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RCRA PERMIT PART B NUMBER HW50289 RCRA FACILITY INVESTIGATION REMEDIATION WORK PLAN FOR SOLID WASTE MANAGEMENT UNIT 64 AND 67 NAS FORT WORTH TX

10/7/1991

ARMY CORP OF ENGINEERS

File: 17G
A.F.

NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 92

CARSWELL AIR FORCE BASE, TEXAS

RCRA Permit, Part B, Number HW50289

WORK PLAN

SWMU NO. 64
FRENCH UNDERDRAIN SYSTEM

SWMU NO. 67
BLDG 1340 - OIL/WATER SEPARATOR

7 October 1991

Prepared By
U.S. Army Corps Of Engineers
Fort Worth District

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1.0 Description of Installation.

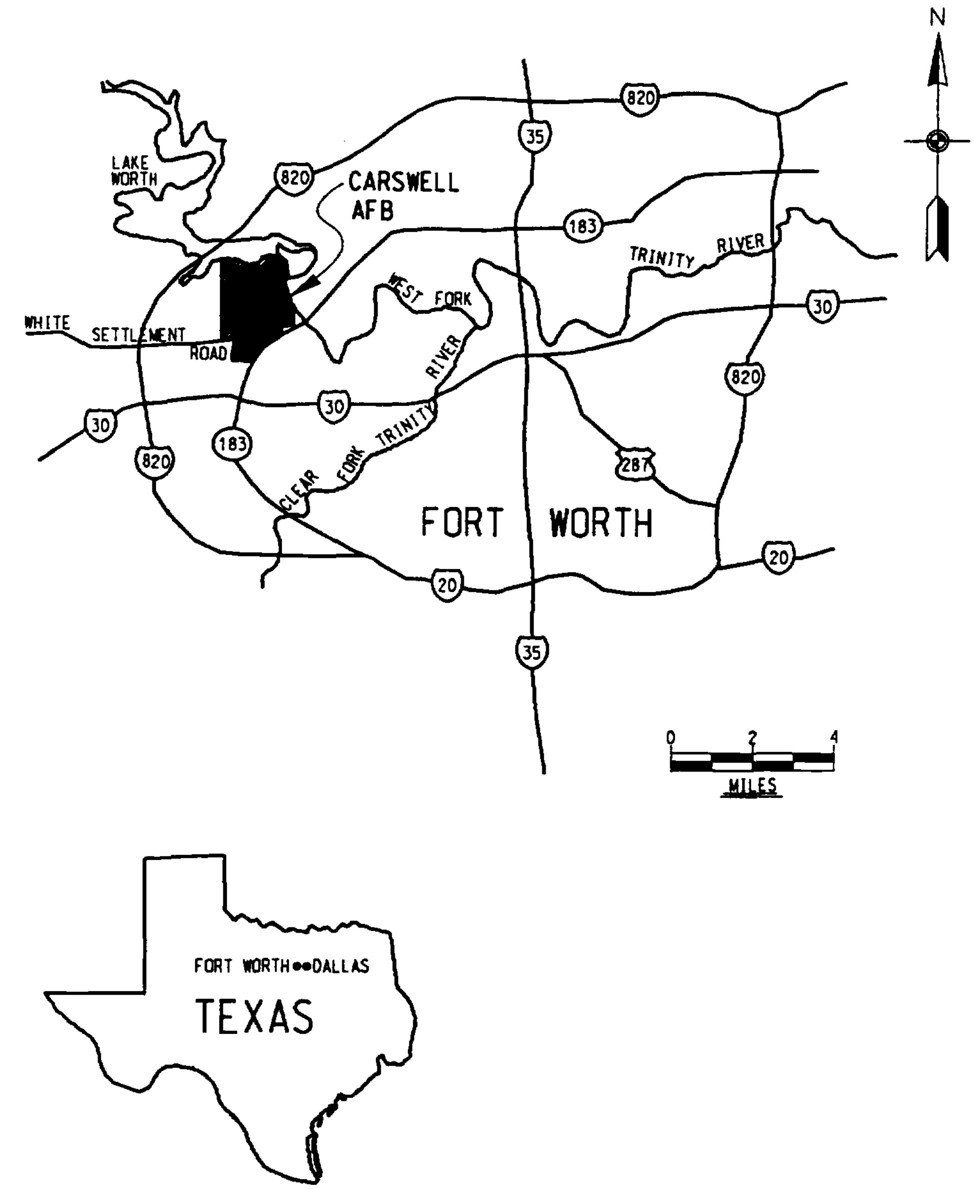
Carswell AFB is located on 2,751 acres of land in Tarrant County, Texas, 6 miles west of the center of Fort Worth and lies between the communities of White Settlement and River Oaks. Carswell AFB lies within a bend of the West Fork of the Trinity River which flows along the northern and eastern boundaries of the base. The river is dammed to form Lake Worth, a drinking water supply and recreation reservoir bordering Carswell AFB to the north. To the west, Carswell AFB is neighbored by Air Force Plant 4, an Air Force-owned, General Dynamics Corporation-operated, aircraft production plant that shares the runway and several facilities with Carswell AFB. To the south Carswell AFB is bordered by urban areas. Off-base facilities include the Intermediate Landing System (ILS) Marker Beacon west of Carswell AFB and the Weapons Storage Area (WSA), 4 miles west of Carswell AFB.

Carswell AFB is the home of the Strategic Air Command's (SAC) 7th Bombardment Wing. As such, the mission of Carswell AFB is to maintain the capability of strategic warfare and air refueling operations. Assigned weapon systems include the Boeing B-52 "H" model bomber and the KC-135A tanker.

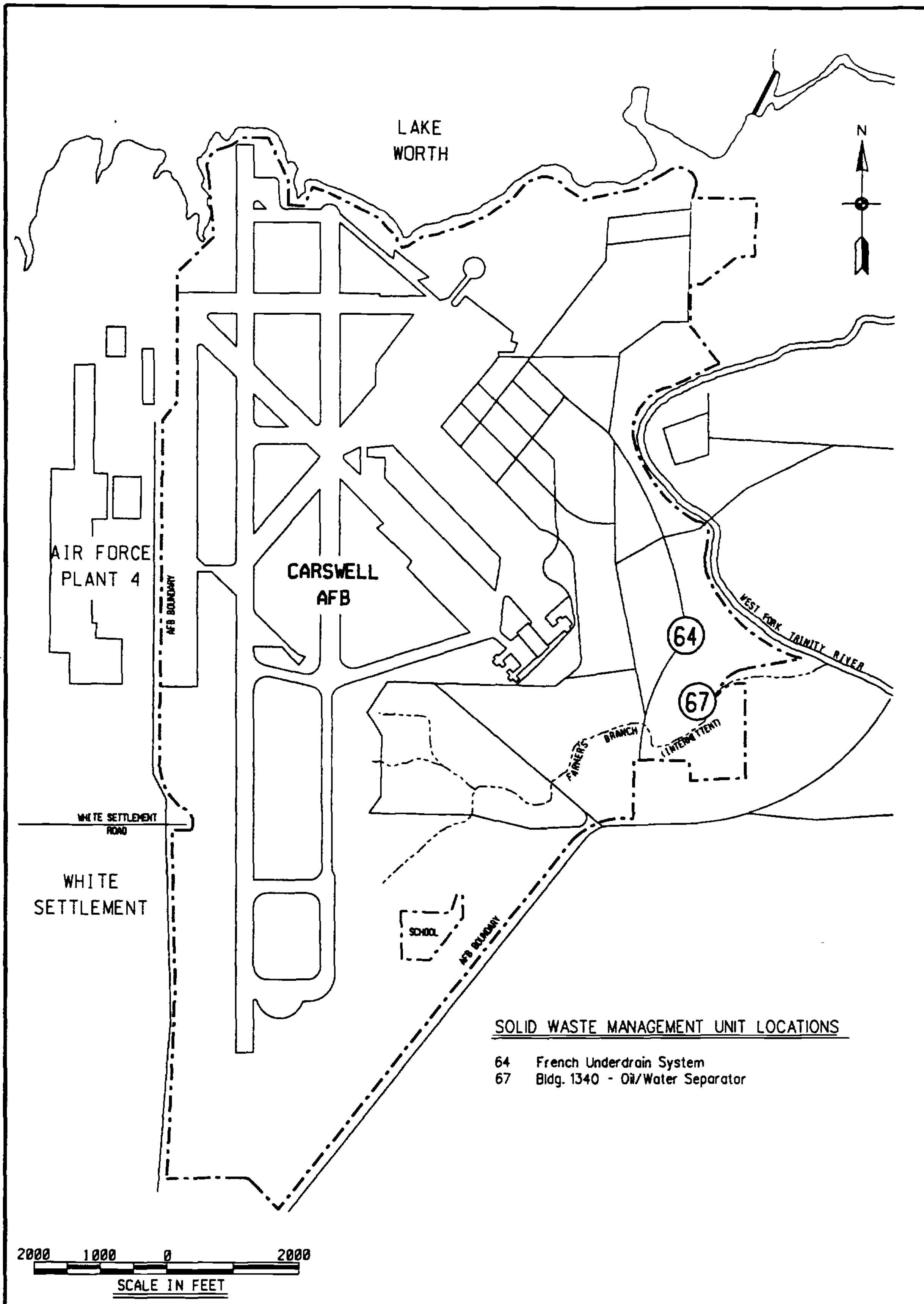
As host unit, the 7th Bombardment Wing oversees aircraft operations and maintenance agencies. In addition to maintaining bombers, tankers, and combat crews capable of strategic warfare, Carswell AFB also houses an extensive air training effort which includes the air training requirements of three tactical squadrons. The 7th Combat Support Group and the USAF Regional Hospital support the combat mission of the Wing. The total work force at Carswell AFB (as of 1984) was approximately 5,100 military and 1,000 civilian personnel.

2.0 Environmental Setting

The following discussion of the Carswell AFB environmental setting is derived primarily from the Installation Restoration Program Phase I Records Search Report (CH2M Hill, 1984). Information from that report is supplemented



CARSWELL AIR FORCE BASE, TEXAS
REGIONAL SETTING
FIGURE 1



CARSWELL AIR FORCE BASE, TEXAS
SOLID WASTE MANAGEMENT UNIT LOCATIONS
FIGURE 2

by information from the literature and from the general findings of studies conducted by the Radian Corporation. The following sections describe the environmental setting of Carswell AFB. Basic features and history of the site investigated in this work plan are also discussed below.

2.1 Geophysical Setting

Carswell AFB is located in northeastern Texas in Tarrant County, six miles west of downtown Fort Worth (Figure 1). The base is bordered by Lake Worth to the north, the West Fork of the Trinity River and the community of Westworth to the east and southeast, the community of White Settlement to the south and southwest and Air Force (AF) Plant 4 to the west. The location of Carswell AFB is shown in Figure 2.

The base lies within an area of primarily residential, recreational, and industrial/commercial land use. The principal industrial use of the area is Air Force Plant 4, an aircraft production plant that borders Carswell AFB to the west and shares the runway with the base. Recreational land use includes the Y.M.C.A's Camp Carter, and various parks on the shores of Lake Worth.

2.1.1 Physiography

The majority of Carswell AFB is located within the Grand Prairie section of the Central Lowlands Physiographic Province. This area is characterized by broad terrace surfaces sloping gently eastward, interrupted by westward-facing escarpments. The land is typically grass covered and treeless, except for isolated stands of upland timber. The northwestern part of Carswell AFB is within the Western Cross Timbers Physiographic Province that is characterized by rolling topography and a heavy growth of post and black-jack oaks.

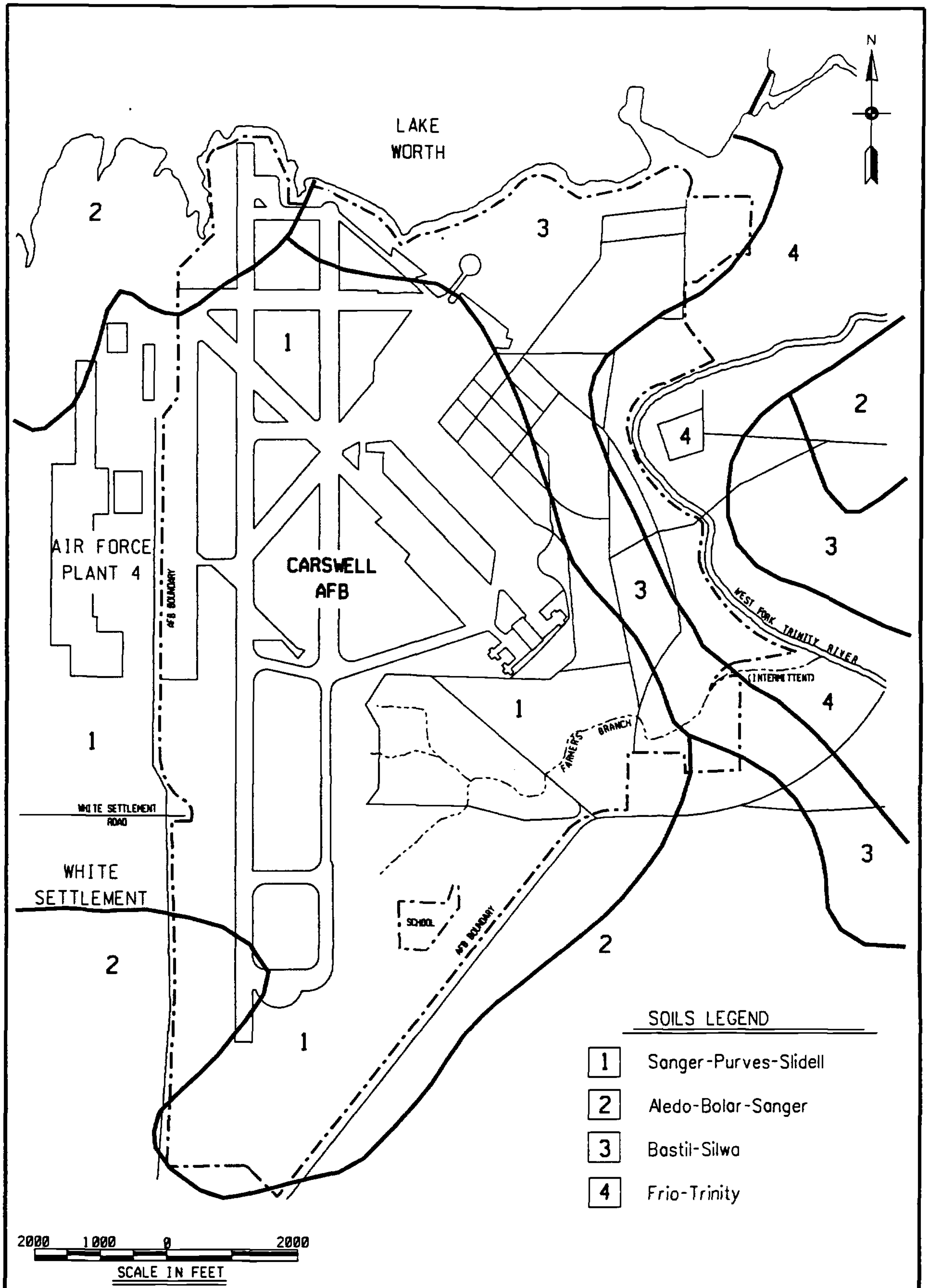
2.1.2 Topography

The topography of the base is fairly flat except for areas near Farmer's Branch and the Trinity River. Land surface slopes gently northeast toward lake Worth and east toward the West Fork of the Trinity River. Elevations on base

TABLE 1. SOIL ASSOCIATIONS FOR CARSWELL AFB, TX

Association	Description	Thickness (inches)	Permeability (cm/sec)
Sanger-Purves-Slidell: Clayey soils of nearly level to gently sloping uplands.	Clay loam Clay over bedrock Silty clay	8-80	$<4.2 \times 10^{-5}$ to 3×10^{-4}
Aledo-Bolar-Sanger: Loamy and clayey soils of gently sloping to moderately steep uplands.	Clay loam over bedrock Clay loam	8-70	$<4.2 \times 10^{-5}$ to 9×10^{-4}
Frio-Trinity: Clayey soil on nearly level flood plains.	Silty clay loam Clay	25-75	$<4.2 \times 10^{-5}$ to 3×10^{-4}
Bastsil-Silawa: Loamy soils on nearly level to sloping stream terraces.	Sandy clay loam	40-80	9×10^{-4} to 3×10^{-3}

SOURCE: U.S. Department of Agriculture, 1981, Soil Survey of Tarrant County: Soil Conservation Service, 218 pp.



CARSWELL AIR FORCE BASE, TEXAS
SOILS ASSOCIATION MAP
FIGURE 3

range from a high of approximately 690 feet above mean sea level (msl) at the southwest corner of the base to a low of approximately 550 feet msl at the east side of the base. The elevation of Lake Worth usually approximates the elevation of the dam spillway, 594 feet msl.

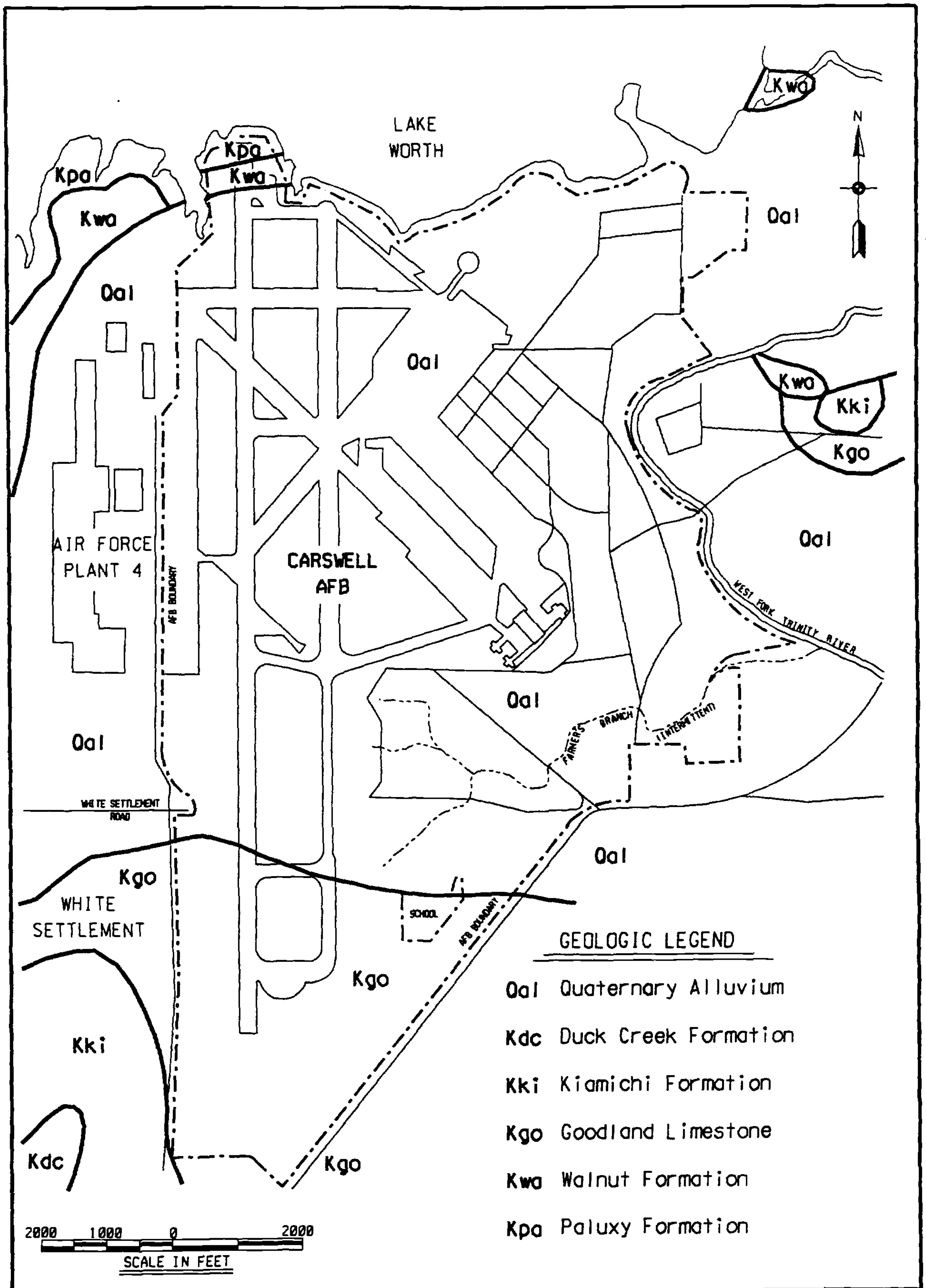
The principal drainage for Carswell AFB is the West Fork of the Trinity River. Farmers Branch drains the southern portion of the base, but in turn discharges into the Trinity. A small portion of the north end of the base drains into Lake Worth.

2.3.2 Geology

Surficial Soils - The U.S.D.A. Soil Conservation Service has identified four soil associations at Carswell AFB. The soils are described in Table 3-1, and their occurrences on base are shown on Figure 3-3. The surficial soils of the installation area are primarily nearly level to gently sloping clayey soils of the Sanger-Purves-Slidell and Aledo-Bolar-Sanger Associations. In addition to the above, the clayey soil of the Frio-Trinity Association and the loamy soil of the Bastsil-Silawa Association occur on the floodplain and stream terraces of the West Fork of the Trinity River.

Lithology - A geologic section showing the rock formations beneath Carswell AFB is presented in Figure 5. Descriptions and properties of units pertinent to this study are summarized in Table 2. From youngest to oldest, the geologic units of interest to Carswell AFB are as follows: (1) Quaternary Alluvium, (2) Cretaceous Goodland Limestone, (3) Cretaceous Walnut Formation, (4) Cretaceous Paluxy Formation, (5) Cretaceous Glen Rose Formation, and (6) Cretaceous Twin Mountains Formation. The occurrence of these units on base is shown on a geologic map, Figure 4.

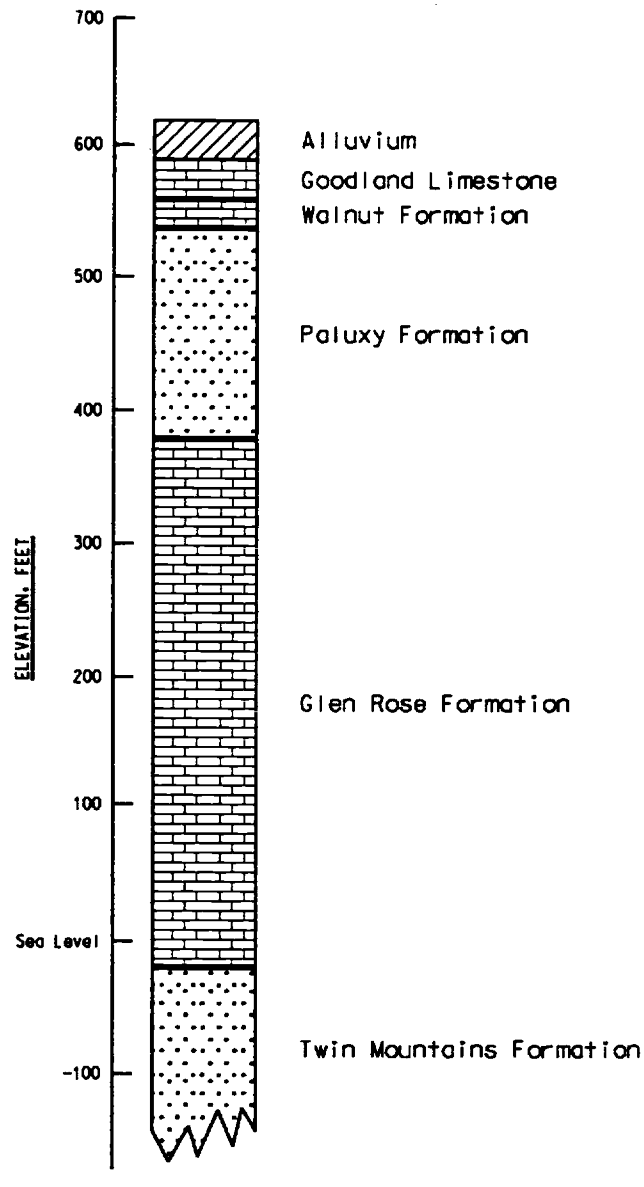
The majority of the base is covered by alluvium deposited by the Trinity River. The alluvium is composed of gravel, sand, silt, and clay of varying thicknesses and lateral extents. The Goodland Limestone is exposed on the



CARSWELL AIR FORCE BASE, TEXAS
GEOLOGIC MAP
FIGURE 4

TABLE 2. GEOLOGIC FORMATIONS BENEATH CARSWELL AFB, TEXAS

System	Series and Group	Formation and Member	Thickness (ft)	Character of Rocks	Topographic Expression	Water-Bearing Properties
Quaternary	Recent and Pleistocene	Alluvium	0-45	Sand, gravel, clay, and silt.	Terrace and flood-plain deposits.	Small to moderate yields. Water unsatisfactory for use unless treated.
Cretaceous	Comanche Series Washita Group	Duck Creek Formation	0-80	Impure limestone and marl, which is blue when fresh and straw-colored when weathered. Fossiliferous with distinctive ammonites.	Bench topography produced by lower limestone unit. Upper marl forms slope separating the Duck Creek from Fort Worth limestone.	Small to moderate yields. Water unsatisfactory for use unless treated.
	Comanche Series Fredericksburg Group	Kiamichi Formation	0-40	Blue and brownish-yellow marl, thin limestone and sandstone flags.	Grassy slope separating scarps of Goodland and Duck Creek formations.	Small to moderate yields. Water unsatisfactory for use unless treated.
		Goodland Limestone	0-130	Chalky-white fossiliferous limestone, and blue to yellowish brown marl.	Prominent glaring-white escarpment along streams.	Small to moderate yields. Water unsatisfactory for use unless treated.
		Walnut Clay	0-60	Shell agglomerate fossiliferous clay and limestone, sandy clay, and black shale.	Forms conspicuous escarpment and waterfalls in western Cross Timbers belt.	Not known to yield water to wells in Tarrant County.
				UNCONFORMITY		
Cretaceous	Comanche Series Trinity Group	Paluxy Sand	140-160	Fine-grained sand, shale, sandy shale, lignite and pyrite.	Sandy soil, hummocky topography, heavily wooded with oaks.	Source of supply for most households, smaller cities, and some industries.
		Glen Rose Limestone	250-400	Fine-grained limestone, shale, marl, and sandstone.	Not exposed in Tarrant County.	Sands yield small supplies to wells in Fort Worth and western Tarrant County. Water too highly mineralized east of Fort Worth.
		Twin Mountains Formation (Formerly Travis Peak Formation)	250-400	Coarse to fine-grained sandstone, red shale, red and yellow clay at base.	Not exposed in Tarrant County.	Principal aquifer in Tarrant County. Yields large supplies for municipal and industrial purposes. Water in upper sands east of Fort Worth may be highly mineralized.
				MAJOR UNCONFORMITY		
Pennsylvanian	Undifferentiated		6,000-7,000	Gray, sandy shale, light quartzitic sandstone, black limestone. Probably represents Strawn formation.	Not exposed in Tarrant County.	Not tested. Probably would not yield fresh water.



