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DEPARTMENT OF THE AIR FORCE

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CANNON AIR FORCE BASE NEW MEXICO

18 FEB 1998

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RECEIVED
MAR 13 1998

Mr. Benito J. Garcia, Chief
Hazardous and Radioactive Materials Bureau
New Mexico Environment Department
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Dear Mr. Garcia

Attached for your information and approval is the Final Work Plan for Site Inspection for Areas of Concern E, F, G, and H at Cannon Air Force Base (AFB).

If you have any questions, please call Mr. John Pike at (505) 784-1092 or Mr. Sanford Hutsell at (505) 784-6378, of my Environmental Flight.

Sincerely

JAMES A. THOMAS III, Colonel, USAF

Attachment:
Final Work Plan

cc:
NMED w/o Atch (C. Will)
NMED GW Bureau (J. Jacobs)
EPA Region VI (D. Neleigh)

FINAL WORK PLAN

LIBRARY COPY

CERCLA SITE INSPECTIONS AT AREAS OF CONCERN (AOCS) E, F, G, AND H

CANNON AFB, NEW MEXICO

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska

January 1998

WORK PLAN

CERCLA SITE INSPECTIONS AT AREAS OF CONCERN (AOCS) E, F, G, AND H CANNON AFB, NEW MEXICO

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska

January 1998

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A-E	Architect-Engineer
AFB	Air Force Base
AOC	Area of Concern
ASTM	American Society for Testing and Materials
B.P.	Before Present
BGS	Below Ground Surface
BRA	Baseline Risk Assessment
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	Centimeter(s)
cm/sec	Centimeter(s)-per-second
cm/yr	Centimeter(s)-per-year
COC	Chemical of Concern
DOT	Department of Transportation
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
EM	Electromagnetic
EPA	Environmental Protection Agency
ft/yr	Feet-per-year
FSP	Field Sampling Plan
gal/ft	Gallons-per-foot
gpm	Gallons-per-minute
HA	Hand Auger Boring
HQ	Hazard Quotient
ICP	Inductively Coupled Plasma
IDW	Investigation-Derived Waste
IEUBK	Integrated Exposure Uptake Biokinetic
Km/hr	Kilometer(s)-per-hour
L/min	Liters-per-minute
m^3/m	Cubicmeters-per-meter
m/yr	Meter(s)-per-year
mg/kg	Milligrams-per-kilogram
mg/L	Milligrams-per-Liter
MSL	Mean Sea Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSC	Media-Specific Concentration
NWR	National Wildlife Refuge
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
SB	Soil Boring

SCEM	Site Conceptual Exposure Model
SSHP	Site Safety and Health Plan
SI	Site Inspection
SOP	Standard Operating Procedure
SOS	Scope of Services
SS	Surface Soil Sample
TM	Technical Manager
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
W-C	Woodward-Clyde

1.1 PURPOSE AND SCOPE

This Work Plan (WP) describes the field sampling requirements for the completion of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Site Inspections (SI) to be completed at four Areas of Concern (AOCs) at Cannon Air Force Base (AFB) near Clovis, New Mexico. These AOCs include AOC-E, -F, -G, and -H. A map of Cannon AFB and the locations of the four AOCs are shown on Figure 1-1.

This WP describes the investigative activities required to provide the necessary information to determine the presence or absence of chemical contamination which may pose an unacceptable risk to human health or the environment at the four AOCs.

This WP is based on and meets the data requirements established in the Scope of Services (SOS) provided by USACE, Omaha District. It includes preparing planning documents, doing a field investigation (surface and subsurface soil sampling), analyzing the field samples for chemicals, evaluating the chemical data, comparing the analytical results to established media-specific concentrations (MSCs), and preparing the final SI report.

Section 2.0 discusses the decision process to be used, including information on site conceptual exposure models and screening-level health risk evaluation methodology.

Section 3.0 includes field sampling procedures and site-specific sampling objectives.

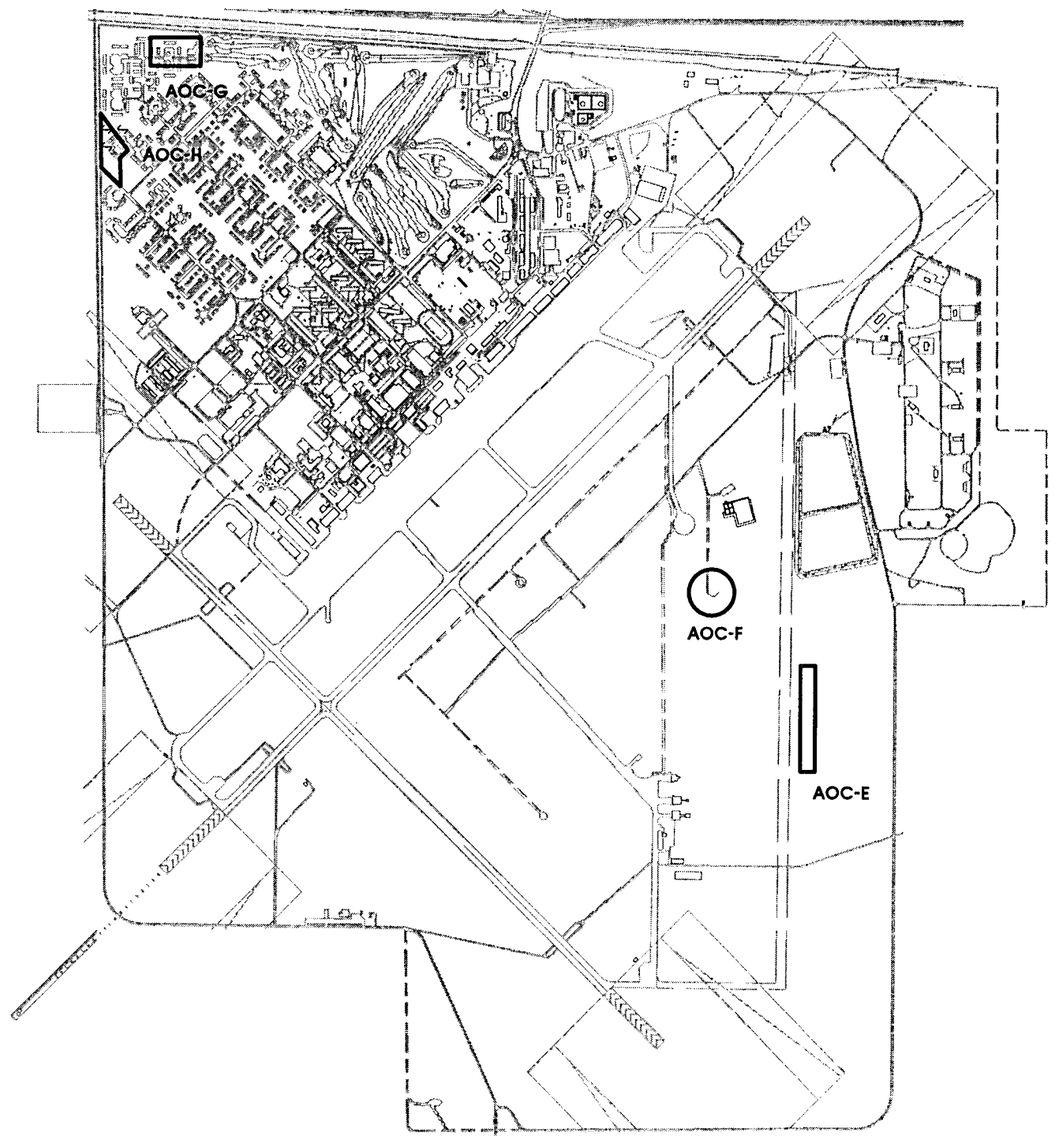
Appendix A contains the QAPP Addendum. Appendix B contains the SSHP Addendum. SOPs are in Appendix C. EPA Region VI Human Health Media-Specific Screening Alternatives are in Appendix D.

1.2 REGULATORY FRAMEWORK

This WP follows the United States Army Corps of Engineers (USACE) specified guidance from the United States Environmental Protection Agency (USEPA) "Guidance for Performing Site Inspections under CERCLA," USEPA OSWER Directive 93415.1-05 (September 1992).

LEGEND

AOC	DESIGNATED AREA
E	RUNWAY RUBBLE PILE
F	CALIBRATION TARGET BERM
G	DISTURBED AREA
H	DISTURBED AREA



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Xrefs: CAN-BASE.DWG

DRN. BY: BAG	DATE: 01/21/98	SITE PLAN AND LOCATION OF AREAS OF CONCERN CANNON AIR FORCE BASE NEW MEXICO	PROJECT NO. M9602R
CHK'D. BY:	REVISION: 0		FIG. NO. 1-1

2.1 SETTING - PHYSICAL GEOGRAPHY

Cannon AFB is situated in the Southern High Plains Physiographic Province in the Llano Estacado subprovince. The Llano Estacado is a nearly flat plain sloping gently (10 to 15 feet per mile) to the east and southeast. Elevations in the eastern New Mexico portion of the Llano Estacado exceed 4,000 feet above mean sea level (msl). In the vicinity of Cannon AFB, elevations range from 4,250 feet to 4,350 feet above msl.

The most prominent geomorphic features in the vicinity of Cannon AFB are blowouts and broad, widely spaced valleys. Less common landforms are relict sand dunes located along the northern side of the Portales Valley south of the Base. Relict dunes are not found on or near Cannon AFB.

Blowouts are broad shallow depressions which form as the result of soil erosion by wind. Blowouts commonly collect surface runoff from small to moderate sized drainage areas. During periods of rainfall, runoff collects in blowouts to form ephemeral playa lakes. Playas have no external surface drainage. Water is lost by infiltration to the soil and evaporation; without recharge, playa lakes persist for only a few days or weeks. Three playas are located within the Base, and several more are found to the north and east of the Base.

Stream valleys tend to be fairly broad and widely spaced. Streams are ephemeral and drainages are poorly developed. No streams exist on or near Cannon AFB. Running Water Draw and Frio Draw, located about 10 and 20 miles, respectively, north of Cannon AFB, are the nearest streams. These are second-order streams. Both streams are very straight, flow southeast, and have rectilinear drainage patterns with short laterals (W-C 1991).

2.2 DEMOGRAPHICS AND LAND USE NEAR CANNON AFB

Cannon AFB is located just south of U.S. Highway 60-84 in a farming and ranching area (Figure 1-1). The majority of the land surrounding Cannon AFB is productive, irrigated farmland or grassland. The major crops are wheat, sorghum, sugar beets, corn, cotton, alfalfa, barley, and peanuts. The land is also used for cattle grazing, both beef and dairy, and Clovis is considered the "Cattle Capital of the Southwest." There were 32,767 people living in Clovis in 1990, while the Cannon AFB population was estimated to be 4,650 in 1990 (W-C 1991).

2.3 CLIMATOLOGY

The climate of east-central New Mexico is classified as tropical semi-arid, with summer temperature and precipitation maxima. Average monthly temperatures range from a January low of 12°C (39°F) to a July high of 26°C (78°F). Extreme daily temperatures range from -24°C (-11°F) to 41°C (106°F) (Lee Wan and Associates 1990). Average monthly precipitation ranges from 1 cm (0.4 inches) in winter to 6.9 cm (2.7 inches) in July. The maximum recorded 24-hour

rainfall is 12.2 cm (4.8 inches), which occurred in August. Rainfall occurs on eight or more days per month during the summer precipitation maximum. Mean annual precipitation is approximately 41 cm (16 inches). The mean annual evapotranspiration rate is 181.4 cm/yr (71.4 inches/yr) (Lee Wan and Associates 1990). Prevailing winds are from the west at an average of 5 km/hr (3.1 mph) during fall, winter, and spring. During the summer, winds are from the south at an average of 3.7 km/hr (2.3 mph).

The atmosphere around the area of Cannon AFB is generally well mixed. The seasonal and annual average mixing heights can vary from 400 meters in the morning to 4,000 meters in the afternoon. The afternoon mixing heights are typically greater during the spring and fall seasons. The morning mixing heights are usually low, due to nighttime heat loss from the ground, producing surface-based temperature inversions. After sunrise, these inversions break up, and solar heating of the earth's surface causes vertical mixing in the atmosphere.

Dust is frequently entrained into the atmosphere in this region of the country because of gusty winds and the semiarid climate. The Texas Panhandle-eastern New Mexico area is considered the worst area in the United States for windblown dust. Occasionally, this windblown dust is of sufficient quantity to restrict visibility. Most of the seasonal dust storms occur in March and April, when the wind speeds are typically high (average 5 km/hr) (W-C 1991).

2.4 GEOLOGY

The near-surface stratigraphic units of interest at Cannon AFB are the Late Miocene-Late Pliocene-age Ogallala Formation and the Early Triassic Dockum Group as shown in Figure 2-1.

The Dockum Group consists of three formations. The stratigraphically lowest unit is the Santa Rosa Sandstone. Overlying the Santa Rosa Sandstone are the Chinle and Redonda Formations. The Chinle and Redonda Formations are composed mainly of red shales with lesser interbedded sands, and are known locally as "redbeds." The top of the Dockum Group is marked by an erosional nonconformity having relief of up to several hundred feet (Lee Wan and Associates 1990).

Overlying the Dockum Group redbeds is the Ogallala Formation. The Ogallala Formation extends from eastern New Mexico and Colorado into Texas, Oklahoma, Kansas, Nebraska, and South Dakota. Drillers' logs from Cannon AFB indicate that the Ogallala Formation varies from 360 feet to 415 feet in thickness. The incised upper surface of Triassic redbeds strongly influences Ogallala thickness. Paleo valleys in the post-Triassic nonconformity are deep and trend dominantly east-west. Ogallala thickness may thus vary significantly over short north-south distances.

The Ogallala is erosionally truncated to the south along the abandoned Portales Valley, to the west along the Pecos River Valley, and to the north in a series of ephemeral stream valleys. The

Ogallala Formation extends more than 125 miles to the east before terminating as an escarpment in Briscoe County, Texas. Springs and seeps are common along the erosional margins of the Ogallala.

The Ogallala dips gently and monoclinally to the southeast in the vicinity of Cannon AFB. As reported in Lee Wan and Associates (1990), data suggest that some Quaternary warping may have occurred; however, most of the structures are well to the northwest and southwest of Cannon AFB. No faults or buried structural lineaments are known in the vicinity of Cannon AFB.

The Ogallala Formation is composed of unconsolidated poorly sorted gravel, sand, silts, and clays. The base of the Ogallala is generally marked by a gravel, cobble, and boulder deposit. This basal member contains sediments derived from igneous and sedimentary rocks transported from the mountains to the west. The Ogallala Formation was laid down as stream and overbank deposits formed within coalescing alluvial fans. These fans form a broad pediment along the eastern flank of the Rocky Mountains. As is typical of alluvial deposits, Ogallala internal stratigraphy varies vertically and horizontally over short distances.

Except where strongly cemented by calcium carbonate (caliche), the sediments of the Ogallala are loose and friable. Authigenic and allogenic clays are found as a trace to abundant matrix mineral (Lee Wan and Associates 1990). As reported by Lee Wan and Associates (1990), five zones have been distinguished within the Ogallala of east central New Mexico on the basis of clay minerals. Smectites (montmorillonites) and attapulgite (with sepeotite) are the dominant clays throughout the Ogallala. Illite is a lesser, but persistent clay, as is kaolinite. Smectite is a swelling clay, causing deep cracks to form in dry surface soils. Smectite in particular and, to a lesser extent, attapulgite and illite, are clays with moderate to high cation exchange capacities (CEC). The formation as a whole should therefore have a relatively high CEC, which should inhibit the migration of charged contaminants, and especially ionic forms of metals.

Caliche is a major feature of the Ogallala Formation, occurring as nearly continuous to discontinuous layers throughout. A generalized geologic section at Cannon AFB is shown in Figure 2-1. Caliche is hard, white to pale tan on fresh surfaces, weathering to gray, and has a chalky appearance. Caliche forms as calcium carbonate, leached from overlying sediments, and precipitates in the pore space of the host sediments. Precipitation is caused by the evaporation of downward percolating water. The caliche may thus mark the position of ancient vadose zones. As reported in Lee Wan and Associates (1990) radiocarbon dates for the upper "climax" caliche range from -27,000 yr. Before Present (B.P.) to -42,000 yr. B.P.

Caliche is relatively soluble in acidic water (pH < 7) or in waters containing dissolved CO_2. The top surface of the upper "climax" caliche in fresh outcrop shows solution etching.

The Ogallala has numerous continuous to discontinuous caliche layers throughout its thickness. The uppermost caliche, termed the "climax" caliche, is pisolitic (consisting of spherical concentrically laminated aggregates 1 to 10 mm in diameter, (Lee Wan and Associates 1990). The pisolites are thought to have formed as the caliche was repeatedly chemically-weathered and brecciated during Pleistocene pluvials (wet climate episodes) and later recemented during drier intervals. This upper caliche crops out around playas and the bounding escarpments of the Ogallala, and is locally termed "caprock." The "climax" caliche is typically 3 to 5 feet thick. Caliches which occur lower in the Ogallala are platy and harder. Caliche may be thin or absent below playas (W-C 1991).

2.5 HYDROGEOLOGY

The lower portion of the Ogallala Formation is the primary regional aquifer for both potable and irrigation water. No deeper aquifers are utilized in the vicinity of Cannon AFB. The Ogallala aquifer is part of the High Plains Aquifer which extends continuously from Wyoming and South Dakota into New Mexico and Texas. In east central New Mexico, the Ogallala aquifer rests on Dockum Group redbeds, which serve as the basal confining layer. The Ogallala is a water table, or unconfined, aquifer (Lee Wan and Associates 1990). The Ogallala aquifer has a southeasterly regional gradient of about 13 feet/mile. Well yields vary from less than one gallon per minute (gpm) in thin silts and sands, and up to 1,600 gpm in thick sands and gravels (Lee Wan and Associates 1990). Water quality is generally good, with hardness and fluorides being somewhat high (Lee Wan and Associates 1990).

At Cannon AFB, the depth to groundwater is greater than 200 feet, and the Ogallala aquifer has an average saturated thickness of 120 feet based on mid-1960s data. Saturated thickness ranges from 93 to 143 feet, and is influenced by the configuration of the erosional nonconformity surface marking the top of the Dockum Group. The local groundwater gradient is southeasterly at 7.5 feet/mile (Lee Wan and Associates 1990). Figure 2-2 shows water table elevation contours for 1984. Flow within the saturated zone may be influenced by the configuration of the top of the Dockum Group. Yields in tests of Cannon AFB water wells have ranged from 776 L/min (205 gpm) to 4,353 L/min (1150 gpm). Specific capacities range from 0.14 m^3/m (11.4 gal/ft) to 0.35 m^3/m (27.9 gal/ft) (Lee Wan and Associates 1990).

Very rough estimates of hydraulic conductivity were made from well pump tests in water wells 5 and 9 (Figure 2-3) using the Theis equation. An estimate of hydraulic conductivity for water well 8 was based on water level recovery data using the Bouwer and Rice approach (Lee Wan and Associates 1990). The data used in these calculations were obtained to evaluate pump rates, efficiency, and well yield, and were not intended for use in calculating aquifer properties. The results of these calculations should therefore be considered as first approximations.

Hydraulic conductivity values for water wells 5 and 9 were found to be approximately 2.0×10^{-3} cm/sec. Calculations for water well 8 resulted in a hydraulic conductivity of 2.0×10^{-2} cm/sec. In addition, slug testing of two monitoring wells (MW-O and MW-N) was done by

Woodward-Clyde in February 1995 (W-C 1995a). The estimated hydraulic conductivities from these slug tests were both 3 x 10^{-3} cm/sec. These estimates appear to be low when compared to published hydraulic conductivity data for sands and gravels. As reported in Lee Wan and Associates (1990) a groundwater flow velocity of about 45 m/yr (150 ft/yr) has been estimated. This calculates out to a hydraulic conductivity of approximately 1.0 x 10^{-1} cm/sec. Again, this appears to be low when compared with published data (Freeze and Cherry 1979).

The presence of interstitial clays may account for both the variability and low values of hydraulic conductivities. Boring logs from Cannon AFB IRP projects and published reports (Lee Wan and Associates 1990) indicated that interstitial and interstratified clays are abundant in the Ogallala Formation.

Recharge to the Ogallala is primarily through precipitation. As reported in Lee Wan and Associates (1990), a recharge rate of 0.5 inches/year was calculated using the Theis equation. Lee Wan and Associates (1990) reported that the recharge rate may be as much as 1.0 inches/yr. Due to the high evapotranspiration rate and low precipitation, recharge probably occurs only during heavy rainfall events in which the infiltration capacity of the soil is exceeded and runoff occurs, or during cool months when precipitation exceeds evapotranspiration. Excess runoff flows to playas, and the presence of water in playas may allow deep percolation to the aquifer. The occurrence of this process is evidenced by the presence of clay deposits in, and thin or nonexistent caliche layers directly below, playas. Caliche is soluble in acidic rain waters, and is leached over time to form percolation pathways.

Discharge from the Ogallala occurs through well pumping and springs along the eroded margins of the formation. Spring discharge does not occur on or near Cannon AFB. Domestic and irrigation water wells are common on and around the Base, however. The rate of discharge exceeds the rate of recharge. Water levels in the Ogallala have declined steadily from the 1930s to the present. A decline of 50 to 100 feet has been observed in the area around Clovis, New Mexico for the period from the 1930s to 1980. Lee Wan and Associates (1990), states "the largest area of water level decline exceeding 100 feet occurs south of the Canadian River extending from Curry Co., New Mexico to Crosby Co., Texas."

The dominant uses of groundwater in the Cannon AFB area are for potable and irrigation water. Numerous wells are found in the Cannon AFB area, most of which provide only irrigation water (Figure 2-3).

The Ogallala will continue to be used as the primary source of potable and irrigation water for eastern New Mexico. The New Mexico State Engineer designated Curry County as a Water Basin in 1989. This designation allows for regulation of water rights, usage, and well drilling (W-C 1991).

2.6 SOILS

Soils in the vicinity of Cannon AFB are classified as SM to SC under the Unified Classification Systems, and as aridisols (calciorthids) under the Soil Conservation Service Comprehensive Soil Classification System. The following summary is based on the Soil Conservation Service Curry County Soil Survey as reported in Lee Wan and Associates (1990).

The most common soil type on the Base is the Amarillo fine sandy loam, 0- to 2-percent slope phase (map symbol Ab Figure 2-4). This soil consists of a thin sandy A horizon, well-defined clayey B_{1-3} horizons, with a calcic B_3 horizon at depths below 40 inches. The calcic B_3 horizon lies on a calcic C horizon, or on caliche. The Amarillo fine sandy loam is present on all relatively flat surfaces at the Base, but is also found on slopes associated with playas (map symbol Ac).

Clovis fine sandy loams, 0- to 2-percent slope phase (map symbol Cb) and 2- to 5-percent slope phase (map symbol Cc), are very similar to Amarillo fine sandy loams. In the Clovis soils, the depth to the calcic C horizon ranges from 28 to 56 inches. The depth to caliche exceeds 56 inches. Clovis and Amarillo fine sandy loams occur in close association.

In a few limited areas, particularly along the steeper slopes around playas, Mausker fine sandy loam, 0- to 2-percent slope phase (map symbol Ma), and 2- to 5-percent phase (map symbol M6) are found. Mausker fine sandy loams have no B horizons and are very calcareous. The calcic C horizon is within 2 feet of the surface.

The A and B horizons of Amarillo and Clovis fine sandy loams are rapidly to moderately permeable. Mausker fine sandy loam A and Ac horizons are rapidly permeable. Permeabilities in calcic B and C horizons are moderate (Lee Wan and Associates 1990).

2.7 BACKGROUND METALS CONCENTRATIONS IN SOIL AND WATER QUALITY

The natural soils in the vicinity of Cannon AFB are alkaline and rich in metals in general. Typically high concentrations of aluminum, iron, magnesium, manganese, and potassium combine with elevated levels of many other metals in the natural soils. Calcium is naturally present in the soils at levels up to nearly 200,000 mg/kg. Tightly cemented layers of "caliche" are present in several horizons in the natural soils and the Ogallala aquifer below.

The background levels of inorganic compounds in surface and subsurface soil at Cannon AFB are presented in Table 2-2 in the form of a mean value and statistical information on the ranges encountered for each element. Table 2-2 has been adapted from a final report by Woodward-Clyde dated September 1997 entitled "Concentrations of Inorganics and Background

Concentrations of Pesticides at Cannon Air Force Base, New Mexico". This report summarizes background data for soil from numerous past investigations in the vicinity.

The mean values and upper tolerance limits (UTLs) presented in Table 2-2 are the background levels used in the screening of soil chemical results for this RFI. In addition to comparison to the UTL of the Base-wide background data (which is necessarily from a limited data set), other sources of naturally-occurring metals concentrations, such as USGS (1984), were considered when determining whether metals concentrations are within background levels.

The groundwater quality at Cannon AFB is generally good, with dissolved solids ranging from 250 to 500 mg/L (Gutentag et al. 1984) and fluorides ranging from 2.2 to 2.7 mg/L (William Matotan and Associates, Inc. 1985). The general water quality from the Ogallala aquifer over a broad region is presented in Table 2-3, and water quality data for samples from production wells and monitoring wells within the bounds of Cannon AFB are presented in Table 2-4.

2.8 BIOLOGICAL RESOURCES

Land adjacent to Cannon AFB is primarily used for agriculture, and there is little natural vegetation remaining in the area. The wildlife species that are common to agricultural areas throughout the region include bobwhite quail and pheasant. There are a few playa lakes in the area; these are used by upland game for cover, by waterfowl for resting and feeding, and by wildlife in general for drinking. Nearby riverbeds also provide water sources during rainy seasons. During periods of low rainfall, the riverbeds are dry (W-C 1991).

2.8.1 Plant Resources

The climate of the Base area is considered to be semiarid. The thin layer of topsoil in the vicinity of Cannon AFB is sandy loam, which is highly susceptible to wind erosion. The undisturbed natural vegetation is mostly shortgrass prairie, including blue grama grassland and mixed grama grassland vegetation types, which have moderately fast recovery rates.

Much of the study area has been previously cleared for agricultural crops. The predominant land use of the region is rangeland, primarily for cattle grazing. In general, moderately grazed rangeland areas of the types occurring in the project area are highly productive in terms of both forage quality and quantity. The rangeland in the vicinity may support up to 15 to 20 head of cattle per section, depending on the rainfall. Large trees do not uniformly exist in the vicinity of the range except where planted around buildings and other structures on the Base. Woodlands composed of large shrubs and small trees are confined to riparian areas and playa lakes in the vicinity (W-C 1991).

The following plants are candidate species for the Federal List of Endangered and Threatened Wildlife and Plants and are found within a 50-mile radius of Cannon AFB: chatterbox orchid (*Epipactus gigantea*), spiny aster (*Aster harridus*), Whittmans milkvetch (*Asragalus witmanii*),

dune unicorn plant (*Proboscidea sabulosa*), and the tall plains spruce (*Eupjorbia strictior*). The dune unicorn plant is also on the state endangered plant species list. No federally protected endangered plants are known to be present on the Base (Lee Wan and Associates 1990).

2.8.2 Wildlife Resources

The eastern New Mexico area contains many nongame wildlife species that are typical of the High Plains. Most of these species are distributed widely throughout the western United States. Species diversity is low in most habitats because of the low vegetation diversity. Most amphibian species are associated with riparian habitats and playa lakes. Reptiles are found in all terrestrial habitat types, but are most abundant in scrub/grasslands. Nocturnal rodents are the most abundant members of the small mammal community.

Grasslands on the High Plains support a variety of seed-eating sparrows and other ground-dwelling birds, both as residents and migrants. Raptors (hawks and owls) are relatively abundant in all habitats in the region. Insectivorous and tree-nesting species are most abundant in riparian areas. Shorebirds and waterbirds and migratory waterfowl in general utilize the rivers, playa lakes, and reservoirs of the region.

Two National Wildlife Refuges (NWRs) are located on the periphery of the Base area. The Grulla and Muleshoe NWRs are within 30 miles of Cannon AFB. These areas provide high-quality habitat for migratory and breeding waterfowl.

Big-game species in the area include mule deer, white-tailed deer, pronghorn, and barbary sheep. Pronghorn are the most abundant game animal in the area. Several species of upland game, such as quail, ring-necked pheasant, and turkey are common in the area. Reservoirs (Ute Lake, Conchas Lake, and Clayton Lake) and playa lakes are important waterfowl habitats in the region. Numerous species of native and introduced fish inhabit the rivers and perennial streams, and the reservoirs support recreational fishing of warm-water species such as walleye, crappie, channel catfish, largemouth bass, and bluegill.

As determined by the regional office of the U.S. Fish and Wildlife Service, two federally listed endangered animal species, the bald eagle and peregrine falcon, are known to inhabit the area within a 50-mile radius of Cannon AFB. The New Mexico Department of Game and Fish also indicated that the state endangered Mississippi Kite, Baird's Sparrow, and the Black-Footed Ferret may also occur in the vicinity of the Base. The federal- and state-protected species are listed in Table 2-1.

Within Curry County, the only state-protected bird that is expected to occur is the Mississippi Kite. In New Mexico, since the early 1960s, this kite summers regularly and breeds in the Clovis region. The birds frequent the golf course at Cannon AFB. Two other state-protected birds that may occur within Curry County are the McCown's Longspur and Baird's Sparrow. These two species have not been sighted regularly in recent years. No information is available on the

McCown's Longspur in New Mexico; however, Baird's Sparrow occurs mainly in autumn during migration in the eastern plains and southern lowlands. Migrants appear as early as the first week of August and move further south by November. The species seems to have declined in abundance throughout its range in the Southwest due to the loss of shrubby shortgrass habitats.

State-protected birds known to occur infrequently are the bald eagle and the peregrine falcon. The bald eagle migrates and winters from the northern border of New Mexico to the Gila, lower Rio Grande, middle Pecos, and Canadian valleys. It is seen occasionally in summer and as a breeding bird, with nests reported in the extreme northern and western parts of the state. Winter and migrant populations appear to have increased with reservoir construction. The peregrine falcon is widely distributed but population numbers are low. The American subspecies breeds statewide in New Mexico, but mainly west of the eastern plains (Source: Draft Environmental Impact Statement - Cannon AFB 1990).

TABLE 2-1
FEDERAL- AND STATE-PROTECTED ANIMALS POTENTIALLY OCCURRING IN THE VICINITY OF CANNON AFB (CURRY COUNTY)

Common Name	Scientific Name	Federal Status	State Status
Birds			
Mississippi kite	*Ictinia mississippiensis*		Endangered (Group 2)
Barid's sparrow	*Ammodramus baridii*		Endangered (Group 2)
Bald eagle	*Haliaeetus leucocephalus*	Endangered	Endangered (Group 2)
Peregrine falcon	*Falco perigrinus*	Endangered	Endangered (Group 1)
Mammals			
Black-footed ferret	*Mustela nigripes*	Endangered	Possibly Extinct

Endangered (Group 1): Species whose prospects of survival or recruitment within the state are in jeopardy

Endangered (Group 2): Species whose prospects of survival or recruitment within the state are likely to become jeopardized in the foreseeable future.

Possibly Extinct: Potentially no longer in existence in the state.

Source: Lee Wan and Associates 1990

TABLE 2-2
SUMMARY OF BACKGROUND ELEMENTAL CONCENTRATIONS[1] IN SOIL SAMPLES[2] AT CANNON AFB, NEW MEXICO

	Mean (x)		Standard Deviation (s)		95% Upper Tolerance Limit of Background Concentrations (UTLs)	
Element	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil
Aluminum	5,508	5,932	1,964	2,183	8,950	12,214
Antimony	ND (3)	ND (3)	ND (3)	ND (3)	3.15 (3)	16 (3)
Arsenic	2.1	2.1 (4)	0.48	0.96 (4)	3.6	4.3 (4)
Barium	100	210	165	199	670	890
Beryllium	0.35 (4)	0.35 (4)	0.13 (4)	0.17 (4)	0.78 (4)	0.73 (4)
Cadmium	ND (3)	ND (3)	ND (3)	ND (3)	0.435 (3)	1.3 (3)
Calcium	5,645	89,410	11,366	64,611	44,800	237,498
Chromium (total)	7.1	5.6	1.3	2.33	10.5	13.3
Cobalt	2.9	2.6 (4)	1.0	1.4 (4)	6.6	4.7 (4)
Copper	6.8	3.8 (4)	4.6	1.97 (4)	18.3	8.3 (4)
Iron	6,458	5,148	1,349	2,262	10,100	13,148
Lead	6.8	4.7	1.6	1.7	12	8.7
Magnesium	1,066	4,260	390	3,856	1,930	19,300
Manganese	139	83	51	50	307	333
Mercury	0.025 (4)	ND (3)	0.016 (4)	ND (3)	0.056 (4)	0.019 (3)
Nickel	5.5	5.9 (4)	1.6	2.41 (4)	11	14.9 (4)
Potassium	1,345	1,222	413	417	2,691	2,512
Selenium	ND (3)	0.47 (4)	ND (3)	0.31 (4)	0.26 (3)	1.1 (4)
Silver	--- (5)	ND (3)	--- (5)	ND (3)	0.4 (5)	2.65 (3)
Sodium	91	351 (4)	10	253 (4)	102	1,227 (4)
Thallium	ND (3)	ND (3)	ND (3)	ND (3)	0.6 (3)	2.65 (3)
Vanadium	14.9	16	2.8	5.2	23.3	32.8
Zinc	15.4	12.1	5.2	4.8	32.2	30.6

(1) All concentrations are in milligrams per kilogram (mg/kg).
(2) From report entitled "Naturally Occurring Concentrations of Inorganics and Background Concentrations of Pesticides at Cannon Air Force Base, New Mexico" (W-C 1997).
(3) All analytical sample were nondetect; therefore, a mean and standard deviation was not calculated. One-half the highest reporting limit is used as the 95% UTL. The actual mean, standard deviation, and UTL may be less than these values.
(4) Values determined from a data set including one-half of the reporting limits for nondetects.
(5) Silver was detected in only one sample; therefore, a mean and standard deviation was not calculated. The single detected concentration is used as the 95% UTL.

TABLE 2-3
REGIONAL WATER QUALITY[1] - OGALLALA AQUIFER[2]

	Sherman Co. Nebraska	Laramie Co. Wyoming	Red Willow Co. Nebraska	Kit Carson Co. Colorado	Kiowa Co. Colorado	Stanton Co. Kansas	Meade Co. Kansas	Union Co. New Mexico	Roberts Co. Texas	Gaines Co. Texas	Gaines Co. Texas	Mean ()
Silica	63	28	58	36	22	20	23	38	27	58	64	40
Calcium	94	45	56	30	228	51	63	56	46	72	231	88
Magnesium	14	5.5	15	10	114	20	19	34	18	20	225	45
Sodium and Potassium	21	6.4	19	27	226	35	245	17	37	44	845	138
Bicarbonate	336	157	200	181	184	180	210	215	243	221	282	219
Sulfate	18	6.5	13	10	1,170[5]	8.1	94	49	32	104	1,351[5]	260
Chloride	18	2.8	3.9	3.0	143	30	350[5]	46	28	43	1,109[5]	162
Fluoride	---	0.4	0.8	1.8	4.0[5]	1.4	1.0	1.6	0.8	1.5	4.0[5]	1.6
Nitrate	7.6	7.0	---	7.6	3.9	12[5]	1.7	24[5]	3.9	5.6	4.2	7.0
Dissolved Solids	403	191	273	214	2,140[5]	339	900[5]	372	312	507[5]	3,970[5]	875
pH[3]	7.7	7.4	7.7	8.0	7.7	7.6	7.7	7.4	8.0	7.3	7.4	7.6
Specific Conductance[4]	605	281	420	325	2,630	555	1,650	628	507	675	5,350	1,240

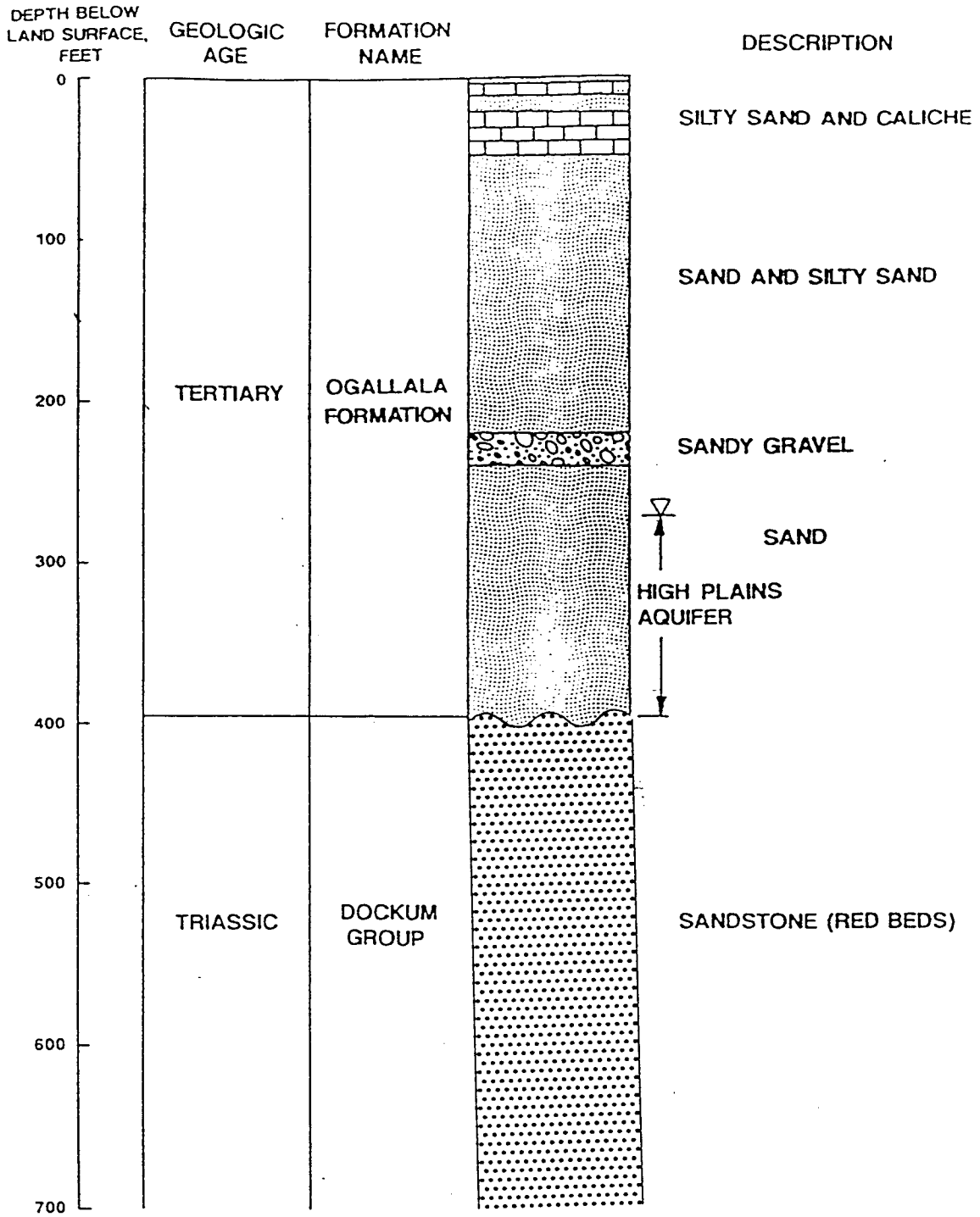
1) Concentrations are in milligrams per liter (mg/L) unless otherwise indicated
2) Source: Krothe, et al. 1982
3) pH units
4) Micro mhos (:mhos)
5) Exceed U.S. Environmental Protection Agency Regulations (1976, 1977)

TABLE 2-4
WATER QUALITY SUMMARY[1] FOR CANNON AFB PRODUCTION WELLS AND MONITORING WELLS

	Minimum	Maximum	Mean	MCL[2]
Antimony	0.06U	0.06U	0.06[5]	0.01//0.005[3]
Arsenic	0.005U	0.05U	0.02[5]	0.051
Barium	0.022	0.2	0.50[5]	1.0
Beryllium	0.002U	0.002U	0.002[5]	0.01[3]
Cadmium	0.005U	0.01U	0.0008[5]	0.005[3]
Chloride	42	63.5	52.2	250
Chromium	0.01U	0.001	0.04[5]	0.01
Cobalt	0.01U	0.01U	0.01[5]	*
Copper	0.001U	0.02U	0.012[5]	1.0*
Cyanide	0.005U	0.005U	0.005[5]	0.2
Fluoride	1.8	2.6	2.3	2
Lead	0.005U	0.05U	0.015[5]	0.05
Manganese	0.00	0.01U	0.0075[5]	0.05
Mercury	0.0002U	0.003	0.001[5]	0.002
Nickel	0.04U	0.032	0.04[5]	1.0[3]
Nitrate	0.9	6.6	1.8	10.0
Selenium	0.01UJ	0.0049J	0 0.01501[5]	0.05
Silver	0.01U	0.05U	0.02[5]	1.0[4]
Sulfate	115	132	125	250
Thallium	0.01U	0.01U	0.01[5]	0.022/0.001[3]
Tin	0.1U	0.1U	0.1[5]	*
Uranium	0.0036	0.0062	0.0046	5.0
Vanadium	0.02	0.031	0.026	*
Zinc	0.0041J	0.09	0.05	5.0
TDS	385	479	451	500
pH (units)	7.5	7.95	7.78	6.5-8.5

MCL = Maximum contaminant level
UJ = Estimated as nondetect at the CRQL
J = Estimated value
U = Not detected
CRQL = Contract-Required Quantitation Limit
* = No primary or secondary MCL or proposed MCL as of March 1992

[1] All concentrations are in milligrams per liter (mg/L). Values calculated from historical data for Cannon AFB wells 1, 2, 3, 4, 7, 8, 113A, and 101E for period from 1966 through 1991.
[2] Primary MCL in effect as of July 30, 1992
[3] Proposed primary MCL
[4] Secondary MCL in effect as of July 30, 1992
[5] Detection limits (using one times the value) were also used to calculate means.



