CAFB95

DEPARTMENT OF THE AIR FORCE

HEADQUARTERS 27th FIGHTER WING (ACC)
CANNON AIR FORCE BASE, NEW MEXICO

for CAFB

21 AUG 1995

W. P. Ard, Colonel, USAF
Commander, 27th Support Group
100 S DL Ingram Blvd Suite 200
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Ms. Barbara Hoditschek
RCRA Permits
New Mexico Environment Department
2052 Galisteo Street
Santa Fe NM 87502

Dear Ms. Hoditschek

Enclosed is the final workplan for Landfill 5, Solid Waste Management Unit 113 incorporating all previously requested changes. The final field work started on 18 Jul 95.

If you have any questions, please contact Mr. Sanford Hutsell or Mr. John Constantine at (505) 784-4348.

Sincerely

W. P. ARD, Colonel, USAF
Commander, 27th Support Group

Attachment:
Final Workplan for Landfill 5

cc:
Region VI EPA (W. Honker)
HQ ACC CES/ESV w/o Atch (M. Calvert)

FINAL
WORK PLAN - VOLUME I

LIBRARY COPY

WORK PLAN
DATA MANAGEMENT PLAN
PROJECT MANAGEMENT PLAN
SITE SAFETY AND HEALTH PLAN
RCRA FACILITY
INVESTIGATION PHASE I
FOR LANDFILL NO. 5
(SWMU NO 113/IRF NO. LF-5)
PROJECT CZQZ 92 7007
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

Commander 27 FW
100 South D.L. Ingram Blvd.
Suite 100
Cannon AFB, NM 88103-5214

July 1995

FINAL

WORK PLAN - VOLUME I

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FOR LANDFILL NO. 5

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July 1995

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CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

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

July 1995

Woodward-Clyde

Woodward-Clyde Consultants
101 S. 108th Avenue
Omaha, NE 68154

C3M11M

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ACC	Air Combat Command
AFB	Air Force Base
ARAR	Applicable and Relevant or Appropriate Requirements
B.P.	Before Present
BRA	Baseline Risk Assessment
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CEC	cation exchange capacities
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	centimeters per second
CMS	Corrective Measures Study
CRP	Community Relations Plan
CRQL	Contract Required Quantitation Limit
DCQAP	Data Collection Quality Assurance Plan
DMP	Data Management Plan
DOD	U.S. Department of Defense
DQCR	Data Quality Control Report
DQO	Data Quality Objectives
EPFC	Exposure Pathway Flow Chart
FS	Feasibility Study
FSP	Field Sampling Plan
ft/ft	feet per foot
gpm	gallon per minute
HEAST	Health Effects Assessment Summary Tables
HSP	Health and Safety Plan
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
mg/L	milligrams per liter
mph	miles per hour
msl	mean sea level
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMNHP	New Mexico Natural Heritage Program
NMWCC	New Mexico Water Quality Control Commission
NWR	National Wildlife Refuge
PARCC	Precision, accuracy,
PMP	Project Management Plan
RAS	Relevant and Applicable Standards

RBC	Risk-Based Concentrations
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contamination Levels
SOPs	Standard Operating Procedures
SOS	Scope of Service
SSHP	Site Safety and Health Plan
SWMU	Solid Waste Management Skills
T/E	threatened/endangered
TBC	to be considered
TFW	Tactical Fighter Wing
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USDA	United States Department of Agriculture
USDA-SCS	United States Department of Agriculture - Soil Conservation Service Soil Classification System
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
W-C	Woodward-Clyde

PREFACE

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan was prepared by consultants Lee Wan and Associates in June 1990 and finalized in October 1990 for the investigation of 27 Solid Waste Management Units (SWMU) at Cannon Air Force Base (AFB), Clovis, New Mexico (Lee Wan and Associates 1990). The RFI Work Plan approved by the United States Environmental Protection Agency (USEPA) Region VI on December 11, 1990 consisted of the following documents:

- Data Collection Quality Assurance Plan (DCQAP)
- Data Management Plan (DMP)
- Health and Safety Plan (HSP)
- Field Sampling Plan (FSP)
- Community Relations Plan (CRP)
- Program Management Plan

In July 1991, the United States Army Corps of Engineers (USACE) Omaha District on behalf of Cannon AFB contracted Woodward-Clyde (W-C) to conduct environmental investigations at 18 of the 27 SWMUs addressed by the Lee Wan RFI Work Plan. The 18 SWMUs investigated were listed in Appendix I to Cannon AFB's RCRA Part B permit and included:

AGE Ditch	SWMU 34
Engine Test Cell	SWMU 86, 87, 88 89,90
NE Storm Drainage Area	SWMU 95
Wastewater Lagoons	SWMU 101, 102
Landfill No. 5	**SWMU 113**
Old Entomology Rinse Area	SWMU 96
Sludge Weathering Pit	SWMU 76
Fire Training No. 1	SWMU 78
Solvent Disposal	SWMU 81
Fire Training No. 2	SWMU 106

Fire Training No. 3	SWMU 107
Fire Training No. 4	SWMU 109
Sanitary Sewer Line	SWMU 98

The USACE Scope of Service (SOS) dated June 26, 1991 directed W-C to ensure that the investigation of each SWMU would serve a dual purpose and encompass both RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements for evaluating the nature and extent of hazardous wastes potentially occurring at each SWMU. The reasons for having the investigation address both RCRA and CERCLA requirements are discussed below.

The investigations conducted by W-C were called a Remedial Investigation (RI) to satisfy funding requirements under the U.S. Air Force Installation Restoration Program (IRP). The IRP is legally mandated under CERCLA; therefore, site investigations and clean-up must follow CERCLA guidance.

As a condition of their RCRA Part B permit, Cannon AFB must evaluate SWMUs identified by USEPA during the RCRA Facility Assessment (RFA). Therefore, the investigations to be conducted are designed to satisfy RFI guidance for characterizing the SWMUs and developing and implementing corrective action measures, if necessary.

This Work Plan is being prepared to address further environmental investigation at Landfill No. 5 (SWMU No. 113/IRP No. LF-5) at Cannon AFB under W-C's USACE Contract Number DACW-45-93-D005, Delivery Order No. 0012, executed on June 30, 1993. The additional investigation at Landfill No. 5 is being performed for USACE on behalf of Cannon AFB to further satisfy conditions of Cannon AFB's RCRA Part B permit. However, since the State of New Mexico Environment Department (NMED) is the lead agency for this project and this investigation was not included in the Lee Wan Work Plan, the following work plan documents are being prepared as the Work Plan for this project:

- Data Collection Quality Assurance Plan (DCQAP)
- Data Management Plan (DMP)

- Project Management Plan (PMP)
- Site Safety and Heath Plan (SSHP)

The current Community Relations Plan has been deemed sufficient by USACE and Cannon AFB and will be administered by Cannon AFB personnel. Therefore, it is not being revised for the Landfill No. 5 investigation.

The scope of work to be completed under this investigation includes the completion of a detailed site survey of Landfill No. 5 (SWMU No. 113/IRP No. LF-5) using the Base Coordinate System. This work will result in the placement of a 50 by 50 foot grid over Landfill No. 5 and the generation of a topographic base map using one-foot contours. This map and grid system will be used in performing both a geophysical survey and an 800-point soil gas survey over Landfill No. 5. Data generated from the geophysical survey and soil gas survey will be used to aid in location of 30 soil borings to be drilled and sampled to document the presence or absence of hazardous constituents in the native soil beneath the landfill burial cells. The data generated from this field effort will be of sufficient quality to support:

- Identification of data gaps
- Recommendations for additional field investigation
- Identification of the need for interim corrective measures or a Corrective Measures study (Remedial Action or Feasibility Study under CERCLA)
- Future baseline risk assessment studies, if necessary
- A No Further Action recommendation
- Identification of preliminary corrective measures (remedial alternatives under CERCLA)

Specifically, the purpose for the RFI at Landfill No. 5 is to:

- Evaluate whether release(s) of hazardous constituents to the environment (native soil beneath the landfill cells) has occurred at Landfill No. 5

- If a release has occurred, evaluate the nature and extent (chemical composition and direction), rate (vertical and horizontal), and extent (vertical and horizontal) of the release(s)

- Evaluate the potential threat to human health and the environment

- Evaluate whether interim corrective measures are necessary to support the evaluation and selection of the final corrective measure

The RFI as presented in this Phase I Work Plan for Landfill No. 5 is planned to be conducted using a phased approach. Use of a phased approach is appropriate for Landfill No. 5 because (1) no subsurface sampling and chemical analysis has previously been performed under RCRA, (2) no release to the environment has been documented to have occurred, and (3) responsible use of U.S. Department of Defense (DOD) funds require a phased investigation approach.

The primary objective for the Phase I RFI at Landfill No. 5 is to evaluate whether a release of hazardous constituents to the environment has occurred. However, data collected will also provide information that can be used to support the other purposes of the RFI for Landfill No. 5 previously listed. Additional phases of investigation will be conducted to complete the RFI process if required, based on the results of this Phase I RFI.

1.0
INTRODUCTION

This document serves as the Work Plan for the Phase I RFI to be conducted at Landfill No. 5 (SWMU No. 113/IRP No. LF-5) located on Cannon AFB, near Clovis, New Mexico. Landfill No. 5 was previously investigated during the 18 SWMU RI performed in 1992 by W-C. During the 1992 investigation of Landfill No. 5, only existing groundwater monitoring wells were sampled and a CERCLA (USEPA 1988) baseline risk assessment was performed. Results of this investigation indicated that groundwater beneath Landfill No. 5 has not been impacted by past activities at Landfill No. 5 (W-C 1992). At the request of NMED, Cannon AFB agreed to additional subsurface investigation at Landfill No. 5 to evaluate whether contaminants are present in the subsurface soils beneath Landfill No. 5 and, if present, the nature and extent of contamination.

This Phase I Work Plan follows the USEPA *RCRA Facility Investigation Guidance*, Volumes 1 through 4 (EPA 530/SW-89-031) (USEPA 1989a). This Work Plan, the DCQAP and SSHP also meet USEPA guidance for conducting remedial investigations under CERCLA (USEPA 1989b).

The overall purpose of the RFI is to obtain the data necessary to evaluate whether (1) a release of hazardous constituents to the environment has occurred and, if so, to characterize the nature, extent, and rate of migration of releases of hazardous constituents; (2) a potential threat to human health and the environment exists; and (3) interim corrective measures and/or a Corrective Measures Study (Feasibility Study/Remedial Alternatives under CERCLA) may be necessary. The following are the objectives of the Landfill No. 5 Phase I RFI to be conducted at Cannon AFB:

- Collect the quantity and quality of data necessary to characterize the physical setting and nature and extent of potential hazardous constituents associated with Landfill No. 5

- Evaluate the data to identify data gaps and determine whether an additional investigation(s) is required to complete the RFI process

- Evaluate the data collected to identify potential migration pathways for future evaluation of human health and environmental risks (if required) associated with chemicals found in environmental media beneath Landfill No. 5. (Note: During the Phase I RFI at Landfill No. 5, analytical data are being collected only for soils beneath the landfill cells.)

- Provide data for use in identifying appropriate remedial actions (i.e., Corrective Measures Study (CMS) under RCRA or a Feasibility Study under CERCLA)

- Recommend No Further Action if supported by the findings of this investigation

This Phase I Work Plan has been prepared based on findings and recommendations from previous U.S. Air Force IRP investigations at the base, specifically those related to Landfill No. 5. The Phase I RFI Workplan will also guide the planned RFI investigation to satisfy the Cannon AFB RCRA Part B permit conditions.

Recommendations and decision rationale for the following are presented in this Work Plan:

- Conducting additional field work
- Performing a Baseline Risk Assessment in the future
- Developing and screening potential corrective measures (remedial responses under CERCLA)
- Evaluating Relevant and Applicable Standards (RASs)
- Developing Data Quality Objectives

2.1 HISTORY OF CANNON AIR FORCE BASE

The following information was obtained from the Installation Restoration Program Records Search document prepared by CH2M Hill (1983) and the Cannon AFB Joint Military Telephone Directory (American Publishers 1991).

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. The vicinity map of Cannon AFB is shown in Figure 2-1, and the site map of Cannon AFB is shown in Figure 2-2. The Melrose Bombing Range is an off-base facility located approximately 25 miles southwest of Cannon AFB.

Cannon AFB dates to 1929 when Portair Field was established on the site. Portair Field was a civilian passenger terminal for early commercial transcontinental flights. 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. Flying, bombing, and gunnery classes continued through the end of World War II. By mid-1946, however, the airfield was placed on a reduced operational status and flying activities decreased. The installation was deactivated in May 1947. The types of aircraft stationed at Cannon AFB from 1942 to 1947 included B-17, B-24, and B-29 heavy bombers.

The base was reassigned to the Tactical Air Command in July 1951. The first unit, the 140th Fighter-Bomber Wing, arrived in October of that year. The airfield was formally reactivated in November 1951 as Clovis Air Force Base. Between 1952 and 1957, the 50th and 388th Fighter-Bomber Wings were activated and, upon their transfer, were replaced by the 312th and 474th Groups. Predominant aircraft stationed at Cannon AFB from 1951 to 1957 included the P-51 "Mustang" fighter and the F-86 "Sabre" fighter jet.

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 October 1957, the 312th and 474th Fighter-Bomber Groups were redesignated tactical fighter wings, and the 832nd Air Division was activated to oversee their activities.

In 1959, the 312th Tactical Fighter Wing (TFW) was deactivated and replaced at Cannon AFB by the 27th TFW. In December 1965, the base's mission changed to that of a replacement training unit, and the 27th TFW became the largest such unit in the Tactical Air Command. The predominant aircraft stationed at Cannon AFB from 1957 to 1965 was the F-100 "Super Sabre" fighter jet.

The 832nd Air Division was deactivated in July 1975, leaving the 27th TFW the principal Air Force unit at Cannon AFB. In early 1981, the 27th TFW was designated a Rapid Deployment Joint Task Force member.

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. Aircraft stationed at Cannon AFB since 1965 include the F-100 "Super Sabre" fighter jet (1957-1969), the F-111A (1969), the F-111E (1969-1971), and the F-111D (1971-present).

Approximately 70 F-111D aircraft are assigned to Cannon AFB. The total work force on Cannon AFB is approximately 5,940, which includes 5,040 military and 900 civil service personnel.

In 1992, Cannon AFB became part of the Air Combat Command (ACC) as the result of the overall realignment of Air Force Commands and the ongoing downsizing of the U.S. Military.

2.2 FACILITY CHARACTERISTICS

2.2.1 Physical Geography

Cannon AFB is situated in the Southern High Plains Physiographic Province in the Llano Estacado subprovince (Figure 2-3) (Hawley et al. 1976). 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 that 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 approximately 10 and 20 miles, respectively, north of Cannon AFB, are the nearest streams (USGS 1985). These are second-order streams. Both streams are very straight, flow southeast, and have rectilinear drainage patterns with short laterals.

2.2.2 Land Use Near Cannon Air Force Base

Cannon AFB is located just south of U.S. Highway 60-84 in a farming and ranching area (Figure 2-1). 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." In 1990, 32,767 people lived in Clovis; the Cannon AFB population was estimated as 4,650 (USAF 1991).

2.2.3 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 39°F to a July high of 78°F. Extreme daily temperatures range from -11°F to 106°F. Average monthly precipitation ranges from 0.4 inches in winter to 2.7 inches in July. The maximum recorded 24-hour rainfall is 4.7 inches, which occurred in August 1985 (Hale 1992). Rainfall occurs on eight or more days per month during the summer precipitation maximum. Mean annual precipitation is approximately 15 inches. The mean annual lake evaporation is 69 inches/year. Prevailing winds are from the west at an average of 8 miles per hour (mph) (USAF 1990).

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 (USAF 1990).

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.

2.2.4 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 Figures 2-4 and 2-5.

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 unconformity having relief of up to several hundred feet (Lee Wan and Associates 1990).

The Ogallala Formation overlies the Dockum Group redbeds. 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 the Ogallala thickness. Stream valleys in the post-Triassic unconformity are deep and trend dominantly east-west. Thus, Ogallala thickness may 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 to exist 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 by 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, 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 2-5. 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. Lee Wan and Associates (1990) give radiocarbon dates for the upper "climax" caliche range from approximately 27,000 years Before Present (B.P.) to approximately 42,000 years B.P.

Caliche is relatively soluble in acidic water (pH<7) or in waters containing dissolved carbon dioxide. 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 (Lee Wan and Associates 1990). The pisolites are thought to have formed as the caliche was repeatedly chemically-weathered and brecciated during Pleistocene pluvials and later recemented during drier intervals. This upper caliche outcrops 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 is likely thin or absent below playas.

2.2.5 Hydrogeology

The lower portion of the Ogallala Formation is the primary regional aquifer for both potable and irrigation water. No deeper aquifers are used 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. The Ogallala aquifer has a southeasterly regional gradient of about 10 to 15 feet per mile (Weeks and Gutentag 1981). Well yields vary from less than one gallon per minute (gpm) in thin silts and sands, and up to 1600 gpm in thick sands and gravels (Lee Wan and Associates 1990). Water quality 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 (William Matotan and Associates, Inc. 1985).

At Cannon AFB, 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 unconformity surface marking the top of the Dockum Group. The local groundwater gradient is southeasterly at 7 to 15 feet per mile (USAF 1990). Figure 2-6 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 205 gpm to 1,150 gpm. Specific capacities range from 11.4 gallons/feet to 27.9 gallons/feet (Lee Wan and Associates 1990).

Very rough estimates of hydraulic conductivity were made from well pump tests conducted by Cannon AFB in water wells 5, 8 and 9 (Figure 2-7) using the Theis equation. 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 estimates only.

Hydraulic conductivity values for water wells 5 and 9 were approximately 2.0×10^{-3} centimeters per second (cm/sec). Calculations for water well 8 result in a hydraulic conductivity of 2.0×10^{-2} cm/sec. These estimates appear to be low when compared to published hydraulic conductivity data for sands and gravels (Freeze and Cherry 1979). As reported in Kearney (1987), a groundwater flow velocity of about 150 feet/year has been estimated. This calculates out to a hydraulic conductivity of approximately 1.0×10^{-1} cm/sec.

Hydraulic information specific to Landfill No. 5 (SWMU No. 113/ IRP No. LF-5) was obtained during the 18 SWMU RI conducted by W-C in 1991 (W-C 1992). The hydraulic gradient for groundwater beneath Landfill No. 5 is approximately 0.0025 feet per foot (ft/ft) based on water level elevation for data collected as part of the 18 SWMU RI. Using the hydraulic conductivity values previously reported and a reasonable effective porosity of 28 percent, the groundwater velocity can be estimated as ranging from 0.069 feet/day to 0.134 feet/day.

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 Formation is primarily through precipitation. Kearney (1987) indicated that the recharge rate may be as much as 1.0 inches/year. Due to the high evapotranspiration rate and low precipitation, recharge 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 allows deep percolation to the aquifer. The occurrence of this process is evidenced by the presence of clay deposits in playas and the possibility that caliche is thin or absent directly below, playas. Caliche is soluble in acidic rain waters and is leached over time to form percolation pathways.

Discharge from the Ogallala Formation occurs through well pumping and springs along the eroded margins. 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 local recharge. Water levels in the Ogallala Formation have declined steadily from the 1930s to the present. From the 1930s to 1980, a decline of 50 to 100 feet has been observed in the area around Clovis, New Mexico. Luckey et al. (1981) states, "the largest area of water level decline exceeding 100 feet occurs south of the Canadian River extending from Curry County, New Mexico to Crosby County, Texas."

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.

2.2.6 Soils

Soils in the vicinity of Cannon AFB are classified as silty sand (SM) to clayey sand (SC) under the Unified Classification System, and as aridisols (calciorthids) under the United States Department of Agriculture - Soil Conservation Service Comprehensive Soil Classification System (USDA-SCS). The following summary is based on the Curry County Soil Survey (USDA 1958). Figure 2-8 depicts the various soil types mapped at Cannon AFB. Soil characteristics are briefly described in the following paragraphs.

The most common soil type on Cannon AFB is the Amarillo fine sandy loam, 0 to 2 percent slope phase (map symbol Ab). 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 surface soil is brown (7.5 YR 5/5, dry), and subsurface soils are reddish-brown (5 YR 4/4, dry) to yellowish-red (15 YR 5/6, dry). The calcic C horizon underlying the Amarillo Fine Sandy loam is white. The Amarillo fine sandy loam soil type is present on all relatively flat surfaces at the base but is also found on slopes associated with playas (map symbol Ac). A small area of Amarillo loamy fine sandy 0 to 2 percent slope phase (map symbol Ag) is mapped in the southeast corner of the base.

Clovis fine sandy loams, 0 to 2 percent slope phase (map symbol Cb) and 2 to 5 percent slope phase (map symbol Cc) are similar to Amarillo fine sandy loams. Clovis soils are reddish-brown on the surface and in the subsurface, with a white Calcic C horizon. 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 Mb) are found. Mausker fine sandy loams have no B horizons and are very calcareous. Mausker fine sandy loam soils are brown (10 YR 5/3, dry) to light brown (7.15 YR 6/4, dry) at the surface with a pink to reddish-yellow (7.5 YR 7/5, dry) calcic C horizon. Associated with the Mausker fine sandy loam soils around the base Playa Lake are Potter fine sandy loam soils, 0 to 5 percent slope phase (map symbol Pa). This soil typically has a thin A horizon, is grayish brown (10 YR 5/2, dry), with no B horizon; it is similar to Mausker soils. Potter soils are shallow and strongly calcareous, and overlie hard consolidated caliche. The calcic C horizon is within two 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 (USDA 1958).

2.2.7 Biological Resources

Land adjacent to Cannon AFB is primarily used for agriculture, and little natural vegetation remains in the area. The wildlife species that are common to agricultural areas throughout the region include bobwhite quail and pheasant. The few playa lakes in the area 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.

2.2.7.1 Plant Resources

The climate of the Cannon AFB area is considered 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 Cannon AFB. Woodlands composed of large shrubs and small trees are confined to riparian areas and playa lakes in the vicinity.

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 witmanil*), 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 Cannon AFB (Lee Wan and Associates 1990).

2.2.7.2 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, waterbirds and migratory waterfowl in general use 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 most likely 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 within Curry County that may occur, but not regularly in recent time, are the McCown's longspur and Baird's sparrow. 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, mainly west of the eastern plains.

2.3 LANDFILL NO. 5 (SWMU NO. 113/IRP NO. LF-5)

2.3.1 Description of Landfill No. 5

This SWMU is in an inactive landfill located in the southeastern area of the base and occupies approximately 70 acres (Figure 2-2). Cell No. 3, which is closed, is RCRA regulated because until mid-1981 this cell received hazardous waste. No additional hazardous wastes were placed in this cell from 1981 until its closure in 1983. Landfill closure consisted of placing an impermeable cap over Cell No. 3, in accordance with NMED and USEPA requirements. Additional groundwater monitoring wells were also

In 1992, the USACE installed two additional groundwater monitoring wells (L and M) along the eastern edge of Landfill No. 5 at the request of NMED in an attempt to ensure detection of potential contaminant releases from Landfill No. 5. Also in 1992, the USACE performed trenching activities to better define the cell boundaries of Cell No. 3. Based on this information, Cell No. 3 was completely capped during a project completed in July 1993.

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)
Baird'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

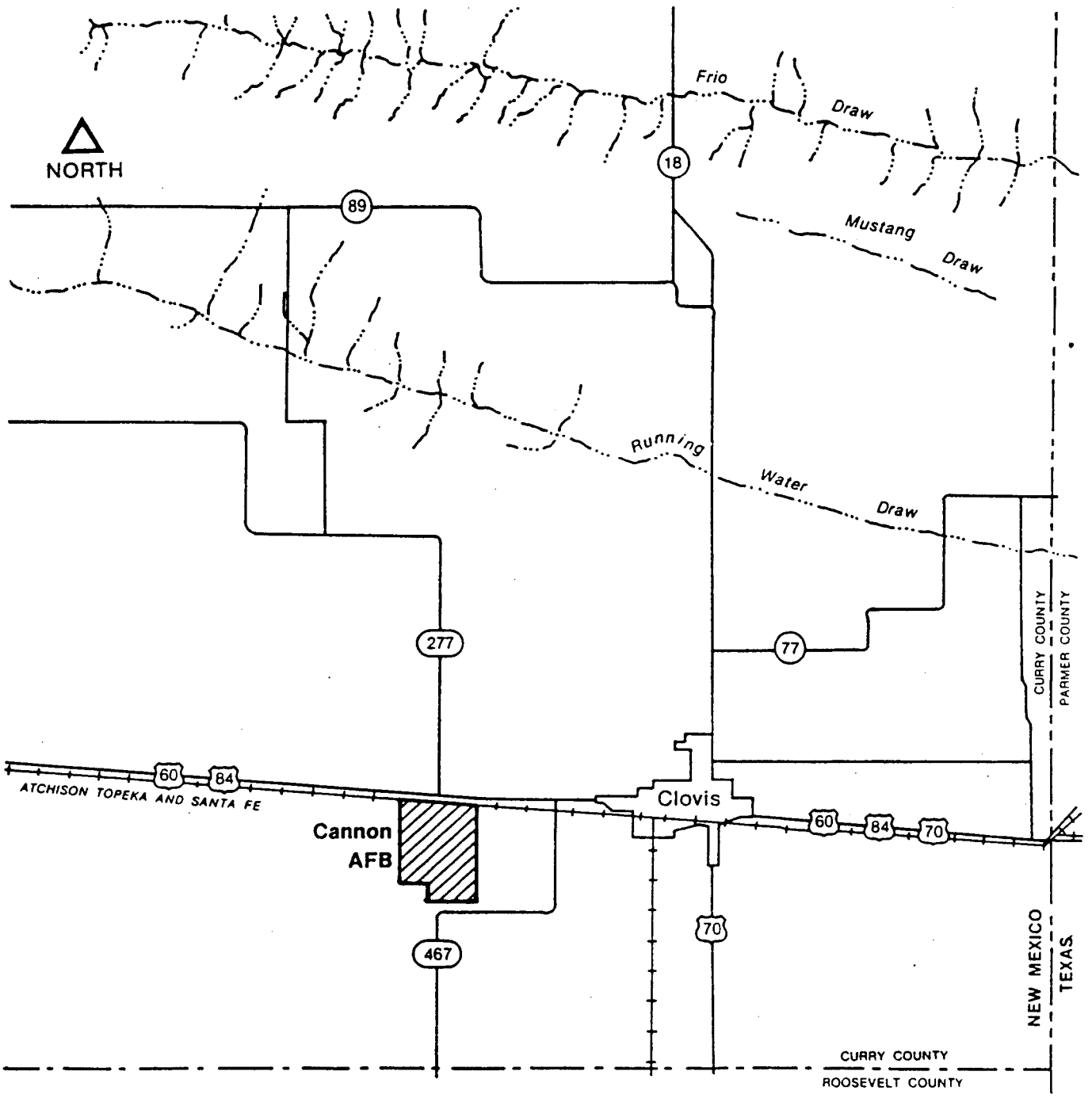
Endangered (group 1): Species whose prospects of survival or recruitment within the state are in jeopardy.

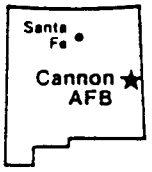
Endangered (group 2): Species whose prospects of survival or recruitment within the state are likely to become jeopardized in the foreseeable future.

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

Source: Lee Wan and Associates 1990.

136236





0 5
MILES

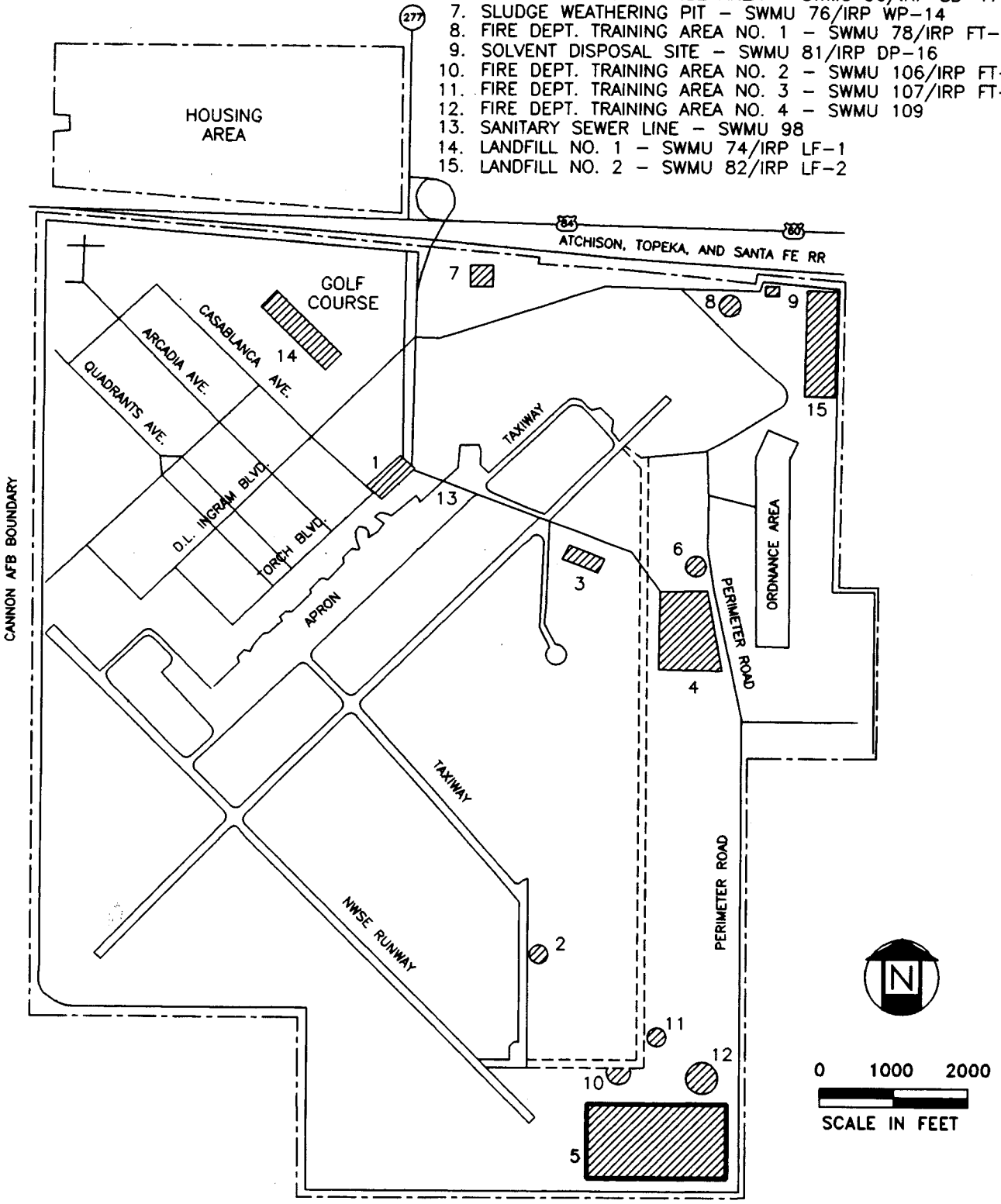
BASE MAP ADAPTED FROM FINAL REPORT, IRP PHASE II, (RADIAN 1986)

Job No. : C3M11M	**VICINITY MAP**
Prepared by : J.T.A.	**CANNON AFB, NM**
Date : 8/13/93	

FIG. 2-1

EXPLANATION

1. AGE DRAINAGE DITCH – SWMU 34/IRP SD-15
2. ENGINE TEST CELL AREA – SWMU 86-90/IRP SD-11
3. NE STORMWATER DRAINAGE AREA – SWMU 95/IRP SD-20
4. WASTEWATER LAGOONS – SWMU 101,102
5. **LANDFILL NO. 5 – SWMU 113/IRP LF-5**
6. OLD ENTOMOLOGY RINSE AREA – SWMU 96/IRP SD-17
7. SLUDGE WEATHERING PIT – SWMU 76/IRP WP-14
8. FIRE DEPT. TRAINING AREA NO. 1 – SWMU 78/IRP FT-6
9. SOLVENT DISPOSAL SITE – SWMU 81/IRP DP-16
10. FIRE DEPT. TRAINING AREA NO. 2 – SWMU 106/IRP FT-7
11. FIRE DEPT. TRAINING AREA NO. 3 – SWMU 107/IRP FT-8
12. FIRE DEPT. TRAINING AREA NO. 4 – SWMU 109
13. SANITARY SEWER LINE – SWMU 98
14. LANDFILL NO. 1 – SWMU 74/IRP LF-1
15. LANDFILL NO. 2 – SWMU 82/IRP LF-2



Job No. : C3M11M	IRP/SWMU SITE LOCATION MAP
Prepared by : D.A.K.	CANNON AFB, NEW MEXICO
Date : 8/22/93	

3M11FXX

FIG. 2-2

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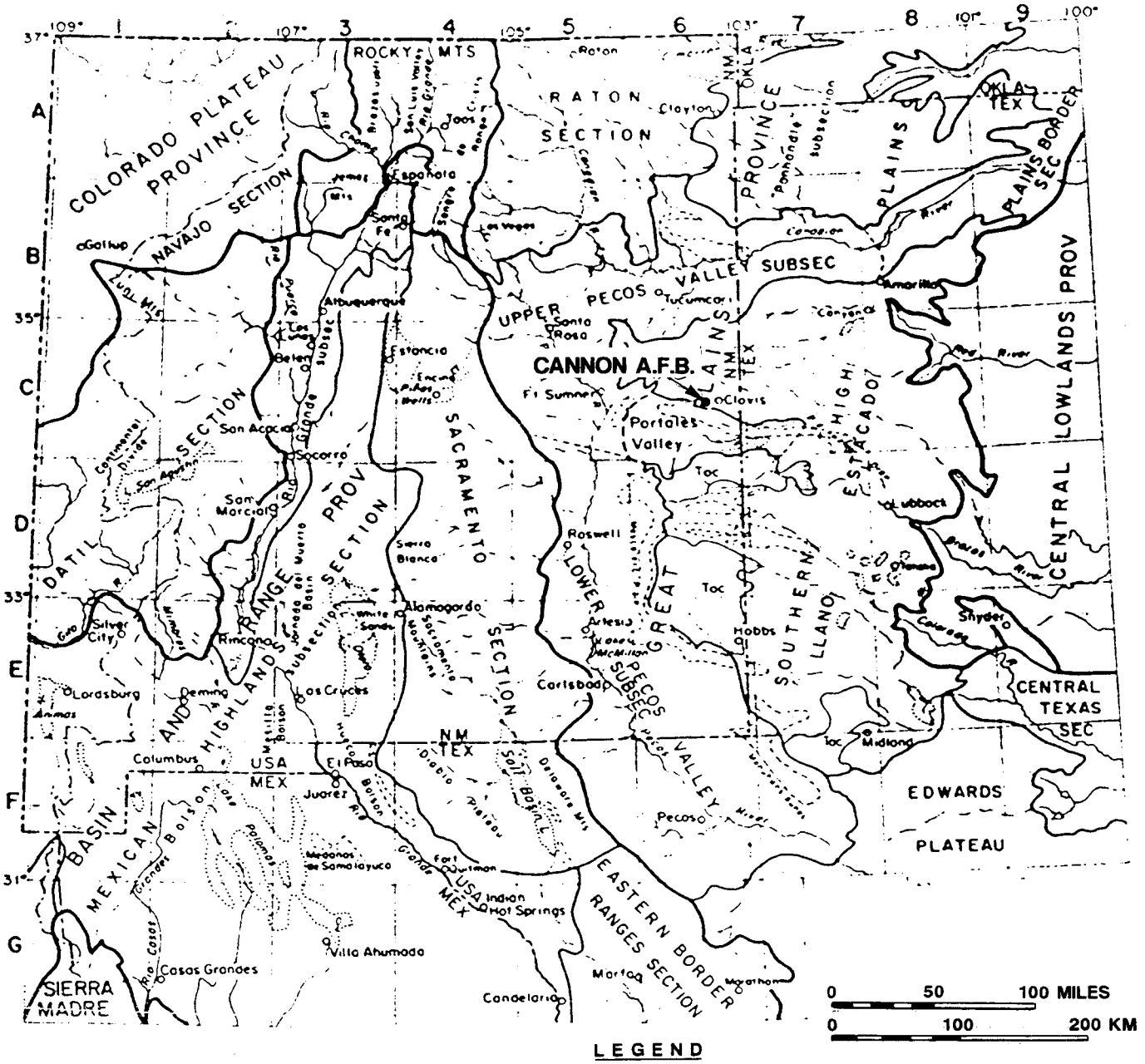


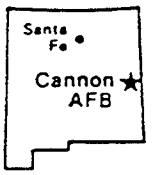
LEGEND

UPPER QUATERNARY EOLION SAND SHEETS WITH DUNE FIELDS

DEPRESSIONS OCUPIED BY UPPER PLEISTOCENE "FLUVIAL" LAKES

Toc — RELICT OGALLA CAPROCK SURFACE

SOURCE: QUATERNARY STRATIGRAPHY IN THE BASIN & RANGE AND GREAT PLAINS PROVINCES NEW MEXICO & WEST TEXAS; HAWLEY, BACKMAN, MANLEY.

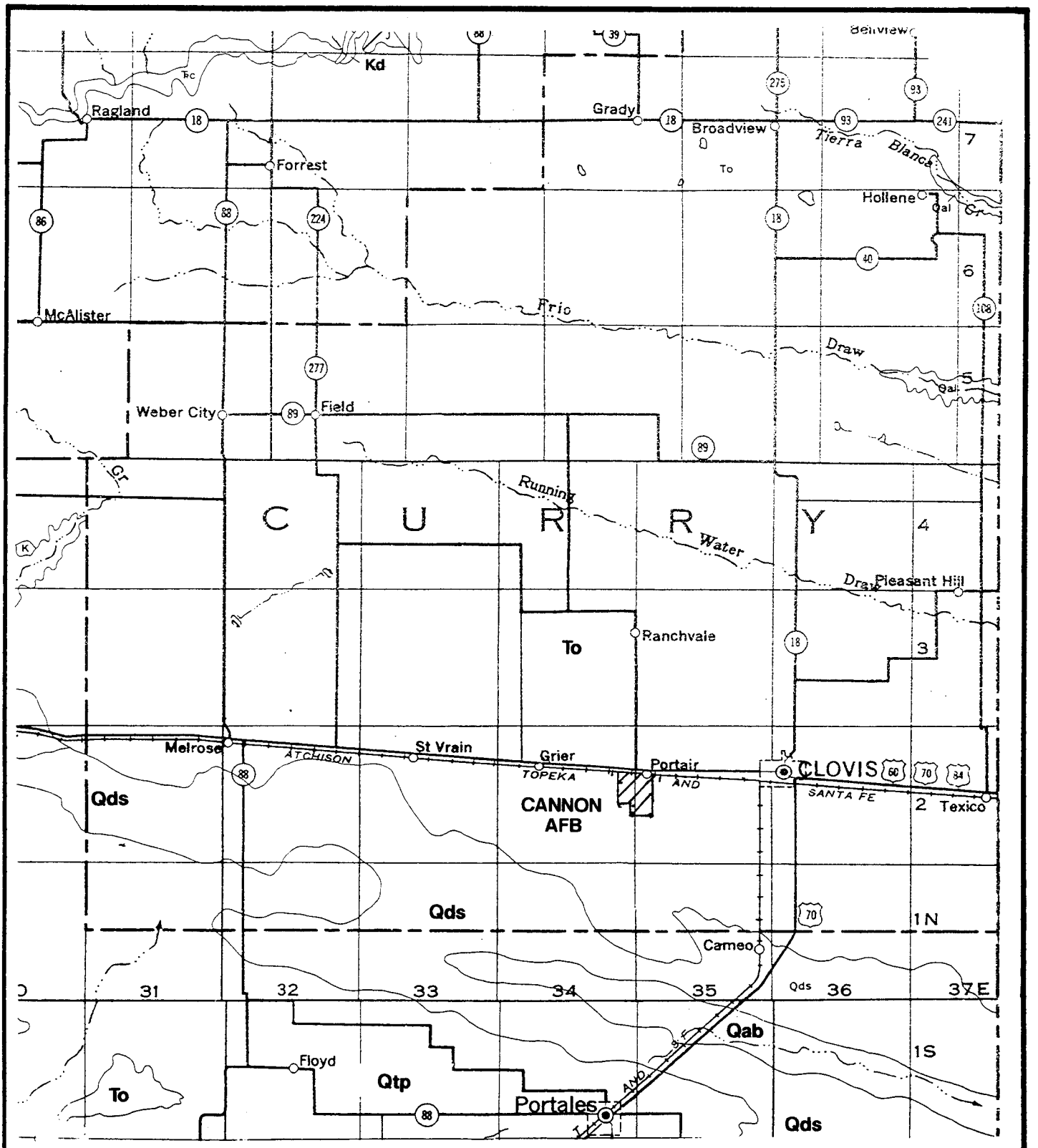


NEW MEXICO

Job No. : C3M11M	GEOMORPHIC PROVINCE MAP
Prepared by : D.A.K.	CANNON AFB, NEW MEXICO
Date : 8/20/93	

FIG. 2-3

150271

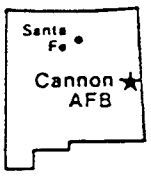


LEGEND

QTp	GRAVEL, SAND & CALICHE
Qds	DUNE SAND
Qab	ALLUVIUM
To	OGALLALA FORMATION

N

0 2.5 5 10
SCALE IN MILES



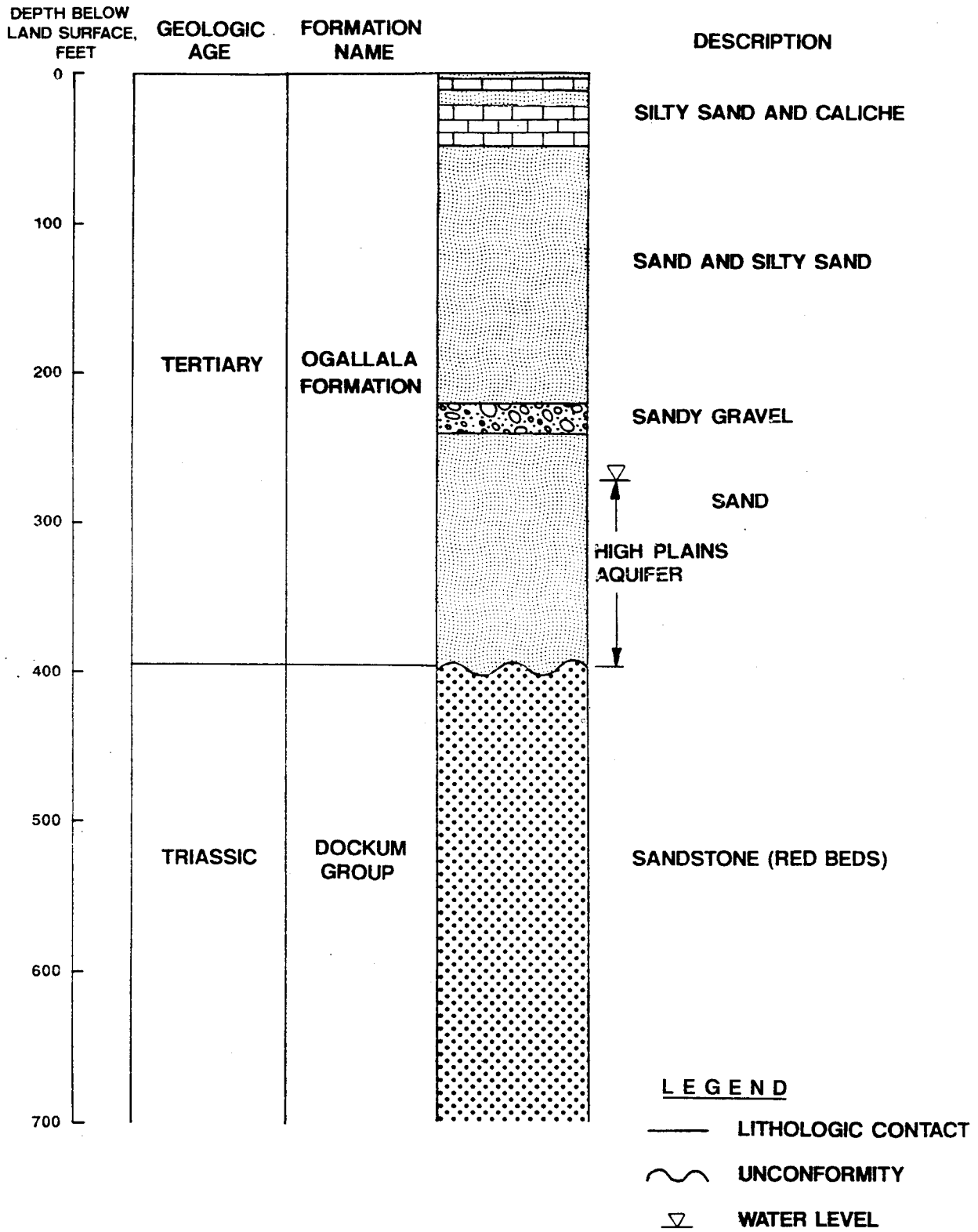
NEW MEXICO

SOURCE: U.S.G.S. GEOLOGIC MAP OF NORTHERN N.M., 1962

Job No. : C3M11M	**GENERALIZED GEOLOGIC MAP**
Prepared by : D.A.K.	**CANNON AFB, NEW MEXICO**
Date : 8/20/93	

FIG. 2-4

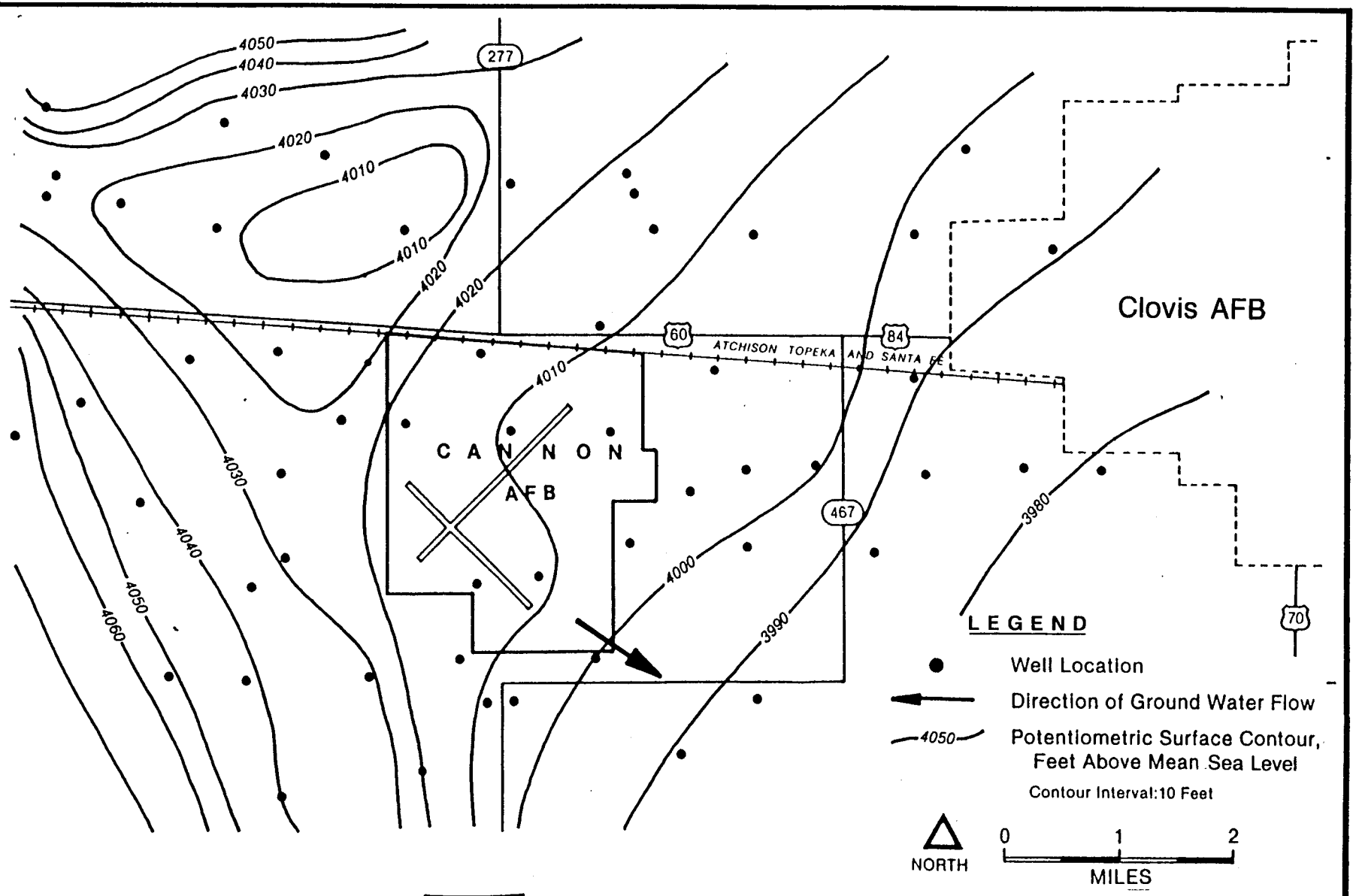
150271



MODIFIED FROM GUTENTAG ET.AL. 1984

Job No. : C3M11M	GENERALIZED GEOLOGIC COLUMN OF
Prepared by : D.A.K.	CANNON AFB, NEW MEXICO
Date : 8/20/93	

FIG. 2-5



NEW MEXICO

GROUNDWATER ELEVATION IN THE VICINITY OF CANNON AFB, NEW MEXICO - JANUARY-FEBRUARY 1982

BASE MAP ADAPTED FROM FINAL REPORT, IRP PHASE II, (RADIAN 1986)

Job No. : C3M11M

Prepared by: D.A.K.

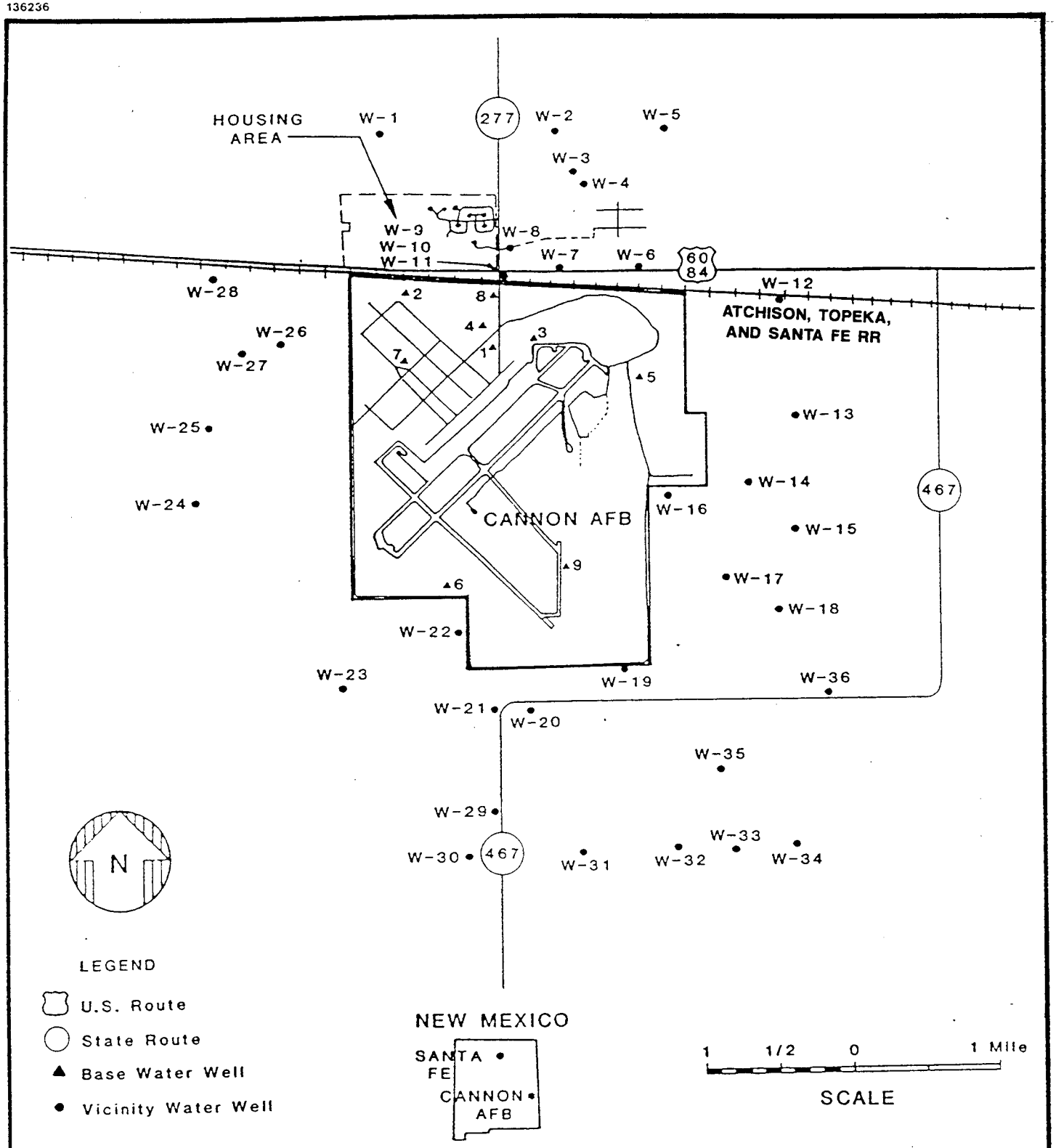
Date: 8/20/93

ALTITUDE AND CONFIGURATION OF WATER TABLE, VICINITY OF CANNON AFB, NEW MEXICO

FIG. 2-6

136236

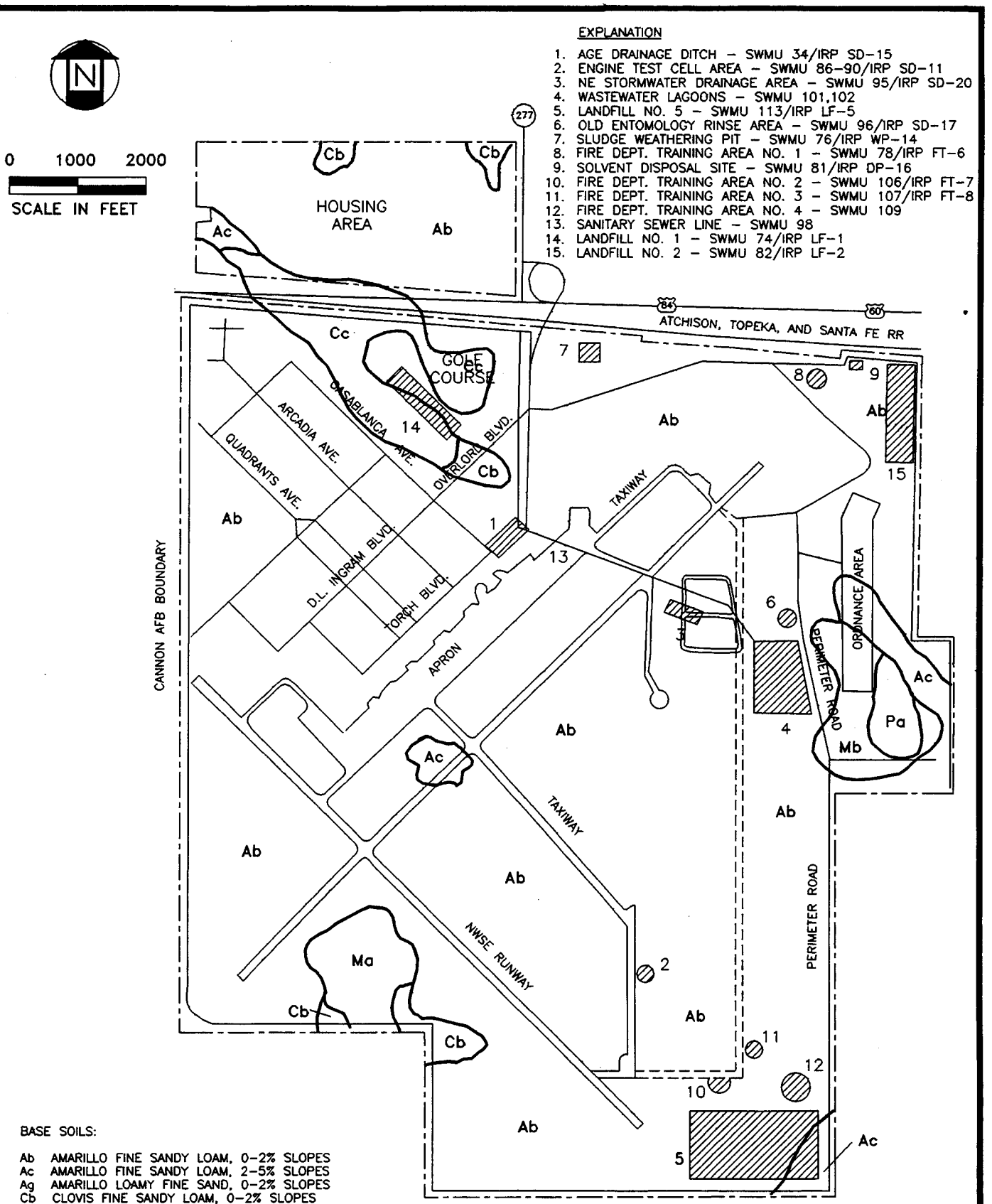
136236



SOURCE: FINAL REPORT, IRP PHASE II (RADIAN 1986)

Job No. : C3M11M	WATER WELL LOCATIONS ON AND NEAR CANNON AFB, NM
Prepared by : M.J.A.	
Date : 8/20/93	

FIG. 2-7



BASE SOILS:

Ab AMARILLO FINE SANDY LOAM, 0-2% SLOPES
Ac AMARILLO FINE SANDY LOAM, 2-5% SLOPES
Ag AMARILLO LOAMY FINE SAND, 0-2% SLOPES
Cb CLOVIS FINE SANDY LOAM, 0-2% SLOPES
Cc CLOVIS FINE SANDY LOAM, 2-5% SLOPES
Ma MANSKER FINE SANDY LOAM, 0-2% SLOPES
Mb MANSKER FINE SANDY LOAM, 2-5% SLOPES
Pa POTTER FINE SANDY LOAM, 0-5% SLOPES

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

Job No. : C3M11M	DISTRIBUTION OF SOILS BY TYPE
Prepared by : D.A.K.	CANNON AFB, NEW MEXICO
Date : 8/22/93	

3M11F28

FIG. 2-8

3.0
INITIAL EVALUATION

The program approach for the RFI for Landfill No. 5 at Cannon AFB is to review known information including results of past investigations, past and present operational history, and the physical setting at Landfill No. 5. Then, through use of the Data Quality Objectives Process, identify data needs and formulate a sampling plan to collect the necessary data for Landfill No. 5. The rationale for sampling locations, number of samples, and analytical parameters is presented in Section 4.0-Work Plan Rationale of this document, and Section 4.0-Field Activities in the DCQAP (Work Plan Volume II). A discussion of the Data Quality Objectives (DQO) process and how it was applied to the planned RFI is presented in the following section.

3.1 DATA QUALITY OBJECTIVES PROCESS

3.1.1 Purpose of Data Quality Objectives

DQOs are quantitative and qualitative statements derived from the output of each step of the DQO Process that:

- Clarify the study objectives
- Define the type of data to collect to meet the study objectives
- Determine the most appropriate conditions from which to collect the data
- Specify the required decision accuracy parameters that will be used as the basis for establishing the quantity and quality of data needed to support the decision

The DQOs are then used to develop a scientific and resource-effective sampling design.

3.1.2 Data Quality Objectives Process

The DQO process is a series of planning steps based on the Scientific Method that is designed to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application. The objectives of the DQO process are to provide data of sufficient quality to support decisions regarding corrective measures, to reduce overall costs of sampling and analytical activities, and to accelerate project planning and implementation.

The DQO Process was developed by the USEPA to help Agency personnel avoid collecting data that are inconsequential to decision making. The process allows the decision makers to define their data requirements and acceptable levels of decision errors during planning, before they collect the data. Application of the DQO Process should result in data collection designs (sampling plans) that will yield results of appropriate quality for defensible decision making (USEPA 1993a).

The DQO process consists of a number of steps and is often divided into three stages as illustrated in Table 3-1. The DQO process is integrated with development of the sampling and analysis plans and should be revised, as needed, based upon the results of each data collection activity. This process is outlined below.

3.1.2.1 Stage 1 - Identify Decision Types (Initial Evaluation)

Stage 1 of the DQO process identifies the individuals responsible for decisions, data uses, and available data; determines if additional data is needed; and identifies the types of decisions which will be made regarding site remediation. Available information on Landfill No. 5 will be compiled and analyzed to describe suspected sources, contaminant pathways, and potential receptors. Stage 1 results in the specification of the decision-making process, identification of reasons additional data is needed, and sets the foundation for Stages 2 and 3 of the DQO development process as shown in Table 3-1.

3.1.2.2 Stage 2 - Identify Data Uses/Needs (Work Plan Rationale)

Stage 2 specifies the data (quantity/quality) necessary to meet the objectives set in Stage 1. This stage stipulates criteria for determining data adequacy. Stage 2 includes selection of the sampling approaches and the analytical options used for the site.

3.1.2.3 Stage 3 - Design Data Collection Program

Stage 3 specifies how to assemble data collection components and develop data collection documentation. Methods have been specified by which acceptable data will be obtained to make decisions. This information will be provided in the sampling and analysis plan.

3.1.3 Integration of Data Quality Objectives with the Data Collection Quality Assurance Plan

During Stage 2 of the DQO process, specific DQOs will be developed based on media or sample activity. The intent of Stage 3 is to compile the information and DQOs developed for specific tasks into a comprehensive data collection program. The output of the DQO process is a well-defined sampling and analysis plan with summary information provided in the work plan. The sampling and analysis plan will identify the individuals responsible and the procedures for field activities and sample analysis.

The DQO process also develops the requirements for assessing the quality of any data in the RFI program and determines data acceptability according to the RFI requirements. This review consists of data acceptance and management and is addressed in the Data Collection Quality Assurance Plan and the DMP. The DMP is presented in Appendix A.

The three-stage data quality objective process which was used to define the data objectives, specific task objectives, and quality assurance objectives for the RFI to be conducted at Landfill No. 5 are discussed in more detail in Section 4.0 of this work plan.

3.2 PAST WASTE MANAGEMENT PRACTICES

Information regarding specific past waste management practices for Cannon AFB is contained in past investigation reports. A summary of those practices is presented here as they relate to SWMU No. 113/IRP No. LF-5. The locations of Landfill No. 5 and the other Appendix I SWMUs previously investigated (W-C 1992) as shown in Figure 2-2. A more detailed description of past waste management practices and potential contaminants is discussed in Section 4.0 of this Work Plan. In general, paste waste management activities at Cannon AFB included:

- Solid and hazardous waste disposal in landfills
- Fire training exercises using aircraft fuels
- Wastewater treatment activities
- Landfarming of fuel tank bottom sludges
- Collection of spent materials from aircraft engine testing/cleaning
- Disposal of spent cleaning agents/oils into the sanitary sewer waste water lagoons (SWMU No. 101/102) which ultimately discharged to the Playa Lake (SWMU No. 103)

3.3 BEHAVIOR OF CONTAMINANT PLUMES

The "pendant plume" model of contaminant migration in a semi-arid region with a deep unconfined water table forms the conceptual basis for soil and groundwater sampling at Cannon AFB (Kearney 1987). Site-specific sampling plans are designed to account for the presence of clays, caliche, and release quantities. The pendant plume conceptual model for subsurface contaminant migration is discussed below in more detail.

The behavior of contaminants in unsaturated clay-rich sediments and soils is a complex physicochemical process. Due to the depth to the water table (greater than 200 ft) and lack of precipitation and water infiltration as a contaminant carrier, only large or continuous releases of liquid contaminants may be expected to reach the water table. The presence of low permeability (but not impermeable) caliche layers as well as chemically active (i.e., high CEC) clays will also act to impede contaminant migration.

installed in 1984 (Radian 1986) and 1992 by USACE to meet RCRA release detection monitoring requirements.

2.3.2 Potential Contaminants

Waste materials received at the landfill included domestic solid waste, waste oils, and solvents; paint, paint remover, and thinners; pesticide containers; and various empty cans and drums. Until mid-1981, approximately 5 to 10 drums per month of waste oils and solvents were disposed in Cell No. 3 (Radian 1986). Tree limbs and construction debris were placed in the landfill until 1991. No investigative work will be performed in the closed area encompassing Cell No. 3.

2.3.3 Existing Situation

Cell No. 3 has been permanently closed with a cap, fenced separately for security, and had a series of monitoring wells installed on the south and east edges of Landfill No. 5 to detect contaminant migration in groundwater. The remaining area of Landfill No. 5 is covered with natural vegetation.

In 1991, W-C collected groundwater samples for Appendix IX constituents (40 CFR 264) from five groundwater monitoring wells at Landfill No. 5 (W-C 1992). Results of chemical analysis of these samples indicated that no analytes other than metals were detected above the contract required quantitation limit (CRQL). Metals analysis revealed the presence of barium and vanadium in all five groundwater samples. Both metals had concentrations below their MCLs (for barium, 1.0 mg/L; for vanadium, no maximum contaminant level (MCL) is established). The concentration of vanadium ranged from 0.023 mg/L to 0.036 mg/L. Lead was detected in one groundwater sample from well 113B at 0.016 mg/L. This concentration is at the action level (0.015 milligrams per liter [mg/L]) for drinking water samples collected at the tap. Evaluation of the chemical data collected during this investigation indicated that the quality of groundwater has not been affected by past activities at Landfill No. 5.

Capillarity will also have a role in attenuating contaminant migration. As illustrated in Figure 3-1, a relatively small contaminant release will tend to form a "pendant plume." A pendant plume extends downward from the release site with little lateral spread. Downward migration will continue until capillarity and clay adsorption eliminates free liquids (i.e., liquids which can be drained rapidly by gravity). Pendant plumes may spread laterally if low permeability layers are encountered during downward movement (Figure 3-1) . However, in the absence of a carrier fluid such as water, lateral spread will be severely limited.

Relatively large plumes may not be fully attenuated by caliche or clays and may reach the water table. Figure 3-1 illustrates this situation. In this instance, a water table with a shallow gradient could limit the rate of migration.

Caliche, as a low-permeability barrier, will act to retard downward movement of the liquid phase contaminant plume. However, lateral spreading immediately above the caliche layer may occur. As a rule of thumb, a difference of permeability of two orders of magnitude or more will provide an effective barrier in the absence of significant head differences. While the vertical migration pathway provides a significant change in head, if generally small quantities of liquids are involved, it is unlikely that the liquids would migrate to a great depth through competent caliche given the complex nature of flow in the unsaturated zone. However, migration along fractures in the caliche, where present, may allow deeper migration in some locations. (It should be noted that fractured caliche as discussed above has not been documented as occurring at Cannon AFB beneath Landfill No. 5. If it is encountered during the Phase I RFI, physical descriptions will be included in the Phase I RFI report.