CARSWELL AIR FORCE BASE, TEXAS
STRATIGRAPHIC COLUMN
FIGURE 5

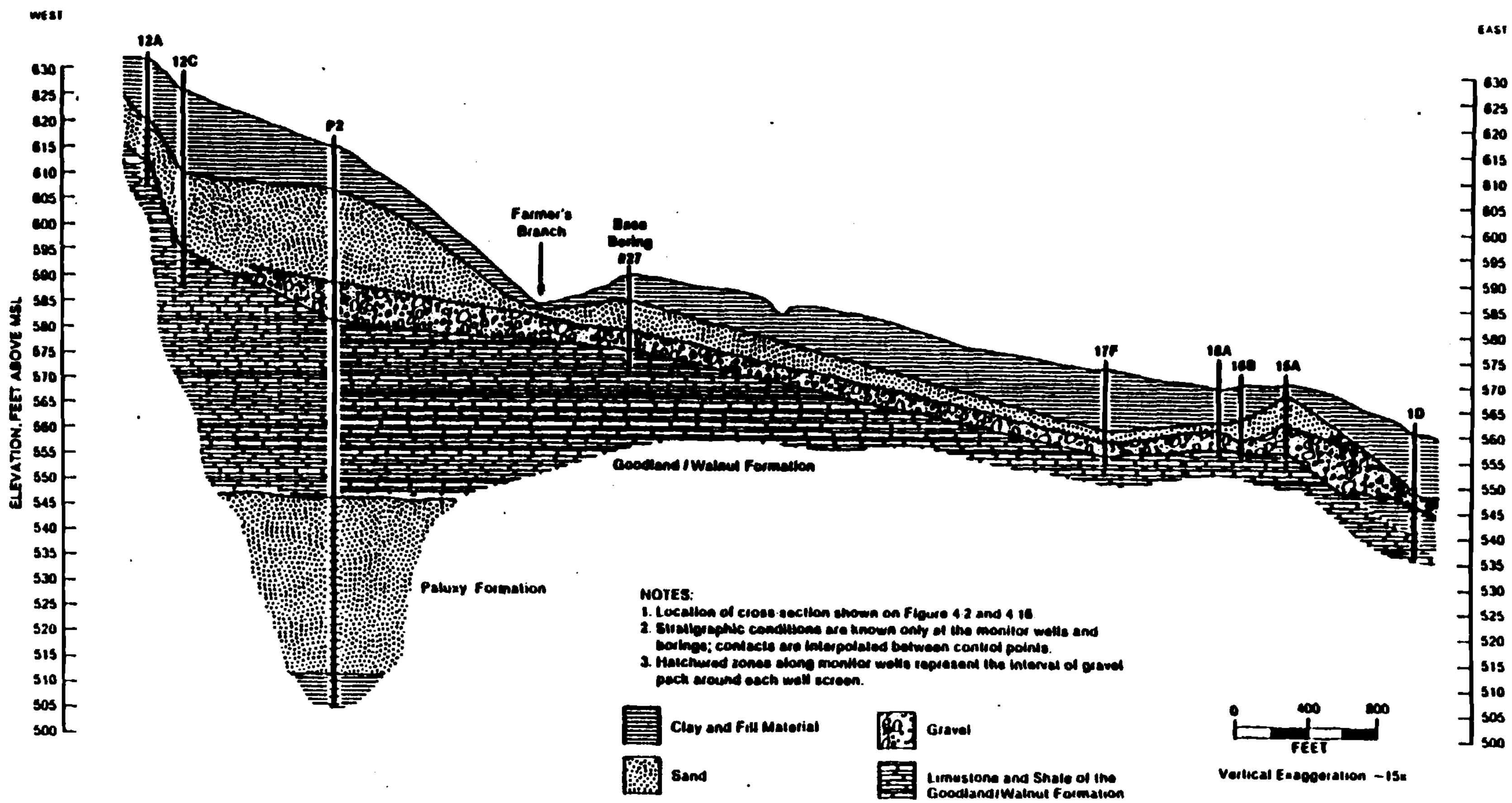


Figure 5A   Geologic Cross Section A-A', Carswell AFB, Texas southern portion of the base, south of White Settlement road. The Goodland is a chalky-white, fossiliferous limestone and marl. A small area exposing the Walnut and Paluxy Formations occurs in the northwestern corner of the base along the shores of Lake Worth. The Walnut Formation is a shell-agglomerate limestone with varying amounts of clay and shale. The Paluxy Formation is primarily a fine- to coarse-grained sand with minor amounts of clay, sandy clay, pyrite, lignite, and shale. Neither the Glen Rose Limestone, nor the Twin Mountains Formation are exposed at Carswell AFB.

Structure - Carswell AFB is located on the relatively stable Texas craton, west of the faults that lie along the Ouachita Structural Belt. No major faults or fracture zones have been mapped near the base. The regional dip of the rocks beneath Carswell AFB is between 35 and 40 feet per mile in an easterly to southeasterly direction. The stratigraphic and structural relationships of the uppermost geologic units at Carswell AFB are illustrated in Figure 5A. The geologic cross section was taken from a southwest to northeast direction across the southern portion of the base.

2.3 Hydrogeology

2.3.1 Surface Water

Carswell AFB is located within the Trinity River Basin just south of Lake Worth, a man-made reservoir on that river. Part of the base is drained by Framers Branch which discharges into the West Fork Trinity River just south of the cantonment area. Farmers Branch begins within the community of White Settlement and flows eastward. Just south of Air Force Plant 4, Farmers Branch flows under the runway within two large culverts.

Most of the base surface drainage is intercepted by a series of storm drains and culverts, directed to oil/water separators and discharged to the West Fork Trinity River downstream of Lake Worth. A small portion of the north end of the base drains into Lake Worth.

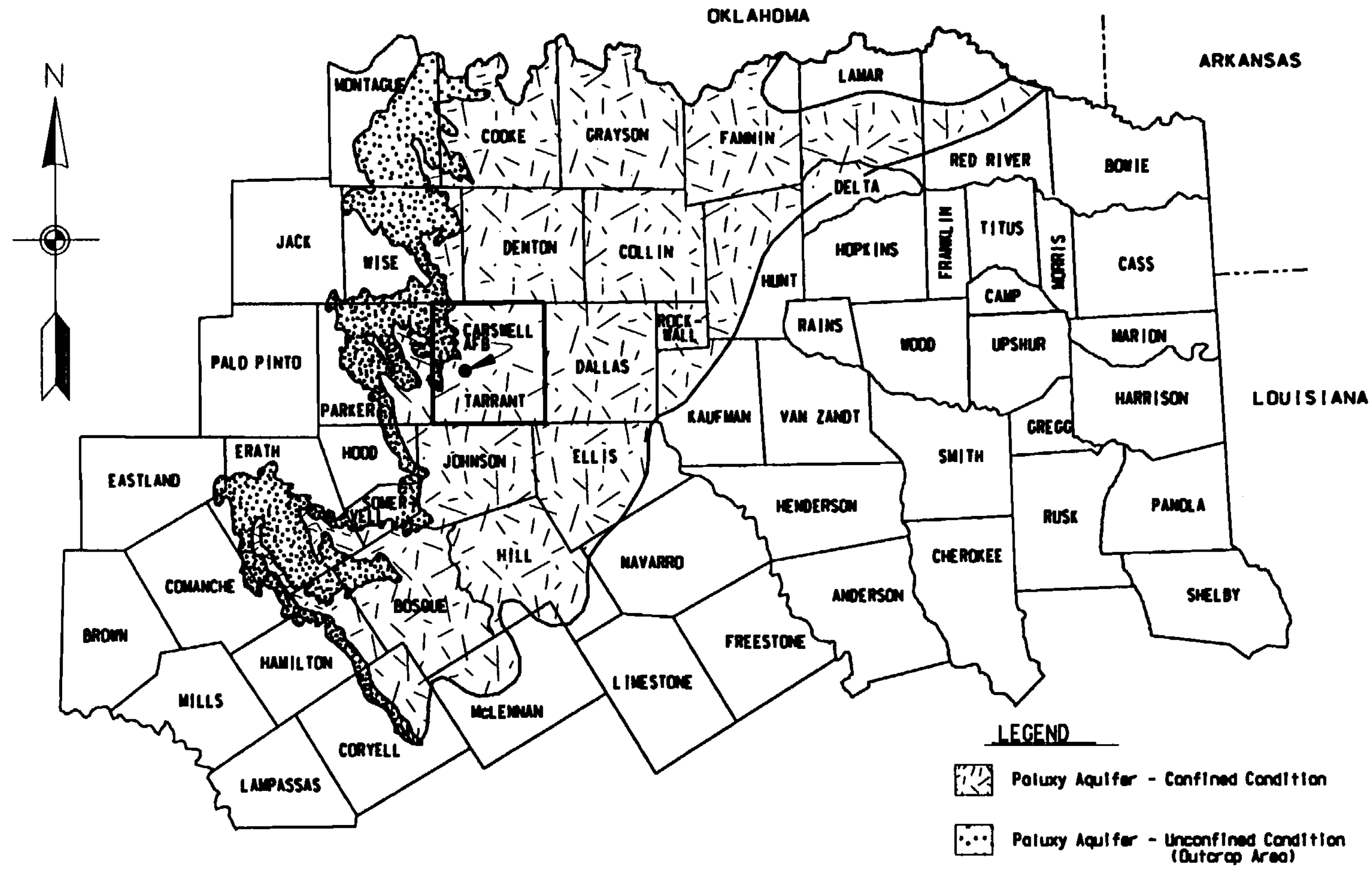
2.3.2 Groundwater

On the basis of their water-bearing properties, the geologic units at Carswell AFB may be divided into the following five hydrogeologic units, listed from most shallow to deepest: (1) an upper perched-water zone occurring in the alluvial terrace deposits left by the Trinity River; (2) an aquitard or predominantly dry limestone of the Goodland and Walnut Formations; (3) an aquifer in the Paluxy sand; (4) an aquitard of relatively impermeable limestone in the Glen Rose Formation; and (5) a major aquifer in the sandstone of the Twin Mountains Formation. Each of these units is examined in more detail below.

Upper Zone - Groundwater occurs within the coarse sand and gravels deposited by the Trinity River, but these deposits are usually limited in areal extent and isolated by surrounding low-permeability clays and silts. Recharge to the water-bearing deposits is local, from rainfall and infiltration from stream channels and drainage ditches. Water flow in the alluvium is basically eastward, toward the West Fork of the Trinity River.

In parts of Tarrant County, generally close to the Trinity River, water in the alluvium is developed for irrigation and residential use. The community of River Oaks, immediately east of Carswell AFB, had supply wells that developed water from the alluvial deposits at a location near the USAF hospital. The wells were abandoned when Carswell AFB purchased the property for hospital construction. For the most part, groundwater is not economical to develop from the alluvium due to the limited distribution of the water and susceptibility to surface/storm water pollution.

Goodland/Walnut Aquitard - The perched water present in the alluvium is separated from the aquifers below by the low permeability limestones and shales of the Goodland Limestone and Walnut Formation. The aquitard is composed of moist clay and shale layers interbedded with dry limestone beds. Though primarily dry, drillers in the area report that small amounts of water enter the



CARSWELL AIR FORCE BASE, TEXAS
AREAL EXTENT OF THE PALUXY AQUIFER, NORTH TEXAS
FIGURE 6

TABLE 3. RANGE OF CONSTITUENTS IN GROUND WATER FROM SELECTED WELLS IN THE PALUXY FORMATION, TARRANT COUNTY

Constituent or Property	Concentration
Bicarbonate (HCO_3)	177-689
Boron (B)	0.1-0.6
Calcium (Ca)	0-120
Chloride (CL)	5-117
Fluoride (F)	0-4.5
Iron (Fe)	0-9.9
Magnesium(Mg)	0-43
Nitrate (NO_3)	0-10.0
Silica (SiO_2)	1-30
Sodium (Na)	11-740
Sulfate (SO_4)	6-1,080
Dissolved Solids	264-2,176
Total Hardness ($CaCO_3$)	2-401
Percent Sodium (%)	7.1-99.5
pH	7.1-9.2
Sodium-Absorption Ratio (SAR)	0.2-68.8
Residual Sodium Carbonate (RSC)	0-10.0
Specific Conductance (umhos at 25°C)	427-3,193

NOTE: Analyses given are in milligrams per liter except percent sodium, specific conductance, pH, SAR, and RSC.

SOURCE: Texas Department of Water Resources, 1982.

borehole while drilling through the Walnut Formation, suggesting that groundwater may move through the Walnut along bedding planes (Hargis and Associates, Inc., 1984). The thickness of the Goodland/Walnut aquitard is approximately 25 feet or greater beneath most of Carswell AFB. However, the top of the aquitard is an erosional surface and weathering may have reduced the thickness of the limestone in isolated areas. A soil boring at Air Force Plant 4, across the runway to the west from Carswell AFB, revealed that the Goodland Limestone had been completely eroded and only 3 feet of the Walnut Formation remained (Hargis and Associates, Inc., 1984). It is also reported that the upper zone and Paluxy Formation are in contact at the eastern boundary of AF Plant 4, where both the Goodland and Walnut Formations have been removed by erosion (Hargis and Associates, 1985). In areas of similarly extensive erosion, water in the upper zone could come in contact with water in the Paluxy aquifer.

Paluxy Aquifer - The Paluxy aquifer is the most shallow aquifer occurring beneath Carswell AFB. The aquifer's area extent is shown in Figure 6. In the base area, water in the Paluxy would naturally occur under confined conditions beneath the Goodland/Walnut aquitard (except where the aquitard is missing due to erosion, as discussed above). However, extensive pumping in the Fort Worth area has lowered the Paluxy potentiometric surface below the top of the formation, resulting in unconfined conditions beneath the base. The Paluxy Formation is divided into upper and lower sand members and the aquifer is likewise divided into upper and lower aquifers. The upper sand is fine-grained and shaley and the lower sand is coarser; therefore, most wells are completed in the lower section.

Recharge to the Paluxy aquifer occurs where the formation outcrops west of Carswell AFB. The Paluxy also outcrops north of the base in the bed of Lake Worth. The lake represents a significant recharge point for the aquifer and creates a potentiometric high in its vicinity. Regional groundwater flow within the Paluxy is eastward, in the direction of the regional dip. At Carswell AFB, groundwater flow is influenced by the Lake Worth potentiometric high and by a potentiometric low created by the groundwater withdrawals of the community of White Settlement, resulting in a more southeasterly flow direction.

Transmissivities in the Paluxy aquifer range from 1,263 to 13,808 gallons per day per foot (gpd/ft) and average 3,700 gpd/ft. The Paluxy Formation thickness ranges from 140 to 190 feet and averages 160 feet in Tarrant County. The actual water-bearing thickness in the Carswell AFB area probably approximates the formation thickness, but the aquifer is separated into two distinct water-bearing zones. In the vicinity of Carswell AFB, permeabilities range from 13 to 140 gpd/ft^2 (based on an approximate thickness for the aquifer of 100 ft.) Well yields within the Paluxy aquifer range from 10 to 480 gallons per minute (gpm) and average approximately 100 gpm.

The Paluxy aquifer is an important source of potable groundwater in the Fort Worth area. Communities surrounding Carswell AFB, especially White Settlement, develop municipal water supplies from the Paluxy, as well as from the deeper Twin Mountains aquifer. As a result of its extensive use as a water supply, water levels in the Paluxy aquifer have declined significantly over the years. Water levels in the immediate Carswell AFB vicinity have not decreased as much as in the Fort Worth area in general because the base does not develop water from the Paluxy.

Water quality in the Paluxy aquifer is generally good and is satisfactory for potable use. The range of chemical constituents occurring within Paluxy water is given in Table 3.

<u>Glen Rose Aquitard</u> - Below the Paluxy Aquifer are the fine-grained limestone, shale, marl, and sandstone beds of the Glen Rose Formation. The thickness of the formation varies from 250 to 450 feet. Though the sands in the Glen Rose Formation yield small supplies to wells in Fort Worth and western

TABLE 4. METEOROLOGICAL DATA SUMMARY FOR CARSWELL AFB, TEXAS

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Temperature (°F)													
Mean	45	50	57	66	74	82	86	85	78	68	56	49	66
Average Daily Maximum	55	60	67	76	83	91	95	95	88	78	66	59	76
Average Daily Minimum	35	39	46	56	64	72	75	75	68	57	46	38	56
Highest Recorded	88	88	85	89	100	111	109	110	107	105	89	91	110
Lowest Recorded	2	6	11	31	42	55	61	60	46	33	17	11	2
Precipitation (inches)													
Mean	1.7	1.9	2.1	3.9	4.2	3.1	2.5	2.1	3.6	3.1	1.8	1.9	31.9
Maximum Monthly	5.9	4.7	6.5	14.2	15.2	8.8	9.0	6.0	9.6	10.7	7.4	6.7	15.2
Minimum Monthly	0.1	0.1	a	0.8	0.8	0.1	a	a	a	a	a	a	a
Maximum in 24 hours	2.8	3.2	3.4	3.3	5.7	3.5	5.9	3.1	4.0	3.2	2.8	2.9	5.9
Days with Thunderstorms	1	2	3	6	8	6	5	5	4	3	1	1	45
Snowfall (inches)													
Mean	2	1	6	0	0	0	0	0	0	0	b	b	3
Maximum Monthly	8	12	7	0	0	0	0	0	0	0	4	3	8
Maximum in 24 hours	5	8	7	0	0	0	0	0	0	0	4	3	8
Relative Humidity (%)													
Mean	62	61	61	64	68	64	58	60	65	65	63	62	63
Surface Winds (knots)													
Mean	8	8	9	9	7	8	6	5	6	6	8	8	7
Maximum	50	63	69	64	68	65	56	54	80	45	54	58	80
Prevailing Direction	S	S	S	S	S	S	S	S	S	S	S	S	S

Source: United States Air Force, Carswell AFB, Texas. Period of Record: 1946-1978.

[a]Less than one tenth inch.

[b]Less than 1 inch.

Tarrant County, the relatively impermeable limestone is an aquitard restricting water movement between the Paluxy aquifer above and the Twin Mountains aquifer below.

Twin Mountains Aquifer - The Twin Mountains Formation is the oldest formation used for water supply in the Carswell AFB area. The formation consists of a vasal conglomerate of chert and quartz, grading upward into coarse-to fine-grained sand interbedded with shale. The thickness of the formation varies between 250 and 430 feet.

Recharge to the Twin Mountains aquifer occurs west of Carswell AFB, where the formation crops out. Water movement is eastward in the downdip direction. Like water in the Paluxy aquifer, Twin Mountains water occurs under water-table conditions in the recharge area and becomes confined as it moves downdip.

The Twin Mountains aquifer is the principal aquifer in Tarrant County. The formation yields large water supplies for municipal and industrial purposes. Transmissivities in the Twin Mountains aquifer range from 1,950 to 29,700 gpd/ft and average 8,450 gpd/ft in Tarrant County. Permeabilities range from 8 to 165 gpd/ft^2 and average 68 gpd/ft^2 in Tarrant County.

Groundwater withdrawals from the Twin Mountains aquifer, primarily for municipal water supply, have resulted in declining water levels. Between 1955 and 1976, the potentiometric surface of the aquifer dropped approximately 250 feet. Water quality in the Twin Mountains aquifer is suitable for potable use throughout the Fort Worth area.

2.3.3 Climatology/Air

Carswell AFB is located near 33 north latitude in north central Texas. The climate is humid subtropical with hot summers and dry winters. Tropical maritime air masses control the weather during much of the year; however, the passage of polar cold fronts and continental air masses create large variations in winter temperatures. Meteorological data summarizing the period 1946 through 1978 are presented in Table 4 and discussed briefly below.

The average annual temperature for Carswell AFB is 66 degrees F and monthly mean temperatures vary from 45 degrees F in January to 86 degrees F in July. The average daily minimum temperature in January is 35 degrees F and the lowest recorded temperature is 2 degrees F. The average daily maximum temperature in July and August is 95 degrees F and the highest temperature recorded at the base was 111 degrees in the month of June. On the average, freezing temperatures occur at Carswell AFB on 33 days per year.

Mean annual precipitation recorded at Carswell AFB is 32 inches. The wettest month is May with a secondary maximum in September. The period from November to March is generally dry with a secondary minimum in August. Snowfall accounts for a small percentage of the total precipitation between November and March. On the average, measurable snowfall occurs on 2 days per year. Lake evaporation at Carswell AFB is estimated to be approximately 57 inches per year. Evapotranspiration over land areas may be greater or less than lake evaporation depending on vegetative cover type and moisture availability. Average net precipitation is expected to be equal to the difference between average total precipitation and average lake evaporation or approximately minus 25 inches per year.

Thunderstorm activity occurs at Carswell AFB an average of 45 days per year. The greatest number of these storms occurs between April and June. Hail may fall on two to three days per year, and the maximum precipitation recorded in a 24-hour period is 5.9 inches.

Mean cloud cover averages 50 percent at Carswell AFB with clear weather occurring frequently during all months. Some fog is present on an average of 83 days per year. Wind speed averages 7 knots; however, a maximum of 80 knots has been recorded. Wind direction is predominantly from the south during all months.

2.4 Human Environment

2.4.1 Population

The total work force at Carswell AFB is approximately 6,100, which includes about 1,000 civilian personnel.

2.4.2 Demographics

The city of Fort Worth had a population of 414,562 based on a 1984 estimate. This estimate also included a population density of 1,617 people per square mile. The smaller suburbs of Fort Worth adjacent to Carswell AFB had 1980 population data as follows:

White Settlement	-	13,508
Westworth	-	3,651
River Oaks	-	6,890

2.4.3 Land Use

The base is surrounded by residential, commercial, recreational, and industrial land. Residential land use is to the southwest, southeast and east of the base. Commercial property is south and recreational (Lake Worth) is north of the base. Air Force Plant 4 is the industrial facility directly west of Carswell AFB.

2.4.4 Map Preparation

To support the reporting effort, maps will be prepared utilizing an inhouse PC-based system Intergraph. This system will permit relatively fast development of report maps and map changes. The system permits the integrating and development of geologic cross sections and plane maps. Additionally, the system permits various scales to provide the optimum map size for the report. The results will be maps, figures and legends that are clear for ease of interpretation and of publishable quality.

In general, the following types of maps and figures will be developed:

- General Carswell AFB installation features and boundaries (e.g., major installation support and operational facilities);

- Site locations and plan views;
- Monitoring well/boring/sampling locations/cross sections; and
- Surface drainages and water bodies.

Some of the specific types of maps and figures that will be developed include hydrogeological cross-sections, water table elevation contour maps, water well inventory locations and related data.

3.0 **Site Specific Background Information**

3.0 **Site Specific Background:**

SWMU No. 64, French Underdrain System

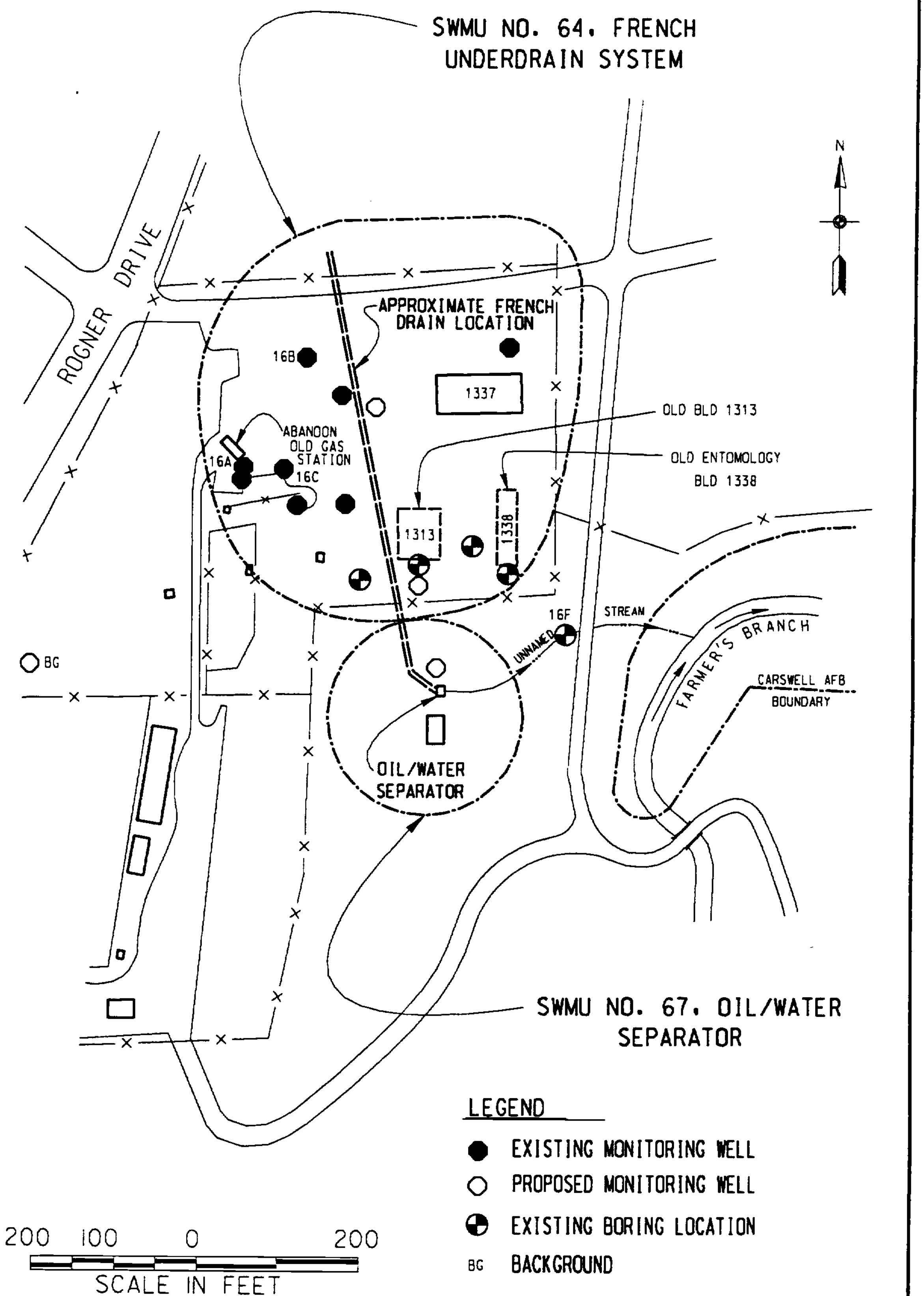
SWMU No. 67, Bldg 1340, Oil/Water Separator

SWMU No. 64 is divided into two parts located to the south and west of SWMU No. 63, the entomology dry well (Figure 7). The Unnamed Stream, a small tributary of Farmers Branch, located south of the old entomology shed, and near the confluence of Farmers Branch and the Trinity River and a paved lot in the vicinity of an abandoned gasoline service station to the west of SWMU No. 63. The small stream is the discharge from an oil/water separator (abandoned), SWMU No. 67, Bldg 1340 oil-water separator, located immediately south of the fenced civil engineering yard, and receives its perennial flow from ground water entering the separator. The separator is connected to a french underdrain system (abandoned), SWMU No. 64, which was installed to aid in the removal of fuels from the ground water either at SWMU No. 68, POL Tank Farm, or at the abandoned gasoline service station. This separator has not been routinely cleaned for a number of years and reportedly contains hydrocarbon constituents.

Soil samples were collected from four hand augered borings along the Unnamed Stream during Stage 1. All samples had values of selenium (9.1-24 mg/Kg) higher than the range of normally found in soils. The lead content of the shallow soil samples (18-20 mg/Kg) is at the high end of the normal range and higher than the lead content of most other soils analyzed at Carswell AFB. Oil and grease values were found to be high in almost all of the soil samples analyzed (27-240 mg/Kg). The concentrations were highest closest to the oil water separator and generally decrease with the distance downstream.