LEGEND

LITHOLOGIC CONTACT

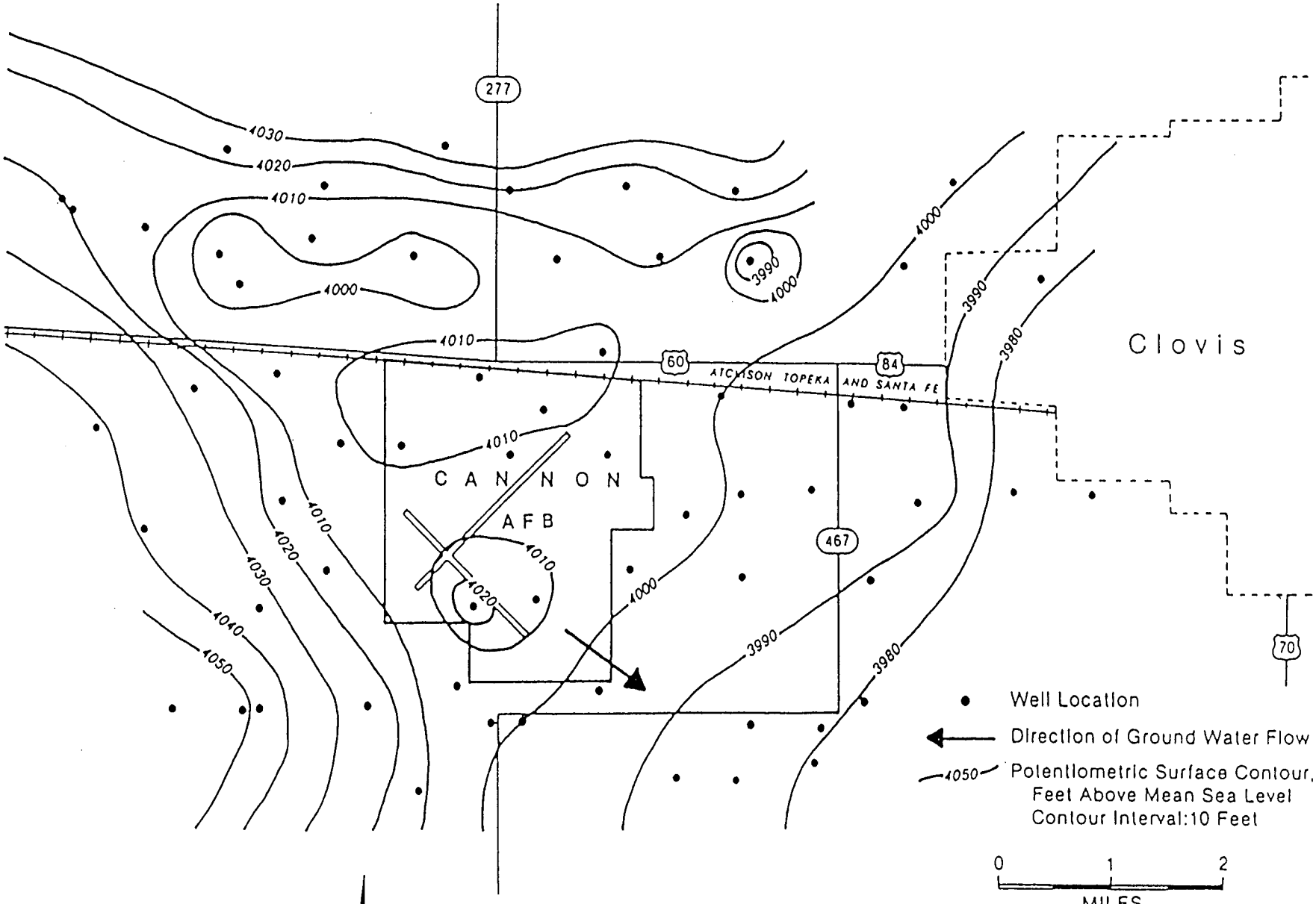
UNCONFORMITY

WATER LEVEL

SOURCE: MODIFIED FROM GUTENTAG ET.AL., 1984

January 20, 1998 9:00:42 a.m.
Drawing: T:\TITLES\DY8X11.DWG (TSSM)

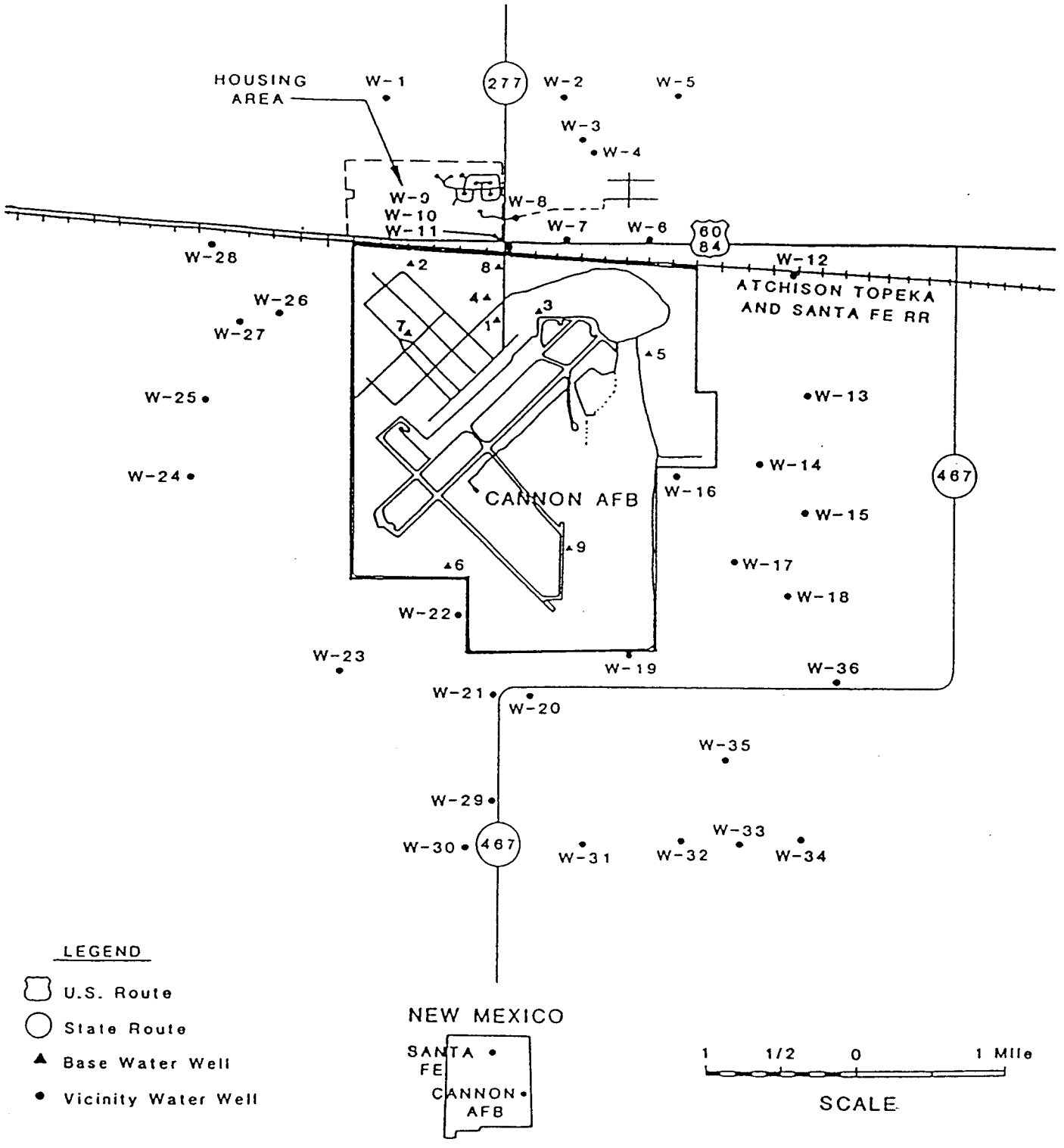
DRN. BY: TSSM	DATE: 01/20/98	GENERALIZED GEOLOGIC STRATA AT CANNON AIR FORCE BASE NEW MEXICO	PROJECT No. M9602R
CHK'D. BY:	REVISIONS: 0		FIG. No. 2-1



SOURCE: FINAL REPORT, IRP PHASE II

January 20, 1998 9:11:13 a.m.
Drawing: T:\TITLES\DY11X8.DWG (TSSM)

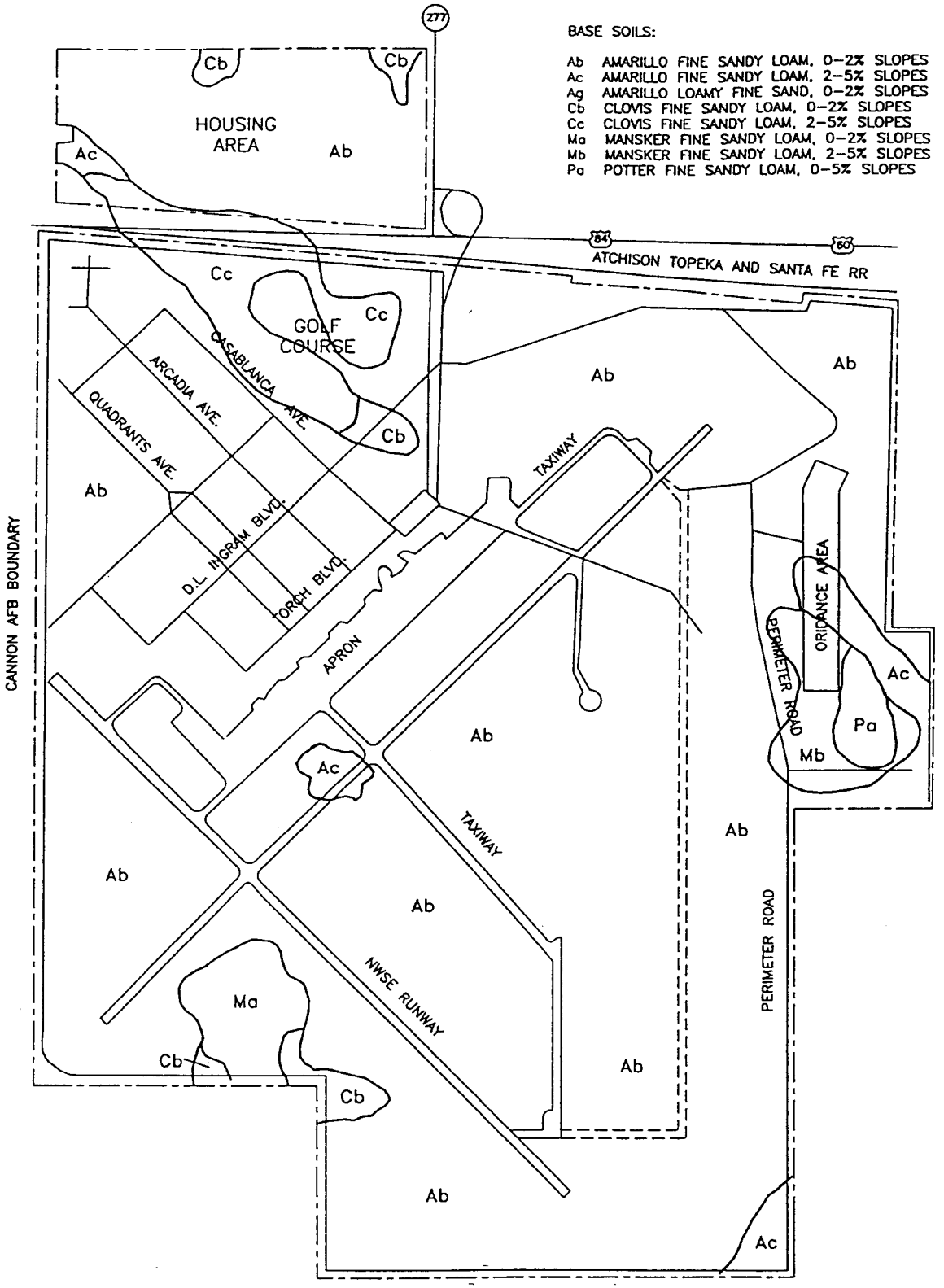
DRN BY TSSM	DATE 01/20/98	POTENTIOMETRIC SURFACE CONTOUR MAP, VICINTY OF CANNON AIR FORCE BASE NEW MEXICO	PROJECT No.	FIG. No.
CHK'D BY	REVISIONS: 0		M9602R	2-2



BASE MAP ADAPTED FROM: FINAL REPORT, IRP PHASE II

January 20, 1998 9:00:42 a.m.
Drawing: T:\TITLES\DY8X11.DWG (TSSM)

DRN. BY: TSSM	DATE: 01/20/98	WATER WELL LOCATIONS ON AND NEAR CANNON AIR FORCE BASE NEW MEXICO	PROJECT No.	FIG. No.
CHK'D. BY:	REVISIONS: 0		M9602R	2-3



SOURCE: USDA-S.C.S, SOIL SURVEY
COURRY COUNTY N.M., 1958

N

2000 1000 0 2000
SCALE IN FEET

January 20, 1998 9:00:42 a.m.
Drawing: T:\TITLES\DY8X11.DWG (TSSM)

DRN. BY: TSSM	DATE: 01/20/98	DISTRIBUTION OF SOILS, BY TYPE CANNON AIR FORCE BASE NEW MEXICO	PROJECT No.	FIG. No.
CHK'D. BY:	REVISIONS: 0		M9602R	2-4

3.1 DESCRIPTION OF THE DECISION PROCESS

The following decision process has been used to assess the data needs and investigative approach for AOCs -E, -F, -G, and -H. The Data Quality Objective (DQO) evaluation process is designed to provide soil data of sufficient quality and quantity to evaluate whether a release has occurred that could pose a risk to human health and to evaluate the need for further evaluation, such as collection of additional data, completion of a Baseline Risk Assessment (BRA), or possibly completion of a Feasibility Study (FS).

A general decision diagram (Figure 3-1) was developed for the Cannon AFB AOCs -E, -F, -G, and -H to present a logical decision process that will be used to evaluate the data resulting from the investigation to assure that project objectives are met.

The soils investigation decision process is designed to identify appropriate actions based on three alternative actions: no further action, interim action, and further investigation or evaluation. The recommendation for the selection of alternative action will depend upon whether chemicals of potential concern (COPCs) are detected in soils at levels that may pose an unacceptable risk to human health or the environment. This section provides a summary of the decision-making process that will be used.

The decision process will be implemented by first evaluating and summarizing existing historical information and analytical data. Historical information will be used to identify COPCs and to identify potential sites of chemical release.

Soil will be sampled and analyzed for COPCs. The analyte lists from which COPCs will be selected are discussed in the QAPP Addendum (Appendix A). Site-related COPCs will then be selected based on the results of the sampling program. Metals and pesticides that do not exceed background levels, and chemicals which are attributable to field or laboratory contamination, will not be included as site-related COPCs. Organic chemicals that do not have EPA-established toxicity factors will not be evaluated quantitatively, but their potential contribution to site risks will be evaluated qualitatively.

The potential for site-related contaminants to impact groundwater will be assessed by evaluating the vertical distribution of contaminants in the soil column. If the concentrations of COPCs decrease significantly with depth, and the concentrations are below levels that are likely to migrate to groundwater (based on fate and transport properties of the contaminant and the vadose zone), the potential for transport to groundwater will be considered to be insignificant. If the concentrations do not decrease with depth, further investigation of the groundwater pathway will be recommended. If the concentrations are at levels that could potentially migrate to groundwater at concentrations of concern (based on comparison to EPA Region VI soil-screening levels), fate and transport modeling will be done to evaluate the potential for contaminant transport to groundwater.

Concentrations of COPCs detected will be evaluated for potential human health and environmental risks by comparing maximum detected concentrations (which are higher than concentrations to which human receptors would routinely be exposed) to highly conservative (protective) human health risk-based concentrations (i.e., EPA Region VI Human Health Media-Specific Screening Levels). This conservative screening approach permits identifying sites that pose no unacceptable risk under highly conservative exposure assumptions and that, therefore, warrant no further evaluation or action. The approach also permits identification of sites that may warrant further evaluation based on exceedance of stringent risk-based concentrations. The methods used in the screening-level human health risk evaluations are presented in Section 3.6.

The results of this evaluation will be used to make recommendations regarding the three alternatives stated above. The recommendations will be made on the following basis:

- If the vertical extent and lateral extent of contamination has been defined, no threat to human health exists based on comparison of maximum concentrations (excluding metals/pesticides below background, field/lab contaminants) to EPA Region VI MSCs, and no potential threat to the environment is apparent, then no further action will be recommended.
- If an unacceptable threat to human health is imminent, a source is well defined, and a source control is readily identified, an interim action to control the source will be recommended.
- If there is a potential significant threat to human health based on exceedance of EPA Region VI MSCs, further investigation will be recommended for the site. Further investigation may include additional field investigation and/or a BRA.

3.2 PRELIMINARY DEVELOPMENT OF SITE CONCEPTUAL EXPOSURE MODELS (SCEMs)

The initial step in the evaluation of the site is the development of a Site Conceptual Exposure Model (SCEM), which provides a framework for evaluating potential risks associated with the site, aids in the identification of data needs, and assists in the identification of appropriate preliminary remediation goals targeted to significant exposure pathways. Upon completion of the field sampling program, the SCEM will be reviewed and modified (if necessary) in order to re-evaluate the site, taking into consideration the analytical results and fate and transport properties of site-related chemicals.

The SCEMs present chemical release sources and transport media, potential human receptors, and intake mechanisms for each potential exposure pathway. An exposure pathway describes the means by which release, transport, and intake by receptor populations of site-related COPCs occurs. An exposure pathway consists of four necessary elements:

- A source and mechanism of chemical release to the environment
- An environmental transport medium for the released chemical (e.g., air, groundwater, or surface water)

- A point of potential human exposure to transported chemicals (e.g., a domestic drinking water well)
- A human intake mechanism (e.g., inhalation or ingestion) at the point of exposure

All four elements must be present for an exposure pathway to be complete and for chemical exposure to occur. In the SCEM, potentially significant pathways are denoted with solid lines, and pathways that are considered to be insignificant relative to other pathways are denoted with dashed lines.

Potential exposure pathways are evaluated with respect to potential chemical sources at the site. Exposure pathways are considered to be potentially complete if there are chemical release and transport mechanisms and identified exposure points and receptors for that exposure pathway. Incomplete exposure pathways do not result in actual exposure to human or environmental receptors and, therefore, do not pose a potential risk. Incomplete exposure pathways are not shown on the SCEM. Insignificant pathways are those that could conceivably be complete and result in an exposure, but the resulting exposure would undoubtedly be at levels that would not pose a significant risk.

The SCEMs for AOCs -E, -F, -G, and -H are presented in Figures 3-2 through 3-5, respectively. The primary source at AOC-E is debris that was disposed of at the site. The primary sources at AOC-F are spent lead munitions and other waste materials that may have been used or disposed of at the site. The use of AOCs -G and -H are not known. Likely primary contaminant sources at these sites are materials that may have been used or were disposed of at the sites.

Chemicals from the primary sources may be transported away from the primary source areas, affecting other media that may in turn act as secondary sources. Percolation and leaching of the wastes to the subsurface soil are shown as primary chemical release mechanisms. Subsurface soils are an important secondary source of potential chemical release. Site-related chemicals in soils may infiltrate/percolate through the soil and be released to groundwater.

Other release mechanisms, such as direct contact (soil ingestion and dermal contact), surface runoff, wind erosion, or volatilization to the atmosphere, are also depicted in the SCEMs. Transport by storm runoff is not considered a significant pathway for human exposure at the AOCs because there are no developed drainageways at the sites and portions of the sites are covered with pavement.

Surface soils may provide exposures to Base workers (occupational exposures), hypothetical future construction workers, future trespassers, or residents. AOCs -E and -F are located in industrialized areas of the Base (the railroad and the runway); therefore, residential development is not a likely future land use. Residential exposures are possible at AOCs -G and -H because the suspected areas are within Base residential housing areas. Air emissions (volatile and particulates) from surface soil may also provide exposures to Base workers, construction

workers, trespassers, and residents. Subsurface soils and air emissions from subsurface soil (i.e., during excavation) may provide exposures to construction workers. Groundwater is used for domestic purposes on and off Base.

Contact with surface soil is considered to be the only complete and significant pathway for ecological receptors. However, due to the small size of the AOCs, it is unlikely that significant populations of valued ecological resources are present at the sites. Therefore, there is no need for a screening-level ecological risk assessment.

3.3 CRITICAL DATA

Critical data are data that are crucial for decision-making (e.g., whether a site requires no further investigation or should be carried into an FS). Critical data may be from special sampling locations or from a selected subset of samples from locations of roughly equal importance. Data from a specific field sample such as a sediment sample immediately downstream of a discharge point, may be designated as critical if it were necessary to know contaminant concentrations at that specific location for source or exposure pathway characterization. In other cases, data from a selected number of any of several field samples (e.g., a subset of all the surface soil samples taken at a site), may be designated as critical when the objective is to estimate mean contaminant concentrations over the area.

Following EPA guidelines (EPA 1989), critical data must be from environmental media representing each major exposure pathway and must be 100 percent complete, that is, valid results must be obtained for all data deemed critical. A complete set of critical data may be taken from more than one sample (i.e., if one sample has missing or rejected analytes, data from another comparable sample can be used to complete the critical data set). If the missing or rejected data do not hinder the decision-making process (e.g., they are not potential COPCs), they are not considered to be critical data, and the critical data set is still 100 percent complete. If decisions cannot be made because of missing or rejected data, a recommendation will be made that the project managers determine what corrective action should be taken. COPCs are defined as chemicals that are site-related (i.e., they are derived from the site and are at concentrations that exceed background levels); and that have EPA-derived toxicity factors (i.e., carcinogenic slope factors or noncarcinogenic reference doses) or that have potential toxicity that can be addressed qualitatively (e.g., lead). COPCs will be derived from the analyte list described in the QAPP Addendum (Appendix A). This procedure permits retaining valid data from the original data set and compiling a complete, representative, and valid set of critical data without unnecessary resampling.

3.4 DETECTION LIMITS

To select appropriate analytical methods, method detection limits have been compared with analyte-specific concentrations of concern such as MSCs. MSCs are concentrations that under given exposure assumptions, will produce a specified risk. For this discussion, MSCs are

concentrations which are estimated to cause carcinogenic risks of 1×10^{-6} (Class A and B carcinogens) and 1×10^{-5} (Class C carcinogens) or a hazard quotient of 1.

3.5 EVALUATION OF BACKGROUND CONCENTRATIONS

A comparison of AOC sample concentrations to background concentrations will be used to determine whether metals and pesticides detected in soil samples are site related. The following sections describe the approaches used for each.

Soils are derived from parent geologic materials as a result of physical, chemical, and biological processes. The soil system is a highly heterogeneous matrix of inorganic and organic components. The relative proportions of these components are dependent upon factors influencing soil formations, such as topography, climate, depositional processes, and time (Sposito and Page 1984). Total concentrations of metals in soils may vary depending upon location; for example, at the surface, soils are influenced by leaching, runoff, atmospheric deposition, and biotic uptake, as well as anthropogenic activity. The ranges of naturally occurring or "background" concentrations of metals in soils is greatly varied due to the composition of parent material and, therefore, care must be taken in the interpretation of metals data generated during an investigation.

3.5.1 Metals

For the SI, metals concentrations in AOC soils will be compared to background soils concentrations presented in "Naturally Occurring Concentrations of Inorganics and Background Concentrations of Pesticides at Cannon Air Force Base, New Mexico" (W-C 1997). The approach will compare the maximum concentrations detected at an AOC to the 95 percent upper tolerance limit (UTL) of the background concentrations. Using this technique, individual samples at the AOCs with high concentrations relative to background levels (i.e., which could represent a site-related release) can be identified. In addition, concentrations detected in AOC soils will be compared to regional soils metals concentrations reported in the literature.

3.5.2 Pesticides

At AOCs -G and -H, four shallow soil samples will be collected and used to develop background concentrations for pesticides. For each pesticide detected, a 95 percent UTL will be calculated using the methodology described in W-C 1997. Maximum detected pesticide concentrations at AOCs -G and -H will be compared to the calculated UTLs. A pesticide is considered to exceed background if the maximum detected site concentration exceeds the UTL.

3.6 SCREENING-LEVEL HEALTH RISK EVALUATION METHODOLOGY

This section provides a description of the approach that will be used in the screening-level health risk evaluation for AOCs-E, -F, -G, and -H. Potential human health impacts will be evaluated by

comparing maximum chemical concentrations (of chemicals that exceed background) found at the site with EPA Region VI Human Health MSCs.

The goal of this evaluation process is to make a determination as to whether or not a release has occurred at an AOC that could pose a potential risk to human health. The risk-based approach outlined in this section provides an upper-bound estimate of potential human health impacts because conservative screening criteria and maximum chemical concentrations are used to estimate potential impacts. If the vertical extent and lateral extent of contamination has been defined and no potential human health risks are indicated for an AOC using these conservative criteria, then no further investigation is recommended for the AOC.

3.6.1 Derivation of Screening Criteria

The MSCs will be taken from the Region VI table which is provided in Appendix D (EPA 1997). The latest available version will be used. These MSCs are based on 1×10^{-6} excess cancer risk or a hazard quotient equal to 1, assuming residential ingestion exposures. It must be emphasized that this is a highly conservative approach used for screening purposes only; risks that would be estimated in a site-specific quantitative BRA are likely to be much lower than the risk levels calculated using these screening criteria. A maximum chemical concentration that exceeds a screening-level MSC does not mean that a health risk exists because the maximum concentration detected is not the concentration to which people would routinely be exposed, and the exposure assumptions used to derive the MSCs are not site-specific.

For a carcinogen, the soil MSC is the concentration of a chemical in soil that is estimated to result in an excess cancer risk of 1×10^{-6} (1 in 1,000,000) for Class A and B carcinogens or 1×10^{-5} for Class C carcinogens, assuming long-term (30-year) daily exposures. A range of 1×10^{-6} to 1×10^{-4} (1 in 1,000,000 to 1 in 10,000) is EPA's target excess cancer risk range for cleanup under Superfund and RCRA (EPA 1991). Therefore, MSCs based on target risks of 1×10^{-6} and 1×10^{-5} are conservative (protective) values, and exceedances of these MSCs do not necessarily mean that a health risk is present. Exceedance of the MSCs may mean, however, that further evaluation of chemical concentrations, exposure assumptions, and carcinogenicity may be warranted.

For noncarcinogens, MSCs are the concentrations in soil that are estimated to result in a "hazard quotient" (HQ) of 1.0. A hazard quotient is the ratio of the estimated daily dose from the assumed exposure to a reference dose (RfD), established by EPA, that is considered safe for a lifetime of daily exposure. A hazard quotient of 1 means that no toxic effects are likely to occur, even to sensitive individuals exposed for a lifetime. A hazard quotient above 1 does not mean that toxic effects will necessarily occur, but that further evaluation of exposures and chemical toxicity is required. It should be noted that the values for noncarcinogens do not account for chemical mixtures. If more than one noncarcinogen is expected, then the noncarcinogenic MSC should be divided by 10.

EPA Region VI MSCs for soil exposures are based on the ingestion, inhalation, and dermal exposure routes. Soil MSCs are available for industrial and residential scenarios. AOCs -E and -F are located in industrialized areas of the Base; therefore, industrial MSCs will be used for screening at these sites. AOCs -G and -H are within residential housing areas; therefore, residential MSCs will be used for these areas.

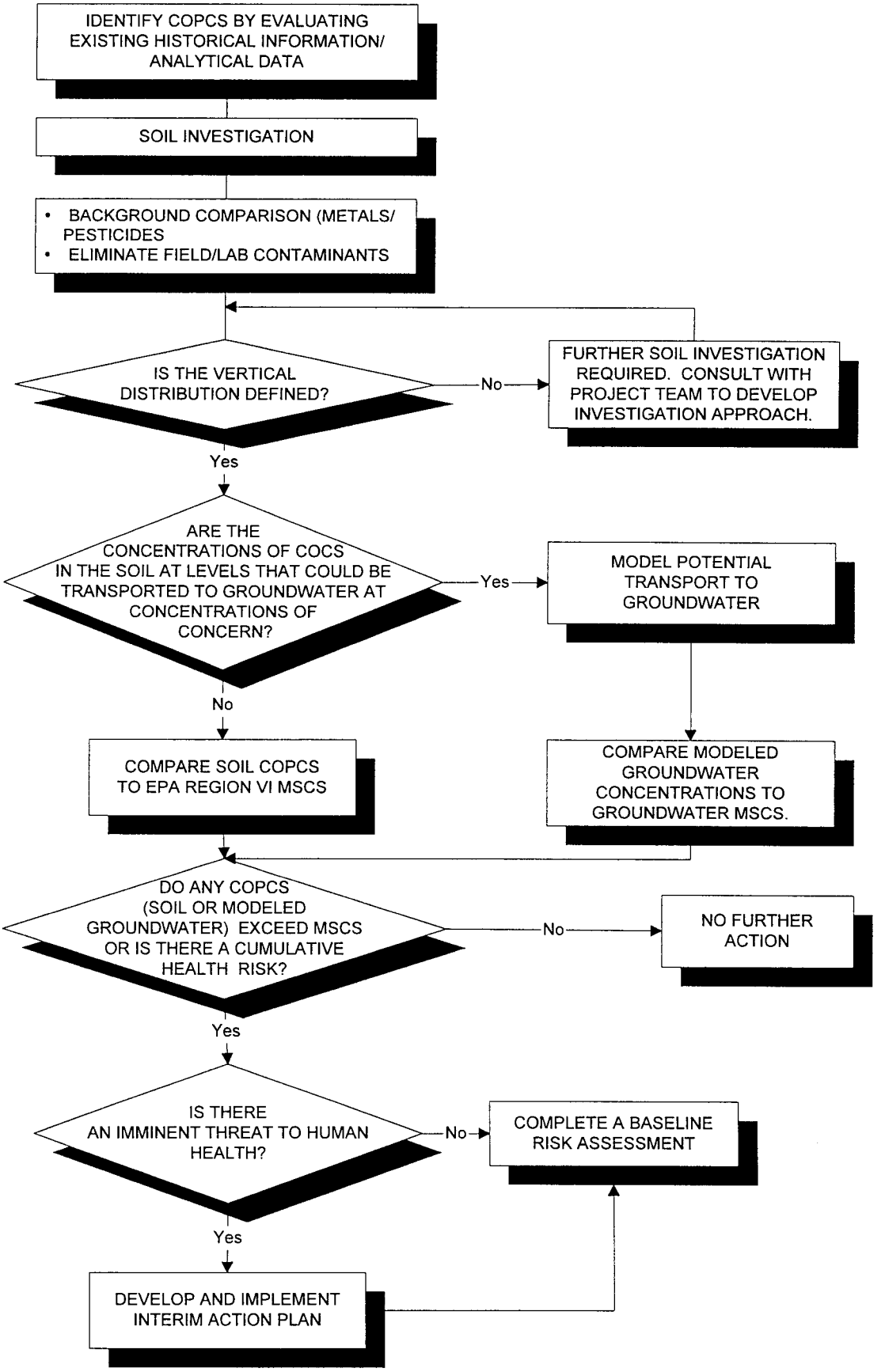
It is important to note that MSCs are not cleanup goals. Cleanup goals are determined on a site-specific basis. Rather, comparing soil concentrations to screening-level MSCs is adopted as a means of screening whether the chemicals in soils could pose a threat to human health. If the screening-level MSCs are not exceeded, no further action is recommended. If the screening-level MSCs are exceeded, further evaluation of potential risks will be completed.

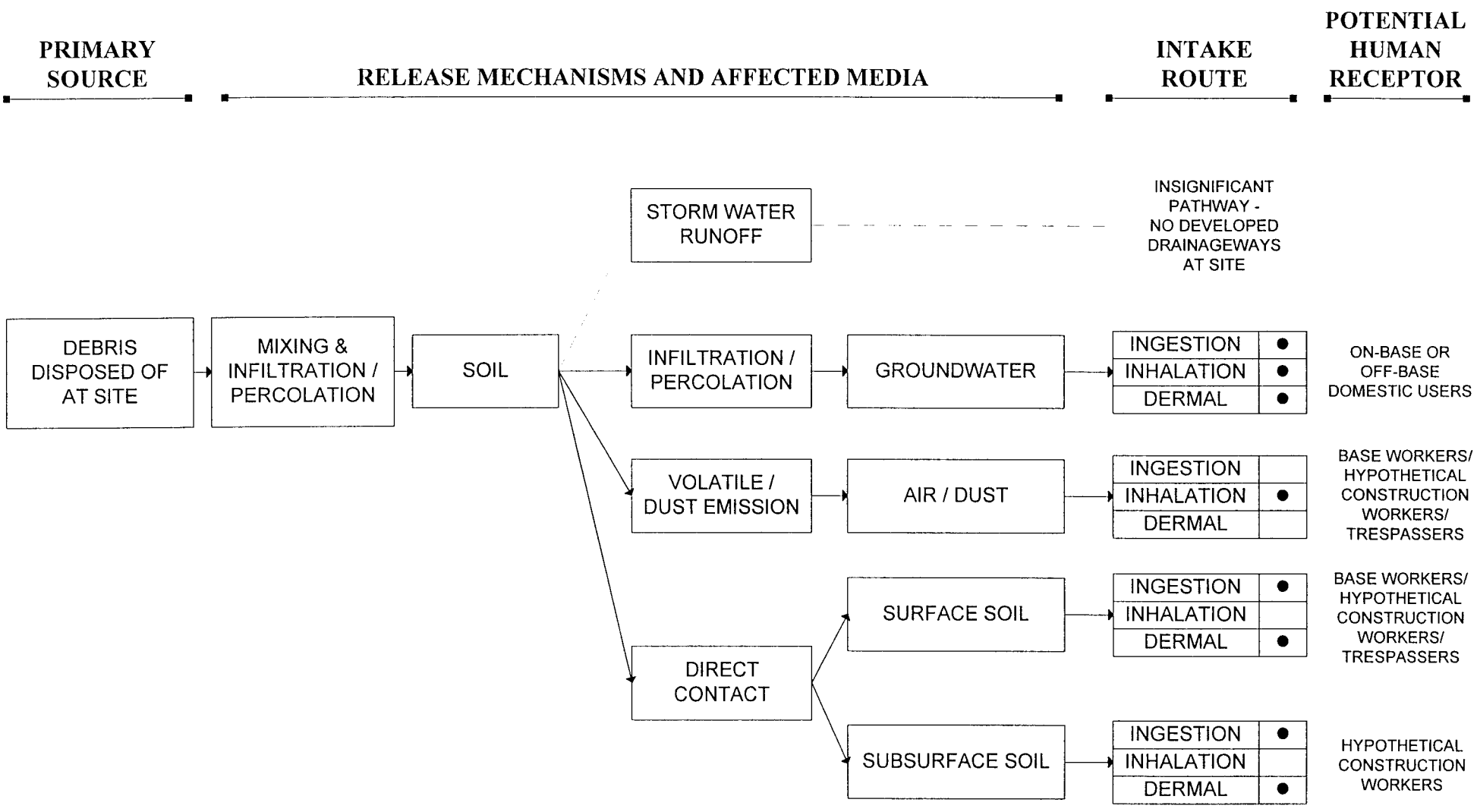
MSCs for Lead in Soil

EPA withdrew the toxicity factor (i.e., the RfD) for lead in 1989, primarily due to the lack of a discernible threshold dose and because of the numerous sources of lead in the environment. However, EPA guidance (EPA 1994) recommends an interim soil lead concentration of 400 mg/kg for residential scenarios at CERCLA and RCRA corrective action sites. This level is supported by EPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model (EPA 1994), which predicts that exposures of children ages 0 to 6 years to soils with approximately these levels will not result in blood lead levels that exceed a level of concern (10 μg/dL) established by the Centers for Disease Control. The interim soil lead concentration is the level above which there is sufficient concern that a site-specific study of risks should be conducted if exposure to children is expected at the site. Based on the residential soil-screening level for lead, Region VI set the industrial soil MSC for lead at 2,000.

FIGURE 3-1

CANNON AFB
DECISION DIAGRAM FOR SITE INSPECTIONS AT AOCs -E, -F, -G, AND -H

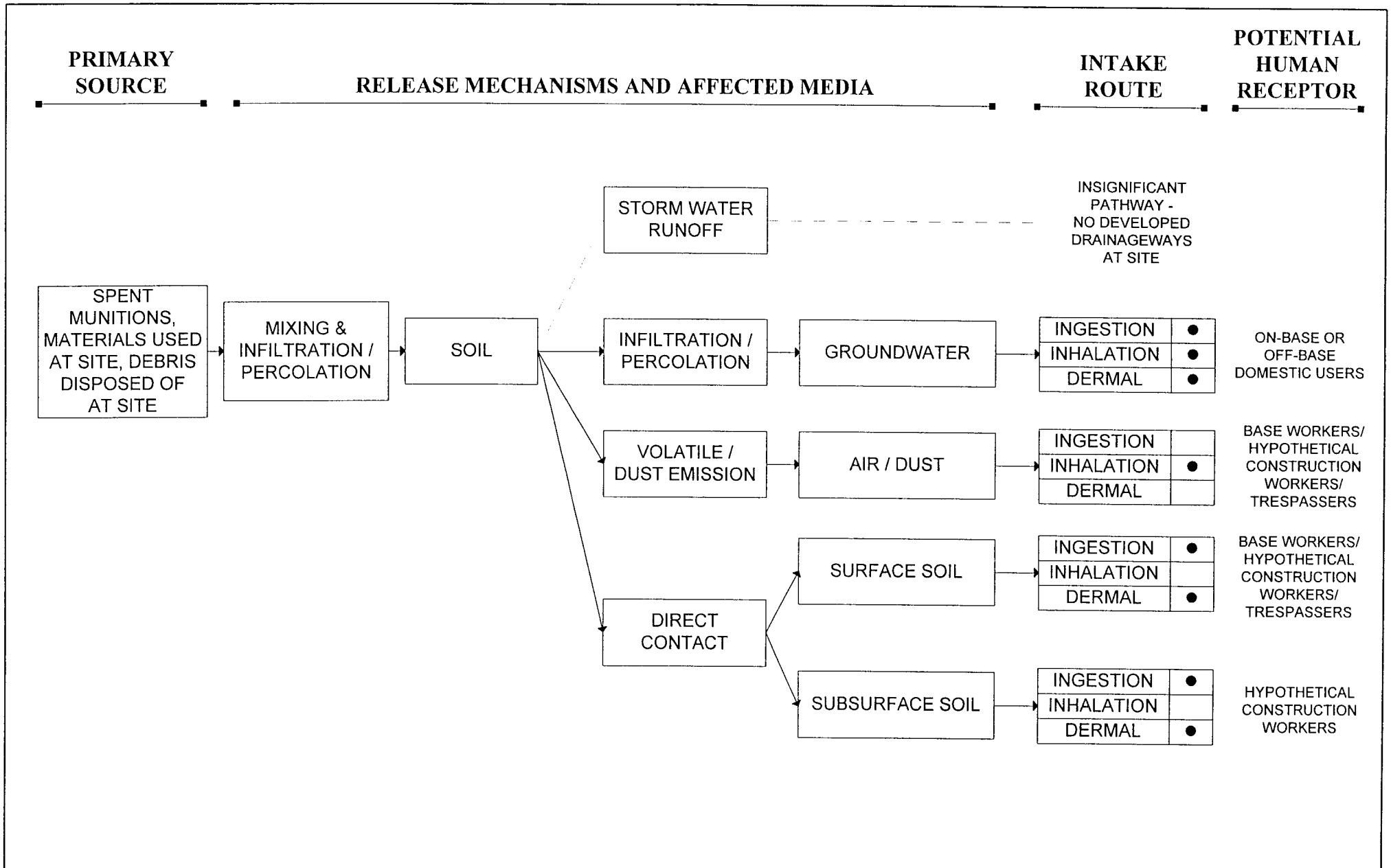




— SOLID LINES REPRESENT POTENTIALLY COMPLETE PATHWAYS.

