Remedial Investigation (RI)/Feasibility Study (FS) Work Plan Tourtelot Cleanup Project Benicia, California

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EXECUTIVE SUMMARY

The goal of the Tourtelot Cleanup Project is to make the property completely safe. The process involves investigating and removing residual ordnance and hazardous substances left from the U.S. Army's use of the land as part of the Benicia Arsenal during World War II through the 1950s.

This document, the Remedial Investigation (RI)/ Feasibility Study (FS) Work Plan for the Tourtelot Property and Portions of Adjoining Properties, presents the methods and procedures to be used to evaluate the nature and extent of potentially hazardous waste in soil, sediment, surface water, and groundwater at the Tourtelot and portions of adjoining properties (hereafter referred to as the "Project Site"). The purpose of the FS is to provide the rationale for using the anticipated remedy of restoring the land to background levels.

The Tourtelot Site is in the City of Benicia, Solano County, California, and consists of approximately 220 acres. The surrounding community consists of residential, industrial, commercial, recreational, and undeveloped areas.

Considerable investigation has been conducted at the site since an inert howitzer round was discovered in mid-1996 when preliminary site preparation for residential development was occurring. The property owner Granite Management Corporation suspended development activities and retained environmental consultants experienced with former military sites to geophysically map the property, remove ordnance, and take soil and surface water samples. In late fall 1996, six pieces of ordnance were found. In addition, the U.S. Army Corps of Engineers (USACE) has conducted investigations of the site as part of its ongoing Benicia Arsenal work.

In 1999, an RI/FS for ordnance and explosives/unexploded ordnance (OE/UXO) was completed and is documented in an engineering evaluation/cost analysis (EE/CA) investigation for the USACE. The EE/CA investigation was conducted over the entire Former Benicia Arsenal, including the Project Site. Portions of the Project Site were geophysically mapped, and subsurface anomalies that were identified were intrusively investigated to determine the presence or absence of OE/UXO.

After public review and Department of Toxic Substances Control (DTSC) approval of the RI/FS Work Plan, experienced environmental contractors will take additional soil and water samples, analyze the resulting data and prepare a report.

The RI/FS Work Plan is organized as follows:

- **Section 1.0 - Project Management Plan.** Presents the purpose and objectives of the work plan; a brief history of the area; a detailed site description (including location, geology, soils, hydrology, and both biological and cultural resources); and identifies and briefly describes previous investigations conducted at the site. This section also provides a

conceptual site model that describes the scope of work to be performed; discusses key project management positions; organization and responsibilities; provides a schedule of major work tasks; and discusses documents to be provided.

- **Section 2.0 - Field Sampling Plan (FSP).** Describes all field investigation sampling activities to be conducted, including, but not limited to: previous sampling performed during the interim sampling program, sampling methods and protocols to be incorporated during the follow-on focused sampling program (including sampling locations), types of samples to be collected at the project site, drilling methods, equipment use, and decontamination procedures. This FSP also includes detailed procedures for the disposal of all investigation-derived waste. FSP components that address the geophysical investigation are documented in the EE/CA .

- **Section 3.0 - Quality Assurance Project Plan (QAPP).** This section describes the quality assurance/quality control (QA/QC) procedures for analytical work and data management to be implemented on this project. Data Quality Objectives (DQOs) are presented to provide a statement of the problem, identification of the decision, and definition of the study boundaries. This QAPP also includes the types of analytical methods to be used (including field analytical procedures, equipment calibration, and record keeping procedures) and data validation to be performed.

- **Section 4.0 - Health and Safety Plan (HASP).** Provides a plan for the protection of worker and public safety and health during the performance of all field activities. This HASP covers a broad range of health and safety issues that may be encountered during the field investigation, including but not limited to: general site safety rules, a hazard analysis (which describes the types of hazards present at the Project Site), environmental contaminants potentially present at the Project Site, UXO avoidance, and an emergency contingency plan (which details all procedures to be followed in the event of an emergency).

- **Section 5.0 - References.** Provides and inventory of the reference materials used in the preparation of the RI/FS Work Plan.

- **Appendix A - Soil and Surface Water Sampling Results.** Provides the results of the soil and surface water sampling conducted in 1998.

- **Appendix B - Geophysical Data.** Provides the results of a 1997 geophysical survey over approximately 400 acres of the Former Benicia Arsenal, including much of the project site. The survey was conducted by NORCAL Geophysical Consultants, Inc., using a total magnetic field vertical gradient system.

- **Appendix C - Well Permit Application and Well Development Forms.** Provides a copy of a Solano County Well Permit Application and applicable forms supporting well development.

- **Appendix D - Health and Safety Documentation.** This appendix provides copies of health and safety forms associated with implementation of the RI/FS field operations.

- **Appendix E - California State Preliminary Remedial Goals (PRGs).** This appendix provides a detailed list of the current California State PRGs.

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ACRONYMS/ABBREVIATIONS

AFLA	association for laboratory accreditation
AA	Atomic absorption
ACS	American Chemical Standards
AIHA	American Industrial Hygiene Association
AP	anti-personnel
ARCH	air rotary casing hammer
ASTM	American Society of Testing and Materials
bgs	below ground surface
BPM	beats per minute
CAM	California Assessment Manual
C	celsius
C/SS	calibration/service specifications
CCAL	continuing calibration standards
CCR	California Code of Regulation
CCV	continuing calibration verification
CDDs/CDF	chlorinated dibenzo-p-dioxins and dibenzofurans
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	code of federal regulations
CIH	certified industrial hygienist
CLP	contract laboratory program
CNDDB	California Natural Diversity Data Base
COC	chain-of-custody
CPC	chemically protective clothing
CPR	cardiopulmonary resuscitation
CVAA	cold vapor atomic absorption
cy	cubic yards
DBA	decibel absolute
DEM	Department of Environmental Management
DI	deionized
DOD	Department of Defense
DOT	Department of Transportation
DQA	Data Quality Assessments
DQCR	daily quality control reports
DQO	data quality objectives
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
EC	electrical conductivity
EDD	electronic data deliverable
EDL	estimated detection limit
EE/CA	Engineering Evaluation/Cost Analysis
EIR	Environmental Impact Report
ELAP	environmental laboratory accreditation programs
EM	electromagnetic
EPA	Environmental Protection Agency
F	Fahrenheit
FA	flare area
FS	Feasibility Study
FSP	Field Sampling Plan
FTL	field team leader
FUDS	formerly used defense sites
GC	gas chromatography
GC/FID	gas chromatograph/flame ionization detector

GC/MS	gas chromatograph/mass spectrometric
GC/HRMS	gas chromatograph/high resolution mass spectrometric
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	hydrochloric acid
HE	high explosive
HNO_3	concentrated nitric acid
HPLC	high performance liquid chromatography
HRGC/HRMS	high resolution gas chromatography/high resolution mass spectometry
HSA	hollow-stem auger
HSM	health and safety manager
HSO	Health and Safety Officer
HTRW	hazardous toxic and radioactive waste
IC	ion chromatographic
ICAL	initial calibration
ICP	inductively coupled plasma
ID	inside diameter
IDL	instrument detection limit
IDW	investigation-derived waste
IVC	independent viability check
LCS/LCD	laboratory control samples/laboratory control duplicates
LCS	laboratory control samples
LCSD	laboratory control samples duplicates
LIMS	Laboratory Information Management System
LUFT	leaking underground fuel tank
MDL	method detection limits
mg/kg	milligrams per kilogram
mg/l	micrograms per liter
mL	milliliter
mm	millimeter
MS/MSD	matrix spike/matrix spike duplicate
MSDS	Material Safety Data Sheet
msl	mean sea level
NCR	nonconformance report
ND	non-detected
ng/l	nanograms per liter
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NORCAL	Geophysical Consultants, Inc.
nm	nano meter
NTU	Nephelometric Turbidity Unit
OE	ordnance and explosives
OESM	ordnance and explosives safety manager
OSHA	Occupation Safety and Health Administration
PAH	polyaromatic hydrocarbons
PC	project chemist
PCDD	polychlorinated dibenzodioxins
PCDF	polychlorinated dibenzofurans
PE	project engineer
pH	hydrogen ion concentration
PM	project manager
POL	petroleum, oils, and lubricants
PPE	personal protective equipment
ppq	part-per-quadrillion

ppt	part-per-trillion
PQL	practical quantitation limits
PRG	polyvinyl chloride
psi	pounds per square inch
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QCSM	quality control systems manager
RAP	Remedial Action Plan
RDX	cyclonite
RF	response factors
RI	Remedial Investigation
RPD	relative percent difference
RSD	relative standard deviation
S/N	signal-to-noise
SAP	Sampling Analysis Plan
SARM	Standard Analytical Reference Materials
Sequoia Analytical	Sequoia Analytical Laboratory of Petaluma
SOP	standard operating procedures
SPF	sun protection factor
SSC	Site Safety Coordinator
SSO	Site Safety Officer
SVOC	semivolatile organic compounds
TAL	target analyte list
TCL	target compound list
TDL	target detection limit
TEF	toxicity equivalence factors
TEPH	total extractable petroleum hydrocarbons
TMI	total magnetic filed
TNT	trinitrotoluene
TPH	total petroleum hydrocarboms
USA	underground services alert
USACE	U.S. Army Corps of Engineers
UV	unltraviolet
UXO	unexploded ordnance
v/v	volume to volume
VOC	volatile organic compound
WBGT	wet bulb globe temperature
WDM	window defining mix

1.0 PROJECT MANAGEMENT PLAN/SCOPING DOCUMENT

This Remedial Investigation (RI)/Feasibility Study (FS) Work Plan describes the methods and procedures to be employed to evaluate the vertical and lateral extent of hazardous waste on the Tourtelot Property and portions of adjoining properties. This RI/FS Work Plan has been prepared to assess site conditions. Additional work plans will be developed for the cleanup of the Tourtelot Property and portions of some adjoining properties. An RI/FS for ordnance and explosives (OE) and unexploded ordnance (UXO) was completed and is documented in the engineering evaluation/cost analysis (EE/CA) for the Former Benicia Arsenal prepared for the U.S. Army Corps of Engineers (USACE) (Earth Tech, 1999). The Tourtelot Property and portions of some adjoining properties are referred to in this work plan as the "Project Site." The project applicant for this RI/FS includes Granite Management Corporation (Granite), the current owner of the Tourtelot Property.

The acronym "HTRW" is routinely used by Department of Defense (DOD) in the context of environmental investigation and cleanup of Formerly Used Defense Sites (FUDS). It is an umbrella term and stands comprehensively for "Hazardous, Toxic, and Radioactive Waste." The acronym "HTRW" is used in this RI/FS Work Plan for consistency with other arsenal-wide environmental investigations and cleanup documents. It is important to note that no radioactive waste is present at the Project Site and that the use of this acronym is not intended to imply that radioactive waste is a concern.

When investigating FUDS sites that may contain UXO and/or OE (both considered hazardous) and OE scrap (inert and non-hazardous), DOD often uses the term "UXO" as an acronym to be inclusive of all ordnance items that may be found at a site. UXO is similarly used in this RI/FS Work Plan for consistency with other arsenal-wide documents. It is important to note that the UXO at the Project Site did not originate from artillery firing or bombing range activities.

1.1 PURPOSE AND OBJECTIVES

The purpose of the RI is to evaluate the nature and extent of potential hazardous waste in soil, sediment, surface water, and groundwater at the Project Site. The data collected during this investigation will be used to evaluate the extent of and assess remedial measures for potential hazardous waste. The objective of this RI is to determine the horizontal and vertical extent of potential hazardous waste in soils at specific locations on the Project Site and to investigate potential effects to surface water and groundwater.

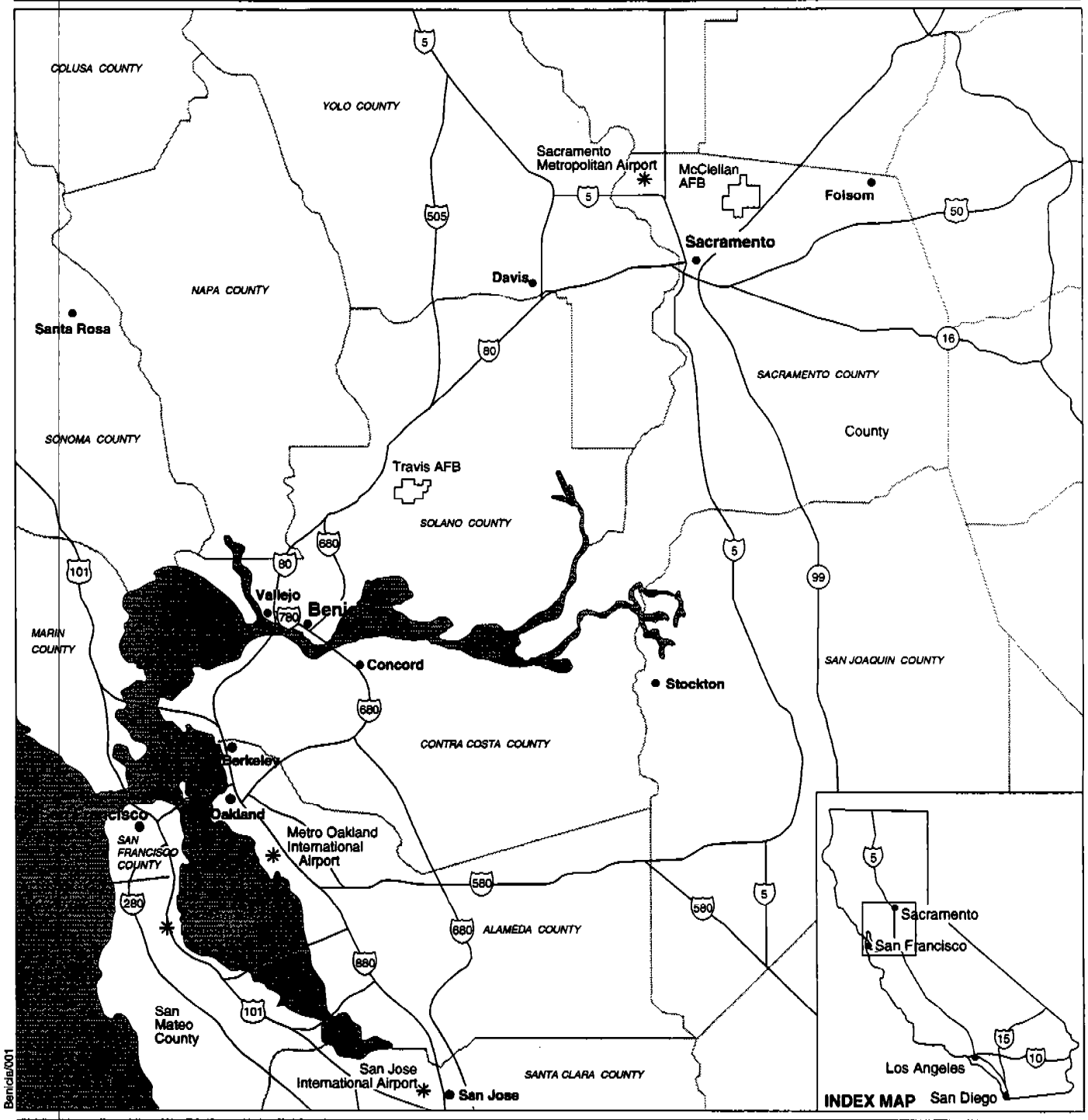
The purpose of the FS is to provide the rationale for using the anticipated remedy of restoring the site to background levels.

This RI/FS Work Plan is being prepared for the California Department of Toxic Substances Control (DTSC) in response to the Imminent and/or Substantial Endangerment Determination and Remedial Action Order (Docket No. I/SE 98/99-011). This RI/FS Work Plan is prepared in accordance with the U.S. Environmental Protection Agency's (EPA's) "*Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*" (October 1998). This RI/FS approach meets the objectives that are stated in Section 5.2.1 of the order. They include:

> Evaluate the nature and extent of hazardous waste in soil, surface water, and groundwater at the Project Site and contamination from the Project Site, including off-site areas affected by the Project Site.
>
> Identify all actual and potential exposure pathways and routes through environmental media.
>
> Determine the magnitude and probability of actual or potential harm to public health, safety, or welfare or to the environment posed by the threatened or actual release of hazardous substances at or from the Project Site.
>
> Identify and evaluate appropriate response measures to prevent or minimize future releases and mitigate any releases that have already occurred.
>
> Develop remedial action objectives for soil that are protective of adults and children in a residential exposure scenario.
>
> Ensure that in areas where ordnance may exist a minimum of 10 feet of UXO-free soil remains on or near the surface, or that a minimum of 4 feet of UXO-free soil remains at a depth below the lowest estimated area of any excavation deeper than 6 feet.
>
> Collect and evaluate the information necessary to prepare a Final Remedial Action Plan (RAP) in accordance with the requirements of Health and Safety Code Section 25356.1.

1.2 PROJECT LOCATION

The Project Site is in the City of Benicia, Solano County, California, approximately 30 miles northeast of San Francisco (Figure 1-1). Consisting of approximately 220 acres, it is partially within the boundaries of the Former Benicia Arsenal (Figure 1-2). The site has rolling topography that includes areas referred to as the North Valley and the South Valley, and it is bordered by the Southampton residential development to the west and south, the Exxon refinery to the south, industrial and commercial facilities to the east and north, and open space to the west and south (Earth Tech, 1999). Within this Project Site boundary, three specific areas (the Demolition Area, the Trinitrotoluene [TNT]



EXPLANATION

- ✳ Airports
- (99) California State Highway
- (101) U.S. Highway
- (280) Interstate Highway
- —— County Boundary

0 3.5 7 14 Miles

Regional Map

Figure 1-1

EXPLANATION

680 Interstate Highway

Former Benicia Arsenal Boundary (estimated)

Project Area

0 .125 .25 .5 Mile

Project Site Location Map

Figure 1-2

Strips Area, and the Flare Area) have been identified as containing HTRW (Figure 1-3). The Howitzer Test Area and the Ammunition Renovation/Primer Destruction Area have both been identified as suspected HTRW areas.

1.3 HISTORY AND DESCRIPTION OF PROJECT SITE

1.3.1 History of Project Site

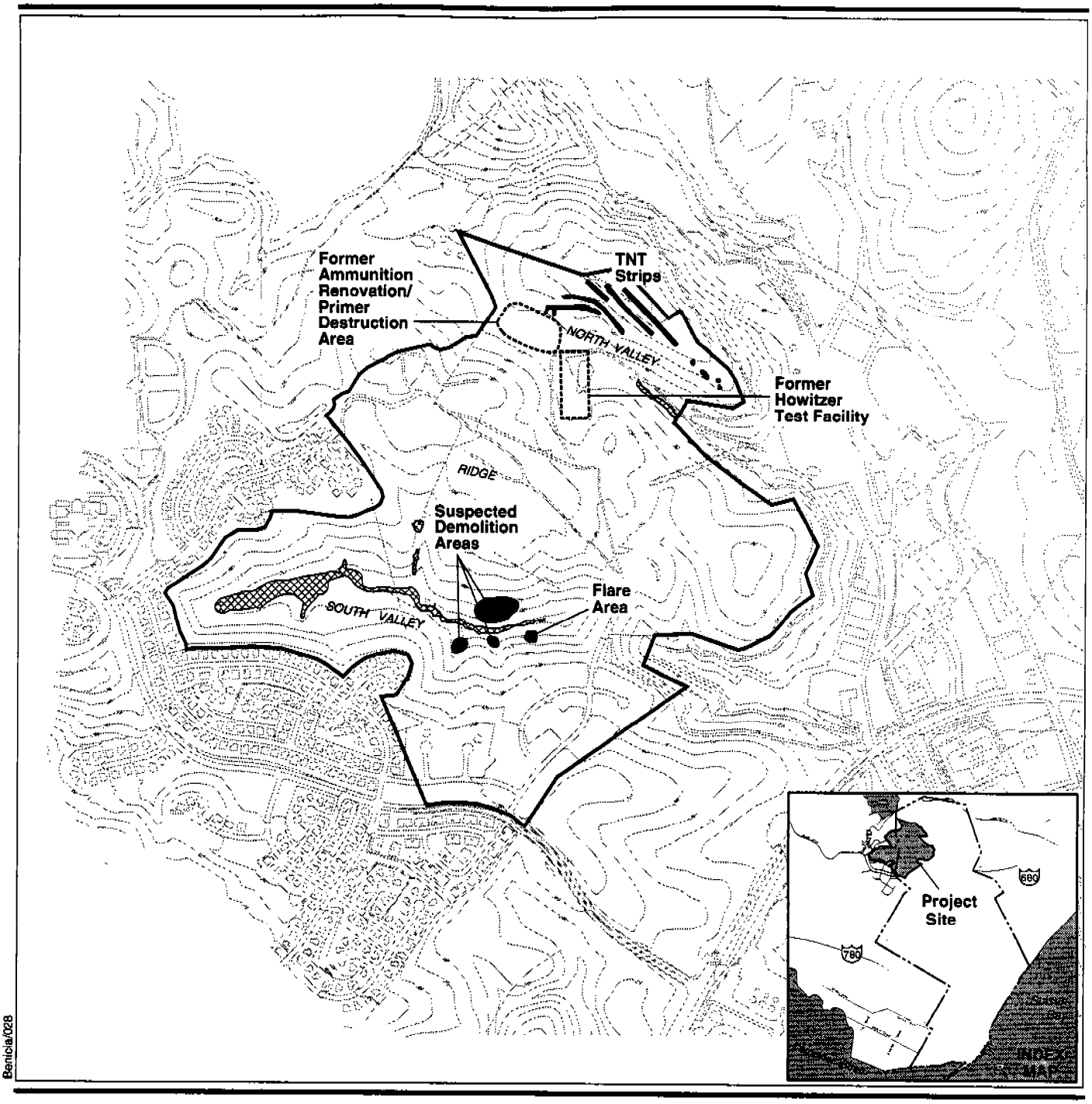
The U.S. Army acquired approximately 2,700 acres of land in Benicia between 1849 and 1958. The Army established the Benicia Arsenal on this land and used it as a depot for ordnance. In 1944, the Army leased a 200-acre piece of undeveloped ranchland known as the Tourtelot Property that was situated next to the Benicia Arsenal.

Between 1945 and 1947, the Army began developing the Tourtelot Property for a number of different activities in the North Valley and South Valley (see Figure 1-3). Roads were built, and the Army used approximately 6 acres in the North Valley for activities associated with checking the accuracy of locally manufactured howitzer gun barrels.

The Howitzer Test Area was used to test howitzer barrels and propellant by firing various-sized howitzer projectiles filled with concrete or gravel. This was performed in order to determine if the barrels functioned correctly and whether the propellant was the right mixture. The Howitzer Test Area consisted of two large concrete tunnels, concrete pads, and a concrete/wood-frame building. Adjacent to the Howitzer Test Area was the Primer Destruction Area. Primers for various munitions were pulled out and placed onto a conveyor belt (Jacobs Engineering, 1999). The primers were then dropped into a cage fired by oil burners. Once in the cage, the primers were ignited and destroyed. The burned primers, now inert scrap metal, were removed from the cage and recycled. The Ammunition Renovation Area consisted of two wooden buildings and two canvas shelters (Jacobs Engineering, 1999), which were used to inspect and refurbish ordnance items stored at the arsenal. On the ridge south of the North Valley, aged, out-of-service dynamite was reportedly disposed of through burning (Dynamite Burn Area). Aged dynamite was burned by placing single sticks of dynamite on a long piece of paper and igniting the paper. Although not reported in the historical records, similar burning of explosives is believed to have resulted in the TNT strips shown in Figure 1-3.

The Army used portions of the South Valley to destroy ordnance. At least two demolition areas (used to explosively destroy ordnance) and a flare area occupied the South Valley. Another suspected demolition area is also located in the South Valley (see Figure 1-3). The Army used explosive materials or accelerants in this area to dispose of out-of-service munitions.

In 1955 and 1960, the Army's leases for the Tourtelot Property terminated. In January 1962, DOD declared the entire Benicia Arsenal excess. It remained vacant until 1975, when the City of Benicia leased some of it to private



Benicia/028

EXPLANATION

Project Site Boundary

Wetland

HTRW Investigation Areas

0 250 500 1000 Feet

Note: Contour interval equals 25 feet.

Figure 1-3

developers. The Tourtelot Property remained under private ownership and was not developed. In 1971, portions of the Tourtelot Property were acquired by developers, and the remaining 110-acre parcel was acquired from Mary Tourtelot in 1981 as part of the Southampton residential development. In 1989, the City if Benicia approved the Environmental Impact Report (EIR) for residential development of the land. In the early 1990s, grading activities were conducted (in support of off-site and on-site tract development) at the Tourtelot Property. An estimated 600,000 cubic yards (cy) of soil, approximately 40 to 50 feet in elevation, was removed from the ridge between the North and South Valleys. It is unknown where the soil was eventually deposited; however, some of the soil (approximately 200,000 cy) may have been used to construct the McAllister Drive land bridge extending across the eastern end of the South Valley. In mid-1996, during preliminary site preparation, the Army's concrete structures were dismantled, and concrete-filled howitzer shells were unearthed. The soil mounded around the tunnels is currently stockpiled in the North Valley in the Howitzer Test Area and Ammunition Renovation/Primer Destruction Area. Granite promptly took several steps to make the Tourtelot Property safe, including stopping the preliminary construction activities, alerting officials about the shells' discovery, putting a fence around the site, and hiring a security service. Local and state officials were notified, and as early as May 1996, the City of Benicia, the U.S. Army Corps of Engineers, and Granite were in communication with DTSC. In response, DTSC asked that development activities remain suspended and that DTSC be kept apprised of investigation and cleanup activities. Granite retained military-trained explosive specialists and initiated preliminary site investigations for HTRW and OE at this time (see Section 1.4 for further details). In late fall 1996, live ordnance was first encountered and reported by Granite to local military personnel for handling. Granite provided its investigation data to the USACE for inclusion in its work. In 1998, the USACE began investigation of the Project Site as part of an arsenal investigation to characterize the area for OE/UXO.

The Project Site remains undeveloped except for one structure. The Tourtelot Property is currently fenced, and access is controlled. Adjoining land is also enclosed by fencing.

1.3.2 Description of Project Site

1.3.2.1 Topography.

The Project Site is characterized by rolling topography (Photographs 1-1 and 1-2) with areas of steep terrain. The elevation at the Project Site varies from 75 feet above mean sea level (msl) in the southern region to 250 feet above msl in the northern region.

1.3.2.2 Geology.

The Project Site and surrounding area lies at the southern end of the Sulphur Springs Mountains, which generally consist of lower Cretaceous-age

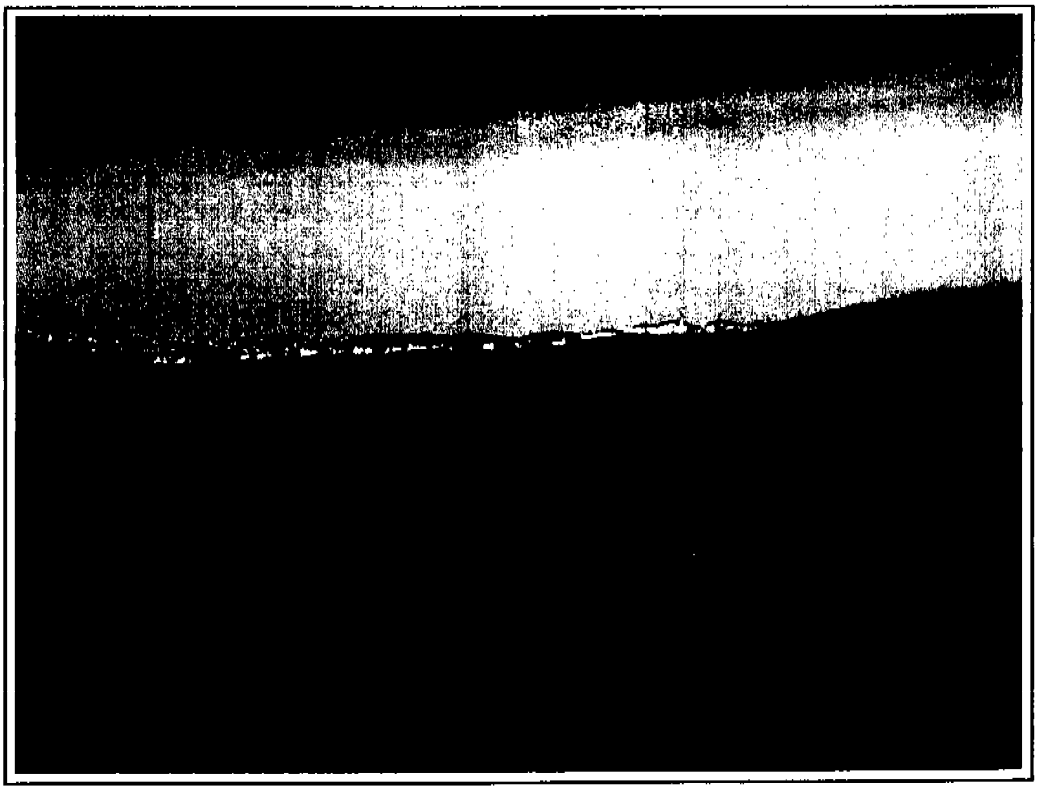


Photo 1-1. South Valley (Tourtelot Property).
View: From McAllister Land Bridge looking west.

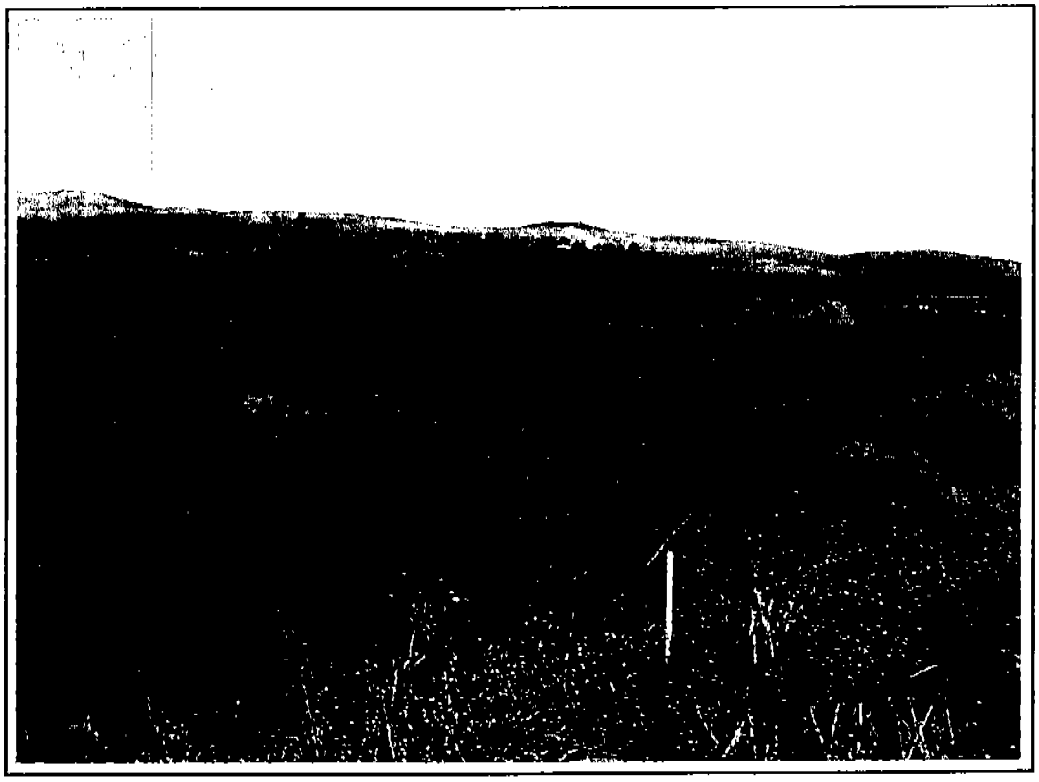


Photo 1-2. East portion of ridge on Tourtelot Property.
View: From Piercy Drive Lots looking north.

(approximately 50-150 million-year-old) marine siltstones and sandstones overlain by Plio-Pleistocene-age (approximately 1 to 3 million-year-old) marine clays. Most of the valleys have a sequence of older alluvium overlain by younger (recent deposits) alluvium.

The alluvium on the Project Site and surrounding area postdates and overlies the Merced Formation (Norris and Webb, 1990). A thin veneer of vertebrate fossil- bearing, alluvial gravels (pediment) may be found at a higher elevation overlying the Merced Formation; this is sometimes referred to as the "North Merced Gravel." The thickness of the Merced Formation varies from a few inches to 40 feet throughout the Project Site and surrounding area (Jacobs Engineering, 1999).

In the upland areas of the arsenal, bedrock outcrops may be present. The bedrock consists of steeply dipping, fractured, marine siltstones, sandstones, and shales of the Paleocene-age Martinez Formation and lower Cretaceous-age Great Valley Sequence (Jacobs Engineering, 1999). These generally strike northwest and dip west-southwest. The siltstones and sandstones are typically tan to yellowish brown. Shale, where present, is red to reddish brown.

1.3.2.3 Soils.

Soils in the Project Site generally have low slope strength, low to moderate permeability, and high runoff potential (California State Parks Service, 1991). Soil composition in the Project Site consists of the Dibble-Los Osos association (United States Department of Agriculture, 1977). This association is composed of approximately 60 percent Dibble soils, 30 percent Los Osos soils, and 10 percent Altamont and Millsholm soils. The soils in this association are moderately deep and formed in materials weathered from sandstone. The Dibble soils are typified by a pale-brown loam or clay loam surface layer. The subsoil is generally a dark yellowish-brown heavy clay loam and light, olive-brown light clay. The parent material is a light, olive-brown sandstone at a depth of approximately 20 to 40 inches. The Los Osos soils are characterized by a brown loam or clay loam surface layer. The subsoil is generally a brown, heavy clay loam and light clay. The parent material is a light, olive-brown sandstone at a depth of 20 to 40 inches. The Altamont soils consist of well-drained soils underlain by siltstone at a depth of 25 to 40 inches. These soils are on dissected terraces. The surface layer is generally a dark, grayish-brown clay and heavy clay loam 28 inches thick underlain by a light, olive-brown silty clay loam 10 inches thick. A light, yellowish-brown siltstone is at a depth of 38 inches. Areas where these soils are dry are characterized by large cracks in the surface and extend into the substratum. The Millsholm soils consist of well-drained soils on mountainous uplands. These soils are underlain by sandstone at a depth of approximately 10 to 20 inches. The soil is generally a brown to dark yellowish-brown loam approximately 17 inches thick. The substratum is light yellowish-brown sandstone.

In 1988/1989, Engeo Incorporated conducted a preliminary soils exploration for Benicia, California (Engeo Incorporated, 1990). Engeo Incorporated drilled a total of 22 borings, several of which were in the Project Site. The soils encountered in the borings were found to consist mostly of brown to dark brown silty and sandy clays. Depth of soil deposition varies from a few feet on hillsides to in excess of 20 feet in the major swales. Bedrock is weathered and fractured and consists mostly of claystone with various interbedded deposits of sandstone and siltstone.

1.3.2.4 Hydrology and Hydrogeology

An unnamed creek flows from west to east through the South Valley. This area is commonly referred to as the wetlands. Several seeps have been reported on the Project Site.

The location, quality, and quantity of groundwater beneath the Project Site and surrounding area are not well known. In 1872, a well was drilled in the southern portion of the arsenal. Groundwater in this well was first encountered at a depth of 960 feet. The water in this well contained organic matter and was determined to be unfit for human consumption. The well was blocked off to a depth of 960 feet using cement, sand, and grain sacks (Cowell, 1963). Since this time, several monitoring wells have been installed at the Former Benicia Arsenal by private parties for the purposes of environmental investigation. The wells have indicated water-bearing strata at shallower depths.

In 1988/1989, during the process of conducting a soils exploration (in support of site development and foundation design), Engeo Incorporated drilled 22 borings and encountered groundwater at relatively shallow depths (Enego Incorporated, 1990). Based on data collected from this investigation, groundwater should be expected locally, and particularly at the interface between weathered and unweathered rock. This interface is characterized by a change in color from brown to blue gray.

Detailed hydrogeologic information is currently not available for the Project Site (Brown and Caldwell, 1999). However, a drilling log for a well installed immediately west of East 2nd Street identified shallow groundwater at a depth of approximately 70 feet below ground surface (bgs).

In the flat areas of the Former Benicia Arsenal bordering Carquinez Strait and Suisun Bay, it is likely that groundwater is hydrologically connected to these bodies of water (Jacobs Engineering, 1999). Groundwater in these areas is relatively shallow and is likely under tidal influence.

1.3.2.5 Biological Resources

The Project Site and surrounding area supports a number of biological resources. The following sections provide information pertaining to vegetation, wildlife, and sensitive species that may occur on or near the Project Site.

Vegetation. The Project Site and surrounding area is characterized primarily by nonnative grasslands. This disturbed habitat contains a high percentage of nonnative, introduced weedy species. A creek flows west to east through the southern portion of the Project Site, supporting areas of willow riparian and freshwater marsh vegetation. Additionally, several seeps are present on some of the hillsides; these feed into the creek and also support limited wetland vegetation.

Nonnative grasslands. The majority of the Project Site is covered with nonnative annual grassland vegetation. Present on the hillsides, ridgetops, and some of the valley floor areas of the Project Site, this habitat is dominated by weedy introduced plant species such as slender wild oats (*Avena barbata*), ripgut brome (*Bromus diandrus*), red brome (*Bromus madritensis* ssp. *rubens*), foxtail barley (*Hordeum jubatum*), wild radish (*Raphanus sativus*), fennel (*Foeniculum vulgare*), cheeseweed (*Malva parviflora*), and cardoon (*Cynara cardunculus*). Some native plant species are present and include California wild poppy (*Eschscholzia californica*), various lupines (*Lupinus* sp.), blue dicks (*Dichelostemma capitatum*), and coyote brush (*Baccharis pilularis*) (U.S. Army Corps of Engineers, Sacramento District, 1997).

Willow Riparian and Freshwater Marsh Areas. The creek that crosses the southern portion of the Project Site supports both willow riparian and freshwater marsh vegetation. This creek seems to originate from precipitation, surface runoff, seasonal water flow from off-site sources, and possibly from the hillside seeps. It is not connected with Lake Herman. The creek flows east from a culvert near the southwest boundary of the Project Site to a culvert under McAllister Drive. Wetland vegetation occurs along the creek and in seep areas on the hillsides. Creek wetlands consist mainly of freshwater marsh species such as narrow-leaved cattail (*Typha angustifolia*), Olney's bulrush (*Scirpus americanus*), and tule (*Scirpus acutus* var. *occidentalis*). Scattered arroyo willows (*Salix lasiolepis*) occur along the length of the creek. Plant species present in the seep areas include iris-leaved rush (*Juncus xiphioides*), creeping wild rye (*Leymus triticoides*), narrow-leaved cattail, and common velvet grass (*Holcus lanatus*).

Wildlife. Habitat for wildlife at the Project Site includes disturbed areas, nonnative grasslands, freshwater marsh, and willow riparian communities.

Portions of the site have been disturbed. Such areas may support species tolerant of disturbance. Common species observed in these areas include northwestern fence lizard (*Sceloporus occidentalis occidentalis*), house finch (*Carpodacus mexicanus*), Brewer's blackbird (*Euphagus cyanocephalus*), American crow (*Corvus brachyrhynchos*), house sparrow (*Passer domesticus*), and California ground squirrel (*Spermophilus beecheyi*).

The nonnative grassland areas present on the Project Site provide habitat for several reptiles, birds and mammals. Common species present include northwestern fence lizard, Pacific gopher snake (*Pituophis melanoleucus*

catenifer), lesser goldfinch (*Carduelis psaltria*), western meadowlark (*Sturnella neglecta*), ring-necked pheasant (*Phasianus colchicus*), California towhee (*Pipilo crissalis*), Botta's pocket gopher (*Thomomys bottae*), coyote (*Canis latrans*), and mule deer (*Odocoileus hemionus*). Several raptor species most likely utilize the site for foraging, and species observed included red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), and northern harrier (*Circus cyaneus*).

The wetland present on the site provide habitat for a variety of species including Pacific treefrog (*Hyla[Pseudacris] regilla*), California newt (*Taricha torosa*), red-winged blackbird (*Agelaius phoeniceus*), common yellowthroat (*Geothlypis trichas*), and beaver (*Castor canadensis*).

Sensitive Species. The majority of sensitive species listed on the California Natural Diversity Data Base (CNDDB) as occurring in the Project Site and surrounding area are associated with northern coastal salt marsh habitats, which are well south and east of the Project Site. No habitat exists for these species on the Project Site. Specific surveys were performed for California red-legged frog (*Rana aurora draytonii*) during July 1998 by Wetlands Research Associates, Inc., and in July 1999 by Earth Tech. California red-legged frogs were not observed during either survey and have not been recorded on the site historically. Similarly, no giant garter snakes (*Thamnophis couchii gigas*) have been observed on the Project Site during surveys. The Suisun song sparrow (*Melospiza melodia maxillaris*), a federal Species of Concern has been observed in the immediate Project Site vicinity and may occur on the Project Site. The federally listed endangered American peregrine falcon (*Falco peregrinus anatum*) may forage over the Project Site but would not be expected to nest in the area because of the lack of suitable cliff sites.

1.3.2.6 Cultural Resources.

There are no known cultural resources in the Project Site.

1.4 SUMMARY OF PREVIOUS INVESTIGATIONS/FINDINGS

1.4.1 Previous Investigations and Results

Granite Management Corporation conducted initial HTRW investigations on portions of the Project Site in 1998. Eighty-four soil samples were collected from selected areas on the Project Site (Figure 1-4) at approximately 2 to 5 inches bgs. Many of the samples were analyzed for metals (EPA Method 6000 and 7000 series), explosive compounds (EPA Method 8330), phosphorus (EPA Method 365.3), and nitrate and nitrate/nitrite as nitrogen (EPA Method 353.2) by California-certified Sequoia Analytical Laboratory of Petaluma (Sequoia Analytical). Other samples were analyzed for 2,4,6-TNT and cyclonite (RDX) using the Ensys® Soil Test System, a field testing method. Confirmation analysis for TNT and RDX was also performed in the laboratory for selected samples for which the field test method was utilized. In addition, two surface

water samples were collected from the wetlands in the South Valley of the Project Site (see Figure 1-4). Both samples were analyzed for total and dissolved metals (EPA Method 6010A), explosive compounds (EPA Method 8330), and nitrate and nitrate/nitrite as nitrogen (EPA Method 353.2) by Sequoia Analytical. A summary of sample analysis results is provided in Tables A-1 through A-6 in Appendix A. Except as discussed in Section 1.5, no substances were detected above local background concentrations.

1.4.2 Previous Unexploded Ordnance Investigations/Findings

DOD conducted OE clearance activities at the Demolition Area on the Project Site in 1955 (U.S. Army Corps of Engineers, St. Louis District, 1994a,b). However, during a later inspection of the area in 1955, several live OE items were found, and it was recommended that a second clearance be performed in the area. No record of a possible second clearance could be found. When a concrete-filled howitzer shell was encountered during preliminary site preparations in mid-1996, Granite retained OE experts and initiated OE/UXO investigations on the Tourtelot Property. The work included geophysical mapping and UXO removal.

The initial geophysical surveys at the site were limited to the Howitzer Test Area and limited random data collection areas across the Project Site. An EM-61, a high resolution, time-domain metal detector, was used to collect data for the initial surveys. Data collection within the Howitzer Test Area was performed prior to site preparation activities, which included the removal of the test tunnels and firing butts. Electronic copies of the EM61 data and subsequent magnetic data collected are available in Appendix B.

In 1997, NORCAL Geophysical Consultants, Inc. (NORCAL) performed a total magnetic field (TMF) vertical gradient survey over the majority of the Project Site (Figure 1-5) in an effort to determine if any OE/UXO existed within the area. This survey consisted of the investigation of contiguous, 200- by 200-foot grids utilizing cesium vapor magnetometers arrayed to measure the vertical gradient of the total magnetic field. The magnetometer survey did not include borrow areas where surficial materials had been stripped and the ground surface regraded, or wetlands in the North and South Valley.

These data were collected along east-west traverses spaced 5 feet apart. Measurements were recorded at (nominally) 1-foot intervals along each traverse, as interpolated from 50-foot fiducials marked along each line. The data were recorded relative to grid origins and transformed into California State Plane coordinates (NAD27) by reference to the coordinate location of the grid origin as tied to the California State Plane system by a land surveyor.

During the USACE UXO site investigation for the arsenal, the magnetometry data was evaluated by direct comparison of EM61 data collected during the Former Benicia Arsenal EE/CA investigation. To evaluate the comparative anomaly detection resolution of the survey parameters used to collect the

magnetometer data, electromagnetic (EM) data were collected over OE sampling grids (100 by 100 feet) and processed to identify anomalies of interest. The EM data collected by Earth Tech and the magnetometer gradiometer data collected in 1997 were then compared to the data from OE sampling grids.

The conclusions of this comparison indicated that magnetometers did not perform as well as EM systems in detecting small, near-surface targets, and the line spacing (5 feet versus the 2.5 feet to be used for the EM data) was too great to adequately resolve targets that are more distant from the traverse centerline. However, the magnetic data was sufficient to discriminate an adequate range of target types. Further detail regarding the evaluation of the geophysical data is available in the Former Benicia Arsenal EE/CA (Earth Tech, 1999).

In selected areas, identified magnetic anomalies were investigated by excavating the location of the anomaly until an anomaly source was located (see Figure 1-5). When UXO was encountered, it was identified, removed, and disposed of by demolition. Six UXO items were removed, including two 37-millimeter (mm) high-explosive (HE) rounds, two 40-mm anti-aircraft HE rounds, one 60-mm HE mortar shell, and one 76-mm anti-personnel (AP) HE round. The OE/UXO investigation was suspended pending further investigation of the arsenal by the USACE.

The USACE conducted an EE/CA investigation for the entire Former Benicia Arsenal, including the Project Site. Portions of the property were geophysically mapped, and subsurface anomalies that were identified were sampled to determine the presence or absence of OE/UXO. Two OE items were encountered on the Project Site (one 75-mm unfuzed shrapnel projectile and one 37-mm fuzed projectile) during the EE/CA investigation, these were disposed of by demolition (Earth Tech, 1999).

1.5 CONCEPTUAL SITE MODEL

This section provides a conceptual site model for areas in the Project Site that are suspected or known to contain HTRW (see Figure 1-3). A site-specific summary of the areas, resources, and potential transport pathways potentially affected by HTRW at the three known sites (TNT Strips Area, Flare Area, and Demolition Area) is provided in the following subsections. Two additional sites have been identified; these include the Howitzer Test Facility and the Ammunition Renovation/Primer Destruction Area. These two sites have been identified as areas potentially containing HTRW resulting from past arsenal activities (see Section 1.3.1).

The resources identified in this section include geology (Section 1.3.2.2), soils (Section 1.3.2.3), hydrology and hydrogeology (i.e., groundwater, seeps, surface water) (Section 1.3.2.4), and biological resources (i.e., flora and fauna) (Section 1.3.2.5).

These conceptual site models have been established based on all available information, and their development will be an ongoing process as additional data/information becomes available. These models will be utilized to integrate information from various disciplines and to identify additional data needs that will determine subsequent data collection.

Potential adverse effects to the aforementioned resources include, but are not limited to: HTRW in both surface and subsurface water, HTRW in soils, and injury to various species of both flora and fauna in the vicinity of these sites. HTRW, such as TNT, would be the result of past arsenal activities. The following subsections provide a brief description of the possible extent of HTRW in these resources.

1.5.1 TNT Strips

The TNT strips are in the northernmost area of the Project Site (North Valley). This area is situated on hillsides gently sloping to the south and consists of five elongated strips, approximately 6 feet wide and between 300 and 800 feet in length (Photograph 1-3) and four small patch areas, which collectively appear to be an extension of the northernmost strip (Photograph 1-4). The site is covered with fennel and grasses, except for the strips themselves, which are unvegetated soil. Of the five identified strips, only one has shown any evidence of lateral migration via erosion. These strips are estimated to be approximately 50 years old based on historical photograph observations. Exposed soil in the strips is characterized by a deep red color with crystalline materials observable in the dry season. Based on observable evidence in the field, HTRW has become fixed to the soil, with relatively little vertical or horizontal migration. Near-surface soil samples (approximately 2-5 inches bgs) were collected at this area in fall 1998 and were screened for metals and explosive compounds. Soil samples from the strips registered elevated levels of TNT. Concentrations of other explosive compounds and metals were not elevated in soil samples from the strips. Previous sampling results can be found in Appendix A. Sampling locations are shown on Figure 1-4.

These samples mentioned above provided insufficient data to determine the vertical and lateral extent of TNT in the soil at the strips. It appears that HTRW associated with the TNT strips may be localized and has not affected surface or subsurface water or surrounding biological resources. Burning of TNT or other explosive compounds may have resulted in measurable amounts of metals, PAHs, or explosives in soil. These substances may be mobile in this environment and therefore the small wetlands potentially downgradient of the TNT strips will also be sampled for the same constituents. DTSC has requested that some samples also be analyzed for dioxins.

1.5.2 Flare Area

The Flare Area is in the South Valley (see Figure 1-3) and was used to dispose of flares by burning. It is a relatively level area less than 0.25 acre in size and moderately vegetated with grasses and some scattered sage scrub. This area

Photo 1-3. TNT Strip (TNT-2). View: Looking northwest along strip.

Photo 1-4. Small patch TNT Strip on east end of TNT-1.

was identified on aerial photographs, and its location was confirmed through field observations. Ash, metal fragments, and pieces from flare bodies and mortar rounds have been observed on the ground surface. The debris found indicates that flares and other OE/UXO were burned or disposed of there. The area may have been modified by minor landslides and slope wash. Previous sampling for HTRW in fall 1998 identified elevated levels of antimony, barium, copper, lead, and zinc in a single near-surface soil sample. Previous sampling results can be found in Appendix A. Sampling locations are shown on Figure 1-4.

Results from the one sample collected in this area indicated elevated levels of five metals in the soil; consequently, it can be assumed that additional locations in this area contain similar elevated levels of metals. RDX at a trace concentration is the only explosive compound detected in the Flare Area. The physiography and geologic conditions at this area are a limiting factor in the lateral and vertical migration of HTRW. The area is at the bottom of a valley in a small side drainage. It is unlikely that HTRW has migrated beyond the bottom of the valley, which is a limited geographic area and easily defined. Soils in this portion of the site may extend as deep as 20 feet bgs. Surface and subsurface water may also be affected if HTRW is present due to the close proximity of the wetland. Since there is no evidence of dead/stressed vegetation, it appears that there are no effects to surrounding biological resources. Tests that may show detectable concentrations of substances in soils from flare burning activities are phosphates, explosives, PAHs, and metals. Sediments in the adjacent wetland will be analyzed for the same substances. DTSC has requested that a soil sample also be analyzed for dioxins.

1.5.3 Demolition Areas

There are three suspected demolition areas that vary in size from approximately 0.25 to 0.5 acre, in the bottom of the South Valley, immediately west of the Flare Area (see Figure 1-3). The U.S. Army used the demolition areas to explosively destroy ordnance requiring demilitarization. These sites are moderately vegetated with grasses and some scattered sage scrub. Demolition of ordnance occurred in the South Valley in the 1950s. Ordnance was reportedly detonated along the base of the northern slope of the South Valley in an area identifiable by four dark spots on historical aerial photographs. A potential second demolition area may have been approximately 300 feet southwest of the primary demolition area. This second area is suggested by the density of anomalies identified on the initial geophysical survey conducted by NORCAL Geophysical. Soil exposures in both of these areas show a wide variety of fragmentation, scrap metal, wire, fuzes, and other related OE/UXO debris. The thickness of this debris is anticipated to be as great as 20 feet near the base of the slope. Previous HTRW sampling was conducted in fall 1998 and identified no elevated levels of metals or explosive compounds. Previous sampling results can be found in Appendix A. Sampling locations are shown on Figure 1-4. Burning or demolition of OE may have resulted in soils being affected with the following substances: PAHs, explosives, and metals. DTSC has requested that soils in this area also be tested for dioxins.

The number of samples taken in this area was insufficient to evaluate whether HTRW is present in the soils. As stated for the Flare Area, due to physiographic and geologic constraints, the areal extent of HTRW would likely be limited to an easily defined area.

1.5.4 Howitzer Test Facility

The Howitzer Test Facility was used to test howitzer barrels and propellants. It is a relatively flat area of approximately 3.0 acres notched into the hillside along the northern portion of the North Valley (see Figure 1-3). This area used to contain two firing butts and two test tunnels in which howitzer rounds filled with inert materials were fired to determine if the barrels were functioning correctly and whether the propellant mixture was correct. The site is moderately vegetated with fennel, grasses, and occasional sage scrub. The howitzer tunnels have been dismantled. The material removed from the test tunnels, along with other soils disturbed during the dismantling, remain within this area and are herein referred to as "stockpiles." During the investigation following the discovery of the inert 155-mm howitzer round, other inert 155-mm howitzer rounds and scrap, inert fuzes, and other OE/UXO debris were found in the soil along the North Valley. Screening analysis of soil from the gravel fill from within the howitzer tunnels, conducted for disposal profiling, revealed slightly elevated concentrations of metals. Limited soil sampling during the initial characterization studies did not identify substantially elevated concentrations of either metals or explosive residues. Previous sampling results can be found in Appendix A. As previously stated, valleys have physiographic and geologic conditions that naturally limit the migration of HTRW. Substances expected here are the same as those expected in Section 1.5.1 (TNT Strips).

1.5.5 Ammunition Renovation/Primer Destruction Area

The Ammunition Renovation/Primer Destruction Area covers approximately 3.0 acres at the northwest end of the North Valley immediately adjacent to the Howitzer Test Facility (see Figure 1-3). The Ammunition Renovation Area was used to inspect and refurbish ordnance items stored at the arsenal. The Primer Destruction Area was used to destroy primers by placing them in a burn cage and incinerating them. This area was also dismantled, and debris/soil generated from this activity remains within the site and is referred to as a" stockpile." The area is relatively flat and moderately vegetated with fennel, grasses, and occasional sage scrub. Only one near-surface soil sample was taken on the outer edge of this area; it was found to be non-detect (ND) for TNT. One sample cannot identify the presence, extent, or transport medium for this site. Therefore, additional sampling will be needed to determine the absence or presence of HTRW at this area. Previous sampling results can be found in Appendix A. No evidence of dead/stressed vegetation has been observed at the site; therefore, it can be assumed that there is no effect to biological resources. Should HTRW be present in the area, it would be limited to the North Valley for reasons previously stated for the Howitzer Test Facility. Substances expected here are the same as those expected in Section 1.5.1.

1.6 PROJECT ORGANIZATION

The organizational structure for this project is shown on Figure 1-6. This organizational structure provides the Project Manager (PM) with a dedicated project team, including project engineers, technical and administrative support staff, and subcontracting managers. A detailed description of Earth Tech member responsibilities is presented in this section.

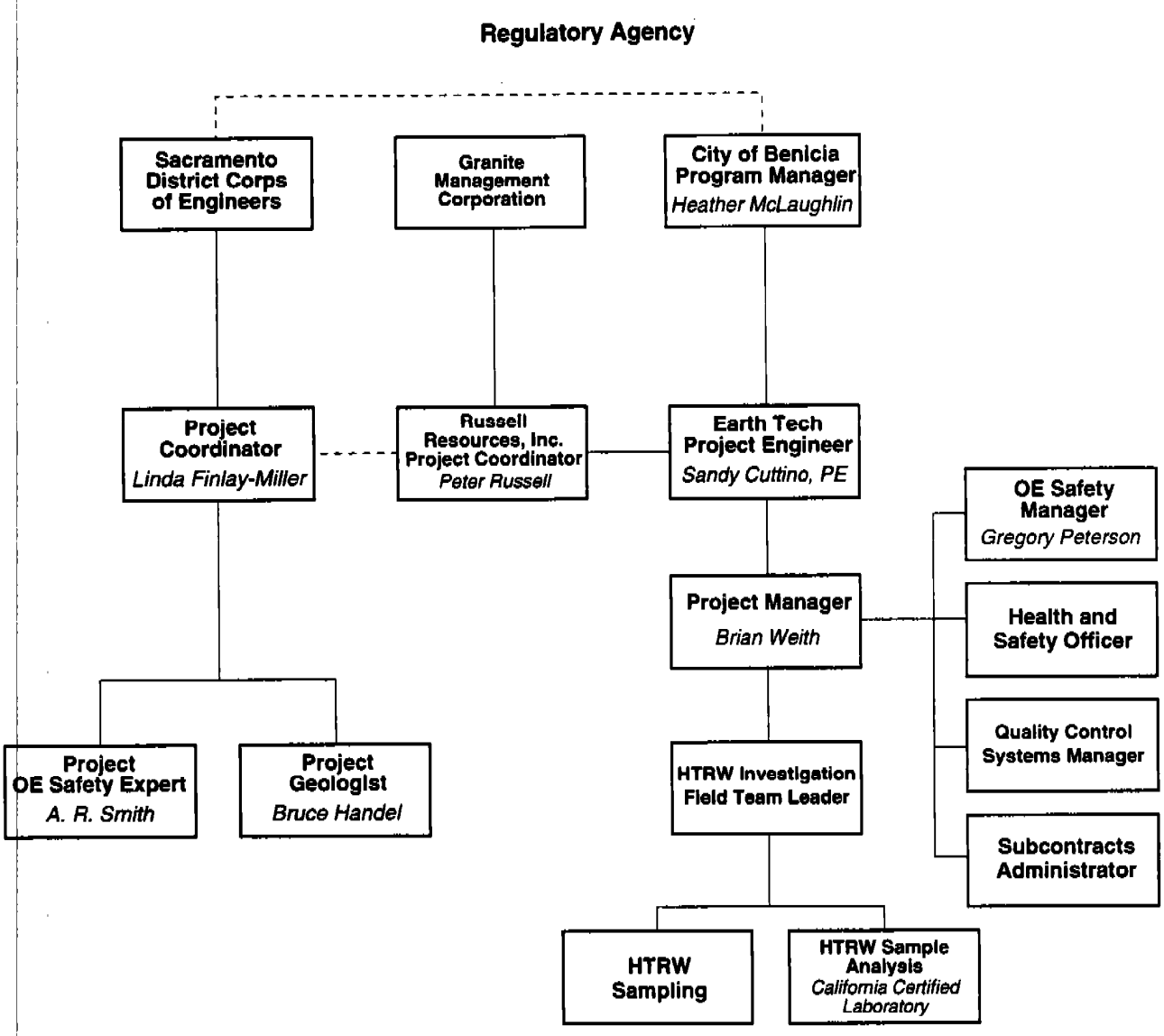
This project organization is designed to provide a clear line of management responsibility and authority; facilitate delegation of authority to the management level responsible for completing the RI/FS and related work products; and maintain appropriate cost, schedule, and quality control. The organization reflects strong technical and management leadership and provides a direct line of communication between Earth Tech managers and Granite Management Corporation's representative, Russell Resources, Inc. A direct line of communication also exists between Earth Tech and the City of Benicia. Lines of communication from Earth Tech to the DTSC and the Sacramento District Corps of Engineers are through Russell Resources, Inc. The Earth Tech lines of authority flow from the Project Engineer (PE) to the support staff.

Program Management Responsibilities. It is the responsibility of all management personnel who may affect the quality of the RI/FS, studies, operations, or other quality-related functions to be aware of and implement the policies and practices set forth in this document and include the Field Sampling Plan (FSP), the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP). The PE may delegate authority to appropriate personnel to assure activities are conducted in a compliant, cost-effective, and timely manner. However, responsibility for the project will remain with the PE. A summary of the responsibilities of project management personnel is provided below:

Project Engineer (PE). The PE, who is responsible for the overall direction, coordination, technical consistency, and review of the RI/FS, will monitor the performance of all project staff through the PM. The PE will have the authority to select or dismiss staff; select or terminate major subcontractors; approve or disapprove budgets and schedules; stop work; and communicate with Russell Resources, Inc., and the City of Benicia as necessary, to evaluate the progress on any task and ensure the early resolution of any problem. Communication with DTSC and the Sacramento District Corps of Engineers will be coordinated with Russell Resources, Inc. The PE is responsible for overall direction, coordination, technical consistency, and review of the entire contract. Specific responsibilities include:

Final approval and review of project plans, all project deliverables, schedules, contract changes, and manpower allocations for each task

Approval of budgets and schedules, and changes in budgets or schedules



Benicia/042

Project Organization Chart

Figure 1-6

Designation of a PM for the RI/FS

Ensuring availability of key personnel assigned to the project for the duration of the project

Overseeing coordination among management, field teams, and support personnel to ensure consistency of performance

Communicating, as necessary, with the City of Benicia Program Manager to evaluate the progress of the program and to facilitate the early resolution of any potential problem.

Project Manager. The PM, who will report directly to the PE, will be fully responsible and accountable for all project activities, and will serve as the focal point and main channel of communication between Russell Resources, Inc., and the project team regarding technical and scheduling matters. The PM will establish and interpret project policies; monitor schedule and cost; coordinate all reporting and other forms of communications; ensure necessary resources are made available; prepare RI/FS project plans; identify and resolve potential problems or conflicts; and provide for safe performance and quality of the work. Other duties, as appropriate, will include:

Allocating work assignment, budgets, and schedules to members of the project team, and orienting the staff to the goals and objectives of the RI/FS

Evaluating the qualifications of project staff and critical subcontractor personnel, and identifying individuals who need additional training

Assigning project field managers to direct specific field activities and providing them with the necessary resources.

Tracking the performance of the RI/FS

Reviewing, approving, and consistently implementing the project planning documents (e.g., this work plan) and procedures including approval of monitoring well site locations, chemical analysis parameters, geophysical techniques, schedules, and manpower allocations

Addressing specific tasks for compliance with federal, state, and local regulations/laws, and directives

Providing overall technical, quality, and performance consistency throughout the RI/FS

Identifying procurement needs (e.g., materials, services, subcontracts) and coordinating project procurements with the subcontract administrator

Identifying, documenting, and notifying the PE, the quality control systems manager (QCSM), the Health and Safety Officer (HSO), the OE Safety Manager (OESM), and project staff of changes in project scope

Reviewing procurement documents, sampling logs, laboratory reports, and final reports

Interacting with regulatory or public agencies at the request of Russell Resources, Inc., and preparing progress reports

Disseminating project-related information from Russell Resources, Inc.

Preparing the RI/FS Report and related presentations at progress meetings between the project team and Russell Resources, Inc.

Reporting any significant conditions adverse to quality and obtaining concurrence by the QCSM on proposed resolutions

Reviewing quality assurance audit reports and any resulting corrective action disposition.

Quality Control Systems Manager (QCSM). The QCSM will be appointed by the PM to be principally responsible for execution of all quality control (QC) operations for field and laboratory activities. The QCSM will have knowledge of chemical quality control and experience in the sampling and analysis of hazardous chemicals. The QCSM will be directly responsible to the PM.

The QCSM is responsible for the implementation of the QAPP and the site-specific field sampling plan, and will provide overall direction of the project QC function for field and laboratory activities. The QCSM, or her/his designee, will interface with the client and regulatory agencies on the quality functions of the project and will coordinate activities with the PM. In addition, he/she will, as necessary, perform audits, surveillance, document reviews, and other quality functions as required to determine the continued effectiveness of the QAPP. The QCSM will, as necessary, audit compliance with the QAPP, and will perform QC review of selected project tasks. Other responsibilities will include, but will not be limited to:

Reporting regularly to the PM on the status of QAPP implementation

Providing quality orientation training and disseminating applicable quality information to the project staff

Maintaining the authority to stop work that is not in compliance with the project

Coordinating all QC functions on the project

Identifying the need for corrective actions, and initiating, recommending, and coordinating solutions for project-wide issues. Maintaining a formal corrective actions tracking system

Reviewing project-generated procurement documents to assure that applicable quality requirements are adequately stipulated and followed

Performing periodic quality inspections of project records

Coordinating submittal of all quality-related reports

Providing oversight for data validation and field auditing activities

Providing QC oversight of equipment preventive maintenance, decontamination, and calibration.

Health and Safety Officer. The HSO will be principally responsible for execution of all health and safety operations for field activities. The HSO will have knowledge of the Occupational Safety and Health Administration (OSHA) requirements and corporate health and safety requirements.

The HSO is responsible for the implementation of the HASP and will provide overall direction of the health and safety function for field activities. The HSO, or her/his designee, will administer health and safety functions of the project and will coordinate activities with the PM. In addition, the HSO will perform any necessary audits, surveillance, document reviews, and other health and safety functions as required to determine the continued effectiveness of the HASP. Other responsibilities will include, but will not be limited to:

Coordinating the Program Certified Industrial Hygienist (CIH) review of the HASP and obtaining the CIH certification of the HASP

Ensuring regulatory and operational compliance with OSHA requirements, the HASP, and Earth Tech corporate health and safety requirements

Reviewing health and safety training and medical monitoring

Working with the PM and the Field Team Leader (FTL) to ensure that all health and safety requirements outlined in the HASP are implemented in the field

Performing document reviews, and other health and safety functions as required to determine the continued effectiveness of the HASP

Performing random health and safety assessments in the field, implementing corrective measures for site-specific health and safety deficiencies, and verifying resolution of any resulting corrective actions

Oversight of a site safety coordinator (SSC), who will monitor the labeling, shipping, and control of hazardous or potentially hazardous samples and materials, and brief all field personnel concerning health and safety requirements.

Ordnance and Explosives Safety Manager (OESM). The OESM will be appointed by the PM to be principally responsible for execution of all OE operations for field activities. The OESM will have knowledge of all requirements mandated by OSHA, USACE, U.S. EPA, Title 8 of the California Code of Regulations (8 CCR), and the Earth Tech Corporate Health and Safety Program. The OESM will be directly responsible to the PM.

The OESM is responsible for the implementation of the UXO avoidance procedures specified in the HASP and will provide overall direction of the project UXO escort and avoidance functions for field activities. The OESM, or his/her designee, will interface with the Field Site Leader on OE safety functions of the project and will coordinate activities with the PM. In addition, he/she will, as necessary, perform audits, surveillance, document reviews, and other OE safety functions as required to determine the continued effectiveness of the HASP. The OESM will, as necessary, audit compliance with the HASP, and will perform OE safety reviews of selected project tasks. Other responsibilities will include, but will not be limited to:

Performing and documenting regular and frequent UXO site hazard inspections and observing employees at work

Stopping work when necessary to prevent injury or illness associated with UXO and to ensure personal and environmental health and safety

Investigating all injuries and illnesses resulting from UXO-related incidents

Implementing UXO avoidance procedures to eliminate or mitigate hazards

Providing the UXO safety portions of training sessions or briefings for site and visitor personnel.

Field Team Leader. The Field Team Leader (FTL) reports to the PM and is responsible for project setup in the field, including identifying and scheduling personnel resources, materials, and equipment. The FTL is assigned to oversee and control all field activities, and is responsible for field cost tracking through administrators and project billing. The FTL will also conduct project control assessments and provide purchasing support for small purchases necessary to initiate the project. The FTL will provide site level implementation of environmental protection, fire protection, occupational safety and health requirements, and permitting for this project. The FTL has the organizational freedom and authority to implement changes to work practices; identify problems and proposed solutions; and if necessary, stop work activities that could pose a threat to personnel or the environment. The FTL will coordinate activities with the PM and other project personnel as appropriate. Duties of the FTL include, but are not limited to:

Initiating the HTRW Investigation field activities with the required resources, materials, and equipment

Directing all field activities, supervising field staff and any subcontractors, and ensuring that field procedures described in the FSP/HASP are implemented

Maintaining daily records of work performed, personnel on site, and any work stoppages or communications with other agencies pertaining to the project

Managing equipment preventive maintenance, decontamination, and calibration programs

Assisting the QCSM with instruction of field personnel in the sample management techniques included in the QAPP

Ensuring that the samples taken meet the sampling requirements

Ensuring the collection of equipment rinsate samples

Assisting the QCSM in assuring preventive maintenance is conducted on instruments used for sampling and analysis

Using a correction tracking system in order to ensure correction of field work and laboratory deficiencies.

Site Safety Coordinator. The FTL will also serve as the Site Safety Coordinator (SSC) for this Project. The SSC is responsible for performing the routine duties for health and safety, and will coordinate any necessary assistance from the

designated HSO. The SSC will administer this HASP and the applicable site-specific safety guidance document. Additional SSC responsibilities include:

Reading and becoming familiar with this HASP

Enforcing the requirements of this HASP and other applicable safety requirements

Stopping work, if necessary, to prevent injury or illness and ensure personal and environmental health and safety

Determining excavation routes, and establishing/posting local emergency contact telephone numbers

Ensuring that all applicable site personnel and visitors have received the proper training and medical monitoring before entering any controlled areas

Presiding over any tailgate safety meeting and maintaining appropriate training documentation/attendance records

Implementing air monitoring according to directives in this HASP

Implementing changes in health and safety procedures as directed by the HSO and/or approved addenda to this HASP.

1.7 PROJECT SCHEDULE

The RI/FS includes development of this work plan, the field investigation, and a report documenting the results of the field investigation. A schedule of the activities associated with the RI/FS is provided in Table 1-1. Figure 1-7 shows the completion date of the project deliverables for this RI/FS. Figure 1-8 shows the anticipated time line for remedial activities.

The RI/FS is just one task of a larger environmental investigation and restoration project that also includes the preparation of an environmental impact report for the Tourtelot Property Cleanup Project. The RI/FS will be conducted concurrently with these other activities in response to the DTSC Imminent and/or Substantial Endangerment Determination and Remedial Action Order (Docket No. I/SE 98/99-011).

1.8 PROJECT DELIVERABLES

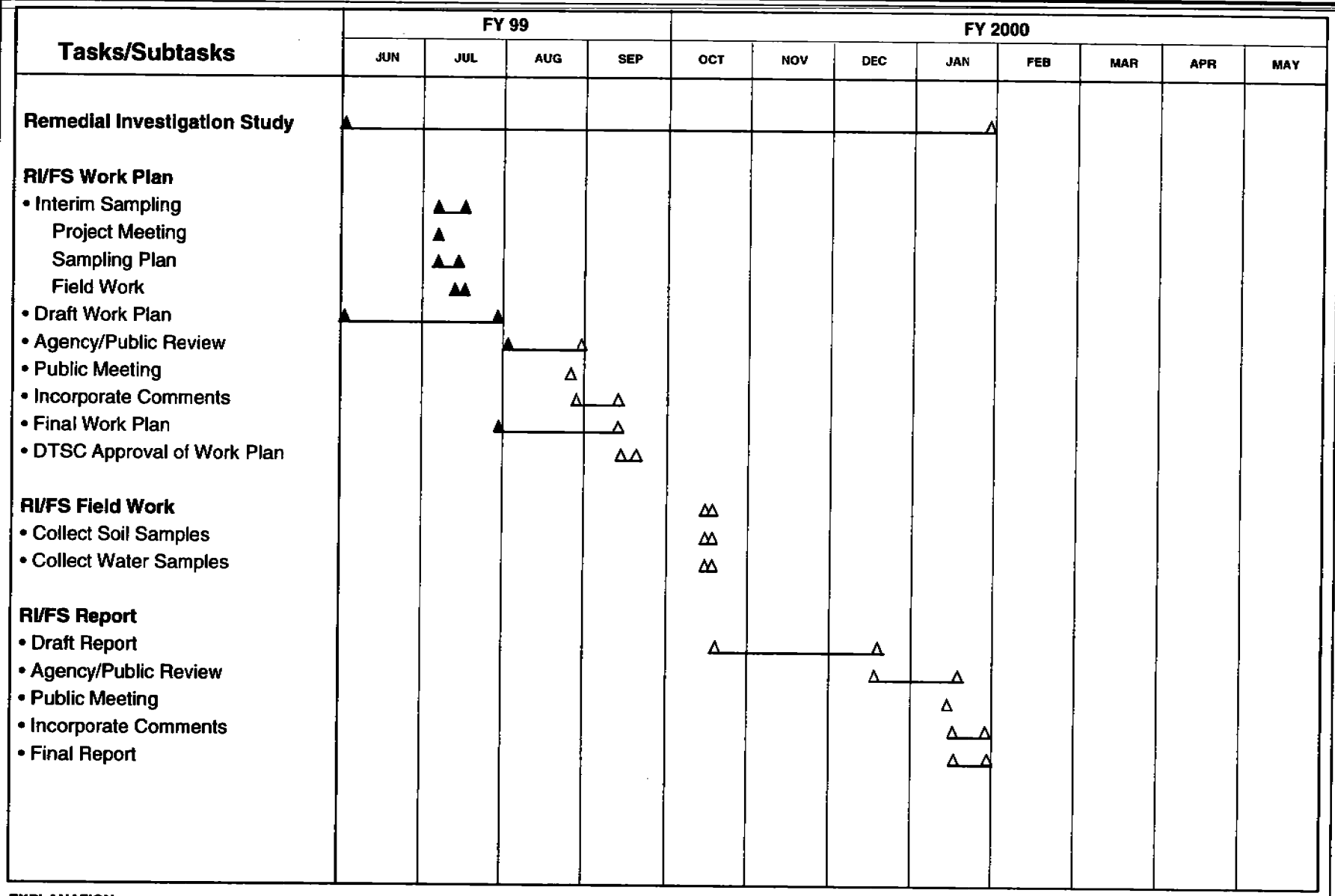
A report will be submitted that presents and evaluates field investigation results, addresses health and ecological risks, and provides the rationale for site restoration to background levels.

Table 1-1. RI/FS Schedule of Activities

Activity	Start Date	Completion Date
RI/FS Work Plan	01 June 1999	31 July 1999
Project Meeting	06 July 1999	06 July 1999
Agency/Public Review of RI/FS Work Plan	02 August 1999	31 August 1999
Public Meeting	25 August 1999	25 August 1999
Final RI/FS Work Plan	01 September 1999	12 September 1999
DTSC Review/Approval of Final Work Plan	13 September 1999	19 September 1999
Field Mobilization/ Sampling	20 September 1999	17 October 1999
RI/FS Report	18 October 1999	17 December 1999
Agency/Public Review	17 December 1999	17 January 2000
Public Meeting	13 January 2000	13 January 2000
Final RI/FS Report	18 January 2000	29 January 2000

RI/FS = Remedial Investigation/Feasibility Study

Project Planning Chart
Remedial Investigation/Feasibility Study
Tourtelot Cleanup Project, Benicia, California



EXPLANATION

△ Schedule milestone (not completed) ◇ Schedule slip (not completed) —— Subtask duration

▲ Schedule milestone (completed) ◆ Schedule slip (completed) - - - - Intermittent or uncertain

EARTH TECH

Figure 1-7

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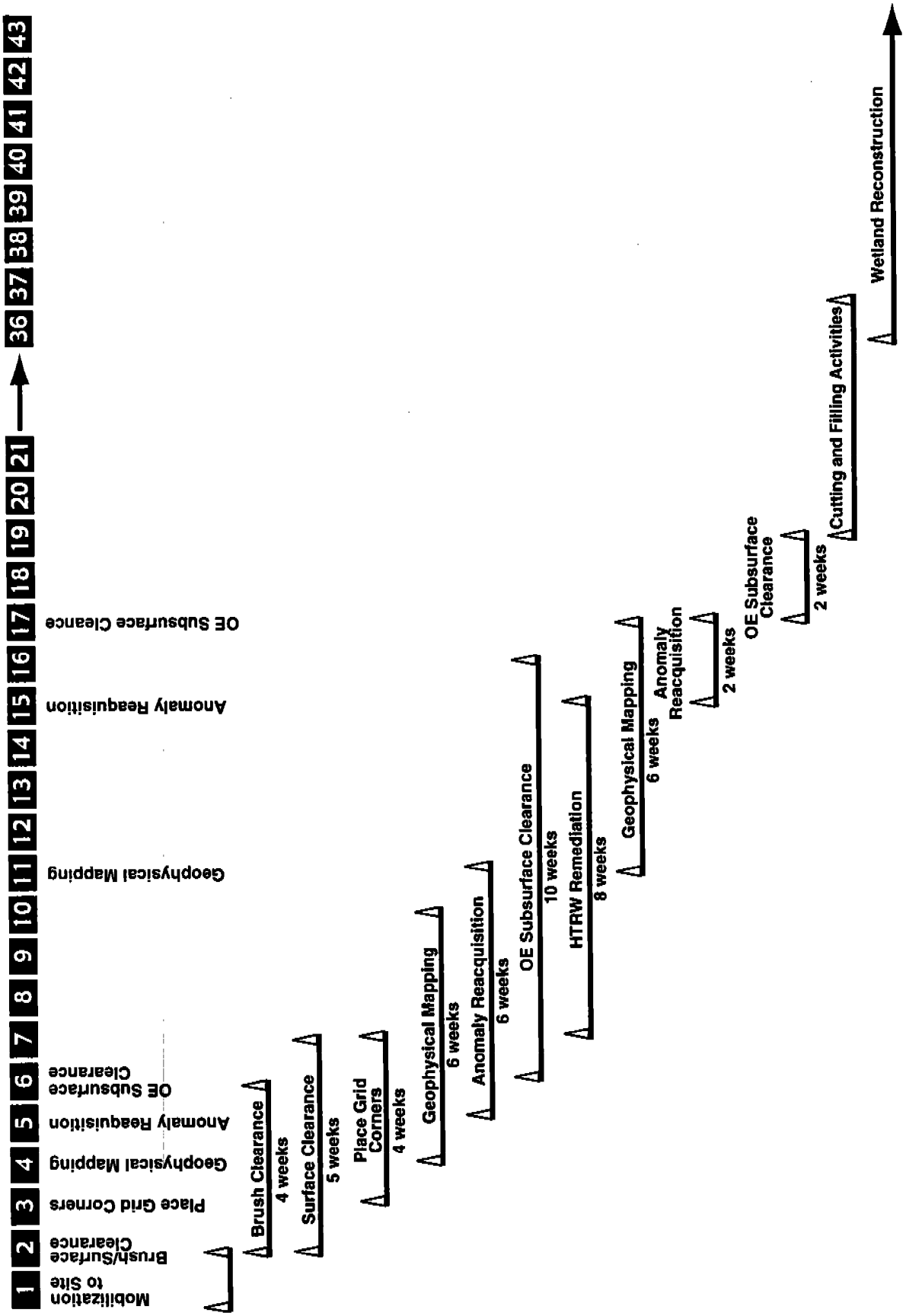
Figure 1-8
TIMELINE FOR REMEDIAL ACTIVITIES



2.0 FIELD INVESTIGATION SAMPLING AND ANALYSIS PLAN

This section presents the FSP for the proposed HTRW field investigation activities at the Project Site. This FSP, in conjunction with the QAPP presented in Section 3.0, will be used to ensure that (1) all sample and field measurements are consistent with the project data quality objectives (DQOs), (2) samples are collected, identified, handled, preserved, packaged, and shipped in such a manner as to maintain their integrity and validity, and (3) field data are collected in such a manner as to ensure accuracy, precision, completeness, representativeness and comparability, and provide an adequate database for achieving the DQOs.

2.1 PROPOSED SCOPE OF WORK

The overall objectives of the field investigation activities are to (1) assess the presence and extent of HTRW at the Project Site, (2) better quantify the volume of HTRW-affected soil to be potentially excavated and removed, (3) evaluate the need for pretreatment of HTRW-affected soils, and (4) evaluate the potential need for remediation of sediment in the wetlands area.

The proposed scope of work for the field investigation activities at the Project Site will be conducted in a phased approach, following the protocols and procedures presented in this FSP. An interim sampling program is being conducted to better define the nature and extent of potential HTRW in the following areas: five TNT strips (TNT-1 through TNT-5) in the North Valley; three demolition areas (DA-1 through DA-3) in the South Valley; and, one flare area (FA), also in the South Valley. Sampling of three soil stockpile areas in the North Valley and sediment in the wetlands area in the South Valley have also been included in the interim sampling program.

Data from the interim sampling program will be used to conduct a follow-on focused sampling program designed to (1) provide additional information in demolition and flare areas, (2) provide soil quality information for the Ammunition Demolition/Primer Destruction, and (3) fill any data gaps observed as a result of the interim sampling program. The follow-on focused sampling program will also include an investigation of both the surface water and groundwater at the Project Site through the collection of surface water samples from the wetlands in the South Valley, surface seep samples from South Valley sideslopes, and installation of temporary groundwater monitoring wells in the North Valley.

Figure 2-1 shows the interim and proposed follow-on sampling locations. Other sampling locations may be included in the follow-on focused investigation; however, these locations are to be determined based on the results of the interim sampling program, and are not shown on Figure 2-1.

Tables 2-1A and 2-1B summarize the ongoing interim and proposed follow-on focused sampling programs, respectively, including sample matrix, number of samples to be collected, depth of sample collection, and analyses to be performed. Table 2-1B excludes any "to-be-determined" sampling and analysis.

Once the results of the interim sampling program have been received and the data evaluated, additional sampling locations (beyond those already specified for in the follow-on focused sampling program) may be required to fill specific data gaps. At that time, a revised Figure 2-1 showing the proposed additional sampling locations, and a revised Table 2-1B showing the proposed sample matrix, number of samples to be collected, depth of sample collection, and analyses to be performed will be submitted to the DTSC prior to proceeding with the additional sampling activities.

2.1.1 Interim Sampling Program

As previously stated, the interim sampling program is ongoing. Field sample collection activities were conducted, in accordance with the protocols and procedures presented in this FSP, between July 19 and July 21, 1999. The analytical results from this sampling program are pending.

2.1.1.1 TNT Strips.

The purpose of the interim sampling program at the TNT Strips Area is to better evaluate the extent of soil that may need to be excavated and removed, and to evaluate the possible need for pretreatment. The lack of vegetation within the TNT Strip Area provides an indication of the lateral extent of TNT-related activities in this area. One shallow boring was advanced toward both ends of each TNT strip (see Figure 2-1). Soil samples were collected at 1 foot bgs and 2 feet bgs. One additional boring was advanced toward the center of each TNT strip. Soil samples from the center boring location were collected at 1, 2, and 4 feet bgs. Two additional borings were advanced in adjacent vegetated areas near two of the TNT strips (TNT-2 and TNT-5) to evaluate whether any potential contamination has extended beyond those areas defined by a lack of vegetation. Soil samples were collected at 1 and 2 feet bgs at these boring locations. A surface soil sample was also collected from an area of distinct soil discoloration noted at one of the TNT strips (TNT-5). All interim soil samples from the TNT strips are being analyzed using the following methods (see Table 2-1A):

- PAHs by EPA Method 8310
- California Assessment Manual (CAM) 17 Metals by EPA Methods 6010/7000
- Explosives by EPA Method 8330.