Samples of surface water were collected and analyzed from four locations in two sampling rounds. Samples were analyzed for water quality indicators, heavy metals, oil and grease, purgeable halocarbons, and purgeable aromatics. Total dissolved solids at the four sampling locations were less than 500 mg/L and remained relatively stable between sampling events. Chloride and nitrate concentrations increased between sampling rounds at all locations, with all values below Secondary Drinking Water Regulations, except for a sample from Round 2 in which chloride was detected at 710 mg/L, up from 24 mg/L for Round 1. Surface water samples from the stream had two metals that exceeded MCLs. Arsenic surpassed MCLs in the second sampling round at two locations and chromium matched MCLs in the second round from one location. Iron and manganese exceeded MCLGs in all samples taken from the site. Oil and grease was detected at all four locations and in every sample, except the second round at one location. The highest concentration was 2.4 mg/L, which was detected in the second round. With the exception of this increase, all other oil and greatest concentrations decreased between samplings. The only detection of purgeable halocarbons occurred at the most downstream sampling location, with the finding of tetrachloroethene which was below MCLs. Benzene was detected in levels exceeding MCLs at all four locations during the first round. Values ranged from 39 ug/L to 120 ug/L. However, in the second round of samples, benzene was not detected at any of the sample locations.

Results of the Stage 2 investigation indicates that the Unnamed Stream is receiving quantities of petroleum hydrocarbons. Contamination may be because of the oil water separator and french drain malfunction.



SOIL AND WATER SAMPLING LOCATIONS
SWMU NO. 64, FRENCH UNDERDRAIN SYSTEM
SWMU NO. 67, OIL/WATER SEPARATOR
FIGURE 7

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4.0 <u>Site No. 64 and 67 Specific Discussion.</u>

The site consists of two areas - one is the Oil/Water Separator and the other one is the French Underdrain System. The Oil/Water Separator is connected to the French Underdrain System that was reportedly built in 1965 to intercept hydrocarbon products leaking from a UST (abandoned gas station) into sewer pipes. The separator discharges to the unnamed stream that is a small tributary of Farmers Branch.

The Oil/Water Separator and French Underdrain System are located south of the new Communications Building, Bldg. 1337. The direction, length and depth of the French Underdrain System has not been determined. The Oil/Water Separator and the French Underdrain System are no longer in use, both being out of service for about 20 years with no maintenance being performed.

The following is summarized from these reports: (1) Radian Corp., IRP Stage 2 Phase II: Confirmation/Quantification, October 1986; Radian Corp., IRP Stage 2 Draft, Remedial Investigation December 1990, and (2) Maxim Engineers, Inc., Subsurface Contamination Assessment Bldg No. 1337, April 1990.

<u>FRENCH UNDERDRAIN SYSTEM</u> - The french drain for the Oil/Water Separator was installed due to a gasoline leak at the former gas station or POL tank farm. However, the oil, grease and TOC water inside the separator (collected on the inflow side) were not as high as those detected in the groundwater. This suggests that the contamination is moving downgradient to Farmers Branch and bypassing the drain. The highly permeable nature of the sand and gravel deposits could be reducing the effectiveness of the french drain rerouting the groundwater.

East of the french drain, Maxim Engineering, Inc. indicated that hydrocarbon contamination is present at selected borings along the south property boundary at concentrations ranging from 210 to 4800 ppm. Results displayed traces of free product and odors similar to diesel fuel.

West of the french drain, Radian Corporations magnetometer survey indicated the possible existence of two buried tanks located northeast and southeast of the old pump station.

Heavy Metals: Groundwater from borings 16a and 16c contain levels of barium in excess of federal primary drinking water standards. Selenium was found higher than the range normally found in soils.

Organics Indicators: Water from boring 16b does not contain appreciable amounts of organic indicators. Water from borings 16a and 16c does have appreciable amounts of oil and greases.

Herbicides and Insecticides: Not applicable.

Purgeable Halocarbons: TCE and trace of trans-1,2-dichloroethane were detected in boring 16a.

Purgeable Aromatics: Groundwater from organic compounds in borings 16b and 16c indicated high unsaturated purgeable compounds. Water from borings 16a and 16c contain large amounts of oil/water and TOC. Soil boring 16f contained a large amount of toluene.

Findings: Contamination from organic compounds appear to be significant in the groundwater. The high levels of purgeable organic compounds indicate that the contamination is probably from fuels. Given the conditions near the site, fuels may be from a combination of the following sources:

a. A spill from a former gas station.

b. A leak from suspected USTs at the old gas station.

c. A leak from POL Tank Farm (SWMU No. 68)

OIL/WATER SEPARATOR AREA - The following results were obtained from Radian Corp., IRP 2, Stage 2 report.

Heavy Metals: Cadmium and chromium content of water in the Oil/Water

Separator is relatively high compared to other sites on Carswell AFB.

<u>Organic Indicators:</u> There were high amounts of oil/grease and TOC during the month of February 1984, but none in March 1985.

<u>Herbicides and Insecticides:</u> Not applicable in Oil/Water Separator.

<u>Purgeable Halocarbons:</u> TCE was detected in surface water net flow and in the Oil/Water Separator during the month of March 1985.

<u>Purgeable Aromatics:</u> Oil and grease were found to increase with depth in boring 16e.

<u>Findings:</u> Samples were collected in 1990 field program and analyzed for volatile (organic and inorganic), metal species (for filter and unfilter samples) in order to evaluate total dissolved metals (period April to May 1990). The organic and inorganic exceeds the EPA primary drinking water standards. Based on the 1990 volatile organic compound analytical results, the abandoned gasoline station does not appear to be contributing appreciable organic contamination to the shallow groundwater system. Any contaminants in the groundwater would be expected to move hydraulically downgradient, eventually entering the Oil/Water Separator and the unnamed stream or Farmers Branch itself where the initially low concentrations would be further diluted. No metals were detected above MCLs in the shallow groundwater system.

<u>Recommendations:</u> In order to determine the current conditions at the sites and assess the likely environmental impact of past releases, it will be necessary to perform the following site exploration activities.

- o Conduct an oil and gas survey of the old gas station area to identify and confirm the existence of any USTs. This survey will aid the proper placement of monitoring wells.

- o Use the existing monitoring wells to confirm the potentiometric values and groundwater direction, and we propose three new monitoring wells, one monitoring background as shown in Figure 7.

- Use the existing monitoring wells and new monitor wells to assess groundwater contamination. All new well installed will have long screens extending above the water table to intercept floating hydrocarbon product (if any).

- Locate the depth and length of the french underdrain system in order to test the effectiveness and operation of the system. The operation and effectiveness of the system can be tested by placing monitoring wells upgradient and downgradient of the french drain. Sample and analysis of these wells will determine if the french drain is trapping and redirecting hydrocarbon products.

- Assess the operation and function of the existing Oil/Water Separator.

- Perform three single well aquifer tests on selected upper zone wells in order to determine the transmissivity of the upper zone.

- Conduct two rounds of groundwater sampling and analyze for general water quality parameters, petroleum hydrocarbons, metals and volatile organic compounds.

GROUNDWATER TESTING PARAMETERS

Volatile Organics	EPA Method 8240
Benzene, Toluene, Ethylbenzene, Xylene	EPA Method 8240
Metals	
Arsenic	EPA Method 7060
Barium	EPA Method 6010
Cadmium	EPA Method 6010
Chromium	EPA Method 6010
Lead	EPA Method 7471
Mercury	EPA Method 7471
Nickel	EPA Method 6010
Selenium	EPA Method 7740
Silver	EPA Method 6010
Zinc	EPA Method 6010
Oil & Grease	EPA Method 9071
Total Petroleum Hydrocarbons	EPA Method 418.1

5.0 Hydrogeologic Assessment

The purpose of the hydrogeologic assessment is to develop a complete understanding of the ground water system on-and off-base by integrating the available data from earlier investigations and by conducting additional field studies to fill data gaps or provide additional detail where necessary. Specific purposes of this evaluation include: developing a better understanding of on-and off-base ground water flow; relationships between saturated zones; extent and migration of contamination plumes; seasonal changes in water levels and flow. Results of this study will form the framework of the evaluation of groundwater impacts, qualitative risk assessment, and remedial action alternatives. The information developed in the detailed site characterization of individual contamination areas will form an integral part of the data used in this task.

The hydrogeologic assessment will draw on the results of all previous groundwater investigations conducted at Carswell AFB. In addition to those sources, previous studies will now be updated with any regional and area studies by federal, state, and local agencies and other published and unpublished information will be used.

5.1 Geophysical Surveys

Magnetometer surveys will be performed at SWMU 64. Readings of the total magnetic field and magnetic gradient will be taken at appropriate locations using an EDA PPM 500 proton magnetometer (or equivalent).

5.2 Subsurface Soil Surveys

No boreholes will be drilled for this investigation. The existing monitoring wells will be utilized to provide the chemical data.

Air monitoring during all well drilling and soil boring work will be accomplished with an organic vapor analyzer utilizing a photoionization detector (PID) or flame ionization detector (FID) to identify the presence of potentially hazardous and/or toxic vapors or gases. The air monitoring results will be noted in the boring logs. If soil encountered during well drilling is suspected to be hazardous because of abnormal discoloration, odor or air monitoring levels, the drill soil cuttings will be containerized in new, unused drums. A different drum will be used for each boring where soil encountered is suspected to be hazardous. The field log will reflect the boring logs depth(s) from which the suspected contaminated soil cuttings were collected. Composite drill cutting samples will be obtained for chemical analysis in accordance with the EPA publication SW-846, per Table I of Appendix B.

5.3 Monitoring Wells

The objective of the investigation at Carswell AFB is to define the presence, magnitude, direction, rate and extent of movement of any identified contaminants. To accomplish this task, four monitoring wells will be installed.

Drilling Methods:

The field team will use a hollow-stem auger rig to drill the upper zone monitoring wells. This method performs well in unconsolidated sediments, allows the rig to operate without the use of drilling fluids, and permits ease of collection for formation samples. The hollow-stem auger can be used as a temporary casing to prevent the borehole from caving during drilling and completion of test wells. For the depths and geology involved, this drilling method will provide fast, efficient performance at a relatively low operating cost.

Each new monitoring well will be developed as soon as practical after completion. The monitoring wells will be developed by a submersible pump, and/or bailer. Monitoring well development will continue until the discharge water is clear and free of sediment to the fullest extent possible. All water during development will be collected and disposed of through an existing oil/water separator connected to a base sanitary sewer. The development water production (rates), pH, specific conductances and water temperature will be measured. These data will be included in the final report.

Construction of Wells:

Following the completion of drilling operations, each well will be screened above and below the water table surface with a minimum of 10 feet and maximum of 35 feet of screen. The screen will consist of 4-inch diameter PVC casing with up to 0.020-inch slots. The material lengths selected will be based upon site-specific ground water conditions encountered. The screen will be capped at the bottom. All connections will be flush jointed and threaded.

The screened section will be joined to a 4-inch diameter, Schedule 40 PVC, flush threaded casing. The casing will extend from the top of the screen to at least ground surface. To ensure the chemical integrity of the test wells, no glues, solvents, or thread compound will be employed during screen and casing installations. Prior to installation, the casing and screen sections will be thoroughly washed using a high-temperature, high-pressure sprayer, with Base potable water.

Monitoring Well Development:

After the casing and screen have been installed for each well, a sand or gravel pack will be emplaced between the screen and the boring wall. The pack will consist of washed and bagged rounded sand or gravel with a grain size distribution compatible with the screen and the formation. The pack will be emplaced from the bottom of the borehole to 2 feet above the top of the screen. The auger flights will be used as the tremie pipe.

Granulated or pelletized bentonite will be placed (in the well and measure it with a weighted tape) above the sand/gravel pack to a minimum thickness of 2 feet to provide an adequate seal. The bentonite seal will be wetted in the hole using 1-2 gallons of Base potable water to ensure that the seal is developed before cementing operations begin.

Neat cement (Type I Portland cement) grout will be emplaced from above the top of the bentonite seal to land surface. No more than an eight percent gel mixture may be used. For water table conditions, grout will be emplaced through the augers and then the auger string withdrawn. If artesian conditions exist, a small diameter tremie pipe will be used to emplace the grout.

5.3.1 Surface Completions of Monitoring Wells

Two methods for the well surface completions will be employed at Carswell AFB depending on input from base officials. If well stick-up is of concern in an area, the well will be completed flush with the land surface. In the case of flush completion, the PVC casing will be cut 2 to 3 inches below land surface, and a watertight protective manhole with a locking cap will be installed. A locking system will be provided to discourage any tampering.

When above-ground surface completion is used, the PVC well casing will be extended about 2 or 3 feet above land surface. An end plug or casing cap will be provided for each well. The extended PVC casing will be shielded with at least a 4-inch diameter steel guard pipe. The guard pipe will be placed over the PVC casing and cap and will be seated in a 24-inch by 24-inch by 4-inch concrete surface pad. The protective casing will be installed with a lockable cap or lid to discourage vandalism.

In the case of an above-ground completion, three 3-inch diameter steel guard posts, will be installed radially from each wellhead. The guard posts will be placed approximately 2 to 3 feet into the ground and extend 5 feet above the ground surface. At some sites, the guard posts may be removable to facilitate access for sampling activities. In these cases, a locking mechanism will be provided to prevent unauthorized removal.

5.3.2 Surveying of Monitoring Wells and Boreholes

All monitoring wells and boreholes will be surveyed for elevations and locations. A registered professional land surveyor will be retained to survey the vertical elevations of the wells and the tops of the boreholes. This survey will have an accuracy for vertical elevations of ±0.01 foot for all monitoring wells and ±0.1 foot for boreholes. Horizontal locations will be accurate to ±1 foot. All surveying will use an established U.S.C & G.S. or U.S.G.S. benchmark as point of origin. All surveyed points and benchmarks used will be recorded on site maps.

5.3.3 Aquifer Tests

Slug tests will be conducted on three selected monitoring wells after the completion of groundwater sampling. The slug test provides an indication of aquifer characteristics such as hydraulic conductivity. Also, this test is ideally suited for low-producing formations that cannot be pumped. Monitoring wells will be selected with the hydrogeologic characteristics that will optimize slug testing. The resulting data will be used in conjunction with the groundwater geologic data. The slug test equipment will be decontaminated to prevent any well contamination.

5.4 Groundwater Samples

5.4.1 Groundwater Level Measurements

Following completion and development of the monitoring wells, but prior to sampling activities at each site, a round of water level measurements will be conducted on the monitoring wells. Water levels will be measured to the nearest 0.01 foot from the top of the marked casing using an electric line water level indicator. When the electrode of the water level meter comes in contact with the water, a meter reacts or a tone sounds. Additionally, the surface of the water will be examined for the presence of hydrocarbons. If hydrocarbons are present, the thickness of the layer will be measured and recorded.

5.4.2 On-Site Field Analyses

Well Purging. - Each monitoring well will be purged immediately prior to sample collection to ensure that fresh formation water is collected. Purging will occur at least three days after completion of monitoring well development. When possible, sampling will begin at upgradient monitoring wells and/or low contamination areas then move to downgradient and/or higher contamination areas.

Purging operations will be conducted using a submersible pump or a bailer. Purging operations will be considered complete when three wetted well casing volumes have been removed or when the pH (±0.1 unit), temperature (±0.5 degrees C), specific conductance (±10 micromhos), color and odor of the discharge are stabilized. After purging the wells, groundwater samples will be collected from the discharge line of the submersible pump or with a Teflon bailer or 2-inch stainless steel Kemerer sampler. This latter sampler can provide non-aerated groundwater samples at discrete depths which aids in ensuring the integrity of any volatiles in the groundwater.

The methods for obtaining the water data are as follows. All downhole equipment used during the purging of the monitoring wells will be carefully washed to prevent cross-contamination. Details of the decontamination process are provided in the Quality Assurance Project Plan (QAPP) in Appendix C. As an additional step to prevent cross-contamination of the wells, purging/sampling operations will progress from areas suspected to contain little or no contamination to areas assumed to have higher contamination levels. The purged groundwater will be disposed through an oil/water separator connected to a sanitary sewer.

5.4.3 Temperature.

Measurements of the sample temperature will be taken using a mercury thermometer. The field measurement represents the temperature of the groundwater at a particular location and time.

pH - The pH of each sample will be measured by a Myron L pDS (Model EP11/pH) meter or equivalent. The pH of the sample will be measured as quickly as possible after collection.

Specific Conductivity - The specific conductivity of each sample will be measured with a Myron L pDS meter (Model EP11/pH) or equivalent. Elevated specific conductivities indicate the presence of conductive ions in the groundwater.

Sampling for Laboratory Analysis - Water samples collected from the wells will be placed in laboratory prepared containers, preserved as appropriate, chilled to 4 degrees C and shipped to the Southwestern Division Laboratory. The groundwater samples and type of analysis will be summarized per Table I of Appendix B. Also, the table will show data for surface water sampling. Chain of custody documents will accompany all samples. Analytical methods, preservations and holding times are provided in detail in the QAPP (included in Appendix C).

5.4.6 Split Sample Procedures

When split samples are required, the sample will be divided such that all the containers have a representative portion. In the case of solid samples (soil and formation), samples will be split longitudinally when possible and any loose material will be divided as equally as possible among the containers. Samples for volatile contaminants will be placed directly into the sample container with minimal disturbance. Water samples will be split by pouring an equal volume of liquid among the containers for each collection. The containers will then be labeled on-site and the samples recorded in a log book.

5.4.7 Drum Sampling

During the borehole and monitoring well drilling activities, cuttings that are suspected of being hazardous because of abnormal discoloration, odor or air monitoring levels will be containerized as discussed previously in Subsection 5.2, Subsurface Soil Surveys. To determine the final disposition of the cuttings in the drums, a composite sample will be obtained from each drum identified using a stainless steel scoop. Up to two composite samples will be collected for chemical analysis. Each composite sample of the drill cuttings will be analyzed for TCLP concentrations of metals, pesticides, herbicides, volatiles and semivolatiles to determine if the soil cuttings must be disposed of as a hazardous waste.

5.4.8 Evaluation-Related Tasks

The objectives of the data evaluation process are to summarize the existing information on the hazardous waste sources, pathways, receptors, and to evaluate potential impacts on the base and public health, and the environment. Site-specific analytical data resulting from the field investigation at the Base as well as regional information are considered in the evaluation process.

5.4.9 Data Management

The field investigation will generate large amounts of data on the hydrogeology and chemistry about the study sites. A computerized data system will be used to convert the raw field data and analytical data into a usable form for reporting.

Therefore, the computerized data system will be designed to support the following activities.

- o Archive, analyze and manipulate physical, chemical, biological and geological data collected.
- o Analyze data with respect to trends or violations of environmental protection guidelines.
- o Produce subsets of data to form summary reports and data files which can be analyzed by environmental models and statistical algorithms.
- o Interpret relationships between contaminant migration and biogeochemical relationships existing at a particular site.

5.4.10 Schedule for Collecting Samples

Wells shall be monitored during 3 months. Sampling event spaced at 2-

month intervals and analyzed in accordance with USEPA SW-846.

5.5.0 Preliminary Soils and Groundwater Report

The report shall contain a site map (scale: 1" = 50 ft) and it will depict site No. 64 and 67, existing, proposed monitoring wells and geologic cross-sections. Plans and schedule for submitting the hydrologic information and well construction.

5.5.1 Preparation of Final Report

Carswell Air Force Base will prepare the final report on the soils and groundwater. Four copies will be submitted with the RFI. The following items will be included:

a. Contours of the groundwater surface based on measurements in piezometers, monitoring wells and apparent direction of ground water flow.

b. The geologic cross-section depicting the near-surface stratigraphy.

c. Logs of all soil borings, monitoring wells, results of analyses for soil and ground water.

d. Contours of groundwater contamination and definition of plume.

6.0 Certification for Wastes and Submittals

The assessment of the site will be based on the value of the data collected. The physical, chemical data and field observations will be the foundation for making the interpretation about the site. The option of no wastes per Appendix 1X will be exercised if analyses indicate so.

APPENDIX A

Site Specific Safety and Health Plan

APPENDIX A
SITE SPECIFIC SAFETY AND HEALTH PLAN

1. Site Specific Safety and Health Plan.

a. Introduction: The purpose of this Safety and Health Plan is to comply with the minimum requirements to be followed in the work plan activities at SWMUs 64 and 67, French Underdrain System, and Bldg 1340, Oil-Water Separator at Carswell AFB. The objective of this plan is to provide information for determination of the presence or absence of chemical contamination which may have been contained within the material excavated and sampling of site No. 6. The responsibilities for this plan were given to the Corps of Engineers, Fort Worth District (CESWF).

Commander, USAED, Fort Worth

ATTN: CESWF-ED-G

P.O. Box 17300

Fort Worth, TX 76102-0300

Project Manager:

Telephone:

(1) Adherence to the Safety Plan. - Persons involved must be familiar with the instructions and information contained in the Safety Plan. Persons directly involved with the activities must acknowledge by signature that they have read and understand this plan prior to the initiation of on-site activities. The information contained in this Safety Plan will be adhered to at all times. Field modifications will be documented and presented to field personnel during daily safety briefings by the Site Safety Officer (SSO).

(2) Availability of the SP. - This Safety Plan (SP) shall be maintained by the SSO and available on-site for reference and review. This SP will be reviewed by field personnel prior to the start of field operations.

(3) Visitors. - Non-Corps of Engineers personnel will be asked to read this SPP and sign a medical waiver. Site access will be controlled by the SSO. The SSO will inform authorized visitors of potential hazards, and will provide them with site specific safety procedures and equipment before they will be allowed to observe or participate in activities in contamination reduction or exclusion zones.

Visitors will only be allowed to observe operations when necessary. Visitors will be accompanied by the SSO or a person designated by the SSO. No visitors will be allowed in areas of Level D Modified or higher protection unless they have been fully equipped and can provide written documentation of training in that level of protection.

b. **Anticipated On-Site Activities.** - The anticipated on-site activities for this investigation consist of drilling shallow auger borings, monitoring wells, and collecting subsurface soil samples.

2. **Responsibilities and Authorities.**

a. Organization/Administration. This section lists persons involved in project activities and describes their responsibilities. The list of personnel includes, but is not limited to, the Corps of Engineers, Fort Worth District Safety Officer (SO), the Project Manager (PM), the SSO, drilling personnel, and sampling technicians.

Health and safety responsibilities lie in a chain of command headed by the Fort Worth District Safety Officer (CESWF-SO), and managed in the field by the SSO.

b. Authorized Personnel. Personnel authorized on-site includes employees and representatives from the Fort Worth District, Corps of Engineers, representatives of Carswell AFB, State health agency representatives, Texas Water

Commission employees, and visitors. These people must meet requirements of this SPP prior to being allowed access to the site. The perimeter of the contamination reduction zone will be posted with signs restricting entry to authorized personnel only. Carswell AFB is not a secured government facility which is inaccessible to the general public without prior approval. Casual onlookers around the work areas are not expected, but may occasionally be present.

c. <u>Fort Worth District Safety Officer (CESWF-SO).</u> - The CESWF-SO shall direct the implementation of the health and safety program. The responsibilities of the CESWF-SO include the following:

- Provide Hazard Assessment/Analysis for generation of the SSP.
- Act as primary contact for health and safety matters for the PM and field personnel.
- Perform periodic field inspections of health and safety related operations to check conformance with this plan.
- Investigate reports of incidents or accidents and officially report findings.
- Perform in site-specific training, if necessary (i.e., additional training to meet minimum OSHA requirements).
- Provide industrial hygiene/chemical safety guidance to SSO.
- Develop new safety protocols and procedures necessary for new field operations.
- Resolve major outstanding health and safety issues which arise during field operations.
- Provide internal review and approval of health and safety plans.
- Audit key aspects of health and safety program.

d. Project Manager. The Project Manager for this investigation will be assigned by the U.S. Army Corps of Engineers, Fort Worth District (CESWF-ED-GH). The responsibilities of the PM shall include the following:

- Determination of matters relating to schedule, cost, and personnel assignments that are not safety related.
- Temporary suspension of field activities, if health and safety of personnel are endangered, pending evaluation by the CESWF-SO.
- Temporary suspension of an individual from field activities for infractions of this plan, contingent on a recommendation by the SSO and evaluation by the CESWF-SO.
- Periodic site visits to observe field operations.

e. Site Safety Officer (SSO). The SSO has the responsibility to check that individuals involved in the handling of potentially contaminated materials comply with the requirements outlined in this plan. The SSO has the authority to issue a **"quit-stop work action"** if unsafe conditions warrant. Specific health and safety responsibilities of the SSO include the following:

- On-site presence during activities to enforce compliance with this plan. In the event conditions warrant, a **"quit-stop order"** will be issued by the SSO pending investigation by the CESWF-SO and the PM prior to resumption of activities.
- Daily on-site safety briefings for site personnel.
- Locate and identify emergency communication systems that are available nearest the work area.
- Manage health and safety equipment used at the site.
- Establish work/rest regimen.
- Conduct emergency response provisions in conjunction with local

authorities (hospital, fire, security).

- Monitor health and safety conditions during site work.
- Fill out Accident/Injury Report when necessary.
- Maintain a project logbook to record daily operations, air monitoring results, weather conditions, employees on-site, safety problems, and similar information.
- Oversee the setup, inspection, and execution of decontamination.
- In an emergency, provide the fire department and hospital with information regarding the operations.
- Report and correct site specific health and safety violations.
- Act as liaison with the CESWF-SO and the PM regarding field operations.
- Responsible for conducting the work in accordance with the requirements of the Sampling and Analysis Plan.
- Provide appropriate protective equipment for use by personnel, in accordance with this plan.
- Supervise and monitor the performance of personnel to check that proper work practices are in accordance with this plan.

f. Field Personnel. Field personnel will consist of senior crew members, sample handlers, drilling personnel, etc. They will carry out drilling/sampling operations and direct crew work efforts in accordance with this SPP. Table B-1 indicates the anticipated labor pool for this project.

TABLE B-1

ANTICIPATED CESWF LABOR POOL

NAME	TITLE
Rene' Moradel	Chief, Safety Office
Pat Giles	Safety Occupational Specialist
Raymond Hagen	Geologist (PM)
Randy Niebuhr	Geologist
*Jack Stokes	Geologist
**Robert McVey	Geologist
Ted Brewer	Drill Rig Oper
Tom Suits	Drill Rig Oper
Greg Williams	Drill Rig Oper
Jerry Degrate	Drill Rig Oper
Clara Kirby	Civil Engr Tech

*(1) Senior Crew Member.

- Designated by SSO and PM.
- The senior crew member shall make limited emergency decisions should the SSO become incapacitated.
- Documented completion of training to satisfy 29 CFR Part 1910.120.

**(2) Crew.

- Workmen experienced in specific operations and capable of sound workmanship.
- Documented completion of training to satisfy 29 CFR Part 1910.120.

3.0 FIELD ACTIVITIES/HAZARD ANALYSIS

The field activities to be conducted during this program will involve potential health and safety risks to field team members. An analysis of these potential hazards are discussed individually in the following subsections.

The general types of hazards associated with this program are described below.

Mechanical Hazards:	Cuts, contusions (bruises), being struck by or striking objects, or being caught between objects.
Electrical Hazards:	Possible excavation of buried cables and contact with overhead power lines during drilling. Electrical storms.
Chemical Hazards:	Field exposure to chemicals listed in Section 3.1 of this plan.
Fire Hazards:	Possible excavation of buried gas lines. Grass fires. Equipment fires.
Thermal Hazards:	Exposure to outside temperature extremes, especially heat stress when wearing protective clothing.
Acoustical Hazards:	Exposure to excessive noise during drilling operations involving hollow-stem augering and air rotary drilling.

- o Be aware and alert for signs and symptoms of exposure to site contaminants and adverse weather conditions (i.e., temperature extremes and wind chill).

Unexploded Ordnance:	Unexploded ordnance is a very real concern during activities at any military installation. Site

activities should be coordinated with the Explosive Ordnance Disposal detachment before beginning site work.