- - DASHED LINES REPRESENT INCOMPLETE OR INSIGNIFICANT PATHWAYS.

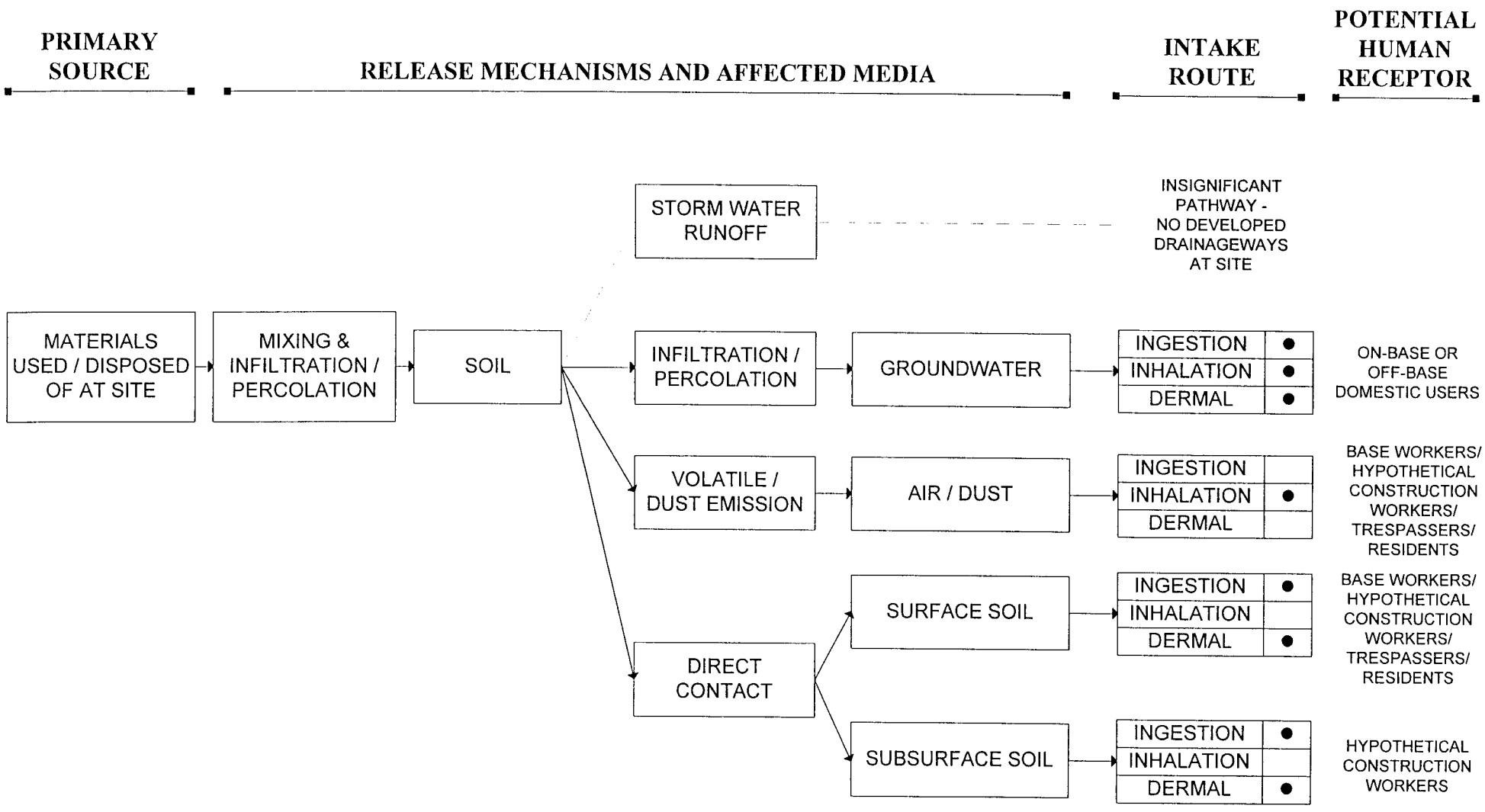
FIGURE NO. 3-2
SITE CONCEPTUAL EXPOSURE MODEL
AOC-E - HUMAN EXPOSURES
CANNON AFB, NEW MEXICO



— SOLID LINES REPRESENT POTENTIALLY COMPLETE PATHWAYS.

- - DASHED LINES REPRESENT INCOMPLETE OR INSIGNIFICANT PATHWAYS.

FIGURE NO. 3-3
SITE CONCEPTUAL EXPOSURE MODEL
AOC-F - HUMAN EXPOSURES
CANNON AFB, NEW MEXICO



— SOLID LINES REPRESENT POTENTIALLY COMPLETE PATHWAYS.

- - DASHED LINES REPRESENT INCOMPLETE OR INSIGNIFICANT PATHWAYS.

FIGURE NO. 3-4
SITE CONCEPTUAL EXPOSURE MODEL
AOC-G - HUMAN EXPOSURES
CANNON AFB, NEW MEXICO

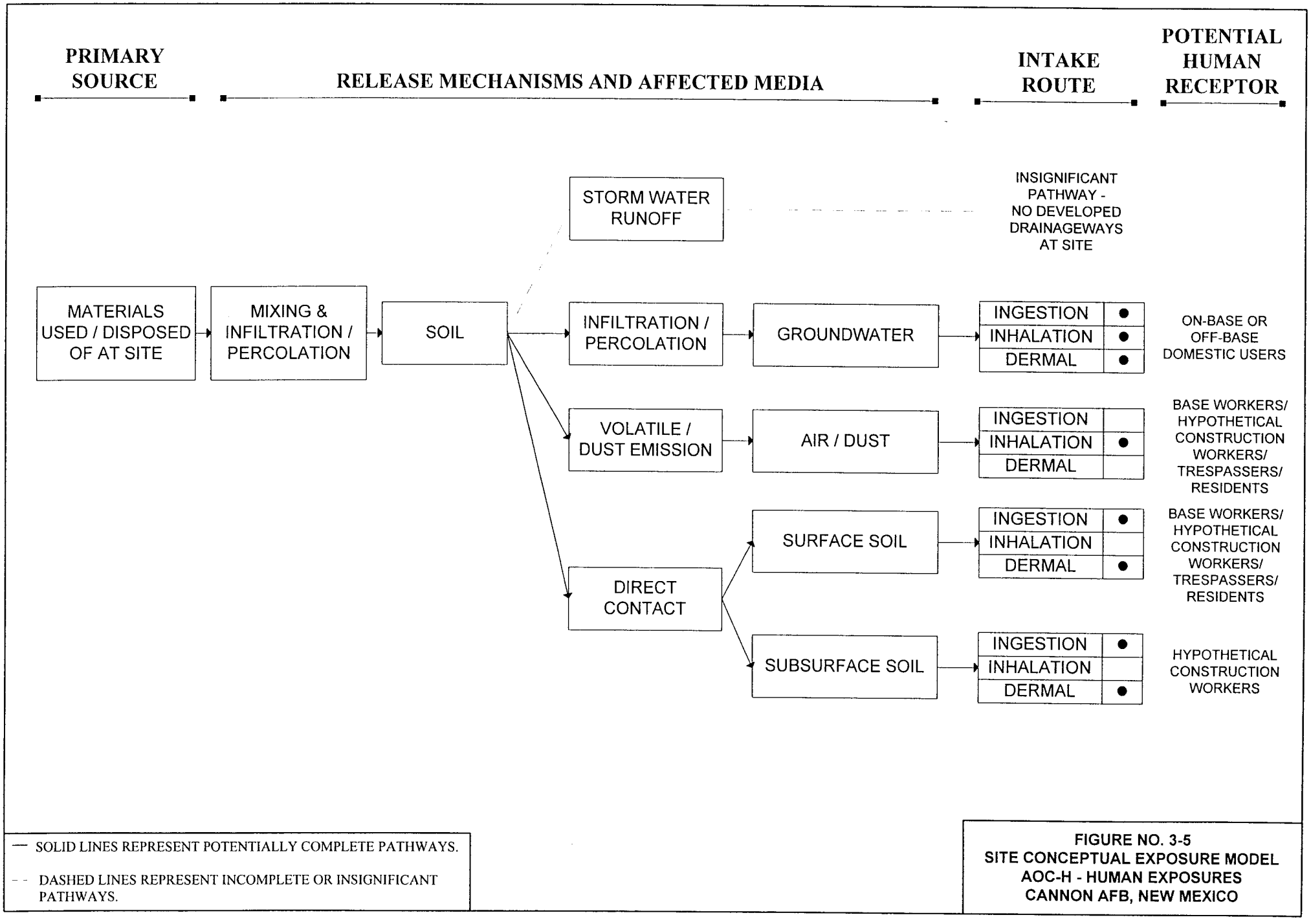


FIGURE NO. 3-5
SITE CONCEPTUAL EXPOSURE MODEL
AOC-H - HUMAN EXPOSURES
CANNON AFB, NEW MEXICO

Q:\M9602\R\WP0F3-5.VSD /dal

1/20/98

The following section provides a description of each of the AOCs being investigated for these SIs at Cannon AFB. The locations of the AOCs are shown on Figure 1-1. This section describes each AOC and briefly discusses potential contaminants which may be present at each site, the existing conditions at each AOC, sampling objectives, and proposed sampling locations and frequencies. Sample designation, sampling equipment and procedures, and sample handling, documentation, and analysis are also presented in this section.

Soil sampling will be done using a truck-mounted drill rig and stainless-steel split-spoon samplers or stainless-steel hand augering equipment, where appropriate, according to the applicable SOPs in Appendix C. Soil boring locations will be finalized on the basis of utility clearances and drilling rig access (and geophysical surveys for AOC-E), and will be agreed upon by Cannon AFB and USACE personnel before drilling commences.

4.1 RUNWAY RUBBLE PILE (AOC-E)

4.1.1 Site Description

AOC-E is located approximately 120 feet east of a former runway that is located east of the current runway (Figure 1-1). The site consists of a rubble pile approximately 1,400 feet long by 200 feet wide by 2 feet high, and trends north-south, parallel to the old runway (Figure 4-1). The debris observed during the site visit consisted primarily of asphalt rubble, with some concrete debris and gravel. The surface of the debris pile was irregular and overgrown with low-growing vegetation (mostly weeds or grasses). Topography at the site was relatively flat with little or no surface drainage. No standing water was observed at the site.

The site was discovered after a 1995 brush fire that exposed the debris pile. A review of aerial photos and personnel interviews indicate the debris was placed at the site some time between 1959 and 1966. This debris is believed to have been stripped from a World War II runway that was demolished. No records were found that indicated any other use for the site.

4.1.2 Sampling Objectives

The overall sampling objectives at the Runway Rubble Pile (AOC-E) are to evaluate the presence or absence of contamination in surface and subsurface soil adjacent to and underneath the rubble pile. This information is required to assess whether any contamination present poses a significant risk to human health or the environment. Media impacted by contamination will be identified and the magnitude of any such impacts will be estimated. Site-specific objectives are to:

- Determine the presence or absence of buried metal anomalies using geophysical survey techniques.
- Identify soil boring locations based on results of geophysical survey.

- Determine the presence or absence (and vertical and lateral extent, if possible) of contamination at the site.
- Evaluate the potential for constituents of concern in soil, if any, to impact groundwater.
- Develop a site characterization that will permit determination of the need for additional investigation and of the scope of work for the next phase of investigation, if needed.

Information gathered for this investigation will be used to develop a conceptual model of the site.

4.1.3 Sampling Locations, Frequencies, and Analysis

The following site-specific activities will be completed to meet the objectives stated in Section 4.1.2. The projected soil sampling breakdown is shown in Table 4.1-1.

4.1.3.1 Geophysical Survey

A Geonics EM-61 geophysical survey will be performed at AOC-E. The survey lines will be spaced 5 feet apart, and data will be recorded at 5-foot intervals. The data will be transferred from the EM-61 recorder to a personal computer. The Geonics EM-61 consists of a portable coincident loop-time domain transmitter and receiver with an additional receiver for depth-to-target estimates and evaluation of near-surface target response (Geonics 1995). The transmitter generates 150 EM pulses per second and measures target response during the off-time between pulses. After each pulse, secondary EM fields are induced briefly in moderately conductive earth and for a longer time in metallic targets. The EM-61 is designed to measure the prolonged buried metal response relatively late in the response period, after the earth response has dissipated. Response from smaller, shallow targets can be readily suppressed using the differential response from the two receiver coils. Six sets of data are recorded for each survey point. These data and the units of measurement are listed below:

- X Coordinate (in feet)
- Y Coordinate (in feet)
- Bottom Coil or Bottom Channel or Channel B (multiVolts [mV])
- Top Coil or Top Channel or Channel T (in mV)
- Normalized Channel or Channel N (in mV)
- Differential Channel or Channel D (in mV)

The bottom channel records the actual response. The top channel has a gain of approximately three and records a somewhat exaggerated response. The normalized channel is a weighted average of the bottom and top channel responses in which the gain on the top channel has been removed. The differential channel is the difference between the bottom and top channel responses. For HTW purposes (detection of all potential source areas regardless of size and

depth), the bottom channel and differential channel will be used primarily for data interpretation, with some consideration given to top and normalized channel data.

Surfer (Win 32) Version 6.02 Surface Mapping System software will be used for regridding and contouring of the data (Golden Software, 1993-96). The grid interval for data will be selected to provide maximum resolution of detected anomalies. Several different color contour intervals will be created and used on selected data sets. The contour interval package that appeared to provide the best data presentation for interpretation will be selected.

The results of the survey will be presented in an analytical report that will include a discussion of methodologies, field techniques, and data interpretation and results. The results will be presented on color contour maps. The report will also include a discussion of recommended soil boring locations and the rationale for selecting these locations.

If no anomalies are identified in the geophysical survey, boring locations will be proposed by Woodward-Clyde and approved by Cannon AFB and USACE personnel, prior to drilling activities at the site.

4.1.3.2 Soil Borings

Eight soil borings will be completed at the site based on the results of the geophysical survey. The borings will be drilled to a depth of 40 feet below the native soil/debris interface. Six analytical samples will be collected from each boring at the following depths below the native soil/debris interface:

- 0 to 2.0 feet
- 3.0 to 5.0 feet
- 8.0 to 10.0 feet
- 18.0 to 20.0 feet
- 28.0 to 30.0 feet
- 38.0 to 40.0 feet

Each sample will be field screened for headspace analysis. Field screening results will be recorded in Column "d" of the boring log. The samples will be submitted for the following chemical analyses:

- VOCs by EPA Method 8260A
- SVOCs by EPA Method 8270
- 23 TAL Metals by EPA Methods 6010 and 7470
- Pesticides/PCBs by EPA Method 8081

4.2 CALIBRATION TARGET AREA (AOC-F)

4.2.1 Site Description

AOC-F is located in the east-central part of Cannon AFB (Figure 1-1). The site is southwest of the current Small Arms Range (Figure 4-2). It consists of an earthen berm that was used as a backstop for the bore sighting of aircraft in the 1950s and 1960s.

The berm is irregularly shaped and consists of fill material comprised mainly of sandy soil with numerous rock fragments. The mound is approximately 15 feet high and sparsely vegetated. Topography at the site is relatively flat, with the exception of the berm, and surface drainage is poorly developed. The area surrounding the berm is mostly covered with low growing vegetation. What appears to have been a target support of some kind is located approximately 150 feet north of the berm. This structure appears to have been built primarily with telephone poles, iron bars, and concrete. The telephone poles have large projectiles imbedded in them. This entire structure lies directly between the concrete pad where aircraft were positioned for bore sighting and the berm. Cannon AFB personnel questioned about this feature were unaware of its existence.

The east side of the berm appears to have been used for borrow material. Several foxholes were dug into the sides and top of the berm as part of military exercises. Small amounts of various types of debris were observed in berm soils, including the following:

- Creosote-treated telephone poles and ties
- Thin phone lines
- Small arms rifle shell casings
- Metal piping
- Projectiles from the bore sighting operations
- Several partially buried, empty, 30- to 40-gallon drums

The debris observed at the time of the site visit represented an estimated 1% to 2% of the berm.

4.2.2 Sampling Objectives

The overall sampling objectives at the Calibration Target Berm (AOC-F) are to evaluate the presence or absence of contamination in surface and subsurface soil within and around the berm. This information is required to assess whether any contamination present poses a significant risk to human health or the environment. Media impacted by contamination will be identified and the magnitude of any such impacts will be estimated. Site-specific objectives are to:

- Determine the presence or absence (and vertical and lateral extent, if possible) of contamination at the site.

- Evaluate the potential for constituents of concern in soil, if any, to impact groundwater.
- Develop a site characterization that will permit determination of the need for additional investigation and of the scope of work for the next phase of investigation, if needed.
- Calculate the volume of soil excavation and cost of disposal for remediation of the site, if necessary.

Information gathered for this investigation will be used to develop a conceptual model of the site.

4.2.3 Sampling Locations, Frequencies, and Analysis

The following site-specific activities will be completed to meet the objectives stated in Section 4.2.2. The projected soil sampling breakdown is shown in Table 4.2-1.

4.2.3.1 Hand Auger Borings

Nine hand-auger borings will be completed on the north side of the berm (Figure 4-3), which is the side of the berm facing the hardstand from which the munitions were fired. Three soil samples will be collected from each boring, and will be collected from the following intervals: from the berm surface (0 to 0.5-foot below the berm surface), and from the 1.5- to 2.0-foot and the 3.5- to 4.0-foot intervals below the berm surface.

Soil collected for sampling will be passed through an aluminum screen to separate projectile fragments and rocks from the loose soil. Soil will be passed through the screen and onto a piece of poly sheeting. The soil will be visually inspected for any remaining pieces of metal. All visible pieces of metal will be discarded and the soil will be composited on the poly sheeting. After compositing, the soil will be placed in the appropriate sample jars. The screen will be washed between samples, and the poly sheeting will be discarded between samples.

The samples will be analyzed for the following:

- Total lead, antimony, and arsenic by Method 6010 (Trace ICP)

4.2.3.2 Surface Soil Sampling

In addition to the hand auger borings, nine surface soil samples will be collected around the target support, between the target support and the berm, and on all sides of the berm (Figure 4-3).

The samples will be submitted for the following chemical analyses:

- Total lead, antimony, and arsenic by Method 6010 (Trace ICP)

4.3 DISTURBED AREA (AOC-G)

4.3.1 Site Description

AOC-G is located in the northwest corner of the Base housing area, in the northwest corner of the Base (Figure 1-1). A disturbed area was identified in aerial photos from 1959. The site appears to have been inactive by 1966. The disturbed area was approximately 735 feet long by 320 feet wide and was oriented east-west lengthwise. The reason for the disturbance is unknown. At least five housing units are located within the area of disturbance. The portions of the disturbed area not covered by the housing units are either grass-covered lawn or paved as streets or driveways.

4.3.2 Sampling Objectives

The overall sampling objectives at the Disturbed Area (AOC-G) are to evaluate the presence or absence of contamination in surface and subsurface soil within the disturbed area identified in aerial photos. This information is required to assess whether any contamination present poses a significant risk to human health or the environment. Media impacted by contamination will be identified and the magnitude of any such impacts will be estimated. Site-specific objectives are to:

- Determine the presence or absence (and vertical and lateral extent, if possible) of contamination at the site.
- Evaluate the potential for constituents of concern in soil, if any, to impact groundwater.
- Develop a site characterization that will permit determination of the need for additional investigation and of the scope of work for the next phase of investigation, if needed.

Information gathered for this investigation will be used to develop a conceptual model of the site.

4.3.3 Sampling Locations, Frequencies, and Analysis

The following site-specific activities will be completed to meet the objectives stated in Section 4.3.2. The projected soil sampling breakdown is shown in Table 4.3-1.

4.3.3.1 Soil Borings

Eight soil borings will be completed at the site. The borings will be located as shown in Figure 4-5.

The boring locations were selected to cover as much of the disturbed area as possible. A uniform grid pattern was not possible due to buildings and utilities. No surface or other features identified in aerial photos or the site visit indicated specific borehole location.

The borings will be drilled to a depth of 40 feet below the native soil/debris interface. Six analytical samples will be collected from each boring at the following depths below the native soil/debris interface:

- 0 to 2.0 feet
- 3.0 to 5.0 feet
- 8.0 to 10.0 feet
- 18.0 to 20.0 feet
- 28.0 to 30.0 feet
- 38.0 to 40.0 feet

Each sample will be field screened for headspace analysis. Field screening results will be recorded in Column "d" of the boring log. The samples will be submitted for the following chemical analyses:

- VOCs by EPA Method 8260A
- SVOCs by EPA Method 8270
- TAL Metals by EPA Methods 6010 and 7470
- Pesticides/PCBs by EPA Method 8081
- TPH by EPA Method 8015
- Herbicides by EPA Method 8151

4.4 DISTURBED AREA (AOC-H)

4.4.1 Site Description

AOC-H is located in the northwest corner of the Base housing area, in the northwest corner of the Base (Figure 1-1). The site is located along the western boundary of the Base. A disturbed area was identified in aerial photos from 1951 as a "blow out," which is a naturally occurring low-lying feature common to this region. This feature appears as a disturbed area in aerial photos from 1954. The disturbed area was irregularly shaped, several hundred feet long, and 350 feet across. The reason for the disturbance is unknown.

Topography at the site is relatively flat. At least five housing units are located within the former disturbed area. The portions of the disturbed area not covered by the housing units are either grass-covered lawn or paved as streets or driveways. Some trees are located within the area of the former disturbance.

4.4.2 Sampling Objectives

The overall sampling objectives at the Disturbed Area (AOC-H) are to evaluate the presence or absence of contamination in surface and subsurface soil within the disturbed area identified in aerial photos. This information is required to assess whether any contamination present poses a significant risk to human health or the environment. Media impacted by contamination will be identified and the magnitude of any such impacts will be estimated. Site-specific objectives are to:

- Determine the presence or absence (and vertical and lateral extent, if possible) of contamination at the site.
- Evaluate the potential for constituents of concern in soil, if any, to impact groundwater.
- Develop a site characterization that will permit determination of the need for additional investigation and of the scope of work for the next phase of investigation, if needed.

Information gathered for this investigation will be used to develop a conceptual model of the site.

4.4.3 Sampling Locations, Frequencies, and Analysis

The following site-specific activities will be completed to meet the objectives stated in Section 4.4.2. The projected soil sampling breakdown is shown in Table 4.4-1.

4.4.3.1 Soil Borings

Six soil borings will be completed at the site. The borings will be located as shown in Figure 4-6.

The boring locations were selected to cover as much of the disturbed area as possible. A uniform grid pattern was not possible due to the irregular shape of the area and the presence of housing units. No surface or other features identified in aerial photos or the site visit indicated specific borehole locations.

The borings will be drilled to a depth of 40 feet below the native soil/debris interface. Six analytical samples will be collected from each boring at the following depths below the native soil/debris interface:

- 0 to 2.0 feet
- 3.0 to 5.0 feet
- 8.0 to 10.0 feet
- 18.0 to 20.0 feet
- 28.0 to 30.0 feet
- 38.0 to 40.0 feet

Each sample will be field screened for headspace analysis. Field screening results will be recorded in Column "d" of the boring log. The samples will be submitted for the following chemical analyses:

- VOCs by EPA Method 8260A
- SVOCs by EPA Method 8270
- TAL Metals by EPA Methods 6010 and 7470
- Pesticides/PCBs by EPA Method 8081
- TPH by EPA Method 8015
- Herbicides by EPA Method 8151

4.5 BACKGROUND PESTICIDE CONCENTRATIONS IN OLD HOUSING AREA

Eight shallow soil samples will be collected adjacent to eight housing units and analyzed for pesticides. The housing units selected for sampling are located within an older housing area since it potentially has been impacted by use of pesticides for a longer period (Figure 4-4). The actual sampling locations may be changed due to field conditions or input by Cannon AFB personnel. Residents of the housing unit will be notified of the proposed sampling in advance by Cannon AFB personnel.

The borings will be completed near housing foundations and will be advanced 4 feet below ground surface. Samples will be collected using a stainless-steel hand auger and will be analyzed for pesticides.

The eight hand-auger samples to be collected from the housing units and analyzed for pesticides will be used to calculate background concentrations for pesticides in the old housing area. Pesticide data from AOCs-G and AOC-H will be compared to the calculated background concentrations. Pesticides that do not exceed background levels will not be considered to be site related, and will not be evaluated further.

4.6 SAMPLE DESIGNATION

The sample designation for field (analytical) and quality assurance/quality control (QA/QC) samples is a three letter and seven-digit/letter unique identification for each sample (CAX-YYYY-ZZZ). CAX is the facility and site identifier, with C for Cannon AFB, A for area-of-concern, and X representing the letter identifying a specific AOC. For example, the sample designation for AOC-E would start as CAE-.

The next four digits (YYYY) identify the sampling method and specific sampled location. The first two characters will represent the method of sampling. The following codes will be used for the first two characters:

- HA - hand auger boring
- SB - soil boring
- SS - surface soil

The last two characters will identify the sample location. Samples from the second soil boring at AOC-E would be identified as CAE-SB02- .

The last set of characters (ZZZ) are the sample identifier. The first number corresponds to the type of sample:

- 0 for soil (analytical)

- 1 for soil MS/MSD
- 2 for field duplicate
- 3 for Missouri River Lab duplicate

Missouri River Lab duplicate samples should be labeled exactly as the sample of which it is a duplicate. The MS/MSD should also be labeled the same as the original sample, but should also have "MS/MSD Extra" written on the label.

The last two numbers correspond to the beginning depth of the sample in feet below ground surface (bgs) for all soil samples. The following is an example of an identification number:

Soil boring no.1 Approximate depth of top of sample in feet-bgs

CAE - SB01 - 018

Cannon AFB Area-of-Concern E Soil analytical sample

Multiple soil samples could be collected from the same boring. The last two digits differentiate among these multiple samples and represent the approximate beginning depth at which the sample was collected.

4.7 SAMPLING EQUIPMENT AND PROCEDURES

The anticipated sampling equipment and procedures that will be used to collect samples are described in the Standard Operating Procedures (SOPs) contained in Appendix C of this document. These SOPs are consistent with procedures identified and described by the EPA (EPA 1987).

Before each sampling event, the Field Manager will meet with the assigned sampling personnel and review the purpose and objectives of the event. This meeting will provide clarification of the sampling event specifics. Topics of discussion and review will include:

- Sampling locations, equipment, and requirements
- Number and type of samples
- Sample identification
- Preservation requirements
- Analytical parameters
- Equipment decontamination procedures
- Chain-of-custody requirements

The procedures for collecting soil samples will be selected, as appropriate, from the SOPs. The Field Manager will be responsible for ensuring that samples are collected with properly

decontaminated equipment and containerized as required by the site-specific sampling procedures.

Decontamination procedures shall be performed in a manner consistent with the most recent EPA guidelines, but as a minimum shall consist of steam cleaning and/or Liquinox, or equivalent wash, followed by a tap water rinse and a double deionized water rinse. Specific decontamination procedures are described in SOP No. 1 in Appendix C.

The projected sampling breakdown summaries for the site are presented in Tables 4.1-1 through 4.4-1. The sample containers, preservation requirements, and holding times for soil are summarized in Table 4-2.

4.8 SAMPLE HANDLING, DOCUMENTATION, AND ANALYSIS

The labeling, preservation, handling, shipping, documentation, and tracking procedures for all samples collected at Cannon AFB are described in SOP No. 12, Sample Handling, Documentation, and Tracking.

All sample labels should be filled out with waterproof ink and numbered. Soil sample labels will be supplied by Woodward-Clyde. Sample containers will be placed in plastic storage bags (double bagged in zipper-lock bags) and wrapped in protective packing material (i.e., foam liners, bubble packing, styrofoam peanuts). Samples will then be placed in a cooler with ice (double bagged using 1-gallon zipper-lock bags) for overnight express carrier shipment to the laboratory. A completed and signed Chain-of-Custody will be placed in each cooler being shipped.

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded in a permanently bound weatherproof field book with consecutively numbered pages.

To supplement the information in the field book, A-E daily quality control reports (DQCRs) will also be completed, forwarded to the USACE TM, and maintained in W-C records for every sample location.

Analyses to be done will be specified on the Chain-of-Custody.

TABLE 4.1-1

PROJECT SOIL SAMPLING BREAKDOWN
RUNWAY RUBBLE PILE (AOC-E)

Method	Parameter	QUALITY CONTROL [2]					Total No. of W-C Samples[1]	QUALITY ASSURANCE [3]		
		No. of Field Samples [2]	No. of Field Duplicates	No. of Trip Blanks	No. of Field Blanks	No. of MS/MSD[1] Samples		No. of Field Splits	No. of Trip Blanks	Total No. of QA Samples
8260A	Volatile Organics	48	4	0	0	2	52	4	0	4
8270	Semivolatile Organics	48	4	0	0	2	52	4	0	4
6010/7470[4]	TAL Metals[4]	48	4	0	0	2	52	4	0	4
8081	Pesticides/PCBs	48	4	0	0	2	52	4	0	4

[1] Two extra 4-oz. VOA jars and two extra 8-oz. jars of soil will be provided from two samples at this AOC for MS/MSD testing by the laboratory. These samples shall be labeled the same as the soil sample they came from and include "MS/MSD - EXTRA".

[2] Samples sent to Quanterra, Inc.

[3] Samples sent to USACE CMQAL

[4] Mercury will be analyzed following USEPA Methods 7470/7471

TABLE 4-2

SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOIL SAMPLES

Method	Parameter	No. of Containers / Sample	Minimum Sample Size	Preservation	Holding Time
8260A	Volatile Organics	2 - 4-oz. glass VOA jars with Teflon-lined septa	10 g	4°C	14 days
8270	Semivolatile Organics	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	30 g	4°C	Extract - 14 days Analyze - 40 days
8015	Petroleum Hydrocarbons[3]	2 - 4-oz. glass VOA jars with Teflon-lined septa [1]	30 g	4°C	28 days
6010/7470[2]	TAL Metals	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	200 g	4°C	6 months 28 days Hg
8081	Pesticides/PCBs	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	100 g	4°C	Extract - 14 days Analyze - 40 days
8051	Herbicides	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	100 g	4°C	Extract - 14 days Analyze - 40 days

[1] 2 - 8-oz. jars are sufficient for Methods 8270, 8081, and 8151, and metals.

[2] Mercury will be analyzed following USEPA Methods 7470/7471

[3] Gasoline range organics (GRO) and diesel range organics (DRO) will be analyzed and reported.

Note: Sample containers will be double-bagged in zipper-lock bags. The bagged packing ice will be placed in double-bagged, 1-gallon, zipper-lock bags.

TABLE 4.2-1

PROJECT SOIL SAMPLING BREAKDOWN
CALIBRATION TARGET BERM (AOC-F)

Method	Parameter	QUALITY CONTROL [2]					Total No. of W-C Samples[1]	QUALITY ASSURANCE [3]		
		No. of Field Samples [2]	No. of Field Duplicates	No. of Trip Blanks	No. of Field Blanks	No. of MS/MSD[1] Samples		No. of Field Splits	No. of Trip Blanks	Total No. of QA Samples
6010 Trace ICP	Total Lead	36	3	0	0	1	39	3	0	3
6010 Trace ICP	Antimony	36	3	0	0	1	39	3	0	3
6010 Trace ICP	Arsenic	36	3	0	0	1	39	3	0	3

[1] Two extra 4-oz. VOA jars and two extra 8-oz. jars of soil will be provided from two samples at this AOC for MS/MSD testing by the laboratory. These samples shall be labeled the same as the soil sample they came from and include "MS/MSD - EXTRA".

[2] Samples sent to Quanterra, Inc.

[3] Samples sent to USACE CMQAL

TABLE 4.3-1

PROJECT SOIL SAMPLING BREAKDOWN
DISTURBED AREA (AOC-G)

Method	Parameter	QUALITY CONTROL [2]					Total No. of W-C Samples[1]	QUALITY ASSURANCE [3]		
		No. of Field Samples [2]	No. of Field Duplicates	No. of Trip Blanks	No. of Field Blanks	No. of MS/MSD[1] Samples		No. of Field Splits	No. of Trip Blanks	Total No. of QA Samples
8260A	Volatile Organics	48	4	0	0	2	52	4	0	4
8270	Semivolatile Organics	48	4	0	0	2	52	4	0	4
6010/7470[4]	TAL Metals	48	4	0	0	2	52	4	0	4
8081	Pesticides/PCBs	48	4	0	0	2	52	4	0	4
8015	Total Petroleum Hydrocarbons[5]	48	4	0	0	2	52	4	0	4
8151	Herbicides	48	4	0	0	2	52	4	0	4

[1] Two extra 4-oz. VOA jars and two extra 8-oz. jars of soil will be provided from two samples at this AOC for MS/MSD testing by the laboratory. These samples shall be labeled the same as the soil sample they came from and include "MS/MSD - EXTRA".

[2] Samples sent to Quanterra, Inc.

[3] Samples sent to USACE CMQAL

[4] Mercury will be analyzed following USEPA Methods 7470/7471

[5] Gasoline range organics (GRO) and diesel range organics (DRO) will be analyzed and reported.

TABLE 4.4-1

PROJECT SOIL SAMPLING BREAKDOWN
DISTURBED AREA (AOC-H)

Method	Parameter	QUALITY CONTROL [2]					Total No. of W-C Samples[1]	QUALITY ASSURANCE [3]		
		No. of Field Samples [2]	No. of Field Duplicates	No. of Trip Blanks	No. of Field Blanks	No. of MS/MSD[1] Samples		No. of Field Splits	No. of Trip Blanks	Total No. of QA Samples
8260A	Volatile Organics	36	3	0	0	2	39	3	0	3
8270	Semivolatile Organics	36	3	0	0	2	39	3	0	3
6010/7470[4]	TAL Metals	36	3	0	0	2	39	3	0	3
8081	Pesticides/PCBs	36	3	0	0	2	39	3	0	3
8015	Total Petroleum Hydrocarbons[5]	36	3	0	0	2	39	3	0	3
8151	Herbicides	36	3	0	0	2	39	3	0	3

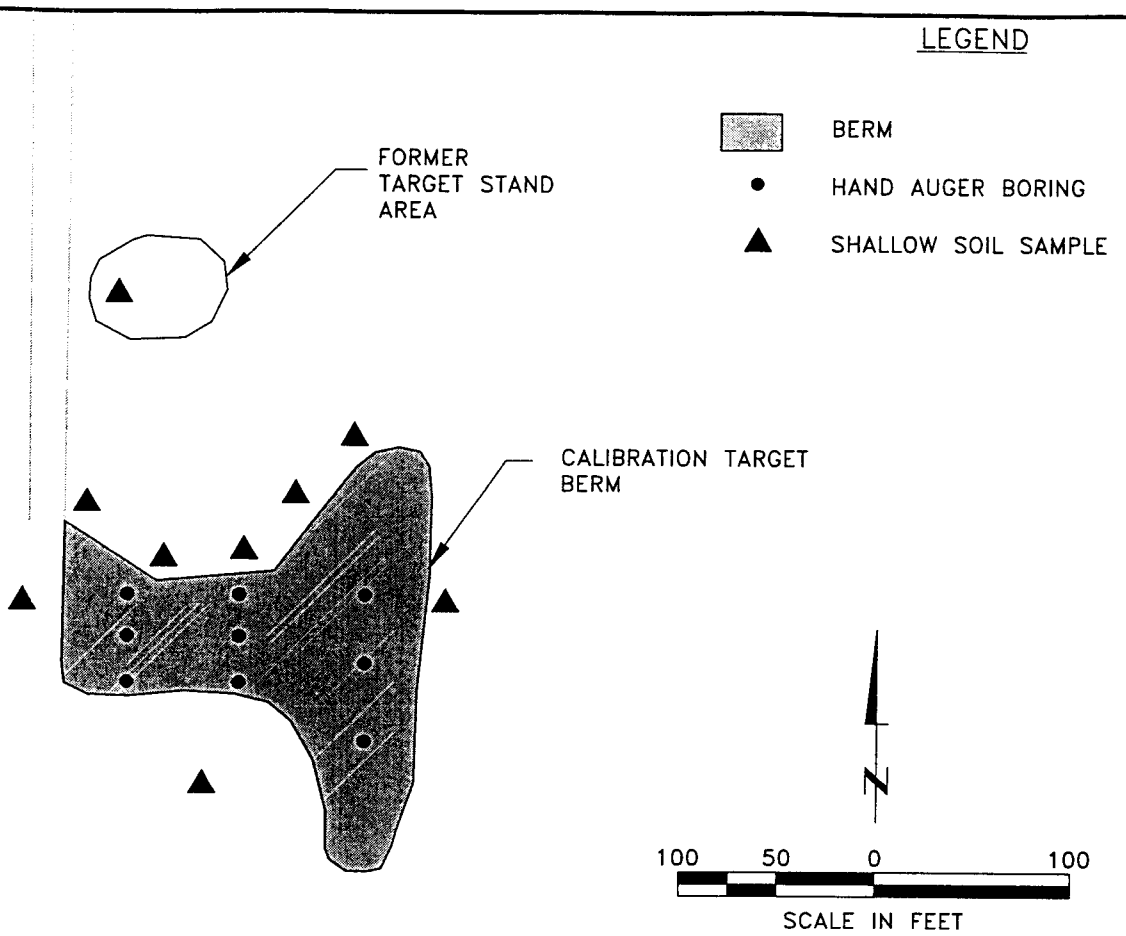
[1] Two extra 4-oz. VOA jars and two extra 8-oz. jars of soil will be provided from two samples at this AOC for MS/MSD testing by the laboratory. These samples shall be labeled the same as the soil sample they came from and include "MS/MSD - EXTRA".

[2] Samples sent to Quanterra, Inc.

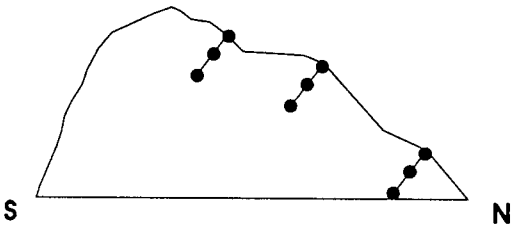
[3] Samples sent to USACE CMQAL

[4] Mercury will be analyzed following USEPA Methods 7470/7471

[5] Gasoline range organics (GRO) and diesel range organics (DRO) will be analyzed and reported.