Table 2-1A
Interim Sampling Program
Page 1 of 8

Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix	EPA 8310 PAHs	CAM 17 Metals 6010/7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN
			Soil					
TNT-1A/1	TNT Strips	1	X	X	X	X		X
TNT-1A/2	TNT Strips	2	X	X	X	X		X
TNT-1B/1	TNT Strips	1	X	X	X	X		X
TNT-1B/2	TNT Strips	2	X	X	X	X		X
TNT-1C/1	TNT Strips	1	X	X	X	X		X
TNT-1C/2	TNT Strips	2	X	X	X	X		X
TNT-1C/4	TNT Strips	4	X	X	X	X		X
TNT-2A/1	TNT Strips	1	X	X	X	X	X	X
TNT-2A/2	TNT Strips	2	X	X	X	X		X
TNT-2B/1	TNT Strips	1	X	X	X	X		X
TNT-2B/2	TNT Strips	2	X	X	X	X		X

Table 2-1A
Interim Sampling Program
Page 2 of 8

Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix	EPA 8310 PAHs	CAM 17 Metals 6010/7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN
			Soil					
TNT-2B/4	TNT Strips	4	X	X	X	X		X
TNT-2C/1.0	TNT Strips	1	X	X	X	X		X
TNT-2C/2.0	TNT Strips	2	X	X	X	X		X
TNT-2D/1	TNT Strips	1	X	X	X	X		X
TNT-2D/2	TNT Strips	2	X	X	X	X		X
TNT-2E/1	TNT Strips	1	X	X	X	X		X
TNT-2E/2	TNT Strips	2	X	X	X	X		X
TNT-3A/1.0	TNT Strips	1	X	X	X	X		X
TNT-3A/2	TNT Strips	2	X	X	X	X		X
TNT-3B/1	TNT Strips	1	X	X	X	X		X
TNT-3B/2	TNT Strips	2	X	X	X	X		X

Table 2-1A
Interim Sampling Program
Page 3 of 8

Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix	EPA 8310 PAHs	CAM 17 Metals 6010/7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN
			Soil					
TNT-3B/4	TNT Strips	4	X	X	X	X		X
TNT-3C/1	TNT Strips	1	X	X	X	X		X
TNT-3C/2	TNT Strips	2	X	X	X	X		X
TNT-4A/1	TNT Strips	1	X	X	X	X		X
TNT-4A/2	TNT Strips	2	X	X	X	X		X
TNT-4B/1	TNT Strips	1	X	X	X	X		X
TNT-4B/2	TNT Strips	2	X	X	X	X		X
TNT-4B/4	TNT Strips	4	X	X	X	X		X
TNT-4C/1	TNT Strips	1	X	X	X	X		X
TNT-4C/2	TNT Strips	2	X	X	X	X		X
TNT-5A/Surface	TNT Strips	Surface	X	X	X	X		X

Table 2-1A
Interim Sampling Program
Page 4 of 8

Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix	EPA 8310 PAHs	CAM 17 Metals 6010/7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN
			Soil					
TNT-5A/1	TNT Strips	1	X	X	X	X	X	X
TNT-5A/2	TNT Strips	2	X	X	X	X		X
TNT-5B/1	TNT Strips	1	X	X	X	X		X
TNT-5B/2	TNT Strips	2	X	X	X	X		X
TNT-5C/1	TNT Strips	1	X	X	X	X		X
TNT-5C/2	TNT Strips	2	X	X	X	X		X
TNT-5D/1	TNT Strips	1	X	X	X	X		X
TNT-5D/2	TNT Strips	2	X	X	X	X		X
TNT-5E/1	TNT Strips	1	X	X	X	X		X
TNT-5E/2	TNT Strips	2	X	X	X	X		X
SP1a1	Soil Stockpile	2[1]	X	X	X	X		

Table 2-1A
Interim Sampling Program
Page 5 of 8

Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix	EPA 8310 PAHs	CAM 17 Metals 6010/7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN
			Soil					
SP1b1	Soil Stockpile	2[1]	X	X	X	X		
SP2a2	Soil Stockpile	2[1]	X	X	X	X		
SP2b2	Soil Stockpile	2[1]	X	X	X	X		
SP3-1B	Soil Stockpile	2[1]	X	X	X	X		
SP3-2B	Soil Stockpile	2[1]	X	X	X	X		
SP3-3A	Soil Stockpile	2[1]	X	X	X	X		
SP3-4-A	Soil Stockpile	2[1]	X	X	X	X		
DA1-1/1	Demolition Areas	1	X	X	X	X		X
DA1-1/2	Demolition Areas	2	X	X	X	X		X
DA1-1/4	Demolition Areas	4	X	X	X	X		X

Table 2-1A
Interim Sampling Program
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Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix	EPA 8310 PAHs	CAM 17 Metals 6010/7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN
			Soil					
DA1-2/1	Demolition Areas	1	X	X	X	X		X
DA1-2/2	Demolition Areas	2	X	X	X	X		X
DA1-2/3.5	Demolition Areas	3.5	X	X	X	X		X
DA2-1/1	Demolition Areas	1	X	X	X	X		X
DA2-1/2	Demolition Areas	2	X	X	X	X		X
DA2-1/3.75	Demolition Areas	3.75	X	X	X	X		X
DA2-2/1	Demolition Areas	1	X	X	X	X		X

Table 2-1A
Interim Sampling Program
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Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix	EPA 8310 PAHs	CAM 17 Metals 6010/7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN
			Soil					
DA2-2/2	Demolition Areas	2	X	X	X	X		X
DA2-2/4	Demolition Areas	4	X	X	X	X		X
DA3-1/1	Demolition Areas	1	X	X	X	X		X
DA3-1/2	Demolition Areas	2	X	X	X	X		X
DA3-1/4	Demolition Areas	4	X	X	X	X		X
DA3-2/1	Demolition Areas	1	X	X	X	X		X
DA3-2/2	Demolition Areas	2	X	X	X	X		X

Table 2-1A
Interim Sampling Program
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Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix	EPA 8310 PAHs	CAM 17 Metals 6010/7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN
			Soil					
DA3-2/4	Demolition Area	4	X	X	X	X		X
FA1/1	Flare Area	1	X	X	X	X		
FA1/2	Flare Area	2	X	X	X	X		
FA2/1	Flare Area	1	X	X	X	X		
FA2/2	Flare Area	2	X	X	X	X		
FA3/.5	Flare Area	.5	X	X	X	X	X	

Notes: Sample Depth
(1) Depth below stockpile surface
CAM = California Assessment Manual
ft. bgs = feet below ground surface
PAHs = Polyaromatic Hydrocarbons
PETN = Pentaerythritol Tetranitrate

Table 2-1B
Follow-on Focused Sampling Program
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Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix					EPA 8310 PAHs	CAM 17 Metals 6010/ 7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN	EPA 8015 TEPH (Petroleum, oil, lubricants)
			Soil	Ground water	Surface Water	Sediment	Surface Seeps						
MW-1	North Valley Ammunition Renovation			X				X	X	X		X	X
BH-1/1	North Valley MW-1 pilot boring	1	X					X	X	X		X	X
BH-1/2	North Valley MW-1 pilot boring	2	X					X	X	X		X	X
BH-1/4	North Valley MW-1 pilot boring	4	X					X	X	X		X	X
BH-1/10	North Valley MW-1 pilot boring	10	X					X	X	X		X	X
MW-2	North Valley			X				X	X	X		X	
SPS-1	South Valley Seep						X	X	X	X			
SPS-2	South Valley Seep						X	X	X	X			

Table 2-1B
Follow-on Focused Sampling Program
Page 2 of 5

Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix					EPA 8310 PAHs	CAM 17 Metals 6010/ 7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN	EPA 8015 TEPH (Petroleum, oil, lubricants)
			Soil	Ground water	Surface Water	Sediment	Surface Seeps						
SPS-3	South Valley Seep						X	X	X	X			
WET-2	Wetland Surface Sediment	0.5				X		X	X	X			
WET-3	Wetland Surface Sediment	0.5				X		X	X	X			
SW-1	Wetland Surface Water				X			X	X	X			
SW-2	Wetland Surface Water				X			X	X	X			
DA1-3/1	Demolition Area	1	X					X	X	X		X	
DA1-3/2	Demolition Area	2	X					X	X	X		X	
DA1-3/4	Demolition Area	4	X					X	X	X		X	
DA1-4/1	Demolition Area	1	X					X	X	X		X	

Table 2-1B
Follow-on Focused Sampling Program
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Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix					EPA 8310 PAHs	CAM 17 Metals 6010/ 7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN	EPA 8015 TEPH (Petroleum, oil, lubricants)
			Soil	Ground water	Surface Water	Sediment	Surface Seeps						
DA1-4/2	Demolition Area	2	X					X	X	X		X	
DA1-4/4	Demolition Area	4	X					X	X	X		X	
DA2-3/1	Demolition Area	1	X					X	X	X		X	
DA2-3/2	Demolition Area	2	X					X	X	X		X	
DA2-3/4	Demolition Area	4	X					X	X	X		X	
DA2-4/1	Demolition Area	1	X					X	X	X		X	
DA2-4/2	Demolition Area	2	X					X	X	X		X	
DA2-4/4	Demolition Area	4	X					X	X	X		X	
DA3-3/1	Demolition Area	1	X					X	X	X		X	
DA3-3/2	Demolition Area	2	X					X	X	X	X	X	
DA3-3/4	Demolition Area	4	X					X	X	X		X	

Table 2-1B
Follow-on Focused Sampling Program
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Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix					EPA 8310 PAHs	CAM 17 Metals 6010/ 7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN	EPA 8015 TEPH (Petroleum, oil, lubricants)
			Soil	Ground water	Surface Water	Sediment	Surface Seeps						
DA3-4/1	Demolition Area	1	X					X	X	X		X	
DA3-4/2	Demolition Area	2	X					X	X	X		X	
DA3-4/4	Demolition Area	4	X					X	X	X		X	
FA-4/1	Flare Area	1	X					X	X	X			
FA-4/2	Flare Area	2	X					X	X	X			
FA-5/1	Flare Area	1	X					X	X	X			
FA-5/2	Flare Area	2	X					X	X	X			
AR-1/1	Ammunition Renovation	1	X					X	X	X		X	X
AR-1/2	Ammunition Renovation	2	X					X	X	X		X	X
AR-1/4	Ammunition Renovation	4	X					X	X	X		X	X
AR-2/1	Ammunition Renovation	1	X					X	X	X	X	X	X

Table 2-1B
Follow-on Focused Sampling Program
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Sample ID #	Sample Location	Sample Depth (ft. bgs)	Sample Matrix					EPA 8310 PAHs	CAM 17 Metals 6010/ 7000	EPA 8330 Explosives	EPA 8290 Dioxin	EPA 8330 Explosive Nitroglycerine & PETN	EPA 8015 TEPH (Petroleum, oil, lubricants)
			Soil	Ground water	Surface Water	Sediment	Surface Seeps						
AR-2/2	Ammunition Renovation	2	X					X	X	X		X	X
AR-2/4	Ammunition Renovation	4	X					X	X	X		X	X

Notes: Sample Depth
CAM = California Assessment Manual
ft. bgs = feet below ground surface
PAHs = Poly Aromatic Hydrocarbons
PETN = Pentaerythritol Tetranitrate
TEPH = Total extractable petroleum hydrocarbons

Additionally, two samples collected from two of the TNT strips (TNT-2 and TNT-5) are being analyzed for dioxins by EPA Method 8290 (see Table 2-1A).

2.1.1.2 Demolition Areas.

The purpose of the interim sampling program at the demolition areas is to better quantify the volume of soil to be potentially excavated and removed, by assessing whether HTRW is present in soil, and if so its lateral and vertical extent. A combination of topographical surface expressions (i.e., surface depression at DA-3) and previous analytical data (see Section 1.4) was used to identify the suspected periphery of each demolition area (see Figure 2-1). Borings were advanced at two periphery locations at each of the demolition areas. Soil samples were collected at 1, 2, and 4 feet bgs. All interim soil samples from the demolition areas are being analyzed using the following methods (see Table 2-1A):

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Methods 6010/7000
- Explosives by EPA Method 8330.

2.1.1.3 Flare Area.

The purpose of the interim sampling program at the FA is to better quantify the volume of soil that may need to be excavated and removed, by defining both the lateral and vertical extent of HTRW. A combination of topographical surface expressions (i.e., area of ash) and previous analytical data (see Section 1.4) was used to preliminarily characterize the FA (see Figure 2-1). Shallow borings were advanced toward the center of the burn area, and at two vegetated periphery locations. Soil samples from the periphery locations were collected at 1 and 2 feet bgs. A near-surface sample (0.5 feet bgs) was collected toward the center of the FA. No deeper samples were collected from this location. All interim soil samples from the FA are being analyzed using the following methods (see Table 2-1A):

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Methods 6010/7000
- Explosives by EPA Method 8330.

Additionally, one sample is being analyzed for dioxin by EPA Method 8290 (see Table 2-1A).

2.1.1.4 Soil Stockpiles.

The purpose of the interim sampling program at the soil stockpile area is to better quantify the volume of soil that may need to be excavated and removed. A lot of debris material (i.e., concrete, gravels, OE scrap) is mixed in with the soil in the stockpile areas. Because the soil in the North Valley stockpiles is from the Howitzer Test Area, samples from the stockpiles will be used to evaluate this area. Two soil samples were collected at 2 feet bgs at each of the two smaller soil

stockpiles (SP-1 and SP-2). Four soil samples were collected at 2 feet bgs at the larger soil stockpile (SP-3). All interim soil samples from the soil stockpiles are being analyzed using the following methods (see Table 2-1A):

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Methods 6010/7000
- Explosives by EPA Method 8330.

2.1.2 Follow-on Focused Sampling Program

The proposed follow-on focused sampling program has been designed to fill specific data gaps that have been identified to date. Other data gaps, which may be identified at a later date based on the results of the interim sampling program, will be addressed as indicated in Section 2.1. The follow-on focused sampling locations are shown on Figure 2-1. Table 2-1B summarizes the sample matrix, number of samples to be collected, depth of sample collection, and analyses to be performed.

2.1.2.1 Demolition Areas.

Two additional borings will be advanced, toward the periphery of each demolition area, to complement the two periphery locations at each demolition area already sampled during the interim sampling program (see Figure 2-1). Soil samples will be collected at 1, 2, and 4 feet bgs.

The soil samples from the Demolition Areas will be analyzed using the following methods (see Table 2-1B):

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Method 6010/7000
- Explosives by EPA Method 8330.

2.1.2.2 Flare Area (FA).

Two additional borings will be advanced, toward the periphery of the FA, to complement the two periphery samples already collected during the interim sampling program (see Figure 2-1). Soil samples will be collected at 1, 2, and 4 feet bgs.

The soil samples from the FA will be analyzed using the following methods (see Table 2-1B):

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Method 6010/7000
- Explosives by EPA Method 8330.

2.1.2.3 Wetlands Sediment and Surface Water.

A grab surface water and sediment sample will be collected from two locations in the South Valley wetlands, one upgradient and one downgradient of the demolition and FA. The water and sediment samples from the wetlands area will be analyzed using the following methods (see Table 2-1B):

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Method 6010/7000
- Explosives by EPA Method 8330.

2.1.2.4 Ammunition Renovation/Primer Destruction Area.

Two borings will be advanced in the Ammunition Renovation/Primer Destruction Area. Soil samples will be collected at 1, 2, 4 feet bgs. Soil samples will also be collected from the pilot boring advanced for during temporary monitoring well installation in this area. Soil samples from the pilot boring will also be collected at 1, 2, 4, and 10 feet bgs.

Soil samples from the Ammunition Renovation/Primer Destruction Area will be analyzed using the following methods:

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Method 6010/7000
- Explosives by EPA Method 8330
- Total Extractable Petroleum Hydrocarbons (TEPH) by Method 8015.

One dioxin sample collected from boring AR-2 at 1-foot bgs will also be analyzed for dioxins by EPA Method 8290.

2.1.2.5 Seeps/Springs.

Three potential seeps, situated along the north sideslope of the South Valley, will be inspected to see if there is any seep water present to collect a surface seep sample. The water samples from the surface seeps will be analyzed, using the following methods (see Table 2-1b):

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Method 6010/7000
- Explosives by EPA Method 8330.

2.1.2.6 Groundwater.

Two temporary groundwater monitoring wells will be installed in the first encountered groundwater-bearing zone at the proposed well locations to evaluate the potential impact of HTRWs on the groundwater beneath Ammunition Renovation/Primer Destruction Howitzer Testing, and TNT Strip Areas and

downgradient of these former facilities (see Figure 2-1). A pilot boring will initially be drilled at each location to verify the depth to the first groundwater-bearing zone. First groundwater is anticipated to be encountered in the alluvium (if sufficient thickness is present) and/or the underlying weathered bedrock zone. Information obtained from the pilot boring will be used to optimize the well design and construction. Once the temporary groundwater monitoring wells are installed and developed, representative groundwater samples will be collected and analyzed using the following methods:

- PAHs by EPA Method 8310
- CAM 17 Metals by EPA Method 6010/7000
- Explosives by EPA Method 8330.

2.1.3 Data Quality Objectives (DQOs)

DQOs are qualitative and quantitative statements developed to specify the quality of data needed from the field and laboratory data collection activities in order to support specific decisions and regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problem being investigated. The DQOs also establish numeric limits for the data to allow the data user (or reviewers) to determine whether data collected are of quality sufficient for use in their intended application. The DQOs for the proposed field activities are discussed in more detail in Section 3.1.4 of the QAPP.

2.2 PRE-FIELD INVESTIGATION ACTIVITIES

The tasks outlined in the following subsections will be conducted prior to the start of any field investigation activities at the Project Site.

2.2.1 Permits

No permits are required by the Solano County Department of Environmental Management (DEM) for exploratory borings. The Solano County DEM does require well permits for installation and abandonment of groundwater monitoring wells (see Section 2.5.3). The well permit application must include the following information:

- Applicant's name, address, and current phone number
- Statement that the contractor performing the work is licensed under the provisions of Chapter 9 of Division 3 of the Business and Professions Code as a well drilling contractor possessing a C-57 Water Well Drilling Contractor's License
- Estimated or proposed depth of the well, casing material, sealing material, sealing method, intended use of the well, and drilling method to be used

- Location of the Project Site, including Assessor's Parcel Number, and location of the well to be installed
- Legal Project Site property owner
- Figure indicating the location of the well with respect to the following items:
    - Project Site property lines
    - Sewage disposal systems
    - Bodies of surface water
    - Drainage pattern of the Project Site
    - Existing wells within 100-foot radius of the proposed well
    - Access roads
    - Structures
    - animal enclosures
    - Underground storage tanks containing hazardous substances.

A copy of the Well Permit Application to be used for both temporary groundwater monitoring well installation and abandonment is included in Appendix C. A minimum of two working days must be allowed for the Solano County DEM to process a well permit application. A Solano County DEM inspector must be present for installation of the well sanitary seal. The inspector requires a minimum of 24 hours' notice.

2.2.2 Health and Safety Plan

All field activities performed at the Project Site as part of this Work Plan will be conducted in accordance with the requirements of the HASP presented in Chapter 4.0. All field activities will be performed by personnel meeting the requirements of 8 CCR Section 5192 (29CFR 1910.120) (Hazardous Waste Operations and Emergency Response [HAZWOPER]). Prior to the start of any field investigation activities, all field personnel and authorized visitors will be required to read and sign the HASP. A site safety meeting will be held each morning in accordance with the HASP.

2.2.3 Utility Clearance and Unexploded Ordnance (UXO) Avoidance

All proposed investigation locations will be pre-marked and cleared of any subsurface obstructions. A private underground utility locator service will be

subcontracted, if necessary, to clear any locations where underground utilities are suspected. Underground Services Alert (USA) will also be notified a minimum of 72 hours before any subsurface work is to begin, as required by law.

2.2.3.1 UXO Avoidance.

All proposed investigation locations will be cleared of UXO both before and during all field investigation activities in accordance with the procedures presented in Attachment D of Appendix D. A UXO specialist, who will also act as the SSC, will accompany each sampling crew during all field investigation activities. Procedures for dealing with any UXO encountered during the field investigation activities are presented in Section 4.9.7 of the HASP.

2.3 DRILLING METHODS

All subsurface drilling activities will be conducted under the direct supervision of a California state registered geologist. The two types of drilling methods presented in the following two subsections may be deployed at the Project Site, depending on the depth of boring advancement and the nature of the weathered and competent bedrock, if encountered. No drilling fluids or lubricants are used in either drilling method; this minimizes the potential for cross-contamination or infiltration of materials into the formation. All downhole drilling equipment will be decontaminated between boring/well locations in accordance with the equipment decontamination procedures presented in Section 2.13.1.

2.3.1 Hollow-Stem Auger Method

The hollow-stem-auger (HSA) drilling method may be used to advance borings to be completed in either valley alluvium or shallow unconsolidated (weathered) bedrock. The HSA drilling technique involves drilling a boring by simultaneously rotating and axially advancing the auger column into unconsolidated or poorly consolidated formations. As the augers are rotated and advanced into the ground, they act as a casing to stabilize the boring. The pilot bit and teeth on the auger head drill into the soil and direct the cuttings to the auger flights. As the auger flights are rotated, the soil cuttings are brought to the surface by movement along the continuous flights on the outside of the hollow stem. The drill cuttings are removed from the ground surface by a shovel and placed in an appropriate container, pending analytical results and a determination of proper disposal (see Section 2.14.1). A pilot bit at the bottom of the auger flights is used to plug the hollow core of the augers during drilling unless soil sampling is being performed (see Section 2.6.3).

2.3.2 Air Rotary Casing Drive Method

The air rotary casing drive method (also known as the air rotary casing hammer [ARCH] method) may be used if competent bedrock or HSA refusal is encountered during drilling. The ARCH method involves drilling a boring by using a drilling bit attached to the lower end of a rotating drill pipe that is placed within a nonrotating

outer "drive" casing. The drill bit advances the boring simultaneously as the non-rotating drive casing is driven into the ground. Air is forced under pressure downward through the drilling rods and bit and back to the ground surface through the annular space between the drive casing and the smaller rotating drill rod. The returning air continuously moves cuttings and groundwater from the area of the drill bit to the surface where they are discharged into a cyclonic separator, which separates the air from the formation cuttings to facilitate sampling and containment of the cuttings pending analytical results and a determination of proper disposal (see Section 2.14.1). The outer casing is driven downward by repeated blows of a percussion hammer mounted on the drill rig. The drive casing keeps the boring open and reduces the flow of groundwater into the boring. The drive casing will typically only be advanced to a depth where it is necessary to keep the boring from collapsing.

2.4 TEMPORARY GROUNDWATER MONITORING WELL INSTALLATION

Prior to installation of the temporary groundwater monitoring wells, Earth Tech will obtain the necessary permits (see Section 2.2.1) from the Solano County DEM and arrange for a Solano County DEM inspector to observe the placement of the well sanitary seals. Following completion of the well installation activities, a Well Completion Report (Form Department of Water Resources [DWR] 188) will be submitted to the State of California DWR for each newly installed well. The Well Completion Report must be signed by a representative of the well driller subcontracted to perform the well installation activities.

Based on the proposed locations of the groundwater monitoring wells, it is anticipated that the temporary groundwater monitoring wells will be installed in the shallow alluvium. However, if groundwater is not encountered, the boring may need to be advanced into either the weathered or competent bedrock.

2.4.1 Pilot Boring

Initially, an 8-inch (nominal) pilot boring will be advanced at each temporary well location to determine the depth to first groundwater using one of the two drilling methods described in Section 2.3. The UXO specialist will clear the proposed pilot boring location, both prior to and during the drilling activities using a magnetometer (or equivalent) to enable the boring to be safely advanced to the target depth. Pilot borings for well installations may be sampled at select intervals, or continuously sampled, depending on lithology and field conditions. Selected soil samples will be retained for chemical analysis. Drill cuttings, soil samples and bedrock cores from the boring will be lithologically logged by the field geologist working under the supervision of a California-state registered geologist (see Section 2.16.3). Soil samples and bedrock cores not retained for chemical analysis will be examined to optimize the length and placement of the well screen interval. The pilot boring will be advanced a minimum of 10 feet into the first water-bearing zone (alluvium or bedrock, depending on field conditions), to determine a sufficient zone of saturation for well installation. Any overdrilled portion of the boring will be backfilled with bentonite chips to the final target depth for temporary well

installation. The bottom of the boring will be tagged to confirm the final boring depth immediately prior to well installation.

2.4.2 Well Construction

The temporary groundwater monitoring wells will be completed in the pilot boring using Schedule 40 polyvinyl chloride (PVC) riser pipe above and below the water table and screened with Schedule 40 PVC factory-slotted well screen. The wells will be constructed using 2-inch casings. All well casings will be flush threaded. Selection of monitoring well filter pack and slot size will be based on either performance of a field sieve analysis on a sample from the water-bearing formation, or visual soil classification by the field geologist. In general, if the wells are screened in fine-grained materials, then 0.010-inch slot well screens with Lonestar #1C to #2/12 sand will likely be used. If the wells are completed in coarser grained materials, 0.020-inch well screens with Lonestar #2/12 to #3 sand may be used. The visual soil classification may be confirmed by sieve analysis at an approved geotechnical testing laboratory.

Screen and casing sections will either be (1) certified clean by the supplier and left in the original plastic wrapping; (2) decontaminated and wrapped in clean plastic prior to drilling activities; or (3) steam cleaned at an Equipment Decontamination Area established at the Project Site, and then wrapped in plastic for transportation to the monitoring well location. The casing will be kept covered, either on a clean plastic ground cover or in the original plastic wrapping, to avoid contamination before the casing is lowered down the boring.

Groundwater wells installed to monitor water table aquifers will generally be screened across the water table. If the wells are installed in fractured bedrock, the screens will generally be installed to cross water-producing zones (which may be a fractured zone well below the static water level). Ten-foot well screens will be used for the temporary groundwater monitoring wells unless field conditions warrant a longer screen length. Low-permeability formations may require longer screens to allow adequate water to enter the well for development/purging procedures.

Blank well casing (riser pipe) will be placed from the top of the well screen to between 2 to 3 feet above the ground surface. The well casing will be sealed at the bottom with a threaded PVC cap, and at the top with a well cap. Centralizers may be placed along the well casing in borings that are drilled using rotary or downhole hammer methods. The centralizers will be placed just above and below the well screen and at select intervals along the blank casing, as necessary. In well casings installed through the HSA annulus, the inside diameter of the auger flights will act as the centralizer.

2.4.2.1 Filter Pack Placement.

Once the casing is installed, the filter pack, consisting of acid-resistant, washed and graded silica sand (sized according to either a visual soil classification or field

sieve analyses), will be placed in the annular space between the well casing and the boring wall. The sand will be furnished in sacks and will be clean and free of oil, acid, organic or other deleterious material. The filter pack will be placed from the bottom of the boring to 2 feet above the top of the well screen.

Depending on the well depth, the filter pack will either be poured or tremied into place as the HSA flights or rotary drive casing is retracted in a stepwise manner. The annular space between the well screen and auger flights or drive casing will be probed with a weighted tape measure to confirm that the hole is open to a depth approximately equal to the bottom of the auger flights or drive casing. The filter pack will be poured or tremied into the annular space. The depth of the filter pack will be periodically probed to measure the progress of the filter pack placement. The auger flights or drive casing will be slowly retracted upward, allowing the filter pack material to settle out through the bottom of the auger flights or drive casing. The auger flights or drive casing will be retracted (without spinning) no more than 6 inches at a time. The depth of the filter pack material will be constantly measured relative to the bottom of the auger flights or drive casing to confirm that the filter material has settled out through the bottom of the flight augers or drive casing. A small amount of filter pack material will always be maintained above the bottom of the auger flights or drive casing.

The filter pack procedure will be closely monitored by constantly probing the depth of the filter pack material and comparing the volume of placed filter pack material with the estimated volume to fill up the annular space. If the volume estimates are consistent, there is assurance that the filter pack material is being uniformly placed along the well screen. Periodic depth probing will also locate any points of bridging between the well casing and the boring or auger flight/drive casing wall. The volume of filter pack material used will be recorded on the Water Table Well Installation Diagram Form (see Appendix C) during filter pack construction. If a significant discrepancy arises between the sand volume used versus the filled volume measured, the source of this error will be identified and corrected. The wells may be initially "developed" during installation by surging and if necessary, by pumping and bailing, to aid in settling the filter pack before placement of the bentonite seal.

Approved potable water may be poured down the annular space to break bridges if they are encountered. The amount of potable water introduced into the well will be kept to a minimum, and the quantities will be recorded on the Water Table Well Installation Diagram Form (see Appendix C) and reported in the final report. A sample of any potable water supply used will be collected and analyzed for all groundwater sampling analytes to document the quality of the potable water.

2.4.2.2 Bentonite Seal Placement.

A 2-foot (minimum) bentonite seal consisting of 100-percent pure sodium bentonite pellets or chips will be placed above the filter pack to separate the filter pack from the cement grout sanitary seal. The bentonite pellets or chips will be free of additives that may affect water quality. If the bentonite seal is to be placed in

unsaturated conditions, bentonite pellets or chips will be placed into the annular space above the filter pack and hydrated with either distilled water or approved potable water of documented quality. If the bentonite seal is to be placed in saturated conditions (i.e., below the water table), the bentonite pellets or chips will be placed above the filter pack in a manner so as to prevent bridging in the annular space. The bentonite pellets or chips will be allowed to hydrate per the manufacturer's specifications.

2.4.2.3 Grout Placement.

After the bentonite seal has hydrated, the remaining annular space will be grouted with a neat, non-shrinking, cement grout. The grout will consist of 2 pounds to not more than 4 pounds of 100-percent pure sodium bentonite powder and 5 gallons to not more than 8 gallons of approved potable water for each 94-pound sack of Type II Portland cement (or equivalent). The grout will be placed by a positive displacement method, such as pumping through a tremie pipe. The bottom of the tremie pipe will be initially positioned in the annular space to a depth not greater than 5 feet above the bentonite seal and constructed to discharge to the sides rather than straight downward. The tremie pipe may be slowly raised as the grout is placed and the auger flights or drive casing is retracted; however, the discharge end of the pipe and the auger flights or drive casing must be submerged at all times until final removal of the auger flights or drive casing. Additional grout will be added from the surface to maintain the level of grout at the ground surface as settlement occurs. If the length of the remaining annular space to be grouted is between 5 to 10 feet, the grout may be poured from the surface rather than tremied into the annular space, as the auger flights or drive casing is retracted.

2.4.3 Well Head Completion

The temporary groundwater monitoring wells will be completed above the ground surface. The well casing will be extended 2 to 3 feet above the ground surface. A steel monument will be placed over the well casing that will allow at least a 4-inch-diameter space between the well casing and steel monument, and then seated in a concrete surface pad. The pad will be sloped away from the well casing to avoid surface accumulation of water. A lockable cap or lid will be installed on the steel monument. A PVC slip cap will be placed on the inside well casing. The northern side of the inside PVC well casing will be notched for use as a survey datum point (see Section 2.10). If necessary, three guard posts of approximately 5 feet in length will be installed radially from each wellhead. The guard posts will be recessed approximately 2 feet into the ground and set in concrete. Each guard post will be filled with concrete and will be clearly marked using paint. All temporary groundwater monitoring wells will be secured with corrosion-resistant locks as soon as possible after drilling

Well completion diagrams showing well construction details will be recorded on the Water Table Well Installation Diagram Form (see Appendix C) by the field geologist who supervised the well installation. Well construction activities will be

summarized in the Daily Field Report (see Appendix C). Any changes from the planned well construction will be noted.

2.4.4 Well Development

All newly installed temporary groundwater monitoring wells will be developed prior to sampling. Newly installed wells will be developed no sooner than 24 hours and no later than 30 days following well completion. Wells will be developed using a combination of bailing, surging, and/or pumping (depending on well depth). The fine-grained materials accumulated in the well casing will be bailed from the well with a bailer until the bottom of the well casing can be probed. After bailing, the well will be surged using a surge block to flush any fine-grained materials from the filter pack. The well will then be bailed again to remove fine-grained materials until the bottom of the well casing can be probed. After the second bailing, a submersible pump will be placed in the well and pumped. During pumping, groundwater parameters consisting of hydrogen ion concentration (pH), electrical conductivity (EC), temperature, and turbidity will be monitored and recorded on the Well Development Form (see Appendix C). Water level measurements and volume of water removed will also be recorded on the form. If possible, pumping rates will also be measured using either the bucket/stopwatch method or an in-line flow meter. The bucket/stopwatch method will consist of pumping the well discharge into a known volume container (usually a calibrated 5-gallon bucket). A stopwatch is started when flow begins entering the container and is stopped when the container is full. This will give the time in minutes and seconds that it takes to discharge the known volume of water from the well. This number will be converted to gallons per minute and recorded on the Well Development Form (see Appendix C). This procedure will be repeated several times to establish an average pumping rate. The gallons pumped during development will be calculated based on the average pumping rate and time the well is pumped.

Wells will be developed until the following field parameters have stabilized, or a minimum of ten well casing volumes have been removed, whichever comes first:

- pH ± 0.2 pH units, of previous reading
- EC ± 10 percent of previous readings
- Temperature ± 1 °Celsius (C) of previous reading.

The results will be recorded on the Well Development Form (see Appendix C). Field instruments used to measure the field parameters will be calibrated according to the procedures presented in Section 2.12.

All purge water will be appropriately contained, pending the groundwater analytical results and a determination of proper disposal (see Section 2.14.2). All purging equipment will be decontaminated between well locations in accordance with the equipment decontamination procedures presented in Section 2.13.1.

2.5 BORING AND TEMPORARY GROUNDWATER MONITORING WELL ABANDONMENT

2.5.1 Shallow Hand Auger Borings

Shallow borings advanced using a hand auger will be abandoned by backfilling the boring after completion of soil sample collection activities. Shallow borings will be backfilled to the ground surface with bentonite chips, which will be hydrated with either distilled water or approved potable water of documented quality.

2.5.2 Deep Borings

The only deep borings proposed as part of the field investigation activities will be advanced using one of the two drilling methods described in Section 2.3 and will be used for temporary groundwater monitoring well installation. If a deep boring cannot be used for a proposed well installation, the boring will be abandoned by backfilling it with a neat, non-shrinking, cement grout. The grout will consist of from 2 pounds to not more than 4 pounds of 100-percent pure sodium bentonite powder and from 5 gallons to not more than 8 gallons of approved potable water for each 94-pound sack of Type II Portland cement (or equivalent).

Depending on the depth of the boring to be abandoned, the grout will be either poured into the boring or tremied through the auger flights or drive casing. As the grout is placed, the auger flights or drive casing will be retracted; however, the discharge end of the auger flights or drive casing must be submerged at all times until final removal of the auger flights or drive casing has occurred. Additional grout will be added from the surface to maintain the level of grout at the ground surface as settlement occurs.

2.5.3 Groundwater Monitoring Wells

The necessary groundwater monitoring well abandonment permit will be obtained from the Solano County DEM (see Section 2.2.1) prior to any well abandonment activities. Following completion of the well abandonment activities, a Well Completion Report (Form DWR 188) must be submitted to the state of California DWR for each abandoned well. The Well Completion Report must be signed by a representative of the well driller subcontracted to perform the well abandonment activities.

The temporary groundwater monitoring wells will be abandoned according to the requirements set forth in *Bulletin 74-90, California Well Standards*, prepared by the state of California DWR. The DWR has responsibility for developing these standards under the California Water Code, Section 231. According to these standards, abandoned wells must be destroyed to ensure that the quality of groundwater is protected and to eliminate a possible physical hazard to humans and animals.

Prior to abandonment, each well will be investigated before it is destroyed to determine its condition and to make sure any undesirable materials or

obstructions have been removed from the well. Since the temporary groundwater monitoring wells will be installed in accordance with the construction standards set forth in *Bulletin 74-90, California Well Standards* (see Section 2.4), the minimum well abandonment guidelines require that the well casing be completely filled with sealing materials.

Temporary groundwater monitoring wells will be abandoned in-place by pressure grouting. The grout will be placed by applying external pressure in excess of hydrostatic pressure. Pressure will be maintained by sealing the well casing while pumping the grout into the casing with a positive displacement pump and monitoring pressures at the surface with a gauge. Typically, the pressure applied to the grout should be sufficient to penetrate the filter pack and geologic materials surrounding the well screen interval. Well abandonment is considered complete when a pressure of 25 pounds per square inch (psi) is maintained at the well head for 5 minutes, or a volume of cement grout equal to the volume of the well screen and casing and 30 percent of the filter pack volume has been placed.

If for any reason the temporary groundwater monitoring wells cannot be abandoned in-place by pressure-grouting, the wells will be over drilled to just below the well depth in order to remove the well casing and construction materials. The boring created as a result of the overdrilling activities will be abandoned as described in Section 2.5.2.

2.6 FIELD SAMPLING ACTIVITIES

Various types of samples (e.g., soil, sediment, surface water, groundwater) will be collected for chemical analysis. Soil/sediment and bedrock samples will also be logged in the field by the geologist supervising the sample collection activities (see Section 2.16.3) and the information recorded on the Test Boring Log (see Appendix C). Immediately following sample collection, the samples will be handled and shipped as described in Section 2.9. All field sampling equipment (including purging equipment) will be decontaminated between sampling locations as described in Section 2.13.1.

2.6.1 Sediment Sample Collection Procedures

Sediment samples will be collected by pushing a certified, pre-cleaned, 6-inch-long by 2-inch-diameter stainless steel liner into the substrate. If necessary, an Ekman® dredge or equivalent device may be used to collect sediment samples where standing water precludes the use of a drive tube. The sediment will be removed from the Ekman® dredge, mixed in a stainless steel mixing bowl with a stainless steel spoon, and placed into laboratory-supplied, pre-cleaned sample containers. Sediment sample collection activities will be recorded on the Surface Water/Sediment Data Form (see Appendix C).

2.6.2 Surface, Near-Surface, and Stockpile Soil Sample Collection Procedures

2.6.2.1 Surface Samples.

Surface scraping may be used to collect soil or sediment samples from the ground surface. A thin layer of soil or sediment will be scraped using a stainless steel spoon and placed directly into a pre-cleaned sample container.

2.6.2.2 Near-Surface Samples.

Near-surface samples will be collected using a hand auger equipped with a 3-inch-diameter cylindrical stainless steel bit. Hand augering will be used to collect shallow soil samples up to 5 feet bgs and from the soil stockpiles.

The UXO specialist will initially clear the proposed hand auger boring location, from the ground surface to a depth of 1-foot bgs, using a Schonstedt Magnetic Locator (or equivalent) to enable soil samples to be safely collected from the target depths within the first 1 foot bgs. The hand auger will be advanced to the desired depth of sample collection within the first 1-foot bgs, and any excess cuttings will be removed from the boring. A 6-inch-long by 2.5-inch-diameter drive sampler will be attached to a sampling rods and lowered to the bottom of the boring. The sampler will contain one 6-inch-long by 2-inch-diameter, certified, pre-cleaned, stainless steel liner. The sampler will not be allowed to drop onto the soil being sampled. A hand-driven slide hammer will be attached to the top of the sampling rods. The dead weight of the sampler, rods, and slide hammer will rest on the bottom of the boring and a seating blow applied. If excessive cuttings are encountered at the bottom of the boring, the sampler and rods will be removed and the cuttings cleaned out. The sample rods will be marked at 6-inch increments so the advance of the sampler can be observed. The sampler will be driven into the undisturbed formation with blows from the slide hammer. Blows will be applied until the sampler has advanced 6 inches or until it is determined that no visible advancement is being made. After the sampler is driven to the desired depth, it will be brought to the surface, opened, and the liner removed. The percent of recovery will be recorded on either the Test Boring Log or in the Daily Field Report (see Appendix C).

After soil samples have been collected within the first 1 foot bgs, the UXO specialist will place the instrument tip down the boring to clear the next 1-foot depth interval prior to continuation of the hand augering and sample collection. This process will be duplicated at each proposed sample boring location. At locations where soil sample collection is proposed to a depth of up to 5 feet bgs, the UXO specialist will clear a 1-foot square area around the proposed boring location. The soil from this cleared area will then be removed, after sample collection within the first 1-foot bgs interval has been completed, so the magnetometer can be placed into the excavated hole. With the body of the meter placed in the excavated hole, the tip of the meter will be able to clear a boring depth, advanced at 1-foot intervals, up to a maximum depth of 5 feet bgs.

2.6.2.3 Stockpile Samples.

Samples collected from the soil stockpile areas will be collected by removing 2 feet of topsoil/debris from the proposed stockpile sampling location using a pick and shovel, then collecting an undisturbed soil sample using the hand drive sample method described in Section 2.6.2.2.

2.6.3 Soil Sample Collection Procedures During Monitoring Well Installation

The only deep borings proposed as part of the field investigation activities will be advanced using one of the two drilling methods described in Section 2.3 and will be used for temporary groundwater monitoring well installation. During drilling, subsurface samples may be collected either continuously or at discrete intervals (i.e., 5-foot intervals), depending on field conditions. A combination of the drill cuttings and samples will be used to lithologically log the boring, using the Test Boring Log (see Appendix C), and to assist in the optimum well design and construction.

To collect soil (or unconsolidated bedrock) samples using the HSA drilling method, the pilot bit is removed and, if necessary, the inside of the hollow stem is cleaned out. Soil samples will be collected by lowering a split-spoon sampler (fitted with certified, pre-cleaned, stainless steel liners), attached to the drill rods or wire-line, to the bottom of the boring. To collect soil (or unconsolidated bedrock) samples using the ARCH method, the rotary drill is withdrawn, then soil samples are collected by lowering a split-spoon sampler (fitted with certified, pre-cleaned, stainless steel liners), attached to the drill rods or wire-line, to the bottom of the boring; similar to the HSA method.

In both drilling methods, the split-spoon sampler will be driven into the undisturbed formation with a 140-pound hammer repeatedly dropped from a height of approximately 30 inches. The number of times required for the hammer to drop to collect 6 inches of samples will be recorded on the Test Boring Log (see Appendix B) to provide qualitative information regarding the density of the material encountered. The nominal size of the split-spoon sampler will be either 1.5 or 2.5 inches inside diameter (ID), 18 inches in length, and manufactured of stainless steel.

Three 6-inch-long, certified, pre-cleaned, stainless steel liners will be placed inside the spilt-spoon sampler. Upon sample retrieval, the split-spoon sampler will be opened and the lead sample liner retained for chemical analysis. The two remaining sample liners will used for lithologic description.

2.6.4 Continuous Core Sample Collection Procedures

If it is determined in the field that continuous core samples are required to adequately log the boring, a coring system will be lowered through the HSA flights or air rotary drive casing. In unconsolidated materials, the lead auger flight will be

equipped with a 5-foot Laskey barrel (or equivalent), which will be advanced just ahead of the auger bit. In consolidated bedrock, the air coring apparatus will be lowered through the inside of the drive casing. The core will then be advanced by its high speed rotation and the weight of the apparatus resting on the bit. High-pressure air with a potable water mist will be used to cool the bit, to minimize dust generation, and to remove the generated cuttings.

The Laskey barrel or air core system will be advanced up to 5 feet, at which time the coring will be stopped and the apparatus withdrawn to the surface for lithologic description. Coring rate, penetration depths, sample collection times, and lithologic descriptions will be recorded on the Test Boring Log (see Appendix C).

2.6.5 Grab Surface Water and Seep and Drainage Sample Collection Procedures

Grab surface water samples from the wetlands area, grab surface seep samples from seep areas, and surface drainage samples will be collected in laboratory-supplied, pre-cleaned sample bottles containing the appropriate preservatives, if applicable, for the proposed analytical test method (see Section 2.15). Grab surface water samples will be collected by holding the sample bottles at the desired depth within the water column in areas where water has ponded. If necessary, a Van Dorn® sampler or equivalent device may be used to collect the surface water samples, which will allow collection of surface water from a discrete depth. The water collected from the sampler will then be transferred to the laboratory-supplied, pre-cleaned sample bottles containing the appropriate preservatives. Depending on field conditions, grab surface seep and drainage samples will be collected by holding the sample bottles beneath the seep and drainage point, respectively. If necessary, a stainless steel bowl or similar device will be used to help contain sufficient seep and/or drainage water for sample collection. Grab surface water, seep, and drainage sample collection activities will be recorded on the Surface Water/Sediment Data Form (see Appendix C).

2.6.6 Groundwater Sample Collection Procedures

Groundwater samples will be collected from each of the newly installed temporary groundwater monitoring wells after equilibrium conditions have been reached following well development (see Section 2.4.4). Groundwater sample collection activities will be recorded on the Well Purging and Sample Collection Form (see Appendix C).

2.6.6.1 Well Purging.

The water standing in the well may not be representative of insitu groundwater quality. Therefore, it is necessary to purge the well prior to sampling to achieve a representative sample. Before purging the well, the static water level will be measured using an electric sounder, as described in Section 2.11. After the static water level has been measured, the depth to the bottom of the well will be sounded.

After the static water level and well depth have been measured, a pump will be lowered into the well and set in the lower portion of the submerged well screen. Low-yield wells may also be purged utilizing a Teflon™ or disposable polyethylene bailer. The flow rate of the pump will be monitored using a calibrated 5-gallon bucket or equivalent measuring method. The flow rates will be periodically checked and recorded on the Well Purging and Sample Collection Form (see Appendix C). If the well is capable of yielding three well casing volumes, samples will be collected at regular intervals during the purging and measured for pH, EC, temperature, and turbidity. Wells will be continually purged until the following field parameters have stabilized, or a minimum of three well casing volumes have been removed, whichever comes first:

- pH ± 0.2 pH units, of previous reading
- EC ± 10 percent of previous readings
- Temperature ± 1 °C of previous reading.

During purging, values for each of the field parameters will be recorded on the Well Purging and Sample Collection Form (see Appendix C). Field instruments used to measure the field parameters will be calibrated according to the procedures presented in Section 2.12. Color and any odor observed will also be recorded. If the well recovers quickly, it will be sampled as soon as possible. If recharge is slow, groundwater samples will be collected after the water level has recovered to 80 percent of its static water level, or within 16 hours after completion of purging, whichever comes first. If the well is not capable of stabilizing or producing three well casing volumes, the well will be purged until dry and the samples collected as soon as a sufficient amount of water has reentered the well.

As indicated above, the equipment to be used for purging the wells will typically consist of a stainless steel submersible pump or a Teflon™ or disposable polyethylene bailer. Purge pump intakes will be equipped with a positive foot check valve to prevent purged water from flowing back into the well. All purge water will be appropriately contained pending groundwater analytical results and proper disposal (see Section 2.14.1).

2.6.6.2 Sample Withdrawal.

Table 2-2 lists the bottles to be used to collect each type of sample and their holding times. Samples will be collected using a Teflon™ or disposable polyethylene bailer. The portions of bailer lines that enter the water will be stainless steel or Teflon™-lined cable. Samples collected for chemical analysis will be collected in plastic or glass containers filled to capacity. If preservatives are in the containers, they will not be allowed to overflow while filling. The pH of the preserved samples will be checked in the field by pouring a small amount of the sample onto pH paper. The pH paper will not make contact with the sample container. If needed, more acid may be added until the proper pH is attained (i.e., pH<2). Both the preservation check and any added acid will be noted on the Chain-of-Custody Record (see Appendix C).

Table 2-2. Recommended Sample Container, Preservation, and Holding Times for Selected Analytical Test Methods

			Volume Required		Preservation [b]		
Parameter	Aqueous Sample Container[a]	Field Filter[e]	Water (ml)*	Soil (g)	Water	Soil	Maximum Holding Times [c]**
Metals (SW6010B)	P, G, T	X	1000	250	HNO_3 to pH <2	4°C	6 months
Mercury (SW7470A/SW7471A)	P, G, T	X	1000	10	HNO_3 to pH <2	4°C	28 days
Total Petroleum Hydrocarbons: TEPH C-12 to C-36 (Mod SW8015 LUFT)	G, amber, T		1,000	250	Cool 4°C	4°C	7 days (water) and 14 days (soil) until extraction, 40 days after extraction
Dioxins/Furans (SW8280A/ SW8290)	G, Teflon™ screw cap		1000	250	Cool 4°C (0.008% $Na_2S_2O_3$[d]) store in dark	4°C	7 days until extraction, 40 days after extraction
Nitroaromatics & Nitroamines and Nitroglycerin/PETN (SW8330) Collect Separate Containers for Nitroglycerin/PETN	G, Teflon™-screw cap		1000	50	Cool 4°C (0.008% $Na_2S_2O_3$[d])	4°C	30 days (water) and 14 days (soils) until extraction, 45 days after extraction
Electrical Conductivity (120.1)(field)	P, G		100	NA	None Required	NA	Analyze immediately
Hydrogen ion (pH) (150.1) (field)	P, G		50	NA	None Required	NA	Analyze immediately
Temperature (170.1) (field)	P, G		1000	NA	None Required	NA	Analyze immediately
Turbidity (180.1) (field)	P, G		100	NA	None Required	NA	Analyze immediately

NOTE: See Next Page

NOTE: * Do not pre-wash bottle with samples.
** Extraction holding times are from date of sample collection; analysis times are from date of extraction.

REFERENCE: This table includes the requirements of the U.S. Environmental Protection Agency, as published in the Code of Federal Regulations, Volume 49, Number 209, 40CFR 136, dated October 26, 1984, page 43260.

(a) Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T). Soil samples may be collected in either glass jars or stainless steel liners with both ends sealed with Teflon™ paper and plastic caps.

(b) Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automatic sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting are completed.

(c) Samples should be analyzed as soon as possible after collection. The times listed are maximum times (in calendar days) that samples may be held before analysis and still be considered valid. Samples may be held for longer periods of time only if the monitoring laboratory has data on file to show that the specific types of samples under study are stable for the longer time. Some samples may not be stable for the maximum time period given in the table. The monitoring laboratory is obligated to hold the sample for a shorter period if knowledge exists to show this is necessary to maintain sample stability.

All groundwater samples designated for metals analysis will be unfiltered samples to determine total metal concentrations; which are useful for evaluations of risk.

Groundwater samples will be collected in the following order:

- Semi-volatile organic compounds (i.e., PAHs)
- Dioxins
- Explosives
- Total metals.

Field parameters (i.e., pH, EC, temperature, turbidity) will be measured and recorded after sample collection to document the stability of the water over the sampling period. Water levels will be measured after sample collection and after well conditions have stabilized.

2.7 FIELD QUALITY CONTROL

Field QC samples will be collected during the field investigation activities to assess the influence of sampling procedures, equipment, and handling on the reported results, as discussed in Section 3.2.5.1 of the QAPP. The following types of QC samples will be collected.

2.7.1 Duplicate Samples

Field duplicates are samples collected separately at a particular location and time, in order to assess error associated with sample heterogeneity, sampling methodology applicability, and sampling handling techniques. Collocated duplicates are collected separately and placed directly into sample containers. Theoretically, each sample equally represents the medium at a given time and location. This is the required type of sample for volatiles analyses and most water samples. Homogenized duplicates are duplicates of nonaqueous matrices whose subsequent analysis permits prior homogenization of the media, and are obtained in sufficient volume to fill all sample containers. The media is then homogenized, divided into two or more equal parts, and aliquots of each part are used to fill each sample container.

Since more information can be obtained from samples with detectable concentrations, efforts will be made to select duplicate samples from those areas anticipated to have the highest potential for contamination. Field duplicate soil samples will number 10 percent of the original sample number on a project-wide basis (rather than a sampling round basis). The duplicate samples will be collected, labeled, packaged, and sealed in the same manner as the original field samples and submitted "blind" to the analytical laboratory. The duplicate samples will be analyzed for the same parameters as the original field samples.

Collected duplicates are defined as two samples collected independently at a single sampling location during a single act of sampling for analysis at one

laboratory for each specified method. Field duplicate water samples will be collected independently (i.e., from separate bailers) at a well location during one act of sampling. Duplicate water samples will be collected by sequentially filling a sample bottle for a particular analysis and then the identical sample bottle for the duplicate sample. This procedure will be continued for each type of sample bottle until all sample bottles are filled.

Field duplicates soil samples will generally be collected from two consecutive sample liners collected at one boring or sampling location during a single act of sampling. However, depending on required sample volume, the soil stratigraphy being sampled, or other considerations, two separate aliquots of soil may be collected from a single liner and placed into two separate containers.

2.7.3 Equipment Blanks, Filter Blanks, and Temperature Blanks

2.7.3.1 Equipment Blanks.

Equipment blanks will be used to evaluate decontamination procedures for field sampling equipment. One set of equipment blanks will be collected each day of soil sampling for each sampling crew. For water samples collected with Teflon™ bailers, one equipment blank will be collected per day. For disposable bailers, no equipment blanks will be collected. For water samples pumped through a sampling device (except for metal filtration chambers, which require a filtration blank), one equipment blank will be collected per pump each day of sampling. Equipment blanks are samples of Type II reagent grade water or equivalent water that has been poured through (in the case of bailers and split-spoon samplers) or pumped through (in the case of pumps) the sampling device, transferred into the appropriate sample bottles, and transported to the laboratory for analysis. Equipment blanks will be prepared immediately after the sampling device has been decontaminated, preferably at the start or finish of the sampling day. Equipment blank samples will be collected, labeled, packaged, and sealed in the same manner as the original field samples and submitted "blind" to the analytical laboratory. Equipment blank samples will be analyzed for all analyses performed on associated samples of the associated matrix.

Soil samples collected in certified, pre-cleaned, stainless steel liners driven directly into the sample medium without possible cross-contamination from other equipment will not require an equipment blank.

2.7.3.2 Filter Blanks.

Filter blanks will generally not be required for this project. However, in the event that water samples have extremely high sediment content, sample filtering for metals samples or other inorganic analyses may be required. If required, filter blanks will be prepared from one of every ten filters per filter lot, and will be analyzed for the same parameters as the associated filtered samples. For water samples pumped through a metal filtration chamber, one field filter blank will be

collected per filter unit each day of sampling. Field filter blanks are prepared by filtering Type II reagent grade or equivalent water through a clean 0.45-micron membrane filter, collecting the water in the appropriate sample containers, and transporting it to the laboratory for inorganic analysis.

2.7.3.3 Temperature Blanks.

Temperature blanks will accompany each cooler shipment of water samples, soil samples, or soil and water samples sent to the laboratory for analysis by methods requiring sample preservation by cooling. A temperature blank is a sample bottle containing water. One temperature blank will accompany each cooler containing either water samples, soil samples, or water and soil samples.

2.7.4 Field-Designated Matrix Spike/Matrix Spike Duplicate (MS/MSD) Samples

Matrix Spikes/Matrix Spike Duplicates (MS/MSD) should be field-designated by the sampler. For every batch of 20 or fewer soil samples within a sampling event from a major lithological type or from a major, distinct aqueous matrix, the laboratory will prepare and analyze an MS/MSD pair from a project sample collected by Earth Tech. The sampler will designate one or more of the samples by noting on the Chain-of-Custody (COC) Record that the sample(s) are for MS/MSD (in the remarks column but not on the sample). It is important to provide a sufficient volume of MS/MSD water samples. Three times the usual volume, or more if specified by the laboratory, should be provided for the MS/MSD and marked on the COC Record (see Appendix C). For water samples that require multiple containers (usually one for each analysis), a single sample number will apply to all containers of that sample. Samples designated for MS/MSD analysis should be typical of the matrix should and not be highly contaminated in order to minimize MS/MSD imprecision resulting from high levels of environmental contamination. In order to minimize the effects of soil heterogeneity, the laboratory will use a single or adjacent liners.

2.7.5 Field Audits

The PM, or designee, will periodically observe field personnel to ascertain adherence to the field protocols and procedures set forth in this SAP. Any deviations from the field protocols and procedures that could compromise the quality of the data obtained will be reported by the field geologist to the PM, who will decide what action to take. Any such deviations will be documented on a non-conformance report (see Section 3.3.2.4, Figure 3-2) to include a description of the problem, how it was discovered, the corrective action, the follow-up and confirmation, and the appropriate signatures of those involved.

2.8 SAMPLE STORAGE, PRESERVATION, AND HOLDING TIMES

Sample bottles pre-cleaned and treated according to EPA specifications for the appropriate methods will be supplied by the analytical laboratory. Certified, pre-cleaned, stainless steel liners will be used for soil/sediment sample collection. Detailed requirements for sample containers and preservatives are presented in Section 3.2.8 of the QAPP. Table 2-2 lists the recommended sample containers, and the preservation and holding times for each proposed analytical test method and matrix.

2.9 SAMPLE HANDLING AND SHIPMENT

2.9.1 Sample Sealing

Each sample container will be sealed immediately after sample collection. In the case of soil liners, each end of the liner will be covered with Teflon™ sheeting and plastic end caps, and secured with Teflon™-tape. In the case of the bottles used for water samples, sample bottle lids will not be mixed, and all sample lids will stay with the original bottles. If the water sample volume is low due to limited sample availability, the water level will be marked on the side of the sample bottle with a grease pencil. This procedure will help the laboratory determine if any leakage occurred during shipment.

2.9.2 Sample Identification System

All samples collected will be assigned a unique sample identification number. The following unique sample identification system will be used for the Project Site. Other sample numbers may be substituted, based on field conditions, provided the sample numbers used remain unique.

TNT Strips - Soil samples collected from the five TNT Strips (see Figure 2-1) will use the following unique numbering system:

TNT-1A/1

where: TNT-1 = TNT Strip #1 (other strips will be designated -2, -3, -4, -5)

A = First sampling location (subsequent sample locations associated with TNT Strip #1 will be designated B, C, D, E, etc.)

1 = Sample collection depth in feet bgs ("surface" will replace a sample depth for surface samples). Consecutive depths will be used for duplicate samples.

Demolition Areas - Soil samples collected from the three Demolition Areas (see Figure 2-1) will use the following unique numbering system:

DA1-1/1

where: DA1 = Demolition Area #1 (other areas will be designated 2, 3, etc.)

1 = First sampling location (subsequent sample locations associated with Demolition Area #1 will be designated 2, 3, 4, etc.)

1 = Sample collection depth in feet bgs ("surface" will replace a sample depth for surface samples). Consecutive depths will be used for duplicate samples.

Flare Area - Soil samples collected from the Flare Area (see Figure 2-1) will use the following unique numbering system:

FA1/1

where: FA = Flare Area

1 = First sampling location (subsequent sample locations associated with Flare Burn Area will be designated 2, 3, 4, etc.)

1 = Sample collection depth in feet bgs ("surface" will replace a sample depth for surface samples). Consecutive depths will be used for duplicate samples.

Soil Stockpiles - Soil samples collected from the three soil Stockpile Areas (see Figure 2-1) will use the following unique numbering system:

SP3-1A

where: SP3 = Soil Stockpile #3

1 = First sampling location (subsequent sample locations associated with soil Stockpile #3 will be designated -2, -3, -4, etc.)

A = Original sample (B will be used for a replicate/QA sample)

Wetlands Sediment and Surface Water - Two types of samples, sediment and surface water, will be collected from the South Valley Wetland (see Figure 2-1). Sediment samples collected from the South Valley Wetland will use the following unique numbering system:

WET-1A

where: WET = South Valley Wetland (sediment)

1 = First sampling location (subsequent sample locations associated with the South Valley Wetlands will be designated -2, -3, -4, etc.)

A = Original sample (B will be used for a duplicate/QA sample)

Grab surface water samples collected from the Wetlands Area will use the following unique numbering system:

SW-1A

where: SW = Wetlands Area (grab surface water)

1 = First sampling location (subsequent sample locations will be designated -2, -3, -4, etc.)

A = Original sample (B will be used for a duplicate/QA sample)

Surface Seeps - Surface seep water samples, collected from the designated Seep Areas (see Figure 2-1) will use the following unique numbering system:

SS-1A

where: SS = Surface Seep

1 = First sampling location (subsequent sample locations will be designated -2, -3, -4, etc.)

A = Original sample (B will be used for duplicate/QA sample)

Ammunition Renovation/Primer Destruction Area - Soil samples collected from the Ammunition Renovation/Primer Destruction (see Figure 2-1) will use the following unique numbering system:

AR-1/1

where: AR = Ammunition Renovation/Primer Destruction Area

1 = First sample location (subsequent sample locations associated with the Ammunition Renovation/Primer Destruction Area will be designated 2, 3, 4, etc.)

1 = Sample collection depth in feet bgs ("surface" will replace a sample depth for surface samples). Consecutive depths will be used for duplicate samples.

Temporary Groundwater Monitoring Wells - Soil samples and groundwater samples, collected from the pilot boring and temporary groundwater monitoring wells (see Figure 2-1), will use the following unique numbering system:

BH-1/1

where: BH = Boring

1 = Boring number (correspond to well number)

1 = Sample collection depth in feet bgs. Consecutive depths will be used for duplicate samples.

MW-1A

where: MW = Monitoring Well

1 = Well number

A = Original sample (B will be used for duplicate/QA sample)

2.9.3 Sample Labeling

Each sample will be labeled immediately after the sample is collected and the sample container is sealed. Information recorded on the sample label will include the following:

- Project name
- Project number
- Unique sample identification number
- Date and time of sample collection
- Sampler's name or initials
- Preservatives used
- Analysis required.

Sample labels will be affixed by the sampler to the sample containers. Sample labels will be covered, if necessary, with clear tape after being affixed to the sample container, to protect the label from moisture.

2.9.4 Sample Packaging and Shipment

U.S. Department of Transportation (DOT) regulations will be followed for packaging and shipment. Samples will be properly packaged for shipment and submitted to the designated analytical laboratory for analysis, under strict COC protocol (see Section 2.16.2). All glass sample bottles will be wrapped in bubble-wrap or equivalent and sealed in self-sealing plastic bags to minimize the potential for cross-contamination and breakage during shipment. Soil samples contained in stainless steel liners will be sealed in self-sealing plastic bags.

Each cooler will be filled with the sealed and bubble-wrapped sample containers. Additional packaging will be used to prevent sample containers from moving or from making contact during shipment. Enough double-bagged ice or blue ice will

be added to the coolers to maintain sample temperature at 4° ±2° Celsius during shipment. A temperature blank will be placed in each cooler along with the samples.

2.9.4.1 Shipment by Commercial Carrier or Courier Service.

If the sample coolers are to be shipped by a commercial carrier or courier service (other than the analytical laboratory), the COC Record (see Appendix B) accompanying the coolers to the analytical laboratory will be placed inside a sealed plastic bag and taped to the inside of the cooler lid. The coolers will then be secured and custody-sealed for shipment to the analytical laboratory. The custody seal will consist of a regular paper custody seal or filament tape wrapped around the cooler at least twice, with the tape end signed before the cooler is shipped. Wide, clear tape will be placed over paper custody seals to help ensure against accidental breakage. Custody seals will be used for all sample containers shipped by either a commercial carrier (i.e., Federal Express) or a courier service.

The coolers will be transported as environmental samples to the analytical laboratory as expeditiously as possible (e.g., via Federal Express overnight delivery service, if necessary). If the samples are sent by a commercial carrier, a bill of lading will be used. Receipts of the bills of lading will be retained as part of the permanent documentation. Commercial carriers/courier services are not required to sign-off on the COC Record as long as the form is sealed inside the sample cooler and the custody seals remain intact. A standard airbill will be necessary in order to ship environmental samples by a commercial carrier.

2.9.4.2 Shipment by Earth Tech or Analytical Laboratory.

If the samples are delivered directly to the analytical laboratory by Earth Tech field personnel, or picked up from either the Project Site or Earth Tech's San Jose office by the analytical laboratory, the COC Record need not be secured inside the cooler lid. The COC Record will be handed directly to the analytical laboratory personnel after COC sign-off protocols have been completed. Custody seals will not be required for coolers delivered by Earth Tech or picked up by the analytical laboratory.

2.10 SURVEYING

All boring and temporary groundwater monitoring well locations will be surveyed to a standard horizontal and vertical control by a surveyor licensed in the state of California. Boring elevations will be measured to the ground surface, and well elevations will be measured to the top of the PVC well casing. The measuring point will be clearly and permanently marked on the north side of the PVC well casing. All elevations will be measured to the nearest 0.01 foot and referenced to msl. The horizontal locations will be measured to the nearest 0.01 foot and referenced to the California State Plane Coordinate System.

2.11 MEASUREMENT OF WATER LEVELS

Water levels in the groundwater monitoring wells will be measured to establish depth to groundwater. Measurements will be recorded as feet below the surveyed measuring point (i.e., top of the PVC well casing) to the nearest 0.01 foot, and recorded as feet above msl. Water level measurements will be collected after the groundwater monitoring wells are installed, developed, and allowed to stabilize prior to any well purging activities. Water level measurements will also be recorded before and after groundwater sampling activities. To reduce the potential for the water level tape to come into contact with the sides of the well casing, it will be lowered slowly into the well. Separate measurements will be made until two sequential measurements differ by no more than 0.01 foot. Water level measurements will be recorded on the Water Elevation Form (see Appendix C).

2.12 FIELD TEST EQUIPMENT

Field test equipment procedures for various meters that will be used to obtain field data during the investigation activities are presented in this section and summarized in Table 2-3. Procedures for using health and safety field monitoring equipment (i.e., magnetometer) are presented in the HASP (see Chapter 4.0). Field instruments will be calibrated prior to use, and the calibration information will be recorded on either the Instrument Calibration Log or the Field Meter Instrument Calibration Log - Temperature, Conductivity, Dissolved Oxygen (see Appendix C). All field instruments will be maintained, calibrated or checked, and operated according to the manufacturers' specifications and guidelines. Test equipment, calibration frequencies, and field QC procedures are summarized in Tables 2-3, 2-4, and 2-5.

Table 2-3. Typical Field Parameters and Measuring Equipment

Parameter	Equipment (or equivalent)
Water Conductivity	Cambridge Scientific Hydac pH/EC Meter
Water pH	Cambridge Scientific Hydac pH/EC Meter
Water Temperature	Thermometer (°C)
Water Turbidity	HF Scientific DRT-15C Turbidimeter, or LaMotte Chemical Model 2008 Turbidity Meter
Depth to Water	Electric Tape (Sounder)
Volume of Discharged Groundwater	Calibrated 5-gallon bucket or flow meter

Table 2-4. Calibration Check Frequency For Field Test Equipment

Equipment	Calibration Frequency
pH/Conductivity Meter	Calibration check prior to use and at end of day.
Thermometer	No field calibration
Turbidity Meter	Standardization check prior to use and at the end of each day.
Electric Tape	No field calibration
Container for Measuring Water Volume	Visual inspection before use

2.12.1 Hydrogen Ion Concentration (pH) Meter

The pH meter, which will be used to measure pH according to EPA Method 150.1, will be calibrated at the beginning and end of each sampling day. The calibration will include setting of a range with a 7.0-pH buffer solution and a 4.0-pH or a 10.0-pH buffer solution, depending on whether acidic or alkaline water conditions are expected. The calibrating standards will be checked to ensure they do not exceed any expiration dates. The battery will be checked regularly. The pH electrode will contain sufficient liquid, and the outside of the probe will be kept moist. The electrode will be rinsed with de-ionized (DI) water after each reading and the storage cap replaced. The pH meter will be checked periodically during the sampling period. If drifting occurs (i.e., the reading varies by more than one tenth of a unit between calibration checks), the probe will be cleaned and the meter recalibrated.

2.12.2 Electrical Conductivity (EC) Meter

The EC meter will be used to measure EC according to EPA Method 120.1. The EC meter will be calibrated over the operating range expected in the field. Calibration will be made with a potassium chloride solution at the beginning and end of each sampling day. The calibrating standard will be checked to ensure it does not exceed any expiration date. The battery will be checked regularly. The electrode will be rinsed with DI water after each reading, and the electrode will be kept clean.

2.12.3 Temperature Meter

Water temperature will be measured according to EPA Method 170.1, using the temperature compensation probe on the pH meter, EC meter, or with a digital thermometer that will be rinsed with DI water after each use. The field digital thermometer will be checked for accuracy once per year using a National Institute

Table 2-5. Summary of Field Quality Control Procedures

Method	Parameter	QC Performed	Frequency[a]	Acceptance Criteria	Corrective Action
120.1	Conductance (aqueous)	Duplicate analysis	10%	RPD <5%	1) Obtain third value 2) Recalibrate
150.1	pH (aqueous)	Duplicate analysis	10%	±0.1 pH	1) Obtain third value 2) Recalibrate
170.1	Temperature (aqueous)	Duplicate analysis	10%	±1.0°C	1) Obtain third value 2) Use different thermometer
180.1	Turbidity (aqueous)	Duplicate analysis	10%	RPD <15%	1) Obtain third value 2) Recalibrate
ASTM D422	Grain size (soil)	Duplicate analysis	10%	RPD <10%	1) Obtain third value

Note: (a) Frequencies for duplicate samples and field blanks are computed based on the number of samples taken and the number of analyses specified in the FSP.

of Standards and Technology (NIST)-calibrated mercury thermometer. If the field thermometer does not read within ±1 degree Celsius units, a new field thermometer will be used.

2.12.4 Turbidity Meter

The turbidity meter will be used to measure turbidity according to EPA Method 180.1. The turbidity meter will be calibrated at the beginning and end of each sampling day using factory-supplied standards. The meter will be calibrated against the standard closest to the anticipated value of the sample (i.e., typically 0 Nephelometric Turbidity Units [NTUs] to 10 NTUs). Care will be taken to ensure that no air bubbles are in the standard solution and that the outside of the vial is clean of all marks which may affect the reading, including fingerprints. Sample vials will be kept clean from smudges and dirt and will be rinsed with DI water between samples. The battery will be checked regularly.

2.12.5 Water Level Meter

The water level meter tape will be calibrated before commencement of field activities by checking the markings on the tape against a steel tape. Water level readings will be recorded to the nearest 0.01 foot. The alarm function will be checked before use by immersion in water.

2.13 DECONTAMINATION PROCEDURES

2.13.1 Equipment Decontamination

The purpose of decontamination procedures during drilling, well installation, and soil/sediment, and water sampling is to prevent foreign contamination of samples and cross contamination between sampling locations. Before use, all drilling equipment and sampling equipment will be decontaminated by steam-cleaning, or alternatively by washing with a non-phosphate detergent such as Liquinox® or Alconox™ (or equivalent). Equipment washed with a nonphosphate detergent will be double rinsed using potable water and a DI (or Type II reagent grade) water. The following item-specific decontamination procedures will be followed:

- **Heavy equipment (i.e., drill rig)** - Remove loose material by a brush and steam clean with high pressure water or portable high pressure steam spray followed by a soap and water rinse prior to drilling at each new Project Site

- **Auger flights and/or drive casing, drill rods, etc.** - Steam clean with high pressure water or portable high pressure steam spray followed by a soap and water rinse prior to drilling each boring

- **Downhole abandonment equipment (i.e., tremie pipes)** - Steam clean with high pressure water or portable high pressure steam spray followed by a soap and water rinse between each well

- **Hand augers** - Nonphosphate detergent wash followed by a double rinse with potable water; then DI (or Type II reagent grade) water between each boring

- **Samplers** - Steam clean with high pressure water or portable high pressure steam spray followed by a soap and water rinse or nonphosphate detergent wash followed by a double rinse with potable water; then DI (or Type II reagent grade) water between each sampling location

- **Well casing and Screen** - Steam clean with high pressure water or portable high pressure steam spray followed by a soap and water rinse before installation unless sealed in plastic and certified clean by the manufacturer

- **Non-disposable Teflon™ bailer** - Steam clean or non-phosphate detergent wash followed by a double rinse with potable water; then DI (or Type II reagent grade) water between each sampling location

- **Water level meter** - Nonphosphate detergent wash followed by a double rinse with potable water; then DI (or Type II reagent grade) water between each measurement location

- **Field Instrument Probes** - Wiped with a damp, disposable paper wipe and/or rinsed with DI (or Type II reagent grade) water.

Sampling equipment that is not readily decontaminated will be discarded after each use. Discarded materials, including decontamination solutions, will be accumulated and stored in appropriate containers pending proper disposal (see Section 2.14).

Pumps will be decontaminated by flushing/pumping a nonphosphate detergent-water solution, potable water; then DI (or Type II reagent grade) water through the components. The pumps will be disassembled as far as possible (down to the check valve,) steam cleaned with a hot water and nonphosphate detergent solution, and then rinsed with hot water. The pump will then be reassembled, submerged in a nonphosphate detergent-water mixture, and allowed to pump 20 to 30 gallons through its components. The pump will then be steam cleaned again, and 20 to 30 gallons of potable water will be pumped through the components. The exterior of the pump inlet hose will be steam cleaned. If dedicated polyethylene tubing is utilized for well development/purging activities, the exterior of the pump will be cleaned with a nonphosphate detergent-water mixture and rinsed with DI water.

2.13.2 Personnel Decontamination

Decontamination procedures will be performed by all field personnel who have been in contact with contaminated or potentially contaminated materials. Procedures for decontamination of field personnel are presented in Section 4.10.1 of the HASP.

2.14 INVESTIGATION-DERIVED WASTE (IDW)

This section outlines the procedures to be used for proper collection, characterization, storage, containerization, and transport and disposal (if necessary) of IDWs. IDW is defined as waste generated during the field investigation activities that has the potential to be hazardous and thus requires special handling.

Proper collection and disposal characterization procedures for soil, development/purgewater, decontamination rinsate, disposable protective clothing, and plastic ground covers are presented in the following sections.

2.14.1 Soil

IDW soil from drilling and sampling activities may contain hazardous constituents. IDW soil will be placed into DOT-approved 55 gallon drums or other approved containers (i.e., roll-off bins), and appropriately labeled, pending the results of the field sampling program. When the analytical results are received, soil identified as nonhazardous will be disposed of properly onsite, if possible, or disposed of at a local landfill. If the investigation results indicate the soil is hazardous and off-site disposal is necessary, additional sampling will be conducted as required by the potential disposal facility. IDW soil samples will be handled and shipped to the analytical laboratory in the same manner as the field samples. Hazardous soil will be transported by a licensed hazardous waste hauler and disposed of at a licensed disposal facility.

2.14.2 Water

IDW water derived from water sampling activities (including well development water and purge water) and decontamination rinsate will be placed in DOT-approved 55-gallon drums or other approved containers and appropriately labeled, as described in Section 2.14.5. IDW water samples will be collected from selected containers. If more than one container contains water from the same source, only one of the containers will be sampled. IDW water samples will be handled and shipped to the analytical laboratory in the same manner as the field samples. The analytical results will be used to determine appropriate disposal. If the water is determined to be nonhazardous, it may be discharged directly to the ground surface, on a portion of the Project Site that has not been affected by contaminants, in a manner to prevent surface ponding and run-off. Hazardous

water will be transported by a licensed hazardous waste hauler and disposed of at a licensed disposal facility.

2.14.3 Disposable Protective Clothing and Ground Covers

Other wastes include disposable protective clothing, plastic ground covers, and non-reusable sampling equipment (e.g., disposable bailers) that have come in contact with contaminated or potentially contaminated soil or water. These wastes will be collected, decontaminated, bagged, and placed in the garbage bin next to the guard shack for nonhazardous waste disposal, as appropriate. These wastes will not be mixed with the soil or water IDW.

2.14.4 Waste Containers and Storage

IDW soils and other solid wastes will be containerized in DOT-approved 17H 55-gallon drums with removable lids, or other approved containers. Liquid wastes will be containerized in DOT-approved 17H 55-gallon drums with nonremovable lids, or in a portable tank. All IDW containers will be inspected for physical integrity before filling.

2.14.5 Labeling of Containers

All IDW containers will be clearly labeled as follows, with a grease pencil:

- Matrix (i.e., soil, water)
- Date waste generated
- Where waste generated (i.e., boring/well locations)
- "Non-Hazardous, Pending Analysis."

If the analytical results characterize the IDW container contents as hazardous, a hazardous waste label will be placed on the container and the IDW disposed of within 90 days of the date the waste was generated.

2.14.6 Waste Handling and Off-Site Disposal

Waste handling, including loading and transport, will be conducted by a licensed waste disposal contractor. Whenever possible, waste characterized as hazardous will be disposed of in a manner by which a "Certification of Destruction" can be issued by the disposal facility. Granite Management Corporation will be identified as the waste generator. Hazardous and Nonhazardous Waste Manifests and Bills of Lading will be filled out and signed by Granite Management Corporation, or their designated agent.

2.15 ANALYTICAL TEST METHODS

The field analyses expected to be required for this project include the following: pH by EPA Method 150.1, conductivity by EPA Method 120.1, temperature by

EPA Method 170.1, and turbidity by EPA Method 180.1. A brief description of the field analytical methods to be used are presented in Section 3.2.4.1 of the QAPP.

The laboratory analyses expected to be required for this project include the following: CAM-17 metals by EPA Methods SW6010B, SW7470A, and SW7471A; total extractable petroleum hydrocarbons (TEPH) as C10-C50 by California Leaking Underground Fuel Tank (LUFT) modified EPA Method SW8015 (SW8015D); dioxins and furans by EPA Method SW8290; PAHs by EPA Method SW8310; PETN and nitroglycerin by EPA Method SW8321; and nitroaromatics and nitroamines, including PETN and nitroglycerin if requested (explosives), by EPA Method SW8330. A brief description of the digestion and analytical methods to be used are presented in Section 3.2.4.2 of the QAPP.

2.16 GENERAL FIELD AND LABORATORY DOCUMENTATION

The following field data documentation will be used to record all field investigation activities at the Project Site. Measurements made and samples collected will be recorded in either the Daily Field Report or on an appropriate field activity form. Examples of field forms anticipated to be used during the field investigation activities are included in Appendix C. Other forms may be added or substituted, provided they contain all the relevant information required to adequately document the field investigation activities. All entries on field forms will be made in indelible ink, and no white-out will be allowed. If an incorrect entry is made on any field form, the information will be crossed out with a single strike mark, initialed, and date marked. All equipment used to make measurements will be identified, along with the date of calibration. All field forms will be signed and dated by field personnel responsible for their completion.

2.16.1 Daily Field Reports

Daily Field Reports or log books will provide the means of recording investigation and data collection activities on a daily basis. As such, entries will be described in as much detail as possible so that persons going to the Project Site are able to reconstruct a particular situation without reliance on memory. Daily Field Reports/log books will contain, but not be limited to, the following information (it is acceptable for some of this information to be recorded on other field activity forms to avoid duplication):

- Project name/site
- Date
- Weather conditions
- Field personnel performing investigation activities
- Subcontractors

- Work performed
- Location of work (i.e., boring/well location)
- Sampling performed, including specifics (e.g., number and type of samples collected, borings advanced, wells installed)
- Field parameter measurements, including calibration checks
- Decontamination procedures
- IDW containment procedures (i.e., number of storage drums)
- Names and affiliation of visitors to the Project Site
- Problems encountered and corrective actions
- Other pertinent comments.

2.16.2 Chain-of-Custody (COC) Record

COC procedures provide an accurate written record tracing possession of individual samples from the time of field collection through to analytical laboratory analysis. A sample is considered in custody if it is:

- In a person's possession
- In a secure area after having been in a persons's physical possession
- In a designated secure area restricted to authorized personnel.

The Chain-of-Custody Record will be used to document the samples taken and the analyses requested. Information that field personnel will record on the Chain-of-Custody Record (in indelible ink) includes the following:

- Project name/site
- Sampling location and/or well designation
- Name and signature of sampler(s)
- Dates and times of sample collection
- Sample designation (grab or composite)
- Matrix
- Container types and preservatives
- Number of sample containers

- Analyses to be performed
- Special instructions (i.e., short holding times)
- Signatures of individuals involved in custody (including, date and times of transfer)
- Airbill number, if appropriate.

Corrections may be made on the COC Record by drawing one line through the incorrect entry, entering the correction information, and initialing and dating the change.

If the samples are shipped by commercial carrier or courier service, the COC Record initiated in the field will be signed and dated, placed in a sealed plastic bag, and taped to the inside of the cooler lid. Signed airbills will serve as evidence of custody transfer between the field personnel and commercial carrier/courier service and the analytical laboratory. Copies of the COC Record and the airbill will be retained by the field personnel prior to shipment. Upon receipt of the cooler, analytical laboratory personnel will sign, date, and retain one copy of the COC Record and the airbill for their records, returning the completed COC Record and signed airbill to Earth Tech.

If the samples are either delivered directly to the analytical laboratory by Earth Tech field personnel or picked up from either the Project Site or Earth Tech's San Jose office by the analytical laboratory, the COC Record initiated in the field will be signed and dated as relinquished by the field personnel, and signed and dated as received by the analytical laboratory. Copies of the Chain-of-Custody Record will be retained by the field personnel prior to relinquishment of the samples to the analytical laboratory.

Information that will be recorded on the COC Record, or another appropriate document (e.g., laboratory logbook or Laboratory Information Management System), at the time of sample receipt by the analytical laboratory will include the following:

- Status of custody seals, if used
- Temperature of the temperature blank
- Identification number of broken sample containers, if any
- Description of discrepancies between the COC Record, sample labels, and requested analyses
- pH of aqueous samples to determine if samples are properly preserved.

Laboratory personnel will contact Earth Tech's PM regarding any discrepancies in the paperwork and sample preservation and will document non-conformance and corrective actions according to the analytical laboratory's standard operating procedures.

2.16.3 Geologic Logs

The on-site field geologist will prepare and maintain a geologic log for all soil borings advanced by either a drill rig (see Section 2.3) or a hand auger (see Section 2.6.2). Soil cuttings/samples will be classified in accordance with the American Society of Testing and Materials (ASTM) D 2488 *Description and Identification of Soils (Visual-Manual Procedures)*. Bedrock cutting/samples will be identified and recorded using the standard nomenclature in the *Classification of Rocks* (Colorado School of Mines, 1955). The geologic log will record, but not be limited to, the following information:

- Project name/site
- Date/time
- Weather conditions
- Field personnel performing investigation activities
- Drilling contractor
- Drilling and sampling method
- Reference elevation for all depth measurements
- Depth of each change of stratum
- Thickness of each stratum
- Soil or rock description
- Depth interval from which sample was collected
- Nominal boring diameter
- Depth at which groundwater is first encountered
- Location of any fractures, joints, faults, cavities, or weathered zone if cored
- Well construction details
- Depth to first encountered water
- Depth to static water level upon completion of well.

Each geologic log will be reviewed and approved by a California state-registered geologist supervising the project.

2.16.4 Water Well Installation Diagram

The Water Well Installation Diagram Form will be used to provide a diagrammatic representation of the temporary groundwater monitoring well construction. The form will record, but not be limited to, the following information:

- Well construction details, including
  - Depth and type of well casing
  - Description of well screen (length, location, diameter, slot size);
  - Filter pack depth and type
  - Bentonite seal depth
  - Grout seal depth
  - Type of cement grout.
- Volumes of construction materials used
- Volume of water used, if any
- Manufacturer information for well construction materials.

2.16.5 Surface Water/Sediment Form

The Surface Water/Sediment Form will be used to record grab surface water, surface seep, and sediment sample collection activities. The form will record, but not be limited to, the following information:

- Project name/site
- Date/time
- Weather conditions
- Field personnel performing investigation activities
- Field parameters (pH, EC, temperature and turbidity) (surface water and surface seep samples only)
- Sample numbers
- Sampling equipment
- Physical description of sampling location.

2.16.6 Well Development Form

Well development data will be recorded on the Well Development Form. The form will record, but not be limited to, the following information:

- Project name/site
- Date/time
- Weather conditions
- Field personnel performing investigation activities
- Well number
- Static water level prior to and after development
- Depth to bottom of the well
- Standing water column
- Volume of water removed
- Development method
- Field parameters (pH, EC, temperature and turbidity)
- Comments (i.e., conditions that may affect development).

2.16.7 Well Purging and Sample Collection Form

Groundwater purging and sample collection activities will be recorded on the Well Purging and Sample Collection Form. The form will record, but not be limited to, the following information:

- Project name/site
- Date/time
- Weather conditions
- Field personnel performing investigation activities
- Well number
- Static water level prior to and after purging
- Static water level after sampling
- Depth to bottom of the well
- Standing water column
- Volume of purge water removed
- Purge and sampling method
- Field parameters (pH, EC, temperature and turbidity)
- Comments (i.e., conditions that may affect development).

2.16.8 Instrument Calibration Logs

Field instrument calibration information will be recorded on either the Instrument Calibration Log or the Field Meter Instrument Calibration Log - Temperature, Conductivity, Dissolved Oxygen. The logs will record, but not be limited to, the following information:

- Date calibrated
- Field personnel performing the calibration

- Instrument and model
- Standards calibrated
- Adjustments made
- Comments.

2.16.9 Water Level Form

Groundwater level measurements may also be recorded on the Water Elevation Form. The form will record, but not be limited to, the following information:

- Project name/site
- Date/time
- Weather conditions
- Well number
- Depth to standing water
- Depth to bottom of well
- Elevation of well casing
- Well integrity (i.e., locked, capped, cracked, obstructions)
- Comments.

2.16.10 Health and Safety Data Forms

Health and safety activities conducted during the field investigation activities will be documented on the appropriate health and safety forms presented in the HASP (see Chapter 4.0).

2.16.11 Photographs

Photographs will be recorded in the Construction Photo Log. The log will record, but not be limited to, the following information:

- Project name/site
- Date/time taken
- Picture number
- Photographer
- Description (i.e., location, subject, names of any personnel included in the photograph).

2.17 FIELD DATA MANAGEMENT

General guidance for field data recording, validation, reporting, and assessment is presented in this section. General guidance for laboratory data management is included in the QAPP (see Chapter 3.0).

2.17.1 Data Recording

Field data will be recorded either in the Daily Field Report or on the appropriate field activity forms (see Section 2.16). A unique field identification number will be assigned to each sample throughout the field investigation program, as indicated in Section 2.9.2. Sample COC documentation will be completed, as described in Section 2.16.2, to document chain of possession and track the samples throughout shipping, handling, and analysis. A corresponding laboratory identification number will be assigned and will be used to track each sample through the analytical process.

All field forms will be signed and dated by the person entering the data, using indelible ink and no white-out. All changes to documentation will be performed by striking out the incorrect data with a single line and initialing and dating the correction.

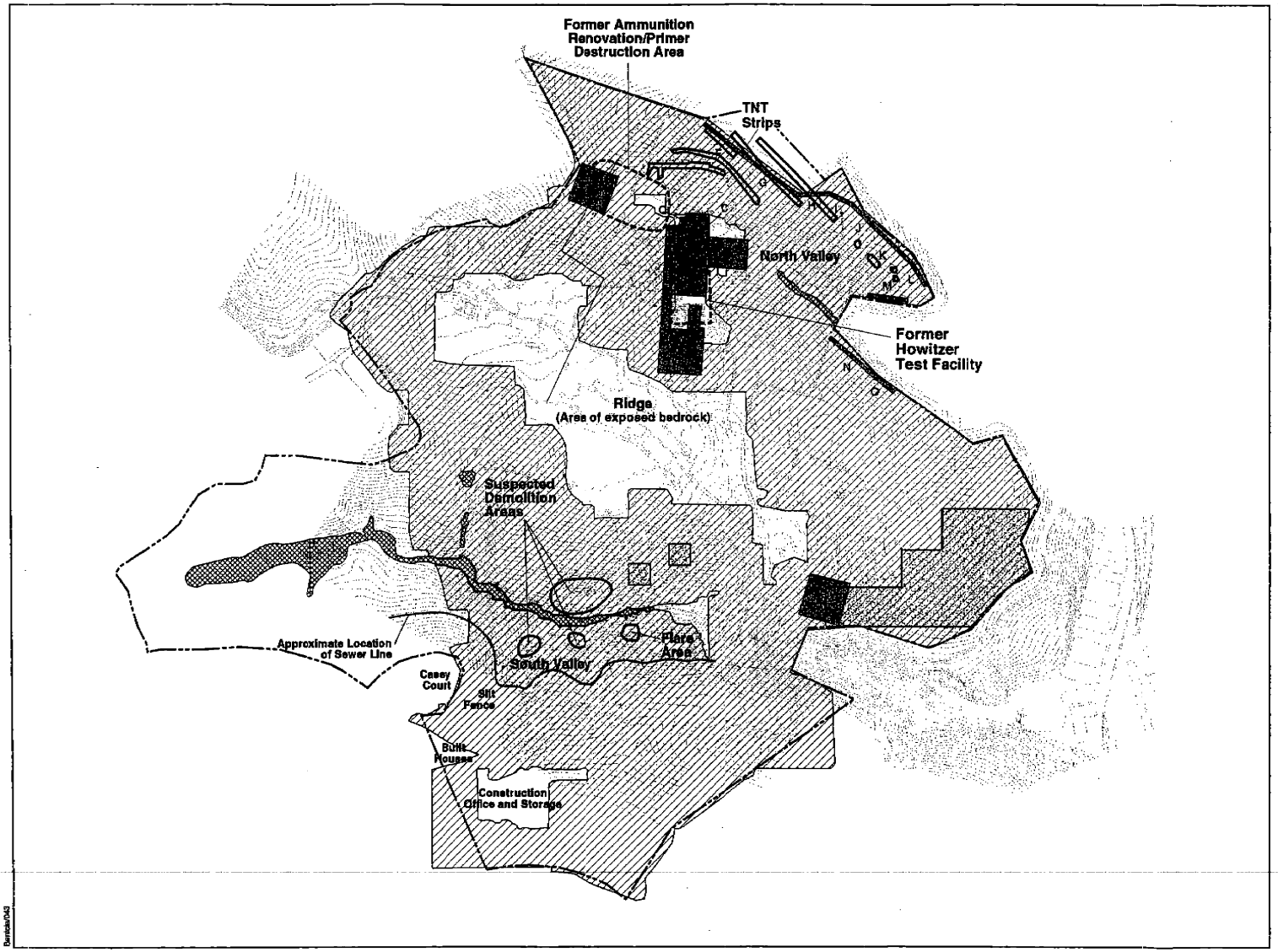
Field data will be validated through the review of the field documentation to identify inconsistencies or anomalous values. Earth Tech's Project Manager, or designee, will be responsible for performing daily reviews of all field documentation for accuracy, legibility, and completeness, and for maintaining such information in the project file. Any inconsistencies discovered will be resolved immediately, if possible, by seeking clarification from personnel responsible for the data collection. All field personnel will be responsible for following the sampling and documentation procedures described this chapter and the QAPP (see Chapter 3.0) to ensure that accurate and defensible data are obtained.