3.1 Hazard Analysis: Hollow-Stem Auger Drilling

Hollow-stem auger drilling activities will potentially expose field personnel to the hazards listed below:

Chemical Hazards:

o Exposure to chemical contamination present in groundwater and soils. Suspected chemical contamination presently includes:
  - aromatic hydrocarbon compounds,
  - chlorinated hydrocarbon compounds,
  - petroleum products,
  - metals, and
  - pesticides.

Drilling personnel will also be exposed to exhaust fumes from the equipment operation.

Physical Hazards:

o Exposure to physical hazards associated with hollow-stem augering include the following:
  - snapping cables,
  - brush, equipment, or gas-main fires,
  - being hit by equipment,
  - becoming entwined in rotating tools,
  - falling objects,
  - drilling into buried utilities or waste ordnance,
  - exposure to excessive noise, and

- exposure to extreme outside temperatures.

3.2 Hazard Analysis: Air/Mud Rotary Drilling

During the installation of monitor wells using the air/mud rotary technique, the field team will generally be exposed to the same chemical and physical hazards as listed for the hollow-stem auger work.

3.3 Hazard Analysis: Development and Sampling of Monitor Wells

During development and sampling of the monitor wells there is a potential for exposure to contaminated groundwater. The various types of chemical contaminants listed in Section 3.1 (Chemical Hazards) should be considered present during well development and sampling. Use of electrical pumping equipment during development and sampling of the wells also presents some electrical shock hazards.

3.4 Hazard Analysis: Aquifer Testing

The greatest potential hazard associated with aquifer testing is possible exposure to contaminated groundwater. However, due to the nature of the test, this potential is limited. As described in Section 3.3 electrical shocks associated with the use of electrical pumps and automatic gaging equipment are also possible.

3.5 Hazard Analysis: Magnetometer Survey

Potential hazards associated with this activity are limited to physical hazards such as slips, trips, and falls. The magnetometer survey itself poses no hazards to field personnel.

3.6 Hazard Analysis: Soil Vapor Analysis

During soil vapor analysis, the field team could be exposed to hazardous vapors emanating from contaminated soil. The most probable types of airborne contaminants are volatile organic compounds (see Section 3.1). Physical hazards, similar to those listed in Section 3.1 are also possible.

3.7 Hazard Analysis: Soil Boring and Sampling

This activity will be accomplished using the hollow-stem auger drilling technique and split spoon or Shelby tube core samplers. The potential hazards are the same as those listed in Section 3.1.

3.8 Hazard Analysis: Sample Preparation and Shipment

After the samples have been collected in sampling jars, the samples must be preserved, as appropriate, and properly packaged to protect shipping personnel from potential exposure to contaminants. There is no great hazard in performing the packaging operation, yet if this operation is not done properly, unsuspecting individuals may be exposed if the containers leak or break. Preservation of water samples may involve the use of acids or bases to adjust sample pH. Proper precautions must be taken to avoid contact with these reagents.

3.9 Other Hazards: Heat Stress, Hypothermia, and Frostbite

During field work conducted in warm conditions, the Supervising Geologist must be alert for the signs and symptoms of heat stress. A hazard exists when individuals are required to work in warm temperatures while wearing impervious protective clothing. When the ambient air temperature at the site exceeds about 65 degrees Fahrenheit, heat stress may become a problem. When field activities are conducted during cold weather conditions (below freezing ambient air temperature or high wind chill factor) the Supervising Geologist must be alert for signs of hypothermia or frostbite.

3.10 Safe Work Practices and Personnel Protection

The following subsections describe procedures for safely performing the different tasks required at the sites included in this program. Based on the results of the hazards analysis of field activities summarized in the preceding section, activities at all sites can be safely conducted using either modified EPA level C or D personal protection. As defined for this project, EPA level C protection includes:

- Tyvek coveralls,
- Hard hat,
- Safety glasses or splash goggles,
- Air purifying full- or half-face respirator (worn),
- Rubber boots, and
- Gloves.

EPA Level D protection includes:

- Long sleeve shirt and trousers,
- Hard hat,
- Safety glasses or splash goggles,
- Air purifying, full- or half face respirator (carried).
- Rubber boots, and
- Gloves.

In addition, hearing protection is required during drilling operations and in any areas where aircraft engines pose a potential noise hazard.

Site 64 and 67 requires EPA Level D protection. This protection includes... Depending on actual site conditions encountered at the time of field activities, the SSO may increase or decrease the required level of protection. Some general guidelines that will be used are as follows:

o Disposable Tyvek coveralls should be worn by drilling personnel who handle potentially contaminated auger flights and other parts of the downhole drilling equipment. Tyvek coveralls should only be worn when there is a high probability of skin contact with contaminants. They should not be worn in the absence of splash or dust hazards. They contribute little in the way of skin protection against volatile organic chemicals and greatly increase the danger of heat injury. Heat stress monitoring will be increased when workers are wearing Tyvek clothing.

o Chemical splash goggles or safety glasses with side shields should be worn at all times during field activities.

o PVC disposable gloves worn over butyl rubber or nitrile gloves will provide an extra measure of hand protection when handling contaminated soils and water samples.

o Respiratory protection will be worn during drilling and sampling activities that may expose the field team to hazardous airborne materials. In cases where monitoring confirms that contamination is not present, the SSO may discontinue the use of respiratory protection. Air monitoring activities will increase when respirators are not being used (see Section 6, Exposure Monitoring Plan).

o Hearing protection will be worn during operation of heavy equipment.

Personal protective equipment, for the prevention of personnel exposure to chemical hazards via inhalation and skin contact, and to reduce potential physical hazards, are described in the following subsections. An equipment supplies list, including personal protective equipment and vendors will be provided piror to start work.

4.0 <u>Dermal Protection</u>

Drilling operations may expose field team members to certain dermal hazards, should contaminated soil or groundwater come in contact with their skin or eyes. To reduce the risk of physical contact with hazardous materials:

o Disposable Tyvek coveralls will be worn by the field team when handling wet drill cuttings or physically handling any of the drilling equipment (auger flights, etc.) that potentially have contacted the contaminated materials.

- Eye protection (safety glasses with side shields meeting ANCI std. 281.1) will be worn by all field team members during all drilling and sampling activities. Splash goggles will be worn during steam cleaning activity.
- Neoprene or PVC boots with steel toes will be worn by all field team members when contact with contaminated soils or standing water may occur. (steel toed boots must be worn at all times by personnel working near drill rigs of other heavy equipment).

4.1 <u>Respiratory Protection</u>

The following guidelines will be in force regarding respiratory protection:

- Air purifying respirators fitted with combination organic vapor/High Efficiency Particulate (HEP) filter/cartridges will be worn when the field activities disturb the soils.
- Approved Respirator
    - MSA Comfo II Half Mask with GMA-H Cartridges or equivalent
    - MSA Ultratwin Full Mask with GMA-H Cartridges or equivalent.

4.2 <u>Hearing Protection</u>

Since operations will be conducted near aircraft engines and jet taxi and maintenance areas, the noise level of these activities combined with that from the drilling rigs may result in a noise hazard. The field team must protect their hearing during drilling operations by wearing either or both of the devices listed below:

- E.A.R. brand foam ear plugs,
- Ear muffs

4.3 Head Protection

Head protection will be worn by all employees at all times they are on site. The type of head protection selected for this project is a nonmetallic, impact resistant hard hat (Class B helmet).

5.0 Personnel Training

During drilling and sampling of the sites, team members will be provided with and required to wear the recommended equipment. The following paragraphs discuss training information for respiratory protection. Personnel training will be as outlined in OSHA Standard 1910.120, including initial training - 40 hrs instruction at site; on site occasionally - 24 hrs instruction off the site; worker regularly on site - 24 hrs training off the site one day field experience under supervision; additional 16 hour and 2 days of training.

5.1 Respiratory Protection Training

Respirators will be provided to the field team by their respective firms. All personnel have or will be qualitatively fit tested with their personally assigned respirator as part of the OSHA Health and Safety Training. The team members will be expected to use these respirators properly.

The half-face air purifying respirator, equipped with the proper cartridge, is capable of filtering certain gases, vapors, dusts, mists, fumes, and particulates out of inhaled air. This respirator does not provide oxygen and should not be used in oxygen deficient atmospheres or Immediately Dangerous to Life and Health (IDLH) conditions. The respirator will not provide adequate protection if the face seal is poor, and all male members of the field team will be required to shave daily before wearing this respirator. It is a violation of

OSHA regulations to wear a respirator with any facial hair that interferes with the face seal. Contact lenses are also prohibited when respirator protection is required.

Respirators must fit properly to afford adequate protection. To ensure that a proper fit is obtained, fit testing is performed. The SSO will perform three types of fit tests at the start of field activities and will ensure that each person is periodically checked for proper respirator fit. These tests are:

- Negative pressure testing,
- Positive pressure testing, and
- Odor testing.

5.2 Personal Hygiene Practices

The field team must pay strict attention to the hygiene requirements listed below to avoid ingesting or sustained dermal contact with any of the possible site contaminants:

- Never put anything in your mouth, including your fingers, while conducting field activities.
- All employees must wash their hands, forearms, face and neck, before eating, drinking, smoking, or using the rest room. There will be no exceptions to this rule.
- At the end of the day, each employee will shower thoroughly.

6.0 Exposure Monitoring Plan

Employee exposure to site contaminants and physical hazards will be monitored during the site activities by using a combination of techniques:

- Organic vapor measurements using photoionization detector (PID) HNu or comparable device);

- Air quality screening for total organic vapors and selected organic compounds using indicator colorimetric tubes (Draeger tubes); and
- Heat and cold stress monitoring will be conducted by the SSO through field observations and body temperature measurements.

6.1 Chemical Exposure Monitoring Plan

The SSO will monitor airborne levels of organic contaminants during all drilling activities (monitor well drilling and soil coring). Measurements will be taken in the borehole, over cuttings, and in the breathing zone for comparison with background levels. Monitoring for chemical exposure will include the following activities:

- Obtain a background organic vapor reading near the upwind boundary of the site, using a photoionization detector (PID).
- Monitor the ambient air in the vicinity of the drill rig with the PID during drilling activities:
  - check borehole concentrations whenever the drill stem is broken to add new sections; and
  - if borehole concentrations or concentrations over cuttings increase from background, immediately check breathing zone concentrations.
- Drilling operations will be suspended and respiratory protection requirements will be reevaluated if the PID total organics measurement in the breathing zone increases by more than 5ppm above background;
- Use Draeger "Polytest" tubes for backup of the PID in the event of malfunction and to verify PID total organic concentrations; and
- Use compound-specific Draeger tubes (benzene, trichloroethylene,

tetrachloroethylene, vinyl chloride, and toluene) for on-site identification of organic contaminants.

6.2 Heat Stress Control and Monitoring Plan

Workers who wear protective clothing will be at increased risk of heat stress. The Supervising Geologist should observe the field team at all times and be alert for the signs of heat illness.

- Make sure that the workers adhere to a work/rest schedule; and
- Everyone on site should replace lost fluids frequently.

6.2.1 Heat Stress Control

The SSO will set work and break schedules depending on how heavy the work load is and the outside temperature in coordination with the drilling supervisor. Generally, workers conducting drilling activity in protective clothing need to break in the shade at least 10 minutes out of every hour during elevated temperatures. Rest time should also include fluid replacement with electrolytes (e.e., Gatorade or equivalent).

During conditions where the temperature, humidity, and solar radiation are high and the air movement is low, the following procedures should be followed whenever possible to prevent heat stress injury:

- Limit work activity periods to reduce the amount of heat the body produces.
- Workloads and/or duration of physical exertion should be less during the first days of exposure to heat and should be gradually increased to allow acclimatization.
- Schedule heavy work during the cooler periods of the day.
- Alternate work and rest periods in heat stress conditions; in moderately hot conditions, 5-minute rest periods in the shade alternating with 25-

minute work.periods in the sun may be desirable. Under severe conditions, the duration of rest periods should be increased.

o A heat stressed worker may lose up to a quart of water per hour. This loss must be replaced, or a rapid rise in body temperature will occur. In conditions of moderate heat, replace 5 to 7 quarts of water per worker per day. In severe conditions of heat stress, replace 9 to 13 quarts of water per worker per day.

6.2.2 <u>Heat Stress Monitoring</u>

The SSO should perform monitoring activities for heat stress when workers are using protective clothing in elevated temperatures. The heat stress monitoring plan includes:

o Measurement of worker heart rate (pulse beats 15 seconds x 4 or 30 seconds x 2);

o Measurement of body temperature with forehead fever strips; and

o Observation of the field team for sign and symptoms of heat stress which includes:

- pale, clammy skin progressing to hot, dry, and red skin,
- profuse perspiration,
- cramps,
- headaches,
- nausea, and
- fainting.

The following criteria will be used to institute heat stress controls (increase resting breaks, stop work, etc.).

o Heart rate >110 bpm (beats per minute) at beginning of rest period; shorten next work cycle by one-third.

- Heart rate >90 bpm at 3 minutes into rest period; shorten next work cycle by one-third.
- Oral temperature >99.6 degrees F at beginning of rest period; shorten next work cycle by one-third.
- Oral temperature >100.6 degrees F at any time; remove impermeable clothing and begin rest period until temperature drops to 99.6 degrees F.

6.3 Frostbite Control and Monitoring Program

During cold conditions, the Supervising Geologist and members of the field team must be alert for the signs and symptoms of frostbite. Frostbite occurs when part of the body is affected by below freezing temperatures. The flow of blood to the affected area(s) stops, and skin cells may be permanently damaged in severe cases. It is possible that sudden weather changes may occur during the scheduled field activities with freezing temperatures, high winds and wind chill factors. Frostbite could easily result if proper precautions are not taken. The symptoms of frostbite are hard, pale, cold skin that becomes red and painful when thawed out. Hands, feet, nose and ears are most susceptible.

To avoid frostbite, it is important to wear several layers of warm clothes under a windproof outer garment such as the Tyvek coverall. Also make sure that the face, hands, and feet are protected. These precautions are also effective for prevention of hypothermia which may occur under similar conditions.

If frostbite occurs:

- Get the victim medical attention as soon as possible;
- Provide shelter from wind and administer warm drinks;
- Cover frozen areas with additional clothing or blankets;
- Encourage gradual, gentle movement, but do not allow the person to walk if the feet are frozen;

- Do not use direct heat or rub the frostbitten area (s); and
- Do not put frostbitten areas under warm or hot water.

7.0 Work Zones and Decontamination Procedures

To minimize the transfer of possible hazardous substances from the site, contamination control procedures are needed. Contaminants must be removed from clothing, personnel, and equipment prior to relocation from a work zone. For drilling activities, a formal series of work zones, centering on the borehole and rig, will be established. These zones are described in the following subsections. For all other activities, the general sampling equipment and personal protection equipment decontamination procedures described in Section 7.2 will be followed. Decontamination will be fully completed prior to moving off site.

7.1 Work Zones

Prevention of exposure and spread of contamination will be controlled through establishment of work zones. Three work zones will be used in this project: 1) Exclusion Zone, 2) Decontamination Zone, and 3) Support Zone.

7.1.1 Exclusion Zone

The Exclusion Zone is the area where disturbance activities (monitor well installation or coring activity) are conducted and where contaminants and physical hazards may be present. Only properly trained individuals who are wearing appropriate personal protection equipment will be allowed to enter and work in this zone. The size of the Exclusion Zone will be established by the Supervising Geologist based on site-specific conditions, but generally includes the area within a 25-foot radius of the drill site.

7.1.2 Decontamination Zone

The Decontamination Zone is a corridor which leads from the Exclusion Zone to the Support Zone. This corridor will contain wash buckets, solid waste disposal containers, brushes, and equipment drop tarps. All decontaminants activities will occur in this area.

7.1.3 Support Zone

The Support Zone is the area where the field team will reside when not performing site work. This area is to be used for eating, equipment storage, and staging. It is extremely important to locate the Support Zone in an area that is know to be free of contamination and as far upwind from the drill site as practical (at least 50 feet).

7.2 Decontamination Procedures

Equipment Decontamination Procedures

Equipment (spades, bailers, shovels) must be decontaminated before they may be used at other sites. Usually, a water washing in a detergent solution followed by a potable water and distilled water rinse will be sufficient to remove contaminants. Occasionally, washing with acetone or other solvents may be required. Remember, some solvents are toxic or extremely flammable and should be used with caution.

Rig Decontamination Procedures

1. Use a high pressure water wash to remove site contaminants from the drill rig and associated equipment (auger flights).

2. Set up wooden pallets and lay flights down to wash with the high pressure water. Remember to wear splash goggles during this activity.

Personal Protective Equipment Decontamination Procedures

1. Remove outer gloves and dispose in trash container. Hard hats, safety glasses, and boots should be cleaned at the end of the day. Set up wash and rinse stations within the Decontamination Zone using detergent, potable

water, and brushes.

2. Remove and dispose coveralls. Continue wearing boots, undergloves, and respirator.

3. Remove undergloves and respirator in the Support Zone.

4. Respirators must be disassembled and washed with detergent at the end of each work shift.

5. Disposable garments and spent respirator cartridge should be deposited in covered containers for eventual disposal.

8.0 Emergency Response and Communication Plan

The objective of the emergency response and communication plan is to ensure that the field team knows how to contact emergency help quickly. The Supervising Geologist will determine how to access the base emergency response network by coordinating with the Air Force Point of Contact.

8.1 Emergency Medical Response

Before beginning site activities make sure that each field team member knows where the nearest emergency medical facility is and how to get there.

- Locate the closest telephone;
- Post the telephone number of the nearest ambulance service (private or military);
- Make sure that the field team is aware of the location of a first aid kit and eyewash; and
- The Supervising Geologist should be prepared to handle minor injuries.

8.2 Fire Emergency Procedures

The threat of fire on this particular project is considered slight because any contaminated material will be aqueous or solid. Fire hazards will, however, exist in the following activities:

- Equipment refueling;
- High pressure water cleaning fuel storage and refueling activities;
- Any welding activities; and
- Any solvents that are used in decontamination.

The Supervising Geologist should check to see that each vehicle and drilling rig fire extinguisher is appropriate for the fire hazard presented by this project. Generally, Type A, B, C extinguishers are appropriate.

The field team should be prepared to fight small fires with extinguishers. In the event of a large fire, the field team should contact the base emergency number and report the fire.

The Supervising Geologist will take the following action in the event of a fire:

- Try to extinguish fire, if small;
- Notify all site personnel that a fire exists;
- Shutdown site activities;
- Account for all site workers; and
- Evacuate the site, if necessary.

9.0 Record Keeping Procedures

To document the safety and health program for the Carswell AFB investigation, the Project Director will keep records of the following:

- Documents certifying that each member of the field team has completed an occupational medical examination.
- Documentation that each member of the field team has successfully completed at least 40 hours of health and safety training.
- Certification of the successful completion of fit testing for respirators.

- Signed certificates by the field team that they have read and understand the safety and health requirements contained in this plan.

APPENDIX B

Sampling and Analysis Quality Assurance/Quality Control Plan

U S ARMY CORPS OF ENGINEERS
SOUTHWESTERN DIVISION LABORATORY

Sampling and Analyses
Quality Assurance/Quality Control Plan

January 1991

I. Purpose:

The purpose of this QA/QC plan is to describe the quality assurance and quality control procedures followed by the Southwestern Division Laboratory and their contractors when performing analyses of samples from their clients. These procedures are used to ensure that the generation, processing, verification and reporting of the data by the laboratories are reliable, accurate and properly documented.

II. References:

The following references were used in the preparation of this plan:

A. U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Wastes, SW 846, November 1986.

B. American Public Health Association and American Waterworks Association, Standard Methods for the Examination of Water and Wastewater, 16th ed., 1985.

C. U.S. Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes, EPA - 600/4-79-020, 1979.

D. U.S. Environmental Protection Agency, Handbook for Sample Preparation of Water and Wastewater, EPA - 600/14-82-029, 1982.

E. U.S. Environmental Protection Agency/Corps of Engineers, Procedures for Handling and Chemical Analysis of Sediment and Water Samples, EPA/CE-81-1, 1981.

F. U.S. Army Corps of Engineers, Chemical Data Quality Management for Hazardous Waste Remedial Activities, ER 1110-1-263, March 1990.

G. Forester and Mason, Journal of Forensic Chemistry, Vol. 19, #1, pages 155 to 162, 1974.

III. Sample Collection:

A. Well Sampling:

All groundwater samples shall be taken using a stainless steel or teflon bailer. Each sample container shall be filled directly from the spout or discharge tube. Samples shall be placed in appropriate containers as detailed in Table I. Labels must be affixed to each container with the following information written with permanent ink: well identification, date, required analysis, methods of preservation, sampler's identification.

B. Soil Sampling:

Soil samples shall be taken by augering with a drill rig. Samples shall be collected in glass liter or half-liter wide-mouthed jars with teflon lined caps. Labels must be affixed to each container with the following information written with permanent ink: well or boring identification, depth, date, required analysis, sampler's identification.

C. Sediment Sampling:

Bottom sediment samples shall be taken using a core or grab sampler, depending on which method provides the most representative sample of the site. Samples will be collected either with a glass or stainless steel sampler, mixed in the field and placed in glass liter or half-liter wide-mouthed jars with teflon lined caps. Labels must be affixed to each container with the following information written with permanent ink: location identification, date, depth, required analysis, sampler's identification.

IV. Cleaning Sampling Equipment:

Water samplers used for collecting inorganic samples may be cleaned with non-phosphate detergent followed by rinses with tap water, dilute hydrochloric acid and distilled water. Water samplers used for collecting organic samples shall be cleaned with non-phosphate detergent followed by rinses with tap water, distilled water, pesticide grade hexane and pesticide grade methanol. The last two rinses should be done under a hood or well ventilated conditions. Drilling rigs and core samplers used for soil and sediment sampling shall be steam cleaned after each sampling or boring.

V. **Sample Preparation and Preservation:**

A. Preservatives:

Preservatives are listed in Table I. All chemical preservatives shall be of reagent grade quality. Preservatives shall be added dropwise from dedicated containers in order to achieve proper pH or concentration at the sampling site. A calibrated pH meter shall be used to check pHs.

B. Refrigeration:

Keep all samples refrigerated or iced down in coolers if space permits; otherwise, refrigerate those samples needing refrigeration as indicated in Table I.

VI. **QA Samples:**

There shall be a minimum of one QA field split or duplicate sample taken for every ten samples of each matrix type collected. There shall also be a minimum of one blank sample for each matrix type for every ten samples. Field blanks may consist of clean or background soil samples, water from background wells, sample rinsates, or distilled water as appropriate to the sample type.

VII. **Documentation:**

A. Fieldbook:

A field book shall be kept of all operations and contain the following: well or boring number, date, water level, well evacuation procedure and rate of recharge, sample method, pH and conductivity readings, any unusual conditions noted (odor, color, well damage, etc.) times of collection, preservation and shipment, sampler's name and any information regarding blank samples.

B. Field Data Form:

The field data form includes selected information from the fieldbook relevant to the analyses of the sample; such as, pH, conductivity, unusual odor or color, water level,etc. This form shall be shipped in the cooler.

C. Chain of Custody Form:

The chain of custody form is required to establish possession of the samples from collection to analyses. This form shall be shipped in the cooler with the samples and must be signed by both the sample collector and the sample preparer.

VIII. Shipment:

Samples shall be placed in coolers equipped with inserts to hold containers securely. Samples shall be covered with ice and have accompanying documentation sealed in plastic bags inside the coolers. Coolers shall be sealed with straps or tape and have a minimum of two chain of custody seals placed across the opening. Coolers may be shipped by commercial or government carrier and must be received by SWD Laboratory within 24 hours of the time the samples were collected.

Table I

Sampling and Preservation Procedures

Parameter	Container	Preparation
Volatile Organics	Three 40 ml glass vials	Zero headspace, Refrigeration, HCl to pH<2
pH	One 500 ml plastic	Refrigeration
Conductivity	One 500 ml plastic	Refrigeration
Metals	One liter plastic	Nitric Acid to pH<2, Refrigeration
Hex. Chromium	One liter plastic	Refrigeration
Cyanide	One 500 ml plastic	Sodium Hydroxide to pH>12, Refrigeration
Total Organic Halides	One one-liter amber glass	Sulfuric Acid to pH<2, Refrigeration
Total Organic Carbon	One 40 ml glass vial	Sulfuric Acid to pH<2, Refrigeration
Semivolatile Extractable Organics	Two one-liter amber glass	Refrigeration
Pesticides/PCB's	Two one-liter amber glass	Refrigeration
Herbicides	One one-liter amber glass	Refrigeration
Sulfates	One 250 ml plastic	Refrigeration
Fluoride	One 250 ml plastic	Refrigeration
Chloride	One 250 ml plastic	Refrigeration
Nitrate	One 250 ml plastic	Refrigeration
Phenols	One one-liter amber glass	Sulfuric Acid to pH<2, Refrigeration

Total Petroleum Hydrocarbons	One one-liter amber glass	Hydrochloric Acid to pH<2, Refrigeration
Chemical Oxygen Demand	One 500 ml amber glass	Sulfuric Acid to pH<2, Refrigeration
Oil and Grease	One one-liter amber glass	Hydrochloric Acid to pH<2, Refrigeration
Total Solids -- Dissolved Suspended	One 500 ml plastic	Refrigeration
Alkalinity	One 500 ml plastic	Refrigeration
Explosives	Two one-liter amber glass	Refrigeration
Ignitability	One one-liter amber glass	Refrigeration
Corrosivity	One one-liter plastic	Refrigeration
Reactivity	One one-liter plastic	Refrigeration
Gross Alpha, Beta	One one-liter plastic	Nitric Acid to pH <2, Refrigeration
Total Radium	One one-liter plastic	Nitric acid to pH <2, Refrigeration

Note: The above information applies only to water samples. All soil and sediment samples shall be collected into liter or half-liter wide-mouth glass jars with teflon-lined caps and kept refrigerated.

Table II

Analytical Methods

Water Samples

Volatile Organics	EPA Method 8240
pH	EPA Method 9040
Conductivity	EPA Method 120.1
Metals	
Mercury	EPA Method 7470
Arsenic	EPA Method 7060
Selenium	EPA Method 7740
Others	EPA Method 6010
Cyanide	EPA Method 9010
Total Organic Halides	EPA Method 9020
Total Organic Carbon	EPA Method 9060
Semivolatile Organics	EPA Method 8270/8250
Pesticides/PCB's	EPA Method 8080
Herbicides	EPA Method 8150
Sulfates	EPA Method 300.0
Fluoride	EPA Method 300.0
Chloride	EPA Method 300.0
Nitrate/Nitrite	EPA Method 300.0
Phenols	EPA Method 9065
Total Petroleum Hydrocarbons	EPA Method 418.1
Carbon Oxygen Demand	EPA Method 410.1
Oil and Grease	EPA Method 9070
Total Suspended Solids	EPA Method 160.2
Total Dissolved Solids	EPA Method 160.1
Alkalinity	EPA Method 310.1

Soil Samples

Volatile Organics	EPA Method 8240
Benzene, Toluene, Ethylbenzene, Xylene	EPA Method 8240 or 8020
Semivolatile Organics	EPA Method 8270/8250
Pesticides/PCB's	EPA Method 8080
Herbicides	EPA Method 8150
Metals	
Mercury	EPA Method 7471
Arsenic	EPA Method 7060
Selenium	EPA Method 7740
Others	EPA Method 6010
Flashpoint	EPA Method 1010
pH	EPA Method 9045
Oil and Grease	EPA Method 9071
Total Petroleum Hydrocarbons	EPA Method 9071
Conductivity	EPA Method 120.1
Cyanide	EPA Method 9010
Ignitability	EPA Method 1010
Corrosivity	EPA Method 9045
Total Organic Halides	EPA Method 450.1

U S ARMY CORP OF ENGINEERS
SOUTHWESTERN DIVISION LABORATORY
4815 Cass Street
Dallas, Texas 75235

Chain-of-Custody Form

Location________________________________ Date______________________

Site_____________________________________ Well/Boring Number_______

Number of containers in shipment:

	glass	plastic
liter	________	________
vial	________	________

Parameters sampled:

pH ________
Conductivity ________
Vol. Organics* ________
Metals** ________
Cyanide ________
TOX ________
Tot. Pet. Hyd. ________
Ignitability ________
Pesticides ________
Other Analyses ________
____
____
____

*Volatile Organics:
Regular detection limits ________
0.5 ppb detection limits ________

**Metals: (circle desired analyses)

As, Ba. Be, Ca, Cd, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Se,

Ag, Zn, EP Toxicity Prep.