Clays, zeolites, metal oxides, and humus are chemically active soil/sediment constituents which can impede or trap migrating contaminants. These particulates have large surface areas and slight to moderate electronegative surface and interlayer charges. Cationic contaminants in water may partition and adsorb to clay or humus. The degree of partitioning depends on clay CEC, amount of humus, types and concentrations of natural and contaminant ions; ionic valency, and the presence of dissolved organic co-contaminants (Matthess 1984). Multivalent cationic metals will tend to strongly sorb to

clays. Semivolatile organics may also be sorbed to clays and humus. However, volatile organics such as xylene will not sorb and may actually increase permeability relative to organics. Areas in which fuel releases have occurred may, therefore, need to be sampled to greater depths than areas in which metals are of concern.

3.4 PRELIMINARY IDENTIFICATION OF CONTAMINANT MIGRATION PATHWAYS

The initial step in the evaluation of Landfill No. 5 is the development of an Exposure Pathway Flow Chart (EPFC) which provides a framework for evaluating potential risks associated with the SWMU, aids in the identification of data needs, and assists in the identification of appropriate preliminary remediation goals targeted to significant exposure pathways. The EPFC was used initially to assist in the development of the sampling strategy for Landfill No. 5. Upon completion of the field sampling program, the EPFC will be used to re-evaluate Landfill No. 5, taking into consideration the analytical results and fate and transport properties of chemicals detected beneath the disposal cells at Landfill No. 5.

Figure 3-2 shows the EPFC with chemical sources and potential human exposure pathways for Landfill No. 5. The EPFC presents 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 chemicals of concern occurs. An exposure pathway consists of five 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)

- Human receptors located at these points of exposure

- A human intake mechanism (e.g., inhalation or ingestion) at the point of exposure

All five elements must be present for an exposure pathway to be complete and for chemical exposure to occur. In the EPFCs, 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 were evaluated with respect to possible chemical sources at Landfill No. 5. Exposure pathways were 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.

The potential sources of chemical emissions from Landfill No. 5 are presented in Figure 3-2. The primary potential source is generally waste (e.g., fuels, oils, and solvents) that have leaked into subsurface soils; the secondary potential sources are other media, such as subsurface soil or water, impacted by the primary source.

Chemicals in these media or sources may be transported away from Landfill No. 5, thereby affecting other media that may act as tertiary sources. Percolation and leaching of the wastes to the subsurface soil is shown as a primary chemical release mechanism. Subsurface soils are an important secondary source of potential chemical release. Chemicals released from Landfill No. 5 may infiltrate/percolate through the soil and be released to groundwater.

The previous RI conducted at Landfill No. 5 included groundwater sampling and analysis for Appendix IX constituents at five groundwater monitoring locations (MW-A, MW-B, MW-C, MW-D, and MW-I). The results of this sampling and analysis, and previous groundwater samples collected by Cannon AFB at these groundwater monitoring

locations indicated that groundwater beneath Landfill No. 5 had not been impacted by past activities at Landfill No. 5 (W-C 1992). Currently, Cannon AFB is collecting groundwater samples for chemical analysis at four groundwater monitoring locations (MW-A, MW-I, MW-L, and MW-M). These four monitoring wells are being sampled as part of the compliance monitoring program for Cell 3, located within Landfill No. 5. As such, these wells do no monitor groundwater quality for the entire Landfill No. 5. The Phase I RFI for Landfill No. 5, is being performed to evaluate whether release(s) of hazardous constituents has occurred from landfill cells within Landfill No. 5. Following completion of the RFI for Landfill No. 5 and the collection, analysis and review of the first year of Cell 3 Post Closure compliance groundwater monitoring, Cannon AFB will re-evaluate the need for the installation and monitoring of additional groundwater monitoring wells at Landfill No. 5.

Based on past RFIs and RIs conducted for other landfills at Cannon AFB, most of the contamination, if present, within the soils at Landfill No. 5, will likely exist as localized low concentrations of petroleum hydrocarbons and aromatic volatile organic compounds in the near-surface soils, with little opportunity to migrate beyond the immediate area of release because of small volumes of source materials. The caliche underlying most of the soils at Cannon AFB is fairly impermeable.

Other types of release mechanisms, such as direct contact, surface runoff, wind erosion, or volatilization to the atmosphere, are also depicted in the EPFC. Landfill No. 5 has a soil and vegetation cover and is located in an area with little, if any, drainage features; surface transport of chemicals by storm water runoff is likely to be limited in extent. Therefore, transport by storm water runoff is not considered a significant pathway for human exposure. Volatilization of chemicals and release of airborne particulates via wind erosion are potentially significant pathways of on-site inhalation exposure if significant surface contamination exists. Direct contact with contaminated soil and subsequent incidental soil ingestion is another potentially significant exposure pathway.

3.5 PUBLIC HEALTH AND ENVIRONMENTAL IMPACTS

A Baseline Risk Assessment (BRA) may be conducted as a follow-on to the Landfill No. 5 RFI. The data quality considerations for this RFI include as an objective that all data be of sufficient quality to support a BRA should one be required at a later time. The BRA will identify chemical compounds of concern and evaluate their potential impacts to human health and the environment. The results of the BRA will be used to formulate remedial actions as necessary. The human health risk assessment and environmental evaluation prepared for Landfill No. 5, if complete exposure pathways are present, will supplement the BRA previously performed on Landfill No. 5 as a part of the 18 SWMU RI conducted by W-C in 1992 (W-C 1992).

3.6 PRELIMINARY IDENTIFICATION OF REMEDIAL ACTION TECHNOLOGIES

Possible corrective measures technologies have been preliminarily identified for Landfill No. 5. At this time, the technologies under consideration as shown in Table 3-2 include no action, landfill capping, soil vapor extraction of contaminated soils where soil permeabilities allow, and in situ bioremediation. Following completion of the Phase I RFI, and if results warrant, data gaps in information required to support evaluation of potential corrective measures technologies will be evaluated. During a Phase II (or additional phases) of investigation, additional data will be collected for a complete evaluation of potential corrective measures technologies. In addition, during potential future CMSs (Feasibility Studies under CERCLA), these and perhaps other corrective measures technologies will be identified and evaluated.

Potential treatment technologies and their assorted containment or disposal requirements for remediation of contaminated soil will be screened for their technical applicability to Landfill No. 5. Technologies found to be appropriate will be combined to form alternatives for source control and/or management of migration measures. Data collected in this field investigation that may identify site characteristics that could limit or promote the use of certain remedial technologies will be evaluated as part of the screening process. Technologies that are clearly limited by site characteristics,

contaminant properties, or that may prove difficult to implement will be eliminated from consideration.

Based on the results of field investigations and consideration of potential remedial technologies, a limited number of alternatives will be developed ranging from an alternative that, to the degree possible, would eliminate the need for long-term management at the sites to alternatives involving treatments which reduce toxicity, migration, or volume. In addition, an alternative involving No Action or containment with little or no treatment use of Landfill No. 5 as a CAMU will be included in the range of alternatives. The alternatives will be developed in consultation with the NMED and USEPA and will be oriented at site-specific information obtained from the field investigation.

TABLE 3-1

DQO THREE-STAGE PROCESS

STAGE 1

IDENTIFY DECISION TYPES

Identify and involve data users

Evaluate available data

Develop conceptual model

Specify objectives/decisions

STAGE 2

IDENTIFY DATA USES/NEEDS

Identify data uses

Identify data types

Identify data quality needs

Identify data quantity needs

Evaluate sampling/analysis options

Review PARCC parameters

STAGE 3

DESIGN DATA COLLECTION PROGRAM

Assemble data collection components

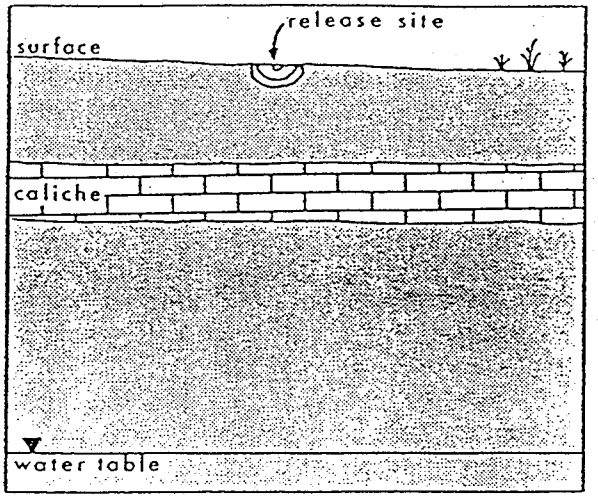
Develop data collection documentation

TABLE 3-2

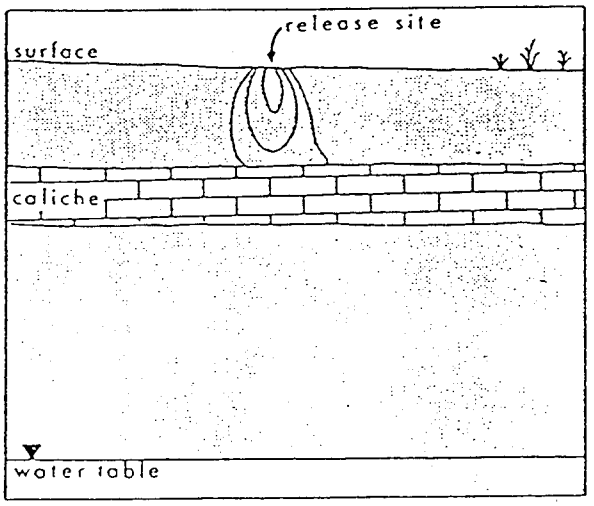
Potential General Response Actions, Remedial Technologies, and Process Options

Media	General Response Action	Remedial Technology	Process Option
Soil	No action	None	None
	Institutional controls	Land use	• Deed restrictions • Zoning restrictions
		Access restrictions	Fencing and post warnings
	Containment	Capping	• Native Soil Vegetation • Clay • Composite • Synthetic membrane
		Vertical barriers*	• Slurry wall • Grout curtain • Sheet piling • Compacted clay cut-off wall
	Removal*	Removal	Excavation
	Treatment	In situ	• Soil vapor extraction • Bioventing • Air sparging with air treatment • Gas collection with air treatment • Bioremediation
		Ex situ*	• Landfarming • Bioslurry reactor
		Air treatment	• Flare

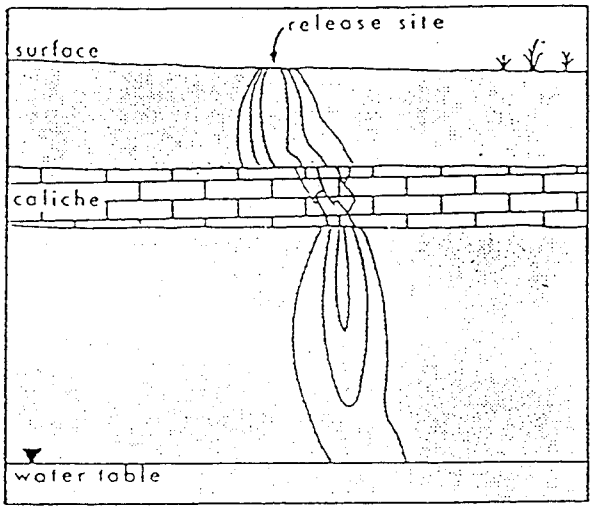
* Technologies that most likely will not be applicable to particular site; however, they can be evaluated in the CMS.



A. Single event release of a small quantity.



B. Single event release of a large quantity.



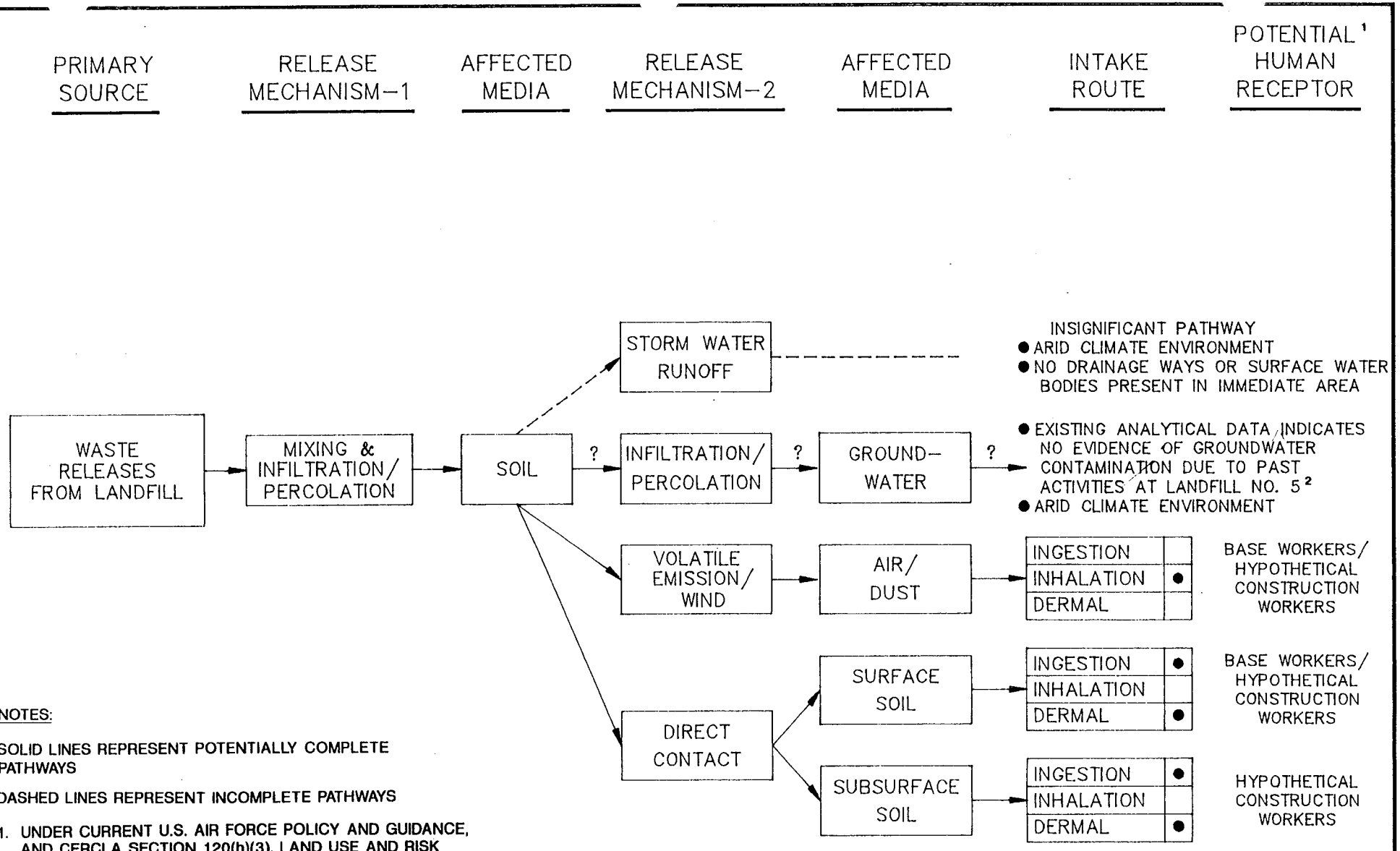
C. Continuous release of contaminants. Note migration of liquids through fractures in the caliche.

SOURCE: LEE WAN AND ASSOC., 1990

Job No. : 89MC114W	**SUBSURFACE CONTAMINANT MIGRATION SCENARIOS**
Prepared by : J.L.E.	**CANNON AFB, NM**
Date : 8/28/91	

FIG. 3-1

CAD FILE: (115.DWG V=SEPARATORS 08/26/1993 16:58



NOTES:

SOLID LINES REPRESENT POTENTIALLY COMPLETE PATHWAYS

DASHED LINES REPRESENT INCOMPLETE PATHWAYS

1. UNDER CURRENT U.S. AIR FORCE POLICY AND GUIDANCE, AND CERCLA SECTION 120(h)(3), LAND USE AND RISK WILL BE RE-EVALUATED IF, IN THE FUTURE, LAND USE CHANGES OCCUR AT CANNON AFB THAT COULD AFFECT THE LAND USE FOR LANDFILL NO. 5.

2. THE ADEQUACY OF THE EXISTING GROUNDWATER MONITORING NETWORK WILL BE RE-EVALUATED FOLLOWING COMPLETION OF THE RFI AT LANDFILL NO. 5 AND REVIEW OF THE FIRST YEAR OF CELL 3 POST CLOSURE COMPLIANCE MONITORING SAMPLING AND ANALYSIS.

DRN BY JTA	DATE 08/19/93	PRELIMINARY EXPOSURE PATHWAY FLOW CHART LANDFILL NO. 5 (SWMU NO. 113/IRP NO. LF-5) CANNON AIR FORCE BASE NEW MEXICO	PROJECT NO.	FIG. NO.
CHK'D BY .	REVISIONS: 0		C3M11M	3-2

4.0
WORK PLAN RATIONALE

This section outlines the assessment of the data needs, data gaps, investigation approach, and data quality requirements needed to meet the purpose for the RFI. The primary purpose of the Phase I RFI at Landfill No. 5 is the investigation of potential subsurface soil contamination that may have resulted from past activities at Landfill No. 5 (SWMU No. 113/IRP No. LF-5) located on Cannon AFB. Results of the Phase I RFI will be used to evaluate whether a release of hazardous constituents to the environment (native soil beneath landfill cells) has occurred or could potentially occur in the future which may pose a significant risk to human health and the environment. The DQO process has been used to develop sampling plans and sampling locations at Landfill No. 5. The Phase I RFI at Landfill No. 5 includes laying out a 50-foot by 50-foot surveying grid and performing a geophysical survey using 50-foot north-south spacing and up to a 25-foot east-west spacing. An 800-point soil gas survey will be performed over the same area based on the 50-foot by 50-foot grid, concentrating in the eastern two-thirds of the Landfill No. 5 SWMU where trenching, burning, and burying of waste material has been historically carried out. This necessitates that the actual spacing for the soil gas survey may be adjusted following the geophysical survey. The planned survey and sampling grid is shown in Figure 4-1. Based on the results of the geophysical and soil gas surveys, 30 soil boring locations will be identified from which subsurface soil samples will be collected for analysis.

4.1 DATA QUALITY OBJECTIVES

The following Data Quality Objectives were developed based on the overall objectives and primary purpose of the Phase I RFI.

- Identify suspected source areas within Landfill No. 5 having the potential to release hazardous constituents into the environment

- Collect environmental data of sufficient quality and quantity to define the nature, extent and rate of migration of releases of hazardous constituents to the environment

- Interpret the data collected to determine if additional phases of investigation are needed to address data gaps as well as whether interim corrective measures and/or Corrective Measures Study (Feasibility Study/Remedial Action under CERCLA) may be necessary

- Collect environmental data of sufficient quality and quantity to determine the potential for releases to migrate toward receptors for the significant pathways identified in Section 3.4

- Collect environmental data of sufficient quality to be used in a screening level Health Risk and Environmental Assessment or BRA (to be conducted in the future, if required) and collect data of sufficient quantity to address all significant exposure pathways

- Collect sufficient quality and quantity of environmental data to support a recommendation of "no further action," if warranted, following the evaluation of the findings of the investigation

- Collect data of a quality that can be used as part of any required follow-on study including a Corrective Measures Study

The decision diagram shown in Figure 4-2 has been developed for Phase I for the Landfill No. 5 RFI to present a logical decision process that will be used to evaluate the data needs necessary to achieve the project objectives. At each decision point, both NMED and EPA will be consulted and agreement reached before finalizing any decision. The diagram represents the decision process to evaluate the soil exposure pathway. The groundwater pathway is considered insignificant at this time since previous investigations have indicated that no significant impact to groundwater has occurred due to past activities at Landfill No. 5. However, if results of the Phase I investigation indicate the

potential for groundwater contamination, the groundwater pathway would be considered. Each step of the Phase I RFI for Landfill No. 5 as shown in Figure 4-2 is presented in additional detail in Section 4.2.

4.2 RFI INVESTIGATION DECISION PROCESS

The following decision process was used to assess the data needs and investigative approach for Landfill No. 5. The DQO evaluation process was designed to provide data of sufficient quality and quantity to determine if releases have occurred from Landfill No. 5 that could pose a risk to human health or the environment, to evaluate the need for additional data to complete a Baseline Risk Assessment (BRA) in the future, and complete a Corrective Measure Study, if warranted.

The RFI soils investigation decision process is designed to identify appropriate actions for Landfill No. 5 based on three alternative actions: no further investigation, interim action, and further investigation and evaluation in a final RFI/CMS (feasibility study under CERCLA). The recommendation for the selection of alternative action for Landfill No. 5 will depend on whether chemicals of interest 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 to evaluate Landfill No. 5.

The decision process was implemented by first evaluating and summarizing existing historical information and analytical data collected for Landfill No. 5. Historical information was used to identify potential chemicals of interest for Landfill No. 5, and was considered in selecting the phased investigation approach discussed below.

Phase I

This phase of the Landfill No. 5 RFI will allow for the evaluation of whether a release of hazardous constituents has occurred. Phase I includes 6 steps of investigation activities which are discussed below.

Steps 1 through 3: Based on historical information for Landfill No. 5, geophysical and soil gas surveys will be performed to delineate potential contaminant plumes for further investigation, through soil boring and sampling. Then subsurface soil will be sampled and analyzed for chemicals of interest. The analyte lists from which chemicals of interest were identified are discussed in the DCQAP. Sampling will be focused in areas within Landfill No. 5 that have the greatest potential for resulting in a release to the environment.

Step 4: Following review of the Phase I soil gas and geophysical surveys, 30 soil boring locations will be identified for surface and subsurface soil sampling and chemical analysis. These preliminary locations will be presented to the regulatory agency(s) for concurrence prior to this step of investigation.. If no potential source area is identified, the 30 soil borings will be located to target the suspected Landfill No. 5 cell area.

Step 5: After the Phase I RFI soil samples have been analyzed, the physical and chemical data will be reviewed and an evaluation made as to whether an imminent threat to human health and the environment is suspected. If no threat is apparent, this data evaluation step will continue as an iterative process as shown in Figure 4-2, with comparisons of exposure concentrations to RCRA Subpart S action levels, RASs, and background data (for inorganic compounds and metals). For potentially significant contaminants that do not have RCRA Action Levels but have EPA toxicity factors, action levels will be calculated.

To address potential cumulative effects of exposure to multiple contaminants in soil, a screening-level risk evaluation will be made by calculating ratios of chemical concentrations (either maximum or 95% upper confidence limit of arithmetic mean) to action levels, and summing the ratios (separate ratio sums are calculated for

carcinogens and noncarcinogens). Ratio sums above 1 indicate a hazard index above 1 (for noncarcinogens) or a cumulative cancer risk above 10^{-6} (for carcinogens). Analytical results from all sample intervals will be used in the screening-level risk evaluation, even though humans are not expected to contact subsurface soils.

If the results of the Phase I RFI and screening-level risk evaluation indicate possible cause for concern for adverse human health effects (ratio sums greater than 1), the regulatory agencies and Cannon AFB will discuss the need for any additional investigation and risk assessment to support risk management decisions for Landfill No. 5.

Chemicals of interest for evaluating site conditions at Landfill No. 5 will be selected by identifying chemicals reported above the analytical reporting limits. Metals and inorganic compounds that do not exceed background levels will not be included as chemicals of interest. Organic chemicals that do not have EPA toxicity factors will not be considered as chemicals of interest

Phase II (and beyond)

Step 6: After the decisions for Steps 1 through 5 shown in Figure 4-2 have been made, any data gaps will be identified and resulting additional phases of work will be defined and planned. The additional phases of investigation may include the collection of additional data defining the nature and extent of contamination, support for corrective measures, and for risk assessment purposes.

Step 7: The risk assessment activities will be performed at this step in the RFI, if required.

Step 8: Dependent upon the outcome of steps 5, 6, and 7, the need for a corrective measures study will be evaluated.

4.3 LANDFILL No. 5 (SWMU No. 113/ IRP No. LF-5) DQO PROCESS

This section describes the data needs and investigative activities for the Phase I RFI of Landfill No. 5 (SWMU No. 113/IRP No. LF-5).

Landfill No. 5 is in an inactive landfill located in the southeastern area of the base and occupies approximately 70 acres (Figure 2-2). Cell No. 3, which is closed, is RCRA regulated because until mid-1981 this cell received hazardous waste. No additional hazardous wastes were placed in this cell from 1981 to its closure in 1983. Tree limbs and construction debris were placed in the landfill until 1991. Waste materials received at the landfill included domestic solid waste, waste oils, and solvents; paint, paint remover, and thinners; pesticide containers; and various empty cans and drums. Cell No. 3 has been permanently closed with a cap, separate fencing for security, and a series of monitoring wells to detect contaminant migration in groundwater. The remaining area of Landfill No. 5 is covered with natural vegetation.

In 1991, W-C collected groundwater samples for Appendix IX constituents (40 CFR 264) from five groundwater monitoring wells at Landfill No. 5 (W-C 1992). Results of chemical analysis of these samples indicated that no analytes other than metals were detected above the CRQL. Metals analysis revealed the presence of barium and vanadium in all five groundwater samples. Both metals had concentrations below their MCLs (for barium, 1.0 mg/L; for vanadium, no MCL is established). The concentration of vanadium ranged from 0.023 mg/L to 0.036 mg/L. Lead was detected in one groundwater sample from well 113B at an estimated concentration of 0.016 mg/L analyzed for total lead (unfiltered sample). The value for total lead was qualified with an estimated flag code because the associated matrix spike relative percent difference was greater than the control limit specified in the Quality Assurance Project Plan. This concentration is at the action level (0.015 mg/L) for drinking water samples collected at the tap. However, lead was not detected at the reporting limit of 0.005 mg/L for dissolved lead in the sample at well 113B or in any of the other samples collected and

analyzed for dissolved lead from monitoring wells at Landfill No. 5. Evaluation of the chemical data collected during this investigation indicated that the quality of groundwater has not been affected by past activities at Landfill No. 5.

4.3.1 Data Needs

The following data needed to meet the objectives of the Phase I investigation at Landfill No. 5:

- Locate suspected source areas within the landfill having potential contaminant plumes from past waste disposal

- Characterize concentrations of chemicals in the surface soil in areas having the greatest potential for releases from the landfill (i.e., at areas having the highest potential chemical concentrations)

- Characterize concentrations of chemicals in the subsurface soil in areas having the greatest potential for releases from the landfill (i.e., at areas having the highest potential chemical concentrations)

- Characterize the vertical and horizontal distribution of chemicals of concern in soil to address the potential for transport to groundwater at concentrations of concern.

4.3.2 Data Gaps

Past investigation at Landfill No. 5 has included the installation and sampling of groundwater monitoring wells. Data from these investigations (Radian 1986; W-C 1992) indicate that groundwater has not been impacted due to past activities at Landfill No. 5. However, very little surface or subsurface soil sampling has been conducted to characterize the nature and extent of contamination, if present, in soils at the landfill. Therefore, the data gaps at Landfill No. 5 are the same as the data needs.

4.3.3 Investigative Approach

The goal of the RFI at Landfill No. 5 is to satisfy the data needs, i.e., to eliminate the data gaps identified above. The potential release point at Landfill No. 5 is from the burial cells to the subsurface soil beneath the landfill. Geophysical and soil gas surveys will be performed at Landfill No. 5 to identify potential contaminant plumes likely associated with historic landfill cells. Based on the results of these surveys, thirty soil borings will be located, to allow for the collection and subsequent laboratory analysis of surface and subsurface soil samples. Surface soil samples (at selected soil boring locations) will be collected to evaluate if concentrations of chemicals of interest exist at the surface that could pose a potential risk to human health or the environment. Subsurface soil samples will be collected from beneath the landfill-native soil interface to evaluate if a release from the landfill has occurred, and if so, do concentrations of chemicals of interest in subsurface soils pose a potential risk to human health or the environment. No sampling from within the landfill cells themselves is planned to be conducted as part of Phase I for the Landfill No. 5 RFI. The subsurface soil samples collected will also be used to characterize the vertical distribution of contamination, so that the potential impact to environmental media can be addressed. However, dependent upon the analytical results collected during Phase I, additional samples may be collected in a future phase(s) of investigation to complete the RFI process. If, during the Phase I investigation, a release to the soil is shown or the potential for a release to occur in the future is suspected, the additional phase(s) of investigation would include characterization of the source area. Any future phase(s) of investigation may include activities to better define the horizontal and vertical extent of contamination beneath the landfill through the installation of additional soil borings, vadose zone vapor sampling, and/or contaminant migration modeling. Following the completion of the Phase I RFI for Landfill No. 5, addenda to this Work Plan would be prepared detailing the additional phase(s) of investigation.

4.4 DATA QUALITY REQUIREMENTS

Data quality requirements define the quality and quantity of data needed to achieve the objectives (principally completion of the future baseline risk assessment, if required, and/or to evaluate further investigative needs for Landfill No. 5) of the RFI. Data quality requirements address factors such as sampling plans, designation of critical data, data precision, accuracy, representativeness, comparability, and completeness, detection limits required, and quality assurance/quality control sampling. Quality assurance objectives, which describe the minimum quality of data necessary to achieve the task objectives, are specified in the Sampling and Analysis Plan (FSP and DCQAP) for all analytical data.

The primary objective of this RFI is to determine whether hazardous material has been released from Landfill No. 5 resulting in an unacceptable risk to human health or the environment. This objective will be met by collecting data of the quality and quantity which are determined to be useable and sufficient by the end users to make decisions or identify data gaps. According to the DQO process, sampling locations will be selected so that this objective could be met as efficiently as possible. Specific sample locations will be selected based on: existing knowledge of wastes and waste handling practices at a Landfill No. 5, results of geophysical and soil gas surveys, knowledge of potential transport pathways from the landfill, and potential exposure pathways from Landfill No. 5 to receptors. Using these guidelines, sampling locations will be selected so that, with a high level of confidence based on professional judgment, all potential significant releases from a Landfill No. 5 will be detected and quantified.

4.5 IDENTIFICATION OF RELEVANT AND APPLICABLE STANDARDS

Both RCRA and CERCLA requirements for evaluating the nature and extent of hazardous wastes potentially occurring at Landfill No. 5 will be addressed in the investigations at Cannon AFB.

Cannon AFB must evaluate the SWMUs identified by the USEPA during the RFA as a condition of their RCRA Part B permit. The investigations conducted by W-C are

designed to satisfy RFI guidance for characterizing the SWMUs and developing and implementing corrective action measures, if necessary.

Cannon AFB is conducting this investigation under the conditions of their RCRA Part B permit and the Air Force's IRP. Cannon AFB's RCRA Part B permit requires that Cannon AFB identify all relevant and applicable standards for the protection of human health and the environment. The IRP requires that the investigation follow the regulatory requirements of CERCLA and is the basis for assessment and response actions on USAF installations under the provisions of CERCLA. SARA augmented the scope and requirements of CERCLA and gave specific directives to federal facilities regarding investigation of waste disposal sites. Under Superfund Amendments and Authorization (SARA), determination of applicable and relevant or appropriate requirements (ARARs) is required, and potential remediation alternatives should be considered at the initiation of a RI/FS (USEPA 1988, 1989b).

As part of future CMSs feasibility studies [FS] under CERCLA), alternative remedial or corrective action measures will be evaluated to assess the degree to which they attain or exceed relevant and applicable standards federal and state public health and environmental standards. A preliminary identification and discussion of relevant and applicable standards (RASs) for the planned RFI at Cannon AFB is presented below. Review of these RASs will highlight any site-specific regulatory conditions that might either limit the choice of alternatives or place limits on contaminant concentrations at the site.

The RASs presented herein are chemical-specific and location-specific. Identification of action-specific RASs can only be addressed once detailed remedial alternatives are developed.

4.5.1 Definition of Relevant and Applicable Standards

Cleanup standards for remedial actions must attain a general standard of cleanup that assures protection of human health and the environment, is cost-effective, and uses permanent solutions and alternative treatment technologies or resource recovery

technologies to the maximum extent practicable. In addition, SARA requires that any hazardous substance or pollutant remaining on site meet the level or standard of control established by standards, requirements, criteria, or limitations that have been established under any federal environmental law, or any more stringent standards, requirements, criteria, or limitations promulgated in accordance with a state environmental statute.

A requirement may be either applicable or relevant and appropriate to remedial activities at a site, but not necessarily both. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a site.

If a regulation is not applicable, it may still be relevant and appropriate. The basic considerations are whether the requirement (1) regulates or addresses problems or situations sufficiently similar to those encountered at the subject site (i.e., relevance) and (2) is appropriate to the circumstances of the release or threatened release so that its use is well suited to the particular site. Determining whether a requirement is relevant and appropriate is site-specific and must be based on best professional judgment. This judgment is based on a number of factors, including the characteristics of the remedial action, the hazardous substances present at the site, and the physical circumstances of the site and of the release, as compared to the statutory or regulatory requirement. Compliance with all requirements found to be applicable or relevant and appropriate is mandatory under SARA unless a waiver is obtained from USEPA.

"To be considered" materials (TBCs) are nonpromulgated advisories, proposed rules, criteria, or guidance documents issued by federal or state governments that do not have the status of potential RASs. However, these advisories and guidance are to be considered when determining protective cleanup levels where no RASs exists, or where RASs are not sufficiently protective of human health and the environment. In these circumstances, TBC values are used to establish cleanup targets.

4.5.2 Chemical-Specific ARARS

The chemical-specific RASs and other criteria or guidelines to be considered are presented in Tables 4-1 and 4-2. This information is based on standards, guidelines, and criteria in relevant literature, discussions with appropriate state regulatory agency personnel, and past project experience.

Chemical-specific requirements are based on health or risk-based concentration limits of discharge limitations in environmental media (i.e., water, soil) for specific hazardous chemicals. These requirements may be used to set cleanup levels for the chemicals of concern in the designated media, or to set a safe level of discharge (e.g., water, air, etc.) that may occur as part of the remedial activity.

Sources for potential target cleanup levels included selected standards, criteria, and guidelines that are typically considered as RASs for remedial actions conducted under CERCLA, as well as some recently published guidance and proposed action levels developed under RCRA that should be regarded as TBCs. In addition, New Mexico has developed cleanup levels for special wastes and underground storage tank-related remediation, as well as standards for groundwater. New Mexico has also defined toxic pollutants in its Water Quality Standards. Any contaminant or combination of contaminants from the list in WQCCR, Part 1, Section 101.UU found at detectable levels may have to be evaluated for risk to human health and the environment. A summary of these federal and state regulations, standards, and guidance is presented in Table 4-1.

For groundwater, MCLs established under the Safe Drinking Water Act (SDWA) are often accepted by regulatory agencies as cleanup levels for groundwater remedial activities, especially if the groundwater is or could be a drinking water source. Non-zero maximum Contaminant Level Goals (MCLGs) are also established under the SDWA. However, MCLGs are not federally enforceable and should only be used if site-specific health risk conditions warrant their use.

Since groundwater in the vicinity of Cannon AFB is classified as a current source of drinking water (Class IIA Groundwaters), the identification of potential target cleanup levels for groundwater samples from Cannon AFB focused on standards, criteria, and guidelines primarily for drinking water. These standards include MCLs and MCLGs, as well as the New Mexico drinking water standards, and are presented in Table 4-2. Also included are hazardous constituent concentration limits under RCRA Subpart F, which are applicable to releases from RCRA-regulated units. Secondary maximum contamination levels (SMCLs) established under SDWA are also presented in Table 4-2 although they are not federally enforceable and should be regarded as TBCs. In addition, the MCLs for several chemicals (footnoted by [d] in Table 4-2) are not yet in effect and should be considered TBCs. If no value is shown for a possible contaminant in Table 4-2, there are currently no standards for that contaminant. Repeated nondetect analytical results for any constituent during routine groundwater monitoring may allow the constituent to be dropped from the list of analytes, subject to the approval of NMED and USEPA.

State and federal standards and criteria for surface water quality are not considered applicable or relevant and appropriate as long as there is no possibility of remedial activities impacting surface water bodies. The nearest off-site surface water body is 1.1 miles from Landfill No. 5 and is upgradient, so there is little possibility of remedial activities impacting the offsite water body. Two playa lakes are located on Cannon AFB. One playa is located in the southwest section of the base, south of the runway area, and a second playa is located east of the wastewater sewage lagoons. The southwest playa receives storm water runoff from the western sections of the base, and the playa lake located east of the wastewater sewage lagoons receives treated effluent. Both base playa lakes are located upgradient from Landfill No. 5 and would likely not be impacted by remedial activities at Landfill No. 5. At one time, a playa lake was located due west of the landfill; however, the lake has been filled in with rubble and construction debris so it can no longer be considered a surface water body. However, should any remediation of the landfill involve discharge of groundwater to a surface water body, compliance with both the state and federal surface water quality standards and criteria would be required.

A letter dated January 8, 1992 from Col. David Benson to the New Mexico Environmental Department states that asbestos containing materials had been disposed of in Landfill 5 in accordance with New Mexico Solid Waste Regulations, special Waste Requirements (USAF 1992). This regulation is considered applicable if asbestos waste continues to be disposed of in Landfill 5 or is removed and disposed of elsewhere.

4.5.3 To Be Considered

In general, very few cleanup standards exist for soil contamination. Often cleanup levels are based on guidance developed from Underground Storage Tank (UST) investigations or, if non-petroleum wastes are involved, levels are based on site-specific risk assessment, hazardous waste definition, or background levels. Recently some human health-based criteria for soil and water contaminant levels have been published as guidance for RFIs (hereinafter referred to as the RFI Guidance), and RCRA-related action levels have been proposed (Tables 4-3 and 4-4). However, these figures were developed specifically for application in RCRA-related activities, although it appears they are being used as proposed RASs, where no other standards exist. These guidelines are presented, therefore, as TBCs rather than as chemical-specific RASs and represent "potential" cleanup levels only. Actual cleanup levels that may be applied to a particular area will depend on site-specific requirements based in part on the RCRA Facility Investigation and are subject to final approval by the appropriate regulatory agency or agencies. The RCRA levels are presented and used for the purposes of this RASs analysis because there are no other sources of standards or guidance for contaminated soils cleanup levels.

The RFI guidance levels presented in Tables 4-3 and 4-4 for cleanup of contaminated soils are based on EPA-derived chronic exposure assumptions and are intended as screening levels at RCRA facilities to determine whether a more detailed health-risk evaluation (CMS) is warranted. As previously discussed, they do not necessarily represent a target cleanup level. The proposed RCRA Subpart S action levels, also presented in Tables 4-3 and 4-4, if exceeded, would also trigger a CMS. However, because these levels are only proposed, at this time they are not enforceable under

RCRA (55 FR 30798, July 27, 1990). The equations used to derive the action levels/criteria use essentially identical parameters.

Other regulations or requirements that may need "to be considered" included the New Mexico UST Regulations and the New Mexico Special Waste Requirements Regulations. Those regulations set cleanup standards for soils contaminated with petroleum hydrocarbons associated with underground storage tanks (so-called benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds and total petroleum hydrocarbons).

4.5.4 Location-Specific RASs

Although the universe of location-specific RASs is identified in Table 4-5, only those regulations that are deemed RASs for the Cannon site are discussed below. Location-specific RASs are restrictions placed on the types of activities that may occur in particular locations. Potential location-specific RASs for Cannon AFB are presented in Table 4-5 with an explanation as to whether the regulation is applicable or relevant and appropriate and why. The location of a site may be an important characteristic in determining its impact on human health and the environment; thus, individual states may establish location-specific RASs. These RASs may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Examples of location-specific RASs include federal and state requirements for preservation of historic landmarks, endangered species and wetlands protection, and the restrictions on management of hazardous waste in floodplain areas.

Because of the possible presence of both federal- and state-listed threatened/endangered (T/E) species at the site, the federal and state Endangered Species Acts are both considered "potentially" applicable. If T/E species are found at the site, these acts would be applicable. In addition, there are bald eagles, peregrine falcons, other raptors and waterfowl, and their habitat within a 50-mile radius of Cannon AFB (Lee Wan and Associates 1990). Both the Migratory Bird Treaty Act and the Bald Eagle Protection Act are considered applicable if any of the species protected by these two Acts or their habitats are impacted by remedial actions.

Section 106 of the National Historic Preservation Act, the Historic and Archaeological Data Preservation Act, and the Archaeological Resource Protection Act are also considered "potentially" applicable due to a federal agency having authority over any actions that could impact on historically significant objects, buildings, or structures at the site. Although no buildings, objects, or structures at Cannon AFB have yet been placed on the National Register of Historic Places, the evaluation process is still ongoing at the base. Due to both architectural and archaeological surveys being conducted on Cannon AFB, the State Cultural Properties Act is also considered "potentially" applicable and negotiations with the State Historic Preservation Office should be renewed prior to any remedial activity.

Although there is uncertainty concerning the future definition of wetlands, it is the opinion of the U.S. Fish and Wildlife Service that the playas at the base fall under the current definition of wetland areas under federal wetland delineation guidance (Hagenbuck 1991). The federal regulations governing wetlands, however, are not considered RASs as long as the project does not impact the wetland areas. If the playa lakes on base continue to be considered wetlands and if the remedial activities should impact these wetland areas, then the regulations would be considered applicable and coordination with the U.S. Fish and Wildlife Service would need to be initiated prior to any remedial activity. The State of New Mexico does not have its own wetlands regulations at this time.

TABLE 4-1

SUMMARY OF POTENTIAL CHEMICAL-SPECIFIC RASs/TBCs CANNON AFB - LANDFILL 5

Standard, Requirement, or Criteria	Description	Comment
FEDERAL		
Safe Drinking Water Act (40 USC Sect. 300)		
National Primary Drinking Water Standards [40 CFR Parts 141, 142, (1990, 1991)	Establishes maximum contaminant levels (MCLs) for specific contaminants that are health-based standards for public drinking water systems.	MCLs are applicable for drinking water at the tap. MCLs are relevant and appropriate for organic and inorganic contamination of groundwater that is or may be used for drinking.
National Secondary Drinking Water Standards (40 CFR Part 143)	Establishes secondary maximum contaminant levels (SMCLs) that are nonenforceable guidelines for public drinking water systems to protect the aesthetic quality of the water.	SMCLs may be "to be considered" if groundwater is used as a drinking water source.
Maximum Contaminants Level Goals (MCLGs) [PL No. 99-339, 100 Stat. 642 (1986), (1990, 1991); 40 CFR 141,142]	Establishes drinking water quality goals at a level at which no adverse health effects may occur with an adequate margin of safety.	MCLGs set above zero levels are relevant and appropriate for existing or potential sources of drinking water. MCLGs may be relevant and appropriate if the risk posed by multiple contaminants or pathways is in excess of 10^{-4}.
Resource, Conservation, and Recovery Act (RCRA)		
Releases from Solid Waste Management Units (40 CFR Part 264)	Subpart F (264.94) gives concentration limits in groundwater for hazardous constituents from a regulated unit.	Applicable if organic and inorganic contamination of groundwater is found at a RCRA regulated unit.

TABLE 4-1
SUMMARY OF
POTENTIAL CHEMICAL-SPECIFIC RASs/ TBCs
CANNON AFB - LANDFILL 5

Standard, Requirement, or Criteria	Description	Comment
RCRA Facility Investigation Guidance (EPA 1989a)	Guidance levels for cleanup of contaminated soils based on EPA-derived chronic exposure assumptions; intended as screening levels at RCRA facilities to determine if a more detailed health-risk evaluation is warranted.	To be considered if contaminated soils are found.
Proposed RCRA Action Levels (55 FR 30798, 27 July 1990)	Risk-based action levels for contaminants in soil which, if exceeded, would trigger the need for a Corrective Measures Study.	To be considered if contaminated soils are found.
STATE		
New Mexico Water Quality Act, 1978		
New Mexico Drinking Water Regulations (4/16/91)(New Mexico Water Supply Regulations, Sections 202 to 203)	Establishes MCLs and standards for sources of drinking water.	State MCLs are applicable or relevant and appropriate to contaminated water if the state MCL is more stringent than federal requirements.
New Mexico Water Quality Regulations, amended through August 17, 1991 (WQCCR Part 3, Sections 100 through 103)	Establishes human health, domestic water supply, and irrigation use standards for ground water protection.	Applicable if remedial activities include discharges onto or below the surface of the ground.
New Mexico Water Quality Regulations, amended through August, 1991 (WQCCR Part 1, Section 101.UU)	Establishes definition of toxic pollutant based on effects to human health and the environment. Requires a determination of health and environmental risk due to the presence of the contaminant.	Applicable if groundwater related to the source area contains any of the contaminants listed in the definition of toxic pollutants.

TABLE 4-1
SUMMARY OF
POTENTIAL CHEMICAL-SPECIFIC RASs/ TBCs
CANNON AFB - LANDFILL 5

Standard, Requirement, or Criteria	Description	Comment
New Mexico Hazardous Waste Act 1978		
New Mexico Underground Storage Tank Regulations, amended through July 18, 1991, Section 1209	Sets cleanup levels for soils contaminated with benzene, aromatic hydrocarbons, or petroleum products.	May be "to be considered" if soils are contaminated with benzene, aromatic hydrocarbons, or petroleum products.
New Mexico Solid Waste Regulations		
New Mexico Special Waste Requirements Regulations, adopted effective January 30, 1992, Part VII	Sets disposal levels for soils contaminated with BTEX compounds and total petroleum hydrocarbons. Also sets disposal standards for asbestos waste.	May be "to be considered" if soils are contaminated with petroleum hydrocarbons. Asbestos requirements may be applicable if asbestos waste continues to be disposed in Landfill 5 or is removed and placed elsewhere.

TABLE 4-2

POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs GROUNDWATER QUALITY STANDARDS CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
pH	Field Parameter	6.5-8.5*					6.0-9.0	6.0-9.0
Total Dissolved Solids	Indicator	500,000 μg/L*					1,000,000 μg/L	1,000,000 μg/L
Carbonate	Anion							
Chloride	Anion	250,000 μg/L*					250,000 μg/L	250,000 μg/L
Fluoride	Anion	4,000 μg/L, 2,000 μg/L*	4,000 μg/L		4,000 μg/L	1,600 μg/L		1,600 μg/L
N as Nitrate	Anion	10,000 μg/L	10,000 μg/L(c)		10,000 μg/L	10,000 μg/L		10,000 μg/L
N as Nitrate+Nitrite	Anion	10,000 μg/L(c)	10,000 μg/L(c)					
N as Nitrite	Anion	1,000 μg/L(c)	1,000 μg/L(c)					
Potassium	Anion							
Sulfate	Anion	250,000 μg/L*					600,000 μg/L	600,000 μg/L
Aluminum	Metal	0.5 to 200 μg/L*(c)						5,000 μg/L
Antimony	Metal	6 μg/L(d)	6 μg/L(d)					
Arsenic	Metal	50 μg/L		50 μg/L	50 μg/L	100 μg/L		100 μg/L
Barium	Metal	2,000 μg/L(e)	2,000 μg/L(e)	1,000 μg/L	1,000 μg/L	1,000 μg/L		1,000 μg/L
Beryllium	Metal	4.0 μg/L(d)	4 μg/L(d)					
Boron	Metal							750 μg/L
Cadmium	Metal	5 μg/L(c)	5 μg/L(c)	10 μg/L	10 μg/L	10 μg/L		10 μg/L
Calcium	Metal							
Chromium	Metal	100 μg/L(c)	100 μg/L(c)	50 μg/L	50 μg/L	50 μg/L		50 μg/L
Cobalt	Metal							50 μg/L

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Copper	Metal	1,000 μg/L* 1,300 μg/L***	1,300 μg/L(f)				1,000 μg/L	1,000 μg/L
Cyanide	Metal	200 μg/L(d)	200 μg/L(d)			200 μg/L		200 μg/L
Iron	Metal	300 μg/L*					1,000 μg/L	1,000 μg/L
Lead	Metal	50 μg/L 15 μg/L***	0(f)	50 μg/L	50 μg/L	50 μg/L		50 μg/L
Magnesium	Metal							
Manganese	Metal	50 μg/L*					200 μg/L	200 μg/L
Mercury	Metal	2 μg/L	2 μg/L(c)	2 μg/L	2 μg/L	2 μg/L		2 μg/L
Molybdenum	Metal							1,000 μg/L
Nickel	Metal	100 μg/L(d)	100 μg/L(d)					200 μg/L
Selenium	Metal	50 μg/L(c)	50 μg/L(c)	10 μg/L	10 μg/L	50 μg/L		50 μg/L
Silver	Metal	100 μg/L*(c)		50 μg/L	50 μg/L	50 μg/L		50 μg/L
Sodium	Metal							
Thallium	Metal	2 μg/L(d)	0.5 μg/L(d)					
Tin	Metal							
Titanium	Metal							
Tungsten	Metal							
Vanadium	Metal							
Zinc	Metal	5,000 μg/L*					10,000 μg/L	10,000 μg/L
Gross Alpha	Radionuclide	15 pCi/L			15 pCi/L			
Gross Beta	Radionuclide	4 mrem/yr						
Radium 226+228	Radionuclide	5 pCi/L			5 pCi/L	30 pCi/L		30 pCi/L

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Strontium 90	Radionuclide	8 pCi/L			8 pCi/L			
Tritium	Radionuclide	20,000 pCi/L			20,000 pCi/L			
Uranium (total)	Radionuclide					5,000 μg/L		5,000 μg/L
1,1-Dichloroethane	Volatile					25 μg/L		25 μg/L
1,1-Dichloroethene	Volatile	7 μg/L	7 μg/L		7 μg/L	5 μg/L		5 μg/L
1,1,1-Trichloroethane	Volatile	200 μg/L	200 μg/L		200 μg/L	60 μg/L		60 μg/L
1,1,2,2-Tetrachloroethane	Volatile					10 μg/L		10 μg/L
1,1,2,2-Tetrachloroethene	Volatile					20 μg/L		20 μg/L
1,1,2-Trichloroethane	Volatile	5 μg/L(d)	3 μg/L(d)			10 μg/L		10 μg/L
1,1,2-Trichloroethene	Volatile					100 μg/L		100 μg/L
1,2-Dichloroethane	Volatile	5 μg/L	0 μg/L		5 μg/L	10 μg/L		10 μg/L
1,2-Dichloroethene	Volatile							
1,2-Dichloropropane	Volatile	5 μg/L(c)	0 μg/L(c)					
4-Methyl-2-pentanone	Volatile							
Acetone	Volatile							
Benzene	Volatile	5 μg/L	0 μg/L		5 μg/L	10 μg/L		10 μg/L
Bromodichloromethane	Volatile							
Bromoform	Volatile	Tot THM* < 100 μg/L						
Bromomethane	Volatile							
Carbon Tetrachloride	Volatile	5 μg/L	0 μg/L		5 μg/L	10 μg/L		10 μg/L
Chlorobenzene (mono)	Volatile	100 μg/L(c)	100 μg/L(c)					
Chlorobenzilate	Volatile							

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Chloroethane	Volatile							
Chloroform	Volatile	Tot THM** <100 µg/L			Tot THM** 100 µg/L	100 µg/L		100 µg/L
Chloroprene	Volatile							
Chloromethane	Volatile							
Cis-1,2-Dichloroethene	Volatile	70 µg/L(c)	70 µg/L(c)					
Cis-1,3-Dichloropropene	Volatile							
Dibromochloromethane	Volatile	Tot THM** <100 µg/L						
Ethyl Benzene	Volatile	700 µg/L(c)	700 µg/L(c)			750 µg/L		750 µg/L
Methylene Chloride	Volatile	5 µg/L(d)	0 µg/L(d)			100 µg/L		100 µg/L
Styrene	Volatile	100 µg/L(c)	100 µg/L(c)					
Tetrachloroethanes	Volatile							
Tetrachloroethene	Volatile	5 µg/L(c)	0 µg/L(c)					
Toluene	Volatile	1,000 µg/L(c)	1,000 µg/L(c)			750 µg/L		
Total Trihalomethanes	Volatile	100 µg/L						
Total Xylenes	Volatile	10,000 µg/L(c)	10,000 µg/L(c)			620 µg/L		620 µg/L
Trans-1,2-Dichloroethene	Volatile	100 µg/L(c)	100 µg/L(c)					
Trans-1,3-Dichloropropene	Volatile							
Trichloroethanes	Volatile							
Trichloroethene	Volatile	5 µg/L	0 µg/L		5 µg/L			
Vinyl Acetate	Volatile							
Vinyl Chloride	Volatile	2 µg/L	0 µg/L		2 µg/L	1µg/L		1 µg/L

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
1,2-Dichlorobenzene (ortho)	Semivolatile	600 μg/L(c)	600 μg/L(c)					
1,3-Dichlorobenzene (meta)	Semivolatile	600 μg/L	600 μg/L					
1,4-Dichlorobenzene (para)	Semivolatile	75 μg/L	75 μg/L		75 μg/L			
1,2,4-Trichlorobenzene	Semivolatile	70 μg/L(d)	70 μg/L(d)					
2-Chloronaphthalene	Semivolatile							
2-Chlorophenol	Semivolatile							
2-Methylnaphthalene	Semivolatile							
2-Nitroaniline	Semivolatile							
2-Nitrophenol	Semivolatile							
2,3,7,8-Tetrachlorodibenzo-p-dioxin	Semivolatile	$3x10^{-8}$(d)	0 μg/L(d)					
2,4-Dichlorophenol	Semivolatile							
2,4-Dichlorophenoxyacetic Acid (2,4-D)	Semivolatile (H)	70 μg/L(c)	70 μg/L(c)	100 μg/L	100 μg/L			
2,4-Dimethylphenol	Semivolatile							
2,4-Dinitrophenol	Semivolatile							
2,4-Dinitrotoluene	Semivolatile							
2,4,5-TP Silvex	Semivolatile (H)	50 μg/L(c)	50 μg/L(c)	10 μg/L	10 μg/L			
2,4,6-Trichlorophenol	Semivolatile							
3-Nitroaniline	Semivolatile							
4-Bromophenyl Phenylether	Semivolatile							
4-Chloroaniline	Semivolatile							
4-Chlorophenyl Phenyl Ether	Semivolatile							

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
4-Chloro-3-methylphenol	Semivolatile							
4-Nitroaniline	Semivolatile							
4,6-Dinitro-2-methylphenol	Semivolatile							
Acenaphthalene	Semivolatile							
Acrylonitrile	Semivolatile							
Alachlor	Semivolatile	2 µg/L	0 µg/L					
Aldicarb	Semivolatile (P)	3 µg/L(e)	1 µg/L(e)					
Aldicarb Sulfone	Semivolatile (P)	2 µg/L	1 µg/L					
Aldicarb Sulfoxide	Semivolatile (P)	4 µg/L	1 µg/L					
Aldrin	Semivolatile (P)							
Aniline	Semivolatile							
Anthracene	Semivolatile							
Atrazine	Semivolatile	3 µg/L(c)	3 µg/L(c)					
Benzo(a)anthracene	Semivolatile							
Benzo(a)pyrene	Semivolatile	0.2 µg/L(d)	0 µg/L(d)			0.7 µg/L		0.7 µg/L
Benzo(b)fluoranthene	Semivolatile							
Benzo(g,h,i)perylene	Semivolatile							
Benzo(k)fluoranthene	Semivolatile							
Benzyl Alcohol	Semivolatile							
Bis(2-Chloroethoxy)methane	Semivolatile							
Bis(2-Chloroethyl)ether	Semivolatile							
Bis(2-Chloroisopropyl)ether	Semivolatile							

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Bis(2-Ethylhexyl)phthalate	Semivolatile							
Butyl Benzylphthalate	Semivolatile							
Carbofuran	Semivolatile (P)	40 µg/L(c)	40 µg/L(c)					
Carbon Disulfide	Semivolatile							
Chlordane	Semivolatile (P)	2 µg/L(c)	0 µg/L(c)					
Chlorophenol	Semivolatile							
DDT	Semivolatile (P)							
DDT metabolite (DDE)	Semivolatile (P)							
DDT metabolite (DDD)	Semivolatile (P)							
Dalapon	Semivolatile (P)	200 µg/L(d)	200 µg/L(d)					
Diallite	Semivolatile							
Dibenzofuran	Semivolatile							
Dibenz(a,h)anthracene	Semivolatile							
Dibromochloropropane	Semivolatile (P)	0.2 µg/L	0 µg/L					
Dichlorobenzene	Semivolatile							
Dichlorobenzidine	Semivolatile							
Dieldrin	Semivolatile (P)							
Di(2-ethylhexyl)adipate	Semivolatile (P)	400 µg/L(d)	400 µg/L(d)					
Diethylphthalate	Semivolatile							
Di(2-ethylhexyl)phthalate	Semivolatile	6.0 µg/L(d)	0 µg/L(d)					
Dimethoate	Semivolatile							
Dimethylphthalate	Semivolatile							

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Dinitrotoluene	Semivolatile							
Dinoseb	Semivolatile(H)	7 µg/L(d)	7 µg/L(d)					
Di-n-octylphthalate	Semivolatile							
Diquat	Semivolatile(P)	20 µg/L(d)	20 µg/L(d)					
Endosulfan I	Semivolatile (P)							
Endosulfan II	Semivolatile (P)							
Endosulfan Sulfate	Semivolatile (P)							
Endothall	Semivolatile (P)	100 µg/L	100 µg/L					
Endrin	Semivolatile (P)	2.0 µg/L(d)	2.0 µg/L(d)	0.2 µg/L	0.2 µg/L			
Ethylene Dibromide	Semivolatile	0.05 µg/L(c)	0 µg/L(c)			0.1 µg/L		0.1 µg/L
Fluoranthene	Semivolatile							
Fluorene	Semivolatile							
Glyphosate	Semivolatile(P)	700 µg/L(d)	700 µg/L(d)					
Heptachlor	Semivolatile (P)	0.4 µg/L(c)	0 µg/L(c)					
Heptachlor Epoxide	Semivolatile (P)	0.2 µg/L(c)	0 µg/L(c)					
Hexachlorobenzene	Semivolatile	1.0 µg/L(d)	0 µg/L(d)					
Hexachlorobutadiene	Semivolatile							
Hexachlorocyclohexane, Alpha	Semivolatile (P)							
Hexachlorocyclohexane, Beta	Semivolatile (P)							
Hexachlorocyclohexane, (Lindane)	Semivolatile (P)	0.2 µg/L(c)	0.2 µg/L(c)	4 µg/L	4 µg/L			
Hexachlorocyclohexane, Technical	Semivolatile (P)							

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Hexachlorocyclopentadiene	Semivolatile	50 μg/L(d)	50 μg/L(d)					
Hexachloroethane	Semivolatile							
Indeno(1,2,3-cd)pyrene	Semivolatile							
Methoxychlor	Semivolatile (P)	40 μg/L	40 μg/L(c)	100 μg/L	100 μg/L			
Naphthalene	Semivolatile							
Nitrobenzene	Semivolatile							
Nitrophenols	Semivolatile							
Nitrosodibutylamine	Semivolatile							
Nitrosodiethylamine	Semivolatile							
Nitrosodimethylamine	Semivolatile							
Nitrosopyrrolidine	Semivolatile							
N-Nitrosodiphenylamine	Semivolatile							
N-Nitroso-di-n-dipropylamine	Semivolatile							
Oxamyl	Semivolatile(P)	200 μg/L(d)	200 μg/L(d)					
PCBs	PCBs	0.5 μg/L(c)	0 μg/L(c)			1 μg/L		1 μg/L
Pentachlorinated Ethanes	Semivolatile							
Pentachlorophenol	Semivolatile	1 μg/L(c)	0 μg/L(e)					
Phenanthrene	Semivolatile							
Phenol	Semivolatile				5 μg/L		5 μg/L	5 μg/L
Picloram	Semivolatile (H)	500 μg/L	500 μg/L					
Polynuclear Aromatic Hydrocarbons (total PAH)	Semivolatile				30 μg/L	30 μg/L		30 μg/L

TABLE 4-2
POTENTIAL SITE-WIDE CHEMICAL-SPECIFIC RASs/TBCs
GROUNDWATER QUALITY STANDARDS
CANNON AFB - LANDFILL 5

		FEDERAL STANDARDS			STATE STANDARDS NMWQCC Groundwater Quality Standards (g)			
Parameter	Type	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level Goal (a) ARARs/TBCs	RCRA Subpart F Concentration Limit (40 CFR 264.94) (b)	Community Water Supply System (h)	Human Health	Other Standards for Domestic Water Supply	Irrigation Use
Pyrene	Semivolatile							
Simazine	Semivolatile(P)	4 μg/L(d)	4 μg/L(d)					
Trans-1,2-Dichloroethene	Semivolatile	100 μg/L	100 μg/L					
Toxaphene	Semivolatile (P)	3 μg/L(c)	0 μg/L(c)	5 μg/L	5 μg/L			

EXPLANATION OF TABLE

(P) Pesticide (H) Herbicide

* = secondary maximum contaminant level (TBCs)
** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
*** = action levels in no more than 10% of tap samples, 56 FR 26460, 6/7/91, effective 12/7/92

NMWQCC = New Mexico Water Quality Control Commission
RCRA = Resource Conservation and Recovery Act
SDWA = Safe Drinking Water Act
(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of 5/1990)
(b) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual EPA/540/G-89/006, August 1988
(c) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526; 1/30/91)
(d) EPA National Primary Drinking Water Regulations, 40 CFR 141 and 40 CFR 142, Final Rule (57FR 31776, 7/17/92); Effective date is January 17, 1994, (therefore TBCs) except for endrin, which is effective 8/17/92.
(e) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective January 1, 1993 (56 FR 30266, 7/01/91)
(f) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142; effective December 7, 1992 (56 FR 26460, 6/7/91)
(g) NM Water Quality Control Commission, NM Water Quality Regulations, Part 3, Section 3-103, 11/16/1967 amended through August 17, 1991
(h) New Mexico Drinking Water/Water Supply Regulations, adopted April 16, 1991

If no values are shown for a possible contaminant, there are no standards at this time.