2.17.2 Data Reporting

Measurement data generated during the field investigation activities will be reported in tabular form to support data use and interpretation. The report formats will vary depending on the objectives of the field investigation. In general, data will be presented according to sampling location, analytical method, parameter, and/or matrix.

2.17.3 Data Assessment

Measurement data will be assessed and documented to quantitatively assess data quality, identify possible limitations on data use, and assess whether the site-specific DQOs have been met. The use of standard field, analytical, and QC procedures are designed to control the sampling processes in order to produce data of sufficient quality for the project needs. If a problem occurs in spite of these controls, the data assessment must identify the problem, determine which data are affected, state how use may be limited, and make recommendations for corrective actions as necessary. Corrective actions may include, but not be limited to, resampling at a particular location.



Magnetometer Survey Area

EXPLANATION

- Project Site Boundary
- Old Fence Line
- Phase I - EM61 data
- Phase II - Magnetometer data
- Previously Cleared Area
- Wetland

Note: This is a preliminary map as of February 1997. Information provided is subject to revision. Topography for the area is a compilation of several maps which may not depict current topographic conditions.

Source: SECOR International, Inc.

0 125 250 500 Feet

Figure 1-5

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3.0 QUALITY ASSURANCE PROJECT PLAN

This document describes the quality assurance (QA) and QC procedures for field activities, sampling, analytical, and data management aspects of the work conducted at the Project Site. These procedures will be used to assure accurate, precise, complete, representative, legally defensible, and comparable data for the HTRW investigation efforts.

This QAPP was prepared in accordance with the following EPA guidance for developing QAPPs: *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*, Draft Interim Final (EPA QA/R-5, August 1994); *EPA Guidance for Quality Assurance Project Plans* (EPA QA/G-5 Final, August, 1997). The QAPP also complies with the following U.S. EPA interim final guidance on developing and using data quality objectives: *Guidance for the Data Quality Objectives Process* (EPA QA/G-4 Final, September, 1994); *Data Quality Objectives Process for Superfund* (EPA/540/G-93/071, September 1993); *Guidance for Environmental Data Collection in Support of Environmental Decision Making Using the Data Quality Objectives Process* (EPA QA/G-2, July 1993); and *Guidance for Data Quality Assessment* (EPA QA/G-9 QA96 Version, July 1996).

3.1 PROJECT MANAGEMENT

A detailed description of the Earth Tech Project organization is presented in Section 1-6. The organizational structure for this project is shown on Figure 1-6. This organizational structure provides the project engineer with a dedicated project team, including project and QC managers, technical and administrative support staff, and subcontracting managers.

It is the personal responsibility of all Earth Tech and subcontractor personnel involved in field sampling or laboratory analytical procedures to understand and maintain the quality controls applicable to their work.

3.1.1 Project Organization And Responsibility

A detailed description of the project organization, including Earth Tech member responsibilities, is presented in Section 1-6. The organizational structure for this project is shown on Figure 1-6. This section establishes Earth Tech's project organization, functional responsibilities of key staff, levels of authority among key participants, and lines of communication for activities affecting quality.

3.1.1.1 Earth Tech Project Personnel.

The project team has been selected to provide the specific technical and management capabilities and qualifications as required by the investigative and/or remedial action tasks. These personnel have appropriate educational qualifications and specific previous project experience on related projects. The project organization will ensure that all project objectives will be met in a timely,

cost-effective manner. A list of key personnel and their project titles is provided on Figure 1-6.

3.1.1.2 Laboratory Project Personnel.

The responsibilities and authorities of key laboratory personnel are discussed in the following paragraphs.

Laboratory Project Manager (PM)

The analytical laboratory PM will have ultimate responsibility for analytical performance, including adherence to contract requirements and quality control requirements. He will serve as the primary laboratory contact person for the client and Earth Tech, and any change in the scope of work will be processed through him. He will monitor the progress and timeliness of the work, reviewing work orders and all laboratory reports. As analytical laboratory PM, he is responsible for ensuring that corrective action has been taken to address problems identified by QC sample results or QA audit findings.

Laboratory Project Quality Assurance (QA) Officer

The laboratory quality assurance officer has responsibility for development and administration of the project-specific QA/QC program. This role includes preparation of written documents defining QA/QC procedures, review and approval of laboratory QC procedures, supervision of sample control operations, and oversight of interlaboratory testing programs and laboratory certifications. In addition, he will submit control samples to the analysts, maintain control charts with warnings and control limits, and evaluate acceptability of control sample results. He will be responsible for spot-checking data sets to ensure that the appropriate QC measures have been taken and for evaluating the effectiveness of the laboratory QA/QC program through audits. Unacceptable findings will be reported to the Laboratory PM for follow-up.

Analytical Supervisors

The supervisors will assign tests within the schedule established by the analytical laboratory PM, and will closely monitor operations performed by laboratory analysts. Each supervisor is responsible for reviewing and approving data generated by his staff. This review assures that the internal QC criteria have been met and that calculations have been performed properly. No results may be reported without a supervisor's written approval of the data.

3.1.2 Project Definition And Background

The project description including site history, a site map, a location map, an area map, geology/hydrology, and sampling locations, is included in Section 1 of this Work Plan.

3.1.3 Project Description

The purpose of this project is to outline methods and procedures for characterizing the nature and extent of HTRW at the Project Site. The data collected during this investigation will be used to quantify the volume of, and assess remedial measures for, potential HTRW. The objective of remediating the site is to remove all HTRW, thus making the site completely safe and suitable for residential land use. A detailed description of the project is included in Section 1 of this Work Plan.

3.1.4 Data Quality Objectives (DQOs)

The primary function of field sampling and measurement is to generate data of quantity and quality sufficient to support project decision-making. To achieve this goal, DQOs will be employed for this project to determine the type, quantity, and quality of project data that needs to be collected. The DQO development process is described in the interim final EPA guidance documents entitled *Guidance for the Data Quality Objectives Process* (EPA QA/G-4 Final, September, 1994) and *Data Quality Objectives Process for Superfund* (EPA/540/G-93/071, September 1993). DQOs are qualitative and quantitative statements developed by data users to specify the quality and quantity of data from field and laboratory data generation activities required to support project decision making or regulatory actions, while minimizing data collection expenditures by defining data requirements and acceptable levels of decision errors during the planning stage of projects.

The DQO process provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when and where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect. The final product of the DQO process is a data collection design that meets the quantitative and qualitative needs of the study.

To evaluate the data using the DQO process, it is necessary to have first established decision quality criteria using the DQO process or its equivalent. DQOs for field record and analytical data QA/QC are included in this QAPP. These DQOs define criteria for valid and defensible data, and include all of the elements and objectives for data quality specified throughout the QAPP. DQOs for environmental assessment are included in this section of the QAPP. These DQOs include the remaining elements and objectives in the DQO process, such as sampling locations, number of samples collected and analyses performed, criteria for interpretation of the data, and statistical analysis (if required) of the data.

3.1.4.1 The Seven-Step DQO Process.

The DQO process involves the following seven steps:

1. Problem Statement
2. Decision Identification

3. Identification of Decision Input
4. Definition of Study Boundaries
5. Decision Rule
6. Limits of Decision Error
7. Optimization of the Design

Problem Statement. Previous investigations at the Project Site have identified HTRW in the soil in localized areas. The following data contribute to HTRW characterization of specified areas of the Project Site:

- Elevated levels of explosives have been identified within the TNT strips along the northeast boundary of the project
- Elevated levels of metals have been detected in the FA in the South Valley
- There are two known and one suspected demolition areas within the project site.
- Screening analysis of gravel fill within the former Howitzer Tunnels found elevated concentrations of metals.

The North Valley, because it was utilized for a variety of activity, is considered a suspected HTRW site. Additional information is required to further define the areal and lateral extent of contaminants within this area.

Decision Identification. The following decisions will be made based on the data gathered during the RI/FS and incorporated into the RI/FS conclusions:

- Determination of the vertical and lateral extent of affected soils that require removal in order to have clean closure on the site
- Determination of possible remedial actions, if any, that may be required for surface or groundwater in order to have clean closure on the site.

Identification of Decision Input. Decision-making inputs will include data gathered from each suspected and known HTRW site. Additional soil samples will be collected along the TNT Strip Area and around the Demolition Area and the FA. Two soil borings will be advanced into bedrock in the North Valley. If groundwater is encountered, the borings will be converted into groundwater wells, developed, and the groundwater samples will be collected. Soil samples will be collected from the Ammunition Renovation/Primer Destruction Area in the North Valley. Water samples from seeps and springs, if located and produce sufficient water to be sampled, will be collected. Water and sediment samples will be collected from the wetland in the South Valley. Details of the planned activities are included in FSP.

- A total of 10 soil samples will be collected from the borings in the North Valley. Soil borings will be located in the central portion and down gradient of the Ammunition Renovation/Primer Destruction Area. Concentration levels of petroleum, oils, and lubricants (POLs), explosives, PAHs, and metals will be determined. If groundwater is encountered in these soil borings, the borings will be converted into groundwater monitoring wells and one groundwater sample will be collected and analyzed for the same substances. Additionally one sample collected from the central portion of the site will be analyzed for dioxin.

- A total of 24 soil samples will be collected from around the FA and demolition areas and analyzed for concentration levels of explosives, metals, and PAHs. If required, pending the results of interim sample, dioxin concentration levels will be determined.

- There are 3 seeps and springs preliminarily identified on the site which are down gradient of the reported Dynamite Burn Area believed to have been located on the ridge area which was used as a soils borrow site. Water grab samples will be collected from each seep and spring. Water samples will be analyzed for explosives, metals, and PAHs.

- Two water grab samples will be collected from the wetland in the South Valley, one upstream and one downstream of the FA and Demolition Areas. Sediment samples will also be collected from these locations. Samples will be analyzed for explosives, metals, and PAHs.

- Characterization of the concentrations of naturally occurring analytes to establish background levels will be based on previous environmental investigations by others. These investigations were located within the City of Benicia. In addition, soil survey data from locations within Solona county will be used.

Definition of Study Boundaries. This RI/FS addresses only the HTRW issues at the site. Information regarding UXO at the site is included in the USACE Former Benicia Arsenal Draft EE/CA Report, June 1999 and will be addressed in the UXO Removal Work Plan to be submitted at a later date. Study boundaries have been defined by the Tourtelot Property boundary, and review of available records (including historical aerial photos) to include potentially affected portions of adjoining properties. The individual sites have been defined as follows:

- The lateral extent of the TNT Strips Area was established by review of historical aerial photographs, field reconnaissance surveys, and field screening data.

- The lateral extent of the Demolition Areas, two confirmed and one suspected, were established by field reconnaissance surveys, field screening data, and review of historical aerial photographs. The outer limits of the affected area will be estblished by sample and step-out methods.

- The lateral extent of the FA was established by field reconnaissance surveys, field screening data, and review of historical aerial photographs. The outer limits of the affected area will be established by sample and step-out methods.

- The lateral extent of the Ammunition Renovation/Primer Destruction and Howitzer Testing stockpile Areas in the North Valley are based on review of historical records and photographs and geography of the valley.

Decision Rules. The extent of the removal of soils will be based on validated data. Laboratory contaminants or artifacts of sampling, shipping, or analysis will be removed from consideration.

The data gathered from this study will be compared to state regulatory levels (Preliminary Remedial Goals for residential areas) and accepted background levels. Analytes not detected or those at concentrations below regulatory and background levels will be removed from further consideration. Appendix E provides a complete listing of California State Preliminary Remedial Goals (PRGs) for residential areas.

Some analytical detection limits are recognized to be above the established decision thresholds. In these cases, other data (e.g., previous detection, historical usage, known degradation byproducts of confirmed releases) suggest the presence of those analytes. The default decision threshold will be one-half of the laboratory-reported detection limit, the analyte is assumed not to be present otherwise.

Limits of Decision Error. This QAPP provides procedures that will be followed during sample collection and analysis to assure the quality of the analytical data collected. All sample results used in the decision process will have met the minimum quality control measures outlined in this QAPP. The quality controls that will be implemented are designed to meet EPA quality levels (EPA/540/G-93/071) for consistency in the field and laboratory activities.

Data quality levels (analytical levels based on the end use of the data) are determined by the methods of analysis and the level of QC required for each method as defined in this QAPP. The specific limits for the acceptance of data

and quality control measures to quantitatively define those limits are presented in this QAPP.

Collection of field samples will use a step-out sampling approach in order to define the lateral and vertical extent of contaminants at each area. PRGs and background levels will be used to determine if the maximum extent of HTRW is defined.

With the exception of the TNT strips, physical boundaries, mainly topography and geologic conditions, naturally limit the extent to which HTRW may migrate from the source. Because of this, HTRW would be geographically limited to the bottom of the valleys, with the exception of the TNT strips. Geologic and physiographic features of the Project Site preclude the use of standard statistical approaches used to ensure completeness of coverage. Therefore, traditional and proven sample and step out approaches will be used to characterize these areas.

Standard statistical techniques would not be applicable to the TNT strips either. The TNT strips are on the side of a hill, and the migration of contaminants would be limited to the downhill direction. Therefore, the sample step-out technique will also be used for this site.

Decision error is eliminated by assuming that the first clean boring, as defined by having all sample results collected from a boring below the PRGs and acceptable background levels, as the maximum extent of contamination for a given site.

Optimization of the Design. Specifications for data quality regarding the quantification of concentration levels of HTRW within media (water or soil) in terms of sensitivity, precision, and accuracy are presented in this QAPP.

The representativeness of the samples collected is discussed herein in terms of coverage of the suspected or confirmed HTRW areas. The comparability of the samples is evaluated in terms of PRGs and recognized background levels for the Benicia area.

The Demolition Areas and the FA are geographically limited by topography and geologic conditions. Initial sampling locations to evaluate the lateral migration of HTRW have been placed at the maximum lateral extent of disturbances either observed in the field or on historical aerial photographs for these sites. It is the goal of the HTRW investigation to assess the lateral and vertical extent of HTRW and not necessarily the maximum concentration. Therefore, given the sample location and geologic conditions, field samples should be representative of the on-site soil conditions.

The remediation of affected soils will be to remove them from the site. Therefore, defining the maximum contaminant levels during site characterization by collecting samples in the center of the disturbed areas will not be necessary, except to evaluate the need for pretreatment. However, additional samples

would be required during removal activities for characterization for acceptance at an off-site disposal facility and confirmation that all HTRW has been removed.

Water samples from the wetlands in the South Valley are proposed to be collected upgradient and downgradient of the FA and Demolition Areas. This should provide a reasonable assessment of whether the surface waters in the South Valley have been affected by on-site activities. The sampling results will also be compared to results from samples collected from the area in 1998. These samples, coupled with the results of previous samples, should provide reasonable representation of water quality in the South Valley and whether remedial action is required. If surface waters are found to be affected, subsurface waters will need to be sampled.

The TNT strips are visually well defined laterally in historical aerial photographs and field observations. Sample collection along the strips will provide a reasonable representation of the concentration levels within the strips and define the vertical extent of HTRW. In order to confirm the lateral extent of HTRW, the step-out approach is reasonable. The combination of samples both within and outside the observable extent of the strips will provide a reasonable representation of the soil profiles, in terms of HTRW within and around the TNT strips.

The results of the sampling will be compared to applicable PRGs and local background levels.

Samples to be collected from the North Valley will be collected at the screening level to determine if past activities associated with the Howitzer Test and Ammunition Renovation/Primer Destruction Areas may have affected the soils or groundwater in the valley. Two sample locations were chosen, one near the center of activities, and one at the downgradient end of the valley. The sampling method will assess whether groundwater is present and if so, whether it has it been affected by past activities in the North Valley. The monitoring well to be installed at the center of the valley will provide a representative sample near the potential source. The monitoring well to be installed at the east end of the valley will be used to assess the groundwater (if present) as it exits the site. Results from these samples will be compared to PRGs for drinking water. Soil Samples from two other locations in the Ammunition Renovation/Primer Destruction Area (in addition to those from the central boring) will access whether soil impacts exist in the area. The North Valley soil stockpiles samples will fulfill the same role for the Howitzer Test Area. The results of the soil analysis will be compared to applicable PRGs and local background soil concentrations

3.1.4.2 Definition of Data Quality Criteria.

The quality of analytical data is measured through the use of data quality criteria. Data quality criteria include the following: accuracy, precision, completeness, representativeness, comparability, and sensitivity.

Accuracy. Accuracy is the degree of agreement of a measurement or average of measurements with an accepted reference or "true" value. Accuracy is a measure of bias in the system.

Accuracy of the measurement data will be assessed and controlled as follows. Results for blank, matrix, laboratory control, and surrogate spikes will be the primary indicators of accuracy. These results will be used to control accuracy within acceptable limits by requiring that they meet specific criteria. As spiked samples are analyzed, spike recoveries will be calculated and compared to pre-established acceptance limits.

Acceptance limits will be based upon established laboratory capabilities for similar samples using control chart techniques. In this approach, the control limits reflect the minimum and maximum recoveries expected for individual measurements for an in-control system. Recoveries outside the established limits indicate some assignable cause, other than normal measurement error, and need for corrective action. This includes recalibration of the instrument, reanalysis of the QC sample, the samples in the batch, or flagging the data as suspect if the problems cannot be resolved. For highly contaminated samples, recovery of matrix spikes may depend on sample homogeneity.

Precision. Precision is a measure of mutual agreement among individual measurements of the same property under prescribed similar conditions. Precision is independent of the error (accuracy) of the analyses and reflects only the degree to which the measurements agree with one another, not the degree to which they agree with the "true" value for the parameter measured.

Precision of the measurement data for this project will be based upon duplicate analyses (replicability), control sample analyses (repeatability), and results for duplicate field samples (sampling replicability). Field duplicates are defined as two samples collected independently at a single sampling location during a single act of sampling for analysis at one laboratory for each specified method. Field duplicates will be collected for groundwater samples using separate bailers and will be analyzed for all parameters. Field duplicate soil samples will generally be collected from a single liner or from two adjacent sample liners collected at one borehole or sampling location during a single act of sampling. Field duplicates will be treated as separate samples and will undergo sample preparation and analysis for the same analytes at one laboratory for each specified method. Field duplicate soil samples will number 10 percent of the original sample number on a project-wide basis (rather than a sampling round basis).

Discretely sampled field duplicates are useful in determining sampling variability. However, greater than expected differences between duplicates may occur because of variability in the sample material. In these instances, a visual examination of the sample material will be performed to document the reason for the difference. Field duplicates will be used as a quality control measure to monitor precision relative to sample collection activities. Analytical precision will

be evaluated by using MS/MSD, duplicate laboratory control samples (LCS/LCD) or by using sample duplicates.

Precision is calculated in terms of Relative Percent Difference (RPD), which is expressed as follows:

$$RPD = \frac{|X_1 - X_2|}{(X_1 + X_2)/2}$$

where X_1 and X_2 represent the individual values found for the target analyte in the two replicate analyses. RPDs must be compared to the laboratory-established RPD for the analysis. Precision of duplicates may depend on sample homogeneity.

The analyst or his supervisor must investigate the cause of data outside stated acceptance limits. Follow-up action includes recalibration, reanalysis of laboratory QC samples, sample reanalysis, or flagging the data as suspect if problems cannot be resolved.

Completeness. Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under correct, normal conditions.

Data completeness is a measure of the extent to which the database resulting from a measurement effort fulfills objectives for the amount of data required. Completeness is defined as the valid data percentage of the total tests requested.

$$Completeness(\%) = \left(\frac{number\ of\ valid\ analyses\ per\ method}{number\ of\ requested\ analyses\ per\ method} \right) x\ 100$$

Valid analyses are defined as those where the sample arrived at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a completed COC. Furthermore, the sample must be analyzed within the specified holding time and in such a manner that analytical QC acceptance criteria are met.

Completeness for the entire project also involves completeness of field and laboratory documentation, whether all samples and analyses specified in the FSP have been processed and the procedures specified in the Work Plan and laboratory SOPs have been implemented.

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

The characteristics of representativeness are usually not quantifiable. Subjective factors to be taken into account are as follows:

- Degree of homogeneity of a site
- Degree of homogeneity of a sample taken from one point in a site
- Available information on which a sampling plan is based.

Sampling replicability, as defined under precision, is also used to assess representativeness. Two samples collected at the same location and at the same time are considered to be equally representative of this condition, at a given point in space and time. To maximize representativeness of results, sampling techniques, sample size, and sampling locations will be carefully chosen in order to provide laboratory samples representative of the site and the specific area. For instance, properly installed monitoring wells ensure that the water being sampled originates from the aquifer of concern. Care must be taken to ensure proper stabilization of measured water parameters, clarity, and color before groundwater samples are taken. Precautions, such as not operating combustion engines near a well during sampling, must be taken so that introduction of extraneous compounds does not threaten the representativeness of the samples. Soil and sediment samples are even less homogeneous than water; consequently, it is important for the sampler and analyst to exercise good judgment when removing a sample. Samples exhibiting obvious stratification or lithologic changes should not be used as replicates. Within the laboratory, precautions are taken to extract from the sample container an aliquot representative of the whole sample. This includes premixing the sample and discarding pebbles from soil samples. For samples requiring analysis of volatile organic compounds, premixing or homogenizing should be kept to a minimum.

Comparability. Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved sample collection techniques and analytical methods, consistency in the basis of analysis (e.g., wet weight, volume), consistency in reporting units, and analysis of standard reference materials.

Data comparability will be achieved by using standard units of measure (i.e., micrograms per liter [mg/L] for metals and inorganics in water samples, µg/L for organics in water, and milligrams per kilogram [mg/kg] [dry weight] for both inorganics and organics in soil samples).

The use of standard methods to collect and analyze samples, along with instruments calibrated against Standard Analytical Reference Materials (SARM), which are NIST-traceable standards, will also ensure comparability.

Comparability also depends on the other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with confidence.

Sensitivity. Quantitation limits are based on the extent to which the equipment, laboratory or field, or analytical process can provide accurate, minimum data measurements of a reliable quality for specific constituents in actual field samples. The actual quantitation limit for a given analysis will vary depending on instrument sensitivity and matrix effects. The minimum project requirements have been considered when setting the quantitation limits for this project.

3.1.4.3 Quantitative Laboratory DQOs.

Project analytical DQOs are quantifiable for accuracy, precision, and completeness. Accuracy and precision are specified for laboratory analyses as acceptance criteria, which are discussed in Section 3.2.5.2. QC procedures and control limits are discussed, and summary tables for acceptance criteria are presented in Section 3.2.5.3. Procedures used to assess data precision, accuracy, and completeness are presented in Section 3.2.5.4.

3.1.4.4 Appropriate Analytical Levels.

Two descriptive data categories, screening data and definitive data, have been developed and are described in the EPA document *Data Quality Objectives Process for Superfund* (EPA 540-R-93-071, September 1993). These data categories are associated with the type of site, level of precision and accuracy required, and intended use of the data, (i.e., the type of data to be generated depends on the qualitative and quantitative DQOs developed for the project). Only definitive data is expected to be used for this project.

Definitive data are generated using rigorous analytical methods, such as approved EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined.

3.1.5 Special Training Requirements/Certification

All Earth Tech and subcontractor project personnel will be qualified and adequately trained to perform the work to which they are assigned. The PM will determine the minimum qualifications and training required for project personnel. Copies of personnel qualifications and training received will be maintained in training files by the responsible supervisor. The Earth Tech FTL and Laboratory PM, or their respective designees, will document, prior to the start of work, that all field and analytical personnel have received, read, and understood all procedures pertinent to the work that project personnel are assigned to perform.

Training for the HTRW investigation will include:

- Briefings on site-specific technical and quality issues and procedures as they relate to each worker's duties. Examples include project mission, objectives and quality requirements, sampling and shipping protocols, COC requirements, project safety and biological/cultural resources issues.

- Documentation of experience or training for specific field equipment to be operated by workers. This includes operation, field calibration (as applicable), and maintenance/repair.

Personnel training will be reviewed by the PM to ensure that the training is appropriate, adequate, and current.

3.1.6 Documentation and Records

3.1.6.1 Laboratory Documentation.

In most cases, calculations from raw data are included in discussions of analytical procedures presented in the EPA methods. These data reduction and validation procedures will not be repeated herein. Details of data reduction, validation, and reporting not addressed elsewhere are discussed in this section.

Calculations. Data reduction calculations used for this project are typically included on the standard reporting forms developed by the laboratories and associated with each individual method or groups of methods. Calculations not covered on the standard reporting forms include computer-based data reduction programs. The laboratory is responsible for maintaining a listing of these data reduction programs and for being able to demonstrate their validity. The complete calculation procedures used in computer-based data reduction programs (e.g., gas chromatography [GC]/MS and GC analyses) are based on the calculation procedures specified in each method and will not be covered herein.

Some instruments are configured to operate independently and without computers. For these, the signal is recorded as a strip chart trace, numerical output on a printer strip, or direct reading from a digital or analog dial. In such cases, additional work is required by the analyst to reduce the data to a reportable format. The original signal must be multiplied by a calibration factor or compared with a standard curve. The aliquot result must be divided by the mass or volume of sample to produce a concentration-based final result. Most calculations are carried out on hand-held scientific calculators; simple programs are used for some. All of these data are recorded in a dedicated bench book for the particular determination in question. Results for single- or multiple-component tests are hand entered by the analyst in the assigned book.

Some laboratory tests, such as titrations or sensory evaluations, are not instrumented. For these, the quantitative result or observation is recorded

directly in a bound book by the assigned analyst. Calculations like those described above may be needed; these are recorded in the same book.

Unless otherwise specified, all data will be calculated and reported in units consistent with other organizations reporting similar data to allow comparability of databases among organizations. Data will be reported in micrograms per liter (µg/L) for organics (except total petroleum hydrocarbons [TPH] methods) and mg/L for TPH methods, metals and inorganics in aqueous samples; and mg/kg (dry weight) for soils. Dioxins and furans will be reported in nanograms per liter (ng/L) for aqueous samples and µg/kg (dry weight) for solid samples.

Data Integrity. Data integrity during collection and reporting of data will be assured through use of approved data forms and bound logbooks. The forms and logbooks will be signed and dated and checked by another equally competent person. Changes to documentation must be dated and initialed, and files of data secured. The same principles will be followed for both field and laboratory data. The integrity of databases will be assured by limited access. Corrective actions will be implemented and documented when data or instrumentation do not meet criteria. The tables specifying calibration and internal procedures include specific corrective actions and requirements.

Treatment of Outliers. Control charts and calibration curves will be used to review the data and identify outlying results. QC charts are prepared from laboratory control samples. Control limits are statistically calculated from a minimum of 20 data points. Control limits are set as the mean ± 3 standard deviations. Results that are more than 3 standard deviations from the mean are "out of control" and are cause for immediately halting the analysis and investigation.

Warning limits are at the mean ± 2 standard deviations. Results exceeding the warning limits but not the control limits alert the analyst to a potential problem. Sample results are accepted, but the procedures and standards are checked. If the laboratory control sample exceeds the acceptance criteria, the analyst will stop work on the analysis. The analyst and supervisor will investigate potential causes of the problem. After the cause is determined and corrected, samples from the original set may be reanalyzed along with duplicate spiked samples and a laboratory control sample after the impact on the data generated has been assessed.

All QC information will be recorded in the notebooks and printouts in the same format used for sample results. It is the analyst's responsibility to check the QC information against limits for the analysis. When an analysis of a QC sample (blank, spike, check standard, replicate, or similar sample) shows that the analysis of that batch of samples is not in control, the analyst will immediately bring the matter to the attention of the supervisor. The supervisor will, if necessary, consult with the laboratory QA manager and/or the laboratory project manager to determine whether the analysis can proceed, or if selected samples should be rerun, or specific corrective action needs to be taken before analyzing additional samples. Out-of-control analyses must be documented by the

supervisor. The analyst or supervisor will file a corrective action report with the laboratory QA manager.

Laboratory Data Management. When the laboratory receives and logs in the contents of the shipping containers, the laboratory's sample custodial supervisor or the laboratory PM will log the sample information into the Laboratory Information Management System (LIMS). As analyses proceed, additional data for all analyses will be maintained in the LIMS. Upon completion of all analyses, the laboratory will produce an electronic data deliverable (EDD) in the required format for delivery with the hard copy data package to the Earth Tech project chemist.

Data Archive. Data storage and documentation will be maintained using logbooks and data sheets that will be kept on file. All computer-acquired/ generated raw data are stored on magnetic tape, floppy disk, or other required media format, and the paper hard copies are kept on file in the job folders at the laboratories for 5 years. The central file for the sampling and analytical effort will be maintained by Earth Tech in the Colton office for a period of 5 years after the final report is issued.

3.1.6.2 Field Documentation.

Field data documentation includes bound field notebooks and data sheets, such as borehole logs, well completion logs, and field parameter stabilization forms. Field personnel record all on-site measurements and field observations (e.g., all pertinent sampling information, equipment calibration). Use of COC forms ensure that the sample is controlled at all times and that transfer of control is properly documented. Field data requirements and procedures are specified in Section 2.16 of the FSP.

3.1.6.3 Data Reporting.

Field data reporting includes reporting of field data documentation specified in the previous section and in Section 2.16 of the FSP. All field data will be reviewed by the FTL and forwarded to the QCSM or project chemist for review, validation, and storage with the project files in the Earth Tech Colton office.

Laboratory data reporting is an extensive activity beginning with a department report of reviewed data compiled into a complete data package, and finalized by laboratory PM/project QA review and approval. Upon completion of data review at all levels, and subsequent clerical preparation and final typographical review, reports are signed by the laboratory PM and/or designate. The project analytical laboratory will provide several types of data reporting, including:

1. Electronic data files are in ASCII files that are importable into the Earth Tech database. Any laboratory subcontracting analyses to other approved laboratories is responsible to ensure that acceptable EDDs are provided for those analyses unless otherwise specified in the contract with Earth Tech. Files for

reference in configuring EDDs are available from the Data Coordinator.

2. Hard copy analytical data packages with results in the form of Comprehensive Certificates of Analysis (considered equivalent to EPA Level III for definitive analyses), which will include the following:

   - The original of the signed COC form and cooler receipt form documenting receipt in laboratory.
   - A cross-reference of field sample number to laboratory sample number.
   - A cross-reference to identify all applicable laboratory QC samples with the field sample.
   - A glossary to define the symbols and terms used in the laboratory report.
   - Sample collection, extraction, and analysis dates for each sample (may be included on the sample summary results forms).
   - Practical quantitation limits (PQLs), method detection limits (MDLs), and dilution factors for each sample (may be included on the sample summary results forms).
   - A reference for the analytical methodology used (may be included on the sample summary results forms).
   - A case narrative that discusses the QA/QC results and discusses the corrective actions taken whenever laboratory control limits are exceeded. Any other problems that affect data quality will also be discussed.
   - Sample results summary reports (the analytical results for the sample), including the date of analysis, analytical method used, sample results reporting each analyte as a detected concentration or as less than the detection limit, reporting limits, method detection limits, dilution factors, surrogate recoveries (where applicable), laboratory qualifier flags, and adequate information to correlate the analytical results to the run log such as the time and date, instrument ID and/or file ID for GC and GC/MS. PQLs and MDLs will be corrected for the dilution factor.
   - QA/QC summary reports providing data on method blanks, check samples, surrogate recoveries, internal standard areas, laboratory duplicates, matrix spikes, matrix spike duplicates, laboratory control samples, serial dilution results (SW6010B), whichever are applicable to the particular method. QA/QC summary

reports will also list laboratory qualifier flags (or a flag to indicate that the result exceeds the QC limit, such as an asterisk), laboratory control limits, and definitions of laboratory qualifiers.

Method blank results will report any detected concentration for all analytes in the method. The QA/QC summary report will also list laboratory control limits and discuss the corrective actions taken whenever laboratory control limits are exceeded. Any other problems that affect data quality will also be discussed.

- Results of initial and continuing calibrations clearly correlating the sample analyses with the associated calibration check samples. This will include initial calibration (ICAL) summary worksheets, including time, date, instrument ID, file IDs, response factors (RF), percent RSD or correlation coefficient (r); and continuing calibration verification (CCV) reports or worksheets including time, date, injection number, true value (or ICAL average RF), found value (or RF), and percent difference (%D), as appropriate.

- Sample preparation logs or worksheets and injection or analytical run logs.

- For all methods, each analysis will be performed at and reported from the lowest possible dilution free of interference. For metals by SW6010B and other multi-analyte inorganic methods, results for analytes requiring dilution due to exceeded calibration range, detector saturation, or associated wavelength interference will be reported from the diluted analysis as required, while all other analytes will be reported from the undiluted analysis. When analyses for organic analyses are performed at more than one dilution to quantitate compounds within the calibration range, results for each analysis will be reported, including associated QC results.

Raw data packages (considered equivalent to EPA Level III for definitive analyses) will be provided for 10 percent of the data. The raw data packages will include all information specified above for the hard copy analytical data packages, plus the raw data generated from each analytical method performed, including chromatograms, mass spectra, and instrument-generated quantitation reports, or bench sheets, worksheets, and calculation sheets. In addition, printouts for all manual integrations for CG/MS methods will be included in the raw data packages. Earth Tech will specify project sample groups to be reported with raw data packages on the COC/request for analysis forms.

3.2 MEASUREMENT/DATA ACQUISITION

3.2.1 Sampling Process Design

A detailed discussion of the sampling design, sample types and matrices, and sampling frequencies is provided in Section 2.1 of the FSP.

3.2.2 Sampling Methods Requirements

Detailed discussions of the sampling methods requirements, including investigation location clearance, drilling, well installation, water level measurement, sample collection, and decontamination are provided in the FSP. EPA Methods to be used for field analyses are summarized in Section 3.2.5.1 of the QAPP. Specific requirements for the use of these methods are included in Section 2.11 of the FSP.

3.2.3 Sample Handling and Custody Requirements

3.2.3.1 Sample Collection.

A detailed discussion of sampling collection protocols is provided in Section 2.6 of the FSP, with sample preservation requirements presented in Section 2.8 of the FSP. Sample preservation, container, and holding time requirements are summarized in Table 2-2 of the FSP. Field QC is summarized in Section 3.2.5.1 of the QAPP and discussed in detail in Section 2.7 of the FSP. Documentation of field sampling activities is discussed in Section 2.16 of the FSP. To maintain sample integrity, all requirements in the above-referenced sections of the FSP must be followed and documented.

In an effort to control common problems (e.g., labeling errors, COC errors, preservation failures), Earth Tech provides training for field personnel in the proper execution of these procedures, as well as concurrent review by QA personnel of COC forms. Daily communication with field personnel and the laboratory is also part of these preventative measures. Corrective action is discussed in Section 3.3.2.4 of this QAPP.

3.2.3.2 Field and Laboratory Sample Custody.

Field Operations. Sample custody procedures are based on EPA-recommended procedures that emphasize careful documentation of sample collection and sample transfer. To ensure that all of the important information pertaining to each sample is recorded, the documentation procedures detailed below and in the referenced sections of the FSP will be executed and reviewed for compliance in the data quality assessment (refer to Section 3.3.3 of the QAPP).

Sample Identification. The field sample identification numbers will be designated by a three-part code. The field sample numbering system is described in Section 2.9.2 of the FSP.

Samples are identified by a sample label that will be affixed by the sampler to the sample container used, as described in Section 2.9.3 of the FSP.

Sample Packaging and Shipping. All samples will be packaged carefully to avoid breakage or contamination, and will be shipped to the laboratory at proper temperatures. Shipping time will be minimized to prevent holding time violations. The sample packaging and shipping requirements are specified in Section 2.9.4 of the FSP.

Sample Custody in the Field. Procedures to complete COC records are described in Section 2.16.2 of the FSP. To maintain and document sample custody, the following chain-of-custody procedures will be strictly followed. A sample is considered to be under custody if:

- It is an actual possession of the responsible person
- It is in view, following physical possession
- It is in the possession of a responsible person and is locked or sealed to prevent tampering
- It is in a secure area.

Laboratory Operations. All sample log-in, storage, and COC documentation are the responsibility of the sample control supervisor, who is responsible for retaining shipment documents and verifying data entered into the sample custody records. In addition, the sample control supervisor will ensure that sample storage is secure and maintained at the proper temperature.

When the laboratory receives and logs in the contents of the shipping containers, the laboratory's sample control supervisor or the laboratory PM will fax the sample log-in summary with completed COC Record to Earth Tech's QCSM or project chemist within 24 hours. Earth Tech's QCSM or project chemist will verify the completeness of the shipment, the accuracy of sample information, and coordinate with the laboratory to confirm that there is adequate sample volume for planned analyses. If a problem arises, the Earth Tech's QCSM or project chemist will coordinate a solution with the Earth Tech field team, the Laboratory PM, and the party that shipped the samples.

Sample Handling. Upon receipt in the laboratory, the integrity of the shipping container is checked by verifying that the custody seal is not broken. The temperature of the temperature blank is measured and preservation of samples checked (except for volatiles); the samples are checked for breakage, leakage, damage, and the contents of the shipping container verified against the COC documentation. Documentation of custody seal integrity, temperature and sample preservations are made on the cooler receipt form. Samples must be received at a temperature of 6 degrees (°) celsius (C) or less, but not frozen.

Any problems are documented on the COC or in a sample control communication form, and the Earth Tech Project Manager is contacted immediately. The sample custodian will document the following:

- Date of sample receipt
- Source of sample
- Sample accession number

- Analytical test requested
- Matrix
- Number of samples
- Final disposition of sample (after final data validation and acceptance by client).

Samples are placed in the appropriate 4°C sample refrigerator. Aqueous samples for metal analyses do not require refrigeration at 4°C. Information about samples with suspected high contamination levels will be noted by the sample collectors on the COC forms. Samples identified as having high contamination levels are stored separately, as are samples submitted for volatile analysis. All refrigerators are maintained at 4°C ± 2°C,° and temperatures are monitored and recorded daily by sample control personnel. Preservatives, containers, holding times, and volume requirements for project-required tests are given in Table 2-2 of the FSP. All samples are kept under the proper environmental control until after holding times have expired and there are no QA/QC problems with any analysis on those samples.

Sample Identification. Each sample received will be assigned a unique laboratory sample accession number.

This unique accession number, along with pertinent sampling information, will be logged into the sample control database system and the LIMS. One of the functions of the LIMS is to assist in tracking samples while they are in the custody of the laboratory. Other information recorded will include date and time of sampling, sample description, location, and required analytical tests. Samples of similar matrix are batched in lots of 20 or fewer at the time of sample preparation, or at the time of analysis, if no preparation is required.

Sample Custody Records. All samples will be accompanied by a COC record. A COC record must also be used if the laboratory relinquishes control of the samples to subcontractor laboratories or returns the samples to the originator. A sample sign-out sheet is used to track the samples within the laboratory. All chain-of-custody records are filed permanently with the analytical data. The completed original COC will be forwarded to Earth Tech with the final report.

3.2.4 Analytical Methods Requirements

3.2.4.1 Field Parameters.

Detailed discussions of field measurement parameters, protocols, equipment, and its calibration and maintenance are presented in Section 2.11 of the FSP.

Properties of water and soil samples will be measured during field activities. Geophysical techniques will be used for clearance activities. Groundwater samples will be measured for conductivity, pH, temperature, and turbidity. Also

measured will be depth to water in wells and the volume of water discharge. A brief description of the methods can be found in the following paragraphs:

Field Analytical Procedures

EPA Method 120.1 - Specific Conductance (Field). The specific conductance of water samples will be determined in the field using a conductivity meter. The conductivity meter will be calibrated daily against a standard solution per manufacturer's instructions.

EPA Method 150.1 - pH (Field). The pH of water samples will be measured in the field potentiometrically using a standard pH meter. The pH meter will be routinely calibrated in accordance with manufacturer's recommended procedures using buffered standards and will be checked daily and when activities or environmental changes occur that might affect instrument accuracy.

EPA Method 170.1 - Temperature (Field). Temperature will be measured for selected water samples according to EPA Method 170.1 using a calibrated thermometer.

EPA Method 180.1 - Turbidity (Field). Turbidity will be measured in the field nephelometrically using a turbidimeter and reported in NTUs. The turbidimeter will be calibrated routinely per manufacturer's instructions and standardized before each use.

Equipment Calibration and Maintenance. Detailed discussion of field equipment calibration and maintenance is presented in Section 2.12 of the FSP.

The equipment used in collecting field data will include a variety of instruments. Proper maintenance, calibration, and operation of each instrument will be the responsibility of the field personnel assigned to the project. All instruments and equipment used during the studies will be maintained, calibrated, and operated according to the manufacturers' guidelines and recommendations.

All instruments are to be stored, transported, and handled with care to preserve equipment accuracy. Damaged instruments will be taken out of service immediately and not used again until repaired and recalibrated by a qualified technician.

Field equipment will be calibrated prior to use in the field as appropriate. The calibration procedures will follow standard manufacturer's instructions to ensure that the equipment is functioning within tolerances required by the project. Calibration procedures for commonly used equipment are described in Section 2.12 of the FSP. A record of field calibration of analytical instruments will be maintained by field personnel on the appropriate Instrument Calibration Logs. These records will be subject to QA audit. In addition, any notes on unusual results, changing of standards, battery charging, and operation and maintenance will be included in the logbook.

Decontamination. Detailed discussion of field decontamination procedures is presented in Section 2.13 of the FSP.

Control Parameters. Before groundwater samples are taken, temperature, pH, EC, and turbidity are monitored to establish whether they have stabilized or not. Acceptable values for stabilization are specified in Section 2.XX of the FSP. Temperature, pH, EC, turbidity and dissolved oxygen measurements will be taken at the time groundwater samples are collected for laboratory analyses. Duplicate groundwater samples, which will number 10 percent of the entire sampling program, will be measured for temperature, pH, EC, turbidity, and dissolved oxygen.

Recordkeeping. Detailed discussions of field documentation procedures are presented in Section 2.16 of the FSP.

3.2.4.2 Laboratory Analytical Procedures.

The purpose of the laboratory analyses is to identify the types and concentrations of contaminants in soil, sediment, groundwater, and surface water. The analytical procedures for the definitive level analyses of the samples in this project specified in Table XX of the FSP will conform to the requirements specified in *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, SW-846 3rd edition (EPA, 1986a), Final Update I (EPA, 1992), Final Update II (EPA, 1994c), and Final Update III (EPA, 1996); *Methods for Chemical Analysis of Water and Wastes*, EPA Manual 600/4-79-020 (EPA, 1983 with additions); *Leaking Underground Fuel Tank Field Manual* (State of California, 1989); and *Annual Book of ASTM Standards*: Vol. 4.08, Soil and Rock, and 11.01, Water (ASTM, latest edition).

The analyses expected to be required for this project include the following: CAM-17 metals by EPA methods SW6010B, SW7470A, and SW7471A; TEPH as C12-C36 by California LUFT modified EPA Method SW8015 (SW8015D); dioxins and furans by EPA Method SW8290; PAHs by EPA Method SW8310; nitroaromatics and nitroamines, including PETN and nitroglycerin (explosives) by EPA Method SW8330, and soil moisture content by ASTM Method D2216. A brief description of the digestion and analytical methods to be used are presented in the following subsections.

For each method, the target analyte list (TAL) for inorganics or the target compound list (TCL) for organics are specified in Table 3.2-1 with a listing of the required PQLs. PQLs will be based on and must exceed laboratory-specific MDLs. Quality control criteria for the analytical program are presented in Section 3.2.5 of this QAPP. However, instances may arise where high sample concentrations, nonhomogeneity of samples, or matrix interferences preclude achieving the detection limits or associated quality control criteria. In such instances, the reason for deviations from these detection limits that result in noncompliance with quality control QC criteria will be reported on a QC Nonconformance Report and in the QA report, and will be included in the monthly status reports to the technical program manager.

TABLE 3-1. PRACTICAL QUANTITATION LIMITS FOR DEFINITIVE LEVEL ANALYSES

(Page 1 of 2)

Parameter	Method W=Water S=Soil	Analyte	Water (µg/L)	Soil (mg/kg)
Metals	SW6010B	Antimony	0.060 (mg/L)	3.0
	SW6010B	Arsenic	0.004 (mg/L)	0.80
	SW6010B	Barium	0.005 (mg/L)	1.0
	SW6010B	Beryllium	0.002 (mg/L)	0.40
	SW6010B	Cadmium	0.005 (mg/L)	0.8
	SW6010B	Chromium	0.005 (mg/L)	1.0
	SW6010B	Cobalt	0.002 (mg/L)	1.0
	SW6010B	Copper	0.005 (mg/L)	1.0
	SW6010B	Lead	0.003 (mg/L)	0.60
	SW6010B	Molybdenum	0.005 (mg/L)	1.0
	SW6010B	Nickel	0.005 (mg/L)	1.0
	SW6010B	Selenium	0.010 (mg/L)	2.0
	SW6010B	Silver	0.003 (mg/L)	0.6
	SW6010B	Thallium	0.010 (mg/L)	2.0
	SW6010B	Vanadium	0.002 (mg/L)	1.0
	SW6010B	Zinc	0.020 (mg/L)	4.0
	SW6010B	Aluminum	0.10 (mg/L)	20.0
	SW6010B	Calcium	0.50 (mg/L)	100
	SW6010B	Iron	0..20 (mg/L)	1.0
	SW6010B	Magnesium	0.50 (mg/L)	100
	SW6010B	Manganese	0.050 (mg/L)	1.0
	SW6010B	Potassium	1.0 (mg/L)	200
	SW6010B	Sodium	1.0 (mg/L)	200
	SW7470 (W)	Mercury	0.0002 (mg/L)	-
	SW7471 (S)	Mercury	-	0.02
Total Petroleum Hydrocarbons	*Mod 8015 - LUFT	TEPH as C12-C36 Hyrocarbons	0.2 mg/L	2
Dioxins/Furans	SW8290	**Dioxins**		
		2,3,7,8-TCDD	10 pg/L	1.0 pg/g
		1,2,3,7,8-PeCDD	50 pg/L	5.0 pg/g
		1,2,3,4,7,8-HxCDD	50 pg/L	5.0 pg/g
		1,2,3,6,7,8-HxCDD	50 pg/L	5.0 pg/g
		1,2,3,7,8,9-HxCDD	50 pg/L	5.0 pg/g
		1,2,3,4,6,7,8-HpCDD	50 pg/L	5.0 pg/g
		OCDD	100 pg/L	10 pg/g
		Furans		
		2,3,7,8-TCDF	10 pg/L	1.0 pg/g
		1,2,3,7,8-PeCDF	50 pg/L	5.0 pg/g
		2,3,4,7,8-PeCDF	50 pg/L	5.0 pg/g
		1,2,3,4,7,8-HxCDF	50 pg/L	5.0 pg/g
Dioxins/Furans (Continued)	SW8290	1,2,3,6,7,8-HxCDF	50 pg/L	5.0 pg/g
		1,2,3,7,8,9-HxCDF	50 pg/L	5.0 pg/g
		2,3,4,6,7,8-HxCDF	50 pg/L	5.0 pg/g

TABLE 3-1. PRACTICAL QUANTITATION LIMITS FOR DEFINITIVE LEVEL ANALYSES
(Page 2 of 2)

Parameter	Method W=Water S=Soil	Analyte	Water (µg/L)	Soil (mg/kg)
		1,2,3,4,6,7,8,-HpCDF	50 pg/L	5.0 pg/g
		1,2,3,4,7,8,9-HpCDF	50 pg/L	5.0 pg/g
		OCDF	100 pg/L	10 pg/g
PAHs	SW3510/SW8310 (W)	Napthalene	0.3	0.02
	SW3550/SW8310 (S)	Acenaphthylene	0.3	0.02
		Acenaphthene	0.3	0.02
		Fluorene	0.3	0.02
		Phenanthrene	0.3	0.02
		Anthracene	0.3	0.02
		Fluoranthrene	0.3	0.02
		Pyrene	0.3	0.02
		Benzo(a)anthracene	0.3	0.02
		Chrysene	0.3	0.02
		Benzo(b)fluoranthene	0.3	0.02
		Benzo(k)fluoranthene	0.3	0.02
		Benzo(a)pyrene	0.3	0.02
		Dibenzo(a,h)anthracene	0.3	0.02
		Benzo(g,h,i)perylene	0.3	0.02
		Indeno(1,2,3-c,d)pyrene	0.3	0.02
Explosives	SW8330	HMX	5.0	0.25
		RDX	5.0	0.25
		4-Amino-2,6-dinitrotoluene	5.0	0.25
		1,3,5-TNB	5.0	0.25
		1,3-DNB	5.0	0.25
		Methyl-2,3,6-trinitrophenyl-nitramine (Tetryl)	5.0	0.25
		Nitrobenzene	5.0	0.25
		2,4,6-TNT	5.0	0.25
		2,4-DNT	5.0	0.25
		2,6-DNT	5.0	0.25
		o-Nitrotoluene	5.0	0.25
		m-Nitrotoluene	5.0	0.25
		p-Nitrotoluene	5.0	0.25
		Nitroglycerin	25	0.5
		PETN	50	0.5/1.0[(a)]

The methods cited are from the following sources:

"E" Methods Methods for ChemicalAnalysis of Water and Wastes, EPA Manual, 600/4-79-020 (USEPA, 1983--with additions)
"SW " Methods Test methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition (USEPA, 1986)
"*" Methods Leaking Underground Fuel Tank Field Manual (State of California, 1989)
(a) May be reported for some samples not associated with the TNT Strips

Metals Analyses. Inductively coupled plasma (ICP) atomic emission spectroscopy and cold vapor atomic absorption (CVAA) will be employed to measure levels of specified metals in the samples. Sample digestion is required prior to all ICP and CVAA analyses.

Preparation Methods

EPA Method SW3005A - Acid Digestion of Waters and Ground Waters For Total Recoverable or Dissolved Metals. This digestion method is used to prepare surface water and groundwater samples for analysis by ICP. For the analysis of dissolved metals, the sample must be filtered with a 0.45-micron filter at the time of collection, prior to acidification with nitric acid. The preservation (i.e., pH) of water samples collected for metals is checked and documented prior to digestion. A 100-milliliter (ml) aliquot of the acidified sample is heated with 2 ml of concentrated nitric acid (HNO_3) and 5 ml of concentrated hydrochloric acid (HCl) until the volume is reduced to 15 to 20 ml. Filtering with a 5.0 micron filter may be performed if insoluble material is present. The final volume is adjusted to 100 ml. The laboratory may perform the digestion using a 50 percent proportion of the volumes specified above.

EPA Method SW3050B - Acid Digestion of Sediments, Sludges, and Solids. This digestion method is used to prepare sediment and soil samples for analysis by ICP and trace ICP. A portion of the sample is digested with repeated additions of nitric acid and hydrogen peroxide. The digestate is then refluxed using concentrated HCl for ICP. The final volume is adjusted to 100 ml.

Sample digestion procedures for analysis of mercury by EPA Methods SW7470A (waters) and SW7471A (soils) are included in the respective methods.

Analysis by Inductively Coupled Plasma (ICP)

EPA Method SW6010B - ICP. ICP determines elements in solution. All matrices, including groundwater, surface water, industrial wastes, soils, sludges, and sediments, require digestion by EPA Methods SW3005A (aqueous samples) or SW3050B (solid samples) prior to analysis.

This method provides simultaneous multi-elemental determination of analytes by ICP. Element-emitted light is measured by optical spectrometry. Samples are nebulized, and the resulting aerosol is transported to a plasma torch.

Element- specific atomic line emission spectra are produced by radio-frequency ICP. The spectra are dispersed and the lines monitored by photomultiplier tubes. The background will be measured and the results corrected for background levels.

Elements traditionally requiring analysis by Graphite Furnace Atomic Absorption (GFAA) (e.g., antimony, arsenic, cadmium, lead, selenium, thallium) to achieve the detection limits required for this project are analyzed by ICP trace analysis

on a Thermo Jarrell Ash ICAP 61 E Trace Analyzer or similar instrument, which can achieve the detection limits specified in Table 3-1.

Analysis by Atomic Absorption Spectroscopy

EPA Methods SW7471A and SW7470A - Mercury by CVAA. Mercury will be determined in solid samples using EPA Method SW7471A, and in aqueous samples using EPA Method SW7470A. Methods SW7471A and SW7470A are CVAA procedures for determining the concentration of mercury in waste samples. Sample preparation is specified in the method. Following dissolution, mercury in the sample is reduced to the elemental state, aerated from solution in a closed system, and passed through a cell positioned in the light path of an atomic absorption spectrometer. Mercury concentration is measured by the absorption of radiation by mercury vapor.

Organic Analyses. This section presents brief summaries of the extraction and analysis procedures for organic compounds that will be used by the analytical laboratory to analyze the soil and groundwater samples collected during the project.

Extraction Procedures - For water samples, EPA Method SW3510C or SW3520B will be used. EPA Method SW3540C or SW3550B will be used for soil samples.

EPA Method SW3510C - Separatory Funnel Liquid-Liquid Extraction. Method SW3510C is a procedure for isolating and concentrating nonpurgeable water-insoluble and slightly water-soluble organic compounds from aqueous samples prior to chromatographic analyses. A measured volume of sample is placed into a separatory funnel, adjusted if necessary to a specific pH, and serially extracted with methylene chloride. The extract is dried, concentrated (if necessary), and exchanged into a solvent compatible with the cleanup or determinative method to be used (if necessary).

EPA Method SW3520C - Continuous Liquid-Liquid Extraction. Method SW3520C is a procedure for isolating and concentrating nonpurgeable water-insoluble and slightly water-soluble organic compounds from aqueous samples. A measured volume of sample is placed into a continuous liquid-liquid extractor, adjusted if necessary to a specific pH, and extracted with methylene chloride for 18 to 24 hours. The extract is dried, concentrated (if necessary), and exchanged into a solvent compatible with the cleanup or determinative method to be used (if necessary).

EPA Method SW3540C - Soxhlet Extraction. Method SW3540C is a procedure for extracting nonvolatile and semivolatile organic compounds (SVOCs) from solids such as soils, sediments and concrete. The soxhlet extraction process ensures intimate contact of the sample matrix with the extraction solvent. Extraction is accomplished by mixing the solid sample with anhydrous sodium sulfate and extracting it for 16 to 24 hours with an appropriate solvent in the soxhlet extractor. The extract is then dried, concentrated, and treated using a

cleanup method, or analyzed directly by the appropriate measurement technique.

EPA Method SW3550B - Sonication (Ultrasonic) Extraction. EPA Method SW3550A is a procedure for extracting nonvolatile and SVOCs from solids such as soils, sediments, sludges, concrete, and wastes. The sonication process ensures intimate contact of the sample matrix with the extraction solvent. A weighed sample of the solid material is ground (if necessary), mixed with anhydrous sodium sulfate to form a free-flowing powder, and then dispersed into the solvent using sonication. The sonication extraction into solvent is repeated three times for the low concentration method, and one time for the medium concentration method. The extract is then separated by vacuum filtration or centrifugation, dried, concentrated and, if required, treated using a cleanup method (see below). The resulting solution is analyzed using the appropriate method. Methylene chloride will generally be used as the solvent, although other solvents may be used for specific analytical applications as noted in each analytical method.

As indicated in SW-846 Update III, EPA Method SW3550B may result in the degradation of phosphate esters. Accordingly, care will be taken when applying EPA Method SW3550B to the preparation of soil samples for analysis by EPA Method SW8270C. When sonication is used as the extraction method, the temperature of the cooling bath will be monitored to minimize degradation of the phosphate esters that may exist in the sample.

Organic Analysis by Gas Chromatograph (GC)

Modified EPA SW8015 (CA LUFT) - Total Petroleum Hydrocarbons by GC/flame ionization detector (FID). The analysis of POLs may be required for this project. CA LUFT modified EPA Method SW8015 for Total Extractable Petroleum Hydrocarbons is expected to be used to quantitate POLs. This method will be used to determine TPHs (diesel, jet fuel, and other petroleum fuels or oils) as C12 through C36 by the extraction, headspace, or purge and trap method, injection into a GC, and detection by a flame ionization detector (FID). This analysis requires extraction (SW3510C for water and SW3550B for soil samples) prior to GC analysis.

Organic Analyses by Gas Chromatographic/High Resolution Mass Spectrometric (GC/HRMS)

U.S. EPA Method 8290 - Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS). EPA Method SW8290 is appropriate for the detection and quantitation of PCDDs (tetra- through octa-chlorinated homologues) and PCDFs (tetra- through octa-chlorinated homologues) in a variety of sample matrices at part-per-trillion (ppt) to part-per-quadrillion (ppq) concentrations.

Method SW8290 is used to detect dioxins and furans in a variety of matrices and uses additional quality controls to allow more sophisticated determinations of detection limits and matrix spike recoveries than other routine GC and GC/MS methods. SW8290 requires isotopically labeled analogs of target analytes to be spiked into each sample before extraction, and uses nine C13 analogs, one furan, and one dioxin at each chlorination level. These isotopically labeled analogs elute and behave as target analytes, without interfering with the analysis. Target analytes are quantitated relative to the isotope analog; therefore, their calculated concentration is compensated for extraction efficiency.

There is a three-tiered approach to reporting and detection limits according to current laboratory conventions (alternate reporting conventions are available upon request). In the absence of target analytes, a sample-specific estimated detection limit (EDL) is calculated based on signal-to-noise (S/N) ratios at the retention time of the analyte. The target analyte is then reported as "not detected" at the EDL. When target analytes are found, they are reported down to the lowest calibration standard concentration without conditional modifiers such as a J flag. Below the SW846 specified reporting limits, qualitatively confirmed analytes are reported as "estimated" down to the target detection limit (TDL) to denote the less certain quantitation. The TDL is a value set by the lab at which there is no significant chance of false positives. If there is a peak below the TDL, and all qualitative criteria such as retention time, ion ratios, S/N ratio, the absence of diphenyl ether, and analyst judgment, are not met, a detection limit based on the ion peaks is calculated and the target analyte is reported as "not detected" at that calculated detection limit.

The assessment of matrix effects on method performance can be met in SW8290 with the isotopically labeled analogs. These isotopes are spiked into each sample, and therefore, matrix effects on method performance can be judged by the recovery of these isotopes for each sample. Sample analysis acceptance is controlled by the performance of these isotopes in the sample. Furthermore, the batch-specific LCS are also not required since the batch-specific method blank uses isotopically labeled analogs of the target analytes and controls the batch. Quanterra still analyzes LCS at a 5-percent frequency as an ongoing system and standard check. No MS/MSD is performed for SW8290 sample analyses (unless specifically requested by the client), and batch control will be done by the recovery of the spiked, isotopically labeled analogs in the method blanks.

Upon client request, the 2,3,7,8-tetrachlorodibenzo-dioxin (TCDD) toxicity equivalence will be calculated in accordance with the procedures given in U.S. EPA "Update of Toxicity Equivalence Factors (TEFs) for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs/CDFs)" March 1989 (EPA 625/3-89/016) and as described in the U.S. EPA Contract Laboratory Program Statement of Work, DFLM01.0. TEFs are assigned to each of the 2,3,7,8-substituted PCDDs/PCDFs in order to relate their toxicity to that of 2,3,7,8-TCDD. Note that EDL and detection limit values are not normally included in the TEF adjusted

concentration. Second column confirmation will be performed only for 2,3,7,8-TCDF presumptive positives greater than the TDL.

Organic Analysis by High Performance Liquid Chromatography (HPLC)

EPA Method SW8310 - Polyaromatic Hydrocarbons. Method SW8310 is a high performance liquid chromatographic (HPLC) method with ultraviolet (UV) and fluorescence with photodiode array detection for the detection of ppb levels of certain PAHs. Prior to use of this method, appropriate sample extraction techniques must be used. A 5- to 25-microliter (µl) aliquot of the extract is injected into an HPLC, and compounds in the effluent are detected by UV and fluorescence detectors. All concentrations greater than the MDL must be confirmed on the alternate detector.

EPA Method SW8330 - Explosives. EPA Method SW8330 is an HPLC method for the determination of ppb levels of certain explosive residues in soil, sediment and aqueous matrices. Due to their prevalence at defense installations, nitroglycerin and PETN have been included as additional analytes and are being requested as indicated by site-specific conditions. Nitroglycerin and PETN require separate extraction and analysis to meet the required detection limits and to remove interferences. Prior to using this method, appropriate sample preparation techniques must be used, as specified in the method.

In the low-level, salting-out method with no evaporation, aqueous samples of low concentration are extracted by a salting-out extraction procedure with acetonitrile and sodium chloride. The small volume of acetonitrile that remains undissolved above the salt water is drawn off and transferred to a smaller volumetric flask. It is back-extracted by vigorous stirring with a specific volume of saltwater. After equilibration, the phases are allowed to separate, and the small volume of acetonitrile residing in the narrow neck of the volumetric flask is removed using a Pasteur pipet. The concentrated extract is diluted 1:1 with reagent grade water. An aliquot is separated on a C-18 reverse-phase column, determined at 254 nanometers (nm), and confirmed on a CN reverse-phase column. Alternatively, solid phase extraction cartridges or other acceptable and appropriate techniques may be used for extraction.

In the high-level direct injection method, aqueous samples of higher concentration can be diluted 1:1 volume-to-volume (v/v) with methanol or acetonitrile, filtered, separated on a C-18 reverse-phase column, determined at 254 nm, and confirmed on a cyanide (CN) reverse-phase column. If HMX is an important analyte, methanol is used.

Soil and sediment samples are extracted using acetonitrile in an ultrasonic bath and filtered before chromatography.

Non-Metals Inorganic Analyses.

EPA Method 300.0 - Common Anions - Nitrate and Nitrite. This is an ion chromatographic (IC) method applicable to determinations of anions in water. Anion identification is supported by the addition of spike solutions covering the anions of interest. A small volume of the sample (0.2 ml to 0.5 ml) is introduced into an IC. Samples that contain particles larger than 0.45 µl require prior filtration. The anions of interest are separated in an anion separator column, eluted through the addition of a sodium carbonate/sodium bicarbonate solution, and measured by a conductivity detector. The measured conductivity level is compared to the calibration chart to determine the concentration of the analyte.

EPA Method 150.1 - pH/EPA Method 9045 - Soil pH. The pH of water samples will be measured potentiometrically using a standard pH meter.

Soil samples are mixed either with Type II water or with a calcium chloride solution, depending on whether the soil is calcareous or noncalcareous. The pH of the solution is then measured with a pH meter.

ASTM D 2216 - Soil Moisture Content. All solid samples must be analyzed for soil moisture content so the results can be reported on a dry weight basis. Determining soil moisture content involves transferring a weighed sample to a tared container, then placing the sample and container to dry in a preheated oven at 110°C ± 5°C. During the drying period, a current of dried air should flow through the oven. After the drying period, the sample will be removed and allowed to cool in a desiccator before weighing. The modified formula for calculating moisture, listed below, will be used for the calculations:

$$w = [(W1-W2)/(W1-WC)] \times 100$$

Where: w = Moisture content, %
W1 = Weight of container and moist soil, grams
W2 = Weight of container and oven-dried soil, grams
WC = Weight of container, grams.

Additional Analytical Methods. If methods other than those specified in the project FSP are to be used, the following procedure must be completed before using an unspecified analytical method. A copy of the proposed method, the expected precision and accuracy, and an explanation for the change must be submitted to the laboratory QA/QC officer, the client, and DTSC for review and approval.

Detection Limits. Detection limits are required for all methods of quantitative analysis to evaluate method performance. Detection limits for many analytical procedures are often highly dependent on the matrix of the sample or material that is tested. Interferences frequently require sample dilution and/or method modifications that change the detection limit.

Terminology. The MDL is an empirically derived value used to estimate the lowest concentration a method can detect in a matrix-free environment. SW846 defines MDL as the minimum concentration of an analyte that can be detected and reported with 99-percent confidence that the value is above zero. PQLs refer to the lowest concentration of an analyte that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The instrument detection limit (IDL) refers to the smallest signal above background noise that an instrument can reliably detect. The detection limit actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects. IDLs are used for analysis of aqueous extracts of metals, and are used to calculate the MDLs for metals methods.

Procedures. MDL studies for GC and GC/MS are performed per 40 Code of Federal Regulations (CFR) Part 136, Appendix B, by analysis of a standard solution (each analyte in reagent water) at a concentration of three to five times the instrument manufacturer's suggested IDL, with seven consecutive measurements on one day. The IDL studies for ICP and atomic absorption (AA) are performed per EPA Contract Laboratory Program Statement of Work, dated July 1988. The PQL is validated by analysis of a standard at the level of PQL. The PQL is generally two to five times the laboratory-determined MDL or IDL, and the PQL is always at least greater than or equal to the MDL/IDL.

Values. All sample results will be reported down to the MDL. The highest MDL for a method may be used when multiple instruments and sample preparation procedures are available in the laboratory. Analytes found above the MDL, but below the PQL, are quantitated and flagged (J) as an estimated value. Matrix effects requiring dilution will be considered in assessing laboratory compliance with requirements for sensitivity.

Project-specific reporting limits (maximum acceptable PQLs) are presented in Table 3-1.

3.2.5 Analytical Quality Control Requirements

3.2.5.1 Quality Control for Field Activities.

Samples will be collected using the sampling procedures discussed in Section 2.11 of the FSP. QC procedures will be an integral part of each sampling methodology. These procedures will focus upon ensuring the collection of representative samples that are free from external contamination.

Although different extraction and/or analytical procedures will be used for the various parameters of interest, certain general QC procedures are applicable to all methods. Generally, these include the following; however, specific field QC requirements are addressed in detail in Section 2.7 of the FSP:

- Sampling apparatus will be thoroughly cleaned between each sampling event to prevent cross-contamination of the samples. Sampling equipment used to collect samples for semivolatile

organic analysis will not be allowed to come in contact with any type of plastic (e.g., plastic storage bags).

- One set of equipment blanks will be collected each day of soil sampling. For water samples collected with disposable bailers, no equipment blank will be collected. For water samples collected with reusable (Teflon™) bailers, one equipment blank per day will be collected. For water samples pumped through a sampling device (except for metal filtration chambers, which require a filtration blank), one equipment blank will be collected per pump each day of sampling. Equipment blanks will be analyzed for all analyses performed on associated samples of the same matrix.

- Filter blanks will be collected only if filtration becomes required. For water samples pumped through a metal filtration chamber, one field filter blank will be collected per filter unit each day of sampling. Field filter blanks will be analyzed for inorganic analyses requiring filtration due to high sediment content when required.

- Temperature blanks will accompany each cooler shipped to the laboratory for analysis.

- Duplicate water and soil samples will be collected at a frequency of 10 percent to provide a measure of method variability (i.e., total variability due to both sampling and analytical procedures) and natural variability of the parameter of interest within the water matrix. Duplicate samples will be collected at the locations most likely to contain contamination, based on information at the time of sampling. The frequency of 10 percent will be determined on a project-wide, rather than sampling-round, basis. Duplicate samples will be analyzed for the same parameters as the original field samples.

- MS/MSD should be field designated by the sampler. For every batch of 20 or fewer soil samples within a sampling event from a major lithological type or from a major, distinct aqueous matrix, the laboratory will prepare and analyze an MS/MSD pair from a project sample collected by Earth Tech. The sampler will designate one or more of the samples by noting on the COC Record that the sample(s) are for MS/MSD (in the Remarks column but not on the sample). It is important to provide a sufficient volume of MS/MSD water samples. Three times the usual volume, or more if specified by the laboratory, should be provided for the MS/MSD and marked on the COC Record. For water samples that require multiple containers (usually one for each analysis), a single sample number will apply to all containers of that sample. Samples designated for MS/MSD

analysis should be typical of the matrix and should not be highly contaminated in order to minimize MS/MSD imprecision resulting from high levels of environmental contamination. In order to minimize the effects of soil heterogeneity, the laboratory will use a single or adjacent liners.

- COC records will accompany all samples.

3.2.5.2 Quality Control For Laboratory Analyses.

Internal QC focuses on ensuring that each chemical measurement has the highest probability of meeting method protocol in terms of precision and accuracy. QC samples such as method blanks, spikes, duplicates and spiked duplicates are evaluated and documented on a routine basis. Spike and surrogate recoveries are compared on an ongoing basis with standards and surrogates obtained from suppliers of concentrated mixtures with certified concentrations with purity checks exceeding 95 percent. These comparisons are used to develop laboratory- established control limits, which are calculated at a 99-percent confidence level. Where obtainable, spiking compounds and surrogates will be The American Association for Laboratory Accreditation (A2LA)-certified reference materials procured from Supelco, ULTRA Scientific, or an equivalent A2LA-registered reference materials supplier. Table 3-2 specifies QC protocol required for each method and corrective actions to be taken when QC parameters are out of control.

Laboratory QA/QC Samples and Protocol

Analytical Batch. The basic unit for analytical QC is the QC batch. A batch consists of up to 20 environmental samples (not including laboratory QC samples) that can be processed within 24 hours or an instrument operating cycle (e.g., 12-hour GC instrument cycle), whichever is smaller. The practice of holding open a batch for a more extended period is not acceptable. Samples within a QC batch are extracted (if applicable) or analyzed together with the same method sequence, the same lots of reagents, and with manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each QC batch should be of similar composition.

Method Blank. A method blank is an artificial sample used to monitor the analytical system for interferences and contamination from glassware, reagents, and similar materials. The method blank is taken through the entire sample preparation process, and is included with each batch of extractions/digestions prepared or with each 20 samples, whichever is more frequent. Method blanks for analyses of aqueous samples will be deionized or Type II Reagent-Grade water, depending on the analysis. A clean, solid matrix (e.g., baked, acid-washed sand) will be used as a method blank sample for analyses of soil or sediment samples for most analyses.

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

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Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW6010B (ICP)	Metals (Dissolved or Total)	Method Blank	5% (one per batch of 20 or fewer samples)	<PQL[a] for all analytes	1) If concentration in associated sample is <PQL or >10X the contamination, note the blank contamination in the case narrative and report sample result. Otherwise: 2) Reanalyze blank once 3) Determine source of contamination (analyze a system blank) 3a) If source is instrument, perform maintainance, reanalyze blank and samples 3b) If source is preparation, reprep and reanalyze method blank and all samples (other than those in 1) associated with the contaminated blank.
		Matrix Spike/Matrix Spike Duplicate (MS/MSD) (Predigestion spike)	5% (one per SDG of 20 or fewer samples)	See Table 3-3 for accuracy (recovery) and precision (RPD) criteria.	1) Check calculations 2) Evaluate the System. (instrument) 3) Check LCS: If recoveries are within QC limits, flag data and note in the case narrative as attributable to matrix effects. If LCS recoveries are not within QC limits, see below.
		ICP Serial Dilution (5X)	5% (one per SDG of 20 or fewer samples)	1:5 dilution must agree within 10% D for analytes with undiluted results >50X the IDL	1) Report and flag data 2) Note in case narrative 3) No laboratory corrective action

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW6010A (Continued)		Laboratory Control Sample (LCS)	1 per preparation batch (maximum batch size of 20 samples)	See Table 3-4 for accuracy (recovery) criteria	1) Evaluate the system (instrument). See [b] 2) Recheck calculations 3) If LCS is high and associated sample results ND, note in case narrative, report sample results 4) Reanalyze LCS if appropriate. 5a) If reanalysis acceptable, reanalyze associated samples (other than those in 3) 5b) If still out, reprep and reanalyze LCS and all associated samples (other than those in 3)
	Field QC:	Equipment Blank	Once per day per sampling team for reusable equipment	<PQL[a] for all analytes	No laboratory corrective action
		Unspiked Duplicate Samples	10% (one per 10 samples)	≤30 RPD -Waters ≤40 RPD - Soils	No laboratory corrective action
		Filter Blank	One of every ten filters per filter lot	<PQL[a] for all analytes	No laboratory corrective action

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW7470A/7471A (CVAA)	Mercury (Dissolved or Total)	Method blank	1 per batch of 20 samples or less	<PQL[a] for all analytes	1) If concentration in associated sample is <PQL or >10X the contamination, note the blank contamination in the case narrative and report sample result. Otherwise: 2) Reanalyze blank once 3) Determine source of contamination (analyze a system blank) 3a) If source is instrument, perform maintainance, reanalyze blank and samples 3b) If source is preparation, reprep and reanalyze method blank and all samples (other than those in 1) associated with the contaminated blank.
		Matrix Spike/Matrix Spike Duplicate (MS/MSD) (Predigestion spike)	5% (one per SDG of 20 or fewer samples)	See Table 3-3 for accuracy (recovery) and precision (RPD) criteria.	1) Check calculations 2) Evaluate the System. (instrument) 3) Check LCS: If recoveries are within QC limits, flag data and note in the case narrative as attributable to matrix effects. If LCS recoveries are not within QC limits, see below.
		Laboratory Control Sample (LCS)	1 per preparation batch (maximum batch size of 20 samples)	See Table 3-4 for accuracy (recovery) criteria	1) Evaluate the system (instrument). See [b] 2) Recheck calculations 3) If LCS is high and associated sample results ND, note in case narrative, report sample results 4) Reanalyze LCS if appropriate. (Continued)

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

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Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW7470A/7471A (Continued)		(LCS Continued)			5a) If reanalysis acceptable, reanalyze associated samples (other than those in 3) 5b) If still out, reprep and reanalyze LCS and all associated samples (other than those in 3)
	Field QC:	Equipment Blank	Once per day per sampling team for reusable equipment	<PQL[a] for all analytes	No laboratory corrective action
		Unspiked Duplicate Samples	10% (one per 10 samples)	≤30 RPD -Waters ≤40 RPD - Soils	No laboratory corrective action
		Filter Blank	One of every ten filters per filter lot	<PQL[a] for all analytes	No laboratory corrective action
LUFT Mod SW8015 TEPH (GC/FID/PID)	TEPH (C12 - C36)	Method blank	1 per batch of 20 samples or less	<PQL[a] for all analytes	1) If concentration in associated sample is <PQL or >10X the contamination, note the blank contamination in the case narrative and report sample result. Otherwise: 2) Reanalyze blank once 3) Determine source of contamination (analyze a system blank) 3a) If source is instrument, perform maintainance, reanalyze blank and samples 3b) If source is preparation, reprep and reanalyze method blank and all samples (other than those in 1) associated with the contaminated blank.

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

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Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
CALUFT SW8015 TEPH (Continued)		Surrogate spikes	Every sample, method blank, and standard	Refer to Table 3-5 Does not apply if more than 5X dilution for extractables	1) Check calculations, standards and system 2) If surrogate is out, check instrument performance; if problem is found, correct and reanalyze sample, or proceed to 3. 3) If still unacceptable and within holding time or if positive results detected, reextract and reanalyze sample, unless chromatogram indicates interference, in which case one reanalysis is acceptable. Report both sets of results. If beyond holding time, assess impact and qualify data. Discuss in case narrative.
		Matrix Spike/Matrix Spike Duplicate (MS/MSD)	5% (one per SDG of 20 or fewer samples)	See Table 3-3 for accuracy (recovery) and precision (RPD) criteria.	1) Check calculations 2) Evaluate the System. (instrument) 3) Check LCS: If recoveries are within QC limits, flag data and note in the case narrative as attributable to matrix effects. If LCS recoveries are not within QC limits, see below.

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
CALUFT SW8015 TEPH (Continued)		Laboratory Control Sample (LCS)	1 per preparation batch (maximum batch size of 20 samples)	See Table 3-4 for accuracy (recovery) criteria	1) Evaluate the system (instrument). See [b] 2) Recheck calculations 3) If LCS is high and associated sample results ND, note in case narrative, report sample results 4) Reanalyze LCS if appropriate. 5a) If reanalysis acceptable, reanalyze associated samples (other than those in 3) 5b) If still out, reprep and reanalyze LCS and all associated samples (other than those in 3)
	Field QC:	Equipment Blank	Once per day per sampling team for reusable equipment	<PQL[a] for all analytes	No laboratory corrective action
		Unspiked Duplicate Samples	10% (one per 10 samples)	≤30 RPD -Waters ≤40 RPD - Soils	No laboratory corrective action
SW8290 (GC/HRMS)	Dioxins/Furans	Method blank	1 per batch of 20 samples or less per matrix	Ratio of a given 2,3,7,8 substituted PCDD/PCDF isomer ≤ % of the appropriate internal standard.	1) Reanalyze method blank. 2) If still exceeds and analyte conc. concentration in sample < CRQL or > 10x blank concentration, report results. 3) If noncompliant and analyte concentration in sample is between CRQL and 10x blank concentration, reextract/reanalyze affected samples.

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW8290 (Continued)		Internal Standards (surrogates are used as internal standards)	Every sample, method blank, and LCS	Refer to Table 3-5	1) Check chromatogram for interference. If found, flag data. 2) Check instrument and reanalyze the extract if a problem is found and corrected. 3) Check S/N. If < 10:1, reextract. 4) Evaluate data usability and flag as appropriate. 5) Reextract and reanalyze adversely affected samples.
		Matrix Spike/Matrix Spike Duplicate (MS/MSD) Laboratory Duplicate Sample	Not Required by the method, may be requested: 5% (one per SDG of 20 or fewer samples)	See Table 3-3 for accuracy (recovery) and precision (RPD) criteria.	1) Review data for usability. 2) Narrate outliers.
		Laboratory Control Sample (include natives.)	At a frequency of 5% (1 per 20 samples analyzed.)	See Table 3-4 for accuracy (recovery) criteria	1) Review Internal Standards, as above. 2) Evaluate data for usability. 3) If sample results are ND and CRQLs are met, no action required. 4) If samples have positives, > CRQL, reextract and reanalyze analytes outside the acceptance criteria.
	Field QC:	Equipment Blank	Once per day per sampling team for reusable equipment	<PQL[a] for all analytes	No laboratory corrective action
		Unspiked Duplicate Samples	10% (one per 10 samples)	≤30 RPD -Waters ≤40 RPD - Soils	No laboratory corrective action

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES
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Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW8310 (HPLC)	PAHs	Method blank	1 per batch of 20 samples or less	<PQL[a] for all analytes	1) If concentration in associated sample is <PQL or >10X the contamination, note the blank contamination in the case narrative and report sample result. Otherwise: 2) Reanalyze blank once 3) Determine source of contamination (analyze a system blank) 3a) If source is instrument, perform maintainance, reanalyze blank and samples 3b) If source is preparation, reprep and reanalyze method blank and all samples (other than those in 1) associated with the contaminated blank.
		Matrix Spike/Matrix Spike Duplicate (MS/MSD) or MS and Laboratory Duplicate Sample	5% (one per SDG of 20 or fewer samples)	See Table 3-3 for accuracy (recovery) and precision (RPD) criteria.	1) Check calculations 2) Evaluate the System. (instrument) 3) Check LCS: If recoveries are within QC limits, flag data and note in the case narrative as attributable to matrix effects. If LCS recoveries are not within QC limits, see below.
		Laboratory Control Sample (LCS)	1 per preparation batch (maximum batch size of 20 samples)	See Table 3-4 for accuracy (recovery) criteria	1) Evaluate the system (instrument). See [b] 2) Recheck calculations 3) If LCS is high and associated sample results ND, note in case (Continued)

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES
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Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW8310 (Continued)		LCS (Continued)			(Continued) narrative, report sample results 4) Reanalyze LCS if appropriate. 5a) If reanalysis acceptable, reanalyze associated samples (other than those in 3) 5b) If still out, reprep and reanalyze LCS and all associated samples (other than those in 3)
	Field QC:	Equipment Blank	Once per day per sampling team for reusable equipment	<PQL[a] for all analytes	No laboratory corrective action
		Unspiked Duplicate Samples	10% (one per 10 samples)	≤30 RPD -Waters ≤40 RPD - Soils	No laboratory corrective action
SW8330 (HPLC/UV)	Explosives: Nitroaromatics and Nitroamines and Nitroglycerin/PETN	Method blank	1 per batch of 20 samples or less	<PQL[a] for all analytes	1) If concentration in associated sample is <PQL or >10X the contamination, note the blank contamination in the case narrative and report sample result. Otherwise: 2) Reanalyze blank once 3) Determine source of contamination (analyze a system blank) 3a) If source is instrument, perform maintainance, reanalyze blank and samples 3b) If source is preparation, reprep and reanalyze method blank and all samples (other than those in 1) associated with the contaminated blank.

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW8330 (Continued)		Surrogate spikes	Every sample, method blank, and standard	Refer to Table 3-5 Does not apply if more than 5X dilution	1) Check calculations, standards and system 2) If surrogate is out, check instrument performance; if problem is found, correct and reanalyze sample, or proceed to 3. 3) If still unacceptable and within holding time or if positive results detected, reextract and reanalyze sample, unless chromatogram indicates interference (and for purgeables), in which case one reanalysis is acceptable. Report both sets of results. If beyond holding time, assess impact and qualify data. Discuss in case narrative.
		Matrix Spike/Matrix Spike Duplicate (MS/MSD)	5% (one per SDG of 20 or fewer samples)	See Table 3-3 for accuracy (recovery) and precision (RPD) criteria.	1) Check calculations 2) Evaluate the System. (instrument) 3) Check LCS: If recoveries are within QC limits, flag data and note in the case narrative as attributable to matrix effects. If LCS recoveries are not within QC limits, see below.
		Laboratory Control Sample (LCS)	1 per preparation batch (maximum batch size of 20 samples)	See Table 3-4 for accuracy (recovery) criteria	1) Evaluate the system (instrument). See [b] 2) Recheck calculations 3) If LCS is high and associated sample results ND, note in case (Continued)

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES
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Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
SW8330 (Continued)		LCS (Continued)			(Continued) narrative, report sample results 4) Reanalyze LCS if appropriate. 5a) If reanalysis acceptable, reanalyze associated samples (other than those in 3) 5b) If still out, reprep and reanalyze LCS and all associated samples (other than those in 3)
		Second Column or Second Detector Confirmation	100% for all positive results	Results ±50% D	1) If not confimed (NC), report results as ND 2) If 2nd column confirms, summarize primary and confirmation results with %D, or report both sets of results
	Field QC:	Equipment Blank	Once per day per sampling team for reusable equipment	<PQL[a] for all analytes	No laboratory corrective action
		Unspiked Duplicate Samples	10% (one per 10 samples)	≤30 RPD -Waters ≤40 RPD - Soils	No laboratory corrective action
SW9045C/ 150.1	pH (soil)	Laboratory Duplicate Sample	5% (one per SDG of 20 or fewer samples)	± 0.3 pH units	Obtain third value
		Laboratory Control Sample (LCS)	1 per preparation batch (maximum batch size of 20 samples)	± 0.3 pH units	1) Check calibration 2) Reanalyze LCS and affected samples
	Field QC:	Replicate (soil) Samples	10% (one per 10 samples)	± 0.3 pH units	No laboratory corrective action

TABLE 3-2. SUMMARY OF FIELD AND LABORATORY QUALITY CONTROL PROCEDURES

Method	Parameter	QC Performed	Frequency	Acceptance Criteria	Corrective Action
General Inorganics (Spikeable): 365.2 [c],	General Inorganics (Spikeable): Total Phosphorous	Method Blank	5% (one per batch of 20 or fewer samples)	<PQL[a] for all analytes	1) If concentration in associated sample is <PQL or >10X the contamination, note the blank contamination in the case narrative and report sample result. Otherwise: 2) Reanalyze blank once 3) Determine source of contamination (analyze a system blank) 3a) If source is instrument, perform maintainance, reanalyze blank and samples 3b) If source is preparation, reprep and reanalyze method blank and all samples (other than those in 1) associated with the contaminated blank.
		Matrix Spike/Matrix Spike Duplicate (MS/MSD) or MS and Laboratory Duplicate Sample (must use EAFB sample)	5% (one per SDG of 20 or fewer samples)	See Table 3-3 for accuracy (recovery) and precision (RPD) criteria.	1) Check calculations 2) Evaluate the System. (instrument) 3) Check LCS: If recoveries are within QC limits, flag data and note in the case narrative as attributable to matrix effects. If LCS recoveries are not within QC limits, see below.
ASTM D2216	Soil Moisture Control (Performed on all soil samples)	Laboratory Duplicate Sample	5%	RPD ≤ 10% calculated on percent solids	Obtain third value
	<u>Field QC:</u>	Replicate (soil) Samples	10% (one per 10 samples)	RPD ≤ 10% calculated on percent solids	No laboratory corrective action

Notes:

(a) Practical Quantitation Limits (PQLs) listed in Table 3-1.

(b) Laboratory batch control is based on preparation batches. Preparation batches use a Laboratory Control Sample (LCS) to determine batch acceptability.