CUSTODY RECORD
Signature and Title

Relinquished By	Received By	Date	Time

U S ARMY CORPS OF ENGINEERS
SOUTHWESTERN DIVISION LABORATORY
4815 Cass Street
Dallas, Texas 75235

Field Data Sheet

Location________________________ Date____________________

Site____________________________ Well/Boring Number__________

Casing Diameter_________________ Casing Type_______________

Rate of Recharge________________

Riser Elevation_________________

Depth of Water__________________ Time of Measurement__________

Measuring Device____

Well Purged Dry_________________ Continuous Recharge_________

pH Measurements

____

____

____

____

Date____________________

Time____________________

Meter Type/Model____________

Spec. Conductance, mhos/cm

____

____

____

____

Time____________________

Meter Type/Model____________

Temperature_______________

Notes concerning condition of well, odors, color, etc.:

____

____

Sampler's Signature________________________________

IX. Sample Custody:

A. Sample Receiving and Chain-of-Custody Procedures are designed to track the movement of samples from the time they leave the sampling site to the time they are analyzed.

1. All samples are received in a designated area of SWD Laboratory by a sample custodian. Each sample is thoroughly examined to ensure that proper sampling, preservation, packaging and labeling techniques have been employed.

2. Each sample is assigned a unique SWD Laboratory sample number and recorded in a bound log book which includes lab and field sample numbers, date sampled, date arrived to SWD, Corps of Engineer District or client generating sample, location of sampled area, sample description, and list of analyses requested. This information is also maintained on computer files.

3. The Chain-of-Custody is checked for accuracy and signed and dated. Any significant information concerning samples is recorded on the Chain-of-Custody at this time.

B. Sample Storage:

1. Samples are stored at 4C -- checked and recorded daily -- in six 3'x6'x6' stainless steel refrigerators.

2. Samples are stored for a minimum of six weeks after data has been submitted to client.

3. Volatile samples are stored separately in two, 21 cu. ft., refrigerators.

C. Contract Laboratories:

1. Samples which are to be transferred to a contract laboratory are shipped within twenty-four hours of receipt by SWD Laboratory.

2. Samples are shipped in coolers with form- fitting inserts and covered with ice. Coolers are secured with straps and chain-of-custody seals then shipped for next day delivery by commercial carrier.

3. Sample shipment includes samples, chain-of-custody documentation with explicit instructions concerning sample identification, required analyses, turnaround date and sample collection date.

D. Requirements of Contract Laboratories:

1. Contractor must be validated by the Corps of Engineers Missouri River Division Laboratory.

2. Contractor must have minimum duplicity of all major analytical equipment.

3. Contractor must be certified by the Oklahoma Water Resources Board.

X. Reporting and Recording Data: Analytical data is reported and recorded in the following manner:

A. All raw data is recorded in bound books and/or computer printout.

B. Written reports are submitted to the client after a project is completed or at regular intervals for long-time projects. Each report contains the following information:

1. Identification of samples by the field number and by the SWD number.

2. Minimum detection limits for each constituent reported.

3. Quality control and quality assurance data such as method blanks, surrogate recoveries, duplicates and spikes applicable to the data set.

4. Analytical results.

5. Date analyzed.

6. Date sample collected and date received by SWD.

7. Method of analyses.

C. Data and information concerning analyses is available by telephone, computer interface or modem, or computer disc.

D. Laboratory Director maintains records of all reports submitted to clients.

E. Environmental Services Section maintains records of all raw data, hard copy of all reports, and computer records of all analytical and quality control data.

XI. **Preventative Maintenance:** In order to prevent instrument down time and costly instrument repairs, SWD uses the following methods of maintenance:

A. Service maintenance contracts are purchased for all major equipment such as both Perkin Elmer Atomic Absorption Spectrophotometers, the ARL ICAP, the Hewlett-Packard GC/MSD, the Hewlett-Packard GC, the Dohrmann TOX Analyzer, the Waters IC/HPLC and the O. I. TOC Analyzer.

B. Specific operator manuals are used to outline preventative maintenance plans for all equipment.

C. Each instrument has an instrument log book in which the daily performance, preventative maintenance activity, problems, etc. are recorded.

XII. **Data Validation:** Data validation is accomplished by monitoring the precision and accuracy of quality control data, system audits and by utilizing known and blind standards.

A. Initial Calibration: At the beginning of each day, each instrument is calibrated by standard samples according to the prescribed method. This calibration is verified by an analysis of method blank samples immediately after the calibration procedure and immediately before sample analyses.

1. Standards are either bought or prepared using certified chemicals as specified in the methods.

2. Data from standards are accumulated starting from the lowest concentration and ending with the highest.

3. Calibration is verified by an EPA Quality Control Sample at the rate of at least 10%. Calibration curves are generated using at least three data points.

4. Calibration data is recorded on raw data sheets and kept in bound books and/or computer files.

5. Method blanks are prepared for every twenty samples or less containing appropriate amounts of reagents used in sample preparation. Data from the blank is determined and recorded after calibration. If the method blank is above the required detection limit and/or the lowest analyte is less than ten times the blank concentration, the entire sample set will be reanalyzed.

B. Spiked Sample Analyses: Spiked samples are samples altered by the addition of known amounts of analytes. These samples are analyzed along with actual samples. The percentage of analyte recovery is then calculated to ascertain quality of data.

1. Spiked samples are prepared before sample preparation procedures (digestion, extraction, etc.) and generated at the rate of at least 10% of samples.

2. Individual percent recoveries are calculated as follows:

$$\text{Recovery} = \frac{(SSR - SR) \times 100}{SA}$$

where SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

3. Percent recoveries outside the range of 80 to 120% are considered outliers. Spike recoveries are disregarded for samples in which the concentration is four or more times the spike amount.

C. Duplicate Sample Analyses: A second spiked sample is prepared and analyzed as above. The information generated is used as a check on instrument reliability, operator error, chemical problems, etc.

1. The relative percent difference between the spike sample and the spike sample duplicate is calculated as follows:

$$RPD = \frac{(D1 - D2) \times 100}{(D1 + D2)/2}$$

where RPD = Relative Percent Difference
D1 = First Spiked Sample Value
D2 = Second Spiked Sample Value

2. Results of duplicate analyses for samples with concentrations greater than five time the required detection limit shall have RPD of less than twenty percent to be acceptable.

D. Corrective Action: If some, but not all, spiked and/or duplicate spiked samples are found to be outliers, the entire sample set is reanalyzed using the sample extract or digestate. If all the spikes and/or duplicate spiked samples are outliers, the entire sample set shall be reanalyzed starting from the initial step (digestion, extraction, etc.). A thorough investigation of reagents, instrument condition and calibration, and any other factors contributing to the problem of accuracy and precision will be conducted in order to correct any problems.

E. External Quality Assurance Program: SWD Laboratory participates in a QA program provided by the U. S. EPA Environmental Monitoring and Support Laboratory of Cincinnati, Ohio, the certification program by the Oklahoma Water Resource Board, and the U. S. Army Corps of Engineers validation program.

XIII. Procedure for Cleaning Glassware:

A. Trace Metals Analyses:

1. Prior to use, glassware for trace metals analyses is rinsed with pesticide grade hexane.

2. After use, glassware is rinsed with tap water, washed with a Liqui-Nox solution, rinsed twice with tap water, and, finally, rinsed with distilled or deionized water.

3. Stained glassware is cleaned with a strong acid solution, then washed and rinsed as above.

B. Organic Analyses:

1. Prior to use, glassware for organic analyses is rinsed with pesticide grade hexane.

2. After use, glassware is rinsed with tap water, then sonicated for fifteen minutes in a solution of Liqui-Nox in a sonication bath. This is followed with a tap water rinse, two distilled water rinses, and an acetone rinse. After glassware is dry, it is placed in the muffle furnace at 550C for four hours.

3. Stained glassware is cleaned with a strong acid solution after sonication, then washed and rinsed as above.

C. Other:

1. Glassware used for phosphate determination is not washed with detergents containing phosphates.

2. Glassware used for ammonia, Kjeldahl nitrogen and nitrate/nitrite is rinsed with ammonia free water.

XIV. Sample Disposal:

A. Samples are stored for a minimum of six weeks after the report is generated. The date a report is issued is put into both the sample log book and the work order book. The sample storage area for completed samples is separate from current samples and inventoried at regular intervals.

B. Hazardous samples are either returned to the client when completed or combined in specially marked containers for proper hazardous disposal.

XV. Safety:

A. Emergency Equipment:

1. The laboratory is equipped with four overhead showers, two eye washers and four fire extinguishers.

2. A Red Cross first aid kit is located on the premises.

3. All safety equipment is checked on a regular basis.

B. Protective Equipment:

1. All personnel are provided with laboratory coats, disposable aprons, gloves, respirators and protective eyewear.

2. All personnel are given a medical examination annually.

C. Ventilation:

1. The laboratory has four ventilation hoods and they are used whenever toxic or flammable materials are used.

XVI. **Personnel:** At the present time the laboratory is staffed by three chemists and two technicians. Two other chemist positions and two technician positions will be opening by the middle of 1991.

Personnel currently on staff and their responsibilities are as follows:

Catherine Hutchins, Chief, Environmental Services Section

1. Provide work assignments and coordinate projects within the Chemistry section
2. Maintain and upgrade QA/QC program
3. Train personnel
4. Purchase equipment, supplies, and materials necessary for maintaining laboratory
5. Consult engineers, geologists and field personnel
6. Evaluate and contract outside laboratories for overflow work
7. Evaluate laboratory data and write reports
8. Prepare Final QA/QC Reports for major projects

Anhmai Tran, Chemist

1. QA/QC manager
2. Chemical analyses using wet methods
3. Chemical analyses using atomic absorption spectroscopy, spectrophotometry, TOC analyzer, ion analyzer, microprocessor, gas chromatography, TOX analyzer
4. Train personnel
5. Evaluate data

Donald Bradshaw, Chemist

1. Safety officer
2. Chemical analyses using wet methods
3. Chemical analyses using atomic absorption spectroscopy, spectrophotometry, TOC analyzer, microprocessor, TOX analyzer, infrared spectrometer
4. Sample tracking manager

Albert Acosta, Lead Technician

1. Computer operations and data management
2. Sample preparation and analyses for trace metals
3. Sample receiving and tracking
4. Chemical analyses using wet methods
5. Chemical analyses using ICP and AA methods.

Franklin Kelly, Technician

1. Sample preparation and analyses for ions
2. Sample receiving
3. Chemical analyses using wet methods

Resume of Catherine E. Hutchins

1223 Lodema Lane
Duncanville, Texas 75116

Work Experience:

February 1988 to present:
US Army Corp of Engineers, Southwestern Division Laboratory
4815 Cass Street, Dallas, Texas 75235
Position: Chief, Environmental Services Section
Supervisor: Mr. William Tanner
214/905-9130
Duties include: Performing professional analytical and physical testing of water, soil and dredged material received by the laboratory. Primarily use microanalytical techniques such as Atomic Absorption, Gas Chromatography, TOC, colorimetric, volumetric, gravimetric and wet chemistry analyses. Utilize professional knowledge and education covering a wide range of test procedures and theoretical principles to accomplish assignments. Directs work assignments to technicians from the receiving of samples to the writing of comprehensive scientific reports to clients. Extensive work on the IBM XT and AT using Lotus 1-2-3, dBase, Wordstar and Smartware systems.

February 1983 to September 1985:
State of Louisiana, Dept. of Environmental Quality
P.O. Box 44111, Cap. Station, Baton Rouge, Louisiana 70804
Position: Environmental Engineer
Supervisor: Mr. Thomas Bradley
504/838-5365
Duties included: Conducted inspections of complex major and minor industrial and municipal wastewater dischargers having Federal and/or State discharge permits. Conducted compliance assurance portion of major stream surveys. Performed routine surveillance of nonpermitted industries and municipalities. Investigated various environmental complaints and hazardous incidents. Coordinated work assignments of subordinates. Conducted comprehensive field sampling and analyses, oftentimes under extremely hazardous conditions. Conducted Performance Audit Inspections of public and private laboratories to ensure proper sample collection, preservation and analyses procedures were being adhered to. Reviewed and verified provisions or conditions of Wastewater Discharge Permits and Discharge Monitoring Reports for the EPA.

April 1980 to February 1983:

Jefferson Parish Environmental Department
3600 Jefferson Highway, Jefferson, Louisiana 70121
Position: Environmental Engineer
Supervisor: Dr. Michael Loden
504/367-6611

Duties included: Coordinated the Federal Pretreatment Program directives as they applied to Jefferson Parish. This comprised direct collection or supervision of collection by subordinates of water and wastewater samples from industrial and sewage treatment plants. This required interpretation of analytical data for judgmental decisions regarding compliance to Federal, State and Parish law. Duties further entailed preparation of the specific billing format to be assessed violators. In addition, it was required to respond to various environmental complaints and hazardous incidents. Further responsibilities included working closely with sewerage department engineers to upgrade sewerage system, sewage treatment plants and quality of sewage from industries. Also, taught the Certified Sewerage Treatment Plant Operators' course, a Hazardous Materials course to firefighters, and a Hazardous Gases course to plant operators.

June 1979 to April 1980:

Jefferson Parish Water Quality Laboratory
3600 Jefferson Highway, Jefferson, Louisiana 70121
Position: Chemist
Supervisor: Mr. Wayne Koffskey
504/367-6611

Duties included: Collecting and analyzing water and wastewater samples using instrumental and wet techniques. Organic materials were analyzed using TOC, spectrophotometric and gas chromatographic methods. Metals were detected using atomic absorption and atomic fluorescence methods. In addition, conventional wet chemical tests for COD, oil and grease, BOD, total suspended solids, nitrates, sulfates, surfactants, settleable solids and fecal coliform were performed as required. Extensive use of computer was required to record data and perform statistical analysis.

Related Training:

Sewage Treatment Plant Operators Licenses
- Activated Sludge Class IV, June 1982.
  - Recertified in June 1985.
- Biofiltration Class IV, June 1982.
  - Recertified in June 1985.

Rookie Firefighter School, August 1982.
Hazardous Materials Course, December 1982.
Computer Courses:
- Lotus 1-2-3, June 1988
- dBase, June 1988
- Advanced Lotus 1-2-3, May 1989

ARL ICP School, June 1989
Hewlett-Packard GC Training, November 1989
Dohrmann TOX Training, October 1989
Managing Environmental Compliance at Federal Facilities Course, November 1989
Hewlett-Packard GC/MS Training, March 1990
Waters IC/HPLC Training, February 1990
Environmental Laws and Regulations Course, June 1990
HTW Overview Training Course, July 1990

Education:

Eastern Illinois University
Charleston, Illinois 61920
Degree: Master of Science, May 1978.
Major: Chemistry -- emphasis on Environmental and Physical
Thesis: Amperometric Determination of Chemical Oxygen Demand

University of Illinois
Champaign, Illinois 61820
Degree: Bachelor of Science, May 1976.
Major: Chemistry
Minors: Physics and Mathematics

Resume of Anhmai Tran

2020 Via Bellena
Carrollton, Texas 75006

Work Experience:

April 1989 to present:
SWD Laboratory, US Army Corps of Engineers
4815 Cass Street, Dallas, Texas 75235
Position: Chemist
Supervisor: Catherine Hutchins
214/905-9130
Duties include: Sample tracking manager. Wet and instrumental chemical analyses. Train personnel.

1988 to April 1989:
Hydrocontrol Corporation
4574 Claire Chennault, Dallas, Texas 75248
Position: Chemist
Duties included: Testing and analyzing water samples. Preparing, testing and standardizing chemical solutions for customers.

1987 to 1988:
Baylor College of Dentistry
3302 Gaston Avenue, Dallas, Texas 75246
Position: Research Technician
Duties included: Prepare chemical reagents, set up laboratory instruments, photograph research pictures.

1981 to 1986:
Hydrocontrol Corporation
3801 South Moulton, Oklahoma City, Oklahoma 73158
Position: Chemist
Duties included: Research and development, test and analyze water samples. Prepare, test and standardize chemical solutions for customers.

1980 to 1981:
Oklahoma State Department of Health
1000 N.E. 10th, Oklahoma City, Oklahoma 73123
Position: Assistant Chemist
Duties included: Wet and instrumental analyses of water samples.

Related Training:

Computer Courses:
- Lotus 1-2-3, May 1989
- dBase III, June 1989

Dohrmann TOX Training, October 1989
Hewlett-Packard GC Training, November 1989
Hewlett-Packard GC/MS Training, March 1990
Waters IC/HPLC Training, May 1990

Education:

Oklahoma University
Norman, Oklahoma
Degree: Bachelor of Science, December 1979
Major: Chemistry
Minor: Physics

Saigon University
Saigon, Viet Nam
Degree: Bachelor of Science, April 1975
Major: Biochemistry

Resume of Donald Bradshaw

2422 North MacArthur Blvd.
Apartment #1236
Irving, Texas
75062

Work Experience:

January 1991 to present:
US Army Corps of Engineers, SWD Laboratory
4815 Cass Street, Dallas Texas 75235
Position: Chemist

June 1988 to December 1990:
City of Olney
201 E. Main Street, Olney, Texas 76374
Position: Wastewater Plant Operator

August 1984 to May 1987:
Professional Food Service Management Co.
3400 Taft Blvd., Wichita Falls, Texas 76308
Position: Assistant Chef

Education:

Midwestern State University, Wichita Falls, Texas
Degree: Bachelor of Science, May 1987
Major: Chemistry
Minor: Biology

Resume of Albert Acosta

3633 Big Horn Trail
Plano, Texas 75075

Work Experience:

April 1989 to present
US Army Corps of Engineers, SWD Laboratory
4815 Cass Street, Dallas, Texas 75235
Position: Chemistry Technician

September 1988 to September 1989
Brookhaven Community College
Farmers Branch, Texas
Position: Physics Teaching Assistant

Education:

University of Texas, Arlington, Texas
Degree: Bachelor of Science, May 1992
Major: Chemistry

Related Training:

ARL ICP Training, December 1990

Resume of Franklin Kelly

206 Bowles Court
Kennedale, Texas
76060

Work Experience:

May 1990 to present:
US Army Corps of Engineers, SWD Laboratory
4815 Cass Street, Dallas, Texas 75235
Position: Chemistry Technician

May 1989 to September 1989
Tarrant County Water Control
Fort Worth, Texas
Position: Technician

March 1987 to May 1989:
US Army
Dallas, Texas
Position: Signal Corps

Education:

Tarrant County Junior College, Fort Worth, Texas
Degree: Associates in Arts, June 1989
Major: Pre-Civil Engineering

XVII. Personnel Training:

A. Full time employees receive periodic outside training in environmental analyses, sampling, hazardous waste management and computer operations.

B. Students and part time employees receive on-the-job training based on needs described in job description, observe slide presentations and films describing use and operation of major equipment, and must demonstrate proficiency before being allowed to analyze samples.

C. New employees are hired for a one year probationary period. During that time the employee's work is constantly reviewed and evaluated for performance and productivity.

D. All employees' performance is reviewed annually.

XVIII. Laboratory Validations and Certifications:

A. The Southwestern Division Laboratory is validated on an annual basis by the Missouri River Division Chemical Review Section to do analyses for metals, pesticides and PCB's under the Corps of Engineers' Hazardous and Toxic Waste Program. Within a year validation to perform petroleum hydrocarbon, purgeable volatile organics, and explosive analyses should be completed.

B. SWD Laboratory is certified bi-annually by the Oklahoma Water Resources Board and annually by the State of Arkansas Water Commission to do a variety of chemical analyses for projects which are under their regulatory control.

C. EPA audit samples are analyzed bi-annually by SWD Laboratory as part of the interlaboratory QA/QC program.

XIX. Equipment:

A. Instrumentation:

Item	Manufacturer	Model	Age, Yr
pH Meter	Cole-Parmer	5986-60	4
Specific Ion Analyzer	Orion	901	11
Conductivity Meter	YSI	32	New
Conductivity Meter	Barnstead	PM 70-CB	3
UV-Visible Spectrophotometer	Milton Roy Co.	20D	3
Atomic Absorption Spectrophotometer	Perkin-Elmer	401	15
Atomic Absorption Spectrophotometer	Perkin-Elmer	5000,HGA 500	5
Total Organic Carbon Analyzer	O. I. Corp.	700	4
Gas Chromatograph	Hewlett-Packard	5890	1
BOD Analyzer	YSI	54A	5
Inductively Coupled Plasma Analyzer	ARL	3410	2
Total Organic Halide Analyzer	Dohrmann	20A	1
HPLC/IC	Waters	510/820/484	New
Gas Chromatograph/ Mass Spectrometer	Hewlett-Packard	5890/5970B	New

Equipment To Be Purchased in Fiscal Year 1991:

Mercury Cold Vapor Analyzer--to replace Perkin Elmer #401 AA

Purge and Trap System for Gas Chromatograph--to enable laboratory to perform purgeable volatile organic analyses

IR Spectrometer--to enable laboratory to perform total petroleum hydrocarbon and oil and grease analyses

LC Automatic Sampler, HPLC Pump, UV/Vis Detector and Control Boards--to upgrade HPLC/IC system in order to perform explosive analyses

B. Major Laboratory Equipment:

Six Refrigerators 3'x6'x6'	Nor-Lake		7
Two Refrigerators 3'x3'x5'	Kenmore	106	9
Radiant Heat Oven	Lab Line	Imperial III	11
Forced Draft Oven	Blue M	OV-18C	1
Furnace	Heavi-Duty		31
Muffle Furnace	Hoskins		31
Three Fume Hoods	Labconco		12
Fume Hood	Allen-Bradley		30
Distillation System	Barnstead	A-1013	5
Distillation System	Barnstead	A-1013	2
Ion Exchange System	Millipore	Milli-Q	10
Centrifuge	IEC	2K	12
Centrifuge	IEC	EXD	25
Centrifuge	Lab Line	Imperial III	11
Centrifuge	Barnstead	1250	11
Balance	Fisher	B-5	22
Balance	Mettler	PC400	12
Balance	Mettler	K-7	22
Balance	Mettler	AE200	3
Balance	Ohaus	B300	4
Balance	Sartorius	1202	4
Ultrasonic Cleaner	Mettler		10
Sonicator	Ultrasonics	W-375	7
Roto-evaporator	Buchi	R110	8
Small Hot Plate	Lindberg		Unk

Large Hot Plate	Lindberg		3
Large Hot Plate	Lindberg		2
Small Water Bath	Blue M		8
Large Water Bath	Blue M		3
Vortex Mixer	S/I	K-550-G	6
Autoclave	Barnstead	1250	9
Ampule Sealer	O. I. Corp.		4
Automatic Digestion Unit	Technicon	BD-40	3
Magnetic Stirrer/ Hot Plate	Corning		1

APPENDIX C

Quality Assurance Project Plan

QUALITY ASSURANCE PROJECT PLAN

FOR RCRA FACILITY INVESTIGATIONS

SWMU No. 62 and SWMU No.64 & 67

PREPARED BY:

U.S. ARMY CORPS OF ENGINEERS

Fort Worth District

PREPARED FOR:

Carswell Air Force Base

	signature	date
Quality Assurance Officer	________________________	________
Program Manager	________________________	________
Field Manager	________________________	________

QUALITY ASSURANCE PROJECT PLAN
RCRA FACILITY INVESTIGATIONS

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LIST OF ACRONYMS

ASTM	American Society of Testing Materials
COC	chain of custody form
COD	chemical oxygen demand
COE	Corps of Engineers
DOE	U. S. Department of Energy
EPA	U. S. Environmental Protection Agency
HE	high explosive
HTW	hazardous and toxic waste
HTW QA&IH	HTW Quality Assurance and Industrial Hygiene Section
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
MRD Lab	Corps of Engineers Missouri River Division Laboratory
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
RFI	RCRA Facilities Investigation
SSHP	Site Specific Health and Safety Plan
SWD Lab	Corps of Engineers Southwestern Division Laboratory

1.0 INTRODUCTION.

1.1 General. The purpose of this Quality Assurance Project Plan (QAPP) is to document the procedures required to ensure that all data obtained from the investigative activities in the Carswell AFB Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI) study are of acceptable quality. The validity and representativeness of this data must be ensured, so that the magnitude and extent of contamination can be accurately defined and remedial decisions can be made which are technically sound. Quality assurance (QA) is the Government activity required to assure desired and verifiable levels of quality in all aspects of an investigation. Quality control (QC) is the functional mechanism to achieve quality data. The QA program, administered by the Government, will ensure that the QC program will result in high quality data. This document will describe the QA/QC procedures for each aspect of the investigations which will meet the data quality objectives of this project. Procedures in this QAPP came from *Chemical Quality Data Management for Hazardous Waste Remedial Activities,* ER-1110-1-263 (ref. 8), a Corps of Engineers regulation, with additional guidance from *RCRA Facility Investigations Guidance,* SW-87-001 (ref. 15), *Test Methods for Evaluating Solid Waste,* SW-846, (ref. 13).

1.2 Organization. This document discusses the data quality procedures and techniques to be used in the work plans for investigations at Carswell AFB, Fort Worth, Texas. The study will be accomplished through the sampling and analysis of soil, bedrock, sediments, surface water, and groundwater, and the installation of monitoring wells. A description of the project is given in Section 2. Section 3 describes project organization and personnel; Section 4 discusses the quality assurance objectives for this project; Section 5 discusses the field work to be performed and the procedures to be used in drilling, well installation, and sampling of soil, rock, sediment, groundwater, and surface water; and Section 6 discusses sample handling and testing. Sections 7 through 10 discuss sample integrity, data reduction and validation, audits, and corrective action.

1.3 Deviations From Established Procedure. This section discusses procedural deviations and changes to the approved work plan. Any deviations in procedures which are temporary or involve unexpected conditions during field investigations and which will not change the objectives of the RFI work plan will be made by the field manager or the project manager. These changes will be documented and will be reported in the RFI report. In the event that deviations become necessary which could change the objectives of the RFI work plan, the Carswell AFB will submit, in writing, to the Texas Water Commission (TWC), a request for work plan modification. The request will include the details of the current procedures (if applicable), the proposed change, the rationale for the change, and a proposed time frame for action by the TWC. The TWC will reply in writing on their intent to act on the submitted request within a reasonable period of time after receiving the request. Once the modification has been approved by the TWC, the appropriate changes will be made in the RFI work plan. The modification will also be documented in the RFI report.

2.0 PROJECT BACKGROUND.

2.1 Site Description. Carswell Air Force Base is the home of the Strategic Air Command (SAC) 7th Bombardment Wing. The mission of Carswell AFB is to maintain the capability of strategic warfare and air refueling operations. SWMU No.62 Landfill No.6 (figure No.8 of work plan) and SWMU No.64 & 67, French Underdrain System and Oil/Water separator (figure No.7 of work plan) work areas encompass this QAPP.