PLAN VIEW



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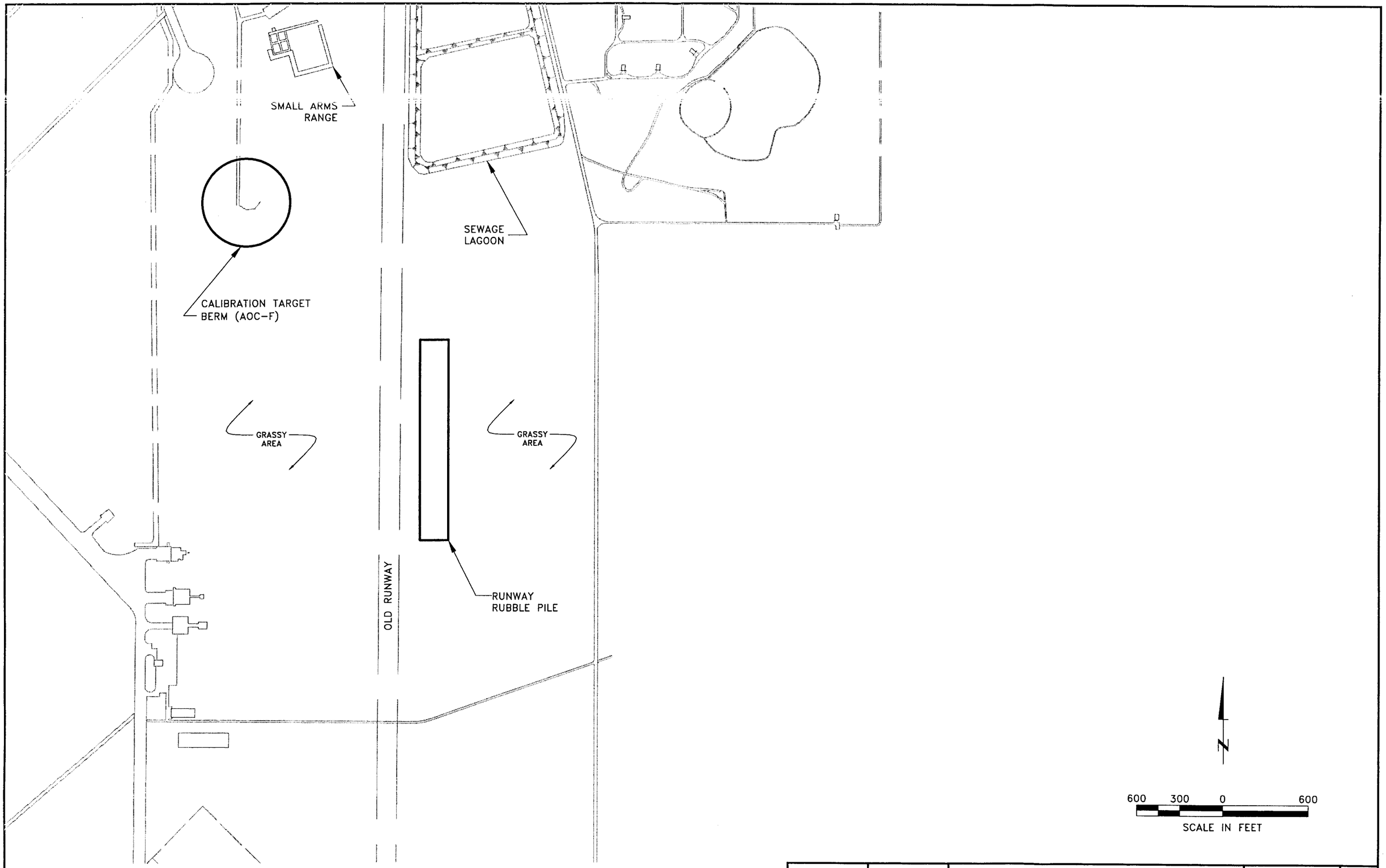
Xrefs: CAN-BASE.DWG

DRN. BY: BAG	DATE: 01/20/98	SAMPLE LOCATION PLAN AOC-F CANNON AIR FORCE BASE NEW MEXICO	PROJECT NO.	FIG. NO.
CHK'D. BY:	REVISION: 0		M9602R	4-3



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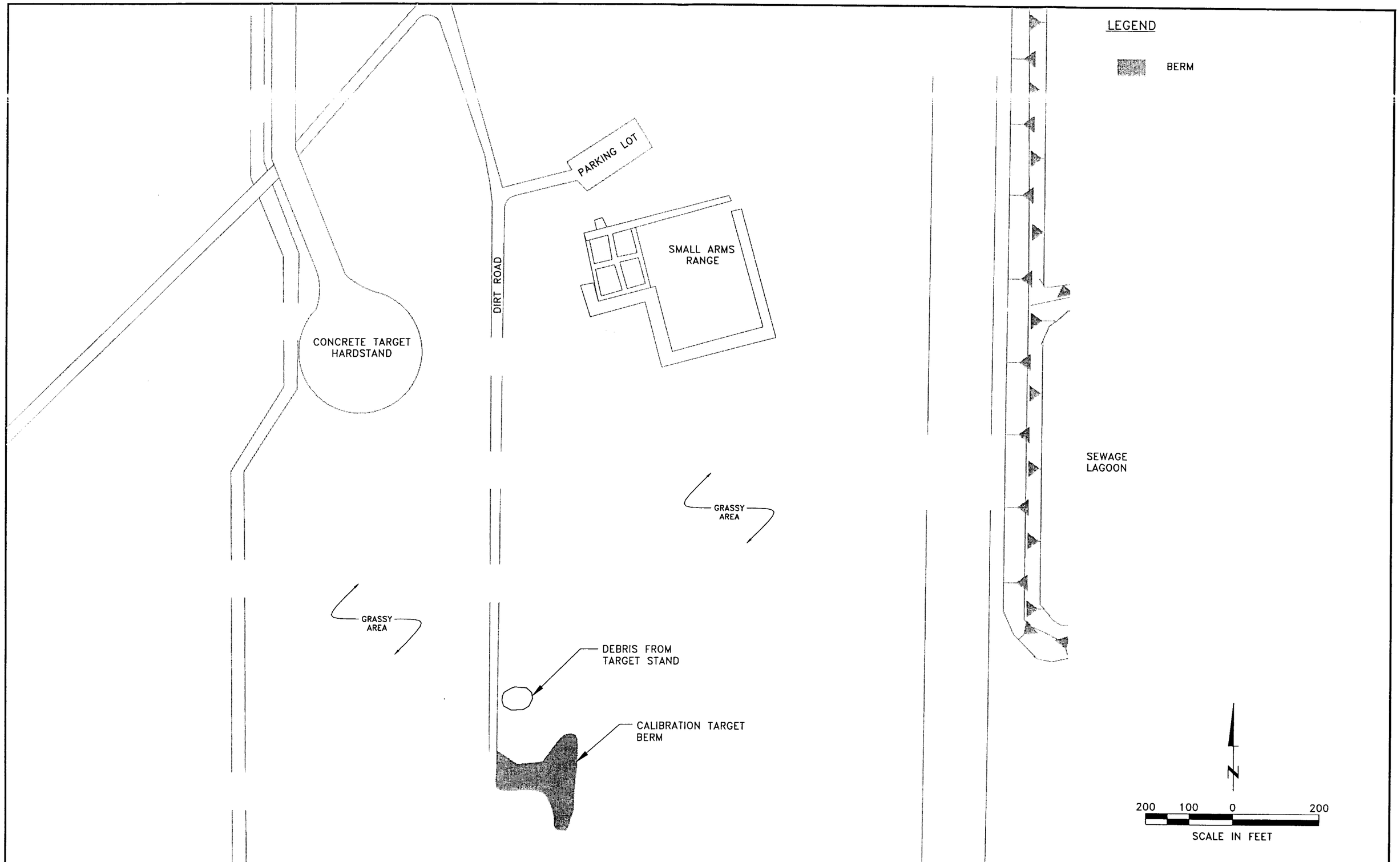
Xrefs: CAN-BASE.DWG

DRN. BY: BAG	DATE: 01/20/98	SITE PLAN AND LOCATION OF AOC-E CANNON AIR FORCE BASE NEW MEXICO	PROJECT NO.	FIG. NO.
CHK'D. BY:	REVISION: 0		M9602R	4-1



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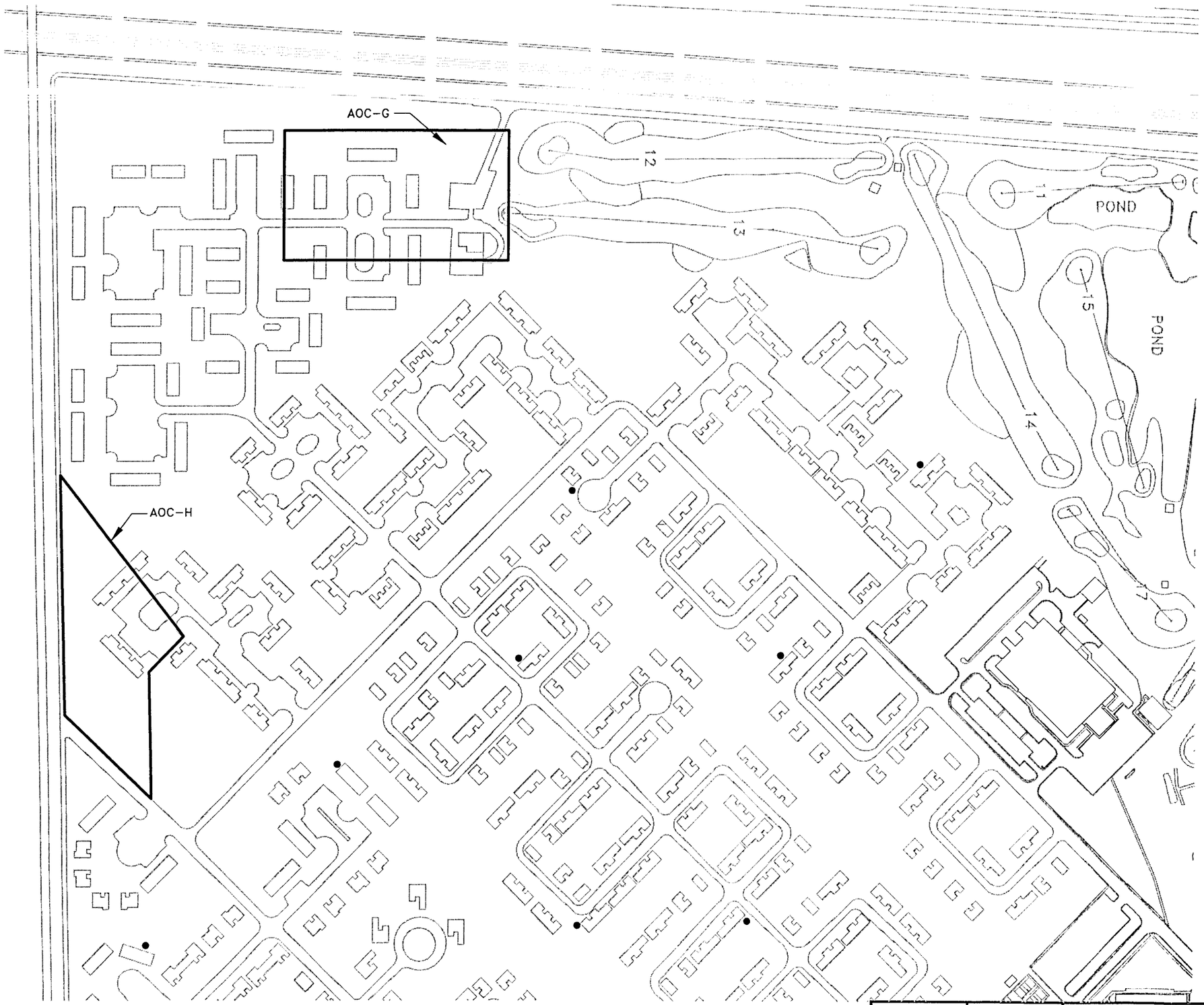
CHK'D. BY:	REVISION: 0		FIG. NO. 4-2



LEGEND

● HAND AUGER SAMPLING LOCATIONS FOR BACKGROUND PESTICIDE CONCENTRATIONS

N

300 150 0 300

SCALE IN FEET

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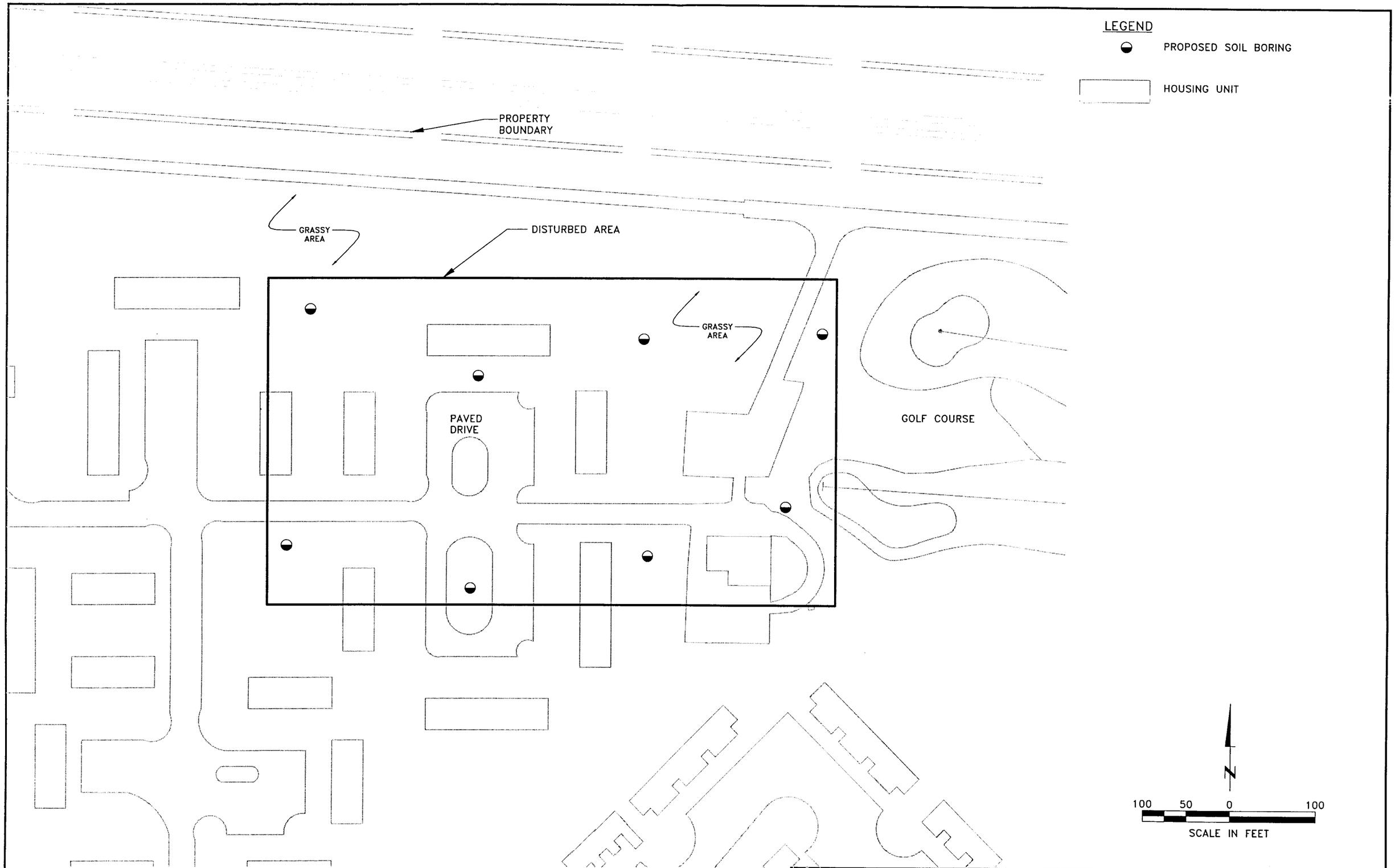
CHK'D. BY:	REVISION: 0		FIG. NO. 4-4



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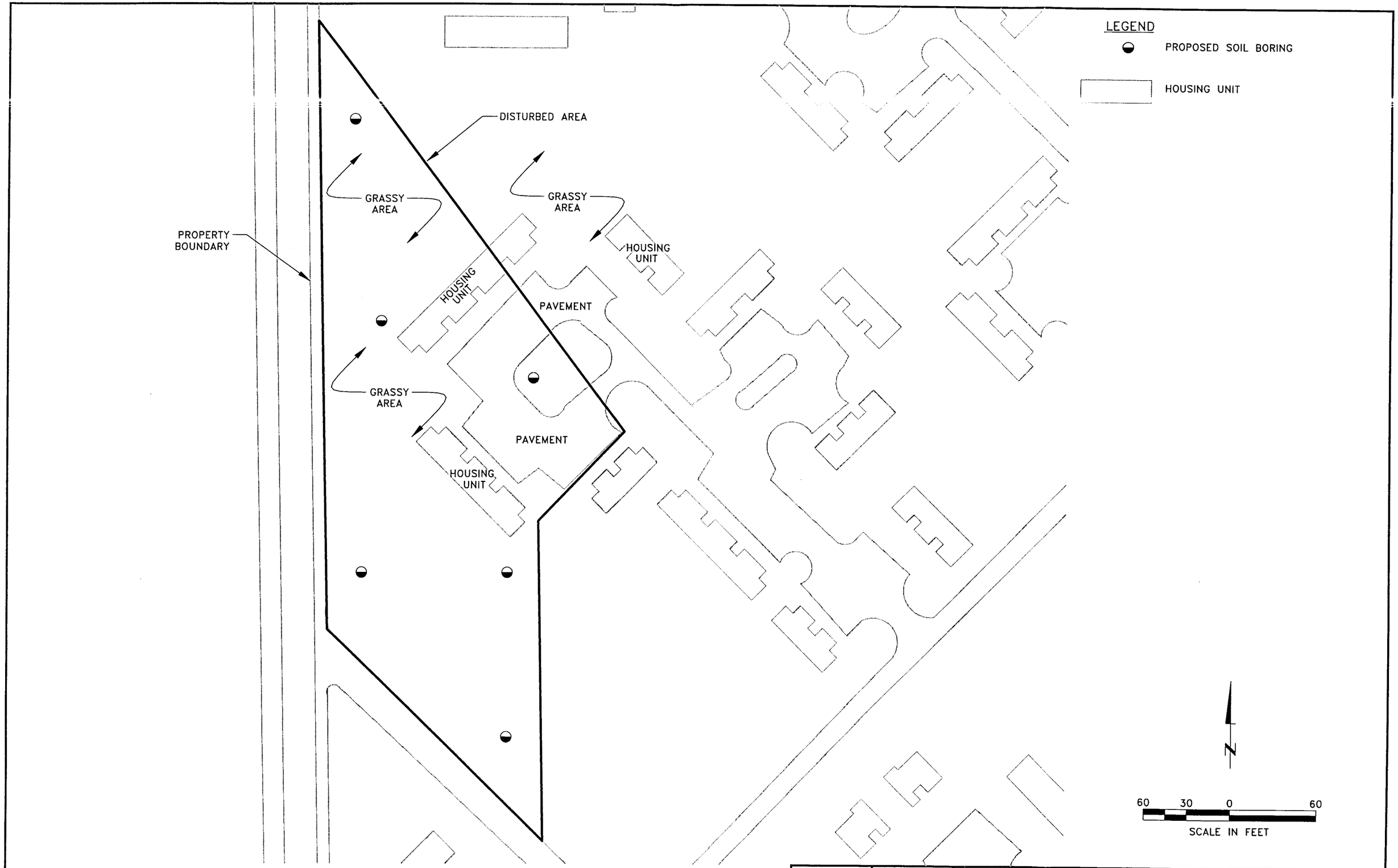

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CHK'D. BY:	REVISION: 0			

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QUALITY ASSURANCE PROJECT PLAN ADDENDUM

CERCLA SITE INSPECTIONS AT 4 AREAS OF CONCERN (AOCS) - AOCS -E, -F, -G, AND -H CANNON AFB, NEW MEXICO

Prepared for
U.S. Department of the Army
Corps of Engineers, Omaha District
Omaha, Nebraska

January 1998

Woodward-Clyde

101 South 108th Avenue
Omaha, Nebraska 68154
M9602R

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1.1 PURPOSE AND SCOPE

This Quality Assurance Project Plan (QAPP) Addendum is designed to provide specific guidance and quality assurance/quality control (QA/QC) requirements for the generation of environmental data of known quality and will only address changes to the QAPP (W-C 1991) which are applicable to the current data collecting effort. This data will be used in making decision for the Site Inspection (SI) for areas of concern (AOC) E, F, G, and H at Cannon Air Force Base (AFB), New Mexico.

This document provides discussion of project objectives, procedures, and specific measurements to be performed and evaluated in the assessment of data generated for the Cannon AFB SI. Specific Standard Operating Procedures (SOPs) are also provided as a means of maintaining consistency with respect to procedures commonly used in conjunction with data collection. SOPs are located in Appendix C of the Cannon AFB SI Work Plan Addendum.

This QAPP Addendum has been prepared by Woodward-Clyde (W-C) under Indefinite Delivery Contract Number DACA45-96-D-0017 (Delivery Order 0016) with USACE, Omaha District. The Work Plan documents were prepared in accordance with Interim Final Guidance for Performing Site Inspections under CERCLA, USEPA OSWER Directive 9345.1-05, September 1992; Guidance for Performing Site Inspections under CERCLA, EPA/540-R-92-021, September 1992; applicable elements of the USACE Engineering Regulation ER 1110-1-263, Engineering and Design Chemical Quality Management for Hazardous Waste Remedial Activities (USACE April 1996), and other applicable regulations and guidances. This QAPP Addendum is written to include the SI activities associated with this investigation of AOCs E, F, G, and H.

1.2 WORK PLAN INTEGRATION

This QAPP Addendum is an integral part of the Work Plan Addendum prepared for implementation of SI activities to be completed at Cannon AFB. The QAPP Addendum and HSP Addendum are Appendices to the WP Addendum. The WP Addendum (for the respective AOCs) details the objectives and planned activities for the Cannon SI. It also presents the schedule, specifics concerning staffing, and other management activities.

This QAPP Addendum, in conjunction with the original Cannon AFB QAPP (W-C 1991) addresses the Quality Control (QC) and Quality Assurance (QA) for the Cannon AFB SI. The following identifies how this QAPP Addendum should be used in conjunction with the original QAPP (W-C 1991).

1.3 QAPP ADDENDUM ORGANIZATION

Section 1.0	Introduction - Addendum
Section 2.0	Project Description - Addendum

Section 3.0	Project Organization and Responsibility - See Original QAPP
Section 4.0	Quality Assurance Objectives - Addendum
Section 5.0	Sampling and Field Procedures - See Original QAPP
Section 6.0	Sample and Document Custody - See Original QAPP
Section 7.0	Calibration Procedures and Frequency - See Original QAPP
Section 8.0	Analytical Procedures - Addendum
Section 9.0	Analytical Data Reduction, Reporting, and Review Process - See Original QAPP
Section 10.0	Internal Quality Control Checks - See Original QAPP
Section 11.0	Performance and System Audits - See Original QAPP
Section 12.0	Preventative Maintenance - See Original QAPP
Section 13.0	Data Measurement Assessment Procedures - See Original QAPP
Section 14.0	Corrective Action - See Original QAPP
Section 15.0	Quality Assurance Reports to Management - See Original QAPP
Section 16.0	Data Management - See Original QAPP
Section 17.0	References - See Field Sampling Plan Addendum

2.1 ENVIRONMENTAL SETTING

The following is a summary of the environmental setting of Cannon AFB. A more detailed description of each AOC is given in Section 2 of the WP.

Cannon AFB is located in Curry County, New Mexico, approximately 7 miles west of the City of Clovis. The Base is situated on approximately 4,320 acres of land. Cannon AFB dates to 1929, when civilian Portair Field was established on the site. In 1942, the Army Air Corps took control of the civilian airfield, and it became known as the Clovis Army Air Base. In early 1945, the Base was renamed Clovis Army Air Field. The installation was deactivated in May 1947.

The Base was reassigned to the Tactical Air Command in July 1951 and formally reactivated in November 1951 as Clovis Air Force Base. In June 1957, the Base became a permanent installation and was renamed Clovis Air Force Base. In June 1957, the Base became a permanent installation and was renamed Cannon Air Force Base in honor of the late General John K. Cannon, a former commander of the Tactical Air Command. In 1992, Cannon AFB was transferred to Air Combat Command (ACC). The primary mission of Cannon AFB has remained relatively unchanged since 1965, i.e., to develop and maintain an F-111 Tactical Fighter Wing capable of day, night and all-weather combat operations and to provide replacement training of combat aircrews for tactical organizations worldwide. There are approximately 70 F-111D aircraft assigned to Cannon AFB.

2.2 SUMMARY OF THE DATA QUALITY OBJECTIVES DEVELOPMENT PROCESS

Discussion of the Data Quality Objectives (DQOs) development process associated with the SI for Cannon AFB is provided in the WP Section 3. Specific task objective details are summarized below.

DQOs are defined as quantitative and qualitative statements which specify the quality of the data and define the level of uncertainty that will be acceptable regarding decisions to be made for the various Cannon AFB AOCs. DQOs result from an iterative process of logical interaction between the decision maker(s) and the technical team to develop statements which describe the level of uncertainty the decision maker(s) are willing to accept in the environmental data. This level of uncertainty is then used as the basis for designing the data collection program.

The data generated during the SI will be assessed for the use in meeting the project objectives in accordance with the criteria specified in this QAPP. The following paragraphs present a summary of the DQO process for the Cannon AFB SI.

2.2.1 Statement of the Problem

Additional information is needed to determine the presence or absence of chemical contamination which may have been caused by the Department of Defense (DOD)-related activities during operation of the facilities.

2.2.2 Definition of the Domain for Decisions

The domain defined for decisions regarding the existence or extent of a release to soil will be limited to the respective AOC boundaries laterally.

The domain defined for decisions regarding soil exposure pathways will be limited to the respective AOC boundaries.

2.2.3 Data Inputs

The following is a summary of the data inputs identified as appropriate to support decisions for the respective AOCs:

- Published and unpublished reports as well as other existing data and information regarding activities, existence, conditions, or concentrations of contaminants at the respective AOCs.
- Collection of soil samples for chemical analysis. Standard Operating Procedures for sampling are presented in Appendix C of the WP. Chemical analysis will be performed off site, utilizing EPA SW-846, or other appropriate EPA methodologies. QA/QC criteria to be used in evaluation of the data are provided in Section 4 of this QAPP Addendum. Project Reporting Limits are presented in Section 8.0 of this QAPP Addendum.
- Soil samples will be analyzed for the following: VOCs by 8260A, SVOCs by 8270, TAL metals by 6010/7000, pesticides/PCBs by 8081, chlorinated herbicides by 8151, and petroleum hydrocarbons (gasoline and diesel range) by Modified 8015.
- QA/QC samples will be taken at each AOC as specified in the WP.

2.2.4 Constraints on Uncertainty

The purpose of establishing constraints on uncertainty is to provide a means for evaluating the level decision makers are willing to accept. Consideration of false positives and false negatives is necessary in the evaluation of the consequences of making an incorrect decision.

Uncertainty in laboratory data arises from error in the measurement process. Measurement errors may be either systematic or random. Bias refers to the amount of systematic error in the measurement process; it is a measure of the average degree of agreement between measured values and the "true" value of the parameter measured. Precision is a measure of random error in

the measurement process; it describes the degree to which data generated from repeated measurements differ from one another. Limits for uncertainty in measurements for laboratory data are specified in Section 4.

2.3 PROJECT DEFINITIONS

The following definitions apply to terms commonly used in the text of this document:

Accuracy	Nearness of a measurement of the mean (x) of a set of measurements to the true value. Accuracy is evaluated by the percent recovery of sample spikes, analysis of laboratory control samples, and reference materials.
Ambient Blank	Usually an aqueous sample that is as free of analyte as possible, carried to the site and exposed to ambient atmosphere for a duration that is typical for field samples. This ambient blank will then be analyzed for volatile organic chemicals and will serve as a check on ambient airborne contamination.
Analytical Batch	The basic unit for analytical quality control is the analytical batch. The analytical batch is defined as 20 or fewer samples which are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each analytical batch should be of similar matrix (e.g., groundwater, surface water, soil, sediment, sludge, etc.
Batch	Synonymous with Sample Delivery Group (SDG)
Calibration Blank	Usually an organic or aqueous solution that is as free of analyte as possible and prepared with the same volume of chemical reagents used in the preparation of the calibration standards and diluted to the appropriate

	volume with the same solvent (water or organic) used in the preparation of the calibration standard. The calibration blank is used to give the null reading for the instrument response versus concentration calibration curve.
Case	A finite, usually predetermined number of samples collected over a given time period from a particular site. For this QAPP, a Case will consist of all samples of similar matrix to be collected under the Field Sampling Plan.
CLP	U.S. Environmental Protection Agency Contract Laboratory Program.
Comparability	A measure of the confidence with which one data set can be compared with another.
Completeness	A measure of the amount of valid sample data obtained from the measurement system compared to the amount of sample data that are analyzed. Valid results are those results which meet or exceed quality control criteria and satisfy quality assurance objective.
Critical Data	Those data considered to be crucial for purposes of risk assessment.
Decontamination Water	A sample of water used for decontaminating field equipment. The source of this water can be the tanks used by contractors to transport the water to a site or a hydrant.
Duplicate	Duplicate samples are two samples taken and analyzed independently. In cases where aliquoting is impossible, as in the case of volatiles nonhomogenized samples must be taken for the duplicate analysis.
Environmental Samples	An environmental sample or field sample is a representative sample of any material

	(aqueous, nonaqueous, or multimedia) collected from any source for which determination or composition or contamination is requested or required.
EPA	Environmental Protection Agency
Field Blank	A sample matrix that is as free of analyte as possible and is transferred from one vessel to another at the sampling site using the sampling technique as closely as possible, including a typical holding time in the sampling equipment, and preserved with the appropriate reagents. This serves as a check on reagents and environmental contamination.
Matrix Duplicate Sample	An aliquot of the homogenized sample which is prepared and analyzed identically to the original sample. Used in metals and cyanide analyses in place of the Matrix Spike Duplicate to measure precision of laboratory preparation and analysis.
Matrix Spike (MS)	A matrix spike is employed to provide a measure of accuracy for the method used in a given matrix. A matrix spike analysis is performed by adding a predetermined quantity of stock solutions of certain analytes to a sample matrix prior to sample extraction/digestion and analysis.
Matrix Spike Duplicate (MSD)	A second matrix spike sample prepared identically to the matrix spike on a duplicate sample of the matrix. Used to measure precision of laboratory preparation and analysis.
MDL	The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is

	determined from replicate analyses of a sample in a given matrix containing low concentrations of the analyte.
Method Blank	A sample matrix that is as free of analyte as possible and contains all the reagents in the same volume as used in the processing of the samples. The method blank must be carried throughout the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The blank is used to monitor for possible contamination resulting from the preparation or processing of the sample.
Opportunity Samples	Samples taken for appropriate chemical analysis at locations determined in the field as important in the fulfillment of site objectives.
Performance Evaluation Sample	A material of known composition that is analyzed concurrently with test samples during a measurement process. It is used to verify the performance of the analytical system.
Precision	Precision is the agreement between a set of replicate measurements without assumption or knowledge of the true value. Precision is evaluated as the relative percent difference or relative standard deviation for replicate or split samples.
QAPP	Quality Assurance Project Plan
Reporting Limit	The reporting limit is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
Representativeness	The degree to which a single measurement is indicative of the characteristics of a large

sample or area or the degree to which data represents field conditions.

Rinsate

Rinsate (or rinsate blank) is usually reagent water that is as free of analyte as possible and is transported to the site and poured over or through the sample collection device, collected in a sample container, and returned to the laboratory. This serves as a check on sampling device cleanliness and potential cross contamination.

RPD

Relative Percent Difference, calculated as:

$$RPD\ (\%) = \frac{\frac{|S - D|}{(S + D)}}{2} \times 100$$

where: S = first sample value (original

D = second sample value

(duplicate)

SDG

Sample Delivery Group, defined as a group of 20 or fewer samples of similar matrix submitted to the laboratory in a period of 14 days or less.

SOW

Statement of Work

Trip Blank

A sample of reagent water that is as free of organic analyte as possible and is transported to the sampling site and returned to the laboratory without being opened. This serves as a check on sample contamination originating from the container or sample transport.

4.1 GENERAL

The overall QA philosophy for the SI at Cannon AFB is to provide measurement tools so that data collected will be defensible and of known quality. As such, the environmental data generated must meet quality assurance objectives designed to support decisions to be made concerning the respective AOCs. Quality assurance activities for field measurement systems are also an important aspect of this design. Activities for nonchemical data will be discussed in the appropriate SOPs. The following paragraphs discuss field and laboratory analytical measurements.

All laboratory procedures are documented in writing as either laboratory Standard Operating Procedures (SOPs) or Method Procedures (MPs), which are edited and controlled. Internal quality control procedures for analytical services will be conducted by the laboratory in accordance with their LQMP and SOPs (available upon request). These specifications include the types of QC samples required (sample spikes, surrogate spikes, reference samples, controls, blanks), the frequency of each, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria. The QC level of effort for analytical testing is summarized in Table 4-1.

The laboratory will document, in each data package provided, that analytical QC functions have been met. Any samples analyzed in nonconformance with the QC criteria will be reanalyzed by the laboratory if the laboratory procedures were not in control, as assessed by laboratory control samples and other data specific to the analysis, and if sufficient sample volume is available. If sufficient sample is not available or holding times would be compromised, it may be necessary to obtain replacement samples.

Quality assurance objectives for analytical data are usually expressed in terms of precision, accuracy, completeness, representativeness, comparability and sensitivity. Target ranges for these objectives are presented for analytical testing and field measurements. Variances from the quality assurance objectives will result in the implementation of appropriate corrective measures and an assessment of the impact of corrective measures on the usability of the data in the decision-making process. The documentation acquired as a result of QC procedures will be included in the assessment of the usability of the analytical data.

The specific project objectives for the SI and the data needs and uses are described in detail in the WP and summarized in Section 2.2 of this QAPP. In general, analytical data generated from the SI will be used to determine the level and extent of possible contamination. Data generated for the SI to be used to support other AOC decisions will involve the following elements:

- Soil samples, along with designated QC samples, will be sent to an off-site analytical laboratory and analyzed for AOC-specific VOCs, SVOCs, TAL metals, total petroleum hydrocarbons (TPH), gasoline and diesel range organics (GRO/DRO), pesticides/PCBs, and herbicides.

- Quality control samples and procedures to be utilized by the laboratory for each analysis are described in the LQMP (available upon request).
- A data review of each sample delivery group shall be completed as described in Section 9.0 of the original QAPP. This review will be completed using EPA Functional Guidelines where appropriate. A minimum of 10 percent of the analytical data, as defined in Section 9.0, will undergo complete validation.
- Data will be assessed for its usability to support AOC-specific decisions.

As part of the USACE quality assurance program, designated duplicate/split samples will be sent to the Missouri River Laboratory (MRL) for analysis.

4.2 FIELD QA/QC SAMPLES

The following paragraphs describe the QA/QC samples anticipated for the Cannon AFB SI.

4.2.1 Field Duplicates

Field duplicate samples for soil will be collected and submitted for analysis in conjunction with the field samples. Field duplicates will be sampled such that collocated samples will be obtained from the sampling device in a manner which minimizes loss due to volatilization (i.e., VOA samples will be collected first). Additionally, for soil, the material remaining in each half of the sampling device will be homogenized separately in stainless-steel bowls before the materials are collected for additional analyses. Duplicate water samples for nonvolatile analysis will be necessarily collocated.

Field duplicate results will provide estimates of overall precision of sample collection, field sample preparation, and laboratory analysis (total within-batch measurement variability). Subdividing one or both of the collocated samples just prior to analysis provides for an estimate of laboratory precision. Soil duplicates homogenized for nonvolatile analysis provide information on sampling precision as well as providing an estimate of representativeness in addition to laboratory precision. Additionally, samples will be split and analyzed by two different laboratories (the contracted analytical laboratory and MRL) which will help quantify the error associated with subsampling (i.e., split preparation) and laboratory bias or to estimate interlaboratory variability.

In general, field duplicates will represent 10 percent of the samples collected (at least one per matrix per AOC). While the location and number of duplicates have been specified in the WP, additional duplicates may be collected depending upon conditions encountered during field activities. These additional duplicate samples would be collected whenever such collection and analysis would be required for assessing the usability of the data. Evaluation criteria for field duplicates are discussed in Section 4.5.1.

4.2.2 Matrix Spike/Matrix Spike Duplicate Samples

Matrix spike and matrix spike duplicate (MS/MSD) samples specific to Cannon AFB AOC matrices will be submitted for organic analysis in conjunction with the field samples. Also, matrix spike and duplicate (MS/D) samples will be submitted for metals analysis. Results from MS/MSD or MS/D samples may be used to assess the potential for sample matrix interferences versus laboratory analytical errors, as well as to monitor the accuracy of the analysis.

In general, field MS/MSD or MS/D samples will represent 10 percent of the samples collected (at least one per matrix per AOC). While the location and number of duplicates have been specified in the WP, additional MS/MSD may be collected depending upon conditions encountered during field activities. These additional MS/MSD samples would be collected whenever such collection and analysis would be required for assessing the usability of the data. Evaluation criteria for field MS/MSD are available in Tables 4-2 through 4-7.

4.3 LABORATORY QA/QC SAMPLES

4.3.1 Method or Preparation Blank

A method blank consists of analyte-free deionized water or washed sea sand for organic analysis of solids. The method blank is carried through each step of the analytical method. The method blank data will be used to evaluate contamination attributed to laboratory operations during analysis.

4.3.2 Laboratory Control Samples (LCS)

Laboratory control samples (LCS) are well-characterized, laboratory-generated samples and will be used to monitor the laboratory's day-to-day performance of analytical methods. LCS will be used to monitor the accuracy of the analytical process independent of matrix effects.

The results of the LCS will be compared to well-defined acceptance criteria (Tables 4-2 through 4-7) to determine whether the laboratory system is "in control". Controlling lab operations with LCS (rather than surrogates or MS/MSD) offers the advantage of being able to differentiate low recoveries due to procedural errors from those due to matrix effects.

4.3.3 Surrogate Spike

A compound or compounds are added to every blank, sample, matrix spike, matrix spike duplicate, and standard if specified in the analytical methodology. The results are utilized to evaluate the accuracy of analytical measurement on a sample-specific basis. Surrogates are generally brominated, fluorinated, or isotopically labeled compounds not expected to be detected

in environmental media. Results are expressed in Percent Recovery of the surrogate spike. QC evaluation criteria for surrogate spikes are presented in Table 4-8.

4.4 QUANTITATIVE QA/QC MEASUREMENTS

4.4.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Precision can be assessed by replicate measurements of known laboratory standards and analysis of duplicate environmental samples. Precision will typically be determined as relative percent difference (RPD) between duplicate sample results; however, replicate samples can be compared by calculating the sample standard deviation.

Duplicate environmental samples submitted from the field will comply with the criteria established in the WP. Precision acceptance criteria for duplicate laboratory control samples to be achieved by the analytical laboratory for the parameters to be analyzed are provided in Tables 4-2a through 4-2e. Precision evaluation criteria for surrogate spikes, MS/MSD, and duplicate environmental samples are provided in Tables 4-4 through 4-6.

4.4.2 Accuracy

Accuracy is the degree of agreement of a measurement to an accepted reference or true value. An evaluation of the accuracy of a measurement system provides an estimate of bias. The accuracy of an analytical method is evaluated by analyzing known reference standards. The percent recovery achieved by analysis of known reference standards or spiking compounds will be used to define the accuracy for the compounds of interest. One known reference standard is also analyzed for every batch of 20 samples. The percent recovery of an analyte is calculated by dividing the "true" value, T, into the observed value, X, and multiplying by 100.

The specific criteria ranges of accuracy for each measurement parameter are defined within the analytical test methods. Acceptable accuracy measures are also dependent on the sample matrix. Accuracy acceptance criteria (percent recovery) for the parameters to be analyzed are provided in Tables 4-2 through 4-7. The measurement of these data quality objectives are assessed for the laboratory control samples. Criteria for matrix spikes will be used to assess the potential for matrix interference. Table 4-8 provides accuracy evaluation criteria for surrogate and matrix spikes.