The samples in the preparation batch will be considered out of control if any compound in the LCS is outside of the acceptance limits listed in Table 3-4. An out-of-control situation requires reanalysis and or re-preparation and reanalysis of the samples with appropriate quality control, or an assessment of the data if reanalysis is not possible. If any of the spiked analytes are not within control, the following corrective action will be performed:

1) If the out-of-control analyses of the LCS exceed the upper control limit and the sample results are ND, no further action is required.
2) If the out-of-control analyses of the LCS are below the lower control limit or exceed the upper control limit and the sample results for the out-of-control analyte are detected, the LCS is reanalyzed. If the reanalysis is acceptable, the method blank and all associated samples including QC samples are reanalyzed and reported.
3) If the reanalysis is not acceptable and the holding time has not expired, all associated samples are re-prepared with appropriate QC and reanalyzed. If the holding time is expired, the program QA manager is contacted to determine if the re-preparation and reanalysis should proceed.

Duplicates and Spikes. Depending on the method, duplicate samples or MS/MSDs are analyzed for each shipment for each different sample matrix. For certain methods, circumstances may dictate using duplicate samples and one spiked sample. Spiked samples that do not meet established accuracy criteria will be further evaluated under the laboratory data validation protocol. Only samples from the project will be spiked or used as duplicates. Organic matrix spiking solutions are prepared from either neat materials or sources independent of the calibration standards and contain all analytes of interest. Inorganic MSs are prepared by adding the analytes of interest at an appropriate concentration. Table 3-3 lists MS spike concentrations and MS/MSD percent recovery and RPD control limits for each method.

The laboratory data validation protocol will include accuracy and precision measurements from MS/MSDs. Individual compound recoveries will be compared with acceptance limits specified in Table 3-3. In the event a matrix spike analyte fails acceptance criteria, the MS/MSD will be reextracted/reanalyzed once. Only those target analytes that failed MS criteria must be within acceptance limits in the reextraction/reanalyses for the MS/MSD method to be considered in control.

Once it has been established that the analytes that failed acceptance criteria in the MS and/or MSD have passed acceptance criteria in the LCS, these analytes will be considered out of control due to sample matrix effects. If these analytes also fail the acceptance criteria in the LCS, impact on the data will be assessed and the incident will be discussed in the case narrative or the samples will be re-extracted/reanalyzed with appropriate QC.

All samples analyzed or prepared in a process batch without an MS and MSD will, at a minimum, have a method blank and LCS/LCSD included in their process batch. The RPD will be reported in addition to the percent recoveries in this case.

Laboratory Control Samples (LCS). LCS (method spikes) is defined as blank soil or reagent water spiked with a known amount of analyte from a source different than that used for the calibration standards and included with every batch of samples. The LCS measures method performance under interference-free conditions. LCS results, together with matrix spike results, can establish the presence of any matrix effects. LCS duplicates (LCSDs) must be prepared and analyzed for each process batch. All analytes of interest will be spiked into the LCS. Table 3-4 lists LCS spike concentrations and LCS/LCSD percent recovery and RPD control limits for each method.

The laboratory data validation protocol will include accuracy measurements from LCSs. Individual compound recoveries will be compared with LCS acceptance limits specified for each method in Table 3-4. If an LCS recovery does not meet acceptance criteria, the analyte will be considered out of control and corrective action will be required, as specified in Table 3-4. If LCS analytes that are out of control exceed the upper limit and the associated sample results are non-detected (ND), no further action is required. If LCS analytes that are out of

TABLE 3-3. CONTROL LIMITS FOR MATRIX SPIKES AND MATRIX SPIKE DUPLICATES

(Page 1 of 3)

Analytical Method	Spiking Compounds	Final Spike Concentration: Water (µg/L)	Final Spike Concentration: Soil/Sediments (mg/kg)	Laboratory Control Limits: Percent Recovery (%) Water	Laboratory Control Limits: Percent Recovery (%) Soil/Sediments	Laboratory Control Limits: Relative Percent Difference (%) Water	Laboratory Control Limits: Relative Percent Difference (%) Soil/Sediments
SW6010B	Antimony	0.1 mg/L	20	75-125	75-125	20	35
	Arsenic	0.1 mg/L	20	75-125	75-125	20	35
	Barium	0.1 mg/L	100	75-125	75-125	20	35
	Berylium	0.01 mg/L	20	75-125	75-125	20	35
	Cadmium	0.01 mg/L	10	75-125	75-125	20	35
	Chromium	0.04 mg/L	20	75-125	75-125	20	35
	Cobalt	0.1 mg/L	20	75-125	75-125	20	35
	Copper	0.04 mg/L	20	75-125	75-125	20	35
	Lead	0.1 mg/L	100	75-125	75-125	20	35
	Molybdenum	0.1 mg/L	20	75-125	75-125	20	35
	Nickel	0.1 mg/L	20	75-125	75-125	20	35
	Selenium	0.1 mg/L	20	75-125	75-125	20	35
	Silver	0.04 mg/L	20	75-125	75-125	20	35
	Thallium	0.1 mg/L	100	75-125	75-125	20	35
	Vanadium	0.04 mg/L	20	75-125	75-125	20	35
	Zinc	0.1 mg/L	100	75-125	75-125	20	35
	Aluminum	*2.0 mg/L*	*200*	75-125	75-125	20	35
	Calcium	*100 mg/L*	*10,000*	75-125	75-125	20	35
	Iron	*1.0 mg/L*	*100*	75-125	75-125	20	35
	Manganese	*0.5 mg/L*	*50*	75-125	75-125	20	35
	Magnesium	*50 mg/L*	*5000*	75-125	75-125	20	35
	Potassium	*50 mg/L*	*5000*	75-125	75-125	20	35
	Sodium	*100 mg/L*	*10,000*	75-125	75-125	20	35
SW7470A	Mercury	0.002 mg/L	-	75-125	75-125	20	35
SW7471A	Mercury	-	0.02	75-125	75-125	20	35
LUFT Mod. SW8015	Motor Oil	2 mg/L	67	60-117	60-117	35	50
SW8290(1)	Matrix:						
	2,3,7,8-TCDD	200 pg/L	20 pg/g	73-144	50-150	50	50
	2,3,7,8-TCDF	200 pg/L	20 pg/g	70-135	50-150	50	50
	1,2,3,7,8-PeCDD	1000 pg/L	100 pg/g	85-131	50-150	50	50
	1,2,3,7,8-PeCDF	1000 pg/L	100 pg/g	79-136	50-150	50	50
	2,3,4,7,8-PeCDF	1000 pg/L	100 pg/g	56-154	50-150	50	50

TABLE 3-3. CONTROL LIMITS FOR MATRIX SPIKES AND MATRIX SPIKE DUPLICATES
(Page 2 of 3)

Analytical Method	Spiking Compounds	Final Spike Concentration: Water (µg/L)	Final Spike Concentration: Soil/Sediments (mg/kg)	Laboratory Control Limits: Percent Recovery (%) Water	Laboratory Control Limits: Percent Recovery (%) Soil/Sediments	Laboratory Control Limits: Relative Percent Difference (%) Water	Laboratory Control Limits: Relative Percent Difference (%) Soil/Sediments
	1,2,3,4,7,8-HxCDD	1000 pg/L	100 pg/g	58-146	50-150	50	50
	1,2,3,6,7,8-HxCDD	1000 pg/L	100 pg/g	80-131	50-150	50	50
	1,2,3,7,8,9-HxCCDD	1000 pg/L	100 pg/g	60-154	50-150	50	50
	1,2,3,4,7,8-HxCDF	1000 pg/L	100 pg/g	77-124	50-150	50	50
	1,2,3,6,7,8-HxCDF	1000 pg/L	100 pg/g	69-135	50-150	50	50
	1,2,3,7,8,9-HxCDF	1000 pg/L	100 pg/g	58-141	50-150	50	50
	2,3,4,6,7,8-HxCDF	1000 pg/L	100 pg/g	58-140	50-150	50	50
	1,2,3,4,6,7,8-HpCDD	1000 pg/L	100 pg/g	78-134	50-150	50	50
	1,2,3,4,6,7,8-HpCDF	1000 pg/L	100 pg/g	80-115	50-150	50	50
	1,2,3,4,7,8,9-HpCDF	1000 pg/L	100 pg/g	68-151	50-150	50	50
	OCDD	2000 pg/L	200 pg/g	73-144	50-150	50	50
	OCDF	2000 pg/L	200 pg/g	64-152	50-150	50	50
(2)(3)	^{13}C-2,3,7,8-TCDD	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-2,3,7,8-TCDF	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,7,8-PeCDD	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,7,8-PeCDF	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,6,7,8-HxCDD	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,4,7,8-HxCDF	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,4,6,7,8-HpCDD	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,4,6,7,8-HpCDF	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-OCDD	4000 pg/L	400 pg/g	40-135	40-135	N/A	N/A
SW8310	Acenaphthene	4	0.27	35-135	65-135	30	35
	Acenaphthalene	4	0.27	35-135	65-135	30	35
	Anthracene	4	0.27	35-135	65-135	30	35
	Benzo(a)anthracene	4	0.27	35-135	65-135	30	35
(4)	Benzo(a)pyrene	4	0.27	39-103	50-150	30	35
	Benzo(b)fluoranthene	4	0.27	35-135	65-135	30	35
	Benzo(g,h,i)perylene	4	0.27	35-135	65-135	30	35
	Benzo(k)fluoranthene	4	0.27	35-135	65-135	30	35
	Chrysene	4	0.27	35-135	65-135	30	35
	Dibenzo(a,h)anthracene	4	0.27	35-135	65-135	30	35
	Fluoranthene	4	0.27	35-135	65-135	30	35
(4)	Fluorene	4	0.27	26-90	50-150	30	35
	Indeno(1,2,3-c,d)pyrene	4	0.27	35-135	65-135	30	35
	Naphthalene	4	0.27	35-135	65-135	30	35

TABLE 3-3. CONTROL LIMITS FOR MATRIX SPIKES AND MATRIX SPIKE DUPLICATES

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Analytical Method	Spiking Compounds	Final Spike Concentration: Water (µg/L)	Final Spike Concentration: Soil/Sediments (mg/kg)	Laboratory Control Limits: Percent Recovery (%) Water	Laboratory Control Limits: Percent Recovery (%) Soil/Sediments	Laboratory Control Limits: Relative Percent Difference (%) Water	Laboratory Control Limits: Relative Percent Difference (%) Soil/Sediments
	Phenanthrene	4	0.27	35-135	65-135	30	35
(4)	Pyrene	4	0.27	33-106	50-150	30	35
SW8330 (4)	HMX	20	0.25	65-135	65-135	20	35
(4)	RDX	20	0.25	65-135	65-135	20	35
	1,3,5-TNB	20	0.25	65-135	65-135	20	35
	1,3-DNB	20	0.25	65-135	65-135	20	35
(4)	Tetryl	20	0.25	50-150	50-150	20	35
(4)	2,4,6-TNT	20	0.25	65-135	65-135	20	35
	2,4-DNT	20	0.25	65-135	65-135	20	35
	2,6-DNT	20	0.25	65-135	65-135	20	35
	o-Nitrotoluene	20	0.25	65-135	65-135	20	35
	m-Nitrotoluene	20	0.25	65-135	65-135	20	35
	p-Nitrotoluene	20	0.25	65-135	65-135	20	35
	Nitrobenzene	20	0.25	65-135	65-135	20	35
	Nitroglycerin	200	10	50-150	50-150	50	50
	PETN	100	5.0	50-150	50-150	50	50
*160.1	-	-	-	-	-	-	-
300.0	Nitrate-N	5 mg/L	50	80-120	80-120	20	35
	Nitrite-N	5 mg/L	50	80-120	80-120	20	35
365.2	Total Phosphorous	5 mg/L	50	80-120	80-120	20	35

* No matrix spike - only laboratory control sample (see Table 3-4)
N/A Not Applicable
(1) Native compound limits are COE default limits
(2) Method default control limits. Signal-to-noise is also evaluated for data acceptability
(3) The labeled analytes are spiked into all samples. RQD will be used to compare sample/duplicate IS recoveries.
(4) These compounds will be used for laboratory control. The laboratory will not control on the other compounds, however, the control limits will be used for data validation.

TABLE 3-4. CONTROL LIMITS FOR FOR LABORATORY CONTROL SAMPLES
(Page 1 of 3)

		Final Spike Concentration		Laboratory Control Limits			
Analytical	Spiking	Water	Soil/Sediments	Percent Recovery (%)		Relative Percent Difference (%)	
Method	Compounds	(µg/L)	(mg/kg)	Water	Soil/Sediments	Water	Soil/Sediments
SW6010B	Antimony	0.1 mg/L	20	75-125	75-125	20	35
	Arsenic	0.1 mg/L	20	75-125	75-125	20	35
	Barium	0.1 mg/L	100	75-125	75-125	20	35
	Berylium	0.01 mg/L	20	75-125	75-125	20	35
	Cadmium	0.01 mg/L	10	75-125	75-125	20	35
	Chromium	0.04 mg/L	20	75-125	75-125	20	35
	Cobalt	0.1 mg/L	20	75-125	75-125	20	35
	Copper	0.04 mg/L	20	75-125	75-125	20	35
	Lead	0.1 mg/L	100	75-125	75-125	20	35
	Molybdenum	0.1 mg/L	20	75-125	75-125	20	35
	Nickel	0.1 mg/L	20	75-125	75-125	20	35
	Selenium	0.1 mg/L	20	75-125	75-125	20	35
	Silver	0.04 mg/L	20	75-125	75-125	20	35
	Thallium	0.1 mg/L	100	75-125	75-125	20	35
	Vanadium	0.04 mg/L	20	75-125	75-125	20	35
	Zinc	0.1 mg/L	100	75-125	75-125	20	35
	Aluminum	*2.0 mg/L*	*200*	75-125	75-125	20	35
	Calcium	*100 mg/L*	*10,000*	75-125	75-125	20	35
	Iron	*1.0 mg/L*	*100*	75-125	75-125	20	35
	Manganese	*0.5 mg/L*	*50*	75-125	75-125	20	35
	Magnesium	*50 mg/L*	*5000*	75-125	75-125	20	35
	Potassium	*50 mg/L*	*5000*	75-125	75-125	20	35
	Sodium	*100 mg/L*	*10,000*	75-125	75-125	20	35
SW7470A	Mercury	0.002 mg/L	-	75-125	75-125	20	35
SW7471A	Mercury	-	0.02	75-125	75-125	20	35
LUFT Mod. SW8015	Motor Oil	2 mg/L	67	60-117	60-117	35	50
SW8290(1)	Matrix:						
	2,3,7,8-TCDD	200 pg/L	20 pg/g	73-144	50-150	50	50
	2,3,7,8-TCDF	200 pg/L	20 pg/g	70-135	50-150	50	50
	1,2,3,7,8-PeCDD	1000 pg/L	100 pg/g	85-131	50-150	50	50
	1,2,3,7,8-PeCDF	1000 pg/L	100 pg/g	79-136	50-150	50	50
	2,3,4,7,8-PeCDF	1000 pg/L	100 pg/g	56-154	50-150	50	50

TABLE 3-4. CONTROL LIMITS FOR FOR LABORATORY CONTROL SAMPLES
(Page 2 of 3)

		Final Spike Concentration		Laboratory Control Limits			
Analytical	Spiking	Water	Soil/Sediments	Percent Recovery (%)		Relative Percent Difference (%)	
Method	Compounds	(µg/L)	(mg/kg)	Water	Soil/Sediments	Water	Soil/Sediments
	1,2,3,4,7,8-HxCDD	1000 pg/L	100 pg/g	58-146	50-150	50	50
	1,2,3,6,7,8-HxCDD	1000 pg/L	100 pg/g	80-131	50-150	50	50
	1,2,3,7,8,9-HxCCDD	1000 pg/L	100 pg/g	60-154	50-150	50	50
	1,2,3,4,7,8-HxCDF	1000 pg/L	100 pg/g	77-124	50-150	50	50
	1,2,3,6,7,8-HxCDF	1000 pg/L	100 pg/g	69-135	50-150	50	50
	1,2,3,7,8,9-HxCDF	1000 pg/L	100 pg/g	58-141	50-150	50	50
	2,3,4,6,7,8-HxCDF	1000 pg/L	100 pg/g	58-140	50-150	50	50
	1,2,3,4,6,7,8-HpCDD	1000 pg/L	100 pg/g	78-134	50-150	50	50
	1,2,3,4,6,7,8-HpCDF	1000 pg/L	100 pg/g	80-115	50-150	50	50
	1,2,3,4,7,8,9-HpCDF	1000 pg/L	100 pg/g	68-151	50-150	50	50
	OCDD	2000 pg/L	200 pg/g	73-144	50-150	50	50
	OCDF	2000 pg/L	200 pg/g	64-152	50-150	50	50
(2)(3)	^{13}C-2,3,7,8-TCDD	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-2,3,7,8-TCDF	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,7,8-PeCDD	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,7,8-PeCDF	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,6,7,8-HxCDD	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,4,7,8-HxCDF	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,4,6,7,8-HpCDD	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-1,2,3,4,6,7,8-HpCDF	2000 pg/L	200 pg/g	40-135	40-135	N/A	N/A
(2)(3)	^{13}C-OCDD	4000 pg/L	400 pg/g	40-135	40-135	N/A	N/A
SW8310	Acenaphthene	4	0.27	35-135	65-135	30	35
	Acenaphthalene	4	0.27	35-135	65-135	30	35
	Anthracene	4	0.27	35-135	65-135	30	35
	Benzo(a)anthracene	4	0.27	35-135	65-135	30	35
(4)	Benzo(a)pyrene	4	0.27	39-103	50-150	30	35
	Benzo(b)fluoranthene	4	0.27	35-135	65-135	30	35
	Benzo(g,h,i)perylene	4	0.27	35-135	65-135	30	35
	Benzo(k)fluoranthene	4	0.27	35-135	65-135	30	35
	Chrysene	4	0.27	35-135	65-135	30	35
	Dibenzo(a,h)anthracene	4	0.27	35-135	65-135	30	35
	Fluoranthene	4	0.27	35-135	65-135	30	35
(4)	Fluorene	4	0.27	26-90	50-150	30	35
	Indeno(1,2,3-c,d)pyrene	4	0.27	35-135	65-135	30	35
	Naphthalene	4	0.27	35-135	65-135	30	35

TABLE 3-4. CONTROL LIMITS FOR FOR LABORATORY CONTROL SAMPLES
(Page 3 of 3)

		Final Spike Concentration		Laboratory Control Limits			
Analytical	Spiking	Water	Soil/Sediments	Percent Recovery (%)		Relative Percent Difference (%)	
Method	Compounds	(µg/L)	(mg/kg)	Water	Soil/Sediments	Water	Soil/Sediments
	Phenanthrene	4	0.27	35-135	65-135	30	35
(4)	Pyrene	4	0.27	33-106	50-150	30	35
SW8330 (4)	HMX	20	0.25	65-135	65-135	20	35
(4)	RDX	20	0.25	65-135	65-135	20	35
	1,3,5-TNB	20	0.25	65-135	65-135	20	35
	1,3-DNB	20	0.25	65-135	65-135	20	35
(4)	Tetryl	20	0.25	50-150	50-150	20	35
(4)	2,4,6-TNT	20	0.25	65-135	65-135	20	35
	2,4-DNT	20	0.25	65-135	65-135	20	35
	2,6-DNT	20	0.25	65-135	65-135	20	35
	o-Nitrotoluene	20	0.25	65-135	65-135	20	35
	m-Nitrotoluene	20	0.25	65-135	65-135	20	35
	p-Nitrotoluene	20	0.25	65-135	65-135	20	35
	Nitrobenzene	20	0.25	65-135	65-135	20	35
	Nitroglycerin	200	10	50-150	50-150	50	50
	PETN	100	5.0	50-150	50-150	50	50
160.1	TDS	100 mg/L	-	80-120	-	20	-
300.0	Nitrate-N	5 mg/L	50	80-120	80-120	20	35
	Nitrite-N	5 mg/L	50	80-120	80-120	20	35
365.2	Total Phosphorous	5 mg/L	50	80-120	80-120	20	35

N/A Not Applicable
(1) Native compound limits are COE default limits
(2) Method default control limits. Signal-to-noise is also evaluated for data acceptability
(3) The labeled analytes are spiked into all samples. RQD will be used to compare sample/duplicate IS recoveries.
(4) These compounds will be used for laboratory control. The laboratory will not control on the other compounds, however, the control limits will be used for data validation.

control are below the lower acceptance limit, the LCS, blank, and associated samples are reanalyzed. If the reanalysis does not yield acceptable data, the samples are re-extracted with appropriate QC, if the samples are still within holding times. If these analyses also fail the acceptance criteria in the LCS, impact on the data will be assessed and the incident will be discussed in the case narrative.

Surrogate Compounds. For GC and GC/MS analyses, the analytical process includes the addition, subsequent detection, and recovery calculations of surrogate spiking compounds. Surrogate compounds are added to every sample at the beginning of the sample preparation, and the surrogate recovery is used to monitor matrix effects and sample preparation. Compounds that meet the following criteria are suitable surrogate compounds:

- Compounds not requested for analysis
- Compounds that do not interfere with the determination of required analytes
- Compounds that are not naturally occurring, yet are chemically similar to the required analytes
- Compounds exhibiting similar response to analytes under determination. Samples are re-extracted/reanalyzed once when surrogate recovery is outside control limits. Table 3-5 specifies the surrogate spike compounds, concentrations, and percent recovery control limits for the methods in this project. Table 3-2 specifies corrective actions required for each method when surrogates are out of control.

Internal Standards. Internal standards are compounds not found in the sample that are added at the time of analysis and used to quantitate results and correct for injection variability. Method SW8290 employs the use of internal standards for quantitation, calibration, and instrument optimization.

Reagents. Laboratory reagent water that meets the requirements of Type II reagent water, as described in ASTM Part 11, is checked daily. The resistivity of the water is measured and recorded in a logbook. Blanks are routinely analyzed for purity and accompany each batch tested.

High-purity reagents are purchased as dictated by each test method and are documented by batch, lot number, and supplier, as well as time period of laboratory use (date opened, date depleted).

Establishment of Control Limits. Each laboratory monitors the percent spike recovery in LCS, MS and MSD, and the surrogate recovery in all samples where surrogates are appropriate. The RPD in MS/MSD or sample/duplicate, depending on the method, is also monitored. From these results, in-house control limits are calculated. The MS, LCS, and surrogate acceptance limits are

periodically updated. Before an update occurs, the laboratory will notify Earth Tech.

Spikes and duplicates/spike duplicates will be run for each different matrix and at least once for every 20 samples or each batch. Surrogate spikes are used in every sample where appropriate for the method.

Control charts have been established to monitor trends, warning, or out-of-control situations as they happen. After a minimum of 20 results have been obtained for a spiked blank, spiked sample, or spiked duplicate for each particular analysis, the mean result and its standard deviation will be tabulated. The control chart will be a graph of the mean value line with upper and lower warning control lines. The warning limit will be set at ±2 standard deviations of the mean and the out-of-control limits at ±3 standard deviations of the mean. This will be performed for each procedure and matrix type. Results from the same matrix type and procedure will be plotted for the most recent 20 data points. Control limits are evaluated periodically and updated as appropriate.

3.2.5.3 Quality Control (QC) Procedures and Control Limits.

Summaries of QC procedures for selected methods are provided in Table 3-2. See laboratory method protocols for details.

Criteria for evaluating matrix spike QC data are presented in Table 3-3. Percent recovery and RPD are listed for each method, matrix, and spiking compound. Spike concentrations are also included in the table. Table 3-4 shows the QC criteria and control limits for LCSs. Surrogate recovery criteria are listed in Table 3-5. Laboratory-established criteria are used for QC criteria except in the case of metals, for which standard EPA Contract Laboratory Program (CLP) criteria will be used.

3.2.5.4 Procedures Used to Assess Data Precision, Accuracy and Completeness.

The two aspects of data quality of primary concern are precision and accuracy. Accuracy reflects the degree to which the measured value represents the actual or "true" value for a given parameter and includes elements of both bias and precision. Precision is a measure of the variability associated with the measurement system. The completeness of the data will be evaluated based upon the valid data percentage of the total tests conducted.

Control charts are useful tools in assessing QC efforts through graphical displays of a parameter and its variability over time. The parameter plotted is related to control sample testing, either in terms of percent recovery or RPD in the case of duplicates.

Unless otherwise noted, control chart ranges span ± 2 and ± 3 standard deviations from the mean. A Gaussian distribution will provide 5 percent outliers from 2 standard deviations. QC results require corrective action referencing the

TABLE 3-5. CONTROL LIMITS FOR SURROGATE SPIKES

Analytical Method	Anticipated Spiking Compounds (Surrogates)	Final Spike Concentration Water (µg/L)	Final Spike Concentration Solids (mg/kg)	Laboratory Control Limits Percent Recovery (%) Samples Water	Samples Solids	Blanks and LCS Water	Blanks and LCS Solids
LUFT/Mod SW8015 TEPH (C12-C36)	o-Terphenyl	0.10 mg/L	3.3	49-106	60-117	51-109	60-111
SW8330	2,4-Dinitrofluorobenzene	20	0.25	65-135	65-135	65-135	65-135
SW8310	o-Terphenyl	4	0.27	10-88	65-135	47-102	65-135
						RPD	RPD
SW8290	$^{13}C_{12}$-2,3,7,8-TCDD	2000 pg/L	200 pg/g	40-135	40-135	50	50
	$^{13}C_{12}$-1,2,3,7,8-TCDF	2000 pg/L	200 pg/g	40-135	40-135	50	50
	$^{13}C_{12}$-1,2,3,7,8-PeCDD	2000 pg/L	200 pg/g	40-135	40-135	50	50
	$^{13}C_{12}$-1,2,3,7,8-PeCDF	2000 pg/L	200 pg/g	40-135	40-135	50	50
	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	2000 pg/L	200 pg/g	40-135	40-135	50	50
	$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	2000 pg/L	200 pg/g	40-135	40-135	50	50
	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	2000 pg/L	200 pg/g	40-135	40-135	50	50
	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	2000 pg/L	200 pg/g	40-135	40-135	50	50
	$^{13}C_{12}$-OCDD	4000 pg/L	400 pg/g	40-135	40-135	50	50

Notes:
Surrogates are to be spiked into and used to control all standards, samples (including environmental samples, LCSs, and field QC samples) and blanks.

Surrogate control limits are to be established based on historical data. In the absence of sufficient historical data, control limits are estimated, and will be established once historical data is available.

NA = Not Analyzed

TBD=To be determined.

sample batch related to the out-of-control QC. A group of seven QC data points that occur sequentially above or below the calculated mean also indicates the need for corrective action.

Precision. QC procedures, such as control sample analyses and replicate analyses, represent the primary mechanism for evaluating measurement data variability or precision. Replicate analyses will be used to define analytical replicability, while results for replicate samples may be used to define the total variability (replicability) of the sampling/analytical system as a whole.

Control limits for control sample analyses, acceptability limits for replicate analyses, and response factor agreement criteria specified herein are based upon precision in terms of the relative standard deviation (RSD), or RPD. The standard deviation is a measure of the average distance of individual observations from the mean. It is usually denoted "s" and defined as:

$$s = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \left[\sum_{i=1}^{n} x_i\right]^2 / n}{n-1}}$$

In this equation, n is the number of observations, and x_i is the ith observation.

The percent RSD is a measure of variability that is adjusted for the magnitude of the values in the sample:

$$\%RSD = \frac{Standard\ Deviation}{Sample\ Mean} \ x\ 100$$

The percent RSD is used when the size of the standard deviation changes with the size of the mean.

RPD is another measure of variability that is adjusted for the magnitude of the measured values. It is used only when the sample contains only two observations and is given by:

$$RPD = \frac{|X_1 - X_2|}{(X_1 + X_2)/2} \ x\ 100$$

where X_1 and X_2 are duplicate sample measurement results. RPD is directly related to RSD for duplicate results by:

$$RPD = \sqrt{2}\ RSD$$

RSD is used for calculating precision of response factors in calibration procedures and acceptability of the calibration. RPD is calculated on sample duplicates or matrix spike/matrix spike duplicates. The arithmetic mean and standard deviation of the RPDs are calculated, and the upper control limits, set at ± 3 standard deviations, constitute the acceptance criteria for precision. RPDs are based on MS/MSD or laboratory duplicate analyses. RPD for field measurements are based on sample duplicates. RPDs cannot be calculated in the instance that one or both values are non-detects. In these cases an evaluation will be made during data validation on the replication.

Accuracy. For surrogate compounds, laboratory control samples, and continuing calibration check standards, a database of percent recovery is collected. The calculation formula for percent recovery is:

$$\%\ Recovery = \frac{Concentration\ found}{Concentration\ spiked}\ x\ 100$$

A similar calculation used to determine the performance of a method for recovery of a spike concentration added to a sample is the percent spike recovery:

$$\%\ Spike\ Recovery = \frac{Value\ of\ sample\ plus\ spike - Value\ of\ unspiked\ sample}{Value\ of\ spike\ added}\ x\ 100$$

The arithmetic mean and standard deviation of the percent (spike) recoveries are calculated on a minimum of 20 points. From this information, warning limits and control limits for accuracy are determined. Warning limits are defined as mean ±2 standard deviations. Control limits are mean ±3 standard deviations. The percent recovery of each subsequent QC sample is plotted on a control chart and compared with the calculated control limits.

For matrix spikes, the assignable cause for recoveries outside acceptable limits may be, and often is, due to matrix interferences. The analytical system performance will be checked by analysis of a LCS. If a matrix effect is confirmed by acceptable performance on the LCS, the MS/MSD data will be flagged. These LCS results will provide another measure of accuracy of the measurement data.

Blanks will make up one other group of QC checks that will address measurement bias. Instead of assessing and controlling overall accuracy, field and laboratory blanks will be used to control bias due to sample contamination and to assess the extent to which this source of bias affects the measurement results. Since sample contamination generally occurs at relatively low concentrations, contamination effects are most pronounced, in terms of relative error, for low-concentration samples.

Method blanks will be used to control contamination introduced during sample preparation and analysis. Blank acceptability is detailed in Section 3.4.1 of the QAPP for laboratories and in Section 3.4.2 for data validation.

Field blanks will be used primarily to assess the overall magnitude and extent of contamination. Contamination introduced during sample collection may be estimated from the difference between field and laboratory blank results. Some types of field blanks, such as equipment blanks, will be used primarily in a qualitative role.

Completeness. Completeness for each parameter is calculated as:

$$Completeness = \frac{Number\ of\ successful\ analyses\ per\ method}{Number\ of\ requested\ analyses\ per\ method}\ x\ 100$$

Factors that adversely affect completeness objectives include:

- Receipt of samples in broken containers
- Receipt of samples in which COC or sample integrity is compromised in some way
- Samples received with volume insufficient to perform initial analyses or repeat analyses, if initial efforts do not meet QC acceptance criteria
- Improperly preserved samples, causing the analytical results to be unusable
- Samples held in the field or laboratory longer than expected, thereby jeopardizing holding time requirements, causing the analytical results to be unusable
- Samples for which analytical QC acceptance criteria are not met, causing the analytical results to be unusable
- Rejection of sample results.

Despite strict adherence to a QA plan, random error will occur in laboratory operations. Because the laboratories are committed to minimizing these errors, the following level of completeness will be the minimum acceptable practice for all laboratory operations:

- At least 95 percent of all analytical batches reported will have acceptable quality control results.
- At least 95 percent of all analytical methods will be in control.

3.2.6 Instrument/Equipment Testing, Inspection, and Maintenance

The primary objective of a preventive maintenance program is to help ensure the timely and effective completion of a measurement effort by minimizing the down time of crucial sampling and/or analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas: maintenance responsibilities; maintenance schedules; and adequate inventory of critical spare parts and equipment.

3.2.6.1 Maintenance Responsibilities.

Maintenance responsibilities for laboratory equipment are assigned to the respective laboratory managers. The laboratory managers then establish maintenance procedures and schedules for each major equipment item. These are contained in the maintenance logbooks assigned to each instrument.

3.2.6.2 Maintenance Schedules.

The effectiveness of any maintenance program depends to a large extent on adherence to specific maintenance schedules for each major equipment item. A specific schedule is established for all routine maintenance activities. Other maintenance activities may also be identified as requiring attention on an as-needed basis. Manufacturers' recommendations and/or sample throughput provide the basis for the established maintenance schedules, and manufacturers' service contracts provide primary maintenance for many major instruments (e.g., GC/MS instruments, atomic absorption spectrometers, analytical balances). Maintenance activities for each instrument are documented in a maintenance log that indicates the required frequency for each procedure and provides for dated entries. A list of laboratory instrumentation, spare parts for project laboratory equipment, and maintenance schedules, will be maintained and available for inspection at the laboratory.

3.2.6.3 Spare Parts.

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment down time. This inventory emphasizes those parts (and supplies) that are subject to frequent failure, have limited useful lifetimes, or cannot be obtained in a timely manner should failure occur.

The laboratory manager is responsible for maintaining an adequate inventory of necessary spare parts. Sufficient equipment must be on hand to continue analyses in the event that an instrument encounters problems. In addition to backup instrumentation, a supply of spare parts such as GC columns, fittings and septums, atomic absorption lamps, mirrors and diaphragms, graphite furnace tubes, and other ancillary equipment must be maintained.

3.2.7 Laboratory Instrument Calibration Procedures and Frequency

Analytical instruments will be calibrated using traceable standards in accordance with the specified analytical methods and manufacturers' procedures. At a minimum, calibration procedures, at a minimum, include the equipment to be calibrated, the reference standards used for calibration and calibration verification, the calibration techniques and the sequential actions, acceptable performance tolerances, frequency of calibration verification, and calibration documentation format. Records of standard preparation and instrument calibration will be maintained. The analysis daily benchlogbook, maintained for each analytical instrument, will include at a minimum: the date and time of calibration, the initials of the person performing the calibration, the calibrator reference number and concentration. Table 3-6 provides a summary of laboratory calibration practices for the project.

Note that the analysis and selective reporting of duplicate continuing calibration verification (CCV) standards is not an acceptable practice. If duplicate CCVs are analyzed, results for CCVs bracketing reported sample or QC results must be reported and applied for corrective action purposes. If sample or QC results are reported from before and after a pair of CCVs, results for both CCVs must be reported and results applied to bracketed samples.

3.2.7.1 Standards.

When available, standards will be A2LA-certified reference materials purchased from Supelco, ULTRA Scientific, or an equivalent registered reference materials supplier. These standards are used for calibration standards. Whenever possible, standards traceable to EPA or NIST standards will be maintained for use as an independent viability check (IVC) of the reference materials purchased for calibration of instrumentation. NIST standards are available from the NIST. Wherever practicable, the multipoint calibration curve will include a standard at a concentration at or below the PQL.

A standard logbook is used to document the preparation of standards and provide a means to trace each solution to the starting materials. Each entry is dated and signed by the preparer. The following information is documented for each standard:

- Name of standard solution
- Lot number and manufacturer
- Initial concentration of each compound or solution
- Volume of each standard and solvent used
- A unique identification number to track the standard used
- Final volume of solution
- Final concentration of solution components
- Date prepared and initials of person who prepared the standard
- Expiration date.

TABLE 3-6. SUMMARY OF CALIBRATION PROCEDURES
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Method	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
SW6010B (ICP)	Metals (Total and Dissolved)	Initial Calibration: High calibration standard and a blank for all analytes.	Before initial sample analysis or every 24 hours; whenever major modification are made to the system; or if continuing calibration acceptance criteria are not met	%RSD <5%	1) Reanalyze the standard(s) 2) Prepare and analyze new standard(s) 3) Recalibrate following system maintenance.
		Initial calibration verification (ICV) (instrument check standard)	After initial calibration	90-110% of expected value	1) Reanalyze ICV. 2)Repeat Initial Calibration.
		Initial calibration blank (ICB)	After every ICV	<PQL[a] for each analyte	1) Repeat Initial Calibration blank.
		ICP interference check	Run at beginning of daily run, after 8 hours and end of run	80-120% of true value for EPA check sample elements	1) Verify calibration as necessary 2) Verify IECS and update as necessary 3) Recalibrate
		Continuing calibration verification (CCV)	Every 10 samples and at the end of the analytical run.	90-110% of expected value	1) Reanalyze CCV. If acceptable, reanalyze all samples since last acceptable CCV. 2) Repeat Initial Calibration. Reanalyze all samples since last acceptable CCV.
		Continuing calibration blank (CCB)	After every CCV and at the end of the analytical run.	<PQL[a] for each analyte	1) Reanalyze CCB. 2) Rerun affected samples [b] back to last acceptable CCB.

TABLE 3-6. SUMMARY OF CALIBRATION PROCEDURES
(Page 2 of 6)

Method	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
SW7470A/SW7471A	Mercury	Multipoint calibration (minimum three points, five for mercury)	Daily prior to analyses	r ≥ 0.995	Recalibrate
		Calibration blank	After initial calibration and after each continuing calibration verification	<PQL [a] for each analyte	1) Rerun 2) Clean system 3) Rerun affected samples [b] back to last acceptable CCB.
		Initial calibration verification (ICV)	After calibration	± 20%	1) Reanalyze standard 2) Recalibrate
		Continuing calibration verification (CCV)	10%, plus end of run	Same as initial calibration check	1) Reanalyze standard 2) Recalibrate 3) Reanalyze affected samples
LUFT Modified SW8015/SW8021A (GC/FID/PID)	Total Petroleum Hydrocarbons	Multipoint calibration (minimum five points) for motor oil or appropriate fuel for C12-C36	Initially and as required	RSD ≤ 20% or r ≥ 0.995[c]	1) Evaluate system 2) Recalibrate
		Continuing calibration verification standard for each of: gasoline, diesel and jet fuel	Daily and after every 10 samples	± 15% Difference	1) Evaluate system 2) Repeat calibration check 3) Recalibrate 4) Reanalyze affected samples

TABLE 3-6. SUMMARY OF CALIBRATION PROCEDURES
(Page 3 of 6)

Method	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
SW8290 (GC/MS)	Dioxins/Furans	Tune using PFK	Once per 12 hours, prior to sample analysis	Resolving power ≥ 10,000 at m/z=304.9824 & m/z 380.9760 + 5 ppm of expected mass	1)Retune instrument. 2)Reanalyze PFK.
		Window defining mix (WDM) Column Performance Check Solution (CPSM)	Prior to ICAL, once per 12 hours prior to sample analysis	Used to set retention times. CPSM must have ≤ 25% valley resolution for 2378-TCDD	1) Readjust windows. 2) Evaluate system. 3) Perform maintenance. 4) Reanalyze WDM/CPSM.
		Multipoint calibration (5 points, ICAL) for all analytes	Initially and as required	Int. std %RSD ≤ 30% Natives %RSD ≤ 20% Retention time must bewithin -1 to +3 seconds of labeled IS or 0.005 RRT units. Ion ratios within Table A limits, and S/N ≥ 2.5	1) Evaluate system. 2) Recalibrate.
		Daily continuing calibration standard (CCAL).	At the beginning of a 12 hour sequence, prior to sample analysis and to close 12 hours of sample analysis	%D of IS ≤ 30% from avg RRF (ICAL). %D of natives ≤ 20% from avg RRF (ICAL). RT must be within -1 to +3 seconds of labeled IS or 0.005 RRT units. Ion ratios are within limits (see Footnote D)	1) Evaluate system. 2) Reanalyze CCAL. 3) Recalibrate for beginning CCAL as necessary. 4) Assess impact on data for ending CCAL

TABLE 3-6. SUMMARY OF CALIBRATION PROCEDURES
(Page 4 of 6)

Method	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
SW8310 (HPLC/UV)	PAHs	Multipoint calibration (minimum five points) for all analytes	Initially and as required. Use RF with area closest to sample area.	$r \geq 0.995$ or average % RSD for RF $\leq$ 20%[c]	Recalibrate
		Initial calibration (second source) verification standard (ICV)	Immediately after initial calibration, Prior to analysis	±20%	Repeat calibration
SW8310 (Continued)	PAHs	Continuing calibration verification (CCV)	Every 10 samples (excluding CCVs and instrument blanks) and at end of sequence	± 20%	1) Reanalyze standard 2) Racalibrate 3) Reanalyze affected samples
		Retention time window calculated for each analyte	Each initial calibration and calibration verification	± 3 standard deviation from 72-hour study	1) Perform maintenance 2) Reanalyze all samples analyzed since the last retention time check

TABLE 3-6. SUMMARY OF CALIBRATION PROCEDURES
(Page 5 of 6)

Method	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
SW8330 (HPLC/UV)	Nitroaromatics and Nitramines	Multipoint calibration (minimum five points) for all analytes	Initially and as required	r ≥ 0.995 or average % RSD for RF ≤ 20%[c]	1) Evaluate system 2) Recalibrate
		Initial calibration (second source) verification standard (ICV)	Immediately after initial calibration, Prior to analysis	Average RF±15% D from expected concentration	1) Evaluate system 2) Repeat calibration check 3) Recalibrate if still out 4) Reanalyze affected samples
		Calibration check standard (CCV)	Daily before sample analysis, every 10 samples (excluding CCVs and instrument blanks) and at end of sequence	±15% D for each compound; average must be ≤15%D for all compounds, or corrective action required	1) Evaluate system 2) If >15% and samples ND, report data and evaluate standards for trends 3) Reanalyze samples subsequent to last acceptable CCV 4) Perform new ICV as needed 5) Recalibrate as necessary
		Retention time window calculated for each analyte	Each initial calibration and calibration verification	± 3 standard deviation from 72-hour study	1) Perform maintenance 2) Reanalyze all samples analyzed since the last retention time check
SW9045C	pH	Two-point calibration	Prior to analysis	Measured value within ± 0.1 pH unit	1) Recalibrate 2) See instrument manual

Notes:

[a] Practical Quantitation Limits (PQLs) listed in Table 3-1.

TABLE 3-6. SUMMARY OF CALIBRATION PROCEDURES
(Page 6 of 6)

(b) Affected samples are samples with detected results for the analyte in question <5X the blank contamination (10X for common laboratory contaminants).

(c) If the average %RSD for all compounds >20% for GC or >15% for GC/MS, must use r or r^2 for all compounds. The use of r/ r^2 or % RSD is calibration specific. This acceptance criteria cannot be used interchangeably for a single calibration event.

(d) The acceptance criteria for spectral ion intensities are given below:

PCDDs	Selected Ions (m/z)	Relative Intensity	PCDFs	Selected Ions (m/z)	Relative Intensity
Tetra	320/322	0.65-0.89	Tetra	304/306	0.65-0.89
Penta	356/358	1.24-1.86	Penta	340/342	1.24-1.86
Hexa	390/392	1.05-1.43	Hexa	374/376	1.05-1.43
Hepta	424/426	0.88-1.20	Hepta	408/410	0.88-1.20
Octa	458/460	0.76-1.02	Octa	442/444	0.76-1.02

Internal Standards			Recovery Standards		
^{13}C-TCDF	316/318	065-089	^{13}C-TCDD	332/334	0.65-0.89
^{13}C-TCDD	332/334	0.65-0.89	^{13}C-HxCDD	402/404	1.05-1.43
^{13}C-HxCDD	402/404	1.04-1.43			
^{13}C-HpCDF	420/422	0.88-1.20			
^{13}C-OCDD	470/472	0.76-1.02			

Standards are labeled by:

- Reference to standard log
- Identification of material or method
- Nominal concentration
- Preparation and expiration dates
- Identification of preparer.

Individual entries are described in reagent sections of SOPs describing standard solutions required for analysis. The final check of standard viability is analysis and subsequent comparison against a certified traceable standard independent of the prepared working standard.

Stock and working solutions must be prepared fresh as often as required by their stability and must be checked regularly for signs of deterioration (e.g., discoloration, formation of precipitates, and changes in concentrations). Stock and working solutions will be discarded if signs of discoloration are evident or on their expiration date. Expired standards may be revalidated by comparison with fresh standards.

Stock solutions for volatile organic compounds (VOCs) should not be held for more than 30 days. Working calibration standards should be prepared fresh weekly. Stock solutions for SVOCs should not be held for more than 12 months. Dilutions below 1 ppm should not be held more than 30 days.

3.2.7.2 Calibration Procedures.

Calibration procedures for field methods are presented in Section 2.12 of the FSP. For laboratory analytical methods, calibration procedures for each type of instrument or technique are discussed below. Method-specific procedures and acceptance criteria are listed in Table 3-6.

Inductively Coupled Plasma (ICP). The ICP will be calibrated daily before sample analysis. The calibration method chosen from the ICP computer method file must be appropriate for the analysis requested. Calibration for the elements of interest is accomplished by aspirating calibration standards in order according to instructions in the SOP. The percent RSD for the elements in the standards aspirated should be equal to or less than 5. If the RSDs are higher than this limit, the standard must be reaspirated. All elements in the initial calibration verification and interference check standards will be within ±10 percent and ±20 percent of the true value, respectively. If an element is not within these limits, a recalibration for that element is necessary. Continuing calibration check standards will be run every 10 samples with an acceptance limit of ±10 percent of the true value. If an element does not meet QC limits, sample analysis will be stopped and recalibration for that element performed.

Atomic Absorption (AA). Daily calibration is performed on both AA flame, graphite furnace, and cold vapor techniques. A minimum of three concentrations are run to optimize sensitivity and instrument linearity. If the

correlation coefficient is $\leq$0.995, additional calibration runs are performed. Background correction for light scattering, ionization, and spectral interference is used.

Atomic Absorption (AA) - Cold Vapor. Calibration of the vapor accessory and preparation of calibration standards for mercury determinations will be performed daily. Standards are prepared by successive dilutions of a stock mercury standard with 5 percent HNO_3. The calibration standards and the calibration blank are prepared with the same reagents in the same proportions that are used for sample preparation. A calibration blank and a minimum of five standards in increasing concentrations are read for calibration. Calibration verification is performed every 10 samples, with an acceptance limit of ±20 percent of the true value. If this criteria is not met, sample analysis will be stopped and recalibration performed.

Gas Chromatography (GC). The external standard calibration technique is used for calibrating the gas chromatograph. Calibration standards are prepared according to the standard operating procedure for the method.

A calibration curve is prepared for each analyte of interest at five concentration levels for SW846 8000 series methods, including the LUFT Mod. 8015 methods. One of these standards should be slightly above the MDL. The other standards should bracket the range expected in real samples but should not exceed the working range of the detector being used.

A reagent water blank is run prior to calibration to show the absence of interferences. The calibration standards are introduced into the system, and a calibration curve is generated for each analyte. The calibration factor is calculated as follows:

$$Calibration\ factor\ (CF) = \frac{Total\ Area\ of\ Peak*}{Mass\ injected\ (in\ nanograms)}$$

For multiresponse analytes (e.g., polychlorinated biphyenyls [PCBs], the area from at least five major peaks will be used for quantitation.

Acceptance criteria for instrument response linearity checks are based upon the correlation coefficient, r, of the best fit line for the calibration data points or the RSD for calibration factors calculated for each analyte at each level over the working range. The correlation coefficient is calculated as:

$$r = \frac{n\sum(xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}$$

Where:

x = Calibration concentrations
y = Instrument response (peak area)
n = Number of calibration points (x,y data pairs).

The percent RSD is calculated as:

$$\%\ RSD = \frac{SD}{\bar{x}} \times 100$$

where:

$\bar{x}$ = Mean of five initial calibration factors for a compound
SD = Standard deviation of the calibration factors for a compound.

$$SD = s = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \left[\sum_{i=1}^{n} x_i\right]^2 / n}{n-1}}$$

If the coefficient of correlation, r, is $\geq$ 0.995, or the RSD $\leq$ 20 percent for all compounds, the calibration is valid. The use of r or percent RSD is instrument-specific. This acceptance criterion cannot be used interchangeably on a single instrument.

The calibration curve or calibration factor must be checked daily by injecting at least one calibration standard, usually the mid-range standard.

The percent difference is calculated and should be within ± 15 percent.

$$Percent\ Difference = \frac{R_1 - R_2}{R_1}\ x\ 100$$

Where:

R_1 = Average calibration factor from initial calibration
R_2 = Calibration factor from continuing calibration

Retention time windows must be established per SW846, Method 8000, for each analyte during initial calibration. A check of the retention time window must be made prior to sample analysis using the calibration check standard. A warning

limit specific to the method is used. Failure of the standard to meet the retention time window will result in recalibration.

High Performance Liquid Chromatography (HPLC). The external standard calibration technique is used for HPLC calibration. Calibration standards are prepared according to the SOP for the method. Before using any clean-up procedures, the analyst should process a series of calibration standards through the procedure to confirm elution patterns and the absence of interferences from the reagents.

A calibration curve is prepared for each analyte of interest at five or more concentration levels for each analyte of interest. One of these standards should be at or near the PQL. The other standards should bracket the range expected in real samples but should not exceed the working range of the detector being used. Two types of calibration curves may be used: linear or non-linear.

A reagent water blank is run prior to calibration to show the absence of interferences. The calibration standards are introduced into the system and a calibration curve is generated for each analyte and the calibration factor is calculated as for GC, addressed previously.

Acceptance criteria for instrument response linearity checks are based upon the correlation coefficient, r, of the best fit line for the calibration data points or the RSD for calibration factors calculated for each analyte at each level over the working range. If the correlation coefficient, r, is ≥ 0.995 or the average percent RSD is ≤ 20 percent for all compounds, the calibration is valid, and a calibration factor may be used for quantitation. The use of r or percent RSD is instrument-specific. This acceptance criterion cannot be used interchangeably on a single instrument. The calibration factor or calibration curve for each analyte and surrogate is compared to the ICAL responses prior to sample analysis.

After every ten samples a continuing CCV is analyzed, usually the mid-range standard. The percent difference is calculated for each analyte and the average percent difference for all compounds should be within $\pm$ 15 percent. Otherwise, the analysis is suspended and corrective actions implemented.

Retention time windows must be established per SW846, Method 8000, for each analyte during initial calibration. A check of the retention time window must be made prior to sample analysis using the calibration check standard. A warning limit specific to the method is used. Failure of the standard to meet the retention time window will result in recalibration.

Gas Chromatography/High Resolution Mass Spectrometry (GC/HRMS). The calibration for dioxins and furans by GC/HRMS is very complex and is not presented in its entirety here. The reader is directed to Section 7.7 of EPA Method SW8290 for a detailed description of the calibration procedure. A very brief summary is presented below. A summary of calibration requirements and criteria is presented in the Table 3-6 footnote.

The instrument is tuned with a 2-μL injection of PFK. The resulting mass spectra must meet all the criteria listed in Table 3-6 before analysis begins. A window defining mix (WDM) must be analyzed before ICAL, and once every 12 hours before sample analysis. The WDM must meet the criteria specified in Table 3-6. Calibration standards at a minimum of five concentration levels are prepared from a secondary dilution of stock standards. All of the compounds listed in EPA Method SW8290 must be used as calibration standards. The ICAL must meet the criteria specified in Table 3-6. Continuing calibration standards (CCALs) must be analyzed daily, and at a minimum of once per 12 hours prior to sample analysis. The CCALs must meet the criteria specified in Table 3-6. Failure to meet the criteria specified in the method and in Table 3-6 will result in the corrective actions specified in Table 3-6.

Ultraviolet/Visible Spectrophotometry. Working standard solutions must be prepared daily by diluting stock solutions with reagent water or reagent grade solvents prior to use. At least three standard solutions and preferably five standard solutions plus a blank are measured and a standard curve generated for each method. The linearity of the calibration is acceptable if $r \geq 0.995$. A check standard is used every 10 samples to verify calibration.

pH Meter. The pH meter is calibrated with commercially available buffers at a minimum of two points that bracket the expected pH of the samples and are approximately three pH units or more apart. The electrodes are immersed in the standard for 2 to 3 minutes or until a stable reading is obtained. The procedure is repeated until a consistent reading is obtained for the standard solution. After every 10 samples, the calibration must be checked with one of the buffers. The reading must not differ from the theoretical value by more than ±0.1 pH units.

Thermometer. All thermometers will be calibrated once a year using a NIST-certified thermometer as a reference. A minimum one-point calibration will be performed. If the readings are off by more than 0.3°C, the thermometer will be tagged showing the variation. A thermometer that reads more than ±5°C different from the reference thermometer will be discarded. Mercury thermometers will be checked for separation of the mercury column before calibration.

Analytical Balance. All balances are serviced and calibrated at least twice per year to maintain calibration. Class "S" weights are used to verify the calibration of the balance each day it is used by recording the readings of known weights that bracket the sample weight. Calibration records are kept in logbooks at the balance.

3.2.8 Inspection/Acceptance Requirements for Supplies and Consumables

When available, analytical standards will be A2LA-certified reference materials purchased from Supelco, ULTRA Scientific, or an equivalent registered reference materials supplier. These standards are used for calibration standards. Whenever possible, standards traceable to EPA or NIST standards

will be maintained for use as an IVC of the reference materials purchased for calibration of instrumentation. NIST standards are available from the NIST.

Reagents used for organic analysis will be at least pesticide-grade or equivalent. Reagents for inorganic analysis will be at least American Chemical Standard (ACS) certified grade or equivalent. Reagents for metals analysis will be at least trace-metalgrade or equivalent.

Glass water sample containers will be certified from the manufacturer for SVOC, pesticide/PCB, and metals analyses. Each case of containers will include a Certificate of Assurance or a Certificate of Analysis verifying that the containers conform to the manufacturer's performance-based specification. Plastic water sample containers will be high-density polyethylene, leakproof and breakproof, and pre-cleaned and certified with independent laboratory analysis (Class 3000). Glass soil samples containers will be certified from the manufacturer for SVOC, pesticide/ PCB, and metals analyses. Each case of containers will include a Certificate of Assurance or a Certificate of Analysis verifying that the containers conform to the manufacturer's performance-based specification. All soil sampling metal sleeves or other sample containers will also be certified as contaminant-free.

Water organic sample preservatives will be at least pesticide-grade or equivalent. Water inorganic sample preservatives for metals will be at least trace-metalgrade or equivalent. Sample preservatives for other inorganic analyses will be at least Certified Grade or equivalent.

Decontamination water (deionized) will be analyzed via field blanks for possible contamination. Field blanks will be analyzed once per sampling event per each source of water.

3.2.9 Data Acquisition Requirements (Non-direct Measurements)

Previously obtained data, published or unpublished, may be available in computer data bases, literature files, or from other sources. The acceptance of the data for use on the project must be preceded by an evaluation as to the validity of the data. This evaluation must be based on information regarding the data validation procedures used on the data, and any qualifiers assigned; or, if no data validation was performed, a review of available documentation with regards to the data. Based on available information, a determination will be made as to the usability of the data and any limitations on its use.

3.2.10 Data Management

When the laboratory receives and logs in the contents of the shipping containers, the laboratory's sample custodial supervisor or the laboratory PM will log the sample information into the LIMS. As analyses proceed, additional data

for all analyses will be maintained in the LIMS. Upon completion of all analyses, the laboratory will produce an EDD in the required format for delivery with the hard copy data package to the Earth Tech QCSM or project chemist.

Information in the laboratory EDDs will be uploaded and maintained in a database at Earth Tech. Electronic documentation is reviewed by the project chemist, or a designated representative such as a data manager. Laboratory data packages will be maintained in the project files at Earth Tech. Analytical and field QC data will be reviewed by the QCSM or project chemist and PM and included in the final report.

A data management flow chart is presented in Figure 3-1.

3.3 ASSESSMENT/OVERSIGHT

3.3.1 Contractor Quality Control

Key QC personnel roles and responsibilities are identified in Section 1.6 of the Work Plan along with their function and qualifications. All contractors will be required to follow all QA/QC requirements specified in the FSP, QAPP, and HASP of the Project Work Plan. The PM is responsible for verifying contractor QC. In the event that the QA/QC requirements in the Work Plan are not followed, the PM and QCSM will have the authority to stop work until corrective actions are implemented.

3.3.2 Assessments and Response Actions

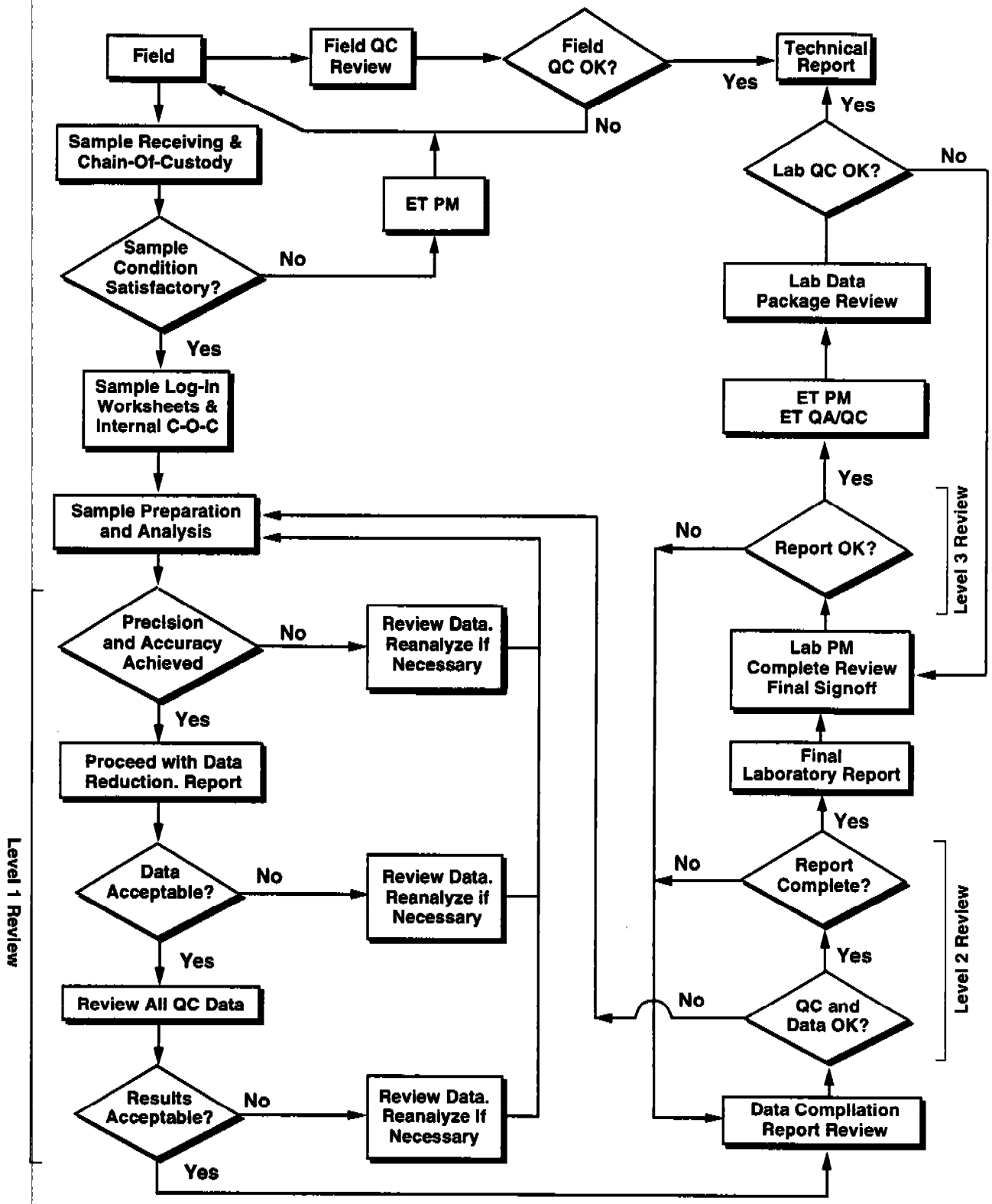
During the course of a project, various assessments will take place. These assessments include peer review of plans and reports, readiness reviews, field and laboratory audits, performance evaluations, audits of data quality, and data quality assessments.

3.3.2.1 Peer Review.

Peer review will be performed on all planning documents (e.g., Work Plan, final reports) before delivery. The documents will be reviewed for technical adequacy, accuracy, compliance with technical procedures, contract and regulatory requirements, as well as editorial quality. Peer review will be documented, as will acceptance of responses to comments.

3.3.2.2 Readiness Review.

A readiness review will be conducted by the PM and QCMS prior to commencing field activities. The review will ensure that all plans have been



QA/QC Data Flowchart

Figure 3-1

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completed and distributed, permits have been acquired, key personnel have been assigned and field personnel are trained, equipment is available and calibrated, subcontractors have been procured and meet project requirements, arrangements have been made for waste disposal, and that all possible precautions have been taken to prevent problems during the project.

3.3.2.3 Performance and Systems Audits.

A QA audit is an independent assessment of a measurement system. The purpose of performance evaluation audits is to quantitatively assess the measurement data quality. These audits provide a direct evaluation of the various measurement systems' capabilities to generate quality data. A systems audit is a qualitative evaluation of the adequacy of the overall measurement system(s) to provide data of known quality that are sufficient, in terms of quantity and quality, to meet the program objectives. Questions regarding qualitative issues, such as management policies, sample custody procedures, record keeping, and data handling systems, are addressed.

QA Auditor. The QCSM will function as the QA auditor for field activities and will monitor the performance of the field and laboratory QA program. This will be achieved through regular contact with the field and analytical QA staff.

Field Audits. At least once in the course of the field investigation for this project, the QCSM or his representative will be on site to perform a field QA audit, which will include the following tasks:

- Observe procedures and techniques in use in the various measurement efforts, including field sampling and analysis
- Check and verify instrument and sampling equipment calibration records
- Assess the effectiveness of and adherence to the prescribed QA procedures
- Review document control and COC procedures
- Review completeness of data forms and notebooks
- Review the nonconformance reporting procedures
- Identify any weakness in the sampling/analytical approach and techniques

- Assess the overall data quality of the various sampling/analytical systems.

Generally, the role of the field auditor is to observe and document the overall performance of each of the various sampling and field analytical efforts. Upon completion of the field audit, the auditor will discuss any specific weaknesses with the FTL and make recommendations for corrective action. Based on the audit results, the auditor may, as necessary, initiate corrective action at the project level through the PM. Discussion of any adverse audit findings will be summarized and distributed to the PM, QCSM, and FTL. It is the responsibility of the PM to respond to any deficiencies.

Laboratory Audits

Federal Audits. The project laboratory has been audited by the following state and federal agencies and national programs, as well as by private contractors for other federal projects:

- State of California Department of Health Services Environmental Laboratory Accreditation Program (ELAP) California certification
- U.S. Army Corps of Engineers (USACE)
- U.S. Department of Energy - Lawrence Livermore National Laboratory
- U.S. Bureau of Reclamation
- A2LA Accreditation.

All audit times, dates, reports, and findings are on file at the laboratory and available for review upon request. Earth Tech, its client, or representatives of any regulatory agency associated with this project will be provided access to the project laboratory for auditing purposes if an on-site audit is deemed necessary.

Internal Audits. Systems audits are conducted periodically at each facility. These systems audits monitor the conformance of the laboratory to the QA program and include assessment of facilities, staff, SOPs, sample management, and general documentation procedures. At the completion of each audit, the auditor provides a written report detailing areas of concern. Internal laboratory audits are on file at the laboratory, and may be reviewed upon request.

Performance Evaluation.

Performance Evaluation Check Samples. The project laboratory participates in the following performance evaluation sample programs:

- EPA or equivalent semiannual drinking water performance check samples (WS series).
- EPA or equivalent semiannual wastewater performance check samples (WP series).
- California ELAP certification performance check samples
- USACE certification performance check samples

The QA department evaluates performance evaluation results and develops a corrective action plan for "Non-Acceptable" results. This plan is then submitted to EPA or other appropriate regulatory agencies for review. All performance evaluation program sample results and corrective actions are available upon request at the laboratory.

Certification Programs. The project laboratory is accredited by the following agencies for the analyses required for this project:

- CA-DHS ELAP for the analysis of hazardous wastes, drinking water, and wastewater
- USACE - Missouri River Division - multimedia sample analysis for organic and inorganic parameters
- A2LA.

3.3.2.4 Corrective Action.

Field Activities. During the course of the project it will be the responsibility of the PM, FTL, and field team members to see that all procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem. Engineering and scientific calculations will be checked and corrected as required by technical personnel, and normally require no QA reporting.

A nonconformance exists if there is a deviation from or noncompliance with contract specifications, the QA program, approved procedures, or Work Plans. Nonconformances also include major errors in documented analysis, data or

results, and deficiencies in documentation or any other aspect of the project that affects quality. Personnel who identify a nonconformance should report the condition by completing Part A of the Nonconformance Report (NCR) and distributing the NCR to the supervisor, PM, and QA/QC officer. The sample numbers of the samples affected by the nonconformance should be noted on the NCR. Figure 3-2 is an example of an NCR form. The supervisor, PM, and QA/QC officer will review the NCR to determine if:

- Ongoing work should be stopped.
- The nonconformance involves a major deviation from the contract or client-approved Work Plans, or may significantly impact the cost or schedule of the work, in which case the nonconformance will be reported to the client.
- The nonconformance has any impact on previously obtained data or reports submitted to the client or other organization. If affected, the PM will note the impact in the Remarks section of the NCR and notify in writing all individuals and organizations that may be affected by the nonconformance and resulting data.

The evaluation will be documented by completing Part B of the NCR.

The supervisor will recommend corrective action to resolve the nonconformance by completing Part C of the NCR, and the recommended corrective action will be and then review and approval by the PM and QA/QC officer will be documented in Part D of the NCR.

The approved corrective action will be implemented by appropriate personnel, and the review and approval by the PM and QA/QC officer will be implemented in Part D of the NCR.

Laboratory Activities. Corrective action is dictated by the type and extent of the nonconformance. Corrective action may be initiated and carried out by nonsupervisory staff, but final approval and data review by management is necessary before reporting any information. All potentially affected data must be thoroughly reviewed for acceptance or rejection.

When errors, deficiencies, or out-of-control situations exist, the QA program provides systematic procedures, called "corrective actions," to resolve problems and restore proper functioning to the analytical system.

Laboratory personnel are alerted that corrective actions may be necessary if:

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Nonconformance Report (NCR)

NCR No. _____

Project _____ Project No. _____

Activity _____ Location _____

Part A
Description of non-conformance

Personnel reporting non-conformance _____ Date _____

Part B
Evaluation of non-conformance

			Significant condition adverse to quality	Yes	No
Work stoppage required	Yes	No	Impacts previous data/reports	Yes	No

Remarks _____

Evaluated by _____ Date _____ Title _____

Approved by _____ Date _____ _____ Date _____
Project Manager Program QA/QC officer

Part C
Recommended corrective action/disposition

Evaluated by _____ Date _____ Title _____

Approved by _____ Date _____ _____ Date _____
Project Manager Program QA/QC officer

Part D
Corrective action/disposition

Completed by _____ Date _____

Remarks _____

Corrective action approved and NCR closed by:

_____ Date _____ _____ Date _____
Project Manager Program QA/QC officer

Nonconformance Report Form

Figure 3-2

- QC data are outside the acceptable windows for precision and accuracy

- Blanks, LCS/LCD contain contaminants above acceptable levels

- Undesirable trends are detected in spike recoveries or RPD between duplicates

- There are unusual changes in detection limits

- Deficiencies are detected by the QA department during internal or external audits or from the results of performance evaluation samples

- Inquiries concerning data quality are received from clients.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA department for further investigation. Once resolved, an anomaly form is filled out describing the corrective action procedure. The anomaly form is kept in a project folder, and a copy is filed with the QA department.

Samples are monitored closely so that they can be analyzed within the recommended holding time. However, should a sample be analyzed outside of holding time, an anomaly form is filled out and the laboratory PM is informed immediately. It is his/her responsibility to inform the Earth Tech QCSM and project chemist so that a decision can be made regarding resampling. All unresolved nonconformances that may affect data quality for this project must be discussed in the case narrative included in the data package. Nonconformances serious enough to warrant the rejection of data must be brought to the attention of the Earth Tech QCSM and project chemist within 24 hours of discovery.

3.3.3 Reports to Management

Effective management of a field sampling and analytical effort requires timely assessment and review of field and laboratory activities. This will require effective interaction and feedback between the field team members and Project Manager, and between the laboratories and the QCSM or project QC chemist.

3.3.3.1 QA Reporting Procedure.

The laboratory PMs and appropriate project team members will be responsible for keeping the PM and QCSM up to date regarding the status of their respective tasks so that quick and effective solutions can be implemented should any data quality problems arise.

Sampling activities will be reviewed on a daily basis by the on-site task leader to determine if the sampling QC requirements are being fulfilled, such as the proper numbers of blanks and duplicate samples taken for each parameter sampled. All data sheets and logbooks will be reviewed daily. Any needed corrective action will be initiated and documented daily. Daily reports will be prepared when required by the project.

The field task leader is also responsible for tabulating the number of borings and samples taken on a weekly basis. This information will be reported weekly to the QCSM and the PM.

The laboratory PM and QA officer have the responsibility of reviewing all laboratory analytical activities to ensure compliance with the QC requirements outlined in the QAPP. This review serves as a control function in that it should be conducted frequently so that deviations from method requirements will be immediately identified and corrected.

The laboratory PM is responsible for submitting a weekly sample status report to the project QC chemist. All laboratory data reports are also to be sent to the QCSM or project chemist as soon as they are finalized.

Upon receipt, each data package will be reviewed for completeness and adherence to the QC protocol established for each type of analysis. A summary report detailing the sampling and analysis status and any QA/QC problems will be prepared by the QCSM or project chemist after receipt of the field and laboratory reports and review of the analytical data reports, and sent to the PM.

3.3.3.2 Report Content.

As appropriate, the required periodic reports will contain information on the status of the project and any quality problems. This includes:

- Activities and general program status
- Calibration and QC data problems
- Unscheduled maintenance activities

- Corrective action activities
- Status of any unresolved problems
- Assessment and summary of data completeness
- Any significant QA/QC problems and recommended and/or implemented solutions not included above.

The field auditor will prepare audit reports following each performance and systems audit that address the audit results and provide a qualitative assessment of overall system performance. These reports will be submitted to the Earth Tech PM. The laboratory PM will provide the QCSM with updates of any internal, state, or federal agency audits that occur within the project sampling period, including copies of audit reports and corrective actions if non-compliance with project-related activities is determined.

Problems requiring swift resolution will be brought to the immediate attention of the PM or QCSM via the nonconformance reporting/corrective action scheme discussed in Section 3.3.2.4.

3.4 DATA VALIDATION AND USABILITY

3.4.1 Laboratory Data Review, Validation, and Verification

The laboratory system for ensuring valid data includes several levels of review. Each level commands specific action to prevent the unqualified release of erroneous data and to correct any problems discovered during the review process.

All analytical data generated at the laboratory are extensively checked for accuracy and completeness. The data validation process consists of data generation, reduction, and three levels of review, as described below.

<u>Level 1 Review</u>

The analyst who generates the analytical data has the prime responsibility for the correctness and completeness of the data. All data are generated and reduced following protocols specified in laboratory SOPs. Each analyst reviews the quality of his or her work based on an established set of guidelines. The analyst reviews the data package to ensure that:

- Sample preparation information is correct and complete; analysis information is correct and complete

- The appropriate SOPs have been followed
- Analytical results are correct and complete
- QC samples are within established control limits; blanks are within appropriate QC limits
- Special sample preparation and analytical requirements have been met
- Documentation is complete (e.g., all anomalies in the preparation and analysis have been documented; out-of-control forms, if required, are complete; holding times are documented.

This initial review step, performed by the analyst, is designated Level 1 review. The analyst then passes the data package to an independent reviewer who performs a Level 2 review.

Level 2 Review

This is performed by a supervisor or data review specialist whose function is to provide an independent review of the data package. This review is structured to ensure that:

- Calibration data are scientifically sound, appropriate to the method, and completely documented
- QC samples are within established guidelines
- Qualitative identification of sample components is correct
- Quantitative results are correct
- Documentation is complete and correct (e.g., anomalies in the preparation and analysis have been documented; out-of-control forms, if required, are complete; holding times are documented
- The data are ready for incorporation into the final report
- The data package is complete and ready for data archive.

Level 2 review is structured so that all calibration data and QC sample results are reviewed, and all of the analytical results from 10 percent of the samples are

checked back to the bench sheet. If no problems are found with the data package, the review is considered complete. If any problems are found with the data package, an additional 10 percent of the samples are checked to the bench sheet. The process continues until no errors are found or until the data package has been reviewed in its entirety. Level 2 data review is documented and the signature of the reviewer and the date of review recorded. The reviewed data are then approved for release and a final report is prepared.

Level 3 Review

Before the report is released to the client, the Laboratory PM who is responsible for interfacing directly with Earth Tech reviews the report to ensure that the data meets the overall objectives of the project.

Each step of this review process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of the data is essential in ensuring that data of high quality are generated consistently.

In addition to the three levels of review discussed above, the divisional QA department conducts QA data audits of randomly selected projects. The frequency of the audits is determined by the error rate found. The QA data audit includes verifying that holding times have been met, calibration checks are adequate, qualitative and quantitative results are correct, documentation is complete, and QC results are complete and accurate. Any problems identified are reported to the appropriate laboratory managers for follow-up corrective actions.

The criteria for evaluation of blanks applies to any blank associated with the samples. If problems with any blank exist, all data associated with that batch must be carefully evaluated to determine whether or not there is an inherent variability in the data for that batch or if the problem is an isolated occurrence not affecting other data. Any detected concentration found in the blanks will be reported.

For organic analyses, the presence of target analytes in laboratory blanks above the PQL and confirmed in the associated samples will result in re-extraction and reanalysis of associated samples and the blank.

For metals and wet chemistry analysis, the policy is that the concentration of the target analytes in the blank must be below the PQL. A blank containing an analyte(s) above the PQL is considered unacceptable unless the lowest concentration of the analyte in the associated samples is at least 10 times the blank concentration or the concentration of the analyte in all samples associated with the blank is below the PQL.

3.4.2 Earth Tech Data Review, Validation, and Verification

3.4.2.1 Data Review and Verification.

Data review is performed both on field data sheets and laboratory data packages. Field data are checked for documentation completeness on data sheets and in logbooks, adherence to sample collection and testing procedures, inclusion of required field QC samples, correct preservation of samples, and complete and correct COC forms with signature and date at each transfer of custody.

Analytical laboratory data are checked for completeness of analyses as requested, inclusion of required frequency of QC samples, conformance to acceptance criteria for QC samples, adherence to holding time requirements, and second column confirmation where required.

For projects where electronic disk deliverables are provided by the laboratory, data are further evaluated electronically using specialized programs and reports developed by Earth Tech personnel. Parameters for this evaluation include the following:

- Holding time compliance
- Contamination in laboratory as field blanks
- Surrogate recovery calculations and control limits
- MS/MSD and LCS recovery calculations and control limits
- RPD calculations for MS/MSD and field duplicates.

By performing these QC checks electronically, Earth Tech reduces the overall costs associated with data checking and validation. In addition, the review takes significantly less time to conduct than otherwise would be possible with the large data sets generated by site activities. The resulting data are also readily available for other applications, such as the statistical evaluations performed as part of the risk characterization and the sensitivity analysis performed as part of the feasibility study process.

3.4.2.2 Data Validation.

Data validation is a systematic process of reviewing a body of data to provide assurance that the data are adequate for their intended use. The validation activities will be performed in accordance with the following EPA documents as appropriate:

- *EPA National Functional Guidelines for Organic Data Review, February 1994a, EPA-540/R-94-012*

- *EPA National Functional Guidelines for Inorganic Data Review, February 1994b, EPA-540/R-94-013*

- *EPA Region IX. Guidance Document, Laboratory Documentation Requirements for Data Validation. January 1990 (DCN 9QA-07-90)*

Field data validation will include daily checks to ensure that all field data sheets are properly filled out, that the notebooks contain all the required information, and that all documents are signed and dated. It also includes a check that the information on the COC correlates with the field logs so that any discrepancies can be relayed to the laboratory immediately.

Final data validation by Earth Tech is the responsibility of the QCSM. Field data are checked for completeness of documentation on field data sheets and logbooks, for adherence to sample collecting and testing procedures, and for inclusion of the required number of field duplicates, equipments blanks, etc. COCs will be checked for signature and date at each transfer of custody, for correct information as compared to the field logbooks/data sheets, and for correct preservation documentation and analyses requests.

Earth Tech will request that the project analytical laboratory report 10 percent of project samples and associated field and laboratory QC samples in full raw data (EPA Level IV) packages. Earth Tech will specify the sample and sample groups using a random selection process for the 10 percent. Critical samples, if identified, or other samples determined to be of decision-making significance, will be included in the 10 percent. Validation of EPA Level III data packages will consist of cursory validation based upon review of the QC summary forms and other Level III documentation, and validation of Level IV data packages will consist of full validation based on review of all forms as well as review of the additional raw data for acceptable calibration criteria and frequency, spot checks of calculations, use of proper procedures as documented in the laboratory notebooks. If any serious analytical problems are identified, Level IV data will be requested from the laboratory for additional data packages to receive full raw data review.

Data validation will include checking that required QC samples (e.g., method blanks, LCSs, MS/MSDs, check samples) have been performed at the required frequency and that the QC acceptance criteria listed in Section 3.2.5 have been met for these samples. Surrogate spikes will be checked to verify that they were performed where required, and that recovery acceptance criteria listed in Table 3-5 have been met. Instrument initial and continuing calibration data will be reviewed for completeness and conformance to acceptance criteria. Samples will be checked to confirm that sample preparation and analysis were performed within holding times, and that second chromatographic column or MS confirmation were performed where required. Anomaly reports will be reviewed for acceptable corrective action for all out-of-control events.

Results from field duplicates and replicates will be compared and RPD values will be calculated, where possible. The RPD value is not defined for duplicate pairs for which one or both results are below reporting limits (RLs). For values less than 5 times the RL, RPDs will not be calculated. In these cases, results within one RL for waters, or within two RL for soils, will be considered acceptable. RPDs below 40 percent for soils and 30 percent for waters generally represent good agreement. For higher RPDs or otherwise notable disagreement between duplicates, sample heterogeneity is generally the cause. If field duplicate pairs frequently exhibit differences greater than 40 percent for soils and 30 percent for waters, sampling and/or analytical procedures need to be reevaluated. Data are evaluated but not qualified for field duplicate results. The results of the evaluation will be examined and addressed in the final data report and in Data Quality Assessment (Section 3.4.3.1).

All laboratory and field blanks associated with definitive level data will be reviewed for blank contamination and the sample results qualified in the event that the contamination level is more than one-fifth (one-tenth for common laboratory contaminants) of the sample result. Blank qualified results are considered to be ND at the reported level, or at the PQL for organic compounds reported at less than the PQL, according to the blank qualification rules specified in the Functional Guidelines. If, in the professional judgment of the validator, results in a sample to be blank-qualified are due to real concentrations of an analyte in the sample, the result may be estimated without being considered to be ND. In instances where more than one blank is associated with a given sample, qualification should be based upon comparison with the associated blank having the highest concentration of a contaminant. Results for environmental samples must not be corrected by subtracting concentrations of analytes detected in associated blanks.

Qualifiers will be assigned by the reviewer to all data failing to meet the analytical and QC criteria specified in this QAPP, including criteria and control limits specified in Tables 3-1 through 3-6, according to the validation protocols specified previously. Data qualified as "R" are rejected and considered unusable. Data qualified with the "J" qualifier are considered estimated and usable for limited purposes. "J+" indicates the possibility that the result may be biased high, and that the actual chemical level may be lower than the reported result. "J-" indicates the possibility that the result may be biased low, and that the actual chemical level may be higher than the reported result or detection limit reported for an ND result.

Most of the qualifiers to be used by the laboratory and in validation are taken from the User's Guide to Contract Laboratory Program EPA/540/8-89/012, December 1988. Matrix effects will be noted in the final data report for samples where the MS/MSD was out of criteria, but the LCS was within limits. ND sample results may be qualified where the LCS recovery is below control limits.

Data are reviewed and validated by experienced personnel in conformance with EPA data validation guidelines and the level of analytical quality prescribed for

the project. Data review and validation is documented on special forms, included as Figures 3-3 through 3-9. For projects where EDDs are provided by the laboratory, data are evaluated electronically using specialized programs and reports developed by Earth Tech. In this case, the data required to be entered on the review forms are printed out in a format similar to the forms, and only some of the forms need to be filled out by the reviewer/validator.

3.4.3 Reconciliation with DQOs

3.4.3.1 Data Quality Assessment.

Data Quality Assessment (DQA) is the scientific and statistical evaluation of data to determine if data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. DQA is built on the premise that data quality, as a concept, is meaningful only when it relates to the intended use of the data. The DQA process involves the following five steps according to EPA guidance on DQA in Guidance for Data Quality Assessment: Practical Methods for Data Analysis (EPA/QA G-9, July 1996):

1) Review the DQOs to assure they are still applicable, and review the sampling design and data collection documentation for consistency with the DQOs.

2) Conduct a preliminary data review by validating the data, reviewing the Quality Assurance Summary Report (QASR), calculating basic statistics, and generating tables or graphs of the data. Use this information to learn about the structure of the data and to identify patterns, relationships, or potential anomalies.

3) Select an appropriate statistical test to identify the underlying assumptions that must hold for the statistical procedures to be valid.

4) Verify the assumptions of the statistical test to evaluate whether the underlying assumptions hold, or whether departures are acceptable, given the actual data and other information about the study.

5) Draw conclusions from the data by performing the calculations required for the statistical test and document the inferences drawn as a result of these calculations as well as the performance of the sampling design.

The DQOs for this project specified in Section 3.1.4 of this QAPP will be assessed in two phases. DQOs for field record and analytical data QA/QC will

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Figure 3-3
Data Validation Summary Sheet

Project _____ Lab _____ Job No _____ Validation Level ____

Matrix _____ No. of Samples _____ DUP ___ TB ___ EB ___ AB ___ Sampling Date _____

Reviewer _____ Date _____ Validator _____ Date _____

Final Reviewer _____ Date _____ Final Validator _____ Date _____

Report Needs Revision ❑ Yes ❑ No ❑ Revision Received ❑ Final Date final _____

Qualifiers are Needed ❑ Yes ❑ No

Q	Method						
		Blanks ❑ Yes ❑ No	❑ LMB Sample No.	❑ TB	❑ AB	❑ EB Analyte(s)	❑ FB
		Hold Time ❑ Yes ❑ No	Sample No.			Qualifier	
		Confirmation ❑ Yes ❑ No;N/A	Sample No.				
		Surrogates ❑ Yes ❑ No ❑ N/A	Sample No.			Qualifier	
		QC Samples ❑ Yes ❑ No	❑ MS/MSD Sample No.	❑ LCS Analyte(s)		❑ DUP Qualifier	
		Field Duplicates ❑ Yes ❑ No;N/A	Sample No.	Analyte(s)			
		Preservation ❑ Yes ❑ No;N/A	Sample No.	Problem			
		Other Problems (Chain of Custody, Analysis not Performed per Request, Tuning, Calibration, Internal Standards, etc.)					

Form DV-005a
2/99

QC Level _____

Figure 3-4
Chain of Custody Documentation

Project _____ Lab _____ Job No. _____

Matrix _____ No. of Samples _____ DUP ___ TB ___ EB ___ AB ___ Sampling Date (s) _____

Shipment No.

Chain of Custody Record

1.	Project Name	Yes	No	
2.	Project No.	Yes	No	
3.	Shipment No.	Yes	No	
4.	Airbill No.	Yes	No	NA
5.	Cooler No.	Yes	No	
6.	Samplers' Signature	Yes	No	
7.	Field Sample ID	Yes	No	
8.	Matrix	Yes	No	
9.	Sample Depth Interval	Yes	No	NA
10.	Sampling Date	Yes	No	
11.	Sampling Time	Yes	No	
12.	Type/Size of Container	Yes	No	
13.	Preservation	Yes	No	
14.	Filtered/Unfiltered	Yes	No	
15.	No. of Containers	Yes	No	
16.	Analysis Required	Yes	No	
17.	MS/MSD	Yes	No	NA
18.	Relinquished By/Received By	Yes	No	
19.	Relinquished/Received Date and Time	Yes	No	
20.	Special Requirements	Yes	No	NA

Field Sample Identifier/Code Reference Sheet

21.	Project Charge No.	Yes	No	COC Match?	Y	N
22.	Shipping Date	Yes	No	COC Match?	Y	N
23.	Shipment No.	Yes	No	COC Match?	Y	N
24.	Field Sample ID/Base/Location/Extension	Yes	No	COC Match?	Y	N
25.	Sample Type	Yes	No			
26.	Matrix	Yes	No	COC Match?	Y	N
27.	Sampling Depth/Begin/End	Yes	No	COC Match?	Y	N
28.	Sample Date	Yes	No	COC Match?	Y	N
29.	Sample Time	Yes	No	COC Match?	Y	N

If all information is complete and correct, check "yes".
If not, check "no", and enter item number in comments and explain.