3.0 PROJECT ORGANIZATION. The Fort Worth District, U.S. Army Corps of Engineers (COE), will use a multi-disciplinary project team from the District's Geotechnical Branch to oversee all project activities.

3.1 Field Personnel. Field operations will be conducted by the Fort Worth District, a contractor, or both. Activities will be coordinated by the COE Field Manager. The COE Field Manager will coordinate all field activities with the District Office and provide safety and quality control oversight. Each contractor will also designate a Field Manager who will coordinate activities with the COE Field Manager.

3.1.1 Fort Worth District Field Crews. District drilling crews consist of a driller, two helpers and a geologist. Water sampling crews consist of two individuals experienced in environmental water sampling. Field crews are supervised by the Chief, Engineering Geology Section. Members of Fort Worth District field crews have worked on hazardous waste investigation projects on military installations in Texas, Oklahoma, Arkansas, and New Mexico. Crew members attend formal and informal training sessions, including hazardous and toxic waste (HTW) safety training. The average hazardous waste experience level of the water sampling crew members is approximately 2 years. The average hazardous waste experience level of the drilling crew members is approximately 6 years.

3.2 Quality Control Personnel. All RFI program personnel are responsible for monitoring and reviewing all procedures used in every stage of the work to ensure that data generated in the course of execution of the work plan is accurate, complete, precise and representative of the site studied. The Field Manager or a member of his staff is designated as the Quality Control Officer and is responsible for the proper execution of field QC, as discussed in Section 5.10.

3.3 Quality Assurance Personnel. Quality assurance will be performed by the Fort Worth District, Geotechnical Branch, Hazardous Waste Management Section (HWM). This section reports to the Chief, Geotechnical Branch and will be responsible for office and field audits and reviewing laboratory audits. The audit function is discussed in Section 9. HWM Section will oversee performance and system audits of this investigative program, perform an on-going review of QA procedures, and help coordinate QA training for project personnel.

3.4 Laboratory. Analytical testing and quality control testing are performed by contract laboratories. QA testing is performed by the Corps of Engineers Southwestern Division Laboratory (SWD Lab). SWD Lab's responsibilities include procuring analytical services, analyzing QA samples, and validating chemical data. Details on SWD Lab organization, responsibilities and key personnel are contained in their QA/QC Plan, which is on file in Appendix B of work the plan.

3.4.1 Sampling by Fort Worth District Field Crews. When sampling is performed by Fort Worth District field crews, SWD Lab receives shipments of samples from the field, which it passes on to its contract laboratories, except for the QA samples. These laboratories currently include Southwest Laboratories of Oklahoma, Broken Arrow, OK; NDRC Laboratories, Richardson, TX; and Alpha Nuclear, Arlington, TX. In addition, three new analytical laboratories will be selected by March 1991.

3.4.2 Sampling by Contract Field Crews. When sampling is performed by A-E contractors, their laboratories receive all samples except the QA samples, which are sent to SWD Lab. Contract laboratories include Southwest Research Institute, San Antonio, TX, through Burns and McDonnell, and Raba-Kistner, San Antonio, TX, through Ebasco Services, Inc. Additional laboratories could be added as new AE contractors are selected.

3.4.3 Laboratory Validation. SWD Lab and all contract laboratories are validated by the Corps of Engineers Missouri River Division Laboratory (MRD Lab). The validation process involves review of their laboratory quality management manual, laboratory performance on audit sample analyses, and an on-site inspection. This validation process is discussed in detail in Appendix B of ER-1110-1-263 (ref. 8).

4.0 QUALITY ASSURANCE OBJECTIVES. The data quality objectives of this project have been chosen to meet the goals of site characterization, risk assessment, and remedial design. These goals can be achieved with analytical support between Level III and Level IV, as described in ref. 14. As described in ref. 7, the minimum internal data reporting requirements which will be required of all analytical laboratories includes the following:

- Sample identification numbers will be cross-referenced with laboratory ID's and QC sample numbers.

- The laboratory will note problems with arriving samples on an appropriate form.

- Each anality will be reported as an actual value or less than a specified quantitation limit (listed in Appendix II). Each questionable result (based on laboratory QC) will be reported as such. Soil samples will be reported on a dry weight basis with the moisture content. Dilution factors, extraction dates, and analysis dates will also be reported.

- QC samples will include laboratory blanks, surrogate spikes, matrix spikes, laboratory duplicates, field duplicates, and field blanks. These samples will be analyzed as specified in the analytical method or as specified in this QAPP.

The data developed from the investigations described in this work plan should meet the objectives discussed below with respect to precision, representativeness, accuracy, completeness, and comparability. The majority of this data will be developed in the laboratory from the analysis of field samples and the remainder will be measured in the field.

4.1 Accuracy. Accuracy is the degree to which a measurement agrees with the actual value, i.e., the amount of measurement bias. Accuracy is expressed as a percent recovery of a known concentration of reference material. The accuracy of an analytical procedure is determined by the addition of a known amount of material (matrix spike) to a field sample matrix or a standard matrix. A standard matrix is made up of distilled water or sterile, clean soil with approximately the same physical properties (porosity, permeability, plasticity, grain size, etc.) as the field sample. The field sample matrix is described as all components of the sample mixture except the anality (the compound being analyzed). The lab will be required to perform matrix spiking on 10% of field samples, as well as on 5 to 10% of standard matrix samples.

Field sample Matrix and standard matrix sample spiking show how the sample matrix-anality chemical interactions affect the analytical results. The matrix behavior of the spiked field sample will be comparable to that of the matrix of the original sample. The matrix spike consists of a known amount of an anality which is added to the matrix before analysis. After analysis for the spike is completed, the accuracy of the procedure is expressed as a percent recovery as shown by the following equation:

$$\% \text{ recovery} = \frac{(C_2 - C_1)}{C_0} \times 100\%,$$

where C_0 = amount of anality added to the sample matrix,
C_1 = amount of anality present in the unspiked sample matrix (equal to zero for the standard matrix),
and C_2 = amount of spiked material recovered in the analysis.

Typically, the amount of a refence anality spiked into a field sample matrix is specified by the laboratory quality control program, or 3 to 5 times the background concentration of the anality in the sample matrix. Samples cannot be spiked for all organic compounds which could possibly exist in the field sample matrix, however, a set of surrogate compounds, each of whose physical and chemical properties is similar, is used as surrogate matrix spikes, or surrogates. Acceptable recovery ranges for each class of organic compounds are discussed in the analytical methods for each parameter.

4.2 Precision. Precision is a measure of the degree of reproducibility of an analytical value and is used as a check on the quality of the sampling and analytical procedures. Precision is determined by analyzing replicate samples. The significance of a precision measurement depends on whether the sample is a field replicate, lab replicate, or a matrix spike replicate. Field replicates are taken at the rate of 10% or one per batch (each daily shipment of samples from a site), whichever is greater. Precision of the analytical method, at each stage, is determined by calculation of a relative percent difference (RPD) between duplicate analytical recoveries of a sample component, relative to the average of those recoveries:

$$\text{RPD} = \frac{|C_2 - C_1|}{(C_2 + C_1) \div 2} \times 100\%$$

where C_1 = anality concentration in the sample,
C_2 = anality concentration in the sample replicate,

and $| \ |$ = an absolute value (It is customary to express RPD as a positive number).

These calculations are usually performed on matrix spikes and matrix spike duplicates.

4.3 Completeness. Field completeness will be assessed by comparing the number of samples collected to the number of samples planned. Analytical completeness will be assessed by comparing the total number of samples with valid analytical results to the number of samples collected. The overall project completeness is, therefore, a comparison between the total number of valid samples to the number of samples planned. The results will be calculated following data validation and reduction. Completeness (C) is determined by:

$$C = \frac{P_1}{P_0} \times 100\%$$

where P_0 = total number of samples planned,
and P_1 = number of valid data points.

A value of 90% or higher is the goal. For values less than 90%, problems in the sampling or analytical procedures should be examined and possible solutions explored.

4.4 Representativeness. Representativeness expresses the degree to which sample data accurately and precisely represent actual site conditions. The determination of the representativeness of the data will be performed by:

- Comparing actual sampling procedures to those outlined in the work plan.
- Identifying and eliminating nonrepresentative data in site characterization activities.
- Comparing analytical results of field duplicates with samples to determine the spread in the data.
- Examining blanks for cross contamination.

Representativeness is a qualitative determination. The representativeness objective of this work plan is to eliminate all non-representative data.

4.5 Comparability. Comparability isa qualitative measure of the confidence with which one data set can be compared to another. These data sets include data generated by different laboratories performed under this work plan, data generated by laboratories in previous investigative phases, data generated by the same laboratory over a period of several years, or data obtained using differing sampling techniques or analytical protocols. The comparability objectives of this work plan are (1) to generate consistent data using standard test methods; and (2) to salvage as much previously generated data as possible.

4.6 Sensitivity. Sensitivity is a general term which refers to the calibration sensitivity and the analytical sensitivity of a piece of equipment. The calibration sensitivity is the slope of the calibration curve evaluated in the concentration range of interest. The analytical sensitivity is the ratio of the calibration sensitivity to the standard deviation of the analytical signal at a given anality concentration. The detection limit, which is based on the sensitivity of the analysis, is the smallest reported concentration in a sample within a specified level of confidence. Quantitation limits represent the sum of all of the uncertainties in the analytical procedure plus a safety factor. The detection limit is a part of the quantitation limit. Quantitation limits are given in Tables B-4 to B-9.

5.0 FIELD OPERATIONS. This section discusses drilling, well installation, sampling, decontamination, waste disposal, other field procedures, and field QA/QC.

5.1 Oversight.

5.1.1 Field Manager. Field activities will be overseen by the Field Manager, who will meet with the sampling and drilling crews prior to the start of the project. The purpose of the meeting is to review the objectives of the investigation and resolve any unclear details. The Field Manager will discuss drilling locations and clearances, sampling parameters and equipment, decontamination, and any special considerations of this site. The Field Manager is responsible for ensuring that sampling procedures as discussed in this work plan are followed, that the paperwork is completed correctly, and that the quality control procedures are correctly implemented. The Field Manager will serve as a liaison between the sampling crew and the laboratory and between the field crews and the project manager.

5.1.2 Drill Rig Inspector. A geologist will serve as an inspector for all drilling activities. He will have a degree in geology and drill rig experience. The inspector will prepare and describe samples, cuttings, and core, monitor drilling operations, oversee well installation, record ground-water data, and prepare well diagrams and geologic logs.

5.2 Drilling. Techniques utilized to advance borings are dependent upon the specific problems and objectives at each location, such as the type of samples required, depth of well to be installed, and the presence of caliche and uncemented zones. Dry or air drilling techniques will be used whenever possible. However, drilling with water or mud may be required in instances where dry or air techniques are attempted and fail. In methods utilizing air as the circulating medium, cuttings will be routed directly through a cyclone, a device which separates air and cuttings, and which is discussed in Section 5.2.6.1. Cuttings which settle out from the cyclone will be collected and disposed of as discussed in Section 11. Compressed air will be passed through an in-line filter to avoid introduction of oil or other impurities into the borehole. Drill pipe, bits, barrels, casing, and other equipment used below ground will be steam cleaned as discussed in Section 5.9. Drilling techniques which may be used in drilling boreholes and monitoring wells are discussed below. Several different techniques may be used at each location to produce the best results. These techniques include:

- Hollow stem augering

- Dual wall reverse circulation drilling

- Dual or triple wall reverse circulation percussion hammer drilling

- Drill-through driven casing

- Conventional water, or mud rotary drilling

5.2.1 Hollow Stem Auger. This drilling technique utilizes hollow flight augers with a cutting head attached to penetrate the formation. A sampling device, such as a split spoon, is lowered through the auger string to take a drive sample. Variations of the method include use of a pilot bit or wireline core sampler in the center of the auger assembly. Use of a hollow stem auger has the following advantages:

- Maintains hole stability in unconsolidated or poorly consolidated materials.

- Allows drilling without added fluids.

- Permits good formation sampling with split spoon, Shelby tube, or wireline core sampler.

- Allows for recognition of saturated zones.

- Produces large diameter holes if formation is sufficiently stable to stand open when the augers are retracted.

- Large internal diameter augers (6 inches or greater) can be utilized as temporary surface casing for other drilling techniques.

- Waste is limited to the auger cuttings which are collected at the top of the hole. These are generally placed into a collection container as discussed in Section 5.11. Dust is minimal. Liquid waste is not present unless a saturated zone is encountered.

Limitations include:

- Difficulty of penetration below 100 feet, penetration limited to soils and soft hard rock formation.

- Risk of losing auger flights (and hole) at excessive depths.

- Inability to use the technique for well installation because of depth limitations.

- Need for air monitoring for volatiles in potentially contaminated areas.

This method of drilling will primarily be useful for determining stratigraphy and obtaining samples at shallow to moderate depths (100 feet). The relative ease of obtaining samples unaffected by any drilling fluids is a key consideration in employing this method.

5.2.2 Dual-Wall Reverse Circulation Air Drilling. This drilling method was developed in Canada for penetration of glacial till, alluvium, permafrost and other unstable formations. It is a modification of conventional air rotary drilling. Two drill pipe strings are utilized (outer and inner), with a drill bit attached only to the inner drill pipe. The drill bit has a slightly greater diameter than the outer drill pipe so the casing essentially drops by gravity into the drill hole. Air is circulated down between the inner and the outer casing past the bit and up the inner casing with the cuttings which are passed through a cyclone. Advantages of this system include:

- Rapid drilling through either unconsolidated or consolidated materials is possible.

- Cuttings are indicative of the formation currently being drilled since caving from higher in the borehole is not present. The air circulation returns cuttings to the surface very rapidly allowing accurate logging.

- Recognition of saturated zones is indicated by water reaching the surface with the cuttings. Water levels can be determined through the drill string.

- Small diameter geophysical logging tools can be run through the casing.

- Borehole integrity is maintained by the outer casing.

- System is capable of achieving depths of up to 1000 feet.

Limitations include:

- Sampling with split spoon or other samplers may not be possible depending on bit size and type. Therefore, collection of whole samples may be difficult or impossible.

- Only small diameter well casings can be installed through drill string (generally 2 inches or less). Installation of filter packs is usually not possible.

- Inner drill string and bit cannot be retracted through outer casing. All drill string must be tripped out of the hole.

5.2.3 Dual or Triple Wall Reverse Circulation Percussion Hammer Drilling. This method is similar to dual wall reverse circulation air drilling in that two drill pipe strings are used with air circulated down the outer and up the inner to remove the cuttings from the bit and bring them to the surface. The outer casing is fitted with an open-faced drive bit and is driven by a percussion hammer rather than rotated into the ground. The impact is applied only to the outer pipe. The inner and outer drill pipes are an integral unit which does not allow retraction of the inner casing. Drill string with a 9-inch outside diameter and 6-inch inside diameter is commonly available. Dual wall equipment with an inside diameter of 8 inches will be available (if needed) by the time field investigations commence at Carswell AFB which will allow installation of 4-inch diameter wells. A variation of this method utilizes triple wall casing. This system also employs a dual wall drill string with an additional outer casing. The outermost casing is simultaneously driven with the outer pipe of the dual wall casing, but is not physically joined to it. This allows retraction of the inner drill casings while leaving the third (triple wall) in place to maintain borehole integrity. Applications of this variation include installation of large diameter wells at shallow to moderate depths, and use as temporary casing to allow insertion of conventional rotary equipment or other tools. Depth of penetration with a triple wall casing is probably limited to a few hundred feet, but will depend on site specific conditions and equipment capabilities. This variation may be very helpful in increasing drilling rates through caliche zones in the upper part of the section. Penetration to total depth with the triple wall is not essential since the dual wall alone allows installation of 5-inch diameter wells.

Specific advantages of dual and triple wall reverse circulation percussion drilling include:

- Good penetration rates through unconsolidated material varying from clay to cobbles or even boulders.

- Detection of saturated zones and measurement of water levels through the drill stem.

- Installation of monitoring wells through drill string.

- Sampling with conventional samplers through drill string without the necessity of tripping out of the hole.

- Ability to run geophysical logs through drill string.

- Minimization of flow of fluids along the annulus, which is cased during all drilling operations.

- Ability to drill with air and maintain hole integrity in unstable formations.

- Flexibility to alternate with conventional air rotary to penetrate resistant zones if triple wall technique is utilized.

- Availability of single rigs capable of utilizing this methodology as well as dual wall reverse circulation rotary, and conventional rotary drilling.

Limitations of this method include:

- Penetration of consolidated layers may be difficult with the unassisted dual wall system.

- Required operational depths at Pantex of approximately 300 to 500 feet and large diameter require use of only maximum capability rigs.

- Risk of casing becoming stuck at depth. Rigs with a very large pulling capacity are required.

The dual wall percussion method allows the same ease of sampling as use of hollow stem augers, while being effective at depths of 450 to 500 feet. Three hundred-foot, 4-inch diameter monitoring wells have been installed at Pantex Plant with this method.

5.2.4 Drilling Through Driven Casing. As in the methods above, this method effectively stabilizes the borehole during drilling in unstable formations, without requiring water or mud. In this system an outer casing is driven into the ground around and above an advancing rotary drill bit and pipe. The bit typically is smaller in diameter than the internal diameter of the driven casing. The driven casing is fitted with a drive shoe. Air or water is circulated down through the center drill pipe and out the bit, then up through the driven casing. Essentially, this is conventional airor water rotary drilling with the addition of an outer casing to allow drilling in unconsolidated formations. Advantages of this system include:

- Borehole stability is maintained by the casing in unconsolidated formations.
- Penetration rates are rapid in unconsolidated material, and use of the bit allows successful penetration of resistant or consolidated layers.
- Cuttings are not mixed with material from higher in the borehole.
- Recognition of saturated zones and measurement of water levels is possible.
- Whole soil samples can be obtained through the outer casing when the inner drill string is retracted.
- Wells (5 inch and larger) can be installed within the outer drive casing.

Limitations include:

- The inner drill string must be retracted from the hole to allow sampling with split-spoon or Shelby tube.
- At depth, the risk of stuck casing increases.

5.2.5 Conventional Air, Water, or Mud Rotary Drilling. In this method a rotary drill bit and pipe are used to advance the hole. The circulating fluid (air, water, or mud) is pumped down through the drill string and out the bit recirculating to the surface through the open annulus. Advantages of this system include:

- Rapid penetration of most types of formation material.

- Rigs, drill pipe, and bits are commonly available for virtually any desired hole diameter.

- Drilling depths of hundreds to thousands of feet are feasible.

- Allows split-spoon and Shelby tube sampling in unconsolidated materials. Denison samplers can be used in liquid-filled holes.

- Virtually any type of geophysical log can be run in a liquid-filled open hole.

- Allows recognition of saturated zones and measurement of water levels if air has been used as the circulating fluid.

- Use of mud allows successful drilling and well installation in most types of formations.

Limitations include:

- Water or mud must be used to maintain hole stability in unconsolidated material such as alluvium.

- A large volume of cuttings and potentially contaminated fluids is produced.

- Recognition of saturated zones is difficult to impossible if water or mud are used.

- Significant infiltration of fluid into unsaturated formations may occur.

- Cuttings may require washing to be logged and will be mixed with material from layers higher in the borehole.

- Formation damage resulting from invasion of drilling fluids will increase required well development effort and may permanently affect well performance and groundwater sample quality.

- Drill string must be retracted from the hole to use most sampling devices.

- Water or mud washing of samples may make them unusable for chemical analyses.

5.2.6 Drilling fluids. Drilling fluids are used to lubricate the bit, remove cuttings and keep the boring open. Different materials perform these tasks differently and are discussed below.

5.2.6.1 Air. Air is used primarily to evacuate cuttings from the hole. Its advantage is that it does not moisten samples and compromise their usefulness for testing and it does not mask water-bearing zones. Air and cuttings leaving the hole are collected in a cyclone, located about 10 feet from the work area. The purpose of the cyclone is to minimize dust produced in the drilling. Air is discharged from the top of the device and cuttings settle out and are collected in a container.

5.2.6.2 Water. Water may be used in cases where air rotary methods do not work. In such cases, potable water will be provided by Carswell AFB. The water will be accessible from the work site and will be analyzed as needed for the same parameters as in the sampling program.

5.2.6.3 Mud. Mud is water with bentonite with or without other additives. Bentonite adds viscosity and aids in keeping the boring open. Additives, if used, will be selected with care to ensure that the groundwater chemistry will not be altered. A specialized type of mud is foam, which is made of a biodegradable polymer with properties similar to soap. It aids in lubrication of the bit and reducing dust from air drilling methods.

5.2.7 Soil and Rock Samplers. Sampling equipment to be used in conjunction with the drilling techniques discussed above is described in this section. Other types of sampling equipment may be used depending on what is available from the drilling contractor. Sampling techniques for soil and rock are discussed in Section 5.7.3.

5.2.7.1 Rockbit. A rockbit produces cuttings which are removed by air or other fluids. Cuttings are useful for lithologic identification and moisture approximation (if drilled with air). Cuttings are not suitable for any type of sample.

5.2.7.2 Core Barrel. A core barrel is a double-walled sampling device with a bit located on the outer barrel. It is used by itself, or modified, and used with other types of drilling equipment. A core barrel produces an undisturbed sample suitable for chemical or physical tests. Drill fluid, if present, should be removed from the sample to prevent moisture penetration. A sample of core, if encased in wax, is suitable for permeability determinations and bulk density as well as physical tests for disturbed samples.

5.2.7.3 Denison Barrel. A Denison barrel is also a double-walled sampling device similar to a core barrel but shorter. The inner barrel is fitted with an metal sampling tube 2 feet long. It also takes an undisturbed sample, which is placed into the sampling tube as it is drilled. The tube is removed from the barrel, capped, and waxed. It takes good samples in poorly consolidated materials. Denison samples are suitable for the same types of tests as core samples.

5.2.7.4 Split Spoon. A split spoon is a small diameter sampling device which is driven into the soil with a drive hammer. It is frequently used inside hollow stem augers or other types of casing. The sample is representative of the materials encountered, but is not undisturbed. It can be used for chemical tests or physical tests not requiring an undisturbed sample such as Atterberg limits, cation exchange capacity, soil pH, grain size distribution, moisture content, or clay mineralogy.

5.2.7.5 Shelby Tube. A Shelby tube is a thin-walled sampler which is pushed into the soil. It takes samples primarily in unconsolidated, cohesive materials. A Shelby tube might be useful in sampling near surface materials or playa sediments. It does not produce an undisturbed sample for purposes of laboratory testing.

5.2.8 Geological Logs. The strata encountered during drilling will be described in detail, using the Corps of Engineers geological log form (Eng Form 1836). The log will describe each lithologic unit encountered, groundwater information, sample depths, and drilling methods. The descriptions of core and other samples will include lithology, color, grain size and range of grain size, secondary minerals such as carbonate cement, moisture content, sedimentary structures, presence and general orientation of fractures, and other data determined to be pertinent by the geologist. Boring descriptions will be determined from geophysical logs or from characterization of cuttings and drill action, where samples or core are not taken. A geologic log form is given in Appendix A.

5.2.9 Borehole abandonment. All borings not converted into monitoring wells will be abandoned by filling with a cement grout. The grout will have the composition as described in Section 5.3.5.1. After the grout has dried, the settlement depression will be filled to the surface with additional grout..

5.3 Well Installation.

5.3.1 Types of Well Installations. Wells will be drilled using one of the methods listed in Section 5.2. The type of well expected to be installed at Carswell AFB.

- Sallow groundwater monitoring well.

The wells will be installed at an approximate depth of 30 feet for the perched groundwater zone. Unforeseen site-specific field conditions may require modification, but general design and well construction/use objectives will not be affected.

5.3.2 Shallow Aquifer Monitoring Well.

5.3.2.1 Well Casing. Four-inch nominal diameter, flush-threaded (F480), schedule 40 PVC casing will be installed from the screen to approximately three feet above the surface. Dependent upon the type of drilling method, centralizers will be used as needed to keep the casing centered in the well bore. Centralizers are not necessary when dual-wall drilling systems are used.

5.3.2.2 Riser and Cap. Surface construction of well pads, covers, etc., will comply with Texas Water Commission requirements. Approximately 3 feet of well casing will be left above ground and enclosed in a protective steel pipe. The protective casing will extend two feet below the ground surface and will have a locking cover to prevent entry of unauthorized personnel and rainwater. A four by four-foot 3000 psi concrete pad, four to six inches thick, will be poured around the protective casing at the ground surface, sloped to promote drainage. A surveyor's bolt will be placed in the concrete pad adjacent the protective covering to serve as a ground level reference. Four metal posts will be placed in the concrete pad to protect the well.

5.3.2.3 Screen. Wells will be screened with four-inch diameter Sch 40 PVC flush threaded screen. The perched aquifer saturated zone may be subject to seasonal or other temporal variations in thickness. The screen will be placed ten feet above the top of the saturated zone and extend to its base to insure that installed wells will intercept the top of the saturated zone. Due to the varying thickness of the perched groundwater zone, the length of screen may vary from 10 to 20 feet. Screen opening size will be 0.01 inches unless formation grain size indicates this is inappropriate. The Field Manager may elect to have an assortment of screen sizes available early in the drilling program. It is anticipated that standard sizes will be known based on boring results as the investigations proceed.

5.3.2.4 Sump. A three-foot long, four-inch diameter PVC sump below the screen is proposed for those wells that have a sufficient thickness of the fine-grained zone (i.e., where the perching layer is at least more than three feet thick). It is possible that the perching zone may inadvertently be completely penetrated during drilling if it is only a few feet thick. Should this occur, the bottom of the borehole will be plugged back with bentonite or other appropriate material above the base of the perching unit before operations proceed.

5.3.2.5 Filter Pack. A sand filter will be placed in the annulus between the well screen and the borehole from the bottom of the hole to approximately four feet above the top of the screen via a tremie pipe (pumped wet or dropped dry), or down the outer drill pipe as appropriate. A factory prepared and washed 20-40 filter sand is anticipated for most applications. However, a variety of sand gradations will be available during early stages of the investigations to insure the filter pack is appropriate for the formation characteristics. The sand will be stockpiled in an uncontaminated area and transported in the bags to the well site.

5.3.2.6 Seal. An approximately three-foot thick bentonite seal will be placed above the filter sand in the well annulus. This will be accomplished by using pellets or a gel and installing via a tremie pipe by dropping or pumping. If well conditions and drilling method permit, the seal may be dropped down the annulus between the drill pipe and the well casing.

5.3.3 Materials Used in Well Construction.

5.3.3.1 Bentonite. Well seals will be composed of bentonite pellets, flakes, powder or gel as appropriate to insure successful installation. Bentonite powder may be used during drilling. The manufacturer, brand, and amount of bentonite used will be recorded on the field data sheet and in the field journal. Any other drilling additives must meet the same requirements for non-interference with groundwater monitoring objectives as high purity bentonite. If used, these other additives will be documented as to source, manufacturer, and chemical composition. The use of any additives (e.g. drilling mud polymers or foams) will be avoided during drilling operations in saturated zones which will be subsequently monitored.

5.3.3.2 Grout. Grout will be used for monitoring well construction and borehole abandonment. The grout will consist of a pumpable mixture of water, cement, and approximately 5% bentonite. Grout will be pumped or poured through a tremie or into an open hole or pipe. The quantities of grout used will be recorded on the well log and in the field journal. Grouting will be accomplished in an appropriate manner for the specific application. Generally, grout will be pumped through a tremie pipe placed in the annulus just above the previously installed seal. The grout will be pumped in stages (5 to 10 feet at a time) with the tremie being withdrawn to the top of the preceding grout level each time. This will aid in achieving an acceptable grout while minimizing the probability of voids in the annulus.