4.4.3 Method/Project-Required Detection Limits

Reporting limits are defined as the lowest level of measurement that can be reliably achieved within specified limits of precision and accuracy under routine laboratory operating conditions. Tables 8-2 through 8-7 list the project-required reporting limits for analyses to be conducted

under this QAPP Addendum. These are the reporting limits that the laboratory must be able to meet on pure water using the analytical methods specified in Table 8-1. The reporting limits for samples may be considerably higher depending upon the sample matrix.

The reporting limits desired for analyses at Cannon AFB are expected to meet requirements for risk-based decisions. However, when using EPA SW-846 methodologies that cover a broad range of compounds, there is a potential for certain analytes to exhibit elevated reporting limits. These occasions will be addressed as they arise and evaluated against the DQOs. When it can be anticipated that information on chemicals of concern is needed below reporting limits normally obtained by one methodology, another method may be utilized to provide supplemental information.

4.4.4 Analytical Completeness

The overall laboratory completeness goal for data for this project shall be 90 percent. If the completeness criterion of 90% is not achieved, W-C will evaluate the impact on the decisions and consult with USACE to determine appropriate actions.

4.5 QUALITATIVE QA/QC MEASUREMENTS

4.5.1 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition.

Collocated duplicate samples will be collected and utilized as a means to assess field representativeness. Satisfactory representativeness will be assessed by the agreement between analytical results for collocated field duplicate samples. Satisfactory representativeness will be determined by the following criteria. The first level of evaluation will be to compare results to the evaluation criteria listed in Tables 4-2 through 4-7. Should these criteria be exceeded, further assessment with respect to project objectives will occur.

For analytes with both sample concentrations greater than 5x the reporting limit, the duplicate sample results should agree within 50 percent relative percent difference (RPD) for soil samples. For analytes with either or both sample concentrations less than 5x the reporting limit, duplicate sample results should agree within ± 2x the reporting limit for soil samples. Results for analytes not meeting these criteria will be qualified as estimated in all associated samples during the review process.

Representativeness will be maintained during the sampling effort by completing all sampling in compliance with the procedures described in Section 5.0 of this document and in respective

sections in the FSP. A summary of the collocated duplicate samples to be collected is provided in the FSP.

4.5.2 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision as these quantities are measures of data reliability. Data are comparable if siting considerations, collection techniques, and measurement procedures, methods, and reporting are equivalent for the samples within a sample set. A qualitative assessment of data comparability will be made of applicable data sets.

TABLE 4-1

QC LEVEL OF EFFORT FOR ANALYTICAL TESTING

Parameters	QC Measure	Minimum Frequency
Metals	Calibration Blank	Each calibration, beginning and end of each run; 10% frequency
	Initial Calibration Verification	Daily for each instrument setup
	Continuing Calibration Verification	Beginning and end of each run; 10% frequency or every 2 hours
	Preparation Blank	One per analytical batch[1]
	Laboratory Duplicate	One per analytical batch[1]
	Matrix Spike Analysis	One per analytical batch[1]
	Laboratory Control Sample Analysis	One per analytical batch[1]
	Analytical Spike (AA-Furnace)	Each sample (at least a single analytical spike will be performed to determine if the method of standard additions is required)
	Serial Dilution (ICP)	One per sample delivery group
	Interference Check Sample (ICP)	Beginning and end of each run or twice per 8-hour shift, whichever is more frequent
Volatile Organic Compounds, Semivolatile Organic Compounds, Pesticides/PCBs, Herbicides, and Total Petroleum Hydrocarbons (TPH) (GRO/DRO)	Laboratory Blank	One per analytical batch
	Continuing Calibration	Daily for each instrument setup
	Laboratory Control Sample	One per analytical batch
	Second Column Confirmation	Gas chromatography methods, where appropriate (e.g., pesticides)
	Matrix Spike Analysis	One per analytical batch[1]
	Matrix Spike Duplicate Analysis	One per analytical batch[1]
	Surrogate Spike	Each sample

[1] An analytical batch consists of 20 or fewer samples extracted/analyzed together.

TABLE 4-2

ACCURACY AND PRECISION FOR VOCS BY METHOD[1] 8260A

Analyte	Accuracy	Precision
Benzene	70-130	≤ 20
Chlorobenzene	70-130	≤ 20
1,1-Dichloroethane	70-130	≤ 20
Toluene	70-130	≤ 20
Trichoroethene	70-130	≤ 20

Note: The above criteria apply to matrix spike/matrix spike duplicate and laboratory control sample analyses.

1 All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 Final Update.

TABLE 4-3

ACCURACY AND PRECISION FOR SVOCS BY METHOD[1] 8270

Analyte	Accuracy	Precision
Acenaphthene	47-145	≤28
1,4-Dichlorobenzene	20-124	≤32
Dimethyl phthalate	39-139	≤32
N-Nitrosodi-n-propylamine	10-230	≤55
Pyrene	52-115	≤25
1,2,4-Trichlorobenzene	44-142	≤28
4-Chloro-3-methylphenol	22-147	≤37
2-Chlorophenol	23-134	≤29
4-Nitrophenol	10-132	≤47
Pentachlorophenol	14-176	≤49
Phenol	5-112	≤23

Note: The above criteria apply to matrix spike/matrix spike duplicate and laboratory control sample analyses.

1 All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 Final Update.

TABLE 4-4

ACCURACY AND PRECISION FOR PESTICIDES/PCBS BY METHOD[1] 8081

Analyte	Accuracy	Precision
Aldrin	42-122	≤ 25
Gamma BHC	32-127	≤ 25
4, 4'-DDT	25-160	≤ 25
Dieldrin	36-146	≤ 25
Endrin	30-147	≤ 25
Heptachlor	34-111	≤ 25

Note: The above criteria apply to matrix spike/matrix spike duplicate and laboratory control sample analyses.

1 All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 Final Update.

TABLE 4-5

ACCURACY AND PRECISION FOR HERBICIDES BY METHOD[1] 8051

Analyte	Accuracy	Precision
2,4-D	40-140	≤ 25
2,4,5-T	40-140	≤ 25
2,4,5-TP (Silvex)	40-140	≤ 25

Note: The above criteria apply to matrix spike/matrix spike duplicate and laboratory control sample analyses.

1 All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 Final Update.

TABLE 4-6

ACCURACY AND PRECISION FOR TPH BY METHOD[1] 8015

Analyte	Accuracy	Precision
TPH - GRO	70-130	≤ 25
TPH - DRO	30-150	≤ 25

Note: The above criteria apply to matrix spike/matrix spike duplicate and laboratory control sample analyses.

1 All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 Final Update.

TABLE 4-7

ACCURACY AND PRECISION FOR METALS BY METHOD[1] 6010/7470

Analyte	Accuracy	Precision
Aluminum	75-125	≤ 25
Antimony	60-140	≤ 25
Arsenic	75-125	≤ 25
Barium	75-125	≤ 25
Beryllium	75-125	≤ 25
Cadmium	75-125	≤ 25
Calcium	75-125	≤ 25
Chromium	75-125	≤ 25
Cobalt	75-125	≤ 25
Copper	75-125	≤ 25
Iron	75-125	≤ 25
Lead	75-125	≤ 25
Magnesium	75-125	≤ 25
Manganese	75-125	≤ 25
Mercury	75-125	≤ 25
Nickel	75-125	≤ 25
Potassium	75-125	≤ 25
Selenium	75-125	≤ 25
Silver	60-140	≤ 30
Sodium	75-125	≤ 25
Thallium	75-125	≤ 25
Vanadium	75-125	≤ 25
Zinc	75-125	≤ 25

Note: The above criteria apply to matrix spike/matrix spike duplicate and laboratory control sample analyses.

1 All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 Final Update.

TABLE 4-8

SURROGATE RECOVERY CRITERIA

Parameter	Method[1]	Analyte	Accuracy
Volatile Organics	8260A	Dibromofluoromethane	80-120
		Toluene-d_8	81-117
		Bromofluorobenzene	74-121
Semivolatile Organics	8270	Nitrobenzene-d_5	23-120
		2-Fluorobiphenyl	30-115
		Terphenyl-d_{14}	18-137
		Phenol-d_6	24-113
		2-Fluorophenol	25-121
		2,4,6-Tribromophenol	19-122
Pesticides/PCBs	8081	Decachlorobiphenyl	60-140
		2,4,5,6-Tetrachloro-m-xylene	60-140
Herbicides	8151	2,4-Dichlorophenyl acetic acid	60-145
TPH	8015	Fluorobenzene(GRO)	70-130
		Triacontane(DRO)	60-140

1 All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 Final Update.

PCB = Polychlorinated Biphenyls
TPH = Total Petroleum Hydrocarbons
GRO = Gasoline Range Organics
DRO = Diesel Range Organics

8.1 LABORATORY PROCEDURES

The general laboratory procedures anticipated for the SI of AOCs E, F, G, and H at Cannon AFB are summarized in Table 8-1 and include EPA SW-846 and other appropriate EPA methodologies. The specific analyses planned for each SWMU are defined in the FSP. Specific laboratory practices for the methods listed below, including sample preparation, sample tracking, and documentation controls, are provided in the QAPP in Appendix C.

8.1.1 Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOCs) include compounds among varying classes such as halogenated organics, nonhalogenated organics, and aromatic organics. The first two classes generally contain contaminants associated with solvents such as TCE. The third class includes compounds associated with petroleum hydrocarbons such as BTEX.

Method 8260A is a purge-and-trap gas chromatographic (GC) method appropriate for analysis of suspected VOCs and employs mass spectrometry (MS) for detection. The power of GC/MS lies in the capacity for positive identification at project-required quantitation limits. Volatile organic compounds to be analyzed by GC/MS at Cannon AFB are listed in Table 8-2 with associated reporting limits.

8.1.2 Semivolatile Organic Compounds (SVOCs)

Method 8270 is a GC/MS method appropriate for determining SVOCs (base/neutral and acid extractable). This procedure will include analysis to detect the general classes of compounds such as phenols, nitrosamines, polyaromatic hydrocarbons (PAHs), and other less volatile compounds of concern. The list of SVOC analytes and reporting limits are provided in Table 8-3.

8.1.3 Organochlorine Pesticides and PCBs

The organochlorine pesticides and highly chlorinated aroclors or polychlorinated biphenyls (PCBs) are persistent in the environment and, therefore, more available for exposure or bioaccumulation. GC Method 8081, with the associated sample extraction, is indicated where these compounds may have been utilized or disposed. The pesticides/PCBs and associated reporting limits for soil and water are provided in Table 8-4.

8.1.4 Chlorinated Herbicides

Chlorinated herbicides will be analyzed where indicated using GC Method 8151. The analyte list and associated reporting limits are provided in Table 8-5. Method 8151 is a gas-

chromatographic method employing an electron capture detector or an electrolytic conductivity detector.

8.1.5 Petroleum Hydrocarbons

Samples will be analyzed for total petroleum hydrocarbons by Modified Method 8015. The laboratory will report data as GRO and DRO. This method utilizes fingerprinting by gas chromatography/mass spectrometry for identification. Reporting limits are provided in Table 8-6.

8.1.6 Metals

In general, the metals analyses for the SI at Cannon AFB consist of TAL metals. This list can be shortened once metal contamination becomes more defined. Interpretation of metals data can be complex, particularly when background and/or naturally occurring levels complicate the analysis.

The methodology for metals analyses is provided in Table 8-1. The following are various factors which influence the use of particular methods:

- Detection limits
- Interference
- Stability
- Project-specific DQOs

Most metals, with a few exceptions (see Table 8-1), are detected at levels appropriate for Cannon AFB DQOs by inductively coupled plasma emission spectroscopy (ICP) of trace ICP. Method 6010 is indicated for soil analysis. Mercury will be analyzed by Cold Vapor Atomic Absorption Method 7470. Table 8-7 provides reporting limits for the various ICP, AA, and CVAA methods.

TABLE 8-1

ANALYTICAL PROCEDURES FOR CANNON AFB SITE INSPECTIONS

Parameter	Technique[1]	Extraction and Analysis Method
		Soil
Volatile Organics	GC/MS	5030/8260A
Semivolatile Organics	GC/MS	3540 or 3550/8270
Organochlorine Pesticides and PCBs	GC/ECD	3550/8081
Chlorinated Herbicides	GC/ELCD	3540 or 3550/8151
Metals[2]	ICP	3050/6010
Mercury	CV	7471
Total Petroleum Hydrocarbons		
Gasoline Range	GC/FID	5020/8015
Diesel Range	GC/FID	3550/8015

1 GC = Gas chromatograph, GC/MS = gas chromatography/mass spectrometry, ICP = inductively coupled plasma, CV = cold vapor, ECD = electron capture detector, ELCD = electrolytic conductivity detector, FID = flame ionization detector. The 3000-9000 methods are from the 3rd Edition, SW-846.

2 Includes target analyte list metals.

TABLE 8-2

REPORTING LIMITS FOR VOLATILE ORGANICS BY METHOD 8260A

	Method Detection Limits	Reporting Limit
Volatile Organics	µg/kg	µg/kg
Acetone	1.36	20
Acrylonitrile	1.85	5
Benzene	0.47	5
Bromobenzene	0.69	5
Bromochloromethane	0.60	5
Bromodichloromethane	0.42	5
Bromoform	0.35	5
Carbon Disulfide	0.43	5
Carbon Tetrachloride	0.72	5
Chlorobenzene	0.46	5
Chloroethane	0.59	5
Chloroform	0.52	5
2-Chlorotoluene	0.97	5
4-Chlorotoluene	1.00	5
2-Chloroethylvinyl ether	0.75	10
Dibromochloromethane	0.50	5
1,2-Dibromo-3-chloropropane	1.14	25
1,2-Dibromoethane	0.40	5
1,2-Dichlorobenzene	0.50	5
1,3-Dichlorobenzene	0.93	5
1,4-Dichlorobenzene	0.99	5
trans-1,4-Dichloro-2-butene	2.19	100
1,1-Dichloroethane	0.49	5
1,2-Dichloroethane	0.40	5
1,1-Dichloroethene	0.55	5
cis-1,2-Dichloroethene	0.55	5
trans-1,2-Dichloroethene	0.47	5
1,2-Dichloropropane	0.85	5
2,2-Dichloropropane	0.50	5
1,1-Dichloropropene	0.73	5
1,3-Dichloropropane	0.58	5
cis-1,3-Dichloropropene	0.54	5
trans-1,3-Dichloropropene	0.43	5
Ethylbenzene	0.83	5
2-Hexanone	3.23	50
Bromomethane	0.88	5
Chloromethane	5.66	5
Dibromomethane	.42	5
2-Butanone	1.68	100
Iodomethane	0.86	5
Methylene chloride	0.44	5
4-Methyl-2-pentanone	2.40	100
Styrene	0.70	5
1,1,1,2-Tetrachloroethane	0.59	5
1,1,2,2-Tetrachloroethane	1.01	5
Tetrachloroethene	1.51	5

TABLE 8-2

REPORTING LIMITS FOR VOLATILE ORGANICS BY METHOD 8260A

	Method Detection Limits	Reporting Limit
Toluene	0.59	5
1,2,3-Trichlorobenzene	1.65	5
1,2,4-Trichlorobenzene	0.92	5
1,1,1-Trichloroethane	0.44	5
1,1,2-Trichloroethane	0.64	5
Trichloroethene	0.54	5
Trichlorofluoromethane	0.49	5
1,2,3-Trichloropropane	1.44	5
1,3,5-Trimethylbenzene	0.57	5
1,2,4-Trimethylbenzene	0.79	5
Vinyl acetate	1.14	50
Vinyl chloride	0.58	2
m,p-Xylene	1.99	5
o-Xylene	0.66	5

All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, Final Update.

TABLE 8-3

REPORTING LIMITS FOR SEMIVOLATILE ORGANICS BY METHOD 8270

	Method Dection Limits	Reporting Limit
Semivolatile Organics	mg//kg	mg/kg
Acenaphthene	0.07	0.330
Acenaphthylene	0.07	0.330
Anthracene	0.05	0.330
Benzo(a)anthracene	0.07	0.330
Benzo(b)fluoranthene	0.07	0.330
Benzo(k)fluoranthene	0.09	0.330
Benzo(g,h,i)perylene	0.08	0.330
Benzo(a)pyrene	0.07	0.330
Benzyl alcohol	0.05	0.650
Bis(2-chloroethoxy)methane	0.07	0.330
Bis(2-chloroethyl)ether	0.05	0.330
Bis(2-chloroisopropyl)ether	0.07	0.330
Bis(2-ethylhexyl)phthalate	0.06	0.330
4-Bromophenyl phenyl ether	0.06	0.330
Butyl benzyl phthalate	0.06	0.330
Carbazole	0.04	0.330
4-Chloroaniline	0.3	0.330
2-Chloronaphthalene	0.07	0.330
4-Chlorophenyl phenyl ether	0.05	0.330
Chrysene	0.08	0.330
Dibenz(a,h)anthracene	0.07	0.330
Dibenzofuran	0.05	0.330
Di-n-butylphthalate	0.06	0.330
1,2-Dichlorobenzene	0.06	0.330
1,3-Dichlorobenzene	0.05	0.330
1,4-Dichlorobenzene	0.06	0.330
3,3'-Dichlorobenzidine	0.2	0.330
Diethyl phthalate	0.3	0.330
Dimethyl phthalate	0.06	0.330
2,4-Dinitrotoluene	0.02	0.330
2,6-Dinitrotoluene	0.05	0.330
Di-n-octylphthalate	0.06	0.330
Fluoranthene	0.06	0.330
Fluorene	0.06	0.330
Hexachlorobenzene	0.05	0.330
Hexachlorobutadiene	0.07	0.330
Hexachlorocyclopentadiene	0.04	0.330
Hexachloroethane	0.07	0.330
Indeno(1,2,3-cd)pyrene	0.07	0.330
Isophorone	0.07	0.330
2-Methylnaphthalene	0.08	0.330
Naphthalene	0.07	0.330
2-Nitroaniline	0.04	1.650
3-Nitroaniline	0.05	1.650
4-Nitroaniline	1	1.650
Nitrobenzene	0.06	0.330
N-Nitrosodiphenylamine	0.06	0.330
N-Nitrosodi-n-propylamine	0.07	0.330
Phenanthrene	0.06	0.330
Pyrene	0.005	0.330
1,2,4-Trichlorobenzene	0.06	0.330
Benzoic acid	0.21	0.800
4-Chloro-3-methylphenol	0.07	0.650
2-Chlorophenol	0.06	0.330

TABLE 8-3

REPORTING LIMITS FOR SEMIVOLATILE ORGANICS BY METHOD 8270

	Method Detection Limits	Reporting Limit
2,4-Dichlorophenol	0.07	0.330
2,4-Dimethyl phenol	0.1	0.330
4,6-Dinitro-2-methylphenol	0.06	1.650
2,4-Dinitrophenol	0.4	1.650
2-Methylphenol	0.06	0.330
4-Methylphenol	0.08	0.330
2-Nitrophenol	0.06	0.330
4-Nitrophenol	0.1	0.800
Pentachlorophenol	0.06	1.650
Phenol	0.06	0.330
2,4,5-Trichlorophenol	0.06	1.650
2,4,6-Trichlorophenol	0.05	0.330

All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, Final Update.

TABLE 8-4

REPORTING LIMITS FOR PESTICIDES/PCBS

	Method Detection Limits	Reporting Limit
Chlorinated Pesticides/PCBs	µg/kg	µg/kg
Aldrin	0.00072	0.004
Alpha-BHC	0.00071	0.003
Beta-BHC	0.00134	0.006
Delta-BHC	0.00063	0.009
Gamma-BHC(Lindane)	0.00056	0.004
alpha-Chlordane	0.00033	0.005
gamma-Chlordane	0.00032	0.005
4,4'-DDD	0.00039	0.011
4,4'-DDE	0.00052	0.004
4,4'-DDT	0.00026	0.012
Dieldrin	0.00058	0.002
Endosulfan I	0.00055	0.014
Endosulfan II	0.00053	0.004
Endosulfan Sulfate	0.00212	0.066
Endrin	0.00035	0.006
Endrin Aldehyde	0.00066	0.023
Heptachlor	0.00091	0.003
Heptachlor Epoxide	0.00056	0.083
Methoxychlor	0.00217	0.176
Toxaphene	0.0253	0.24
Aroclor-1016	0.015	0.065
Aroclor-1221	0.0208	0.065
Aroclor-1232	0.0208	0.065
Aroclor-1242	0.0208	0.065
Aroclor-1248	0.0208	0.065
Aroclor-1254	0.0048	0.065
Aroclor-1260	0.0048	0.065

All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, Final Update.

TABLE 8-5

REPORTING LIMITS FOR CHLORINATED HERBICIDES

	Method Detection Limits	Reporting Limit
Chlorinated Herbicides	µg/kg	µg/kg
2,4-D	8.141	50
2,4-DB	9.13	50
2,4,5-T	1.92	5
2,4,5-TP(Silvex)	0.341	5
Dalapon	22	200
Dicamba	1.24	5
Dichloprop	8.09	50
Dinoseb	11.1	20
MCPA	51.1	20000
MCPP	298	20000

All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, Final Update.

TABLE 8-6

REPORTING LIMITS FOR PETROLEUM HYDROCARBONS

	Method Detection Limits	Reporting Limit
TPH-GRO	µg/kg	µg/kg
TPH as Gasoline Range Organics	6.5	50
TPH-DRO	mg/kg	mg/kg
TPH as Diesel Range Organics	1.0	10

All samples will be analyzed by the referenced method as outlined in "Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, Final Update.

TABLE 8-7

REPORTING LIMITS FOR METALS

	Method Detection Limits	Reporting Limit
Metals	mg/kg	mg/kg
Aluminum	8.01	10
Antimony	0.40	5
Arsenic	0.26	1
Barium	0.12	1
Beryllium	0.03	0.3
Cadmium	0.05	0.5
Calcium	1.26	50
Chromium	0.29	0.5
Cobalt	0.17	1
Copper	031	1
Iron	6.05	10
Lead	0.22	0.5
Magnesium	1.68	50
Manganese	0.05	1
Mercury	0.04	0.12
Nickel	0.20	1
Potassium	14.0	100
Selenium	0.57	1
Silver	0.36	0.5
Sodium	39.6	100
Thallium	0.89	1
Vanadium	0.44	1
Zinc	1.01	2

All samples will be analyzed by Method 6010 (Mercury 7470/7471) as outlined in "Test Methods forEvaluating Solid Waste Physical/Chemical Methods, SW-846, Final Update.

Project Name Cannon AFB Site Inspections **Project #** M9602R **Location** Cannon AFB, New Mexico

Project Manager Steve Cox **Effective Dates** 1-1-98 through 12-31-98 **Prepared By** Jeff Hopkins

( ) New Plan (X) Amendment to Existing Approved HSP RCRA Facility Investigations Appendix III SWMUs, September 1993

Description of Activities

Preliminary Assessment	( )	Cleanup	( )	Active	(X)	Landfill	( )	Unknown	( )
Initial Investigation "Walk Through"	( )	Oversight	( )	Inactive	( )	Uncontrolled	( )	Jet Engine Test Stand	( )
Initial Investigation "Sampling"	(X)	Long-term monitoring	( )	Secure	(X)	Industrial	( )		
Site Characterization	( )	Background Sampling	( )	Unsecure	( )	Recovery	( )		
				Enclosed Space	( )	Well Field	( )		

Scope of Work:

The overall intent of this investigation is to obtain the additional data necessary to sufficiently characterize naturally-occurring background concentrations for inorganics and pesticides to support recommendations for further study or recommend "no further action" if warranted. The fieldwork will include geophysical surveys, soil borings, hand auger borings, and surface soil samples.

Surrounding Area: ( ) Residential ( ) Industrial ( ) Commercial ( ) Rural ( ) Urban (X) Other:: (Military Installation)

Site Location and Description:

Cannon Air Force Base (AFB) is located near Clovis, New Mexico. Four Areas of Concern (AOCs) will be evaluated. A detailed description of the physical settings of AOCs -E, -F, -G, and -H can be found in Section 3 of the Field Sampling Plan.

5.0
EQUIPMENT DECONTAMINATION PROCEDURES

Specific equipment decontamination procedures are described in the following paragraphs. Equipment decontamination will include:

- Drilling equipment decontamination (augers, drill stems, drill bits, other downhole equipment) will be conducted prior to drilling and between each boring location. Before any equipment is removed from the site, it will be decontaminated according to the procedure for decontamination of drilling and heavy equipment described in SOP No. 1.

- Sampling equipment decontamination (stainless steel split-spoon samplers, stainless steel stirring devices, etc.) will be conducted between individual sampling points to minimize potential cross-contamination. Soil sampling will require one clean stainless steel split-spoon sampler per sample. Sampling equipment will be decontaminated between each sample according to the procedure for decontamination of sampling equipment described in SOP No. 1.

5.1 DRILLING EQUIPMENT DECONTAMINATION PROCEDURES

Augers will be scraped off as they are withdrawn from a boring. The cuttings will be disposed of as outlined in Section 4.2. The following step in accordance with SOP No. 1, will be used to decontaminate drilling and heavy equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure.

- Equipment showing gross contamination or having drilling cuttings caked on will be scraped off with a flat-bladed scraper. The scrapings will be containerized. Drill cuttings should not be washed down the drain.

- Equipment that will not be damaged by water, such as drill rigs, augers, drill bits, and tools will be sprayed with detergent water by a high-pressure steamer,

then rinsed with clear potable water. This water will be obtained at an approved source.

- Decontamination will continue until all equipment is devoid, both inside and out, of any asphaltic, bituminous, or other encrusting or coating materials, such as grease, gravel, and soil.

Following decontamination, drilling equipment will be placed on the clean drill rig and moved to a clean area. If the equipment is not used immediately, it should be stored in a designated secure, clean area and covered with plastic sheeting.

Drilling equipment will be decontaminated prior to drilling, between each boring, and prior to leaving the site. Decontamination will occur at the designated decontamination area.

5.2 SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

The following steps in accordance with SOP No. 1, will be used to decontaminate sampling equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure.

- Equipment showing gross contamination will be placed in a wash tub and the gross contamination will be scraped off with a flat-bladed scraper. The scrapings will be containerized.

- Equipment that will not be damaged by water will be placed in a wash tub containing Liquinox (or low-sudsing detergent) along with potable water and scrubbed with a bristle brush or similar utensil. Equipment will be rinsed with clear potable water, in a second wash tub or bucket, followed by a double deionized water rinse.

- When sampling for organic volatiles, semivolatiles, or pesticides/PCB, the potable water rinse of the equipment will be followed by a double distilled or deionized water rinse.

- Equipment that may be damaged by water, such as an HNu or OVA, will be carefully wiped clean using a sponge and detergent water, and rinsed with deionized water. Oily or tarry contamination will be removed by sparing use of a solvent followed by a sponge and deionized water wipe-off. Care will be taken to prevent any equipment damage.

- Detergent waters will be replaced between borings. Rinse waters will be contained in pump sprayers to prevent used rinse water from contaminating subsequent samples.

Following decontamination, sampling equipment will be placed in a clean area on clean plastic sheeting to prevent contact with contaminated soil. If the equipment is not used immediately, it will be covered or wrapped in plastic sheeting to minimize potential airborne contamination.

Decontamination of all soil sampling equipment that will contact the sample will occur between samples.

5.3 DECONTAMINATION PROCEDURE DOCUMENTATION

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded with waterproof ink in the sampler's field notebook with consecutively numbered pages. The information entered in the field book concerning decontamination should include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination steps/observations
- Weather conditions

FIGURE 1

Field Sampling Data Sheet for Soil (Surface or Subsurface) Samples

Location Identification: _____ Date: _____

Samplers' Signature: _____ Time: _____

Type of Sample: Surface: _____ Subsurface: _____

Type of Soil Cover: _____

Depth Interval: _____

Sample Identification: _____

Soil type (i.e. sand silt clay) _____

USCS Abbreviation _____

Color _____

Staining _____

Odor _____

Containers	Number	Preservatives

QA/QC Samples Collected: _____

Comments: _____

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 8
BORING LOG COMPLETION AND
LITHOLOGIC DESCRIPTION OF SUBSURFACE SAMPLES

CANNON AIR FORCE BASE SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005

W-C PROJECT NUMBER M9602R

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3.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods for the lithologic logging of boreholes at Cannon Air Force Base. This SOP serves as a supplement to the Quality Assurance Project Plan (QAPP). This SOP is intended to be used with the QAPP and other SOPs, such as SOP No. 7, Subsurface Drilling and Soil Sampling.

The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly log boreholes.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that lithologic logging of boreholes is performed in accordance with this Standard Operating Procedure. This Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for logging boreholes according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing the activities associated with this procedure to assure that borehole logging is being completed according to this procedure.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.0
PROCEDURES FOR LITHOLOGIC LOGGING OF BOREHOLES

5.1 HAZARDOUS AND TOXIC WASTE (HTW) BORING LOG COMPLETION

A "site geologist" (geologist or geotechnical engineer) experienced in borehole drilling and soil sampling will be present at each operating drill rig. This site geologist will be responsible for logging samples, preparing samples for shipment to the laboratory for analyses, monitoring drilling operations, recording water losses or gains and groundwater data, and preparing boring logs.

5.2 EQUIPMENT NEEDS

- HTW Drilling Log Forms
- Indelible Pens
- Straight Edge
- Fiberglass Tape Measure

5.3 PROCEDURES

Logs will be prepared on the HTW Drilling Log form that accompanies this SOP. A blank HTW boring is provided at the end of this SOP (Figure 1). Logs will be prepared in the field by a qualified, experienced geologist or geotechnical engineer as borings are drilled. Each log will be signed by the preparer.

All log entries will be printed. Photo reproductions will be clear and legible. Illegible or incomplete logs are not acceptable. Survey coordinates will be completed at a later date and will be included on the final computer-drafted copies of the boring log. One legible copy of each field log will be completed and sent/mailed with DQCRs on a weekly basis.

Borehole depths and sample intervals will be measured to 0.1 foot.

All relevant information blanks in the log heading and log body will be completed. If surveyed horizontal control is not available at the time of drilling, location sketches, referenced by measured distances from prominent surface features, will be shown on the first page of the log.

Logs will identify the depth at which water is first encountered and the depth to water prior to grouting the boring. The absence of water in borings also shall be indicated. The time between encountering the groundwater and the last measurement of the depth to groundwater will be noted on the log.

Column b

Log scale will be 1 inch = 1 foot.

Column c

Every material type encountered will be described in column "c" of the log form. Unconsolidated materials will be described as outlined below and in the sequence:

1. Descriptive USCS classification
2. Consistency of cohesive materials or apparent density of non-cohesive materials
3. Plasticity
4. Cementation
5. Moisture content assessment; e.g., moist, wet, saturated, etc.
6. Color
7. Grain size
8. Grain shape
9. Other descriptive features (bedding characteristics, organic materials, macrostructure of fine-grained soils; e.g., root holes, fractures, etc.)
10. Depositional type (alluvium, till, loess, etc.)

Stratigraphic/lithologic changes will be identified in column "c" by a solid horizontal line at the appropriate scale depth on the log which corresponds to the measured borehole depths at

which changes occur. Stratigraphic/lithologic changes will be measured to the nearest 0.1 foot. Gradational transitions will be identified by a horizontal dashed line at the appropriate scale depth based on the best judgment of the logger. All lines will be drawn with a straight edge, not free hand.

Column d

The calibration information for the PID will be written at the top of the column on the first page, along with the background level in parts per million (ppm). For each sample interval, the following information will be provided in column "d":

1. Breathing Zone reading in ppm
2. Headspace Screen reading in ppm

Columns e and f

Logs will clearly show, in columns "e" and "f", the depth intervals from which all samples for off-site analysis were obtained, including depth intervals for duplicate samples. Soil sampling intervals will be shown in column "e", including depths from which attempts were made and length of sample recovered from each attempt.

Column g

The blow counts for each 0.5-foot interval will be recorded at the appropriate depth in column "g". A line drawn with a straight edge will extend across column "g" to indicate each 0.5-foot interval.

Column h

Soil sample information with the split-spoon samplers will be recorded in column "h" and will include the following:

1. N value -- the sum of the blow counts from the second and third half-foot intervals in column "g"

2. Recovery -- in feet
3. Time of sample collection

Soil sample information with the continuous soil core barrel will be recorded in consecutively numbered runs in column "h" and will include the following:

1. Start and stop time of each sample run
2. Depth to top and bottom of each sample run
3. Length of sample recovered from each run
4. Measured depth to the bottom of the hole after sample is removed from each run

Logs will include all other information relevant to a particular investigation in column "h", including, but not limited to:

1. Odors
2. Staining
3. Drilling difficulties and how resolved
4. PID/FID measurements or other field screening or test results
5. Any other observed evidence of contamination in samples

Logs will show the total depth of penetration and sampling. The bottom of the hole will be clearly identified on the log with a continuous double line across the width of the log and with the notation "Bottom of Hole = XXX feet".

Logs will identify any intervals of hole instability, and will show depths and types of any temporary casing used. Any drilling or sampling problems will be recorded on logs, including descriptions of problem resolution.

Boring logs will be included as appendices to the Draft Project Report and Final Project Report and will be computer generated.

In the field, visual estimates of the volume of secondary soil constituents can be reported by such terms as "trace" (1-10 percent), "little" (10-20 percent), "some (20-35 percent), and "and"

(35-50 percent) or by an estimated specific percentage. The quantitative range of each of the terms used is to be defined either within a general legend or on each log.

When used to supplement other sampling techniques, auger-flight cutting samples will be described in terms of the appropriate soil parameters, to the extent practical. "Classification" will be minimally described for these samples, along with a description of drill action and water losses/gains for the corresponding depth. Notations will be made on the log that these descriptions are based on observations of material other than samples; e.g., "from cuttings".

The drilling equipment used will be described on each log. Information such as drill rod size, bit size and type, and rig manufacturer and model will be recorded.

All special problems encountered during drilling and their resolution will be recorded on the log. This would include sudden tool drops, unrecovered tools in the borehole, and lost casings.

The dates for the start and completion of borings will be recorded on the boring log. Changes in shift, day, driller, and site geologist will also be noted on the boring log.

Logs will identify any drilling fluid (water) losses, including depths at which they occur, rate of loss and total volume lost.

Logs will show blow counts, hammer type and weight, and length of hammer fall for driven samplers. Blow counts will be recorded in half-foot increments when a standard penetration test is performed. For penetration less than a half-foot, the count will be annotated with the distance over which the count was taken. Refusal, if reached, will be noted.

Significant color changes in the drilling fluid return will be recorded, even when intact soil samples or rock core are being obtained. The color change (from and to), depth at which change occurred, and a lithologic description of the cuttings before and after the change will be recorded.

Special abbreviations used on a log will be defined either in the log where used, or in a general legend.

6.0
LITHOLOGIC DESCRIPTION OF SURFACE AND SUBSURFACE SOIL SAMPLES

6.1 EQUIPMENT NEEDS

- Drill rig and related equipment (see SOP 7)
- Stainless steel 3-inch split spoon
- Stainless steel 5-foot continuous soil core barrel
- Pocket knife or small spatula
- Hand lens
- Camera and film
- Field forms
- Field logbook
- Indelible pens

6.2 PROCEDURES

Soil samples will be classified according to the Unified Soil Classification System (USCS), following methods outlined in ASTM D 2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and the Standard Nomenclature for Description of Soils of the U.S. Army Corps of Engineers, Omaha District.

The field geologist will describe and classify soil materials based on field observations using methods discussed above and will enter the lithologic classifications into the HTW boring log. Final boring logs will be prepared using observations of the field geologist an the driller. Laboratory analyses will not be used to confirm or modify the visual-manual classifications.

The field geologist will subdivide materials into stratigraphic units of practical thickness based on significant lithologic changes, measure depth intervals to the nearest 0.1 foot, and record the readings on the boring log. Very thin intervals may be described as lenses, laminae, or beds within a larger stratigraphic unit, with the depth intervals noted.

Field soil classifications will be based on estimated grain-size distribution in reference to ASTM flow charts for identifying fine-grained and coarse-grained soils. The order of descriptive terminology on the boring log generally will follow the USACE Standard Nomenclature for Description of Soils. The orders is as follows:

1. USCS Classification -- determined from flow charts in ASTM D 2488; e.g., silty sand (SM), lean clay (CL), etc.
2. Density -- for dominantly coarse-grained materials (silt, sand, gravel), based on blow counts in Standard Penetration Tests (Sats) in ASTM D 1586.
3. Consistency -- for dominantly fine-grained materials, based on blow counts in Sats in ASTMD 1586.
4. Plasticity -- described as non-plastic, low, medium, or high, based on field test described in ASTM D 2488.
5. Cementation -- described as high, moderate, or weak, according to field test in ASTM D 2488.
6. Moisture -- generally described as dry, moist, wet, or saturated.
7. Color -- for moist samples, determined by visual description such as brown, gray, olive, etc.
8. Grain Size -- estimated percentages of grain size categories; e.g., 10% silt, 50% fine sand, 40% medium sand.
9. Grain Shape -- for coarse-grained materials, generally described as angular, subangular, subrounded, or rounded.
10. Other features -- includes any other notable identifying characteristics, such as fractures, structures, bedding, fossil content, nature of contents with overlying or underlying strata, etc.
11. Depositional Type -- e.g., alluvium, outwash, till, etc., if it can be determined.

The blow counts from each 0.5-foot interval will be recorded in column "g" and will be used to determine the density/consistency of the soil in that interval. The N value (see table) will be entered in column h. The following table permits adjustment for different split-spoon samplers:

Standard Penetration Test (SPT)

Standard Penetration Tests are made by driving a standard split-spoon sampler with a 140-pound hammer falling 30 inches and counting the number of blows required to advance the sampler a distance of 12 inches (blows per foot). The N value is the sum of the blow counts for the second and third 0.5-foot intervals.

Density (Sand and Gravel)				Consistency (Silt and Clay)			
Spoon Diameter (I.D.) -- Inches				Spoon Diameter (I.D.) -- Inches			
Description	1.4	2.0	2.5	Description	1.4	2.0	2.5
Very Loose	0-4	0-5	0-7	Very Soft	0-2	0-2	0-2
Loose	4-10	5-12	7-18	Soft	2-4	2-4	2-4
Medium Dense	10-29	12-37	18-51	Medium Stiff	4-8	4-9	4-0
Dense	29-47	37-60	51-86	Stiff	8-15	9-17	9-18
Very Dense	>48	>60	>86	Very Stiff	15-30	17-39	18-42
				Hard	30-60	39-78	42-85
				Very Hard	>60	>78	>85

FIGURE 1

HTRW DRILLING LOG	DISTRICT	HOLE NUMBER
1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET SHEETS OF

3. PROJECT	4.LOCATION
5. NAME OF DRILLER	6. MANUFACTURE'S DESIGNATION OF DRILL
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION
	9. SURFACE ELEVATION
	10. DATE STARTED / 11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE

20. SAMPLES FOR CHEMICAL	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

LOCATION SKETCH/COMMENTS SCALE:

PROJECT	HOLE NO.

ENG FORM 5056-R, AUG 94 (Proponent: CECW-EG)

HTW DRILLING LOG

HOLE NO.

PROJECT	INSPECTOR	SHEET OF SHEETS

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h
	1.0						
	2.0						
	3.0						
	4.0						
	5.0						
	6.0						
	7.0						
	8.0						
	9.0						

PROJECT	HOLE NO.

HTW DRILLING LOG

HOLE NO.

PROJECT	INSPECTOR	SHEET OF SHEETS

ELEV a.	DEPTH b.	DESCRIPTION OF MATERIALS c.	FIELD SCREENING RESULTS d.	GEOTECH SAMPLE OR CORE BOX NO. e.	ANALYTICAL SAMPLE NO. f.	BLOW COUNTS g.	REMARKS h.
	11.0						
	12.0						
	13.0						
	14.0						
	15.0						
	16.0						
	17.0						
	18.0						
	19.0						

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 9
BOREHOLE ABANDONMENT

CANNON AIR FORCE BASE SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005

W-C PROJECT NUMBER M9602R

2.0
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3.0
PURPOSE AND SCOPE

The purpose of this document is to define the Standard Operating Procedure (SOP) for borehole abandonment at Cannon Air Force Base.