Comments:

_____

_____

_____

_____

Were changes made to COC or Cross Reference Sheet? Yes _____ No _____

Changes:

_____

_____

_____

_____

Form DV-007
2-98

EARTH TECH

Figure 3-5
Data Review Sheet

Project _____ Lab _____ Lab Job No. _____

Method _____ Matrix _____ Batch No. _____

QC SAMPLE ID	E/A DATE	SURROGATES/I.S.	% RECOVERY	RPD
MS/MSD				
LCS/LCD				
LMB			CONTAMINANTS	

LAB	FIELD SAMPLE ID	S/E/A DATE	SURROGATES/I.S.	HITS/ND;2ND CO; DUP	FLAG

Form DV-001
12/94

EARTH TECH

Figure 3-6
Blank Evaluation Sheet

Project _____ Lab _____ Lab Job No. _____

Matrix _____

Contaminants are present in the following blanks:

Blank ID	S/E/A Date	Method	Contaminant	Result	Associated Sample ID	Result	Flag

Form DV-002
1/95

EARTH TECH

Figure 3-7
Calibration and Instrument Information - Organics Review Sheet

Project _____ Lab _____ Lab Job No. _____

Method _____ Matrix _____ Batch No. _____

GC Analyses: Instrument ID _____

	DATE	TIME	FREQUENCY	ACCEPT CRITERIA	RESULTS	RAW DATA CHECK
INITIAL CALIBRATION				$r \geq 0.995$ RSD $\leq$ 20%		
CONTINUING CALIBRATION			Daily	$\pm$ 15% D		
CALIBRATION CHECK (CCV)			10% End	$\pm$ 15% D		
SYSTEM PERFORMANCE CHECK			Daily			

COMMENTS _____

GCMS Analyses: Instrument ID _____

	DATE	TIME	FREQUENCY	ACCEPT CRITERIA	RESULTS	RAW DATA CHECK
BFB/DFTPP TUNING I.C.			Before I.C.			
			Every 12 hrs			
INITIAL CALIBRATION						
CONTINUING CALIBRATION			Every 12 hrs			
INTERNAL STANDARDS IN CALIBRATION CHECK			Every 12 hrs			

COMMENTS _____

Form DV-006A
12/94

EARTH TECH

Figure 3-8
Calibration and Instrument Information - Inorganics
Review Sheet

Project _____ Lab _____ Lab Job No. _____

Method _____ Matrix _____ Batch No. _____

Metals Analyses: Instrument ID _____

	Date	Time	Frequency	Accept Criteria	Results	Raw Data Check
INITIAL CALIBRATION			Daily			
ICP HIGH STANDARD						
ICV			After initial calibration			
CCV			10% End			
ICB			After initial calibration			
CCB			10% End			
ICS			Beginning End	± 20% ± 20%		
ICP SER. DIL.						
MSA						

Inorganic Analyses: Instrument ID _____

	Date	Time	Frequency	Accept Criteria	Results	Raw Data Check
INITIAL CALIBRATION						
CONTINUING CALIBRATION OR ICV			Daily or after I.C.			
CCV			10% End			
ICB			After I.C.			
CCB			10% End			

Comments _____

Form DV-006B
1/95

EARTH TECH

Figure 3-9
Duplicate Summary Form: Method _____

Project _____ Matrix _____

Lab Job No. _____ Units _____

Lab _____

*Due to dilution, sample quantitation limit is affected.

RL	Parameter	Sample ID	Dup ID	RPD	Flag	Sample ID	Dup ID	RPD	Flag	Sample ID	Dup ID	RPD	Flag
	Field												
	Lab												
	Dilution												

RL = Reporting Limit

Form DV-003
10/1/92

be assessed by comparison to the requirements, control limits, or other QA/QC criteria, and goals specified in the QAPP. If the data meet the DQO elements and objectives for data quality specified throughout the QAPP, the data are considered valid and defensible data within the parameters of usability determined in the processes of data verification, validation and qualification, and usability assessment (Sections 3.4.1, 3.4.2, and 3.4.3). The data usability assessment is summarized in the final report, which is supported by the data validation reports. After the environmental data have been collected, validated, and assessed for usability in accordance with the requirements of the QAPP, the data must then be evaluated to determine whether the project-specific DQOs specified in Section 3.1.4 of this QAPP were met. Assessment of these DQOs includes evaluation of the remaining elements and objectives in the DQO process, such as evaluation of sample locations, number of samples collected and analyses performed; statistical analysis of the data according to the five steps previously described above, if applicable; interpretation of the data with respect to decision errors and the decision rules; satisfactory resolution of the problem; and optimizing the DQOs for any future investigations performed based on the same sampling model or modifying the sampling model for further investigation.

For this project, the statistical processes may not be applicable, as the sampling plan calls for authoritative (judgment) sampling, wherein an expert determines sample location based on specific knowledge of contamination history instead of sampling in a probabilistic or otherwise statistically oriented manner.

3.4.3.2 Documentation.

Field QC procedures (e.g., duplicate sampling, blanks, and duplicate readings of field tests) are documented in the field notebooks and/or on field data sheets. All field documentation is reviewed by the FTL during audits and by the project chemist during validation at the end of the task.

Laboratory QC activities, (e.g., standard preparation, inclusion of matrix spikes/duplicates, results of blanks) are documented in logbooks, through computer printouts, and on analysis data sheets. All QC data is calculated and checked by the analyst and reviewed by the analytical supervisor. Review of QC activities is documented through the use of checklists that are signed by the reviewer and then checked by the laboratory PM as part of the laboratory report review. All QC NCR are reviewed, holding times are checked, and inclusion of second column confirmations are verified at this time. Originals of all laboratory-generated COC documentation and data sheets as well as customer-provided documentation are maintained in document files according to job number. Copies of all QC data except for data stored on computer disk are also stored in these files.

Data deliverables review procedures will be performed by Earth Tech. Information in EDDs will be maintained in a data base at Earth Tech. Electronic

documentation is reviewed by the project chemist, or a designated representative such as a data manager. Laboratory data packages will be maintained in the project files at Earth Tech. Data verification and validation activities will be documented in worksheets and communications records that will be filed with the laboratory data packages. Documentation related to laboratory deliverables will be reviewed by the QCSM or the project chemist. All data deliverables and project reports will be maintained in the project files storeroom at the Colton office of Earth Tech.

4.0 HEALTH AND SAFETY PLAN

4.1 INTRODUCTION

The provisions of this HASP are mandatory for all Earth Tech personnel involved in the RI/FS activities at the Project Site. This HASP provides the specification for the minimum acceptable requirements for all subcontractor organizations, and notification of the chemical and physical hazards expected to be associated with the Earth Tech-managed activities addressed in this document.

Operational changes to this HASP that could affect the health and/or safety of site personnel, the community, or the environment will not be made without prior approval of the Earth Tech PM and the appropriate Earth Tech Health and Safety Officer. In the event of a conflict between this plan and federal, state, or local regulations, the more stringent will apply.

4.1.1 Policy Statement

It is the policy of Earth Tech to provide a safe and healthful work environment for all its employees. Earth Tech considers no phase of operations or administration to be of greater importance than injury and illness prevention. Safety takes precedence over expediency or shortcuts. At Earth Tech, we believe every accident and every injury is avoidable. We will take every reasonable step to reduce the possibility of injury, illness, or accident.

This HASP presents procedures to be employed during all on-site work activities. The practices and procedures presented in this HASP are mandatory for all Earth Tech employees (and subcontractors) while they are engaged in work operations at the Project Site. Earth Tech also requires that all visitors to areas under its control abide by these procedures.

4.1.2 Applicability

This HASP addresses all applicable HASP elements as presented in 8 California Code of Regulations (CCR) §5192 (b). The applicable elements include those items that are identified as part of the Scope of Work (Section 3.2) or as potential workplace hazards which may be encountered during the performance of planned work activities (Section 4.5.1). Any elements not discussed in this HASP have been determined to be inapplicable to planned work activities or to present no significant worker hazards, and have therefore been omitted for clarity.

4.1.3 References

This HASP complies with applicable OSHA, EPA, and Cal/OSHA regulations, and standards developed for the Project Site. This HASP follows the requirements found in the following documents:

> *Title 29 of the Code of Federal Regulations, Part 1910 (29 CFR 1910), Occupational Safety and Health Standards (OSHA).*
>
> *Title 8 of the California Code of Regulations (8 CCR), Chapter 4, Subchapter 4 (Construction Safety Orders) and Subchapter 7 (General Industry Safety Orders).*

4.2 HEALTH AND SAFETY RESPONSIBILITIES

Site activities will be performed by Earth Tech and subcontractor personnel. Accordingly, the following assignment of health and safety-related responsibilities is made.

4.2.1 All Earth Tech Personnel

Each person is responsible for his/her own health and safety, for completing tasks in a safe manner, and for reporting any unsafe acts or conditions to his/her supervisor and/or the Field Team Leader (FTL). All personnel are responsible for continuous adherence to these health and safety procedures during the performance of their work. No person may work in a manner that conflicts with the letter or intent of safety and environmental precautions expressed in these procedures. After due warnings, Earth Tech will dismiss from the site any person who violates safety procedures. Earth Tech employees are subject to progressive discipline and may be terminated for blatant or continued violations. All on-site personnel will be trained in accordance with requirements specified in this document.

4.2.2 Project Manager (PM) (Mr. Brian Weith)

The PM has overall management authority for ensuring that all project activities are completed in accordance with requirements set forth in this plan. The PM will confer with the designated Health and Safety Officer on all matters affecting health and safety. Other health and safety-related duties of the PM include:

> Reading and becoming familiar with this HASP
>
> Requiring a prompt and thorough investigation of all accidents
>
> Scheduling an Accident Review Board within 10 days of an injury involving a workers' compensation claim or OSHA recordability, or any accident with more than a $500 loss

Providing day-to-day management of site work activities.

4.2.3 Health And Safety Officer

The designated Health and Safety Officer (HSO) is responsible for overseeing all aspects of the site safety program and preparing any site-specific safety guidance documents or addenda to this plan. The HSO does not report to the PM, and is separately accountable to Earth Tech senior management for site health and safety. The HSO will act as the sole contact to all regulatory agencies on matters of safety and health. The HSO's other responsibilities include:

General health and safety program administration

Conducting project health and safety audits as warranted

Developing site-specific employee/community emergency response plans, as required, based on expected hazards

Determining the level of personal protection required

Updating equipment or procedures based on information obtained during site operations

As required, establishing air monitoring parameters based on expected contaminants.

4.2.4 Field Team Leader (FTL)/Site Safety Coordinator (SSC)

The Field Team Leader (FTL) will also serve as the Site Safety Coordinator (SSC) and is responsible for performing the routine duties for health and safety, and will coordinate any necessary assistance from the designated HSO. The SSC will administer this HASP and the applicable site-specific safety guidance document. Additional SSC responsibilities include:

Reading and becoming familiar with this HASP

Enforcing the requirements of this HASP and other applicable safety requirements

Stopping work, if necessary, to prevent injury or illness and ensure personal and environmental health and safety

Determining evacuation routes, and establishing/posting local emergency contact telephone numbers

Ensuring that all applicable site personnel and visitors have received the proper training and medical monitoring before entering any controlled areas

Presenting any tailgate safety meeting and maintaining appropriate training documentation/attendance records

Implementing air monitoring according to directives in this HASP

Implementing changes in health and safety procedures as directed by the HSO and/or approved addenda to this HASP.

4.2.5 Ordnance and Explosives Safety Manager (OESM)

The OESM will be appointed by the PM to be principally responsible for execution of all OE operations for field activities. The OESM will have knowledge of all requirements mandated by OSHA, USACE, U.S. EPA, Title 8 of the CCRs, and Earth Tech's Corporate Health and Safety Program. The OESM will be directly responsible to the PM.

The OESM is responsible for the implementation of the site-specific HASP and will provide overall direction of the project UXO escort and avoidance functions for field activities. The OESM, or his/her designee, will interface with the Field Site Leader on ordnance and explosive safety functions of the project and will coordinate activities with the PM. In addition, the OESM will, as necessary, perform audits, surveillance, document reviews, and other ordnance and explosive safety functions as required to determine the continued effectiveness of the HASP. The OESM will, as necessary, audit compliance with the HASP, and will perform OE safety reviews of selected project tasks. Other responsibilities will include, but will not be limited to:

Performing and documenting regular and frequent site hazard inspections and observing employees at work

Stopping work when necessary to prevent injury or illness and to ensure personal and environmental health and safety

Investigating all injuries and illnesses

Developing and implementing corrective action plans to eliminate or mitigate hazards

Providing the UXO safety portions of training sessions or briefings for site and visitor personnel

Ensuring the proper use of personal protective equipment (PPE)

Conduct the UXO safety portion of visitor orientation briefs

Ensure that all UXO related site operations are conducted in accordance with this document and other relevant safety and health regulations and standards

4.2.6 Subcontractors

Each subcontractor's management will provide qualified employees and allocate sufficient time, materials, and equipment to safely complete assigned tasks. In particular, each subcontractor is responsible for equipping its personnel with any required PPE. All on-site employees of each subcontractor must meet the training and medical monitoring requirements specified in Section 4.4. Work operations performed by these subcontractors will be under the control of Earth Tech, who is responsible for oversight of work activities to ensure that all requirements specified in this HASP are observed. Each subcontractor is expected to perform its operations in accordance with its own unique safety policies and procedures, to ensure that hazards associated with the performance of the work activities are properly controlled.

Hazards not listed in this HASP but known to any subcontractor, or known to be associated with a subcontractor's services, must be identified and addressed to the Earth Tech PM or SSC prior to commencement of work operations. The SSC or authorized representative has the authority to halt any subcontractor operations, and to remove any subcontractor or subcontractor employee from the site for failure to comply with established health and safety procedures or for operating in an unsafe manner.

Attachment B of Appendix D provides Earth Tech's *General Subcontractor Safety Rules*, which will be observed by all subcontractor organizations.

4.2.7 On-site Personnel and Visitors

All personnel working for Earth Tech or its subcontractors are required to read and acknowledge their understanding of this HASP. All visitors to controlled areas of the site must also read and acknowledge their understanding of this HASP. All personnel are expected to abide by its requirements and cooperate with site supervision to ensure a safe and healthful work site. Personnel must immediately report any of the following to the PM:

Accidents and injuries, no matter how minor

Unexpected or uncontrolled releases of any hazardous substances

Any symptoms of exposure to a hazardous substance

Any unsafe or malfunctioning equipment

Any changes in site conditions that may affect the health or safety of project personnel.

4.3 SITE BACKGROUND AND SCOPE OF WORK

A detailed description of the Site Background is provided in Section 1.0 of this RI/FS Work Plan, while the Scope of Work is presented in Section 2.0.

4.4 GENERAL HEALTH AND SAFETY PROGRAMS

All Earth Tech and subcontractor personnel performing work in controlled areas of the Project Site will be qualified as HAZWOPER workers. Accordingly, the requirements outlined in the following subsections will apply for all personnel performing any controlled-area work operations.

4.4.1 Medical Screening and Health Surveillance

All Earth Tech and subcontractor personnel will have completed a HAZWOPER physical exam in accordance with the requirements of 8 CCR §5192 (f). Each person's most current exam will have been completed within the previous 365 days, and based on those exam results, each person will be medically authorized by an occupational physician to perform HAZWOPER activities.

4.4.2 Training Requirements

All personnel on site will meet the following training requirements.

4.4.2.1 General Training Requirements.

All field personnel and visitors involved with site activities will have completed the necessary HAZWOPER training requirements established in 8 CCR §5192 (e)(2) and (e)(3) [40-hour or 24-hour initial training], 8 CCR §5192 (e)(8) [annual refresher training], and 8 CCR §5192 (e)(4) [supervisor training].

4.4.2.2 Initial Orientation Training.

Prior to the start of on-site activities, all Earth Tech and subcontractor personnel will attend a site safety/orientation briefing, to be conducted by the SSC. This training will address all elements of the site health and safety program (as presented in this HASP and referenced Earth Tech and regulatory health and safety requirements). This training will also include instruction in:

Toxic and physical hazards associated with identified environmental contaminants of concern

Anticipated exposure hazards (as determined based on analysis of work operations and site contaminant concentrations)

Requirements and rationale used in the selection of safety equipment

On-site monitoring procedures

Decontamination procedures

Care and use of selected PPE

Emergency Notification and Response Procedures.

The training content and a list of all attendees will be documented and maintained with the project files.

Worker personnel initially assigned to the site after work operations have commenced will be provided with orientation training by the SSC which will address the above requirements. All visitors to the site (personnel not assigned to work on site) will be provided with an abbreviated version of this training, along with specific orientation as to the hazards present on site at the time of the visit and any applicable safety requirements (e.g., escorts).

4.4.2.3 Tailgate Safety Briefings.

A tailgate safety briefing will be conducted at the start of each work day. The SSC will conduct the tailgate safety briefings and will review and discuss the health and safety issues associated with the day's planned work activities, problems encountered, and modifications to existing procedures. Documentation of the tailgate safety briefings will be accomplished by using the Tailgate Safety Briefing Sign-in Log, a copy of which is included in Attachment A of Appendix D. The SSC will maintain copies of all tailgate safety briefing sign-in logs in the project files. All field personnel associated with each day's project activities are required to attend these meetings.

4.4.2.4 Hazard Communication Training.

Section 4.5.2 provides information concerning environmental contaminants that could be expected to be encountered during the planned work operations. In addition, any organization wishing to bring any hazardous material onto any Earth Tech-controlled work site must first provide a copy of the item's Material Safety Data Sheet (MSDS) to the SSC for approval and filing (the SSC will maintain copies of all MSDSs on site). In accordance with the requirements of Title 8 CCR §5194, all personnel will be briefed on the hazards of any chemical product they use and will be aware of and have access to all MSDSs.

4.4.3 General Site Safety Rules

The following general requirements apply to all on-site activities (including work occurring outside controlled work areas).

4.4.3.1 Smoking, Eating, and Drinking.

Smoking, eating, and drinking will not be permitted except in specifically designated areas of the site, which shall be outside any designated exclusion zones or other designated work areas. Field workers will perform proper decontamination procedures when leaving an exclusion zone prior to eating or drinking. Consumption of alcoholic beverages is prohibited anywhere on the Project Site.

4.4.3.2 Site Awareness.

Site personnel will be familiar with the physical characteristics and requirements of the work site, including ongoing activities of other personnel at the Project Site, that may affect the Earth Tech work area. Personnel will also be aware of:

Emergency procedures and evacuation assembly points

Location of protective and emergency equipment and relevant first-aid procedures.

The number of personnel and equipment in work areas should be minimized, consistent with site operations.

4.4.3.3 Buddy System.

Except as designated by the SSC, all on-site personnel will operate using the two-man concept (buddy system). All personnel will operate in teams of two or more (a single-man entry into any controlled work area is prohibited), whose members will maintain visual contact with each other at all times. Team members must observe each other and should be alert for signs of heat stress or toxic exposure.

4.4.3.4 Housekeeping.

During site activities, work areas will be continuously policed for identification of excess trash and unnecessary debris. Excess debris and trash will be collected and stored in an appropriate container (e.g., plastic trash bags, garbage can, roll-off bin) prior to disposal. At no time will debris or trash be intermingled with waste PPE or contaminated materials. Anyone observed throwing contaminated material or PPE away with municipal wastes will be removed from the site.

4.4.3.5 Personal Hygiene.

At a minimum, adequate supplies of personal hygiene supplies will be available for use by site personnel. Personal hygiene items will include the following:

Water Supply

A water supply meeting the following requirements will be utilized:

Potable Water. An adequate supply of potable water will be available for field personnel consumption. Potable water can be provided in the form of water bottles, canteens, water coolers, or drinking fountains. Where drinking fountains are not available, individual-use cups will be provided as well as adequate disposal containers. Potable water containers will be properly identified in order to distinguish them from nonpotable water sources.

Nonpotable Water. Nonpotable water may be used for handwashing and cleaning activities but will not be used for drinking purposes.

Toilet Facilities

A toilet facility will be provided for use by site personnel. If access is available, existing site toilet facilities will meet this requirement.

Washing Facilities

Employees will be provided washing facilities (e.g., buckets with water and Alconox) at each work location. Water and hand soap (or a similar substance) will be used by each employee upon exiting any controlled work area, prior to breaks, and at the end of daily work activities.

4.4.3.6 Drum Handling.

Where containers of a capacity greater than 10 gallons are used for containerizing chemical products or waste materials, their handling will be accomplished in accordance with the following:

> When not in use, drums/containers will be covered with a tight-fitting lid
>
> At the conclusion of each work shift, all drums/containers will be placed in the designated waste storage area. This area will be properly marked and secured
>
> Mechanical or powered drum handling equipment will be used to move drums/containers. Manual handling of the drums leads

to musculo-skeletal injuries and will be avoided to the extent possible.

4.4.3.7 Heat Stress Prevention.

Heat stress can be a significant field site hazard, especially for workers wearing protective clothing. Depending on the ambient conditions and the work being performed, heat stress can occur very rapidly, within as little as 15 minutes. Site personnel will be instructed in the identification of a heat stress victim, the first-aid treatment procedures for the victim, and the prevention of heat stress casualties.

Workers should be encouraged to immediately report any difficulties or heat-related problems that they may experience or observe in fellow workers. Supervisors should use such information to alter the work-break schedule to accommodate such problems. During breaks, workers should be encouraged to drink plenty of water or other liquids to replace lost fluids and to help cool off. Should any worker exhibit signs of severe heat distress, such as profuse sweating, extreme confusion and irritability, or pale, clammy skin, that worker should be relieved of all duties at once and made to rest in a cool location and drink plenty of water. Anyone exhibiting symptoms of heat stroke (red, dry skin, or unconsciousness) should be taken immediately to the nearest medical facility. Steps should be taken to cool the person during transportation (e.g., removing clothing, wetting the skin, air conditioning). Severe heat stress (heat stroke) is a life-threatening condition that must be treated by a competent medical authority.

Heat-Related Illnesses

The following guidance can be used in the identification and treatment of heat-related illness.

Heat Stress. The mildest form of heat-related illness. Victims exhibit irritability, lethargy, and significant sweating. The victim may complain of headache or nausea. This is the initial stage of overheating, and prompt action at this point may prevent more severe heat-related illness from occurring.

First Aid: Provide the victim with a work break during which he/she may relax, remove any excess protective clothing, and drink cool fluids. An air conditioned spot is an ideal break location, if available. Once the victim shows improvement, he/she may resume working; however, the work pace should be moderated to prevent recurrence of the symptoms.

Heat Exhaustion. Usually begins with muscular weakness, dizziness, nausea, and a staggering gait. Vomiting is frequent. The bowels may move involuntarily. The victim is very pale, with clammy skin, and he or she may perspire profusely. The

pulse is weak and fast; breathing is shallow. Faint may occur unless the victim lies down.

First Aid: Immediately remove the victim from the work area to a shady or cool area with good air circulation (avoid drafts or sudden chilling). Remove all protective outer wear. Call a physician. Treat the victim for shock. (Make the victim lie down, raise his or her feet 6-12 inches and keep him or her warm but loosen all clothing.) If the victim is conscious, it may be helpful to give him or her sips of water. Transport victim to a medical facility as soon as possible.

Heat Stroke. This is the most serious of heat illness and represents the collapse of the body's cooling mechanisms. As a result, body temperatures often rise to between 105°-110°Fahrenheit. As the victim progresses toward heat stroke, symptoms such as headache, dizziness, nausea, oppression can be noted, and the skin is observed to be dry, red, and hot. Sudden collapse and loss of consciousness follows quickly, and death is imminent if exposure continues. Heat stroke can occur suddenly.

First Aid: Immediately move the victim to a cool and shady area. Remove all protective outer wear and all personal clothing. Lay the victim on his or her back with the head and shoulders slightly elevated. Apply cold wet towels or ice bags to the head, armpits, and thighs. Sponge off the bare skin with cool water or rubbing alcohol, if available, or even place the victim in a tub of cool water. The objective is to cool without chilling the victim. Give no stimulants or hot drinks. Since heat stroke is a severe medical condition requiring professional medical attention, emergency medical help should be summoned immediately to provide on-site treatment of the victim and proper transport to a medical facility.

Skin Hazards

Sunburn and prickly heat are both symptoms of skin irritation/damage produced through exposure to sunlight and operating in hot work environments. Protect exposed skin with an appropriate sun-screen. A sun-screen with a sun protection factor (SPF) of 15 or greater is recommended for a full day in the sun. Heat rash, also known as prickly heat, can be prevented by the application of a hydrophobic, water repellent barrier cream such as Kerodex 71.

4.4.4 Lighting

At a minimum, all portions of each work location will be sufficiently lit so that all surfaces are illuminated at 10-foot candle strength or greater. Since work activities are expected to be conducted exclusively outdoors and during daylight hours, the need for supplemental lighting is not anticipated.

4.4.5 Accident or Incident Reports

Any accident/incident involving Earth Tech or subcontractor personnel that occurs on the Project Site will be promptly reported to the SSC or PM, who will notify the HSO. The supervisor of the injured employee or work crew where the accident occurred will initiate a written report. The *Supervisor's Report of Incident* form, found in Attachment A of Appendix D, will be used, and must be fully completed to ensure that all relevant information is recorded. The PM or SSC must complete the "Manager" section of the report(s) and forward it to the HSO, who will review the documentation, and assist in the performance of any necessary accident investigation or other follow-up. The PM will ensure that the recommendations resulting from any investigation are implemented without delay.

4.4.6 Visitor Clearances

Visitors will not be allowed within any controlled work area unless they comply with the health and safety requirements of this HASP and can demonstrate an acceptable need for entry into the work area. All visitors (including the site owner or the owner's representative, regulatory agency representatives or Earth Tech clients) desiring to enter any controlled work area must observe the following procedures:

> A written confirmation must be received by Earth Tech documenting that each of the visitors has received the proper training and medical monitoring required by this HASP. Verbal confirmation can be considered acceptable provided such confirmation is made by an officer or other authorized representative of the visitor's organization.
>
> Each visitor will be briefed on the hazards associated with the site activities being performed and must acknowledge receipt of this briefing by signing the appropriate tailgate safety briefing form.

If the site visitor requires entry to any exclusion zone, but does not comply with the above requirements, all work activities within the exclusion zone must be suspended and monitoring using direct reading instruments must indicate that no airborne contaminant concentrations are present that exceed the established background levels. Until these requirements have been met, entry will not be permitted.

4.5 HAZARD ASSESSMENT

Planned activities will involve disturbance (e.g., drilling) of soils within the site, and installation of piping and concrete structures. Potential hazards associated with this work include, but are not limited to:

Exposure to environmental contaminants (various chlorinated solvents, heavy metals, and low-pH materials)

Hazardous noise (from heavy equipment)

Slip, trip, and fall hazards

Heat stress, especially when wearing chemically protective clothing

Cleaning and decontamination of equipment.

4.5.1 Task Hazard Analyses

The following analyses address the hazards determined to be associated with each identified work task to be performed. In evaluating the site conditions (on-site contamination) and the potential impact on personnel performing this work, it was determined that of the possible related exposure modes, inhalation is of primary concern, with skin contact, skin absorption, and ingestion determined to be of only secondary concern.

In evaluating the task hazards, it is anticipated that site personnel will not encounter any significantly contaminated soils that would present a skin contact hazard.

4.5.1.1 Site Reconnaissance.

This work includes delineation and staking of work area boundaries, identification of subsurface structure locations, and similar work. As non-intrusive activities, there is little potential for release of soil gases or contact with contaminated materials, and in some cases, UXO. The primary hazards associated with this work are the potential for encountering UXO, and slip, trip, and fall hazards due to the presence of unprepared walking surfaces. Other hazards that may be encountered include heat stress and sunburn. To protect against these hazards, the following requirements should be met:

Follow the requirements for UXO avoidance. Do not touch, move, or disturb any material or equipment that is unidentifiable

Watch carefully where you walk. Do not step in shadows until you are sure of your footing. Shadows may hide pits, holes, or other areas of unstable footing

Carefully choose your footholds when crossing rocky, vegetation-covered, uneven, or loose ground surfaces

Stay within site of your buddy.

Applicable Specific Safety Procedures: Slips, Trips, and Falls (Section 4.6.1)

Personal Protective Equipment: Level D ensemble (Section 4.7.1)

Monitoring Requirements: No specific monitoring procedures or recording of monitoring results is required for this task.

4.5.1.2 Drilling/Groundwater Monitoring Well Installation.

HSA drilling will be used for the installation of boreholes and groundwater monitoring wells. The use of these drilling techniques presents several potential hazards to personnel. There is the potential for personnel to be exposed to any of the potential site contaminants via skin contact and/or inhalation (concentrations of contaminants may exceed the applicable Permissible Exposure Limits). To protect against exposure, personnel will utilize PPE as specified below, and will conduct monitoring for airborne contaminant concentrations.

Drilling operations produce hazardous noise levels (in excess of 90 A-weighted sound level [dBA]) and personnel are required to utilize hearing protection inside any controlled work area whenever drilling occurs. Spinning augers can catch loose clothing. Lifting of heavy equipment and materials (e.g., bentonite bags) can cause severe injury unless proper lifting practices are used. Elevated drill rig masts present the potential for overhead hazards, requiring that hardhats be worn at all times.

During well casing installation, there is the potential for some contact with groundwater, which can present potential skin contact and inhalation hazards due to the presence of contaminants in the groundwater.

Applicable Safe Work Procedures: Slips, Trips, Falls and Protruding Objects (Section 4.6.1)
Hazardous Noise Environments (Section 4.6.2)
Heavy Machinery (Section 4.6.3)
Underground Utilities (Section 4.6.4)
Dust Suppression (Section 4.6.5)

PPE Requirements: Modified Level D ensemble (Section 4.8.1)

Air Monitoring Requirements: As specified in Section 4.7.1.

Additional requirements for drilling equipment setup and operation are presented in Attachment B of Appendix D and will be complied with at all times during the performance of drilling activities.

4.5.1.3 Groundwater Monitoring Well Development.

During groundwater extraction well and monitoring well development, personnel will be required to handle significant quantities of potentially contaminated groundwater. This presents potential skin contact and inhalation hazards due to the potential for groundwater to be contaminated. Personnel will be required to wear the PPE specified below to protect against this hazard. In addition, sealed monitoring wells can accumulate soil vapors and present inhalation and explosivity hazards. Upon opening any monitoring well that has been sealed for more than 24 hours, personnel will allow the well to vent for at least five minutes prior to performing any work.

Applicable Safe Work Procedures: Slips, Trips, and Falls and Protruding Objects (Section 4.6.1)

Hazardous Noise Environments (Section 4.6.2)

PPE Requirements: Modified Level D ensemble (Section 4.8.2)

Air Monitoring Requirements: As specified in Section 4.7.1.

4.5.1.4 Groundwater Sampling.

During groundwater sample collection, personnel will be required to handle potentially contaminated groundwater. This presents potential skin contact and inhalation hazards due to the potential for groundwater to be contaminated. Personnel will be required to wear the PPE specified below to protect against this hazard. In addition, sealed monitoring wells can accumulate soil vapors, presenting inhalation and explosivity hazards. Upon opening any monitoring well that has been sealed for more than 24 hours, personnel will allow the well to vent for at least five minutes prior to performing any work.

Applicable Safe Work Procedures: Slips, Trips, and Falls and Protruding Objects (Section 4.6.1)

Hazardous Noise Environments (Section 4.6.2)

PPE Requirements: Modified Level D ensemble (Section 4.8.2)

Air Monitoring Requirements: As specified in Section 4.7.1.

4.5.1.5 Equipment Decontamination.

Equipment used in the installation of borings and groundwater monitoring wells will require decontamination prior to leaving the Project Site. Only portions of the equipment contacting subsurface soils (e.g., augers, tires) will require cleaning, which can be accomplished using physical removal methods including brush removal, wiping, and/or use of a steam cleaner unit.

Since no significant contamination is expected in the topmost soils, this task presents no significant inhalation of skin exposure hazards. However, personnel should be trained in the use of the steam cleaner, which has exposed hot surfaces during use. The pressurized hot water stream can cause significant physical and thermal injury if sprayed on exposed skin, so personnel not involved in clean-up should not be present in any work area where a steam cleaner is in use.

To provide further protection, personnel will use the specified PPE.

Applicable Specific Safety Procedures: None

Personal Protective Equipment: Level D ensemble (Section 4.8.1), modified by the use of a face shield and leather working gloves.

Monitoring Requirements: None

4.5.1.6 Management/Handling of Derived Wastes.

Work activities will generate decontamination fluids, waste PPE and decontamination materials, and excess sediment. Wastes will be containerized and placed into drums. Handling of wastes presents a minimal potential for skin contact; inhalation is not expected to present a hazard.

Applicable Specific Safe Work Procedures: Drum Handling (Section 4.4.3.6)

Personal Protective Equipment: Level D PPE (Section 4.8.1) modified by the use of chemically protective inner gloves (N-DEX or similar nitrile glove) while containerizing wastes

Monitoring Requirements: None

4.5.1.7 Unanticipated Work Activities.

Where work activities are identified that are not addressed in this HASP, appropriate safety documentation and procedures will be implemented. Prior to initiation of work activities any subcontractor organization tasked with performance of such work will submit a work procedure document that presents appropriate safety procedures applicable to the specific work activities to be undertaken. Submitted safety procedures will be reviewed by the HSO for adequacy and compliance with applicable regulatory requirements and the requirements presented in this HASP. Work will not be initiated until this review is completed and any identified deficiencies corrected to the satisfaction of the HSO.

The HSO may issue an exemption to this requirement based on the nature of the work activities to be undertaken.

4.5.2 Environmental Contaminant Hazards

As identified in existing site documentation, there are three distinct classes of environmental contaminants at the Project Site:

PAHs
Heavy metals - primarily cadmium, chromium and nickel
Trinitrotoluene

There is a very limited potential for encountering significantly contaminated soils during this work. However, migration of soil vapors may create the potential for encountering contaminated soil-gases during drilling and soil sampling activities.

The following is a discussion of the site-specific conditions and corresponding hazards associated with the identified contaminant types.

4.5.2.1 Polyaromatic Hydrocarbons (PAHs).

Anthrene
Benzo(a)anthracene

Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(g,h,i)perylene
Benzo(d,e,f)phenanthrene
Benzo(a)pyrene
Chrysene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Phenanthrene.

These are PAHs, and in the pure state, they are yellowish crystalline solids. These chemicals are found in coal tar and in products of incomplete combustion. They have varying degrees of potency for causing cancer, with benzo(a)pyrene being among the most potent. These PAHs are evaluated collectively as coal tar pitch volatiles. Coal tar pitch volatiles may cause photo-sensitization and a rash where sunlight strikes the skin. Exposure may also cause cancer of lungs, skin, bladder or kidneys. Benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, and indeno (1,2,3-cd) pyrene have been identified as carcinogenic. Polyaromatic compounds are formed when petroleum fuels are burned in a smoky flame.

4.5.2.2 Heavy Metals.

As a group, the heavy metals (which at the Project Site can include cadmium, chromium and nickel) are toxic to a number of organs and organ systems in the body including the liver, kidneys, blood-forming organs (which are primarily in the bones), and the central nervous system (CNS). Acute exposure to metals can produce symptoms such as stomach distress and vomiting, mental confusion and sluggishness, heart palpitations, breathing difficulties, and renal (kidney) failure. Chronic exposure can be characterized by deterioration in function of the liver and kidneys, CNS degradation, and abnormal changes in blood cell counts (especially in white blood cells). Exposure to chromium may also lead to formation of lung and gastric cancers.

It is anticipated that metals contamination will not be encountered in this project, since all work will be limited to disturbances involving "clean" surface soils. If metals were unexpectantly present in these soils, the primary route of exposure is contact with contaminated soils and water, which can lead to entry through open wounds or contamination and ingestion of food. Preventing this route of exposure necessitates the use of dust control measures and appropriate protective clothing and decontamination procedures. Inhalation is of secondary concern, since required dust control measures should adequately control any potential exposures. An aerosol meter will be used for monitoring during excavation work to verify that airborne dust levels are properly controlled.

4.5.2.3 Trinitrotoluene.

Trinitroluene (TNT) is an explosive compound that exhibits relatively stable properties when handled correctly. It has a low sensitivity to impact and friction, which makes it a common use as a military and industrial explosive. TNT has similar effects of other nitro-compounds. Long-term exposure to TNT may result in irritation to the gastrointestinal tract. Other indications of exposure to TNT include: toxic jaundice, aplastic anemia, and methaemoglobaimea (effects of oxygen deficiency), and cataract formation. Exposure routes for TNT are absorption, inhalation, and ingestion, with skin absorption being the primary cause for concern. Dermatitis is not a common illness associated with TNT exposure; however, indications are evident by orange staining of the hands, arms and face. Papular eruption and reddening of exposed skin has also been observed as a symptom of prolonged skin exposure. The Threshold Limit Value (TLV) has been recommended at 0.1 mg/m^3 by the American Conference of Governmental Industrial Hygienists (ACGIH), while federal OSHA has established the Permissible Exposure Limit (PEL) for TNT at 0.5 mg/m^3. Both agencies have applied a "skin" notation to the exposure limits, indicating that dermal exposure is a significant potential hazard.

Protection against skin exposure can be provided by the use of chemically protective gloves and other clothing.

4.6 ACTIVITY-SPECIFIC HEALTH AND SAFETY PROCEDURES

The following safety procedures will apply to work operations as specified in the task hazard analyses presented in Section 4.5.1.

4.6.1 Slips, Trips, and Falls, and Protruding Objects

Hazards from protruding objects, careless movements, or placement of materials on paths or in foot traffic areas present a problem with regard to slips, trips, and falls, and puncture wounds. Personnel will use a reasonable amount of effort to ensure the prevention of such injuries.

4.6.2 Hazardous Noise Safety

Working around large equipment often creates excessive noise. The adverse effects of noise can include physical damage to the ear, pain, and temporary and/or permanent hearing loss. Workers can also be startled, annoyed, or distracted by noise during critical activities.

Earth Tech has compiled noise monitoring data indicating that work locations within 25 feet of operating heavy equipment (e.g., drill rigs, earthworking equipment) can result in exposure to hazardous levels of noise (levels greater than 90 dBA). Accordingly, all personnel are required to use hearing protection (i.e., ear plugs or ear muffs) within 25 feet of any operating piece of heavy equipment.

The HSO may also choose to monitor employee exposure to hazardous noise levels as part of Earth Tech's Hearing Conservation Program.

4.6.3 Heavy Machinery

The use of heavy machinery (i.e., drilling equipment) in areas where unprotected personnel are operating warrants special attention on the part of all personnel. Operators should ensure that equipment is working properly and is being run in a safe manner, and should be aware of the location of unprotected personnel at all times while operating this machinery to avoid serious accidents.

4.6.4 Underground Utilities

Various forms of underground utility lines or pipes may be encountered during intrusive work activities. Prior to the start of intrusive operations, USA (Dig Alert) will be contacted at least 48 hours prior to the work.

Should intrusive operations cause equipment to come into contact with utility lines, the SSC and the HSO will be notified immediately, and a Supervisor's Report of Incident (see Attachment A of Appendix D) will be completed. Work will be suspended until the appropriate actions can be taken for the particular situations assessed.

4.6.5 Dust Suppression

In order to minimize potential releases of dust during site activities, it may be necessary to employ positive dust suppression techniques. In general, this will require the use of water to keep exposed soil surfaces wet and to prevent blowing dust. Water can be applied using hoses or portable sprayers. Specific procedures can be determined based upon the amount of dust being generated, results of air monitoring in the work area (where performed), and site conditions.

If mitigation measures are found to be inadequate, the SSC will halt on-site operations until effective control can be achieved.

4.7 AIR MONITORING PROCEDURES

Airborne particulate monitoring will be performed to assess the concentrations of fugitive dusts that may be released during site activities. Air monitoring will be accomplished both in worker breathing zones and at the boundaries of the established controlled work areas.

Monitoring will be conducted using an MIE mini-RAM aerosol monitor for airborne dusts.

Calibration of the mini-RAM instrument will be performed daily in accordance with the manufacturers' instructions. Daily calibration results will be recorded in Earth Tech's log books.

4.7.1 Work Area (Breathing Zone) Monitoring

Measurements of worker breathing zone concentrations of the specified contaminants will be accomplished at 30-minute intervals.

Initially, air monitoring results will be used to determine if there is a need for use of respiratory protection (i.e., monitoring results show dust concentrations above the Table 4-1 limits). Table 4-1 specifies the criteria to assess the appropriateness of elected protection measures.

Table 4-1. Exposure Monitoring Program Action Levels

Parameter	Location and Interval	Measured Concentration	Response
Airborne Dusts (mini-RAM)	Breathing Zone, at 15 minute intervals during all drilling activities	< 5 mg/m^3	No respiratory protection required.
		5-15mg/m^3 (Sustained for more than 5 minutes)	Air Purifying Respirators (w/N99 cartridges) required.
		or > 15 mg/m^3 (Instantaneous)	If Level C has been discontinued contact the HSO, implement mitigation measures, and upgrade PPE to Level C before continuing work.
		>15mg/m^3 (Sustained for more than 5 minutes)	Cease work, exit, and contact the HSO. Air purifying respirators required for continued work.
		or > 25 mg/m^3 (Instantaneous)	

HSO = Health and Safety Officer

4.7.2 Work Space Boundary Monitoring

Release of contaminants to the community will be monitored through determination of airborne levels of contaminants present at the boundary of the controlled area(s). Table 4-2 specifies the criteria to be used for evaluation of these monitoring results.

4.7.3 Personal Sampling

Measurement of employee exposure to chemical contaminants will be performed at the discretion of the HSO. Monitoring techniques will also be determined by the HSO, and will conform with applicable OSHA and National Institute of Occupational Safety and Health (NIOSH) sampling methods.

Table 4-2. WBGT Values for Level D Work/Rest Cycles

	°F –WBGT		
Work-Rest Regimen	Light Work	Moderate Work	Heavy Work
Continuous Work	86	80	77
75% Work – 25% Rest	87	82	78
50% Work – 50% Rest	89	85	82
25% Work – 75% Rest	90	88	86

Source: Reprinted from ACGIH's 1999 Threshold Limit Values for Chemical Substances and Physical Agents.

Samples will be collected by, or under the direction of, a member of the Earth Tech Health and Safety Department. Any analytical laboratory performing analysis of personal samples will be accredited by the American Industrial Hygiene Association (AIHA) and be a participant in the AIHA Proficiency Analytical Testing (PAT) program.

4.7.4 Heat Stress Monitoring

The prevention of heat stress-related accidents/illnesses is best performed through continuous observation of employees and routine heat stress awareness training activities. Heat stress monitoring can be accomplished using one of the techniques discussed below.

Any results obtained from monitoring techniques should be used as guidance only. To properly mitigate the effects of heat stress, it is necessary to establish a work routine that incorporates adequate rest periods to allow workers to remove protective clothing, drink fluids (vital when extreme sweating is occurring), rest, and recover. The frequency and length of such work breaks must be determined by the individual work location supervisor based upon factors such as the ambient temperature and sunshine, the amount of physical labor being performed, the physical condition of the workers, and protective clothing being used. While heat stress measurement techniques provide guidance in optimizing this routine, breaks must always be sufficient to prevent workers from manifesting symptoms of heat stress, regardless of monitoring results.

To determine appropriate work/rest cycles, evaluation of heat stress will be performed whenever field work activities are occurring. The Basic Instrument Measurements Method shown in the following must be used for personnel using Level D protective equipment only. Where any type of chemically protective clothing (CPC) is in use, the Modified Instrument Measurements Method will be

used together with the Direct Observation Method to provide guidance in appropriate work/rest cycles.

4.7.4.1 Basic Instrument Measurements Method.

This method will be used only to monitor heat stress where workers are not using CPC. The Wet Bulb Globe Temperature (WBGT) value will be determined using a WBGT meter (Reuter-Stokes 214 DL or equivalent), and compared with the values shown in Table 4-2 to determine appropriate work/rest cycles.

4.7.4.2 Modified Instrument Measurements Method

This method will be used whenever personnel use CPC. The WBGT value will be determined as above. The measured value will then be compared to the values shown in Table 4-3 to determine the appropriate work/rest cycle.

Table 4-3. WBGT Values for CPC Work/Rest Cycles

	°F –WBGT		
Work-Rest Regimen	Light Work	Moderate Work	Heavy Work
Continuous Work	75	69	66
75% Work – 25% Rest	76	71	67
50% Work – 50% Rest	78	74	71
25% Work – 75% Rest	79	77	75

Source: Modified from ACGIH's 1999 Threshold Limit Values for Chemical Substances and Physical Agents.

4.7.4.3 Direct Observation.

This method will also be used whenever personnel use CPC. At the start of the work day, each worker's baseline pulse rate will be determined in beats per minute (bpm). Worker pulse rates will then be measured at the beginning and end of each break period. As recommended by the ACGIH, each worker's maximum heart rate at the start of any break should be less than [180 minus worker's age] bpm. If this value is exceeded for any worker, the duration of the following work period will be decreased by at least 10 minutes. At the end of each work period, all workers' heart rates must have returned to within ±10% of the baseline pulse rate. If any worker's pulse rate exceeds this value, the break period will be extended for at least 5 minutes, at the end of which pulse rates will be re-measured and the end-of-break criteria again applied.

4.8 PROTECTIVE EQUIPMENT ENSEMBLES

The use of protective equipment ensembles specified in the individual task hazard analyses (Section 4.5.1) will conform to the following requirements.

4.8.1 Level D

Level D PPE will be the minimum acceptable protective clothing/equipment to be used during site work activities. The Level D ensemble provides limited physical protection from abrasion, but no significant skin contact protection for chemical exposure.

Level D Equipment List

Long pants and shirt with sleeves
Hard hat
Safety glasses
Safety-toe boots (leather boots acceptable for this project)
Full-face air purifying respirator (available for emergency use).

Where there is a desire to provide limited skin protection from chemical hazards, the use of chemically protective gloves can be specified. In such cases, the inner glove will be made of nitrile rubber (N-DEX model gloves or equivalent), and outer gloves will be made from nitrile rubber (Solvex or equivalent gloves).

4.8.2 Modified Level D

The Modified Level D ensemble provides moderate skin protection against chemical contact, but no respiratory protection.

Modified Level D Equipment List

Tyvek disposable outer coveralls, hoods optional

Nitrile outer gloves (Solvex or equivalent), taped to outer coveralls

Nitrile inner gloves (N-DEX only)

Hard hat

Safety glasses/faceshield

Safety-toe boots (leather boots acceptable for this project)

Full-face air purifying respirator (available for emergency use).

4.8.3 Level C

The Level C ensemble provides moderate skin protection against chemical contact, as well as respiratory protection from low to moderate concentrations of airborne contaminants.

Level C Equipment List

Polyethylene-coated Tyvek disposable outer coveralls with hood (hood taped-sealed to respirator)

Nitrile outer gloves (Solvex or equivalent), taped to outer coveralls

Nitrile inner gloves (N-DEX only)

Safety-toe boots (leather boots acceptable for this project)

Boot covers (taped to coveralls)

Full-face air purifying respirator, equipped with organic vapor cartridges.

4.8.4 Level B and Level A

The use of Level B or Level A protective equipment will not be required for this project.

4.9 SITE AND CONTAMINATION CONTROL

4.9.1 Overall Site Control

Overall control of the Project Site is the responsibility of Earth Tech. Access to the site will be secured through an entrance gate to the Project Site and will be limited to authorized personnel only.

4.9.2 Work Area Control

Earth Tech is responsible for properly controlling its work locations to prevent injury to other personnel operating at the site. To ensure that conflicts do not occur, Earth Tech will coordinate daily work activities with the other organizations performing work at the site (if any), and will inform each organization of the hazards and clearance requirements for each work activity so that they can inform/manage their personnel accordingly.

4.9.2.1 Exclusion Zones.

Exclusion zone boundaries will be set such that all physical, noise, and chemical contaminant hazards are fully contained within. Unless otherwise indicated (by specific site or work conditions or by perimeter monitoring results), an area of 35 feet in all directions from each work location will be considered as the boundaries of each exclusion zone. Where feasible, boundaries of each exclusion zone will be designated using cones, yellow "CAUTION" tape and/or other positive physical/visual barriers. However, it is recognized that during some work operations (i.e., hand augering, etc.), the work pace will preclude use of this equipment. In such instances, visual control of the work area should be adequate due to the limited potential for unexpected entry.

Within each exclusion zone, Earth Tech will have complete control of all operations and personnel. Only Earth Tech-authorized personnel, who must meet the training and medical monitoring requirements specified in Sections 4.4.1 and 4.4.2., will be permitted within any exclusion zone. Once an exclusion zone is established, access will be limited to qualified personnel equipped with the proper PPE. Access will be through a designated entry control point.

4.9.2.2 Contamination Reduction Zone (C.Z.).

Since it is considered unlikely that significant soil contamination will be encountered, there is limited need for establishment of specific CRIS around each exclusion zone. Instead, Earth Tech will establish designated entry/exit areas. These locations will serve as C.Z./decontamination locations (see Section 4.8.3).

4.10 DECONTAMINATION

All personnel and equipment entering any controlled work area must be adequately decontaminated prior to exiting the area. The following general guidance should be used in developing site-specific decontamination procedures as appropriate to the types and levels of contamination encountered.

4.10.1 Personnel Decontamination

Decontamination procedures must be carried out on all personnel who have been in contact with contaminated materials. Under no circumstances (except emergency evacuations) will personnel be allowed to leave a controlled work area where contaminants are exposed without performing decontamination.

Decontamination of personnel should be performed at a Personal Decontamination Station on the site and should consist primarily of soap and water washing and water rinse of exterior protective gear to remove contaminants, followed by doffing of the gear. Coveralls should be removed by turning the clothing inside out. A procedure appropriate to the degree of

contamination should be established. The extent of washing required, or modifications to the sequence, may be specified as appropriate.

Level D Personnel Decontamination: Personnel exiting the exclusion zone while site activities require the use of Level D PPE will perform decontamination in accordance with the following guidelines:

> Place tools, instruments, samples, and trash at an appropriate location. The equipment drop area should be clean and dry and at a minimum, plastic bags should be available for trash. Waste PPE will not be placed in the same containers as general trash.
>
> Inspect equipment, samples, and if applicable, tools for signs of residual amounts of contamination or excessive soil buildup. If present, soils and contamination must be completely cleaned from equipment, samples, and tools prior to removal from the exclusion zone areas.
>
> Personnel will visually check themselves for signs of excessive soils and possible contamination. If observed, soils and contamination will be completely removed before further decontamination is performed.
>
> Prior to exiting the exclusion zone areas, personnel will wash their hands with soap and water in order to minimize the potential for contaminant exposure.

Modified Level D Personnel Decontamination: Where activities are performed in Modified Level D PPE, personnel will perform decontamination using the following guidelines:

> Place tools, instruments, samples and trash at an appropriate location. The equipment drop area should be clean and dry and at a minimum, plastic bags should be available for trash. Waste PPE will not be placed in the same containers as general trash.
>
> Inspect equipment, samples, and if applicable, tools for signs of residual amounts of contamination or excessive soil buildup. If present, soils and contamination must be completely cleaned from equipment, samples, and tools prior to removal from the exclusion zone areas.
>
> Personnel will visually check themselves for signs of excessive soils and possible contamination. If observed, soils and contamination will be completely removed before further decontamination is performed.

Wash and rinse outer work gloves and boots (boot covers) with soap and water.

Wash/brush off outer protective coverall (Tyvek).

Untaped wrists and ankles.

Remove outer work gloves and place them in an appropriate container specified for waste PPE.

Remove outer Tyvek coveralls and place them in an appropriate container specified for waste PPE.

Wash, rinse, and remove inner protective gloves and place them in an appropriate container specified for waste PPE.

Wash hands using soap and water (separate from other decontamination cleaners/solutions).

Level C Personnel Decontamination: Personnel involved in activities requiring the use of Level C PPE will observe the following decontamination guidelines:

Place tools, instruments, samples and trash at an appropriate location. These areas should be clean and dry, and at a minimum should contain plastic bags for trash. Waste PPE will not be placed in the same containers as general trash.

Inspect equipment, samples, and if applicable, tools for signs of residual amounts of contamination or excessive soil buildup. If present, soils and contamination must be completely cleaned from equipment, samples, and tools prior to removal from the exclusion zone areas. Personnel will visually check themselves for signs of excessive soils and possible contamination. If observed, soils and contamination will be completely removed before further decontamination is performed.

Wash and rinse outer work gloves and boots (boot covers) with soap and water.

Wash/brush off outer protective coverall (Tyvek).

Untaped wrists and ankles.

Remove outer work gloves and place them in an appropriate container specified for waste PPE.

Remove outer Tyvek coveralls and place them in an appropriate container specified for waste PPE.

Remove respirator mask (also goggles if worn).

Wash, rinse and remove inner protective gloves and place them in an appropriate container specified for waste PPE.

Wash hands using soap and water (separate from other decontamination cleaners/solutions).

Respirator Decontamination: If worn, respirators will be decontaminated each day. Taken from the drop area, the masks will be disassembled, the cartridges disposed of, and the rest placed in a cleansing solution. Personnel will inspect their own masks to be sure of proper strap readjustment for correct fit.

Certain parts of contaminated respirators, such as the harness assembly or cloth components, are difficult to decontaminate. If grossly contaminated, they may have to be discarded and replaced.

In addition to being decontaminated, all respirators, protective clothing, and other personal articles must be sanitized before they can be used again. The insides of masks and clothing become soiled from exhalation, body oils, and perspiration. The manufacturer's instructions should be followed in sanitizing the respirator mask. If practical, protective clothing should be machine washed after a thorough decontamination. Otherwise, it should be cleaned by hand.

4.10.2 Equipment Decontamination

Equipment that might require decontamination includes heavy equipment, tools, monitoring equipment, sampling equipment, and sample containers; trucks and trailers; and the decontamination equipment itself when the decontamination is closed down. Before entering the site, all equipment will be cleaned to remove grease, oil, encrusted dirt, or other potential contaminants. The following is general guidance for use in determining equipment decontamination procedures:

Tools: Tools will be dropped into a plastic pail, tub, or other container in the exclusion zone. They will be brushed off, rinsed, and transferred into a second pail to be carried to the decontamination station. Generally, tools will be washed with a detergent solution and finally, rinsed with clean water.

Avoid using wooden tools; they cannot be adequately decontaminated due to their absorptive properties. If used, wooden tools cannot be removed from the exclusion zone until the end of the project, and then only to be disposed of as hazardous waste.

Sampling Equipment: Sampling equipment will be decontaminated before and between sampling to prevent cross-contamination, and when the equipment leaves the exclusion zone. Sampling equipment may include trowels, shovels, bailers, submersible pumps, geotechnical samplers, sleeves, and backhoes buckets.

All sampling equipment will be decontaminated using an Alconox wash, or equivalent, followed by two clean-water rinses. The sampling tool will then be rinsed with deionized or distilled water and air dried.

Heavy Equipment: Where significant amounts of site soils accumulate on site equipment, cleaning will be accomplished with high-pressure water or a portable high-pressure steam spray followed by a soap and water wash and rinse. Loose material will be removed by brush.

All cleaning water and debris will be collected and sampled to determine proper disposal options.

Monitoring Instruments: Monitoring equipment should be protected as much as possible from contamination. Drape, mask, or otherwise cover as much of the instruments as possible with plastic without hindering the operation of the unit. Many instruments can be placed in a clear plastic bag that allows reading of the scale and operation of the knobs.

Contaminated instruments will be taken from the drop area, their protective coverings removed, and disposed of in appropriate containers. Any remaining dirt or obvious contamination will be brushed or wiped with a damp, disposable paper wipe. The units can then be placed in a clean plastic tub, taken inside, wiped with damp, disposable wipes, and dried.

Be aware that many instrument manufacturers and rental companies will not accept contaminated equipment for repair, and that a heavily contaminated piece of equipment, if improperly handled, may have to be disposed of as hazardous waste.

4.10.3 Disposal Of Decontamination Wastes

Solid and liquid decontamination waste should be containerized. Solids may be double bagged or placed in a sealed drum or similar container. Liquids will be collected during decontamination and placed in sealed containers or pumped into holding tanks for future testing and disposal. Containers must be clearly labeled for content, the operation from which they were filled, and the dates.

4.10.4 Decontamination During Emergencies

During emergencies, the need to quickly respond to an accident or injury must be weighed against the risk to the injured party from chemical exposure. It may be that the time lost or the additional handling of an injured person during the

decontamination process may cause greater harm to the individual than the exposure that would be received by undressing that person without proper decontamination.

An additional consideration when bypassing decontamination of injured personnel is the acceptance of contaminated personnel at emergency medical facilities. Many facilities will not accept contaminated personnel. Site response personnel should accompany contaminated victims to the medical facility to advise on matters involving decontamination.

4.11 EMERGENCY CONTINGENCY PLAN

4.11.1 General

There are four types of emergencies that could occur during performance of this project:

Illnesses and physical injuries

Catastrophic event at the work site (fire, explosion, earthquake, or chemical)

Catastrophic event involving site personnel and/or equipment.

Although a catastrophic event or severe medical emergency is unlikely to occur during work activities, an emergency contingency plan has been prepared for this project should such critical situations arise.

4.11.2 Responsibilities

4.11.2.1 Project Manager (PM)/Site Safety Coordinator (SSC).

The PM/SSC will be the primary contact individual and coordinator of all emergency activities. He/she will be responsible for:

Evaluating the severity of the emergency

Implementing appropriate response action

Summoning appropriate emergency services (e.g., fire department, ambulance)

Notifying all site personnel, the HSO, and concerned authorities of the emergency situation.

4.11.2.2 Other On-site Personnel.

It will be the obligation of the field personnel to inform the SSC of all emergency situations and to abide by their issued response actions. Special medical problems of field personnel (e.g., allergies to insects, plants, prescription medication) will be reported to the SSC.

4.11.3 Emergency Equipment

Provisions will be made to have appropriate emergency equipment available and in proper working condition.

4.11.3.1 First Aid Kits.

Each work team will have access to a first-aid kit meeting the following requirements:

First-aid kits in weatherproof containers, approved by Earth Tech's Occupational Physician and meeting all regulatory requirements, will be present at all locations where Earth Tech employees will be working.

First-aid kits will be available at the job site at all times.

Use of any item from the first-aid kit will necessitate completion of an Accident/Injury Report. The report will be submitted to the HSO within 1 working day of the incident.

First-aid kits will be inspected and restocked weekly. An inventory of first-aid supplies sufficient to restock kits on a weekly basis will be maintained.

Personnel permitted to use first-aid kits will possess a current first-aid provider card.

4.11.3.2 Eyewash Units.

Each work team will have access to an eyewash unit meeting the requirements of ANSI Standard Z358.1-1990, capable of supplying hands-free irrigation for both eyes for at least 15 minutes at a flow rate of at least 0.4 gallon per minute. This unit will be within 50 feet of any work location.

4.11.3.3 Fire Extinguisher.

A fire extinguisher with a minimum rating of 1A, 10B, C will be available to each work team, and within 50 feet of any work location. Use of existing plant

equipment for this purpose is acceptable, as long as personnel are aware of the location of the nearest fire extinguisher at all times.

4.11.4 Notification And Recordkeeping

Any injury or illness will be immediately reported to the PM, who will implement any immediate corrective actions and report the incident to the HSO. OSHA requires notification within 24 hours, and preferably during the same work shift, in the event of a fatality or severe injury requiring hospitalization. The HSO will make such notifications to OSHA and consequently must receive the information in time to make the notification without penalty.

4.11.5 Response Actions - Safety Equipment Problems

An emergency may develop due to malfunction or other problems associated with health and safety equipment being used by field personnel. These equipment problems must be corrected before proceeding with field activities. Health and safety problems that may occur include:

Leaks or tears in protective clothing

Failure of respiratory protective devices

Encountering contaminants for which prescribed protective equipment may not be suitable.

4.11.6 Response Actions - Medical Emergencies

Medical emergencies can be described as situations that present a significant threat to the health of personnel. These can result from chemical exposures, heat stress, cold stress, and poisonous insect or snake bites. Medical emergencies must be dealt with immediately, and proper care should be administered. This may be in the form of first aid and emergency hospitalization.

Telephone numbers and locations for local fire department, hospitals, ambulance service, and other emergency services will be maintained by the SSC (see Table 4-4). Information regarding nonemergency medical treatment for on-site injury, on-site illness, or on-site exposure to chemical contaminants will be provided to the hospital by the SSC.

4.11.7 Response Actions – Unexploded Ordnance (UXO) Avoidance

If UXO is encountered during site activities, site personnel will comply with the UXO Avoidance Procedures presented in Attachment D of Appendix D.

4.11.8 Response Actions – Worksite Catastrophic Events

In the event of a catastrophic incident at the worksite:

> Work activities will cease and all project personnel will be evacuated from the work location. The evacuation will proceed in a direction opposite of the critically affected area with all personnel assembling in a predesignated location outside of the job site proper.
>
> A headcount will be taken of the assembled employees, and any injured individuals will be administered first aid.
>
> If not present at the work location, the SSC will be contacted immediately.

Immediate notification of the event will be provided to the PM or HSO by the SSC.

Table 4.4. Emergency Contacts and Telephone Numbers

Fire Department 911

Ambulance 911

Police 911

Information and Response Organizations

California Dept. of Health Services (Sacramento) ..... (916) 445-4171

California Dept. of Fish and Game (Sacramento) ..... (916) 445-4171

EPA Region 9 (San Francisco) ..... (415) 974-8071

Earth Tech Personnel

Health and Safety Manager
Robert Poll. ..... (562) 951-2242
Mobile: (562) 884-1414

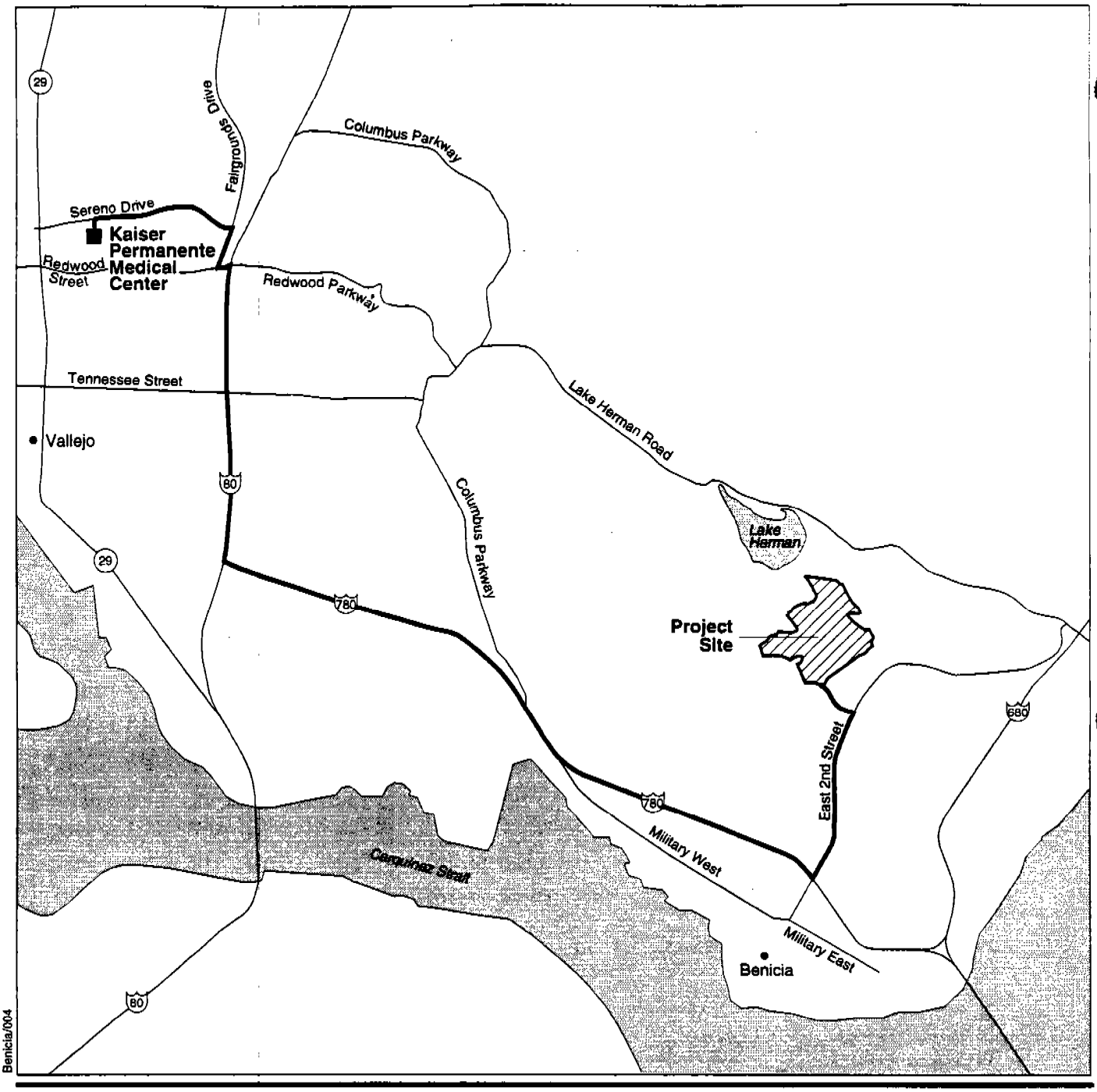
Health and Safety Officer
Johnathan Moore. ..... (562) 951-2265
Mobile: (562) 884-3732

Project Manager
Brian Weith ..... (909) 424-1919

Site Safety Coordinator/Field Team Leader
Michael Dukes. ..... (909) 424-1919

Directions to Hospital

From the site, head south on east 2nd Street to Interstate 780. Proceed west on I-780 to Highway 80. Head north on 80 and exit at Redwood Street. Head west on Redwood and make a right onto Fairgrounds Drive. Proceed north on Fairgrounds Drive to Serrano Drive. Make a left onto Serrano and the hospital will be on the left-hand-side of the street.



EXPLANATION

- (11) State Highway
- (84) Interstate Highway
- Hospital Route

0 .25 .5 1 Mile

Hospital Location Map

Kaiser Permanente Medical Center
975 Sereno Drive
Vallejo, CA 94589
(707) 648-6200

Figure 4-1

SIGNATURE PAGE

I have read and reviewed the HASP for the Tourtelot Cleanup Project Site. I have been instructed in the contents of this document and understand the information presented. I will comply with the provisions contained therein.

PRINT NAME	SIGNATURE	ORGANIZATION	DATE

5.0 REFERENCES

American Public Health Association, American Water Works Association, and the Water Environment Federation, 1992. Standard Methods for the Examination of Water and Wastewater, 18th ed., Washington, D.C. Brown and Caldwell, 1999. Final Arsenal-Wide Investigation Work Plan, February.

American Society for Testing and Materials, (ASTM), 1988. Annual Book of ASTM Standards: Vol. 4.08, Soil and Rock.

American Society for Testing and Materials, (ASTM), 1988. Annual Book of ASTM Standards: Vol. 11.01, Water.

American Society for Testing and Materials, (ASTM) 1990. Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers, ASTM Standard D5092-90, Volume D4.08 Soil and Rock.

Brown and Caldwell, 1999. Final Arsenal-wide Investigation Work Plan, February.

California Department of Health Services, California Code of Regulations, Title 22.

California Department of Water Resources, 1990. Water Well Standards: State of California, Bulletin 74-81.

California State Parks, 1991. Benicia State Recreation Area General Plan, June.

Cowell, Josephine W., 1963. History of Benicia Arsenal, Benicia, California. Berkeley: Howell-North Press.

Earth Tech, 1999. Draft Engineering Evaluation/Cost Analysis, Former Benicia Arsenal, Benicia, California, prepared for U.S. Army Corps of Engineers, Huntsville Division, Ordnance and Explosive Design Center, June.

Engeo Incorporated, 1990. Report to Southampton Company, Benicia, California on the Preliminary Soils Exploration for Southampton Units D-1 Through D-7, Benicia, California, February.

Jacobs Engineering, 1999. Final Benicia Arsenal Records Research Report, April.

State of California, 1989. Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup and Underground Storage Tank Closure, Leaking Underground Fuel Tank Task Force, October 1989.

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

U.S. Army Corps of Engineers, Sacramento District, 1997. Draft Environmental Assessment, Benicia Arsenal Site Investigation, Benicia, California, August.

U.S. Army Corps of Engineers, St Louis District, 1994a. Archives Search Report Findings, Benicia Arsenal, Benicia, Solano County, California, March.

U.S. Army Corps of Engineers, St. Louis District, 1994b. Archives Search Report Conclusions and Recommendations, Benicia Arsenal, Benicia, Solano County, California, March.

U.S. Department of Agriculture Soil Conservation Service, 1977. Soil Survey of Solano County, California, May.

U.S. Environmental Protection Agency (EPA), 40 Code of Federal Regulations, Protection of the Environment.

U.S. Environmental Protection Agency, 1980. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80, EPA 600-4-83-004.

U.S. Environmental Protection Agency, 1983. Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020.

U.S. Environmental Protection Agency, 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, Second Edition, EPA-600/4-84-076.

U.S. Environmental Protection Agency, 1985. Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water. June 1985, Rev. Nov. 1985.

U.S. Environmental Protection Agency, 1986a. Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods, SW-846, Third Edition.

U.S. Environmental Protection Agency, 1986b. RCRA Ground Water Monitoring Technical Enforcement Guidance Document, Office of Solid Waste and Emergency Response, OSWER Directive 9950.1.

U.S. Environmental Protection Agency, 1987. A Compendium of Superfund Field Operations Methods, Office of Emergency and Remedial Response, EPA/540/P-87-001, OSWER Directive 9355.0-14, produced by U.S. Department of Commerce National Technical Information Service.

U.S. Environmental Protection Agency, 1988. User's Guide to Contract Laboratory Program, EPA/540/8-89/012, December 1988.

U.S. Environmental Protection Agency, 1990 (January). Guidance Document, Laboratory Documentation Requirements for Data Validation. Document Control No. 9QA-07-90, Quality Assurance Management Section, US EPA Region 9, San Francisco, California.

U.S. Environmental Protection Agency, 1992. Final Update I for Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846.

U.S. Environmental Protection Agency, 1993. Data Quality Objectives Process for Superfund, September 1993, EPA 540-R-93-071.

U.S. Environmental Protection Agency, 1994a (February). National Functional Guidelines for Organic Data Review, February 1994, EPA-540/R-94-012.

U.S. Environmental Protection Agency, 1994b (February). National Functional Guidelines for Inorganic Data Review, EPA-540R/R-94-013.

U.S. Environmental Protection Agency, 1994c. Update II for Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846.

U.S. Environmental Protection Agency, 1996. Update III for Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846.

U.S. Environmental Protection Agency, 1998. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, October.

Wetlands Research Associates, Inc., 1998. *California Red-Legged Frog Field Survey Report*, Southhampton Hills Project, Benicia, California. Prepared for Pacific Bay Homes, August 1998.

40 CFR 136, Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, Appendix B to Pack 136, October 1984.

APPENDIX A

SOIL AND SURFACE WATER SAMPLING RESULTS

Table A-1
Soil Analytical Program
Granite Management Corporation
Benicia, California

Sample Identification	Metals Lab Analysis	Explosive Compounds Lab Analysis	Confirmation Analysis of Metals	Confirmation of Explosive Compounds	TNT Field Analysis	RDX Field Analysis
SS-1	X	X				
SS-2	X	X				
SS-3	X	X				
SS-4	X	X				
SS-5	X	X				
SS-6	X	X				
SS-7	X	X				
SS-8	X	X				
SS-9	X	X				
SS-10	X	X				
SS-11	X	X				
SS-12	X	X				
SS-13	X	X				
SS-14	X	X				
SS-15	X	X				
SS-16	X	X				
SS-17	X	X				
SS-18	X	X				
SS-19	X	X				
SS-20	X	X				
SS-21	X	X				
SS-22	X	X	X	X	X	
SS-23	X	X				
SS-24	X	X				
SS-25	X	X		X		
SS-26	X	X			X	
SS-27	X	X			X	
SS-28	X	X		X	X	
SS-29	X	X			X	
SS-30	X	X			X	X
SS-31	X	X				
SS-32	X	X				
SS-33	X	X			X	
SS-35	X	X				
SS-36	X	X				

Source: SECOR International, Inc.

Table A-1
Soil Analytical Program
Granite Management Corporation
Benicia, California

Sample Identification	Metals Lab Analysis	Explosive Compounds Lab Analysis	Confirmation Analysis of Metals	Confirmation of Explosive Compounds	TNT Field Analysis	RDX Field Analysis
SS-37	X	X				
SS-38	X	X				
SS-39	X	X				
SS-40	X	X				
SS-41	X	X				
SS-42	X	X				
SS-43	X	X				
SS-44	X	X				
WS-1	X	X	X			
WS-2	X	X	X			
FSS-1					X	
FSS-2					X	
FSS-3					X	
FSS-4					X	
FSS-5					X	
FSS-6					X	
FSS-7					X	
FSS-8					X	X
FSS-9					X	
FSS-10				X	X	X
FSS-11					X	
FSS-12					X	
FSS-13					X	
FSS-14					X	
FSS-15					X	
FSS-16					X	
FSS-17					X	
FSS-18					X	
FSS-19					X	
FSS-20					X	
FSS-21					X	
FSS-22					X	
FSS-23					X	
FSS-24					X	
FSS-25					X	

Source: SECOR International, Inc.

Table A-1
Soil Analytical Program
Granite Management Corporation
Benicia, California

Sample Identification	Metals Lab Analysis	Explosive Compounds Lab Analysis	Confirmation Analysis of Metals	Confirmation of Explosive Compounds	TNT Field Analysis	RDX Field Analysis
FSS-26					X	X
FSS-27					X	
FSS-28					X	
FSS-29					X	X
FSS-30					X	
FSS-31					X	
FSS-32					X	
FSS-33					X	X
FSS-34					X	X
FSS-35					X	X
FSS-36					X	X
FSS-37					X	
FSS-38					X	
FSS-39					X	
FSS-40				X	X	
FSS-41					X	X

Notes:
SS = soil sample
FSS = field screening soil sample
TNT = 2,4,6-Trinitrotoluene
RDX = cyclonite
Sample SS-34 does not exist.

Source: SECOR International, Inc.

Table 1-2
Soil Analytical Data - Metals, Nitrate and Nitrate/Nitrite as Nitrogen
Granite Management Corporation
Benicia, California

	Coordinates			Antimony		Manganese		Potassium		Arsenic		Barium		Beryllium		Cadmium	
Sample Identification	X	Y	Date	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SS-1	N4060	E8351	9/9/98	ND	5.0	1200	5.0	1500	10	ND	5.0	220	0.50	0.89	0.50	ND	0.50
SS-2	N4040	E8202	9/9/98	ND	5.0	1500	5.0	1400	10	ND	5.0	250	0.50	1.0	0.50	ND	0.50
SS-3	N4200	E8000	9/9/98	ND	5.0	690	5.0	1500	10	ND	5.0	180	0.50	0.84	0.50	ND	0.50
SS-4	N4140	E7900	9/9/98	ND	5.0	890	5.0	1300	10	ND	5.0	160	0.50	0.85	0.50	ND	0.50
SS-5	N4150	E7714	9/9/98	ND	5.0	2100	5.0	1800	10	ND	5.0	300	0.50	1.3	0.50	ND	0.50
SS-6	N4400	E7600	9/9/98	ND	5.0	1700	5.0	2400	10	ND	5.0	180	0.50	0.90	0.50	0.95	0.50
SS-7	N2016	E8487	11/20/98	ND	6.00	651	0.500	1110	500	17.7	10.0	253	0.400	0.791	0.100	ND	1.00
SS-8	N2200	E8600	11/20/98	ND	6.00	907	0.500	1930	500	19.7	10.0	250	0.400	0.756	0.100	ND	1.00
SS-9	N2302	E8598	11/20/98	ND	6.00	1240	1.00	2370	500	18.6	10.0	307	0.400	0.888	0.100	ND	1.00
SS-10	N1800	E9000	11/20/98	ND	6.00	1050	1.00	1760	500	20.5	10.0	319	0.400	0.838	0.100	ND	1.00
SS-11	N2129	E9175	11/20/98	ND	6.00	834	0.500	2330	500	13.0	10.0	599	0.400	0.769	0.100	ND	1.00
SS-12	N2084	E8151	11/20/98	ND	6.00	1070	1.00	2210	500	21.9	10.0	305	0.400	0.765	0.100	ND	1.00
SS-13	N1800	E8000	11/20/98	ND	6.00	558	0.500	987	500	13.5	10.0	338	0.400	0.601	0.100	ND	1.00
SS-14	N2551	E8309	11/20/98	ND	6.00	1180	1.00	2170	500	18.7	10.0	262	0.400	0.953	0.100	ND	1.00
SS-15	N2600	E8600	11/20/98	ND	6.00	840	0.500	1500	500	18.4	10.0	182	0.400	0.712	0.100	ND	1.00
SS-16	N3000	E8800	11/20/98	ND	6.00	820	0.500	2590	500	48.1	10.0	163	0.400	0.723	0.100	1.67	1.00
SS-17	N2600	E9600	11/20/98	ND	6.00	513	0.500	1330	500	14.0	10.0	176	0.400	0.696	0.100	ND	1.00
SS-18	N2800	E8300	11/20/98	ND	6.00	832	0.500	2500	500	13.1	10.0	286	0.400	0.905	0.100	ND	1.00
SS-19	N3707	E8002	11/20/98	ND	6.00	917	0.500	2040	500	17.0	10.0	238	0.400	0.804	0.100	ND	1.00
SS-20	N3780	E7508	11/20/98	ND	6.00	545	0.500	2240	500	13.7	10.0	331	0.400	0.805	0.100	ND	1.00
SS-21	N1800	E7747	11/20/98	ND	6.00	922	0.500	2150	500	16.5	10.0	212	0.400	0.793	0.100	ND	1.00
SS-22	N1777	E7629	11/20/98	1470	600	395	50.0	ND	50000	ND	1000	74100	40.0	ND	10.0	ND	100
				666	48	236	12.0	-	-	9.9*	1.0*	76.600	160.0	ND	4.0	ND	4
SS-23	N1704	E7353	11/20/98	ND	6.00	928	1.00	2260	500	16.8	10.0	206	0.400	0.821	0.100	ND	1.00
SS-24	N1725	E7093	11/20/98	ND	6.00	759	0.500	1770	500	14.7	10.0	173	0.400	0.778	0.100	ND	1.00
SS-25	N1927	E7238	11/20/98	ND	6.00	589	0.500	1040	500	13.4	10.0	158	0.400	0.547	0.100	ND	1.00
SS-26	N1933	E7348	11/20/98	ND	6.00	735	0.500	1250	500	19.1	10.0	183	0.400	0.637	0.100	ND	1.00

Source: SECOR International, Inc.

Table A-2
Soil Analytical Data - Metals, Nitrate and Nitrate/Nitrite as Nitrogen
Granite Management Corporation
Benicia, California

	Coordinates			Antimony		Manganese		Potassium		Arsenic		Barium		Beryllium		Cadmium	
Sample Identification	X	Y	Date	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SS-27	N1905	E7353	11/20/98	ND	6.00	614	0.500	1420	500	16.3	10.0	197	0.400	0.650	0.100	ND	1.00
SS-28	N1942	E7400	11/20/98	ND	6.00	448	0.500	881	500	16.7	10.0	182	0.400	0.599	0.100	ND	1.00
SS-29	N2073	E7357	11/20/98	ND	6.00	662	0.500	1560	500	17.2	10.0	190	0.400	0.650	0.100	ND	1.00
SS-30	N2200	E7400	11/20/98	ND	6.00	886	0.500	1660	500	16.8	10.0	258	0.400	0.699	0.100	ND	1.00
SS-31	N2200	E7300	11/20/98	ND	6.00	791	0.500	1660	500	15.9	10.0	237	0.400	0.673	0.100	1.18	1.00
SS-32	N2200	E7200	11/20/98	ND	6.00	712	0.500	1670	500	16.6	10.0	221	0.400	0.621	0.100	1.23	1.00
SS-33	N2000	E7600	11/20/98	ND	6.00	805	0.500	1630	500	21.1	10.0	331	0.400	0.933	0.100	ND	1.00
SS-35	N3265	E7914	11/20/98	ND	6.00	517	0.500	1130	500	16.6	10.0	152	0.400	0.676	0.100	ND	1.00
SS-36	N3472	E8526	11/20/98	ND	6.00	629	0.500	1740	500	18.1	10.0	176	0.400	0.759	0.100	ND	1.00
SS-37	N3700	E8600	11/20/98	ND	6.00	1090	1.00	1780	500	13.6	10.0	219	0.400	0.786	0.100	ND	1.00
SS-38	N3800	E8800	11/20/98	ND	6.00	1130	1.00	2110	500	15.7	10.0	227	0.400	0.898	0.100	ND	1.00
SS-39	N4500	E7200	11/20/98	ND	6.00	1320	1.00	2700	500	20.0	10.0	183	0.400	0.778	0.100	ND	1.00
SS-40	N3700	E7200	11/20/98	ND	6.00	599	0.500	1910	500	19.7	10.0	223	0.400	0.599	0.100	ND	1.00
SS-41	N3000	E7000	11/20/98	ND	6.00	904	0.500	1440	500	11.4	10.0	307	0.400	0.510	0.100	ND	1.00
SS-42	N2800	E6800	11/20/98	ND	6.00	943	0.500	1190	500	17.5	10.0	372	0.400	0.669	0.100	ND	1.00
SS-43	N2417	E6856	11/20/98	ND	6.00	1070	1.00	1830	500	18.3	10.0	245	0.400	0.766	0.100	1.21	1.00
SS-44	N2700	E7200	11/20/98	ND	6.00	1160	1.00	1400	500	13.2	10.0	183	0.400	0.549	0.100	1.07	1.00

Notes:
mg/kg = milligrams per kilogram
ND = not detected above the method reporting limit
Sample SS-34 does not exist
Samples collected from depths ranging from 2 to 5 inches below the ground surface.
* = result by EPA Method 7000 series, all others by EPA Method 6000 series.

Source: SECO[illegible]onal, Inc.

Table #2
Soil Analytical Data - Metals, Nitrate and Nitrate/Nitrite as Nitrogen
Granite Management Corporation
Benicia, California

	Coordinates			Chromium		Cobalt		Copper		Lead		Molybdenum		Nickel		Selenium	
Sample Identification	X	Y	Date	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SS-1	N4060	E8351	9/9/98	41	0.50	12	0.50	54	0.50	9.1	1.0	ND	0.50	50	1.0	ND	5.0
SS-2	N4040	E8202	9/9/98	44	0.50	15	0.50	54	0.50	9.2	1.0	ND	0.50	50	1.0	ND	5.0
SS-3	N4200	E8000	9/9/98	34	0.50	11	0.50	37	0.50	ND	1.0	ND	0.50	25	1.0	ND	5.0
SS-4	N4140	E7900	9/9/98	37	0.50	7.2	0.50	35	0.50	ND	1.0	ND	0.50	28	1.0	ND	5.0
SS-5	N4150	E7714	9/9/98	71	0.50	27	0.50	71	0.50	ND	1.0	ND	0.50	64	1.0	ND	5.0
SS-6	N4400	E7600	9/9/98	47	0.50	15	0.50	61	0.50	30	1.0	ND	0.50	52	1.0	ND	5.0
SS-7	N2016	E8487	11/20/98	39.7	1.00	13.1	0.700	37.7	1.00	8.84	7.50	ND	2.00	30.8	3.00	ND	10.0
SS-8	N2200	E8600	11/20/98	38.6	1.00	14.9	0.700	49.1	1.00	31.8	7.50	ND	2.00	41.0	3.00	ND	10.0
SS-9	N2302	E8598	11/20/98	49.2	1.00	17.4	0.700	57.7	1.00	23.6	7.50	ND	2.00	53.4	3.00	ND	10.0
SS-10	N1800	E9000	11/20/98	38.3	1.00	16.2	0.700	42.9	1.00	34.0	7.50	ND	2.00	36.0	3.00	ND	10.0
SS-11	N2129	E9175	11/20/98	41.3	1.00	13.8	0.700	46.8	1.00	10.8	7.50	ND	2.00	46.7	3.00	ND	10.0
SS-12	N2084	E8151	11/20/98	39.5	1.00	21.6	0.700	57.6	1.00	17.7	7.50	ND	2.00	47.4	3.00	ND	10.0
SS-13	N1800	E8000	11/20/98	31.1	1.00	13.7	0.700	44.9	1.00	ND	7.50	ND	2.00	34.7	3.00	ND	10.0
SS-14	N2551	E8309	11/20/98	50.1	1.00	16.3	0.700	53.7	1.00	26.5	7.50	ND	2.00	48.4	3.00	ND	10.0
SS-15	N2600	E8600	11/20/98	34.8	1.00	15.1	0.700	40.7	1.00	25.6	7.50	ND	2.00	32.0	3.00	ND	10.0
SS-16	N3000	E8800	11/20/98	38.2	1.00	14.0	0.700	48.2	1.00	76.3	7.50	ND	2.00	43.0	3.00	ND	10.0
SS-17	N2600	E9600	11/20/98	27.6	1.00	11.6	0.700	38.3	1.00	28.6	7.50	ND	2.00	27.0	3.00	ND	10.0
SS-18	N2800	E8300	11/20/98	47.1	1.00	13.5	0.700	48.6	1.00	16.1	7.50	ND	2.00	41.8	3.00	ND	10.0
SS-19	N3707	E8002	11/20/98	43.1	1.00	16.4	0.700	48.5	1.00	16.0	7.50	ND	2.00	48.0	3.00	ND	10.0
SS-20	N3780	E7508	11/20/98	41.2	1.00	12.3	0.700	47.1	1.00	21.4	7.50	ND	2.00	36.5	3.00	ND	10.0
SS-21	N1800	E7747	11/20/98	39.5	1.00	15.2	0.700	45.4	1.00	20.0	7.50	ND	2.00	41.5	3.00	ND	10.0
SS-22	N1777	E7629	11/20/98	185	100	80.2	70.0	24200	100	46600	750	ND	200	ND	300	ND	1000
				87.5	8	-	-	21,200	20	42,200/32,000*	40/5,000*	-	-	50.3	32	ND*	2.5*
SS-23	N1704	E7353	11/20/98	50.4	1.00	20.6	0.700	55.1	1.00	25.8	7.50	ND	2.00	52.4	3.00	ND	10.0
SS-24	N1725	E7093	11/20/98	46.4	1.00	14.6	0.700	48.9	1.00	12.7	7.50	ND	2.00	48.6	3.00	ND	10.0
SS-25	N1927	E7238	11/20/98	26.4	1.00	13.7	0.700	44.8	1.00	24.9	7.50	ND	2.00	24.6	3.00	ND	10.0
SS-26	N1933	E7348	11/20/98	38.1	1.00	13.8	0.700	49.9	1.00	12.9	7.50	ND	2.00	34.0	3.00	ND	10.0

Source: SECOR International, Inc.