5.3.3.3 Riser Pipe and Screen. Screens and raiser pipe will be Schedule 40 PVC joint by flush joint threds.

5.3.4 Development. After the monitoring well installation is completed, wells will be developed to remove drill fluid and cuttings as well as fines from the sand filter which might clog up the well screen. Each well will be bailed and/or pumped until the water runs clear. Water and cuttings will be disposed of in accordance with Section 5.11.

5.3.5 Well schematics. A well diagram will be prepared for each well which will contain all pertinent information concerning the well, such as drilling method, installation technique, diameter, casing materials, depth, locations of the bentonite seal, screen length and opening size, filter pack length and gradation, grout, and the riser pipe height. A geologic log will also be prepared for each well. Log and well schematic forms are shown in Appendix A.

5.4 Location Surveys. All borings and monitoring wells will be physically located by survey. The survey contractor if needed will be required to meet or exceed a Third Order Class 1 survey, with an accuracy of 1 in 10,000. This accuracy equates to approximately 0.01 foot horizontally and vertically.

The contractor will use one of 70 bench marks set from monumentation established by the U. S. Coast and Geodetic Survey. Horizontal control will be in accordance with Texas State Plane Coordinate System, North Zone, using NAD 83, and vertical control will be in accordance with sea level datum of the National Geodetic Survey 1929. The contractor will be prohibited from exceeding 300 feet in each leg of his vertical traverse and from closing on the same bench mark.

5.5 Geophysical Surveys.

5.5.1 Surface Geophysics. Surface geophysics will be used to determine stratigraphy and the continuity of lithologic units across the base and the playas and at specific sites. The following surveys may be used during the RFI at Carswell AFB.

5.5.1.1 Seismic Surveys. Seismic surveys include both reflection and refraction. They measure the travel time of a generated wave through or reflected from subsurface layers. These surveys give reliable information about the continuity and density of these layers.

5.5.1.2 Electrical Resistivity. Electrical resistivity measures the electrical resistance of subsurface layers. An electrical current is implanted in the ground with two electrodes, and the potential difference is measured by non-current carrying electrodes. The depth of penetration is determined by electrode spacing. Resistivity is a measure of the porosity and permeability and the amount and dissolved ion concentration of the pore water.

5.5.1.3 Ground Penetrating Radar. Ground penetrating radar measures the travel time and amplitude of reflected high frequency radio waves. A small antenna, moved slowly across the ground surface, radiates energy downward. Reflected energy is continuously recorded and a shallow subsurface profile is generated. Radar is best for locating near surface strata and anamolies. It is particularly good for locating buried pipes, drums, and tanks. It will be used in this site-specific capacity.

5.5.1.4 Other Surveys. Other surveys which could be performed include electromagnetic conductivity and magnetometer surveys. Electromagnetic conductivity determines the horizontal and vertical variations of conductivity in the shallow subsurface, and magnetic surveys are used to

locate magnetic material in a similar manner as ground penetrating radar, but with greater depth of penetration.

5.5.2 Downhole Geophysical Logs. Geophysical logging will be performed in all borings of significant depth. Specific applications will be decided in the field based upon boring depth, location, casing present, and condition. Geophysical logs may not be run in cases where borings are only a short distance (few feet to tens of feet) from holes which have been previously logged. Geophysical logs will be used to yield information on lithology, stratigraphy, water saturation, formation density, porosity, well construction/condition, and to allow correlation of boreholes. Specific types of logs which may be employed during investigations at Carswell AFB are discussed below.

5.5.2.1 Spontaneous Potential. This log is applicable in water or mud filled open holes. Natural electrical potential resulting from the interaction of borehole fluids, formation matrix, and formation fluids are measured such that the log records vertical variation of this voltage. Typically this log is used for correlation and to define bed thickness.

5.5.2.2 Natural Gamma Ray. This log can be run in dry holes or liquid filled holes, and can be run through PVC or metal casing. A detector in the borehole measures natural radiation in the formations intercepted by the borehole. The natural radiation is a function of the concentration of gamma emitters present (potassium, thorium, uranium). Generally, the concentration of these elements is higher in clays than other lithologies. The log is used for correlation, defining bed thickness, and in lithologic determination.

5.5.2.3 Resistivity Logs. This type of log is applicable in fluid-filled open holes. An electrical current is either applied directly to the borehole environment or induced. A variety of this type of electrical source logs are available commercially, e.g. induction logs, multiple point and spacing resistivity logs, laterlogs, microresistivity logs, and microlaterlogs. Typical uses include thin bed recognition, correlation, and estimation and/or calculation of water saturation.

5.5.2.4 Neutron Logs. This log can be run in open or cased holes, in water or a dry borehole. The logging sonde contains a neutron emitter (plutonium-beryllium or americium-beryllium). The neutrons from the source react with hydrogen nuclei in the formation to produce secondary gamma radiation and lower energy (thermal) neutrons. Generally, the detector responds to the gamma radiation. In water saturated formations, neutron response is a function of formation porosity. The neutron log can also be used to estimate water saturation in the vadose zone if total porosity is known.

5.5.2.5 Bulk Density (Gamma Gamma) Log. This log is primarily useful in uncased holes, but may be modified to yield useful results in cased holes, particularly if the casing is non-metallic. Spacing of the source and detector are varied to allow various depths of investigation (i.e. diameter around the borehole). The sonde contains a medium-energy gamma ray source which is placed against the borehole wall. The detector measures back scattered gamma rays which are proportional to electron density of the formation. Electron density is related to the true bulk density which in turn depends on the density of the rock matrix material, the formation porosity, and the density of the fluids filling the pores. The log is typically used to determine porosity and lithology. It is particularly useful when a neutron log is also available.

5.5.2.6 Caliper. The caliper log is generally run in uncased holes, but may also be run in existing wells where casing deterioration is suspected. The sonde uses three or more extending arms which provide a measurement of well diameter. This allows assessment of washout zones and can be used to calibrate neutron log porosity measurements.

5.5.2.7 Acoustic Bond Log. This is a shallow investigation (i.e. short diameter) sonic velocity log. It is run in cased holes. The primary application of this log is to assess the quality of well construction. It may be run in new wells if concern over the grout bonding to the formation and casing exists, or in existing wells.

5.6 Physical Groundwater Testing.

5.6.1 Equilibrium Water Level. Once the well is completed, both the water level and bottom of well will be measured to the nearest 0.01 foot. Measurements will be marked from the top of the casing and recorded in the field journal and other appropriate forms. An electric probe will be used to establish equilibrium water levels and bottom of the well depth. Any well condition problems noted should also be recorded in the field journal. The probe will be rinsed in Type II reagent grade water immediately before being lowered into the well and immediately after removing it from the well. If the well is heavily contaminated, additional cleaning of the probe may be required as described in Section 5.8.

5.6.2 Slug Tests. Slug tests are performed in order to determine the hydraulic parameters of the aquifer. The purpose of this test is to determine permeability of a stratum, taking into account bedding planes, fractures, and other discontinuities. Slug tests can give a more reliable indication of permeability than a laboratory test, which is performed on a very small test specimen. A known volume (slug) of water is removed from a well, and the rate of recharge is recorded.

5.6.3 Packer Tests. Packer tests may be used during drilling of the monitoring wells, to determine the permeability of discrete lithologic intervals. Results from the packer tests effectively delineate a permeability profile for the strata encountered during well boring, and yield useful information with regard to both vertical and horizontal groundwater movement in the vadose and phreatic zones. Each stratum to be tested in the borehole is sealed off by a pair of inflated packers. If the test is performed during drilling, then the bottom of the hole will serve the same purpose as the second packer. Water will be pumped under pressure into the zone between the packers. The pump rate and pressure will be used to calculate the permeability.

5.6.4 Pump Tests. A pump test is also used to determine aquifer characteristics. One well is designated as the pump well and additional wells are used for measuring water levels during the test. The test is conducted for a sufficient period of time to establish equilibrium conditions. During the pumping period, water levels are measured in all of the wells with enough frequency to establish a drawdown rate. After pumping has ceased, the wells are again measured to establish a recovery rate. A pump test is more expensive and difficult to administer than slug tests or packer tests, but yields information pertinent to an area, rather than just a point as is the case with the above. It can also determine a cone of depression and boundary conditions, such as permeability distribution. Groundwater removed from a pump test will be disposed of in accordance with Section 5.11, if it comes from a contaminated area.

5.7 Sampling Procedures. Samples are portions of a solid or liquid material which are tested for a set of parameters. These may be physical tests or chemical tests. Table 5.1 lists the parameters which are likely to be tested at the various sites at Carswell AFB. A complete list of parameters under each grouping are given in Appendix B. Additional parameters could be added if necessary to properly characterize the site

TABLE 5.1 PARAMETERS TO BE TESTED AT CARSWELL AFB

parameter	water groundwater	soil soil/rock
volatiles	X	X
semivolatiles	X	X
pesticides	X	X
metals	X	X
cyanide	X	
dioxins/furans	X	X
field parameters	X	

5.7.1 Groundwater sampling.

5.7.1.1 Open and Dedicated Wells. Open wells are wells which will not be fitted with dedicated purging and sampling equipment. They will be purged with a portable purging system and sampled with teflon bailers. The portable system typically consists of a submersible or purge pump and a discharge pipe. The purge pump will be operated by a portable generator. The generator will not introduce oils into the well during purging operations. After purging is completed, the equipment will be removed from the well and cleaned thoroughly with distilled water and a nylon brush. The bailers will be taken to the field lab and cleaned as described in Section 5.9. If the well shows evidence of heavy contamination, the purging system will cleaned in the same manner as the bailers. Some monitoring wells may be equipped with dedicated purge pumps and/or bladder or piston sampling pumps. Any active production wells on or off-site which contain dedicated production pumps will be purged and sampled from the production pumps, if sampling is required.

5.7.1.2 Well Evacuation Procedures. Prior to sampling, the stagnant water within the well (five casing volumes) will be removed so that fresh formation water can enter. If after five volumes, pH and conductivity have not stabilized, then additional volumes will be removed. Handling and disposal of purge water is discussed in section 5.11. The well should be sampled as soon as possible after purging. For slowly recharging wells, sampling should take place as soon as sufficient recharge has occurred to fill sampling containers. The sampling crew will record the recharge rate, if not immediate, the date, time, and rate of purging, and any unusual conditions noted with this operation. Non-dedicated purging equipment will be thoroughly scrubbed and rinsed with Type II reagent grade water each time it is used. Under heavily contaminated or unknown conditions, additional rinses will be performed, as discussed in Section 5.9.

5.7.1.3 Sampling. Wells will be sampled with a dedicated teflon bladder pump, a piston pump, or a teflon bailer. The pumping rate should be about 100 ml/minute, which is low enough to prevent agitation. Bailers will be slowly lowered into the wells. A generator, if used, will be placed downwind of the well to prevent fumes from contaminating the sample. Each pre-cleaned sample container will be filled directly from the bailer or discharge tube of the pump. A common container will not be used to fill sample bottles. Sampling equipment and containers will be kept from ground contact, and may be laid on plastic sheets on the ground. Upgradient wells will be sampled before downgradient wells. Sampling will proceed from the least contaminated to the most contaminated, if that information is available. Samples of groundwater for chemical analysis are taken in the following order:

- Field parameters
- Volatile organics
- Pesticides
- Semivolatile organics
- Dioxins/furans
- Metals
- Cyanide
- General quality indicators

Table B.1 lists container, preservation, and handling requirements for each parameter and Table B.2 lists holding times. The sequence of operations for groundwater sampling is as follows:

- Purge slow-recharging wells at the outset of the sampling day.
- Purge and sample other wells.
- Sample slow rechargers, if possible.
- Preserve the samples.
- Package and ship the samples to the laboratory.

5.7.1.4 Immiscible Layers. Immiscible liquid layers are not expected to be encountered; however, procedures for dealing with immiscible layers in groundwater are included in this plan and are listed below.

- the level of the immiscible layer surface and water interface will be determined with an electronic probe. The apparent thickness of the immiscible layer is defined as the difference between the liquid level and the interface level.

- A sample will be collected, using a transparent Teflon bailer. Presence of the immiscible layer will be confirmed visually.

5.7.2 Soil, Rock, and Sediment Sampling. Samples of soil and rock from drill holes will be taken using flight augers, Shelby tubes, split spoon samplers, Denison samplers, or a core barrel. Undisturbed samples will be sealed in wax and disturbed samples will be placed in plastic or glass jars and shipped to SWD Lab. Disturbed samples will be either taken as discrete samples or as composites from the lower auger flights or throughout the length of the sample. All samples will be as representative of the strata as possible. Core that is contaminated will be disposed of in accordance with Section 5.11. Grab samples of soil and sediment will be collected using stainless steel coring tubes, augers, or other appropriate collection devices. Ditches will be sampled by obtaining both grab and composite samples at discrete depths and depth ranges.

5.7.2.1 Chemical Testing. Soil, sediment, and rock samples will be analyzed for the parameters listed in Table 5.1. Samples will be placed in pre-cleaned glass jars with teflon-lined caps. The samples will be packed in ice-filled ice chests, and shipped to the laboratory by bus or over-night carrier to SWD Lab. QA/QC samples for soil and rock consist of equip-ment blanks and replicates as discussed in Section 5.10.

5.7.2.2 Physical Testing. Soil, sediment, and rock samples will be described in the field and tested for Atterberg limits, grain size distribution, moisture content, density, specific gravity, permeability, pH, and cation exchange capacity. Clay mineralogy will be determined on several samples. Soil samples will be classified using the Unified Soil Classifica-tion System. Density, permeability, and specific gravity require undisturbed samples. Samples will be shipped to SWD Lab or to a contract laboratory for testing. Replicates will be taken as needed for QA/QC purposes by splitting a sample into three portions or taking three grabs from the sampler. The two additional samples will consist of a QC sample to be tested by the same lab and a QA sample to be tested by SWD Lab. Methods for physical tests are given in Table B-3.

5.7.3 Surface Water Sampling. Water samples will be collected directly into the sampling bottle or by such sampling devices as a Kemmerer sampler or a plexiglass Van Dorn sampler. Surface water samples are antic-ipated at Playa 1, which contains water most of the year. Parameters to be tested are listed in Table 5.1.

5.8 Field Screening. Field screening techniques give an indication of the degree of contamination. These techniques are used to locate areas for more extensive exploration and sampling, to define the lower limits of sampling and testing in a borehole, and to determine safety hazards for worker protection and transport.

5.8.1 Organics.

5.8.1.1 Headspace Analysis. A headspace analysis tests the air in a sampling jar for volatile organics. A sample will be placed in a glass jar, which will be covered with foil, and warmed to a temperature of at least 90° F for one to two hours. At the end of the warming period, the vapor space in the jar will be tested with Draeger tubes. The temperature of the soil and the length of warming will be recorded. This test gives an indication of presence or absence of volatiles.

5.8.1.2. Field GC Analysis. A gas chromatograph will be set up in the field laboratory to screen selected samples for organics. Results of these analyses will be used to determine where samples for laboratory analysis are to be taken.

5.8.1.3 Soil Gas Surveys. Air-filled voids in the soil may contain compounds which volatilize from the groundwater below. A soil gas survey is a systematic sampling, analysis, and interpretation of the soil gas and what it represents. Sampling devices are placed in the ground on a grid to obtain samples of soil gas, which is analyzed either on site or in the laboratory. Soil gas surveys can detect contaminant plumes, the parent product, and the degree of weathering.

5.8.1.4 Air Monitoring for Worker Protection. Air monitoring with a photoionization detector, combustible gas meter, or flame ionization detector, will be used as discussed in the Site Specifie Health and Safety Plan (SSHP).

5.9 Decontamination.

5.9.1 Drilling Equipment. Drilling equipment (augers, bits, core barrels, rods, and tools) will be steam cleaned or hot water pressure cleaned prior to use in each boring. At each drill site, a decontamination station will be established in the contamination reduction corridor for the washing of drilling and sampling equipment. Waste washwater will be collected. Each member of the drilling crew will don a new pair of gloves before beginning each soil boring. The person taking the samples will wear disposable plastic gloves and will change them between each sampling interval. Used gloves will be bagged and disposed of in a manner which meets RCRA guidelines, as discussed in Section 5.11.

5.9.2 Well casing. All casing and screens used in monitoring well construction will remain in the factory-sealed containers until use. These materials will be placed on a clean, dry tarp or on blocks during assembly. If contact with the ground does occur, the affected sections will be cleaned with low sudsing soap and potable water.

5.9.3 Sampling Equipment. Bailers and other sampling equipment will be cleaned at the end of the work day. Enough clean sampling equipment will be taken to the field each day so that none needs to be reused in that day's sampling. The sampling equipment will be transported in sealed, clean containers, and care will be taken to avoid contamination. Sampling equipment will be washed with a non-phosphate detergent, tap water, distilled water, and hexane, in that order, allowed to air dry, and sealed back into clean containers. A cleaning seal will accompany each bailer with the following information: equipment identification number, date and time cleaned, and signature of the person who cleaned the equipment. The inclusion of the cleaning seal and numbering of the equipment allows for the tracking of any cleaning or cross contamination problems between samples. Purging equipment will be cleaned with distilled water and a brush. If the purging equipment is heavilly contaminated, as determined by sight, smell, and air monitoring, it will be cleaned as described above. Each member of the sampling crew will don a new pair of gloves at each sampling location. The person who actually takes the samples will wear disposable plastic gloves and will change them between each sampling interval for each sampling site. Used gloves will be bagged and disposed of as discussed in Section 5.11.

5.10 Field QA/QC.

5.10.1 Chemical Samples. QA/QC samples for water, sediment, and soil will be used to verify that the sampling and analytical techniques are being performed properly. QC samples are taken in the field and analyzed with the field samples by the same laboratory. QA samples are analyzed by SWD Lab to check the performance of the contract laboratory. QC samples required for soils and water sampling include travel blanks, equipment blanks, and replicates. QA samples also include replicates. QA/QC samples are entered into the field journal along with their associated samples and are described below.

5.10.1.1 Travel Blanks. Travel blanks consist of American Society of Testing Materials (ASTM) Type II reagent water sealed into a sample vial in the field laboratory. The blank is not opened again until it is received in the laboratory. One travel blank will be prepared for each shipment of water samples containing volatiles, all of which are shipped in the same ice chest to the lab each day. Travel blanks measure cross contamination during shipment and contamination sources contacted during shipment. They are analyzed for volatiles.

5.10.1.2 Equipment Blanks. Equipment blanks for water or soil samples will consist of ASTM Type II water which has been poured over or through non-dedicated sampling equipment such as augers, knives, spoons, or bailers. They will be shipped in the ice chest with the associated samples from the site. Equipment blanks will be prepared and preserved in the same manner as a water sample. Equipment blanks measure the effectiveness of equipment decontamination. Equipment blanks are taken at a rate of 1 for every 20 samples and are analyzed for the same constituents as the associated soil or water samples.

5.10.1.3 Replicate Samples. Replicate samples or splits are extra samples as identical as possible to the original. They may consist of a composite, or as a series of grab samples from the same source. Every tenth sample is taken in triplicate. One of each set of these replicates will be sent to SWD Lab as an audit sample (QA sample) for the contract laboratory, and the other two samples will be sent to the analytical lab as a field sample and a QC sample, each with a unique sample number. In cases where only sufficient sample exists for a duplicate set, every fifth sample is a duplicate. This duplicate alternates as a QC and QA sample. Field tests will be done in duplicate.

5.10.2 Samples for Physical Testing. QA/QC on samples for physical testing consists of replicate samples as described in Section 5.10.1.3.

5.11 Disposal of RFI Generated Wastes. Waste will be derived from the RFI activities at Carswell AFB. The activities that have the potential to generate waste are soil sampling and monitoring well installation, and groundwater sampling. The sampling results of previous investigations will be utilized to assist in determining the type of waste that may be generated. The RFI generated waste from soil sampling and well installation will be managed as a solid waste that has the potential to be considered hazardous waste. It will be contained in such a manner to insure that the waste from each sampling location for each medium is kept separate from the other waste until the results of the sampling are received and an accurate determination of the status of the waste can be made. The Fort Worth District will be responsible for managing the waste generated during the investigation activities until it is turned over to the management and operating contractor for storage and disposal and manifesting, if needed. The waste will be managed such that all Federal and State regulations governing the disposal of hazardous waste (as defined in 40 CFR, Parts 260-265 and 268) and non-hazardous solid waste will be followed. If any of the waste is transported off site for disposal, the management and operating contractor and/or the Carswell AFB will be responsible for signing the manifest.

6.0 SAMPLE HANDLING AND TESTING.

6.1 Sample Numbering System. Sample numbers are assigned as follows:

CAFBss-hhhh-xaaa-bb

CAFBss refers to the site being investigated at Carswell Air Force Base,
hhhh is the well or boring number,
x describes the sample medium, where

1 = groundwater
2 = soil or rock
3 = ditch sediment
4 = playa sediment
5 = surface water,

aaa is the sample number,
bb is a QA/QC modifier, when needed, where

QA = a QA sample (split for SWD Lab)
QC = a QC sample (split for contract lab)
TB = travel blank
EB = equipment blank.

6.2 Preparing Samples. A field laboratory may be established at Carswell AFB. This lab could either be a mobile lab or a trailer in a fixed location. The field laboratory will be used for reagent preparation, sample filtering, sample preservation, equipment decontamination and cleaning, labelling bottles, and doing paperwork. When samples are brought in from the field, they are preserved according to Table B.1. They are then placed in the ice chest in styrofoam inserts which have cutouts to accommodate the jars. The styrofoam prevents breakage. The ice chest is filled with ice and the chain of custody form and field data form are placed inside in a zip-lock plastic bag placed on top of the ice. The ice is double bagged if the samples are to be shipped by air. If the samples are to be shipped by bus, ice is placed directly over the samples to allow for maximum cooling. The ice chest is wrapped with nylon strapping and a seal is placed on the strapping. A separate ice chest is used for each set of samples. All of the volatile organics samples, however, are placed in one ice chest with a travel blank and a separate COC. The samples are then delivered to the bus station. Samples are always shipped on the day they are sampled.

6.3 Receiving Samples. After the ice chests are picked up from the bus station, the samples are logged in, the COC is signed, and the samples are checked for breakage or leakage. The temperature of the ice bath is checked. If the temperature exceeds 4°C or if any other problems are noted, this information is recorded on the COC and the District office is notified of the problem. Samples are repackaged and shipped to contract laboratories using similar procedures as described in Section 6.2.

6.4 Laboratory Procedures. Laboratory analytical procedures come from the following sources: U. S. Environmental Protection Agency (SW 846 and EPA-600, refs. 13 and 11), Standard Methods (ref. 1). Analytical methods from these sources are given in Table B-2. Quantitation limits are given in Tables B-4 through B-9. Quantitation limits, however, are dependent on the concentration of the components in the matrix to be analyzed. Calibration of laboratory instruments will be performed according to manufacturer's recommendations.

7.0 SAMPLE INTEGRITY. The quality of analytical data is suspect if the integrity of the sample cannot be ensured. Integrity includes the procedures and written records which, when taken together, verify that the sample is as represented.

7.1 Security. Security involves procedures which ensure sample integrity. Security is required until final disposal of the sample after laboratory analysis is complete. Aspects of sample security are discussed below.

7.1.1 Security of the Well. Each well will have a locking cap and keys will be given out only to those who need them. Carswell AFB facility access to the monitoring wells will be limited.

7.1.2 Security of the Sample in the Field. Samples, once taken, will be in the possession of the sampling crew or locked in the field laboratory. QA and QC samples will be taken, which, when analyzed, will also document the integrity of the sample.

7.1.3 Security of the Sample in the Lab. Samples will be stored in a secure area in the laboratory with limited access to authorized laboratory personnel. Upon receipt of the ice chests, laboratory personnel will check the temperature of the ice bath, the condition of the samples, and the accuracy of the accompanying paperwork.

7.2 Custody. Custody consists of formal records which document integrity. These records are described below.

7.2.1 Chain of Custody Form. The chain of custody form (COC) is a record which describes the sample, the date and method of sampling, and the analyses required. It has spaces for signatures of those receiving and relinquishing the samples. The form is normally signed by the sampler, the individual preparing the samples for shipment, and the receiving individual at the laboratory. A copy of this form is sent to the District office regularly. The original COC is returned to the Fort Worth District in the hard copy laboratory report, where it is placed on file. An example of this form is given in Appendix A.

7.2.2 Laboratory Traffic Report. Samples which are sent from SWD Lab to a contract lab are sent with this form. It is a laboratory chain of custody form which gives the sampling date, the analyses to be performed and the date the results are needed. Because various fractions of the sample might be sent to several contract labs, the original COC cannot be used. The traffic reports are also returned to the District in the hard copy laboratory reports.

7.2.3 Bill of Lading. A bill of lading (bus bill or airbill) documents receipt of the samples by the carrier. It is not possible for the carrier's representative to sign the COC since it is sealed in the ice chest. Bills of lading are kept on file in the District Office.

7.3 Sample Tracking and Identification. Other than the items listed in 7.2, there is additional documentation which demonstrate sample integrity. These are listed as follows:

7.3.1 Field Log Book. The field log book is a bound record, kept by the water sampling crew, in which sampling information is recorded. It is taken to the wells to record purging and sampling data, water levels, and other items of interest. It is used in the field lab to record preservation and preparation procedures for shipment. It is also used to record equipment calibration and decontamination of sampling equipment. In case of concurrent operations, sampling information will be transferred to the field log book in the field lab. The information for the COC and field data form comes from the field log book. The field log book is not the same as the field journal, which is kept by the Field Manager.

7.3.2 Field Data Form. The field data form transmits necessary information about the well to the lab. Field measurements such as pH, conductivity, and water levels as well as problems with the well or the sample are noted on this form. An example is shown in Appendix A.

7.3.3 Sample Labels. Labels on each jar contain the well or boring number, the sample number, preservation (if any), the analysis to be performed, and the sampler's initials. Examples are provided in Appendix A.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING.

8.1 Analytical Data.

8.1.1 Field Data. Field data reduction will be performed in the Fort Worth District Office. Data validation in the field is determined primarily by making several readings (QC checks for reproducibility). Periodic QA oversight is also a part of the validation process. The field data is sent to the lab on the field data form and is returned to the District in the hard copy lab reports.

8.1.2 Laboratory Data. Laboratory data are reduced at the contract lab, which generates a laboratory report containing the analytical data and field and lab QC. SWD Lab performs a QA validation and generates a summary report, which is submitted to the HWM Section, where it is reviewed, then submitted to the project staff. A sample QA validation form is given in Appendix D. On this sample form, "laboratory contamination" will be retitled "representativeness" and shall include evaluation of blanks and chain of custody control. "QA/QC data comparison" will be retitled "Comparability" and will include comparisons of the Government's QA samples to the QC dulicates. Table B-10 outlines the items which will be evaluated when the data is evaluated. Laboratory deliverables include the following:

- analytical data, results of field and laboratory blanks, matrix spikes, and matrix spike duplicates, surrogate recoveries, and field splits, and COC forms;
- QA validation report;
- ASCII or DBASE format data files.

Calibration and internal standards information, raw data, and all instrumentation graphs and traces will be available from the laboratory, if needed.

8.2 Technical Data. Technical data refers to data of several types, such as groundwater flow calculations, stratigraphic maps generated from geologic and geophysical field data, isopleth profiles of contaminants, and statistical models. Technical data will be reduced, validated, and reported by the project staff, and is subject to review by the HWM Section. Data reduction involves the digitizing of plot data not already provided in graphical form, and creation of computer disk files containing all information related to the data forms listed above. Technical data reduction is discussed in detail in the Data Management Plan.