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Herbicides				
2,4,5-T	200	800	800 (d)	-
2,4,5-TP (Silvex)	600	-	640 (d)	-
2,4-D	800	800	800 (d)	-
2,4-DB	-	-	640(d)	-
Dalaphon	-	-	2,400 (d)	-
Dicamba	-	-	2,400 (d)	-
Dichlorprop	-	-	-	-
Dinoseb	80	-	80 (d)	-
MCPA	-	-	40 (d)	-
MCPP	-	-	80 (d)	-
Pesticides/PCBs				
4,4'-DDD*	2.9	3	2.9 (d)	
4,4'-DDT*	2.1	2	2.1(d)	-
4,4'-DDE*	2.1	2	2.1(d)	-
Aldrin*	0.04	0.04	0.04(d)	-
alpha-BHC*	-	0.10	0.11(d)	-
alpha-Chlordane*	0.54	0.50	0.54(d)	-
Aroclor-1016*	0.09	0.09	(e)	(f)
Aroclor-1221*	0.09	0.09	(e)	(f)
Aroclor-1232*	0.09	0.09	(e)	(f)
Aroclor-1242*	0.09	0.09	(e)	(f)
Aroclor-1248*	0.09	0.09	(e)	(f)
Aroclor-1254*	0.09	0.09	(e)	(f)
Aroclor-1260*	0.09	0.09	(e)	(f)

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Pesticides/PCBs (cont'd)				
beta-BHC*	-	4	0.39(d)	-
Chlordane*	0.54	0.50	0.54(1)	
delta-BHC	-	-	-	-
Diallate*	-	-	11.5(g)	
Dieldrin*	0.04	0.04	0.044(d)	-
Dimethoate	2,000	0.01	16(d)	
Disulfoton	3	3	3.2(d)	
Endosulfan I**	4	4	480(g,h)	-
Endosulfan II**	-	-	480(h)	-
Endosulfan sulfate	-	-	480(h)	
Endrin	20	20	24(d)	-
Endrin ketone	-	-	-	-
Famphur	-	-	-	
gamma-BHC	20	0.50	0.54(g)	-
gamma-Chlordane*	0.54	0.50	0.54(d)	-
Heptachlor	0.16	0.20	0.16(d)	-
Heptachlor epoxide*	0.077	0.08	0.077(d)	-
Isodrin	-	-	-	
Kepone	-	-	-	
Methoxychlor	-	-	400(d)	-
Methyl parathion	20	20	20(d)	
Parathion	20	500	480(g)	
Phorate	-	-	16(g)	
Toxaphene*	0.64	0.60	0.64(d)	-

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Semivolatiles				
1,2,4,5-tetrachlorobenzene	20	20	24(d)	
1,2,4-trichlorobenzene	2,000	2,000	800(d)	-
1,2-dichlorobenzene	-	-	7,200(d)	-
1,3,5-trinitrobenzene	-	-	4(d)	
1,3-dichlorobenzene	-	-	8(d)	-
1,3-dinitrobenzene	-	8	8(d)	
1,4-dichlorobenzene*	-	-	29(g)	
1,4-naphthoquinone	-	-	-	
1-naphthylamine	-	-	-	
2,3,4,6-tetrachlorophenol	2,000	2,000	2,400(d)	
2,4,5-trichlorophenol	8,000	8,000	8,000(d)	-
2,4,6-trichlorophenol*	35	40	6.4(d)	-
2,2'-oxybis(1-chloropropane)	-	-	-	-
2,4-dichlorophenol	200	-	240(d)	-
2,4-dimethylphenol	-	-	1,600(d)	-
2,4-dinitrophenol	200	200	160(d)	-
2,4-dinitrotoluene	2.27	-	160(d)	-
2,6-dichlorophenol	-	-	-	
2,6-dinitrotoluene*	-	1 (i)	80(g)	-
2-acetylaminefluorone	-	-	-	
2-chloronaphthalene	-	-	6,400(d)	-
2-chlorophenol	-	-	400(d)	-
2-methylnaphthalene	-	-	-	0.3-220(j)
2-methylphenol	4,000	4,000	4,000(d)	-
2-naphthylamine	-	-	-	

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Semivolatiles (cont'd)				
2-nitroaniline	-	-	-	-
2-nitrophenol	-	-	-	-
2-picoline	-	-	-	
3-3'-dichlorobenzidine*	-	2	1.6(d)	-
3,3'-dimethylbenzidine	-	-	-	
3-methyl cholanthrene	0.074	-	-	
3-methylphenol	4,000	4,000	4,000(d)	
3-nitroaniline	-	-	-	-
4,6-dinitro-2-methylphenol	-	-	-	-
4-aminobiphenyl	-	-	-	
4-bromophenylphenyl ether	-	-	-	-
4-chloro-3-methylphenol	-	-	-	-
4-chloroaniline	-	-	320(d)	-
4-chlorophenylphenyl ether	-	-	-	-
4-methylphenol	4,000	4,000	400(g)	-
4-nitroaniline	-	-	-	-
4-nitro-1-oxide-quinoline	-	-	-	
4-nitrophenol	-	-	-	-
5-nitro-o-toluidine	-	-	-	
acenaphthene	-	-	4,800(d)	-
acenaphthylene	-	-	-	-
acetophenone	8,000	8,000	8,000(d)	
aniline	270	100	-	
anthracene	-	-	24,000(d)	-
aramite*	-	-	28(d)	

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Semivolatiles (cont'd)				
benzo(a)anthracene*	0.22	-	0.96(k)	0.3-220(j)
benzo(a)pyrene*	0.06	-	0.096(d)	0.3-220(j)
benzo(b)fluoranthene*	-	-	0.96(k)	0.3-220(j)
benzo(g,h,i)perylene	-	-	-	0.3-220(j)
benzo(k)fluoranthene*	-	-	9.6(k)	0.3-220(j)
benzoic acid	-	-	320,000(d)	-
benzyl alcohol	-	-	24,000(g)	-
bis(2-chloroethoxy)methane	-	-	-	
bis(2-chloroethyl)ether*	0.64	0.60	0.64(d)	-
bis(2-ethylhexyl)phthalate*	83	50	50(d)	0.3-220(j)
butyl benzyl phthalate	-	20,000	16,000(d)	0.3-220(j)
carbazole*	-	-	35(g)	-
chlorobenzilate*	-	-	2.6(g)	
p-chloro-m-cresol	-	-	-	
chrysene*	-	-	96(k)	0.3-220(j)
dibenzo(a,h)anthracene	0.0143	-	0.096(k)	0.3-220(j)
dibenzofuran	-	-	-	0.3-220(j)
dichlorodifluoromethane	20,000	20,000	16,000(d)	
dichlorodiisopropyl ether	-	-	-	
diethylphthalate	60,000	60,000	64,000(d)	-
o,o-diethyl o-pyrazinyl phosphoro-thioate	-	-	-	
p-dimethylaminoazobenzene	-	-	-	
7,12-dimethylbenz(a)anthracene	-	-	-	
alpha,alpha-dimethylphenethylamine	-	-	-	
dimethylphthalate	-	-	800,000(g)	-

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Semivolatiles (cont'd)				
di-n-butylphthalate	8,000	8,000	8,000(d)	-
di-n-octylphthalate	-	-	1,600(g)	-
diphenylamine	2,000	2,000	2,000(d)	
ethyl methanesulfonate	-	-	-	
fluoranthene	-	-	3,200(d)	0.3-220(j)
fluorene	-	-	3,200(d)	0.3-220(j)
hexachlorobenzene*	0.41	-	0.44(d)	-
hexachlorobutadiene	90	90	9(d)	-
hexachlorocyclopentadiene	600	-	560(d)	-
hexachloroethane*	80	80	50(d)	-
hexachlorophene	-	20	24(d)	
hexachloropropene	-	-	-	
indeno(1,2,3-cd)pyrene*	-	-	0.96(k)	0.3-220(j)
isosafrole	-	-	-	
isophorone*	2,000	2,000	736(d)	-
methacrylonitrile	8	8	8(d)	
methapyrilene	-	-	-	
methyl methane sulfonate	-	-	-	
n-nitrosodiethylamine*	-	0.005	0.0047(d)	
n-nitrosodimethylamine*	0.014	0.01	0.014(d)	
n-nitrosomethylethylamine*	0.032	0.03	0.032(d)	
n-nitrosomorpholine	-	-	-	
n-nitroso-di-n-butylamine*	-	0.10	0.13(d)	
n-nitroso-di-n-propylamine*	0.10	0.10	0.1(d)	-
n-nitrosodiphenylamine*	-	100	143(d)	-

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Semivolatiles (cont'd)				
n-nitrosopiperidine	-	-	-	
n-nitrosopyrrolidine*	0.33	0.30	0.33(d)	
naphthalene	-	-	-	0.3-220(j)
nitrobenzene	40	40	40(d)	-
pentachlorobenzene	60	60	64(d)	
pentachloroethane	-	-	-	
pentachloronitrobenzene*	27.3	200	2.7(g)	
pentachlorophenol*	2,000	2,000	6(d)	-
phenacetin	-	1	-	
phenanthrene	-	-	-	-
phenol	3,000	50,000	48,000(d)	-
p-phenylenediamine	-	-	15,200(g)	
pronamide	6,000	6,000	6,000(d)	
pyrene	-	-	2,400(d)	0.3-220(j)
pyridine	80	80	80(d)	
safrole	-	-	-	
tetraethyldithiopyrophosphate	-	40	40(d)	
trans-1,4-dichloro-2-butene	-	-	-	
o-toluidine	-	-	-	
o,o,o-triethyl phosphorothioate	-	-	-	
Volatiles				
1,1,1-trichloroethane	7,000	7,000	-	-
1,1,1,2-tetrachloroethane*	-	300	27(d)	
1,1,2,2-tetrachloroethane*	35	40	3.5(d)	-

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Volatiles (cont'd)				
1,1,2-trichloroethane	120	100	1.2(d)	-
1,1-dichlorethane*	-	-	8,000(g)	-
1,1-dichloroethene	12	10	1.2(d)	-
1,2-dibromo-3-chloropropane*	0.032	-	0.5(g)	
1,2-dibromoethane*	-	0.008	0.0082(d)	
1,2-dichloroethane*	7.7	8	7.7(d)	
1,2-dichloroethene (total)	-	-	720(g)	-
1,2-dichloropropane	-	-	-	
1,2,3-trichloropropane	80	500	480(d)	
1,4-dioxane*	143	60	64(d)	
2-butanone (MEK)	4,000	4,000	48,000(d)	-
2-hexanone (MnBK)	-	-	-	-
4-methyl-2-pentanone (MIBK)	4,000	4,000	6,400(g)	-
acetone	8,000	8,000	8,000(d)	-
acetonitrile	500	500	480(d)	
acrolein	-	-	1,600(g)	
acrylonitrile*	1.30	1.0	1.3(d)	
allyl chloride	-	-	-	
benzene*	24	-	24(d)	<100(l)
bromodichloromethane*	2,000	0.50	11(d)	-
bromoform*	2,000	2,000	89(d)	-
bromomethane	30	100	112(d)	-
carbon disulfide	8,000	8,000	8,000(d)	-
carbon tetrachloride*	5.4	5	5.4(d)	-
chlorobenzene	2,000	2,000	1,600(d)	-

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Volatiles (cont'd)				
chloroethane	-	-	-	-
chloroform*	110	100	115(d)	-
chloromethane	-	-	54(g)	-
chloroprene	-	-	-	
cis-1,3-dichloropropene	3.9	20	3.9(g)	-
dibromochloromethane*	-	-	8.3(d)	-
ethylbenzene	8,000	8,000	8,000(d)	<500 (l)
ethyl cyanide	-	-	-	
ethyl methacrylate	-	-	7,200(g)	
isobutyl alcohol	20,000	20,000	24,000(d)	
methyl bromide	-	-	112(d)	
methylene bromide	-	-	-	
methylene chloride*	93	90	93(d)	-
methyl iodide	-	-	-	
methyl methacrylate	-	-	6,400(g)	
styrene	20,000	20,000	16,000(d)	-
tetrachloroethene*	140	10	800(d)	-
toluene	20,000	20,000	16,000(d)	<500 (l)
trans-1,2-dichloroethene	-	-	1,600(d)	
trans-1,3-dichloropropene	20	20	3.9(g)	-
trichloroethene*	64	60	-	-
trichlorofluoromethane	20,000	20,000	24,000(d)	
vinyl acetate	-	-	-	
vinyl chloride*	-	-	0.37(g)	-
xylenes (total)	200,000	200,000	160,000(d)	<500 (l)

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)
Hydrocarbons				
Polycyclic Aromatic	-	-	-	<50 ppm(m)
Hydrocarbons (PAHs)	-	-	-	-
Total Petroleum Hydrocarbons (TPH)	-	-	-	<1000 ppm(n)
Dioxins and Furans				
2,3,7,8,(x,y)-hexachlorodibenzodioxin*	1.10E-04	-	5E-05(o)	
2,3,7,8,(x)-pentachlorodibenzodioxin*	-	-	9E-06(o)	
2,3,7,8-tetrachlorodibenzodioxin*	-	-	5E-06(o)	
1,2,3,7,8-pentachlorodibenzofuran*	-	-	9E-05(o)	
2,3,4,7,8-pentachlorodibenzofuran*	-	-	9E-06(o)	
2,3,7,8,(x,y)-hexachlorodibenzofuran*	-	-	5E-05(o)	
2,3,7,8-tetrachlorodibenzofuran*	-	-	5E-05(o)	

(a) RCRA Facility Investigation Guidance (EPA 1989a); human health-based criteria for systemic toxicants representing an estimate of the daily exposure an individual can experience without appreciable risk of health effects during a lifetime.
(b) Source: Corrective Action for SWMUs at Hazardous Waste Management Facilities (55 FR 30798, 27 July 1990): these risk based levels trigger the need for a corrective measure study.
(c) Human health proposed action levels calculated using guidance in 55 FR 30798
(d) Calculated from toxicity values provided in IRIS April, 1994.
(e) 55 FR 30798. EPA has already established standards for cleanup of PCBs under TSCA. The agency has determined that the TSCA cleanup standards are relevant to RCRA corrective action.
(f) Cleanup levels for PCB spills occuring before May 4, 1987 are at the discretion of the EPA regional administrator. 40 CFR 761 (Subpart G).
(g) Calculated from toxicity values provided in HEAST 1994.
(h) Toxicity values for Endosulfan adopted for Endosulfan I, Endosulfan II, and Endosulfan sulfate
(i) Value for mixture of dinitrotoluene isomers
(j) Range of anthropogenic and naturally occurring PAH concentrations (Blumer 1977, Mallet 1961)

TABLE 4-3

POTENTIAL SCREENING CONCENTRATIONS FOR ORGANIC COMPOUNDS IN SOIL
(To Be Considered)
CANNON AFB

	RFI Guidance(a) TBCs (mg/kg)	Proposed RCRA Action Level(b) TBCs (mg/kg)	Proposed RCRA Action Level(c) TBCs (mg/kg)	Other TBCs (mg/kg)

(k) EPA 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. EPA/625/3-89/016. March 1989.

(l) The sum of benzene, toluene, ethylbenzene, and xylene isomer concentrations is less than 500 mg/kg, with benzene individually less than 100 mg/kg. New Mexico Environmental Improvement Board, New Mexico Special Waste Requirement Regulations. Adopted effective January 30, 1992.

(m) New Mexico Department of Environmental Improvement New Mexico UST Regulations, amended through July 18, 1991.

(n) New Mexico Environmental Improvement Board, New Mexico Special Waste Requirement Regulations, Adopted effective January 30, 1992

(o) EPA 1989. Interim Procedures for Estimating risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and -Dibenzofurans (CDDs and CDFs). EPA/625/3-89/016. March 1989.

* Carcinogens

TABLE 4-4

POTENTIAL SCREENING CONCENTRATIONS FOR INORGANIC COMPOUNDS IN SOIL (TO BE CONSIDERED) CANNON AFB - LANDFILL NO. 5

Compound	RFI Guidance TBCs[a] (mg/kg)	Proposed RCRA Action Level Level TBCs[b] (mg/kg)	Proposed RCRA Action Level TBCs[c] (mg/kg)	Other TBCs[d] (mg/kg)	Average Background Concentration[e] (mg/kg)	Range of Background Concentrations[e,f] (mg/kg)
aluminum	-	-	-	-	5700	860 - 10,540
antimony	30	30	32[g]	-	6.75	1.33 - 12.2
arsenic*	-	80	0.4[g]	-	3.5	0 - 15.5
barium	4,000	4,000	5600[g]	-	166	0 - 642
beryllium*	0.14	0.2	0.16[g]	-	0.41	0.09 - 0.73
cadmium	-	40	40[g]	-	1.1	0 - 2.9
calcium	-	-	-	-	69,200	0 - 186,400
chromium III	80,000	-	80,000[g]	-	6.98	1.42 - 12.5
chromium VI	400	400	400[g]	-		
cobalt	-	-	-	-	2.5	0.5 - 4.5
copper	-	-	-	-	5.4	0 - 13.0
cyanide	2,000	2,000	1,600[g]	-		
iron	-	-	-	-	4,780	840 - 8,720
lead	-	-	-	500 - 1000	7.12	0 - 25.8
magnesium	-	-	-	-	4,650	0 - 11,790
manganese	-	-	8,000[g]	-	72	0 - 164
mercury	-	20	24[h]	-	0.11	0.9 - 0.13
nickel	2,000	2,000	-	-	5.0	1.0 - 9.0
potassium	-	-	-	-	1360	148 - 2,572
selenium	-	-	400[g]	-	8.23	0 - 56.6
silver	200	200	400[g]	-	1.2	0.2 - 2.2

TABLE 4-4
POTENTIAL SCREENING CONCENTRATIONS FOR INORGANIC COMPOUNDS IN SOIL (TO BE CONSIDERED) CANNON AFB - LANDFILL NO. 5

Compound	RFI Guidance TBCs[a] (mg/kg)	Proposed RCRA Action Level Level TBCs[b] (mg/kg)	Proposed RCRA Action Level TBCs[c] (mg/kg)	Other TBCs[d] (mg/kg)	Average Background Concentration[e] (mg/kg)	Range of Background Concentrations[e,f] (mg/kg)
sodium	-	-	-	-	514	0 - 1,042
thallium	-	-	-	-	0.50	0 - 1.2
vanadium	-	-	-	-	14.9	4.50 - 25.3
zinc	-	-	24,000[g]	-	11.3	0.72 - 21.9

[a] RCRA Facility Investigation Guidance (EPA 1989a); human health-based criteria for systemic toxicants representing an estimate of the daily exposure an individual can experience without appreciable risk of health effects during a lifetime.
[b] Source: Corrective Action for SWMUs at Hazardous Waste Management Facilities (55 FR 30798, 27 July 1990). These risk-based levels trigger the need for a corrective action measure study.
[c] Human Health proposed action levels using calculations in 55 FR 30798. Sources of toxicity factors used in calculations include: (1) Integrated Risk Information System (IRIS) and (2) Health Effects Assessment Summary Tables (HEAST) FY1992.
[d] Source: OSWER Directive 9355.4-02.
[e] Source: Woodward-Clyde Consultants, 1993.
[f] Average $\pm$ 2 standard deviations
[g] IRIS April, 1994
[h] HEAST 1994
* Carcinogen

TABLE 4-5

SUMMARY OF POTENTIAL LOCATION-SPECIFIC RASs
CANNON AFB - LANDFILL 5

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
Resource Conservation and Recovery Act (RCRA)			
1. New facilities where treatment, storage or disposal of hazardous waste will be conducted is prohibited within 61 meters (200 feet) of a fault displaced in Holocene time [40 CFR 264.18(a)]*	No	No	Treatment, storage, and disposal of waste will not be conducted within 61 meters of a fault displaced in Holocene time.
2. New facilities where treatment, storage or disposal of hazardous waste will be conducted is prohibited within the 100-year floodplain. [40 CFR 264.18(b)]*	No	No	Treatment, storage, and disposal of waste will not be conducted within the 100-year floodplain of adjacent rivers.
3. Prohibits noncontainerized or bulk liquid hazardous waste placement in salt domes, salt bed formations, and underground mines or caves. [40 CFR 264.18(c)]*	No	No	No action that would place waste in a salt dome or salt bed formation, underground mine, or cave is anticipated at this site.
E.O. 11988 Protection of Floodplains			
4. Limits activities in floodplain. Floodplain is defined as "the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of off-shore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year." [40 CFR 6, Appendix A and 40 CRF 6.302]	No	No	Remedial activities will not be conducted within any floodplains.

*Adopted by the State of New Mexico and incorporated within Part V of the New Mexico Hazardous Waste Management Regulations.

TABLE 4-5
SUMMARY OF POTENTIAL LOCATION-SPECIFIC RASs
CANNON AFB - LANDFILL 5

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
E.O. 11990 Protection of Wetlands			
5. Minimizes impacts on areas designated as wetlands. [40 CRF 6, Appendix A]	No	No	Although playas are considered wetlands by the U.S. Fish and Wildlife Service, regulations are applicable only if the remedial activities impact the wetland areas. No impacts to the wetland areas are anticipated at this time.
Clean Water Act Section 404			
6. Action to prohibit discharge of dredged or fill material into waters of U.S. without permit. [33 USC 1251; 40 CFR 230; 33 CFR 320-330]	No	No	Dredge and fill permit requirements will not apply because no waters of the U.S. will be impacted by remedial activities on the site.
7. Requires Federal agencies to avoid, to the extent possible, adverse impacts associated with destruction or loss of wetlands	No	No	As described above, although wetlands are considered by the U.S. Fish and Wildlife Service to occur on the base in the form of playas, regulations are applicable only if the remedial activities impact the wetland area.

TABLE 4-5
SUMMARY OF POTENTIAL LOCATION-SPECIFIC RASs
CANNON AFB - LANDFILL 5

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
Endangered Species Act			
8. Protects endangered species and threatened species and preserves their habitat. [16 USC 1531 et seq.; 50 CFR 200, 50 CFR 402]	Yes	---	Although Walk, Haydel & Associates report in their Remedial Investigation that there are no critical habitats in the immediate vicinity of the site (according to the Wildlife Management Plan for the base), two federally listed endangered species are known to inhabit the area within a 50-mile radius of the site (Lee Wan & Associates, Inc. 1990).
Bald Eagle Protection Act			
9. Protects all eagle species and restricts activities that may threaten or adversely affect their habitat (16 USC Section 688 et seq.)	Yes	---	If eagle species are found to occur on the base, special protection provisions will need to be coordinated with US Fish and Wildlife Service. Bald eagles are known to inhabit the area within a 50-mile radius of the site (Lee Wan & Associates, Inc., 1990).
Migratory Bird Treaty Act			
10. Protects migratory, resident, or range habitat of migratory birds including raptors and waterfowl. (16 USC Section 703 et seq.).	Yes	--	Remedial actions cannot threaten or adversely affect the habitats of migratory waterfowl or raptors.

TABLE 4-5
SUMMARY OF POTENTIAL LOCATION-SPECIFIC RASs
CANNON AFB - LANDFILL 5

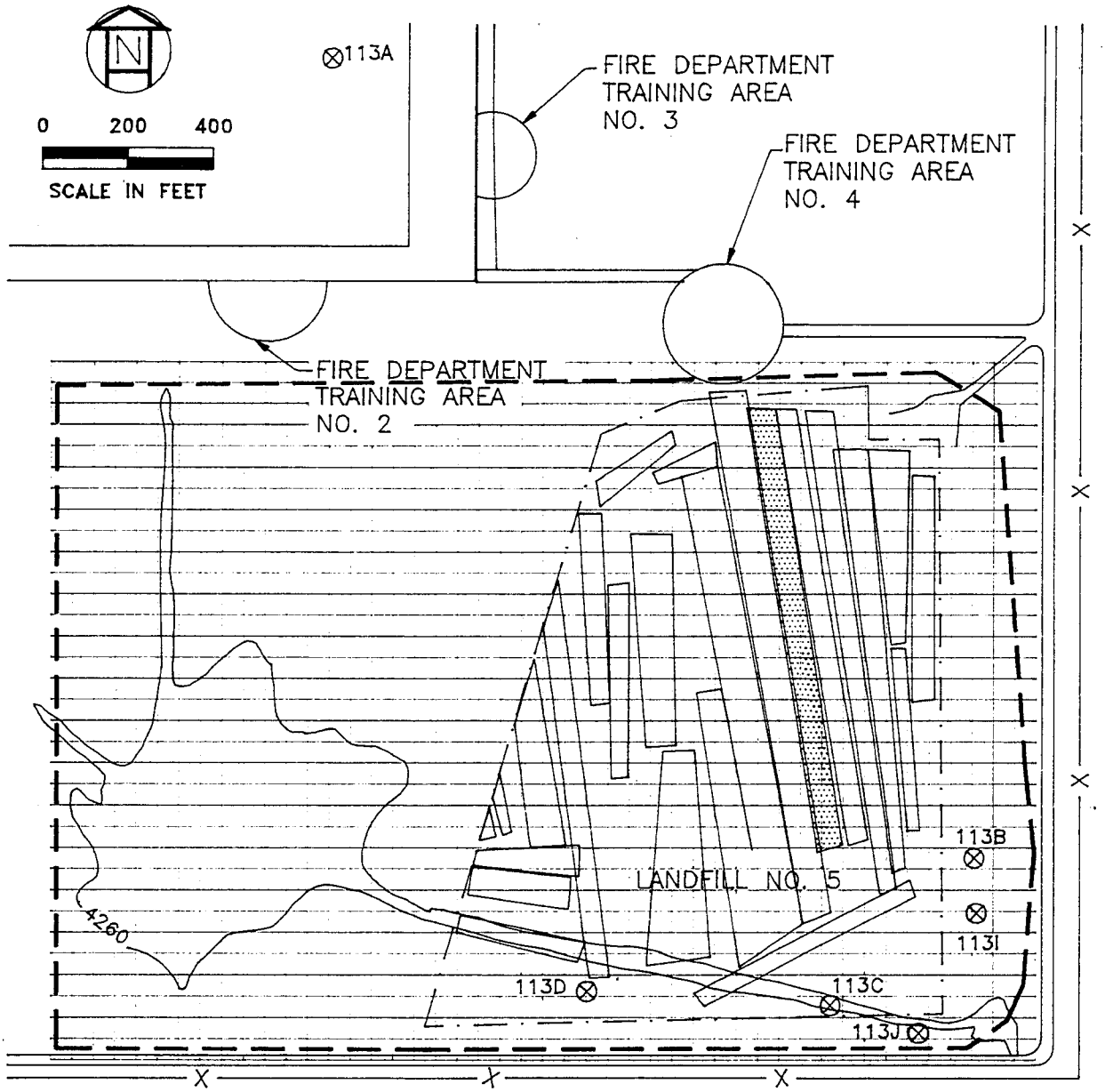
Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
Wilderness Act			
11. Limits activities within an area designed as a wilderness area. [16 USC 1311 et seq.; 50CFR 53.1 et seq.]	No	No	The site is not within a federally owned area designated as a wilderness area.
12. Limits the type of activities permitted in an area designated as a National Wildlife Refuge system [16 USC 668 et seq.; 50 CFR Part 27]	No	No	The site is not in an area designated as part of the National Wildlife Refuge System. (The closest NWRS are over 25 miles from the site.)
Fish and Wildlife Coordination Act			
13. Prohibits activities affecting/modifying streams or bodies of water if the activity has a negative impact on fish or wildlife. [16 USC 661 et seq.; 33 CFR Parts 320-330; 40 CFR 6.302]	No	No	As described above, no streams, rivers, or playas will be impacted by remedial activities.
Wild and Scenic Rivers Act			
14. Protects rivers that are designated as wild, scenic, or recreational. [16 USC 1271; 40 CFR 6.302(e)]	No	No	No rivers designated as wild, scenic or recreational will be affected by remedial activities.

TABLE 4-5
SUMMARY OF POTENTIAL LOCATION-SPECIFIC RASs
CANNON AFB - LANDFILL 5

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
National Historic Preservation Act (NHPA)			
15. Requires the preservation of historic properties included in or eligible for the National Register of Historic Places and to minimize harm to National Historic Landmarks. [16 USC 470 et seq.; 7 CFR 650; 36 CFR Part 65, Part 800]	Yes	---	Pursuant to Section 106 of NHPA, proposed federal undertaking in any state shall take into consideration the effect of the undertaking on any site, building, structure, or object that is included or eligible for inclusion in the National Register; nothing has been placed on the register to date, but surveys are ongoing. Also applicable if historical sites are discovered during a remedial action or if known historical sites exist near a remedial action site.
The Historic and Archaeological Data Preservation Act of 1974			
16. Establishes procedures to provide for preservation of historical and archaeological data which might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity program (16 USC 469, 40 CFR 6.301(c))	Yes	---	May be available if remedial activities affect historical and/or undiscovered archaeological data of the site.
The Archaeological Resource Protection Act of 1979			
17. Requires a permit for any excavation or removal of archaeological resources form public or Indian lands (16 USC 470aa-47011)	Yes	---	May be applicable if any remedial activity involves removal of archaeological resources; substantive requirements need to be met.

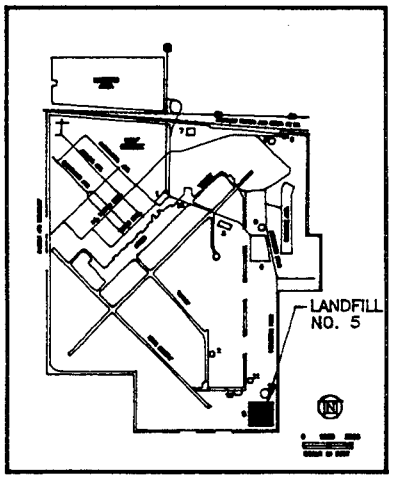
TABLE 4-5
SUMMARY OF POTENTIAL LOCATION-SPECIFIC RASs
CANNON AFB - LANDFILL 5

Requirement	Potentially Applicable?	Potentially Relevant and Appropriate?	Comments
Coastal Zone Management Act			
18. Limits activities affecting the coastal zone, including lands thereunder and adjacent shorelands. [16 USC Section 1451 et seq.]	No	No	The site is not located in the coastal zone management area.
State Regulations			
Endangered Species Act (New Mexico Regulation 682)			
19. Requires coordination with the Department of Game and Fish if activities impact on endangered/ threatened species or their habitat.	Yes	---	As stated above, although Walk, Haydel & Associates report in their Remedial Investigation that there are no significant habitats in the immediate vicinity of the site, state listed threatened/endangered species have been identified at or near the base.
1978 New Mexico State Cultural Properties Act (Sections 18-6-1 through 18-6-17 NMSA 1978)			
20. Provides for the preservation, protection, and enhancement of structures, sites, and objects of historical significance within the State.	Yes	--	Although the Cannon AFB site including its properties/buildings are not listed on the State Register of Historic Places, coordination with the State Historic Preservation Office is ongoing with respect to the historical and archaeological surveys that have been conducted at the base; State laws closely follow the federal laws.



LEGEND

⊗ 113C	MONITORING WELL LOCATION
— —	SWMU BOUNDARY
— · —	FENCE BOUNDARY
———	CELL BOUNDARY
▒	RCRA REGULATED CELL #3, (CAPPED) NO FURTHER FIELDWORK PLANNED FOR THIS AREA UNDER THIS INVESTIGATION
———	PLANNED GEOPHYSICAL AND SOIL GAS SURVEY GRID LINE

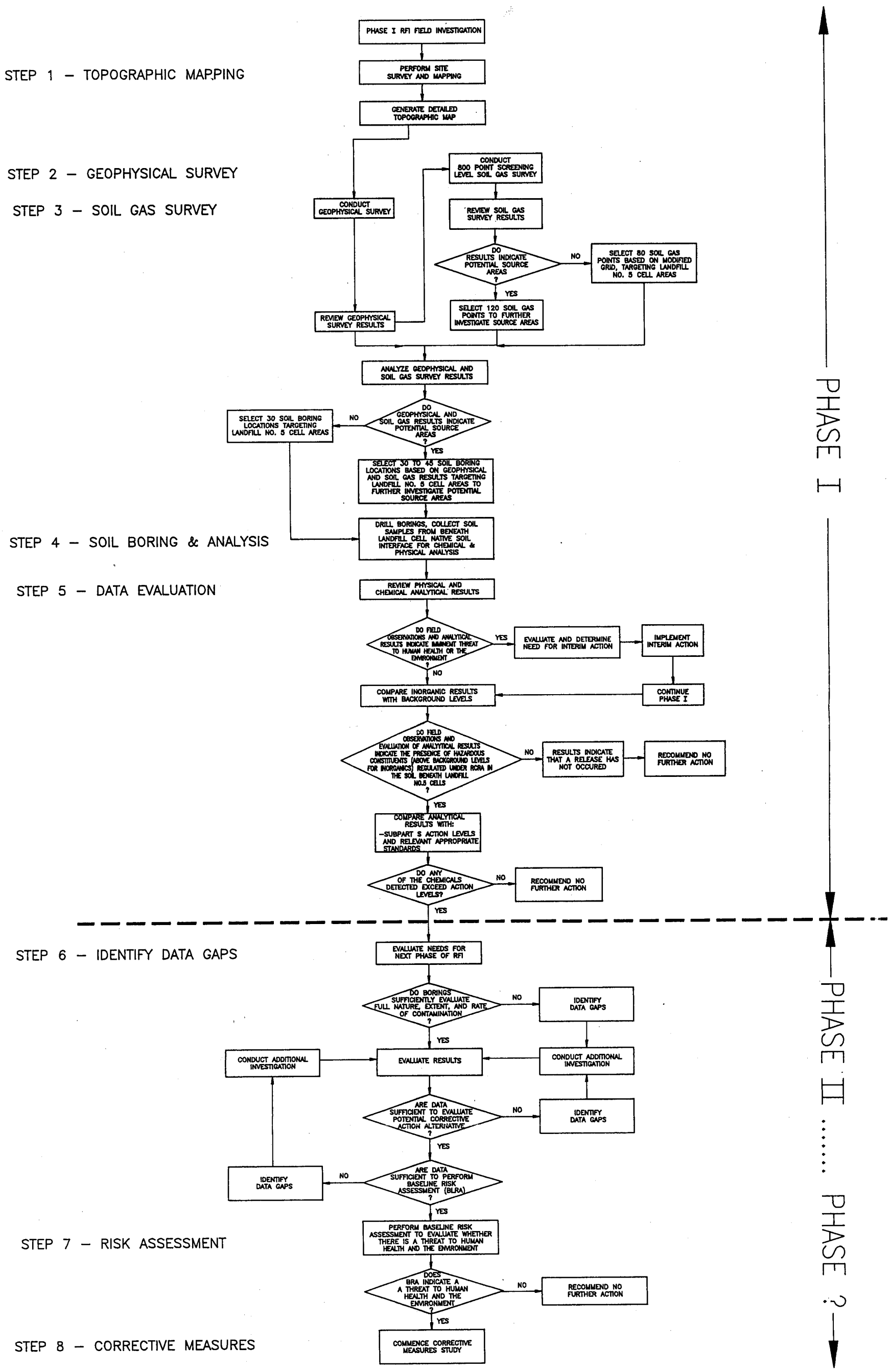


Job No. : C3M11M	LANDFILL NO.5 CELL AND GRID LOCATION MAP SWMU NO. 113 CANNON AFB, NEW MEXICO
Prepared by : B.J.R.	
Date : 8/22/93	

3M11F31

FIG. 4-1

PHASE I RFI OBJECTIVE: EVALUATE THE PRESENCE OR ABSENCE OF A RELEASE TO THE ENVIRONMENT FROM LANDFILL NO. 5



Job No. : C3MIIM	DECISION DIAGRAM SUMMARIZING THE PHASED RFI PROCESS FOR LANDFILL NO. 5 (SWMU NO. 113/IRP NO. LF-5) CANNON AIR FORCE BASE
Prepared by : J.T.A.	
Date : 8/5/94	

M11001

FIG. 4–2

5.0
RCRA FACILITY INVESTIGATION TASKS

The RFI process involves the execution of a series of tasks that have been identified in the project proposal. These include the tasks identified in the DCQAP and the tasks tentatively identified to be conducted after site characterization. The identified RFI tasks are only briefly described because most are documented in more detail in the DCQAP.

TASK 1. PROJECT PLANNING

This task includes efforts related to initiating the RFI as directed by the regulatory agency. The project planning task is defined as complete when the RFI Work Plan and supplemental plans (i.e., DCQAP, DMP, PMP, and SSHP) are approved. The following typical elements are included in this task:

- Obtaining easements/permits/site access.

  It will be necessary to obtain permits for contractor work and site access at Cannon AFB. This will include obtaining vehicle passes and digging/ excavation (utilities clearance) permits. Arrangements for these permits and monitoring will be made with the appropriate Cannon AFB personnel.

- Review of topographic maps and existing aerial photographs.

  Existing site maps and photographs will be reviewed during the preparation of the RFI Work Plans. Additional site maps will be prepared with these documents, as necessary.

- Collection and evaluation of existing data.

  The existing data have been summarized in the DCQAP.

- Identification of data needs and DQOs.

  The DQOs and data needs for the Phase I RFI have been identified and presented in Section 4.0 of this Work Plan and in DCQP (Work Plan Volume II).

- Initiation of subcontract procurement.

  Subcontractors will be used to perform several portions of the RFI including the field work site surveying geophysical survey, soil gas survey, drilling, and the laboratory analyses. Subcontractors will be hired as soon as this Phase I RFI Work Plan is approved.

- Initiation of coordination with analytical laboratories.

  Coordination with the analytical laboratories will be initiated when this Phase I RFI Work Plan is approved.

TASK 2. FIELD INVESTIGATION

This task involves efforts related to conducting the Phase I RFI field work and includes the procurement of subcontractors related to field efforts. The task begins when any element, as outlined in the Work Plan, is approved (in whole or in part) and field work is authorized. Field investigation is defined as complete when sufficient data have been collected to meet the requirements of the DQOs and the contractor and subcontractors are demobilized from the field. The following activities are included in this task:

- Mobilization
- Site survey/topographic mapping

- Geophysical survey
- Soil gas survey
- Geological investigation
- Field screening/analyses

Field investigations will be performed according to Section 4.0 - Field Activities in the DCQAP. Investigations will be performed according to Standard Operating Procedures (SOPs). The SOPs applicable to Cannon AFB field activities are provided in the DCQAP.

TASK 3. SAMPLE ANALYSIS/VALIDATION

This task includes efforts relating to the analysis and validation of samples after they leave the field. Separate monitoring of support laboratories may be required. Any efforts associated with laboratory procurement are also included in this task. The task ends on the date that data validation is complete. The following typical activities are usually included in this task:

- Sample management
- Use of mobile laboratories
- Chemical analysis of samples
- Testing of physical parameters
- Data package preparation and delivery
- Data validation
- Laboratory Quality Control

Procedures and specifications for sample analysis and validation are given in the DCQAP for analytes included in the scope of work. This includes detection limits, precision, accuracy, recovery limits and industry standards. If additional analytes are added at a later date, the analytical parameters will be addressed in the DCQAP.

TASK 4. SAMPLE LOCATION SURVEY

A topographical survey of Landfill No. 5 will be performed as part of this RFI. The RFI includes laying out and surveying a 50-foot by 50-foot grid for use during the geophysical and soil gas surveys. In addition, all sample locations will be surveyed and tied into the base coordinate system in accordance with guidance furnished in the USACE SOS. All surveying activities will be performed by a New Mexico-licensed land surveyor.

TASK 5A. DAILY QUALITY CONTROL REPORTS

The W-C field Site Manager will be responsible for completing a DQCR each day in accordance with the DCQAP and the USACE SOS. These reports will ultimately be summarized as part of the QC Summary Report for the project record. The DQCR is the mechanism for communicating daily QA/QC activities and any observations regarding problems or variations from plan that may have occurred that day. A form is provided (example in DCQAP) to facilitate complete reporting each day. Copies of the DQCR will be forwarded to the Quality Assurance Officer for review and submitted to the USACE Technical Manager on a weekly basis. If problem situations occur, the DQCR will be faxed to the USACE Technical Manager on a daily basis until the problems are corrected.

TASK 5B. DATA VALIDATION AND EVALUATION

This task includes validation of all chemical testing data in accordance with the DCQAP and interpretation of data after it has been validated. The task begins as soon as data from the laboratory are received by the project team, and it is considered to be complete when all of the data from the laboratory have been validated and found to be usable. The following activities are involved:

- Data validation according to the DCQAP
- Data evaluation
- Data reduction and tabulation
- Task management and quality control

- Task management responsibilities (discussed in Section 6.0, Project Management)
- Quality control procedures specified in the DCQAP

The Data Management Plan included as Appendix A to the Work Plan provides guidelines for storing and reporting data collected during the RFI.

TASK 5C. QUALITY CONTROL SUMMARY REPORT

When data validation is completed and all the data is available, the Quality Control Summary Report will be completed. This report includes a summary of all daily QC reports from the field, all QA/QC reports from the laboratory, and a complete review of the data quality discussing any qualification or restrictions placed on the use of the data. This task will be considered complete when the report has been accepted by the USACE.

TASK 6. REPORTS

This task includes all efforts related to the preparation of the investigation findings after the data have been evaluated under Task 5B. The task covers all draft and final reports as well as task management and quality control. The task ends when the last RFI document is approved by USACE, Cannon AFB, and the regulatory agencies.

The following are typical activities:

- Evaluating data
- Preparing a report
- Reviewing and providing quality control efforts
- Printing and providing quality control efforts
- Holding review meetings
- Revising the report on the basis of agency comments
- Providing task management and control

TASK 7. PROJECT MEETINGS

All project meetings and related travel will be covered under this task.

TASK 8. PROJECT MANAGEMENT

Project Management is required for all phases of the project to assure results of the required quality. This task is described in detail in Section 6.0. The Project Management Plan is also provided as Appendix B.

6.0
PROJECT MANAGEMENT

Specific project management responsibilities and protocols and a project organizational structure have been established to manage the planned Phase I RFI. The details of project management including a discussion of these topics are presented in the PMP included in Appendix B.

A detailed schedule and funding and budget control procedures for conducting the Phase I RFI and transmitting the draft and final Phase I RFI report are also contained in the PMP.

7.0
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APPENDIX A
DATA MANAGEMENT PLAN

REMEDIAL INVESTIGATION

DATA MANAGEMENT PLAN

CANNON AFB, NEW MEXICO

JULY 1995

Prepared for

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A1.0
INTRODUCTION

To manage the large amount of scientific and technical data that will be generated from Cannon AFB remedial investigation, this Data Management Plan (DMP) has been developed. The purpose of this DMP is to ensure that the available data are stored for extended periods of time in a secure, controlled, and retrievable manner in order to be accurately and efficiently transferred into useful information. This plan addresses the planning, implementation, and responsibilities to optimize the use of the database. This plan also provides the format(s) to be used to present the data and the data Quality Assurance/Quality Control (QA/QC) plan.

The primary users of the scientific and technical information for the Landfill No. 5 (SWMU No. 113/IRP No. LF-5) RFI data will be risk assessment scientists, chemists, civil/chemical engineers, geochemists, geologists, and hydrogeologists. Specific reports will be prepared and/or the data transferred to other software packages/programs for use in analyzing and interpreting investigation results. Use of this DMP in conjunction with DCQAP SOP No. 11 Data Management (provided as Attachment 1) will ensure that the needs of these users are addressed.

A2.0
OBJECTIVES AND STRATEGIES

The following objectives were established for this DMP:

- Define the responsibilities of the Data Management Team.
- Ensure the database systems design is amenable to systematic review, and provide access to the data for analysis.
- Identify methods of data presentation.

To achieve the first objective, the strategy is to define the responsibilities and staff of the data management team. For the second objective, the strategy is to utilize a database system that is single user, and capable of electronic data transfer. For the last objective, the strategy is to illustrate how the data may be presented.

A3.0
PARTICIPANTS AND RESPONSIBILITIES

A3.1 PROJECT DATA MANAGER

The Project Data Manager has responsibility for the overall data management program including systematic updating of data and review of the computerized data management system (DMS). This person will incorporate the QA guidelines and instruct laboratory, Computer Information System (CIS) Administrator and field personnel in the proper procedures for coding data and oversee the operation of the DMS. Authority of the Data Manager includes the following:

- Determine the appropriate QA/QC procedures and document control.
- Directly communicate with data management personnel in ensuring procedures for data transmittal and problem resolution.

A3.2 COMPUTER INFORMATION SYSTEM (CIS) ADMINISTRATOR

A CIS Administrator will ensure that the proper database system is chosen. The proper database system will ensure that data are preserved, retrievable, traceable, and sufficient for future use and available for response to regulatory, agency and user requirements.

The CIS Administrator is also responsible for executing the proper procedures for the handling of the computer-based data as well as coordinating with the Project Data Manager and any other members of the data management team as necessary for problem resolution. He will also facilitate electronic loading and quality control checks of any electronic data.

A3.3 FIELD DATA COORDINATOR

The Field Data Coordinator is responsible for ensuring that all data management procedures are correctly implemented in the field. He/she will be responsible for ensuring that all

samples are assigned appropriate site IDs that will be maintained throughout analysis and the reporting of results. He/she will also maintain and review field documentation. The Field Data Coordinator will ensure that all field team members use appropriate sample tags and Chain-of-Custody (COC) records to clearly identify sample locations, sample matrices, and the requested analyses.

A4.0
DATABASE SYSTEM DESIGN

The database system will be designed to generate appropriate reports and tables, provide systematic review, and efficient access and retention to optimize the use of data. It is recognized that different types of data (e.g., locations, metal and volatile organic concentrations) from a variety of sources (e.g., boring logs, laboratory analyses) will be collected at various times at the site. To accommodate the various types of information, and to allow for easy reporting, retrieval, and site characterization, an appropriate automated database management system will be selected.

Woodward-Clyde (W-C) will utilize an in house develped database system WCEDGE (Environmental Data Intergraation and Export) to handle sample data management considering the site, categorization, as well as the types of chemical data. Currently the categorizing is as follows:

- Volatile Organics
- Semi-volatile Organics
- Pesticides and PCBs
- Herbicides
- Metals
- Total Petroleum Hydrocarbons
- Soil Gas Survey Results
- Other Relevant Data (e.g., field notes,survey information, field parameters).

In order to plan and design a database system that will include all such items, discussions will be held with the users of the information, the CIS Administrator, and the Project Data Manager. Following these discussions, all data types, data to be collected and descriptions of the data will be defined. After all the data have been entered, a summary list of all the data in the database will be generated and distributed to the users, administrator and manager for review.

The DMS is amenable to reporting of either all or part of the data in selected fields. Further, all or any subset of the data can be selected for a systematic review and analysis. WCEDGE has the capibility to export data to numerous personnel computer applications, such as Wordperfect, Autocad, Excel, Statgraphics, and Stanford Graphics for review and analysis.

Woodward-Clyde has the capability to provide the collected data to the Army Corps of Engineers in ASCII or DBASE III-compatible file formats.

A5.0
DATA PRESENTATION

All data will be arranged and presented in a clear and logical format. Tabular, graphical, and other visual displays will be used for organizing and evaluating such data to assist in the decision making process during the investigation.

A5.1 TABLES

Tabular presentations of both raw and sorted data will be used for data presentation as discussed below. Tables of derived data may be developed and used, where necessary.

A5.1.1 Listed (Raw) Data

Simple lists of data alone are not adequate to illustrate trends of patterns resulting from a contaminant release but are a good starting point for other presentation formats. These lists are also valuable for sample validation and auditing. Therefore, such lists will be used for reporting results during the RFI. Each data record will provide the following information:

- Unique sample code
- Sampling location and sample type
- Sampling date
- Laboratory analysis identification number
- Property or component measured
- Result of analysis (e.g., concentration)
- Detection limits
- Reporting units

Additional data including suspected outliers or samples contaminated due to improper collection, preservation, or storage procedures will be identified in the database with a qualifier notation and such data will not be used in reports or other presentational formats

unless requested. The rejected data will be marked as such in the data tables, and explanations of rejected data will be presented in footnotes.

The following list is an example of some of the field data to be collected.

- Name and address of sampler
- Purpose of sampling
- Date and time of sampling
- Sample type (e.g., soil) and suspected contaminants
- Sampling location, description, and grid coordinates
- Sample weight or volume
- Number of samples taken
- Sample identification number(s)
- Field observations
- Field measurements made (e.g., OVA, PID)
- Weather conditions
- Name and signature of person responsible for observation

Any unusual conditions encountered during sampling (e.g., difficulties with any sampling equipment, post-sampling contamination, or loss of samples) will also be described.

A5.1.2 Sorted Summary Tables

Presentation of results grouped according to data categories will be used to display trends or patterns in data. Examples of categories of data include the medium tested, sampling data, sampling location, and constituent or property measured.

A5.1.3 Derived Data Tables

Derived data are those data which have been calculated from a set of raw data. Examples include measures of central tendency, measures of statistical scattering, or the results of calculation based on indirect measurements of a physical parameter. Where derived data are

presented in tabular or graphic form, there will be a clear reference to the method of calculation and the location of the raw data.

A5.2 GRAPHICAL PRESENTATION OF DATA

Graphic methods of data presentation can often illustrate trends and patterns better than tables. Graphic formats which will be used for environmental data such as bar graphs, line graphs, areal maps, and isopleth-maps are discussed below.

A5.2.1 Bar Graphs and Line Graphs

Bar graphs and line graphs (Figures A5-1 and A5-2) will be used to display changes in contaminant concentrations with time, distance from a source, or other variables. Bar graphs will be used where there is not enough information to assume continuity between data points.

A5.2.2 Area Maps

Area maps will be used to show facility features, including buildings, roads, boundaries and other man-made features. Natural features, such as stream courses, will also be shown. Area maps will be used to identify SWMUs, well locations, and the locations of other activities.

A5.2.3 Topographic Maps

Topographic maps show changes in relative or absolute elevations by the use of elevations contours. A contour is an imaginary line connecting points of equal elevation. Maps of surface topography will commonly be combined with area maps. Maps showing the topography of the top of the bedrock surface are special geologic maps. These will contain minimal information on surface features. Structural maps are geologic/topographic maps which show the relative elevations of some buried feature.

A5.2.4 Geologic Maps

Geologic maps are maps which illustrate the patterns of lithologic or other primary or secondary rock characteristics below the soil or residuum. Geologic maps may be used to illustrate important geologic or hydrogeologic data.

A5.2.5 Hydrogeologic Maps

Hydrogeologic maps include water elevations (a type of topographic map), potentiometric surfaces, flow directions, hydraulic conductivity variations, or other physical or chemical parameters necessary for illustrating groundwater data.

A5.2.6 Contaminant Isopleth Maps

The distribution of hazardous constituents at a site may be represented by superimposing contaminant concentrations over a map of the site (Figure A5-3). Distributions may be shown by listing individual measurements, or by contour plots of the contaminant concentrations using techniques such as contamination shown at discrete points, display of average concentrations, and contaminant isopleth maps.

A5.2.7 Isopach Maps

Isopach maps are contour maps in which each line represents a unit of thickness of a geologic material (e.g., the soil layer) (Figure A5-4). The isopach map displays thickness only and does not provide information on absolute depth of slope.

A5.2.8 Vertical Profiles or Cross-Sections

Vertical profiles are especially useful for displaying the distribution of contaminant release in all media (Figure A5-5). For soil and groundwater, the usual approach is to select several soil borings (or monitoring wells) that lie in approximately a straight line through the center of the contaminant release. This cross-section represents a transect of the site. A diagram of the soil (or groundwater) profile should be prepared along the length of the transect, displaying subsurface stratigraphy, location of the waste source, and the location and depth

of boreholes. The locations of transect and contributing data points must be shown on an area map which is referenced to the cross-section.

A5.2.9 Three-dimensional Data Plots

This technique is used to represent contaminant concentration across the study area as a three dimensional surface (Figure A5-6). The smoothing of concentration dissimilarities between adjacent sampling locations makes patterns in the data easier to visualize. Precise concentrations, however, cannot be displayed in this format because the apparent heights of the contours change as the figure is rotated.

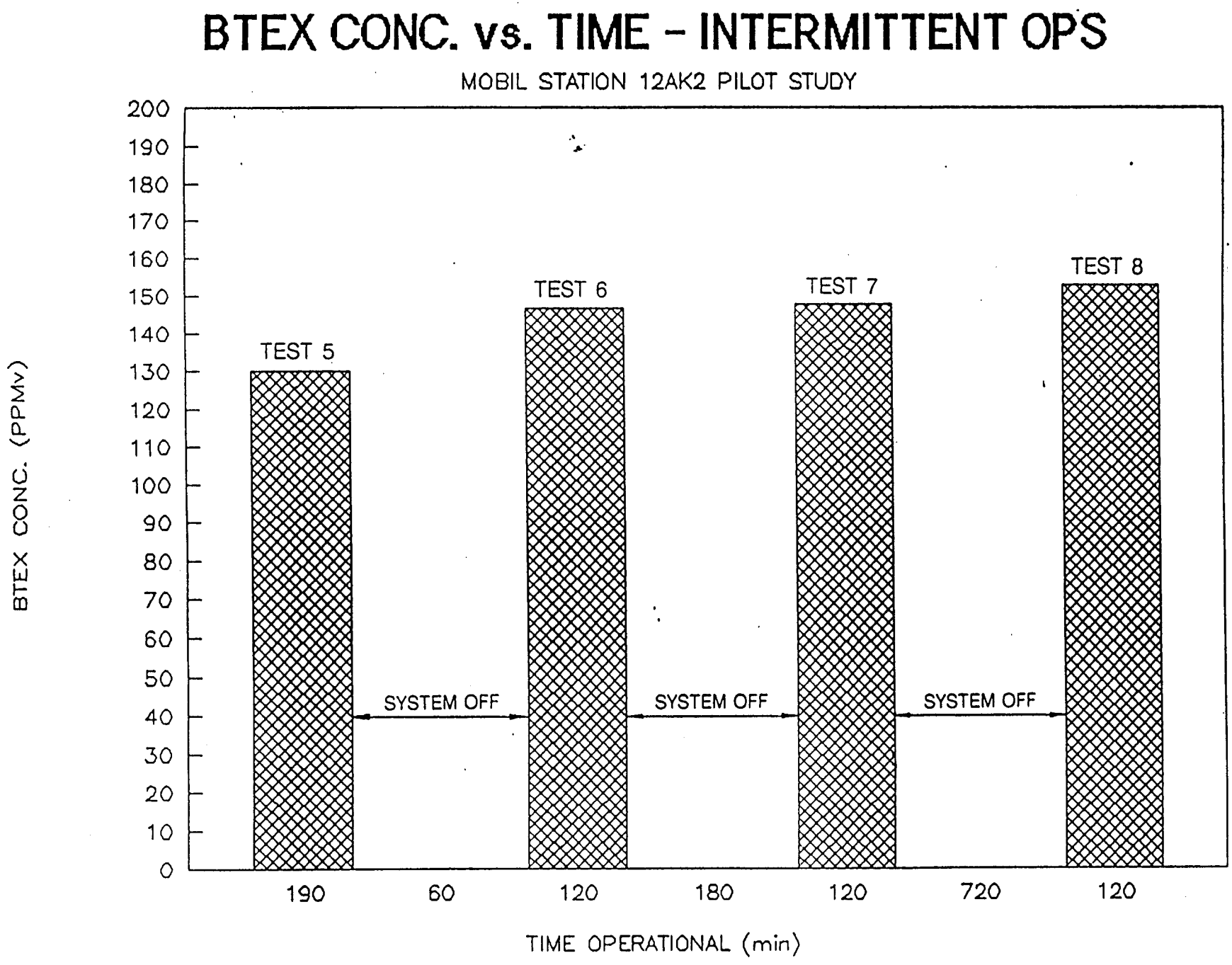
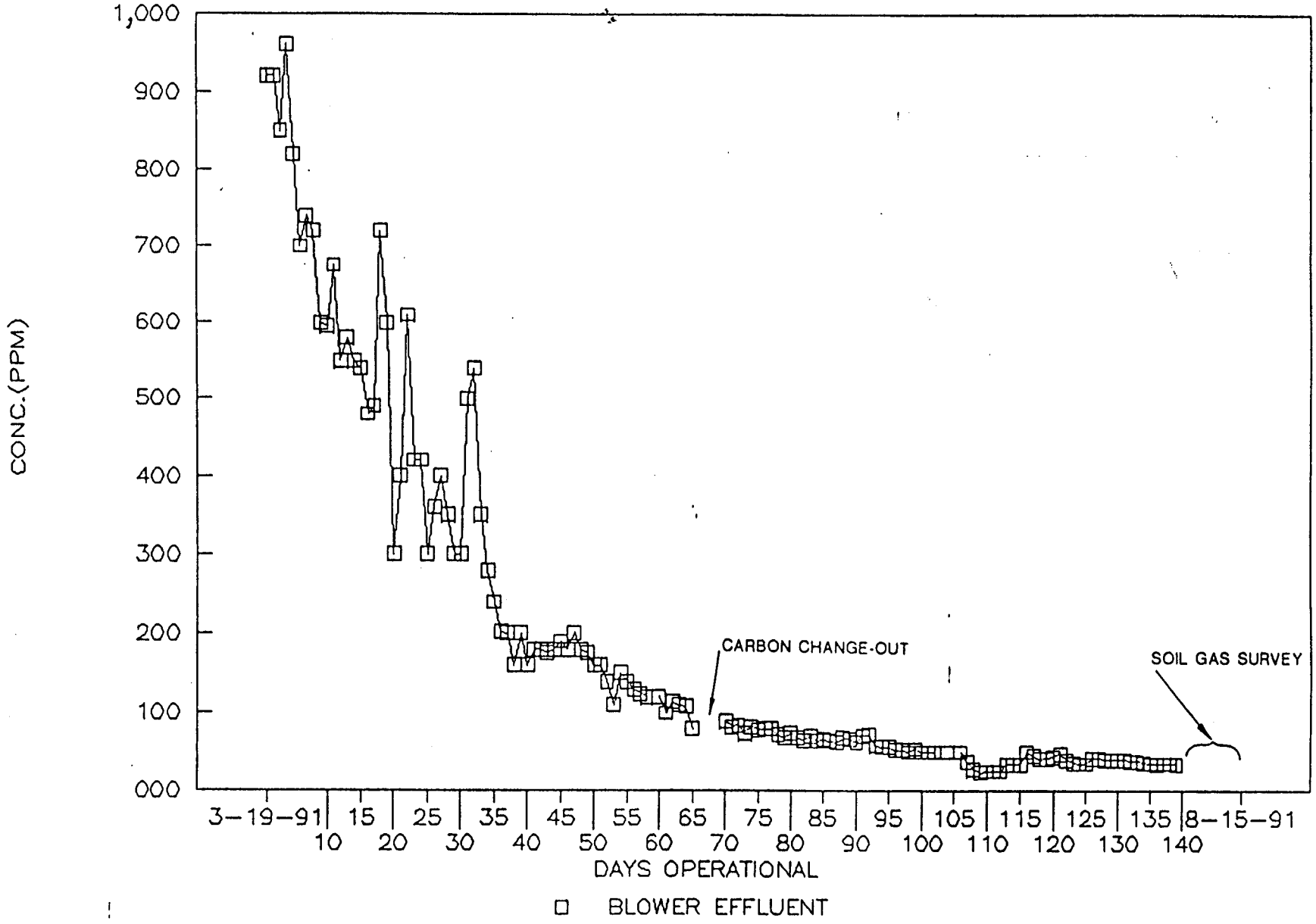


FIGURE A5-1 BAR GRAPH EXAMPLE

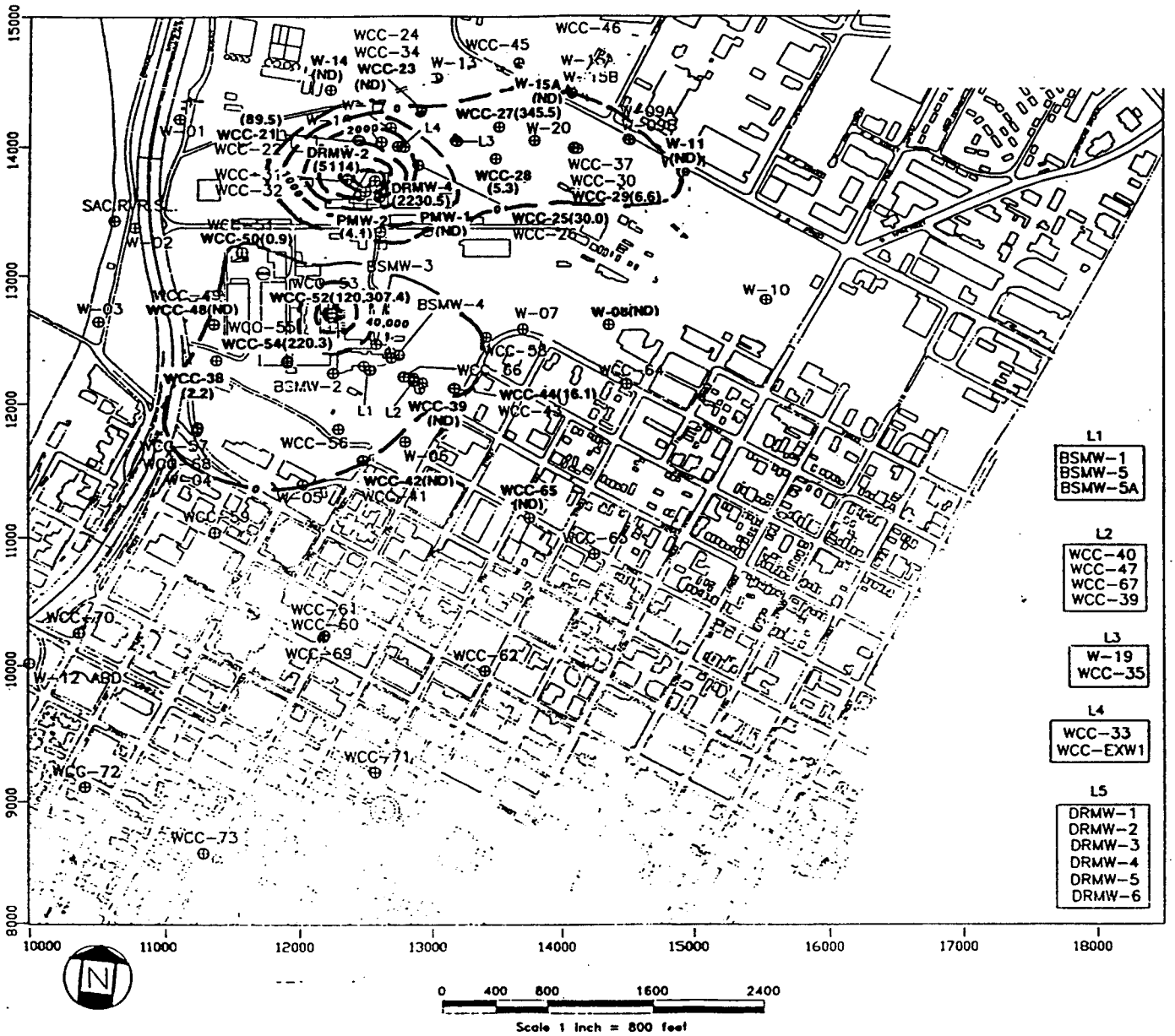
VES EXHAUST CONCENTRATION vs TIME *

MCCOOK,NEBRASKA



★ ***NOTE: VALUES GIVEN ARE PRIOR TO CARBON TREATMENT***

FIGURE A5-2 LINE GRAPH EXAMPLE



LEGEND

⊕ PMW-2 — WELL NO.

(4.1) = CONCENTRATION (ug/l)

(ND) = NON-DETECTABLE CONCENTRATION

NOTE:

ALL CONCENTRATIONS IN ug/l

CONTOUR INTERVAL = 1000 ug/l
EXCEPT IN VICINITY OF WCC-52,
WHERE CONTOUR INTERVAL = 40,000 ug/l

Job No. : 89MC114W	CONTAMINANT ISOPLETH MAP
Prepared by: A.C.F.	
Date: 9/30/91	

FIG. A5-3

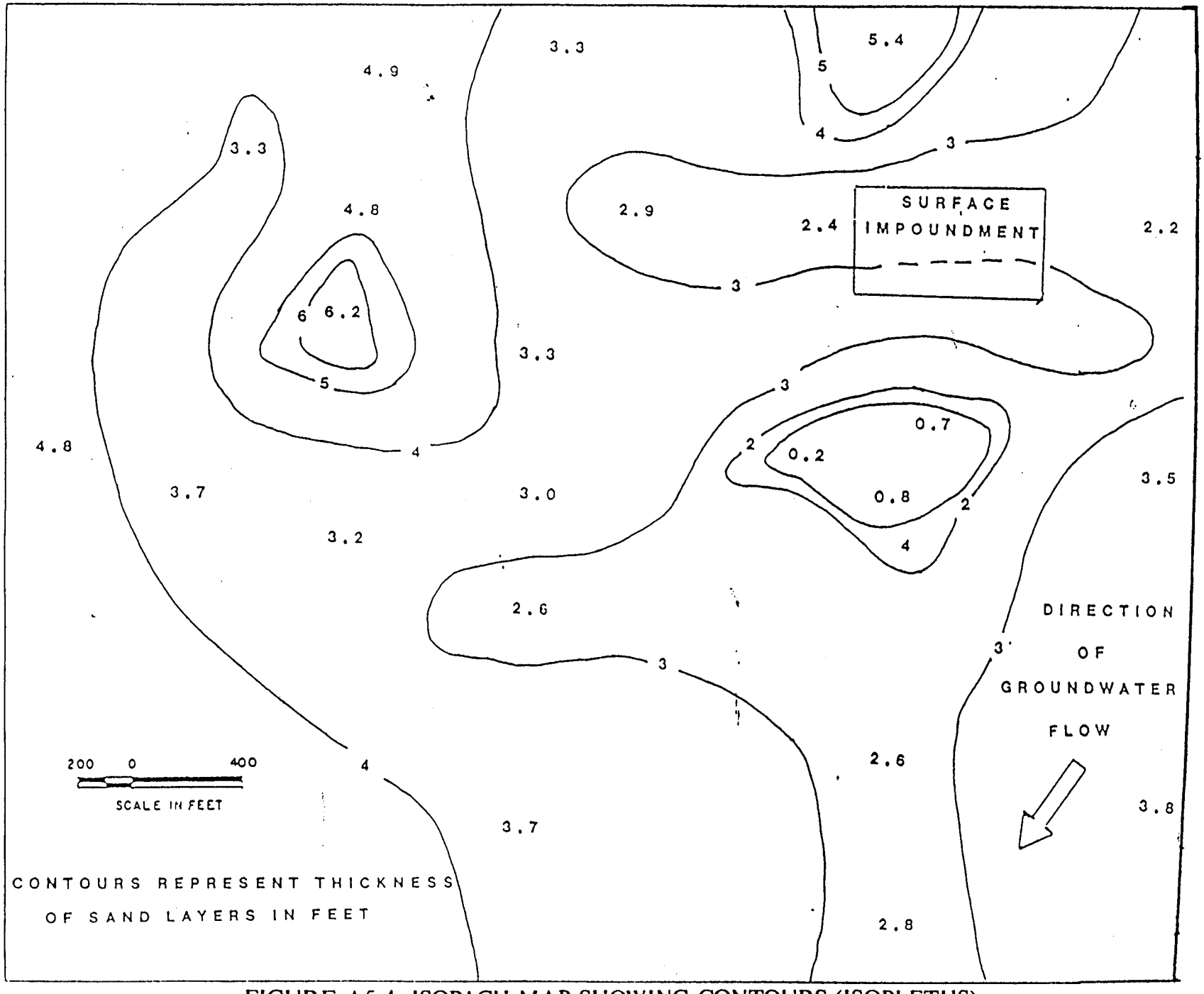


FIGURE A5-4 ISOPACH MAP SHOWING CONTOURS (ISOPLETHS)

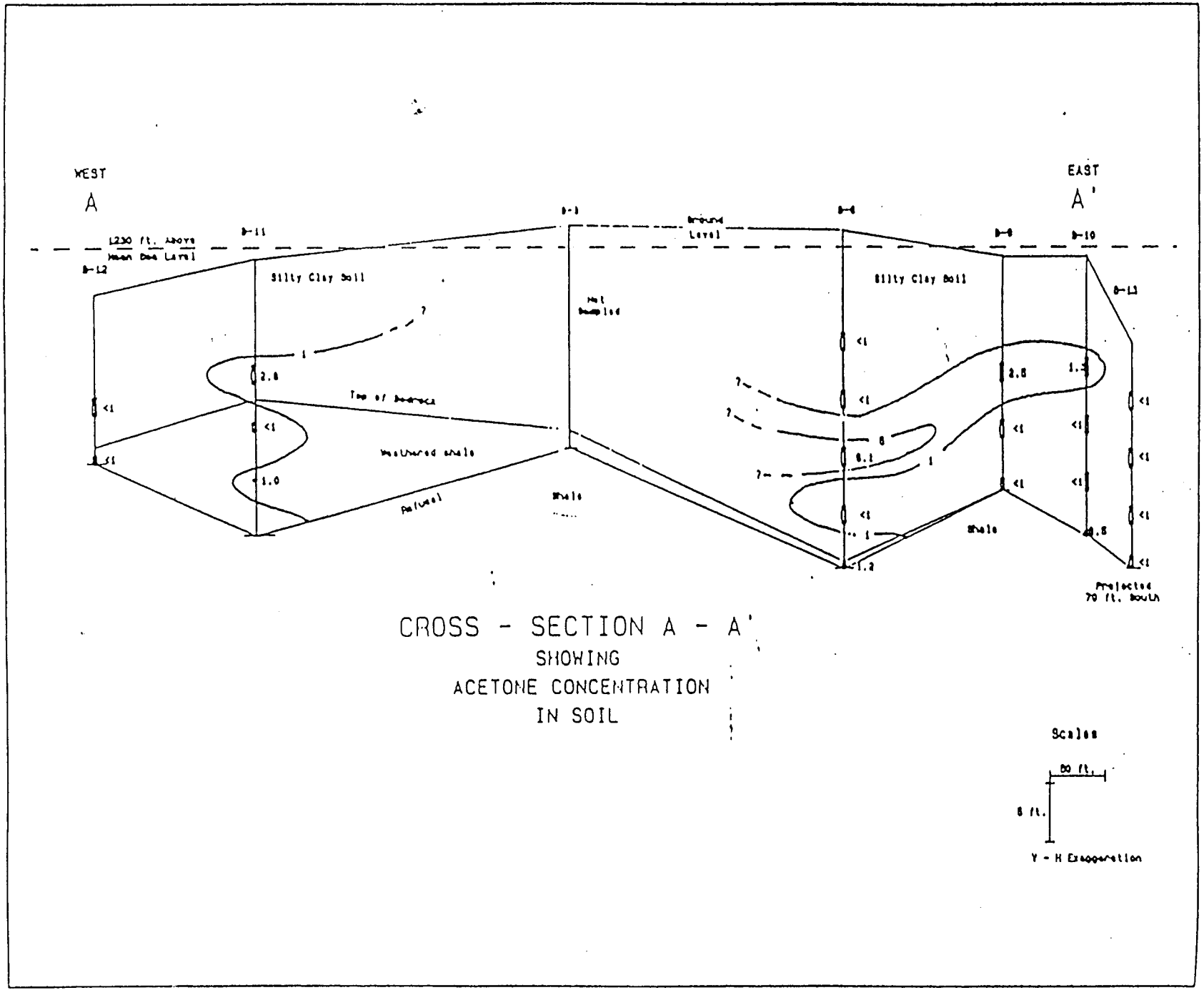


FIGURE A5-5 CROSS-SECTION A-A SITE SUBSURFACE PROFILE

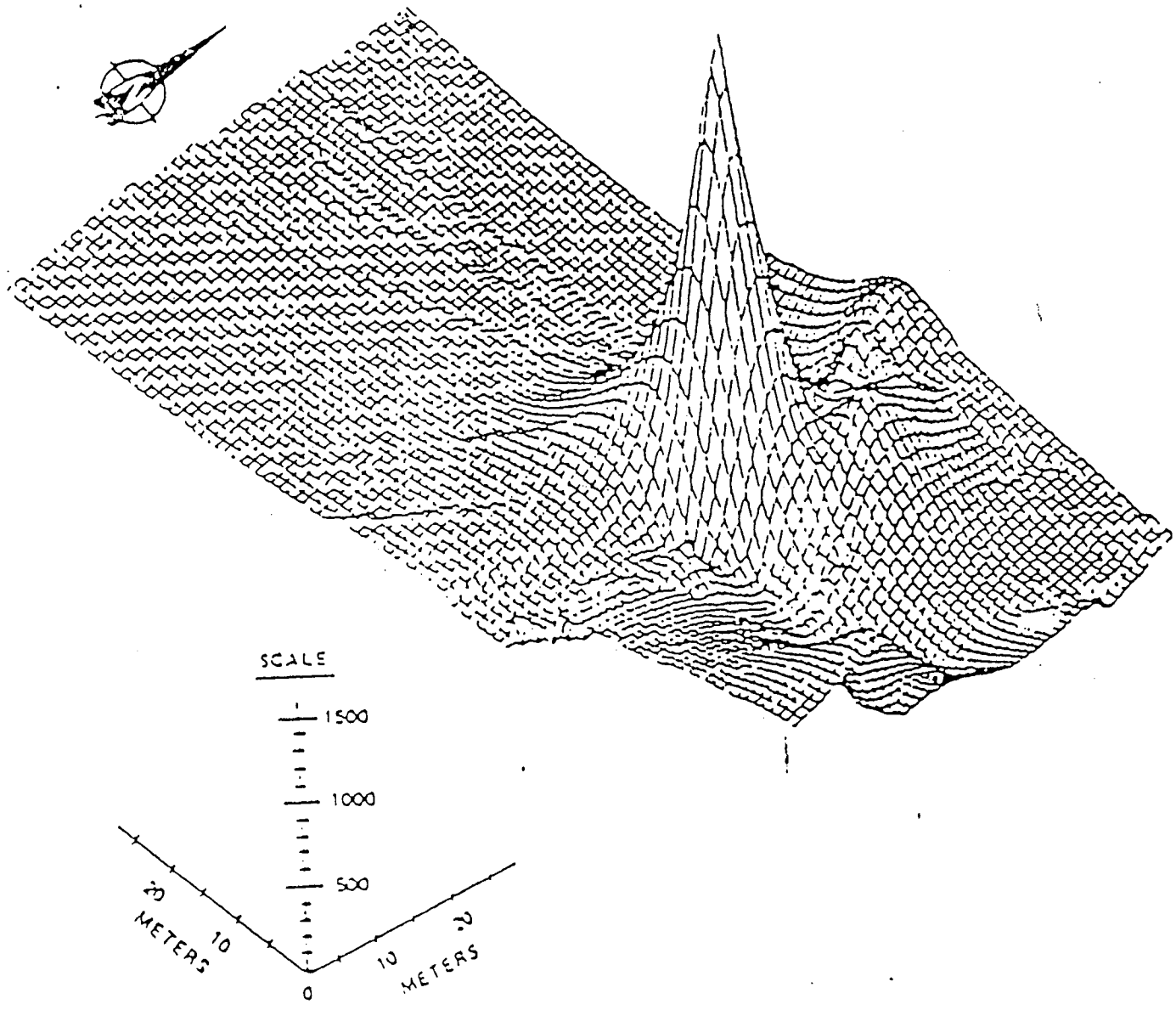


FIGURE A5-6 THREE-DIMENSIONAL DATA PLOT OF SOIL PCB CONCENTRATIONS (ug/kg)

ATTACHMENT 1
DATA MANAGEMENT STANDARD OPERATING PROCEDURE

STANDARD OPERATING PROCEDURE No. 11
DATA MANAGEMENT

CANNON AIR FORCE BASE LANDFILL NO. 5
RCRA FACILITY INVESTIGATION, PHASE I
CLOVIS, NEW MEXICO

USACE CONTRACT NO. DACW-45-93-D-0005
DELIVERY ORDER NO. 0012
W-C PROJECT NUMBER C3M11M

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FIGURE 2 DATA MANAGEMENT SYSTEM DETAILED FLOW DIAGRAM
FIGURE 3 CHAIN OF CUSTODY RECORD
FIGURE 4 DATA TRANSMITTAL FORM
FIGURE 5 DATA CORRECTION/CHANGE FORM

3.0
PURPOSE AND SCOPE

The goal of the data management Standard Operating Procedure (SOP) is to provide a validated database for the end user. This procedure is designed to eliminate errors in the database and to provide documentation that corrections have been completed. The process also provides the status of the database directly to the end user. The primary purpose of a data management plan, such as this SOP, is to communicate to users and decision-makers how information will be entered, accessed, reviewed, and used.