This SOP serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This SOP is intended to be used with the WP and other SOPs.

The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly perform abandonment.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that borehole abandonment is performed in accordance with this Standard Operating Procedure. This Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for performing borehole abandonment according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing the activities associated with this procedure to assure that borehole abandonment is being completed according to this procedure.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.0
PROCEDURE FOR BOREHOLE ABANDONMENT

Abandonment is the procedure by which any boring (or well) is permanently closed. Abandonment procedures should preclude any current or subsequent discharges from entering the abandoned boring or well and thereby terminate access to the subsurface environment through that borehole.

Upon completion of soil sampling and advancement of the boring to its predetermined depth, the soil boring will be abandoned immediately, unless saturated conditions have been encountered. For borings encountering saturated conditions, a 24-hour groundwater level will be measured before backfilling. Borings left open overnight will be covered to lessen the potential for injury to personnel and to minimize the potential for any surface drainage to enter the boring. The following steps will be performed to abandon a boring:

1. All boreholes to be abandoned regardless of depth will be grouted. Upon completion of drilling, the borings will be grouted subsequent to the removal of the hollow-stem augers. Grouting will be accomplished by placing a tremie pipe to the bottom of the boring and pumping grout through this pipe until undiluted grout flows from the boring at ground surface. The grout mix will be in proportions of one sack (94 pounds) of Portland cement, 3-5 pounds of powdered bentonite, and a maximum of 7 gallons of water. The bentonite will be well mixed with the water prior to adding the cement. Twenty-four hours after grouting, the borehole will be checked for grout settlement and will be topped off to the ground surface with grout, if necessary.

2. Upon completion of the boring, all downhole equipment will be scraped clean as it is withdrawn from the hole. Decontamination and cuttings disposal will be performed in accordance with SOP No. 1, Equipment Decontamination and SOP No. 7, Subsurface Drilling and Soil Sampling.

3. Where borings penetrate surface pavements, walkways, or sidewalks, it will be necessary to patch the pavement surface following backfilling. Concrete pavements should be filled with low slump (less than 4 inches) concrete mix. Asphaltic concrete

pavements should be filled with asphaltic concrete patch mix and thoroughly compacted by ramming. The surface of any patch should be screeded level upon completion. In freezing weather, the concrete mix must be protected from freezing for 48 hours after placement.

4. For each abandoned boring, a record on the boring log as well as in the field log book will be provided after the abandonment is completed. The record will include the data listed below; all depths should be measured from the ground surface.

   a. Project name and boring designation

   b. Location with respect to any replacement boring

   c. Open depth prior to grouting and depth to which grout pipe was placed

   d. Copy of the boring log

   e. Description and total quantity of grout used initially

   f. Description and daily quantities of grout used to compensate for settlement

   g. Dates of grouting

   h. Water level prior to grouting and date measured

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 12
SAMPLE HANDLING, DOCUMENTATION, AND TRACKING

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005

W-C PROJECT NUMBER M9602R

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FIGURE 3 EXAMPLE CHAIN-OF-CUSTODY FORM

2.0
PURPOSE AND SCOPE

The purpose of this document is to define the standard procedures for sample handling, documentation, and analysis for the Cannon Air Force Base project. This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This procedure is intended to be used together with the WP and other SOPs and is referenced in all SOPs that apply to sampling.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that samples are handled, documented, and analyzed according to this procedure. The Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for sample handling and documentation according to this procedure. They report their progress and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing sample handling and tracking activities to assure that they are being completed according to this procedure. The W-C Field Task Leader will be designated to assist in this process.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

4.0
PROCEDURES FOR SAMPLE HANDLING, DOCUMENTATION, AND ANALYSIS

4.1 SAMPLE LABELING

All sample labels should be filled out with waterproof ink and numbered. Soil samples collected in stainless steel liners will be capped immediately following collection and a completed label attached. For soil samples collected in jars and sample bottles for groundwater analyses, sample labels should be completed and attached prior to sample collection. A typical sample label is shown as Figure 1.

Labels may be partially completed prior to sample collection. The date, time, sampler's initials, and the sample identification number should not be completed until the time of sample collection. At a minimum, each numbered label shall contain the following information:

- Project/Facility (Cannon)
- Grab or composite sample
- Sampler's company affiliation
- Date and time of sample collection
- Analyses required
- Preservation used
- Sampler's initials
- Filtered (if applicable)
- MRD LIMS No. identified if sample is collected for USACE MRD Laboratory
- Sample identification (see below)

The sample designation for field (analytical) and quality assurance/quality control (QA/QC) samples is a three-letter and seven-digit/letter unique identification for each sample (CAX-YYYY-ZZZ). CAX is the facility and site identifier, with C for Cannon AFB, A for area-of-concern, and X representing the letter identifying a specific AOC. For example, the sample designation for AOC-E would start as CAE-.

The next four digits (YYYY) identify the sampling method and specific sampled location. The first two characters will represent the method of sampling. The following codes will be used for the first two characters:

- HA - hand-auger boring
- SB - soil boring
- SS - surface soil

The last two characters will identify the sample location. Samples from the second soil boring at AOC-E would be identified as CAE-SB02-.

The last set of characters (ZZZ) are the sample identifier. The first number corresponds to the type of sample:

- 0 for soil (analytical)
- 1 for soil MS/MSD
- 2 for field duplicate
- 3 for Missouri River Lab duplicate

Missouri River Lab duplicate samples should be labeled exactly as the sample of which it is a duplicate. The MS/MSD should also be labeled the same as the original sample, but should also have "MS/MSD Extra" written on the label.

The last two numbers correspond to the beginning depth of the sample in feet below ground surface (bgs) for all soil samples. The following is an example of an identification number:

Soil boring no.1 — Approximate depth of the top of sample in feet bgs

CAE - SB01 - 018

Cannon AFB Area-of-Concern E — Soil analytical sample

Multiple soil samples could be collected from the same boring. The last two digits differentiate among these multiple samples and represent the approximate beginning depth at which the sample was collected.

4.2 SAMPLE HANDLING

This section discusses proper sample containers, preservatives, and handling and shipping procedures. Tables 1 and 2 summarize the information contained in this section.

4.2.1 Sampling Containers

Certified, commercially clean sample containers shall be obtained from the contract analytical lab. If appropriate, the bottles shall be labeled by the lab to indicate the type of sample to be collected. Required preservatives (with the exception of sodium thiosulfate) shall be prepared and placed in the bottles for aqueous analyses at the laboratory prior to shipment to the site.

4.2.2 Sample Preservation

All samples will be stored on ice in an insulated cooler immediately following sample collection. Soil samples do not require additional preservation. As noted above, sample containers for aqueous samples will be sent by the laboratory containing the appropriate preservatives.

4.3 SAMPLE HANDLING AND SHIPPING

Sample containers will be placed in plastic storage bags (double bagged in zipper-lock bags) and wrapped in protective packing material (if appropriate). Samples will then be placed in a cooler with ice (double bagged using 1-gallon zipper-lock bags) for shipment to the laboratory. Samples collected in glass containers will be placed on the bottom of the cooler, and the ice will be placed on top of the jars. The drain on the cooler shall be taped shut. The glass containers will be packed in foam liners and bubble packing or styrofoam peanuts to ensure that no breakage occurs during shipment. Samples will be shipped by overnight

express carrier for delivery to the analytical laboratory and to the CMQA laboratory. Custody seals on the cooler will be covered with clear plastic tape.

A completed chain-of-custody form for each cooler will be placed in a zipper-lock bag and taped to the inside of the cooler lid. Coolers will be wrapped with strapping tape at two locations to secure lids. Numbered and signed custody seals shall be placed on the outside of each cooler. In addition, "Fragile" labels and "This Side Up" labels shall be placed on the outside of each cooler containing glass bottles. Put "This Side Up" labels on all four sides and "Fragile" labels on at least two sides. Note that each cooler cannot exceed the weight limit set by the shipper.

4.3.1 Holding Times and Analyses

The holding time is specified as the maximum allowable time between sample collection and analysis and/or extraction, based on the analyte of interest, stability factors, and preservation methods. Samples should be sent by overnight courier service to the laboratory daily after collection.

Chemical constituents which will be analyzed during the field investigation have been identified by AOC in the WP.

4.4 SAMPLE DOCUMENTATION AND TRACKING

This section describes documentation required in the field notes, Daily Quality Control Reports, and sample Chain-of-Custody requirements.

4.4.1 Field Notes

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded with waterproof ink in a permanently bound weatherproof field book with consecutively numbered pages and, if applicable, on field sampling data sheets.

The information in the field book will include the following as a minimum. Additional information is included in the specific SOPs regarding the appropriate data sheets.

- Project name
- Location of sample
- Sampler's signature
- Date and time of sample collection
- Sample identification numbers and sample depth (if applicable)
- Description of samples (matrix sampled), composite or grab sample
- Analysis to be performed
- Number and volume of samples
- Description of QA/QC samples (if collected)
- Sample methods or reference to the appropriate SOP
- Sample handling, including filtration and preservation, as appropriate for samples
- Field observations
- Personnel present

Changes or deletions in the field book should be lined out with a single strike mark, initialed and dated by person making change, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the collector's memory.

Each page of the field book will be signed by the person making the entry. Anyone making entries in another person's field book will sign and date those entries.

4.4.2 A-E Daily Quality Control Report

To supplement the information recorded in the field book, A-E daily quality control reports (DQCRs) will also be maintained at every sampling location. An example of the DQCR is shown as Figure 2. DQCRs will be maintained by members of the field sampling team and cross-checked for completeness at the end of each day by the sampling team members and/or Field Manager. They will be signed and dated by individuals making entries and initialed by the reviewer upon completion. A copy of the DQCR will be delivered to the Base

Environmental Office the morning of the following day. Copies of the DQCR will be forwarded to the Quality Assurance Officer for review and submitted to the USACE Project Manager within 5 days of completion of sampling. If there are any problems, the DQCR will be faxed to the USACE Project Manager on the following morning.

4.4.3 Sample Chain-Of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Information on the custody, transfer, handling, and shipping of samples will be recorded on a Chain-of-Custody (COC) form. An example COC form is shown as Figure 3.

The sample handler will be responsible for initiating and filling out the COC form. The COC will be signed by the sampler when the sampler relinquishes the samples to anyone else. It is not necessary for the shipping company to sign COC; however, the airbill shall be retained by the sample handler for tracking purposes. A COC form will be completed for each set of samples collected daily, and will contain the following information:

- Sampler's signature and affiliation
- Project number
- Date and time of collection
- Sample identification number
- Sample type/matrix
- Grab or composite sample
- Preservative used
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times (laboratory)
- Method of shipment (i.e. Federal Express)

The person responsible for delivery of the samples to the shipping company will sign the COC form, retain the last copy of the three-part COC form, document the method shipment, and send the original and the second copy of the COC form with the sample (taped in a

ziploc bag to inner cooler lid). Upon receipt at the laboratory, the person receiving the samples will sign the COC form and return the second copy to the Project manager. Copies of the COC forms and all custody documentation will be received and kept in the central files. The original COC forms will remain with the samples until final disposition of the samples by the laboratory. The analytical laboratory will dispose of the samples in an appropriate manner 60 to 90 days after data reporting. After sample disposal, a copy of the original COC will be sent to the Project manager by the analytical laboratory to be incorporated into the central files. Sample tracking will be done by using W-C's Sample Information Management System (SIMSII) as described in the Data Management Plan.

TABLE 1

SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOIL SAMPLES

Method	Parameter	No. of Containers / Sample	Minimum Sample Size	Preservation	Holding Time
8260A	Volatile Organics	2 - 4-oz. glass VOA jars with Teflon-lined septa	10 g	4°C	14 days
8270	Semivolatile Organics	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	30 g	4°C	Extract - 14 days Analyze - 40 days
8015	Petroleum Hydrocarbons[3]	2 - 4-oz. glass VOA jars with Teflon-lined septa [1]	30 g	4°C	28 days
6010/7470[2]	TAL Metals	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	200 g	4°C	6 months 28 days Hg
8081	Pesticides/PCBs	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	100 g	4°C	Extract - 14 days Analyze - 40 days
8051	Herbicides	1 - 8-oz. wide-mouth glass jar with Teflon-lined lid [1]	100 g	4°C	Extract - 14 days Analyze - 40 days

[1] 2 - 8-oz. jars are sufficient for Methods 8270, 8081, and 8151, and metals.

[2] Mercury will be analyzed following USEPA Methods 7470/7471

[3] Gasoline range organics (GRO) and diesel range organics (DRO) will be analyzed and reported.

Note: Sample containers will be double-bagged in zipper-lock bags. The bagged packing ice will be placed in double-bagged, 1-gallon, zipper-lock bags.

FIGURE 1

Typical Sample Label

Woodward-Clyde

101 South 108th Ave. Phone (402) 334-8181
Omaha, NE 68154 Fax: (402) 334-1984

Project: Cannon AFB

Sample ID:_____

Analysis: 8260A VOCs

Preservative: 4°C Date:_____

Sampler(s)_____Time:_____

Project _____ Report No. _____
Project No. _____ Date _____

FIGURE 2

Date

_____

W-C DAILY QUALITY CONTROL REPORT

Day	S	M	T	W	TH	F	S

Weather	Bright Sun	Clear	Overcast	Rain	Snow
Temp	To 32	32-50	50-70	70-85	85 up
Wind	Still	Moderate	High	Report No.	
Humidity	Dry	Moderate	Humid		

COE Project Manager _____
Project _____
Project No. _____
Contract No. _____

Subcontractors on Site:
Equipment on Site:
Visitors on Site:
W-C Personnel on Site:
Work Performed (including sampling):

DQCR.frm /dal

Sheet ___ of ___

Quality Control Activities (including field calibrations):
Health and Safety Levels and Activities:
Problems Encountered/Corrective Actions Taken:
Downtime/Standby:
Special Notes:

By _____ Title _____

Woodv Clyde
101 South 1(e., Omaha, NE 68154
(402) 334-8181 Fax (402) 334-1984

FIGI 3
SAMPLE CHAIN OF CUSTODY RECORD

Project Name	Project No.
Project Location	Project Manager
Sampler(s)	Sampling Company

Sample		Type		Sample	Sample*	Sample*	Sampling		Containers		Analytical Parameters								Remarks
Date	Time	Comp.	Grab	Identification	Begin Depth	End Depth	Method	Matrix	No.	Type									

* Only applicable for nonaqueous samples

Signatures	Date	Time	Shipping Details	Special Instructions
Relinquished by:			Method of Shipment	
Received by:			Airbill No.	
Relinquished by:			Lab Address	
Received for Laboratory by:				

White copy - Laboratory Yellow copy - Laboratory Pink copy - W-C

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 14
HEADSPACE ANALYSIS

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005

W-C PROJECT NUMBER M9602R

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2.0
PURPOSE AND SCOPE

This document defines the standard procedures for performing headspace analysis of soil and water samples in the field at Cannon Air Force Base (AFB). This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP) and gives the description of equipment and procedures for field screening of soil and water samples. Samples locations and frequency of collection are specified in WP. This procedure is intended to be used together with the WP and other SOPs.

Applicable SOPs are listed below:

- SOP No. 4 - Groundwater Sampling
- SOP No. 7 - Subsurface Drilling and Sampling
- SOP No. 12 - Sample Handling, Documentation, and Tracking

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that headspace analysis is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

The designated project staff are responsible for completing the headspace analysis process according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing headspace analysis to assure that they are completed according to this procedure. Problems related to headspace analysis are also the responsibility of the W-C Task Leader.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

4.0
HEADSPACE ANALYSIS

4.1 EQUIPMENT LIST

The following equipment is required for headspace analysis:

- Clean glass sample containers
- Paper towels
- Aluminum foil
- Organic vapor analyzer equipped with a photoionization detector (PID) or flame ionization detector (FID)
- Field book
- Waterproof and permanent marking pens
- Daily quality Control Report form (DQCR)

4.2 FIELD SCREENING PROCEDURES

A portion of each soil or water sample will be placed in the appropriate glass container. The container should be filled approximately three-fourths full for water and one-half full for soil. The mouth of the container will be covered with aluminum foil, tightly capped, and the samples will be allowed to equilibrate for 30 minutes. Care must be taken in the selection of soils with respect to consistency and sample placement in the container in order to achieve comparability and consistency. The disposition of the sample in the container will be recorded in the field logbook. All headspace material will be containerized as specified in SOP No. 15 after analysis.

The sample headspace in the container shall be analyzed with an organic vapor analyzer by removing the lid and inserting the instrument probe through the foil liner. Care must be taken in the selection of appropriate foil, placement of the foil on the container, and removal of the lid so as not to compromise the integrity of the seal. If the seal has been compromised, this will be recorded appropriately or a new sample taken if possible.

4.3 ORGANIC VAPOR ANALYZER SELECTION

The selection of the appropriate organic vapor analyzer equipped with either a PID or an FID shall be based on contaminants of concern and/or ambient conditions at the respective site. The lamp selected for the PID, where applicable, will be based on the relative ionization potentials of the expected volatile contaminants. The selected instrument and rationale for use will be recorded on the DQCR and in the field logbook.

4.4 CALIBRATION

The instrument(s) selected for use in accordance with data quality objectives and site requirements shall be calibrated according to the manufacturers recommendations and specifications. These procedures will be attached to this SOP where applicable.

4.5 DOCUMENTATION

All procedures and field conditions shall be recorded on the DQCR and in the field logbook. The record shall include a description of the material being screened as well as site conditions such as humidity and the equilibration time and temperature. The headspace screening results shall be recorded on the HTW boring log.

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 15
INVESTIGATION-DERIVED WASTES

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005

W-C PROJECT NUMBER M9602R

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2.0
PURPOSE AND SCOPE

This document defines the standard procedures for handling and final disposition of Investigation-Derived Wastes (IDW) at Cannon Air Force Base (AFB). This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP).

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that management of investigation-derived waste (IDW) is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

The designated project staff are responsible for handling IDW according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing IDW activities to assure that they are completed according to this procedure. Problems related to equipment decontamination are also the responsibility of the W-C Task Leader.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

4.0
INVESTIGATION DERIVED WASTES

The fieldwork planned at Cannon AFB during the Site Investigation (SI) will produce investigation-derived wastes (IDW). These will consist of the soil from the drilling of soil borings and headspace analysis, the well development/purge water from the monitoring well, and the potable water used to decontaminate the drilling and sampling equipment and personnel, and the used Personnel Protective Equipment (PPE).

5.0
SOIL CUTTINGS

The soil cuttings generated by the drilling and sampling of all soil borings and monitoring wells will be placed into DOT rated 55-gallon drums. Mixing of the cuttings from several borings is permissible in order to fill the drums as full as possible. However, only cuttings from individual AOCs can be mixed, and the splitting of cuttings from one boring into several drums should be avoided. The drums will be sealed and labeled with permanent markings indicating the AOC number, the boring(s) number, the matrix, date, drum ID number, geologist's initials, and the base contact, including phone number. If cuttings from an individual boring must be split, the depths of the cuttings will also be included on the drums. The drums will then be moved to a temporary storage facility designated by Cannon AFB and placed on wooden pallets. Drums from individual AOCs will be segregated from each other as much as possible. Composite samples from the drums will be collected and analyzed and will be used in conjunction with specific sample data to profile the IDW. IDW will be categorized as either nonhazardous and disposed of on site, nonhazardous and disposed of off site, or hazardous. It has been assumed that all IDW will fall in the first two categories. W-C will complete and submit all appropriate paperwork and will arrange for the disposal of all nonhazardous IDW. If the soil is hazardous, the appropriate method of disposal will be discussed and agreed upon by Cannon AFB, USACE, and W-C personnel.

6.0
DECONTAMINATION WATER

During the field activities, equipment used for the various sampling methods will be decontaminated before and after use according to the procedures in SOP No. 1. This water will be containerized and placed into a DOT-rated drum and transported to the temporary storage facility.

It is anticipated that this decontamination water will not have any significant levels of contaminants since it is originally potable water. A headspace analysis will be performed to determine if any significant volatile organic compounds (VOCs) are present. Noncontaminated water will either be discharged onto the ground or into a wastewater lagoon on Cannon AFB as directed by Cannon AFB and USACE personnel. If the decontamination water is not acceptable, it will be characterized further to determine if it is necessary to ship to a licensed hazardous waste facility.

7.0
USED PERSONNEL PROTECTIVE EQUIPMENT

Any personnel protective equipment (i.e., gloves, duct tape, Tyvek, etc.) used during field activities will be placed into 55-gallon drums, sealed, and labeled with the appropriate information. **No mixing of wastes will be allowed (i.e., soil with PPE trash).** PPE from individual AOCs does not need to be segregated. If the drum is not full after the work has been completed at one AOC, PPE from the next AOC may be placed into it.

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NUMBER 17
SURFACE GEOPHYSICAL SURVEYS

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-005

W-C PROJECT NUMBER M9602R

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2.0
PURPOSE AND SCOPE

This document defines the standard operating procedure (SOP) for conducting surface geophysical surveys involving electromagnetic (EM) technique using a Geonics EM-61 instrument. This SOP serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This SOP gives a description of equipment field procedures and data reductions necessary to perform EM-61 surveys. The locations and frequency of surface geophysical surveying are specified in the WP. Oversight and supervision of geophysical surveys will be conducted by a senior level geophysicist.

This procedure is intended to be used together with the WP and other SOPs. For this investigation at Cannon AFB, the surface geophysical techniques will be employed to detect potential buried metallic objects.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assigning project staff to perform the geophysical surveys. The task leader is also responsible for assuring that these and any other appropriate procedures are followed by all project personnel.

The designated project staff assigned to perform geophysical surveys are responsible for completing the geophysical survey according to this and other appropriate procedures. All staff are responsible for reporting deviations or nonconformance of the procedure to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

Only qualified personnel shall be allowed to perform geophysical surveys. Qualifications are based on education, previous experience, or on-the-job training and supervision by another qualified person. Oversight and supervision of the geophysical surveys will be conducted by a trained senior level geophysicist. Project staff performing the surveys will be trained geophysicist or trained personnel with significant geophysical background and experience approved by the senior geophysicist. All staff involved with the geophysical surveys shall have previous experience with data collection and interpretation procedures for the methods used. The Project Manager shall document personnel qualifications related to this procedure in the project QA files.

4.0
EM-61 GEOPHYSICAL SURVEY

The EM-61 is a time domain EM instrument that is specifically designed to detect buried metal objects. The instrument generates rapid EM pulses through a transmitter coil. These pulses induce secondary EM fields in the near subsurface. The secondary EM fields induced from moderately conductive subsurface materials (i.e., soil and rock) are of relatively short duration. However, the secondary EM fields induced from metallic objects such as drums are of relatively long duration. The EM-61 measures this prolonged response from metallic objects after the EM response from conductive earth materials dissipate. The system can provide high resolution of buried metallic targets. Depth of investigation of the instrument is relatively unaffected by site-specific subsurface conditions. The instrument is reportedly capable of detecting a single 55-gallon drum to a depth of 10 feet. The instrument records EM response in units of millivolts. The EM response values are subsequently plotted on a map so that their variation over the site can be analyzed.

4.1 EQUIPMENT LIST

The following is a list of equipment that will be necessary to complete an EM survey:

- Geonics EM-61
- Wood stakes or lath
- Flagging
- Field notebook
- Waterproof and permanent marking pens

4.2 ELECTROMAGNETICS SURVEY PROCEDURES

A standard field procedure for collecting EM data using the Geonics EM-61 is described below; however, for the purposes of this SOP, it is assumed that certain minimum preparations have been made prior to initiation of any data collection:

- Existing and appropriate site, area, and regional subsurface geologic and hydrogeologic information including soil characteristics will be reviewed.

- Known hazards that pose a threat to the safety of field personnel will be defined.

- The purpose and expectations of the subsurface investigation will be defined.

- Appropriate field parameters will be defined, given the purpose of the survey.

- The locations of line endpoints along each line will be surveyed and denoted in the field with lath or other wood stakes.

Design of appropriate field parameters must consider the following:

- Station spacing affects survey resolution. A station spacing of 1 to 5 feet is commonly used. Actual spacing must take required resolution into account.

- Accurate definition of an EM profile anomaly requires four or more anomalous readings.

- Background EM response noise must be evaluated and/or determined to assess the potential usefulness of an EM survey. High noise levels can make interpretation difficult and can cause significant anomalies to be overlooked. Actual background noise must be considered when collecting and interpreting the EM data.

A standard field procedure for conducting an EM survey using the Geonics EM-61 is described below:

- A visual survey along the proposed lines will be conducted. The visual survey will include a review of site utility plans; notation of overhead wires, notation of manhole covers, buried cables, or indications of buried gas lines; and site

locators will confirm the presence of any possible telephone and utility features.

- Excessive amounts or large pieces of metal on the ground surface will be noted in the field notebook.

- The instrument battery will be checked for sufficient charge and the instrument tested using manufacturer's procedures for proper operation.

- If the survey is to be conducted using the measuring wheel trigger mode, the instrument will be calibrated by conducting a test line of set length. Several passes will be conducted along the test line to calibrate the wheel mode trigger distance to the site-specific ground conditions. No other calibration of the EM-61 is required.

- The site survey traverse will be initiated with the EM-61 instrument.

- The obtained EM response values will be recorded in a data logger.

- The above procedure will be continued for each station along the line.

- Data will be downloaded from the data logger to the computer for further analysis.

4.3 DATA REDUCTION AND INTERPRETATION

The standard procedure for reducing and interpreting the EM data obtained using the EM-61 is described below.

- If data were collected using the wheel mode trigger, the data stationing will be corrected using the actual start and end station values.

- EM response values over the surveyed site will be plotted.

- By comparing the results of all plots, the data will be contoured to determine the lateral variations of EM response over the site.

1.0

TITLE PAGE

STANDARD OPERATING PROCEDURE NUMBER 18
SOIL HOMOGENIZATION

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-005

W-C PROJECT NUMBER M9602R

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4.2	PROCEDURE	-5-

2.0
PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure for soil homogenization for the Cannon Air Force Base project. This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This procedure is intended to be used with the WP and other SOPs.

This SOP identifies the procedures for homogenizing soil samples (except for VOC analyses) which accurately depict the conditions at the site.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that soil homogenization is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

The designated project staff are responsible for completing the soil homogenization process according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing homogenization activities to assure that they are completed according to this procedure. Problems related to equipment decontamination are also the responsibility of the W-C Task Leader.

All personal assigned to complete this procedure shall be qualified to perform the portions of the procedures assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

4.0
PROCEDURES

4.1 EQUIPMENT LIST

- Stainless-steel bowl or pan
- Stainless-steel spoon or spatula
- Poly sheeting
- Sample containers
- Disposable nitrile gloves

4.2 PROCEDURE

After the samples for VOC headspace screening (see SOP 14) and VOC laboratory analysis have been collected and placed on ice at 4°C, soil collected for the remaining chemical analyses for each selected interval will be thoroughly mixed before being placed in appropriate sample containers. For surface soil samples not collected with a split-spoon sampler, the soil will be removed from the sampling device and immediately homogenized.

The soil for the sample interval will be placed in a stainless-steel pan or bowl and thoroughly mixed using a stainless-steel or Teflon-coated steel spoon or spatula. The soil or sediment in the pan will be scraped from the sides, corners, and bottom of the pan, rolled to the middle of the pan, and initially mixed. The sample then will be quartered and moved to the four corners of the pan or bowl, and each quarter of the sample will be mixed individually. The soils then will be rolled to the center of the container, and the entire sample mixed again. This procedure will be continued to ensure that all parts of the sample are mixed and that the sample is as homogenous as possible before being placed in the sample containers. An assessment of the completeness of homogenization will be based on the uniformity of color and texture of the entire sample.

Soil samples collected for metals analysis only, may be homogenized on poly sheeting instead of using a stainless-steel bowl. The poly sheeting will be discarded after each sample.

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NUMBER 19
FIELD DOCUMENTATION

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-005

W-C PROJECT NUMBER M9602R

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2.0
PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure for field documentation for the Cannon Air Force Base project. This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This procedure is intended to be used with the WP and the other SOPs. The field document procedures outline the procedures to appropriately document all field activities.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that field documentation is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

The designated project staff are responsible for completing the field documentation process according to this procedure. The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing field documentation activities to assure that they are completed according to this procedure.

The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

4.0
FIELD DOCUMENTATION

Several types of documentation will be prepared in the field to record information concerning soil borings, well installation, and sampling related activities. These will include field logbooks, daily quality control reports, instrument calibration forms, and those forms presented in previous SOPs.

4.1 BORING LOGS

A complete and accurate log entry for each soil boring will be prepared and entered onto a separate boring log. These boring logs will be considered the primary location to record all information obtained during drilling. Each log will include the name of the project, hole number, location of boring, type of sampling equipment, groundwater information, and description of materials. Soil materials will be visually classified using the USCS. Soil descriptions will follow ASTM D 2488-84, etc. Descriptions will be based on visual inspection of the material in the field (refer to SOP 8). Examples of these forms are provided in SOP 8.

4.2 FIELD LOGBOOK

Field observations and readings will be recorded by the field geologist in a bound notebook with pre-numbered pages. This will be done so that the logic of decisions may be traced, or data comparisons may be accomplished once off-site analytical results become available. In addition, the logbook is the legal document for field activities. Indelible ink will be used for all entries. Each page must be signed and dated by the preparer. A brief listing of pertinent data to be recorded in the field notebook includes, but is not limited to the following:

- Date/time
- Sample location
- Weather information
- Instrument calibration data
- Brief descriptions of sample matrices, including any observations

- The number of samples obtained, ID numbers, number and type of containers used, preservation methods used, sampler's name and initials
- Comments, remarks about field activities

4.3 SURVEYING

After soil sampling activities, the location of the boring will be surveyed and marked by the installation of a wooden stake. Soil sample locations will be surveyed to the nearest 0.1 foot.

During the field investigation, each field team will be responsible for completing a Daily Quality Control Report (DQCR). This report will include a description of any problems encountered and any corrective actions taken. These reports also will include information about personnel and equipment at the site, work performed (including samples obtained), weather conditions, safety levels and equipment, and quality control activities. An example of a Daily Quality Control Report form is provided in SOP No. 12.

These reports will be compiled and sent to the CENWO Technical Manager (TM) by regular mail at the end of every work week. However, if problems arise, the A-E shall notify the USACE TM immediately. Each day, all personnel at the site, plus any visitors to the site will be listed on the DQCR. A copy of these reports will be delivered to the Base Environmental Office on a daily basis.

4.4 INSTRUMENT CALIBRATION

Field instruments will be calibrated on a daily basis according to the manufacturer's instructions, as stated in the Work Plan. Calibration documentation will be completed in the field logbook.

Site History:

The history of Cannon AFB is described in Section 2.1 of the QAPP. The area surrounding the sampling locations for this investigation are generally undeveloped with the exception of roadways and perimeter fences.

Previous Investigations and Reports:

Numerous environmental investigations have been completed at Cannon AFB. Reports generated by Woodward-Clyde include:

- Remedial Investigation - Appendix I SWMUs (W-C 1992-1993)
- RFI (Phase I) - Landfills 1 and 2 (W-C 1992-1993)
- RFI (Phase I) - Appendix III SWMUs (W-C 1993)
- RFI (Phase II) - Appendix II SWMUs (W-C 1994-1995)
- RFI (Phase II) - Appendix III SWMUs (W-C 1994-1995)

Previous Monitoring Results:

There are no previous monitoring results for these AOCs.

Known or Suspected Releases at the Site:

there are no known or suspected releases at any of these sites. AOCs -G and -H are being investigated because of disturbances found on historic aerial photographs. AOC-E is being investigated because it is a rubble pile. AOC-F is being investigated because it is an earthen berm used for weapons calibration.

Chemical Hazards

Chemical hazards at AOC-F may include lead, antimony, and arsenic. Exposure routes including inhalation, ingestion, and dermal contact will be minimized by good work practices, proper PPE, and proper decontamination activities.

Physical Hazards

Physical hazards may include slips, trips, and falls, and heat or cold stress. A detailed description of these hazards and hazards associated with drilling are in the attached SOPs.

Working around heavy equipment presents a risk of physical injury and noise exposure.

Biological Hazards - Field personnel are at risk of exposure to insect bites, bee stings, and poisonous plants and snakes.

Hazard Assessment

(X) Heat Stress (attach guidelines)
( ) Cold Stress (attach guidelines)
( ) Explosion/Flammable
( ) Oxygen Deficient
( ) Radiological
(X) Biological

(X) Inorganic Chemicals
(X) Organic Chemicals
(X) Buried/Overhead Utilities
(X Other (Noise)

Overall Hazard Evaluation ( ) High ( ) Medium (X) Low ( ) Unknown

Explanation:

The protocol for workspace monitoring should provide warning if potentially dangerous chemicals are encountered.

Good work practices and the use of appropriate PPE should minimize the risk to physical, chemical, and biological hazards.

Field Investigation Activities Covered Under This Plan

Task Description/Specific Technique-Standard Operating Procedures/Site Location	Type	Primary	Contingency	Schedule/Notes
1. Soil Borings and Surface Soil Sampling, Geophysical Surveys	Intrusive	D	Stop Work	

Site Access and Establishment of Work Zones:

An exclusion zone will be established at least 10 feet around each sampling location. Decontamination will be done at the edge of the exclusion zone or at a centralized location.

General Safety Procedures:

Personnel will use the buddy system

A safety briefing will be held at the beginning of field activities

No eating, drinking, smoking, or other hand-to-mouth activities in the established exclusion zone.

All health and safety incidents are to be reported following W-C Operating Procedure No. HS-102 (attached). In addition, an Accident Investigation Report (USACE Eng From 3394, Sep 89) shall also be submitted in the event of any accident resulting from activities specified in the Health and Safety Plan. A copy of ENG Form 3394 is attached in this plan.

Protectiv ,uipment: (Specify by task. Indicate type and/or material, as necess.)

Tasks: 1

Level: D

[X] **Primary**

Respiratory

- [X] Not Needed
- [ ] SCBA, Airline:
- [ ] APR:
- [ ] Cartridge:
- [ ] Escape Mask:
- [ ] Other:

Head and Eye

- [ ] Not Needed
- [X] Safety Glasses:
- [ ] Face Shield:
- [ ] Goggles:
- [X] Hard Hat: when working with drill rig
- [ ] Other:

Boots

- [ ] Not Needed
- [X] Boots: Steel toe work boots
- [ ] Overboots:

Protective Clothing

- [X] Not Needed
- [ ] Tyvek Coverall:
- [ ] Polycoat Coverall
- [ ] Saranex Coverall
- [ ] Coverall
- [ ] Other:

Gloves

- [ ] Not Needed
- [ ] Undergloves:
- [X] Gloves: Nitrile or Latex (when handling soil)

Other (specify below)

Hearing protection when noise levels are expected to exceed 85 dBA

Monitoring Equipment:

Instrument	Tasks	Action Guidelines	Comments
PID	1	10 ppm in breathing zone; contact HSO.	Calibrate to benzene equivalent with 100 ppm isobutylene.

Emergency Contacts	Name	Telephone	Emergency Contacts	Name	Telephone
Health and Safety Officer	Jeff Hopkins	402/334-8181			
Corporate Health and Safety Officer	Charles Self Phil Jones	318/478-5532 215/542-8300			
On-Site/Client Representative	Sanford Hutsell	505/784/2739			
Fire Department	Cannon AFB	505/784-3117			
Police Department	Cannon AFB	505/784-2667			

Medical Emergency	
Cannon AFB Hospital Building 1400 Cannon AFB, New Mexico	505/784-4033

Directions to Hospital

Cannon AFB (Figure 1)

The Base hospital is located in Building 1400 on Casablanca Avenue on the northwest corner of the Base. The Site Safety Officer is responsible for making sure all personnel have been shown the location of the hospital.

Attach Map With Route To Hospital

Site Health and Safety Plan Approvals

PM Signature: [signature] Date: 1-21-98

BUHSO Signature: [signature] Date: 1-21-98

CHSO Signature: [signature] Date:

Attachments:

(X) Heat Stress (HS-201)
(X) Incident/Accident Reporting (HS-102)

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Standard Operating Procedure No. 3	-	(not used)
Standard Operating Procedure No. 4	-	(not used)
Standard Operating Procedure No. 5	-	(not used)
Standard Operating Procedure No. 6	-	Surface Soil Sampling
Standard Operating Procedure No. 7	-	Subsurface Drilling and Sampling
Standard Operating Procedure No. 8	-	Boring Log Completeion and Lithologic Description of Subsurface Samples
Standard Operating Procedure No. 9	-	Borehole Abandonment
Standard Operating Procedure No. 10	-	(not used)
Standard Operating Procedure No. 11	-	(not used)
Standard Operating Procedure No. 12	-	Sample Handling, Documentation, and Tracking
Standard Operating Procedure No. 13	-	(not used)
Standard Operating Procedure No. 14	-	Headspace Analysis
Standard Operating Procedure No. 15	-	Investigation-Derived Wastes
Standard Operating Procedure No. 16	-	(not used)
Standard Operating Procedure No. 17	-	Surface Geophysical Surveys
Standard Operating Procedure No. 18	-	Soil Homogenization
Standard Operating Procedure No. 19	-	Field Documentation

1.0

TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 1
EQUIPMENT DECONTAMINATION

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005

W-C PROJECT NUMBER M9602R

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2.0
INTRODUCTION

The purpose of this document is to define the standard procedure for equipment decontamination for the Cannon Air Force Base project. This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This procedure is intended to be used with the WP and the other SOPs.

The overall objective of multimedia sampling programs is to obtain samples which accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminant materials can be brought to a sampling location and/or introduced into the medium of interest during the sampling program (e.g., by bailing or pumping of groundwater with equipment previously contaminated at another sampling site). Trace quantities of these materials can contaminate the sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the conditions associated with the site. Decontamination of sampling equipment (e.g., soil sampling equipment) and field support equipment (e.g., drill rigs, vehicles) is required at Cannon Air Force Base to ensure that sampling cross-contamination is prevented, and that on-site contaminants are not carried off site.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that equipment decontamination is conducted according to this procedure. The Project Manager will designate qualified project staff to complete this procedure.

The designated project staff are responsible for completing the equipment decontamination process according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing decontamination activities to assure that they are completed according to this procedure. Problems related to equipment decontamination are also the responsibility of the W-C Task Leader.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

4.0
PROCEDURE

4.1 EQUIPMENT LIST

The following is a list of equipment that may be needed to perform decontamination:

- Brushes
- Wash tubs (minimum of three) or
- 5-gallon buckets (minimum of three)
- Scrapers
- Steam cleaner or high-pressure sprayer (portable)
- Large metal horse trough
- Disposal drums
- Brushes
- Paper towels
- Liquinox detergent (or equivalent)
- Potable tap water
- Deionized water
- Garden-type water sprayers
- Plastic tubing for bailers
- Plastic trash bags

4.2 DECONTAMINATION

4.2.1 Personnel

A temporary personnel decontamination line will be set up around each exclusion zone. If contamination is not encountered, a dry decontamination station may be established which consists of discarding of disposable PPE.

If real-time monitoring instruments indicate that contamination has been encountered (i.e., action levels are exceeded requiring an upgrade from initial PPE levels), or if the initial PPE is B or C, a complete personnel decontamination station will be established.

The temporary decontamination line should provide space to wash and rinse boots, gloves, and all sampling or measuring equipment prior to placing the equipment into a vehicle, and a container to dispose of used disposable items such as gloves, tape, or tyvek (if used).

The decontamination procedure for field personnel shall include:

1. Glove and boot wash in a Liquinox solution
2. Glove and boot rinse
3. Duct tape removal
4. Outer glove removal
5. Coverall removal
6. Respirator removal (if used)
7. Inner glove removal

4.2.2 Sampling Equipment

The following steps will be used to decontaminate small sampling equipment, such as stainless steel trowels, stainless steel bowls, etc.:

- Personnel will dress in suitable safety equipment to reduce personal exposure.

- Gross contamination on equipment will be scraped off at the sampling site.

