusion that Hill AFB is a potential contributor to the low level organic compounds found in the Layton area. Most of the VOCs observed in ground water and field drain samples are currently used or have been used in the past at Hill AFB or could be a degradation product of those compounds. These include TCE, 1,1,1-trichloroethane, dichloroethenes, and dichloroethanes. Contaminants detected in ground water and field drain samples in Layton were also detected in soil gas near Ponds 1, 2, and 3, and Berman Pond on Hill AFB.

High concentrations of VOCs have been discharged from the Hill AFB IWTP to the NDC sewer prior to March 1988. However, based on the limited data collected in the study area, there does not appear to be a correlation between the type of contaminants detected in the IWTP effluent and those detected in samples collected from the field drains and monitor wells. 1,1,1-Trichloroethane and 1,2-dichlorethane were the only two compounds consistently detected in all three types of samples: ground water, field drain, and NDC sewer lines. Trichloroethylene was detected in the field drains and ground water but not in the NDC sewer line effluent sampled during this study. From October 1986 through March 1988, very high levels of methylene chloride (up to 121,037 ug/l) and toluene (up to 6870 ug/l) were discharged down the NDC sewer line. However, these compounds have not been detected in ground water and field drain samples to date. Hill AFB has greatly reduced its discharge of organic compounds to the NDC sewer line since March 1988.

Variability in concentrations of organic compounds, observed at individual sampling points, can be attributed to variability in aquifer composition, ground water flow rates, and concentrations near the MDLs. However, the repeated detections of compounds verified their presence in the sampled medium.

In the study area, coarse-grained sediments (interdistributary and down current off-shoot channels) provide a relatively more transmissive conduit for ground water flow. The fine-grained sediments with numerous silts, silty clays, clay lenses, and higher organic carbon content, provide adsorption sites for organic compounds. As long as there is an active source area, the organic compounds will be transported through the aquifer, and at the same time will be adsorbed into the fine-grained zones. Depending upon the number of years the source has been active, the degree of surface recharge, and the resultant ground water flow rate, the volume of organic compounds adsorbed onto the fine-grained materials could vary.

Once a source is removed, the ground water flow will very slowly desorb the chemical constituents from the fine-grained zones. This could explain the presence of TCE in field drain samples even though the compound has not been utilized on Hill AFB for ten years. Likewise, other organic compounds could also be desorbed from the fine grained zones.

Wells completed in fine-grained sediment containing relatively high concentrations of organic carbon yield relatively greater concentrations of desorbed detectable organics, for example ESE-W4. Conversely, wells completed in fine-grained zones with relatively low organic carbon content exhibit sporadic detection of organics due to relative dilution of desorbed compounds. Wells completed throughout the area exhibit variable results due to variations in sorption and flow characteristics of the heterogeneous aquifer system.

The uppermost sediments, including the agricultural soil horizon, have relatively greater organic carbon contents compared to the deeper oxidized deltaic sediments. The field drains collect water from the uppermost water table (sediments with high carbon content) over a large area, whereas the wells collect water from sediments within a narrow zone of the deltaic sediments. This may account for the higher concentration of many of the constituents in the field drains.

PRELIMINARY RISK ASSESSMENT

A preliminary risk assessment was performed to address the potential off-site environmental risk associated with contamination at Hill AFB. The indicator chemicals selected for the risk assessment were:

- Benzene
- TCE
- Chromium
- Trans-1,2-Dichloroethene
- 1,2-Dichloroethane

Fate and transport analysis indicates that organic compounds in the study area are confined to the shallow ground water system with the exception of minor VOCs in the air.

A low potential health risk exists as associated with human exposure to VOCs from Hill AFB. The exposure analysis has identified multiple potential pathways by which compounds in the ground water or field drain system may reach receptors. While each pathway may represent only a small exposure, the addition of exposure pathways may result in a combined dose of chemical constituents to the receptor population. The potential of any exposure for each pathway is expected to be low both in terms of the number of persons exposed and the duration and frequency of exposure.

Based on the results of the preliminary risk assessment, there is no evidence that exposure is currently occurring. It is important to note that this study represents an initial screening and that future detailed site investigations at Hill AFB or the off-base area may identify additional source areas. As additional data is collected, a detailed risk assessment may be warranted.