This data management plan addresses the following issues:

1. Sample Documentation
2. Data Deliverables
3. Sample Tracking
4. Data Entry
5. Data Proofing
6. Data Reporting

A Data Management System (DMS), which includes a sample tracking system and a database management program, must be in place prior to initiation of field activities. The DMS may consist of either two separate systems (i.e., a sample tracking system and a database management program) or a single system that combines both functions. The sample tracking portion of the DMS may consist of either a simple spreadsheet (e.g., Excel or Lotus) or a sample tracking program (e.g., SIMSII or similar sample tracking program) capable of meeting the requirements in Section 7.0 of this SOP. A database management program capable of meeting the requirements of Section 8.0 would also be acceptable (e.g., Paradox®, Oracle). This SOP allows for the sample tracking function and the database management function to be operated independent of location. However, if one DMS is in place (i.e., SIMSII) but two functions are operated from different locations, it is important that the

primary system be updated for both these functions, either periodically during the project study or at the conclusion of the study.

Figure 1 provides an overview of the DMS described in this SOP. The preferred pathway for the flow of data includes entering only validated sample data into the database. An optional pathway is also shown in Figure 1 for entry of non-validated data into the database and generating preliminary reports. All preliminary reports generated from the database will indicate the status of the data on a per sample, per analysis basis (see Sections 8.0, 9.0, and 10.0). A detailed DMS diagram is shown in Figure 2.

This SOP serves as a supplement to the Data Collection Quality Project Plan (DCQAP) and the Field Sampling Plan (FSP) for particular studies at Cannon AFB. This procedures is intended to be used together with the FSP and other SOPs.

4.0
RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager is responsible for assuring that chemical data derived from studies at Cannon AFB are managed 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 implementing and carrying out data management activities 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.

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. 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 of 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
SAMPLE DOCUMENTATION

Sample identification and documentation will be as described in SOP No. 9, Sample Handling, and Documentation and Analysis. The following are considered key elements in properly documenting and tracking samples.

5.1 FIELD LOGBOOKS

The field logbooks are used to document all samples collected for a project. The field logbooks will contain, as a minimum, the following information for each sample taken:

1. Field sample ID
2. Date and time of sampling
3. Sample location
4. Sample description
5. Sample depth
6. Analyses being requested
7. Number of containers filled
8. Associated Quality Control (QC) samples (e.g., field replicates, matrix spikes, etc.)

To track the number of samples and analyses requested, it is imperative that all samples (whether they are being analyzed for chemical or geotechnical parameters, or not at all), be entered into the field logbooks.

The assignment of QC samples (e.g., field replicates, matrix spikes, matrix spike duplicates, laboratory duplicates) to associated field samples must be designated by the Field Task Manager or designee, in consultation with the Project Quality Assurance/Quality Control (QA/QC) Officer or designee, prior to the start of field activities, and documented in the field

logbooks. The assignment of QC samples is important for the subsequent evaluation of the sample data quality.

5.2 CHAIN OF CUSTODY FORMS

Chain of custody (COC) forms must be used to document the transport and receipt of samples from the field to the laboratory as specified in SOP 9, Sampling Handling, Documentation and Analysis. A sample COC is shown in Figure 3. For data management purposes, the major information needs in the COC are:

1. Date and time the sample was taken.

2. Woodward-Clyde Consultants (WCC) Sample Identification.

3. Chemical analysis being requested is indicated by placing an `X' or `✓' under the appropriate analytical parameter. The total number of containers sent to the lab for each sample should be indicated on the COC form. The laboratory requirements for optimum and minimum sample volume should be established prior to the start of the field sampling activities. This information should be provided to the field staff so that problems with sample volume can be quickly recognized and addressed. If any samples are to be placed on hold or special instructions are required, this should be clearly indicated on the COC form.

4. Air bill number (if applicable).

5. Field personnel will designate the preferred sample delivery groups and will indicate the sample delivery group (SDG) number on the top of the COC form. A SDG will consist of 20 samples or less of a similar matrix (i.e., soil/sediment), excluding QC samples, collected over a period of 14 days or less.

6. The completed COC form and associated samples will be placed in a cooler for shipment to the laboratory. Multiple SDGs may be shipped in the same cooler but samples listed on a COC form may not be mixed in separate coolers.

7. The sample COC must be signed off whenever custody is relinquished.

8. Following shipment of samples to the laboratory(s), the Field Task Manager or designee will fax copies of the completed COC form(s) to the analytical laboratory, the Data Manager, and the Project QA/QC Officer (see Figure 2).

5.3 SAMPLE RECEIPT CONFIRMATIONN

All laboratories receiving samples from WCC will be required to provide sample receipt confirmation. This confirmation should include a copy of the tabular listing showing the samples entered into the laboratory's data management system by sample delivery group number, the corresponding laboratory ID, and the analyses requested for each sample. The laboratory is required to provide only a tabular listing of the samples received if only a single analysis is requested for each sample. The confirmation should be faxed to the on-site Field Task Manager or designee on the day of sample receipt and a hard copy sent to the Project QA/QC Officer. The Field Task Manager or designee is responsible for checking the confirmation received from the laboratory versus the COC form(s) to determine whether (1) all samples were received by the laboratory, (2) all samples and analyses were correctly entered into the laboratory's data management system, (3) unique field IDs and laboratory IDs were assigned to each sample, and (4) all required samples/analyses were collected and analyzed as specified in the FSP. The Field Task Manager or designee will notify the laboratory by phone and/or by fax of any discrepancies observed during the sample confirmation check.

The Field Task Manager or designee will be responsible for the sample IDs, corresponding laboratory IDs, collection dates, and the test parameters being entered into the Data Management System (i.e., sample tracking system and database management program).

6.0
DATA DELIVERABLES

Data deliverable requirements from the laboratory will be determined prior to the start of the field work and should be documented in a contract or contract addendum. Electronic deliverables should be in a WCC-defined format and the laboratory notified that they will be held responsible for ensuring that electronic deliverables will accurately reflect the data reported in hard copy format. As part of the data deliverable requirements, the Project Manager shall designate the WCC personnel to receive the sample data from the laboratory. If the laboratory data are to be sent to the Project Manager or designee, it shall be the Project Manager's responsibility to update the sample tracking system and to forward the data packages to the data reviewer for validation (Section 7.0).

7.0
SAMPLE TRACKING AND DATA MANAGEMENT

A major part of managing chemical data is knowing how many samples have been taken, analyses requested, and analysis due dates. In addition, some chemical data may be more urgently needed than others, requiring these data to be prioritized over the rest of the data.

Sample tracking and data management include all forms of data collection and documentation and may include printing sample labels, printing COC forms in the field, checking holding times, and tracking outstanding analyses. A sample tracking system (STS) should be in place prior to the initiation of field sampling activities and may consist of either a simple spreadsheet, such as Excel or Lotus, or a sample tracking program such as the Sample Information Management System (SIMSII) developed by WCC. If a spreadsheet is to be utilized for sample tracking, its format shall be developed and reviewed prior to initiation of the project. The STS should, as a minimum, contain the field sample ID, the laboratory's sample ID, sample matrix, the designated SDG number, the analyses requested, the holding time limits for the analyses, date collected, sample preservation, laboratory performing analyses, assignment of QC samples (e.g., field replicates, rinsates, matrix spikes), and data fields for indicating the following data completion stages:

- Sample data receipt
- SDG data package completeness check
- Data validation/QC review completion per sample per analysis
- Data sent for input into database
- Data entry check completed
- Database proofed against validated data result sheets

The sample COC forms and the laboratory receipt confirmation listings serve as the initial data entry sheets for the STS providing the field sample ID numbers, laboratory IDs, analyses requested, date of collection, SDG number, and laboratory performing the analyses.

The laboratory will submit a separate analytical data package for each SDG. Upon receipt of the analytical data for an SDG, the data recipient will be responsible for updating the STS to indicate that data were received for the samples contained in the SDG data package (see Figure 2), for notifying the Project Manager that data have been received, and for forwarding the data package to the designated data reviewer for validation. If the SDG data package is missing sample results for one or more samples, the laboratory will be notified of the discrepancy.

Following the initial check of the sample data received, the SDG data package will be checked against the required data deliverables for completeness by the data reviewer. If the SDG is complete, the data reviewer will be responsible for updating the STS to indicate that the SDG completeness check was performed. If any discrepancies are noted, the laboratory will be notified and redeliverables requested.

If the SDG is complete, or if the data present are sufficient for validation of the data, the data validation efforts will begin. Following validation of the data for an SDG, assignment of appropriate data qualifiers (if required) and peer review of the data validation, the data reviewer will be responsible for updating the STS to indicate that the data validation has been completed and qualifiers assigned.

Upon completion of the data validation (including peer review), the validated sample results will be sent by the data reviewer to the data manager for entry into the database. A separate data transmittal form (Figure 4) will accompany the results from each SDG data package indicating the status of the attached results. The data will be entered and the entry checked by the database manager or designee as described in Section 8.0 of this SOP. Upon completion of the data entry, the database manager or designee will sign and date the data transmittal form that accompanied the data results to indicate that the sample data were entered into the database and the entry checked. A copy of the completed form will be sent to the Project QA/QC Officer.

The use of the above data fields and data transmittal form helps to ensure that the proper steps in data management are followed and documented. The Project QA/QC Officer or designee will check a minimum of one SDG per project study to verify that the steps documented as complete were performed (e.g., sample data received, SDG data package complete, data validation complete, data entered into database).

8.0
DATA ENTRY

A database management program capable of managing all sample data and generating reports, queries, graphs, and exports of the data should be in place prior to the initiation of field activities. WCC has developed WCEDGE (Environmental Data Integration and Export) to handle sample data management as a centralized information repository capable of handling all of Woodward-Clyde's chemical and geological/geotechnical information. EDGE has been designed to take advantage of `Client/Server' architecture. This technology enables a `Server' to control and distribute data to a large number of `Clients'. The Servers for this system are the SCO Unix computers, and the clients are desktop PCs running Microsoft Windows™ and EDGE. The Client/Server technology combined with Woodward-Clyde's wide area network enables anyone using EDGE to access data anywhere on the wide area network.

Analytical data can be entered in two ways: (1) manual entry of field and laboratory data from the field logbooks and laboratory data sheets into the data system, and (2) analytical data being downloaded into the database from data disks supplied by the laboratory(s). Electronic deliverables are the preferred method for receipt and entry of laboratory data, making data entry more efficient.

Chemical data results and supporting QC data should be provided whenever possible in electronic format and accompanied by a printed hard copy. This will minimize data entry errors from manual input into the database. The data will be provided by the laboratory in sample delivery groups (SDGs) of 20 samples or less of a similar matrix type excluding QC samples. WCC will designate the preferred SDGs on the COC forms as described in Section 5.0 of this SOP.

8.1 ENTRY OF VALIDATED SAMPLE DATA

Upon completion of the data validation (including peer review), the validated Lab Result Sheets will be sent by the data reviewer to the data manager for entry into the database. A data transmittal form (Figure 4) will accompany the results from each SDG data package indicating the status of the attached results. For sample data being entered by WCC personnel, all data should be manually entered from the validated Lab Result Sheets by one of two methods:

- Double key entry (different data entry personnel for each keyed entry step) followed by a 10 percent proof of entered data. If errors are found, an additional 10 percent of the entered data will be proofed. If additional errors are found, 100 percent of the entered data will be proofed.

- Single key data entry followed by a 100 percent review of the single key entered data by a second party to check for errors.

Upon completion of the data entry, the Data Manager will sign and date the data transmittal form that accompanied the data and return a copy of the completed form to the Project QA/QC Officer or designee.

8.2 ENTRY OF NON-VALIDATED SAMPLE DATA

At times, non-validated sample data may be entered into the database either directly from the lab result sheets due to a need by an end user for preliminary data or due to sample data being received in an electronic format directly from the laboratory. In the first instance, the data transmittal form accompanying the sample results will indicate the current status of the sample data (e.g., data not validated or reviewed). For data received directly from the laboratory in an electronic format, the Data Manager will notify the Project QA/QC Officer

of receipt of data from the laboratory prior to entry of the data into the database. The Data Manager, in consultation with the Project QA/QC Officer, will determine the current status of the data and a data transmittal form will be completed to document the status of the data being entered. In both cases, the Data Manager or designee will enter the status of the data in the database status field. This status field will be included in any preliminary reports generated from the database (see Section 10.0 of this SOP).

For data entered into the database from a data file provided by the laboratory, a minimum of 10 percent of the data will be proofed by the Data Manager or designee against the hard copy of the data supplied by the laboratory (i.e., lab result sheets). If errors or discrepancies are found, an additional 10 percent of the data will be proofed. If additional errors are found, 100 percent of the entered data will be proofed. The laboratory will be notified of any discrepancies found.

8.3 CORRECTIONS AND CHANGES TO SAMPLE DATA

It is expected that changes or corrections may be required to the data entered into the STS or the database (e.g., cancellation of sample analyses, additions of qualifiers to non-validated data, field logbook errors). In those instances where changes are required to the database prior to the final QC review (Section 9.0), all changes must be accompanied by a Data Correction/Change form (see Figure 5 for an example form) that will detail the changes to be made, and document that the changes were completed.

9.0
DATA PROOFING

Problems encountered in data management are typically due to inconsistencies or errors in the reporting of the data. The data in the database should be checked electronically and/or manually via database printouts. The data checks should include identifying:

1. Incorrect field sample numbers
2. Duplicate data and samples
3. Improper parameter names
4. Samples with missing data
5. Missing samples
6. Incorrect sample collection data
7. Incorrect units
8. Incorrect qualifiers
9. Missing detection limits, as applicable
10. Number of significant figures reported

It is important that data inconsistencies and errors be identified as soon as possible to allow for corrections of any problems prior to use of the data. All data received from a laboratory should be checked for inconsistencies similar to those listed above.

9.1 DATA ENTRY QC PROCEDURE

Following the sample receipt confirmation (Section 5.0), the Field Task Manager or designee will be responsible for either entering the sample IDs, corresponding laboratory IDs, collection dates, and the test parameters directly into the database management program (i.e., sample tracking system and database management system) or providing the data to the Data Manager or designee for entry into the database. The initial sample data entry will be

proofed as described in Section 8.0 of this SOP for electronic, double key and single key entry.

For sample results (validated or non-validated) entered by WCC personnel, proofing of the entered data will be performed as described in Section 8.0 of this SOP.

For all corrections, addition of data qualifiers, and other required changes to the database, 100 percent of the changes will be proofed by the Data Manager or designee for potential entry errors.

9.2 DATABASE QC PROCEDURE

The following data QC procedure should be followed for proofing the database to the validated data:

1. The database QC review will be completed on a SDG basis. A hard copy of the database, organized by SDG, will be checked by the Project QA/QC Officer or designee against information in the SDG as described below.

2. Clearly mark corrections to the hard copy database report in red ink.

3. Using the data entry sheets and laboratory data sheets, check that the WCC sample IDs are correctly listed on the database hard copy, and that all samples for the SDG are reported on the database hard copy.

4. Using the validated and qualified laboratory data sheets (Lab Sheets), check that all the analyses requested for each sample are reported on the database hard copy.

5. Using the Lab Sheets, check that the units reported on the database hard copy are correctly reported (i.e., check that the analytical matrix is reported correctly), as liters (L) for aqueous samples, and kilograms (Kg) for solids, and that the power of the unit is correct for the analytical method (i.e., micrograms [μg] or milligrams [mg]).

6. Using the Lab Sheets, check that all WCC qualifiers, results, units, and reporting limit changes are correctly reported on the database hard copy. All assigned validation qualifiers and all changes to the database will be checked for potential entry errors.

7. Using the Lab Sheets as a basis, check values (results and reporting limits) for all analytes for a given sample, at a frequency of approximately 10 percent of the samples for each SDG. For SDGs with results reported for more than 10 analytes for all samples, check the values and reporting limits for a minimum of one analyte per sample. If errors are found, an additional 10 percent of results and reporting limits will be checked for similar errors. If errors are found in the second 10 percent, then all results and reporting limits will be checked.

8. For each SDG, note any questions concerning the reporting of the data and check with the Project QA/QC Officer and Project Manager before returning the reviewed and edited database hard copy to the Data Manager.

9. Keep a copy of the edited hard copy database.

10. Check the corrected copy of the database to determine that corrections have been completed (i.e., verify the final hard copy of the database).

11. Following completion of the QC procedure, the Project Manager, in consultation with the Project QA/QC Officer and Data Manager, will change the database reporting status to `FINAL'.

12. After completing the QC check of approximately 10 percent of the SDGs, discuss the general findings of the review procedure with the Project QA/QC Officer and the Project Manager. Depending upon the review findings, appropriate modifications to the review procedure may be put into effect.

10.0
DATA REPORTING

To make efficient use of the database to support decisions, it is important for the end user to know the status (i.e., preliminary or final) and quality (i.e., non-validated, validated) of the data in the database. This is of primary importance if non-validated data have been entered into the database and distributed to project personnel. Therefore, every database report generated will indicate the current status of the database. In addition, until the database is finalized (i.e., all data validated, peer reviewed, and the database QC completed), authorization for access to the database is limited to the Project Manager, Project QA/QC Officer or designee, and the Data Manager or designee. If there is a need for preliminary data by an end user, authorization must be obtained from the Project Manager.

10.1 PRELIMINARY DATABASE REPORTS

For reports generated from the database prior to the database being determined to be final by the Project Manager in consultation with the Project QA/QC Officer and the Data Manager (e.g., non-validated data in database), all database reports will include (1) a header indicating that the database is `**PRELIMINARY**,' and (2) a status line per sample per analysis type (e.g., mercury, methyl mercury, ICP metals, fluoride, chloride, etc.) indicating the current status of the data for that sample. The status lines indicate the following:

- **Pre-QC** - Sample results have been entered into the database but the data entry has not been proofed. This may include manual entry of validated or non-validated results or entry of non-validated results from a data file supplied by the laboratory.

- **QC** - Entered sample data have been qualified in accordance with the validation/review and have been proofed in accordance with this SOP.

- **Validated** - Data have been validated, qualifiers assigned, and the validated data entered and proofed.

For `**PRELIMINARY**' database reports, the reported sample results are subject to change and should be used with caution by the end user.

10.2 FINAL DATABASE REPORTS

When all sample data have been validated, the database QC completed for a given project study, and the database approved as final by the Project Manager in consultation with the Project QA/QC Officer and Data Manager, the header on all database reports generated will indicate `**FINAL**' and the data status line will be deleted.

All persons receiving copies of the `FINAL' database report(s) for a given task or project will be listed on a distribution list for that database report. Any changes required to the data in the `FINAL' database version for a given project will be made in consultation with the Project Manager. If changes are approved and made to the database, then all individuals on the distribution list for that database report(s) will be sent a notice highlighting the revisions made and a copy of the revised `FINAL' database report(s).

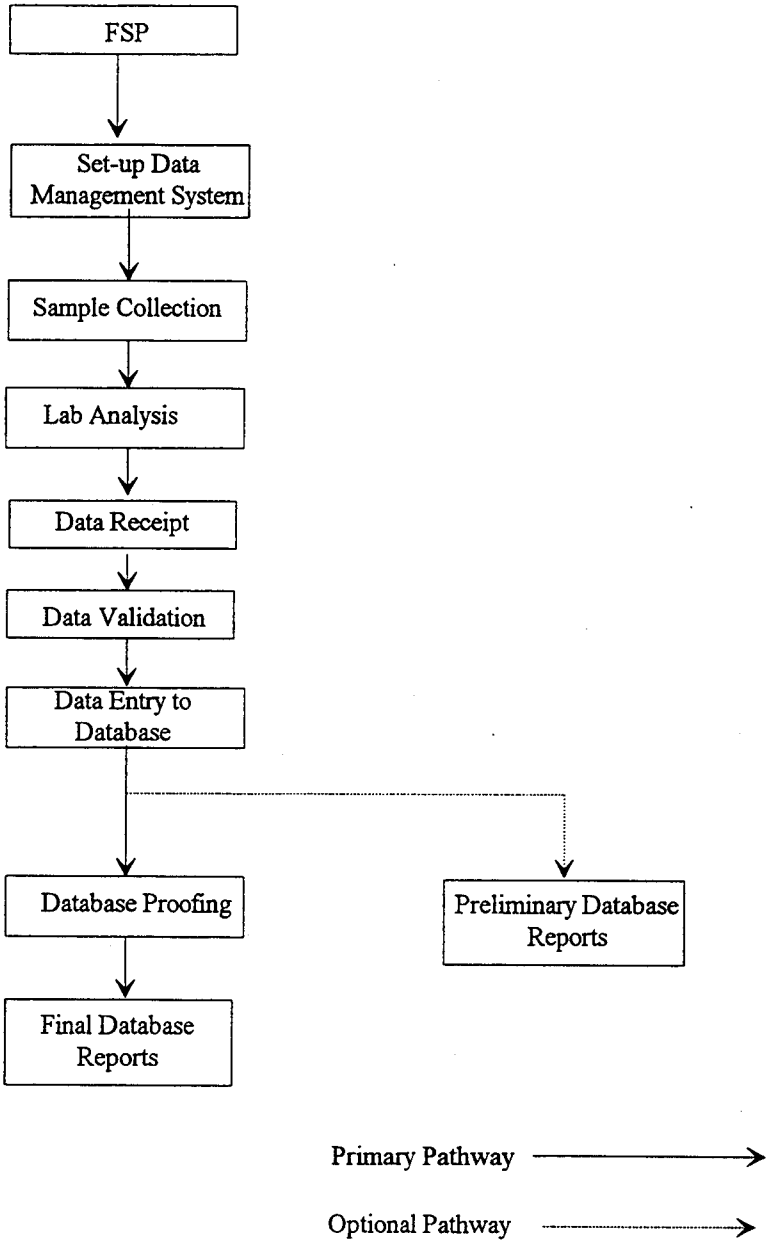

FIGURE 1

DATA MANAGEMENT SYSTEM GENERAL FLOW DIAGRAM

(C3M11M-1C) (FIG-1.DWG)

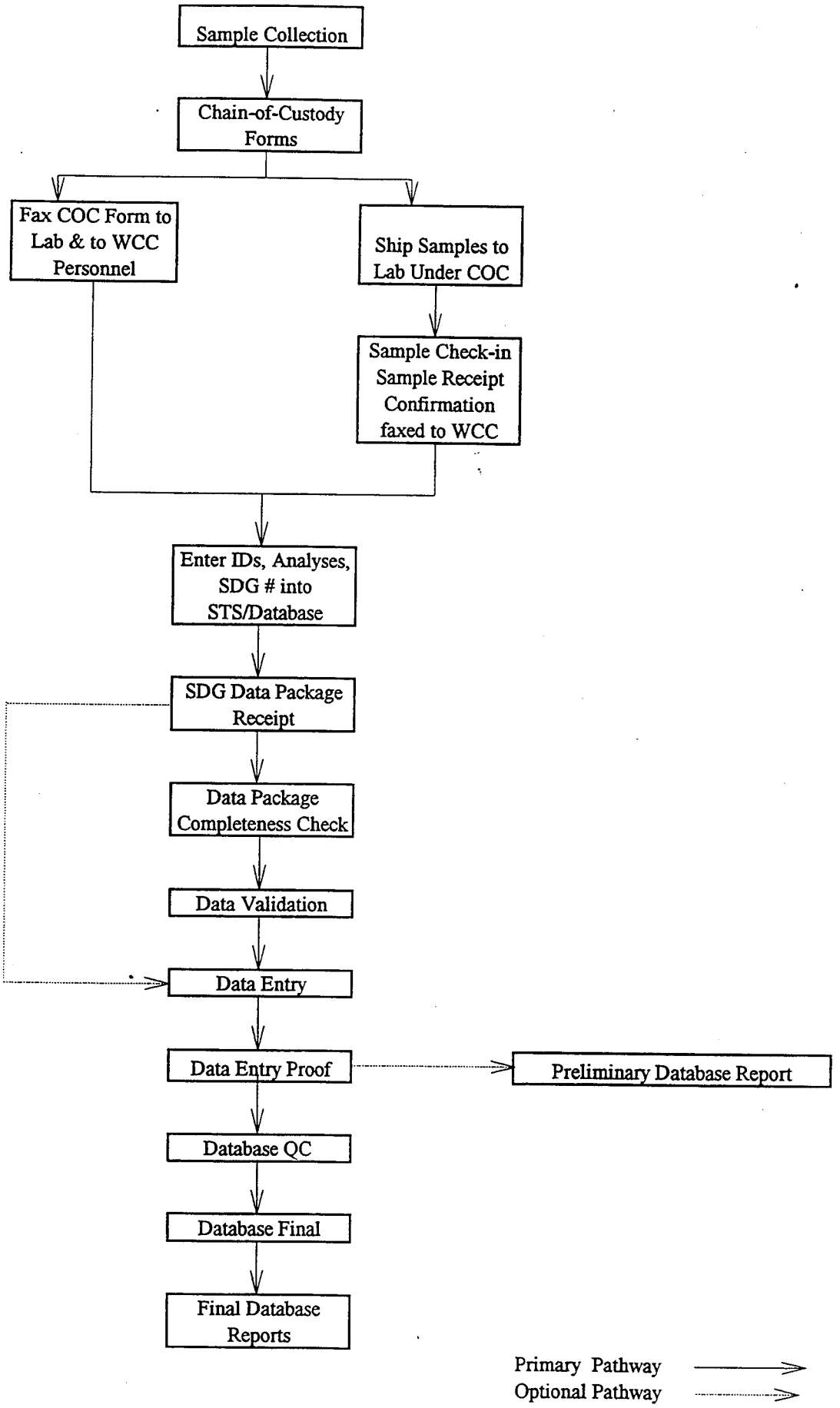

FIGURE 2
DATA MANAGEMENT SYSTEM DETAILED FLOW DIAGRAM

Woodward-Clyde Consultants

Stanford Place 3, Suite 1000
Denver, Colorado 80237

4582 South Ulster Street
303-694-2770

Chain of Custody Record

PROJECT NO.

SAMPLERS: (Signature)

ANALYSES

NUMBER OF CONTAINERS

REMARKS (Sample preservation, handling procedures, etc.)

For _____

DATE	TIME	SAMPLE NUMBER								
										Matrix-
										All samples stored on ice.
										Contact Personnel:
				TOTAL NUMBER OF CONTAINERS						

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
METHOD OF SHIPMENT:		SHIPPED BY: (Signature)	COURIER: (Signature)	RECEIVED FOR LAB BY: (Signature)	DATE/TIME

DATA TRANSMITTAL FORM

Data Transmitted

The attached laboratory data for Sample Delivery Group Number _____ contains analytical data for the following analyses:

___ Volatile Organics
___ Semivolatile Organics
___ Pesticides/PCBs
___ Herbicides
___ ICP Metals
___ GFAA Metals
___ Mercury
___ TOC
___ TPH
___ Other - _____

The data are reported on a wet/dry weight basis (circle one)

The status of the attached data is:

___ Data Not Validated
___ Data Validated

Data Reviewer _____ Date _____

Data Entry

The status of data entry is as follows:

___ Data entered but entry not proofed
___ Data entered and entry proofed

Data Entry By _____ Date _____

Entry proofed by _____ Date _____

Figure 4

DATA CORRECTION/CHANGE FORM

The following changes and/or corrections to the database are required:

___ Data qualifiers have been assigned to the attached sample data for SDG _____

___ The following sample analyses have been cancelled:

___ Other changes or corrections (describe below):

Changes Requested By _____ Date _____

Changes Made By _____ Date _____

Changes Checked By _____ Date _____

Figure 5

APPENDIX B
PROJECT MANAGEMENT PLAN

RCRA FACILITY INVESTIGATION

PROJECT MANAGEMENT PLAN

CANNON AFB, NEW MEXICO

JULY 1995

Prepared for

UNITED STATES AIR FORCE
27 CSG/DEV
Cannon AFB, NM 88103-5128

and

U.S. DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
215 NORTH 17TH STREET
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B1.0
INTRODUCTION

A RCRA Facility Investigation (RFI), Phase I will be conducted to further evaluate the nature and extent of contamination and human health risks associated with Landfill No. 5, Solid Waste Management Unit No. 113 Installation Restoration Program No. LF-5 (SWMU No. 113/IRP No. LF-5) at Cannon Air Force Base, Clovis, New Mexico. The results of the Phase I investigation will be used to evaluate potential corrective measures (remedial alternatives under CERCLA) for closure of Landfill No. 5.

Field investigation planned for the Phase I investigation will include a geophysical survey, soil gas survey, and the collection of surface and subsurface soil samples. Results of past investigations are discussed in the Field Investigation Section of the Data Collection Quality Assurance Plan which is included as Volume II to the Phase I Work Plan for this RFI.

This Project Management Plan will be used to manage the following RFI tasks:

- Project Planning (including schedule and budget control)
- Field Investigation
- Sample Analysis and Validation
- Data Evaluation
- Risk Assessment
- Preliminary Remedial Alternative and Correction Measures Development and Screening
- RFI Reports
- Community Relations Support

The Scope of Work for the above tasks is presented in the RFI Work Plan.

B2.1 RESPONSIBILITIES OF KEY PERSONNEL

The organizational structure and responsibility, defined below and in Figure B2-1, is designed to provide adequate project control and proper quality assurance for site investigative activities at Cannon AFB. Further, the necessary communication and independent review are discussed. Ultimate responsibility for the conduct of the RFI programs at Cannon AFB rests with the installation commander (27 FW/CC), Brigadier General William M. Guth. Daily management of RFI activities is vested in the 27 CES/CEVR Branch of Civil Engineering and is the responsibility of Mr. John Constantine, IRP Remedial Project Manager, Environmental Management Flight. The U.S. Army Corps of Engineers (USACE Omaha District) has been contracted to perform the RFI with Mr. Douglas Mellema as the USACE Technical Manager. The specific environmental investigations to be performed to evaluate the nature and extent of potential soil contamination (if present) beneath Landfill No. 5 (SWMU NO. 113/IRP No. LF-5) will be performed by Woodward-Clyde (W-C) under contract to the USACE.

The following key W-C project personnel are described below:

- Program Manager/Responsible Professional
- Project Manager
- Project QA/QC Officer
- Project Health and Safety Officer
- Task Leaders
- QA/QC Coordinators
- Project Staff
- Site Health and Safety Officer

B2.1.1 Program Manager/Responsible Professional

The Program Manager has overall responsibility to the USACE, Omaha District, for activities on the project and monitoring the Project Manager's activities. The Program Manager has overall responsibility for the development of the DCQAP, for monitoring the quality of the technical and managerial aspects of the project, and for implementing the DCQAP and (where necessary) corrective measures. Mr. Ken Nass of Woodward-Clyde will be the Program Manager for this project.

B2.1.2 Project Manager

Mr. Jeff Ehrenzeller will serve as the Project Manager and Mr. Tom Acre of W-C will serve as the Technical Manager for this project. The Project Manager has primary responsibility for the completion of all activities on the project. He is responsible to the Program Manager and USACE for the day-to-day control of planning, scheduling, cost control, and implementation of the project, and for the development of the technical reports and other project documents. The Project Manager monitors all project personnel in planning, coordinating, and controlling all technical aspects of the tasks. The Technical Manager is responsible for the technical aspects of the project, and assists the Project Manager in the day-to-day project activities.

B2.1.3 Project QA/QC Officer

The QA/QC Officer reports to the Program Manager and works directly with the Project Manager and other project personnel. Dr. Alan A. Roberts of W-C, who will serve as the QA/QC Officer, has the responsibility to monitor and verify that the work is performed in accordance with this plan, the FSP, the SOPs, and other applicable procedures. The QA/QC Officer also has the responsibility to assess the effectiveness of the QA/QC program and to recommend modifications to the program when applicable. The QA/QC Officer is responsible for assuring that personnel assigned to the project are trained and indoctrinated relative to the requirements of the QA/QC Program. He is also responsible for reviewing and verifying the disposition of nonconformance and corrective action reports, and for periodic quality assurance audits. The QA/QC Officer will advise the Project Manager on implementation of

the QA/QC program, but the QA/QC functions of the QA/QC Officer and QA/QC representatives are independent of the Project Manager. The QA/QC Officer is responsible for the coordination with the Government Quality Assurance Laboratory which has been designated as the USACE Missouri River Division Laboratory. The QA Officer has the authority to halt work in case of major problems or nonconformances to the QA plan or if numerous minor problems are not corrected in a timely manner.

B2.1.4 Project Health and Safety Officer

Ms. Kathleen Fischer, who will serve as the Project Health and Safety Officer (PHSO), reports to the Program Manager and works directly with the Project Manager and other project personnel. The PHSO has the responsibility to monitor and verify that the work is performed in accordance with the HSP written for site investigations at Cannon AFB. The PHSO will advise the Project manager regarding health and safety issues, but will function independently of the Project Manager. The PHSO will also designate and oversee the activities of the Site Health and Safety Officer.

B2.1.5 Task Leaders

Each Task Leader is responsible to the Project Manager for planning, scheduling, cost control, and completion of assigned project tasks. The Task Leader is responsible for implementing the QA/QC program related to assigned tasks at Cannon AFB. Task leaders for the following RFI tasks are:

Ms. Karen Phillips (W-C)	-	RFI Field Investigation
Dr. Alan A. Roberts (W-C)	-	Chemistry

B2.1.6 Project Staff

Each member of the project staff is responsible to the Task Leader and/or Project Manager for completion of assigned project activities. Members of the project staff are responsible for understanding and implementing QA/QC program as it applies to their project activities. Key individuals expected to be involved in this project are as follows:

Jeff Ehrenzeller (Project Manager)	Ken Nass (Program Manager)
Tom Acre (Technical Manager)	Alan Roberts (Chemistry, Task Manager)
Karen Phillips (Site Manager, Geologist)	Julie Essey (Chemistry, Data Manager)
John Nicholl (Geophysics, Task Manager)	Kathleen Fischer (Health and Safety)
Jeff Bugbee (Data Management)	Geoff Webb (Chemistry, Data Management)
Jim Zitek (Chemistry Support)	Jerry Meinzer (Chemistry, Soil Gas)

B2.1.7 QA/QC Coordinator

A QA/QC Coordinator(s) may be appointed by the QA/QC Officer to review, monitor, and report on the conformance to QA/QC program requirements for specific project activities or tasks. A QA/QC Coordinator may perform audits and, as QA/QC Coordinator, shall report to the QA/QC Officer. As QA/QC Coordinator, the designated staff member may also perform project-related activities, but may not perform a quality-monitoring function on his or her own work. As a QA/QC Coordinator, the designated staff member may also advise the task group(s) on QA/QC methods and practices. The QA/QC Coordinator will maintain a record of quality-monitoring activities and will inform the QA/QC Officer of these monitoring activities.

B2.1.8 Site Health and Safety Officer

The Site Health and Safety Officer (SHSO) monitors all site activities and is responsible for the implementation of and compliance with the Project Health and Safety Plan. The SHSO reports directly to the Project Health and Safety Officer.

B2.2 QUALIFICATIONS OF PERSONNEL

All personnel assigned to the project, including employees and consultants, will be qualified to perform the tasks to which they are assigned.

Appraisal of the qualifications of technical personnel assigned to the project will be made by the Project Manager. The appraisal will include the 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 further training is required and, if required, by what method. On-the-job training is an acceptable method, provided such training is provided by a person qualified to perform the trainee's assignment and the results of that training are documented.

All documents concerning qualification appraisal will be stored in the project administrative files.

B2.3 REGULATORY COORDINATION

The State of New Mexico Environment Department (NMED) is the lead agency for regulatory oversight of investigation and closure of Landfill No. 5 (SWMU No. 113/IRP No. LF-5) discussed in Section 1.0. Mr. John Constantine, IRP Remedial Project Manager, Environmental Management Flight for Cannon AFB, will be responsible for overall project coordination with NMED and U.S. EPA Region VI including transmittal of all appropriate documents. At Mr. Constantine's direction USACE and W-C personnel will assist with various aspects of regulatory coordination.

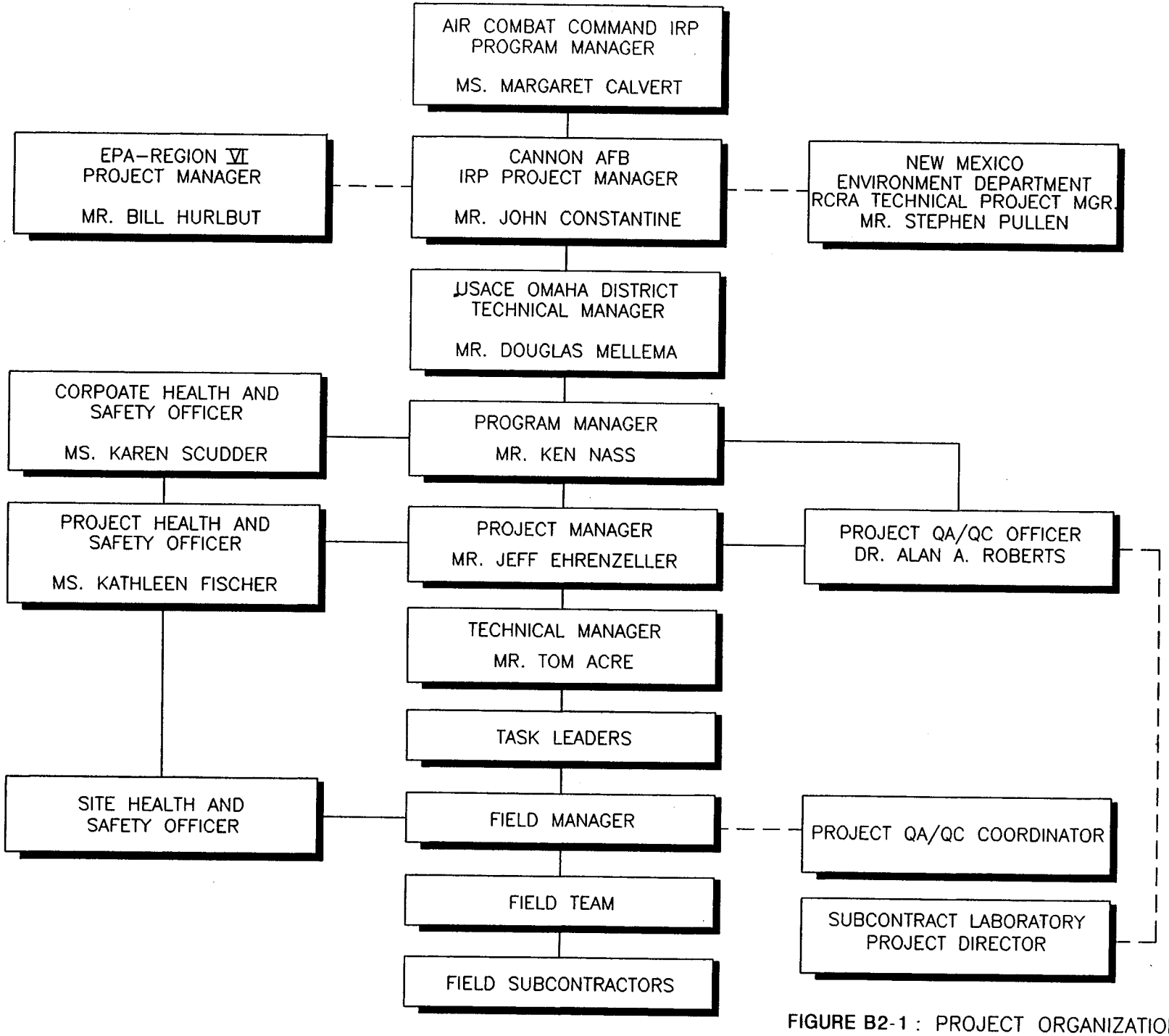


FIGURE B2-1 : PROJECT ORGANIZATION CHART
LANDFILL NO. 5, CANNON AFB, NEW MEXICO

MC114W

B3.0
PROJECT SCHEDULE

The overall Phase I RFI project schedule is shown in Figure B3-1. The estimated time duration for each Phase I RFI task is also shown. This phase of the project is expected to be completed by January 1997 when the Final Phase I RFI report is transmitted. This schedule assumes no delays caused by regulatory review or any force majeure.

The project schedule assumes that regulatory agency review of and comment (if required) on the Work Plan documents and the Draft Phase I RFI report will take place during the same time period in which Cannon AFB and the USACE personnel are reviewing and commenting on said revised plans and draft reports.

The W-C project manager will be responsible for ensuring that the project remains on schedule except in instances where force majeure or items such as regulatory review time are beyond his/her control. As stipulated in Cannon AFB's RCRA Part B permit, the RFI report will be submitted to the agency for review 60 days after completion of the RFI. For the purposes of this schedule, this phase of the RFI will be deemed complete after USACE and Cannon AFB have reviewed the Pre-Draft Phase I RFI report for completeness. The schedule shown in Figure B3-1 will be updated as necessary as the project progresses, however, duration of each RFI schedule element will remain the same.

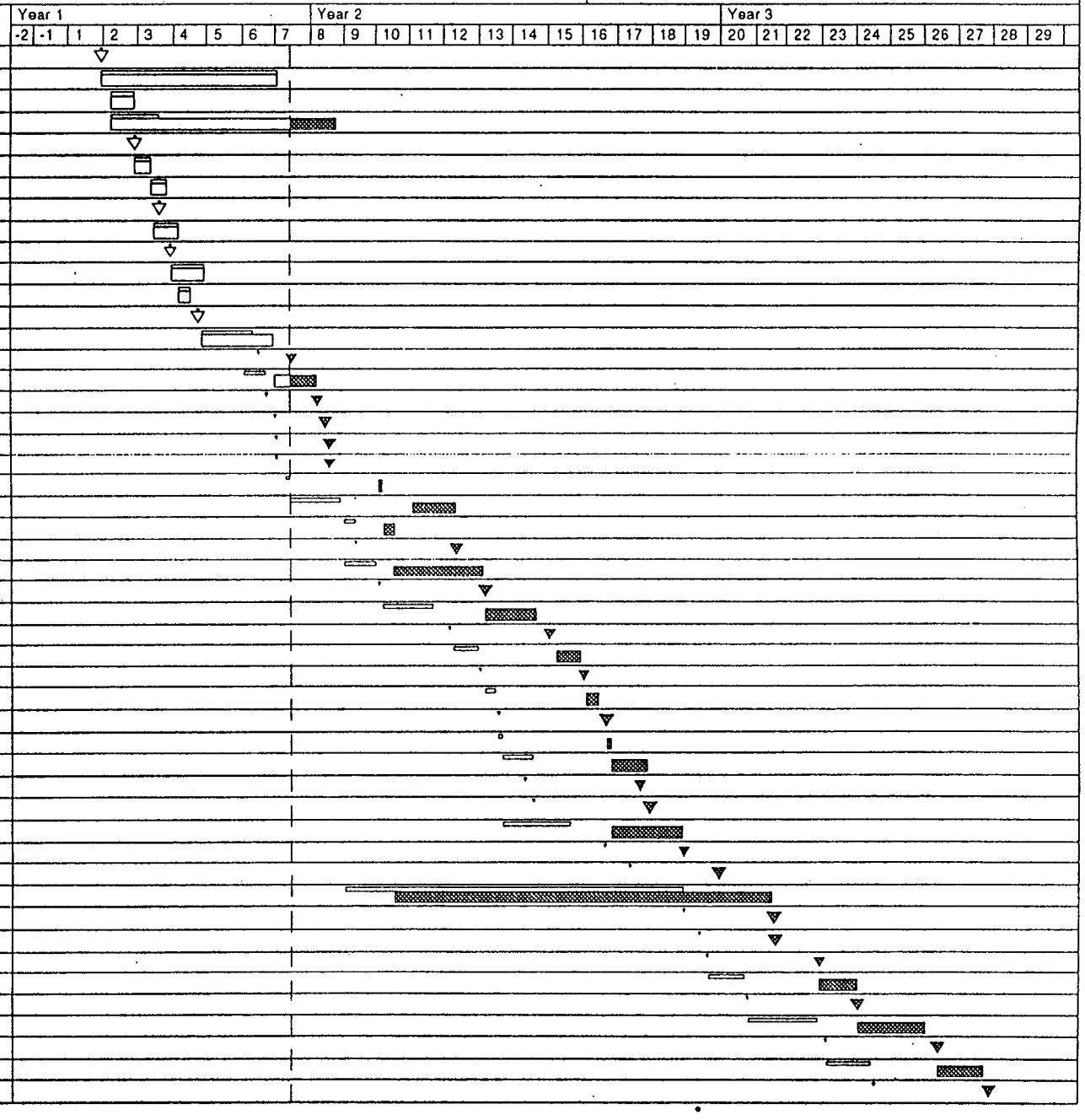
Date: 08/08/94

C3M11M | Page 1 / 1

FIGURE B3-1
USACE - CANNON AIR FORCE BASE
LANDFILL No. 5 RFI SCHEDULE

Legend: Critical, Non-Crit., Summary, Hammock, Subproject, Plan, Early

Description	Dur
Award Work Order	0
Project Planning and Events	0
ARAR's Analysis	0
Prepare Pre-Draft RFI Work Plans	42
ARAR's Submittal	0
USACE and USAF ARARs Review	0
Revise ARARs	0
Pre-Draft RFI Work Plans Submittal	0
USACE and USAF Review of Pre-Draft Work Plans	0
ARARs Distribution	0
NMED ARARs Review	0
Revise Pre-Draft RFI Work Plans	0
Draft RFI Work Plans Submittal	0
USACE, USAF, USEPA, NMED Review Draft RFI WP	0
RFI Work Plan Meeting	0
Revise Draft RFI Work Plans	24
Submit Pre-Work Plans to USACE and USAF	0
USACE and USAF Approval of RFI Work Plans	0
Pre-Work Safety Meeting	0
USACE and USAF Authorization to Proceed	0
Mobilization - Phase I	3
Soil Gas Survey	39
Geophysical Survey	10
Demobilization - Phase I	0
Plot/Analysis Soil Gas Survey and Geophysics	80
Draft Soil Gas Survey and Geophysics Submittal	0
NMED Review of Soil Gas Survey and Geophysics	45
Submit Phase II Soil Boring Plan	0
NMED Review of Phase II Soil Boring Plan	21
Phase II Soil Boring Program Meeting	0
Revise Phase II Soil Boring Plan	11
USACE and USAF Approval of Phase II Boring Plan	0
Mobilization - Phase II	4
Perform Phase II Soil Boring Program	31
Demobilization Meeting	0
Demobilization - Phase II	0
Chemical Analysis/Coordination	63
Submit Quality Control Summary Report	0
Laboratory Analytical Meeting	0
RFI Report Preparation	335
Pre-Draft RFI Report Submittal	0
USACE Review of Pre-Draft RFI Report	0
Pre-Draft RFI Report Meeting	0
Revise Pre-Draft RFI Report	34
Draft RFI Report Submittal	0
USACE, USAF, USEPA, NMED Review of Draft RFI Rpt.	61
Draft RFI Report Meeting	0
Revise Draft RFI Report	41
Distribute Final RFI Report	0



B4.1 FUNDING SOURCE, AUTHORITIES, AND RESTRICTIONS

The Air Force has a 5-year budget cycle which governs the allocation of operations and maintenance (O&M) funds. The Air Force provides input to the operations and maintenance to the Department of Defense which, in turn, provides input to Congress. Congress distributes a limited funding base so not all desirable activities will necessarily be fully funded in any given fiscal year. Notwithstanding the availability of funds, any Federal Facilities Agreements that may influence this RFI cannot contain provisions that represent a commitment of funding beyond that authorized under current public law.

B4.2 BUDGET TRACKING

The W-C project manager will be responsible for completing tasks within budget. Budget tracking details will be presented to the USACE in the monthly progress reports discussed in Section 5.0.

B5.1 REPORTING

To track the project's progress the W-C project manager will submit a monthly progress report to the USACE. The report will discuss the following:

- Work completed
- Upcoming work
- Problems encountered (including schedule delays)
- Changes in scope
- Meetings attended
- Percent of tasks and overall project complete
- Percent of budget(s) expended

In addition, a daily written Quality Report documenting field quality control (QC) activities, QC deviations, and an evaluation of the quality of sampling will be submitted to the USACE during field operations. The reports discussed above may be transmitted by USACE to other entities as deemed necessary.

B5.2 PROJECT FILES

Explicit data collection, management, and reporting requirements are covered in separate documents (i.e., Field Sampling Plan and Data Collection Quality Assurance Project Plan).

However a general outline of the project file system which will be used for the project is shown below.

I. Communications

A. Internal
B. External

II. Quality assurance/quality control

A. Procedures
B. Tracking
C. Audit reports
D. Deviation notification

III. Technical information

A. Analytical data
B. Field data
C. Graphic resources
D. Data quality acceptance
E. Calculations/evaluations
F. Regulatory compliance

IV. Management

A. Schedule
B. Budget
C. Release site database

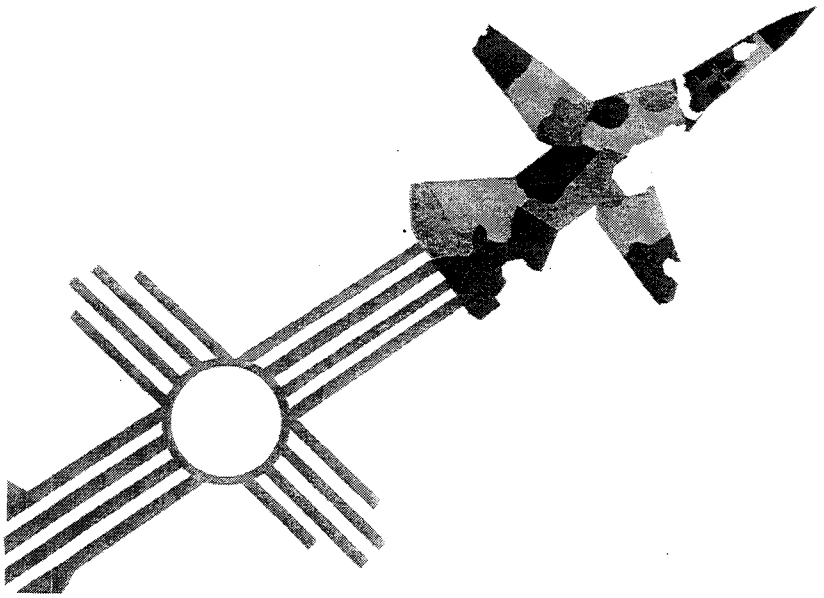
V. Health and Safety

A. Plans/procedures
B. Audit reports
C. Documents
D. Plans

E. Reports

VI. References

FINAL



SITE SAFETY AND HEALTH PLAN
RCRA FACILITY INVESTIGATION
PHASE I FOR LANDFILL NO. 5
(SWMU NO. 113/IRP NO. LF-5)
PROJECT CZQZ 92 7007
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

Commander 27 FW
100 South D.L. Ingram Blvd.
Suite 100
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January 1995

FINAL

SITE SAFETY AND HEALTH PLAN
RCRA FACILITY INVESTIGATION
PHASE I FOR LANDFILL NO. 5
(SWMU NO. 113/IRP NO. LF-5)
PROJECT CZQZ 92 7007
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

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

January 1995

Woodward-Clyde

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Omaha, NE 68154

C3M11M

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LIST OF ACRONYMS

AFB	Air Force Base
AGE	Aerospace Ground Equipment
CHSA	Corporate Health and Safety Administrator
CHSO	Corporate Health and Safety Officer
CMHS	Hygiene/Chemical Safety Guidance
CMHS	Corporate Manager, Health and Safety
CRZ	Contamination Reduction Zone
EZ	Exclusion Zone
HSO	Health and Safety Officer
HSP	Health and Safety Plans
HST	Health and Safety Technician
LEL	Lower Explosive Limit
NMED	New Mexico Environmental Department
P	President
PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
RFI	RCRA/Facility Investigation
SCBA	Self-Contained Breathing Apparatus
SSHP	Site Safety and Health Plan
SSO	Site Safety Officers
USACE	U.S. Army Corps of Engineers
W-C	Woodward-Clyde

1.1 PROJECT IDENTIFICATION AND APPROVALS

Project Name:	Cannon Air Force Base Landfill No. 5 RFI
Project Number:	C3M11M
Business Unit:	Denver
Project Manager:	Jeffrey L. Ehrenzeller
Date of Issue:	January 1995
Effective Dates:	January 1995 through December 1995

Approvals:

Jeffrey L. Ehrenzeller — 2-17-95

Project Manager — Date

Jeffrey L. Ehrenzeller, P.G.

Kathleen Fischer — 2-17-95

Denver Health and Safety Officer — Date

Kathleen Fischer

Karen Scudder — 2-17-95

Corporate Health and Safety Officer — Date

Karen Scudder, CIH

2.0
INTRODUCTION

This Site Safety and Health Plan (SSHP) establishes guidelines and requirements for the health and safety of field personnel during field activities associated with U.S. Army Corps of Engineers Contract No. DACW-45-90-D-0005, Delivery Order No. 0012 at Cannon Air Force Base (AFB) in Clovis, New Mexico. The specific activities addressed by this plan are defined in Section 5.0. All Woodward-Clyde (W-C) on-site personnel and W-C subcontractors are required to read this plan and agree to abide by the provisions of this plan by signing the attached Compliance Agreement. In addition, on-site personnel must comply with the W-C written Health and Safety Program and the U.S Army Corps of Engineers, Safety and Health Requirements Manual EM 385-1-1.

The health and safety guidelines and requirements presented are based on a review of available information and an evaluation of potential hazards. This plan outlines the health and safety procedures and equipment required for activities at this site to minimize the potential for exposures of field personnel. This plan may be modified by the Project Manager, the business unit Health and Safety Officer (HSO), and the Corporate Health and Safety Officer (CHSO) in response to additional information obtained regarding the potential hazards to field investigative personnel.

HEALTH AND SAFETY POSITION REQUIREMENTS

PERSON	RESPONSIBILITIES	AUTHORITIES
W-C Project Manager	• Assure that the project is performed in a manner consistent with the W-C Health and Safety Program • Assure that the Health and Safety Plan (HSP) is prepared, approved, and properly implemented • Assure that adequate funds are allocated to fully implement project health and safety • Coordinate with the HSO on health and safety matters	• Assign an HSO approved SSO to the project and, if necessary, assign a suitably qualified replacement • Suspend field activities if health and safety of personnel are endangered, pending further consideration by the HSO and/or CHSO. • Suspend a W-C individual from field activities for infractions of the HSP, pending an evaluation by the HSO, CHSO and/or WCGI Health and Safety Manager.
WCGI Health and Safety Manager Phil Jones	• Administer the Health and Safety Program • Track health and safety regulations that affect W-C • Maintain W-C records pertaining to medical surveillance, training, fit testing, chemical exposure, and incidents • Update the W-C Health and Safety Manual • Manage the W-C employee medical surveillance program • Audit key aspects of the W-C Health and Safety Program • Supervise CHSOs	• Implement improvements to the W-C Health and Safety Program • Approve the health and safety qualifications of employees • Establish employee training and medical surveillance procedures • Approve or disapprove Health and Safety Plans • Suspend work on any project that jeopardizes the health and safety of personnel.

W-C Corporate Health and Safety Officer (CHSO) Karen Scudder	• Direct the implementation and coordination of the Health and Safety Program of the Operating Group (or responsibility area) and provide recommendations for improvement of the program • Determine the need for project Health and Safety Plans • Maintain a high level of understanding regarding health and safety regulations affecting W-C • Review and approve Health and Safety Plans • Monitor implementation of Health and Safety Plans • Investigate reports of incidents or accidents and report to Health and Safety Manager • Provide W-C employee health and safety training in the Operating Group, particularly refresher training • Determine whether an accidental exposure or injury merits a change in the affected individual's work assignments and whether changes in work practices are required • Coordinate Operating Units with regard to health and safety equipment needs • Supervise HSOs through the matrix management system in cooperation with the Operating Unit Manager	• Approve or disapprove Health and Safety Plans • Direct Operating Unit HSO to prepare project Health and Safety Plans • Access and review W-C project files • Direct changes in personnel work practices to improve health and safety of employees • Remove individuals from project, if their conduct jeopardizes their health and safety or that of coworkers • Suspend work on any project that jeopardizes the health and safety of personnel involved.

W-C Operating Unit Health and Safety Officer (HSO) Kathleen Fischer	• Administer the Health and Safety Program within the Operating Unit • Maintain a working understanding of key government health and safety regulations and W-C health and safety policies • Interface with project managers concerning health and safety • Report to CHSO on health and safety matters • Develop or review, approve or disapprove project Health and Safety Plans prior to submittal to the CHSO for review • Conduct W-C staff training and orientation on health and safety-related activities • Appoint or approve SSOs • Monitor compliance with Health and Safety Plans and conduct site audits • Assist project managers in obtaining required health and safety equipment • Approve personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training • Answer employee questions and concerns regarding health and safety	• Suspend work or otherwise limit exposures to personnel, if health and safety risks are unacceptable • Direct personnel to change work practices, if existing practices are deemed to be hazardous to health and safety of personnel • Remove personnel from projects, if their actions or conditions endanger their health and safety, or the health and safety of co-workers.

W-C Site Safety Officer (SSO) To be determined	• Direct health and safety activities on site • Immediately report all safety-related incidents or accidents to the HSO and the Project Manager. • Assist Project Managers in all aspects of implementing Health and Safety Plans • Maintain health and safety equipment on site • Implement emergency procedures, as required. • Review certifications/medical surveillance status of all site personnel prior to site access • Maintain health and safety records for W-C and subcontractor personnel on site (including medical examinations, training, compliance agreements, and incident/accident reports).	• Temporarily suspend field activities if health and safety of personnel are endangered, pending further consideration by the HSO and/or CHSO • Temporarily suspend a W-C individual from field activities for infractions of the Safety and Health Plan, pending an evaluation by the HSO and/or CHSO

4.1 OVERALL SITE

Cannon AFB is located about 7 miles west of Clovis, New Mexico in Curry County, New Mexico (Figure 4-1). Since 1971, the primary mission of Cannon AFB has been to develop and maintain an F111D tactical fighter wing, capable of day, night and all-weather combat operations and to provide replacement training of combat aircrews for tactical organizations worldwide. Currently, there are approximately 70 F111D aircraft assigned to Cannon AFB (USAF 1990).

Wastes have been generated and disposed of at Cannon AFB since the beginning of industrial startup operations in 1942. The major industrial operations include jet engine and aerospace ground equipment (AGE) maintenance, corrosion control, and vehicle maintenance shops.

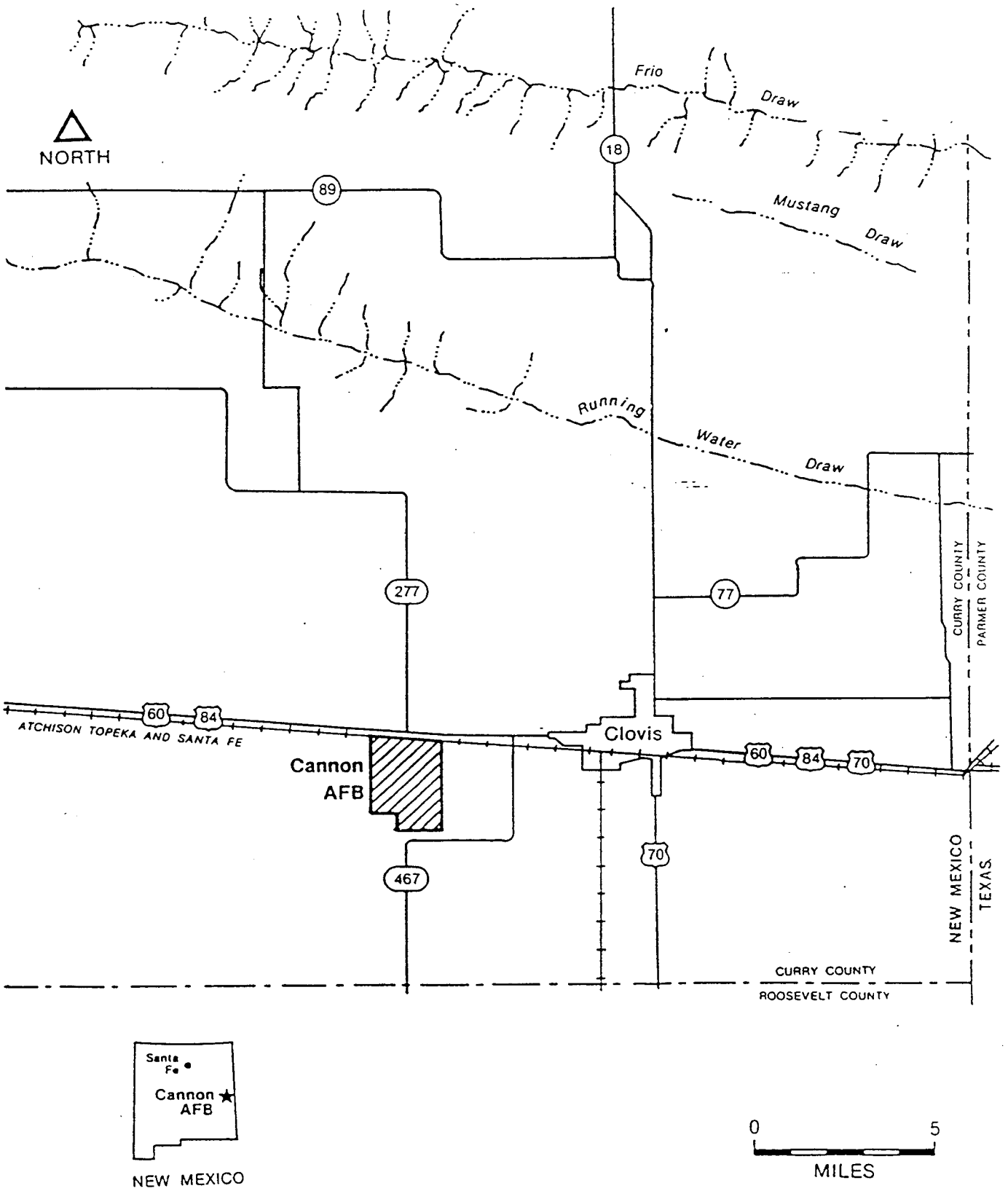
4.2 LANDFILL NO. 5 (SWMU No. 113/IRP No. LF-5)

This unit is an active landfill located in the southeastern area of the base occupying about 70 acres (Figures 4-2 and 4-3). Cell No. 3, which is closed, is RCRA regulated because until mid-1981 this cell received hazardous waste. Cell No. 3 has been permanently closed with a cap, separate fencing for security, and a series of monitoring wells were installed on the south and east edges of the landfill to detect contaminant migration. From 1981 until the cell was closed in 1983, it did not receive additional hazardous waste. In 1992, the U.S. Army Corp of Engineers (USACE) installed two additional monitoring wells along the eastern edge of Landfill No. 5 at the request of New Mexico Environmental Department (NMED) in an attempt to ensure detection of potential contaminant releases from Landfill No. 5. Also, in 1992, the USACE performed trenching activities to better define the cell boundaries of Cell No. 3. Based on this information, Cell No. 3 was completely capped during a project completed in July 1993.

Waste materials received at this landfill included domestic solid waste, asbestos, waste oils, and solvents, paint, paint remover and thinners, pesticide containers, and various empty cans

and drums. The waste materials reportedly were generally disposed of into trenches at the landfill, and the material was burned prior to closing the trenches. Until mid-1981, approximately 5 to 10 drums per month of waste oils and solvents were disposed (CH_2M Hill 1983). W-C performed similar investigations at Landfill No. 2 at Cannon AFB in 1992, which reportedly received wastes similar to those placed in Landfill No. 5. Field screening and analytical results indicated that the wastes were burned before burial.