- Equipment that will not be damaged by water will be either pressure-washed and/or placed in a wash tub or bucket containing Liquinox or low-sudsing detergent along with potable water and scrubbed with a bristle brush or similar utensil. Equipment will be rinsed with tap water in a second wash tub or bucket followed by a double deionized water rinse applied with pump sprayers.

- The water level indicator will be decontaminated using the equipment decontamination procedure described in the third bulleted item. Care will be taken to prevent damage to equipment.

- Rinse and detergent waters will be replaced with new solutions between borings or sample locations.

- Used rinse and detergent water will be contained in 55-gallon drums or holding tanks for storage at Landfill 5 or area designated by Cannon AFB.

Following decontamination, equipment will be placed in a clean area or in clean plastic.

4.2.3 Drilling and Heavy Equipment

Prior to moving onto each area of concern (AOC), drilling and heavy equipment will be decontaminated at the decontamination area (Landfill 5). Between each boring, augers will be decontaminated downslope and a minimum of 50 feet away from sampling locations using a portable steam cleaner and large metal trough. The following steps will be used to decontaminate drilling and heavy equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure.

- Equipment showing gross contamination or having drill cuttings caked on will be scraped off with a flat-bladed scraper at the sampling site.

- Drill rig, augers, drill bits, and shovels will be sprayed with detergent water (heated to at least 160°F) by a high-pressure washer, then rinsed with potable water. Care should be taken to adequately clean the insides of the hollow-stem augers.

- Decontamination water generated at each AOC will be contained in the trough and pumped into drums for storage at the central decontamination station. Soil cuttings generated during drilling will be contained in drums.

- Drums will be labeled with matrix, depth, location, date, AOC and boring numbers, drum I.D. number, geologists' initials, and the Base contact, including phone number.

The designated clean area at Landfill 5 will be protected from potential contamination by several techniques: setting up exclusion zones; setting up temporary decontamination lines around each exclusion zone as needed; scraping gross contamination off equipment at the sampling site; containing used rinse and detergent water in 55-gallon drums or nonleaking holding tanks; containing any soil cuttings in 55-gallon drums; and following decontamination, placing all equipment in clean plastic or designated clean area.

Following decontamination, drilling equipment will be placed on the clean drill rig and moved to the clean area at Landfill 5. If the equipment is not used immediately, it should be stored at the designated clean area at Landfill 5.

4.2.4 Equipment Leaving the Site

Vehicles used for nonconstruction activities shall be cleaned on an as-needed basis as determined by the Site Safety Officer by soap and water on the outside and vacuuming the inside. Cleaning will be required for very dirty vehicles which will be leaving the area. The cleaning shall take place on site. On-site equipment such as drilling rigs will be pressure washed on site before the equipment is removed from the site to limit off-site exposure to potential contaminants.

4.2.5 Wastewater

It will be necessary to contain small volumes of used wash and rinse solutions and transport them to the central decontamination area (Landfill 5). This wastewater will be containerized in labeled drums and stored in a secured area at Landfill 5. The SOP on Investigation-Derived Waste (No. 15) will govern the final disposal of this wastewater.

4.2.6 Other Wastes

Solid wastes such as used personal protective equipment will be collected in drums. When drums are full, they will be sealed. Each drum will be labeled with its contents and the date, using paint or other permanent marker. Drums will be stored in a secured area at Landfill 5 and managed according to SOP No. 15 - Investigation-Derived Wastes.

4.3 DOCUMENTATION

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded with waterproof ink in the sampler's field notebook with consecutively numbered pages. The information entered in the field book concerning decontamination should include the following:

- Decontamination personnel
- Date and start and end times
- Decontamination steps/observations
- Weather conditions
- Waste drum(s) generated and I.D. numbers

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 6
SURFACE SOIL SAMPLING

CANNON AIR FORCE BASE SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005

W-C PROJECT NUMBER M9602R

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3.0
PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure for collecting surface soil samples for the Cannon AFB project. This Standard Operating Procedure (SOP) serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This procedure gives descriptions of equipment, field procedures, and QA/QC procedures necessary to collect surface soil samples. The sample locations and frequency of collection are specified in the WP.

This procedure is intended to be used together with the WP and several other SOPs. Sample identification, labeling, handling, and chain-of-custody procedures are described in SOP No. 12. SOP No. 12 also includes the listing of sample containers, preservatives, and holding times applicable to sample collected using this SOP. SOP No. 1 describes decontamination procedures which are also applicable to this SOP.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that these procedures are followed during field operations by reviewing the field notebooks and analytical data when they are available. The Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for completing the review and reporting progress according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing surface soil sampling activities to assure that they are being completed according to this procedure. Problems related to reporting by the field crew are also the responsibility of the W-C Task Leader.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

5.0
PROCEDURE

5.1 EQUIPMENT LIST

Equipment to be used in surface soil sampling is as follows:

- Stainless steel or Teflon-coated hand auger
- Ruler with 1/10-foot increments
- Field notebook
- Stainless steel knife
- Stainless steel spoons/trowels
- Stainless steel mixing bowl
- Sample containers supplied by analytical laboratory
- Sample container labels
- Cooler with ice
- Clear cellophane tape to cover labels
- Paper towels
- Camera with film
- Waterproof marking pens
- Plastic sheeting
- Plastic bags
- Electric tape
- Health and Safety Equipment as specified in the SSHP

Equipment used during decontamination:

- Liquinox soap (or equivalent)
- Potable tap water
- Deionized or distilled water
- Brushes
- Decontamination buckets/pails
- Several spray or squirt bottles

5.2 SAMPLING PROCEDURES

This section provides step-by-step procedures for surface soil sampling with a hand auger. Observations made during the sampling effort should be recorded in the field notebook.

5.2.1 Equipment Decontamination

Before any samples are taken, the equipment must be decontaminated according to procedures specified in SOP No. 1 and in the Site Safety and Health Plan (SSHP). Sampling equipment will be decontaminated between sampling stations and between collection of samples at different depths at the same location.

5.2.2 Obtaining Surface Soil Samples

Upon arrival at the sampling site, entries will be made into the field notebook describing the sample location number, the general appearance of soil (i.e., noticeable stains etc.) and soil cover (i.e., grass, gravel), the time of sampling, and any unusual phenomenon. A plastic sheet should be placed near the sampling station and all sampling equipment should be placed on this sheet.

Clear any existing vegetation or other foreign matter from the sampling location surface. Using the hand auger or stainless steel spoon/trowel, collect samples from the appropriate depth as specified in the WP. An appropriate amount of sample should be collected for the sample containers. When the sample has been collected, any amount on the side of the hand auger sampler in the smear zone should be removed by using the stainless steel knife. Since loose materials can easily volatize from the 0 to 0.5-foot interval, VOC samples will not be collected from this interval. Correspondingly, the VOC samples should be collected from the other 0.5-foot intervals since the sampler will be driven 2 feet at each sampling depth. The part of the recovered sample collected for volatile organic analysis should be placed into the appropriate sample container as soon as possible. The remainder of the recovered sample should be placed in the mixing bowl as quickly as possible.

With the remaining recovered soil in the mixing bowl, the sample should be homogenized with a decontaminated mixing instrument (e.g., a stainless steel spoon). The remaining

recovered soil should be divided equally into the remaining sample containers. QA/QC sample containers should be filled from the same mixtures as one of the samples. Sample containers shall be labeled in accordance with SOP No. 12 in indelible ink and covered with clear cellophane tape to preserve the integrity of the label.

5.2.3 Field Quality Assurance/Quality Control Procedures and Samples

QA/QC samples are designed to help identify potential sources of sample contamination and evaluate potential error introduced by sample collection and handling. All QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with other samples for analysis. Specific QA/QC samples that will be collected at each site are described in the WP.

Duplicate Samples

Duplicate samples are samples collected to check for the natural sample variance and the consistency of field techniques and laboratory analysis. For surface soil sampling, the initial sample bottles for volatile organics will be filled first, then the sample will be homogenized and the rest of the duplicate bottles filled until all necessary sample bottles for both the initial sample and the duplicate sample have been filled. The duplicate surface soil sample will be handled in the same manner as the primary sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

5.3 SAMPLE HANDLING

Sample containers and preservatives are specified in SOP No. 12, Sample Handling, Documentation, and Analysis. Samples will be labeled and handled as described in SOP No. 12.

5.4 DOCUMENTATION

5.4.1 Field Sampling Data Sheet

A field sampling data sheet will be completed at each sample location (Figure 1). Items not applicable to the sampling will be labeled as not applicable (NA). The information on the data sheet includes the following:

- Sampling location
- Date and time of sampling
- Person performing sampling
- Type of sample
- Type of soil cover
- Depth interval
- Soil type (describe)
- USCS Abbreviation
- Color (describe), staining (describe), odor (describe)
- Sample identification number
- Number of samples taken
- Preservation of samples
- Record of any QC samples from site
- Any irregularities or problems which may have a bearing on sample quality.

5.4.2 Field Notes

Field notes will also be kept during sampling activities. The following information will be recorded in the bound field notebook using waterproof ink:

- Names of personnel
- Weather conditions
- Date and time of sampling
- Location and sample station number
- Times that procedures and measurements are completed
- Decontamination times
- Calibration information

FIGURE 1

Field Sampling Data Sheet for Soil (Surface or Subsurface) Samples

Location Identification: Date: _____

Samplers' Signature: _____ Time: _____

Type of Sample: Surface: _____ Subsurface: _____

Type of Soil Cover: _____

Depth Interval: _____

Sample Identification: _____

Soil type (i.e. sand silt clay) _____

USCS Abbreviation _____

Color _____

Staining _____

Odor _____

Containers	Number	Preservatives

QA/QC Samples Collected: _____

Comments: _____

1.0
TITLE PAGE

STANDARD OPERATING PROCEDURE NO. 7
SUBSURFACE DRILLING AND SAMPLING

CANNON AIR FORCE BASE
SITE INSPECTIONS
CANNON AFB, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005

W-C PROJECT NUMBER M9602R

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2.0
PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods for subsurface drilling and sampling at Cannon Air Force Base. Soil samples will be collected for field screening (i.e., headspace and visual analysis) and identifying the soil types and submitted for chemical analysis.

This SOP serves as a supplement to the Quality Assurance Project Plan (QAPP) and the Work Plan (WP). This SOP is intended to be used with the WP and other SOPs, such as SOP No. 8, Lithologic Description of Subsurface Samples and SOP No. 14, Headspace Analysis.

The step-by-step procedures described herein are sufficiently detailed to allow field personnel to properly perform subsurface drilling and sampling.

3.0
RESPONSIBILITIES AND QUALIFICATIONS

The Woodward-Clyde (W-C) Cannon AFB Project Manager is responsible for assuring that subsurface drilling and sampling are performed in accordance with this Standard Operating Procedure. This Project Manager will designate qualified project staff to complete this procedure and the required reviews.

The designated project staff are responsible for performing subsurface drilling and sampling according to this procedure. They report their progress, and any problems, to the Task Leader or Project Manager. Staff members are responsible for understanding the activities assigned to them and the quality assurance requirements associated with the activities.

The W-C Project QA/QC Officer or designee will be responsible for periodically reviewing the activities associated with this procedure to assure that subsurface drilling and sampling are being completed according to this procedure.

All personnel assigned to complete this procedure shall be qualified to perform the portions of the procedure assigned to them. The Project Manager will make the appraisal of qualifications and will document the qualifications in the project Quality Assurance files. The Project Manager's appraisal of qualifications will include a comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether future training is required, and, if required, by what method. On-the-job training is an acceptable method, provided such training is received from a person qualified to perform the trainee's assignment and the results of that training are documented.

4.1 EQUIPMENT LIST

The following is a list of soil sampling equipment:

- Split-spoon sampler, 3-inch O.D. (stainless steel)
- Cement for grouting (portland cement, Type II or V)
- Stainless steel mixing bowl
- Stainless steel stirring devices
- High-pressure steamer/sprayer (provided by drilling contractor)
- Long-handled bristle brushes
- Wash/rinse tubs
- Liquinox detergent
- Auger rig with appropriate equipment for drilling and sampling
- Weighted tape measure
- Water level probe
- Drums for containment of cuttings
- Appropriate health and safety equipment
- Logbook
- Boring log forms
- Tape (electrical and Teflon)
- Waterproof markers and labels
- Paper towels
- Baggies, ziploc bags
- Large plastic bags

4.2 DRILLING METHOD

Borings will be drilled using a truck-mounted drilling rig utilizing hollow-stem augers. No water may be introduced into the boreholes. No bentonite, barite, polymers, or other additives or viscosifying agents will be introduced into the borehole or used during drilling.

If lubrication is required on the drill pipe joints, Teflon tape or vegetable oil is acceptable. The rig shall be free of leaks which could contaminate the boreholes (i.e., hydraulic fluid, oil, gas, etc.).

Health and Safety equipment specified in the Site Safety and Health Plan (SSHP) will be donned before proceeding with subsurface drilling and soil sampling. The SSHP will specify action levels for various contaminants and the field monitoring required to measure ambient conditions.

All work areas around exploratory borings will be restored to a physical condition equivalent to that of predrilling, as near as practical. This will include drill cuttings removal and rut removal.

All drill cuttings will be containerized and moved to a central secured location for storage. Containers (drums) will be sealed, labeled with a paint pen, and recorded so that their contents can be identified as to material, source, and depth. Multiple drums from that same boring will have approximate depths labeled on each drum. The labeling will be such that it will be legible for the length of time that may transpire before final disposal of the drummed contents. The disposal of soil will be dependent on laboratory analytical results.

4.3 SOIL SAMPLING METHOD

Intact subsurface soil samples will be taken for physical description and chemical analyses. Samples will be collected as outlined in the WP. Sampling will be done in advance of the lead auger to minimize potential cross-contamination. Samples will be collected with a stainless steel split-spoon sampler. The sampler will be driven with a 140-pound hammer and 30-inch drop for a total of 2 feet. Standard blow counts will be recorded for driving the sampler 6, 12, 18, and 24 inches, according to ASTM Method D 1586-84 with the N-value being the sum of the second and third 0.5-foot interval. Provisions will be made to use other sample collection methods if this method results in poor sample recovery in some depth intervals. Soil grab samples for volatile organic analyses will be obtained by subsampling the material retrieved in the split spoon. Subsampling will be done immediately upon opening the split spoon, and shall be done as soon as possible once the split-spoon sample is taken from the boring. The portion of the split-spoon sample which represents slough will

not be sampled. A sample for VOC analysis will be collected at each sampling interval. The VOC samples will be placed into the proper sample container, marked with the boring number and depth, and placed in an iced sample cooler. After completion of the boring, the depth intervals selected for chemical analysis will be retained while the unused intervals will be discarded into the cuttings drum. The soil remaining in the split spoon after VOC sampling at each depth interval will be placed into a new 1-gallon Ziploc bag. After completion of the boring and selection of the depth intervals for chemical analysis, the soil will be removed from the bag and composited. Compositing of soil samples for nonvolatile chemical analyses shall be performed in a stainless steel bowl using stainless steel stirring devices. Soil from intervals not selected for analysis will be placed in the cuttings drum.

Soil samples from split-spoon samplers that are to undergo chemical and geotechnical analyses will be placed in glass or plastic jars with airtight, screw-type lids. A sample volume adequate for the analysis to be conducted will be collected. Minimum information on each sample container will include the project name, date, boring number, sample number, and depth of sample. The CMQAL LMS number will be included on all QA samples. All information that appears on the container will also appear on the boring log. Sample handling, documentation, and analysis procedures are more fully discussed in SOP No. 12.

4.4 DOCUMENTATION

4.4.1 Field Boring Log

A copy of the USACE Omaha District HTW field boring log is shown as Figure 1 in SOP No. 8. The appropriate spaces for drilling method and equipment shall be completed prior to drilling.

4.4.2 Field Sampling Data Sheet

In addition to recording the field sampling data on the HTW boring log, a field sampling data sheet will also be completed at each sample location (Figure 1). Items not applicable to the sampling will be labeled as not applicable (NA). The information on the data sheet includes the following:

- Sampling location
- Date and time of sampling
- Person performing sampling
- Soil type (describe), USCS Abbreviation
- Color (describe), staining (describe), odor (describe)
- Sample identification number
- Number of samples taken
- Preservation of samples
- Type of sample
- Type of soil cover
- Depth interval
- Record of any QC samples from site
- Any irregularities or problems which may have a bearing on sampling quality.

4.4.3 Field Notes

Field notes will also be kept during sampling activities. The following information will be recorded in the bound field notebook using waterproof ink:

- Names of personnel
- Weather conditions
- Date and time of sampling
- Location and sample station number
- Times that procedures and measurements are completed
- Decontamination times
- Calibration information

EPA Region 6

Human Health

Media-Specific Screening Levels

U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, Texas 75202

Screening Levels
Uses and Limitations

- A consultation with a Risk Assessor should take place before making a final decision in the corrective/remedial action process.

- The screening levels should only used in the preliminary stages of the investigations, i.e., screen.

- All values are risk-based with exceptions and their respective basis for the calculations/values noted.

- Risk-based concentrations for carcinogens were calculated at the following risk levels: Class A or B = 10^{-6}, Class C = 10^{-5}, "Blank" = 10^{-6}.

- The screening levels only address human health protection.

- Values do not account for chemical mixtures. If more than one non-carcinogen is expected, than the non-carcinogenic chemical screening level should be divided by 10.

- Exceedance of a screening level does not indicate a required action.

- Unrestricted land use, i.e., residential values should be considered in the initial screening of sites for which future residential land use cannot be definitively ruled out.

- The selection of constituents of potential concern (COPC's) can be conducted against these values once the screening levels for the non-carcinogenic compounds are divided by a factor of 10 to account for chemical mixtures.

- Sources used to compile the screening levels were:

Region IX Preliminary Remediation Goals (PRGs)
- Tap Water Values, Direct soil exposure values.

EPA Region III Risk-Based Concentration Table
- Tap Water and Soil Values labeled "I", Ambient Air Values, Fish Values, Soil Screening Levels

EPA's *Draft Soil Screening Level Guidance*
- Soil screening levels.

EPA Region 6 Current and Proposed National Primary and Secondary Drinking Water Regulations Table
- Drinking values labeled MCL's.

Risk Assessment Guidance for Superfund (RAGS), Health Effects Assessment Summary Tables (HEAST), Agency for Toxic Substances and Disease Registry Toxicological Profiles, and *EPA Provisional Guidance*
- Technical reference documents.

Region 6 Draft Supplemental Guidance to RAGS
- Technical reference documents.

OSWER Directives
- Policy documents, e.g., residential soil lead screening level.

Elemental Composition of Surficial Materials in the Conterminous United States and *OSWER Regional Toxics Coordinators Memorandum* titled "Background Metals in Soil" dated March 14, 1989.
- Soil regional background values.

↑ conc. at 10^{-5}

EPA Region 6
Human Health
Media-Specific Screening Levels

Legend: MCL = Maximum Contaminant Level
SAT = risk-based value above expected saturation point
max = maximum concentration
PEST = Pesticide Herb = Herbicide
VOC = Volatile Organic Compound
SVOC = Semi-Volatile Organic Compound
"Blank" = Missing data for generation of value.

Basis: C= carcinogenic effects N = non-carcinogenic effects
E = EPA draft Soil Screening Level S = soil saturation concentration
M' = EPA MCL I = Ingestion route only

Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Acephate	PEST	C			77 C	7.2 C	3.6 C	510 C	2200 C		
Acetaldehyde					94N I	0.81 C					
Acetochlor	PEST				730 N	73N	27 N	1300 N	14000 N		
Acetone	VOC				610 N	370 N	140 N	2000 N	8400 N	62000 E	8 E
Acetone cyanohydrin					2600 N	150 N	95 N	4600 N	48000 N		
Acetonitrile	VOC				220 N	52 N	8.1 N	390 N	4100 N		
Acetophenone	SVOC				0.04 N	0.021 N	140 N	5600 N	45000N		
Acifluorfen	PEST				470 N	47 N	18 N	850 N	8900 N		
Acrolein	PEST				730 N	0.021 N	27 N	1300N	12000N		
Acrylamide		B2			0.015 C	0.0014 C	0.0007 C	0.098 C	0.41 C		
Acrylic acid					18000 N	1 N	680 N	32000N	SAT		
Acrylonitrile	VOC	B1			0.12 C I	0.026 C	0.0058 C	0.13 C	0.30 C		
Alachlor	PEST			2	0.8 C	0.078 C	0.039 C	5.5 C	24 C		
Alar	PEST				5500 N	550 N	200 N	9800 N	SAT		
Aldicarb	PEST			7	37 N	3.7 N	1.4 N	65 N	680 N	570 S	0.036 M'
Aldicarb sulfone				7	37 N	3.7 N	1.4 N	65N	680 N		
Aldrin	PEST	B2			0.004 C	0.00037 C	0.00019 C	0.026C	0.11 C	0.5 E	0.005 E
Ally					9100 N	910 N	340 N	16000N	SAT		

EPA Region 6
Human Health
Media-Specific Screening Levels

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Basis: C= carcinogenic effects N = non-carcinogenic effects
E = EPA draft Soil Screening Level S = soil saturation concentration
M' = EPA MCL I = Ingestion route only

Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Allyl alcohol	VOC				180 N	18 N	6.8 N	330 N	3400 N		
Allyl chloride	VOC				1800 N	1 N	68 N	3300 N	34000N		
Aluminum			45,000		37000 N	3700 N	1400 N	77000 N	SAT		
Aluminum phosphide	PEST				15 N	1.5 N	0.54 N	31N	680 N		
Amdro	PEST				11 N	1.1 N	0.41 N	21N	200 N		
Ametryn	PEST				330 N	33 N	12 N	590 N	6100 N		
m-Aminophenol					2600 N	260 N	95 N	4600 N	48000N		
4-Aminopyridine	PEST				0.73 N	0.073 N	0.027 N	1.3N	14 N		
Amitraz	PEST				91 N	9.1 N	3.4 N	160 N	1700 N		
Ammonia					1000 N I	100 N					
Ammonium sulfamate	PEST				7300 N	730 N	270 N	13000 N	SAT		
Aniline	SVOC	B2			11 N	1 N	0.55 C	19 C	200 C	45 N	0.031 N
Antimony and compounds				6	15 N	1.5 N	0.54 N	31 N	680 N		
Antimony pentoxide					18 N	1.8 N	0.68 N	38 N	850 N		
Antimony potassium tartrate					33 N	3.3 N	1.2 N	69 N	1500 N		
Antimony tetroxide					15 N	1.5 N	0.54 N	31 N	680 N		
Antimony trioxide					15 N	1.5 N	0.54 N	31 N	680 N		
Apollo	PEST				470 N	47 N	18 N	850 N	8900 N		

EPA Region 6
Human Health
Media-Specific Screening Levels

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-6}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Aramite	PEST	B2	1.1-16.7	50	2.7 C	0.25 C	0.13 C	18 C	76 C		
Arsenic (noncancer)					23 N I	1.1 N	0.41 N	22 N	610 N I	380 E	15 E
Arsenic (as carcinogen)		A			0.04 C	0.00041 C	0.0021 C	0.32 C	2.0 C	380 E	15 E
Arsine					0.52 N I	0.052 N					
Assure	PEST				330 N	33 N	12 N	590 N	6100 N		
Asulam	PEST				1800 N	180 N	68 N	3300 N	34000 N		
Atrazine	PEST			3	0.3 C	0.028 C	0.014 C	2.0 C	8.6 C		
Avermectin B1	PEST				15 N	1.5 N	0.54 N	26 N	270 N		
Azobenzene		B2			0.61 C	0.058 C	0.029 C	4.0 C	17 C		
Barium and compounds			430	2000	2600 N	0.52 N	95 N	5300 N	SAT	SAT	32 E
Baygon	PEST				150 N	15 N	5.4 N	260 N	2700N		
Bayleton	PEST				1100 N	110 N	41 N	2000 N	20000N		
Baythroid	PEST				910 N	91 N	34 N	1600 N	17000 N		
Benefin	PEST				11000 N	1100 N	410 N	20000 N	SAT		
Benomyl	PEST				1800 N	180 N	68 N	3300 N	34000 N		
Bentazon	PEST				91 N	9.1 N	3.4 N	160 N	1700 N		
Benzaldehyde					610 N I	370 N	140 N	6500 N	68000 N		
Benzene	VOC			5	0.4 C	0.22 C	0.11 C	1.4 C	3.2 C	0.5 E	0.02 E

EPA Region 6
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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Benzenethiol					0.37 N I	0.037 N	0.014 N	0.78 N I	20 N I		
Benzidine	SVOC	A			0.0003 C	0.00003 C	0.00001 C	0.002 C	0.008 C	1.3 C	1.1E-06 C
Benzoic acid	SVOC				150000 N	15000 N	5400 N	SAT	SAT	320 S	280 E
Benzotrichloride		B2			0.0052 C	0.00048 C	0.00024 C	0.034 C	0.150 C	0.012 C	0.000073 C
Benzyl alcohol	SVOC				11000 N	1100 N	410 N	20000 N	SAT		
Benzyl chloride		B2			0.066 C	0.037 C	0.019 C	1.4 C	3.9 C	0.5 C	0.00036 C
Beryllium and compounds		B2	0.5-2	4	0.02 C	0.00075 C	0.00073 C	0.14 C	1.10 C	690 E	180 E
Bidrin					3.7 N	0.37 N	0.14 N	6.5 N	68 N		
Biphenthrin (Talstar)	PEST				550 N	55 N	20 N	980 N	10000 N		
1,1-Biphenyl					1800 N	180 N	68 N	3300 N	34000 N	9000 S	110 N
Bis(2-chloroethyl)ether		B2			0.0098 C	0.0054 C	0.0029 C	0.07 C	0.17 C	0.3 E	0.0003 E
Bis(2-chloroisopropyl)ether	SVOC				0.27 C	0.18 C	0.045 C	3.9 C	12 C		
Bis(chloromethyl)ether		A			0.00005 C	0.00003 C	0.00001 C	0.0001 C	0.0003 C	0.00004 C	1.0E-07 C
Bis(2-chloro-1-methylethyl)ether					0.96 C	0.089 C	0.045 C	6.3 C	27 C		
Bis(2-ethylhexyl)phthalate (DEHP)	SVOC				4.8 C	0.45 C	0.23 C	32 C	140 C	210 E	11 E
Bisphenol A					1800 N	180 N	68 N	3300 N	34000 N		
Boron (and borates)			2-100		3300 N	21 N	120 N	5900 N	61000 N		
Boron trifluoride					7.3 N I	0.73 N					

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Bromodichloromethane	VOC	D			0.18 C	0.1 C	0.051 C	1.4 C	3.4 C	1800E	0.3 E
Bromoethene (vinyl bromide)					0.1 C	0.057 C		0.45 C	1.0 C		
Bromoform (tribromomethane)	VOC	B2			2.4 C I	1.6 C	0.4 C	56 C	240 C	46 E	0.5 E
Bromomethane	VOC				8.7 N I	5.2 N	1.9 N	15 N	57 N	2 E	0.1 E
4-Bromophenyl phenyl ether	SVOC				2100 N I	210 N	78 N	4500 N I	120000 N I		
Bromophos					180 N	18 N	6.8 N	330 N	3400 N		
Bromoxynil	PEST				180 N	73 N	27 N	1300 N	14000 N		
Bromoxynil octanoate	PEST				730 N	73 N	27 N	1300 N	14000 N		
1,3-Butadiene		B2			0.011 C	0.0064 C		0.009 C	0.02 N	0.0013 C	0.000072 c
1-Butanol	VOC				3700 N	370 N	140 N	6500 N	68000 N	9700 E	8 E
Butyl benzyl phthalate					7300 N	730 N	270 N	13000 N	SAT	530 E	68 E
Butylate					1800 N	180 N	68 N	3300 N	34000 N		
sec-Butylbenzene	VOC				61 N I	37 N	14 N	780 N I	20000 N I	80 S	0.27 M'
tert-Butylbenzene	VOC				61 N I	37 N	14 N	780 N I	20000 N I		0.27 M'
Butylphthalyl butylglycolate					37000 N	3700 N	1400 N	65000 N	SAT		
Cacodylic acid	PEST				110 N	11 N	4.1 N	200 N	2000 N		
Cadmium and compounds			0.01-1.0	5	18 N	0.00099 C	0.68 N	38 N	850 N	920 E	6 E
Caprolactam					18000 N	1800 N	680 N	33000 N	SAT		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*		*Risk-Based Screening Levels*					*Soil Screening Level Transfers from Soil to:*	
				Drinking Water (MCL's)	*Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)*			
								Residential	*Industrial*	*Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Captafol	PEST				7.8 C	0.73 C	0.37 C	52 N	220 C		
Captan	PEST				19 C	1.8 C	0.9 C	130 C	550 C		
Carbaryl	PEST				3700 N	370 N	140 N	6500 N	68000 N	0.34 S	23 N
Carbofuran	SVOC			40	180 N	18 N	6.8 N	330 N	3400 N		
Carbon disulfide					21 N	730 N	140 N	16 N	52 N	11 E	14 E
Carbon tetrachloride				5	0.2 C	0.12 C	0.024 C	0.47 C	1.1 C	0.2 E	0.03 E
Carbosulfan	PEST				370 N	37 N	14 N	650 N	6800 N		
Carboxin	PEST				3700 N	370 N	140 N	6500 N	68000 N		
Chloral					73 N	7.3 N	2.7 N	130 N	1400 N		
Chloramben	PEST				550 N	55 N	20 N	980 N	10000 N		
Chloranil					0.17 C	0.016 C	0.0078 C	1.1 C	4.7 C		
Chlordane	PEST			2	0.05 C	0.0049 C	0.0024 C	0.34 C	1.5 C	10 E	2 E
Chlorimuron-ethyl					730 N	73 N	27 N	1300 N	14000 N		
Chlorine					3700 N	370 N	140 N	7700 N	SAT		
Chlorine dioxide	PEST				2.1 N I	0.21 N					
Chloroacetaldehyde					250 N I	25 N	9.3 N	540 N I	14000 N I		
Chloroacetic acid					73 N	7.3 N	2.7 N	130 N	1400 N		
2-Chloroacetophenone					0.05 N	0.031 N		0.07 N	0.27 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
4-Chloroaniline Chlorobenzene Chlorobenzilate	SVOC VOC PEST				150 N 39 N 0.25 C	15 N 21 N 0.023 C	5.4 N 27 N 0.012 C	260 N 160 N 1.6 C	2700 N 570 N 7.1 C	1200 S 94 E	0.3 E 0.6 E
p-Chlorobenzoic acid 4-Chlorobenzotrifluoride 2-Chloro-1,3-butadiene					7300 N 730 N 14 N	730 N 73 N 7.3 N	270 N 27 N 27 N	13000 N 1300 N 6.3 N	SAT 14000 N 21 N	86 N	7.5 N
1-Chlorobutane Chlorodibromomethane 1-Chloro-1,1-difluoroethane	VOC VOC				2400 N 0.13 C I 87000 N	1500 N 0.075 C 52000 N	540 N 0.038 C	810 S 7.6 C I	810 S 68 C I	1900 E	0.2 E
Chlorodifluoromethane Chloroethane 2-Chloroethyl vinyl ether	VOC VOC VOC				87000 N 8600 N 150 N I	52000 N 10000 N 91 N	540 N 34 N	350 S 31000 N I 2000 N I	350 S SAT 51000 N I	2600 S	33 N
Chloroform Chloromethane 4-Chloro-2,2-methylaniline hydrochloride	VOC VOC	B2			0.16 C 1.5 C 0.15 C	0.078 C 0.99 C 0.014 C	0.52 C 0.24 C 0.0069 C	0.53 C 2.0 C 0.77 C	1.1 C 4.3 C 3.3 C	0.2 E 0.063 C	0.3 E 0.0066 C
4-Chloro-2-methylaniline beta-Chloronaphthalene o-Chloronitrobenzene	SVOC				0.12 C 2900 N 0.42 C I	0.011 C 290 N 0.25 C	0.0054 C 110 N 0.13 C	0.97 C 5200 N 18 C	4.1 C 55000 N 76 C	2.8 S	140 N

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
p-Chloronitrobenzene					0.59 C I	0.35 C	0.18 C	25 C	110 C		
2-Chlorophenol	SVOC				180 N	18 N	6.8 N	330 N	3400 N	53000 E	2 E
2-Chloropropane					170 N	100 N		350 N	1300 N	22 N	0.64 N
Chlorothalonil	PEST				6.1 C	0.57 C	0.29 C	41 C	170 C		
o-Chlorotoluene					120 N	73 N	27 N	340 N	1600 S	1200 N	5.6 N
Chlorpropham	PEST				7300 N	730 N	270 N	13000 N	SAT		
Chlorpyrifos	PEST				110 N	11 N	4.1 N	200 N	2000 N		
Chlorpyrifos-methyl	PEST				370 N	37 N	14 N	650 N	6800 N		
Chlorsulfuron	PEST				1800 N	180 N	68 N	3300 N	34000 N		
Chlorthiophos					29 N	2.9 N	1.1 N	52 N	550 N		
Total Chromium (1/6 ratio Cr VI/Cr III)			38	100	37000 N I	0.0021 N	1400 N	210 N	1600 N		
Chromium VI and compounds		A			180 N	0.00015 C	6.8 C	31 C	230 C	140 E	19 E
Coal tar	PEST					0.0028 C					
Cobalt			8		2200 N I	220 N	81 N	4700 N I	SAT		
Coke Oven Emissions		A				0.0029 C					
Copper and compounds			20		1400 N	150 N	54 N	2800 N	63000 N		
Crotonaldehyde		C			0.006 C	0.033 C	0.017 C	0.1 C	0.3 C		
Cumene					19 N	9.4 N	54 N	49 N	160 N	81 N	65 N

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level:* *A/B= 10^{-4}* *C= 10^{-5}* *Blank= 10^{-6}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Cyanides: Barium cyanide Calcium cyanide					3700 N 1500 N	370 N 150 N	140 N 54 N	7700 N 3100 N	SAT 68000 N		
Copper cyanide Cyanazine Cyanogen	PEST				180 N 0.08 C 1500 N	18 N 0.0075 C 150 N	6.8 N 0.0038 C 54 N	380 N 130 C 2600 N	8500 N 2.3 C 27000 N		
Cyanogen bromide Cyanogen chloride Free cyanide					3300 N 1800 N 730 N	330 N 180 N 73 N	120 N 68 N 27 N	5900 N 3300 N 1300 N	SAT 34000 N 14000 N		
Hydrogen cyanide Potassium cyanide Potassium silver cyanide					6.2 N 1800 N 7300 N	3.1N 180 N 730 N	27 N 68 N 270 N	1600 N I 3300 N 13000 N	41000 N I 34000 N SAT		
Silver cyanide Sodium cyanide Thiocyanate					3700 N 1500 N 730 N I	370 N 150 N 73 N	140 N 54 N 27 N	6500 N 2600 N 1600 N I	SAT 27000 N 41000 N I		
Zinc cyanide Cyclohexanone Cyclohexlamine					1800 N 180000 N 7300 N	180 N 18000 N 730 N	68 N 6800 N 270 N	3300 N SAT 13000 N	34000 N SAT SAT		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Cyhalothrin/Karate Cypermethrin Cyromazine	PEST PEST				180 N 370 N 270 N	18 N 37 N 27 N	6.8 N 14 N 10 N	330 N 650 N 490 N	3400 N 6800 N 5100 N		
Dacthal Dalapon Danitol	PEST HERB			200	370 N I 1100 N 18 N	37 N 110 N 91 N	14 N 41 N 34 N	33000 N 2000 N 33 N	SAT 20000 N 340 N		
DDD DDE DDT	PEST PEST PEST	B2 B2 B2			0.28 C 0.2 C 0.2 C	0.026 C 0.018 C 0.018 C	0.013 C 0.0093 C 0.0093 C	1.9 C 1.3 C 1.3 C	7.9 C 5.6 C 5.6 C	37 S 10 S 80 E	0.7 E 0.5 E 1 E
Decabromodiphenyl ether Demeton Diallate	 PEST PEST				61 N I 1.5 N 0.17 C I	37 N 0.15 N 0.1 C	14 N 0.054 N 0.052 C	650 N 2.6 N 7.3 C	6800 N 27 N 31 C		
Diazinon Dibenzofuran 1,4-Dibromobenzene	PEST SVOC				33 N 150 N 61 N I	3.3 N 15 N 37 N	1.2 N 5.4 N 14 N	59 N 260 N 650 N	610 N 2700 N 6800 N	5400 S 120 S	2.8 N 120 S
1,2-Dibromo-3-chloropropane 1,2-Dibromoethane Dibutyl phthalate	VOC VOC	 B2			0.048 C 0.00076 C 3700 N	0.21 N 0.0081 C 370 N	0.0023 C 0.00004 C 140 N	0.32 C 0.005 C 6500 N	1.4 C 0.02 C 68000 N	1.9 N 0.0058 C 100 E	0.00061 M' 0.00018 M' 120 E

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-6}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Dicamba	PEST				1100 N	110 N	41 N	2000 N	20000 N		
1,2-Dichlorobenzene	VOC				270 N I	150 N	120 N	2300 S	2300 S	300 E	6 E
1,3-Dichlorobenzene	VOC			600	540 N	320 N	120 N	2800 S	2800 S		
1,4-Dichlorobenzene	VOC			75	0.5 C	0.26 C	0.13 C	7.4 C	21 C	7700 E	1 E
3,3'-Dichlorobenzidine	SVOC	B2			0.15 C	0.014 C	0.007 C	0.99 C	4.2 C	52 S	0.01 E
1,4-Dichloro-2-butene					0.0012 C	0.00067 C		0.007 C	0.02 C		
Dichlorodifluoromethane	VOC				390 N	210 N	270 N	110 N	350 S	37 N	7.5 N
1,1-Dichloroethane	VOC				810 N	520 N	140 N	840 N	3900 S	980 E	11 E
1,2-Dichloroethane (EDC)	VOC	B2		5	0.12 C	0.069 C	0.035 C	0.44 C	0.98 C	0.3 E	0.01 E
1,1-Dichloroethylene	VOC	C		7	0.5 C	0.36 C	0.053 C	0.4 C	0.8 C	0.04 E	0.03 E
1,2-Dichloroethylene (cis)	VOC			70	61 N	37 N	14 N	59 N	200 N	1500 E	0.2 E
1,2-Dichloroethylene (trans)	VOC			100	120 N	73 N	27 N	170 N	600 N	3600 E	0.3 E
1,2-Dichloroethylene (mixture)	VOC				55 N	33 N	12 N	75 N	270 N		
2,4-Dichlorophenol	SVOC				110 N	11 N	4.1 N	200 N	2000 N	4800 S	0.5 E
2,4-Dichlorophenoxyacetic Acid (2,4-D)	HERB			70	370 N	37 N	14 N	650 N	6800 N	7000 S	1.7 M'
4-(2,4-Dichlorophenoxy)butyric Acid (2.4-DB)	HERB				290 N	29 N	11 N	520 N	5500 N		
1,2-Dichloropropane	VOC			5	0.16 C	0.092 C	0.046 C	0.7 C	1.5 C	11 E	0.02 E
2,3-Dichloropropanol	VOC				110 N	11 N	4.1 N	200 N	2000 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*		*Risk-Based Screening Levels*					*Soil Screening Level Transfers from Soil to:*	
				Drinking Water (MCL's)	*Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)*		*Air*	*Ground Water*
								Residential	*Industrial*		
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
1,3-Dichloropropene Dichlorvos Dicofol	PEST PEST PEST	B2 B2			0.081 C 0.23 C 0.15 C	0.048 C 0.022 C 0.014 C	0.018 C 0.011 C 0.0072 C	0.51 C 1.5 C 1.0 C	1.2 C 6.6 C 4.3 C	0.1 E 3.5 C	0.001 E 0.00072 C
Dicyclopentadiene Dieldrin Diesel emissions	PEST	B2			0.42 N 0.0042 C 52 N I	0.21 N 0.00039 C 5.2 N	41 N 0.0002 C	2300 N I 0.03 C	61000 N I 0.12 C	2 E	0.001 E
Diethyl phthalate Diethylene glycol, monobutyl ether Diethylene glycol, monoethyl ether	SVOC				29000 N 210 N 73000 N	2900 N 21 N 7300 N	1100 N 2700 N	52000 N 370 N SAT	SAT 3900 N SAT	520 E	110 E
Diethylformamide Di(2-ethylhexyl)adipate Diethylstilbestrol				400	400 N 56 N 0.00001 C	40 N 5.2 C 1.3E-06 C	15 N 2.6 C 7.0E-07 C	720 N 370 C 9.5E-05 C	7500 N 1600 C 4.1E-04 C		
Difenzoquat (Avenge) Diflubenzuron 1,1-Difluoroethane	PEST PEST				2900 N 730 N 69000 N	290 N 73 N 42000 N	110 N 27 N	5200 N 1300 N	55000 N 14000 N		
Diisopropyl methylphosphonate (DIMP) Dimethipin Dimethoate	 PEST PEST				2900 N 730 N 7.3 N	290 N 73 N 0.73 N	110 N 27 N 0.27 N	5200 N 1300 N 13 N	55000 N 14000 N 140 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-6} C= 10^{-5} Blank= 10^{-6}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
3,3'-Dimethoxybenzidine Dimethylamine 2,4-Dimethylaniline hydrochloride	SVOC PEST				4.8 C 0.04 N 0.12 C	0.45 C 0.021 N 0.011 C	0.23 C 0.0054 C	32 C 0.062 N 0.8 C	140 C 0.23 N 3.3 C		
2,4-Dimethylaniline N-N-Dimethylaniline 3,3'-Dimethylbenzidine	 SVOC				0.09 C 73 N 0.0073 C	0.0083 C 7.3 N 0.00068 C	0.0042 C 2.7 N 0.00034 C	0.6 C 130 N 0.05 C	2.5 C 1400 N 0.21 C	29 C	0.00039 C
N,N-Dimethylformamide 1,1-Dimethylhydrazine 1,2-Dimethylhydrazine					3700 N 0.026 C 0.0018 C	31 N 0.0018 C 0.00017 C	140 N 0.0012 C 0.00009 C	6500 N 0.17 C 0.01 C	68000 N 0.73 C 0.05 C		
2,4-Dimethylphenol 2,6-Dimethylphenol 3,4-Dimethylphenol	SVOC				730 N 22 N 37 N	73 N 2.2 N 3.7 N	27 N 0.81 N 1.4 N	1300 N 39 N 65 N	14000 N 410 N 680 N	5400 S	3 E
Dimethyl phthalate Dimethyl terephthalate 1,2-Dinitrobenzene	SVOC SVOC				370000 N 3700 N 15 N	37000 N 370 N 1.5 N	14000 N 140 N 0.54 N	SAT 6500 N 26 N	SAT 68000 N 270 N	1600 E	1200 E
1,3-Dinitrobenzene 1,4-Dinitrobenzene 4,6-Dinitro-o-cyclohexyl phenol	SVOC SVOC				3.7 N 15 N 73 N	0.37 N 1.5 N 7.3 N	0.14 N 0.54 N 2.7 N	6.5 N 26 N 130 N	68 N 270 N 1400 N		