9.0 AUDITS. Audits, which are QA procedures designed to meet the data quality objectives discussed in Section 4, are of two basic types as discussed below. Table 9.1 gives the audit elements for the Carswell AFB investigation and their frequency of implementation.

9.1 System Audits. A systems audit is a qualitative evaluation of all components of a project to determine if each component is properly performed. Systems audits are generally performed at the outset of investigations and periodically during the life of a project. Systems audits for office and fieldwork will be performed by HWM Section, and system audits for laboratory work will be performed by the MRD Lab. These audits consist primarily of site inspections. Laboratory site inspection by MRD Lab is discussed in Section 3.4.3 and ER 1110-1-263 (ref. 8).

9.2 Performance Audits. Performance audits are quantitative evaluations of the components of a project. These consist of audit samples to be checked by MRD as a part of the laboratory validation process, QA replicates taken as a part of the sampling process and analyzed by SWD Lab, and laboratory QA procedures as specified by the analytical method.

TABLE 9.1 AUDIT ELEMENTS FOR CARSWELL AFB INVESTIGATIONS

Element	Performed By	Frequency
laboratory site inspection	MRD Lab	when laboratory is selected and as often as 18 months thereafter
field inspections	HWM Sec	monthly or more frequently at first; less frequently thereafter
technical data inspections	HWM Sec	as needed
laboratory check samples	MRD Lab	when laboratory is selected and as often as 18 months thereafter
analysis of field replicates	SWD Lab	every 10 samples
laboratory QA summary report	SWD Lab	one for each laboratory report

10.0 CORRECTIVE ACTION.

10.1 Field Activities. Field activities which are improper will be corrected as quickly as possible. The Field Manager will be responsible to see that corrective action is initiated and documented whenever the error has the potential to compromise the quality of the data being generated or whenever there is a possibility that the error might be repeated. Corrective action can also be initiated by personnel from HWM Section during site visits. QA personnel will complete a trip report, which will be sent to the technical manager through Chief, Geotechnical Branch. This report will document problems and proposed corrective action. It will be a part of the permanent project files. QA personnel will also make recommendations to the field crews through the Field Manager who can give approval for immediate implementation.

10.2 Field Data. Corrective action for poor field data quality (as determined by replicate measurements or prior expectation) consists of remeasurement until successive readings agree within reasonable limits. Examples of frequently made measurements and limits to which they should agree include:

- pH - Measurements should agree within 0.02 pH unit.
- conductivity - Measurements should agree within 2 numbers of the last significant digit.
- depth and water level measurements - Readings should agree within 0.01 foot.

If remeasurement is not successful, then instrument calibration and operation and the user's technique will be evaluated.

10.3 Laboratory. Laboratory corrective action is described in the analytical method for that analysis.

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15. U. S. Environmental Protection Agency, 1987, "Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations", SW-87-001.

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APPENDIX A

FORMS USED IN FIELD SAMPLING ACTIVITIES

APPENDIX A
FORMS USED IN FIELD SAMPLING ACTIVITIES
TABLE OF CONTENTS

MIPR#	SWD LAB#	CHEST#	TEMP.

GROUND-WATER AND VOLATILE ORGANICS SAMPLE
CHAIN OF CUSTODY

U.S. Army Corps of Engineers
Fort Worth District, Fort Worth, TX.

Location: Date: ________ Time: ______

Site: Boring No. ______________

Proj. Engineer: Phone No.

CONTAINERS

Glass	Plastic	Vial	Amber	Chest No.	Custody Seal#

PARAMETERS

	Parameter	Test Method	*

*Containers: [] = Plastic {} = Vials () = Amber || = Glass

CUSTODY RECORD

Relinquished by	Received by	Date	Time

MIPR#	SWD LAB#	CHEST#	TEMP.

CHAIN OF CUSTODY
SOIL SAMPLES

U.S. Army Corps of Engineers
Fort Worth District, Fort Worth, TX.

Location: Date:__________ Time: _______

Site: Boring No.____________________

Proj. Engineer: Phone No.

CONTAINERS

Jars (3 each)	Sample No. (s)				Total	C/Seal No.

PARAMETERS

	PARAMETER	TEST METHOD

CUSTODY RECORD

Relinquished by	Received by	Date	Time
______________	______________	________	________
______________	______________	________	________
______________	______________	________	________

Hole No.

DRILLING LOG	DIVISION	INSTALLATION	SHEET OF SHEETS

1. PROJECT	10. SIZE AND TYPE OF BIT
	11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*
2. LOCATION *(Coordinates or Station)*	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
4. HOLE NO. *(As shown on drawing title and file number)*	14. TOTAL NUMBER CORE BOXES
5. NAME OF DRILLER	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS *(Description)* d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth of weathering, etc., if significant)* g

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

WATER SAMPLES FIELD DATA FORM

PROJECT: ______________________ DATE: ___/___/___

SITE: ______________________ TYPE OF SAMPLE: __________

WELL NO: __________ LOCATION: ______________________

CSG DIAMETER: __________ CSG TYPE: ______________________

RISER ELEVATION: ______________________

DEPTH TO WATER FROM TOP OF CASING: __________ TIME: ___:___

RATE OF RECHARGE: ______________________

DEPTH TO WATER AT TIME OF SAMPLING: __________ TIME: ___:___

WATER TABLE: __________ MEASURING DEVICE: __________

PH: ________ ________ TIME: ___:___ TYPE: __________

PH: ________ ________

CONDUCTIVITY,umhos/cm TIME: ___:___ TYPE: __________

________ ________ TEMPERATURE: __________

________ ________ TURBIDITY: __________

CHEST# __________ C/SEAL# __________ BUS BILL# __________

CHEST# __________ C/SEAL# __________ BUS BILL# __________

NOTES CONCERNING CONDITION OF WELL, ODOR, COLOR, AND PROBLEMS

____

____

____

____

____

____

____

SAMPLE COLLECTOR: ______________________

District________________

Project________________

Location________________

Hole No.________________

Sample No.______________

Depth__________________

Date___________________

Label for 40 ml Glass Vial - Liquids

DEPARTMENT OF THE ARMY (214) 767-2411
SOUTHWESTERN DIVISION, CORPS OF ENGINEERS FTS 729-2411
PO BOX 36045, 4815 CASS STREET
DALLAS, TEXAS 75235-8011

District______________________ Project_________________________

Location______________________ Date__________ Time____________

Hole No.______________________ Sample No.__________ Depth_______

Check One:

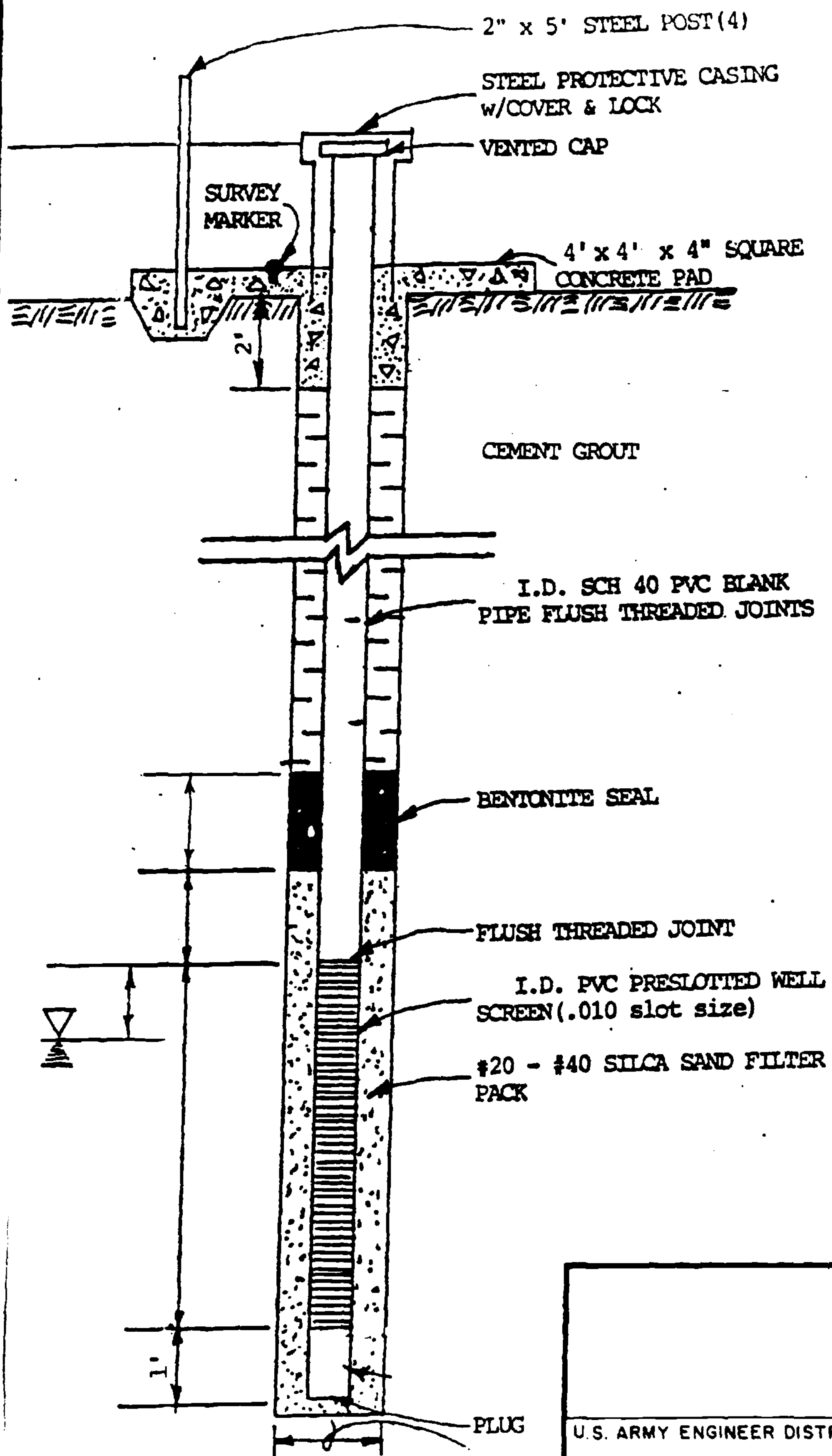
_____Extractable Organics (base/neutrals, acid and Pesticide)	_____Metals	_____TOX
	_____Phenols	_____Other
	_____Cyanide	_____
_____Volatile Organics	_____TOC	_____

Has Sample been Preserved?_________Yes _________No

Remarks____

Sampler's Signature____

Label for 1 Liter Glass Container - Solids and Liquids



U.S. ARMY ENGINEER DISTRICT, FT. WORTH

APPENDIX B

TABLES

APPENDIX B
TABLE OF CONTENTS

TABLE B.1 SAMPLE CONTAINERS, PRESERVATION, AND PREPARATION FOR WATER SAMPLES

PARAMETER	SIZE AND TYPE OF CONTAINER	# OF CONTAINERS	ICE	METHOD OF PRESERVATION
volatiles	40 ml glass vial	3	Y	no head space
semivolatiles	liter amber glass	2	Y	no head space, air bubbles, or agitation
pH	½ pint glass	1	N	field test
conductivity	½ pint glass	1	N	field test
temperature	½ pint glass	1	N	field test
pesticides/PCBs	liter amber glass	2	Y	
common anions	liter glass	1	Y	
cyanide	liter plastic	1	Y	1 N NaOH to pH >12
metals	liter plastic	1	Y	nitric acid to pH <2
hexavalent Cr	liter plastic	1	Y	
alkalinity, carbonate, bicarbonate, total hardness, TDS, TSS	liter plastic	1	Y	
BOD	liter glass	1	Y	
TRPH	liter amber glass	2	Y	hydrochloric acid to pH <2
TOC	40 ml glass vial	2	Y	sulfuric acid to pH <2
COD	liter glass	1	Y	sulfuric acid to pH <2
dioxin/furan	liter amber glass	1	Y	no head space
nitrate/nitrite	liter plastic or glass	1	Y	sulfuric acid to pH <2
radiometrics	liter glass	1	Y	nitric acid to pH <2
high explosives	liter amber glass	2	Y	

TABLE B.2 MAXIMUM HOLDING TIMES AND ANALYTICAL METHODS IN SOIL AND WATER

PARAMETER	EXTRACTION	ANALYSIS	ANALYTICAL REFERENCE	METHOD METHOD #
Volatiles	-	14 days		
basic scan			SW-846	8240
TCLP			SW-846	1311/8240
additional compounds				
tetrahydrofuran			SW-846	8015
4,4'-dimethylforamide			SW-846	8015
methanol			SW-846	8015
ethyl acetate			SW-846	8015
isopropanol			SW-846	8015
propanol			SW-846	8015
dimethylsulfoxide			SW-846	8000
MTBE			SW-846	8020
Semivolatiles				
basic scan			SW-846	8270
TCLP			SW-846	1311/8270
in water	7 days	40 days		
in soil	14 days	40 days		
additional compounds			SW-846	modified 8270
4,4'-methylene bis o-chloroaniline)				
Pesticides/PCBs				
basic scan			SW-846	8080
TCLP			SW-846	1311/8080
in water	7 days	40 days		
in soil	14 days	40 days		
TRPH		28 days	EPA-600	418.1
Metals				
arsenic	-	6 months	SW-846	7060
mercury in soil	-	28 days	SW-846	7470
mercury in water		28 days	SW-846	7471
selenium	-	6 months	SW-846	7740
hexavalent chromium	-	24 hours	SW-846	7196
others	-	6 months	SW-846	6010
TCLP			SW-846	1311/6010 etc.
Common Anions	-			
chloride		28 days	SW-846	9250
phosphate		28 days	EPA-600	365.2
fluoride		28 days	EPA-600	340.2
sulfate		28 days	SW-846	9038
sulfite		28 days	EPA-600	377.1
nitrate/nitrite		14 days	EPA-600	353.2
Cyanide	-	14 days	EPA-600	335.2

TABLE B.2 (CONT.) MAXIMUM HOLDING TIMES AND ANALYTICAL METHODS IN SOIL AND WATER

PARAMETER	EXTRACTION	ANALYSIS	ANALYTICAL REFERENCE	METHOD METHOD #
Radiometrics	-	6 months		
gross alpha and beta			SW-846	9310
radium 223, 224, 226			SW-846	9315
strontium 89			STAND	7500-Sr
cesium 134			STAND	7500-Cs
Alkalinity, incl. carbonate and bicarbonate		14 days	EPA-600	310.1
total phosphorus		48 hours	EPA-600	365.4
Total dissolved solids		7 days	EPA-600	160.1
Total suspended solids		7 days	EPA-600	160.2
BOD - 5 day test		6 hours	EPA-600	405.1
Total organic carbon		28 days	SW-846	9060
Chemical oxygen demand		28 days	EPA-600	410.1
High explosives				
in water	7 days	40 days	SW-846	8330*
in soil	14 days	40 days	SW-846	8330*
Dioxins/Furans	7 days	30 days	SW-846	8280
PH	-	immediate	SOP	2.2
Conductivity	-	immediate	SOP	2.2
Temperature		immediate	SOP	2.2

* Different methods exist for each HE. Tulsa District is researching single method for all HE. See discussion in Section 6.4.

STND	reference 1	EPA-600	reference 11
SOP	reference 10	SW-846	reference 13

TABLE B.3 METHOD SOURCE FOR PHYSICAL TESTS

TEST	METHOD SOURCE
Clay mineralogy	ASTM D4647
Grain size	ASTM D421, D422, D1140
Atterberg limits	ASTM D4318
Specific gravity	ASTM D854
Triaxial permeability	EM-1110-2-1906
Moisture content	ASTM D2216
Density	ASTM D2937
Cation exchange capacity	AGRI Method 5A

ASTM	reference 2
AGRI	reference 9
EM	reference 7

TABLE B.4 REQUIRED QUANTITATION LIMITS FOR VOLATILE ANALYSES IN SOIL AND WATER

PARAMETER	WATER (ug/l)	LOW-LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
Chloromethane	10	10	basic 8240 scan
Bromomethane	10	10	"
Vinyl chloride	10	10	"
Chloroethane	10	10	"
Methylene chloride	5	5	"
Acetone	10	10	"
Carbon disulfide	5	5	"
1,1-dichloroethane	5	5	"
1,1-dichloroethene	5	5	"
cis-1,2-dichloroethene	5	5	"
trans-1,2-dichloroethene	5	5	"
Chloroform	5	5	"
1,2-dichloroethane	5	5	"
2-butanone (MEK)	10	10	"
1,1,1-trichloroethane	5	5	"
Carbon tetrachloride	5	5	"
Vinyl acetate	10	5	"
Bromodichloromethane	5	5	"
1,2-dichloropropane	5	5	"
Trichloroethene	5	5	"
Dibromochloromethane	5	5	"
1,1,2-trichloroethane	5	5	"
Benzene	5	5	"
trans-1,3-dichloropropene	5	5	"
4-methyl-2-pentanone	10	10	"
2-hexanone	10	10	"
Tetrachloroethene	5	5	"
Toluene	5	5	"
1,1,2,2-tetrachloroethane	5	5	"
Chlorobenzene	5	5	"
Ethylbenzene	5	5	"
Styrene	5	5	"
Xylenes (total)	5	5	"
Acrolein	?	?	"
Acrylonitrile	10	10	"
Dibromomethane	5	5	"
Dichlorodifluoromethane	5	5	"
1,4-dichloro-2-butene	10	10	"
Ethyl methacrylate	5	5	"
1,2,3-trichloropropane	5	5	"
Dichloromethane	5	5	"
Iodomethane	10	10	"
Trichlorofluoromethane	5	5	"

TABLE B.4 REQUIRED QUANTITATION LIMITS FOR VOLATILE ANALYSES IN SOIL AND WATER

PARAMETER	WATER (ug/l)	LOW-LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
Tetrahydrofuran	100	100	additional compound
4,4-dimethylforamide	100	100	"
Methanol	50	50	"
Ethyl acetate	50	50	"
Isopropanol	50	50	"
Propanol	50	50	"
Dimethylsulfoxide	100	100	"

Medium soil/sediment quantitation limits are equal to 125 times the low soil/sediment quantitation limits.

TABLE B.5 REQUIRED QUANTITATION LIMITS FOR SEMIVOLATILE ANALYSIS IN SOIL AND WATER

PARAMETER	WATER (ug/l)	LOW LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
Phenol	10	330	basic 8270 scan
Bis(2-chloroethyl) ether	10	330	"
2-chlorophenol	10	330	"
1,3-dichlorobenzene	10	330	"
1,4-dichlorobenzene	10	330	"
Benzyl alcohol	10	330	"
1,2-dichlorobenzene	10	330	"
2-methylphenol	10	330	"
Bis(2-chloroisopropyl) ether	10	330	"
4-methylphenol	10	330	"
N-nitrosodi-n-propylamine	46	1600	"
Hexachloroethane	10	330	"
Nitrobenzene	10	330	"
Isophorone	10	330	"
2-nitrophenol	10	330	"
2,4-dimethylphenol	10	330	"
Benzoic acid	50	1600	"
Bis(2-chloroethoxy) methane	10	330	"
2,4-dichlorophenol	10	330	"
1,2,4-trichlorobenzene	10	330	"
Naphthalene	10	330	"
4-chloroaniline	10	330	"
Hexachloro-1,3-butadiene	10	330	"
4-chloro-3-methylphenol (para-chloro-meta-cresol)	10	330	"
2-methylnaphthalene	10	330	"
Hexachlorocyclopentadiene	10	330	"
2,4,6-trichlorophenol	10	330	"
2,4,5-trichlorophenol	50	1600	"
2-chloronaphthalene	10	330	"
2-nitroaniline	50	1600	"
Dimethyl phthalate	10	330	"
Acenaphthylene	10	330	"
2,6-dinitrotoluene	10	330	"
3-nitroaniline	50	1600	"
Acenaphthene	10	330	"
2,4-dinitrophenol	50	1600	"
4-nitrophenol	50	1600	"
Dibenzofuran	10	330	"
2,4-dinitrotoluene	10	330	"
Diethyl phthalate	10	330	"
4-chlorophenyl phenyl ether	10	330	"
Fluorene	10	330	"

TABLE B.5 (CONT.) REQUIRED QUANTITATION LIMITS FOR SEMIVOLATILE ANALYSES IN SOIL AND WATER

PARAMETER	WATER (ug/l)	LOW LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
4-nitroaniline	50	1600	basic scan
4,6-dinitro-2-methylphenol	50	1600	"
N-nitrosodiphenylamine	10	330	"
4-bromophenyl phenyl ether	10	330	"
Hexachlorobenzene	10	330	"
Pentachlorophenol	50	1600	"
Phenanthrene	10	330	"
Anthracene	10	330	"
Di-n-butyl phthalate	10	330	"
Fluoranthene	10	330	"
Pyrene	10	330	"
Butyl benzyl phthalate	10	330	"
3,3'-dichlorobenzidine	20	660	"
Benzo(a)anthracene	10	330	"
Chrysene	10	330	"
Bis(2-ethylhexyl)phthalate	10	330	"
Di-n-octyl phthalate	10	330	"
Benzo(b)fluoranthene	10	330	"
Benzo(k)fluoranthene	10	330	"
Benzo(a)pyrene	10	330	"
Indeno(1,2,3-cd)pyrene	10	330	"
Dibenz(a,h)anthracene	10	330	"
Benzo(g,h,i)perylene	10	330	"
1-chloroanaphthalene	10	660	"
3-methylphenol	10	330	"
diphenylamine	20	1000	"
1,2-diphenylhydrazine	50	1600	"
4,4'-methylene bis o-chloroaniline)	20	1300	aditional compound

Medium soil/sediment quantitation limits are 60 times the low soil/sediment quantitation limits.

TABLE B.6 REQUIRED QUANTITATION LIMITS FOR PESTICIDE ANALYSES IN SOIL AND WATER

PARAMETER	WATER (ug/l)	LOW-LEVEL SOIL/SEDIMENT (ug/kg)	PROCEDURE
Aldrin	0.4	63.2	basic 8080 scan
alpha-BHC	0.3	47.4	"
beta-BHC	0.6	94.8	"
delta-BHC	0.9	142.2	"
gamma-BHC	0.4	63.2	"
Chlordane	1.4	221.2	"
4,4'-DDD	1.1	173.8	"
4,4'-DDE	0.4	63.2	"
4,4'-DDT	1.2	189.6	"
Dieldrin	0.2	31.6	"
Endosulfan I	1.4	221.2	"
Endosulfan II	0.4	63.2	"
Endosulfan sulfate	6.6	1042.8	"
Endrin	0.6	94.8	"
Endrin aldehyde	2.3	363.4	"
Heptachlor	0.3	47.4	"
Heptachlor epoxide	8.3	1311.4	"
Methoxychlor	18	2844	"
Toxaphene	24	3792	"
Arochlor-1018	1	158	"
Arochlor-1221	1	158	"
Arochlor-1232	1	158	"
Arochlor-1242	1	158	"
Arochlor-1248	1	158	"
Arochlor-1254	1	158	"
Arochlor-1260	1	158	"

TABLE B.7 REQUIRED QUANTITATION LIMITS FOR INORGANIC AND OTHER ANALYSES IN SOIL AND WATER

PARAMETER	WATER (mg/l)	SOIL/SEDIMENT (mg/kg)
	metals	
Arsenic	0.01	2
Barium	0.2	40
Cadmium	0.005	1
Chromium	0.01	2
Lead	0.005	1
Mercury	0.0002	0.1
Selenium	0.005	1
Silver	0.01	2
Beryllium	0.005	1
Calcium	0.01	2
Iron	0.3	60
Magnesium	0.03	6
Manganese	0.05	2
Potassium	0.1	5
Sodium	0.5	100
Zinc	0.02	10
	common anions	
Chloride	1	
Fluoride	0.1	
Sulfate	1	1
Sulfite	2	2
Phosphate, total as P	0.05	
Nitrate/nitrite	0.1	0.1
	limnological parameters	
Total dissolved solids	10	
Total suspended solids	10	
BOD - 5 day test	30	
Phosphorus, total	0.05	
Chemical oxygen demand	5	
Total organic carbon	none estab.	
Cyanide, total and amenable	0.02	1
Carbonate	10	
Bicarbonate	10	
Total hardness	10	
Alkalinity	10	100

TABLE B.8 REQUIRED QUANTITATION LIMITS FOR DIOXIN AND FURAN ANALYSES IN SOIL AND WATER

PARAMETER		WATER ug/l	SOIL/SEDIMENT ug/kg
Heptachlorodibenzo-p-dioxin	(HKPCDD)	0.2	2
Heptachlorodibenzo-furan	(HPCDF)	0.2	2
Hexachlorodibenzo-p-dioxin	(HXCDD)	0.2	2
Hexachlorodibenzo-p-furan	(HXCDF)	0.2	2
Octachlorodibenzo-p-dioxin	(OCDD)	0.2	2
Octachlorodibenzo-p-furan	(OCDF)	0.2	2
Tetrachlorodibenzo-p-dioxin	(TCDD)	0.2	2
Tetrachlorodibenzo-furan	(TCDF)	0.2	2
2,3,7,8-tetrachlorodibenzo-p-dioxin	(HXCDD)	0.2	2
2,3,7,8-tetrachlorodibenzo-furan	(HXCDF)	0.2	2
Pentachlorodibenzo-p-dioxin	(PCDD)	0.2	2
Pentachlorodibenzo-furan	(PCDF)	0.2	2

TABLE B.9 VALIDATION REPORT CHECK SHEET

ITEM	DQO*	PARAMETERS	FREQUENCY	ACCEPTABLE RESULTS
ANALYTICAL PARAMETER				
analytical method	C	all	each analysis	as specified on COC or Table B-2
holding time	P,A,R	all	each analysis	see Table B-2
quantitation limit	P,A,R	all	each analysis	see tables B-4 to B-9
matrix spike	A	all	1/batch or 5%	see SW-846
matrix spike dup	P	all	1/batch or 5%	see SW-8468
relative % difference	P	all	1/batch or 5%	see SW-8468
method blank	R	all	representative	clean
surrogate recovery	A	organics	each analysis	see SW-846
QC DUPLICATE (SAME LAB)	P	all	10% or 1/batch	water, ± 100% soil, ± 400%
QA DUPLICATE (OTHER LAB)	C	all	10% or 1/batch	water, ± 100% soil, ± 400%
TRIP BLANK	R	volatiles	1 per ice chest with volatiles	clean
EQUIPMENT BLANK	R	all	5%	clean
CHAIN OF CUSTODY FORM	R		1 per container	
filled out correctly				no missing or incorrect info see Table B-1
signatures				no lapses in custody
FIELD DATA FORM	R		1 per sample/well	
filled out correctly				no missing or incorrect info
purge and sampling time				< 24 hr lapse

* Data Quality Objective: P= precision, A = accuracy, R = representiveness, C = comparabi

APPENDIX C
SAMPLE QA REPORT FORMAT
ER 1110-1-263

(SAMPLE FORMAT)

______ LAB NO.

DEPARTMENT OF THE ARMY
________________ DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY

__________, ________, ______
(city) (state) (zip)

Subject: Chemical Quality Assurance Report

Project: ________________
Intended Use: ________________
Source of Material: ________________

Submitted by: ________________
Date Sampled: ________________, Date Received: ________________
Method of Test or Specification: See attached Tables 1 - ____

References: ________________

-- REMARKS --

1. CONTRACTOR DATA EVALUATION: (General comments)

   a. ACCURACY:

   b. PRECISION:

   c. LABORATORY CONTMINATION:

2. QA/QC DATA COMPARISON:

3. OTHER PROBLEMS:

4. CORRECTIVE ACTION:

Submitted by:

Director, ____________ Laboratory

FINAL PAGE

ADMINISTRATIVE RECORD

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ADMINISTRATIVE RECORD

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