Woodward-Clyde Consultants



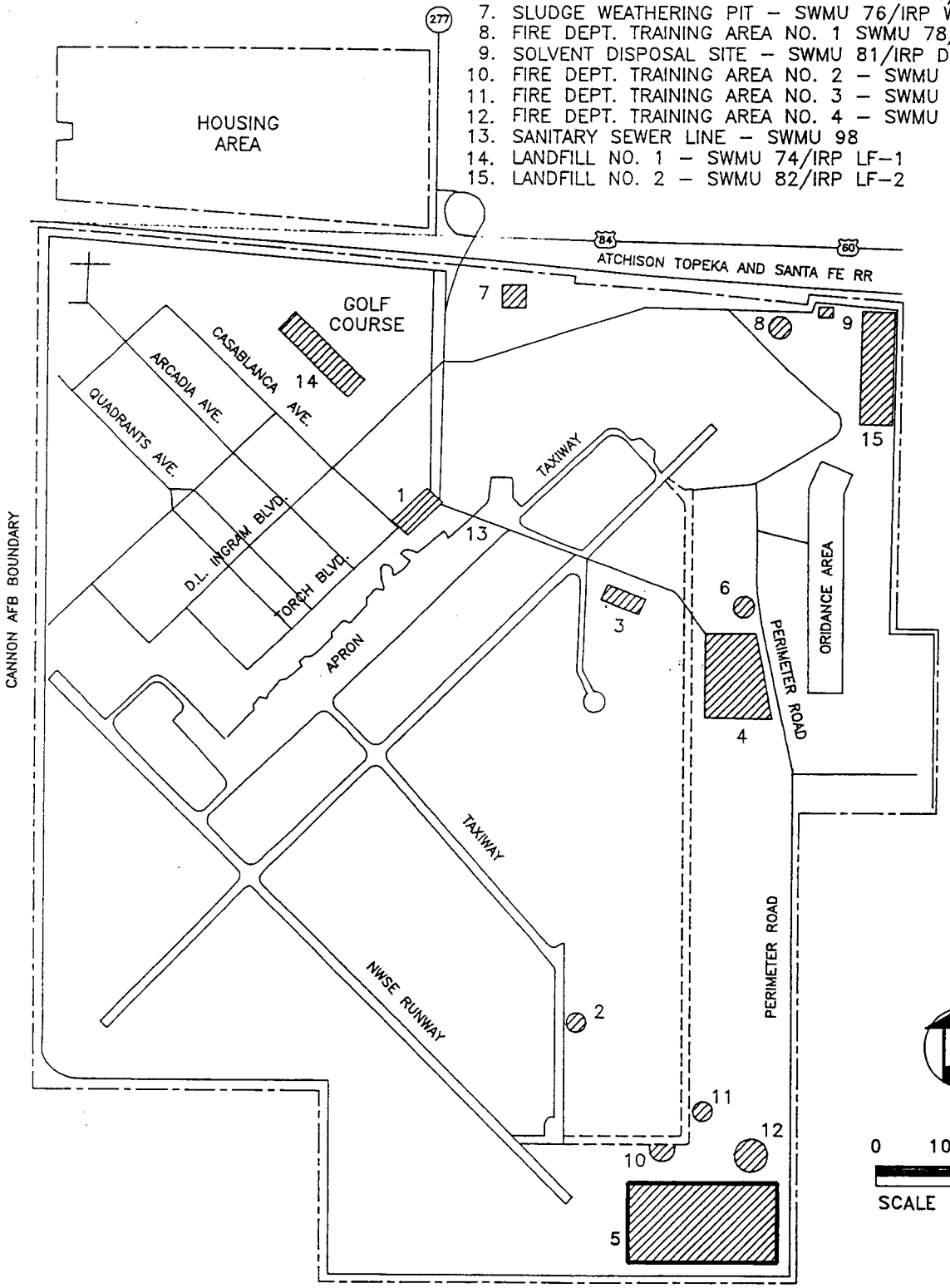
BASE MAP ADAPTED FROM: FINAL REPORT, IRP PHASE II

Job No. : 89MC114W	VICINITY MAP CANNON AFB, NM
Prepared by : J.T.A.	
Date : 8/23/91	

FIG. 4-1

EXPLANATION

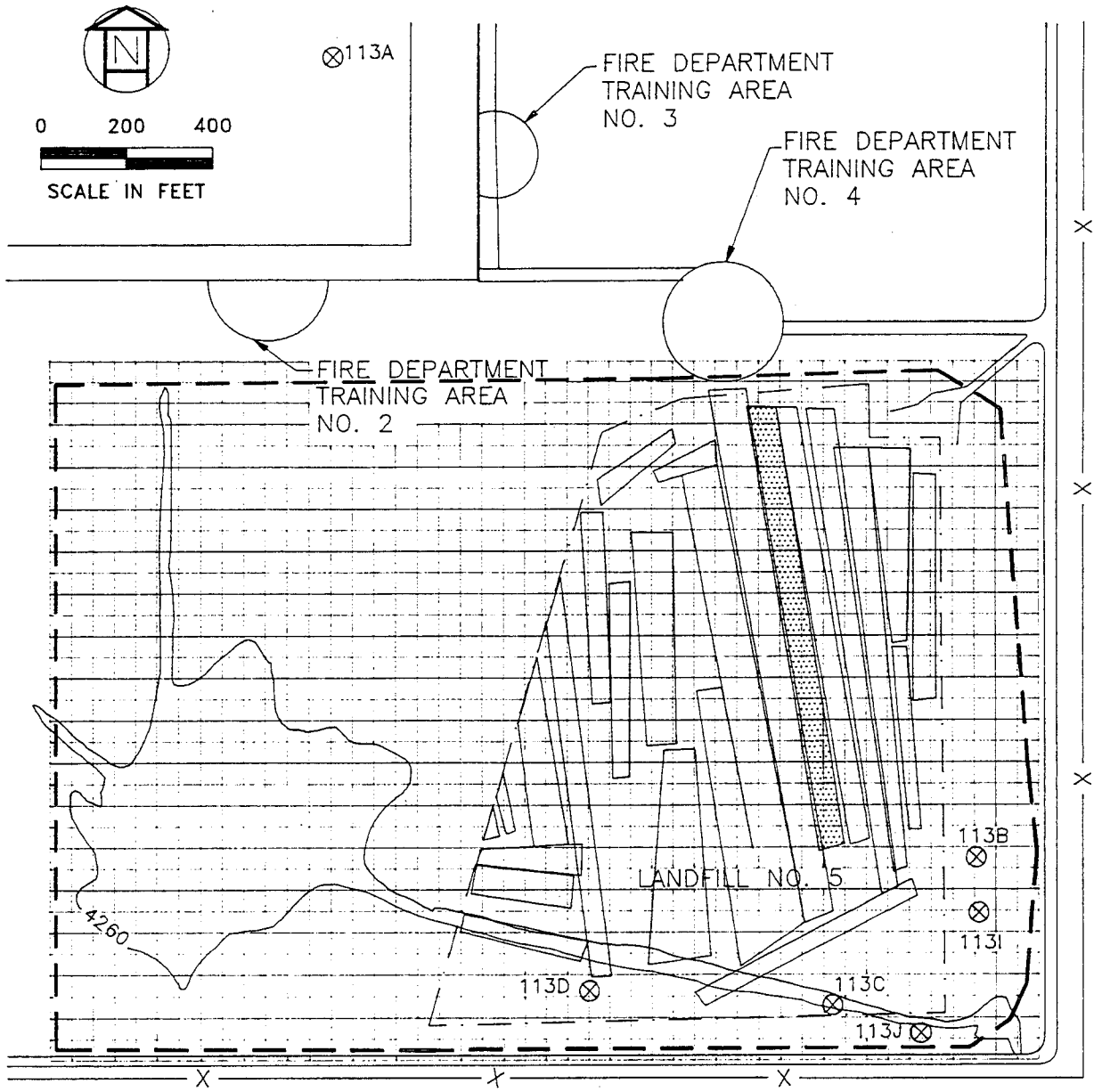
1. AGE DRAINAGE DITCH – SWMU 34/IRP SD–15
2. ENGINE TEST CELL AREA – SWMU 86–90/IRP SD–11
3. NE STORMWATER DRAINAGE AREA – SWMU 95/IRP SD–20
4. WASTEWATER LAGOONS – SWMU 101,102
5. LANDFILL NO. 5 – SWMU 113/IRP LF–5
6. OLD ENTOMOLOGY RINSE AREA – SWMU 96/IRP SD–17
7. SLUDGE WEATHERING PIT – SWMU 76/IRP WP–14
8. FIRE DEPT. TRAINING AREA NO. 1 SWMU 78/IRP FT–6
9. SOLVENT DISPOSAL SITE – SWMU 81/IRP DP–16
10. FIRE DEPT. TRAINING AREA NO. 2 – SWMU 106/IRP FT–7
11. FIRE DEPT. TRAINING AREA NO. 3 – SWMU 107/IRP FT–8
12. FIRE DEPT. TRAINING AREA NO. 4 – SWMU 109
13. SANITARY SEWER LINE – SWMU 98
14. LANDFILL NO. 1 – SWMU 74/IRP LF–1
15. LANDFILL NO. 2 – SWMU 82/IRP LF–2



Job No. : C3M11M	IRP/SWMU SITE LOCATION MAP
Prepared by : D.A.K.	CANNON AFB, NEW MEXICO
Date : 8/22/93	

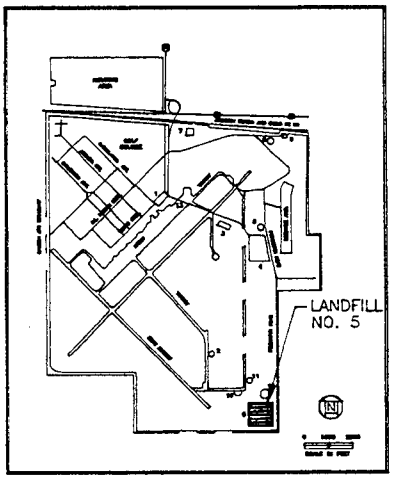
3M11FXX

FIG. 4-2



LEGEND

⊗ 113C	MONITORING WELL LOCATION
— —	SWMU BOUNDARY
— · —	FENCE BOUNDARY
———	CELL BOUNDARY
▒	RCRA REGULATED CELL #3, (CAPPED) NO FURTHER FIELDWORK PLANNED FOR THIS AREA UNDER THIS INVESTIGATION



Job No. :	C3M11M
Prepared by :	B.J.R.
Date :	8/22/93

LANDFILL NO.5 CELL AND GRID LOCATION MAP
SWMU NO. 113
CANNON AFB, NEW MEXICO

3M11F31

Figure 4-3

5.0
SCOPE OF WORK

The generalized scope of work for the Landfill No. 5 (SWMU No. 113/IRP No. LF-5) RCRA Facility Investigation (RFI) includes:

- A surface geophysical survey
- A 800 point soil gas survey to a depth of 5 to 10 feet
- Drilling and sampling of 30 60-foot borings

The objective of the work is to identify and quantify contaminants which may be leaking from the respective burial cells into the soils underlying the landfill.

6.1 CHEMICAL HAZARDS

Chemical hazards expected to be encountered at this site include compounds historically discarded in the landfill and include unknown concentrations of asbestos; waste oils; waste solvents; paint; paint remover; thinners; pesticides and domestic waste. Exposure limits and physicochemical characteristics of common solvents, fuels, and pesticides are shown in Table 6-1. Material Safety Data Sheets for these materials are included in Appendix A.

Personnel conducting the geophysical survey are not expected to encounter an chemical hazards because this work is not intrusive.

The soil gas survey will require intrusive work to a depth of only 5 to 10 feet. The potential routes of exposure to chemical hazards for this activity include inhalation, ingestion and dermal contact. The potential for exposure via all routes is expected to be low as the amount of waste exposed will be limited.

The greatest risk of chemical exposure is likely to occur during drilling activities. The potential routes of exposure include inhalation, dermal, and ingestion.

Compounds with a high vapor pressure may enter the borehole during drilling activities. In general, however the concentration of contaminants decreases quickly after exiting the borehole. Personnel should not be exposed to high concentrations of contaminants in their breathing zone. However, site procedures, including frequent monitoring and use of respiratory protective equipment will be utilized to protect personnel from these hazards. Without these procedures, the risk of chemical exposure via inhalation is expected to be moderate during drilling operations.

Some solvents and pesticides can be absorbed through the skin. It is anticipated, however that personnel will not come into contact with significant amounts of waste materials during

sampling activities. The potential for exposure to chemicals of concern is expected to be low.

The potential for exposure to chemicals of concern by ingestion of wastes materials is expected to be low. Personnel on site are expected to utilize good personal hygiene practices. In addition, specific procedures have been developed to prevent personnel from ingestion exposures.

6.2 PHYSICAL HAZARDS

6.2.1 Drilling

The hazards involved with the use of drill rigs are significant and include the hazards of pinch points; entrapment in machinery; impact from moving parts; fatigue; electrocution from lightning, overhead wires, or buried utilities; and improper operations. Use of hand tools, moving the rig, and conducting required repairs can increase physical risks. Excessive noise may be generated from drilling rigs. Working with and around a drill rig can involve a high risk of serious injury or death.

Work around heavy equipment can always be dangerous. Workers must be careful to communicate with heavy equipment operators regarding their location and should maintain a safe distance from operating equipment at all times.

6.2.2 Personal Protective Equipment

The personal protective equipment (PPE) which may be required for some activities places a physical strain on the wearer and may increase the risk of heat stress. In addition, PPE such as gloves and protective clothing limits manual dexterity and physical movement.

6.2.3 Noise Exposure

Work at this site will be conducted near drill rigs which may expose personnel to high noise levels. In addition workers may be exposed to noise from jet engines on nearby taxiways.

6.2.4 Slips, Trips, and Falls

Some sampling will be completed in areas with steep slopes, and uneven ground. Workers in these areas risk injury by slips, trips, and falls.

6.2.5 Methane

During intrusive activities on or near areas of solid water disposal, the presence of methane should be anticipated. Methane, which is also known as marsh gas and methyl hydride, is a flammable, colorless, odorless, and tasteless gas that is lighter than air and will accumulate in high places. It is a major constituent of natural gas. Methane is generated by the decomposition of organic materials within the landfill and is extremely flammable. Air containing between 5 and 15 percent (50,000 to 150,000 ppm) methane and at least 12 percent oxygen can explode. However, as this range is variable, any occurrence of the gas should be considered dangerous. The main hazard involved with methane is its flammability, but is does cause oxygen deficiency at concentrations above 87 percent. Methane is generally considered nontoxic.

6.3 BIOLOGICAL HAZARDS

6.3.1 Insects

During field work at this site, personnel may encounter a wide variety of insects including bees, mosquitos, ticks, and spiders. Field personnel are encouraged to use insect repellent when mosquitos are present.

Stings of bees and wasps may cause serious allergic reactions in certain individuals. The SSO should identify all personnel with known insect allergies or sensitivities before field work begins.

Spider bites can be extremely serious, e.g., those of the black widow or brown recluse. Others are unpleasant or uncomfortable, resulting in rashes, itching, and possible infection. The possibility of allergies greatly increases the danger since people are not usually aware

of such allergies until they have been bitten. Therefore, spiders should be regarded as potentially hazardous.

Ticks are parasites that feed on the blood of an animal/human host and can carry several severe diseases, the least bringing several days of fever and pain and the worst causing brain damage. This hazard is discussed in greater detail in Appendix B.

6.3.2 Other Animals

Chipmunks, ground squirrels, rats, and other mammals have been known to harbor fleas carrying bubonic plague. Their bites can also transmit rabies and other infections. Chipmunk-like animals pose a special problem because people tend to try to feed them or pet them, the increased contact bringing greater possibility of danger. Avoid wildlife when possible.

Poisonous snakes may also be encountered on site. Personnel should check for snakes before walking through grassy or debris-strewn areas. Care should be taken when lifting possible habitats of snakes and spiders such as debris and cover.

TABLE 6-1
PHYSIOCHEMICAL CHARACTERISTICS OF CHEMICALS OF CONCERN

	CAS #	OSHA PEL	ACGIH TLV/ Recommended Exposure Limits	IDLH	Vapor Pressure	Specific Gravity	Skin Hazard	Odor Threshold	Carcinogen Category	Photon Relative Response	Ionization Potential
					mm @ 68 F	@ 68 F				10.6 eV	eV
Acetone	67-64-1	750 ppm 1000 ppm S	750 ppm 1000 ppm S	2000 ppm	180	0.79	NO	mint like 47.5 - 1613.9 mg/m³	IRIS D	1.2	9.69
Aldrin	309-00-2	0.25 mg/m³	0.25 mg/m³	100 mg/m³	0.00008	1.6	YES	odorless	IRIS B2	NA	
Benzene	71-43-2	1 ppm 5 ppm S	0.1 ppm (a) 10 ppm	3000 ppm	75	0.88	YES	aromatic 5 - 119 ppm	IRIS A	0.5	9.24
Carbon Tetrachloride	56-23-5	2 ppm	5 ppm	300 ppm	91	1.59	YES	sweet, aromatic 21.4 ppm	IRIS B2	NA	11.47
Coal Tar Pitch Volatiles	65996-93-2	0.2 mg/m³		700 mg/m³	varies	varies	YES		IARC I	NA	
D 2,4-	95-75-7	10 mg/m³	10 mg/m³	500 mg/m³	8.50E-02	1.57	NO			NE	
DDE (p,p' Dichlorophenyldichloroethylene)	72-55-9	NE	0.00029 (D)	NE	6.5E-06				IRIS B2	NA	
DDT (Dichlorodiphenyltrichloroethane)	50-29-3	1 mg/m³	1 mg/m³	NE	1.5E-07	0.99	YES	fruit-like, aromatic 0.35 ppm in water	IRIS B2	NA	
Dieldrin	60-57-1	0.25 mg/m³	0.25 mg/m³	450 mg/m³	1.6E-07	1.75	YES	odorless to mild, chemical 0.041 ppm	IRIS B2	NA	

TABLE 6-1
(Continued)

	CAS #	OSHA PEL	ACGIH TLV/ Recommended Exposure Limits	IDLH	Vapor Pressure	Specific Gravity	Skin Hazard	Odor Threshold	Carcinogen Category	Photon Relative Response	Ionization Potential
Ethyl Benzene	100-41-4	100 ppm 125 ppm S	100 ppm 125 ppm S	2000 ppm	8.6	0.87	NO	aromatic	IRIS D	0.6	8.76
Malathion	121-75-5	5 mg/m³ R 10 mg/m³ T	10 mg/m³	5000 mg/m³	0.000032	1.21	YES	skunk-like 13.5 mg/m³	NE	NA	
Methyl Chloroform (1,1,1-Trichloroethane)	71-55-6	350 ppm 450 ppm S	350 ppm 450 ppm S	1000 ppm	100	1.34	NO			NA	11.00
Methylene Chloride	75-09-2	25 ppm 125 ppm S	50 ppm	5000 ppm	350	1.33	NO	sweet, pleasant 160 - 307 ppm	IRIS B2	NA	11.32
Parathion	56-38-2	0.1 mg/m³	0.1 mg/m³	20 mg/m³	0.003	1.27	YES	faint, garlic-like 0.470 mg/m³	IRIS C	NA	
T 2,4,5-	93-76-5	10 mg/m³	10 mg/m³	NE	4.62E-09	1.8	NO			NE	
Tetrachloroethylene (Perchloroethylene)	127-18-4	25 ppm	50 ppm 200 ppm C	500 ppm	14	1.62	NO	midly sweet desensitizes olefactory 4.68 - 50 ppm	IARC 2B	0.6	9.32
Toluene	108-88-3	100 ppm 150 ppm S	50 ppm	2000 ppm	21	0.87	YES	sweet pungent 2.14 ppm	IRIS D	0.5	8.82
Trichloroethylene	79-01-6	50 ppm 200 ppm S	50 ppm 200 ppm S	1000 ppm	58	1.46	NO	sweet chloroform 21.4 ppm	IARC 3	0.6	9.45
Vanadium	1314-62-1	0.05 mg/m³	0.05 mg/m³	70 mg/m³	~0	3.36	NO		NE	NA	
Xylene, all isomers	1330-20-7	100 ppm 150 ppm S	100 ppm 150 ppm S	1000 ppm	9	NA	NO	aromatic	IRIS D	NE	

TABLE 6-1
(Continued)

NOTES

a	=	These TLVs have not yet been adopted. ACGIH has placed them under notice of intended changes.
ACGIH	=	American Conference of Governmental Industrial Hygienists
c	=	These PEL/TLVs have not been established. The compounds are considered less toxic than Phenol and the odor thresholds are low enough
		to indicate exposure if the PEL for Phenol is adopted for these compounds.
C	=	Ceiling Limit, shall not be exceeded at any time during the work day
CAS #	=	Chemical Abstracts Service Registry Number
D	=	Contaminant intake that should not induce adverse effects to human health or should not pose a risk of cancer occurrence greater than a predetermined risk level.
		Developed by US Army Medical Bioengineering R&D Laboratory. Expressed in mg/kg/day.
IARC	=	International Agency For Research on Cancer
IDLH	=	Immediately Dangerous to Life or Health
IRIS	=	Integrated Risk Information System
MW	=	Molecular weight
mg/m^3	=	milligrams of contaminant per cubic meter of air
NA	=	Not Applicable
NE	=	Not Established
OSHA	=	Occupational Safety and Health Administration
PEL	=	Permissible Exposure Limit, unless noted is the TWA, Time Weighted Average (usually for 8 hours a day, 5 days a week), mandated by law
ppm	=	parts of contaminant per million parts of air
R	=	Respirable Dust
S	=	Short Term Exposure Limit (STEL) usually 15 minutes, four times in one day

TABLE 6-1
(Concluded)

S/5/2	=	STEL for 5 minutes, twice per day
Skin Hazard	=	Contaminant can be absorbed through intact skin.
T	=	Total Dust
TLV	=	Threshold Limit Value, unless noted is the TWA, Time Weighted Average (usually for 8 hours a day, 5 days a week), recommended
Carcinogenic Category		
IRIS IARC		
A 1		Human Carcinogen
B1 2A		Probable Human Carcinogen (limited human data)
B2 2B		Probable Human Carcinogen (sufficient in animals, inadequate evidence in humans).
C 3		Possible Human Carcinogen
D 4		Not Classifiable
E		Evidence of Non-Carcinogen

7.0
GENERAL HEALTH AND SAFETY REQUIREMENTS

7.1 PERSONNEL CLEARANCE

W-C employees must obtain health and safety clearances before beginning field work at the Cannon AFB. W-C employees assigned to field operation must have (1) been certified by a W-C-approved physician as being physically fit and able to perform their assigned field work, (2) successfully completed a W-C 40-hour basic health and safety training course (Level C) for field personnel or the equivalent and subsequent 8-hour refresher courses, and (3) passed a respirator fit test with isoamyl acetate and/or irritant smoke as indicators. Site managers and supervisors must have successfully completed an 8-hour manager's health and safety course in addition to all other clearance requirements. The SSO must have current certification in CPR and First Aid in addition to requirements for field personnel.

W-C subcontractor employees must also have similar medical, training, and respirator fit clearances and will be required to provide proof of clearance before beginning work.

7.2 SAFETY BRIEFINGS

Before field work begins, all field personnel, including subcontractor employees, must be briefed on their work assignments and safety procedures contained in this document. Each person must be provided with and read a copy of this SSHP. At the end of the meeting, attendees should be informally quizzed to assess their understanding of the health and safety requirements, and should sign a safety compliance agreement form stating that they have read, understand, and agree to comply with the provisions of this plan. Individuals refusing to sign the agreement will be prohibited from conducting field work during this investigation.

The SSO will conduct this briefing. The documentation form for the briefing is attached in Appendix C. This form is to be completed and maintained in W-C records, including the Health and Safety file.

7.3 VISITOR CLEARANCE

Visitors entering a contamination reduction zone and exclusion zone at a Landfill No. 5 (SWMU No. 113/IRP No. LF.5) will be required to read and verify compliance with the provisions of this SSHP. In addition, visitors will be expected to comply with relevant OSHA requirements such as medical monitoring and training (Section 7.1). Visitors will also be expected to provide their own protective equipment. For government visitors, four extra sets of PPE (not including respirators, prescriptions safety glasses, or safety boots) shall be maintained on site.

In the event that a visitor does not adhere to the provisions of the SSHP, he/she will be requested to leave the work area. All nonconformance incidents will be recorded in the site log.

7.4 DISTRIBUTION OF HEALTH AND SAFETY PLAN

Before field work begins, a copy of this SSHP must be provided to each W-C and subcontractor employee assigned to field work on the project as well as to an authorized representative of each firm contracted by W-C to perform work on site. The SSO is responsible for ensuring that a copy of the plan is available whenever work is in progress.

7.5 ACCIDENT/INCIDENT REPORTING

In the event of an accident or incident, the SSO will immediately notify the W-C Project Manager (PM) and HSO. Types of accidents or incidents that are considered reportable are:

- Illness resulting from chemical exposure or unknown causes,
- Physical injury, including an injury that does not require medical attention,
- Fire, explosions, and flashes resulting from activities performed by W-C and its subcontractors,
- Infractions of safety rules and requirements, or

- Unexpected chemical exposures.

Work will be suspended to correct the cause of the accident/incident and to modify this plan as necessary.

A W-C accident/incident report form (Appendix D) must be submitted to the PM and the HSO within 24 hours of the occurrence.

7.6 SAFETY COMPLETION REPORT

The SSO will prepare a safety completion report at the end of field activities which includes a critical review of this plan, exposure monitoring data with monitoring dates, and any decisions made based on that data; a summary of incidents and action taken; and recommendations for improving health and safety practices in similar projects. (This report form is in Appendix E.)

7.7 WORK ZONES

Work zones will be required for drilling and soil-gas. For these activities the following procedures are mandatory. Three work zones will be established around each sampling location: the exclusion zone (EZ), the contamination reduction zone (CRZ), and the support zone. An EZ is an area where contamination could or does occur. The EZ will be demarcated using orange cones and/or flagging. All W-C or subcontractor personnel who enter the EZ must be cleared by the SSO, have signed a safety compliance agreement form, and wear the level of protective equipment specified in Section 8.1.3 of this plan.

The CRZ is located immediately outside the exclusion zone. This zone is designed to limit the migration of contaminants from potentially contaminated areas to noncontaminated areas. Decontamination is conducted in this area.

The support zone is an uncontaminated area. Supporting equipment and facilities will be located in this area.

7.8 LABORATORY CONSIDERATIONS

Analysis of all samples collected during the investigation from the site will be handled by the contract laboratory. The laboratory director shall be informed that the samples may contain hazardous levels of contaminants that would require special handling procedures to prevent risks to the health and safety of laboratory personnel.

8.1 PERSONAL PROTECTIVE EQUIPMENT

8.1.1 Hearing Protection

Regulations require that hearing protection be used when noise levels exceed 85 dBA averaged over an 8-hour day. Hearing protection is required during this investigation for exposures of greater than 85 dBA for any length of time. In the absence of instrumentation, an appropriate rule of thumb is that when normal conversation is difficult at a distance of two to three feet, hearing protection is required. W-C personnel and their subcontractors shall have hearing protection on site for use by their employees.

8.1.2 Personal Protection Levels

Levels of personal protection are as follows:

Level D:

- Hard Hat (when working around heavy equipment and when overhead hazards exist)
- Steel Toe Boots (when working around heavy equipment)
- Safety Glasses with side shields or goggles (as required by OSHA)

Modified Level D:

- Uncoated Tyvek coveralls taped at ankles and wrists
- Hard Hat (when working around heavy equipment overhead hazards exist)

- Steel Toe Boots (when working around heavy equipment)
- Boot Covers
- Safety Glasses with side shields or goggles (as required by OSHA)
- Nitrile Gloves (when handling soils within the EZ)
- Latex or Nitrile Inner Gloves (when handling soils within the EZ)

Level C:

- Full face respirator with combination organic vapor/particulate filter cartridges
- Saranex coated Tyvek coveralls taped at ankles and wrists
- Hard Hat (when overhead hazards exist)
- Steel Toe Boots (when working around heavy equipment)
- Boot Covers (except for work in boats or on floating platforms)
- Safety Glasses with side shields or goggles (as required by OSHA)
- Nitrile Gloves (when handling soils within the EZ)
- Latex or Nitrile Inner Gloves (when handling soils within the exclusion zone)

8.1.3 Initial Levels of Protection

- Geophysical Surveying: Level D
- Soil-Gas Surveying: Level D, with Latex or Nitrile gloves
- Drilling: Modified Level D

8.2 AIR MONITORING REQUIREMENTS

8.2.1 Organic Vapor Monitoring

Vapor monitoring with a photoionization detector (PID) shall be performed periodically during all intrusive activities. During drilling operations, a reading must be taken at least one time for every 5 feet drilled and recorded on the HTW drilling log. Monitoring must be performed by individuals trained in the use and care of the PID.

Calibrations are to be completed according to manufacturer's specifications using isobutylene as a calibration gas. A record of calibrations containing date, time, method of calibration, instrument read-out and the name of the individual who conducted the calibration is to be maintained. A example of the calibration record form is contained in Appendix F A report summarizing calibration monitoring results must be written as part of the safety completion report at the end of this project. The main purpose of the air monitoring report is to document personnel exposures. Records of exposures will be maintained in the Health and Safety file.

8.2.2 Combustible Gas Monitoring

Monitoring with a combustible gas indicator (CGI) will be conducted during intrusive activities. Action levels for the monitoring are presented in Section 8.3. During the first few days of the soil gas survey, each sample point will be monitored with the CGI at the probe hole. These readings will be used to determine further monitoring with the CGI for the remainder of the soil gas survey. The determination will be made by the W-C SSO in concurrence with the W-C HSO or CHSO and documented in the field logbook.

Based on the CGI monitoring results, the W-C SSO in concurrence with the W-C HSO or CHSO will determine the frequency of monitoring required for drilling activities. The determination will be documented in the field logbook.

Prior to use each day, the monitor will be calibrated and response-checked according to manufacturer's specifications.

8.2.3 Recordkeeping

A report summarizing monitoring results must be written as part of the safety completion report at the end of this project.

8.3 ACTION LEVELS

MONITORING EQUIPMENT	SAMPLING RESULT	ACTION
PID	Any breathing zone readings over 5 ppm (sustained for 1 minute or more)	Upgrade to Level C PPE
PID	Any breathing zone readings over 25 ppm (sustained for 1 minute or more)	Stop work Contact the HSO
CGI	> 10 percent LEL	Initiate continuous monitoring
CGI	> 20 percent LEL	Stop work Work may be resumed when concentrations drop to 10 percent LEL Continuous monitoring required for the borehole
Observation	unusual odors are detected symptoms of possible exposure occur in any individual while on the job (See MSDS sheets in Appendix A for symptoms)	Stop work Contact the HSO

8.4 DECONTAMINATION

8.4.1 Personnel Decontamination

Decontamination equipment shall be present on site. A temporary decontamination line will be set up at each boring location and decontamination conducted should personnel have contact with grossly contaminated material.

The temporary decontamination line should provide sufficient space to wash and rinse boots, gloves and all sampling equipment prior to placing equipment into a vehicle, as well as a place to discard of used disposable items such as gloves and tyvek. Personnel are advised to shower as soon as possible after leaving the site.

8.4.2 Equipment Decontamination

A temporary equipment decontamination pad will be set up on site. Heavy equipment will be decontaminated with a steam or high pressure sprayer prior to leaving the site. Decontamination water will be contained or allowed to evaporate.

8.5 WORK PRACTICES

8.5.1 General

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in the EZ and the CRZ. The drinking of water, Gatorade, or equivalent fluids may occur in the CRZ at the discretion of the SSO.

- Smoking, carrying lighters and/or matches is prohibited in the EZ and the CRZ.

- No jewelry may be worn by personnel engaged in field work, except for watches, which will be disposed of if they become contaminated.

- No facial hair which interferes with a satisfactory fit of the mask-to-face seal is allowed on personnel required to wear respirators or self-contained breathing apparatus (SCBAs).

- Medicine and alcohol can potentate the effects from exposure to toxic chemicals. PRESCRIBED DRUGS SHOULD NOT BE TAKEN BY PERSONNEL ON OPERATIONS WHERE THE POTENTIAL FOR ABSORPTION, INHALATION, OR INGESTION OF TOXIC SUBSTANCES EXISTS UNLESS SPECIFICALLY APPROVED BY A QUALIFIED PHYSICIAN. Alcoholic beverage intake will not be allowed during working hours or breaks.

- NO PERSON WILL ENTER AN EXCLUSION ZONE ALONE.

- No one will approach or enter areas or spaces where toxic of explosive concentrations of gases or dust may exist without proper equipment available to enable safety entry.

- Entry into trenches or confined spaces will not be permitted.

8.5.2 Drilling

Working with and around a drill rig can involve a high risk of serious injury or death. In order to reduce the risk, proper safety precautions must be observed at all times. Safe drilling procedures are included in Appendix G.

8.5.3 Buddy System

The "buddy system" will be used during all field work requiring the use of disposable coveralls and/or work around drill rigs or other heavy equipment. At no time will an individual enter or leave an exclusion zone alone. Before entering an exclusion zone, each individual will identify his/her "buddy."

8.5.4 Confined Space Entry Procedures

No confined space entry will be permitted during these field activities.

8.5.5 Spill Containment Program

Due to the nature of the work at this site, a spill containment program will not be required.

8.5.6 Excavation Safety

No excavations will be permitted under this SSHP.

8.5.7 Material Handling Procedures

All soils and decontamination water will be placed in 55-gallon drums and stored at the temporary drum storage area at Landfill No. 5 until results of laboratory analysis have been completed. The 55-gallon drum will be marked identifying Landfill No. 5, SWMU No. 113, the boring numbers, the date collected, contractor identification, and the telephone number for the 27 SG CEV office. The drums will also be labeled "contents waiting testing."

8.5.8 Machine Guarding

All machinery which may present a hazard of injury due to moving or impacting parts, electrically charged connections, and hot surfaces including engines and motors, cable and winch systems, and sampling equipment shall have in place the manufactures original machine guarding apparatus (shrouds, screens, guards, grills, mufflers, etc.). All machine guarding will be maintained, checked, and repaired according to the manufactures specifications. Personnel are forbidden from modifying original machine guarding apparatus.

8.5.9 Fall Protection

Work at elevated locations is not anticipated for this project, with the possible exception of repair work on a piece of drilling equipment. Any personnel conducting work at an elevated

location will use fall protection as provided in 29 CFR 1926.104, with a lifeline or lanyard to prevent the worker from falling more than six feet.

8.5.10 Illumination

No night work will be allowed during this investigation.

8.5.11 Sanitation

Shower facilities will not be required during this investigation. Potable water and toilet facilities which comply with 29 CFR 1910.120(n) must be available to on-site personnel.

8.5.12 Communications

8.5.12.1 On-Site Communications

Due to the limited field work and number of personnel required for this project, on-site communications systems will not be utilized. The "buddy system" will be employed at this site, and personnel will be in site of the SSO during all field activities.

8.5.12.2 Off-Site Communications

The SSO will have access to a phone/fax in trailer.

9.1 EMERGENCY SERVICES

9.1.1 Emergency Phone Numbers

All Emergencies:

From a commercial phone: 911
From a base phone: 4117

Security Police: (505) 784-4111

Fire Department: (505) 784-4117 - Emergency Only
(505) 784-4852 - All others

Hospital:

Life threatening injury/illness

Cannon Air Force Base Hospital
Building 1400
(505) 784-4033 (Ambulance) or 911
(505) 784-4034 (All others)

Non-life threatening injury/illness

Clovis High Plains Hospital
2100 N. Thomas
(505) 769-2141

9.1.2 Hospital Route

Hospital route maps are included as Figures 9-1 and 9-2.

Cannon AFB Hospital

The base hospital is located in Building 1400 on Casablanca Avenue on the northwest corner of the base.

Clovis High Plains Hospital

Exit Cannon AFB and turn left on 7th Street (at the 1st light) then turn north on Thomas (at the second light). Hospital is on the west side of the road,

9.1.3 W-C Contacts

Jeffrey L. Ehrenzeller
Project Manager
(303) 740-2799

John T. (Tom) Acre
Assistant Project Manager
(303) 740-2773
Pager: (800) 819-0278

Kathleen Fischer
Health and Safety Officer
(303) 796-4616

Karen Scudder, CIH
Corporate Health and Safety Officer
(303) 740-3837
Pager: (303) 760-1814

9.2 EMERGENCY RESPONSE PROCEDURES

The Site Manager, with assistance from the SSO, has responsibility and authority for coordinating all emergency response activities until proper authorities arrive and assume control.

9.2.1 Emergency Medical Treatment

If an employee working in a contaminated area is physically injured, Red Cross first aid procedures will be followed. Depending on the severity of the injury, emergency medical response may be sought. If the employee can be moved, they will be taken to the edge of the work area (on a stretcher, if needed) where contaminated clothing will be removed (if possible) and emergency first aid administered, and then they will be transported to the hospital.

9.2.1.1 Emergency Medical Procedures

For severe injuries, illnesses, or overexposures:

- Remove the injured or exposed person(s) from immediate danger.
- If possible, at least partial decontamination should be completed. Wash, rinse, and/or cut off protective clothing and equipment and redress the victim in clean coveralls.
- If decontamination cannot be done, wrap the victim in blankets or plastic sheeting to reduce contamination of other personnel.
- Render emergency first aid and call an ambulance for transport to local hospital immediately. Notify emergency personnel of contaminants on-site. This information, which is included in Appendix A and Section 4.0, should be sent with the victim to the hospital.
- Evacuate other personnel on site to a safe place until the SSO determines that it is safe to resume work.
- Report the accident to the PM and HSO immediately and complete an incident report.

For minor injuries or illnesses:

- Complete a full decontamination.
- Administer first aid. Minor injuries may be treated on site, but all injuries will be examined by trained medical personnel. Victims of serious bites or stings will be taken to a medical center.
- Notify the PM and HSO immediately.

9.2.1.2 First Aid - Chemical Injury

If the injury to the worker is chemical in nature (e.g., overexposure), the following first aid procedures are to be instituted as soon as possible:

Eye Exposure	If contaminated solid or liquid gets into the eyes, wash eyes immediately with sterile saline solution lifting the lower and upper lids occasionally. Continue eye wash for 15 minutes. Cover the eye with a dry pad and obtain medical attention

immediately. (Contact lenses are not permitted in the exclusion zone.)

Skin Exposure	If contaminated solid or liquid gets on the skin, promptly wash contaminated skin for 15 minutes using soap or mild detergent and water. If solids or liquid penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medical attention immediately if symptoms warrant.
Breathing	If a person breathes in large amounts of organic vapor, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.
Swallowing	If contaminated solid or liquid has been swallowed **and the person is conscious**, feed the person large quantities of salt water immediately and induce vomiting. Obtain medical attention immediately.

9.2.1.3 First Aid - Physical Injury

Animal Bites	Thoroughly wash the wound with soap and water. Flush the area with running water and apply a sterile dressing. Immobilize affected part until the victim has been attended by a physician. See that the animal is kept alive and in quarantine. Obtain name and address of the owner of the animal. Report all animal bites to Military Public Health at (505) 784-4053.
Burns (minor)	Do not apply vaseline or grease of any kind. Apply cold water applications until pain subsides. Cover with a wet sterile gauze dressing. Do not break blisters or remove tissue. Seek medical attention.
Burns (severe)	Do not remove adhered particles of clothing. Do not apply ice or immerse in cold water. Do not apply ointment, grease or vaseline. Cover burns with thick sterile dressings. Keep burned feet or legs elevated. Seek medical attention immediately.
Cramps	Treat as heat exhaustion. See Appendix H.

Cuts	Apply pressure with sterile gauze dressing, and elevate the area until bleeding stops. Apply a bandage and seek medical attention.
Eyes (foreign objects)	Keep the victim from rubbing the eye. Flush the eye with water. If flushing fails to remove the object, apply a dry, protective dressing and consult a physician.
Fainting	Keep the victim lying down with feet elevated. Loosen tight clothing. If victim vomits, roll him onto his side or turn his head to the side. If necessary wipe out his mouth. Maintain an open airway. Bathe his face gently with cool water. Unless recovery is prompt, seek medical attention.
Fracture	Deformity of an injured part usually means a fracture. If fracture is suspected, splint the part as it lies. Do not attempt to move the injured part of the person. Seek medical attention immediately.
Heatstroke	See Appendix H.
Snake Bites	Keep the bite area as low as possible. Transport the victim immediately to a medical facility.
Insect Bites	Remove "stinger" if present. Keep affected part down below the level of the heart. Apply ice bag. For minor bites and stings apply soothing lotions, such as calamine.
Puncture Wounds	If puncture wound is deeper than skin surface, seek medical attention. Serious infection can arise unless proper treatment is received.
Sprains	Elevate injured part and apply ice bag or cold packs. Do not soak in hot water. If pain and swelling persists, seek medical attention.
Unconsciousness	Never attempt to give anything by mouth. Keep victim flat, maintain an open airway. If victim is not breathing, provide artificial respiration by mouth to mouth breathing and call for an ambulance immediately.

9.2.2 Injury Due to Heat Stress

Environmental conditions may present additional health concerns due to temperature extremes. Effects and treatment of heat stress can be found in Appendix H. It is currently anticipated that field work for this project will be completed during the late fall and winter months.

9.2.3 Fire/Explosion

In the event of a fire or explosion, the local fire department should be summoned immediately. Upon their arrival, the PM or designated alternate will advise the fire commander of the location, nature, and identification of the hazardous materials on-site.

If it is safe to do so, site personnel may:

- Use fire fighting equipment available on site to control or extinguish the fire; and,
- Remove or isolate flammable or other hazardous materials which may contribute to the fire.

Otherwise, immediate evacuation of the area is indicated. In the event of an explosion, all personnel shall be evacuated and the fire department notified. No one shall re-enter the area until it has been cleared by explosives safety personnel.

9.2.4 Natural Disasters

Natural disasters may occur at the site due to weather. These include lightning and high winds.

1. Lightning - Persons should not work in open areas, near trees or other equipment outside during lightning storms. Stop work until the storm passes. If possible, clear the site until the storm passes.
2. High Winds - If high winds are forecast, then the site should be cleared before the winds become hazardous. Workers should be instructed to go to an appropriate shelter.
3. If an evacuation is called, account for all persons before leaving the site.
4. Notify the PM of any work stoppage due to lightening and high winds.

9.3 EMERGENCY EQUIPMENT

This equipment will be stored at appropriate locations selected during site mobilization. Emergency response equipment shall be located in close proximity to the work area.

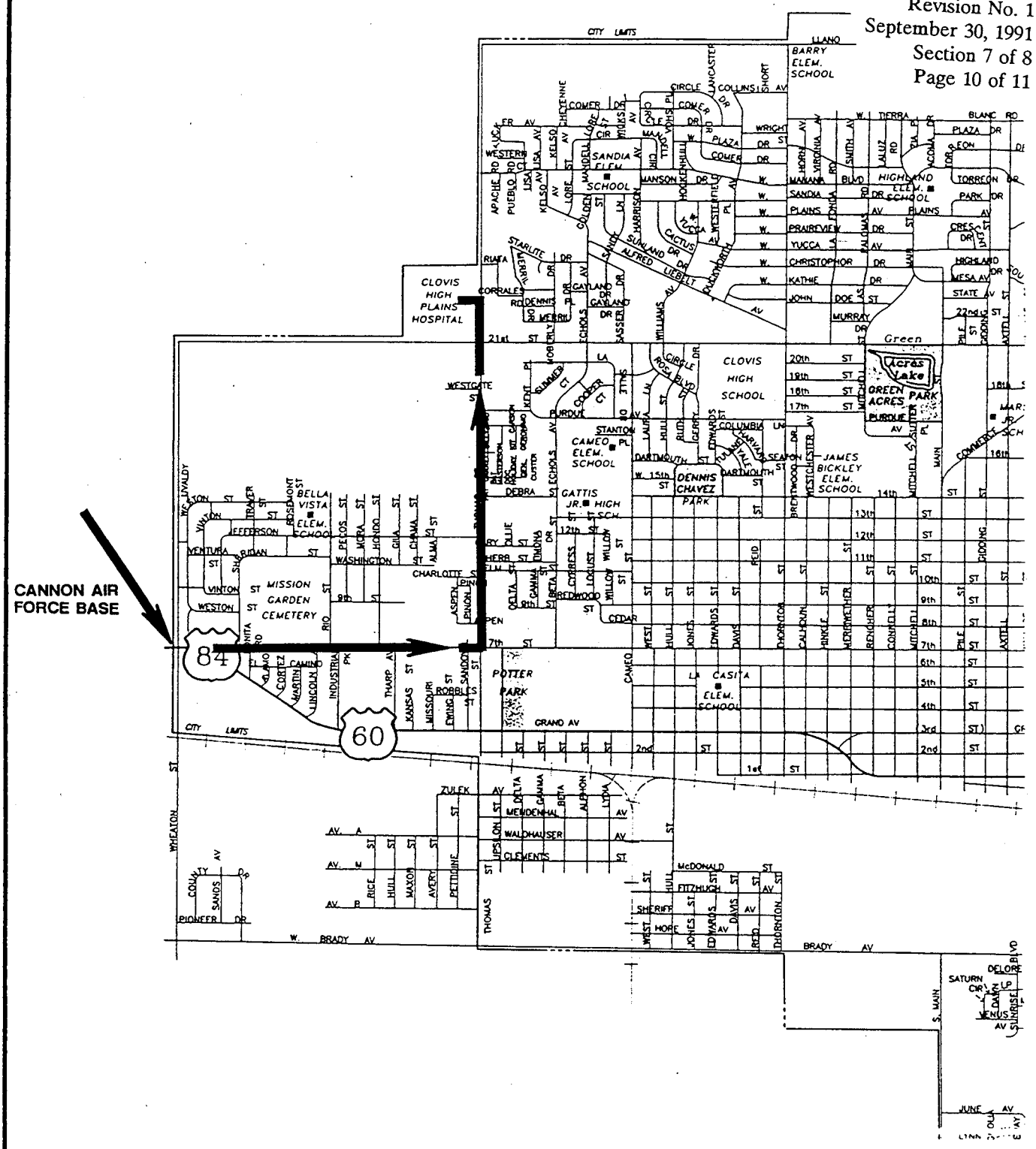
- Fire Extinguishers: One 20-lb-type ABC fire extinguisher will be located at each entrance to each exclusion zone.

- Emergency Eye Wash: An eyewash rated for 15 minutes will be part of the first aid kit. The bottles will be replaced if they have been used.

- First Aid Kit: At least one industrial first aid kit will be provided and maintained fully stocked in the CRZ. First aid kit locations will be specially marked and provided with adequate water and other supplies necessary to cleanse and decontaminate burns, wounds, or lesions.

- Gatorade or the equivalent.

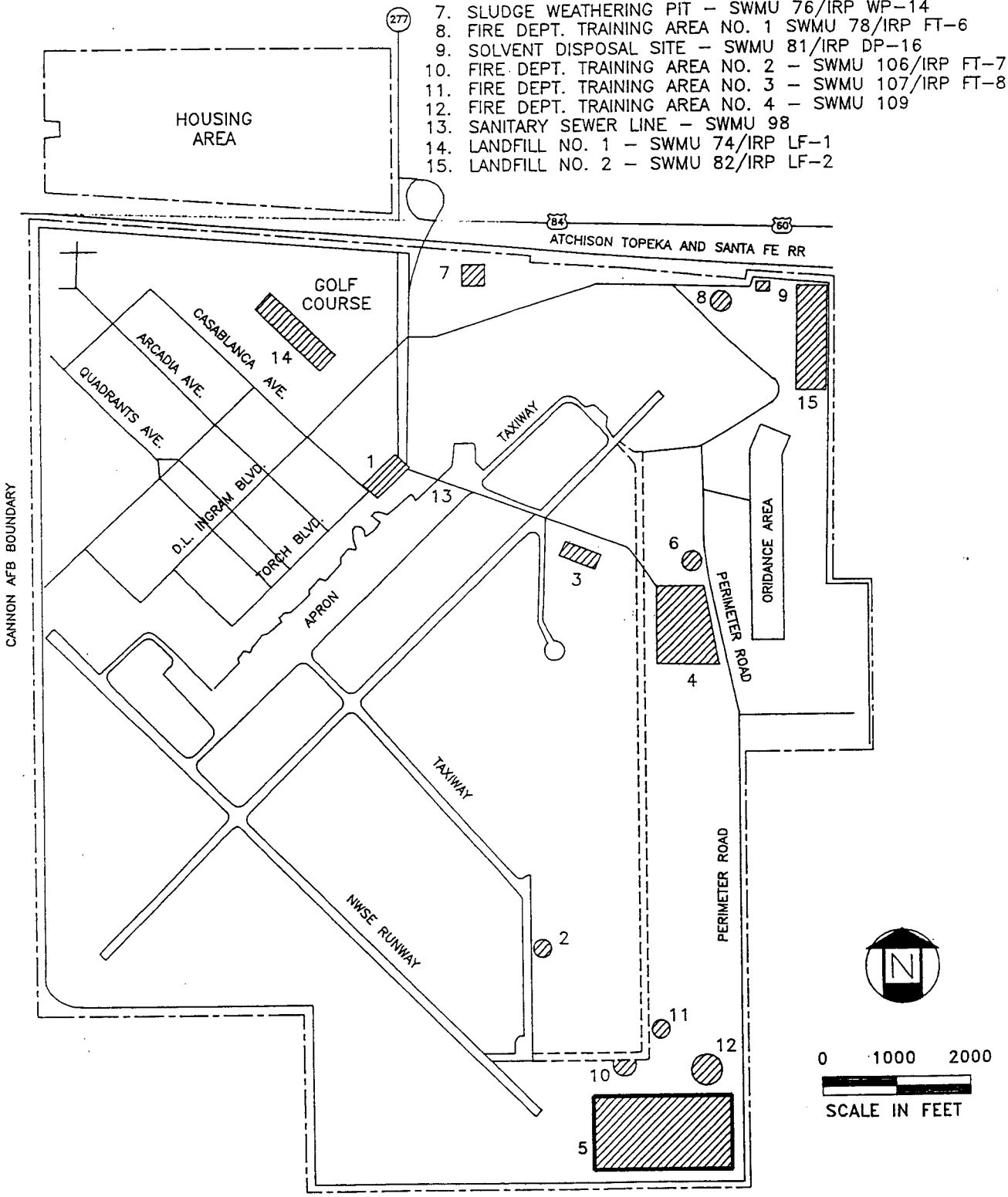
- Extra full set of PPE.



Job No. : 89MC114W	HOSPITAL ROUTE MAP
Prepared by : J.T.A.	
Date : 8/26/91	

EXPLANATION

1. AGE DRAINAGE DITCH – SWMU 34/IRP SD–15
2. ENGINE TEST CELL AREA – SWMU 86–90/IRP SD–11
3. NE STORMWATER DRAINAGE AREA – SWMU 95/IRP SD–20
4. WASTEWATER LAGOONS – SWMU 101,102
5. LANDFILL NO. 5 – SWMU 113/IRP LF–5
6. OLD ENTOMOLOGY RINSE AREA – SWMU 96/IRP SD–17
7. SLUDGE WEATHERING PIT – SWMU 76/IRP WP–14
8. FIRE DEPT. TRAINING AREA NO. 1 SWMU 78/IRP FT–6
9. SOLVENT DISPOSAL SITE – SWMU 81/IRP DP–16
10. FIRE DEPT. TRAINING AREA NO. 2 – SWMU 106/IRP FT–7
11. FIRE DEPT. TRAINING AREA NO. 3 – SWMU 107/IRP FT–8
12. FIRE DEPT. TRAINING AREA NO. 4 – SWMU 109
13. SANITARY SEWER LINE – SWMU 98
14. LANDFILL NO. 1 – SWMU 74/IRP LF–1
15. LANDFILL NO. 2 – SWMU 82/IRP LF–2



Job No. : C3M11M	IRP/SWMU SITE LOCATION MAP
Prepared by : D.A.K.	CANNON AFB, NEW MEXICO
Date : 8/22/93	

3M11FXX

FIG. 9-2

10.0
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APPENDIX A

MATERIAL SAFETY DATA SHEETS

APPENDIX A CONTENTS

Acetone
Aldrin
Automotive Gasoline, Lead-Free
Benzene
Cadmium
Chlordane
Chromium Metal/Powder
2,4-D
DDT
Dibromochloropropane
Dieldrin
Diesel Fuel Oil No. 2-D
Ethyl Benzene
Fuel Oil No. 2
Hexane
Jet Fuels
Lead (Inorganic)
Malathion
Mercury
Methyl Chloroform
Mineral Spirits, Type IV (Stoddard Solvent)
Parathion
Perchloroethylene
Polychlorinated Biphenyls
Silver
Tetraethyl Lead
Toluene
1,1-2 Trichloroethane
Trichloroethylene
Trisodium Phosphate
Used Motor Oil
Xylene
Zinc Metal/Powder

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR ALDRIN

POTENTIAL HUMAN CARCINOGEN

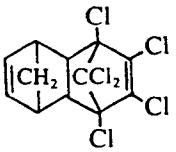
INTRODUCTION

This guideline summarizes pertinent information about aldrin for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

NOTE: Most uses of aldrin were suspended by the U.S. Environmental Protection Agency, effective October 18, 1974. The only uses allowed are direct soil application, seed treatment if labeled "not for food use," dipping of plant roots and tops, subsurface termite control, and hot-caps.

SUBSTANCE IDENTIFICATION

- **Formula:** $C_{12}H_8Cl_6$
- **Structure:**



- **Synonyms:** Aldrex; aldrine; aldrosol; octalene; 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-exo-1,4-endo-5,8-dimethanonaphthalene
- **Identifiers:** CAS 309-00-2; RTECS 102100000; DOT 2761, label required: "Poison"
- **Appearance and odor:** Light to dark brown crystals with a mild chemical odor

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 364.90
2. Boiling point (at 760 mmHg): Decomposes
3. Specific gravity (water = 1): 1.6
4. Melting point: 104°C (219°F)
5. Vapor pressure at 20°C (68°F): 6.0×10^{-6} mmHg
6. Solubility in water: 0.027 mg/l at 27°C (80.6°F)

- **Reactivity**

1. Incompatibilities: Aldrin may react with concentrated mineral acids, acid catalysts, acid oxidizing agents, phenols, or reactive metals.
2. Hazardous decomposition products: Hydrochloric acid fumes and other chlorinated decomposition products may be released in a fire involving aldrin.
3. Caution: Aldrin should be stored in tightly closed containers in a well-ventilated area.

- **Flammability**

Aldrin is nonflammable.

- **Warning properties**

Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for aldrin is 0.25 milligrams of aldrin per cubic meter of air (mg/m³) as a time-weighted average (TWA) concentration over an 8-hour workshift (Skin). The notation "Skin" refers to the potential contribution to overall exposure by the cutaneous route including the mucous membranes and eyes. The National Institute for Occupational Safety and Health (NIOSH) recommends that aldrin be controlled and handled as a potential human carcinogen in the workplace and that exposure be minimized to the lowest feasible limit. The NIOSH recommended exposure limit (REL) is 0.15 mg/m³ as a TWA for up to a 10-hour workshift, 40-hour workweek. The NIOSH REL is the lowest concentration detectable by current NIOSH-validated sampling and analytical methods. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) is 0.25 mg/m³ (Skin) as a TWA for a normal 8-hour workday and a 40-hour workweek (Table 1).

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

Table 1.—Occupational exposure limits for aldrin

	Exposure limits mg/m³
OSHA PEL TWA (Skin)*	0.25
NIOSH REL TWA (Ca)†	§0.15
ACGIH TLV® TWA (Skin)	0.25

* (Skin): Potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes.
† (Ca): NIOSH recommends treating as a potential human carcinogen.
§ Lowest reliably detectable level.

HEALTH HAZARD INFORMATION

• Routes of exposure

Aldrin may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact. Dermal absorption is substantially increased when aldrin is dissolved in organic solvents.

• Summary of toxicology

1. *Effects on animals:* Acute or chronic oral administration of aldrin to dogs and rats produced liver and kidney degeneration; chronic oral administration produced liver cancer in mice and thyroid cancer in rats. Aldrin fed to pregnant hamsters and mice caused increased fetal deaths, as well as congenital anomalies and growth retardation in the offspring.
2. *Effects on humans:* Aldrin is a neurotoxin and has caused electroencephalogram abnormalities following short-term or long-term oral, dermal, or inhalation exposure.

• Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to aldrin can cause hyperirritability, headache, dizziness, nausea, vomiting, blood in the urine, tremors, convulsions, and coma.
2. *Long-term (chronic):* Exposure to aldrin can cause redness of the skin and dermatitis, weight loss, muscular twitching, and convulsions.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to aldrin, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, kidneys, endocrine glands, and hematopoietic (blood-cell-forming), reproductive, and nervous systems.

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to aldrin at or below the NIOSH REL.

The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include: preexisting chronic diseases of the skin, liver, kidneys, endocrine glands, and hematopoietic, reproductive, and nervous systems. Workers should inform their physicians of their potential for exposures to aldrin because internal absorption of this chemical pathologically increases the liver's ability to metabolize and eliminate medications which may be prescribed or taken "over the counter." The physician should obtain baseline values for liver function tests and a complete blood count with reticulocyte count.

• Periodic medical screening and/or biologic monitoring

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to aldrin. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the integrity and physiologic function of the skin, eyes, liver, kidney, and hematopoietic, reproductive, and nervous systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population.

• **Medical practices recommended at the time of job transfer or termination**
The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to aldrin may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• **Sentinel health events**
1. Acute SHE's include: Non-autoimmune hemolytic anemia.
2. Delayed-onset SHE's include: Cataract, toxic hepatitis, and non-autoimmune hemolytic anemia.

MONITORING AND MEASUREMENT PROCEDURES

• **TWA exposure evaluation**
Measurements to determine worker exposure to aldrin should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• **Method**
Sampling and analysis may be performed by collecting aldrin with a glass-fiber filter and a midget impinger containing isooctane. The filter is extracted using isooctane, and analysis is performed using a gas chromatograph with an electrolytic conductivity detector. A detailed sampling and analytical method for aldrin may be found in the *NIOSH Manual of Analytical Methods* (method number 5502).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with aldrin.

SANITATION

Clothing which is contaminated with aldrin should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of aldrin from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of aldrin's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

A change room with showers, washing facilities, and lockers that permit separation of street and work clothes should be provided.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with aldrin should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle aldrin should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to aldrin may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for aldrin

Operations	Controls
During formulation and handling of insecticide	Personal protective equipment, local exhaust ventilation
During maintenance of equipment and storage containers	Personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• **Eye exposure**
Where there is any possibility of a worker's eyes being exposed to aldrin, an eye-wash fountain should be provided within the immediate work area for emergency use.

If aldrin gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• **Skin exposure**
Where there is any possibility of a worker's body being exposed to aldrin, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If aldrin gets on the skin, wash it immediately with soap and water. If aldrin penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If aldrin is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Aldrin solid may be collected and placed in an appropriate container.
3. Aldrin solid or liquid may be collected by vacuuming with an appropriate high-efficiency filtration system.
4. For small quantities of liquids containing aldrin, absorb on paper towels and place in an appropriate container.
5. Large quantities of liquids containing aldrin may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

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Table 3.—Respiratory protection for aldrin

Condition	Minimum respiratory protection*
Any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown or any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

Material Safety Data Sheet

from Genium's Reference Collection
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Schenectady, NY 12303-1836 USA
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GENIUM PUBLISHING CORP.

No. 300

ACETONE
(Revision E)
Issued: September 1985
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: ACETONE

Description (Origin/Uses): Used as a solvent for fats, oils, waxes, resins, rubber, plastics, varnishes, and rubber cements; also used in the manufacture of methyl isobutyl ketone, mesityl oxide, acetic acid, diacetone alcohol, chloroform, iodoform, bromoform, explosives, rayon, photographic films, and isoprene. Used to store acetylene gas. Widely used in the chemical process industry (CPI).

Other Designations: Dimethylformaldehyde; Dimethylketal; Dimethyl Ketone; Ketone Propane; Pyroacetic Acid; Pyroacetic Ether; C_3H_6O; CAS No. 0067-64-1

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 3 / 1 / 0 / -

HMIS			
H	1	R	1
F	3	I	1
R	0	S	2
PPG*		K	4

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Acetone, CAS No. 0067-64-1	Ca 100	**OSHA PELs** 8-Hr TWA: 750 ppm, 1800 mg/m³ STEL: 1000 ppm, 2400 mg/m³ **ACGIH TLVs, 1988-89** TLV-TWA: 750 ppm, 1780 mg/m³ TVL-STEL: 1000 ppm, 2375 mg/m³ **Toxicity Data*** Man, Inhalation, TD_{Lo}: 440 µg/m³ (6 Mins) Man, Inhalation, TD_{Lo}: 10 mg/m³ (6 Hrs)
*See NIOSH, *RTECS* (AL3150000), for additional data with references to reproductive, mutagenic, and irritative effects.		

SECTION 3. PHYSICAL DATA

Boiling Point: 134°F (56°C)
Melting Point: -137°F (-94°C)
Vapor Density (Air = 1): 2
Vapor Pressure: 180 Torrs at 68°F (20°C)
Evaporation Rate: Faster than That of *n*-Butyl Acetate

Molecular Weight: 58 Grams/Mole
Solubility in Water (%): Complete
Specific Gravity (H_2O = 1): 0.778 at 77°F (25°C)
% Volatile by Volume: 100

Appearance and Odor: A clear, colorless, highly flammable, volatile liquid with a characteristic, pleasant, sweetish odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: 1.4°F (-17°C) CC	Autoignition Temperature: 869°F (465°C)	LEL: 2.9% v/v	UEL: 12.8% v/v

Extinguishing Media: Use "alcohol" foam, dry chemical, or carbon dioxide. Use a blanketing effect to smother flames. Use water spray to reduce the rate of burning and to cool containers. Water will probably not be effective in directly extinguishing an acetone fire.

Unusual Fire or Explosion Hazards: Acetone vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Acetone is stable in closed containers during routine operations. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Acetone can react dangerously with strong oxidizing agents such as nitrates, perchlorates, permanganates, and concentrated sulfuric acid; chromic anhydride; chromyl chloride; hydrogen peroxide; hexachloromelamine; nitrosyl chloride; permonosulfuric acid; mixtures of sulfuric acid and nitric acid; mixtures of nitric acid and acetic acid; and potassium *tert*-butoxide.

Conditions to Avoid: Do not expose acetone to sources of ignition and incompatible chemicals.

Hazardous Products of Decomposition: Carbon monoxide and carbon dioxide can be produced during acetone fires.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Acetone is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Inhalation of high concentrations of acetone vapor can cause dryness of the mouth and throat; dizziness, nausea, incoordination, slurred speech, drowsiness, and, in severe exposures, coma. Inhalation of small quantities of acetone vapor for an extended period causes irritation of the respiratory tract, coughing, and headache. Prolonged or repeated skin contact with acetone has a defatting effect causing dryness, irritation, and mild dermatitis. Under routine operating conditions the amount of acetone absorbed through the skin is small. Ingestion of acetone may cause irritation of the gastrointestinal tract and narcosis. Acetone acts primarily as a depressant to the central nervous system (CNS) when exposures are severe or prolonged. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** See Summary of Risks, above. **Chronic Effects:** None reported. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Monitor the exposed person for symptoms of depression of the CNS such as incoordination and drowsiness. **Ingestion. Unlikely.*** If a small amount is ingested, dilute it slowly with 1 to 2 glasses of water or milk. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. ***Note to Physician:** Treatment for accidental ingestion of a small amount of acetone is unnecessary. If a large amount has been ingested, administer a charcoal slurry, either aqueous or mixed with a saline cathartic or sorbital.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup personnel need protection against this liquid's contact with skin or eyes as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.
Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Consider saving the waste hydrochloric acid for use as a neutralizing agent during cleanup operations of basic materials.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U002
CERCLA Hazardous Substance, Reportable Quantity: 5000 lbs (2270 kg), per the Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious butyl or natural rubber gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** Automatic sprinkler systems for fire protection are desirable in work areas. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale acetone vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store acetone in closed containers (carbon steel is recommended) in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks. **Other Precautions:** Use labeled safety cans when handling small amounts of acetone. Acetone presents a dangerous fire hazard; perform all work operations involving it carefully and in a way that will prevent exposing the liquid or its vapor to sources of ignition.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Acetone
DOT Hazard Class: Flammable Liquid
ID No. UN1090
DOT Label: Flammable Liquid
IMO Hazard Class: 3.1
IMO Label: Flammable Liquid
IMDG Packaging Group: II

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

No. 467

AUTOMOTIVE
GASOLINE, LEAD-FREE

Date October 1981

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: AUTOMOTIVE GASOLINE, LEAD-FREE
DESCRIPTION: A volatile blend of hydrocarbons for automotive fuel
OTHER DESIGNATIONS: Petrol, CAS #008 006 619, ASTM D439
MANUFACTURER: Available from several suppliers.

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Gasoline A hydrocarbon blend that can include normal and branched chain alkanes, cycloalkanes, alkenes, aromatics and other additives.** (Lead max 0.013 g/L, phosphorus max 0.0013 g/L, sulfur max 0.10 wt%. May contain benzene, <5%; see ASTM D3606). *ACGIH 1981 TLV (Intended Changes List). See also Am. Ind. Hyg. A. 39 110-117 (1978) **The composition of fuel is varied with altitude and seasonal requirements for a locality. The blend must meet antiknock requirements. (Antiknock Index min 85, ASTM D439.)	100	8-hr TWA 300 ppm or 900 mg/m^3* Man Eye: 500 ppm/1H Moderate irritation Inhalation: TCLo 900 ppm/1H TFX:CNS

SECTION III. PHYSICAL DATA

Distillation at 1 atm, Initial, deg C >39
50% distilled - 77-121
End point ----- <240
Vapor density (Air=1) ---------- 3.0-4.0
Solubility in water ---------- Insoluble

Specific gravity, 60/60 F - 0.72-0.76
Melting point, deg C ------ -90.5-95.4
Evaporation rate --------- N/A

Appearance and Odor: A clear, mobile liquid with a characteristic odor which can be recognized at about 10 ppm in air. (Gasoline may be colored with dye.)

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air % by volume	LOWER	UPPER
-45 F	536-853 F		1.4	7.6

Extinguishing Media: Dry chemical, carbon dioxide, alcohol foam. Use of water may be ineffective to extinguish fire, but use water spray for cooling fire-exposed drums and tanks to prevent pressure rupture. It is a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow along surfaces, reach distant ignition sources and flash back. Can react violently with oxidizing agents.
Firefighters should wear self-contained breathing apparatus and full protective clothing.

SECTION V. REACTIVITY DATA

This is a stable material in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.
This is an OSHA Class IA flammable liquid. A mixture of gasoline vapors and air can be explosive. It is incompatible with oxidizing agents.
Thermal-oxidative degradation can yield carbon monoxide and partially oxidized hydrocarbons.