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Human Health
Media-Specific Screening Levels

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
2,4-Dinitrophenol Dinitrotoluene mixture 2,4-Dinitrotoluene	SVOC SVOC SVOC	B2			73 N 0.099 C 73 N	7.3 N 0.0092 C 7.3 N	2.7 N 0.0046 C 2.7 N	130 N 0.65 C 130 N	1400 N 2.8 C 1400 N	360 N 120 S	0.1 E 0.2 E
2,6-Dinitrotoluene Dinoseb di-n-Octyl phthalate	SVOC HERB SVOC			7	37 N 37 N 730 N	3.7 N 3.7 N 73 N	1.4 N 1.4 N 27 N	65 N 65 N 1300 N	680 N 680 N 14000 N	370 S SAT	0.1 E SAT
1,4-Dioxane Diphenamid Diphenylamine	VOC PEST SVOC	B2			1.0 C 1100 N 910 N	0.57 C 110 N 91 N	0.29 C 41 N 34 N	14 C 2000 N 1600 N	37 C 20000 N 17000 N		
1,2-Diphenylhydrazine Diquat Direct black 38	SVOC PEST	B2		20	0.084 C 80 N 0.0078 C	0.0081 C 8 N 0.00073 C	0.0039 C 3 N 0.00037 C	0.6 C 140 N 0.05 C	2.4 C 1500 N 0.2 C		
Direct blue 6 Direct brown 95 Disulfoton	 PEST				0.0083 C 0.0072 C 1.5 N	0.00077 C 0.00067 C 0.15 N	0.00039 C 0.00034 C 0.054 N	0.06 C 0.05 C 2.6 N	0.2 C 0.2 C 27 N		
1,4-Dithiane Diuron Dodine	 PEST PEST				370 N 73 N 150 N	37 N 7.3 N 15 N	14 N 2.7 N 5.4 N	650 N 130 N 260 N	6800 N 1400 N 2700 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Endosulfan Endothall Endrin	PEST PEST PEST			100 2	1.8 N 730 N 11 N	22 N 73 N 1.1 N	8.1 N 27 N 0.41 N	3.3 N 1300 N 21 N	34 N 14000 N 200 N	1 S 16 S	3 E 0.4 E
Epichlorohydrin 1,2-Epoxybutane Ethephon (2-chloroethyl phosphonic acid)	VOC PEST	B2			2.0 N 210 N 180 N	1 C 21 N 18 N	0.32 C 6.8 N	8.6 C 370 N 330 N	31 C 3900 N 3400 N		
Ethion 2-Ethoxyethanol acetate 2-Ethoxyethanol	PEST				18 N 11000 N 15000 N	1.8 N 1100 N 210 N	0.68 N 410 N 540 N	33 N 20000 N 26000 N	340 N SAT SAT		
Ethyl acrylate EPTC (S-Ethyl dipropylthiocarbamate) Ethyl acetate	VOC				0.23 C 910 N 33000 N	0.13 C 91 N 3300 N	0.066 C 34 N 1200 N	0.5 C 1600 N 59000 N	1.0 C 17000 N SAT		
Ethylbenzene Ethylene cyanohydrin Ethylene diamine	VOC			70	1300 N 11000 N 730 N	1000 N 1100 N 73 N	140 N 410 N 27 N	2900 S 20000 N 1300 N	3100 S SAT 14000 N	260 E	5 E
Ethylene glycol Ethylene glycol, monobutyl ether Ethylene oxide	VOC				73000 N 210 N 0.024 C	7300 N 21 N 0.018 C	2700 N 0.0031 C	130000 N 370 C 0.12 C	SAT 3900 C 0.3 C		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Ethylene thiourea (ETU) Ethyl ether Ethyl methacrylate	VOC				0.11 C 1200 N 550 N	0.053 C 730 N 330 N	0.027 C 270 N 120 N	0.7 C 3800 S 340 S	3.2 C 3800 S 340 S		
Ethyl p-nitrophenyl phenylphosphorothioate Ethylnitrosourea Ethylphthalyl ethyl glycolate					0.37 N 0.00048 C I 110000 N	0.037 N 0.00005 C 11000 N	0.014 N 0.00002 C 4100 N	0.7 N 0.005 C I SAT	6.8 N 0.041 C I SAT		
Express Fenamiphos Fluometuron	PEST PEST PEST				290 N 9.1 N 470 N	29 N 0.91 N 47 N	11 N 0.34 N 18 N	520 N 16 N 850 N	5500 N 170 N 8900 N		
Fluoride Fluoridone Flurprimidol	PEST PEST			4000	2200 N 2900 N 730 N	220 N 290 N 73 N	.81 N 110 N 27 N	3900 N 5200 N 1300 N	41000 N 55000 N 14000 N		
Flutolanil Fluvalinate Folpet	PEST PEST PEST	B2			2200 N 370 N 19 C	220 N 37 N 1.8 C	81 N 14 N 0.9 C	3900 N 650 N 130 C	41000 N 6800 N 550 C		
Fomesafen Fonofos Formaldehyde	PEST PEST	C			3.5 C 73 N 5500 N	0.33 C 7.3 N 0.14 C	0.17 C 2.7 N 270 N	23 C 130 N 9800 N	100 C 1400 N SAT		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Formic Acid Fosetyl- Al Furan	PEST				73000 N 110000 N 37 N	7300 N 11000 N 3.7 N	2700 N 4100 N 1.4 N	SAT SAT 65 N	SAT SAT 680 N		
Furazolidone Furfural Furium	PEST				0.018 C 110 N 0.0013 C	0.0016 C 52 N 0.00013 C	0.00083 C 4.1 N 0.00006 C	0.12 C 200 N 0.009 C	0.5 C 2000 N 0.04 C		
Furmecyclox Glufosinate-ammonium Glycidaldehyde		B2			2.2 C 15 N 15 N	0.21 C 1.5 N 1 N	0.11 C 0.54 N 0.54 N	15 C 26 N 26 N	64 C 270 N 270 N		
Glyphosate Haloxyfop-methyl Harmony	PEST PEST			700	3700 N 1.8 N 470 N	370 N 0.18 N 47 N	140 N 0.068 N 18 N	6500 N 3.3 N 850 N	68000 N 34 N 8900 N		
HCH (alpha) HCH (beta) HCH (gamma) Lindane	PEST PEST PEST	B2 C		 0.2	0.011 C 0.37 C 0.05 C	0.00099 C 0.035 C 0.0048 C	0.0005 C 0.018 C 0.0024 C	0.07 C 3 C 0.34 C	0.3 C 11 C 1.5 C	0.9 E 16 E 4.2 C	0.0004 E 0.002 E 0.006 E
HCH-technical Heptachlor Heptachlor epoxide	PEST PEST PEST	B2 B2 B2		 0.1 0.2	0.037 C 0.2 C 0.007 C	0.0035 C 0.0014 C 0.00069 C	0.0018 C 0.0007 C 0.00035 C	0.3 C 0.1 C 0.05 C	1.1 C 0.4 C 0.2 C	 0.3 E 1 E	 0.06 E 0.03 E

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Hexabromobenzene Hexachlorobenzene Hexachlorobutadiene	PEST VOC	B2 C		1	12 N I 0.04 C 8.6 C	7.3 N 0.0039 C 0.81 C	2.7 N 0.002 C 0.4 C	130 N 0.3 C 57 C	1400 N 1.2 C 240 C	1 E 1 E	0.8 E 0.1 E
Hexachlorocyclopentadiene Hexachlorodibenzo-p-dioxin mixture Hexachloroethane	PEST VOC	B2 C		50	260 N 0.00001 C 48 C	0.073 N 1.4E-06 C 4.5 C	9.5 N 5.0E-07 C 2.3 C	450 N 7.2E-05 C 320 C	4700 N 3.1E-04 C 1400 C	2 E 49 E	10 E 0.2 E
Hexachlorophene Hexahydro-1,3,5-trinitro-1,3,5-triazine 1,6-Hexamethylene diisocyanate	SVOC	C			11 N 6.1 C 0.1 N	1.1 N 0.57 C 0.01 N	0.41 N 0.29 C	20 N 40 C	200 N 170 C		
n-Hexanex Hexazinone Hydrazine, hydrazine sulfate	PEST	B2			350 N I 1200 N 0.022 C	210 N 120 N 0.00037 C	81 N 45 N 0.0011 C	4700 N I 2200 N 0.2 C	SAT 22000 N 0.6 C	32 N	13 N
Hydrogen chloride Hydrogen sulfide Hydroquinone					210 N I 1.8 N 1500 N	21 N 1 N 150 N	4.1 N 54 N	6100 N I 2600 N	230 N I 27000 N		
Imazalil Imazaquin Iprodione	PEST PEST PEST				470 N 9100 N 1500 N	47 N 910 N 150 N	18 N 340 N 54 N	850 N 16000 N 2600 N	8900 N SAT 27000 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Iron					11000 N I	1100 N	410 N	23000 N I	SAT		
Isobutanol	VOC				1800 N I	1100 N	410 N	20000 N	SAT		
Isophorone	PEST	C			710 C	66 C	33 C	4700 C	20000 C	3400 E	0.2 E
Isopropalin	PEST				550 N	55 N	20 N	980 N	10000 N		
Isopropyl methyl phosphonic acid					3700 N	370 N	140 N	6500 N	68000 N		
Isoxaben					1800 N	180 N	68 N	3300 N	34000 N		
Lead			10-18		(Uptake	Biokinetic	Model)	400 N	2000 N		
Kepone	PEST				0.0037 C	0.00035 C	0.00018 C	0.03 C	0.1 C		
Lactofen	PEST				73 N	7.3 N	2.7 N	130 N	1400 N		
Linuron	PEST				73 N	7.3 N	2.7 N	130 N	1400 N		
Lithium					730 N	73 N	27 N	1500 N	34000 N		
Londax	PEST				7300 N	730 N	270 N	13000 N	SAT		
Malathion	PEST				730 N	73 N	27 N	1300 N	14000 N		
Maleic anhydride	SVOC				3700 N	370 N	140 N	6500 N	68000 N		
Maleic hydrazide	PEST				18000 N	1800 N	680 N	33000 N	SAT		
Malononitrile	VOC				0.73 N	0.073 N	0.027 N	1.3 N	14 N		
Mancozeb	PEST				1100 N	110 N	41 N	2000 N	20000 N		
Maneb	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Manganese and compounds			389-850		180 N	0.052 N	6.8 N	380 N	8300 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Mephosfolan					3.3 N I	0.33 N	0.12 N	5.9 N	180 N I		
Mepiquat chloride	PEST				1100 N I	110 N	41 N	2000 N	61000 N I		
Mercuric chloride	PEST				11 N I	1.1 N	0.41 N	23 N I	610 N I		
Mercury (inorganic)			0.10	2	11 N	0.31 N	0.41 N	23 N	510 N	7 E	3 E
Mercury (methyl)					3.7 N I	0.37 N	0.14 N	20 N	200 N I		
Merphos	PEST				1.1 N	0.11 N	0.041 N	2.0 N	21 N		
Merphos oxide	PEST				1.1 N	0.11 N	0.041 N	2.0 N	20 N		
Metalaxyl	PEST				2200 N	220 N	81 N	3900 N	41000 N		
Methacrylonitrile	VOC				1.0 N	0.73 N	0.14 N	1.3 N	5.1 N		
Methamidophos	PEST				1.8 N	0.18 N	0.068 N	3.3 N	34 N		
Methanol	VOC				18000 N	1800 N	680 N	33000 N	SAT		
Methidathion	PEST				37 N	3.7 N	1.4 N	65 N	680 N		
Methomyl	PEST				910 N	91 N	34 N	1600 N	17000 N		
Methoxychlor	PEST			40	180 N	18 N	6.8 N	330 N	3400 N	41 S	62 E
2-Methoxyethanol acetate					73 N	7.3 N	2.7 N	130 N	1400 N		
2-Methoxyethanol					37 N	21 N	1.4 N	65 N	680 N		
2-Methoxy-5-nitroaniline					1.5 C	0.14 C	0.069 C	9.7 C	41 C		
Methyl acetate					6100 N	3700 N	1400 N	20000 N	84000 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Methyl acrylate					1100 N I	110 N	41 N	150 N	520 N		
2-Methylaniline hydrochloride					0.37 C	0.035 C	0.018 C	2.5 C	11 C		
2-Methylaniline					0.28 C	0.026 C	0.013 C	1.9 C	7.9 C		
Methyl chlorocarbonate					37000 N	3700 N	1400 N	65000 N	SAT		
4-(2-Methyl-4-chlorophenoxy) butyric acid	HERB				370 N	37 N	14 N	650 N	6800 N		
2-Methyl-4-chlorophenoxyacetic acid	HERB				18 N	1.8 N	0.68 N	33 N	340 N		
2-(2-Methyl-1,4-chlorophenoxy)propionic acid	HERB				37 N	3.7 N	1.4 N	65 N	680 N		
Methylcyclohexane					31000 N	3100 N		56000 N	SAT	60 S	1500 N
Methylene bromide					61 N I	37 N	14 N	650 N	6800 N		
Methylene chloride	VOC				4.3 C	3.8 C	0.42 C	11 C	25 C	7 E	0.01 E
4,4'-Methylene bis(2-chloroaniline)					0.52 C	0.048 C	0.024 C	3.4 C	15 C		
4,4'-Methylenebisbenzeneamine					0.27 C	0.025 C	0.013 C	1.8 C	7.6 C		
4,4'-Methylene bis(N,N'-dimethyl)aniline		B2			1.5 C	0.14 C	0.069 C	9.7 C	41 C		
4,4'-Methylenediphenyl isocyanate					0.035 N I	0.021 N		0.37 N	3.9 N		
Methyl ethyl ketone					1900 N	1000 N	810 N	8700 N	34000 N		
Methyl hydrazine					0.061 C	0.0057 C	0.0029 C	0.4 C	1.7 C		
Methyl isobutyl ketone					2900 N	84 N	110 N	5200 N	55000 N		
Methyl methacrylate	VOC				2900 N	290 N	110 N	5200 N	55000 N		

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level: A/B= 10^{-4} C= 10^{-5} Blank= 10^{-6}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
2-Methyl-5-nitroaniline					2 C	0.19 C	0.096 C	13 C	58 C		
Methyl parathion	SVOC				9.1 N	0.91 N	0.34 N	16 N	170 N	28 S	0.041 N
2-Methylphenol (o-cresol)	SVOC				1800 N	180 N	68 N	3300 N	34000 N	12000 S	6 E
3-Methylphenol (m-cresol)	SVOC				1800 N	180 N	68 N	3300 N	34000 N		
4-Methylphenol (p-cresol)	SVOC				180 N	18 N	6.8 N	330 N	3400 N		
Methyl styrene (mixture)					60 N	42 N	8.1 N	220 N	1200 N	100 N	1 N
Methyl styrene (alpha)					430 N	260 N	95 N	1800 N	8100 N	8.8 S	7.5 N
Methyl tertbutyl ether (MTBE)	VOC				180 N	3100 N	6.8 N	330 N	3400 N		
Metolaclor (Dual)	PEST				5500 N	550 N	200 N	9800 N	SAT		
Metribuzin	PEST				910 N	91 N	34 N	1600 N	17000 N		
Mirex	PEST				0.037 C	0.0035 C	0.0018 C	0.25 C	1.1 C		
Molinate	PEST				73 N	7.3 N	2.7 N	130 N	1400 N		
Molybdenum					180 N	18 N	6.8 N	380 N	8500 N		
Monochloramine					3700 N	370 N	140 N	6500 N	68000 N		
Naled	PEST				73 N	7.3 N	2.7 N	130 N	1400 N		
2-Naphthylamine	SVOC				0.00052 C I	0.00005 C	0.00002 C	0.005 C I	0.04 C I		
Napropamide	PEST				3700 N	370 N	140 N	6500 N	68000 N		
Nickel refinery dust		A				0.0075 C					

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Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level:* *A/B= 10^{-6}* *C= 10^{-5}* *Blank= 10^{-4}*	*Soil Regional Background Conc./Range (mg/kg)*		*Risk-Based Screening Levels*					*Soil Screening Level Transfers from Soil to:*	
				Drinking Water	*Tap Water*	*Ambient Air*	*Fish*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)*			
				(MCL's)	*(Residential Scenario: Ingestion, & Inhalation)*	*(Residential Scenario)*	*(Recreational Fishing Scenario)*	*Residential*	*Industrial*	*Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Nickel and compounds Nickel subsulfide Nitrapyrin	 PEST	 A 	16	100	730 N 55 N	73 N 0.0037 C 5.5 N	27 N 2 N	1500 N 98 N	34000 N 39000 C 1000 N	6900 E	21 E
Nitrate Nitric Oxide Nitrite				10000 1000	58000 N 3700 N 3700 N	5800 N 370 N 370 N	2200 N 140 N 140 N	SAT 6500 N 6500 N	SAT SAT SAT		
2-Nitroaniline 3-Nitroaniline 4-Nitroaniline	SVOC SVOC SVOC				2.2 N 110 N I 110 N I	0.21 N 11 N 11 N	0.081 N 4.1 N 4.1 N	3.9 N 230 N I 230 N I	41 N 6100 N I 6100 N I		
Nitrobenzene Nitrofurantoin Nitrofurazone	VOC				3.4 N I 2600 N 0.045 C	2.1 N 260 N 0.00067 C	0.68 N 95 N 0.0021 C	33 N 4600 N 0.3 C	340 N 48000 N 1.3 C	110 E	0.09 E
Nitrogen dioxide Nitroguanidine 4-Nitrophenol					37000 N I 3700 N 2300 N I	3700 N 370 N 230 N	1400 N 140 N 84 N	SAT 6500 N 4800 N I	SAT 68000 N SAT		
2-Nitropropane N-Nitrosodi-n-butylamine N-Nitrosodiethanolamine	VOC VOC	 B2 B2			35 C 0.012 C 0.024 C	0.00067 C 0.0011 C 0.0022 C	 0.00058 C 0.0011 C	 0.08 C 0.2 C	 0.4 C 0.7 C		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
N-Nitrosodiethylamine	SVOC	B2			0.00045 C	0.00004 C	0.00002 C	0.003 C	0.01 C		
N-Nitrosodimethylamine	SVOC	B2			0.0013 C	0.00013 C	0.00006 C	0.009 C	0.04 C		
N-Nitrosodiphenylamine	SVOC	B2			14 C	1.3 C	0.64 C	91 C	390 C	29 C	0.2 E
N-Nitroso di-n-propylamine	SVOC				0.0096 C	0.00089 C	0.00045 C	0.06 C	0.3 C	0.014 C	0.00002 E
N-Nitroso-N-methylethylamine		B2			0.0031 C	0.00028 C	0.00014 C	0.02 C	0.09 C		
N-Nitrosopyrrolidine		B2			0.032 C	0.0029 C	0.0015 C	0.2 C	0.9 C		
m-Nitrotoluene					61 N I	37 N	14 N	650 N	6800 N	460 S	0.42 N
o-Nitrotoluene					61 N I	37 N	14 N	780 N I	20000 N I	460 S	0.42 N
p-Nitrotoluene					61 N I	37 N	14 N	650 N	6800 N	460 S	0.42 N
Norflurazon	PEST				1500 N I	150 N	54 N	31000 N I			
NuStar	PEST				26 N	2.6 N	0.95 N	46 N	480 N		
Octabromodiphenyl ether					110 N	11 N	4.1 N	200 N	2000 N		
Octahydro-1357-tetranitro-1357-tetrazocine					1800 N	180 N	68 N	3300 N	34000 N		
Octamethylpyrophosphoramide	SVOC				73 N	7.3 N	2.7 N	130 N	1400 N		
Oryzalin	PEST				1800 N	180 N	68 N	3300 N	34000 N		
Oxadiazon	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Oxamyl	PEST			200	910 N	91 N	34 N	1600 N	17000 N		
Oxyfluorfen	PEST				110 N	11 N	4.1 N	200 N	2000 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Paclobutrazol Paraquat Parathion	PEST PEST PEST				470 N 160 N 220 N	47 N 16 N 22 N	18 N 6.1 N 8.1 N	850 N 290 N 390 N	8900 N 3100 N 4100 N	110 S	3.9 N
Pebulate Pendimethalin Pentabromo-6-chloro cyclohexane	PEST PEST				1800 N 1500 N 2.9 C	180 N 150 N 0.27 C	68 N 54 N 0.14 C	3300 N 2600 N 19 C	34000 N 27000 N 83 C		
Pentabromodiphenyl ether Pentachlorobenzene Pentachloronitrobenzene	SVOC				73 N 4.9 N I 0.041 C I	7.3 N 2.9 N 0.024 C	2.7 N 1.1 N 0.012 C	130 N 52 N 1.7 C	1400 N 550 N 7.3 C	570 N	48 N
Pentachlorophenol Permethrin Phenmedipham	PEST PEST PEST			1	0.56 C 1800 N 9100 N	0.052 C 180 N 910 N	0.026 C 68 N 340 N	2.5 C 3300 N 16000 N	7.9 C 34000 N SAT	7.9 C	0.2 E
Phenol m-Phenylenediamine p-Phenylenediamine	SVOC SVOC SVOC				22000 N 220 N 6900 N	2200 N 22 N 690 N	810 N 8.1 N 260 N	39000 N 390 N 12000 N	SAT 4100 N SAT	21000 S	49 E
Phenylmercuric acetate 2-Phenylphenol Phorate	PEST				2.9 N 35 C 7.3 N	0.29 N 3.2 C 0.73 N	0.11 N 1.6 C 0.27 N	5.2 N 230 C 13 N	55 N 980 C 140 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Phosmet Phosphine Phosphoric acid	PEST				730 N 11 N 100 N I	73 N 0.31 N 10 N	27 N 0.41 N	1300 N 20 N	14000 N 200 N		
Phosphorus (white) p-Phthalic acid Phthalic anhydride	SVOC				0.73 N I 37000 N I 73000 N I	0.073 N 3700 N 130 N	0.027 N 1400 N 2700 N	1.6 N I SAT SAT	41 N I SAT SAT		
Picloram Pirimiphos-methyl Polybrominated biphenyls	PEST PEST				2600 N 370 N 0.0076 C	260 N 37 N 0.0007 C	95 N 14 N 0.00035 C	4600 N 650 N 0.05 C	48000 N 6800 N 0.2 C		
Polychlorinated biphenyls (PCBs) Aroclor 1016 Aroclor 1254	SVOC	B2		0.5	0.009 C 2.6 N 0.73 N	0.00081 C 0.26 N 0.073 N	0.00041 C 0.095 N 0.027 N	0.07 C 4.9 N 1.4 N	0.3 C 65 N 19 N		
Polychlorinated terphenyls (PCTs) Polynuclear aromatic hydrocarbons Acenaphthene	SVOC				0.015 C I 370 N	0.0014 C 220 N	0.0007 C 81 N	0.14 C I 360 S	1.3 C I 360 S	SAT 120 S	200 E
Anthracene Benz[a]anthracene Benzo[b]fluoranthene	SVOC SVOC SVOC	 B2			1800 N 0.092 C 0.092 C	1100 N 0.01 C 0.01 C	410 N 0.0043 C 0.0043 C	19 S 0.6 C 0.6 C	19 S 2.6 C 2.6 C	6.8 S 27 S 23 S	4300 E 0.7 E 4 E

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Benzo[k]fluoranthene	SVOC	B2			0.92 C	0.1 C	0.043 C	6.1 C	26 C		4 E
Benzo[a]pyrene	SVOC	B2		0.2	0.0092 C	0.001 C	0.00043 C	0.06 C	0.3 C	11 S	4 E
Carbazole	SVOC				3.4 C I	0.31 C	0.16 C	32 C I	290 C I	11 S	0.5 E
Chrysene	SVOC				9.2 C	1 C	0.43 C	24 S	24 S	3.6 S	1 E
Dibenz[a,h]anthracene	SVOC				0.0092 C	0.001 C	0.00043 C	0.06 C	0.3 C	7.2 S	11 E
Fluoranthene	SVOC				1500 N	150 N	54 N	2600 N	27000 N	68 S	980 E
Fluorene	SVOC				240 N	150 N	54 N	300 S	300 S	89 S	160 E
Indeno[1,2,3-cd]pyrene	SVOC	B2			0.092 C	0.01 C	0.0043 C	0.6 C	2.6 C	280 S	35 E
Naphthalene	SVOC				240 N	150 N	54 N	800 S	800 S	180 S	30 E
Pyrene	SVOC				1100 N	110 N	41 N	2000 N	20000 N	56 S	1400 E
Prochloraz	PEST	C			4.5 C I	0.42 C	0.21 C	30 C	130 C		
Profluralin					220 N	22 N	8.1 N	390 N	4100 N		
Prometon	PEST				550 N	55 N	20 N	980 N	10000 N		
Prometryn	PEST				150 N	15 N	5.4 N	260 N	2700 N		
Pronamide	PEST				2700 N	270 N	100 N	4900 N	51000 N		
Propachlor	PEST				470 N	47 N	18 N	850 N	8900 N		
Propanil	PEST				180 N	18 N	6.8 N	330 N	3400 N		
Propargite	PEST				730 N	73 N	27 N	1300 N	14000 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Propargyl alcohol	VOC				73 N	7.3 N	2.7 N	130 N	1400 N		
Propazine	PEST				730 N	73 N	27 N	1300 N	14000 N		
Propham	PEST				730 N	73 N	27 N	1300 N	14000 N		
Propiconazole	PEST				470 N	47 N	18 N	850 N	8900 N		
Propylene glycol					730000 N	73000 N	27000 N	SAT	SAT		
Propylene glycol, monoethyl ether					26000 N	2600 N	950 N	46000 N	SAT		
Propylene glycol, monomethyl ether					26000 N	2100 N	950 N	46000 N	SAT		
Propylene oxide		B2			0.22 C	0.49 C	0.013 C	2.7 C I	24 C I		
Pursuit	PEST				9100 N	910 N	340 N	16000 N	SAT		
Pydrin	PEST				910 N	91 N	34 N	1600 N	17000 N		
Pyridine	VOC				37 N	3.7 N	1.4 N	65 N	680 N		
Quinalphos	PEST				18 N	1.8 N	0.68 N	33 N	340 N		
Quinoline					0.0056 C	0.00052 C	0.00026 C	0.04 C	0.2 C		
Resmethrin	PEST				1100 N	110 N	41 N	2000 N	20000 N		
Ronnel	PEST				1800 N	180 N	68 N	3300 N	34000 N		
RDX (Cyclonite)		C			6.1 C	0.6 C		40 C	170 C		
Rotenone	PEST				150 N	15 N	5.4 N	260 N	2700 N		
Savey	PEST				910 N	91 N	34 N	1600 N	17000 N		
Selenious Acid					180 N	18 N	6.8 N	330 N	3400 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Selenium			0.2	50	180 N	18 N	6.8 N	380 N	8500 N		3 E
Selenourea					180 N	18 N	6.8 N	330 N	3400 N		
Sethoxydim	PEST				3300 N	330 N	120 N	5900 N	61000 N		
Silver and compounds			0.01-5		180 N	18 N	6.8 N	380 N	8500 N		
Simazine	PEST			4	0.6 C	0.052 C	0.026 C	3.7 C	16 C		
Sodium azide					150 N	15 N	5.4 N	260 N	2700 N		
Sodium diethyldithiocarbamate					0.25 C	0.023 C	0.012 C	1.6 C	7.1 C		
Sodium fluoroacetate	PEST				0.73 N	0.073 N	0.027 N	1.3 N	14 N		
Sodium metavanadate					37 N	3.7 N	1.4 N	65 N	680 N		
Strontium, stable					22000 N	2200 N	810 N	46000 N	SAT		
Strychnine	PEST				11 N	1.1 N	0.41 N	20 N	200 N		
Styrene	VOC			100	1600 N	1000 N	270 N	2200 S	2200 S	1400 E	2 E
Systhane	PEST				910 N	91 N	34 N	1600 N	17000 N		
2,3,7,8-TCDD (dioxin)				3E-08	4.5E-07 C	5.4E-08 C		3.8E-06 C	2.4E-05 C		
Tebuthiuron	PEST				2600 N	260 N	95 N	4600 N	48000 N		
Temephos	PEST				730 N	73 N	27 N	1300 N	14000 N		
Terbacil	PEST				470 N	47 N	18 N	850 N	8900 N		
Terbufos	PEST				0.91 N	0.091 N	0.034 N	1.6 N	17 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Terbutryn 1,2,4,5-Tetrachlorobenzene 1,1,1,2-Tetrachloroethane	PEST SVOC VOC	 C			37 N 11 N 4.3 C	3.7 N 11 N 2.4 C	1.4 N 0.41 N 1.2 C	65 N 20 N 48 C	680 N 200 N 120 C	91 N	0.69 N
1,1,2,2-Tetrachloroethane Tetrachloroethylene (PCE) 2,3,4,6-Tetrachlorophenol	VOC VOC SVOC	C		5	0.55 C 1.1 C 1100 N	0.31 C 3.1 C 110 N	0.16 C 0.061 C 41 N	9 C 7 C 2000 N	24 C 25 C 20000 N	0.4 E 11 E	0.001 E 0.04 E
p,a,a,a-Tetrachlorotoluene Tetrachlorovinphos Tetraethyldithiopyrophosphate	 PEST PEST				0.00053 C I 2.8 C 18 N	0.00031 C 0.26 C 1.8 N	0.00016 C 0.13 C 0.68 N	0.02 C 19 C 33 N	0.1 C 79 C 340 N		
Tetraethyl lead 1,1,1,2-Tetrafluoroethane Thallic oxide					0.0037 N 140000 N I 2.6 N	0.00037 N 84000 N 0.26 N	0.00014 N 0.095 N	0.006 NI 5.4 N	0.07 N 120 N	0.00068 N	0.000034 N
Thallium Thallium acetate Thallium carbonate				20	 3.3 N 2.9 N	 0.33 N 0.29 N	 0.12 N 0.11 N	 6.9 N 6.1 N	 150 N 140 N		0.4 E
Thallium chloride Thallium nitrate Thallium selenite					2.9 N 3.3 N 3.3 N	0.29 N 0.33 N 0.33 N	0.11 N 0.12 N 0.12 N	6.1 N 6.9 N 6.9 N	140 N 150 N 150 N		

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Human Health
Media-Specific Screening Levels

Legend: MCL = Maximum Contaminant Level SAT = risk-based value above expected saturation point max = maximum concentration PEST = Pesticide Herb = Herbicide VOC = Volatile Organic Compound SVOC = Semi-Volatile Organic Compound *"Blank" = Missing data for generation of value.*					*Basis: C= carcinogenic effects N = non-carcinogenic effects* *E = EPA draft Soil Screening Level S = soil saturation concentration* *M' = EPA MCL I = Ingestion route only*						
Contaminant	*Chemical Group Name*	*Cancer Class* *Risk Level:* *A/B= 10^{-4}* *C= 10^{-5}* *Blank= 10^{-6}*	*Soil Regional Background Conc./Range (mg/kg)*	*Drinking Water (MCL's)*	*Risk-Based Screening Levels* *Tap Water (Residential Scenario: Ingestion, & Inhalation)*	*Ambient Air (Residential Scenario)*	*Fish (Recreational Fishing Scenario)*	*Soil (Ingestion, Inhalation, and Dermal Exposure Routes)* *Residential*	*Industrial*	*Soil Screening Level Transfers from Soil to:* *Air*	*Ground Water*
				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
Thallium sulfate Thiobencarb 2-(Thiocyanomethylthio)-benzothiazole	PEST				2.9 N 370 N 1100 N	0.29 N 37 N 110 N	0.11 N 14 N 41 N	6.1 N 650 N 2000 N	140 N 6800 N 20000 N		
Thiofanox Thiophanate-methyl Thiram	PEST PEST				11 N 2900 N 180 N	1.1 N 290 N 18 N	0.41 N 110 N 6.8 N	20 N 5200 N 330 N	200 N 55000 N 3400 N		
Tin and compounds Toluene Toluene-2,4-diamine	VOC		122	1000	22000 N 720 N 0.021 C	2200 N 420 N 0.002 C	810 N 270 N 0.00099 C	46000 N 1900 N 0.1 C	SAT 2700 S 0.6 C	520 E	5 E
Toluene-2,5-diamine Toluene-2,6-diamine p-Toluidine					22000 N 7300 N 0.35 C	2200 N 730 N 0.033 C	810 N 270 N 0.017 C	39000 N 13000 N 2.3 C	SAT SAT 10 C		
Toxaphene Tralomethrin Triallate	PEST PEST PEST	B2		3	0.061 C 270 N 470 N	0.0056 C 27 N 47 N	0.0029 C 10 N 18 N	0.4 C 490 N 850 N	1.7 C 5100 N 8900 N	5 E	0.04 E
Triasulfuron 1,2,4-Tribromobenzene Tributyltin oxide (TBTO)	PEST PEST				370 N 30 N I 1.1 N	37 N 18 N 0.11 N	14 N 6.8 N 0.041 N	650 N 330 N 2 N	6800 N 3400 N 20 N		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
2,4,6-Trichloroaniline hydrochloride					2.3 C	0.22 C	0.11 C	15 C	66 C		
2,4,6-Trichloroaniline					2.0 C	0.18 C	0.093 C	13 C	56 C		
1,2,4-Trichlorobenzene	VOC			70	190 N	210 N	14 N	620 N	5900 N	240 E	2 E
1,1,1-Trichloroethane	VOC			200	1300 N	1000 N	120 N	3200 N	3000 S	980 E	0.9 E
1,1,2-Trichloroethane	VOC			5	0.2 C	0.11 C	0.055 C	1.4 C	3.3 C	0.8 E	0.01 E
Trichloroethylene (TCE)	VOC			5	1.6 C	1 C	0.29 C	7.1 C	17 C	3 E	0.02 E
Trichlorofluoromethane	VOC				1300 N	730 N	410 N	710 N	2400 N	790 N	13 N
2,4,5-Trichlorophenol	SVOC				3700 N	370 N	140 N	6500 N	68000 N	8200 S	120 E
2,4,6-Trichlorophenol	SVOC	B2			6.1 C	0.57 C	0.29 C	40 C	170 C	150 C	0.06 E
2,4,5-Trichlorophenoxyacetic acid	PEST				370 N	37 N	14 N	650 N	6800 N		
2-(2,4,5-Trichlorophenoxy)propionic acid	PEST				290 N	29 N	11 N	520 N	5500 N		
1,1,2-Trichloropropane					30 N	18 N	6.8 N	51 N	190 N	13 N	0.14 N
1,2,3-Trichloropropane					0.0015 C I	0.00089 C	0.00045 C	0.007 C	0.02 C	0.00003 C	6.0E-06 C
1,2,3-Trichloropropene					31 N	18 N	6.8 N	75 N	290 N		
1,1,2-Trichloro-1,2,2- trifluoroethane					59000 N	31000 N	41000 N	3600 S	3600 S	2400 S	3100 N
Tridiphane	PEST				110 N	11 N	4.1 N	200 N	2000 N		
Triethylamine					12 N	7.3 N		22 N	80 N		
Trifluralin	PEST	C			87 C	8.1 C	4.1 C	580 C	2500 C		

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				µg/L	*µg/L*	*µg/m3*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
1,2,4-Trimethylbenzene	VOC				300 N I	180 N	68 N	3900 N I	SAT		
1,3,5-Trimethylbenzene	VOC				300 N I	180 N	68 N	3900 N I	SAT	98 S	0.26 M
Trimethyl phosphate					1.8 C	0.17 C	0.085 C	12 C	52 C		
1,3,5-Trinitrobenzene	SVOC				1.8 N	0.18 N	0.068 N	3.3 N	34 N		
Trinitrophenylmethylnitramine					370 N	37 N	14 N	650 N	6800 N		
2,4,6-Trinitrotoluene		C			22 C	2.1 C	1.1 C	480 C	640 C		
Uranium (soluble salts)					110 N	11 N	4.1 N	230 N	5100 N		
Vanadium			66		260 N	26 N	9.5 N	540 N	12000 N		
Vanadium pentoxide					330 N	33 N	12 N	690 N	15000 N		
Vanadium sulfate					730 N	73 N	27 N	1500 N	34000 N		
Vernam	PEST				37 N	3.7 N	1.4 N	65 N	680 N		
Vinclozolin	PEST				910 N	91 N	34 N	1600 N	17000 N		
Vinyl acetate	VOC				37000 N	210 N	1400 N	65000 N	SAT	370 E	84 E
Vinyl bromide					5.2 N I	3.1 N				2 N	0.018 N
Vinyl chloride	VOC			2	0.02 C	0.021 C	0.0017 C	0.005 C	0.01 C	0.002 E	0.01 E
Warfarin	PEST				11 N	1.1 N	0.41 N	20N	200 N	0.046 N	1800 N
m-Xylene	VOC				1400 N	730 N	2700 N	980 S	980 S	950 S	240 M
o-Xylene	VOC				1400 N	730 N	2700 N	980 S	980 S	730 S	150 M

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								Residential	*Industrial*	*Air*	*Ground Water*
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p-Xylene Xylene (mixed) Zinc	VOC VOC		22-50	10000	520 N I 1400 N 11000 N	310 N 7300 N 1100 N	2700 N 410 N	980 S 980 S 23000 N	980 S 980 S SAT	1000 S 320 E	220 M 74 E 42000 E
Zinc phosphide Zineb	PEST PEST				11 N 1800 N	1.1 N 180 N	0.41 N 68 N	23 N 3300 N	510 N 34000 N		