Table A-2
Soil Analytical Data - Metals, Nitrate and Nitrate/Nitrite as Nitrogen
Granite Management Corporation
Benicia, California

	Coordinates			Chromium		Cobalt		Copper		Lead		Molybdenum		Nickel		Selenium	
Sample Identification	X	Y	Date	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SS-27	N1905	E7353	11/20/98	28.4	1.00	23.1	0.700	59.1	1.00	27.4	7.50	ND	2.00	31.8	3.00	ND	10.0
SS-28	N1942	E7400	11/20/98	27.8	1.00	13.5	0.700	44.6	1.00	12.7	7.50	ND	2.00	27.0	3.00	ND	10.0
SS-29	N2073	E7357	11/20/98	32.1	1.00	14.7	0.700	53.3	1.00	28.6	7.50	ND	2.00	30.5	3.00	ND	10.0
SS-30	N2200	E7400	11/20/98	31.5	1.00	15.1	0.700	39.3	1.00	34.4	7.50	ND	2.00	30.8	3.00	ND	10.0
SS-31	N2200	E7300	11/20/98	30.5	1.00	16.0	0.700	46.6	1.00	89.0	7.50	ND	2.00	32.3	3.00	ND	10.0
SS-32	N2200	E7200	11/20/98	27.7	1.00	15.5	0.700	40.8	1.00	49.2	7.50	ND	2.00	28.1	3.00	ND	10.0
SS-33	N2000	E7600	11/20/98	45.8	1.00	17.0	0.700	57.1	1.00	12.8	7.50	ND	2.00	45.2	3.00	ND	10.0
SS-35	N3265	E7914	11/20/98	33.8	1.00	11.2	0.700	42.7	1.00	58.7	7.50	ND	2.00	34.8	3.00	ND	10.0
SS-36	N3472	E8526	11/20/98	35.9	1.00	14.3	0.700	49.5	1.00	37.3	7.50	ND	2.00	40.5	3.00	ND	10.0
SS-37	N3700	E8600	11/20/98	36.9	1.00	15.2	0.700	48.6	1.00	20.4	7.50	ND	2.00	46.2	3.00	ND	10.0
SS-38	N3800	E8800	11/20/98	44.1	1.00	16.2	0.700	55.3	1.00	24.8	7.50	ND	2.00	51.9	3.00	ND	10.0
SS-39	N4500	E7200	11/20/98	39.6	1.00	16.7	0.700	52.6	1.00	51.1	7.50	ND	2.00	44.9	3.00	ND	10.0
SS-40	N3700	E7200	11/20/98	26.3	1.00	12.3	0.700	38.1	1.00	56.3	7.50	ND	2.00	26.5	3.00	ND	10.0
SS-41	N3000	E7000	11/20/98	23.7	1.00	13.0	0.700	29.7	1.00	26.6	7.50	ND	2.00	23.1	3.00	ND	10.0
SS-42	N2800	E6800	11/20/98	28.1	1.00	14.8	0.700	37.4	1.00	27.6	7.50	ND	2.00	25.3	3.00	ND	10.0
SS-43	N2417	E6856	11/20/98	35.3	1.00	20.4	0.700	49.1	1.00	40.1	7.50	ND	2.00	39.0	3.00	ND	10.0
SS-44	N2700	E7200	11/20/98	25.1	1.00	19.5	0.700	31.2	1.00	37.1	7.50	ND	2.00	22.8	3.00	ND	10.0

Notes:
mg/kg = milligrams per kilogram
ND = not detected above the method reporting limit
Sample SS-34 does not exist
Samples collected from depths ranging from 2 to 5 inc hes below the ground surface.
* = result by EPA Method 7000 series, all others by EPA Method 6000 series.

Source: SECOR [illegible]ional, Inc.

Table A-2
Soil Analytical Data - Metals, Nitrate and Nitrate/Nitrite as Nitrogen
Granite Management Corporation
Benicia, California

Sample Identification	Coordinates X	Coordinates Y	Date	Silver Result mg/kg	Silver Method Reporting Limit mg/kg	Thallium Result mg/kg	Thallium Method Reporting Limit mg/kg	Vanadium Result mg/kg	Vanadium Method Reporting Limit mg/kg	Zinc Result mg/kg	Zinc Method Reporting Limit mg/kg	Nitrate as Nitrogen Result mg/kg	Nitrate as Nitrogen Method Reporting Limit mg/kg	Nitrate/Nitrite as Nitrogen Result mg/kg	Nitrate/Nitrite as Nitrogen Method Reporting Limit mg/kg	Mercury Result mg/kg	Mercury Method Reporting Limit mg/kg
SS-1	N4060	E8351	9/9/98	ND	0.50	ND	5.0	53	0.50	79	1.0	-	-	-	-	0.044	0.010
SS-2	N4040	E8202	9/9/98	ND	0.50	ND	5.0	63	0.50	65	1.0	-	-	-	-	0.041	0.010
SS-3	N4200	E8000	9/9/98	ND	0.50	ND	5.0	84	0.50	62	1.0	-	-	-	-	0.030	0.010
SS-4	N4140	E7900	9/9/98	ND	0.50	ND	5.0	88	0.50	60	1.0	-	-	-	-	0.039	0.010
SS-5	N4150	E7714	9/9/98	ND	0.50	ND	5.0	90	0.50	79	1.0	-	-	-	-	0.024	0.010
SS-6	N4400	E7600	9/9/98	ND	0.50	ND	5.0	66	0.50	91	1.0	-	-	-	-	0.14	0.010
SS-7	N2016	E8487	11/20/98	ND	0.700	ND	10.0	96.7	1.00	57.8	2.00	1.53	1.00	1.53	1.00	ND	0.050
SS-8	N2200	E8600	11/20/98	ND	0.700	ND	10.0	70.2	1.00	71.0	2.00	ND	1.00	ND	1.00	0.12	0.050
SS-9	N2302	E8598	11/20/98	ND	0.700	ND	10.0	74.7	1.00	79.0	2.00	1.53	1.00	1.53	1.00	0.096	0.050
SS-10	N1800	E9000	11/20/98	ND	0.700	ND	10.0	83.9	1.00	63.0	2.00	1.70	1.00	1.70	1.00	0.11	0.050
SS-11	N2129	E9175	11/20/98	ND	0.700	ND	10.0	57.1	1.00	67.4	2.00	6.20	1.00	6.20	1.00	ND	0.050
SS-12	N2084	E8151	11/20/98	ND	0.700	ND	10.0	67.6	1.00	83.4	2.00	ND	1.00	ND	1.00	0.064	0.050
SS-13	N1800	E8000	11/20/98	ND	0.700	ND	10.0	64.1	1.00	65.5	2.00	ND	1.00	ND	1.00	ND	0.050
SS-14	N2551	E8309	11/20/98	ND	0.700	ND	10.0	74.9	1.00	71.4	2.00	3.14	1.00	3.14	1.00	0.075	0.050
SS-15	N2600	E8600	11/20/98	ND	0.700	ND	10.0	77.6	1.00	64.0	2.00	2.19	1.00	2.73	1.00	0.093	0.050
SS-16	N3000	E8800	11/20/98	ND	0.700	ND	10.0	59.9	1.00	83.9	2.00	9.84	1.00	10.4	1.00	1.9	0.043
SS-17	N2600	E9600	11/20/98	ND	0.700	ND	10.0	61.9	1.00	56.7	2.00	4.15	1.00	4.15	1.00	0.11	0.042
SS-18	N2800	E8300	11/20/98	ND	0.700	ND	10.0	72.0	1.00	63.3	2.00	2.00	1.00	2.00	1.00	0.092	0.050
SS-19	N3707	E8002	11/20/98	ND	0.700	ND	10.0	71.6	1.00	75.3	2.00	1.24	1.00	1.24	1.00	ND	0.040
SS-20	N3780	E7508	11/20/98	ND	0.700	ND	10.0	70.5	1.00	65.9	2.00	1.82	1.00	1.82	1.00	0.11	0.043
SS-21	N1800	E7747	11/20/98	ND	0.700	ND	10.0	68.3	1.00	70.4	2.00	2.76	1.00	2.76	1.00	0.11	0.050
SS-22	N1777	E7629	11/20/98	ND	70.0	ND	1000	ND	100	4560	200	3.21	1.00	4.56	1.00	0.092	0.050
				ND	8.0	ND*	2.5*	-	-	3.870	16	ND	0.25	1.3	0.25	ND*	0.10*
SS-23	N1704	E7353	11/20/98	ND	0.700	ND	10.0	71.1	1.00	86.3	2.00	11.6	1.00	11.6	1.00	0.21	0.050
SS-24	N1725	E7093	11/20/98	ND	0.700	ND	10.0	63.0	1.00	97.9	2.00	9.16	1.00	9.16	1.00	0.12	0.050
SS-25	N1927	E7238	11/20/98	ND	0.700	ND	10.0	67.6	1.00	90.0	2.00	3.00	1.00	3.75	1.00	0.90	0.050
SS-26	N1933	E7348	11/20/98	ND	0.700	ND	10.0	76.2	1.00	72.7	2.00	ND	1.00	ND	1.00	0.39	0.043

Source: SECOR International, Inc.

Table A-2
Soil Analytical Data - Metals, Nitrate and Nitrate/Nitrite as Nitrogen
Granite Management Corporation
Benicia, California

	Coordinates			Silver		Thallium		Vanadium		Zinc		Nitrate as Nitrogen		Nitrate/Nitrite as Nitrogen		Mercury	
Sample Identification	X	Y	Date	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SS-27	N1905	E7353	11/20/98	ND	0.700	ND	10.0	78.6	1.00	74.8	2.00	4.13	1.00	4.13	1.00	0.861	0.200
SS-28	N1942	E7400	11/20/98	ND	0.700	ND	10.0	77.2	1.00	64.5	2.00	ND	1.00	ND	1.00	0.455	0.0500
SS-29	N2073	E7357	11/20/98	ND	0.700	ND	10.0	73.1	1.00	80.1	2.00	4.50	1.00	4.50	1.00	2.17	0.200
SS-30	N2200	E7400	11/20/98	ND	0.700	ND	10.0	75.9	1.00	59.6	2.00	4.63	1.00	4.63	1.00	0.121	0.0500
SS-31	N2200	E7300	11/20/98	ND	0.700	ND	10.0	66.3	1.00	70.1	2.00	1.70	1.00	1.70	1.00	0.679	0.0500
SS-32	N2200	E7200	11/20/98	ND	0.700	ND	10.0	69.1	1.00	71.9	2.00	5.34	1.00	5.34	1.00	0.570	0.0500
SS-33	N2000	E7600	11/20/98	ND	0.700	ND	10.0	91.1	1.00	74.0	2.00	1.44	1.00	1.44	1.00	0.330	0.0500
SS-35	N3265	E7914	11/20/98	ND	0.700	ND	10.0	70.4	1.00	58.3	2.00	1.91	1.00	1.91	1.00	0.0537	0.0500
SS-36	N3472	E8526	11/20/98	ND	0.700	ND	10.0	58.7	1.00	76.8	2.00	7.92	1.00	8.62	1.00	0.102	0.0500
SS-37	N3700	E8600	11/20/98	ND	0.700	ND	10.0	59.2	1.00	61.3	2.00	1.98	1.00	1.98	1.00	0.0615	0.0500
SS-38	N3800	E8800	11/20/98	ND	0.700	ND	10.0	68.2	1.00	69.7	2.00	2.66	1.00	2.66	1.00	0.0630	0.0500
SS-39	N4500	E7200	11/20/98	ND	0.700	ND	10.0	59.2	1.00	85.4	2.00	5.22	1.00	5.22	1.00	0.127	0.0500
SS-40	N3700	E7200	11/20/98	ND	0.700	ND	10.0	65.3	1.00	71.5	2.00	3.65	1.00	3.65	1.00	0.216	0.0500
SS-41	N3000	E7000	11/20/98	ND	0.700	ND	10.0	57.6	1.00	49.5	2.00	5.63	1.00	5.63	1.00	0.0831	0.0500
SS-42	N2800	E6800	11/20/98	ND	0.700	ND	10.0	87.1	1.00	63.6	2.00	3.40	1.00	3.40	1.00	0.0982	0.0500
SS-43	N2417	E6856	11/20/98	ND	0.700	ND	10.0	66.4	1.00	68.2	2.00	1.01	1.00	1.01	1.00	0.238	0.0500
SS-44	N2700	E7200	11/20/98	ND	0.700	ND	10.0	56.1	1.00	52.9	2.00	18.4	1.00	18.4	1.00	0.151	0.0500

Notes:
mg/kg = milligrams per kilogram
ND = not detected above the method reporting limit
Sample SS-34 does not exist
Samples collected from depths ranging from 2 to 5 inc hes below the ground surface.
* = result by EPA Method 7000 series, all others by EPA Method 6000 series.

Source: SECO[illegible]oral, Inc.

Table A-3
Soil Analytical Data - Explosive Compounds and Phosphate
Granite Management Corporation
Benicia, California

	Coordinates			2-Amino-4,6-Dinitrotoluene		2,4-Dinitrotoluene		2,6-Dinitrotoluene		4-Nitrotoluene		3-Nitrotoluene		2-Nitrotoluene		Phosphate	
Sample	X	Y	Date	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg
SS-1	N4060	E8351	9/9/98	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	-	-
SS-2	N4040	E8202	9/9/98	ND	300	ND	300	ND	300	ND	300	ND	300	ND	300	-	-
SS-3	N4200	E8000	9/9/98	ND	300	ND	300	ND	300	ND	300	ND	300	ND	300	-	-
SS-4	N4140	E7900	9/9/98	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	-	-
SS-5	N4150	E7714	9/9/98	ND	30	ND	30	ND	30	ND	30	ND	30	ND	30	-	-
SS-6	N4400	E7600	9/9/98	ND	30	ND	30	ND	30	ND	30	ND	30	ND	30	-	-
SS-7	N2016	E8487	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	11.3	0.500
SS-8	N2200	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	241	2.50
SS-9	N2302	E8598	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	283	2.50
SS-10	N1800	E9000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	174	2.50
SS-11	N2129	E9175	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	394	5.00
SS-12	N2084	E8151	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	21.0	0.500
SS-13	N1800	E8000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	56.1	0.500
SS-14	N2551	E8309	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	223	2.50
SS-15	N2600	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	94.5	0.500
SS-16	N3000	E8800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	375	2.50
SS-17	N2600	E9600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	13.2	0.500
SS-18	N2800	E8300	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	108	1.00
SS-19	N3707	E8002	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	10.5	0.500
SS-20	N3780	E7508	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	296	2.50
SS-21	N1800	E7747	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	311	2.50
SS-22	N1777	E7629	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	17.1	0.500
				ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	18.1	10.0
SS-23	N1704	E7353	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	307	2.50
SS-24	N1725	E7093	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	360	5.00
SS-25	N1927	E7238	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	255	5.00
				ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	-	-
SS-26	N1933	E7348	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	214	2.50
SS-27	N1905	E7353	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	44.1	0.500

Source SECOR International, Inc.

Table A-3
Soil Analytical Data - Explosive Compounds and Phosphate
Granite Management Corporation
Benicia, California

	Coordinates			2-Amino-4,6-Dinitrotoluene		2,4-Dinitrotoluene		2,6-Dinitrotoluene		4-Nitrotoluene		3-Nitrotoluene		2-Nitrotoluene		Phosphate	
Sample	X	Y	Date	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg
SS-28	N1942	E7400	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	149	2.50
				ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	-	-
SS-29	N2073	E7357	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	233	2.50
SS-30	N2200	E7400	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	4.39	0.500
SS-31	N2200	E7300	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	191	2.50
SS-32	N2200	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	287	2.50
SS-33	N2000	E7600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	18.6	0.500
SS-35	N3265	E7914	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	1.70	0.500
SS-36	N3472	E8526	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	26.2	0.500
SS-37	N3700	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	181	2.50
SS-38	N3800	E8800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	258	2.50
SS-39	N4500	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	283	2.50
SS-40	N3700	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	7.82	0.500
SS-41	N3000	E7000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	15.7	0.500
SS-42	N2800	E6800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.500
SS-43	N2417	E6856	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	204	2.50
SS-44	N2700	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	11.0	0.500
FSS-10	N4060	E8351	12/01/98	ND	250	ND	250	ND	250	ND	250	ND	250	ND	250	-	-
FSS-40	N4500	E8200	12/01/98	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	-	-

Notes:
mg/kg = milligrams per kilogram
ND = not detected above the method reporting limit.
Sample SS-34 does not exist.
Samples collected from depths ranging from 2 tto 5 inches below the ground surface.

Source. SEC[illegible]ional, Inc.

Table A-3
Soil Analytical Data - Explosive Compounds and Phosphate
Granite Management Corporation
Benicia, California

	Coordinates			PETN		HMX		Cyclonite (RDX)		1,3,5-Trinitrobenzene		1,3-Dinitrobenzene		Tetryl		Nitrobenzene		2,4,6-Trinitrotoluene (TNT)		4-Amino-2,6-Dinitrotoluene	
Sample	X	Y	Date	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit	Result	Method Reporting Limit
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SS-1	N4060	E8351	9/9/98	-	-	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	72,400	3,000	ND	3,000
SS-2	N4040	E8202	9/9/98	-	-	ND	300	ND	300	ND	300	ND	300	ND	300	ND	300	12,200	300	ND	300
SS-3	N4200	E8000	9/9/98	-	-	ND	300	ND	300	ND	300	ND	300	ND	300	ND	300	4,990	300	ND	300
SS-4	N4140	E7900	9/9/98	-	-	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	49,000	3,000	ND	3,000
SS-5	N4150	E7714	9/9/98	-	-	ND	30	ND	30	ND	30	ND	30	ND	30	ND	30	738	30	ND	30
SS-6	N4400	E7600	9/9/98	-	-	ND	30	ND	30	ND	30	ND	30	ND	30	ND	30	200	30	ND	30
SS-7	N2016	E8487	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-8	N2200	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-9	N2302	E8598	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-10	N1800	E9000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-11	N2129	E9175	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-12	N2084	E8151	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-13	N1800	E8000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-14	N2551	E8309	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-15	N2600	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-16	N3000	E8800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-17	N2600	E9600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-18	N2800	E8300	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-19	N3707	E8002	12/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-20	N3780	E7508	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-21	N1800	E7747	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-22	N1777	E7629	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
				ND	0.50	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25
SS-23	N1704	E7353	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-24	N1725	E7093	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-25	N1927	E7238	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
				-	-	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25
SS-26	N1933	E7348	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	2.7	0.30	ND	0.30	ND	0.30	ND	0.30
SS-27	N1905	E7353	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30

Source: SECOR International, Inc.

Table A-3
Soil Analytical Data - Explosive Compounds and Phosphate
Granite Management Corporation
Benicia, California

	Coordinates			PETN		HMX		Cyclonite (RDX)		1,3,5-Trinitrobenzene		1,3-Dinitrobenzene		Tetryl		Nitrobenzene		2,4,6-Trinitrotoluene (TNT)		4-Amino-2,6-Dinitrotoluene	
Sample	X	Y	Date	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg
SS-28	N1942	E7400	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
				-	-	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25
SS-29	N2073	E7357	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-30	N2200	E7400	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-31	N2200	E7300	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-32	N2200	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-33	N2000	E7600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-35	N3265	E7914	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-36	N3472	E8526	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-37	N3700	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-38	N3800	E8800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-39	N4500	E7200	11/20/98	ND	0.30	ND	0.30	1.73	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-40	N3700	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-41	N3000	E7000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-42	N2800	E6800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-43	N2417	E6856	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
SS-44	N2700	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30
FSS-10	N4060	E8351	12/01/98	-	-	ND	250	ND	250	ND	250	ND	250	ND	250	ND	250	5400	250	ND	250
FSS-40	N4100	E8200	12/01/98	-	-	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25

Notes:
mg/kg = milligrams per kilogram
ND = not detected above the method reporting limit
Sample SS-34 does not exist.
Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Source: SECO[illegible]onal, Inc.

Table A-3
Soil Analytical Data - Explosive Compounds and Phosphate
Granite Management Corporation
Benicia, California

	Coordinates			2-Amino-4,6-Dinitrotoluene		2,4-Dinitrotoluene		2,6-Dinitrotoluene		4-Nitrotoluene		3-Nitrotoluene		2-Nitrotoluene		Phosphate	
Sample	X	Y	Date	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg
SS-1	N4060	E8351	9/9/98	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	-	-
SS-2	N4040	E8202	9/9/98	ND	300	ND	300	ND	300	ND	300	ND	300	ND	300	-	-
SS-3	N4200	E8000	9/9/98	ND	300	ND	300	ND	300	ND	300	ND	300	ND	300	-	-
SS-4	N4140	E7900	9/9/98	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	ND	3,000	-	-
SS-5	N4150	E7714	9/9/98	ND	30	ND	30	ND	30	ND	30	ND	30	ND	30	-	-
SS-6	N4400	E7600	9/9/98	ND	30	ND	30	ND	30	ND	30	ND	30	ND	30	-	-
SS-7	N2016	E8487	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	11.3	0.500
SS-8	N2200	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	241	2.50
SS-9	N2302	E8598	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	283	2.50
SS-10	N1800	E9000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	174	2.50
SS-11	N2129	E9175	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	394	5.00
SS-12	N2084	E8151	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	21.0	0.500
SS-13	N1800	E8000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	56.1	0.500
SS-14	N2551	E8309	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	223	2.50
SS-15	N2600	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	94.5	0.500
SS-16	N3000	E8800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	375	2.50
SS-17	N2600	E9600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	13.2	0.500
SS-18	N2800	E8300	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	108	1.00
SS-19	N3707	E8002	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	10.5	0.500
SS-20	N3780	E7508	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	296	2.50
SS-21	N1800	E7747	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	311	2.50
SS-22	N1777	E7629	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	17.1	0.500
				ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	18.1	10.0
SS-23	N1704	E7353	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	307	2.50
SS-24	N1725	E7093	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	360	5.00
SS-25	N1927	E7238	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	255	5.00
				ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	-	-
SS-26	N1933	E7348	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	214	2.50
SS-27	N1905	E7353	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	44.1	0.500

Source. SECOR International, Inc.

Table A-3
Soil Analytical Data - Explosive Compounds and Phosphate
Granite Management Corporation
Benicia, California

	Coordinates			2-Amino-4,6-Dinitrotoluene		2,4-Dinitrotoluene		2,6-Dinitrotoluene		4-Nitrotoluene		3-Nitrotoluene		2-Nitrotoluene		Phosphate	
Sample	X	Y	Date	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg	Result mg/kg	Method Reporting Limit mg/kg
SS-28	N1942	E7400	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	149	2.50
				ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	-	-
SS-29	N2073	E7357	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	233	2.50
SS-30	N2200	E7400	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	4.39	0.500
SS-31	N2200	E7300	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	191	2.50
SS-32	N2200	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	287	2.50
SS-33	N2000	E7600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	18.6	0.500
SS-35	N3265	E7914	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	1.70	0.500
SS-36	N3472	E8526	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	26.2	0.500
SS-37	N3700	E8600	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	181	2.50
SS-38	N3800	E8800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	258	2.50
SS-39	N4500	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	283	2.50
SS-40	N3700	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	7.82	0.500
SS-41	N3000	E7000	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	15.7	0.500
SS-42	N2800	E6800	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.500
SS-43	N2417	E6856	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	204	2.50
SS-44	N2700	E7200	11/20/98	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	ND	0.30	11.0	0.500
FSS-10	N4060	E8351	12/01/98	ND	250	ND	250	ND	250	ND	250	ND	250	ND	250	-	-
FSS-40	N4100	E8200	12/01/98	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	ND	0.25	-	-

Notes:
mg/kg = milligrams per kilogram
ND = not detected above the method reporting limit.
Sample SS-34 does not exist.
Samples collected from depths ranging from 2 to 5 inches below the ground surface.

Source: SEC[illegible]onal, Inc.

Table A-4
Soil Field Test Results for TNT and RDX
Granite Management Corporation
Benicia, California

Sample ID	X	Y	Date Tested	Time Tested	TNT (mg/kg)	Date Tested	Time Tested	RDX (mg/kg)
SS-22	N1777	E7629	12/1/98	15:10	ND	-	-	-
SS-26	N1933	E7348	12/1/98	14:48	ND	-	-	-
SS-27	N1905	E7353	12/1/98	14:50	ND	-	-	-
SS-28	N1942	E7400	12/1/98	14:52	ND	-	-	-
SS-29	N2073	E7357	12/1/98	15:15	ND	-	-	-
SS-30	N2200	E7400	12/1/98	13:45	ND	12/1/98	14:10	ND
SS-33	N2000	E7600	12/1/98	15:24	ND	-	-	-
FSS-1	N2200	E7000	12/2/98	10:32	ND	-	-	-
FSS-2	N2000	E7000	12/2/98	10:37	ND	-	-	-
FSS-3	N2000	E7400	12/2/98	10:42	ND	-	-	-
FSS-4	N2200	E7400	12/2/98	11:00	ND	-	-	-
FSS-5	N2400	E7400	12/2/98	11:04	ND	-	-	-
FSS-6	N2600	E7200	12/2/98	11:21	ND	-	-	-
FSS-7	N2400	E7200	12/2/98	11:15	ND	-	-	-
FSS-8	N2200	E7200	12/2/98	11:26	ND	12/3/98	15:45	ND
FSS-9	N4400	E7600	12/1/98	16:13	ND	-	-	-
FSS-10	N4060	E8351	12/1/98	16:02	81.55*	12/3/98	15:22	3.1
	N4060	E8351	12/8/98	11:15	2074.3	-	-	-
FSS-11	N2000	E7200	12/2/98	11:32	ND	-	-	-
FSS-12	N2000	E7600	12/2/98	11:37	ND	-	-	-
FSS-13	N2200	E7600	12/2/98	11:52	ND	-	-	-
FSS-14	N2300	E7800	12/2/98	12:08	ND	-	-	-
FSS-15	N2200	E7800	12/2/98	12:03	ND	-	-	-
FSS-16	N2000	E7800	12/2/98	12:15	ND	-	-	-
FSS-17	N2000	E8000	12/2/98	12:18	ND	-	-	-
FSS-18	N2200	E8000	12/2/98	12:23	ND	-	-	-
FSS-19	N1700	E8000	12/2/98	12:55	ND	-	-	-
FSS-20	N1700	E7800	12/2/98	13:02	ND	-	-	-
FSS-21	N1700	E7600	12/2/98	13:46	ND	-	-	-
FSS-22	N1700	E7400	12/2/98	13:51	ND	-	-	-

Source: SECOR International, Inc.

Table A-4
Soil Field Test Results for TNT and RDX
Granite Management Corporation
Benicia, California

Sample ID	X	Y	Date Tested	Time Tested	TNT (mg/kg)	Date Tested	Time Tested	RDX (mg/kg)
FSS-23	N1600	E7400	12/2/98	13:58	ND	-	-	-
FSS-24	N1600	E7200	12/2/98	14:05	ND	-	-	-
FSS-25	N1600	E7000	12/2/98	14:10	ND	-	-	-
FSS-26	N1800	E7000	12/2/98	14:12	ND	12/3/98	15:27	1.4
FSS-27	N1800	E7200	12/2/98	14:19	ND	-	-	-
FSS-28	N1800	E7400	12/2/98	14:22	ND	-	-	-
FSS-29	N1800	E7600	12/2/98	14:27	ND	12/3/98	15:37	2.6
FSS-30	N1800	E7800	12/2/98	14:31	ND	-	-	-
FSS-31	N4200	E7600	12/2/98	15:12	ND	-	-	-
FSS-32	N4000	E7600	12/2/98	15:34	ND	-	-	-
FSS-33	N4000	E7800	12/2/98	16:29	ND	12/3/98	15:49	ND
FSS-34	N4200	E7800	12/2/98	16:31	ND	12/3/98	15:53	ND
FSS-35	N4400	E7800	12/2/98	16:34	ND	12/3/98	16:05	ND
FSS-36	N4200	E8000	12/2/98	16:36	ND	12/3/98	15:59	ND
FSS-37	N4000	E8000	12/2/98	16:40	ND	-	-	-
FSS-38	N3800	E8200	12/3/98	13:22	ND	-	-	-
FSS-39	N4000	E8200	12/3/98	13:26	ND	-	-	-
FSS-40	N4100	E8200	12/3/98	13:29	ND	-	-	-
FSS-41	N4000	E8400	12/3/98	13:32	79.566*	12/3/98	15:15	3.4
	N4000	E8400	12/8/98	11:25	789.5	-	-	-

Notes:
Samples analyzed using EnSys Soil Test System, Rapid Field Screen for TNT and RDX.
Soil samples not air dried
TNT = 2,4,6-Trinitrotoluene
RDX = cyclonite
mg/kg = milligrams per kilogram
SS = soil sample
FSS = field screening soil sample
ND = not detected above the minimum detection limit of the EnSys Test System (1 mg/kg).
- = not analyzed
* = sample concentration was out of the range of the test method (1 to 30 mg/kg), therefore the sample was re-extracted, diluted, and the concentration was re-reported.

Source: SECOR International, Inc.

Table A-5
Surface Water Analytical Data - Total and Dissolved Metals, and Nitrate and Nitrate/Nitrite as Nitrogen
Granite Management Corporation
Benicia, California

Sample Identification	WS-1		WS-1		WS-2		WS-2	
Coordinates	N2000	E6836	N2000	E6836	N1868	E7887	N1868	E7887
Date Collected	11/23/98		11/23/98		11/23/98		11/23/98	
Date Analyzed	12/4/98		12/10/98		12/4/98		12/10/98	
	Total		Dissolved		Total		Dissolved	
	Result µg/L	Method Reporting Limit µg/L	Result µg/L	Method Reporting Limit µg/L	Result µg/L	Method Reporting Limit µg/L	Result µg/L	Method Reporting Limit µg/L
Antimony	ND	60.0	ND	60.0	ND	60.0	ND	60.0
Manganese	377	5.00	25.9	5.00	22.6	5.00	ND	5.00
Potassium	ND	5000	ND	5000	ND	5000	ND	5000
Arsenic	ND	100	ND	100	ND	100	ND	100
Barium	82.3	4.00	56.1	4.00	12.3	4.00	9.24	4.00
Beryllium	ND	1.00	ND	1.00	ND	1.00	ND	1.00
Cadmium	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Chromium	ND	10.0	ND	10.0	ND	10.0	ND	10.0
Cobalt	ND	7.00	ND	7.00	ND	7.00	ND	7.00
Copper	17.8	10.0	ND	10.0	11.8	10.0	ND	10.0
Lead	ND	75.0	ND	75.0	ND	75.0	ND	75.0
Molybdenum	ND	20.0	ND	20.0	ND	20.0	ND	20.0
Nickel	ND	30.0	ND	30.0	ND	30.0	ND	30.0
Selenium	ND	100	ND	100	ND	100	ND	100
Silver	ND	7.00	ND	7.00	ND	7.00	ND	7.00
Thallium	ND	100	ND	100	ND	100	ND	100
Vanadium	11.1	10.0	ND	10.0	ND	10.0	ND	10.0
Zinc	33.6	20.0	28.9	20.0	61.5	20.0	26.0	20.0
Mercury	ND	0.20	ND	0.20	ND	0.20	ND	0.20
Nitrate as Nitrogen	ND	100	-	-	338	100	-	-
Nitrate/Nitrite as Nitrogen	ND	100	-	-	338	100	-	-

Notes:
µg/L = micrograms per liter
ND = not detected above the method reporting limit
- = not analyzed

Source: SECOR International, Inc.

Table A-6
Surface Water Analytical Data - Explosive Compounds and Phosphate
Granite Management Corporation
Benicia, California

Sample Identification	WS-1		WS-2	
Coordinates	N2000	E6836	N1868	E7887
Date Collected	11/23/98		11/23/98	
	Result µg/L	Method Reporting Limit µg/L	Result µg/L	Method Reporting Limit µg/L
PETN	ND	1.50	ND	1.50
HMX	ND	1.50	ND	1.50
Cyclonite (RDX)	ND	1.50	ND	1.50
1,3,5-Trinitrobenzene	ND	1.50	ND	1.50
1,3-Dinitrobenzene	ND	1.50	ND	1.50
Tetryl	ND	1.50	ND	1.50
Nitrobenzene	ND	1.50	ND	1.50
2,4,6-Trinitrotoluene (TNT)	ND	1.50	ND	1.50
4-Amino-2,6-Dinitrotoluene	ND	1.50	ND	1.50
2-Amino-2,6-Dinitrotoluene	ND	1.50	ND	1.50
2,4-Dinitrotoluene	ND	1.50	ND	1.50
2,6-Dinitrotoluene	ND	1.50	ND	1.50
4-Nitrotoluene	ND	1.50	ND	1.50
3-Nitrotoluene	ND	1.50	ND	1.50
2-Nitrotoluene	ND	1.50	ND	1.50
Phosphate	85.3	50.0	95.4	50.0

Notes:
µg/L = micrograms per liter
ND = not detected above the method reporting limit

Source: SECOR International, Inc.

APPENDIX B

GEOPHYSICAL DATA

A. Site Plan

The site plan is a topographic map drawn at a scale of 1 in. = 200 ft. The map shows the outline of the Tourtelot Property as well as cultural features such as surface roads. The lightly shaded areas shown on the map represent the portions of the property surveyed by another contractor during Phase I of the UXO investigation. The cross-hatched areas represent the portion of the property surveyed using both vertical magnetic gradient (MAG) and EM-61 (EM) techniques as part of the Phase II investigation. The aforementioned information has been transferred to Figure 1-5 of the RI/FS Work Plan. The remainder of the property (also Phase II) was also surveyed using MAG alone. The only part of the property that was not surveyed is the area along the top of the ridge where bedrock has been exposed by prior grading activity and the submerged areas. This area is also depicted on the map.

Prior to our (Phase II) geophysical investigation, Emcon established a rectangular survey grid that divides the property into cells measuring 200 ft by 200 ft. The cells are designated by row and column. As shown on the map, the rows are labeled, north to south, 1 through 21. The columns are labeled, west to east, A through S. Also shown are the northing coordinates for each row, and the easting coordinates for each column. For the purpose of data presentation we have also divided the property into quadrants, as follows:

Quadrant	Rows	Column
NW	1 - 10	A - J
NE	1 - 10	K - S
SW	11 - 21	A - J
SE	11 - 21	K - S

The cross-hatched (Phase II) cells are labeled EN-1M through BEN-23M in the order they were surveyed. The remainder of the cells are labeled according to their column and row. These cell designations also bear the prefix of M for MAG data and a suffix of A, B, or C if the cell is subdivided or has been surveyed more than once. The only exceptions to this are a number of grid cells in the SW quadrant. These are labeled according to the type of survey, the Julian date the area was surveyed, the first initial of the person that collected the data, and the data set sequence. Thus, the designation "M325KB" represents magnetometer (M) data collected on November 21 (Julian date 325) by Kimberly (K) as her second (B) data set of the day. However, all of the data sets contained on the zip disk (see below) are designated according to their column and row.

B. Zip Disk

Each zip disk contains six directories labeled, in alphabetical order, em, ne, nw, se, srf, and sw. Descriptions of the contents of each directory are provided in the following paragraphs.

EM This directory contains the EM-61 data files. There are a total of 30 files, 28 of which contain the EM data collected in the 28 cells comprising the cross-hatched areas on the site map. The remaining two files are composites of the other 28. The data files for the cells are labeled according to their column and row, with a prefix of E for EM data. For example the file

"Eo15.dat" contains the EM-61 data collected in Column O, Row 15. The file "sv1-45.dat" contains all of the EM-61data collected in the southwest quadrant of the property (columns F-J, rows 14-16). The file "sv46-80.dat" contains all of the EM-61 data collected in the southeast quadrant of the property (columns M-Q, rows 13-16).

The files are in ASCII format and comprise six columns. The contents of each column are as follows:

Column	Contents
A	Easting in ft
B	Northing in ft
C	Output of top coil (CH1) in millivolts (mV)
D	Output of bottom coil (CH2) in mV
E	Noise suppressed data (0.28*CH1-CH2) in mV
F	Differential data (CH1-CH2) in mV

ne This directory contains the files for the vertical magnetic gradient data collected in the northeast quadrant of the property. The files are labeled according to their column and row with the prefix of m for magnetic, and the suffix v for vertical gradient. For example, the file "mk03v.dat" contains the vertical magnetic gradient data collected in Column K, Row 3. The data are in ASCII format and comprise three columns as follows:

Column	Contents
A	Easting in ft
B	Northing in ft
C	Vertical gradient in nano-Teslas per meter

nw Same as above for the northwest quadrant of the property.

se Same as above for the southeast quadrant of the property.

sw Same as above for the southwest quadrant of the property.

srf This directory contains the files for the vertical magnetic gradient contour maps. There are four files, one for each quadrant of the property, labeled accordingly.

The files were created using Golden Software's Surfer for Windows 6.0. The four maps are contoured using a varying interval. For absolute values ranging from 10 to 200 nT/m the contour interval is 10 (the 0 contour is eliminated). Above 200 the interval increases proportionally. This was done to minimize plotting time and for clarity.

APPENDIX C

WELL PERMIT APPLICATION AND WELL DEVELOPMENT FORMS

Department of
Environmental Management
601 TEXAS STREET
FAIRFIELD, CALIFORNIA • 94533-6301

_____
Site Address

_____
Assessor's Parcel Number

_____
Application/Permit Number

(707) 421-6770

WELL PERMIT APPLICATION

Property Owner_____ Phone_____

Mailing Address _____

Drilling Contractor_____ Phone_____

License Number_____ Expires_____

WORKERS' COMPENSATION DECLARATION

I hereby affirm that I have a certificate of consent to self-insure or a certificate of Workers' Compensation Insurance, or a certified copy thereof (Sec. 3800, Lab. C.)
__Certified copy is hereby furnished. __Certified copy is filed with the County of Solano Environmental Health Division.

Date_____Applicant_____

CERTIFICATE OF EXEMPTION FROM WORKERS' COMPENSATION INSURANCE

(This section need not be completed if the permit is for work valued at three hundred dollars ($300) or less.)
I certify that in the performance of the work for which this permit is issued, I shall not employ any person in any manner so as to become subject to the Workers' Compensation Laws of California.

Date_____Applicant_____

NOTICE TO APPLICANT: If, after making this Certificate of Exemption, you should become subject to the Workers' Compensation provisions of the Labor Code, you must forthwith comply with such provisions or this permit shall be deemed revoked.

PERMIT TYPE: __New Well __Repair/Modification __Destruction

WELL USE: __Domestic __Agriculture __Commercial __Cathodic __Monitoring (Describe_____)

DRILLING METHOD: __Rotary __Cable __Hollow Stem Auger __Other_____

CASING INFORMATION: Material: __Steel __PVC __Other_____ Proposed Depth_____
Wall/Gauge_____in. Casing Diameter_____in. Well Bore Diameter_____in.

ANNULAR SEAL: Depth_____ft. Width of Annular Space _____in.
Sealing Material: __Neat Cement __Sand Cement __Concrete __Bentonite_____

Additional Work Description _____

I hereby agree to comply with all regulations of the Solano County Code pertaining to well construction, repair, modification, destruction and abandonment. The well driller shall furnish Environmental Health with a complete well log upon completion of well construction.

Applicant _____ Date _____
Site Approved _____ Date _____

FOR OFFICE USE ONLY - ENVIRONMENTAL HEALTH

$____Fee paid on_____ Receipt No._____Permit expires_____

WELLAPP.RV1

Department of
Environmental Management
601 TEXAS STREET
FAIRFIELD, CALIFORNIA • 94533-6301

Environmental Health Division
(707) 421-6770

Clifford K. Covey, REHS, CHMM
Program Manager

WELL PERMIT APPLICATION INSTRUCTIONS

1. ***GENERAL COMMENTS*** - Chapter 13.10, Solano County Code establishes standards for the construction, reconstruction, destruction, and inactivation of water, cathodic protection, and monitoring wells. Although well permit applications may be submitted by homeowners, their agent, or a licensed well driller, only a person possessing a C-57 Water Well Drilling Contractor's License can actually perform work on a well. A copy of the license and Worker's Compensation Insurance Certificate must be on file or submitted with application with this office prior to issuance of a permit.

2. ***APPLICATION*** - The well permit application is to be submitted complete and signed. An accurate plot plan/vicinity or site map shall be included with the application. For monitoring wells, only one application is required per site regardless of the number of wells. Prior to issuance of the permit, certain circumstances may exist that would require that a site review be conducted to determine compliance with established standards. Payment of appropriate fee is required at the time of application submittal.

3. ***PERMIT ISSUANCE*** - If all information is provided on the application and the site is approved, a permit shall be issued. Drilling shall not begin until after the permit is received.

4. ***CONSTRUCTION APPROVAL*** - Environmental Health shall be notified at least 24 hours prior to the sealing of the annular space, please call 707-421-6770 and arrange for an inspection. The witnessing of the sealing of the annular space will be required on each well, including well destruction.

Please contact this office at 707-421-6770 if you have any questions or concerns.

welperm.ins

Daily Field Report

EARTH TECH

A tyco INTERNATIONAL LTD. COMPANY

Owner: _____ Report No.: _____

Page _____ of _____

Project: _____ Date: _____

Project: No.: _____ Weather: A.M. _____ P.M. _____

Temp.(°F): High _____ Low _____ Rain _____

Contractor(s) _____

Contractor Super(s) _____

Number and Function of Contractors' Personnel, Hours Worked (Identify Subcontractors Separately)

Contractor	No. of People

Major Constr. Equip. Description	Size/Capacity	No.	No. in Use

Visitors	Representing

Daily Notations: _____

Signature: _____

Daily Field Report

EARTH TECH

A tyco INTERNATIONAL LTD. COMPANY

Project No.: _____ Report No.: _____

Date: _____ Page: _____ of _____

Signature _____

White Copy - Library File Yellow Copy - Owner Pink Copy - Employee's Field File

EARTH TECH

TEST BORING LOG

BOREHOLE NO.: _____

WELL NO.: _____

PROJECT NAME:	PROJECT NO.:
CLIENT:	DRILLING CONTRACTOR:
DRILLING EQUIPMENT:	DRILLER:
SAMPLING METHOD:	TOTAL DEPTH:
START DATE:	COMPLETION DATE:
LOGGED BY:	APPROVED BY:
LOCATION:	SURFACE ELEVATION:

DEPTH	RECOVERY / RQD	BLOW COUNT	SAMPLE NO.	MODE	SOIL CLASS / GRAPHIC LOG	DESCRIPTION	PID READING (PPM)	REMARKS
5								
10								
15								
20								

EARTH TECH

TEST BORING LOG

BOREHOLE NO.: _____

WELL NO.: _____

PROJECT NAME: PROJECT NO.:

DEPTH	RECOVERY / RQD	BLOW COUNT	SAMPLE NO.	MODE	SOIL CLASS / GRAPHIC LOG	DESCRIPTION	PID READING (PPM)	REMARKS
30								
35								
40								
45								
50								
55								

EARTH TECH

A tyco INTERNATIONAL LTD. COMPANY

Chain of Custody Record

Custody Seal #	Earth Tech Cooler #

Project Number	Project Name/Client
Sample Custodian: (Signature)	

Item No.	Sample Description (Field ID Number)	Date	Time	Grab	Comp.	PID Reading (ppm)	Label Number	Analysis Required												Matrix: Sample Type					Matrix: Sample Container				
1																													
2																													
3																													
4																													
5																													
6																													
7																													
8																													
9																													
10																													
11																													
12																													
13																													
14																													
15																													
16																													
17																													
18																													

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Disposed of by: (Signature)	Items:	Date / Time
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Disposed of by: (Signature)	Items:	Date / Time

Send Lab Results To:	Remarks:	Check Delivery Method:	Laboratory Receiving Notes:
	Federal Express Airbill No.: Lab:	☐ Samples delivered in person ☐ Common carrier	Custody Seal Intact? Temp. of Shipping Container: Sample Condition:

Rev. 10/98

White Copy - Lab Yellow Copy - File Pink Copy - Client

F514/Earth.Sci

Water Table Well Installation Diagram

EARTH TECH

A tyco INTERNATIONAL LTD. COMPANY

Site Name _____ Project No. _____ Well No. _____
Northing _____ Easting _____ Surf. Elev. _____ Ref. Boring No. _____
Drilling Contractor: _____ Well Installation Date/Time: _____
Driller's Name: _____ Inspected By: _____ Well Completion Date/Time: _____
Drilling Method: _____ Drilling Fluids (type): _____

Protective Casing:
Material:
Dia. (in):
Length (ft):
Guard Posts
material:
Dia. (in):
Top Cap or Plub: Type:
Concrete Collar:
Manufacturer:
Volumes:
+
=
Material between protective casing and Well Casing:

Upper Seal: Material:
Manufacturer:
Volume (Gal, Lbs)
Hydration: Volume Water:
Well Casing: Material:
Manufacturer:
Casing O.D./I.D.(ft)
Joints:
Annular Space Seal: Material:
Manufacturer:
Final Volumes:
+
+
=
Lower Seal: Material:
Manufacturer:
Volume (Gal, Lbs)
Hydration: Volume Water
Fine Sand: Material:
Manufacturer:
Volume (Gal, Lbs)
Filter Pack: Material:
Manufacturer:
Volume (Gal, Lbs)
Screen: Material:
Manufacturer:
I.D. (ft):
Slot Size:

NOTES: _____

Bottom Cap or Plug: Type: _____ Length: (ft) _____
Material Below Well: _____
Water Source: _____

WATER TABLE WELL INSTALLATION DIAGRAM GENERAL INSTRUCTIONS FOR COMPLETION

NOTE: PRIOR TO USING THIS FORM, READ THE PIEZOMETER AND WATER TABLE WELL INSTALLATION DIAGRAM PREPARATION STANDARD, NUMBER T.12.239. The following instructions are general and do not contain information for all areas to be completed on the installation diagram.

ALL DEPTHS AND MEASUREMENTS ARE TO BE REPORTED TO THE NEAREST 0.01 FT UNLESS OTHERWISE SPECIFIED

Reference Boring No.:	The boring number, this may or may not differ from the Well No.
Well Initiation Date/Time:	Date and time well construction began.
Well Completion Date/Time:	Date and time the concrete collar and protective casing was installed.
Drilling Method:	Method(s) used to drill the borehole.
Drilling Fluids:	Fluids used during drilling (eg. water, bentonite)
Top of Protective Casing and Well Casing:	Measurement from ground surface to the top of the protective casing and well casing.
Top of Screen:	Depth to the top of the screen section (not the top of the slots).
Water Level:	Depth to static water prior to well construction.
Screen Length:	Length of the screen section (not the slotted length).
Material Thickness:	Bottom of the borehole minus the bottom of the well.
Bottom of Borehole:	The total drilling depth of the borehole.
Cap or Plug: (top and bottom)	Circle whether a cap or plug was used. Record the type (slip, j-plug, etc.) and material (PVC, Steel, etc.)
Concrete Collar:	Material in the annular space above the upper seal between protective casing and the well casing, including cement, sand, bentonite, gravel, etc.
Upper Seal/Lower Seal:	Circle whether volume is recorded in Gal. or Lbs. and record the appropriate total volume used. Record the volume of water, in gallons, used to hydrate the seal. Record the time in hours the seal was allowed to hydrate or set prior to proceeding with well construction.
Annular Space Seal:	____lbs. of ____ is the total amount of dry material used in the annular space seal mixture. (i.e. 94 lbs. of Portland Type I Cement). Record the total volume, in gallons, used for the annular space seal.
Fine Sand/Filter Pack:	Report the material (silica, gravel, etc.) and the sieve size (20/40, No. 50, etc). Circle whether volume is being recorded in Gal. or Lbs. and record the appropriate total volume.
Screen:	Slotted length is from the top slot to the bottom slot of the entire screened section(s).
Material Below Well:	All materials below the well including natural collapse, filter pack, or backfill material (i.e. 45' to 42' sand formation collapse, 42' to 41' filter pack.)
Water Source:	Description of source, including hydrant, building, or well location or other pertinent information.
Notes:	Any well construction details or problems during well construction, including but not limited to the following: bridging, natural formation cave-in, heaving sands, water loss or gain during drilling, well straightness tests, grout loss, centralizers, etc.

CASING OR BOREHOLE VOLUME (DRISCOLL, 1986)

Diameter of Casing or Hole (In.)	Gallons per foot of Depth
1	0.041
1 ½	0.092
2	0.164
2 ½	0.255
3	0.367
3 ½	0.500
4	0.653
4 ½	0.826
5	1.020
5 ½	1.234
6	1.469
7	2.000
8	2.611
9	3.305
10	4.080
11	4.937
12	5.875
13	8.000
16	10.44
18	13.22
20	16.32
22	19.75
24	23.50
26	27.58
28	32.00
30	36.72
32	41.78
34	47.16
36	52.88

EQUIVALENTS
1 cm = 0.394 in.
1 in. = 0.083 ft
1 cubic ft = 7.48 gal
100 lb sack sand = 1 cubic foot

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SURFACE WATER

Site _____ Project Number _____

Temperature _____

Date _____ pH _____

Time _____ Conductivity _____

Dissolved Oxygen _____

Collectors _____ Turbidity: Low _____

_____ Medium _____

High _____

Sample Number

Color: _____

Sampling Equipment _____ Odor: _____

_____ Water Depth: _____

Physical Description of Surface Water Sample Location: _____

SEDIMENT

Date _____

Time _____

Collectors _____

_____

Sample Number

Sampling Equipment _____

_____

Physical Description of Sediment Location: _____

Physical Description of Sediment: _____

Well Development (Must Have Well Construction Diagrams)

EARTH TECH

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Well No. [ ]

Date: ____/____/____
Mon. Tues. Weds. Thurs. Fri.

Site: _____

Weather: _____

Project No.: _____

Development: Pumped ☐ Bailed ☐

Other: _____

Pump Type: _____

Bailer Type: _____

Volume Calculation: _____

(D.T.B - D.T.W. x vol./ft. = PVC/well volume) + (N* x H* Annulus vol./ft.) = Total well Volume

* (Wells that cannot be purged dry, 10x's the Total Well Volume must be purged)

(Wells that can be purged dry, slowly removing water, without surging until dry)

Time	Depth to Water (D.T.W.)	Depth to Bottom (D.T.B.)	Volume Removed (gal.)	PH	Cond.	Temp.	Color	Odor Y/N	Turbidity

Comments: _____

*N = porosity of filter pack

*H = length of filter pack or length of saturated filter pack (water level within screen length)

* = A 30-minute surge and purge before the 10x's the Total Well Volume

Annulus	vol./ft.
4"	0.42
6"	1.24
8"	2.38
10"	3.85

Inside Diameter	vol./ft.
1"	0.04
1.25"	0.06
2"	0.16
4"	0.65

Signature: _____

HNU../PP	LEL/%	O_2/%	H_2S/PPM	CO/PPM	

Well Purging and Sample Collection

EARTH TECH

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Project No.: _____ Well No. [ ] Site: _____

Purging Method: ☐ Pumped ☐ Bailed ☐ Other: _____

Pump Type: _____ Bailer Type: _____

Weather Conditions: _____

Volume Calculations: _____

(D.T.B. - D.T.W. x vol./ft. = Gals./well vol.)

(Gals./well vol. X 5 = Total Volume to be removed) Gals./well vol.: _____

Time	Depth to Water (D.T.W.)	Depth to Bottom (D.T.B.)	Volume Removed (gal.)	pH	Cond.	Temp.	Color	Odor Y/N	Turbidity
		Sample Readings							

Comments: _____

Inside Diameter	vol./ft.
1"	0.04
1.25"	0.06
2"	0.16
4"	0.65

Field Blank Taken ☐ Time: _____

Well Duplicate ☐ No.: _____

Signature: _____

Date: ____/____/____

Hnu/PPM	LEL/%	0_2/%	H_2S/PPM	CO/PPM	

Rev. 10/98

F521/Earth.Sci

Field Meter Instrument Calibration Log
Temperature, Conductivity, Dissolved Oxygen

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	THERMOMETER				CONDUCTIVITY			D.O. METER			
Date Calibrated	NBS Reference °C	Field Thermo-meter °C	Correc-tion Factor °C	Cal By	True Value umhos	Meter Readings umhos	Cal By.	Air Temp °C	Calc. D.O. Air (mg/L)	Read D.O. Air (mg/L)	Cal. By

COMMENTS: _____

Thermometer No.: EPA ID No.:

Conductivity Meter: MFG Model: EPA ID No.:

Conductivity Standard: MFG Opened Date:

D.O. Meter: MFG Model: EPA ID No.:

Instrument Calibration Log

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INSTRUMENT: _____

Date Calibrated	Known Standard	Actual Instrument Reading	Adjustments Made	Calibrated By	Comments

COMMENTS: _____

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PROJECT NO. _____ SITE _____

Well Number	Elevation Of Top Of Pipe	Depth To Water	Water Elevation	Depth To Bottom	Well Integrity				Comments
					Locked	Capped	Cracked	Obstruct	

Description Of Site _____

Soil Conditions _____

Weather _____ Temperature _____

Entered On Computer _____ Signature _____ Date _____

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Construction Photo Log

Sheet _____ of _____

Project: _____ Project No.: _____

	Date Taken	Picture No.	Description
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

Notes: _____

APPENDIX D

HEALTH AND SAFETY DOCUMENTATION

ATTACHMENT A

HEALTH AND SAFETY FORMS

Earth Tech, Inc.
HAZWOPER Site Activities
Tailgate Safety Briefing Sign-in Log
Date: Time:

Briefing Conducted By:	Signature:	Company Name:

This sign-in log documents the tailgate safety briefing conducted in accordance with HASP requirements. Personnel who perform work operations onsite are required to attend each safety briefing and acknowledge receipt of such briefings daily.

TOPICS COVERED:		
? General PPE usage	? Decontamination Procedures	? Emergency Procedures
? Hearing Conservation	? Smoking, Eating, and Drinking	? Existing Work Zones
? Respiratory Protection	? Slips, Trips, and Falls	? Lockout/Tagout Safety
? Personal Hygiene	? Heat Stress	? Excavation/Confined Space Safety
? Exposure Guidelines	? Site Control	? New Work Procedures

Personnel Sign-in List

Printed Name	Signature	Company Name

Supervisor's Report of Incident

EARTH TECH

This is an official document to be initiated by the injured employee's supervisor. Please answer all questions completely and forward to the Health and Safety Section office within 24 hours of the injury.

Injured's name		S.S.No.	Sex	Birthdate
Home address		City	State	Zip
Job Title	Section	Hire date	Hourly wage	Phone

Supervisor

Date of incident	Time	Time reported	To whom
Client name	Client address		Time shift began
Exact location of incident		Did injured leave work?	When?
Has injured returned to work? ☐Yes ☐No		Did employee miss a regularly scheduled shift? ☐Yes ☐No	
Doctor/hospital name		Address	
Witness name		Statements attached ☐Yes ☐No	
Nature of injury		Body part	
Medical attention			
Job assignment at time of accident			
Describe incident			
What caused the accident?			
What corrective action has been taken to prevent recurrence?			
Supervisor/foreman Print name		Signature	Date

Manager

Comments on incident and corrective action		
Manager Print name	Signature	Date

Health and Safety

Concur with action taken? ☐Yes ☐No Remarks:		
OSHA classification ☐ Incident only ☐ First aid ☐ No lost work days ☐ Lost work days ☐ Restricted activity ☐ fatality		
Days away from work	Days of restricted work	Total days charged
HS Professional Print name	Signature	Date

ATTACHMENT B

GENERAL SUBCONTRACTOR SAFETY RULES

GENERAL SAFETY RULES FOR CONTRACTORS

Introduction

The rules and requirements contained in this attachment have been written for the guidance of Contractors who are performing work under contract with Earth Tech. This booklet prescribes general requirements. Additional specific rules may be necessary to ensure the safety of workers on a particular job. The Contractor, working in collaboration with the Earth Tech representative, will be expected to establish such additional rules and procedures as may be necessary to conduct a safe operation and comply with all Earth Tech, regulatory, and insurance requirements and those of our clients. Earth Tech health and safety professionals are available to assist.

The term Contractor, as used in this attachment, shall be understood to include any and all persons, sole proprietorships, partnerships, corporations, or other business ventures under contract, oral or written, to Earth Tech.

Contractor is responsible for informing its subcontractors of these requirements, for directing and supervising work of subcontractors, and for assuring that its subcontractors adhere to the requirements herein. Earth Tech may request Contractor to provide proof of its subcontractor's adherence to all rules and regulations and will prohibit access to Earth Tech property or job sites or our client's property for those Contractors not in compliance.

In order to assist Contractor in following these instructions, a Earth Tech Representative will be assigned to the Contractor to act as Earth Tech's agent in all matters relative to work activities at Earth Tech facilities or job sites. Under no circumstances shall any work be started until the Earth Tech Representative has been contacted, a job orientation has been conducted by the Earth Tech Representative, and all permits, insurance, Earth Tech, client, and regulatory pre-job requirements met.

The Earth Tech Representative and the Earth Tech Health and Safety professionals are authorized to stop any work which they may consider hazardous to Earth Tech personnel or equipment or Contractor personnel. This authority may be delegated to appropriate individuals.

General Safety Rules and Requirements

Accident Reporting

All accidents (personal and property damage) shall be reported orally to the Earth Tech Representative as soon as emergency conditions no longer exist. A written report shall follow within 7 days after emergency conditions are resolved.

Alcohol, Firearms, etc.

Alcoholic beverages, illegal drugs or narcotics, or guns and ammunition are not permitted on Earth Tech property or job sites. Personnel under the influence of alcohol or drugs shall not be allowed on Earth Tech property or job sites.

Approvals

The Contractor shall be required to obtain pertinent work permits or authorization and approval from the Earth Tech Representative before:

- Working on existing pipelines or equipment
- Entering tanks or closed vessels
- Entering any designated high-hazard areas
- Using torches, electrodes, electronic motors, forges, soldering irons, any open flames, or any device which could produce sparks or ignition source
- Closing walkways, roads, or restricting traffic
- Starting excavations
- Removing tanks from excavations
- Backfilling excavations
- Using utilities such as steam, water, compressed air, or electricity
- Sandblasting, spray painting, or guniting
- Storing flammable materials such as gasoline, oil, paints, oxygen cylinders, etc.
- Walking or working on roofs of buildings or equipment
- Drilling, boring, preparing test pits, or using geophysical equipment or any other exploratory equipment requiring penetration of surfaces
- Operating cranes or similar equipment near overhead power lines or pipelines
- Opening cutting through firewalls or berms
- Fueling or repairing Contractor operating equipment on Earth Tech property or job sites.

Security

For security reasons, entrance to and exit of Earth Tech facilities and job sites is restricted to those areas designated as the Contractor's work area.

Speed Limits

All vehicles on Earth Tech job sites and facilities must observe a maximum speed limit of 10 mph unless otherwise posted.

Vehicle Safety

- All vehicles must be parked in authorized areas only.
- There will be no passing of moving vehicles at job sites where there are narrow roads and short-sight distances.
- Vehicles will only be operated by personnel with valid licenses and good driving records.
- Vehicles shall have all required inspection and operating permits.
- Seat belts shall be used.

Safe Work Practices

Communication

Communication and coordination is vital to prevent accidents on construction sites. Every worker must be aware of equipment operating in his vicinity.

Confined Space Entry

Confined spaces include storage tanks, bins, sewers, in-ground vaults, degreasers, boilers, vessels, tunnels, manholes, pits. etc. These enclosures, because of inadequate ventilation and/or the introduction of hazardous gases and vapors, may present conditions that could produce asphyxiation or injury.

Before entering a confined space, Contractor must notify the Earth Tech Representative of intent to enter. The Earth Tech Representative will review with Contractor the safe entry requirements which include:

Removal of Contents. Before entering, confined spaces should be as clean and free of hazardous materials and chemicals as possible. Where appropriate, confined spaces may be purged by water or other suitable means. Purging with hazardous solvents should be avoided where possible.

Isolation. All input lines which discharged into the confined space shall be disconnected and capped or isolated. The use of a single in-line valve shut-off as the sole means of isolating the confined space from any input lines is prohibited.

However, the use of a double in-line valving arrangement with a vent or drain in between the two valves is acceptable provided that dangerous air contaminants are not introduced by such venting. Isolation valves shall be locked closed, vent or drain valves shall be locked open, and the key shall be kept by that person performing the job.

Electrical Lockout. Where electrical devices located within the confined space (motors, switches, etc.) are to be repaired or worked on, the line-disconnect switches supplying the power must be tagged and locked in the "OFF" position. The lock key is to be kept by the person performing the job, and only this person is authorized to unlock the switch and remove the tag upon completion of the job. Where more than one person is working on the line, each must place a lock on the switch and retain his own key.

- Where there are multiple sources of power to an electrical device that supplies power to the device through an automatic or manual bus transfer switch, lockout devices must be placed on the breaker nearest to the electrical device that is to be isolated, and an electrician shall test the power supply lines to ensure that power has been secured.
- Line-disconnect switches supplying power to any mechanical apparatus in the confined space (mixers, conveyors, etc.) must also be tagged and locked in the "OFF" position. This must be done for any entry, even though work will not be performed on the apparatus itself.

Securing of Covers. All manhole and cleanout covers shall be removed and the openings maintained clear of any obstructions. When hinged doors or lids are provided, they shall be secured so they cannot close. See **Excavations and Trenches** for guarding requirements.

Testing Atmosphere. A qualified person (NIOSH Publication No. 80-106) using only equipment approved and tagged for Class 1, Division 1 locations shall make appropriate tests of the atmosphere in the confined space and place a record of the test results at the entrance to the confined space. Testing shall ensure the following:

- Combustible gas and vapor concentrations do not exceed 10 percent of the lower explosive limit
- Oxygen content is no less than 20 percent and no greater than 25 percent
- Appropriate respiratory protective equipment and other appropriate personal protective devices have been provided for all employees when concentrations of toxic materials exceed established threshold limit values (TLVs).

Continuous Monitoring. If the nature of the work to be performed introduces, or has the potential to introduce, harmful air contaminants, continuous monitoring of the atmosphere and/or the oxygen content drops below 20 percent, all personnel shall evacuate the confined space immediately.

Ventilation. All confined spaces found to be unsafe must be ventilated by means of mechanical exhaust systems arranged so as to avoid recirculating contaminated air. The Contractor must contact the Earth Tech Representative to obtain approval not to ventilate. Personnel shall be evacuated immediately in the event of failure of the mechanical ventilation system. The confined space shall be retested prior to reentry following ventilation system repair.

Buddy System. At least two workers shall remain outside the confined space. One standby worker shall be stationed just outside the access opening of the any confined space while such space is occupied. This person shall:

- Maintain continuous awareness of the activities and well-being of the occupant in the confined space
- Be able to maintain communication at all times
- Be alert and fully capable of quickly summoning help
- Be physically able and equipped to assist in the rescue of an occupant from a confined space under emergency conditions.

Safety Gear and Personal Protective Equipment. All Contractor employees must be instructed in accordance with OSHA regulations regarding safety gear and personal protective clothing, hard hats, respirators, lifelines, and harnesses. Such instructions shall be received and documented before entering any confined space.

Compressed Gas Cylinders

Valve protection caps. Valve protection caps shall be in place when compressed gas cylinders are transported, moved, or stored.

Cylinder valves. Cylinder valves shall be closed when work is finished and when cylinders are empty or are moved.

Compressed gas cylinders. Compressed gas cylinders shall be secured against rolling or tipping (roped or chained) at all times, except when cylinders are actually being hoisted or carried.

Gas regulators. Gas regulators shall be in proper working order while in use.

Leaks. If a leak develops in a gas cylinder, after donning appropriate safety equipment, immediately remove it to a safe location. If the leak cannot be corrected, report it to the Earth Tech Representative.

Identification of Contents. Cylinders should be permanently marked or stenciled to identify the type of gas in the cylinder.

Breathing Air. All compressed breathing air shall meet OSHA specifications for breathing air quality. All compressed breathing air cylinders shall have their contents checked at the job site for correct oxygen concentration and rejected for breathing air if the oxygen concentration is not 20.7% ±0.2%.

Oil and oily rags. Oil and oily rags shall be kept away from oxygen equipment.

Cranes, Hoists, and Other Heavy Equipment

Contractor personnel will not be permitted to use hoists and powered apparatus belonging to Earth Tech unless approval is obtained in each instance from the Earth Tech Representative.

ROPs. Roll over protection shall be used when conditions or regulations call for such use.

Cutting or Welding

Hot Work/Welding/Burning. "Hot Work" authorization must be obtained from the Earth Tech Representative before any welding, cutting, or other "hot work" is done. "Hot work" permits and results of tests are to be submitted to the Earth Tech Representative at the completion of the job or at the end of each workday.

Welding Flash. Noncombustible or flame-proof shields or screens must be provided to protect welder or others who might be harmed by direct rays or arc.

Personal Protective Equipment. Goggles, gloves, aprons, and other personal protective equipment appropriate to the job shall be used.

High Fire-Hazard Areas

- Contractor personnel are responsible to see that a fire watch is maintained and all adjacent combustible materials are protected or removed as designated by the Earth Tech Representative.
- Contractor shall provide his own calibrated combustible gas meter or other instruments for checking areas before hot work.
- Documentation of calibration shall be submitted to the Earth Tech Representative for review by the Earth Tech Health and Safety Section.
- Contractor is responsible for all testing and monitoring required by applicable regulations and to assure work place safety.
- Earth Tech shall have the right, not the responsibility, to perform additional testing. Earth Tech testing shall not be in lieu of Contractor's requirements.
- In the event of a bona fide emergency, such as emergency spill response work, and where the Contractor warrants that he cannot conduct the required testing, Earth Tech may upon written agreement then conduct all tests necessary to assure safety and regulatory compliance. The Contractor shall cosign the "hot work" permit form when tests are conducted by Earth Tech personnel.
- Contractor shall provide his own fire extinguisher(s) for welding and cutting, as designated by the Earth Tech Representative.

Electrical Safety

Grounding. The noncurrent-carrying metal parts of fixed, portable, or plug-connected equipment shall be grounded. Since ground wires can break, they shall be tested with an electrical resistance meter to assure conductivity as often as necessary to assure safety. Portable tools and appliances protected by an approved system of double insulation need not be grounded.

Extension Cords. Extension Cords shall be the three-wire type for grounded tools (two-wire is permissible for double-insulated tools) and shall be protected from damage; do not fasten with staples or extend across an aisleway or walkway. Worn or frayed cords shall not be used. Cords shall not be run through doorways where the door could cut or damage them.

Light Bulbs. Exposed bulbs on temporary lights shall be guarded to prevent accidental contact, except where bulbs are deeply recessed in the reflector. Temporary lights shall not be suspended by their electric cords unless designed for this use. Explosion-proof bulb covers shall be used when contact with flammable vapors or gases is likely and shall meet Class I, Division I requirements.

Electrical Receptacles. Receptacles for attachment plugs shall be of the approved, dead-front, concealed contact type. Where different voltages, frequencies, or types of current are supplied, receptacles shall be of such design that attachment plugs are not interchangeable.

Wet Environments. Work done in wet environments shall require ground fault interrupters and water-tight connectors.

Emergency Equipment

Earth Tech's fire equipment is not to be moved, relocated, or otherwise rendered inaccessible unless specific permission is granted in each case by the Earth Tech Representative.

Self-contained breathing apparatus, first aid equipment, fire blankets, stretchers, eyewash fountains, and deluge showers are not to be moved, relocated, or blocked without the express permission of the Earth Tech Representative.

Excavations and Trenches

Permits. Before any excavation work begins, all required permits shall be obtained.

"Dig-Alert". Before any excavation work begins, the existence and location of underground pipes, electrical conductors, etc., must be determined by Contractor who shall in turn notify the Earth Tech Representative.

Cave In Protection. The walls and spaces of all excavations and trenches (which will be entered by people) more than 4 feet deep shall be guarded by shoring, sloping of the ground, or some other equivalent means, in accordance with Cal/OSHA regulations.

Daily Inspections. Daily inspections of excavations shall be made by the Contractor. If there is evidence of possible cave-in or slide, all work in the excavation shall cease until the necessary safeguards have been taken.

Egress. Trenches more than 4 feet deep shall have ladders or steps located so as to require 10 feet or less of lateral travel between means of access.

Backfill. All trenches shall be backfilled as soon as practical after work is completed and all associated equipment removed.

Housekeeping. All Contractor equipment, such as pipe, rebar, etc., shall be kept out of traffic lanes and access ways. Equipment shall be stored in a manner which ensures the safety of Earth Tech and Contractor employees at all times.

Fall In Protection. All trenches shall be completely guarded on all sides. Standard guardrails are preferred. However, when wooden or metal barricades are used for trench guarding, they shall be spaced no further apart than 20 feet, and at least two feet from the edge of the trench. Such barricades shall be at least 36 inches high when erected.

- Battery-lighted barricades shall be used as follows:

  (1) A minimum of two battery-lighted barricades shall be used at corners, one on each side of the barricade.

  (2) At least one battery-lighted barricade shall be used where vehicular traffic approaches the trench at right angles.

  (3) Where trenches parallel roadway, distance between battery-lighted barricades shall not exceed 40 feet unless this requirement conflicts with Item (1), above, and additional units are required.

  (4) All battery-lighted units shall be serviced as necessary to ensure equipment is operating.

- Caution tape shall be stretched securely between barricades. The caution tape shall be at least 3/4-inch-wide and shall be yellow or yellow and black and may have the words "CAUTION - DO NOT ENTER."

- Barricaded sections immediately adjacent to where pedestrians cross trenches shall be arranged to direct pedestrians to the walkway or bridge.

Encroachment. Use of other trench excavating equipment, or storage of equipment or supplies within a distance equal to the depth of the trench, will not be permitted without approval by the Earth Tech Representative.

Bridges. All pedestrian bridges shall be of sufficient strength to prevent no greater vertical deflection than one-half inch when a 250-pound weight is applied to the center of the bridge.

- Handrails shall consist of intermediate and top rails on both sides of the bridge. The top rail shall be between 42 and 45 inches above the walking surface and be capable of withstanding a lateral force of 200 pounds against the center of the top rail.

- All surfaces which a person could reasonably contact should be sufficiently

free of splinters, nails, or protrusions which may cause injury.

- All bridges intended for vehicular traffic shall be constructed to withstand twice the load of the heaviest vehicle anticipated.

Earth Grading Activity

Vest. All persons within an area where earthmoving are operating shall wear a safety vest or jacket at all times. Vests may be red, orange, or day-glo green in color, but bright or fluorescent orange is preferred. Significantly faded or damaged vest must be replaced.

Communication. Anytime a test pit is to be excavated, the technician shall notify the grading contractor's **authorized** representative for that area. That individual may be acting in the capacity as a dump man, operator, or supervisor from an independent vehicle. Advise that representative of the test pit location and request their cooperation to promote safety during the test period. This should include their advising those under their supervision of your existence in the grading area. Make a notation on your records of the name of the individual with whom you spoke so that the communication is documented.

- Provide notice to the grading contractor
- Identify location of test pit
- Request the cooperation through the completion of the tests and document accordingly.
- A flag must be affixed to any vehicle driving in an earth grading activity area and hazard warning lights shall be operated.

Flags. Every over-the-road vehicle operating in the area of earthmoving equipment activity must carry a flag. The flag must be at least 300 square inches in area with no dimension less than 12 inches. Flags must be high visibility red, orange, day-glo green and mounted approximately 12 feet above grade level.

Hazard Warning Lights. Every over-the-road vehicle operating in the area of earthmoving equipment activity must operate the hazard warning flashers at all times.

Rotating or Flashing Beacon. All vehicles stationary in the grading area shall use a rotating or flashing amber beacon or strobe light on the top of the cab of the vehicle during all field testing.

Orientation of Test Pits. The technician is responsible for selecting a test pit location. Of paramount concern is the technician's safety. The test pit should be located behind the established pattern of grading equipment and outside any existing patterns. The orientation of the pit should include the use of the technician's vehicle as a barrier to potential oncoming traffic. The waste pile created from the excavation of the test pit should be opposite the vehicle so that the test pit is positioned between the vehicle and the waste pile. A flag shall be placed immediately on top of the waste (spoil) pile, satisfying the same requirements as the vehicle flag.

Zone of Non-Encroachment. The location of the test pit must be selected so that no earthmoving equipment will approach closer than 50 feet from the center of the test pit. This is not only for the technician's safety, but to ensure the integrity of the test. Excessive vibration from the operation of earthmoving equipment operating too closely may impair the accuracy or spoil the test results.

Completion of Tests. Immediately upon completion of tests, record the data and withdraw flags and vehicles outside the grading area to record notes and do calculations.

Fire Prevention

Earth Tech Representative, or his designee, is authorized to correct any condition which he may consider a fire hazard. In any emergency, the site personnel are authorized to act directly with Contractor's Foreman in regard to fire hazards without waiting for the Earth Tech Representative.

Floor Openings

Floor openings shall be guarded by substantial barriers, railings, and/or covering materials strong enough to sustain twice the load of pedestrians or vehicular traffic. Barriers will be supplied by the Contractor.

Where a danger of falling exists for personnel, elevated floor areas must be provided with guardrails. In addition, toeboards shall be provided when the possibility of falling objects striking personnel below exists.

High-Hazard Areas

Although this list may not be all inclusive, there are certain areas and operations at Earth Tech facilities and job sites where extra precautions must be taken because of the nature of the hazards. When starting up any operation, the Contractor is required to check with the Earth Tech Representative for a review of the safety and health rules which apply before entering any of the following areas:

- Confined spaces (tanks, manholes, vaults, pits, etc.)
- Laboratories
- Chemical storage and disposal areas.

The contractor is also required to check with the Earth Tech Representative before any work is done on a flammable gas or solvent line; a tank or vessel that presently contains, or has contained, a flammable material; and before making an excavation anyplace on the site.

Housekeeping

Material should be carefully stacked and located so that it does not block aisles, doors, self-contained breathing apparatus, fire extinguishers, fire blankets, stretchers, emergency eyewash fountains, emergency

safety showers, fixed ladders, stairways, or electrical breaker panels.

- Nails protruding from boards must be removed or bent over.
- All work areas shall be kept clear of form and scrap lumber and all other debris.
- Combustible scrap, waste materials, and debris shall be removed at regular and frequent intervals.
- Containers shall be provided for the collection and separation of refuse by type. Covers shall be provided on containers used for flammable, combustible, or harmful substances.
- Overhead storage of debris, tools, equipment, pipes, etc., is prohibited.
- At the end of each work day, Contractor shall provide for pick up of all debris such as paper, rags, empty cans and bottles, etc.

Ladders

The use of ladders with broken or missing rungs or steps, broken or split handrails, or with other faulty or defective construction is prohibited.

- Ladders must not be placed adjacent to a door unless the door is locked or guarded.
- Metal ladders shall not be used for electrical work.
- Tie off top of ladder to structure.

Medical Service and First Aid

Emergency Medical Service. Preplanned emergency medical service shall be provided as designated by Contractor and approved by the Earth Tech Representative.

First Aid Kit. Each Contractor shall provide a first aid kit for his employees which meets minimum OSHA requirements.

Mobile Cranes

Mobile cranes, including portable crane derricks, power shovels, or similar equipment, shall not be operated within ten feet of overhead electrical power lines.

Overhead Work

No overhead work shall be performed when, as a result of that work, the possibility of a falling object striking any person exists. Do not work above any person at any time.

Personal Protective Clothing and Equipment

In certain construction and maintenance operations, personal protective equipment such as safety glasses, chemical goggles, respirators, hard hats, and protective clothing is required. The type of protective equipment to be worn will be determined by the degree of exposure to the potential hazard. There will be very few occasions when hard hats and eye protection will not be required at Earth Tech job sites. When in doubt of the safety measures to be observed, Contractor shall contact the Earth Tech Health and Safety Section. This shall not, however, relieve Contractor of his responsibilities to determine appropriate protection.

Eye protection is required when engaging in such operations as the following:

- Drilling, chipping, grinding, wire brushing
- Handling caustics and acids
- Breaking bricks or concrete
- Hammering chisels, drift pins, etc.
- Burning or welding
- Other situations which create a possible eye hazard, e.g., chemical environments.

Photographs

Only Earth Tech photographers, with permission from DIPEF, are permitted to carry cameras or take pictures. If progress or finished construction photographs are desired, request for same should be made through the Earth Tech Representative.

Power Tools

Power and Air-Actuated Tools. Gasoline-powered, electric, or air-actuated tools are not to be used on Earth Tech property or job sites without prior approval of the Earth Tech Health and Safety Department. To obtain approval, Contractor must contact the Earth Tech Representative.

Explosive-Actuated Tools. Explosive-actuated (powder-actuated) fastening tools shall meet the design requirements in "American National Standard Safety Requirements for Explosive-Actuated Fastening Tools" (ANSI A10.3-1970). A tool which does not meet these design standards cannot be used.

- Power tools shall never be left unattended in a place where they would be available to unauthorized persons.
- Power tools shall not be used in explosive or flammable atmospheres.

Fall Protection

Appropriate fall protection, such as safety harness and lanyard, must be worn when worker is exposed to falling more than 6 feet. Lanyard or lifeline must be tied off to appropriate structure capable of supporting five times the weight of the person (nominal 1000 pounds).

- Appropriate fall protection, such as safety harness and lanyard, must be worn when working above eight feet on straight or extension ladders when the work involves

pushing, pulling, or action which may dislodge the person from the ladder.

- Safety harnesses are also required on swinging or portable scaffolds when handrails and toeboards are not provided (eight feet or more above ground or floor level).

- Safety harnesses and lifelines (including extraction devices for top entry spaces) are required on all work performed in confined spaces where an oxygen deficiency or toxic vapors may exist.

- All lifelines shall be safety secured to stable and adequate supports.
- Safety harnesses and lifelines must be worn on rooftops where there are no guardrails and where the work is within ten feet of the edge.

Salamanders

- "Hot work" authorization must be obtained from the Earth Tech Representative before using a salamander.

- Salamanders must be a Factory Mutual or Underwriters Laboratories-approved type.

- Position salamanders away from all combustible material to reduce the possibility of uncontrolled fire.

- Guard salamanders from traffic to prevent them from being overturned.

Scaffolds

All scaffolds, whether fabricated on site, purchased, or rented, shall conform to the specifications found in ANSI A10.8, Safety Requirements for Scaffolding. Rolling scaffolds shall maintain a three-to-one height-to-base ratio.

- The footing or anchorage for a scaffold shall be sound, rigid, and capable of carrying the maximum intended load without settling or displacement.

- Unstable objects, such as barrels, boxes, loose bricks, or concrete blocks, shall not be used to support scaffolds or planks.

- No scaffold shall be erected, moved, dismantled, or altered except under the supervision of competent persons.

- Scaffolds and their components shall be capable of supporting at least four times the maximum intended load without failure.

- Guardrails and toeboards shall be installed on all open sides and ends of platforms more than 10 feet above the ground or floor.

- Scaffolds measuring four to ten feet in height, and having a horizontal dimension of less than 45 inches, shall have standard guardrails installed on all open sides and ends of the platform.

- Wire, synthetic, or fiber rope used for suspended scaffolds shall be capable of supporting at least six times the rated load.

- No riveting, welding, burning, or open flame work shall be performed on any staging suspended by means of fiber or synthetic rope.

- Tested fiber or approved synthetic ropes shall be used for or near any work involving the use of corrosive substances.

- All scaffolds, boatswain's (bosun's) chairs, and other work access platforms shall conform to the requirements set forth in the federal OSHA Regulations for Construction (29 CFR 1926.451) except where the specifications in ANSI A10.8 7 or state or local regulations are more rigorous.

Smoking and Open Flames

Smoking and the use of open flames are strictly prohibited in areas where flammable liquids, gases, or highly combustible materials are stored, handled, or processed. Obey "No Smoking" signs. Smoke only in designated areas.

Solvents and Paints

- Adequate ventilation must be maintained at all times when paints or solvents are used.

- Personnel should use proper respiratory protection and protective clothing when toxicity of the material requires such protection.

- Flammable solvents and materials must be used with extreme caution when possible sources of ignition exist.

- Flammable paints and solvents must be stored in an approved (Factory Mutual or Underwriters Laboratories) flammable liquids storage cabinet when storage is required inside the buildings. If an approved cabinet is not available, paints and solvents must be removed from the building when not in use.

- Flammable liquids must be dispensed in safety cans with flash arresters bearing a Factory Mutual or Underwriters Laboratories approval. These containers must be clearly identified as to their contents.

- Material Safety Data sheets, for materials used by the Contractor, shall be maintained by the Contractor, and a copy provided to the Earth Tech Representative.

Tarpaulins

When tarpaulins are required for the detection of hot slag, dust, paint drippings, etc., or as security

barriers, they shall be flame-resistant and in good condition.

Tools

Hand and power tools shall be kept in safe operating condition. Mushroomed heads on cold chisels, star drills, etc., are unsafe and should not be used. Hammers should have handles which are not cracked, split, or broken.

Nonsparking tools may be necessary in certain areas where flammable materials are handled or where sparks could create an explosion.

Transporting Material and Equipment

Extreme care must be taken while carrying sections of pipe, conduit, and other materials to assure safety to Earth Tech, Contractor, and client personnel and property. This includes, but is not limited to, flagging and use of two people to carry pipe of lengths greater than 10 feet.

- Tools, materials, and equipment must not be left unattended in access ways.
- Tools, material, and equipment shall not be removed from the job site without permission of the Earth Tech Representative.

Walking and Work Surfaces

- Workroom floors shall be clean and, to the extent possible, dry.
- Drainage mats, platforms, or false floors should be used where wet processes are performed.
- Floors shall be free from protruding nails, splinters, holes, and loose boards or tiles.
- Permanent aisles or passageways shall be marked.
- Floor holes shall be protected by covers that eave no openings of more than one inch wide.
- Floor openings into which persons can accidentally walk shall be guarded by standard railing and toeboards.
- Open-sided floors, platforms, and runways higher than four feet shall be guarded by standard railings.
- Toeboards shall be used wherever people can pass below, or where hazardous equipment or materials are located below.

Warning Signs

All posted warning, safety, and security signs and barriers shall be observed. Additionally, Contractor shall provide warning signs, barriers, barricades, etc. wherever such protection is needed. Where signs and barricades do not provide adequate protection, particularly along a road, flagmen shall be used.

Contractors are expected to brief their employees on these requirements and enforce these rules with their employees. Earth Tech management may stop or suspend work at any time the Contractor fails to comply with Earth Tech rules and regulations.

Regulatory References

(a) *Standard Operating Safety Guides*, USEPA, November 1984

(b) *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, NIOSH 85-115, 1985

© Title 29 of the Code of Federal Regulations, Part 1910 (29 CFR 1910), Occupational Safety and Health Standards (USDOL/OSHA), with special attention to Section .120, Hazardous Waste Operations and Emergency Response

(d) Title 29 of the Code of Federal Regulations, Part 1926 (29 CFR 1926), Safety and Health Regulations for Construction (USDOL/OSHA), with special attention to Section 1926.65, Hazardous Waste Operations and Emergency Response

(e) Title 8 of the California Code of Regulations, Chapter 4, Subchapter 7, (commencing with Section 3200) General Industry Safety Orders (Cal/OSHA), with special attention to Section 5192, Hazardous Waste Operations and Emergency Response

(f) Title 8 of the California Code of Regulations, Chapter 4, Subchapter 4, (commencing with Section 1500) Construction Safety Orders (Cal/OSHA)

(g) Title 22 of the California Code of Regulations, Division 4, Chapter 30 (commencing with Section 66000) Environmental Health Standards for the Management of Hazardous Waste (California Environmental Protection Agency, Department of Toxic Substances Control)

(h) Title 22 of the California Code of Regulations, Division 2, Chapter 3, (commencing with Section 12000) Safe Drinking Water and Toxic Enforcement Act Regulations (California Health and Welfare Agency)

(I) National Oil and Hazardous Substances Contingency Plan

Drill Rig Safety Guidelines

A. General Drilling Practices

Prior to the start of site work, the drilling subcontractor will inspect all drilling equipment. The inspection will be documented in the field records. If field operations last longer than 1 week, the drilling equipment inspection must be repeated on a weekly basis.

EARTH TECH will conduct geophysical clearance and determine the location of all underground utilities before the start of drilling operations. In addition to obtaining the utility locations from the client, EARTH TECH will make a utility survey of each drilling point. The utility survey shall include both magnetometer and ground-penetrating radar survey. Documentation that nearby utilities have been marked on the ground and that the drill site has been cleared shall be kept in the EARTH TECH project trailer and confirmed to the drilling subcontractor.

Drill rig maintenance and safety is the responsibility of the drilling subcontractor. The following information is provided as general guidelines for safe practices during drilling activities, and installation of monitoring/extraction wells.

1 No food or beverage will be consumed or stored in the work area.

2. EARTH TECH will contact appropriate utilities agency to survey, mark, and flag locations of buried utility lines.

3. Maintain orderly housekeeping on and around the drill rig.

4. Store tools, materials, and supplies to allow safe handling by drill crew members. Proper storage on racks or sills will prevent spreading, rolling, or sliding.

5. Avoid storage or transportation of tools, materials, or supplies within or on the drill rig derrick.

6. Maintain working surfaces free of obstructions or potentially hazardous substances.

7. Store gasoline only in containers specifically designed or approved for such use.

8. Wear eye protection when chipping, chiseling or breaking material that presents risk of flying objects.

9. The departing driller should inform the oncoming driller of any special hazards or ongoing work that may affect the safety of the crew.

10. Fire fighting equipment should not be tampered with and should not be removed for other than the intended fire fighting purposes or for servicing.

11. If lubrication fittings are not accessible with guards in place, machinery should be stopped for oil and greasing.

12. Rigging material equipment for material handling should be checked prior to use on each shift and as often as necessary to ensure it is safe. Defective rigging should be removed from service.

13. The area around the derrick ladder should be kept clear to provide unimpeded access to the ladder.

14. Work areas and walkways should not be obstructed.

15. The rotary table of the rig floor shall be kept free of obstructions and free of undue accumulation of oil, water, ice, or circulating fluids.