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SECTION VI. HEALTH HAZARD INFORMATION

TLV 300 ppm (See Sect. II)

Inhalation causes intense burning of the mucous membranes, throat and respiratory tract; overexposure to vapors can lead to bronchopneumonia. Inhalation of high conc. can cause fatal pulmonary edema. Repeated or prolonged skin exposure causes dermatitis. Can cause blistering of skin due to its defatting properties. Exposure to eyes can cause hyperemia of the conjunctiva.

Ingestion or excessive vapors can cause inebriation, drowsiness, blurred vision, vertigo, confusion, vomiting and cyanosis (2000 ppm produces mild anesthesia in 30 min, higher conc. are intoxicating in less time.) Aspiration after ingestion causes bronchitis, pneumonia, or edema which can be fatal.

FIRST AID:

Eye Contact: Flush thoroughly with running water for 15 min. including under eyelids.

Skin Contact: Remove contaminated clothing. Wash affected area with soap and water.

Inhalation: Remove to fresh air. Restore breathing and administer oxygen if needed.

Ingestion: Do not induce vomiting. Aspiration hazard. Contact physician.

Seek prompt medical assistance for further treatment, observation and support.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of leaks or spills. Remove sources of heat or ignition. Provide adequate ventilation. Clean-up personnel require protection against liquid contact and vapor inhalation. If a leak or spill has not ignited, use water spray to disperse vapors and to protect men attempting to stop the leakage. Contain spill. Do not allow to enter sewer or surface water. Add absorbent solid to small spills or residues and pick up for disposal.

DISPOSAL: Burn scrap material in an approved incinerator. Burn contaminated liquid by spraying into an incinerator. Follow Federal, State, and Local regulations.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Use general and local exhaust ventilation (explosion-proof) to keep vapors below the TLV requirements in the workplace. Respirators should be available for nonroutine or emergency use above the TLV.

Avoid eye contact by use of chemical safety goggles and/or full faceshield where splashing is possible. Wear protective clothing appropriate for the work situation to minimize skin contact such as rubber gloves and boots. Clothing to be changed daily and laundered.

Eyewash fountains, showers and washing facilities should be readily accessible

Provide suitable training to those handling and working with this material.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from sources of heat, ignition and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IA liquid.

Outdoor or detached storage preferred. No smoking in areas of use. Prevent static electric sparks and use explosion-proof electrical services. (Must meet code.)

Avoid skin and eye contact. Avoid inhalation of vapors. Wear clean work clothing daily.

Indoor use of this material requires exhaust ventilation to remove vapors.

ICC Flammable Liquid, Red Label. LABEL: Flammable Liquid DOT I.D. No. UN 1203.

DOT Classification: FLAMMABLE LIQUID

DATA SOURCE(S) CODE: 2,4-9,34,37

APPROVALS: MIS CRD J.M. Quiser

Industrial Hygiene and Safety 10-27-81

MEDICAL REVIEW: 14 November 1981

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Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

Issued: 11/78 Revision: E, 8/90

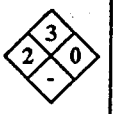
Section 1. Material Identification

32

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.
Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA



HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8

Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
%Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	Autoignition Temperature: 928 °F (498 °C)	LEL: 1.3% v/v	UEL: 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.
Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

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Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection **References:** 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 23

CADMIUM
(Revision C)
Issued: September 1977
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION 27

Material Name: CADMIUM

Description (Origin/Uses): Used in electroplating other metals; in dentistry; in alloys; in nickel-cadmium batteries; and in reactor control rods.

Other Designations: Cd; CAS No. 7440-43-9

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Genium

HMIS
H 3 R 1
F 1 I 4
R 0 S 1
PPG* K 4 (Dust)
*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS, EXPOSURE LIMITS

Cadmium, CAS No. 7440-43-9, ca 100%

OSHA PEL
8-Hr TWA: 0.1 mg/m³ (Cd Fume)
Ceiling: 0.3 mg/m³ (Cd Fume)
8-Hr TWA: 0.2 mg/m³ (Cd Dust)
Ceiling: 0.6 mg/m³ (Cd Dust)

ACGIH NIC,* 1988-89
TLV-TWA: 0.01 mg/m³ (Cadmium and Compounds, as Cd)
ACGIH A2, Suspected Human Carcinogen

ACGIH TLVs, 1988-89
TLV-TWA: 0.05 mg/m³ (Cadmium Dusts and Salts, as Cd)
TLV-Ceiling: 0.05 mg/m³ (Cadmium Oxide Fume, as Cd)
TLV-TWA: 0.05 mg/m³ (Cadmium Oxide Production)

Toxicity Data**
Human, Inhalation, LC_{Lo}: 39 mg/m³ (20 Minutes)

*Notice of Intended Changes, Genium reference 116, p. 39.
**See NIOSH, *RTECS* (EU9800000), for additional data referring to reproductive, tumorigenic, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 1413°F (767°C)
Melting Point: 610°F (321°C)
Vapor Pressure: 0.095 Torr at 610°F (321°C)
Molecular Weight: 112 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 8.642

Appearance and Odor: A soft, blue white, malleable, lustrous metal that can be cut easily with a knife; odorless.
Comments: Cadmium has a significant vapor pressure of 0.000021 torr (corresponding to 0.12 mg/m³) at 315°F (157°C). Heating this metal without using correct engineering controls and/or personal protective equipment can result in overexposure.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method*	Autoignition Temperature*	LEL*	UEL*

Extinguishing Media: *Cadmium metal burns readily in air if it is heated. As with most metals, the reactivity/dust-cloud-explosion hazard increases as the cadmium metal becomes more finely divided. In fact, finely divided, powdered cadmium metal can be pyrophoric (it burns spontaneously in air without any source of ignition). Carbon dioxide, dry chemical, or sand are recommended extinguishing agents for cadmium fires. **Unusual Fire or Explosion Hazards:** Cadmium dust can explode during a fire. Massive cadmium metal does not present this potential explosion hazard; however, certain work operations such as grinding, welding, or cutting, can produce dust made of finely divided cadmium particles. **Warning:** Do not create a dust cloud of cadmium particles, especially during cutting, grinding, or welding operations. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Cadmium is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Cadmium reacts dangerously with ammonium nitrate, hydrazoic acid, tellurium, and zinc (Genium ref. 84). **Conditions to Avoid:** Avoid all exposure to sources of ignition and to incompatible chemicals. **Hazardous Products of Decomposition:** When heated, which is likely during fires and work operations such as welding and machining, cadmium metal can decompose into cadmium metal fume and cadmium oxide fume.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: The ACGIH classifies cadmium and its compounds as suspected human carcinogens (group A2); the IARC lists them as probable human carcinogens (group 2B); and the NTP classifies them as anticipated human carcinogens (group b). **Summary of Risks:** Heating cadmium metal produces intensely irritating cadmium metal fume. The acute effects of its excessive inhalation, which include severe tracheobronchitis, pneumonitis, and pulmonary edema, are life threatening and are usually delayed for several hours; their mortality rate is about 20%. Nonfatal pneumonitis has resulted from exposure to 0.5 to 2.5 mg/m³; a fatality has been reported for five hours' exposure at 9 mg/m³ and for 1 hour's exposure at 40 to 50 mg/m³. There is no warning discomfort or immediate irritation from exposure to cadmium fume. Acute gastroenteritis and symptoms of metal fume fever are associated with even lower acute exposure. Symptoms of acute overexposure include excessive salivation, a dry, burning throat; headache; aching muscles; coughing; chest tightness and pain; nausea; chills, and fever chills; and fever. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, kidneys, and blood. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** See Summary of Risks, above. **Chronic Effects:** Long-term, chronic inhalation of cadmium dust, salts, or fume causes chronic cadmium poisoning characterized by a distinctive, nonhypertrophic emphysema with or without renal tubular injury, accompanied by the urinary excretion of a protein with a molecular weight

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SECTION 6. HEALTH HAZARD INFORMATION, cont.

of 20,000 to 30,000. This protein is itself a sign of early but reversible chronic poisoning. (Possible chromosomal aberrations and decreased birth weight among babies of women exposed to cadmium have been noted.) **Danger:** Continued overexposure from inhalation causes irreversible renal tubular damage. Cancer, anemia, eosinophilia, anosmia, chronic rhinitis, yellowed teeth, and bone changes have been reported. Bone pain in the ribs, backbone, and femur is common; disorders of calcium metabolism develop; and kidney stones and pulmonary fibrosis have been described. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** If a physician is not readily available, give the exposed person 2 to 3 glasses of water to drink and induce vomiting. A physician may administer a gastric lavage followed by saline catharsis. **Comments:** A comprehensive medical program is advised for those who work with cadmium or its compounds. This should include chest X rays and forced-vital-capacity tests. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Chelation therapy may be useful in treatment; calcium disodium edetate and pencillamine are recommended. Dimercaprol (BAL) is not recommended because of reported renal toxicity of the cadmium-BAL complex.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup procedures must not create dusty conditions. Pick up the spilled material using vacuuming, mopping, or wet-sweeping techniques. Cleanup personnel need protection against inhalation of dust and fume (see sect. 8). **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Concentrated solutions of cadmium waste can be precipitated with lime and collected by filtration. Effluent should be treated as needed to reduce the concentration of the cadmium to a level that is within regulatory compliance limits.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. D006 (40 CFR 261.24 [Characteristic of EP toxicity])
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of a cadmium solution is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne levels of cadmium below the OSHA PEL cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommnedations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. Do not wear work clothes home. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale cadmium fume. Do not expose individuals with lung, liver, kidney, and blood ailments to cadmium until such exposure is approved by a physician.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store cadmium in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. Avoid storage situations where corrosion can occur. Keep powdered cadmium in closed containers; prevent the airborne dispersion of powdered cadmium. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations to prevent static sparks. **Other Precautions:** The toxic effects of cadmium are influenced by the presence or absence of other elements such as zinc and selenium. If these materials are present in the workplace, careful evaluation of any exposure to cadmium is required to understand any contributing factors.

Hazardous Materials Table (49 CFR 172.101): Not Listed
Optional Hazardous Materials Table (49 CFR 172.102)

ID No. UN2570

IMO Shipping Name: Cadmium Compounds
IMO Hazard Class: 6.1
IMO Labels: Poison or Saint Andrew's Cross (X)*

*Harmful—Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Occupational Health Guideline for Chlordane *

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $C_{10}H_6Cl_8$ (approx.)
- Synonyms: 1,2,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindane; 1,2,4,5,6,7,8,8-octachloro-2,3, 3a,4,7,7a-hexahydro-4,7-methanoindene
- Appearance and odor: Thick amber liquid with a characteristic chlorine-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for chlordane is 0.5 milligram of chlordane per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Chlordane can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

Exposure to chlordane may cause shaking, blurred vision, irritability, confusion, delirium, staggering, convulsions, and death. Swallowing chlordane may also cause nausea, vomiting, and diarrhea. Chlordane exposure may cause kidney and liver damage. Absorption of chlordane through the skin is rapid and has resulted in death.

- **Reporting signs and symptoms**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to chlordane.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to chlordane at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of convulsive disorders would be expected to be at increased risk from exposure. Examination of the nervous system, eyes, lungs, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—Urinalysis: Since kidney damage has been observed in humans exposed to chlordane, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Chlordane predominantly affects the central nervous system, causing irritability, tremors, and convulsions. Chronic effects are reported in animals. Repeated oral administration to rabbits indicated a cumulative action at daily doses above 5 mg/kg; autopsy revealed focal necrosis of the liver, degenerative changes in the proximal convoluted tubules, pulmonary exudates and gastrointestinal irritation. In humans, inhalation and skin absorption have resulted in blurred vision, cough, confusion, ataxia, and delirium; ingestion has caused abdominal pain, nausea, vomiting, and diarrhea; severe intoxication has caused irritability, tremor, convulsions, and death. A suicidal person who ingested 6 g (104 mg/kg) of chlordane in talc suffered burns of the mouth, severe gastritis, diffuse pneumonia, anuria, mania, and convulsions; death occurred after 9.5 days; autopsy findings were severe necrotizing bronchopneumonia

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

and degeneration of renal tubule epithelium. Skin absorption of chlordane is rapid; a worker who spilled a 25% suspension of chlordane on clothing, which was not removed, began having convulsions 40 minutes later and died shortly thereafter. Technical-grade chlordane is stated to be irritating to the skin and mucous membranes, but this may be due to the presence of unreacted chemical intermediates.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 409.8 (approx).
2. Boiling point (760 mm Hg): (Decomposes); 175 C (347 F) (at 2 mm Hg)
3. Specific gravity (water = 1): 1.57 – 1.67
4. Vapor density (air = 1 at boiling point of chlordane): 14
5. Melting point: Data not available
6. Vapor pressure at 20 C (68 F): 0.00001 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: Temperatures above 200 C (392 F) cause decomposition with formation of chlorine and hydrogen chloride gases.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, chlorine, phosgene, and carbon monoxide) may be released when chlordane decomposes.
4. Special precautions: Chlordane will attack some forms of plastics, rubber, and coatings.

- **Flammability**

1. Not combustible

- **Warning properties**

Since chlordane has such a low vapor pressure, warning properties are not considered. Grant describes certain effects produced by chlordane on the eyes, but these effects were caused by systemic poisoning. They were not local effects. Chlordane is not known to be an eye irritant.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

An analytical method for chlordane is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 6, 1980, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00369-6).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with chlordane.
- If employees' clothing has had any possibility of being contaminated with chlordane, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing which has had any possibility of being contaminated with chlordane should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of chlordane from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the chlordane, the person performing the operation should be informed of chlordane's hazardous properties.
- Where there is any possibility of exposure of an employee's body to chlordane, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with chlordane should be removed immediately and not reworn until the chlordane is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where chlor-

dane may contact the eyes.

SANITATION

• Skin that becomes contaminated with chlordane should be immediately washed or showered with soap or mild detergent and water to remove any chlordane.
• Workers subject to skin contact with chlordane should wash with soap or mild detergent and water any areas of the body which may have contacted chlordane at the end of each work day.
• Eating and smoking should not be permitted in areas where chlordane is handled, processed, or stored.
• Employees who handle chlordane should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to chlordane may occur and control methods which may be effective in each case:

Operation	Controls
Application as an insecticide on pre-planting soil, fire ants, and harvester ants (banned by EPA in 1976)	Personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.
• **Eye Exposure**
If chlordane gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.
• **Skin Exposure**
If chlordane gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If chlordane soaks through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.
• **Breathing**
If a person breathes in large amounts of chlordane, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.
• **Swallowing**
When chlordane has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
• **Rescue**
Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
• If chlordane is spilled or leaked, the following steps should be taken:
1. Ventilate area of spill or leak.
2. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.
• Waste disposal method:
Chlordane may be disposed of by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in sealed containers in a secured sanitary landfill.

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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 20, 1979.

RESPIRATORY PROTECTION FOR CHLORDANE

Condition	Minimum Respiratory Protection* Required Above 0.5 mg/m³
Particulate Concentration	
5 mg/m³ or less	Any chemical cartridge respirator with an organic vapor cartridge(s) and dust and mist filter(s), including pesticide respirators which meet the requirements of this class. Any supplied-air respirator. Any self-contained breathing apparatus.
25 mg/m³ or less	A chemical cartridge respirator with a full facepiece, organic vapor cartridge(s), and dust and mist filter(s), including pesticide respirators which meet the requirements of this class. A chin-style or front- or back-mounted pesticide gas mask. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
500 mg/m³ or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode. A powered chemical cartridge respirator with an organic vapor cartridge and a high efficiency filter, including pesticide respirators which meet the requirements of this class.
Greater than 500 mg/m³** or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates, including pesticide respirators which meet the requirements of this class. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of chlordane; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 500 mg/m³, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

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Material Safety Data Sheets Collection:

Sheet No. 83
Chromium Metal/Powder

Issued: 3/81 Revision: A, 11/89

Section 1. Material Identification 30

Chromium Metal/Powder Description: Obtained from chrome ore, chromite ($FeCr_2O_4$), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.
Other Designations: Chrome; Cr; CAS No. 7440-47-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 1
K 1

Genium

HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

OSHA PEL	ACGIH TLV, 1988-89*	NIOSH REL, 1987†	Toxicity Data‡
8-hr TWA: 1 mg/m³	TLV-TWA: 0.5 mg/m³	8-hr TWA (for chromium metal and insoluble salts): 1 mg Cr/m³	Rat, implant, TD_{Lo}: 1200 µg/kg body weight administered intermittently over six weeks

* This TLV is applicable to Cr^{+2} and Cr^{+3} compounds. For water soluble and water-insoluble Cr^{+6}, the 8-hr TWA is 0.05 mg Cr^{+6}/m^3. Certain water-insoluble Cr^{+6} compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).
† The NIOSH REL (10-hr TWA) for carcinogen Cr^{+6} compounds is 1 µg/m³; for noncarcinogenic Cr^{+6} compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr^{+6} (chromic acid anhydride). Any and all Cr^{+6} materials excluded from the noncarcinogenic group above are carcinogenic Cr^{+6} compounds.
‡ See NIOSH, *RTECS* (GB4200000), for additional data with references to tumorigenic effects.

Section 3. Physical Data

Boiling Point: 4788 °F (2642 °C)
Melting Point: 3452 °F (1900 °C)
Vapor Pressure: 1 mm Hg at 2941 °F (1616 °C)
Vapor Density (Air = 1): 1.79
Atomic Weight: 51.996 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.2 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: Steel-gray, lustrous metal; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: Cloud, 1076 °F (580 °C); dust layer, 752 °F (400 °C)	LEL: Dust cloud explosion, 0.230 oz/ft³	UEL: None reported

Extinguishing Media: Use dry chemical or sand.
Unusual Fire or Explosion Hazards: Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in CO_2 is ignitable and explosive when heated.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high O_2 concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.
Hazardous Products of Decomposition: Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

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Section 6. Health Hazard Data

Carcinogenicity: The NTP and OSHA list chromium as a human carcinogen.
Summary of Risks: When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 (Cr^{+3}) compounds show little or no toxicity. Less soluble chromium 6 (Cr^{+6}) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and skin (Sec. 2). Chromic acid or chromate salts cause irritation of the skin and respiratory passage. Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).
Medical Conditions Aggravated by Long-Term Exposure: An incresed incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.
Target Organs: Respiratory system.
Primary Entry: Inhalation, percutaneous absorption, and ingestion.
Acute Effects: Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.
Chronic Effects: Asthmatic bronchitis.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: Brush off chromium dust. After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomoting. A physician should evaluate all ingestion cases.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.
Physician's Note: Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoetic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr^{+6} to Cr^{+3}. Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.
Disposal: Reclaim salvageable metal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Wear a NIOSH-approved respirator if necessary. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 mg/m^3.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.
Engineering Controls: Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126
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Occupational Health Guideline for 2,4-D *

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $Cl_2C_6H_3OCH_2COOH$
- Synonyms: 2,4-Dichlorophenoxyacetic acid
- Appearance and odor: Colorless, odorless solid

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for 2,4-D is 10 milligrams of 2,4-D per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

2,4-D can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

1. Short-term Exposure: Massive exposure to 2,4-D may cause weakness, stupor, muscle twitching, and convulsions. Contact of the material with the skin may cause a rash. It has caused minor liver and kidney damage in animals.

2. Long-term Exposure: Not known.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to 2,4-D.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to 2,4-D at potentially hazardous levels:

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from 2,4-D exposure.

—Liver disease: 2,4-D causes liver damage in animals. The importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

—Kidney disease: 2,4-D causes kidney damage in animals. The importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Cardiovascular disease: 2,4-D causes ventricular fibrillation in animals. In persons with impaired cardiovascular function, the inhalation of 2,4-D might cause exacerbation of pre-existing disorder.

—Skin disease: 2,4-D can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

—Convulsive disorder or neuropathy: 2,4-D may cause convulsions in humans. Persons with a history of such disorders may be more susceptible to the effects of this agent. 2,4-D may also produce neuropathy by analogy to effects observed in experimental animals.

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

- **Summary of toxicology**

2,4-D dust causes signs of both hypo- and hyperexcitation of the central nervous system in animals. In several species of animals given massive oral doses, sudden death has been ascribed to ventricular fibrillation. If death is delayed, myotonia, stiffness of the extremities, ataxia, paralysis, and coma are seen; autopsy findings have included minor liver and kidney injury. The myotonia characteristic of intoxication by 2,4-D in animals has not been reported in humans. Possibly the only recognized fatal case of poisoning involved a suicidal person who ingested not less than 6500 mg; the

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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person apparently experienced violent convulsions, although they were not actually observed; there were no significant findings at autopsy. A single dose of 3.6 g of 2,4-D administered intravenously to a patient for treatment of disseminated coccidiomycosis caused stupor, hyporeflexia, fibrillary twitching of some muscles, and urinary incontinence; 24 hours after the dose, the patient still complained of profound muscular weakness, which subsided after an additional 24 hours. Contact of the material with the skin may cause dermatitis; skin absorption is slight.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 221
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 1.1 (estimated)
4. Vapor density (air = 1 at boiling point of 2,4-D): 7.63
5. Melting point: 140 C (284 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, at 20 C (68 F): 0.07 ppm
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: None
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride and carbon monoxide) may be released in a fire involving 2,4-D.
4. Special precautions: None

- **Flammability**

1. Flash point: Data not available
2. Autoignition temperature: Data not available
3. Flammable limits in air, % by volume: Data not available
4. Extinguishant: Carbon dioxide, dry chemical, foam, water

- **Warning properties**

Since 2,4-D has a negligible vapor pressure, warning properties are not considered.

Grant states that "2,4-dichlorophenoxyacetic acid (2,4-D) is a herbicide for weed control, often used in the form of its salts or esters. Parenteral administration to dogs has caused sneezing, lacrimation, and rubbing of the eyes, along with gastrointestinal disturbances. In three human beings, absorption of an unspecified ester of dichlorophenoxyacetic acid through the skin caused polyneuritis, but with no disturbance of the eyes or vision." The above do not appear to be local effects on the eye. However, Stolman and Stecher note that this substance can cause irritation of the eyes.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

An analytical method for 2,4-D is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with 2,4-D or liquids containing 2,4-D.
- If employees' clothing may have become contaminated with 2,4-D, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing contaminated with 2,4-D should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of 2,4-D from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the 2,4-D, the person performing the operation should be informed of 2,4-D's hazardous properties.
- Non-impervious clothing which becomes contami-

nated with 2,4-D should be removed promptly and not reworn until the 2,4-D is removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where 2,4-D or liquids containing 2,4-D may contact the eyes.

SANITATION

• Skin that becomes contaminated with 2,4-D should be promptly washed or showered with soap or mild detergent and water to remove any 2,4-D.

• Eating and smoking should not be permitted in areas where solid 2,4-D is handled, processed, or stored.

• Employees who handle 2,4-D or liquids containing 2,4-D should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to 2,4-D may occur and control methods which may be effective in each case:

Operation	Controls
Formulation of herbicides	Process enclosure; local exhaust ventilation; personal protective equipment; washing facilities
Manufacture of 2,4-D	Process enclosure; local exhaust ventilation; personal protective equipment; washing facilities
Application on cereal crops, corn, sorghum, milo, sugar cane, pastures, range land, and lawns for use as an herbicide; use as a plant hormone on agricultural crops	Personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If 2,4-D or liquids containing 2,4-D get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If 2,4-D or liquids containing 2,4-D get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If 2,4-D or liquids containing 2,4-D penetrate through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of 2,4-D, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When 2,4-D has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If 2,4-D is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. For small quantities, sweep onto paper or other suitable material, place in an appropriate container and burn in a safe place (such as a fume hood). Large quantities may be reclaimed; however, if this is not practical, dispose of by burning in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device, as in below or deposit in a secured sanitary landfill.

• Waste disposal methods:

2,4-D may be disposed of:

1. By making packages of 2,4-D in paper or other flammable material and burning in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
2. By dissolving 2,4-D in a flammable solvent (such as alcohol) and atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.
3. By disposal in a secured sanitary landfill.

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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 15, 1977.

RESPIRATORY PROTECTION FOR 2,4-D

Condition	Minimum Respiratory Protection* Required Above 10 mg/m³
Particulate Concentration	
100 mg/m³ or less	Any chemical cartridge respirator with an organic vapor cartridge(s) and dust filter(s), including pesticide respirators which meet the requirements of this class. Any supplied-air respirator. Any self-contained breathing apparatus.
500 mg/m³ or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s), and dust filter(s), including pesticide respirators which meet the requirements of this class. A gas mask with a chin-style or a front- or back-mounted organic vapor canister and dust and mist filter, including pesticide respirators which meet the requirements of this class. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 500 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates, including pesticide respirators which meet the requirements of this class. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR DDT

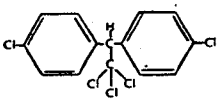
POTENTIAL HUMAN CARCINOGEN

INTRODUCTION

This guideline summarizes pertinent information about DDT for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Formula:** $C_{14}H_9Cl_5$
- **Structure:**



- **Synonyms:** Citox; genitox; dichlorodiphenyltrichloroethane; 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane
- **Identifiers:** CAS 50-29-3; RTECS KJ3325000; DOT 2761
- **Appearance and odor:** Colorless crystals or white to slightly off-white powder with a slightly aromatic odor

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 354.48
2. Boiling point (at 760 mmHg): 260°C (500°F)
3. Specific gravity (water = 1): 1.56
4. Vapor density (air = 1 at boiling point of DDT): 12.2
5. Melting point: 105-109°C (221-228°F)
6. Vapor pressure at 20°C (68°F): 1.5 x 10^{-7} mmHg
7. Practically insoluble in water

- **Reactivity**

1. Incompatibilities: DDT should not be stored in iron containers; DDT should not be mixed with iron and aluminum salts or with alkaline materials. Temperatures greater than 100°C (212°F) may cause decomposition.
2. Hazardous decomposition products: Toxic vapors and gases (e.g., hydrogen chloride) may be released in a fire involving DDT.
3. Caution: DDT should be stored in a tightly closed container in a well-ventilated area.

- **Warning properties**

Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for DDT is 1 milligram of DDT per cubic meter of air (mg/m³) as a time-weighted average (TWA) concentration over an 8-hour workshift (Skin). The notation "Skin" refers to the potential contribution to overall exposure by the cutaneous route including the mucous membranes and eyes. The National Institute for Occupational Safety and Health (NIOSH) recommends that DDT be controlled and handled as a potential human carcinogen in the workplace and that exposure be minimized to the lowest feasible limit. The NIOSH recommended exposure limit (REL) is 0.5 mg/m³ as a TWA for up to a 10-hour workshift, 40-hour workweek. The NIOSH REL is the lowest concentration reliably detectable by current NIOSH-validated sampling and analytical methods. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) is 1 mg/m³ as a TWA for a normal 8-hour workday and a 40-hour workweek; the short-term exposure limit (STEL) is 3 mg/m³ (Table 1).

Table 1.—Occupational exposure limits for DDT

	Exposure limits mg/m³
OSHA PEL TWA (Skin)*	1
NIOSH REL TWA (CA)†	0.5§
ACGIH TLV® TWA	1

* (Skin): Potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes.
† (Ca): NIOSH recommends treating as a potential human carcinogen.
§ Lowest reliably detectable level.

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NOTE: A general ban was ordered by the Environmental Protection Agency on the registration of DDT, effective December 31, 1972. Effective the same date, the ban for uses of DDT by public health officials in disease control programs and by USDA and the military for health quarantine and prescription drugs use was lifted.

HEALTH HAZARD INFORMATION

• Routes of exposure

DDT may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• Summary of toxicology

Effects on animals: Acute oral administration of DDT to rats caused tissue destruction (necrosis) of the liver, mild degeneration of kidney tubules, and changes in electroencephalograms. Chronic oral administration of DDT caused decreased fertility in rats and increased mortality of their offspring, toxic effects on the liver (including necrosis, fat deposition, increased weight, and increased enzyme activity), and liver cancer. In mice, chronic oral administration of DDT produced cancers of the liver, lungs, and lymphatic system.

• Signs and symptoms of exposure

Short-term (acute): Exposure to DDT can cause a prickling sensation of the tongue, lips, and face, a general feeling of ill health, headache, fatigue, vomiting, dizziness, tremors, convulsions, partial paralysis of the hands, and coma. DDT can also cause irritation of the eyes and skin.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to DDT, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic or laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, and reproductive and nervous systems.

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to DDT at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include chronic liver disease. Workers should inform their physicians of their potential for exposures to DDT because internal absorption of this chemical pathologically increases the liver's ability to metabolize and eliminate medications which may be prescribed or taken "over the counter."

• Periodic medical screening and/or biologic monitoring

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to DDT. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function of the eyes, skin, liver, and reproductive and nervous systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population.

• Medical practices recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to DDT may cause adverse reproductive effects or diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to DDT should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• **Method**

Sampling and analysis may be performed by collecting DDT vapors with charcoal adsorption tubes followed by desorption with carbon disulfide and analysis by gas chromatography. Detector tubes or other direct-reading devices calibrated to measure DDT may also be used if available. A detailed sampling and analytical method for DDT may be found in the *NIOSH Manual of Analytical Methods* (method number S 274).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with DDT.

SANITATION

Clothing which is contaminated with DDT should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of DDT from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of DDT's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with DDT should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle DDT should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to DDT may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for DDT

Operations	Controls
During preparation and handling of insecticide	Process enclosure, local exhaust ventilation, personal protective equipment
During maintenance of equipment and storage containers	Personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to DDT, an eye-wash fountain should be provided within the immediate work area for emergency use.

If DDT gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• **Skin exposure**

Where there is any possibility of a worker's body being exposed to DDT, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If DDT gets on the skin, wash it immediately with soap and water. If DDT penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If DDT is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. For small quantities of liquids containing DDT, absorb on paper towels and place in an appropriate container.
3. Large quantities of liquids containing DDT may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.
4. If in solid form, DDT may be collected and placed in an appropriate container.
5. DDT dust may be collected by vacuuming with an appropriate high-efficiency filtration system.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or

minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

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Table 3.—Respiratory protection for DDT

Condition	Minimum respiratory protection*
Any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown or any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

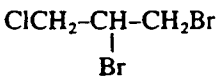
OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR DIBROMOCHLOROPROPANE POTENTIAL HUMAN CARCINOGEN

INTRODUCTION

This guideline summarizes pertinent information about dibromochloropropane (DBCP) for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Formula:** $C_3H_5Br_2Cl$
- **Structure:**



- **Synonyms:** 1-Chloro-2,3-dibromopropane; DBCP; 1,2-dibromo-3-chloropropane
- **Identifiers:** CAS 96-12-8; RTECS TX8750000; DOT 2872, label required: "St. Andrew's Cross (X)"
- **Appearance and odor:** Dense yellow or amber liquid or granular solid with a pungent odor

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 236.35
2. Boiling point (at 760 mmHg): 195°C (383°F)
3. Specific gravity (water = 1): 2.093
4. Melting point: 6°C (43°F)
5. Vapor pressure at 20°C (68°F): 0.8 mmHg
6. Solubility in water, g/100 g water at 20°C (68°F): 0.1
7. Saturation concentration in air (approximate) at 20°C (68°F): 0.1% (1000 ppm)

- **Reactivity**

1. Incompatibilities: DBCP reacts with chemically active metals such as aluminum, magnesium, and tin alloys.
2. Hazardous decomposition products: Toxic vapors and gases (e.g., hydrogen bromide, hydrogen chloride, and carbon monoxide) may be released in a fire involving DBCP.
3. Caution: DBCP will attack some rubber materials and coatings.

- **Flammability**

1. Flash point: 77°C (170°F) (open cup)
2. Extinguishant: Carbon dioxide or dry chemical
3. Class IIIA Combustible Liquid (29 CFR 1910.106)

- **Warning properties**

1. Odor threshold: 0.01-0.03 ppm
2. Evaluation of warning properties for respirator selection: Because of the lack of odor at concentrations below the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL), DBCP is treated as a chemical with poor warning properties.

EXPOSURE LIMITS

The Occupational Safety and Health Administration (OSHA) considers DBCP to be a cancer hazard. The current OSHA permissible exposure limit (PEL) for DBCP is 1 part of DBCP per billion parts of air (ppb) as a time-weighted average (TWA) concentration over an 8-hour workshift; the employer shall assure that no employee is exposed to eye or skin contact with DBCP. The NIOSH REL is 10 ppb as a TWA [0.1 milligrams of DBCP per cubic meter of air (mg/m^3)] for up to a 10-hour workshift, 40-hour workweek; however, the NIOSH REL has been superseded by the OSHA standard promulgated in 1978. The American Conference of Governmental Industrial Hygienists (ACGIH) does not have an assigned threshold limit value (TLV®) for DBCP.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

DBCP may cause adverse health effects following exposure via inhalation or dermal or eye contact.

- **Summary of toxicology**

1. *Effects on animals:* In rats, acute inhalation or oral administration of DBCP caused central nervous system depression with sluggishness and loss of muscular coordination (ataxia), weight loss, and decreased spermatogenesis; acute dermal exposure caused dermal and subcutaneous tissue destruction (necrosis).

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Division of Standards Development and Technology Transfer

Subchronic inhalation of DBCP by rats, guinea pigs, rabbits, or monkeys produced necrosis of the liver, kidney, spleen, testes, or seminiferous tubules; reduction in sperm count; abnormal sperm; or inhibition of the estrous cycle. Cancers of the nasal cavity, tongue, pharynx, lungs, stomach, adrenal glands, or mammary glands have been reported for rats or mice chronically exposed to DBCP by inhalation or oral administration.

2. *Effects on humans:* Low-level repeated or prolonged exposure of male workers has been associated with low sperm count, chromosome abnormality, sterility, decreased testicular size, and increased level of follicle stimulating hormone. These effects have not been associated with exposure in previous years, indicating that they may be reversible following removal from exposure.

• Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to DBCP can cause drowsiness, nausea, vomiting, and irritation of the eyes, nose, throat and skin.

2. *Long-term (chronic):* Exposure to DBCP can cause congestion or fluid in the lungs and inflammation of the eyes or skin.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to DBCP, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the eyes, skin, liver, kidneys, urinary tract, and reproductive and respiratory systems. Medical surveillance for respiratory disease should be conducted by using the principles and methods recommended by NIOSH and the American Thoracic Society (ATS).

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to DBCP at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include a history of chronic skin disease or concurrent dermatitis and a history of reproductive dysfunction. In addition to the medical interview and physical examination, the means to identify these conditions may include an evaluation of fertility.

• Periodic medical screening and/or biologic monitoring

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to DBCP. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function and integrity of the eyes, skin, liver, kidneys, urinary tract, and respiratory and reproductive systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized procedures and evaluation criteria recommended by NIOSH and ATS: standardized questionnaires and tests of lung function.

• Medical practices recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to DBCP may cause adverse reproductive effects and diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• Sentinel health events

1. Acute SHE's include: Contact and/or allergic dermatitis.
2. Delayed-onset or reproductive SHE's include: Infertility in exposed males.

MONITORING AND MEASUREMENT PROCEDURES

• TWA exposure evaluation

Measurements to determine worker exposure to DBCP should be taken so that the TWA exposure is based on a single entire

workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• **Method**

There are no NIOSH validated sampling and analytical methods for DBCP.

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, face shields (8-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with DBCP.

Workers should be provided with and required to use dust- and splash-proof safety goggles where DBCP or other dust may come in contact with the eyes.

SANITATION

Clothing which is contaminated with DBCP should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of DBCP from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of DBCP's hazardous properties.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

Skin that becomes contaminated with DBCP should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle DBCP should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to DBCP may occur and control methods which may be effective in each case are listed in Table 1.

Table 1.—Operations and methods of control for dibromochloropropane

Operations	Controls
During the manufacture of DBCP	Completely enclosed processes, local exhaust ventilation, personal protective equipment
During the formulation of DBCP into pesticides and fumigants	Local exhaust ventilation, protective clothing and equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to DBCP, an eye-wash fountain should be provided within the immediate work area for emergency use.

If DBCP gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• **Skin exposure**

Where there is any possibility of a worker's body being exposed to DBCP, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If DBCP gets on the skin, wash it immediately with soap and water. If DBCP penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If DBCP is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities of liquids containing DBCP, absorb on paper towels and place in an appropriate container. Place towels

in a safe place such as a fume hood for evaporation. Allow sufficient time for evaporation of the vapors so that the hood ductwork is free from DBCP vapors. Burn the paper in a suitable location away from combustible materials.

4. Large quantities of liquids containing DBCP may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container. DBCP should not be allowed to enter a confined space such as a sewer because of the possibility of an explosion.

5. DBCP liquid or solid may be collected by vacuuming with an appropriate system. If a vacuum system is used, there should be no sources of ignition in the vicinity of the spill and flashback prevention devices should be provided.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations, including those requiring confined-space entry (Table 2).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards, 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

For each level of respiratory protection only those respirators that have the minimum required protection factor and meet other use restrictions are listed. All respirators that have higher protection factors may also be used.

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Table 2.—Respiratory protection for dibromochloropropane

Condition	Minimum respiratory protection*
Any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown or any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR DIELDRIN

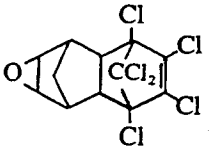
POTENTIAL HUMAN CARCINOGEN

INTRODUCTION

This guideline summarizes pertinent information about dieldrin for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Formula:** $C_{12}H_8Cl_6O$
- **Structure:**



- **Synonyms:** Dieldrex; dieldrine; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro,endo,exo-1,4:5,8-dimethanonaphthalene; illoxol; octalox
- **Identifiers:** CAS 60-57-1; RTECS IO1750000; DOT 2761
- **Appearance and odor:** Light brown crystals with a mild chemical odor

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 380.90
2. Boiling point (at 760 mmHg): Decomposes
3. Specific gravity (water = 1): 1.75
4. Vapor density (air = 1 at boiling point of dieldrin): 13.2
5. Melting point: 176°C (349°F)
6. Vapor pressure at 20°C (68°F): 1.8 x 10^{-7} mmHg
7. Solubility in water, mg/l water at 25°-29°C (77°-84°F): 0.186

- **Reactivity**

1. Incompatibilities: Dieldrin may react with concentrated mineral acids, acid catalysts, acid oxidizing agents, phenols, or reactive metals.
2. Hazardous decomposition products: Hydrochloric acid fumes and other chlorinated decomposition products may be released in a fire involving dieldrin.
3. Caution: Dieldrin should be stored in a tightly closed container in a well-ventilated area.

- **Flammability**

Nonflammable

- **Warning properties**

Evaluation of warning properties for respirator selection: Warning properties are not considered in recommending respirators for use with carcinogens.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for dieldrin is 0.25 milligrams of dieldrin per cubic meter of air (mg/m³) as a time-weighted average (TWA) concentration over an 8-hour workshift (Skin). The notation "Skin" refers to the potential contribution to overall exposure by the cutaneous route including the mucous membranes and eyes. The National Institute for Occupational Safety and Health (NIOSH) recommends that dieldrin be controlled and handled as a potential human carcinogen in the workplace and that exposure be minimized to the lowest feasible limt. The NIOSH recommended exposure limit (REL) is 0.15 mg/m³ as a TWA for up to a 10-hour workshift, 40-hour workweek. The NIOSH REL is the lowest concentration reliably detectable by current NIOSH-validated sampling and analytical methods. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) is 0.25 mg/m³ (Skin) as a TWA for a normal 8-hour workday and a 40-hour workweek (Table 1).

Table 1.—Occupational exposure limits for dieldrin

	Exposure limits mg/m³
OSHA PEL TWA (Skin)*	0.25
NIOSH REL TWA (Ca)†	0.15§
ACGIH TLV® (Skin)	0.25

* (Skin): Potential contribution to overall exposure by the cutaneous route including mucous membranes and eyes.
† (Ca): NIOSH recommends treating as a potential human carcinogen.
§ Lowest reliably detectable level.

NOTE: Most uses of dieldrin were suspended by the Environmental Protection Agency, effective October 18, 1974. The only

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uses allowed are direct soil application, seed treatment if labeled "not for food use," dipping of plant roots and tops, subsurface termite control, and hot-caps.

HEALTH HAZARD

• Routes of exposure

Dieldrin may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact. Dermal absorption is substantially increased when dieldrin is dissolved in organic solvents.

• Summary of toxicology

1. *Effects on animals:* Acute oral administration of dieldrin to rats caused liver and kidney degeneration. Chronic oral administration of dieldrin produced enlarged livers and increased liver enzyme activities in mice and rats, liver and lung cancers in mice, and adrenal cancer in rats. Dieldrin fed to pregnant mice and hamsters caused increased fetal deaths, congenital anomalies, and growth retardation in the offspring.
2. *Effects on humans:* Dieldrin is a neurotoxin and may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.

• Signs and symptoms of exposure

1. *Short-term (acute):* Exposure to dieldrin can cause hyperirritability, headache, dizziness, nausea, vomiting, blood in the urine, tremors, convulsions, and coma.
2. *Long-term (chronic):* Exposure to dieldrin can cause dermatitis, weight loss, muscular twitching, and convulsions.

RECOMMENDED MEDICAL PRACTICES

• Medical surveillance program

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

• Preplacement medical evaluation

Prior to placing a worker in a job with a potential for exposure to dieldrin, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic or laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the skin, eyes, liver, kidneys, and hematopoietic (blood-cell-forming), reproductive, and nervous systems.

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to dieldrin at or below the NIOSH REL. The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include: preexisting chronic diseases of the skin, liver, kidneys, and hematopoietic and reproductive systems. Workers should inform their physicians of their potential for exposures to dieldrin because internal absorption of this chemical pathologically increases the liver's ability to metabolize and eliminate medications which may be prescribed or taken "over the counter." The physician should obtain baseline values for liver function tests and a complete blood count with a reticulocyte count.

• Periodic medical screening and/or biologic monitoring

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to dieldrin. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the integrity and physiologic function of the eyes, skin, liver, kidneys, and hematopoietic, reproductive, and nervous systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population.

• Medical practices recommended at the time of job transfer or termination

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to dieldrin may cause diseases of prolonged induction-latency, the need for medical surveillance may extend well beyond termination of employment.

• Sentinel health events

1. Acute SHE's include: Non-autoimmune hemolytic anemia.
2. Delayed onset SHE's include: Cataract, toxic hepatitis, and non-autoimmune hemolytic anemia.

MONITORING AND MEASUREMENT PROCEDURES

• **TWA exposure evaluation**
Measurements to determine worker exposure to dieldrin should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

• **Method**
Sampling and analysis may be performed by collecting dieldrin with glass fiber filters followed by extraction with isooctane and analysis by gas chromatography. A detailed sampling and analytical method for dieldrin may be found in the *NIOSH Manual of Analytical Methods* (method number S283).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, and other appropriate protective clothing necessary to prevent skin contact with dieldrin.

SANITATION

Clothing which is contaminated with dieldrin should be removed immediately and placed in sealed containers for storage until it can be discarded or until provision is made for the removal of dieldrin from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of dieldrin's hazardous properties. Reusable clothing and equipment should be checked for residual contamination before reuse or storage.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

Workers should be required to shower following a workshift and prior to putting on street clothes. Clean work clothes should be provided daily.

Skin that becomes contaminated with dieldrin should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle dieldrin should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to dieldrin may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for dieldrin

Operations	Controls
During formulation and handling of insecticide	Personal protective equipment, local exhaust ventilation
During maintenance of equipment and storage containers	Personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

• **Eye exposure**
Where there is any possibility of a worker's eyes being exposed to dieldrin, an eye-wash fountain should be provided within the immediate work area for emergency use.

If dieldrin gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this chemical.

• **Skin exposure**
Where there is any possibility of a worker's body being exposed to dieldrin, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If dieldrin gets on the skin, wash it immediately with soap and water. If dieldrin penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

• **Rescue**
If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If dieldrin is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Dieldrin solid may be collected and placed in an appropriate container.
3. Dieldrin dust may be collected by vacuuming with an appropriate high-efficiency filtration system.
4. For small quantities of liquids containing dieldrin, absorb on paper towels and place in an appropriate container.
5. Large quantities of liquids containing dieldrin may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

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Table 3.—Respiratory protection for dieldrin

Condition	Minimum respiratory protection*
Any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown or any detectable concentration	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter
	Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

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Material Safety Data Sheets Collection:

Sheet No. 470
Diesel Fuel Oil No. 2-D

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

Diesel Fuel Oil No. 2-D Description: Diesel fuel is obtained from the middle distillate in petroleum separation; a distillate oil of low sulfur content. It is composed chiefly of unbranched paraffins. Diesel fuel is available in various grades, one of which is synonymous with fuel oil No. 2-D. This diesel fuel oil requires a minimum Cetane No. (efficiency rating for diesel fuel comparable to octane number ratings for gasoline) of 40 (ASTM D613). Used as a fuel for trucks, ships, and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

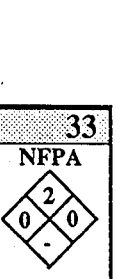
Other Designations: CAS No. 68334-30-5, diesel fuel.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: Diesel fuel oil No. 2-D is a skin irritant and central nervous depressant with high mist concentrations. It is an environmental hazard and moderate fire risk.

R	1
I	-
S	2
K	2

NFPA



HMIS
H 0
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PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Diesel fuel oil No. 2-D*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data‡
None established	Mineral Oil Mist TWA: 5 mg/m³† STEL: 10 mg/m³	None established	Rat, oral, LD_{50}: 9 g/kg produces gastrointestinal (hypermotility, diarrhea) effects

* Diesel fuel No. 2-D tends to be low in aromatics and high in paraffinics. This fuel oil is complex mixture of: 1) >95% paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, 2) sulfur (<0.5%), and 3) benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)]. Although low in the fuel itself, benzene concentrations are likely to be much higher in processing areas.
† As sampled by nonvapor-collecting method.
‡ Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 340 to 675 °F (171 to 358 °C)
Viscosity: 1.9 to 4.1 centistoke at 104 °F (40 °C)
Specific Gravity: <0.86
Water Solubility: Insoluble
Appearance and Odor: Brown, slightly viscous liquid.

Section 4. Fire and Explosion Data

Flash Point: 125 °F (52 °C) min.	Autoignition Temperature: >500 °F (932 °C)	LEL: 0.6% v/v	UEL: 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or foam to fight fire. Use a water spray to cool fire exposed containers. Do not use a forced water spray directly on burning oil since this will scatter the fire. Use a smothering technique for extinguishing fire.

Unusual Fire or Explosion Hazards: Diesel fuel oil No. 2-D is a OSHA Class II combustible liquid. Its volatility is similar to that of gas oil. Vapors may travel to a source of ignition and flash back.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to pollution and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Diesel fuel oil No. 2-D is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: It is incompatible with strong oxidizing agents; heating greatly increases the fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of diesel fuel oil No. 2-D can produce various hydrocarbons and hydrocarbon derivatives, and other partial oxidation products such as carbon dioxide, carbon monoxide, and sulfur dioxide.

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Section 6. Health Hazard Data

Carcinogenicity: Although the IARC has not assigned an overall evaluation to diesel fuels as a group, it has evaluated occupational exposures in petroleum refining as an IARC probable human carcinogen (Group 2A). It has evaluated distillate (light) diesel oils as not classifiable as human carcinogens (Group 3).
Summary of Risks: Although diesel fuel's toxicologic effects should resemble kerosine's, they are somewhat more pronounced due to additives such as sulfurized esters. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, vomiting, and loss of coordination, depending on concentration and exposure time. When removed from exposure area, affected persons usually recover completely. If vomiting occurs after ingestion and if oil is aspirated into the lungs, hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result. A comparative ratio of oral to aspirated lethal doses may be 1 pt vs. 5 ml. Aspiration may also result in transient CNS depression or excitement. Secondary effects may include hypoxia (insufficient oxygen in body cells), infection, pneumatocele formation, and chronic lung dysfunction. Inhalation may result in euphoria, cardiac dysrhythmias, respiratory arrest, and CNS toxicity. Prolonged or repeated skin contact may irritate hair follicles and block sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system, skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal irritation, vomiting, diarrhea, and in severe cases central nervous system depression, progressing to coma or death. Inhalation of aerosols or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish discoloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body have been exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately. Position to avoid aspiration.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Diesel fuel oil No. 2-D spills may be environmental hazards. Report large spills.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with a mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for a OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in storage or use areas.
Engineering Controls: Avoid vapor or mist inhalation and prolonged skin contact. Wear protective rubber gloves and chemical safety glasses where contact with liquid or high mist concentration may occur. Additional suitable protective clothing may be required depending on working conditions. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. At least weekly laundering of work clothes is recommended. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.
Transportation Data (49 CFR 172.101)
DOT Shipping Name: Fuel oil
DOT Hazard Class: Combustible liquid
ID No.: NA1993
DOT Label: None
DOT Packaging Exceptions: 173.118a
DOT Packaging Requirements: None

MSDS Collection **References:** 1, 6, 7, 12, 73, 84, 101, 103, 126, 127, 132, 133, 136, 143, 146
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MD; **Edited by:** JR Stuart, MS

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GENIUM PUBLISHING CORP.

No. 385

ETHYL BENZENE
(Revision A)
Issued: August 1978
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: ETHYL BENZENE

Description (Origin/Uses): Used as a solvent and as an intermediate in the production of styrene monomer.

Other Designations: Phenylethane; Ethylbenzol; $C_2H_5C_6H_5$; CAS No. 0100-41-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 3 / 2 / 0 / -

HMIS			
H	2	R	1
F	3	I	3
R	0	S	2
PPG*		K	4
*See sect. 8			

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Ethyl Benzene, CAS No. 0100-41-4	Ca 100	**OSHA PELs** 8-Hr TWA: 100 ppm, 435 mg/m³ 15- Min STEL: 125 ppm, 545 mg/m³ **ACGIH TLVs, 1988-89** TLV-TWA: 100 ppm, 435 mg/m³ TLV-STEL: 125 ppm, 545 mg/m³ **Toxicity Data*** Human, Inhalation, TC_{Lo}: 100 ppm (8 Hrs) Rat, Oral, LD_{50}: 3500 mg/kg
*See NIOSH, *RTECS* (DA0700000), for additional data with references to reproductive, irritative, and mutagenic effects.		

SECTION 3. PHYSICAL DATA

Boiling Point: 277°F (136°C)
Melting Point: -139°F (-95°C)
Vapor Pressure: 7.1 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 3.7
% Volatile by Volume: Ca 100
Molecular Weight: 106 Grams/Mole
Solubility in Water (%): Slight
Specific Gravity (H_2O = 1): 0.86258 at 77°F (25°C)

Appearance and Odor: A clear, colorless, flammable liquid; characteristic aromatic hydrocarbon odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method: 64°F (18°C) CC	Autoignition Temperature: 810°F (432.22°C)	LEL: 1% v/v	UEL: 6.7% v/v

Extinguishing Media: Use foam, dry chemical, or carbon dioxide to put out ethyl benzene fires. A water spray may be ineffective in extinguishing the fire, because it can scatter and spread the burning liquid. Use water spray to cool fire-exposed containers of ethyl benzene, to disperse ethyl benzene vapor, and to protect personnel attempting to stop an ethyl benzene leak. **Unusual Fire or Explosion Hazards:** This liquid can readily form explosive vapor-air mixtures, especially when heated. Ethyl benzene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back to its origin. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Ethyl benzene is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Hazardous chemical reactions can occur between ethyl benzene and strong oxidizing agents, acids, ammonia, and bases. **Conditions to Avoid:** Avoid any exposure to sources of ignition such as heat, sparks, open flame, and lighted tobacco products, etc., and to incompatible chemicals. Use caution when entering confined spaces, particularly low-lying areas where explosive concentrations of ethyl benzene vapor may be present. Provide good ventilation to such areas to prevent the concentration of this vapor. **Hazardous Products of Decomposition:** Thermal-oxidative degradation can include toxic gases such as carbon monoxide and/or aromatic hydrocarbon gases.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Ethyl benzene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Ethyl benzene vapor is severely irritating to the eyes and to the mucous membranes of the respiratory system. Sustained inhalation of excessive levels can cause depression of the central nervous system (CNS) characterized by dizziness, headache, narcosis, and coma. Skin contact with liquid ethyl benzene causes irritation; dermatitis and defatting can also develop. The acute oral toxicity of ethyl benzene is low; however, ingestion of it presents a serious aspiration hazard. Aspirating even a small amount into the lungs can result in extensive edema (lungs filled with fluid) and hemorrhaging of the lung tissue. No systemic effects are expected at the levels that produce pronounced, unignorable, disagreeable skin and eye irritation. The TLVs cited in section 2 are set to prevent this intolerable irritation. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact **Acute Effects:** Irritation of the skin, eyes, and respiratory system. Also, cardiac-rhythm disturbance due to sensitization; acute bronchitis, bronchospasm, pulmonary and laryngeal edema; euphoria; headache; giddiness; dizziness; and incoordination, as well as possible depression; confusion; and coma. **Chronic Effects:** None reported. **First Aid:** Eyes. Immediately

SECTION 6. HEALTH HAZARD INFORMATION, cont.

flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with plenty of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Unlikely. Should this type of exposure occur, the aspiration hazard must be considered. Do not induce vomiting unless directed to do so by a physician. To prevent aspiration by spontaneous vomiting, keep the victim's head low (between his or her knees). **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Professional judgment is required as to whether or not to induce vomiting because of the possibility of aspiration. A gastric lavage may be administered, followed by saline catharsis, if this procedure is appropriate to the specific incident. Monitor cardiac and pulmonary functions.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale ethyl benzene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store ethyl benzene in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Special Handling/Storage:** Outside, isolated, detached, or remote storage is recommended for large quantities of ethyl benzene. Isolate bulk storage areas from acute fire hazards. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations. **Other:** Use safety cans for transferring small amounts of ethyl benzene.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Ethyl Benzene
DOT Hazard Class: Flammable Liquid
ID No. UN1175
DOT Label: Flammable Liquid
DOT Packaging Exceptions: 49 CFR 173.118
DOT Packaging Requirements: 49 CFR 173.119

IMO Shipping Name: Ethylbenzene
IMO Hazard Class: 3.2
IMO Label: Flammable Liquid
IMDG Packaging Group: II

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Material Safety Data Sheets Collection:

Sheet No. 469
Fuel Oil No. 2

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

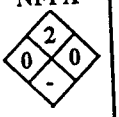
Fuel Oil No. 2 Description: A mixture of petroleum hydrocarbons; a distillate of low sulfur content. Fuel oil no. 2 resembles kerosine. Used as a general-purpose domestic or commercial fuel in atomizing-type burners; as a fuel for trucks, ships and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

Other Designations: CAS No. 68476-30-2, diesel oil.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R	1
I	-
S	2
K	2

NFPA



HMIS
H 0
F 2
R 0
PPG*
* Sec. 8

Cautions: Fuel oil No. 2 is a skin irritant and central nervous system depressant with high mist concentrations. It is an environmental hazard and a dangerous fire hazard when exposed to heat, flame, or oxidizers.

Section 2. Ingredients and Occupational Exposure Limits

Fuel oil No. 2*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data†
None established	None established	None established	Rat, oral, LD_{50}: 9 g/kg; produces gastrointestinal effects (hypermotility, diarrhea)

* A complex mixture (<95%) of paraffinic, olefinic, naphthenic, and aromatic hydrocarbons; sulfur content (<0.5%); and benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)].

† Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 363 to 634 °F (184 to 334 °C)
Viscosity: 268 centistoke at 100 °F (37.8 °C)
Specific Gravity: 0.8654 at 59 °F (15 °C)
Appearance and Odor: Brown, slightly viscous liquid.
Water Solubility: Insoluble
Pour Point:* <21 °F (-6 °C)

*Pour point is the lowest temperature at which a liquid flows from an inverted test container.

Section 4. Fire and Explosion Data

Flash Point: 100 °F (38 °C) min. | **Autoignition Temperature:** 494 °F (257 °C) | **LEL:** 0.6% v/v | **UEL:** 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, foam, water fog or spray. Do not use a forced water spray directly on burning oil since this scatters the fire. Use a smothering technique to extinguish fire.

Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. This fuel oil's volatility is similar to gasoline's.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to health and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Fuel oil no. 2 is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Incompatible with strong oxidizing agents; heating greatly increases fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of fuel oil no. 2 yields various hydrocarbons and hydrocarbon derivatives and partial oxidation products including carbon dioxide, carbon monoxide, and sulfur dioxide.

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Section 6. Health Hazard Data

Carcinogenicity: Although it has not assigned an overall evaluation to fuel oil No. 2, the IARC has evaluated distillate (light) fuel oils as not classifiable as human carcinogen (Group 3; animal evidence limited).
Summary of Risks: Excessive inhalation of aersol or mist can cause respiratory tract irritation, headache, dizziness, nausea, stupor, convulsions, or unconsciousness, depending on concentration and time of exposure. Since intestinal absorption of longer chain hydrocarbons is lower than absorption from lighter fuels, a lesser degree of systemic effects and more diarrhea may result. When removed from exposed area, affected persons usually experience complete recovery. Hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result if oil is aspirated into the lungs. These results are more likely when vomiting after ingestion rather than upon ingestion, as is often the case with lower viscosity fuels. A comparative ratio of oral-to-aspirated lethal doses may be 1 pt vs. 5 ml. Prolonged or repeated skin contact may cause irritation of the hair follicles and may block the sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system (CNS), skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal (GI) irritation, vomiting, diarrhea, and, in severe cases, CNS depression, progressing to coma and death. Inhalation of aerosol or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish coloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body are exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Fuel oil no. 2 is an environmental hazard. Report large spills.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for an OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in areas of storage or use.
Engineering Controls: Avoid prolonged skin contact and vapor or mist inhalation. Use only in a well-ventilated area with personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)
DOT Shipping Name: Fuel oil
DOT Hazard Class: Combustible liquid
ID No.: NA1993
DOT Label: None
DOT Packaging Exceptions: 173.118a
DOT Packaging Requirements: None

MSDS Collection References: 1, 6, 7, 12, 73, 84, 103, 126, 127, 132, 133, 136, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 397
n-Hexane

Issued: 8/83 Revision: C, 8/89

Section 1. Material Identification

29

***n*-Hexane Description:** *n*-Hexane is the chief constituent of petroleum ether or liqroin. Used to determine the refractive index of minerals; and as a mercury replacement in thermometers (usually with blue or red dye).
Other Designations: Normal-hexane; C_6H_{14}; CAS No. 0110-54-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.
Comments: See *MSDS Colletion*, No. 397A, for isohexanes.

R 1
I 3
S 2
K 4

NFPA
HMIS
H 1
F 3
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

n-Hexane, ca 100%*

OSHA PEL
8-hr TWA: 50 ppm, 180 mg/m³

ACGIH TLV, 1988-89
TLV-TWA: 50 ppm, 180 mg/m³

Toxicity Data†
Human, inhalation, TC_{Lo}: 5000 ppm/10 min
Rat, oral, LD_{50}: 28,710 mg/kg

* *n*-Hexane is this product's major component; however, possible contaminants are other isomers of hexane, C_5 to C_7 saturated hydrocarbons, C_5 to C_7 olefinic hydrocarbons, and aromatic hydrocarbons.
† See NIOSH, *RTECS* (MN9275000), for additional data with references to reproductive, irritative, and neurological effects.

Section 3. Physical Data

Boiling Point: 156.11 °F (68.95 °C)
Melting Point: ca -139 °F (-95 °C)
Vapor Pressure: 124 torr at 68 °F (20 °C)
Vapor Density (Air = 1): 3.0
Molecular Weight: 86 g/mol
Specific Gravity (H_2O = 1): 0.66 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear, colorless, mobile, volatile, flammable liquid: a mild hydrocarbon odor.

Section 4. Fire and Explosion Data

Flash Point: -22 °F (-30 °C) CC	Autoignition Temperature: 473 °F (223 °C)	LEL: 1.2% v/v	UEL: 8% v/v

Extinguishing Media: Use carbon dioxide (CO_2), foams, or dry chemical to put out *n*-hexane fires. Never direct solid streams of water into burning pools of liquid since this can scatter and spread the fire. Use water sprays to cool fire-exposed containers, prevent dangerous pressure rise and/or rupture, disperse vapors, and flush unignited spills away from sensitive exposures.
Unusual Fire or Explosion Hazards: *n*-Hexane is a very flammable, volatile liquid which burns like gasoline. It represents a dangerous fire and explosion hazard. Since it evaporates quickly, the resulting denser-than-air vapors can flow along surfaces, collect in low-lying or enclosed areas like sumps and utility rooms, reach distant sources of ignition, and flash back to the original liquid.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

Section 5. Reactivity Data

Stability/Polymerization: *n*-Hexane is stable at room temperature during routine operations. Hazardous polymerization cannot occur.
Chemical Incompatibilities: *n*-Hexane can react violently with strong oxidizing agents.
Conditions to Avoid: Never expose this liquid to any ignition source (heat, sparks, open flames, or uninsulated heating elements).
Hazardous Products of Decomposition: Thermal oxidative degradation of *n*-hexane can produce carbon dioxide and toxic carbon monoxide (CO).

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists *n*-hexane as a carcinogen.
Summary of Risks: The metabolic products of *in vivo* partial oxidation of *n*-hexane include 2, 5-hexanedione. This metabolite is the most highly neurotoxic compound formed from *n*-hexane. Occupational exposures to *n*-hexane are associated with chronic neurotoxic damage to the central nervous system (CNS) and the peripheral nervous system (PNS). The effects are not permanent; Genium reference 100 notes that recovery from neuropathy is usually complete within a year after the exposure. Methyl *n*-butyl ketone (MBK) (*MSDS Collection*, No. 425) produces the neurotoxic metabolite 2, 5-hexadione in even greater quantities than the *n*-hexane. Prevent simultaneous exposures to *n*-hexane and MBK. Genium reference 89 notes: "...concurrent exposure to methyl ethyl ketone, and possibly other chemicals or drugs which boost liver oxidative mechanisms, reduces the time for neuropathy to appear as a result of exposure to both *n*-hexane and MBK." **Medical Conditions Aggravated by Long-Term Exposure:** CNS and PNS disorders, vision defects, and memory diminution. **Target Organs:** Skin, eyes, CNS, PNS. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Irritation of eyes, nose, and upper respiratory tract (URT); dermal erythema (abnormally red skin from capillary congestion), edema (abnormal accumulation of clear, watery fluid in body tissue), and vesiculation (blistering). Acute inhalation causes headache, dizziness, nausea, narcosis, and coma. High concentrations may act as asphyxiants. **Chronic Effects:** Anorexia, nausea, weight loss, malaise; muscular weakness, pain, and spasms in extremities; neurotoxic effects like sensorimotor polyneuropathy, generalized polyneuropathy, and other degenerative changes in the peripheral nervous system (PNS).

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Have a qualified medical personnel adminsister oxygen as required. **Ingestion:** Never induce vomiting! Severe aspiration hazard exists. If vomiting occurs spontaneously, lower victim's head to the knee level. Never give anything by mouth to an unconscious or convulsing person. Administer several ounces of edible oil to drink.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a n-hexane spill control and countermeasure plan (SCCP).* When a spill occurs, notify safety personnel, evacuate unnecessary personnel, eliminate heat and ignition sources, provide maximum explosion-proof ventilation, and implement the SCCP. Cleanup personnel should wear fireproof personal protective equipment (Sec. 8).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Subpart Z)
EPA Designations
Assigned the RCRA Hazardous Waste No. D001 (40 CFR 261.21, Ignitability)
Assigned as a CERCLA Hazardous Substance (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg)
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Where splashing is possible, wear a full face shield. **Respirator:** Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, washing facilities, and properly serviced fire extinguishers. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Other:** Preplacement and periodic medical exams focusing on the skin nd the central nervous system are advised.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Handle this flammable, volatile material with appropriate caution.

Section 9. Special Precautions and Comments

Storage Requirements: Store *n*-hexane in closed containers in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and incompatible chemicals. Protect these containers from physical damage; shield them from direct sunlight.
Engineering Controls: To prevent static sparks, electrically ground and bond all containers, tank cars, and pipes used in shipping, receiving, or transferring operations in production and storage areas. All electrical services, including lights, must be sparkproof.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Hexane
DOT Hazard Class: Flammable liquid
DOT ID No. : UN1208
DOT Label: Flammable liquid
DOT Packaging Requirements: 49 CFR 173.119
DOT Packaging Exceptions: 49 CFR 173.118

IMO Shipping Name: Hexane *(and its isomers)*
IMO Hazard Class: 3.1
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection References: 1, 6, 7, 84-94, 100, 116, 117, 119, 120, 122
Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 298
Jet Fuels

Issued: 8/90

Section 1. Material Identification

32

Jet Fuel Description: A petroleum distillate similar to kerosine composed of C_5 to C_{16} aliphatics, monocyclo-paraffins, aromatics, and olefins (for turbine engines only). Aromatics are a lower percentage for jet fuels, but there are a number of jet fuel types with somewhat different compositions and properties.
Other Designations: Jet A, Jet A-1, Jet B, Jet fuel HEF-3, JP-1, JP-4, JP-5, JP-6.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.
Cautions: *Jet fuel is volatile, combustible, and thus, a dangerous fire hazard.* It is a skin, eye, and respiratory tract irritant. *Ingestion can be harmful, even fatal.*

(a) Jet A and Jet A-1 (combustible) and JP-5 (flammable to combustible).
(b) Jet B (dangerous fire hazard) and JP-4 (dangerous fire hazard and moderate explosion hazard in the form of vapor).

R	1
I	-
S	2
K	2-4*

* Varying flash points

NFPA (a): H 2, F 0, R 0, - ; NFPA (b): H 3, F 1, R 0, -

HMIS		HMIS	
H	1	H	1
F	2	F	3
R	0	R	0
PPG†		PPG†	

† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Jet fuel, ca 100%

1989 OSHA PEL	1989-90 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data*
None established	None established	None established	Rat, oral, LD_{50}: 40 mg/kg Rat, inhalation, LC_{50}: 23 ppm/4 hr Rat, skin, LD_{50}: 317 mg/kg

* These toxicity data pertain to jet fuel HEF-3. See NIOSH, *RTECS* (MH5425100), for additional toxicity data.

Section 3. Physical Data*

Boiling Point: 300 to 550 °F (149 to 288 °C)
Vapor Pressure: 0.1 mm Hg at 20 °C
Viscosity: 1.0 to 2.0 cSt at 72 °F (40 °C)
Relative Density (15 °C/4 °C): 0.79 to 0.84
Water Solubility: Negligible

Appearance and Odor: A clear liquid with a hydrocarbon odor.

* Physical data vary with fuel type. These data pertain to kerosine jet fuels in general.

Section 4. Fire and Explosion Data

Flash Point: 100 °F (37.8 °C), OC*	Autoignition Temperature: 446 °F (230.2 °C)*	LEL: 0.6% v/v	UEL: 3.7% v/v
Jet A and Jet A-1: 110 to 150 °F (43.4 to 65.6 °C) Jet B: -16 to -30 °F (-26.7 to -34.5 °C) JP-1: 95 to 145 °F (35.0 to 62.8 °C) JP-4†: -10 to 30 °F (-23.4 to -1.1 °C) JP-5: 95 to 145 °F (35.0 to 62.8 °C)	JP-1: 442 °F (228 °C) JP-4: 468 °F (242 °C) JP-5: 475 °F (246 °C)	JP-4: 1.3% v/v	JP-4: 8.0% v/v

Extinguishing Media: For large fire, use water spray, fog, or foam. For small fires, use dry chemical or CO_2. Water may be ineffective in fighting fires involving materials with low flash points. Apply in the form of a spray.
Unusual Fire or Explosion Hazards: Jet fuel is volatile and combustible.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

*A higher kerosene cut than JP-4 with fewer impurities.
† 65% gasoline and 35% light petroleum distillate.

Section 5. Reactivity Data

Stability/Polymerization: Jet fuels are stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: A violent reaction occurs with fluorine (F_2). Jet fuels are also incompatible with halogens, strong acids, alkalines, and oxidizers.
Conditions to Avoid: Avoid heat, sparks, flame, and build up of static electricity.
Hazardous Products of Decomposition: Thermal oxidative decomposition of jet fuel can produce carbon monoxide from incomplete combustion.

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Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list jet fuels as a carcinogen.
Summary of Risks: Jet fuel is a moderate skin, eye, and respiratory irritant. Ingestion may be harmful or fatal. The most serious toxic effect following ingestion is aspiration pneumonitis.
Medical Conditions Aggravated by Long-Term Exposure: Individuals with chronic pulmonary disease should not be exposed to jet fuel vapor.
Target Organs: Central nervous system, respiratory tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic exposure through the respiratory or gastrointestinal (GI) tract may result in increasing levels of central nervous system depression, manifest by a staggering gait, slurred speech, or mental confusion. These symptoms could progress to unconsciousness, coma, and death from respiratory failure. Exposure of lung tissue through aspiration of liquid jet fuel causes an immediate irritant and destructive reaction. The inflammatory lung changes cause a chemical pneumonitis, pulmonary edema (fluid in the lungs), and/or bleeding in the lung tissue. Secondary infection as a result of the injury, and scarring may occur with resultant permanent lung damage. The immediate clinical effects are increasing shortness of breath, coughing, bloody sputum, and chest pain. These symptoms may worsen over the following hours to days. Ingestion causes irritation to the GI tract characterized by vomiting, abdominal pain, and diarrhea. Other organs possibly injured through systemic exposure include parenchyma of the liver, kidney, pancreas, and spleen. Exposure to high mist concentrations may irritate the mucous membrane.
Chronic Effects: Chronic lung dysfunction may result from aspiration into the lungs. Prolonged or repeated skin contact can cause dermatitis.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting*. If the victim is nauseated, position head lower than knees to prevent aspiration. Administer vegetable oil and call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a jet fuel spill control and countermeasure program (SCCP).* Notify safety personnel, isolate hazard area and deny entry, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and direct contact with skin or eyes. Immediately absorb spilled jet fuel with noncombustible, inert material such as fire-retardent treated sawdust or diatomaceous earth. Using nonsparking tools, immediately shovel spilled material in appropriate containers for disposal. After completing material pickup, ventilate area and wash spill site. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear nonsparking shoes (rubber, cord, or sewn leather soles).
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials (Sec. 5). Outside or detached storage is preferred.
Engineering Controls: Avoid vapor inhalation and skin or eye contact. Use with appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Jet fuel's greatest hazard is its fire potential. Train all employees to use fire-extinguishing equipment. Perform fire drill exercises periodically. Take all measures to prevent static electricity: electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. Maintain and test grounding and bonding connections. Do not use drag chains or cables on fueling vehicles. After filling jet fuel storage tanks, wait 30 min before opening hatches to permit the relaxation of any static charges generated during filling or hauling. Empty containers or drums retaining residue (liquid and/or vapor) can be dangerous. Do not expose to heat or ignition sources. All drums should be completely drained, properly bunged, and promptly disposed of per local regulations. Practice good personal hygiene and housekeeping procedures. Take care in handling hoses, cans, and funnels wet with jet fuel. Before touching with bare hands, carefully wipe jet fuel containers. Properly dispose of wet rags per EPA hazardous waste requirements. Avoid contamination of jet fuel with water, rust, scale, dirt, and other petroleum products. Use commercial kits (Hydrokit, Aqua-Glo, or "Clear and Bright") to detect water and dirt, respectively.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 1, 73, 84, 103, 126, 132, 133, 136
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

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Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

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* Sec. 8

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 μg/m³
Action Level TWA*: 30 μg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 μg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 μg/m³

1988 NIOSH REL
10-hr TWA: <100 μg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 μg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system . The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

MSDS Collection **References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Occupational Health Guideline for Malathion

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $C_{10}H_{19}O_6PS_2$
- Synonyms: O,O-Dimethyl dithiophosphate of diethyl mercaptosuccinate; O,O-dimethyl S-(1,2-dicarbethoxyethyl) phosphorodithiocite
- Appearance and odor: Colorless to brown liquid with a mild skunk-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for malathion is 15 milligrams of malathion per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. NIOSH has recommended a permissible exposure limit of 15 mg/m^3 averaged over a work shift of up to ten hours per day, forty hours per week. The NIOSH Criteria Document for Malathion should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Malathion can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

1. Short-term Exposure: Malathion is one the least toxic of the organophosphate insecticides. Very large exposures are required to cause symptoms. After inhalation of malathion, breathing and eye effects are the first to appear. These include tightness of the chest, wheezing, a bluish discoloration of the skin, small pupils, aching in and behind the eyes, blurring of the vision, tearing, runny nose, headache, and watering of the mouth. After swallowing malathion, loss of appetite, nausea, vomiting, abdominal cramps and diarrhea may appear within two hours. After skin absorption, sweating and twitching in the area of absorption may occur, usually within 15 minutes to four hours. With severe intoxication by all routes, in addition to the above symptoms, weakness, generalized twitching and paralysis may occur and breathing may stop. In addition, dizziness, confusion, staggering, slurred speech, generalized sweating, irregular or slow heartbeat, convulsions, and coma may occur.

2. Long-term Exposure: Repeated exposure to malathion may make a person more susceptible to the effects of this and related chemicals.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to malathion.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to malathion at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of reduced pulmonary function or recent exposure to anticholinesterase agents would be expected to be at increased risk from exposure. Examination of the respiratory system, liver, and attention to the cholinesterase levels in the blood should be stressed.

—Cholinesterase determination: Malathion can cause depressed levels of activity of cholinesterase in the serum and erythrocytes. The cholinesterase activity in the erythrocytes should be measured by using medically acceptable biochemical tests before employment (or exposure) in order to establish an individual baseline

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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Occupational Safety and Health Administration

value, which should be the mean of two ChE activity measurements, taken at least one day apart.

—14" x 17" chest roentgenogram: Malathion causes human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Malathion is a respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

—Liver function tests: Malathion may cause liver damage. A profile of liver function should be obtained by utilizing a medically acceptable array of biochemical tests.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, with the exception of the cholinesterase determination which should be performed quarterly or at any time overexposure is suspected or signs and symptoms of toxicity occur.

• **Summary of toxicology**

Malathion is a mild anticholinesterase agent; absorption may occur from inhalation of the mist, from skin absorption of solutions, or from ingestion. Malathion is less toxic to humans than most anticholinesterase agents because it is metabolized in the liver to an inactive form. However, ingestion of 50 to 90 cc of a 50% solution of malathion in a petroleum hydrocarbon base caused severe intoxication; the human LD50 is estimated to be about 1 g/kg. Signs and symptoms of intoxication by anticholinesterase agents are caused by the inactivation of the enzyme cholinesterase, which results in the accumulation of acetylcholine at synapses in the nueromuscular system, and secretory glands. After inhalation of extremely high concentrations, respiratory and ocular effects may appear simultaneously. Respiratory effects include tightness in the chest, wheezing, laryngeal spasms, and excessive salivation. Ocular effects include miosis, aching in and behind the eyes (attributed to ciliary spasm), blurring of distant vision, tearing, rhinorrhea, and frontal headache. After ingestion, gastrointestinal effects such as anorexia, nausea, vomiting, abdominal cramps, and diarrhea appear. Effects on the central nervous system may include giddiness, confusion, ataxia, and slurred speech. In a group of workers with maximum exposure of 56 mg/m^3 for 5 hours and an average of 3.3 mg/m^3, the cholinesterase levels in the blood were not significantly lowered and no one exhibited signs of cholinesterase inhibition. In a human experiment in which 4 men were exposed 1 hour daily for 42 days to 84.8 mg/m^3, there was moderate irritation of nose and conjunctiva but there were no cholinergic signs or symptoms.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

1. Molecular weight: 330
2. Boiling point (760 mm Hg): Decomposes
3. Specific gravity (water = 1): 1.23
4. Vapor density (air = 1 at boiling point of malathion): Not applicable
5. Melting point: 2.8 C (37 F)
6. Vapor pressure at 20 C (68 F): 0.00004 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.0145
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: Starts to decompose at 49 C (140 F) but is not hazardous.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as sulfur dioxide, phosphoric acid mist, and carbon monoxide) may be released in a fire involving malathion.
4. Special precautions: Malathion will attack some forms of plastics, rubber, and coatings.

• **Flammability**

1. Not combustible.

• **Warning properties**

Since malathion has a negligible vapor pressure, warning properties are not considered.

Grant states that "undiluted technical liquid malathion dropped on a rabbits's eye caused slight immediate irritation with conjunctival hyperemia and edema of the lids, but the eye returned to normal in twenty-four hours."

The *Documentation of TLV's* notes that workers exposed to 84.8 mg/m^3 experienced moderate eye irritation.

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

An analytical method for malathion is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 3, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00261-4).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not

technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with malathion.
- Non-impervious clothing which becomes contaminated with malathion should be removed promptly and not reworn until the malathion is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where liquid malathion may contact the eyes.
- Where there is any possibility that employees' eyes may be exposed to malathion, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with malathion should be promptly washed or showered with soap or mild detergent and water to remove any malathion.
- Employees who handle malathion should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.
- Eating and smoking should not be permitted in areas where malathion is handled, processed, or stored.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to malathion may occur and control methods which may be effective in each case:

Operation	Controls
Formulation of pesticide products	Process enclosure; local exhaust ventilation; personal protective equipment
Application as an insecticide for treatment of grain, nut, fruit, and fiber crops; grasses, seeds, and tobacco; animals; agricultural premises	Personal protective equipment
Manufacture of malathion	Process enclosure; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If malathion or formulations containing malathion get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If malathion or formulations containing malathion get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If malathion or formulations containing malathion penetrate through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. Get medical attention immediately.

- **Breathing**

If a person breathes in large amounts of malathion, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When malathion or formulations containing malathion have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and

know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If malathion is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Collect for reclamation or absorb in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Malathion may be disposed of by absorbing in vermiculite, dry sand, earth, or a similar material and disposing in sealed containers in a secured sanitary landfill.

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RESPIRATORY PROTECTION FOR MALATHION

Condition	Minimum Respiratory Protection* Required Above 15 mg/m³
Particulate or Vapor Concentration	
150 mg/m³ or less	Any chemical cartridge respirator with an organic vapor cartridge(s) and dust, fume, and mist filter(s), including pesticide respirators which meet the requirements of this class.** Any supplied-air respirator.** Any self-contained breathing apparatus.**
750 mg/m³ or less	Any chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s) and dust, fume, and mist filter(s), including pesticide respirators which meet the requirements of this class. A gas mask with a chin-style or a front- or back-mounted organic vapor canister and dust, fume, and mist filter(s), including pesticide respirators which meet the requirements of this class. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
5000 mg/m³ or less	A powered chemical cartridge respirator with a full facepiece, helmet, or hood, an organic vapor cartridge, and high efficiency particulate filter, including pesticide respirators which meet the requirements of this class. A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 5000 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

**If an employee informs his employer that he is experiencing eye irritation from malathion while wearing a half- or quarter-mask respirator, the employer should provide an equivalent respirator with a full facepiece, helmet, or hood.

Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 26

MERCURY
(Revision C)
Issued: September 1981
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: MERCURY

Description (Origin/Uses): Used in barometers, thermometers, hydrometers, and pyrometers; in mercury arc lamps producing ultraviolet rays; in switches and fluorescent lamps; as a catalyst in oxidations of organic compounds; in alloys; in explosives; and for extracting gold and silver from ore.

Other Designations: Colloidal Mercury; Metallic Mercury; Quicksilver; Hg; Hydrargyrum; CAS No. 7439-97-6

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: Inorganic and organic mercury compounds are highly toxic, as is pure mercury.

Genium

HMIS			
H	3	R	1
F	0	I	4
R	0	S	1
PPG*		K	0

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Mercury, CAS No. 7439-97-6	Ca 100	**OSHA PEL** Ceiling: 1 mg per 10 m³ **ACGIH TLV (Skin*), 1987-88** TLV-TWA: 0.05 mg/m³ as Hg (Mercury Vapor) **Toxicity Data**** Rabbit, Inhalation, LC_{Lo}: 29 mg/m³ (30 Hrs)

*Mercury can be absorbed through intact skin, which contributes to overall exposure.

**See NIOSH, *RTECS* (OV4550000), for additional data with references to reproductive, mutagenic, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 673°F (357°C)
Specific Gravity (H_2O = 1): 13.546 at 68°F (20°C)
Vapor Pressure: 0.0018 Torr at 77°F (25°C)
Water Solubility (%): Insoluble
Molecular Weight: 201 Grams/Mole
Melting Point: -37.93°F (-38.85°C)

Appearance and Odor: A silver, heavy liquid; odorless. **Danger:** Mercury vapor has no warning properties.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Mercury does not burn. Use extinguishing agents that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: When exposed to the high temperatures that occur during a fire, mercury can vaporize to form extremely toxic fumes.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Mercury is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous reactions involving mercury and acetylene, ammonia, boron phosphodiiodide, chlorine, chlorine dioxide, methyl azide, sodium carbide, nitric acid, oleum, and sulfuric acid are reported (Genium ref. 84).

Conditions to Avoid: Do not expose mercury to incompatible chemicals.

Hazardous Products of Decomposition: Extremely toxic mercury metal fumes are likely to be produced during fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Mercury is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Mercury is very toxic due to its liquid and fat solubility, lack of charge, and membrane permeability. It is a slowly cumulative poison that concentrates in the brain, kidneys, and liver. It is very hazardous when spilled or heated. Mercury and its vapor are rapidly absorbed by the membranes lining the respiratory tract, the gastrointestinal (GI) tract, and the skin. Mercury is a teratogen (causes physical defects in embryos). **Medical Conditions Aggravated by Long-Term Exposure:** Preexisting problems of the target organs can be worsened. Provide preplacement and periodic medical exams emphasizing the target organs. **Target Organs:** Skin, eyes, respiratory system, central nervous system (CNS), kidneys. **Primary Entry:** Skin absorption/contact, inhalation. **Acute Effects:** Erosion of the respiratory/GI tracts, nausea, vomiting, bloody diarrhea, shock, headache, metallic taste. Inhalation of high concentrations for short periods can cause pneumonitis, chest pain, dyspnea, coughing, stomatitis, gingivitis, and salivation. **Chronic Effects:** Tremors, emotional problems, loss of concentration, depression, drowsiness, fatigue, insomnia, loss of memory, kidney problems, eye lesions, vision disturbances, sore mouth and throat, problems with the sense of taste or smell, nosebleeds, nasal inflammation, loss of weight or appetite, poor hand-eye coordination, awkwardness, and unsteadiness, as well as dermatitis. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water because of the increased exposure from skin absorption. **Inhalation.** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. Have medical personnel administer oxygen to treat the chemical pneumonitis that may develop. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Note to physician: If indicated by degree of ingestion, saline cathartics and charcoal should be used. Chelation therapy with d-penicillamine may also be indicated.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. Treatment of chronic mercury poisoning requires expert medical care. At the first signs, immediately remove the exposed person from further exposure and have him or her examined and treated by a physician trained in occupational mercury poisoning.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, restrict access to the spill area to necessary personnel, and provide adequate ventilation. Clean up spills promptly. Specialized equipment and/or techniques may be required to safely deal with large mercury spills; if large quantities of mercury are used in the workplace, detailed, prior spill-management planning is recommended. Collect spilled mercury by using a suction pump and an aspirator bottle with a long capillary tube. For finely divided mercury in inaccessible cracks, corners, etc., treatment with calcium polysulfide and excess sulfur is recommended to convert the mercury globules into mercury sulfide. Vacuum cleaners may be used if they are equipped with specially designed mercury-absorbent exhaust filters. Collect the mercury into tightly sealed containers for later disposal or reclamation. Cleanup personnel must use the recommended personal protective equipment (see sect. 8).
Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Do not pour mercury down a drain. Mercury is very harmful to the environment. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Air Contaminant (29 CFR 19010.1000 Subpart Z)

EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste No. U151
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg)*

*Per the Clean Water Act, § 407 (a); Clean Air Act, § 112; and Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of mercury may occur, wear a full face shield or splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent any contact with mercury and the skin.
Ventilation: Install and operate general and local ventilation systems powerful enough to continuously maintain airborne levels of mercury below the OSHA PEL standard cited in section 2.
Safety Stations: Make emergency eyewash stations, washing facilities, and safety/quick-drench showers available in work areas.
Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean mercury from shoes and equipment. Separate work and street clothes; store work clothes in special lockers and always shower before changing to street clothes.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store mercury in a cool, dry, well-ventilated area in tightly closed unbreakable polyethylene containers. Protect these containers from physical damage.
Special Handling/Storage: Construct storage areas to have smooth, hard, nonporous floors with no cracks or spaces so that spilled mercury globules do not form in inaccessible areas.
Comments: Mercury evaporates slowly, but if it is spilled it can form many tiny globules that evaporate much faster than a single pool of it will. In an unventilated area, significant concentration of mercury vapor can develop from this enhanced evaporation effect. This poisonous vapor is particularly hazardous if breathed over a long period of time, so spills or releases of mercury require very meticulous cleaning procedures.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Mercury, Metal
DOT Hazard Class: ORM-B
DOT Label: None
DOT ID No. NA2809
IMO Class: 8
IMO Label: Corrosive

References: 1, 2, 8, 26, 38, 84-94, 100.

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 311

METHYL CHLOROFORM
(Revision E)
Issued: November 1975
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: METHYL CHLOROFORM

Description (Origin/Uses): Used in cold-type metal cleaning; also in cleaning plastic molds.

Other Designations: 1,1,1-Trichloroethane; CH_3CCl_3; CAS No. 0071-55-6

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS			
H	2	R	1
F	0	I	--
R	1	S	2
PPG*		K	1

*See sect. 8

NFPA

SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

Methyl Chloroform, CAS No. 0071-55-6

OSHA PELs
8-Hr TWA: 350 ppm, 1900 mg/m³
STEL: 450 ppm, 2450 mg/m³

ACGIH TLVs, 1988-89
TLV-TWA: 350 ppm, 1900 mg/m³
TLV-STEL: 450 ppm, 2450 mg/m³

Toxicity Data**
Man, Inhalation, LC_{Lo}: 27 g/m³ (10 Mins)
Man, Inhalation, TC_{Lo}: 350 ppm
Human, Oral, TD_{Lo}: 670 mg/kg
Rat, Oral, LD_{50}: 10300 mg/kg

*Contact your supplier for specifications, including details about inhibitors that can be added to the methyl chloroform product.
**See NIOSH, *RTECS* (KJ2975000), for additional data with references to irritative, reproductive, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 165°F (74.1°C)
Melting Point: -26.5°F (-32.5°C)
Vapor Density (Air = 1): 4.55
Vapor Pressure: 100 Torrs at 68°F (20°C)
Molecular Weight: 133 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 1.3376 at 68°F (20°C)
% Volatile by Volume: Ca 100

Appearance and Odor: A colorless liquid; mild, sweetish, pleasant, etherlike odor that may be just perceptible (if unfatigued) at about 100 ppm in the air.

Comments: Small variations in the above-noted physical properties are expected because of the various inhibitors that may be included in the methyl chloroform product.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: None Found	Autoignition Temperature: 998°F (537°C)	LEL: 8.0% v/v	UEL: 10.5% v/v

Extinguishing Media: Methyl chloroform does not burn at ordinary temperatures. High-energy sources such as an electric arc or an elevated temperature are required for ignition of this material. When the source of ignition is removed, methyl chloroform tends to stop burning. Use water spray to cool fire-exposed containers. Use water fog, carbon dioxide, dry chemical, or foam to fight fires involving this material or nearby fires. **Unusual Fire or Explosion Hazards:** Methyl chloroform vapor is heavier than air and may travel a considerable distance to a low-lying high-energy source of ignition and flash back to its origin. Use care in selecting equipment (see sect. 5, Comments). **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Methyl chloroform is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Methyl chloroform can react dangerously with acetone, nitrogen tetroxide, oxygen (gas or liquid), sodium, sodium hydroxide, and sodium-potassium alloys. **Conditions to Avoid:** Avoid exposure to any high-energy source of ignition or to incompatible chemicals. **Hazardous Products of Decomposition:** Toxic and corrosive gases such as hydrogen chloride, dichloracetylene, chlorine, and phosgene can be produced by decomposition of methyl chloroform at high temperatures, contact with hot metals, or exposure to ultraviolet radiation. Phosgene is usually produced in very small quantities; however, the significant irritating properties of hydrogen chloride (the dominant product of decomposition) prevent significant exposure to the phosgene. **Comments:** This material can be hydrolyzed by water to form hydrochloric acid and acetic acid. It will react with strong caustics to form flammable or explosive materials. It attacks natural rubber. Methyl chloroform requires an inhibitor content to prevent corrosion of metals. When the inhibitor is depleted, this material can decompose rapidly by reaction with finely divided white metals such as aluminum, magnesium, or zinc. Do not use these metals in pressurized spraying equipment where methyl chloroform is involved.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Methyl chloroform is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Methyl chloroform exhibits low oral toxicity. It can defat the exposed skin of workers and cause redness and scaling. Although methyl chloroform is low in systemic toxicity, it is an anesthetic that is capable of causing death if it is inhaled at concentrations of 14000 to 15000 ppm. Fatalities that have occurred in poorly ventilated areas such as pits or tanks are attributed to anesthesia and/or sensitization of the myocardium to epinephrine. Quick and complete recovery is reported upon prompt removal of unconscious exposed persons from the area of exposure. The TLV-TWA cited in section 2 is set to prevent initial anesthetic effects and/or objections to the

SECTION 6. HEALTH HAZARD INFORMATION, cont.

odor. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, heart, cardiovascular system, and CNS. **Primary Entry:** Inhalation, skin absorption. **Acute Effects:** Headache, lassitude, dermatitis, skin and eye irritation, cardiac arrhythmias, and depression of the CNS. **Chronic Effects:** None reported. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Unlikely. Should this type of exposure occur, medical help is not readily available, and the amount swallowed was appreciable, give the exposed person milk of magnesia to drink and induce vomiting. Repeat this procedure. Aspiration hazards exist, so the decision whether or not to induce vomiting must be made carefully. If vomiting is to be induced, carry it out as quickly as possible before the ingested methyl chloroform is internally absorbed. This procedure would increase the chance of aspiration. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** The estimated lethal dose by ingestion for a man weighing 150 pounds is 0.5 to 1 pint. Do not use adrenalin or sympathomimetic amines in treatment because of the increased cardiac sensitivity involved. Ingestion may cause spontaneous vomiting.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). Contain large spills and collect or absorb waste with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place liquid or absorbent waste into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U226
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. Suggested materials include neoprene, polyvinyl alcohol, or polyethylene. Natural rubber is not recommended. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** Exercise care in the selection of safety and handling equipment because methyl chloroform attacks natural rubber. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale methyl chloroform vapor. Consider functions of the CVS, CNS, liver, and skin while administering preplacement and periodic medical exams.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store methyl chloroform in closed containers in a cool, dry, well-ventilated area away from sources of ignition and incompatible chemicals (see sect. 5). Protect containers from physical damage. Steel is a recommended material for storage containers. **Special Handling/Storage:** Prevent moisture contamination of storage facilities. Monitor levels of inhibitor. Use caution in cleaning operations involving white metal fines (see sect. 5). **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum, explosion-proof design. Electrically ground and bond all containers and pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks. **Other:** Personnel who regularly work with methyl chloroform should avoid drinking alcoholic beverages shortly before, during, or after exposure.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: 1,1,1-Trichloroethane
DOT Hazard Class: ORM-A
ID No. UN2831
DOT Packaging Requirements: 49 CFR 173.605
DOT Packaging Exceptions: 49 CFR 173.605

IMO Shipping Name: 1,1,1-Trichloromethane
IMO Hazard Class: 6.1
IMO Label: Saint Andrew's Cross (X)*
IMDG Packaging Group: III

*Harmful-Stow away from Foodstuffs (Materials of Class 6.1 Packaging Group III).

References: 1, 38, 84-94, 116, 117, 120, 122.

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Material Safety Data Sheets Collection:

Sheet No. 334C
Mineral Spirits, Type IV

Issued: 4/90

Section 1. Material Identification

31

Mineral Spirits, Type IV, Description: A low dry point mineral spirit. Used as a solvent and paint thinner; in the coatings and dry cleaning industries.
Other Designations: CAS No. 8052-41-3; Texsolve S-2; Varsol 3; stoddard solvent; white spirits.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.
Comments: All mineral spirits are refined petroleum distillates that Genium divides into types I, II, III, and IV (*MSDS Collection*, No. 334, 334A, 334B, and 334C, respectively). Types I and II have a standard aromatic content and 100 °F/37.78 °C and 140 °F/60 °C minimum flash points, respectively. Type III has a high aliphatic content (low or reduced aromatic content), little odor, and a 100 °F/37.78 °C minimum flash point; and type IV has a low dry point and a 100 °F/37.78 °C minimum flash point. These different types have different applications. Consult your manufacturer or supplier to ascertain the exact information applicable to your purchased mineral spirits.

R 1
I 3
S 1
K 2

Genium

HMIS
H 1
F 2
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Mineral spirits, type IV, ca 100%*

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data†
TWA: 100 ppm, 525 mg/m³	TLV-TWA: 100 ppm, 525 mg/m³	10-hr TWA: 350 mg/m³ 15-min ceiling: 1800 mg/m³	Cat, inhalation, LC_{Lo}: 10 g/m³/2.5 hr Human, eye: 470 ppm/15 min

* All mineral spirits are mixtures that typically consist of both straight and branched hydrocarbons, paraffins, naphthenes (cycloparaffins), and aromatic hydrocarbons. However, their physical properties divide them into types I, II, III, and IV. Since these parameters vary among suppliers, the purchaser must determine the mineral spirits' composition based on the supplier's information. Note that the mineral spirits' exact composition can affect disposal, shipping, approved uses, insurance policies, and regulatory liabilities.
† See NIOSH, *RTECS* (WJ8925000), for additional irritative data.

Section 3. Physical Data

Boiling Point: 300 °F/149 °C to 365 °F/185 °C*
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 0.754 to 0.800
Molecular Weight: Not applicable (mixture)
Water Solubility: Insoluble

Appearance and Odor: A clear, colorless liquid; a kerosene-like odor usually perceptible to humans at about 1-ppm concentration.

* This 300 °F/149 °C to 365 °F/185 °C distillation range describes a specific cut of petroleum distillates, as well as defines and distinguishes these mineral spirits from many petroleum distillates (petroleum naptha, petroleum ether, rubber solvent, kerosene, mineral seal oil, and others).

Section 4. Fire and Explosion Data

Flash Point: 100 °F/38.78 °C	Autoignition Temperature: >450 °F/232 °C	LEL: None reported	UEL: None reported

Extinguishing Media: Use water fog, dry chemical, carbon dioxide (CO_2), or foams to put out fires involving this material. Never direct solid streams of water into burning pools of this liquid since this can scatter and spread the flames.
Unusual Fire or Explosion Hazards: During fires, or if heated or misted, this liquid is an explosive, flammable hazard. Finely dispersed mists are a dangerous explosion hazard.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Type IV is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: As a hydrocarbon mixture, type IV can react dangerously with strong oxidizing agents like chlorine and oxygen, as well as with nitric, sulfuric, and phosphoric acids.
Conditions to Avoid: Prevent exposures to heat and ignition sources and incompatible chemicals. Perform processing operations that heat or mist type IV in a careful, controlled manner that minimizes exposure of vapors or mists to possible heat or ignition sources such as lighted tobacco products, open flames, or uninsulated heating elements.
Hazardous Products of Decomposition: Thermal oxidative decomposition of type IV mineral spirits can produce carbon dioxide (CO_2) and carbon monoxide (CO). Depending on your material's exact composition and its unreported contaminants (benzene, toluene, or other aromatics or aliphatics), degradation products could include unidentified aromatic compounds and organics. When heated to decomposition, this material may explode.

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists mineral spirits as a carcinogen.
Summary of Risks: Millions of industrial workers in chemical process and allied industries have been exposed to mineral spirits with minimal serious health effects, aside from the drying, defatting (stripping away of your skin's protective fats and emolients), and irritant skin effects. However, overexposure can depress the central nervous system (CNS) with these symptoms: headache, dizziness, drowsiness, intoxication with euphoria, and possibly unconsciousness. Prolonged or repeated skin contact can cause dermatitis due to this mineral spirits' defatting effect or by sensitization.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes, nose, throat, respiratory system, and CNS.
Primary Entry Routes: Skin or eye contact with the liquid or inhalation of vapors.
Acute Effects: Irritation, redness of skin and eyes; narcotic effects like dizziness, slurred speech, or drunkeness. Ingestion may cause nausea, vomiting, diarrhea, and abdominal pain. After ingestion, the primary concern is aspiration into the lungs. Signs of aspiration pneumonitis include: fever, shortness of breath, increased rate of respiration, and rales (an abnormal rattling sound in the throat). Inhalaing this material may cause arrhythmias.
Chronic Effects: None reported in humans; animal testing indicates possible liver and kidney damage.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Inhalation may cause potentially lethal heart rhythm disturbances. Remove exposed person to fresh air and support breathing as needed.
Ingestion: Treat as an emergency. Potentially fatal aspiration hazard exists. To prevent aspiration, keep victim's head down between his knees. Never give anything by mouth to an unconscious or convulsing person. Never induce vomiting unless directed by qualified medical personnel. Even if aspiration into the lungs does not occur, ingestion of 3 to 4 oz can prove fatal in humans due to the CNS's depressed action.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: *Aspiration of even a few milliliters of mineral spirits can be fatal!* The resulting diffused chemical irritation of the lungs can progress to fatal pulmonary edema after aspiring liquid mineral spirits. To prevent their aspiration of freshly vomited solvent, carefully monitor persons who swallow mineral spirits. Consider intubation in treating any significant ingestion.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a mineral spirits spill control and countermeasure plan (SCCP).* When a spill occurs, notify safety personnel, eliminate heat and ignition sources, provide optimum explosion-proof ventilation, and implement the SCCP. Cleanup crews must use nonsparking tools and equipment and protective clothing to prevent vapor inhalation or skin contact. Absorb the spilled material with vermiculite or a similar material and place in appropriate disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Subpart Z)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, ACGIH TLV, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Never inhale its mists or vapors, especially when processing operations heat or mist this material.

Section 9. Special Precautions and Comments

Storage Requirements: Store this material in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and oxidizing agents. Protect these containers from physical damage. Store in properly labeled, closed metal drums or safety cans.
Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. Use only nonsparking tools and equipment.
Comments: Shipping regulations vary with your particular mineral spirits' physical properties (flash point, boiling point). The data below represent one of several ways to classify mineral spirits, per the actual entries in the table of regulations. Before shipping mineral spirits, ascertain how the pertinent shipping rules apply to your product.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Petroleum distillate
DOT Hazard Class: Combustible liquid *or* Flammable liquid
ID No.: UN1268
DOT Label: None *or* Flammable liquid
DOT Packaging Requirements: None or 173.119
DOT Packaging Exceptions: 173.118a or 173.118

IMO Shipping Name: Petroleum distillates, n.o.s.
IMO Hazard Class: 3.1, 3.2, *or* 3.3
IMO Label: Flammable liquid
IMDG Packaging Group: II
ID No.: UN1268

MSDS Collection References: 1, 6, 7, 38, 73, 84-94, 100, 103, 116, 117, 119, 120, 122, 123, 124, 126
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD M5

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Occupational Health Guideline for Parathion

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $(C_2H_5O)_2PSOC_6H_4NO_2$
- Synonyms: O,O-Diethyl-O,p-nitrophenyl phosphorothioate; ethyl parathion
- Appearance and odor: Yellow to dark brown liquid with a characteristic odor, like garlic.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for parathion is 0.1 milligram of parathion per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. NIOSH has recommended that the permissible exposure limit be reduced to 0.05 mg/m^3. The NIOSH Criteria Document for Parathion should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Parathion can affect the body if it is inhaled, comes in contact with the eyes or skin, or if swallowed. It may enter the body through the skin.

- **Effects of overexposure**

1. Short-term Exposure: After inhalation of parathion, breathing and eye effects are the first to appear. These include tightness of the chest, wheezing, a bluish discoloration of the skin, small pupils, aching in and behind the eyes, blurring of vision, tearing, runny nose, headache, and watering of the mouth. After swallowing parathion, loss of appetite, nausea, vomiting, abdominal cramps and diarrhea may appear within two hours. After skin absorption, sweating and twitching in the area of absorption may occur, usually within 15 minutes to four hours. With severe intoxication by all routes, in addition to the above symptoms, weakness, generalized twitching, and paralysis may occur and breathing may stop. In addition, dizziness, confusion, staggering, slurred speech, generalized sweating, irregular or slow heartbeat, convulsions and coma may occur.

2. Long-term Exposure: Repeated exposure to parathion may make a person more susceptible to the effects of this and related chemicals. Repeated exposure to concentrations which are too small to produce symptoms after a single exposure may result in the onset of symptoms.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to parathion.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to parathion at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of reduced pulmonary function, convulsive disorders, or recent exposure to anticholinesterase agents would be expected to be at increased risk from exposure. Examination of the respiratory system, nervous system, cardiovascular system, eyes, and attention to the cholinesterase levels in the blood should be stressed. The skin should be examined for evidence of chronic disorders.

—Cholinesterase determination: Parathion causes depressed levels of activity of cholinesterase in the serum and erythrocytes. The cholinesterase activity in the serum and erythrocytes should be determined by using

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

medically acceptable biochemical tests prior to any new period of exposure.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, with the exception of the cholinesterase determination. This test should be performed at four-week intervals, except for those employees in areas which may involve intense exposure, for whom the test should be repeated weekly. If any employee works with parathion more than 12 hours per day, he should be tested every 3 weeks. Employees should also be tested at any time overexposure is suspected or signs or symptoms of toxicity appear. Any employee having a 30 to 40% decrease in cholinesterase should be removed from exposure and placed under medical observation.

- **Summary of toxicology**

Parathion is an anticholinesterase agent; absorption may occur from inhalation of the vapor or mist, from skin absorption of the liquid, or from ingestion. Signs and symptoms of overexposure are caused by the inactivation of the enzyme cholinesterase, which results in the accumulation of acetylcholine at synapses in the nervous system and skeletal and smooth muscle secretory glands. The sequence of the development of systemic effects varies with the route of entry. The onset of signs and symptoms may occur promptly or may be delayed for up to 12 hours. After inhalation respiratory and ocular effects are the first to appear, , often within a few minutes after exposure. Respiratory effects include tightness in the chest and wheezing due to bronchoconstriction and excessive bronchial secretion; laryngeal spasms and excessive salivation may add to the respiratory distress; cyanosis may also occur. Ocular effects include miosis, aching in and behind the eyes (attributed to ciliary spasm), blurring of distant vision, tearing, rhinorrhea, and frontal headache. After ingestion, gastrointestinal effects, such as anorexia, nausea, vomiting, abdominal cramps, and diarrhea appear within 15 minutes to 2 hours. After skin absorption, localized sweating and muscular fasciculations in the immediate area occur usually within 15 minutes to 4 hours; skin absorption is somewhat greater at higher ambient temperatures, and is increased by the presence of dermatitis. With severe intoxication by all routes, an excess of acetylcholine at the neuromuscular junctions of skeletal muscle causes weakness aggravated by exertion, involuntary twitchings, fasciculations, and eventually paralysis; the most serious consequence is paralysis of the respiratory muscles. Effects on the central nervous system include giddiness, confusion, ataxia, slurred speech, Cheyne-Stokes respiration, convulsions, coma, and loss of reflexes. The blood pressure may fall to low levels, and cardiac irregularities including complete heart block may occur; these effects may sometimes be reversed by establishing adequate pulmonary ventilation. Complete symptomatic recovery usually occurs within 1 week; increased susceptibility to the effects of anticholinesterase agents persists for weeks after exposure. Daily exposure to concentrations which are insufficient to produce symptoms following a single exposure may result in the onset of symptoms. Continued daily exposure may be followed by increasingly severe effects. A few drops of technical parathion in the eyes of animals have produced lacrimation and moderate conjunctivitis. The minimum lethal oral dose of parathion for humans has been estimated to range from less than 10 mg up to 120 mg. In a study of 115 workers exposed to parathion under varying conditions, the majority excreted significant amounts of p-nitrophenol (a metabolite of parathion) in the urine, while only those with heavier exposures had a measurable decrease in blood cholinesterase.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 291.3
2. Boiling point (760 mm Hg): 375 C (707 F) (calculated)
3. Specific gravity (water = 1): 1.27
4. Vapor density (air = 1 at boiling point of parathion): Not applicable
5. Melting point: 6 C (43 F) (pure grade); 0 C (32 F) (technical grade)
6. Vapor pressure at 20 C (68 F): 0.0004 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): .00002
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: Temperatures above 100 C (212 F) may cause decomposition so that containers burst.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen, phosphorus, sulfur, and carbon monoxide) may be released when parathion decomposes.
4. Special precautions: Parathion will attack some forms of plastics, rubber, and coatings.

- **Flammability**

1. Not combustible

- **Warning properties**

1. Odor Threshold: The odor threshold of parathion is 0.04 ppm (American Society of Testing Materials Bulletin).
2. Eye Irritation Level: The AIHA *Hygienic Guide* states that "a few drops of technical parathion in animals has produced immediate blinking, lacrimation, and moderate conjunctivitis. Pupil constriction was also observed, with a return to normal size and reaction the following day. Eye contact with 1% aqueous suspensions of 15% wettable powders did not show evidence of irritation or other obvious reaction."
3. Evaluation of Warning Properties: Since the odor threshold of parathion is so low, parathion is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Sampling and analyses may be performed by collection of parathion using a filter with subsequent recovery with iso-octane and gas chromatographic analysis. A detailed analytical method for parathion may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161, under the title "NIOSH Analytical Methods for Set T" (order number PB 262 404).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with parathion.

• If employees' clothing has had any possibility of being contaminated with parathion, employees should change into uncontaminated clothing before leaving the work premises.

• Where there is any possibility of exposure of an employee's body to parathion, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Non-impervious clothing which becomes contaminated with parathion should be removed immediately and not reworn until the parathion is removed from the clothing.

• Clothing which has had any possibility of being contaminated with parathion should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of parathion from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the parathion, the person performing the operation should be informed of parathion's hazardous properties.

• Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid parathion contacting the eyes.

• Where there is any possibility that employees' eyes may be exposed to parathion, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

• Skin that becomes contaminated with parathion should be immediately washed or showered with soap or mild detergent and water to remove any parathion.

• Workers subject to skin contact with parathion should wash with soap or mild detergent and water any areas of the body which may have contacted parathion at the end of each work day.

• Eating and smoking should not be permitted in areas where parathion is handled, processed, or stored.

• Employees who handle parathion should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to parathion may occur and control methods which may be effective in each case:

Operation	Controls
Application as a pesticide on agricultural crops, vegetables and ornamentals and on agricultural premises	Personal protective equipment
Formulation for use as an insecticide	Process enclosure; personal protective equipment
Manufacture of parathion	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If parathion or parathion mists get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If parathion or parathion mists get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If parathion or parathion mists penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.

• **Breathing**

If a person breathes in large amounts of parathion, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When parathion has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If parathion is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Collect for reclamation, or absorb in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Parathion may be disposed of by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in sealed containers in a secured sanitary landfill.

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RESPIRATORY PROTECTION FOR PARATHION

Condition	Minimum Respiratory Protection* Required Above 0.1 mg/m³
Particulate or Vapor Concentration	
1 mg/m³ or less	Any chemical cartridge respirator with an organic vapor cartridge(s) and dust, fume, and mist filter(s), including pesticide respirators which meet the requirements of this class. Any supplied-air respirator. Any self-contained breathing apparatus.
5 mg/m³ or less	A chemical cartridge respirator with a full facepiece, organic vapor cartridge(s), and dust, fume, and mist filter(s), including pesticide respirators which meet the requirements of this class. A gas mask with a chin-style or a front- or back-mounted organic vapor canister and dust, fume, and mist filter, including pesticide respirators which meet the requirements of this class. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
20 mg/m³ or less	A powered air-purifying respirator with an organic vapor cartridge and high efficiency particulate filter, including pesticide respirators which meet the requirements of this class. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 20 mg/m³** or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of parathion; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 20 mg/m³, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

Material Safety Data Sheet

From Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 313

PERCHLOROETHYLENE
(Revision D)
Issued: November 1978
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: PERCHLOROETHYLENE

Description (Origin/Uses): Used in commercial dry cleaning and metal-degreasing operations; used to a lesser extent in home products and in veterinary anthelmintics (worming).

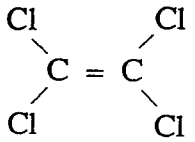
Other Designations: Ethylene Tetrachloride; Tetrachloroethylene; C_2Cl_4; CAS No. 0127-18-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 0 / 2 / 0 / -

HMIS		NFPA	
H	1		
F	0	R	1
R	1	I	3
PPG*		S	2
*See sect. 8		K	0

SECTION 2. INGREDIENTS AND HAZARDS

Ingredients and Hazards	%	Exposure Limits
Perchloroethylene, CAS No. 0127-18-4  *See NIOSH, *RTECS* (No. KX3850000), for additional data with references to reproductive, irritative, tumorigenic, and mutagenic effects.	Ca 100	**OSHA PEL** 8-Hr TWA: 100 ppm Ceiling: 200 ppm Maximum Peak above the Ceiling: 300 ppm for 5 min. in any 3 Hrs **ACGIH TLVs, 1987-88** TLV-TWA: 50 ppm, 340 mg/m³ TLV-STEL: 200 ppm, 1340 mg/m³ **Toxicity Data*** Human, Inhalation, TC_{Lo}: 96 ppm/7 Hrs

SECTION 3. PHYSICAL DATA

Boiling Point: 250°F (121°C)
Specific Gravity (H_2O = 1): 1.623
% Volatile by Volume: 100

Water Solubility (%): Insoluble
Molecular Weight: 166 Grams/Mole
Vapor Pressure: 19 Torrs at 77°F (25°C)
Vapor Density (Air = 1): 5.83

Appearance and Odor: A clear, colorless liquid; ethereal odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Perchloroethylene does not burn. Use extinguishing agents that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: Perchloroethylene vapor is heavier than air and it collects in low-lying areas such as sumps, wells, and underground piping systems. Enter these low-lying areas with appropriate caution.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Use care in selecting safety equipment (see sect. 5, Conditons to Avoid).

SECTION 5. REACTIVITY DATA

Perchloroethylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous chemical reactions involving perchloroethylene and barium, beryllium, or lithium are reported in Genium reference 84, page 491M-208.

Conditions to Avoid: Prevent contact with incompatible chemicals. Avoid exposure to direct sunlight. Monitor the stabilizer level in the perchloroethylene product; get specifications from your supplier for the proper inhibitor levels. This material forms hydrochloric acid (HCl) if the inhibitor level becomes too low. Do not mix perchloroethylene with caustic soda or potash. This material may degrade or attack rubber and some plastics and coatings, so select protective gear and handling equipment carefully.

Hazardous Products of Decomposition: Although perchloroethylene itself does not burn, it can be very hazardous in fires because of thermooxidative degradation at high temperatures to very toxic phosgene and corrosive hydrogen chloride. Electric arcs and perchloroethylene vapor may also produce these products of hazardous decomposition.

SECTION 6. HEALTH HAZARD INFORMATION

Perchloroethylene is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Perchloroethylene affects the central nervous system (CNS), causing incoordination, headache, vertigo, light narcosis, dizziness, unconsciousness, and even death. All of these can occur as the level and duration of exposure continues.

Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** CNS, eyes, skin.
Primary Entry: Inhalation, skin. **Acute Effects:** Irritation of the skin, eyes, and upper respiratory tract (URT); CNS effects.
Chronic Effects: None reported.

FIRST AID
Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.
Skin: Immediately wash the affected area with soap and water.
Inhalation: Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.
Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. Do not induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U210
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per Clean Water Act (CWA), section 307 (a) and Resource Conservation and Recovery Act (RCRA), section 3001

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of perchloroethylene solution may occur, wear a full face shield/splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Consult the *NIOSH Pocket Guide to Chemical Hazards* for general recommendations on respirator protection. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with perchloroethylene. Suggested material includes polyvinyl alcohol, polyethylene, or neoprene. Leather shoes are also appropriate.
Ventilation: Install and operate general and local ventilation systems that are powerful enough to maintain airborne levels of perchloroethylene dust below the OSHA PEL standard cited in section 2. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Avoid inhaling perchloroethylene vapor. Select safety equipment carefully (see sect. 5, Conditions to Avoid).

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store perchloroethylene in a cool, dry, well-ventilated area away from barium, beryllium, and lithium.

Special Handling/Storage: Protect containers from physical damage. Fit all holding tanks with an air-drying venting system that prevents moist air from entering the tank and allows for perchloroethylene vapor expansion and contraction; airtight storage facilities are not recommended. Aluminum is not recommended for storage facilities.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Tetrachloroethylene
DOT ID No. UN1897
DOT Label: None
DOT Hazard Class: ORM-A
IMO Label: Saint Andrew's Cross (X)*
IMO Class: 6.1
*Harmful-Stow away from Foodstuffs (Materials of IMO Class 6.1, Packaging Group III).

References: 1, 12, 73, 84-94, 100, 103.

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GENIUM PUBLISHING CORP.

No. 683

POLYCHLORINATED BIPHENYLS (PCBs)

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION

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Material Name: POLYCHLORINATED BIPHENYLS (PCBs)

Genium

Description (Origin/Uses): Commercial PCBs are mixtures that were once widely manufactured by combining chlorine gas, iron filings, and biphenyls. Their high stability contributes to their intended commercial applications and their accidental, long-term adverse environmental and health effects. PCBs are useful as insulators in electrical equipment because they are electrically nonconductive. Their distribution has been limited since 1976. The Aroclor PCB codes identify PCBs by type. The first two digits of a code indicate whether the PCB contains chlorinated biphenyls (12), chlorinated terphenyls, (54), or both (25, 44); the last two digits indicate the approximate percentage of chlorine. Found in insulating liquid, synthetic rubber, plasticizers, flame retardants, floor tile, printer's ink, paper and fabric coatings, brake linings, paints, automobile body sealants, asphalt, adhesives, electrical capacitors, electrical transformers, vacuum pumps, gas-transmission turbines, heat-transfer fluids, hydraulic fluids, lubricating and cutting oil, copying paper, carbonless copying paper, and fluorescent light ballasts.

Synonym: Chlorodiphenyls

Other Designations (Producer, Trade Name, Nation): Monsanto, Aroclor® (USA, Great Britain); Bayer, Clophen® (German Democratic Republic); Prodelec, Phenoclor®, Pyralene® (France); Kanegafuchi, Kanechlor®; Mitsubishi, Santotherm® (Japan); Caffaro, Fenclor® (Italy).

Trade Name	CAS No.	*RTECS* No.	Trade Name	CAS No.	*RTECS* No.
Aroclors	01336-36-3	TQ1350000	Aroclor 1242	53469-21-9	TQ1356000
Aroclor 1016	12674-11-2	TQ1351000	Aroclor 1248	12672-29-6	TQ1358000
Aroclor 1221	11104-28-2	TQ1352000	Aroclor 1254	11097-69-1	TQ1360000
Aroclor 1232	11141-16-5	TQ1354000	Aroclor 1260	11096-82-5	TQ1362000

HMIS	
H 1	R 1
F 1	I 3
R 0	S 1
PPG*	K 1

SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

PCB-42% Chlorine/Aroclor 1242
CAS No. 53469-21-9
OSHA PEL (Skin*)
8-Hr TWA: 1 mg/m^3
ACGIH TLV (Skin*), 1988-89
TLV-TWA: 1 mg/m^3

PCB-54% Chlorine/Aroclor 1254
CAS No. 11097-69-1
OSHA PEL (Skin*)
8-Hr TWA: 0.5 mg/m^3
ACGIH TLV (Skin*), 1988-89
TLV-TWA: 0.5 mg/m^3

All PCBs/Aroclors
CAS No. 1336-36-3
NIOSH REL 1977
10-Hour TWA: 0.001mg/m^3
Toxicity Data**
Mouse, Oral, LD_{50}: 1900 mg/kg

*This material can be absorbed through intact skin, which contributes to overall exposure.
**See NIOSH, *RTECS* (Genium ref. 90), at the locations specified in section 1 for additional data with references to tumorigenic, reproductive, mutagenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Ranges from 527°F (275°C) to 725°F (385°C)
Solubility in Water (%): Insoluble
Pour Point: Ranges from -31°F (-35°C) to 87.8°F (31°C)

% Volatile by Volume: Ranges from 1.2 to 1.6
Molecular Weight (Average): Aroclor 1242: 258 Grams/Mole
Aroclor 1254: 326 Grams/Mole

Appearance and Odor: Clear to light yellow mobile oil to a sticky resin; a sweet "aromatic" odor. As the percentage of chlorine increases, the PCB becomes thicker and heavier; e.g., Aroclor 1254 is more viscous than Aroclor 1242.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: Not Found	LEL: Not Found	UEL: Not Found

Extinguishing Media: Use water spray/fog, carbon dioxide (CO_2), dry chemical, or "alcohol" foam to extinguish fires that involve polychlorinated biphenyls. Although it is very difficult to ignite PCBs, they are often mixed with more flammable materials (oils, solvents, etc.) **Unusual Fire or Explosion Hazards:** If a transformer containing PCBs is involved in a fire, its owner may be required to report the incident to appropriate authorities. Consult and follow all pertinent Federal, state, and local regulations. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode; fire fighters must also wear a complete set of protective clothing. **Comments:** The hazards of PCB fires are associated with the possibility of their being released into the environment where they and their products of degeneration can pose serious long-term health risks. These potential problems are heightened by the PCBs' resistance to biological and chemical degradation and by the possibility that they will contaminate underground water systems (see sect. 5)

*Ranges from 284°F (140°C) to 392°F (200°C).

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Polychlorinated biphenyls are very stable materials. Hazardous polymerization cannot occur.
Chemical Incompatibilities: PCBs can react dangerously with sodium or potassium. These reactions are part of an industrial process used to destroy PCBs; however, people have been killed by explosions at PCB treatment, storage, and disposal sites. **Conditions to Avoid:** Limit human exposure to PCBs to the lowest possible level; especially avoid contact with skin. **Hazardous Products of Decomposition:** Thermal-oxidative degradation of PCBs can produce toxic gases such as carbon monoxide, chlorine, chlorinated aromatic fragments, phenolics, aldehydes, and hydrogen chloride. Incomplete combustion of PCBs produces toxic compounds such as polychlorinated dibenzofuran (PCDF, the major product of combustion), and polychlorinated dibenzo-*p*-dioxin (PCDD or dioxin).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: The EPA lists PCBs as carcinogens, and the IARC classifies them as probable human carcinogens (group 2B). **Summary of Risks:** Effects of accidental exposure to PCBs include acneform eruptions; eye discharge; swelling of the upper eyelids and hyperemia of the conjunctiva; hyperpigmentation of skin, nails, and mucous membrane; chloroacne; distinctive hair follicles; fever; hearing difficulties; limb spasms; headache; vomiting; and diarrhea. PCBs are potent liver toxins that can be absorbed through unbroken skin in hazardous amounts without immediately discernible pain or discomfort. Severe health effects can develop later. In experimental animals, prolonged or repeated exposure to PCBs by any route results in liver damage at levels that are less than those reported to have caused cancer in rodents. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, eyelids, blood, liver. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Skin and eye irritation, acneform dermatitis, nausea, vomiting, abdominal pain, jaundice, liver damage. **Chronic Effects:** Possible cancer (evidence of this is inconclusive); reproductive effects (jaundice, excessive secretion of tears, dermal chromopexy); and hepatitis. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for 15 minutes. **Skin.** Rinse exposed skin with flooding amounts of water; wash with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Induce vomiting by sticking your finger to the back of the exposed person's throat. Have him or her drink 1 to 2 glasses of milk or water. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** PCBs are poorly metabolized, soluble in lipids, and they accumulate in tissues or organs rich in lipids. Liver function tests can help to determine the extent of body damage in exposed persons. If electrical equipment containing PCBs arcs over, the PCBs or other hydrocarbon dielectric fluids may decompose and give off hydrochloric acid (HCl), a potent respiratory irritant.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any accidental release of PCBs as an emergency. An SPCCP (spill-prevention control and countermeasure plan) must be formulated before spills or leaks occur.* PCBs are resistant to biodegradation, soluble in lipids, and chemically stable; as such they have become significant contaminants of global ecosystems. Releases of PCBs require immediate, competent, professional response from trained personnel. *Each release situation is unique and requires a specifically designed cleanup response.* General recommendations include adhering to Federal regulations (40 CFR Part 761). Notify safety personnel, evacuate nonessential personnel, ventilate the spill area, and contain the PCBs. All wastes, residues, and contaminated cleanup equipment from the incident are subject to EPA requirements (40 CFR 761). Consult your attorney or appropriate regulatory officials for information about reporting requirements and disposal procedures. **Waste Disposal:** Contact your hazardous waste disposal firm or a licensed contractor for detailed recommendations, especially when PCBs are unexpectedly discovered. Follow Federal, state, and local regulations. PCBs are biomagnified in the food chain; i.e., their concentration increases at each link. The disposal of PCBs or of PCB-contaminated materials is strictly regulated; violations of applicable laws can result in fines, lawsuits, and negative publicity. **Warning:** Accidental spills of PCBs that may affect water supplies must be reported to Coast Guard personnel at the National Response Center, telephone (202) 426-2675.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
CERCLA Hazardous Substance, Reportable Quantity: 10 lbs (4.54 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of PCBs is possible, wear a full face shield. Follow OSHA eye- and face-protections regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent any contact of PCBs with your skin. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standards cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contamination into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. Heavily soiled clothing must be properly discarded in a manner consistent with applicable regulations. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in work areas.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage Segregation: Store PCBs in closed containers in a cool, dry, well-ventilated area. Protect containers from physical damage. **Special Handling/Storage:** All storage facilities must have adequate containment systems (dikes; elevated, nonporous holding platforms; retaining walls) to prevent any major release of PCBs into the environment. Carefully design and implement these extra precautions now; do not wait until you have to respond to an accidental release of this material.

Transportation Data (49 CFR 172.101-2; PCBs were the first materials to be directly regulated by Congress by way of TSCA in 1976.)

DOT Shipping Name: Polychlorinated Biphenyls
DOT Hazard Class: ORM-E
ID No. UN 2315
DOT Packaging Requirements: 49 CFR 173.510

IMO Shipping Name: Polychlorinated Biphenyls
IMO Hazard Class: 9
IMDG Packaging Group: II

References: 1, 6, 26, 38, 84-94, 100, 101, 116, 117, 120, 122.

Prepared by PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

Technical Review: Northeast Analytical, Inc. (PCB and VOC Specialists), Schenectady, New York, Telephone: (518) 346-4592

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GENIUM PUBLISHING CORP.

No. 181

SILVER

Issued: April 1986

SECTION 1. MATERIAL IDENTIFICATION

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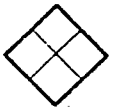
MATERIAL NAME: SILVER
DESCRIPTION: Elemental metal.
OTHER DESIGNATIONS: Ag, Argentum, CAS #7440-22-4.

MANUFACTURER/SUPPLIER: Available from many suppliers.

COMMENTS: Photography products account for 30% of industrial consumption. Additional uses include electrical conductors, coins, silverware, and jewelry.

HMIS
H:1
F:0
R:0
PPE*
*See sect. 8



Not Found

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Silver, Ag	99+	TWA 0.1 mg/m^3* TWA 0.01 mg/m^3** ---------- Rat, Implant, TD: 2570 mg/kg

* Current (1985-86) ACGIH TLV for silver dust and fume.

** Current (1985-86) ACGIH TLV for soluble silver compounds and OSHA exposure limit.

SECTION 3. PHYSICAL DATA

Boiling Point ... 3833.6°F (2112°C)
Vapor Pressure ... Not Found
Water Solubility ... Insoluble
Vapor Density (Air = 1) ... Not Found
Evaporation Rate ... Not Found

Specific Gravity (H_2O = 1) ... 10.5
Melting Point ... 1763.4°F (961.9°C)
Percent Volatile by Volume ... Not Found
Molecular Weight ... 107.87

Appearance and odor: Ductile and malleable lustrous white metal.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not Found	Not Found	Not Found	Not Applicable	Not Applicable

NFPA Classification: Noncombustible.

EXTINGUISHING MEDIA: Use proper extinguisher for surrounding fire.

UNUSUAL FIRE/EXPLOSION HAZARDS: None.

SPECIAL FIRE-FIGHTING PROCEDURES: None.

SECTION 5. REACTIVITY DATA

Silver is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES: Acetylene and silver form an insoluble, explosive acetylide. If silver is treated with nitric acid in the presence of ethyl alcohol, silver fulminate may be formed, which can be detonated.
Ethylenimine forms explosive compounds with silver. Finely divided silver and hydrogen peroxide solutions may explode.
This material is incompatible with oxalic and tartaric acid. Ammonia plus silver may form explosive compounds.
Bromoazide explodes on contact with silver foil.

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SECTION 6. HEALTH HAZARD INFORMATION | TLV

Silver is not considered a carcinogen by the NTP, IARC, or OSHA.

SUMMARY OF RISKS: Silver has no known physiological function in man and will accumulate in most tissues. Chronic accumulation (threshold in excess of 1 gram) in the body can result in argyria, a permanent condition associated with widespread bluish pigmentation of the skin and conjunctiva. TARGET ORGANS: Generally, where contact occurs. PRIMARY ENTRY: Inhalation, long-term handling (causes particles to become embedded in skin), or absorption through sweat glands. ACUTE EFFECTS are associated with soluble silver compounds that may be caustic, causing local irritations or destruction of tissue, depending upon strength of solution. CHRONIC EFFECTS: Argyria may be a local or general effect, depending upon previous exposure. FIRST AID: EYE CONTACT: Flush with water for 15 minutes. Get medical attention.* SKIN CONTACT: Wash skin with soap and water. Argyria from long-term exposure is permanent and cannot be washed away. INHALATION: Remove victim to fresh air. INGESTION: Dilute with water. Get medical attention.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

COMMENTS: The original 0.01 mg/m^3 TLV was established to prevent a lifetime body accumulation exceeding 1 gram, where argyria would become evident. Evaluation of 25 years of data has shown 0.01 mg/m^3 to be too conservative; therefore, the ACGIH raised the TLV to 0.1 mg/m^3.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel; prevent entry into sewers or surface waters. Wear respirator where a dusting hazard is anticipated.

WASTE DISPOSAL: Reclaim or sell waste to a commercial reclaimer.

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES are not required unless metal is in the molten state.

GLOVES: Repeated handling may discolor the skin because of skin rubbing against the metal. Cotton gloves will prevent this cosmetic effect.

RESPIRATOR is required where metal dust or fumes are generated with inadequate exhaust ventilation. Air samples should be collected to quantify the exposure levels.

VENTILATION is required where air exposures exceed the TLV-TWA'S.

OTHER: Reclamation of silver from photographic or X-ray film may involve cyanide compounds. Proper precautions must be taken when working with cyanide compounds. See Genium MSDS #13, Potassium Cyanide, for further information.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Silver is usually stored in locked cabinets or safes to prevent theft.

ENGINEERING CONTROLS: Exhaust ventilation where TLV-TWA is exceeded.

EPA Hazardous Substance Designation: 40 CFR 260

Data Source(s) Code: 2, 4, 6, 14, 59, 82, 84, NFC 1983. DW

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Approvals	JO-Acurocco, 11/86
Indust. Hygiene/Safety	10-86
Medical Review	10/T 86

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GENIUM PUBLISHING CORP.

No. 664

TETRAETHYL LEAD

Issued: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: TETRAETHYL LEAD

Description (Origin/Uses): Used as a gasoline additive to prevent engine knock.

Other Designations: TEL; Tetraethylplumbane; $C_8H_{20}Pb$; CAS No. 0078-00-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 3 2 3

HMIS			
H	3	R	1
F	1	I	4
R	1	S	4
PPG*		K	3
*See sect. 8			

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Tetraethyl Lead, CAS No. 0078-00-2, $Pb(C_2H_5)_4$	Ca 100	IDLH* Level: 40 mg/m³ **OSHA PEL (Skin**)** 8-Hr TWA: 0.075 mg/m³ as Pb (Lead) **ACGIH TLV (Skin**), 1987-88** TLV-TWA: 0.1 mg/m³ as Pb (Lead) **Toxicity Data***** Rat, Oral, LD_{50}: 12300 µg/kg

*Immediately dangerous to life and health.
**This material can be absorbed through intact skin, which contributes to overall exposure.
***See NIOSH, *RTECS* (TB4550000), for additional data with references to reproductive and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Decomposes at 392°F (200°C)
Vapor Pressure: 0.2 Torr at 68°F (20°C); 1 Torr at 100°F (38°C)
Vapor Density (Air = 1): 8.6
Water Solubility (%): Insoluble
Molecular Weight: 323 Grams/Mole
Specific Gravity (H_2O = 1): 1.59 at 52°F (11°C)
Melting Point: -215°F (-137°C)

Appearance and Odor: A colorless liquid usually dyed red, orange, or blue; slightly musty odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
200°F (93.3°C) CC	Not Listed	% by Volume	1.8	Not Listed

Extinguishing Media: Use water spray to extinguish tetraethyl lead fires.

Unusual Fire or Explosion Hazards: Tetraethyl lead vapor is much heavier than air and it collects in enclosed, low-lying areas such as sumps, underground utility rooms, and basements. Eliminate sources of ignition there and do not enter such areas without wearing completely protective clothing.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Tetraethyl lead is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Do not mix this material with strong oxidizing agents or halogenated compounds.

Conditions to Avoid: Avoid physical contact with tetraethyl lead because of its health hazards (see sect. 6).

Hazardous Products of Decomposition: During certain fire conditions tetraethyl lead can decompose and/or react to give off toxic gases such as carbon monoxide (CO), oxides of lead (PbO_x), and/or lead fumes.

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SECTION 6. HEALTH HAZARD INFORMATION

Tetraethyl lead is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks; Warning: Tetraethyl lead penetrates intact skin. Dangerous amounts of this material may be absorbed through unbroken skin even when the airborne concentrations of it are below the exposure limits cited in section 2. Tetraethyl lead affects the central nervous system (CNS) with symptoms such as psychosis, mania, convulsions, etc. The onset of symptoms may be delayed for up to 8 days after exposure. Severe intoxication may be fatal, and if not fatal, recovery may require 1 week to 3 months. **Medical Conditions Aggravated by Long-Term Exposure:** Existing problems with the CNS may be worsened by exposure to tetraethyl lead, so administer preplacement and periodic medical exams emphasizing CNS functions. **Target Organs:** CNS, cardiovascular system, kidneys, eyes. **Primary Entry:** Skin contact/absorption, inhalation. **Acute Effects:** Insomnia, lassitude, anxiety tremors, heart irregularities, hypotension, pallor, nausea, anorexia, hallucinations, convulsions, coma, eye irritation. These are some of the symptoms listed in Genium reference 88, page 221; however, the level and duration of the exposure determine which symptoms actually occur. **Chronic Effects:** Possible cancer.
FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Eye irritation is expected, but it is minor compared to the CNS effects. **Skin.** Immediately remove material by quickly rinsing the affected area with kerosene or a similar petroleum distillate. Then wash with soap and water. **Caution:** The rinsing agent used is flammable; do not ignite it or its vapor, which will create additional hazards. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Do not induce vomiting. That procedure is indicated only if very large amounts of tetraethyl lead have been ingested. Slowly give exposed person 1 to 2 glasses of milk or water to drink to dilute the material. Call a poison control center for specific recommendations.
GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. Hospitalize exposed person for careful observation; monitor blood gases, fluids, and electrolytes. Administer anticonvulsants as required; heavy and prolonged sedation with short-acting barbituates in the hospital may prove effective. DANGER: Some effects of tetraethyl lead exposure may be delayed by a week or more.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate all nonessential personnel, provide maximum possible ventilation, and eliminate all sources of ignition immediately. Cleanup personnel must have protection against contact with and inhalation of vapor (see sect. 8). Use nonsparking tools. Absorb the spilled tetraethyl lead with sand, sawdust, or vermiculite and then place the waste into containers suitable for disposal or reclamation procedures.
Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. P110
CERCLA Hazardous Substance, Reportable Quantity: 100 lbs (45.4 kg), per the Clean Water Act (CWA), sect. 311 (b) (4); and the Resource Conservation and Recovery Act (RCRA), sect. 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency of nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves; boots; aprons; and clean, impervious, body-covering clothing to prevent any possibility of skin contact with liquid tetraethyl lead or its vapor. **Ventilation:** Install and operate both general and local maximum explosion-proof ventilation powerful enough to maintain airborne levels of tetraethyl lead below the OSHA PEL standard cited in section 2. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in all work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Avoid all contact with tetraethyl lead, including skin absorption of its vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store tetraethyl lead in a cool, dry, well-ventilated area away from sources of ignition and incompatible chemicals (see sect. 5).

Engineering Controls: Preplan for routine use and emergency response. Consider installing automatic sensing equipment to detect dangerous levels of tetraethyl lead that may build up in enclosed, low-lying areas such as underground workrooms or storage areas.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Tetraethyl Lead, Liquid	**DOT Label:** Poison	**IMO Class:** 6.1
DOT Hazard Class: Poison B	**DOT ID No.** NA1649	**IMO Label:** Poison

References: 1, 2, 12, 73, 84-94, 100, 103, 112, 113, 114.

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 317
TOLUENE
(Revision D)

Issued: August 1979
Revised: April 1986

SECTION 1. MATERIAL IDENTIFICATION 20

MATERIAL NAME: TOLUENE

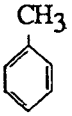
OTHER DESIGNATIONS: Methyl Benzene, Methyl Benzol, Phenylmethane, Toluol, C_7H_8, CAS #0108-88-3

MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Allied Corp., PO Box 2064R, Morristown, NJ 07960; Telephone: (201) 455-4400
Ashland Chemical Co., Industrial Chemicals & Solvents Div., PO Box 2219, Columbus, OH; Telephone: (614) 889-3844

HMIS
H: 2
F: 3
R: 0
PPE*
*See sect. 8

R 1
I 3
S 2
K 4

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Toluene 	ca 100	8-hr TLV: 100 ppm, or 375 mg/m^3* (Skin)**
		Man, Inhalation, TCLo: 100 ppm: Psychotropic***
		Rat, Oral, LD_{50}: 5000 mg/kg Rat, Inhalation, LCLo: 4000 ppm/4 hrs. Rabbit, Skin, LD_{50}: 14 gm/kg
		Human, Eye: 300 ppm

* Current (1985-86) ACGIH TLV. The OSHA PEL is 200 ppm with an acceptable ceiling concentration of 300 ppm and an acceptable maximum peak of 500 ppm/10 minutes.