B. Moving Rig to Drilling Location

1. Inspect the route of travel before moving drill rig off-road. Note rocks, trees, erosion, and uneven surfaces.

2. Remove all passengers from the cab before moving drill rig onto rough or sloped terrain.

3. Engage multiple drive power trains (when available) on rig vehicle when mobilizing off-road.

4. Travel directly up or down grade on slopes when feasible. Avoid off-camber traverse approaches to drill sites.

5. Approach changes in grade squarely to avoid shifting loads or unexpected unweighting.

6. Use a spotter (person at grade) to provide guidance when vertical and lateral clearance is questionable.

7. Use hand brakes and block rigwheels when grades are steep.

8. Lower rig mast before moving rig.

9. Secure all loads to rig prior to off-road mobilization.

10. EARTH TECH will use geophysical techniques, or equivalent, to locate buried utility lines.

C. Raising Mast

1. Locate visually overhead and buried utilities prior to drilling operations.

2. Treat overhead electrical lines as if they were energized and maintain at least a 40-foot clearance.

3. EARTH TECH will contact appropriate utilities agency to manipulate and deactivate overhead service in areas that interfere with drilling operations. Do not attempt to handle utilities.

4. Stabilize and level each work site prior to drill rig setup.

5. The derrick must not be raised until the rig has been blocked, leveled, and chocked.

6. Note wind speed and direction to prevent overhead utility lines from contacting rig derrick. Allow at least a 20-foot clearance between rig mast and utility lines.

D. Hoisting Operations

1. Drillers should never engage the rotary clutch without watching the rotary table and ensuring it is clear of personnel and equipment.

2. Unless the draw works is equipped with an automatic feed control, the brake should not be left unattended without first being tied down.

3. Drill pipe or casing should not be picked up suddenly.

4. Drill pipe should not be hoisted until the driller is sure that the pipe is latched in the elevator, or the derrick man has signaled that he may safely hoist the pipe.

5. During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller should be on the rig floor and no one should be on the rig or derrick.

6. The brakes on the draw works of every drilling rig should be tested by each driller, when he comes on shift, to determine whether they are in good order. The brakes should be thoroughly inspected by a competent individual each week.

7. A hoisting line with a load imposed should not be permitted to be in direct contact with any derrick member or stationary equipment, unless it has been specifically designed for line contact.

8. Workers should never stand near the well bore whenever any wire line device is being run.

9. Hoisting control stations should be kept clean and controls labeled as to their functions.

10. Inspect wire, rope, hoisting hardware, swivels, hooks, bearings, sheaves, guides, rollers, clutches, brakes for the following:

    - abrasions
    - breaks
    - wear
    - fatigue
    - corrosion
    - jamming
    - kinking.

11. Avoid the suspension of loads when hoist is unattended.

12. Prevent hoisting loads directly over field personnel.

13. Restrict hoisting operations during unfavorable environmental conditions such as rain or high winds.

14. Maintain safe hand distance from hoisting equipment (e.g., wire rope, hooks, pinch points) when slack is reduced.

E. Riding Hoisting Equipment

Under no circumstances will personnel be permitted to ride the traveling block or elevators, nor will the cat line be used as a personnel carrier.

F. Cat Line Operations

1. Only experienced workers will be allowed to operate the cat head controls. The kill switch must be clearly labeled and operational prior to operation of the cat line.

2. The cat head area must be kept free of obstructions and entanglements.

3. The operator should not use more wraps than necessary to pick up the load. More than one layer of wrapping is not permitted.

4. Personnel should not stand near, step over, or go under a cable or cat line that is under tension.

5. Employees rigging loads on cat lines should:

   - Keep out from under the load
   - Keep fingers and feet where they will not be crushed
   - Be sure to signal clearly when the load is being picked up
   - Use standard visual signals only and not depend on shouting to coworkers
   - Make sure the load is properly rigged, since a sudden jerk in the cat line will shift or drop the load.

G. Pipe Handling

1. Pipe should be loaded and unloaded, layer by layer, with the bottom layer pinned or blocked securely on all four corners. Each successive layer should be effectively blocked or chocked.

2. Workers should not be permitted on top of the load during loading, unloading, or transferring of pipe or rolling stock.

3. Employees should be instructed never to try to stop rolling pipe or casing; they should be instructed to stand clear of rolling pipe.

4. Slip handles should be used to lift and move slips. Employees should not be permitted to kick slips into position.

5. When pipe is being hoisted, personnel should not stand where the bottom end of the pipe could whip and strike them.

6. Pipe stored in racks, catwalks, or on flatbed trucks should be chocked to prevent rolling.

H. Derrick Operations

1. The derrick climber should be used whenever climbing the derrick. Personnel on the derrick should be tied off, or otherwise protected from falling when working in an unguarded elevated position.

2. All stands of pipe and drill collars racked in a derrick should be secured with rope or otherwise adequately secured.

3. Tools, derrick parts, or materials of any kind should not be thrown from the derrick.

4. The elevators must be properly clamped onto all pipe joints prior to the driller engaging the load.

I. Making and Breaking Joints

1. Tongs should be used for the initial making up and breaking of the joint. The rotary table should not be used for the initial breaking of a joint.

2. Employees making or breaking joints should not be permitted to stand within the arc of the tong handles when the tong pull line is under tension. Employees should handle the tongs only by the appropriate handles.

3. Employees should be trained in the safe use of spinning chains. Spinning chains should not be handled near the rotary table while it is in motion.

J. Drilling Operations

1. Begin auger borings slowly with the drive engine operating at low speed.

2. Establish a communication system between driller, helper, and geologist for responsibilities during drilling operations.

3. Engage auger to power coupling as recommended by manufacturer.

4. Restrict contact with power coupling or auger during rotation.

5. Prevent placing hands or feet under auger during rotation.

6. Prevent placing hands or feet under auger sections during hoisting over hard surfaces.

7. Avoid the removal of spoil cuttings with hands or feet.

8. Assure drill rig is in neutral and the augers are not rotating before cleaning augers.

ATTACHMENT C

HEAVY EQUIPMENT CERTIFICATION REQUIREMENTS

ATTACHMENT D

EARTH TECH HEALTH AND SAFETY POLICY HS203
ACCIDENT REPORTING, INVESTIGATION AND REVIEW

EARTH TECH	PROCEDURE NO. HS203
	DATE December 5, 1995
STANDARD PROCEDURE	SUPERSEDES February 7, 1995
SUBJECT ACCIDENT REPORTING, INVESTIGATION, AND REVIEW	APPROVED Steven L. Scott

1.0 PURPOSE AND POLICY

1.1 Purpose

This procedure prescribes the requirements for incident reporting, investigation, and review. Key requirements include:

- All injuries, vehicle accidents, and significant near miss incidents must be reported and investigated promptly, to determine root cause and prescribe corrective action.
- OSHA-Recordable injuries and illnesses and chargeable vehicle accidents must be reviewed by the Accident Review Board. The Accident Review Board report is submitted and approved through the chain of management to the President.
- All incidents involving a fatality, multiple injuries, major injury, or major property damage shall be immediately reported to the Group President, Division Vice President, Corporate Environmental Health and Safety Director, and General Counsel.
- All Departments/Sections must submit *Supervisor's Report of Incident* to Environmental Health and Safety within 24 hours of the injury. (Reports of incidents where no injury occurred are not as time-critical.)

1.2 Policy

It is the policy of EARTH TECH that all accidents resulting in injury or property loss and significant near miss incidents be reported, investigated, and evaluated for the benefit of improving the management of the Company.

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3.0 RESPONSIBILITY MATRIX

3.1 Procedure Responsibility. The Corporate Director, Environmental Health and Safety is responsible for the issuance, revision, and maintenance of this procedure.

3.2 Action/Approval Responsibilities. The Responsibility Matrix is Attachment 1 in Section 8.0.

4.0 DEFINITIONS

Chargeable Vehicle Accident. Any at-fault vehicle accident meeting any one of the following criteria:

1. Any individual sustains an OSHA-recordable injury as a result of the accident
2. An individual other than an employee of EARTH TECH is a party in the accident
3. Property owned by a person or entity other than EARTH TECH is damaged
4. When only EARTH TECH employees, EARTH TECH owned or leased (not rented) vehicles, and EARTH TECH property is involved and damage exceeds $1000.00.

Company. EARTH TECH, Inc.

Department/Section/Location Manager. The business unit manager of the involved organization. Various parts of the Company are organized in different ways. Small offices sometimes have a section or department number that is the same as the location code. In these small offices, the department or section manager is also the location manager and is also known as the business unit manager. In other small offices, the office is viewed as the branch of a larger department or section. In these cases, the location manager is not the section or department manager. Some of the larger offices hold many sections and departments. The location manager may be a staff manager with no line management responsibility. Regardless of the organization, the intent in this procedure is the Department/Section/Location Manager is at a management level equal to or above the program manager or the project manager.

EHS. Environmental Health and Safety

EHS Professional. A person certified by the American Board of Industrial Hygiene or the Board of Certified Safety Professionals who works to prevent injury or illness.

EHS Staff. A person whose primary work assignment is to prevent injury or illness.

Lost Workday Injury. Cases which involve days away from work or days of restricted work activity or both. Days away from work are: the number of workdays (consecutive or not), excluding the date of injury, the employee would have worked, but could not because of occupational injury or illness; and/or the number of workdays (consecutive or not), excluding the date of injury, on which, because of injury or illness:

1. The employee was assigned to another job on a temporary basis
2. The employee worked at a permanent job less than full time
3. The employee worked at a permanently-assigned job, but could not perform all duties normally connected with it.

Major Injury/Illness. When an employee is hospitalized for more than observation, the injury or illness is considered major.

Major Property Damage. Major property damage has occurred when preliminary loss estimates exceed $5000.

Near Miss Incident. Any incident where no injury occurred, but where the potential for injury existed. A significant near miss incident is an incident in which tragedy is narrowly averted.

OSHA Recordable Injury. All work-related deaths and illnesses, and those work-related injuries which result in:

1. Loss of consciousness
2. Restriction of work or motion
3. Transfer to another job
4. Require medical treatment beyond first aid (see Attachment 6 in Section 8.0).

5.0 PROCEDURE

5.1 Accident/Injury/Near Miss Report.

All incidents involving a fatality, major injury or illness, or major property damage shall be reported to the Group President, Division Vice President, Corporate Environmental Health and Safety (EHS) Director, General Counsel and the Regional/Divisional EHS Manager as soon as possible, but not later than the close of business on the day of the incident. The Corporate EHS Office will notify the EARTH TECH Medical Director to arrange prompt follow-up with the treating physician regarding lost or restricted workday incidents,

5.1.1 Employee

Reports all injuries, illnesses, accidents, and near miss incidents having the potential for injury to his/her supervisor immediately.

5.1.2 Supervisor

- Arranges appropriate medical care via the EARTH TECH clinic, emergency room, 911, or on site first aid provider, as appropriate.
- Immediately notifies the responsible EHS Professional.
- Completes Form HS203-F1 *Supervisor's Report of Incident* (Attachment 2) as soon as possible, but no later than 24 hours after the incident, and forwards to Manager.
- If employees are injured, notifies the Regional Human Resources Representative to initiate the workers' compensation process.

- Immediately notifies General Counsel and Corporate EHS Director in the event of a fatality or multiple serious injuries.

- Any supervisor with first-hand knowledge of an accident or injury, but preferably the supervisor directly responsible for the involved employees, may accomplish the required reporting.

5.1.3 Manager

- The Department/Section or Program Manager reviews the *Supervisor's Report of Incident*, adds comments, concurrence, clarification, or recommendations to achieve correction, signs in the Manager's block and forwards the form to the Environmental Health and Safety Department within 24 hours of the accident.

- Ensures a copy of the *Supervisor's Report of Incident* for each incident is forwarded to Corporate EHS Director in a timely way so that the OSHA Form 200 *Log of Injuries and Illnesses* is current and accurate. OSHA considers violations of their recordkeeping regulations to be willful with penalties as high as $70,000 for each infraction.

5.1.4 Environmental Health and Safety Professional

- Ensures necessary information regarding the incident is recorded and reported.

- Reviews, evaluates, and comments on the *Supervisor's Report of Incident*.

5.1.5 Regional/Division EHS Manager

- Serves as EHS Professional when no other EHS Professional is assigned to the organization which sustained the incident.

- Expedites incident reporting by the Supervisor.

- Assists Manager to evaluate processes, procedures, and actions which led to the incident.

- Expedites timely reporting of the incident and coordinates notification to all appropriate levels of management.

5.1.6 Corporate EHS Director

- Classifies the incident and records on the *OSHA Form 200 Log of Injuries and Illnesses* or equivalent form. Attachment 6 includes Injury/Illness Classification Guidelines.

- In the case of a fatality or multiple serious injuries involving five (5) or more employees, confers with General Counsel and CEO, and notifies the OSHA District Office nearest the site of the occurrence on the same business day as the accident, if possible, but in no case longer than 24 hours after the accident.

- Notifies the EARTH TECH Medical Director to arrange prompt follow-up with the treating physician regarding lost or restricted workday incidents

5.2 **Accident/Injury Investigation.**
All injuries, illnesses, property damage accidents, and significant near miss incidents shall be investigated. The level of effort expended for the accident investigation is commensurate with the actual or potential seriousness of the injuries, illnesses, or property damage.

The investigation shall be started immediately after the occurrence and completed as soon as possible, generally within 3-5 days after the occurrence. A written report (optional sample form provided as Attachment 3) is submitted to the Department/Section Manager, with a copy to the Regional/Division EHS Manager and the Corporate EHS Department.

5.2.1 **Supervisor**

- Take control of investigation once immediate medical care for injured personnel has been accomplished.
- Obtain assistance from the operations/discipline manager, health and safety professional, and others as appropriate, to conduct investigation.
- Collect the facts about the accident, including a descriptive narrative of the conditions which led to the accident.
- Describe and document how the accident occurred. Include sketches, photos, and any relevant documentation.
- Obtain in addition to the above information, reports from external sources, such as police, insurance carriers, testing laboratories, etc. These reports should be obtained as soon as they become available and included in the investigation report.
- List witnesses and collect written statements when possible.
- Identify and discuss the causative factors.
- Identify the unsafe act or unsafe condition that existed at the time of the accident.
- Identify systematic and management deficiencies.
- List the corrective actions to be taken to prevent re-occurrence of this type of accident, the responsible person, and the date by which action is to be completed.

5.2.2 **Operations Manager.** Provides appropriate manpower to assist in the investigation.

5.2.3 **Discipline Manager.** Provides appropriate manpower to assist in the investigation.

5.2.4 **Regional/Division Environmental Health and Safety Manager.**

- Provides guidance to Supervisor to ensure proper conduct of investigation.
- Provides appropriate manpower to assist in the investigation.

5.3 Accident Review Board.

Management review of accidents is the key to prevention of future incidents, and is a key part of each managers responsibility to implement effective health and safety practice.

5.3.1 When to Convene

Each Department/Section/Location Manager who experiences an accident classified as an OSHA recordable, or a chargeable vehicle accident shall convene an accident review board. The actions of the Accident Review Board are more effective the sooner the Board convenes after an accident, providing the involved managers and discipline leaders are available. Convening the Board within 10 days of the incident is a good guideline when practical. The purpose of the board is to review the information gathered for each accident and take appropriate action to prevent recurrence of the accident. Identified action items shall be assigned to appropriate individuals with a schedule of completion. These action items will be tracked, with reports sent to the Group President and/or the Division Vice President as appropriate.

5.3.2 Composition of Board

The Accident Review Board shall be composed of the appropriate members of management and staff, depending on the seriousness of the accident and the management actions likely to be taken to prevent recurrence. Typical Accident Review Boards usually include the Department or Section or Location Manager, the operations or discipline manager and an EHS Staff. When appropriate, a representative of other internal sources of expertise may be requested to sit on the Board.

Accidents which result in actual or potential significant adverse action against the Company shall include a member of the Corporate staff to be included on the Accident Review Board. Accidents resulting in third party fatality, serious injury, or major property loss would be considered to have a significant adverse impact on the Company.

5.3.3 Conduct of Review

The Accident Review Board shall meet with the employee having the accident and his/her supervisor to conduct a detailed review of the accident. The

Accident Review Board examines the documents such as HS203-F1 *Supervisor's Report of Incident*, HS203-F2 *Accident/Injury Investigation*, OSHA Form 101, worker's compensation insurance reports, or police reports to determine the cause and to prevent future accidents. Additional information regarding the accident may be needed and should be added to the record. Note that it is not acceptable to discipline an employee for having an accident. However, when the investigation determines that the accident resulted from a violation of company policy on the employee's part, the employee should be subject to disciplinary action according to EARTH TECH's progressive discipline system.

5.3.4 Accident Review Board Report

The completed Accident Review Board Report Form (Attachment 6) shall be reviewed and signed by the following progression (as appropriate):

- Department/Section/Location Manager
- Regional/Division Environmental Health and Safety Manager
- Division Vice President
- Group President

The Group President will then forward the original to the President of EARTH TECH, with a copies to General Counsel and Corporate EHS Director. The Corporate EHS Director distributes a summary to all EHS Managers.

5.4 Monthly Loss Report.

5.4.1 Regional/Division Environmental Health and Safety Manager.

- Completes and distributes copies of Form HS203-F3 *Monthly Loss Report* (Attachment 5) to Corporate EHS, Group President/Division Vice President, and Department/Section Manager.
- Includes a copy of Form HS203-F1 *Supervisor's Report of Incident* for each incident with the *Monthly Loss Report*.

5.4.2 Regional Human Resources.

- Provides a copy of each workers' compensation claim to Corporate Environmental Health and Safety.
- Provides a copy of the quarterly loss report from the workers' compensation insurance carrier to Corporate Environmental Health and Safety.

5.4.3 Corporate Environmental Health and Safety.

- Provides a copy of the *OSHA Form 200 Log of Injuries and Illnesses* or equivalent form to each location each month.

- Provides copy of Form HS203-F1 *Supervisor's Report of Incident* to Human Resources

6.0 EXCEPTION PROVISIONS

None permitted.

7.0 CROSS REFERENCES

HS105 Record Keeping and Statistical Reports
HS603 Occupational Injury and Illness

8.0 FORMS AND CHECKLISTS

Attachment 1: Responsibility Matrix
Attachment 2: Form HS203-F1 *Supervisor's Report of Incident*
Attachment 3: Form HS203-F2 *Accident/Injury Investigation*
Attachment 4: Form HS203-F3 *Accident Review Board Report*
Attachment 5: Form HS203-F4 *Monthly Loss Report*
Attachment 6: Injury/Illness Classification Guidelines

RESPONSIBILITY MATRIX

Action	Procedure Section	Injured Employee	Employee's Supervisor	Manager	Project/ Location EHS Rep	Regional/ Division EHS Manager	Corporate EHS Director
Reports injury, illness, incident	5.1.1	X	X				
Arrange medical care	5.1.2		X				
File reports	5.1.3		X	X	X	X	
Investigates accident	5.2		X		X		
Notifies OSHA, Medical Director	5.1.5						X
Conducts Accident Review Board	5.3			X			
Submits Monthly Loss Report	5.4		X	X	X	X	
Provides notification to HR	5.4		X				X

Supervisor's Report of Incident

EARTH TECH

This is an official document to be initiated by the injured employee's supervisor. Please answer all questions completely. This report must be forwarded to Health and Safety office within 24 hours of the injury.

Injured's name		S.S.No.	Sex	Birthdate
Home address		City	State	Zip
Job Title	Section	Hire date	Hourly wage	Phone
Property Damaged				Value
Vehicle		☐ Chargeable ☐ Non-chargeable ☐ Not at Fault ☐ DOT		

Supervisor

Date of incident	Time	Time reported	To whom
Client name	Client address		Time shift began
Exact location of incident		Did injured leave work?	When?
Has injured returned to work? ☐Yes ☐No		Did employee miss a regularly scheduled shift? ☐Yes ☐No	
Doctor/hospital name		Address	
Witness name		Statements attached ☐Yes ☐No	
Nature of injury		Body part	
Medical attention			
Job assignment at time of incident			
Describe incident			
What caused the incident?			
What corrective action has been taken to prevent recurrence?			
Supervisor/foreman Print name		Signature	Date

Manager

Comments on incident and corrective action		
Manager Print name	Signature	Date

Environmental Health and Safety

Concur with action taken? ☐Yes ☐No Remarks:		
OSHA classification ☐ Incident only ☐ First aid ☐ No lost work days ☐ Lost work days ☐ Restricted activity ☐ fatality		
Days away from work	Days of restricted work	Total days charged
EHS Professional Print name	Signature	Date

This report contains information protected by the Privacy Act

Accident/Injury Investigation

Must be completed within 72 hours

EARTH TECH

1. Date _____ Section _____ Date of Accident /Injury _____

   Employee Name _____

   Supervisor Name _____

   Job Number/Name _____

   Location of Accident/Injury _____

2. Accident/Injury Classification

Injury	Vehicle	DOT
☐ Near Miss	☐ Chargeable	☐ DOT Vehicle
☐ First Aid	☐ Non-Chargeable	☐ DOT Reportable
☐ OSHA Recordable	☐ Not at Fault	
☐ Lost Workday		General Liability ☐

3. Description (Provide facts, describe how incident occurred, provide diagram (on back) or photos)

   _____

   _____

   _____

4. Analysis 1 (What unsafe acts or conditions contributed to the incident?)

   _____

   _____

   _____

5. Analysis 2 (What systematic or management deficiencies contributed to the incident?)

   _____

   _____

   _____

6. Corrective action (List corrective action items, responsible person, scheduled completion date)

   _____

   _____

   _____

7. Witnesses (Attach statements or indicate why unavailable)

   _____

   _____

   _____

8. Investigated by _____ _____ _____
   Print Name Signature Date

   Manager _____ _____ _____
   Print Name Signature Date

   Attach additional pages if needed.

Accident Review Board

EARTH TECH

The Board

Date of Board	Location
Board Member	Board Member
Board Member	Board Member

The Accident

Accident Date	Type
Report Complete: Yes No	Investigation Complete Yes No
Employee Name	Employee Signature
Employee Name	Employee Signature
Supervisor Name	Supervisor Signature
Supervisor Name	Supervisor Signature
Cause of Accident	
Action by Board	

Acceptance and Approval

ACCEPTED Employee Signature	ACCEPTED Supervisor Signature
APPROVED EHS Manager	REJECTED FOR
APPROVED Department/Section Manager	REJECTED FOR
APPROVED Division Manager/Group President	REJECTED FOR

Monthly Loss Report

EARTH TECH

Reporting Period: _____

Report Covers (Group, Division, or Region): _____

Occupational Injuries and Illnesses

Department/Section Name	Dept/Sec. Number	First Aid	OSHA Recordable	Lost Workday Cases	Total Cases

Summary of Occupational Injuries and Illnesses

Employee Name	Dept/Sec. Number	Date of Injury/Illness	Number of Days Lost	Number of Days of Restriction	Description

Summary of Vehicle and General Liability/Property Damage Accidents

Employee Name	Dept/Sec. Number	Date of Accident	Vehicle Identification	Third Party (Y or N)	Description

Report completed by: _____ Date: _____

Distribution:

Corporate EHS
Group President/Division Manager
Department/Section Manager

Injury/Illness Classification Guide

MEDICAL TREATMENT

The following are generally considered medical treatment. Work-related injuries that receive this type of treatment are considered OSHA-recordable.

- Treatment of infection
- Application of antiseptics during second or subsequent visit to medical care provider
- Treatment of second or third degree burns
- Application of sutures, stitches, or butterflies in lieu of sutures
- Removal of foreign body imbedded in eye
- Removal of foreign body from wound, if procedure is complicated because of depth of imbedment, size, or location
- Use of prescription medications, except single dose administered on first visit for minor pain or discomfort
- Hypodermic injection, excluding tetanus booster given for prophylaxis
- Use of hot or cold soaking therapy during second or subsequent visit to medical care provider
- Cutting away dead skin or tissue, surgical debridement
- Application of heat therapy during second or subsequent visit to medical care provider
- Use of whirlpool bath therapy during second or subsequent visit to medical care provider
- Positive x-ray diagnosis, including fractures, broken bones, herniation, etc.
- Treatment for an amputation involving loss of bone or function
- Admission to a hospital or equivalent medical care facility for treatment

FIRST AID TREATMENT

The following are generally considered first aid treatment. Work-related injuries that receive only first aid treatment and that do not result in lost time or restricted work activity are usually not OSHA recordable. An injury or illness that results in loss of consciousness, time away from work on days following the day of occurrence, restriction of work or motion, or transfer to another job is always OSHA-recordable.

- Application of antiseptics during first visit to medical care provider
- Treatment of first degree burns
- Application of bandages during any visit to medical care provider
- Use of elastic bandages during first visit to medical care provider
- Removal of foreign bodies not imbedded in eye, if only irrigation is required
- Removal of foreign bodies from wound, if procedure is not complicated, for example, if removal is by tweezers or other simple technique
- Use of non-prescription medications and administration of single dose of prescription medication for the relief of minor pain or discomfort
- Soaking therapy on initial visit to medical care provider or removal of bandages by soaking
- Application of hot or cold compresses during first visit to medical care provider
- Application of heat therapy during first visit to medical care provider
- Use of whirlpool bath therapy during first visit to medical care provider
- Negative x-ray diagnosis
- Observation of injury during visit to medical care provider
- Tetanus booster injection given for prophylaxis

ATTACHMENT E

EARTH TECH HEALTH AND SAFETY POLICY HS301
HAZWOPER TRAINING AND REFRESHER

EARTH TECH	PROCEDURE NO. HS301
	DATE June 13, 1996
STANDARD PROCEDURE	SUPERSEDES New
SUBJECT HAZWOPER TRAINING AND REFRESHER	APPROVED James L. Unmack James L. Unmack

1.0 PURPOSE AND POLICY

1.1 Purpose

To establish the EARTH TECH policy for HAZWOPER training, defining who must be trained and how training will be accomplished.

1.2 Policy

It is the policy of EARTH TECH that all employees who have occasion to work on a hazardous waste operation or hazardous waste site or supervise work on a hazardous waste operation or hazardous waste site as defined by 29 CFR 1910.120(b) shall receive training meeting the requirements of 29 CFR 1910.120(e).

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3.0 RESPONSIBILITY MATRIX

3.1 Procedure Responsibility.

The Corporate Director, Health and Safety, is responsible for the issuance, revision, and maintenance of this procedure.

3.2 Action/Approval Responsibilities.

The Responsibility Matrix can be found as Attachment 1 in Section 8.0.

4.0 DEFINITIONS

Hazardous Waste. Hazardous waste means a waste or combination of wastes as defined by 40 CFR 261.3 and 49 CFR 171.8.

Hazardous Waste Operation. Hazardous waste operation means any clean up operation or corrective action at a hazardous waste site.

Hazardous Waste Site. A hazardous waste site is any site where clean up or corrective action is required by a governmental body, whether federal, state, or local, involving hazardous waste. Hazardous waste sites include, but are not limited to, sites on the EPA's National Priority Site List (NPL), state priority site lists, sites recommended for the EPA NPL, and government identified sites before the initial investigation determines the presence or absence of hazardous waste. Hazardous waste sites also include sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 U.S.C. 6901 et seq.) and treatment, storage, and disposal (TSD) facilities regulated by 40 CFR Parts 264 and 265 pursuant to RCRA; or by agencies under agreement with U.S.E.P.A. to implement RCRA regulations, where clean-up operations or corrective actions are conducted, and sites where voluntary clean-up operations are conducted involving hazardous substances or hazardous waste.

HAZWOPER. Hazardous Waste Operations and Emergency Response, as applied to hazardous waste operations.

HAZWOPER Worker. A person who works on hazardous waste operation.

5.0 PROCEDURE

Employees shall not be permitted to participate in or supervise field activities until they have been trained to a level required by their job function and responsibility.

5.1 Business Unit Managers

- Ensure that all employees who are or will be assigned to work on a hazardous waste operation or hazardous waste site or supervise work on a hazardous waste operation or hazardous waste site as defined by 29 CFR 1910.120(b) receive training meeting the requirements of 29 CFR 1910.120(e).

- Schedule or provide for safety and health training meeting the requirements of 29 CFR 1910.120(e).

- Provide adequate facilities for in-house training to meet the needs of the scheduled training.

- Ensure that Project Managers, Response Managers, Construction Managers, and Supervisors of HAZWOPER workers receive 8 hours of hazardous waste operations supervisor training in accordance with 29 CFR 1910.120(e)(4).

5.2 Project, Response, Construction Managers

- Ensure that each of their employees who is assigned to work on a hazardous waste operation or hazardous waste site or supervise work on a hazardous waste operation or hazardous waste site as defined by 29 CFR 1910.120(b) receive a minimum of 40 hours of instruction off the site before being dispatched to the site, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor.

- Ensure that onsite employees who manage or supervise HAZWOPER workers receive 8 hours of hazardous waste operations supervisor training in accordance with 29 CFR 1910.120(e)(4).

- Ensure that each of their employees who is assigned to work on a hazardous waste operation or hazardous waste site or supervise work on a hazardous waste operation or hazardous waste site receives eight hours of refresher training annually.

- Schedule work assignments to allow timely completion of refresher training in accordance with 29 CFR 1910.120(e)(8).

5.3 HAZWOPER Employees

- Attend initial 40 hours of health and safety training for hazardous waste site workers before working on a hazardous waste site or supervising hazardous waste operations.

- Obtain and document a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor. See Attachment 2 to document field experience.

- Attend 8-hour HAZWOPER Refresher training no longer than 365 days from their last HAZWOPER training. If more than 24 months have passed since the last HAZWOPER training, the initial 40-hour training must be repeated.

- Provide copies of their 40-hour HAZWOPER training certificate and their most recent 8-hour HAZWOPER Refresher training certificate to the location Health and Safety Coordinator and to the Project/Response/Construction Manager.

5.4 Health and Safety Coordinators

- Keep a copy of each HAZWOPER training certificate received by employees assigned to the business unit.

- Remind HAZWOPER employees when due to take HAZWOPER refresher training in time to avoid expiration of HAZWOPER training certification.

- Coordinate with Business Unit Managers to schedule HAZWOPER training courses.

- Coordinate with Health and Safety Department to schedule in-house HAZWOPER refresher training.

5.5 Health and Safety Department

- Provides trainers for in-house HAZWOPER refresher training when resources are available.

- Assists Health and Safety Coordinator to schedule out-sourced training.

6.0 EXCEPTION PROVISIONS

Variances to this procedure shall be requested in accordance with established procedures. See HS109.

7.0 CROSS REFERENCE

None

8.0 ATTACHMENTS

Attachment 1: Responsibility Matrix
Attachment 2: References
Attachment 3: Field Experience Documentation

RESPONSIBILITY MATRIX

Action	Procedure Section	Business Unit Manager	PM, RM, CM	HS Coordinator	Corporate EHS Manager
Issuance, revision and maintenance of this procedure	3.1				X
Facilities for training	5.1	X			
Enforcement of training requirements	5.2		X		
Maintenance of training records	5.4			X	

PM Project Manager
RM Response Manager
CM Construction Manager
HS Health and Safety
EHS Environmental Health and Safety

REFERENCES

29 CFR 1910.120 Hazardous Waste Operations and Emergency Response

29 CFR 1926.65 Hazardous Waste Operations and Emergency Response

42 U.S.C. 6901 et seq. Resource Conservation and Recovery Act of 1976

40 CFR 261.3 Definition of Hazardous Waste

40 CFR 264 Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 265 Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

49 CFR 171.8 Definitions and Abbreviations

The Earth Technology Corporation

FIELD EXPERIENCE DOCUMENTATION

NAME: _____

Title 29 of the Code of Federal Regulations, Part 1910.120(e)(3) requires general site workers (such as equipment operators, general laborers, and supervisory personnel) engaged in hazardous substance removal or other activities which expose or potentially expose workers to hazardous substances and health hazards to receive a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor following a minimum of 40 hours of initial instruction off the site. This *on-the-job training* is documented as follows:

DATE	PROJECT	SUPERVISOR'S SIGNATURE

Employee's Signature Date

ATTACHMENT F

EARTH TECH HEALTH AND SAFETY POLICY HS401
HAZARD COMMUNICATION

EARTH TECH	PROCEDURE NO. HS401
	DATE February 1, 1996
STANDARD PROCEDURE	SUPERSEDES New
SUBJECT **HAZARD COMMUNICATION**	APPROVED Steven L. Scott

1.0 PURPOSE, POLICY, AND SUMMARY

1.1 Purpose

This procedure presents a program and a system whereby every employee has access to and receives the information about the materials that he/she is working with so that he/she may protect against the hazards presented by the materials.

1.2 Policy

It is the policy of EARTH TECH that every employee shall have the knowledge of the materials that he/she is working with so that he/she will take adequate precautions to prevent harm to him/herself, the community and the environment.

1.3 Summary

This Hazard Communication Program applies to products and commodities which are known to be present in the work place in such a manner that employees may be harmed by an exposure under normal conditions of use or in a reasonably foreseeable emergency resulting from work place operations. This Hazard Communication Program does not apply to articles, food, cosmetics, radioactive materials or waste/hazardous waste. The Hazard Communication Program contains the following elements:

- A person designated to be responsible for the Hazard Communication Program
- An inventory of all products and commodities that are at the workplace in the form of liquids, compressed gasses, powders, granules, pastes, gels, etc.
- Material Safety Data Sheets (MSDS) for all hazardous materials in the workplace
- Training for all employees who work with hazardous materials
- Procedure to ensure all containers of hazardous materials are properly labeled
- Procedure to access and protect proprietary and trade secret information
- Procedure to protect visitors to the workplace

- Procedures for multi-employer work sites
- A written program.

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3.0 RESPONSIBILITY MATRIX

3.1 **Procedure Responsibility.** The Corporate Director, Environmental Health and Safety is responsible for the issuance, revision, and maintenance of this procedure.

3.2 **Action/Approval Responsibilities.** The Responsibility Matrix is Attachment 1 in Section 8.0.

4.0 DEFINITIONS

Article. A manufactured item:

(1) Which is formed to a specific shape or design during manufacture;

(2) Which has end use function(s) dependent in whole or in part upon it shape or design during end use; and

(3) Which does not release, or otherwise result in exposure to, a hazardous substance under normal conditions of use or in a reasonably foreseeable emergency resulting from workplace operations.

Blasting Agent. Any material or mixture consisting of a fuel and oxidizer, intended for blasting not otherwise classified as an explosive, provided that the finished product, as mixed and packaged for shipment, cannot be detonated by means of a No. 8 test blasting cap when unconfined.

CAS number. The unique identification number assigned by the Chemical Abstracts Service to specific chemical substances.

Chemical name. The scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature, or a name which will clearly identify the substance for the purpose of conducting a hazard evaluation.

Combustible liquid. Any liquid having a flashpoint at or above 100°F (37.8°C), but below 200°F (93.3°C), except any mixture having components with flashpoints of 200°F (93.3°C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Common name. Any designation or identification such as code name, code number, trade name, brand name or generic name used to identify a substance other than by its chemical name.

Compressed gas. Compressed gas means:

(A) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C); or

(B) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or

(C) A liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72.

Container. Any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, tank truck, or the like that contains a hazardous substance. For purposes of this section, pipes or piping systems are not considered to be containers.

Designated representative. Any individual or organization to whom an employee gives written authorization to exercise such employee's rights under this section. A recognized or certified collective bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization.

Distributor. A business, other than a manufacturer or importer, which supplies hazardous substances to other distributors or to employers.

Emergency. Any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment, which may or does result in a release of a hazardous substance into the workplace.

Employee. Every person who is required or directed by any employer, to engage in any employment, or to go to work or be at any time in any place of employment.

Employer. Employer means EARTH TECH, Inc.

Explosive. A substance that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Exposure or Exposed. Any situation arising from work operation where an employee may ingest, inhale, absorb through the skin or eyes, or otherwise come into contract with a hazardous substance.

Flammable. A substance that falls into one of the following categories:

(A) **Aerosol, flammable.** An aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(B) **Gas, flammable.**

1. A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of thirteen (13) percent of volume or less; or

2. A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than twelve (12) percent by volume, regardless of the lower limit;

(C) **Liquid, flammable.** Any liquid having a flashpoint below 100°F (37.8 C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(D) **Solid, flammable.** A solid, other than a blasting agent or explosive as defined above, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint. The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(A) Tagliabue Closed Tester (see American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D56-79)) for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100°F (37.8°C), that do not have a tendency to form a surface film under test; or

(B) Pensky-Martens Closed Tester (see American National Standard Method of Test for Flash Point by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79)) for liquids with a viscosity equal to or greater than 45 SUS at 100°F (37.8°C), or that have a tendency to form a surface film under test; or

(C) Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazard warning. Any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form of warning which convey the health hazards and physical hazards of the substance(s) in the container(s).

Hazardous substance. Any substance which is a physical hazard or a health hazard.

Health hazard. A substance for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes substances which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendix A provides further definitions and explanations of the scope of health hazards covered by this section, and Appendix B describes the criteria to be used to determine whether or not a substance is to be considered hazardous for purposes of this standard.

Identity. Any chemical or common name which is indicated on the material safety data sheet (MSDS) for the substance. The identity used shall permit cross references to be made among the required list of hazardous substances, the label and the MSDS.

Immediate use. The hazardous substance will be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred.

Importer. The first business with employees within the Customs Territory of the United States which receives hazardous substances produced in other countries for the purpose of supplying them to distributors or purchasers within the United States.

Label. Any written, printed, or graphic material displayed on or affixed to containers of hazardous substances.

Manufacturer. A person who produces, synthesizes, extracts, or otherwise makes a hazardous substance.

Material safety data sheet (MSDS). Written or printed material concerning a hazardous substance which is prepared in accordance with section 29 CFR 1910.1200(g).

Mixture. Any solution or intimate admixture of two or more substances, at least one of which is present as a hazardous substance, which do not react chemically with each other.

MSDS means Material Safety Data Sheet, a presentation by the manufacturer of information about the product or commodity prepared in accordance with 29 CFR 1910.1200(g).

NIOSH. The National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services.

Organic peroxide. An organic compound that contains the bivalent-O-O-structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer. A substance other than a blasting agent or explosive as defined above, that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard. A substance for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

Produce. To manufacture, process, formulate, repackage, or relabel.

Pyrophoric. A substance that will ignite spontaneously in air at a temperature of 130°F (54.4°C) or below.

Responsible party. Someone who can provide additional information on the hazardous substance and appropriate emergency procedures, if necessary.

Specific chemical identity. The chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

Substance. Any element, chemical compound or mixture of elements and/or compounds.

Trade secret. Any confidential formula, pattern, process, device, information, or compilation of information which gives its user an opportunity to obtain a business advantage over competitors who do not know or use it. A trade secret shall not include chemical identity information which is readily discoverable through qualitative analysis. Appendix D sets out the criteria to be used in evaluating trade secrets.

Unstable (reactive). A substance which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Use. To package, handle, react, or transfer.

Visitor. Any person, including clients, subcontractors, and fellow EARTH TECH employees, who enter the work area, but are not regularly assigned to the work area.

Water-reactive. A substance that reacts with water to release a gas that is either flammable or presents a health hazard.

Work area. A room or defined space in a workplace where hazardous substances are produced or used, and where employees are present.

Workplace. Any place, and the premises appurtenant thereto, where employment is carried on.

5.0 PROCEDURE

5.1 Responsible Person

5.1.1 Business Unit Manager

Appoints a person, usually the Health and Safety Representative, to be responsible for implementing this Hazard Communication Procedure within the office/shop/lab.

5.1.2 Program Manager

Appoints a person within the program to be responsible for implementing this Hazard Communication Procedure within the program.

5.1.3 Project Manager

Appoints a person within the project, usually the Site Safety Officer, to be responsible for implementing this Hazard Communication Procedure on the project.

5.2 Inventory

5.2.1 Project Inventory

The Project Manager coordinates with the writer of the health and safety plan (HASP) to ensure the HASP contains a list of the hazardous substances (products and commodities) that will be used on the project. The inventory of hazardous substances lists each substance using an identity that is referenced on the appropriate material safety data sheet.

Project employees report to the Project Manager every hazardous material found at the project site which is not on the list of hazardous substances.

5.2.2 Office/Shop/Lab Inventory

The Responsible Person for each office/shop/lab prepares list of hazardous substances used in the office/shop/lab.

Office/shop/lab employees report to the Responsible Person every hazardous material found in the office/shop/lab which is not on the list of hazardous substances.

5.3 Material Safety Data Sheets

5.3.1 Project MSDS File

The Project Manager coordinates with the writer of the health and safety plan (HASP) to ensure the HASP contains a material safety data sheet (MSDS) for each hazardous substance listed.

5.3.2 Office/Shop/Lab MSDS File

The Responsible Person for each office/shop/lab maintains the MSDS file or binder. The Responsible Person requests an MSDS from suppliers and manufacturers to ensure that the MSDS file or binder has an MSDS for each hazardous substance on the inventory. A sample letter to request an MSDS is shown in Attachment 2.

5.3.3 New Information

Whenever a new or revised material safety data sheet is received, such information shall be provided to employees on a timely basis not to exceed 30 days after receipt, if the new information indicates significantly increased risks to, or measures necessary to protect, employee health as compared to those stated on a material safety data sheet previously provided.

5.4 Training

5.4.1 HAZWOPER Training

All HAZWOPER training, including the 40-hour initial training and the 8-hour annual refresher training, includes Hazard Communication training.

5.4.2 Accident Prevention Training

All accident prevention training, injury and illness prevention program training, and safety awareness training includes Hazard Communication training.

5.4.3 Hazard Communication Course Content

Hazard Communication training shall address the following topics:

(A) The elements and requirements of the OSHA hazard communication standard.

(B) Tasks and operations where hazardous substances are present.

(C) The location and availability of the written hazard communication program, including the list(s) of hazardous substances and material safety data sheets.

(D) The methods and observations that may be used to detect the presence or release of a hazardous substance, such as personal and area monitoring, continuous monitoring devices, visual appearance or odor of hazardous substances when being released, etc.

(E) The physical and health hazards of the substances in the work area, and the measures they can take to protect themselves from these hazards, including specific procedures implemented for the project or shop to protect employees from exposure to hazardous substances, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(F) The project or shop specific details of the hazard communication program, including an explanation of the labeling system and the material safety data sheet, and how employees can obtain and use the appropriate hazard information.

(G) Information regarding hazardous substances to which they may be exposed, according to the provisions of the OSHA hazard communication standard.

(H) Information for their physician or collective bargaining agent to receive regarding hazardous substances to which the employee may be exposed according to provisions of this section;

(I) Freedom from discharge or other discrimination due to the employee's exercise of the rights afforded pursuant to the provisions of the Hazardous Substances Information and Training Act.

5.5 Labels

5.5.1 User

Each user shall ensure that each container of hazardous substances in the workplace is labeled, tagged, or marked with the following information:

(A) Identity of the hazardous substance(s) contained therein; and

(B) Appropriate hazard warnings.

5.5.2 Receiving

Employees receiving shipments of hazardous substances shall not accept the shipment, but return it to the shipper, if the containers are not properly labeled with the following information:

(A) Identity of the hazardous substance(s);

(B) Appropriate hazard warnings; and

(C) Name and address of the manufacturer, importer, or other responsible party.

Exception to labeling requirement: For solid metal (such as a steel beam or a metal casting) that is not exempted as an article due to its downstream use, the required label may be transmitted to the customer at the time of the initial shipment, and need not be included with subsequent shipments to the same employer unless the information on the label changes. The label may be transmitted with the initial shipment itself, or with the material safety data sheet that is to be provided prior to or at the time of the first shipment. This exception to requiring labels on every container of hazardous substances is only for the solid metal itself and does not apply to hazardous substances use

conjunction with, or known to be present with, the metal and to which the employees handling the metal may be exposed (for example, cutting fluids or lubricants).

5.6 Trade Secrets

5.6.1 Non-Emergency Access to Trade Secret Information

Each Responsible Person who obtains a material safety data sheet which claims trade secret information forwards a copy of that MSDS to the Corporate Medical Director. The Corporate Medical Director will submit a written request to the supplier explaining the that the information is needed for the following reasons:

(A) To assess the hazards of the substances to which employees will be exposed;

(B) To guide appropriate sampling of the workplace atmosphere to determine employee exposure levels;

(C) To conduct pre-assignment or periodic medical surveillance of exposed employees;

(D) To provide medical treatment to exposed employees;

(E) To guide the selection of appropriate personal protective equipment for exposed employees;

(F) To guide the development of appropriate engineering controls or other protective measures for exposed employees; and,

(G) To conduct studies to determine the health effects of exposure.

The request includes an agreement to protect the confidentiality of the disclosed information with assurance that the trade secret information will not be used for any purpose other than the health needs asserted.

The Medical Director will provide such information as necessary to conduct an industrial hygiene evaluation of employee exposures to the cognizant EHS Professional. If this involves releasing trade secret information, the EHS Professional signs a nondisclosure agreement before receiving such information.

Employees working with materials protected by trade secret have access to the MSDS which does not have protected information.

5.6.2 Emergency Access to Trade Secret Information

Emergency access to trade secret information is provided through the Corporate Medical Director. Where a physician or nurse determines that a medical emergency exists and the specific chemical identity of a hazardous substance is necessary for

emergency or first-aid treatment, the Corporate Medical Director shall request the manufacturer, importer, or other supplier immediately disclose the specific chemical identity of a trade secret substance, regardless of the existence of a written statement of need or a confidentiality agreement. The manufacturer, importer, or other supplier may require a written statement of need and confidentiality agreement, in accordance with the provisions of OSHA's Hazard Communication standard as soon as circumstances permit.

5.7 Visitors

5.7.1 Escorted Visitors

Visitors to the work area who have not received a hazard communication briefing on the hazardous substances present in the work area must be escorted the entire time they are in the work area to ensure that they are not harmed by the hazardous substances.

5.7.2 Unescorted Visitors

The supervisor must ensure all visitors who enter the work area unescorted receive a hazard communication briefing before encountering any of the hazardous substances in the work area.

5.7.3 Multiemployer Worksites

In multi-employer workplaces, any employer bringing hazardous substances into the work area shall inform all the employers sharing the same work area of the hazardous substances to which their employees may be exposed while performing their work, and any suggestions for appropriate protective measures, and shall provide the following:

(A) Material safety data sheets

(B) Any precautionary measures that need to be taken to protect employees during the workplace's normal operating conditions and in foreseeable emergencies; and,

(C) The labeling system used in the workplace.

5.8 Written Program

5.8.1 Hazard Communication in Health and Safety Plans

Health and Safety Plans (HASP) written for HAZWOPER projects contain all the elements of the Hazard Communication Program. Material safety data sheets for hazardous substances which are brought to the project site are included in an appendix to the HASP. See HS209.

5.8.2 Hazard Communication in Injury and Illness Prevention Programs

The Injury and Illness Prevention Program (IIPP) contains all the elements of the Hazard Communication Program. The hazardous substance inventory and MSDS a

maintained in appendices to the IIPP. See HS201.

5.8.3 **Location Specific Hazard Communication Programs**
Each EARTH TECH location where hazardous substances are present that does not have a Hazard Communication Program provided by paragraph 5.8.1 or 5.8.2 above, shall develop a hazard communication in accordance with OSHA's hazard communication regulation, this procedure, and HS157 Location-Specific Work Rules. The location-specific hazard communication program must be in writing and contain all the elements of a hazard communication program as shown in paragraph 1.3.

6.0 EXCEPTION PROVISIONS

Variances to this procedure shall be requested in accordance with established variance procedures. See HS109.

7.0 CROSS REFERENCES

HS157 Location-Specific Work Rules
HS201 Injury and Illness Prevention Program
HS209 Health and Safety Plans

8.0 ATTACHMENTS

Attachment 1: Responsibility Matrix
Attachment 2: Sample Request Letter

RESPONSIBILITY MATRIX

Action	Procedure Section	Department/ Section Managers	Project Manager	Responsible Person	Regional/ Division EHS Manager	Corporate Medical Director	Corporate EHS Manager
Issuance, revision and maintenance of this procedure	3.1						X
Designate Responsible Person	5.1	X	X				
Develop and maintain inventory of hazardous substances	5.2		X	X			
Maintain MSDS file	5.3			X			
Provide training	5.4				X		
Ensure labels on containers	5.5	X	X	X	X		
Access trade secret information	5.6					X	
Protect visitors	5.7	X	X				

SAMPLE REQUEST LETTER

Date

Supplier/Manufacturer
Address
City, State Zip

Gentlemen:

OHSA's Hazard Communication regulation requires manufacturers and importers of hazardous substances to prepare and provide material safety data sheets (MSDS). The same regulation requires employers to have MSDS in their workplaces for all hazardous substances.

We currently purchase the following products from you:

1. _____

2. _____

etc.

Please send a completed MSDS for each of the above listed products, or a statement that the product is exempt from the OSHA Hazard Communication regulation.

Very truly yours,

EARTH TECH, Inc.

ATTACHMENT G

EARTH TECH HEALTH AND SAFETY POLICY HS601
MEDICAL SURVEILLANCE

EARTH TECH	PROCEDURE NO. HS601
	DATE November 3, 1995
STANDARD PROCEDURE	SUPERSEDES New
SUBJECT MEDICAL SURVEILLANCE	APPROVED Steven L. Scott

1.0 PURPOSE AND POLICY

1.1 Purpose

The medical surveillance program ensures that employees are physically fit to perform their assigned duties and that exposures to chemical and physical agents has not compromised their health. The medical surveillance program is designed to monitor the effectiveness of health and safety programs.

The medical surveillance program consists of baseline (initial), periodic (annual or biennial), special, exposure-specific examinations, and exit medical examinations. In addition to ensuring the fitness of workers for demanding assignments and tracking the effects of exposures, the medical surveillance program satisfies regulatory requirements.

1.2 Policy

It is the policy of EARTH TECH that each employee whose work assignments involves potential or actual exposure to harmful agents participate in a medical surveillance program.

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3.0 RESPONSIBILITY MATRIX

3.1 Procedure Responsibility. The Environmental Health and Safety Director is responsible for the issuance, revision, and maintenance of this procedure.

3.2 Action/Approval Responsibilities. The Responsibility Matrix is Attachment 1.

4.0 DEFINITIONS

Light Duty. Light Duty Work is defined as a temporary alternate job assignment other than the employee's normal duties, in response to physical activity restrictions established by an EARTH TECH contract physician or clinic.

Medical Director. The Medical Director is a physician, board certified in occupational medicine, employed by the Medical Services Contractor. The Medical Director manages the services provided by the Medical Services Contractor and provides guidance on medical matters to EARTH TECH.

Medical Services Contractor. The Medical Services Contractor manages all occupational medical services, including medical surveillance programs, substance abuse prevention programs, and care for workers with occupational injuries or illness.

Physical Activity Restriction. To prevent aggravation of an existing condition, the Medical Director recommends a physical activity restriction to limit exposure to a chemical or class of chemicals, such as hepatotoxins; a physical agent, such as temperatures above 26°C WBGT; or an activity, such as lifting in excess of 10 kg.

Safety-Critical. A task or position is designated as safety-critical when the task or position is such that malfeasance or incompetence would endanger the lives of others. Examples, but not a complete list, of positions that have been designated safety-critical by federal and state regulations are

- Drivers of commercial vehicles
- Workers on pipelines carrying fuels or toxic or corrosive substances
- Workers at nuclear power plants
- Operators of cranes of more than 6,000 pounds capacity
- Aircraft pilots

5.0 TEXT

5.1 Classes of Medical Examinations

5.1.1 Baseline/Preplacement/Preemployment

The baseline medical examination is used to identify physical capabilities and medical limitations that may have an impact on the candidate's ability to perform in the position for which he/she is being considered and to provide a baseline against which periodic or project-specific monitoring can be compared. The baseline medical examination is used to determine the suitability of an existing employee for a new assignment (preplacement) or a candidate's suitability to be hired (preemployment).

5.1.2 Periodic/Annual/Biennial

The periodic medical examination is used to evaluate an employee's continued fitness for duty and to assess any impact occupational exposures may have on his/her health status. The periodic examination includes an update to the medical and work history, results of any occupational exposure assessments, and a detailed medical examination tailored to the job description.

The Medical Director determines the frequency of the periodic medical examinations based on regulatory requirements, the position held by the employee, and the level of exposures to physical, chemical and biological agents.

5.1.3 Exposure/Activity/Project-Specific

The exposure-specific examination consists of specific medical tests to assess the impact of occupational exposures associated with a specific activity or project. The Medical Director will require an exposure-specific examination when he/she has reason to believe occupational exposures are impacting or may be impacting the health of an employee, or when he/she receives a recommendation from the Regional EHS Manager. Clients may recommend exposure-specific examinations for persons working on their projects. A client recommendation for an exposure-specific examination will be forwarded to the Regional EHS Manager who will evaluate the request, and if appropriate, forward the recommendation to the Medical Director. The Medical Director will determine the frequency of the exposure-specific medical examinations for each individual employee designated to participate based on sound medical practice and regulatory requirements.

5.1.4 Exit/Termination

An exit medical examination is given when an employee leaves the medical surveillance program, either because of termination of employment with EARTH TECH or because of reassignment to a position not designated to participate in the medical surveillance program. The exit examination assesses any impact occupational exposures may have on his/her health status.

5.2 Participating Employees

5.2.1 Required Participation

Participation in the medical surveillance program is required for employees who are or may be

- Exposed to substances at or above permissible exposure levels (PEL) for 30 or more days per year
- Required to wear a respirator for 30 or more days per year
- Exposed above PEL in accidents or emergency situations
- Working on sites covered by any of the following regulations:
  - 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response
  - 29 CFR 1926.65 Hazardous Waste Operations and Emergency Response
  - 29 CFR 1926.62 Lead
  - 29 CFR 1926.1101 Asbestos
  - 29 CFR 1926.1118 Inorganic Arsenic
  - 29 CFR 1926.1127 Cadmium
  - 29 CFR 1926.1128 Benzene
- Driving a commercial vehicle
- Performing safety-critical tasks

5.2.2 Directed Participation

The Medical Director or the Corporate EHS Director may designate other employees to participate in a medical surveillance program with the concurrence of the other.

5.2.3 Mandatory Participation

All employees designated to participate in the medical surveillance program are required to do so as a condition of employment. Only employees who fall within the above listed categories will be included in the medical surveillance program

5.3 Entry Into the Medical Surveillance Program

5.3.1 Manager

Each Manager evaluates the duties of each employee and prospective employee reporting to him/her. If the duties meets the criteria for required participation in the medical surveillance program (see Section 5.1), then the employee must be enrolled in the medical surveillance program.

Candidates for positions which require medical surveillance may not be hired until satisfactory completion of the baseline (pre-employment) medical examination.

The Manager is responsible for providing the Medical Services Contractor with the following:

- Description of the employee's duties
- Description of actual and potential exposures to chemical, physical, and biological agents and results of measurements when available
- Description of personal protective equipment used or which may be used
- Information from previous examinations which may not be readily available.

5.3.2 Employee

When designated to participate in the medical surveillance program, the employee completes and signs the following documents:

- Medical and Work History Questionnaire
- Medical Records release form for medical records from previous examinations
- Medical Records release authorizing EARTH TECH to receive the results of the examination.

5.3.3 Regional EHS Manager

The Regional EHS Manager reviews employee assignments with Managers in his/her region to ensure all employee who should be participating in the medical surveillance program have been enrolled. The Regional EHS Manager provides such assistance as may be required to ensure all required information is provided to the Medical Director.

5.3.4 Corporate EHS Director

To ensure the appropriate medical examination and tests, the Corporate EHS Director provides the Medical Services Contractor with the following references:

- A copy of the medical program
- A copy of each regulation requiring the examination, including:
  - 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response
  - 29 CFR 1926.65 Hazardous Waste Operations and Emergency Response
  - 29 CFR 1926.62 Lead
  - 29 CFR 1926.1101 Asbestos
  - 29 CFR 1926.1118 Inorganic Arsenic
  - 29 CFR 1926.1127 Cadmium
  - 29 CFR 1926.1128 Benzene
- Where appropriate, a copy of the corresponding state regulations

5.4 Scheduling Preemployment Medical Examination

5.4.1 Human Resources Representative

The Human Resources Representative coordinating the hire will provide the candidate with a baseline medical and work history questionnaire and determine from the candidate the geographical preference for the medical examination. The Human Resources Representative will contact the Medical Services Contractor to obtain the name, address, telephone number and contact person of the contract medical clinic which best suits the geographic preference of the candidate. The Human Resources Representative will coordinate the scheduling of the examination and ensure the scheduling information is provided to the Medical Services Contractor.

5.4.2 Hiring Manager

The hiring Manager informs the candidate that the offer of employment is contingent on the candidate being physically and medically capable of performing the duties of the position for which he/she is being hired. The Manager may not make the final offer until the medical examination is successfully completed and the medical clearance certificate has been received.

5.4.3. Regional EHS Manager

The Regional EHS Manager provides such assistance as is necessary to ensure the job description for the position being filled adequately describes the physical, chemical, and biological stresses of the position, and the PPE used or which may be used, including respiratory protection. The Regional EHS Manager provides

all necessary assistance to ensure that required and appropriate information is provided with the request and authorization for medical examination.

The Regional EHS Manager provides assistance to the hiring Manager to interpret physical activity restrictions if such restrictions are noted on the medical clearance certificate.

5.5 Scheduling Periodic and Exposure-Specific Medical Examinations

5.5.1 Medical Services Contractor

The Medical Services Contractor provides notification to the employee 60 to 30 days before the periodic or exposure-specific medical examination is due. This notification is in the form of a letter or fax to the office of record.

The Medical Services Contractor provides notification of delinquent medical examinations to the Manager, the Regional EHS Manager, and the Corporate EHS Director.

5.5.2 Manager

The Manager ensures the notification of examination due is forwarded to the employee in a timely way.

The Manager arranges the work assignment so that the employee is available to take the medical examination before the expiration of the medical clearance certificate.

The Manager removes the employee from the assignment if the employee has not completed the medical examination before the expiration of the medical clearance certificate.

5.5.3 Regional EHS Manager

The Regional EHS Manager ensures that all exposure assessments appropriate to the employee have been appropriately annotated to show the applicability to the employee and forwarded to the Medical Services Contractor.

The Regional EHS Manager ensures employees on delinquent medical examination list have been removed from designated assignments.

5.6 Scheduling Exit Medical Examinations

5.6.1 Human Resources Representative

Upon notification of termination or impending termination, the Human Resources Representative notifies the Medical Services Contractor to arrange for exit medical examination. The Human Resources Representative ensures terminating and reassigned employees who decline the opportunity to take an exit medical examination sign the waiver.

5.6.2 Manager

Upon notification of termination or reassignment, the Manager contacts the Human Resources Representative.

The Manager releases the terminating or reassigned employee from duties as necessary to complete the exit medical examination.

5.6.3 Regional EHS Manager

The Regional EHS Manager provides such assistance as needed to ensure terminating and reassigned employees are offered the opportunity to take an exit medical examination.

5.7 Medical Records

Medical records must be preserved and protected in accordance with 29 CFR 1910.20 for the duration of employment plus 30 years. Medical records contain information that is protected by the Privacy Act. To meet the obligations of preserving the medical records and protecting the information they contain, EARTH TECH has arranged for the Medical Services Contractor to manage the medical records.

5.7.1 Access to Records

An employee or designated representative may request to review his/her medical and exposure records. Such a request must be in writing, and signed and dated. The Regional EHS Manager will forward the request to the Medical Services Contractor who will provide the employee with a copy of the medical record.

The Medical Services Contractor will supply the copy within 15 days after the request has been submitted by the employee or designated representative. If the copy cannot be supplied within the allotted time, a request for extension will be submitted to the cognizant OSHA office.

5.7.2 Quality Control and Quality Assurance

The Medical Services Contractor performs quality control checks on all medical records to ensure examining physicians appropriately record the findings of the examination and tests.

The Corporate EHS Director has access to all medical records to perform quality assurance checks to ensure proper recording and preservation.

5.8 Reports

5.8.1 Report of Examination

The Medical Services Contractor provides the employee with a confidential report of findings of the examination and a medical clearance certificate. EARTH TECH recommends the employee preserve the medical clearance certificate in a safe place and carry copies of the medical clearance certificate to provide to project managers and clients.

The Medical Services Contractor provides Regional EHS Manager with a copy of the medical clearance certificate.

5.8.2 Examinations Due Report

The Medical Services Contractor produces a list by organization code of employees due to be examined 30 to 60 days before the expiration of their medical clearance certificate. This list is provided to Regional EHS Managers. The Regional EHS Manager ensures each Manager is notified of the employees in his/her charge due examinations so that he/she can schedule appropriately.

The Medical Services Contractor notifies each employee by letter or fax to the office of record 60 to 30 days before the periodic or exposure-specific medical examination is due.

5.8.3 Delinquent Examinations Report

The Medical Services Contractor distributes a report of delinquent medical examinations to the Manager, the Regional EHS Manager, and the Corporate EHS Director.

When an employee's name appears on the delinquent examination report for two consecutive months, the Corporate EHS Director in coordination with the Regional EHS Manager brings this to the attention of the Division Vice President for resolution.

5.8.4. Physical Activity Restriction Report

The Regional EHS Manager maintains a list of employees with physical activity restrictions. The Regional EHS Manager provides each Manager and Project/Location EHS Representative in his/her region with a list of the employees with physical activity restrictions assigned to to their project/location.

The Regional EHS Manager audits locations and projects from time to time to ensure employees with physical activity restrictions are not exceeding their limitations. Evidence of an employee exceeding his/her physical activity restriction is brought to the attention of the Department Manager and the employee's Manager/Supervisor for resolution.

5.8.5 Annual Reports

The Medical Services Contractor provides annual reports of utilization, medical trends, and statistical analyses. These reports are prepared to improve the service, reverse unfavorable trends, and reduce the cost of the medical surveillance program.

5.9 Cost Accounting

The Medical Services Contractor submits invoices directly to Corporate Accounts Payable. Each examination and service provided is coded with the organization code of the employee examined or receiving the service. The cost of medical surveillance is borne by the organizations with employees participating in the program.

6.0 EXCEPTION PROVISIONS

None permitted.

If an office elects not to use the Medical Services Contractor, the examination will be repeated by the Medical Services Contractor at additional cost to the organization.

7.0 CROSS REFERENCE

HS603 Occupational Injury and Illness

8.0 ATTACHMENTS

Attachment 1: Responsibility Matrix
Attachment 2: Medical Services Contractor
Attachment 3: Form HSF601-F1 Authorization For Medical Examination
Attachment 4: Form HSF601-F2 Notification of Physical Activity Restriction

RESPONSIBILITY MATRIX

Action	Procedure Section	Employee	Manager	Project/ Location EHS Rep	Regional/ Division EHS Manager	Corporate EHS Manager
Determining applicability of medical surveillance program	5.3.1		X			
Enrolling in medical surveillance program	5.3	X	X		X	
Scheduling initial examination	5.4		X			
Scheduling periodic examinations	5.5	X				
Scheduling exit examination	5.6		X			
Responding to delinquent examinations	5.8.3	X	X		X	X
Advise Operations about *Physical Activity Restriction*	5.3.3			X	X	

MEDICAL SERVICES CONTRACTOR

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Atlanta, Georgia 30341

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FAX (404) 457-1429

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Staff Accountant

Sherie Dunagan
Staff Accountant

EMR — Medical Management Solutions Through Information Technology

EARTH TECH

AUTHORIZATION FOR MEDICAL EXAMINATION

To be faxed to EMR at least 48-hours prior to exam

Part I - Site Information

Program Coordinator requesting exam: _____

Coordinator's phone #: _____ FAX #: _____

Location (city/state): _____ EMR Site Code: _____

Earth Tech Organizational Code: _____

Part II - Medical Evaluation Required

- ☐ Pre-placement
- ☐ EKG
- ☐ Drug Screen ONLY this visit (EMR Collection Kit)
- ☐ Drug Screen in addition to exam at this visit
- ☐ Examinee requires or will require DOT Certification
- ☐ Additional testing required this visit _____
- ☐ Employee
- ☐ Chest X-ray
- ☐ Non-Nida Drug Screen
- ☐ NIDA Split Specimen Drug Screen
- ☐ Random NIDA Split Specimen Drug Screen (11D1)
- ☐ RUSH
- ☐ Tetanus
- ☐ Breath Alcohol

Type of Exam Requested		Type of Exam Requested	
Field	☐ Baseline (15F) ☐ Annual (26F) ☐ Exit (35Fe)	Combo Field/Asbestos	☐ Baseline (15H) ☐ Annual (26H) ☐ Exit (35He)
Field/DOT	☐ Baseline (15D) ☐ Annual (26D) ☐ Exit (35De)	Field Biennial	☐ Baseline (15B) ☐ Biennial (26B) ☐ Exit (35Be)

Part III - Facility Scheduling Information

Name of Facility to be used: _____

Location of Facility _____

Date of Exam: _____ Facility A#: _____

Part IV - Examinee Information

Name (print): _____ ☐ Male ☐ Female

Social Security #: _____ Date of Birth: _____

Home Address: _____
Street Address

_____
City State Zip

I authorize the release of any medical information necessary to determine my medical or physical condition concerning my application for employment, or ongoing employment, with this company. I further authorize EMR to release the results of this medical information to the designated individual at this company.

_____
Examinee's Signature Date

Fax this Authorization Form to EMR at (770) 455-0814

Questions? Call EMR at (800) 229-3674

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EARTH TECH

NOTIFICATION OF PHYSICAL ACTIVITY RESTRICTION

Employee Name	Employee SS No.	
Job Title	Dept/Sect.	Location

TO MANAGER/SUPERVISOR _____:

- ***Physical Activity Restriction***
  The employee identified above has a medical condition for which the limitations described below are prescribed. Please ensure his/her work assignments are consistent with the limitation. If the limitations are inconsistent with his/her normal duties, please find a light duty work assignment.

  - ☐ No reaching above shoulder
  - ☐ No pushing or pulling
  - ☐ No climbing of stairs or ladders
  - ☐ No operating or working around moving machinery/driving
  - ☐ No lifting over _____ pounds
  - ☐ No repetitive waist bending
  - ☐ No kneeling or squatting
  - ☐ No exposure to hepatotoxic chemicals
  - ☐ No exposure to extreme cold or extreme heat
  - ☐ _____

  _____

  _____

  Duration of Physical Activity Restriction: _____

- ***Light Duty Work***
  If the employee is unable to perform his/her normal duties with the above physical activity restriction, please notify the Regional Environmental Health and Safety Manager. EARTH TECH provides light duty work assignments whenever possible for employees with physical activity restrictions.

- ***Medically Unable to Work***
  If the employee is unable to be placed in any assignment consistent with his/her physical activity restrictions as described above, please notify the Regional Environmental Health and Safety Manager. EARTH TECH assists employees unable to work due to injury or illness in obtaining needed medical care and other benefits available to them.

  Regional EHS Manager: _____ Phone: _____

CURRENT EMPLOYEE LISTING

Name (Last, First)	Date of Birth	Social Security Number	Exposure Category	Loc. Code	Org. Code	Date of Last Medical Exam

Exposure Categories

Field (HAZWOPER)
Combo (Field & Asbestos)
Field & Lead
Field & DOT (Commercial Drivers License)

EHS CONTACT LISTING

Loc. Code	Org. Code	Address	Telephone	Facsimile	Primary Contact	Secondary Contact

APPENDIX E

CALIFORNIA STATE PRELIMINARY REMEDIAL GOALS

California State Preliminary Remedial Goals

~~For Planning Purposes~~

Key: i=IRIS h=HEAST n=NCEA x=WITHDRAWN r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

TOXICITY INFORMATION												CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No.			Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
8.7E-03	i	4.0E-03	i	8.7E-03	r	4.0E-03	r	0	0.10	30560-19-1		Acephate	5.1E+01	ca**	2.2E+02	ca*	7.7E-01	ca*	7.7E+00	ca*		
7.7E-03	r	2.6E-03	r	7.7E-03	i	2.6E-03	i	1	0.10	75-07-0		**Acetaldehyde**	9.2E+00	ca**	2.1E+01	ca**	8.7E-01	ca*	1.5E+00	ca*		
		2.0E-02	i			2.0E-02	r	0	0.10	34256-82-1		Acetochlor	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.0E-01	i			1.0E-01	r	1	0.10	67-64-1		Acetone	2.1E+03	nc	8.8E+03	nc	3.7E+02	nc	6.1E+02	nc	1.6E+01	8.0E-01
		6.0E-04	h			2.9E-03	x	0	0.10	75-86-5		Acetone cyanohydrin	5.2E+01	nc	5.5E+02	nc	1.0E+01	nc	2.9E+01	nc		
		6.0E-03	i			1.4E-02	h	1	0.10	75-05-8		**Acetonitrile**	2.2E+02	nc	1.2E+03	nc	5.2E+01	nc	7.1E+01	nc		
		1.0E-01	i			5.7E-06	x	1	0.10	98-86-2		**Acetophenone**	4.9E-01	nc	1.6E+00	nc	2.1E-02	nc	4.2E-02	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	50594-66-6		Acifluorfen	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
		2.0E-02	h			5.7E-06	i	1	0.10	107-02-8		**Acrolein**	1.0E-01	nc	3.4E-01	nc	2.1E-02	nc	4.2E-02	nc		
4.6E+00	i	2.0E-04	i	4.6E+00	i	2.0E-04	r	0	0.10	79-06-1		Acrylamide	9.8E-02	ca*	4.2E-01	ca	1.5E-03	ca	1.5E-02	ca		
		5.0E-01	i			2.9E-04	i	0	0.10	79-10-7		**Acrylic acid**	3.1E+04	nc	2.9E+05	nc	1.0E+00	nc	1.8E+04	nc		
5.4E-01	i	1.0E-03	h	2.4E-01	i	5.7E-04	i	1	0.10	107-13-1		Acrylonitrile	1.9E-01	ca*	4.7E-01	ca*	2.8E-02	ca*	3.7E+00	ca*		
8.1E-02	h	1.0E-02	i	8.0E-02	r	1.0E-02	r	0	0.10	15972-60-8		Alachlor	5.5E+00	ca*	2.4E+01	ca	8.4E-02	ca	8.4E-01	ca		
		1.5E-01	i			1.5E-01	r	0	0.10	1596-84-5		Alar	9.8E+03	nc	1.0E+05	nc	5.5E+02	nc	5.5E+03	nc		
		1.0E-03	i			1.0E-03	r	0	0.10	116-06-3		Aldicarb	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		1.0E-03	i			1.0E-03	r	0	0.10	1646-88-4		Aldicarb sulfone	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
1.7E+01	i	3.0E-05	i	1.7E+01	i	3.0E-05	r	0	0.10	309-00-2		Aldrin	2.6E-02	ca*	1.1E-01	ca	3.9E-04	ca	4.0E-03	ca	1.2E+04	5.9E+02
		2.5E-01	i			2.5E-01	r	0	0.10	5585-64-8		Ally	1.6E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		5.0E-03	x			5.0E-03	r	0	0.10	107-18-6		Allyl alcohol	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		5.0E-02	h			2.9E-04	i	0	0.10	107-05-1		Allyl chloride	3.2E+03	nc	3.3E+04	nc	1.0E+00	nc	1.8E+03	nc		
		1.0E+00	n					0	0.01	7429-90-5		Aluminum	7.7E+04	nc	1.0E+05	max			3.7E+04	nc		
		4.0E-04	i					0	0.01	20859-73-8		Aluminum phosphide	3.1E+01	nc	6.8E+02	nc			1.5E+01	nc		
		3.0E-04	i			3.0E-04	r	0	0.10	67485-29-4		Amdro	2.0E+01	nc	2.0E+02	nc	1.1E+00	nc	1.1E+01	nc		
		9.0E-03	i			9.0E-03	r	0	0.10	834-12-8		Ametryn	5.9E+02	nc	6.1E+03	nc	3.3E+01	nc	3.3E+02	nc		
		7.0E-02	h			7.0E-02	r	0	0.10	591-27-5		m-Aminophenol	4.6E+03	nc	4.8E+04	nc	2.6E+02	nc	2.6E+03	nc		
		2.0E-05	h			2.0E-05	r	0	0.10	504-24-5		4-Aminopyridine	1.3E+00	nc	1.4E+01	nc	7.3E-02	nc	7.3E-01	nc		
		2.5E-03	i			2.5E-03	r	0	0.10	33089-61-1		Amitraz	1.6E+02	nc	1.7E+03	nc	9.1E+00	nc	9.1E+01	nc		
						2.9E-02	i	n/a	n/a	7664-41-7		Ammonia					1.0E+02	nc				
		2.0E-01	i					0	0.10	7773-06-0		Ammonium sulfamate	1.3E+04	nc	1.0E+05	max			7.3E+03	nc		
5.7E-03	i	2.9E-04	r	5.7E-03	r	2.9E-04	i	0	0.10	62-53-3		Aniline	1.9E+01	nc	2.0E+02	nc	1.0E+00	nc	1.1E+01	nc		
		4.0E-04	i					0	0.01	7440-36-0		Antimony and compounds	3.1E+01	nc	6.8E+02	nc			1.5E+01	nc	5.0E+00	3.0E-01
		5.0E-04	h					0	0.01	1314-60-9		Antimony pentoxide	3.8E+01	nc	8.5E+02	nc			1.8E+01	nc		
		9.0E-04	h					0	0.01	28300-74-5		Antimony potassium tartrate	6.9E+01	nc	1.5E+03	nc			3.3E+01	nc		
		4.0E-04	h					0	0.01	1332-81-6		Antimony tetroxide	3.1E+01	nc	6.8E+02	nc			1.5E+01	nc		
		4.0E-04	h					0	0.01	1309-64-4		Antimony trioxide	3.1E+01	nc	6.8E+02	nc			1.5E+01	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	74115-24-5		Apollo	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
2.5E-02	i	5.0E-02	h	2.5E-02	i	5.0E-02	r	0	0.10	140-57-8		Aramite	1.8E+01	ca*	7.6E+01	ca	2.7E-01	ca	2.7E+00	ca		
		3.0E-04	i					0	0.03	7440-38-2		Arsenic (noncancer endpoint)	2.2E+01	nc								
1.5E+00	i	3.0E-04	i	1.5E+01	i			0	0.03	7440-38-2		Arsenic (cancer endpoint)	3.8E-01	ca*	2.4E+00	ca	4.5E-04	ca	4.5E-02	ca	2.9E+01	1.0E+00
						1.4E-05	i	n/a	n/a	7784-42-1		Arsine					5.2E-02	nc				
		9.0E-03	i			9.0E-03	r	0	0.10	76578-12-6		Assure	5.9E+02	nc	6.1E+03	nc	3.3E+01	nc	3.3E+02	nc		
		5.0E-02	i			5.0E-02	r	0	0.10	3337-71-1		Asulam	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
2.2E-01	h	3.5E-02	h	2.2E-01	r	3.5E-02	h	0	0.10	1912-24-9		Atrazine	2.0E+00	ca	8.6E+00	ca	3.1E-02	ca	3.0E-01	ca		
		4.0E-04	i			4.0E-04	r	0	0.10	71751-41-2		Avermectin B1	2.6E+01	nc	2.7E+02	nc	1.5E+00	nc	1.5E+01	nc		

California State Preliminary Remedial Goals
For Planning Purposes

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TOXICITY INFORMATION												CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.			Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
1.1E-01	i			1.1E-01	i			0	0.10	103-33-3		Azobenzene	4.0E+00	ca	1.7E+01	ca	6.2E-02	ca	6.1E-01	ca		
		7.0E-02	i			1.4E-04	h	0	0.01	7440-39-3		Barium and compounds	5.3E+03	nc	1.0E+05	max	5.2E-01	nc	2.6E+03	nc	1.6E+03	8.2E+01
		4.0E-03	i			4.0E-03	r	0	0.10	114-26-1		Baygon	2.6E+02	nc	2.7E+03	nc	1.5E+01	nc	1.5E+02	nc		
		3.0E-02	i			3.0E-02	r	0	0.10	43121-43-3		Bayleton	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	68359-37-5		Baythroid	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
		3.0E-01	i			3.0E-01	r	0	0.10	1861-40-1		Benefin	2.0E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		5.0E-02	i			5.0E-02	r	0	0.10	17804-35-2		Benomyl	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		2.5E-03	i			2.5E-03	r	0	0.10	25057-89-0		Bentazon	1.6E+02	nc	1.7E+03	nc	9.1E+00	nc	9.1E+01	nc		
		1.0E-01	i			1.0E-01	r	0	0.10	100-52-7		Benzaldehyde	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc		
2.9E-02	i	1.7E-03	r	2.9E-02	i	1.7E-03	n	1	0.10	71-43-2		Benzene	6.3E-01	ca*	1.4E+00	ca*	2.3E-01	ca*	3.9E-01	ca*	3.0E-02	2.0E-03
2.3E+02	i	3.0E-03	i	2.3E+02	i	3.0E-03	r	0	0.10	92-87-5		Benzidine	1.9E-03	ca	8.3E-03	ca	2.9E-05	ca	2.9E-04	ca		
		4.0E+00	i			4.0E+00	i	0	0.10	65-85-0		Benzoic acid	1.0E+05	max	1.0E+05	max	1.5E+04	nc	1.5E+05	nc	4.0E+02	2.0E+01
1.3E+01	i			1.3E+01	r			0	0.10	98-07-7		Benzotrichloride	3.4E-02	ca	1.5E-01	ca	5.2E-04	ca	5.2E-03	ca		
		3.0E-01	h			3.0E-01	r	0	0.10	100-51-6		Benzyl alcohol	2.0E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
1.7E-01	i			1.7E-01	r			1	0.10	100-44-7		Benzyl chloride	8.1E-01	ca	2.0E+00	ca	4.0E-02	ca	6.6E-02	ca		
4.3E+00	i	5.0E-03	i	8.4E+00	i			0	0.01	7440-41-7		Beryllium and compounds	1.4E-01	ca	1.1E+00	ca	8.0E-04	ca	1.6E-02	ca	6.3E+01	3.0E+00
		1.0E-04	i			1.0E-04	r	0	0.10	141-66-2		Bidrin	6.5E+00	nc	6.8E+01	nc	3.7E-01	nc	3.7E+00	nc		
		1.5E-02	i			1.5E-02	r	0	0.10	82657-04-3		Biphenthrin (Talstar)	9.8E+02	nc	1.0E+04	nc	5.5E+01	nc	5.5E+02	nc		
		5.0E-02	i			5.0E-02	r	1	0.10	92-52-4		**1,1-Biphenyl**	3.5E+02	sat	3.5E+02	sat	1.8E+02	nc	3.0E+02	nc		
1.1E+00	i			1.2E+00	i			1	0.10	111-44-4		Bis(2-chloroethyl)ether	4.3E-02	ca	9.7E-02	ca	5.8E-03	ca	9.8E-03	ca	4.0E-04	2.0E-05
7.0E-02	h	4.0E-02	i	3.5E-02	h	4.0E-02	r	1	0.10	39638-32-9		Bis(2-chloroisopropyl)ether	2.5E+00	ca	6.7E+00	ca	1.9E-01	ca	2.7E-01	ca		
2.2E+02	i			2.2E+02	i			1	0.10	542-86-1		Bis(chloromethyl)ether	1.9E-04	ca	4.2E-04	ca	3.1E-05	ca	5.2E-05	ca		
7.0E-02	x			7.0E-02	x			0	0.10	108-60-1		Bis(2-chloro-1-methylethyl)ether	6.3E+00	ca	2.7E+01	ca	9.6E-02	ca	9.6E-01	ca		
1.4E-02	i	2.0E-02	i	1.4E-02	r	2.2E-02	r	0	0.10	117-81-7		Bis(2-ethylhexyl)phthalate (DEHP)	3.2E+01	ca*	1.4E+02	ca	4.8E-01	ca	4.8E+00	ca		
		5.0E-02	i			5.0E-02	r	0	0.10	80-05-7		Bisphenol A	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		9.0E-02	i			5.7E-03	h	0	0.10	7440-42-8		Boron	5.9E+03	nc	6.1E+04	nc	2.1E+01	nc	3.3E+03	nc		
						2.0E-04	h	0	0.10	7637-07-2		Boron trifluoride					7.3E-01	nc				
6.2E-02	i	2.0E-02	i	6.2E-02	r	2.0E-02	r	1	0.10	75-27-4		Bromodichloromethane	6.3E-01	ca	1.4E+00	ca	1.1E-01	ca	1.8E-01	ca	6.0E-01	3.0E-02
7.9E-03	i	2.0E-02	i	3.9E-03	i	2.0E-02	r	0	0.10	75-25-2		Bromoform (tribromomethane)	5.6E+01	ca**	2.4E+02	ca*	1.7E+00	ca*	8.5E+00	ca*	8.0E-01	4.0E-02
		1.4E-03	i			1.4E-03	i	1	0.10	74-83-9		Bromomethane	6.8E+00	nc	2.3E+01	nc	5.2E+00	nc	8.7E+00	nc	2.0E-01	1.0E-02
								0	0.10	101-55-3		4-Bromophenyl phenyl ether										
		5.0E-03	h			5.0E-03	r	0	0.10	2104-96-3		Bromophos	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	1689-84-5		Bromoxynil	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	1.8E+02	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	1689-99-2		Bromoxynil octanoate	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
9.8E-01	r			9.8E-01	i			1	0.10	106-99-0		1,3-Butadiene	6.5E-03	ca	1.4E-02	ca	6.9E-03	ca	1.1E-02	ca		
		1.0E-01	i			1.0E-01	r	0	0.10	71-36-3		1-Butanol	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc	1.7E+01	9.0E-01
		5.0E-02	i			5.0E-02	r	0	0.10	2008-41-5		Butylate	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		2.0E-01	i			2.0E-01	r	0	0.10	85-68-7		Butyl benzyl phthalate	9.3E+02	sat	9.3E+02	sat	7.3E+02	nc	7.3E+03	nc	9.3E+02	8.1E+02
		1.0E+00	i			1.0E+00	r	0	0.10	85-70-1		Butylphthalyl butylglycolate	6.5E+04	nc	1.0E+05	max	3.7E+03	nc	3.7E+04	nc		
		3.0E-03	h			3.0E-03	r	0	0.10	75-60-5		Cacodylic acid	2.0E+02	nc	2.0E+03	nc	1.1E+01	nc	1.1E+02	nc		
		5.0E-04	i	6.3E+00	i	5.7E-05	x	0	0.01	7440-43-9		Cadmium and compounds	3.8E+01	nc	8.5E+02	nc	1.1E-03	ca	1.8E+01	nc	8.0E+00	4.0E-01
												"CAL-Modified PRG" (PEA, 1994)	**9.0E+00**									
		5.0E-01	i			5.0E-01	r	0	0.10	105-60-2		Caprolactam	3.3E+04	nc	1.0E+05	max	1.8E+03	nc	1.8E+04	nc		
8.6E-03	h	2.0E-03	i	8.6E-03	i	2.0E-03	r	0	0.10	2425-06-1		Captafol	5.2E+01	ca**	2.2E+02	ca*	7.8E-01	ca*	7.8E+00	ca*		