** Skin designation indicates that toluene can be absorbed through intact skin and contribute to overall exposure.

*** Affects the mind.

SECTION 3. PHYSICAL DATA

Boiling Point ... 231°F (111°C)
Vapor Pressure @ 20°C, mm Hg ... 22
Water Solubility @ 20°C, wt. % ... 0.05
Vapor Density (Air = 1) ... 3.14

Evaporation Rate (BuAc = 1) ... 2.24
Specific Gravity (H_2O = 1) ... 0.866
Melting Point ... -139°F (-95°C)
Percent Volatile by Volume ... ca 100
Molecular Weight ... 92.15

Appearance and odor: Clear, colorless liquid with a characteristic aromatic odor. The odor is detectable to most individuals in the range of 10 to 15 ppm. Because olfactory fatigue occurs rapidly upon exposure to toluene, odor is not a good warning property.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
40°F (4°C) CC	896°F (480°C)	% by Volume	1.27	7.1

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, alcohol foam. Do not use a solid stream of water because the stream will scatter and spread the fire. Use water spray to cool tanks/containers that are exposed to fire and to disperse vapors.

UNUSUAL FIRE/EXPLOSION HAZARDS: This OSHA class IB flammable liquid is a dangerous fire hazard. It is a moderate fire hazard when exposed to oxidizers, heat, sparks, or open flame. Vapors are heavier than air and may travel a considerable distance to an ignition source and flash back.

SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should wear self-contained breathing apparatus with full facepiece operated in a positive-pressure mode when fighting fires involving toluene.

SECTION 5. REACTIVITY DATA

CHEMICAL INCOMPATIBILITIES: Toluene is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. This material is incompatible with strong oxidizing agents, dinitrogen tetraoxide, silver perchlorate, tetranitromethane, and uranium hexafluoride. Contact with these materials may cause fire or explosion. Nitric acid and toluene, especially in the presence of sulfuric acid, will produce nitrated compounds that are dangerously explosive.

CONDITIONS TO AVOID: Avoid exposure to sparks, open flame, hot surfaces, and all sources of heat and ignition. Toluene will attack some forms of plastics, rubber, and coatings. Thermal decomposition or burning produces carbon dioxide and/or carbon monoxide.

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SECTION 6. HEALTH HAZARD INFORMATION | TLV

Toluene is not considered a carcinogen by the NTP, IARC, or OSHA. SUMMARY OF RISKS: Vapors of toluene may cause irritation of the eyes, nose, upper respiratory tract, and skin. Exposure to 200 ppm for 8 hours causes mild fatigue, weakness, confusion, lacrimation (tearing) and paresthesia (a sensation of prickling, tingling, or creeping on the skin that has no objective cause). Exposure to higher concentrations may cause headache, nausea, dizziness, dilated pupils, and euphoria, and, in severe cases, may cause unconsciousness and death. The liquid is irritating to the eyes and skin. Contact with the eyes may cause transient corneal damage, conjunctival irritation, and burns if not promptly removed. Repeated and/or prolonged contact with the skin may cause drying and cracking. It may be absorbed through the skin in toxic amounts. Ingestion causes irritation of the gastrointestinal tract and may cause effects resembling those from inhalation of the vapor. Chronic overexposure to toluene may cause reversible kidney and liver injury. FIRST AID: EYE CONTACT: Immediately flush eyes, including under eyelids, with running water for at least 15 minutes. Get medical attention if irritation persists.* SKIN CONTACT: Immediately flush skin (for at least 15 minutes) while removing contaminated shoes and clothing. Wash exposed area with soap and water. Get medical attention if irritation persists or if a large area has been exposed.* INHALATION: Remove victim to fresh air. Restore and/or support breathing as required. Keep victim warm and quiet. Get medical help.* INGESTION: Give victim 1 to 2 glasses of water or milk. Contact a poison control center. Do not induce vomiting unless directed to do so. Transport victim to a medical facility. Never give anything by mouth to a person who is unconscious or convulsing. * GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Limit access to spill area to necessary personnel only. Remove leaking containers to safe place if feasible. Cleanup personnel need protection against contact with liquid and inhalation of vapor (see sect. 8).
WASTE DISPOSAL: Absorb small spills with paper towel or vermiculite. Contain large spills and collect if feasible, or absorb with vermiculite or sand. Place waste solvent or absorbent into closed containers for disposal using nonsparking tools. Liquid can be flushed with water to an open holding area for handling. Do not flush to sewer, watershed, or waterway.
COMMENTS: Place in suitable container for disposal by a licensed contractor or burn in an approved incinerator. Consider reclaiming by distillation. Contaminated absorbent can be buried in a sanitary landfill. Follow all Federal, state, and local regulations. TLm 96: 100-10 ppm. Toluene is designated as a hazardous waste by the EPA. The EPA (RCRA) HW No. is U220 (40 CFR 261). The reportable quantity (RQ) is 1000 lbs/454 kg (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute) and be designed to capture heavy vapor. For emergency or nonroutine exposures where the TLV may be exceeded, use an organic chemical cartridge respirator if concentration is less than 200 ppm and an approved canister gas mask or self-contained breathing apparatus with full facepiece if concentration is greater than 200 ppm.
Safety glasses or splash goggles should be worn in all work areas. Neoprene gloves, apron, face shield, boots, and other appropriate protective clothing and equipment should be available and worn as necessary to prevent skin and eye contact. Remove contaminated clothing immediately and do not wear it until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, or open flame. Storage areas must meet OSHA requirements for class IB flammable liquids. Use metal safety cans for handling small amounts. Protect containers from physical damage. Use only with adequate ventilation. Avoid contact with eyes, skin, or clothing. Do not inhale or ingest. Use caution when handling this compound because it can be absorbed through intact skin in toxic amounts. SPECIAL HANDLING/STORAGE: Ground and bond metal containers and equipment to prevent static sparks when making transfers. Do not smoke in use or storage areas. Use nonsparking tools. ENGINEERING CONTROLS: Preplacement and periodic medical exams emphasizing the liver, kidneys, nervous system, lungs, heart, and blood should be provided. Workers exposed to concentrations greater than the action level (50 ppm) should be examined at least once a year. Use of alcohol can aggravate the toxic effects of toluene.
COMMENTS: Emptied containers contain product residues. Handle accordingly!
Toluene is designated as a hazardous substance by the EPA (40 CFR 116). DOT Classification: Flammable liquid. UN1294.
Data Source(s) Code: 1-9, 12, 16, 20, 21, 24, 26, 34, 81, 82. CR

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Approvals	J.O. Accrocco, 11/86.
Indust. Hygiene/Safety	10-86
Medical Review	Oct 86

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GENIUM PUBLISHING CORP.

No. 679

1,1,2-TRICHLOROETHANE

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION 27

Material Name: 1,1,2-TRICHLOROETHANE

Description (Origin/Uses): Prepared by the catalytic chlorination of ethane or ethylene. Used as a solvent for fats, waxes, natural resins, and alkaloids.

Other Designations: ß-Trichloroethane; Ethane Trichloride; Vinyl Trichloride; $CH_2ClCHCl_2$; CAS No. 0079-00-5

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Genium

HMIS
H 1
F 0
R 0
PPG*
*See sect. 8

R 1
I 4
S 2
K 0

SECTION 2. INGREDIENTS AND HAZARDS / % / EXPOSURE LIMITS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
1,1,2-Trichloroethane, CAS No. 0079-00-5	Ca 100	**OSHA PEL (Skin*)** 8-Hr TWA: 10 ppm, 45 mg/m³ **ACGIH TLV (Skin*), 1988-89** TLV-TWA: 10 ppm, 45 mg/m³ **NIOSH REL** Lowest Feasible Level **Toxicity Data**** Rat, Oral, LD_{50}: 580 mg/kg Rat, Inhalation, LC_{Lo}: 500 ppm (8 Hrs)

*This material can be absorbed through intact skin, which contributes to overall exposure.
**See NIOSH, *RTECS* (KJ3150000), for additional data with references to irritative, tumorigenic, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 237°F (114°C)
Melting Point: -33°F (-36°C)
% Volatile by Volume: 100
Vapor Pressure: 19 Torrs at 68°F (20°C)

Molecular Weight: 133 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 1.4416 at 68°F (20°C)

Appearance and Odor: A colorless, nonflammable liquid; sweet, pleasant odor resembling chloroform.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature*	LEL*	UEL*

Extinguishing Media: *1,1,2-Trichloroethane does not burn. Use an extinguishing agent such as "alcohol" foam, water spray, carbon dioxide, or dry chemical to put out the surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode to protect against the harmful effects of the surrounding fire.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: 1,1,2-Trichloroethane is stable in closed containers during routine operations at room temperature. Hazardous polymerization cannot occur.

Chemical Incompatibilities: 1,1,2-Trichloroethane can react dangerously with strong caustics such as sodium hydroxide and chemically active metals such as sodium, potassium, powdered magnesium, aluminum, and sodium-potassium alloys.

Conditions to Avoid: Prevent exposure to these incompatible materials.

Hazardous Products of Decomposition: Thermal-oxidative degradation of this liquid can produce toxic gases such as carbon monoxide (CO) and oxides of chlorine (ClO_x).

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SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: 1,1,2-Trichloroethane is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Inhaling 1,1,2-trichloroethane vapor or absorbing the liquid through the skin depresses the central nervous system (CNS), which can progress to narcosis. Administration of this liquid to experimental animals has produced liver damage (fatty degeneration) and has induced cancer of the liver in mice. 1,1,2-Trichloroethane is 10 to 20 times more toxic than the trichloroethylene congener. **Medical Conditions Aggravated by Long-Term Exposure:** Persons with a history of chronic respiratory, liver, or kidney disease may be at increased risk from exposure to this liquid. Preplacement questionnaires are recommended. **Target Organs:** Skin, eyes, CNS, respiratory system, liver, and kidneys. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Irritation of skin, eyes, nose, throat, and mucous membranes; and anesthesia manifested by CNS effects such as headache, dizziness, drowsiness, and incoordination. **Chronic Effects:** Liver and kidney damage and eventually coma and death may occur. Removal from exposure will reverse this progression.
FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Keep the exposed person warm and at rest until medical help is available. **Ingestion.** Unlikely. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, and provide adequate ventilation. Cleanup personnel should wear protective clothing and equipment (see sect. 8). Soak up the spilled 1,1,2-trichloroethane onto a suitable absorbent such as vermiculite or sawdust and place it into containers suitable for disposal. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)
RCRA Waste, No. U227
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a); and the Resource Conservation and Recovery Act (RCRA), § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent skin contact with 1,1,2-trichloroethane. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale 1,1,2-trichloroethane vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store 1,1,2-trichloroethane in closed containers in a cool, dry, well-ventilated area away from incompatible chemicals (see sect. 5). **Special Handling/Storage:** Storage facilities must have adequate ventilation because this volatile liquid can evaporate and build up hazardous concentrations in these areas.

Transportation Data (49 CFR 172.101-2): Not Listed

References: 1, 38, 84-94, 100, 116, 117, 120, 122.

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GENIUM PUBLISHING CORP.

No. 312
TRICHLOROETHYLENE
(Revision E)

Issued: July 1979
Revised: August 1987

SECTION 1. MATERIAL IDENTIFICATION

23

MATERIAL NAME: TRICHLOROETHYLENE

DESCRIPTION (Origin/Uses): Prepared from *sym*-tetrachloroethane by way of eliminating HCl by boiling with lime. Used to manufacture organic chemicals, pharmaceuticals; in degreasing and dry cleaning; and as a solvent for fats, waxes, rubbers, oils, paints, varnishes, ethers, and cellulose esters.

OTHER DESIGNATIONS: Ethylene Trichloride; TCE; Trichloroethene; 1,1,2-Trichloroethylene; C_2HCl_3; NIOSH *RTECS* #KX4550000; CAS #0079-01-6

MANUFACTURER/SUPPLIER: Available from several suppliers, including: Dow Chemical USA, 2020 Dow Center, Midland, MI 48640; Telephone: (517) 636-1000; (800) 258-CHEM

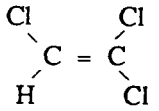
COMMENTS: Trichloroethylene is a toxic solvent and a suspected occupational carcinogen.

HMIS
H 2
F 1
R 1
PPE*
* See sect. 8

R 1
I 3
S 1
K 0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Trichloroethylene, CAS #0079-01-6; NIOSH *RTECS* #KX4550000	100	ACGIH Values 1987-88 TLV-TWA*: 50 ppm, 270 mg/m^3 TLV-STEL**: 200 ppm, 1080 mg/m^3 OSHA PEL 1986*** 8-Hr TWA: 100 ppm Ceiling: 200 ppm NIOSH REL 1986 10-Hr TWA: 25 ppm TOXICITY DATA Human, Oral, LD_{Lo}: 7 g/kg Human, Inhalation, TC_{Lo}: 6900 mg/m^3 (10 Min) Human, Inhalation, TC_{Lo}: 160 ppm/83 Min Human, Inhalation, TD_{Lo}: 812 mg/kg



* The TLV-TWA is set to control subjective complaints such as headache, fatigue, and irritability.

** The TLV-STEL is set to prevent incoordination and other beginning anesthetic effects from TCE. These levels should provide a wide margin of safety in preventing liver injury.

*** The OSHA PEL is 300 ppm for 5 minutes in any 2 hours.

SECTION 3. PHYSICAL DATA

Boiling Point ... 188.6°F (87°C)
Vapor Pressure ... 58 Torr at 68°F (20°C)
Water Solubility ... Insoluble
Vapor Density (Air = 1) ... 4.53

Evaporation Rate ... Not Listed
Specific Gravity ... 1.4649 at 68°F (20°C)
Melting Point ... -120.64°F (-84.8°C)
Molecular Weight ... 131.40 Grams/Mole

Appearance and odor: Colorless, nonflammable mobile liquid; sweetish odor like chloroform.

COMMENTS: TCE is highly soluble in lipids. A high vapor pressure at room temperature provides the potential for TCE vapors to contaminate use areas.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Not Listed	770°F (410°C)	% by Volume	8%	10.5%

EXTINGUISHING MEDIA: TCE has no flash point in a conventional closed tester at room temperature, but it is moderately flammable at higher temperatures. Use dry chemical, carbon dioxide, alcohol foam, or other extinguishing agents suitable for the surrounding fire.

OSHA Flammability Class (29 CFR 1910.106): Not Regulated

UNUSUAL FIRE/EXPLOSION HAZARDS: During fire conditions TCE emits highly toxic and irritating fumes, including hydrochloric acid and phosgene. SPECIAL FIRE-FIGHTING PROCEDURES: Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode. At TCE vapor levels of 300-1000 ppm, fire fighters who lack the proper respiratory equipment may experience incoordination and impaired judgment.

DOT Flammability Class (49 CFR 173.115): Not Regulated

SECTION 5. REACTIVITY DATA

Trichloroethylene is stable. Hazardous polymerization can occur under certain circumstances (see Conditions to Avoid and Comments, below).

CHEMICAL INCOMPATIBILITIES include magnesium or aluminum powder, NaOH, KOH, or other strong alkaline materials. Reactions with alkaline materials may lead to the formation of dangerous explosive mixtures of chloroacetylenes.

CONDITIONS TO AVOID: When TCE is heated (as in the case with vapor degreasers) or exposed to sunlight, it requires extra stabilization against oxidation, degradation, and polymerization. It is slowly decomposed by light when moist.

PRODUCTS OF HAZARDOUS DECOMPOSITION include hydrochloric acid and phosgene under certain conditions at elevated temperatures.

COMMENTS: TCE is stable under normal handling and storage conditions, and hazardous polymerization is not expected to occur. However, failure of the stabilizer at elevated temperatures or other extreme conditions may allow polymerization to take place..

SECTION 6. HEALTH HAZARD INFORMATION

Trichloroethylene is listed as a carcinogen by the NTP, IARC, and OSHA. NIOSH recommends that trichloroethylene be treated as an occupational carcinogen. IARC carcinogenic results are animal suspect, animal positive, and human indefinite. SUMMARY OF RISKS: Moderate exposures to TCE cause symptoms similar to those of alcohol inebriation. Higher concentrations cause narcotic effects. Ventricular fibrillation has been cited as the cause of death following heavy exposures. TCE-induced hepato cellular carcinomas have been detected in mice during tests conducted by the National Cancer Institute (*Chem & Eng News* 54 [April 5, 1976]:4). Organ systems affected by overexposure to TCE are the central nervous system (euphoria, analgesia, anesthesia), degeneration of the liver and kidneys, the lungs (tachypnea), heart (arrhythmia) and skin (irritation, vesication, and paralysis of fingers when immersed in liquid TCE). Contact with the liquid defats the skin, causing topical dermatitis. Certain people appear to experience synergistic effects from TCE exposure concomitant with exposure to caffeine, alcohol, and other drugs. When combined with alcohol intake, toxic effects are increased and may cause a red, blotchy facial and upper body rash commonly called "degreaser's flush." Other reported symptoms of TCE exposure include abnormal fatigue, headache, irritability, gastric disturbances, and intolerance to alcohol. Toxic effects from testing of TCE on humans include hallucination, distorted perception, somnolence (general depressed activity), and jaundice. TARGET ORGANS: Respiratory system, central nervous system, heart, liver, kidneys, and skin. PRIMARY ENTRY: Ingestion, inhalation, skin contact. ACUTE EFFECTS: Headache, vertigo, visual disturbance, tremors, nausea, vomiting, dermatitis, dizziness, drowsiness, and irritation to the eyes, nose, and throat. CHRONIC EFFECTS: None Reported. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: Diseases of the liver, kidneys, lungs, and central nervous system. FIRST AID: EYE CONTACT: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help.* INHALATION: Remove victim to fresh air; restore and/or support his breathing as needed. Do not give adrenalin to the victim. Get medical help.* INGESTION: Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. A professional decision regarding whether or not to induce vomiting is required. Do not give adrenalin to the victim. Get medical help.*

*GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

COMMENTS: Workers' responses to TCE vary significantly because of many factors, including age, health status, nutrition, and intake of alcohol, caffeine, and medicines. Do not use these substances before, during, or after exposure to TCE. If a worker displays any of the symptoms of exposure to TCE, thoroughly investigate all the possible contributing factors to determine, if possible, how much the work environment levels of TCE are responsible.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Inform safety personnel of any trichloroethylene spill or leak and evacuate the area for large spills. Cleanup personnel must use respiratory and liquid contact protection. Adequate ventilation must be provided. Confine the spilled TCE to as small an area as possible. Do not allow it to run off to sewers or open waterways. Pick up spilled TCE with a vacuum cleaner or an absorbent such as vermiculite.

DISPOSAL: Consider reclamation, recycling, or destruction rather than disposal in a landfill.

Trichloroethylene is designated as a hazardous substance by the EPA (40 CFR 116.4).

Trichloroethylene is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U228

EPA Reportable Quantity (40 CFR 117.3): 1000 lbs (454 kgs)

Aquatic Toxicity Rating, TLm 96: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Follow the eye and face protection guidelines of 29 CFR 1910.133. GLOVES: Wear impervious gloves. RESPIRATOR: Use a NIOSH-approved respirator per the *NIOSH Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of TCE requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. WARNING: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. OTHER EQUIPMENT: Wear rubber boots, aprons, and other suitable body protection appropriate to the existing work environment. VENTILATION: Install and operate general and local exhaust ventilation systems of sufficient power to maintain airborne concentrations of TCE below the OSHA PEL standards cited in section 2. SAFETY STATIONS: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. OTHER SPECIAL MODIFICATIONS IN THE WORKPLACE: Because of the unresolved controversy about the carcinogenic status of TCE, all existing personal protective equipment and engineering technology should be used to prevent any possibility of worker contact with this material.

COMMENTS: Practice good personal hygiene. Keep material off of your clothes and equipment. Avoid transfer of material from hands to mouth while eating, drinking, or smoking. Adhere to the sanitation requirements of 29 CFR 1910.141 and 29 CFR 1910.142.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Prevent TCE from coming into contact with strong caustics such as NaOH; KOH; chemically active metal like Ba, Li, Na, Mg, Ti; and powdered aluminum or magnesium in acidic solutions. SPECIAL HANDLING/STORAGE: Store this material in a cool, dry, well-ventilated area. Avoid elevated temperatures because products of toxic and corrosive decomposition from TCE may form. Monitor the level of any stabilizer component that may be added to the TCE. (Consult the technical data from the supplier to determine the specifics of any added stabilizer.) If applicable, follow the supplier's recommendation concerning proper rotation of stock, shelf-life requirements, and levels of stabilizers.

ENGINEERING CONTROLS IN THE WORKPLACE: Avoid collecting aluminum fines (very small particles) or chips in a TCE vapor degreaser. Monitor TCE stabilizer levels regularly. Only trained personnel should operate vapor degreasers.

TRANSPORTATION DATA (per 49 CFR 172.101-2):

DOT Hazard Class: ORM-A	DOT ID No. UN1710	IMO Class: 6.1
IMO Label: St. Andrew's Cross (X)*	DOT Shipping Name: Trichloroethylene	DOT Label: None

* Harmful - Stow away from foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1-9, 12, 14, 21, 73, 87-94. PI

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Approvals J.O. Accurocco

Indust. Hygiene/Safety 11-18-87

Medical Review

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Material Safety Data Sheets Collection:

Sheet No. 43
Trisodium Phosphate

Issued: 11/78 Revision: 11/89

Section 1. Material Identification 30

Trisodium Phosphate Description: Trisodium phosphate crystallizes from water as trisodium phosphate dodecahydrate ($Na_3PO_4 \cdot 12H_2O$) and can exist as several hydrate forms, and as anhydrous salt, depending on processing. Prepared by combining proper proportions of phosphoric acid and soda ash to form disodium phosphate, then adding caustic soda. Used in softening water, tanning leather, manufacturing paper, clarifying sugar; in detergent mixtures, photographic developers, food additives, buffers, emulsifiers, dietary supplements, boiler water compounds, and industrial cleaners.
Other Designations: TSP; trisodium orthophosphate; sodium phosphate, tribasic; tertiary sodium phosphate; trisodium phosphate dodecahydrate ($Na_3PO_4 \cdot 12H_2O$), CAS No. 10101-89-0; Na_3PO_4; CAS No. 7601-54-9.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73)

R 1
I 2
S 2
K 1

Genium

HMIS
H 1
F 0
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Trisodium phosphate, ca 100%

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987	Toxicity Data†
8-hr TWA: 5 mg/kg of respirable dust*	None established	None established	Rabbit, intravenous, LD_{Lo}: 1580 mg/kg

* Under OSHA inert dust limits, assume that airborne particulates not otherwise controlled are limited to a maximum of 5 mg/kg of respirable dust; however, this level may be inadequate to prevent irritation with this material.
† See NIOSH, *RTECS* (TC9490000) for additional data with references to mutagenic effects.

Section 3. Physical Data

Boiling Point: -11 H_2O at 212 °F (100 °C) (decomposes)
Melting Point: 163.9 to 170.1 °F (73.3 to 76.7 °C)
Molecular Weight: 163.94 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 1.62 at 68 °F (20 °C)

Water Solubility: (°F/°C)	(g/100 g)
32/0	1.5
59/15	28.3
158/70	157.0

Appearance and Odor: White or colorless crystalline solid (also as powder flake, granules); no odor.

Section 4. Fire and Explosion Data

Flash Point: Noncombustible	Autoignition Temperature: Noncombustible	LEL: None reported	UEL: None reported

Extinguishing Media: Use what is appropriate to the surrounding fire since this material is noncombustible.
Unusual Fire or Explosion Hazards: In a fire situation at high temperature, phosphates can emit highly toxic phosphorus oxides (PO_x) fumes.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

Section 5. Reactivity Data

Stability/Polymerization: Trisodium phosphate is stable at room temperature in closed containers. Hazardous polymerization cannot occur.
Chemical Incompatibilities: This strong caustic material reacts violently with water and strong acids to generate heat.
Conditions to Avoid: Never heat to decomposition.
Hazardous Products of Decomposition: Thermal oxidative decomposition of trisodium phosphate can produce highly toxic fumes of phosphorus oxides (PO_x) and sodium oxide (Na_2O).

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists trisodium phosphate as a carcinogen.
Summary of Risks: Inhaling this alkaline material's dust or mist irritates the respiratory tract. Aqueous, highly alkaline solutions may also produce caustic burns.
Medical Conditions Aggravated by Long-Term Exposure: Permanent tissue damage to the skin and eyes.
Target Organs: Skin, digestive tract.
Primary Entry: Inhalation and ingestion. Its alkaline nature irritates and may injure the digestive tract. To use as a food additive requires reducing its alkalinity.
Acute Effects: Tissue irritation upon contact with skin and eyes.
Chronic Effects: Prolonged or repeated eye and skin contact causes irritation. Injury to the esophagus from scarring may occur. Alkali exposures may necessitate irrigation for extended duration.
FIRST AID
Eyes: Flush immediately, including under the eyelid[illegible]y but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding am[illegible] water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air.[illegible]port breathing as needed.
Ingestion: Never give anything by mouth to an un[illegible]cious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water or milk to dilute; then give fruit juice or diluted vinegar to drink. *Never induce vomiting* unless instructed by a physician to do so.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Cleanup personnel should wear the necessary personal protective equipment to prevent skin or eye contact and dust inhalation. For liquid (solution) spills, cover the material with an inert solid absorbent (vermiculite or dry sand) and scoop into an appropriate container (with secure lid) for disposal in accordance with existing regulations. Dike with inert absorbent material, as needed, to contain and limit spill area. Sweep, vacuum, or scoop the spilled solid, avoiding dust generation, into a suitable disposal container (with secure lid). Flush residues to drain with plenty of water.
Disposal: Scrap material can be used for neutralizing acid wastes or buried in an approved landfill. If regulations permit, you may flush *small* amounts to drain with large excess of water. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, Sec. 311(b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Chemical safety glasses with side shields are recommended for handling this material.
Respirator: Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). If dusty conditions occur, local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing again. Remove this material from your shoes and equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store this material in tightly sealed containers away from acidic materials in a clean, dry, ventilated area. Prevent physical damage to containers.
Engineering Controls: Avoid dust inhalation, body contact, contact with acidic materials, and heating to decomposition. Note that anhydrous trisodium phosphate and lower hydrates are more alkaline than $Na_3PO_4 \cdot 12H_2O$ *on a weight basis.*

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 1, 2, 4-7, 12, 15, 80, 81, 82, 109
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD M6

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MATERIAL SAFETY
DATA SHEET

USED MOTOR OIL

MSDS NO: 02004056

MANUFACTURER/SUPPLIER:
Amoco Oil Company
200 East Randolph Drive
Chicago, Illinois 60601

EMERGENCY HEALTH INFORMATION: (800) 447-8735
EMERGENCY SPILL INFORMATION: (800) 424-9300
CHEMTREC, U.S.A.
OTHER PRODUCT SAFETY INFORMATION: (312) 856-3907

IMPORTANT COMPONENTS: Used motor oil.
No exposure limit(s) established.

WARNING STATEMENT: Caution! Continuous long-term contact with used motor oils has caused skin cancer in laboratory animal tests.

HMIS/NFPA CODES:(HEALTH;1)(FLAMMABILITY;1)(REACTIVITY;0), Chronic health hazard.

APPEARANCE AND ODOR: Dark brown oily liquid.

HEALTH HAZARD INFORMATION

EYE

EFFECT: No significant irritation expected.

FIRST AID: Flush eyes with plenty of water.

PROTECTION: None required; however, use of eye protection is good industrial practice.

SKIN

EFFECT: Continuous long-term contact with used motor oil has caused skin cancer in laboratory animals. See Toxicology Section.

FIRST AID: Wash exposed skin with soap and water. Remove contaminated clothing, including shoes, and thoroughly clean and dry before reuse. Get medical attention if irritation develops.

PROTECTION: Avoid skin contact. Wear protective clothing and impervious gloves when working with used motor oils.

INHALATION

EFFECT: No significant health hazards identified.

FIRST AID: If adverse effects occur, get medical attention.

PROTECTION: None required; however, use of adequate ventilation is good industrial practice.

INGESTION

EFFECT: Expected to be relatively non-toxic.

FIRST AID: If a large amount is swallowed, induce vomiting. Get medical attention.

FIRE AND EXPLOSION INFORMATION

FLASHPOINT: Greater than 200°F

EXTINGUISHING MEDIA: Agents approved for Class B hazards (e.g., dry chemical, carbon dioxide, halogenated agents, foam, steam) or water fog.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None.

REACTIVITY INFORMATION

DANGEROUS REACTIONS: None identified.

HAZARDOUS DECOMPOSITION: None. Polymerization will not occur. Incomplete burning can produce carbon monoxide, carbon dioxide, and other harmful products.

STABILITY: Stable.

CHEMICAL AND PHYSICAL PROPERTIES

SOLUBILITY IN WATER: Negligible, below 0.1%

STORAGE AND ENVIRONMENTAL PROTECTION

STORAGE REQUIREMENTS: No special requirements.

SPILLS AND LEAKS: Treat as an oil spill. Remove mechanically or contain on an absorbent material.

WASTE DISPOSAL: Disposal must be in accordance with applicable federal, state, or local regulations. Enclosed-controlled incineration is recommended unless directed otherwise by applicable ordinances.

TOXICOLOGICAL INFORMATION

CAUTION!
Continuous long-term contact with used motor oils has caused cancer in animal tests. IARC considers used motor oils from gasoline engines to be an animal carcinogen.

In case of contact, wash exposed skin thoroughly with soap and water or use waterless hand cleaners to remove used motor oils from skin. Do not use gasoline, thinners, or solvents.

Wear protective clothing and impervious gloves when working with used motor oils. Remove oil-soaked clothing, including shoes, and thoroughly clean and dry before reuse.

REGULATORY INFORMATION

CERCLA REPORTABLE QUANTITY:
This product is not reportable under 40 CFR Part 302.4.

DOT PROPER SHIPPING NAME: Not regulated

OSHA HAZARD COMMUNICATION STANDARD: Carcinogen (in animal tests).

REGULATORY INFORMATION - CONTINUED

RCRA STATUS:
This product is not subject to the 40 CFR Part 268.30 land ban on the disposal of certain hazardous wastes.

SARA STATUS:
This product is regulated under the following section(s) of SARA Title III, 42 USC 9601. Spills or releases of the product may be reportable as determined by the information given below:

SECTIONS 311 AND 312 OF SARA AND 40 CFR PART 370:
This product is defined as hazardous by OSHA under 29 CFR Part 1910.1200(d).

TSCA STATUS: All of the components of this product are listed on the TSCA Inventory.

Truck/Rail Shipping Class: Petroleum Lubricating Oil

ISSUE INFORMATION

BY:

R. G. Farmer, Director,
Product Safety & Toxicology

ISSUED: September 29, 1989
SUPERSEDES: February 13, 1989

This material safety data sheet and the information it contains is offered to you in good faith as accurate. We have reviewed any information contained in this data sheet which we received from sources outside our company. We believe that information to be correct but cannot guarantee its accuracy or completeness. Health and safety precautions in this data sheet may not be adequate for all individuals and/or situations. It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. No statement made in this data sheet shall be construed as a permission or recommendation for the use of any product in a manner that might infringe existing patents. No warranty is made, either express or implied.

Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 318

XYLENE (Mixed Isomers)
(Revision D)
Issued: November 1980
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: XYLENE (Mixed Isomers)

Description (Origin/Uses): Used as a raw material for the production of benzoic acid, phthalic anhydride, isophthalic and terephthalic acids and their dimethyl esters in the manufacture of polyester fibers; in sterilizing catgut; with Canadian balsam as oil-immersion in microscopy; and as a cleaning agent in microscopic techniques.

Other Designations: Dimethylbenzene; Xylol; C_8H_{10}; CAS No. 1330-20-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: Although there are three different isomers of xylene (*ortho*, *meta*, and *para*), the health and physical hazards of all three isomers are very similar. This MSDS is written for a xylene mixture of all three isomers, which is usually commercial xylene.

NFPA: 2 3 0 -

HMIS			
H	2	R	1
F	3	I	3
R	0	S	2
PPG*		K	3
*See sect. 8			

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Xylene (Mixed Isomers), CAS No. 1330-20-7* **o*-Xylene, CAS No. 0095-47-6 *m*-Xylene, CAS No. 0108-38-3 *p*-Xylene, CAS No. 0106-42-3 **Check with your supplier to determine if there are additions, contaminants, or impurities (such as benzene) that are present in reportable quantities per 29 CFR 1910. ***Immediately dangerous to life and health. **** See NIOSH, *RTECS* (No. ZE2100000), for additional data with references to reproductive, irritative, and mutagenic effects.	**	IDLH*** Level: 1000 ppm **OSHA PEL** 8-Hr TWA: 100 ppm, 435 mg/m³ **ACGIH TLVs, 1987-88** TLV-TWA: 100 ppm, 435 mg/m³ TLV-STEL: 150 ppm, 655 mg/m³ **Toxicity Data**** Human, Inhalation, TC_{Lo}: 200 ppm Man, Inhalation, LC_{Lo}: 10000 ppm/6 Hrs Rat, Oral, LD_{50}: 4300 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 275°F to 293°F (135°C to 145°C)*
Melting Point: -13°F (-25°C)
Evaporation Rate: 0.6 Relative to BuAc = 1
Specific Gravity (H_2O = 1): 0.86

Water Solubility (%): Insoluble
Molecular Weight: 106 Grams/Mole
% Volatile by Volume: Ca 100
Vapor Pressure: 7 to 9 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 3.7

Appearance and Odor: A clear liquid; aromatic hydrocarbon odor.

*Materials with wider and narrower boiling ranges are commercially available.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
81°F to 90°F (27°C to 32°C)	867°F (464°C)	% by Volume	1%	7%

Extinguishing Media: Use foam, dry chemical, or carbon dioxide. Use water sprays to reduce the rate of burning and to cool containers.

Unusual Fire or Explosion Hazards: Xylene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Xylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

Chemical Incompatibilities: This material may react dangerously with strong oxidizers.

Conditions to Avoid: Avoid any exposure to sources of ignition and to strong oxidizers.

Hazardous Products of Decomposition: Carbon monoxide (CO) may be evolved during xylene fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Xylene is not listed as a carcinogen by the IARC, NTP, or OSHA.
Summary of Risks: Liquid xylene is a skin irritant and causes erythema, dryness, and defatting; prolonged contact may cause blistering. Inhaling xylene can depress the central nervous system (CNS), and ingesting it can result in gastrointestinal disturbance; and possibly hematemesis (vomiting blood). Effects on the eyes, kidneys, liver, lungs, and the CNS are also reported. **Medical Conditions Aggravated by Long-Term Exposure:** Problems with eyes, skin, central nervous system, kidneys, and liver may be worsened by exposure to xylene. **Target Organs:** CNS, eyes, gastrointestinal tract, blood, liver, kidneys, skin. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Dizziness; excitement; drowsiness; incoordination; staggering gait; irritation of eyes, nose, and throat; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; and dermatitis. **Chronic Effects:** Reversible eye damage, headache, loss of appetite, nervousness, pale skin, and skin rash.
FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have a trained person administer oxygen. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Vomiting may occur spontaneously, but do not induce it. If vomiting should occur, keep exposed person's head below his or her hips to prevent aspiration (breathing the liquid xylene into the lungs). Severe hemorrhagic pneumonitis with grave, possibly fatal, pulmonary injury can occur from aspiring very small quantities of xylene.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. If exposure is severe, hospitilization for at least 72 hours with careful monitoring for delayed onset of pulmonary edema is recommended.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of xylene vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.
Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U239
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), section 311 (b) (9)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection reguiations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specifics of the work operation to prevent prolonged or repeated skin contact with xylene. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of xylene below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of xylene into general work areas by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations.
Safety Stations: Make eyewash stations, safety/quick-drench showers, and washing facilities available in areas of use and handling.
Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean xylene from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale xylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store xylene in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage.

Special Handling/Storage: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Xylene	**DOT Label:** Flammable Liquid	**IMO Label:** Flammable Liquid
DOT ID No. UN1307	**DOT Hazard Class:** Flammable Liquid	**IMO Class:** 3.2 or 3.3

References: 1, 2, 12, 73, 84-94, 100, 103.

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 176

ZINC METAL/POWDER

Issued: March 1986

SECTION 1. MATERIAL IDENTIFICATION 19

MATERIAL NAME: ZINC METAL/POWDER

OTHER DESIGNATIONS: Spelter; CAS #7440-66-6; ASTM B-69; Zn

DESCRIPTION: Shining white, malleable, blue-gray metal; bars, sheets, wire, foil, flake, and powder.

HMIS
H: 1
F: 1
R: 1
PPE: *
* See Sect. 8

R 0
I 2
S 1
K -

MANUFACTURERS: Available from several suppliers, including: Meadowbrook Corp., 30 Rockefeller Plaza, New York City, NY 10112; Telephone:)(212) 582-0420

COMMENTS: Commonly used for galvanizing iron and other metals, electroplating, battery cells, and as an alloying component of brass or bronze. Zinc oxide is used as a pigment in cosmetics and ointments.

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
ZINC; CAS #7440-66-6	>98	OSHA PEL* as Zinc Oxide: 5 mg/m^3
* Current ACGIH (1985-86) TWA is 5 mg/m^3 as ZnO fume, while STEL for ZnO is 10 mg/m^3. Metallic zinc particulates can be considered a nuisance dust.		---------- Human, Inhalation TCLo: 1 hr.

SECTION 3. PHYSICAL DATA

Boiling Point ... 1664.6°F (907°C)
Melting Point ... 788°F (420°C)
Vapor Pressure ... 736°C mm Hg 100
Percent Volatile by Volume ... Not Found
Water Solubility ... Insoluble

Molecular Weight ... 65.38
Vapor Density (Air = 1) ... Not Found
Evaporation Rate ... Not Found
Specific Gravity (H_2O = 1) ... 7.14

Appearance and odor: Bright gray-white metallic solid, foil or particulate. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not Found	Powder/650 millijoules	Dust Cloud Exp. Level		

NFPA CLASSIFICATION: 1.
EXTINGUISHING MEDIA: Special mixtures of dry chemical or clean, dry sand. Dust will form explosive mixtures with air. Bulk dust in a damp state may generate heat through chemical reaction and hydrogen gas. UNUSUAL FIRE/EXPLOSION HAZARDS: Zn may generate toxic fumes when heated, causing metal fume fever (see sect. 6). Fire fighters should use self-contained breathing apparatus when fighting fires involving zinc or zinc powder. SPECIAL FIRE-FIGHTING PROCEDURES: Zinc and zinc powder will burn in chlorine gas. Care should be taken to ensure that fires involving bulk quantities of zinc powder that are extinguished with water do not generate heat or possible hydrogen gas with subsequent reignition through the reaction of zinc powder and water. Concentrations of zinc oxide powder should remain open and not be sealed to allow safe drying.

SECTION 5. REACTIVITY DATA

Zinc metal/powder is stable. Hazardous polymerization cannot occur.
CHEMICAL INCOMPATIBILITIES: Contact with acids or alkaline hydroxides will yield hydrogen gas. Zinc may react with halogenated hydrocarbon solvents to form salts and hydrogen gas. The combination of zinc and carbon disulfide will result in an incandescent reaction.
CONDITIONS TO AVOID: Bulk zinc dust should be kept in dry, well-ventilated storage to prevent reaction with water and generation of hydrogen gas. Zn powder reacts explosively with manganese chloride. Zn is resistant to fluorine, chlorine, and bromine, but it reacts strongly with these halogens in the presence of water vapor.
HAZARDOUS DECOMPOSITION PRODUCTS: Zinc and zinc powder will react with water to generate hydrogen gas.
COMMENTS: When combined with oxygen, zinc or zinc powder will generate a fume that can result in metal fume fever (see sect. 6).

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SECTION 6. HEALTH HAZARD INFORMATION | TLV

This product is not considered a carcinogen by the NTP, OSHA, or IARC.

SUMMARY OF RISKS: Zinc metal in most forms is not toxic and is not readily absorbed through the skin, GI tract, or lungs. Zn is considered essential to life. Although most inorganic Zn compounds are potential causes of gastroenteric irritation, a high-level dose is relatively nontoxic when ingested. Inhalation of zinc fumes normally generated by zinc and extreme heat may cause metal fume fever, which is accompanied by dryness and irritation of the throat, coughing and dyspnea, a feeling of weakness, muscle pain, and general malaise. Removal from exposure will normally alleviate symptoms, with no residual or chronic effects.

TARGET ORGANS: Lungs, skin. PRIMARY ENTRY: inhalation, dermal contact.

ACUTE EFFECTS: Inhalation of high levels of zinc fumes may cause metal fume fever.

CHRONIC EFFECTS: Prolonged skin contact may cause a drying dermatitis. Zinc and zinc powder have little history of causing chronic effects.

FIRST AID: EYE CONACT: Flush well with running water to remove particulates; get medical attention if irritation persists.* SKIN CONTACT: For cuts, dermal abrasion, irritation, or thermal burns, get medical attention.* INHALATION: Remove person to fresh air; get medical attention if symptoms persist.* INGESTION: Get medical help if large amount is ingested.

* GET MEDICAL ASSISTANCE = In plant, paramedic, community.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of large powder spills. Clean up, minimizing dust generation, heat, sources of ignition, and moisture. Approved, grounded vacuum cleaners may be used for final cleanup. Place picked-up powder in closed, pressure-vented, dry metal containers.

DISPOSAL: Deposit unsalvageable waste in an approved landfill per Federal, state, and local regulations. Zinc powder should not be shipped if it is wet.

COMMENTS: Consider EPA Code D 001 or D 003 for Zn powder disposal.

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Wear safety goggles to prevent eye contact with particulates.

GLOVES: Wear tightly woven, nonstatic-generating, protective clothing. Special protective clothing is needed for work with hot or molten Zn.

RESPIRATOR: Use NIOSH-approved respirator when dust/fume exceeds the TLV.

VENTILATION: Provide local (explosion-proof) exhaust ventilation to meet TLV requirements. An approved dust-collection system is needed to gather airborne particulates.

OTHER: Preplacement and periodic examination of personnel is suggested. Eyewash stations should be accessible outside the use area. Use of contact lenses in areas of Zn particulate generation should be prohibited because they pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Solid zinc metal does not need special storage segregation; however, zinc powder should be stored dry in a storage area free from ignition sources, chlorine, bromine, or fluorine gas and/or acids.

SPECIAL HANDLING/STORAGE: Follow approved cleaning techniques for zinc powder. Good handling is necessary to control powder dispersal and prevent generation of airborne particulates.

ENGINEERING CONTROLS: Facilities for handling large amounts of zinc powder require special design; approved procedures; use of grounded, electrical, nonsparking tools; and emergency planning for fire and spills.

COMMENTS: See NFPA 491M

NOT designated as a hazardous substance by EPA (40 CFR 116)

DOT Classification: Zn Powder - Flammable Solid

UN1436

Data Source(s) Code: 2-12, 14, 26, 31, 37, 41, 59, 61, 62, 82, 84. OW

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Approvals	[illegible] 6/86
Indust. Hygiene/Safety	DJW 6/86
Medical Review	July 86

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APPENDIX B
TICKS AND TICK-BORNE DISEASES

APPENDIX B
TICKS AND TICK-BORNE DISEASES

Field personnel should be aware of an increased occurrence of tick-borne Lyme disease in the United States. All field personnel should take proper precautions to limit exposure to ticks and tick-borne diseases. These include:

- Cinching and taping clothing at the ankles and wrists, especially the ankles. Ticks lie low on grass blades and shrubs. They encounter your feet, ankles or lower legs and then crawl upward;

- Wear light-colored clothing to facilitate spotting the ticks, and check your clothing periodically. Be especially careful in terrain with tall grass, bushes or woods;

- Use a tick repellant on skin or clothing. Always read the labels before using. Clothing repellents should never be used on the skin; and

- Recognize the signs of a bite or an infection. It takes several hours for a tick to attach and feed; removing it promptly lessens the chance of being infected.

Pregnant women should be particularly careful since the effects of Lyme disease upon the fetus is unknown.

If a tick is discovered on the skin, it is important to remove the entire insect as soon as possible. The most effective method is to grasp the tick as close as possible to the mouth with tweezers or thin, curved forceps. Then, without jerking, pull it upward steadily (a small amount of skin may be removed in the process).

After removing the tick, disinfect the bite with rubbing alcohol plus Adolph's Meat Tenderizer (meat protein, not artificial) or povidone iodine (Betadine). Do not handle the tick; spirochetes could enter the body through breaks in the skin. Dispose of it in alcohol or flush it down the drain. And check the bite occasionally for at least 3 weeks to see if a rash forms. If it does, you have been infected and should seek medical treatment promptly.

The rash generally appears at the bite location from about 2 days to 2 weeks after the bite. It usually starts as a small red spot that expands as the spirochetes spread beyond the bite. Most commonly,

the rash develops into a reddish circle or oval about 2 to 3 inches in diameter. It fades with or without treatment after a few weeks.

Much larger rashes - anywhere from 6 to 20 inches in diameter also occur, especially on the back. Despite their size, large rashes may be easy to miss because they are often very faint.

Other variants include a rash with a red perimeter and a clear center and the so-called bull's-eye rash, which consists of several concentric red rings. Rashes may vary in shape, depending on where they occur on the body. Frequent sites are the thigh, groin, and armpits. People often develop a rash in more than one place.

Early symptoms may include profound fatigue, a stiff neck, and flu-like symptoms such as headache, chills, fever, and muscle aches. Since tick bites do not always produce a rash, those symptoms alone may warrant a medical check for possible Lyme infection - especially if they occur in summer and you live or work in an area that is endemic for Lyme disease.

Without treatment, the spirochetes usually multiply and the disease progressively worsens. The second stage, occurring within weeks to months of the bite, may affect the heart and nervous system. The third state is the chronic arthritic stage, which begins up to a year or more after the bite.

APPENDIX C
SAFETY COMPLIANCE AGREEMENT AND DOCUMENTATION OF SITE SAFETY BRIEFING

SAFETY COMPLIANCE AGREEMENT AND DOCUMENTATION OF SITE SAFETY BRIEFING

DATE _____ TIME _____

SITE LOCATION _____ PROJECT NUMBER _____

SITE SAFETY OFFICER _____ PROJECT MANAGER _____

TOPICS COVERED DURING BRIEFING:

____ EXTENT AND CONCENTRATION OF CHEMICAL HAZARDS ON SITE
____ HEATLH EFFECTS OF CHEMICAL HAZARDS
____ PHYSICAL HAZARDS ON SITE
____ LEVELS OF PROTECTION REQUIRED
____ MONITORING PROCEDURES
____ ACTION LEVELS
____ DECONTAMINATION PROCEDURES
____ LOCATION OF EMERGENCY NUMBERS
____ ROUTE TO THE HOSPITAL
____ LOCATION OF EMERGENCY EQUIPMENT (FIRST AID KIT, FIRE FIGHTING EQUIPMENT . . .)
____ VERIFICATION THAT HEALTH AND SAFETY PLAN HAS BEEN RECEIVED
____ VERIFICATION THAT BRIEFING WAS UNDERSTOOD (MAY REQUIRE VERBALLY QUIZZING PARTICIPANTS OR VERIFYING COMPREHENSION OF ENGLISH.)

_____

_____

I, the undersigned, have received a copy of the safety plan for the refereneced project. I have been given the above verbal briefing and understand the hazards of working at this site. I will comply with all of the health and safety requirements. I understand that I may be prohibited from working on the project for violating any of the requirements.

DOCUMENTATION (SSO MUST SEE VERIFICATION BEFORE INITIALING COLUMN)

ATTENDEES:

NAME	COMPANY	40 HR	FIT	MEDICAL
1. (print) _____ (signature) _____				
2. (print) _____ (signature) _____				
3. (print) _____ (signature) _____				

APPENDIX D
INCIDENT/ACCIDENT REPORT FORM

OPERATING PROCEDURE NO. HS-102

102.0 INCIDENT REPORTS

102.1 PURPOSE

All health and safety incidents shall be reported to Woodward-Clyde (W-C) management and health and safety staff. The prompt investigation and reporting of incidents will reduce the risk of future incidents, better protect W-C employees, and reduce W-C liability.

102.2 DEFINITIONS

A health and safety incident is any event listed below:

- Illness resulting from chemical exposure or suspected chemical exposure.
- Physical injury, including both those that do and do not require medical attention to W-C employees or W-C subcontractors.
- Fire, explosions, and flashes resulting from activities performed by W-C and its subcontractors.
- Property damage resulting from activities performed by W-C and its subcontractors.
- Vehicular accidents occurring on-site, while travelling to and from client locations, or with any company-owned vehicle.
- Infractions of safety rules and requirements.
- Unexpected chemical exposures.
- Complaints from the public regarding W-C field operations.

102.3 REPORTING PROCEDURES

102.3.1 Reporting Format

Incident reports shall be prepared by completing Form HS-102. This form may be obtained from any W-C Health and Safety Officer (HSO) and is attached to this operating procedure.

102.3.2 Responsible Party

Reports of incidents occurring in the field shall be prepared by the Site Safety Officer or, in the absence of the site safety officer, the supervising field engineer, witness, or injured/exposed individual.

102.3.3 Filing

A report must be submitted to the Health and Safety Officer of the Operating Unit to which the Project Manager belongs within 24 hours of each incident involving medical treatment. In turn, the Health and Safety Officer must distribute copies of the report to the Corporate Health and Safety Manager and the Corporate Health and Safety Officer. When an injury or illness is reported, the Health and Safety Officer must deliver a copy of the report to the individual in charge of Human Resources so that a Worker's Compensation Insurance Report can be filed if necessary. Reports must be received by Human Resources within 48 hours of each qualifying incident.

102.3.4 Major Incidents

Incidents that include fatalities, hospitalization of employees or subcontractors, or involve injury/illness of the public shall be reported to the HSO and Project Manager as soon as possible. Any contact with the media should be referred to the Project Manager and Operating Unit Manager.

FORM HS-102
W-C HEALTH AND SAFETY INCIDENT REPORT

Project Name: _____

Project Number: _____

Date of Incident: _____

Time of Incident: _____

Location: _____

_____

TYPE OF INCIDENT (Check all applicable items)

- ☐ Illness
- ☐ Fire, explosion, flash
- ☐ Injury
- ☐ Unexpected exposure
- ☐ Property Damage
- ☐ Vehicular Accident
- ☐ Health & Safety Infraction
- ☐ Other (describe) _____

DESCRIPTION OF INCIDENT (Describe what happened and possible cause. Identify individual involved, witnesses, and their affiliations; and describe emergency or corrective action taken. Attach additional sheets, drawings, or photographs as needed.)

_____

_____

_____

_____

_____

_____

_____

_____

_____

Reporter:

_____	_____	_____
Print Name	Signature	Date

Reporter must deliver this report to the Operating Unit Health & Safety Officer within 24 hours of the reported incident for medical treatment cases and within five days for other incidents.

Reviewed by: _____ _____

Operating Unit Health & Safety Officer — Date

Distribution by HSO:

- WCGI Corporate Health and Safety Manager
- Corporate Health and Safety Officer
- Project Manager
- Personnel Office (medical treatment cases only)

APPENDIX E
SAFETY COMPLETION REPORT FORM

SAFETY COMPLETION REPORT

(This report must be submitted to the Business Unit Health and Safety Officer within five days after completion of the project.)

Report Completed By: _____ Date Completed: _____

Project Name:_____

Project Number:_____

1. Evaluation of Health and Safety Plan (Add a page if additional space is needed.)

   a. Was the plan adequate? _____

   b. Did the plan adequately anticipate chemical and physical hazards actually present at the site? _____

   c. What situations were discovered that were not anticipated in the health and safety plan? _____
   _____

   d. How were these situations handled? _____
   _____
   _____

   e. Was the recommended personal protective equipment, such as gloves, respirators, eye, face and whole body skin protection appropriate to protect employees from chemical hazards? _____

   f. If not, what should be improved in future plans of this type? _____
   _____
   _____

2. Exposure Data

   a. Were any employees exposed to chemical or physical hazards as a result of failure of personal protective equipment or other problem?_____ If yes, give names of employees:
   _____

   b. Was monitoring performed? ____

   c. What type of monitoring?

      _____ area monitoring

      _____ personal (on-employee) monitoring

APPENDIX F
CALIBRATION RECORDS

PHOTOIONIZATION DETECTOR CALIBRATION RECORD

INSTRUMENT _____

MODEL NUMBER _____

SERIAL NUMBER _____

LAMP TYPE _____

CAL. GAS & LOT NO. _____

CAL. DATE	CAL. TIME	INITIAL READING (PPM)	CAL. RESULTS PASS/FAIL	POST CAL. READING (PPM)	CALIBRATOR'S NAME

NOTE: CAL - Calibration

COMBUSTIBLE GAS INDICATOR CALIBRATION RECORD

INSTRUMENT _____

MODEL NUMBER _____

SERIAL NUMBER _____

CAL. GAS & LOT NO. _____

CAL. DATE	CAL. TIME	LEL RESPONSE (%)	OXYGEN RESPONSE (%)	POST CAL. READING		CALIBRATOR'S NAME
				LEL (%)	OXYGEN (%)	

NOTE: CAL - Calibration LEL - Lower Explosive Limit

APPENDIX G
SAFE DRILLING PRACTICES

OPERATING PROCEDURE NO. HS-203

203.0 SAFETY GUIDELINES FOR DRILLING INTO SOIL AND ROCKS

203.1 PURPOSE

The purpose of this Operating Procedure (OP) is to provide an overview for working safely around drilling operations with truck-mounted and other engine-powered drill rigs. The procedure addresses off-road movement of drill rigs, overhead and buried utilities, use of augers, rotary and core drilling, and other drilling operations and activities.

203.2 APPLICATION

The guidelines shall be applied in Woodward-Clyde (W-C) projects in which truck-mounted, or other engine-powered, drill rigs are used. The guidelines are applicable to W-C employees and W-C owned rigs. For drill rigs operated by contractors, the primary responsibility for drilling safety is with the drilling contractor.

203.3 RESPONSIBILITY AND AUTHORITY

Drill rig safety and maintenance is the responsibility of the drill rig operator. W-C employees are responsible for their own safety including recognizing and avoiding drill rig hazards. W-C employees that observe a drill rig condition believed to be unsafe, shall advise the drill rig operator of the unsafe condition.

203.4 SAFETY GUIDELINES

203.4.1 Movement of Drill Rigs

Before moving a rig, the operator must do the following:

1. To the extent practical, walk the planned route of travel and inspect it for depressions, gullies, ruts, and other obstacles.

2. Check the brakes of the truck/carrier, especially if the terrain along the route of travel is rough or sloped.

3. Discharge all passengers before moving on rough or steep terrain.

4. Engage the front axle (on 4x4, 6x6, etc. vehicles) before traversing rough or steep terrain.

Driving drill rigs along the sides of hills or embankments should be avoided; however, if side-hill travel becomes necessary, the operator must conservatively evaluate the ability of the rig to remain upright while on the hill or embankment. The possibility must be considered that the presence of drilling tools on the rig may reduce the ability of the rig to remain upright (raises the center of mass of the rig).

Logs, ditches, road curbs, and other long and horizontal obstacles should be normally approached and driven over squarely, not at an angle.

When close lateral or overhead clearance is encountered, the driver of the rig should be guided by another person on the ground.

Loads on the drill rig and truck must be properly stored while the truck is moving, and the mast must be in the fully lowered position.

After the rig has been positioned to begin drilling, all brakes and/or locks must be set before drilling begins. If the rig is positioned on a steep grade and leveling of the ground is impossible or impractical, the wheel of the transport vehicle should be blocked and other means of preventing the rig from moving or tipping over employed.

203.5 BURIED AND OVERHEAD UTILITIES

The location of overhead and buried utility lines must be determined before drilling begins, and the locations should be noted on boring plans or assignment sheets.

When overhead power lines are close by, the drill rig mast should not be raised unless the distance between the rig and the nearest power line is at least 20 feet or other distance as required by local ordinances, whichever is greater. The drill rig operator or assistant should walk completely around the rig to make sure that proper distance exists.

When the drill rig is positioned near an overhead line, the rig operator should be aware that hoist lines and power lines can be moved towards each other by wind. When necessary and approved by the Project Manager (PM) and the utility and/or powerlines may be shielded, shut down, or moved by the appropriate personnel.

203.6 CLEARING THE WORK AREA

Before a drill rig is positioned to drill, the area on which the rig is to be positioned should be cleared of removable obstacles and the rig should be leveled if sloped. The cleared/leveled area should be large enough to accommodate the rig and supplies.

203.7 SAFE USE OF AUGERS

Never place hands or fingers under the bottom of an auger flight or drill rods when hoisting the augers or rods over the top of another auger or rod in the ground or other hard surfaces, such as the drill rig platform.

Never allow feet to get under the auger or drill rod while they are being hoisted.

When the drill is rotating, stay clear of the drill string and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason.

Move auger cuttings away from the auger with a long-handled shovel or spade; never use hands or feet.

Never clean an auger attached to the drill rig unless the transmission is in neutral or the engine is off, and the auger has stopped rotating.

203.8 SAFE USE OF HAND TOOLS

OSHA regulations regarding hand tools should be observed in addition to the guidelines provided below:

1. Each tool should be used only to perform tasks for which it was originally designed.

2. Damaged tools should be repaired before use or discarded.

3. Safety goggles or glasses should be worn when using a hammer or chisel. Nearby co-workers and by-standers should be required to wear safety goggles or glasses also, or move away.

4. Tools should be kept cleaned and stored in an orderly manner when not in use.

203.9 SAFE USE OF WIRE LINE HOISTS, WIRE ROPE, AND HOISTING HARDWARE

Safety rules described in Title 29 Code of Federal Regulations (CFR) 1926.552 and guidelines contained in the Wire RPE User's Manual published by the American Iron and Steel Institute shall be used whenever wire line hoists, wire rope, or hoisting hardware are used.

203.10 PROTECTIVE GEAR

203.10.1 Minimum Protective Gear

Items listed below should be worn by all members of the drilling team while engaged in drilling activities.

- Hard Hat;

- Safety Shoes (shoes or boots with steel toes and shanks); and
- Gloves.

203.10.2 Other Gear

Items listed below should be worn when conditions warrant their use. Some of the conditions are listed after each item.

1. **Safety Goggles or Glasses:** Use when working within 25 feet of a drill rig or when using hand tools or chemicals that may create eye hazards.

2. **Safety Belts and Lifelines:** Safety belts and lifelines should be worn by all persons working on top of an elevated derrick beam. The lifeline should be secured at a position that will allow a person to fall no more than eight feet.

3. **Life Vests:** Use for work over water.

203.11 TRAFFIC SAFETY

Drilling in streets, parking lots or other areas of vehicular traffic requires definition of the work zones with cones, warning tape, etc. and compliance with local police requirements.

203.12 FIRE SAFETY

1. Fire extinguishers shall be kept on or near drill rigs for fighting small fires.

2. If methane is suspected in the area, a combustible gas instrument (CGI) shall be used to monitor the air near the borehole with all work to stop at 20 percent of the Lower Explosive Limit.

3. Work shall stop during lighting storms.

APPENDIX H
HEAT STRESS

OPERATING PROCEDURES NO. HS-201

201.0 HEAT STRESS

201.1 PURPOSE

The purpose of this Operating Procedure is to provide general information on heat stress and the methods that can be utilized to prevent or minimize the occurrence of heat stress.

Adverse climatic conditions are important considerations in planning and conducting site operations. Ambient temperature effects can include physical discomfort, reduced efficiency, personal injury, and increased accident probability. Heat stress is of particular concern while wearing impermeable protective garments, since these garments inhibit evaporative body cooling.

201.2 TYPES OF HEAT STRESS

Heat stress is the combination of environmental and physical work factors that constitute the total heat load imposed on the body. The environmental factors of heat stress are the air temperature, radiant heat exchange, air movement, and water vapor pressure. Physical work contributes to the total heat stress of the job by producing metabolic heat in the body in proportion to the intensity of the work. The amount and type of clothing also affects heat stress.

Heat strain is the series of physiological responses to heat stress. When the strain is excessive for the exposed individual, a feeling of discomfort or distress may result, and, finally, a heat disorder may ensue. The severity of strain will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat disorder is a general term used to describe one or more of the heat-related disabilities or illnesses shown in Table 201-1.

201.3 METHODS OF CONTROLLING HEAT STRESS

As many of the following control measures, as appropriate, should be utilized to aid in controlling heat stress:

- Provide for adequate liquids to replace lost body fluids. Encourage personnel to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.

- Replace body fluids primarily with water, with commercial mixes such as Gatorade or Quick Kick used only as a portion of the replacement fluids. Avoid excessive use of caffeine drinks such as coffee, colas or tea.

- Establish a work regimen that will provide adequate rest periods for cooling down. The heat exposure Threshold Limit Values (TLV) may be used for guidelines.

- Provide shaded work areas, if possible.

- Wear cooling devices such as vortex tubes or cooling vests.

- Consider adjusting work hours to avoid the worst heat of the day.

- Take breaks in a cool rest area.

- Remove any impermeable protective garments during rest periods.

- Do not assign other tasks to personnel during rest periods.

- Inform personnel of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

201.6 MONITORING

201.6.1 Temperature

The environmental heat stress of an area can be monitored by the Wet Bulb Globe Temperature Index (WBGT) technique. When heat stress is a possibility, a heat stress monitoring device, such as the Wibget Heat Stress Monitor (Reuter Stokes) can be utilized.

The WBGT shall be compared to the TLV outlined by the American Conference of Governmental Industrial Hygienists (ACGIH) TLV guides, and a work-rest regiment can be established in accordance with the WBGT. Note that approximately 5°C must be subtracted from the TLVs listed for heat stress to compensate for the wearing of impermeable protective clothing.

201.6.2 Medical

In addition to the provisions of the Woodward-Clyde (W-C) medical surveillance program, on-site medical monitoring of personnel should be performed for projects where heat stress is a significant concern. Blood pressure, pulse, body temperature (oral), and body weight loss may be utilized.

Heart Rate: Count the radial pulse during a 30-second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third. If the heart rate still exceeds 110 beats per minute at the next rest cycle, shorten the following work cycle by one-third.

Oral Temperature: Use a clinical thermometer or similar device to measure the oral temperature at the end of the work period (before drinking liquids). If the oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period. If the oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.

Do not permit a worker to wear a semipermeable or impermeable garment if his/her oral temperature exceeds 100.6°F (38.1°C).

Body Water Loss: Measure body weight on a scale accurate to ±0.25 pounds at the beginning and end of each work day (also at lunch break, if possible) to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, nude. The body water loss should not exceed 1.5 percent total body weight loss in a work day.

Physiological Monitoring: Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work. The length of the work cycle will be governed by the frequency of the required physiological monitoring.

201.7 REFERENCES

American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents, 1992-1993.

EPA, Standard Operating Safety Guides, 1992, Pages 91-93.

National Institute for occupational Safety and Health, Criteria for a Recommended Standard: Occupational Exposure to Hot Environments, 1986.

TABLE 201-1
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbances	Treatment	Prevention
Temperature Regulation Heatstroke				
Heatstroke: (1) Hot, dry skin; usually red, mottled, or cyanotic; (2) rectal temperature 40.5°C (104°F) and over; (3) confusion, loss of consciousness, convulsions, rectal temperature continues to rise; fatal if treatment is delayed	(1) Sustained exertion in heat by unacclimatized workers; (2) lack of physical fitness and obesity; (3) recent alcohol intake; (4) dehydration; (5) individual susceptibility; and (6) chronic cardiovascular disease	Failure of the central drive for sweating (cause unknown) leading to loss of evaporative cooling and an uncontrolled accelerating rise in t_{re}; there may be partial rather then complete failure of sweating	Immediate and rapid cooling by immersion in chilled water with massage or by wrapping in wet sheet with vigorous fanning with cool dry air; avoid overcooling; treat shock if present	Medical screening of workers, selection based on health and physical fitness; acclimatization for 5-7 days by graded work and heat exposure; monitoring workers during sustained work in severe heat
Circulatory Hypostasis Heat Syncope				
Fainting while standing erect and immobile in heat	Lack of acclimatization	Pooling of blood in dilated vessels of skin and lower parts of body	Remove to cooler area; rest in recumbent position; recovery prompt and complete	Acclimatization; intermittent activity to assist venous return to heat
Water and or Salt Depletion				
(a) <u>Heat Exhaustion</u>				
(1) Fatigue, nausea, headache, giddiness; (2) skin clammy and moist; complexion pale, muddy, or hectic flush; (3) may faint on standing with rapid thready pulse and low blood pressure; (4) oral temperature normal or low, but rectal temperature usually elevated (37.5-38.5°C or 99.5-101.3°F); water restriction type: urine volume small, highly concentrated; salt restriction type; urine less concentrated chlorides less than 3 g/L	(1) Sustained exertion in heat; (2) lack of acclimatization; and (3) failure to replace water lost in sweat	(1) Dehydration from deficiency of water; (2) depletion of circulating blood volume; (3) circulatory strain from competing demands for blood flow to skin and to active muscles	Remove to cooler environment; rest in recumbent position; administer fluids by mouth; keep at rest until urine volume indicates that water balances have been restored	Acclimatize workers using a breaking-in schedule for 5-7 days; supplement dietary salt only during acclimatization; ample drinking water to be available at all times and to be taken frequently during work day
(b) <u>Heat Cramps</u>				
Painful spasms of muscles used during work (arms, legs, or abdominal); onset during or after work hours	(1) Heavy sweating during hot work; (2) drinking large volumes of water without replacing salt loss	Loss of body salt in sweat, water intake dilutes electrolytes; water enters muscles, causing spasm	Salted liquids by mouth or more prompt relief by IV infusion	Adequate salt intake with meals; for unacclimatized workers, supplement salt intake at meals.

TABLE 201-1 (continued)
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbances	Treatment	Prevention
Skin Eruptions				
(a) Heat Rash (miliaria rubra, or "prickly heat")				
Profuse tiny raised red vesicles (blisterlike) on affected areas; prickling sensations during heat exposure	Unrelieved exposure to humid heat with skin continuously wet from unevaporated sweat	Plugging of sweat gland ducts with sweat retention and inflammatory reaction	Mild drying lotions; skin cleanliness to prevent infection	Cool sleeping quarters to allow skin to dry between heat exposures
(b) Anhidrotic Heat Exhaustion (miliaria profunda)				
Extensive areas of skin which do not sweat on heat exposure, but present gooseflesh appearance, which subsides with cool environments; associated with incapacitation in heat	Weeks or months of constant exposure to climatic heat with previous history of extensive heat rash and sunburn	Skin trauma (heat rash; sunburn) causes sweat retention deep in skin; reduced evaporative cooling causes heat intolerance	No effective treatment available for anhidrotic areas of skin; recovery of sweating occurs gradually on return to cooler climate	Treat heat rash and avoid further skin trauma by sunburn; provide periodic relief from sustained heat
Behavioral Disorders				
(a) Heat Fatigue - Transient				
Impaired performance of skilled sensorimotor, mental, or vigilance tasks, in heat	Performance decrement greater in unacclimatized and unskilled worker	Discomfort and physiologic strain	Not indicated unless accompanied by other heat illness	Acclimatization and training for work in the heat
(b) Heat Fatigue - Chronic				
Reduced performance capacity; lowering of self-imposed standards of social behavior (e.g., alcoholic over-indulgence); Inability to concentrate, etc.	Workers at risk come from temperature climates for long residence in tropical latitudes	Psychosocial stresses probably as important as heat stress; may involve hormonal imbalance but no positive evidence	Medical treatment for serious causes; speedy relief of symptoms on returning home	Orientation on life in hot regions (customs, climate, living conditions, etc.)