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TOXICITY INFORMATION												CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No.			Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
3.5E-03	h	1.3E-01	i	3.5E-03	r	1.3E-01	r	0	0.10	133-06-2		Captan	1.3E+02	ca*	5.5E+02	ca	1.9E+00	ca	1.9E+01	ca		
		1.0E-01	i			1.1E-01	r	0	0.10	63-25-2		Carbaryl	6.5E+03	nc	6.8E+04	nc	4.0E+02	nc	3.7E+03	nc		
2.0E-02	h			2.0E-02	r			0	0.10	86-74-8		Carbazole	2.2E+01	ca	9.5E+01	ca	3.4E-01	ca	3.4E+00	ca	6.0E-01	3.0E-02
		5.0E-03	i			5.0E-03	r	0	0.10	1563-66-2		Carbofuran	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		1.0E-01	i			2.9E-03	h	1	0.10	75-15-0		Carbon disulfide	7.5E+00	nc	2.4E+01	nc	1.0E+01	nc	2.1E+01	nc	3.2E+01	2.0E+00
1.3E-01	i	7.0E-04	i	5.3E-02	i	5.7E-04	n	1	0.10	56-23-5		Carbon tetrachloride	2.3E-01	ca*	5.0E-01	ca*	1.3E-01	ca*	1.7E-01	ca*	7.0E-02	3.0E-03
		1.0E-02	i			1.0E-02	r	0	0.10	55285-14-8		Carbosulfan	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		1.0E-01	i			1.0E-01	r	0	0.10	5234-68-4		Carboxin	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc		
		2.0E-03	i			2.0E-03	r	0	0.10	302-17-0		Chloral	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.5E-02	i			1.5E-02	r	0	0.10	133-90-4		Chloramben	9.8E+02	nc	1.0E+04	nc	5.5E+01	nc	5.5E+02	nc		
4.0E-01	h			4.0E-01	r			0	0.10	118-75-2		Chloranil	1.1E+00	ca	4.7E+00	ca	1.7E-02	ca	1.7E-01	ca		
1.3E+00	i	6.0E-05	i	1.3E+00	i	6.0E-05	r	0	0.10	57-74-9		Chlordane	3.4E-01	ca**	1.5E+00	ca*	5.2E-03	ca*	5.2E-02	ca*	1.0E+01	5.0E-01
		2.0E-02	i			2.0E-02	r	0	0.10	90982-32-4		Chlorimuron-ethyl	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.0E-01	i					0	0.01	7782-50-5		Chlorine	7.7E+03	nc	1.7E+05	nc			3.7E+03	nc		
						5.7E-05	i	n/a	n/a	10049-04-4		Chlorine dioxide					2.1E-01	nc				
								1	0.10	107-20-0		Chloroacetaldehyde										
		2.0E-03	h			2.0E-03	r	0	0.10	79-11-8		Chloroacetic acid	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		8.6E-06	r			8.6E-06	i	1	0.10	532-27-4		2-Chloroacetophenone	3.2E-02	nc	1.1E-01	nc	3.1E-02	nc	5.2E-02	nc		
		4.0E-03	i			4.0E-03	r	0	0.10	106-47-8		4-Chloroaniline	2.6E+02	nc	2.7E+03	nc	1.5E+01	nc	1.5E+02	nc	7.0E-01	3.0E-02
		2.0E-02	i			5.7E-03	h	1	0.10	108-90-7		Chlorobenzene	6.5E+01	nc	2.2E+02	nc	2.1E+01	nc	3.9E+01	nc	1.0E+00	7.0E-02
2.7E-01	h	2.0E-02	i	2.7E-01	h	2.0E-02	r	0	0.10	510-15-6		Chlorobenzilate	1.6E+00	ca	7.1E+00	ca	2.5E-02	ca	2.5E-01	ca		
		2.0E-01	h			2.0E-01	r	0	0.10	74-11-3		p-Chlorobenzoic acid	1.3E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		2.0E-02	h			2.0E-02	r	0	0.10	98-56-6		4-Chlorobenzotrifluoride	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-02	h			2.0E-03	h	1	0.10	126-99-8		2-Chloro-1,3-butadiene	3.6E+00	nc	1.2E+01	nc	7.3E+00	nc	1.4E+01	nc		
		4.0E-01	h			4.0E-01	r	1	0.10	109-69-3		1-Chlorobutane	4.8E+02	sat	4.8E+02	sat	1.5E+03	nc	2.4E+03	nc		
		1.4E+01	r			1.4E+01	i	1	0.10	75-68-3		1-Chloro-1,1-difluoroethane (HCFC-142b)	3.4E+02	sat	3.4E+02	sat	5.2E+04	nc	8.7E+04	nc		
								1	0.10	110-75-8		2-Chloroethyl vinyl ether										
		1.4E+01	r			1.4E+01	i	1	0.10	75-45-6		Chlorodifluoromethane	3.4E+02	sat	3.4E+02	sat	5.1E+04	nc	8.5E+04	nc		
6.1E-03	i	1.0E-02	i	8.1E-02	i	1.0E-02	r	1	0.10	67-66-3		Chloroform	2.5E-01	ca	5.3E-01	ca	8.4E-02	ca	1.6E-01	ca	6.0E-01	3.0E-02
1.3E-02	h			6.3E-03	h			1	0.10	74-87-3		Chloromethane	1.2E+00	ca	2.6E+00	ca	1.1E+00	ca	1.5E+00	ca		
5.8E-01	h			5.8E-01	r			0	0.10	95-69-2		4-Chloro-2-methylaniline	7.7E-01	ca	3.3E+00	ca	1.2E-02	ca	1.2E-01	ca		
4.8E-01	h			4.6E-01	r			0	0.10	3165-93-3		4-Chloro-2-methylaniline hydrochloride	9.7E-01	ca	4.1E+00	ca	1.5E-02	ca	1.5E-01	ca		
		8.0E-02	i			8.0E-02	r	1	0.10	91-58-7		**beta-Chloronaphthalene**	1.1E+02	sat	1.1E+02	sat	2.9E+02	nc	4.9E+02	nc		
2.5E-02	h			2.5E-02	r		r	0	0.10	88-73-3		o-Chloronitrobenzene	1.8E+01	ca	7.6E+01	ca	2.7E-01	ca	2.7E+00	ca		
1.6E-02	h			1.6E-02	r		r	0	0.10	100-00-5		p-Chloronitrobenzene	2.5E+01	ca	1.1E+02	ca	3.7E-01	ca	3.7E+00	ca		
		5.0E-03	i			5.0E-03	r	1	0.10	95-57-8		**2-Chlorophenol**	9.1E+01	nc	3.7E+02	nc	1.8E+01	nc	3.8E+01	nc	4.0E+00	2.0E-01
		2.9E-02	r			2.9E-02	h	1	0.10	75-29-6		2-Chloropropane	1.7E+02	nc	5.8E+02	nc	1.0E+02	nc	1.7E+02	nc		
1.1E-02	h	1.5E-02	i	1.1E-02	r	1.5E-02	r	0	0.10	1897-45-6		Chlorothalonil	4.0E+01	ca**	1.7E+02	ca*	6.1E-01	ca*	6.1E+00	ca*		
		2.0E-02	i			2.0E-02	r	1	0.10	95-49-8		o-Chlorotoluene	1.6E+02	nc	5.5E+02	nc	7.3E+01	nc	1.2E+02	nc		
		2.0E-01	i			2.0E-01	r	0	0.10	101-21-3		Chlorpropham	1.3E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		3.0E-03	i			3.0E-03	r	0	0.10	2921-88-2		Chlorpyrifos	2.0E+02	nc	2.0E+03	nc	1.1E+01	nc	1.1E+02	nc		
		1.0E-02	h			1.0E-02	r	0	0.10	5598-13-0		Chlorpyrifos-methyl	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		5.0E-02	i			5.0E-02	r	0	0.10	64902-72-3		Chlorsulfuron	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		8.0E-04	h			8.0E-04	r	0	0.10	602-38-56-4		Chlorthiophos	5.2E+01	nc	5.5E+02	nc	2.9E+00	nc	2.9E+01	nc		

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TOXICITY INFORMATION														CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
				4.2E+01	i			0	0.01	n/a		Total Chromium (1/6 ratio Cr VI/Cr III)	2.1E+02	ca	4.5E+02	ca	1.6E-04	ca			3.8E+01	2.0E+00
		5.0E-03	i	2.9E+02	i			0	0.01	7440-47-3		Chromium VI	3.0E+01	ca	6.4E+01	ca	2.3E-05	ca	1.8E+02	nc	3.8E+01	2.0E+00
												"CAL-Modified PRG" (PEA, 1994)	**2.0E-01**						**1.6E-01**			
		6.0E-02	n			2.9E-04	n	0	0.01	7440-48-4		Cobalt	4.6E+03	nc	9.7E+04	nc	1.0E+00	nc	2.2E+03	nc		
				2.2E+00	i			0	0.01	8007-45-2		Coke Oven Emissions					3.1E-03	ca				
		3.7E-02	h					0	0.01	7440-50-8		Copper and compounds	2.8E+03	nc	6.3E+04	nc			1.4E+03	nc		
1.9E+00	h	1.0E-02	x	1.9E+00	x	1.0E-02	r	1	0.10	123-73-9		Crotonaldehyde	5.3E-03	ca	1.1E-02	ca	3.5E-03	ca	5.9E-03	ca		
		4.0E-02	i			2.6E-03	h	1	0.10	98-82-8		Cumene	1.9E+01	nc	6.2E+01	nc	9.4E+00	nc	1.9E+01	nc		
8.4E-01	h	2.0E-03	h	8.4E-01	r	2.0E-03	r	0	0.10	21725-46-2		Cyanazine	5.3E-01	ca*	2.3E+00	ca	8.0E-03	ca	8.0E-02	ca		
									0.01	n/a		Cyanides										
		1.0E-01	h					0	0.01	542-62-1		Barium cyanide	7.7E+03	nc	1.0E+05	max			3.7E+03	nc		
		4.0E-02	i					0	0.01	592-01-8		Calcium cyanide	3.1E+03	nc	6.8E+04	nc			1.5E+03	nc		
		5.0E-02	i					0	0.01	506-77-4		**Chlorine cyanide**	3.8E+03	nc	8.5E+04	nc			1.8E+03	nc		
		5.0E-03	i					0	0.01	544-92-3		Copper cyanide	3.8E+02	nc	8.5E+03	nc			1.8E+02	nc		
		4.0E-02	i					0	0.10	460-19-5		Cyanogen	2.6E+03	nc	2.7E+04	nc			1.5E+03	nc		
		9.0E-02	i					0	0.10	506-68-3		Cyanogen bromide	5.9E+03	nc	1.0E+05	max			3.3E+03	nc		
		5.0E-02	i					0	0.10	506-77-4		Cyanogen chloride	3.3E+03	nc	3.4E+04	nc			1.8E+03	nc		
		2.0E-02	i					0	0.10	57-12-5		Free cyanide	1.3E+03	nc	1.4E+04	nc			7.3E+02	nc	4.0E+01	2.0E+00
		2.0E-02	i			8.8E-04	i	1	0.10	74-90-8		**Hydrogen cyanide**	1.1E+01	nc	3.5E+01	nc	3.1E+00	nc	6.2E+00	nc		
		5.0E-02	i					0	0.10	151-50-8		Potassium cyanide	3.3E+03	nc	3.4E+04	nc			1.8E+03	nc		
		2.0E-01	i					0	0.10	506-61-6		Potassium silver cyanide	1.3E+04	nc	1.0E+05	max			7.3E+03	nc		
		1.0E-01	i					0	0.10	506-64-9		Silver cyanide	6.5E+03	nc	1.0E+05	max			3.7E+03	nc		
		4.0E-02	i					0	0.10	143-33-9		Sodium cyanide	2.6E+03	nc	2.7E+04	nc			1.5E+03	nc		
		5.0E-02	i					0	0.10	557-21-1		Zinc cyanide	3.3E+03	nc	3.4E+04	nc			1.8E+03	nc		
		5.0E+00	i			5.0E+00	r	0	0.10	108-94-1		Cyclohexanone	1.0E+05	max	1.0E+05	max	1.8E+04	nc	1.8E+05	nc		
		2.0E-01	i			2.0E-01	r	0	0.10	108-91-8		Cyclohexylamine	1.3E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		5.0E-03	i			5.0E-03	r	0	0.10	68085-85-8		Cyhalothrin/Karate	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	52315-07-8		Cypermethrin	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		7.5E-03	i			7.5E-03	r	0	0.10	66215-27-8		Cyromazine	4.9E+02	nc	5.1E+03	nc	2.7E+01	nc	2.7E+02	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	1861-32-1		Dacthal	6.5E+02	nc	1.0E+05	max	3.7E+01	nc	3.7E+02	nc		
		3.0E-02	i			3.0E-02	r	0	0.10	75-99-0		Dalapon	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	39515-41-8		Danitol	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
2.4E-01	i			2.4E-01	r			0	0.10	72-54-8		DDD	1.9E+00	ca	7.9E+00	ca	2.8E-02	ca	2.8E-01	ca	1.6E+01	8.0E-01
3.4E-01	i			3.4E-01	r			0	0.10	72-55-9		DDE	1.3E+00	ca	5.6E+00	ca	2.0E-02	ca	2.0E-01	ca	5.4E+01	3.0E+00
3.4E-01	i	5.0E-04	i	3.4E-01	i	5.0E-04	r	0	0.10	50-29-3		DDT	1.3E+00	ca*	5.6E+00	ca*	2.0E-02	ca*	2.0E-01	ca*	3.2E+01	2.0E+00
		1.0E-02	i			1.0E-02	r	0	0.10	1163-19-5		Decabromodiphenyl ether	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		4.0E-05	i			4.0E-05	r	0	0.10	8065-48-3		Demeton	2.6E+00	nc	2.7E+01	nc	1.5E-01	nc	1.5E+00	nc		
6.1E-02	h			6.1E-02	r			0	0.10	2303-16-4		Diallate	7.3E+00	ca	3.1E+01	ca	1.1E-01	ca	1.1E+00	ca		
		9.0E-04	h			9.0E-04	r	0	0.10	333-41-5		Diazinon	5.9E+01	nc	6.1E+02	nc	3.3E+00	nc	3.3E+01	nc		
		4.0E-03	n			4.0E-03	r	1	0.10	132-64-9		**Dibenzofuran**	1.4E+02	sat	1.4E+02	sat	1.5E+01	nc	2.4E+01	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	106-37-6		1,4-Dibromobenzene	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
8.4E-02	i	2.0E-02	i	8.4E-02	r	2.0E-02	r	0	0.10	124-48-1		Dibromochloromethane	5.3E+00	ca*	2.3E+01	ca	8.0E-02	ca	1.0E+00	ca	4.0E-01	2.0E-02
1.4E+00	h	5.7E-05	r	2.4E-03	h	5.7E-05	r	0	0.10	96-12-8		1,2-Dibromo-3-chloropropane	3.2E-01	ca**	1.4E+00	ca*	2.1E-01	nc	4.8E-02	ca*		
												"CAL-Modified PRG" (PEA, 1994)	**6.0E-02**				**9.6E-04**		**4.7E-03**			

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TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								SOIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
8.5E+01	i	5.7E-05	r	7.7E-01	i	5.7E-05	h	1	0.10	106-93-4	1,2-Dibromoethane	4.9E-03	ca	2.0E-02	ca	8.7E-03	ca*	7.6E-04	ca		
		1.0E-01	i			1.0E-01	r	0	0.10	84-74-2	Dibutyl phthalate	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc	2.3E+03	2.7E+02
		3.0E-02	i			3.0E-02	r	0	0.10	1918-00-9	Dicamba	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
		9.0E-02	i			5.7E-02	h	1	0.10	95-50-1	1,2-Dichlorobenzene	7.0E+02	sat	7.0E+02	sat	2.1E+02	nc	3.7E+02	nc	1.7E+01	9.0E-01
		3.0E-02	e			3.0E-02	r	1	0.10	541-73-1	**1,3-Dichlorobenzene**	5.0E+02	nc	8.6E+02	sat	1.1E+02	nc	1.8E+02	nc		
2.4E-02	h	2.3E-01	i	2.4E-02	r	2.3E-01	i	1	0.10	106-46-7	1,4-Dichlorobenzene	3.6E+00	ca	8.5E+00	ca	2.8E-01	ca	4.7E-01	ca	2.0E+00	1.0E-01
4.5E-01	i			4.5E-01	r			0	0.10	91-94-1	3,3-Dichlorobenzidine	9.9E-01	ca	4.2E+00	ca	1.5E-02	ca	1.5E-01	ca	7.0E-03	3.0E-04
9.3E+00	r			9.3E+00	h			1	0.10	764-41-0	1,4-Dichloro-2-butene	7.5E-03	ca	1.7E-02	ca	7.2E-04	ca	1.2E-03	ca		
		2.0E-01	i			5.7E-02	h	1	0.10	75-71-8	Dichlorodifluoromethane	9.4E+01	nc	3.1E+02	nc	2.1E+02	nc	3.9E+02	nc		
		1.0E-01	h			1.4E-01	h	1	0.10	75-34-3	1,1-Dichloroethane	5.0E+02	nc	1.7E+03	nc	5.2E+02	nc	8.1E+02	nc	2.3E+01	1.0E+00
9.1E-02	i	2.9E-03	r	9.1E-02	i	2.9E-03	n	1	0.10	107-06-2	**1,2-Dichloroethane (EDC)**	2.5E-01	ca*	5.5E-01	ca*	7.4E-02	ca	1.2E-01	ca	2.0E-02	1.0E-03
6.0E-01	i	9.0E-03	i	1.6E-01	i	9.0E-03	r	1	0.10	75-35-4	1,1-Dichloroethylene	3.7E-02	ca	8.0E-02	ca	3.8E-02	ca	4.6E-02	ca	6.0E-02	3.0E-03
		1.0E-02	h			1.0E-02	r	1	0.10	156-59-2	1,2-Dichloroethylene (cis)	3.1E+01	nc	1.0E+02	nc	3.7E+01	nc	6.1E+01	nc	4.0E-01	2.0E-02
		2.0E-02	i			2.0E-02	r	1	0.10	156-60-5	1,2-Dichloroethylene (trans)	7.8E+01	nc	2.7E+02	nc	7.3E+01	nc	1.2E+02	nc	7.0E-01	3.0E-02
		9.0E-03	h			9.0E-03	r	1	0.10	540-59-0	1,2-Dichloroethylene (mixture)	3.5E+01	nc	1.2E+02	nc	3.3E+01	nc	5.5E+01	nc		
		3.0E-03	i			3.0E-03	r	0	0.10	120-83-2	2,4-Dichlorophenol	2.0E+02	nc	2.0E+03	nc	1.1E+01	nc	1.1E+02	nc	1.0E+00	5.0E-02
		8.0E-03	i			8.0E-03	r	0	0.10	94-82-6	4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB	5.2E+02	nc	5.5E+03	nc	2.9E+01	nc	2.9E+02	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	94-75-7	2,4-Dichlorophenoxyacetic Acid (2,4-D)	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
6.8E-02	h	1.1E-03	r	6.8E-02	r	1.1E-03	i	1	0.10	78-87-5	1,2-Dichloropropane	3.1E-01	ca*	6.8E-01	ca*	9.9E-02	ca*	1.6E-01	ca*	3.0E-02	1.0E-03
1.8E-01	h	3.0E-04	i	1.3E-01	h	5.7E-03	i	1	0.10	542-75-6	1,3-Dichloropropene	2.5E-01	ca*	5.5E-01	ca	5.2E-02	ca	8.1E-02	ca	4.0E-03	2.0E-04
		3.0E-03	i			3.0E-03	r	0	0.10	616-23-9	2,3-Dichloropropanol	2.0E+02	nc	2.0E+03	nc	1.1E+01	nc	1.1E+02	nc		
2.9E-01	i	5.0E-04	i	2.9E-01	r	1.4E-04	i	0	0.10	62-73-7	Dichlorvos	1.5E+00	ca**	6.6E+00	ca*	2.3E-02	ca*	2.3E-01	ca*		
4.4E-01	x			4.4E-01	r			0	0.10	115-32-2	Dicofol	1.0E+00	ca	4.3E+00	ca	1.5E-02	ca	1.5E-01	ca		
		3.0E-02	h			5.7E-05	h	1	0.10	77-73-6	Dicyclopentadiene					2.1E-01	nc	4.2E-01	nc		
1.6E+01	i	5.0E-05	r	1.6E+01	i	5.0E-05	r	0	0.10	60-57-1	Dieldrin	2.8E-02	ca*	1.2E-01	ca	4.2E-04	ca	4.2E-03	ca	4.0E-03	2.0E-04
		5.7E-03	h			5.7E-03	x	0	0.10	112-34-5	Diethylene glycol, monobutyl ether	3.7E+02	nc	3.9E+03	nc	2.1E+01	nc	2.1E+02	nc		
		2.0E+00	h			2.0E+00	r	0	0.10	111-90-0	Diethylene glycol, monoethyl ether	1.0E+05	max	1.0E+05	max	7.3E+03	nc	7.3E+04	nc		
		1.1E-02	h			1.1E-02	r	0	0.10	617-84-5	Diethylformamide	7.2E+02	nc	7.5E+03	nc	4.0E+01	nc	4.0E+02	nc		
1.2E-03	i	6.0E-01	i	1.2E-03	r	6.0E-01	r	0	0.10	103-23-1	Di(2-ethylhexyl)adipate	3.7E+02	nc	1.6E+03	nc	5.6E+00	nc	5.6E+01	nc		
		8.0E-01	i			8.0E-01	r	0	0.10	84-66-2	Diethyl phthalate	5.2E+04	nc	1.0E+05	max	2.9E+03	nc	2.9E+04	nc		
4.7E+03	h			4.7E+03	r			0	0.10	56-53-1	Diethylstilbestrol	9.5E-05	ca	4.1E-04	ca	1.4E-06	ca	1.4E-05	ca		
		8.0E-02	i			8.0E-02	r	0	0.10	43222-48-6	Difenzoquat (Avenge)	5.2E+03	nc	5.5E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	35367-38-5	Diflubenzuron	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.1E+01	r			1.1E+01	i	1	0.10	75-37-6	1,1-Difluoroethane					4.2E+04	nc	6.9E+04	nc		
		8.0E-02	i			8.0E-02	r	0	0.10	1445-75-6	Diisopropyl methylphosphonate	5.2E+03	nc	5.5E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	55290-64-7	Dimethipin	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-04	i			2.0E-04	r	0	0.10	60-51-5	Dimethoate	1.3E+01	nc	1.4E+02	nc	7.3E-01	nc	7.3E+00	nc		
1.4E-02	h			1.4E-02	r			0	0.10	119-90-4	3,3'-Dimethoxybenzidine	3.2E+01	ca	1.4E+02	ca	4.8E-01	ca	4.8E+00	ca		
		5.7E-06	r			5.7E-06	x	1	0.10	124-40-3	Dimethylamine	6.5E-02	nc	2.4E-01	nc	2.1E-02	nc	3.5E-02	nc		
		2.0E-03	i			2.0E-03	r	0	0.10	121-69-7	N-N-Dimethylaniline	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
7.5E-01	h			7.5E-01	r			0	0.10	95-68-1	2,4-Dimethylaniline	5.9E-01	ca	2.5E+00	ca	9.0E-03	ca	9.0E-02	ca		
5.8E-01	h			5.8E-01	r			0	0.10	21436-96-4	2,4-Dimethylaniline hydrochloride	7.7E-01	ca	3.3E+00	ca	1.2E-02	ca	1.2E-01	ca		
9.2E+00	h			9.2E+00	r			0	0.10	119-93-7	3,3'-Dimethylbenzidine	4.8E-02	ca	2.1E-01	ca	7.3E-04	ca	7.3E-03	ca		
2.6E+00	x			3.5E+00	x			0	0.10	57-14-7	1,1-Dimethylhydrazine	1.7E-01	ca	7.3E-01	ca	1.9E-03	ca	2.6E-02	ca		

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3.7E+01	x			3.7E+01	x			0	0.10	540-73-8		1,2-Dimethylhydrazine	1.2E-02	ca	5.2E-02	ca	1.8E-04	ca	1.8E-03	ca		
		1.0E-01	h			8.6E-03	i	0	0.10	68-12-2		N,N-Dimethylformamide	6.5E+03	nc	6.8E+04	nc	3.1E+01	nc	3.7E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	105-67-9		2,4-Dimethylphenol	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc	9.0E+00	4.0E-01
		6.0E-04	i			6.0E-04	r	0	0.10	576-26-1		2,6-Dimethylphenol	3.9E+01	nc	4.1E+02	nc	2.2E+00	nc	2.2E+01	nc		
		1.0E-03	i			1.0E-03	r	0	0.10	95-65-8		3,4-Dimethylphenol	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		1.0E+01	h			1.0E+01	r	0	0.10	131-11-3		Dimethyl phthalate	1.0E+05	max	1.0E+05	max	3.7E+04	nc	3.7E+05	nc		
		1.0E-01	i			1.0E-01	r	0	0.10	120-61-6		Dimethyl terephthalate	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc		
		2.0E-03	i			2.0E-03	r	0	0.10	131-89-5		4,6-Dinitro-o-cyclohexyl phenol	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.0E-04	i			1.0E-04	r	0	0.10	99-65-0		1,3-Dinitrobenzene	6.5E+00	nc	6.8E+01	nc	3.7E-01	nc	3.7E+00	nc		
		4.0E-04	h			4.0E-04	r	0	0.10	528-29-0		1,2-Dinitrobenzene	2.6E+01	nc	2.7E+02	nc	1.5E+00	nc	1.5E+01	nc		
		4.0E-04	h			4.0E-04	r	0	0.10	100-25-4		1,4-Dinitrobenzene	2.6E+01	nc	2.7E+02	nc	1.5E+00	nc	1.5E+01	nc		
		2.0E-03	i			2.0E-03	r	0	0.10	51-28-5		2,4-Dinitrophenol	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc	3.0E-01	1.0E-02
6.8E-01	i			6.8E-01	r			0	0.10	25321-14-6		Dinitrotoluene mixture	6.5E-01	ca	2.8E+00	ca	9.9E-03	ca	9.9E-02	ca	8.0E-04	4.0E-05
		2.0E-03	i			2.0E-03	r	0	0.10	121-14-2		2,4-Dinitrotoluene (also see Dinitrotoluene mixture)	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc	8.0E-04	4.0E-05
		1.0E-03	h			1.0E-03	r	0	0.10	606-20-2		2,6-Dinitrotoluene (also see Dinitrotoluene mixture)	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc	7.0E-04	3.0E-05
		1.0E-03	i			1.0E-03	r	0	0.10	88-85-7		Dinoseb	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		2.0E-02	h			2.0E-02	r	0	0.10	117-84-0		di-n-Octyl phthalate	1.3E+03	nc	1.0E+04	sat	7.3E+01	nc	7.3E+02	nc	1.0E+04	1.0E+04
1.1E-02	i			1.1E-02	r			0	0.10	123-91-1		**1,4-Dioxane**	4.0E+01	ca	1.7E+02	ca	6.1E-01	ca	6.1E+00	ca		
		3.0E-02	i			3.0E-02	r	0	0.10	957-51-7		Diphenamid	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	122-39-4		Diphenylamine	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
8.0E-01	i			7.7E-01	i			0	0.10	122-66-7		1,2-Diphenylhydrazine	5.6E-01	ca	2.4E+00	ca	8.7E-03	ca	8.4E-02	ca		
		2.2E-03	i			2.2E-03	r	0	0.10	85-00-7		Diquat	1.4E+02	nc	1.5E+03	nc	8.0E+00	nc	8.0E+01	nc		
5.6E+00	h			5.6E+00	r			0	0.10	1937-37-7		Direct black 38	5.2E-02	ca	2.2E-01	ca	7.8E-04	ca	7.8E-03	ca		
8.1E+00	h			8.1E+00	r			0	0.10	2602-46-2		Direct blue 6	5.5E-02	ca	2.4E-01	ca	8.3E-04	ca	8.3E-03	ca		
9.3E+00	h			9.3E+00	r			0	0.10	16071-86-6		Direct brown 95	4.8E-02	ca	2.1E-01	ca	7.2E-04	ca	7.2E-03	ca		
		4.0E-05	i			4.0E-05	r	0	0.10	298-04-4		Disulfoton	2.6E+00	nc	2.7E+01	nc	1.5E-01	nc	1.5E+00	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	505-29-3		1,4-Dithiane	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		2.0E-03	i			2.0E-03	r	0	0.10	330-54-1		Diuron	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		4.0E-03	i			4.0E-03	r	0	0.10	2439-10-3		Dodine	2.6E+02	nc	2.7E+03	nc	1.5E+01	nc	1.5E+02	nc		
		6.0E-03	i			6.0E-03	r	0	0.10	115-29-7		**Endosulfan**	3.9E+02	nc	4.1E+03	nc	2.2E+01	nc	2.2E+02	nc	1.8E+01	9.0E-01
		2.0E-02	i			2.0E-02	r	0	0.10	145-73-3		Endothall	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		3.0E-04	i			3.0E-04	r	0	0.10	72-20-8		Endrin	2.0E+01	nc	2.0E+02	nc	1.1E+00	nc	1.1E+01	nc	1.0E+00	5.0E-02
9.9E-03	i	2.0E-03	h	4.2E-03	i	2.9E-04	i	1	0.10	106-89-8		Epichlorohydrin	7.5E+00	nc	2.5E+01	nc	1.0E+00	nc	2.0E+00	nc		
		5.7E-03	r			5.7E-03	i	0	0.10	106-88-7		1,2-Epoxybutane	3.7E+02	nc	3.9E+03	nc	2.1E+01	nc	2.1E+02	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	759-94-4		EPTC (S-Ethyl dipropylthiocarbamate)	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
		5.0E-03	i			5.0E-03	r	0	0.10	16672-87-0		Ethephon (2-chloroethyl phosphonic acid)	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		5.0E-04	i			5.0E-04	r	0	0.10	563-12-2		Ethion	3.3E+01	nc	3.4E+02	nc	1.8E+00	nc	1.8E+01	nc		
		4.0E-01	h			5.7E-02	i	0	0.10	110-80-5		2-Ethoxyethanol	2.6E+04	nc	1.0E+05	max	2.1E+02	nc	1.5E+04	nc		
		3.0E-01	h			3.0E-01	r	0	0.10	111-15-9		2-Ethoxyethanol acetate	2.0E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		9.0E-01	i			9.0E-01	r	1	0.10	141-78-6		**Ethyl acetate**	1.8E+04	nc	1.0E+05	max	3.3E+03	nc	5.5E+03	nc		
4.6E-02	h			4.8E-02	r			1	0.10	140-88-5		Ethyl acrylate	2.1E-01	ca	4.5E-01	ca	1.4E-01	ca	2.3E-01	ca		
		1.0E-01	i			2.9E-01	i	1	0.10	100-41-4		Ethylbenzene	2.3E+02	sat	2.3E+02	sat	1.1E+03	nc	1.3E+03	nc	1.3E+01	7.0E-01
		3.0E-01	h			3.0E-01	r	0	0.10	109-78-4		Ethylene cyanohydrin	2.0E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		2.0E-02	h			2.0E-02	r	0	0.10	107-15-3		Ethylene diamine	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		

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TOXICITY INFORMATION												CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No.			Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
		2.0E+00	i			2.0E+00	r	0	0.10	107-21-1		Ethylene glycol	1.3E+05	nc	1.0E+05	max	7.3E+03	nc	7.3E+04	nc		
		5.7E-03	r			5.7E-03	h	0	0.10	111-76-2		Ethylene glycol, monobutyl ether	3.7E+02	nc	3.9E+03	nc	2.1E+01	nc	2.1E+02	nc		
1.0E+00	h			3.5E-01	h			1	0.10	75-21-8		Ethylene oxide	1.3E-01	ca	3.2E-01	ca	1.9E-02	ca	2.4E-02	ca		
1.1E-01	h	8.0E-05	i	1.1E-01	r	8.0E-05	r	0	0.10	96-45-7		Ethylene thiourea (ETU)	4.0E+00	ca**	1.7E+01	ca*	6.1E-02	ca*	6.1E-01	ca*		
		2.0E-02	n			2.0E+00	i	1	0.10	75-00-3		Ethyl chloride	1.1E+03	nc	1.6E+03	sat	1.0E+04	nc	7.1E+02	nc		
		2.0E-01	i			2.0E-01	r	1	0.10	60-29-7		Ethyl ether	1.8E+03	sat	1.8E+03	sat	7.3E+02	nc	1.2E+03	nc		
		9.0E-02	h			9.0E-02	r	1	0.10	97-63-2		Ethyl methacrylate	1.4E+02	sat	1.4E+02	sat	3.3E+02	nc	5.5E+02	nc		
		1.0E-05	i			1.0E-05	r	0	0.10	2104-64-5		Ethyl p-nitrophenyl phenylphosphorothioate	6.5E-01	nc	6.8E+00	nc	3.7E-02	nc	3.7E-01	nc		
		3.0E+00	i			3.0E+00	r	0	0.10	84-72-0		Ethylphthalyl ethyl glycolate	1.0E+05	max	1.0E+05	max	1.1E+04	nc	1.1E+05	nc		
		6.0E-03	i			8.0E-03	r	0	0.10	101200-48-0		Express	5.2E+02	nc	5.5E+03	nc	2.9E+01	nc	2.9E+02	nc		
		2.5E-04	i			2.5E-04	r	0	0.10	22224-92-6		Fenamiphos	1.6E+01	nc	1.7E+02	nc	9.1E-01	nc	9.1E+00	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	2164-17-2		Fluometuron	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
		6.0E-02	i			6.0E-02	r	0	0.10	7782-41-4		Fluorine (soluble fluoride)	3.9E+03	nc	4.1E+04	nc	2.2E+02	nc	2.2E+03	nc		
		8.0E-02	i			6.0E-02	r	0	0.10	59756-60-4		Fluoridone	5.2E+03	nc	5.5E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	56425-91-3		Flurprimidol	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		6.0E-02	i			6.0E-02	r	0	0.10	66332-96-5		Flutolanil	3.9E+03	nc	4.1E+04	nc	2.2E+02	nc	2.2E+03	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	69409-94-5		Fluvalinate	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
3.5E-03	i	1.0E-01	i	3.5E-03	r	1.0E-01	r	0	0.10	133-07-3		Folpet	1.3E+02	ca*	5.5E+02	ca	1.9E+00	ca	1.9E+01	ca		
1.9E-01	i			1.9E-01	r			0	0.10	72178-02-0		Fomesafen	2.3E+00	ca	1.0E+01	ca	3.5E-02	ca	3.5E-01	ca		
		2.0E-03	i			2.0E-03	r	0	0.10	944-22-9		Fonofos	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.5E-01	i	4.6E-02	i			0	0.10	50-00-0		Formaldehyde	9.8E+03	nc	1.0E+05	nc	1.5E-01	ca	5.5E+03	nc		
		2.0E+00	h			2.0E+00	r	0	0.10	64-18-6		Formic Acid	1.0E+05	max	1.0E+05	max	7.3E+03	nc	7.3E+04	nc		
		3.0E+00	i			3.0E+00	r	0	0.10	39148-24-8		Fosetyl-al	1.0E+05	max	1.0E+05	max	1.1E+04	nc	1.1E+05	nc		
		1.0E-03	x			1.0E-03	r	1	0.10	110-00-9		Furan	2.5E+00	nc	8.5E+00	nc	3.7E+00	nc	6.1E+00	nc		
3.8E+00	h			3.8E+00	r			0	0.10	67-45-8		Furazolidone	1.2E-01	ca	5.0E-01	ca	1.8E-03	ca	1.8E-02	ca		
		3.0E-03	i			1.4E-02	h	0	0.10	98-01-1		Furfural	2.0E+02	nc	2.0E+03	nc	5.2E+01	nc	1.1E+02	nc		
5.0E+01	h			5.0E+01	r			0	0.10	531-82-8		Furium	8.9E-03	ca	3.8E-02	ca	1.3E-04	ca	1.3E-03	ca		
3.0E-02	i			3.0E-02	r			0	0.10	60568-05-0		Furmecyclox	1.5E+01	ca	6.4E+01	ca	2.2E-01	ca	2.2E+00	ca		
		4.0E-04	i			4.0E-04	r	0	0.10	77182-82-2		Glufosinate-ammonium	2.6E+01	nc	2.7E+02	nc	1.5E+00	nc	1.5E+01	nc		
		4.0E-04	i			2.9E-04	h	0	0.10	765-34-4		Glycidaldehyde	2.6E+01	nc	2.7E+02	nc	1.0E+00	nc	1.5E+01	nc		
		1.0E-01	i			1.0E-01	r	0	0.10	1071-83-6		Glyphosate	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc		
		5.0E-05	i			5.0E-05	r	0	0.10	69806-40-2		Haloxyfop-methyl	3.3E+00	nc	3.4E+01	nc	1.8E-01	nc	1.8E+00	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	79277-27-3		Harmony	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
4.5E+00	i	5.0E-04	i	4.6E+00	i	5.0E-04	i	0	0.10	76-44-8		Heptachlor	9.9E-02	ca	4.2E-01	ca	1.5E-03	ca	1.5E-02	ca	2.3E+01	1.0E+00
9.1E+00	i	1.3E-05	i	9.1E+00	i	1.3E-05	r	0	0.10	1024-57-3		Heptachlor epoxide	4.9E-02	ca**	2.1E-01	ca*	7.4E-04	ca*	7.4E-03	ca*	7.0E-01	3.0E-02
		2.0E-03	i			2.0E-03	r	0	0.10	87-82-1		Hexabromobenzene	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
1.6E+00	i	8.0E-04	i	1.6E+00	i	8.0E-04	r	0	0.10	118-74-1		Hexachlorobenzene	2.8E-01	ca*	1.2E+00	ca	4.2E-03	ca	4.2E-02	ca	2.0E+00	1.0E-01
7.8E-02	i	2.0E-04	h	7.7E-02	i	2.0E-04	r	0	0.10	87-68-3		Hexachlorobutadiene	5.7E+00	ca**	2.4E+01	ca*	8.7E-02	ca*	8.6E-01	ca*	2.0E+00	1.0E-01
6.3E+00	i			6.3E+00	i			0	0.10	319-84-6		HCH (alpha)	7.1E-02	ca	3.0E-01	ca	1.1E-03	ca	1.1E-02	ca	5.0E-04	3.0E-05
1.8E+00	i			1.8E+00	i			0	0.10	319-85-7		HCH (beta)	2.5E-01	ca	1.1E+00	ca	3.7E-03	ca	3.7E-02	ca	3.0E-03	1.0E-04
1.3E+00	h	3.0E-04	i	1.3E+00	r	3.0E-04	r	0	0.10	58-89-9		HCH (gamma) Lindane	3.4E-01	ca*	1.5E+00	ca	5.2E-03	ca	5.2E-02	ca	9.0E-03	5.0E-04
1.8E+00	i			1.8E+00	i			0	0.10	58-89-9		HCH-technical	2.5E-01	ca	1.1E+00	ca	3.8E-03	ca	3.7E-02	ca	3.0E-03	1.0E-04
		7.0E-03	i			2.0E-05	h	0	0.10	77-47-4		Hexachlorocyclopentadiene	4.5E+02	nc	4.6E+03	nc	7.3E-02	nc	2.6E+02	nc	4.0E+02	2.0E+01
6.2E+03	i			4.6E+03	i			0	0.10	19408-74-3		Hexachlorodibenzo-p-dioxin mixture (HxCDD)	7.2E-05	ca	3.1E-04	ca	1.5E-06	ca	1.1E-05	ca		

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TOXICITY INFORMATION										CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
1.4E-02	i	1.0E-03	i	1.4E-02	i	1.0E-03	r	0	0.10	67-72-1	Hexachloroethane	3.2E+01	ca**	1.4E+02	ca**	4.8E-01	ca**	4.8E+00	ca**	5.0E-01	2.0E-02
		3.0E-04	i			3.0E-04	r	0	0.10	70-30-4	Hexachlorophene	2.0E+01	nc	2.0E+02	nc	1.1E+00	nc	1.1E+01	nc		
1.1E-01	i	3.0E-03	i	1.1E-01	r	3.0E-03	r	0	0.10	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine	4.0E+00	ca*	1.7E+01	ca	6.1E-02	ca	6.1E-01	ca		
		2.9E-06	r			2.9E-06	i	0	0.10	822-06-0	1,6-Hexamethylene diisocyanate					1.0E-02	nc	1.0E-01	nc		
		6.0E-02	h			5.7E-02	i	1	0.10	110-54-3	n-Hexane	1.1E+02	sat	1.1E+02	sat	2.1E+02	nc	3.5E+02	nc		
		3.3E-02	i			3.3E-02	r	0	0.10	51235-04-2	Hexazinone	2.2E+03	nc	2.2E+04	nc	1.2E+02	nc	1.2E+03	nc		
3.0E+00	i			1.7E+01	i			0	0.10	302-01-2	Hydrazine, hydrazine sulfate	1.5E-01	ca	6.4E-01	ca	3.9E-04	ca	2.2E-02	ca		
						5.7E-03	i	0	0.10	7647-01-0	Hydrogen chloride					2.1E+01	nc				
		3.0E-03	i			2.9E-04	i	1	0.10	7783-06-4	Hydrogen sulfide					1.0E+00	nc	2.0E+00	nc		
		4.0E-02	h			4.0E-02	r	0	0.10	123-31-9	p-Hydroquinone	2.6E+03	nc	2.7E+04	nc	1.5E+02	nc	1.5E+03	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	35554-44-0	Imazalil	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
		2.5E-01	i			2.5E-01	r	0	0.10	81335-37-7	Imazaquin	1.6E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		4.0E-02	i			4.0E-02	r	0	0.10	36734-19-7	Iprodione	2.6E+03	nc	2.7E+04	nc	1.5E+02	nc	1.5E+03	nc		
		3.0E-01	i			3.0E-01	r	1	0.10	78-83-1	**Isobutanol**	1.1E+04	nc	1.0E+05	max	1.1E+03	nc	1.8E+03	nc		
9.5E-04	i	2.0E-01	i	9.5E-04	r	2.0E-01	r	0	0.10	78-59-1	Isophorone	4.7E+02	ca*	2.0E+03	ca*	7.1E+00	ca	7.1E+01	ca	5.0E-01	3.0E-02
		1.5E-02	i			1.5E-02	r	0	0.10	33820-53-0	Isopropalin	9.8E+02	nc	1.0E+04	nc	5.5E+01	nc	5.5E+02	nc		
		1.0E-01	i			1.1E-01	r	0	0.10	1832-54-8	Isopropyl methyl phosphonic acid	6.5E+03	nc	6.8E+04	nc	4.0E+02	nc	3.7E+03	nc		
		5.0E-02	i			5.0E-02	r	0	0.10	82558-50-7	Isoxaben	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
1.8E+01	n			1.8E+01	r			0	0.10	143-50-0	Kepone	2.5E-02	ca	1.1E-01	ca	3.7E-04	ca	3.7E-03	ca		
		2.0E-03	i			2.0E-03	r	0	0.10	77501-63-4	Lactofen	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
ased on Uptake Biokinetic Model								0	n/a	7439-92-1	Lead	4.0E+02	nc	1.0E+03	nc			**4.0E+00**	nc		
											"CAL-Modified PRG" (PEA, 1994)	**1.3E+02**									
		1.0E-07	i					0	0.10	78-00-2	Lead (tetraethyl)	6.5E-03	nc	6.8E-02	nc			3.7E-03	nc		
		2.0E-03	i			2.0E-03	r	0	0.10	330-55-2	Linuron	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		2.0E-02	n					0	0.01	7439-93-2	Lithium	1.5E+03	nc	3.4E+04	nc			7.3E+02	nc		
		2.0E-01	i			2.0E-01	r	0	0.10	83055-99-6	Londax	1.3E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	121-75-5	Malathion	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.0E-01	i			1.0E-01	r	0	0.10	108-31-6	Maleic anhydride	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc		
		5.0E-01	i			5.0E-01	r	1	0.10	123-33-1	**Maleic hydrazide**	1.7E+03	nc	2.4E+03	sat	1.8E+03	nc	3.0E+03	nc		
		2.0E-05	h			2.0E-05	r	0	0.10	109-77-3	Malononitrile	1.3E+00	nc	1.4E+01	nc	7.3E-02	nc	7.3E-01	nc		
		3.0E-02	h			3.0E-02	r	0	0.10	8018-01-7	Mancozeb	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
		5.0E-03	i			5.0E-03	r	0	0.10	12427-38-2	Maneb	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		4.7E-02	i			1.4E-05	i	0	0.01	7439-96-5	**Manganese and compounds**	3.2E+03	nc	4.3E+04	nc	5.1E-02	nc	1.7E+03	nc		
		9.0E-05	h			9.0E-05	r	0	0.10	950-10-7	Mephosfolan	5.9E+00	nc	6.1E+01	nc	3.3E-01	nc	3.3E+00	nc		
		3.0E-02	i			3.0E-02	r	0	0.10	24307-26-4	Mepiquat	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
		3.0E-04	i					0	0.01	7439-97-6	Mercuric chloride	2.3E+01	nc	5.1E+02	nc			1.1E+01	nc		
						8.6E-05	i	n/a	n/a	7439-97-6	Mercury (elemental)					3.1E-01	nc				
		1.0E-04	i					0	0.10	22967-92-6	Mercury (methyl)	6.5E+00	nc	6.8E+01	nc			3.7E+00	nc		
		3.0E-05	i			3.0E-05	r	0	0.10	150-50-5	Merphos	2.0E+00	nc	2.0E+01	nc	1.1E-01	nc	1.1E+00	nc		
		3.0E-05	i			3.0E-05	r	0	0.10	78-48-8	Merphos oxide	2.0E+00	nc	2.0E+01	nc	1.1E-01	nc	1.1E+00	nc		
		6.0E-02	i			6.0E-02	r	0	0.10	57837-19-1	Metalaxyl	3.9E+03	nc	4.1E+04	nc	2.2E+02	nc	2.2E+03	nc		
		1.0E-04	i			2.0E-04	h	1	0.10	126-98-7	Methacrylonitrile	2.0E+00	nc	8.1E+00	nc	7.3E-01	nc	1.0E+00	nc		
		5.0E-05	i			5.0E-05	r	0	0.10	10265-92-6	Methamidophos	3.3E+00	nc	3.4E+01	nc	1.8E-01	nc	1.8E+00	nc		
		5.0E-01	i			5.0E-01	r	0	0.10	67-56-1	Methanol	3.3E+04	nc	1.0E+05	max	1.8E+03	nc	1.8E+04	nc		

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TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								SOIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
		1.0E-03	i			1.0E-03	r	0	0.10	950-37-8	Methidathion	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		2.5E-02	i			2.5E-02	r	1	0.10	16752-77-5	**Methomyl**	4.4E+01	nc	1.5E+02	nc	9.1E+01	nc	1.5E+02	nc		
		5.0E-03	i			5.0E-03	r	0	0.10	72-43-5	Methoxychlor	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc	1.6E+02	8.0E+00
		1.0E-03	h			5.7E-03	i	0	0.10	109-86-4	2-Methoxyethanol	6.5E+01	nc	6.8E+02	nc	2.1E+01	nc	3.7E+01	nc		
		2.0E-03	h			2.0E-03	r	0	0.10	110-49-6	2-Methoxyethanol acetate	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
4.6E-02	h			4.6E-02	r			0	0.10	99-59-2	2-Methoxy-5-nitroaniline	9.7E+00	ca	4.1E+01	ca	1.5E-01	ca	1.5E+00	ca		
		1.0E+00	h			1.0E+00	r	1	0.10	79-20-9	Methyl acetate	2.1E+04	nc	8.8E+04	nc	3.7E+03	nc	6.1E+03	nc		
		3.0E-02	h			3.0E-02	r	1	0.10	96-33-3	Methyl acrylate	6.9E+01	nc	2.3E+02	nc	1.1E+02	nc	1.8E+02	nc		
2.4E-01	h			2.4E-01	r			0	0.10	100-61-8	2-Methylaniline (o-toluidine)	1.9E+00	ca	7.9E+00	ca	2.8E-02	ca	2.8E-01	ca		
1.8E-01	h			1.8E-01	r			0	0.10	636-21-5	2-Methylaniline hydrochloride	2.5E+00	ca	1.1E+01	ca	3.7E-02	ca	3.7E-01	ca		
		1.0E+00	x			1.0E+00	r	0	0.10	79-22-1	Methyl chlorocarbonate	6.5E+04	nc	1.0E+05	max	3.7E+03	nc	3.7E+04	nc		
		5.0E-04	i			5.0E-04	r	0	0.10	94-74-6	2-Methyl-4-chlorophenoxyacetic acid	3.3E+01	nc	3.4E+02	nc	1.8E+00	nc	1.8E+01	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	94-81-5	4-(2-Methyl-4-chlorophenoxy) butyric acid	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		1.0E-03	i			1.0E-03	r	0	0.10	93-65-2	2-(2-Methyl-4-chlorophenoxy) propionic acid	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		1.0E-03	i			1.0E-03	r	0	0.10	16484-77-8	2-(2-Methyl-1,4-chlorophenoxy) propionic acid	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		8.6E-01	r			8.6E-01	h	0	0.10	108-87-2	Methylcyclohexane	5.6E+04	nc	1.0E+05	max	3.1E+03	nc	3.1E+04	nc		
2.5E-01	h			2.5E-01	r			0	0.10	101-77-9	4,4'-Methylenebisbenzeneamine	1.8E+00	ca	7.6E+00	ca	2.7E-02	ca	2.7E-01	ca		
1.3E-01	h	7.0E-04	h	1.3E-01	h	7.0E-04	r	0	0.10	101-14-4	4,4'-Methylene bis(2-chloroaniline)	3.4E+00	ca*	1.5E+01	ca*	5.2E-02	ca*	5.2E-01	ca*		
4.6E-02	x			4.6E-02	r			0	0.10	101-61-1	4,4'-Methylene bis(N,N'-dimethyl)aniline	9.7E+00	ca	4.1E+01	ca	1.5E-01	ca	1.5E+00	ca		
		1.0E-02	h			1.0E-02	r	0	0.10	74-95-3	Methylene bromide	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
7.5E-03	i	6.0E-02	i	1.6E-03	i	8.6E-01	h	1	0.10	75-09-2	Methylene chloride	7.8E+00	ca	1.8E+01	ca	4.1E+00	ca	4.3E+00	ca	2.0E-02	1.0E-03
						5.7E-06	i	0	n/a	101-68-8	4,4'-Methylenediphenyl isocyanate					2.1E-02	nc				
		6.0E-01	i			2.9E-01	i	1	0.10	78-93-3	Methyl ethyl ketone	7.1E+03	nc	2.7E+04	nc	1.0E+03	nc	1.9E+03	nc		
1.1E+00	h			1.1E+00	r			0	0.10	60-34-4	Methyl hydrazine	4.0E-01	ca	1.7E+00	ca	6.1E-03	ca	6.1E-02	ca		
		8.0E-02	h			2.3E-02	h	1	0.10	108-10-1	**Methyl isobutyl ketone**	7.7E+02	nc	2.8E+03	nc	8.3E+01	nc	1.6E+02	nc		
		8.0E-02	h			8.0E-02	r	1	0.10	80-62-6	**Methyl methacrylate**	7.6E+02	nc	2.8E+03	nc	2.9E+02	nc	4.9E+02	nc		
3.3E-02	h			3.3E-02	r			0	0.10	99-55-8	2-Methyl-5-nitroaniline	1.3E+01	ca	5.8E+01	ca	2.0E-01	ca	2.0E+00	ca		
		2.5E-04	i			2.5E-04	r	0	0.10	298-00-0	Methyl parathion	1.6E+01	nc	1.7E+02	nc	9.1E-01	nc	9.1E+00	nc		
		5.0E-02	x			5.0E-02	r	0	0.10	95-48-7	2-Methylphenol	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc	1.5E+01	8.0E-01
		5.0E-02	x			5.0E-02	r	0	0.10	108-39-4	3-Methylphenol	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		5.0E-03	h			5.0E-03	r	0	0.10	106-44-5	4-Methylphenol	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		8.0E-03	h			1.1E-02	h	1	0.10	25013-15-4	Methyl styrene (mixture)	1.2E+02	nc	5.2E+02	nc	4.2E+01	nc	6.0E+01	nc		
		7.0E-02	h			7.0E-02	r	1	0.10	98-83-9	Methyl styrene (alpha)	6.8E+02	sat	6.8E+02	sat	2.6E+02	nc	4.3E+02	nc		
		5.0E-03	n			8.6E-01	i	1	0.10	1634-04-4	**Methyl tertbutyl ether (MTBE)**					3.1E+03	nc	1.8E+02	nc		
		1.5E-01	i			1.5E-01	r	0	0.10	51218-45-2	Metolaclor (Dual)	9.8E+03	nc	1.0E+05	max	5.5E+02	nc	5.5E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	21087-64-9	Metribuzin	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
1.8E+00	h	2.0E-04	i	1.8E+00	r	2.0E-04	r	0	0.10	2385-85-5	Mirex	2.5E-01	ca*	1.1E+00	ca	3.7E-03	ca	3.7E-02	ca		
		2.0E-03	i			2.0E-03	r	0	0.10	2212-67-1	Molinate	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		5.0E-03	h					0	0.01	7439-98-7	Molybdenum	3.8E+02	nc	8.5E+03	nc			1.8E+02	nc		
		1.0E-01	h			1.0E-01	h	0	0.10	10599-90-3	Monochloramine	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc		
		2.0E-03	i			2.0E-03	r	0	0.10	300-76-5	Naled	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.0E-01	i			1.0E-01	r	0	0.10	15299-99-7	Napropamide	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc		
		2.0E-02	i					0	0.01	7440-02-0	Nickel (soluble salts)	1.5E+03	nc	3.4E+04	nc			7.3E+02	nc	1.3E+02	7.0E+00
											"CAL-Modified PRG" (PEA, 1994)	**1.5E+02**									

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TOXICITY INFORMATION												CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.			Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
				8.4E-01	i			0	0.01	n/a		Nickel refinery dust					8.0E-03	ca				
				1.7E+00	i			0	0.01	12035-72-2		Nickel subsulfide			1.1E+04	ca	4.0E-03	ca				
		1.5E-03	x			1.5E-03	r	0	0.10	1929-82-4		Nitrapyrin	9.8E+01	nc	1.0E+03	nc	5.5E+00	nc	5.5E+01	nc		
		1.6E+00	i					0	0.10	14797-55-8		Nitrate							5.8E+04	nc		
		1.0E-01	x					0	0.10	10102-43-9		Nitric Oxide	6.5E+03	nc	1.0E+05	max			3.7E+03	nc		
		1.0E-01	i					0	0.10	14797-65-0		Nitrite	6.5E+03	nc	1.0E+05	max			3.7E+03	nc		
		6.0E-05	r			5.7E-05	h	0	0.10	88-74-4		2-Nitroaniline	3.9E+00	nc	4.1E+01	nc	2.1E-01	nc	2.2E+00	nc		
								0	0.10	99-09-2		3-Nitroaniline										
								0	0.10	100-01-6		4-Nitroaniline										
		5.0E-04	i			5.7E-04	h	1	0.10	98-95-3		**Nitrobenzene**	1.8E+01	nc	9.4E+01	nc	2.1E+00	nc	3.4E+00	nc	1.0E-01	7.0E-03
		7.0E-02	h			7.0E-02	r	0	0.10	67-20-9		Nitrofurantoin	4.6E+03	nc	4.8E+04	nc	2.6E+02	nc	2.6E+03	nc		
1.5E+00	h			9.4E+00	h			0	0.10	59-87-0		Nitrofurazone	3.0E-01	ca	1.3E+00	ca	7.2E-04	ca	4.5E-02	ca		
		1.0E+00	x					0	0.10	101102-44-0		Nitrogen dioxide										
		1.0E-01	i			1.0E-01	r	0	0.10	556-86-7		Nitroguanidine	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc		
								0	0.10	100-02-7		4-Nitrophenol										
9.4E+00	r	5.7E-03	r	9.4E+00	h	5.7E-03	i	1	0.10	79-46-9		2-Nitropropane					7.2E-04	ca	3.5E+01	ca		
5.4E+00	i			5.5E+00	i			1	0.10	924-16-3		**N-Nitrosodi-n-butylamine**	2.2E-02	ca	5.5E-02	ca	1.2E-03	ca	2.0E-03	ca		
2.8E+00	i			2.8E+00	r			0	0.10	1116-54-7		N-Nitrosodietharolamine	1.6E-01	ca	6.8E-01	ca	2.4E-03	ca	2.4E-02	ca		
1.5E+02	i			1.5E+02	i			0	0.10	55-18-5		N-Nitrosodiethylamine	3.0E-03	ca	1.3E-02	ca	4.5E-05	ca	4.5E-04	ca		
5.1E+01	i			4.9E+01	i			0	0.10	62-75-9		N-Nitrosodimethylamine	8.7E-03	ca	3.7E-02	ca	1.4E-04	ca	1.3E-03	ca		
4.9E-03	i			4.9E-03	r			0	0.10	86-30-6		N-Nitrosodiphenylamine	9.1E+01	ca	3.9E+02	ca	1.4E+00	ca	1.4E+01	ca	1.0E+00	6.0E-02
7.0E+00	i			7.0E+00	r			0	0.10	621-64-7		N-Nitroso di-n-propylamine	6.3E-02	ca	2.7E-01	ca	9.6E-04	ca	9.6E-03	ca	5.0E-05	2.0E-06
2.2E+01	i			2.2E+01	r			0	0.10	10595-95-6		N-Nitroso-N-methylethylamine	2.0E-02	ca	8.7E-02	ca	3.1E-04	ca	3.1E-03	ca		
2.1E+00	i			2.1E+00	i			0	0.10	930-55-2		N-Nitrosopyrrolidine	2.1E-01	ca	9.1E-01	ca	3.1E-03	ca	3.2E-02	ca		
		1.0E-02	h			1.0E-02	r	0	0.10	99-08-1		m-Nitrotoluene	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		1.0E-02	h			1.0E-02	r	0	0.10	99-99-0		p-Nitrotoluene	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		4.0E-02	i			4.0E-02	r	0	0.10	27314-13-2		Norflurazon										
		7.0E-04	i			7.0E-04	r	0	0.10	85509-19-9		NuStar	4.6E+01	nc	4.8E+02	nc	2.6E+00	nc	2.6E+01	nc		
		3.0E-03	i			3.0E-03	r	0	0.10	32536-52-0		Octabromodiphenyl ether	2.0E+02	nc	2.0E+03	nc	1.1E+01	nc	1.1E+02	nc		
		5.0E-02	i			5.0E-02	r	0	0.10	2691-41-0		Octahydro-1357-tetranitro-1357- tetrazocine (HMX)	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		2.0E-03	h			2.0E-03	r	0	0.10	152-16-9		Octamethylpyrophosphoramide	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		5.0E-02	i			5.0E-02	r	0	0.10	19044-88-3		Oryzalin	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		5.0E-03	i			5.0E-03	r	0	0.10	19666-30-9		Oxadiazon	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	23135-22-0		Oxamyl	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
		3.0E-03	i			3.0E-03	r	0	0.10	42874-03-3		Oxyfluorfen	2.0E+02	nc	2.0E+03	nc	1.1E+01	nc	1.1E+02	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	76738-62-0		Paclobutrazol	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
		4.5E-03	i			4.5E-03	r	0	0.10	4685-14-7		Paraquat	2.9E+02	nc	3.1E+03	nc	1.6E+01	nc	1.6E+02	nc		
		6.0E-03	h			6.0E-03	r	0	0.10	56-38-2		Parathion	3.9E+02	nc	4.1E+03	nc	2.2E+01	nc	2.2E+02	nc		
		5.0E-02	h			5.0E-02	r	0	0.10	1114-71-2		Pebulate	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		4.0E-02	i			4.0E-02	r	0	0.10	40487-42-1		Pendimethalin	2.6E+03	nc	2.7E+04	nc	1.5E+02	nc	1.5E+03	nc		
2.3E-02	h			2.3E-02	r			0	0.10	87-84-3		Pentabromo-6-chloro cyclohexane	1.9E+01	ca	8.3E+01	ca	2.9E-01	ca	2.9E+00	ca		
		2.0E-03	i			2.0E-03	r	0	0.10	32534-81-9		Pentabromodiphenyl ether	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		8.0E-04	i			8.0E-04	r	0	0.10	608-93-5		Pentachlorobenzene	5.2E+01	nc	5.5E+02	nc	2.9E+00	nc	2.9E+01	nc		
2.6E-01	[illegible]	3.0E-03	i	2.6E-01	r	3.0E-03	r	0	0.10	82-68-8		Pentachloronitrobenzene	1.7E+00	ca*	7.3E+00	ca	2.6E-02	ca	2.6E-01	ca		

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TOXICITY INFORMATION												CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No.			Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
1.2E-01	i	3.0E-02	i	1.2E-01	r	3.0E-02	r	0	0.25	87-86-5		Pentachlorophenol	2.5E+00	ca	7.9E+00	ca	5.6E-02	ca	5.6E-01	ca	3.0E-02	1.0E-03
		5.0E-02	i			5.0E-02	r	0	0.10	52645-53-1		Permethrin	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		2.5E-01	i			2.5E-01	r	0	0.10	13684-63-4		Phenmedipham	1.6E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		6.0E-01	i			6.0E-01	r	0	0.10	108-95-2		Phenol	3.9E+04	nc	1.0E+05	max	2.2E+03	nc	2.2E+04	nc	1.0E+02	5.0E+00
		6.0E-03	i			6.0E-03	r	0	0.10	108-45-2		m-Phenylenediamine	3.9E+02	nc	4.1E+03	nc	2.2E+01	nc	2.2E+02	nc		
		1.9E-01	h			1.9E-01	r	0	0.10	106-50-3		p-Phenylenediamine	1.2E+04	nc	1.0E+05	max	6.9E+02	nc	6.9E+03	nc		
		8.0E-05	i			8.0E-05	r	0	0.10	62-38-4		Phenylmercuric acetate	5.2E+00	nc	5.5E+01	nc	2.9E-01	nc	2.9E+00	nc		
1.9E-03	h			1.9E-03	r			0	0.10	90-43-7		2-Phenylphenol	2.3E+02	ca	9.8E+02	ca	3.5E+00	ca	3.5E+01	ca		
		2.0E-04	h			2.0E-04	r	0	0.10	298-02-2		Phorate	1.3E+01	nc	1.4E+02	nc	7.3E-01	nc	7.3E+00	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	732-11-6		Phosmet	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		3.0E-04	h			8.9E-05	i	0	0.10	7803-51-2		Phosphine	2.0E+01	nc	2.0E+02	nc	3.1E-01	nc	1.1E+01	nc		
						2.9E-03	i	n/a	n/a	7664-38-2		**Phosphoric acid**					1.0E+01	nc				
		2.0E-05	i			2.0E-05	r	0	0.10	7723-14-0		Phosphorus (white)					7.3E-02	nc				
		1.0E+00	h			1.0E+00	r	0	0.10	100-21-0		p-Phthalic acid					3.7E+03	nc				
		2.0E+00	i			3.4E-02	h	0	0.10	85-44-9		Phthalic anhydride					1.2E+02	nc				
		7.0E-02	i			7.0E-02	r	0	0.10	1918-02-1		Picloram	4.6E+03	nc	4.8E+04	nc	2.6E+02	nc	2.6E+03	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	23505-41-1		Pirimiphos-methyl	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
6.9E+00	h	7.0E-09	h	8.9E+00	r	7.0E-09	r	0	0.10			Polybrominated biphenyls	5.0E-02	ca**	2.1E-01	ca*	7.6E-04	ca*	7.6E-03	ca*		
7.7E+00	i			7.7E+00	r			0	0.06	1336-36-3		Polychlorinated biphenyls (PCBs)	6.6E-02	ca*	3.4E-01	ca*	8.7E-04	ca*	8.7E-03	ca*		
		7.0E-05	i			7.0E-05	r	0	0.06	12674-11-2		Aroclor 1016 (see PCBs for cancer endpoint)	4.9E+00	nc	6.5E+01	nc	2.6E-01	nc	2.6E+00	nc		
		2.0E-05	i			2.0E-05	r	0	0.06	11097-69-1		Aroclor 1254 (see PCBs for cancer endpoint)	1.4E+00	nc	1.9E+01	nc	7.3E-02	nc	7.3E-01	nc		
									0.10			Polynuclear aromatic hydrocarbons (PAHs)										
		6.0E-02	i			6.0E-02	r	1	0.10	83-32-9		Acenaphthene	1.1E+02	sat	1.1E+02	sat	2.2E+02	nc	3.7E+02	nc	5.7E+02	2.9E+01
		3.0E-01	i			3.0E-01	r	1	0.10	120-12-7		Anthracene	5.7E+00	sat	5.7E+00	sat	1.1E+03	nc	1.8E+03	nc	1.2E+04	5.9E+02
7.3E-01	n			7.3E-01	r			0	0.10	56-55-3		Benz[a]anthracene	6.1E-01	ca	2.6E+00	ca	9.2E-03	ca	9.2E-02	ca	2.0E+00	8.0E-02
7.3E-01	n			7.3E-01	r			0	0.10	205-99-2		Benzo[b]fluoranthene	6.1E-01	ca	2.6E+00	ca	9.2E-03	ca	9.2E-02	ca	5.0E+00	2.0E-01
7.3E-02	n			7.3E-02	r			0	0.10	207-08-9		Benzo[k]fluoranthene	6.1E+00	ca	2.6E+01	ca	9.2E-02	ca	9.2E-01	ca	4.9E+01	2.0E+00
												"CAL-Modified PRG" (PEA, 1994)	**6.1E-01**									
7.3E+00	i			7.3E+00	r			0	0.10	50-32-8		Benzo[a]pyrene	6.1E-02	ca	2.6E-01	ca	9.2E-04	ca	9.2E-03	ca	8.0E+00	4.0E-01
												"CAL-Modified PRG" (PEA, 1994)							**1.5E-03**			
7.3E-03	n			7.3E-03	r			0	0.10	218-01-9		Chrysene	7.2E+00	sat	7.2E+00	sat	9.2E-01	ca	9.2E+00	ca	1.6E+02	8.0E+00
												"CAL-Modified PRG" (PEA, 1994)	**6.1E+00**									
7.3E+00	n			7.3E+00	r			0	0.10	53-70-3		Dibenz[ah]anthracene	6.1E-02	ca	2.6E-01	ca	9.2E-04	ca	9.2E-03	ca	2.0E+00	8.0E-02
		4.0E-02	i			4.0E-02	r	0	0.10	206-44-0		Fluoranthene	2.6E+03	nc	2.7E+04	nc	1.5E+02	nc	1.5E+03	nc	4.3E+03	2.1E+02
		4.0E-02	i			4.0E-02	r	1	0.10	86-73-7		Fluorene	9.0E+01	sat	9.0E+01	sat	1.5E+02	nc	2.4E+02	nc	5.6E+02	2.8E+01
7.3E-01	n			7.3E-01	r			0	0.10	193-39-5		Indeno[1,2,3-cd]pyrene	6.1E-01	ca	2.6E+00	ca	9.2E-03	ca	9.2E-02	ca	1.4E+01	7.0E-01
		4.0E-02	n			4.0E-02	r	1	0.10	91-20-3		Naphthalene	2.4E+02	sat	2.4E+02	sat	1.5E+02	nc	2.4E+02	nc	8.4E+01	4.0E+00
		3.0E-02	i			3.0E-02	r	1	0.10	129-00-0		Pyrene	1.0E+02	sat	1.0E+02	sat	1.1E+02	nc	1.8E+02	nc	4.2E+03	2.1E+02
1.5E-01	i	9.0E-03	i	1.5E-01	r	9.0E-03	r	0	0.10	67747-09-5		Prochloraz	3.0E+00	ca	1.3E+01	ca	4.5E-02	ca	3.3E+02	ca		
		6.0E-03	h			6.0E-03	r	0	0.10	26399-36-0		Profluralin	3.9E+02	nc	4.1E+03	nc	2.2E+01	nc	2.2E+02	nc		
		1.5E-02	i			1.5E-02	r	0	0.10	1610-18-0		Prometon	9.8E+02	nc	1.0E+04	nc	5.5E+01	nc	5.5E+02	nc		
		4.0E-03	i			4.0E-03	r	0	0.10	7287-19-6		Prometryn	2.6E+02	nc	2.7E+03	nc	1.5E+01	nc	1.5E+02	nc		
		7.5E-02	i			7.5E-02	r	0	0.10	23950-58-5		Pronamide	4.9E+03	nc	5.1E+04	nc	2.7E+02	nc	2.7E+03	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	1918-16-7		Propachlor	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		

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TOXICITY INFORMATION												CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.			Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
		5.0E-03	i			5.0E-03	r	0	0.10	709-98-8		Propanil	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	2312-35-8		Propargite	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-03	i			2.0E-03	r	0	0.10	107-19-7		Propargyl alcohol	1.3E+02	nc	1.4E+03	nc	7.3E+00	nc	7.3E+01	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	139-40-2		Propazine	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-02	i			2.0E-02	r	0	0.10	122-42-9		Propham	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	60207-90-1		Propiconazole	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
		2.0E+01	h			2.0E+01	r	0	0.10	57-55-6		Propylene glycol	1.0E+05	max	1.0E+05	max	7.3E+04	nc	7.3E+05	nc		
		7.0E-01	h			7.0E-01	r	0	0.10	111-35-3		Propylene glycol, monoethyl ether	4.6E+04	nc	1.0E+05	max	2.6E+03	nc	2.6E+04	nc		
		7.0E-01	h			5.7E-01	i	0	0.10	107-98-2		Propylene glycol, monomethyl ether	4.6E+04	nc	1.0E+05	max	2.1E+03	nc	2.6E+04	nc		
2.4E-01	i	8.6E-03	r	1.3E-02	i	8.6E-03	i	1	0.10	75-56-9		Propylene oxide					5.2E-01	ca	2.2E-01	ca		
		2.5E-01	i			2.5E-01	r	0	0.10	81335-77-5		Pursuit	1.6E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	51630-58-1		Pydrin	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
		1.0E-03	i			1.0E-03	r	0	0.10	110-86-1		Pyridine	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		5.0E-04	i			5.0E-04	r	0	0.10	13593-03-8		Quinalphos	3.3E+01	nc	3.4E+02	nc	1.8E+00	nc	1.8E+01	nc		
1.2E+01	h			1.2E+01	r			0	0.10	91-22-5		Quinoline	3.7E-02	ca	1.6E-01	ca	5.6E-04	ca	5.6E-03	ca		
1.1E-01	i	3.0E-03	i	1.1E-01	r	3.0E-03	r	0	0.10	121-82-4		RDX (Cyclonite)	4.0E+00	ca*	1.7E+01	ca	6.1E-02	ca	6.1E-01	ca		
		3.0E-02	i			3.0E-02	r	0	0.10	10453-86-8		Resmethrin	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
		5.0E-02	h			5.0E-02	r	0	0.10	299-84-3		Ronnel	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		4.0E-03	i			4.0E-03	r	0	0.10	83-79-4		Rotenone	2.6E+02	nc	2.7E+03	nc	1.5E+01	nc	1.5E+02	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	78578-05-0		Savey	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
		5.0E-03	i					0	0.10	7783-00-8		Selenious Acid	3.3E+02	nc	3.4E+03	nc			1.8E+02	nc		
		5.0E-03	i					0	0.01	7782-49-2		Selenium	3.8E+02	nc	8.5E+03	nc			1.8E+02	nc	5.0E+00	3.0E-01
		5.0E-03	h					0	0.10	630-10-4		Selenourea	3.3E+02	nc	3.4E+03	nc			1.8E+02	nc		
		9.0E-02	i			9.0E-02	r	0	0.10	74051-80-2		Sethoxydim	5.9E+03	nc	6.1E+04	nc	3.3E+02	nc	3.3E+03	nc		
		5.0E-03	i					0	0.01	7440-22-4		Silver and compounds	3.8E+02	nc	8.5E+03	nc			1.8E+02	nc	3.4E+01	2.0E+00
1.2E-01	h	5.0E-03	i	1.2E-01	r	2.0E-03	r	0	0.10	122-34-9		Simazine	3.7E+00	ca*	1.6E+01	ca*	5.6E-02	ca	5.6E-01	ca		
		4.0E-03	i			4.0E-03	r	0	0.10	26628-22-8		Sodium azide	2.6E+02	nc	2.7E+03	nc	1.5E+01	nc	1.5E+02	nc		
2.7E-01	h	3.0E-02	i	2.7E-01	r	3.0E-02	r	0	0.10	148-18-5		Sodium diethyldithiocarbamate	1.6E+00	ca	7.1E+00	ca	2.5E-02	ca	2.5E-01	ca		
		2.0E-05	i			2.0E-05	r	0	0.10	62-74-8		Sodium fluoroacetate	1.3E+00	nc	1.4E+01	nc	7.3E-02	nc	7.3E-01	nc		
		1.0E-03	h			1.0E-03	r	0	0.10	13718-26-8		Sodium metavanadate	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		6.0E-01	i					0	0.01	7440-24-6		Strontium, stable	4.6E+04	nc	1.0E+05	max			2.2E+04	nc		
		3.0E-04	i			3.0E-04	r	0	0.10	57-24-9		Strychnine	2.0E+01	nc	2.0E+02	nc	1.1E+00	nc	1.1E+01	nc		
		2.0E-01	i			2.9E-01	i	1	0.10	100-42-5		Styrene	6.8E+02	sat	6.8E+02	sat	1.1E+03	nc	1.6E+03	nc	4.0E+00	2.0E-01
		2.5E-02	i			2.5E-02	r	0	0.10	88671-89-0		Systhane	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
1.5E+05	h			1.5E+05	h			0	0.03	1746-01-6		2,3,7,8-TCDD (dioxin)	3.8E-06	ca	2.4E-05	ca	4.5E-08	ca	4.5E-07	ca		
		7.0E-02	i			7.0E-02	r	0	0.10	34014-18-1		Tebuthiuron	4.6E+03	nc	4.8E+04	nc	2.6E+02	nc	2.6E+03	nc		
		2.0E-02	h			2.0E-02	r	0	0.10	3383-96-8		Temephos	1.3E+03	nc	1.4E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	5902-51-2		Terbacil	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
		2.5E-05	h			2.5E-05	r	0	0.10	13071-79-9		Terbufos	1.6E+00	nc	1.7E+01	nc	9.1E-02	nc	9.1E-01	nc		
		1.0E-03	i			1.0E-03	r	0	0.10	886-50-0		Terbutryn	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		3.0E-04	i			3.0E-04	r	0	0.10	95-94-3		1,2,4,5-Tetrachlorobenzene	2.0E+01	nc	2.0E+02	nc	1.1E+00	nc	1.1E+01	nc		
2.0E-02	i	3.0E-02	i	2.6E-02	i	3.0E-02	r	1	0.10	630-20-6		1,1,1,2-Tetrachloroethane	2.4E+00	ca	5.4E+00	ca	2.6E-01	ca	4.3E-01	ca		
2.0E-01	i			2.0E-01	i			1	0.10	79-34-5		1,1,2,2-Tetrachloroethane	4.5E-01	ca	1.1E+00	ca	3.3E-02	ca	5.5E-02	ca	3.0E-03	2.0E-04
5.2E-02	n	1.0E-02	i	2.0E-03	n	1.0E-02	r	1	0.10	127-18-4		Tetrachloroethylene (PCE)	5.4E+00	ca	1.7E+01	ca	3.3E+00	ca	1.1E+00	ca	6.0E-02	3.0E-03

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TOXICITY INFORMATION										CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
										"CAL-Modified PRG" (PEA, 1994)						3.2E-01					
		3.0E-02	i			3.0E-02	r	0	0.10	58-90-2	2,3,4,6-Tetrachlorophenol	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
2.0E+01	h			2.0E+01	r			0	0.10	5216-25-1	p,a,a,a-Tetrachlorotoluene	2.2E-02	ca	9.5E-02	ca	3.4E-04	ca	3.4E-03	ca		
2.4E-02	h	3.0E-02	i	2.4E-02	r	3.0E-02	r	0	0.10	961-11-5	Tetrachlorovinphos	1.9E+01	ca	7.9E+01	ca	2.8E-01	ca	2.8E+00	ca		
		5.0E-04	i			5.0E-04	r	0	0.10	3689-24-5	Tetraethyldithiopyrophosphate	3.3E+01	nc	3.4E+02	nc	1.8E+00	nc	1.8E+01	nc		
		7.0E-05	h					0	0.01	1314-32-5	Thallic oxide	5.4E+00	nc	1.2E+02	nc			2.6E+00	nc		
		9.0E-05	i					0	0.01	563-68-8	Thallium acetate	6.9E+00	nc	1.5E+02	nc			3.3E+00	nc	7.0E-01	4.0E-01
		8.0E-05	i					0	0.01	6533-73-9	Thallium carbonate	6.1E+00	nc	1.4E+02	nc			2.9E+00	nc	7.0E-01	4.0E-01
		8.0E-05	i					0	0.01	7791-12-0	Thallium chloride	6.1E+00	nc	1.4E+02	nc			2.9E+00	nc	7.0E-01	4.0E-01
		9.0E-05	i					0	0.01	10102-45-1	Thallium nitrate	6.9E+00	nc	1.5E+02	nc			3.3E+00	nc	7.0E-01	4.0E-01
		9.0E-05	x					0	0.01	12039-52-0	Thallium selenite	6.9E+00	nc	1.5E+02	nc			3.3E+00	nc	7.0E-01	4.0E-01
		8.0E-05	i					0	0.01	7446-18-6	Thallium sulfate	6.1E+00	nc	1.4E+02	nc			2.9E+00	nc	7.0E-01	4.0E-01
		1.0E-02	i			1.0E-02	r	0	0.10	28249-77-6	Thiobencarb	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		3.0E-02	x			3.0E-02	r	0	0.10	3689-24-5	2-(Thiocyanomethylthio)- benzothiazole (TCMTB)	2.0E+03	nc	2.0E+04	nc	1.1E+02	nc	1.1E+03	nc		
		3.0E-04	h			3.0E-04	r	0	0.10	39196-18-4	Thiofanox	2.0E+01	nc	2.0E+02	nc	1.1E+00	nc	1.1E+01	nc		
		8.0E-02	i			8.0E-02	r	0	0.10	23564-05-8	Thiophanate-methyl	5.2E+03	nc	5.5E+04	nc	2.9E+02	nc	2.9E+03	nc		
		5.0E-03	i			5.0E-03	r	0	0.10	137-26-8	Thiram	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		6.0E-01	h					0	0.01	n/a	Tin (inorganic, see tributyltin oxide for organic tin)	4.6E+04	nc	1.0E+05	max			2.2E+04	nc		
		2.0E-01	i			1.1E-01	h	1	0.10	108-88-3	Toluene	7.9E+02	nc	8.8E+02	sat	4.0E+02	nc	7.2E+02	nc	1.2E+01	6.0E-01
3.2E+00	h			3.2E+00	r			0	0.10	95-80-7	Toluene-2,4-diamine	1.4E-01	ca	6.0E-01	ca	2.1E-03	ca	2.1E-02	ca		
		6.0E-01	h			6.0E-01	r	0	0.10	95-70-5	Toluene-2,5-diamine	3.9E+04	nc	1.0E+05	max	2.2E+03	nc	2.2E+04	nc		
		2.0E-01	h			2.0E-01	r	0	0.10	823-40-5	Toluene-2,6-diamine	1.3E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
1.9E-01	i			1.9E-01	r			0	0.10	106-49-0	p-Toluidine	2.3E+00	ca	1.0E+01	ca	3.5E-02	ca	3.5E-01	ca		
1.1E+00	i			1.1E+00	i			0	0.10	8001-35-2	Toxaphene	4.0E-01	ca	1.7E+00	ca	6.0E-03	ca	6.1E-02	ca	3.1E+01	2.0E+00
		7.5E-03	i			7.5E-03	r	0	0.10	66841-25-6	Tralomethrin	4.9E+02	nc	5.1E+03	nc	2.7E+01	nc	2.7E+02	nc		
		1.3E-02	i			1.3E-02	r	0	0.10	2303-17-5	Triallate	8.5E+02	nc	8.9E+03	nc	4.7E+01	nc	4.7E+02	nc		
		1.0E-02	i			1.0E-02	r	0	0.10	62097-30-5	Triasulfuron	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		5.0E-03	i			5.0E-03	r	0	0.10	615-54-3	1,2,4-Tribromobenzene	3.3E+02	nc	3.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		3.0E-05	i			3.0E-05	r	0	0.10	56-35-9	Tributyltin oxide (TBTO)	2.0E+00	nc	2.0E+01	nc	1.1E-01	nc	1.1E+00	nc		
3.4E-02	h			3.4E-02	r			0	0.10	634-93-5	2,4,6-Trichloroaniline	1.3E+01	ca	5.6E+01	ca	2.0E-01	ca	2.0E+00	ca		
2.9E-02	h			2.9E-02	i			0	0.10	33663-50-2	2,4,6-Trichloroaniline hydrochloride	1.5E+01	ca	6.6E+01	ca	2.3E-01	ca	2.3E+00	ca		
		1.0E-02	i			5.7E-02	h	1	0.10	120-82-1	1,2,4-Trichlorobenzene	5.7E+02	nc	5.5E+03	sat	2.1E+02	nc	1.9E+02	nc	5.0E+00	3.0E-01
		3.5E-02	n			2.8E-01	x	1	0.10	71-55-6	**1,1,1-Trichloroethane**	1.2E+03	nc	3.0E+03	sat	1.0E+03	nc	7.9E+02	nc	2.0E+00	1.0E-01
5.7E-02	i	4.0E-03	i	8.6E-02	i	4.0E-03	r	1	0.10	79-00-5	1,1,2-Trichloroethane	6.5E-01	ca	1.5E+00	ca	1.2E-01	ca	2.0E-01	ca	2.0E-02	9.0E-04
1.1E-02	n	6.0E-03	n	8.0E-03	n	5.0E-03	r	1	0.10	79-01-6	Trichloroethylene (TCE)	3.2E+00	ca*	7.0E+00	ca*	1.1E+00	ca*	1.6E+00	ca*	6.0E-02	3.0E-03
		3.0E-01	i			2.0E-01	h	1	0.10	75-69-4	Trichlorofluoromethane	3.8E+02	nc	1.3E+03	nc	7.3E+02	nc	1.3E+03	nc		
		1.0E-01	i			1.0E-01	r	0	0.10	95-95-4	2,4,5-Trichlorophenol	6.5E+03	nc	6.8E+04	nc	3.7E+02	nc	3.7E+03	nc	2.7E+02	1.4E+01
1.1E-02	i			1.1E-02	i			0	0.10	88-06-2	2,4,6-Trichlorophenol	4.0E+01	ca	1.7E+02	ca	6.2E-01	ca	6.1E+00	ca	2.0E-01	8.0E-03
		1.0E-02	i			1.0E-02	r	0	0.10	93-76-5	2,4,5-Trichlorophenoxyacetic Acid	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
		8.0E-03	i			8.0E-03	r	0	0.10	93-72-1	2-(2,4,5-Trichlorophenoxy) propionic acid	5.2E+02	nc	5.5E+03	nc	2.9E+01	nc	2.9E+02	nc		
		5.0E-03	i			5.0E-03	r	1	0.10	598-77-6	1,1,2-Trichloropropane	1.5E+01	nc	5.0E+01	nc	1.8E+01	nc	3.0E+01	nc		
7.0E+00	h	6.0E-03	i	7.0E+00	r	5.0E-03	r	1	0.10	96-18-4	1,2,3-Trichloropropane	1.4E-03	ca	3.1E-03	ca	9.6E-04	ca	1.6E-03	ca		
		5.0E-03	h			5.0E-03	r	1	0.10	96-19-5	1,2,3-Trichloropropene	1.1E+01	nc	3.8E+01	nc	1.8E+01	nc	3.0E+01	nc		
		3.0E+01	i			8.6E+00	h	1	0.10	76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	5.6E+03	sat	5.6E+03	sat	3.1E+04	nc	5.9E+04	nc		

California State Preliminary Remedial Goals
For Planning Purposes

Key : i=IRIS h=HEAST n=NCEA x=WITHDRAWN r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

TOXICITY INFORMATION												CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)								OIL SCREENING LEVEL	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.			Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Groundwater DAF 20 (mg/kg)	DAF 1 (mg/kg)
		3.0E-03	i			3.0E-03	r	0	0.10	58138-08-2		Tridiphane	2.0E+02	nc	2.0E+03	nc	1.1E+01	nc	1.1E+02	nc		
		2.0E-03	r			2.0E-03	i	1	0.10	121-44-8		Triethylamine	2.3E+01	nc	8.4E+01	nc	7.3E+00	nc	1.2E+01	nc		
7.7E-03	i	7.5E-03	i	7.7E-03	r	7.5E-03	r	0	0.10	1582-09-8		Trifluralin	5.8E+01	ca**	2.5E+02	ca*	8.7E-01	ca*	8.7E+00	ca*		
3.7E-02	h			3.7E-02	r			0	0.10	512-56-1		Trimethyl phosphate	1.2E+01	ca	5.2E+01	ca	1.8E-01	ca	1.8E+00	ca		
		5.0E-05	i			5.0E-05	r	0	0.10	99-35-4		1,3,5-Trinitrobenzene	3.3E+00	nc	3.4E+01	nc	1.8E-01	nc	1.8E+00	nc		
		1.0E-02	h			1.0E-02	r	0	0.10	479-45-8		Trinitrophenylmethylnitramine	6.5E+02	nc	6.8E+03	nc	3.7E+01	nc	3.7E+02	nc		
3.0E-02	i	5.0E-04	i	3.0E-02	i	5.0E-04	r	0	0.10	118-96-7		2,4,6-Trinitrotoluene	1.5E+01	ca**	6.4E+01	ca**	2.2E-01	ca**	2.2E+00	ca**		
		3.0E-03	i					0	0.01	7440-61-1		Uranium (soluble salts)										
		7.0E-03	h					0	0.01	7440-62-2		Vanadium	5.4E+02	nc	1.2E+04	nc			2.6E+02	nc	6.0E+03	3.0E+02
		9.0E-03	i					0	0.01	1314-62-1		Vanadium pentoxide	6.9E+02	nc	1.5E+04	nc			3.3E+02	nc	6.0E+03	3.0E+02
		2.0E-02	h					0	0.01	13701-70-7		Vanadium sulfate	1.5E+03	nc	3.4E+04	nc			7.3E+02	nc	6.0E+03	3.0E+02
		1.0E-03	i			1.0E-03	r	0	0.10	1929-77-7		Vernam	6.5E+01	nc	6.8E+02	nc	3.7E+00	nc	3.7E+01	nc		
		2.5E-02	i			2.5E-02	r	0	0.10	50471-44-8		Vinclozolin	1.6E+03	nc	1.7E+04	nc	9.1E+01	nc	9.1E+02	nc		
		1.0E+00	h			5.7E-02	i	1	0.10	108-05-4		**Vinyl acetate**	7.8E+02	nc	2.6E+03	nc	2.1E+02	nc	4.1E+02	nc	1.7E+02	8.0E+00
1.1E-01	r	8.5E-04	r	1.1E-01	h	8.6E-04	i	1	0.10	593-60-2		**Vinyl bromide (bromoethene)**	1.9E-01	ca*	4.1E-01	ca*	6.1E-02	ca*	1.0E-01	ca*		
1.9E+00	h			3.0E-01	h			1	0.10	75-01-4		Vinyl chloride	1.6E-02	ca	3.5E-02	ca	2.2E-02	ca	2.0E-02	ca	1.0E-02	7.0E-04
		3.0E-04	i			3.0E-04	r	0	0.10	81-81-2		Warfarin	2.0E+01	nc	2.0E+02	nc	1.1E+00	nc	1.1E+01	nc		
		2.0E+00	i			2.0E-01	x	1	0.10	108-38-3		m-Xylene	3.2E+02	sat	3.2E+02	sat	7.3E+02	nc	1.4E+03	nc	2.1E+02	1.0E+01
		2.0E+00	i			2.0E-01	x	1	0.10	95-47-6		o-Xylene	3.2E+02	sat	3.2E+02	sat	7.3E+02	nc	1.4E+03	nc	1.9E+02	9.0E+00
								1	0.10	106-42-3		p-Xylene	3.2E+02	sat	3.2E+02	sat					2.0E+02	1.0E+01
		2.0E+00	i			2.0E-01	x	1	0.10	1330-20-7		Xylene (mixed)	3.2E+02	sat	3.2E+02	sat	7.3E+02	nc	1.4E+03	nc	2.0E+02	1.0E+01
		3.0E-01	i					0	0.01	7440-66-6		Zinc	2.3E+04	nc	1.0E+05	max			1.1E+04	nc	1.2E+04	6.2E+02
		3.0E-04	i					0	0.01	1314-84-7		Zinc phosphide	2.3E+01	nc	5.1E+02	nc			1.1E+01	nc		
		5.0E-02	i			5.0E-02	r	0	0.10	12122-67-7		Zineb	3.3E+03	nc	3.4E+04	nc	1.8E+02	nc	1.8E+03	nc		