Remedial Investigation of the High-Explosives (HE) Process Area, Lawrence Livermore National Laboratory Site 300

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Executive Summary

This report presents the results of a Remedial Investigation (RI) to define the extent of high explosives (HE) compounds and volatile organic compounds (VOCs) found in the soil, rocks, and ground water of the HE Process Area of Lawrence Livermore National Laboratory's (LLNL) Site 300 Facility. The report evaluates potential public health and environmental risks associated with these compounds. Hydrogeologic information available before February 15, 1990, is included; however, chemical analyses and water-level data are reported through March 1990.

This report is intended to assist the California Regional Water Quality Control Board (RWQCB)—Central Valley Region and the U.S. Environmental Protection Agency (EPA) in evaluating the extent of environmental contamination of the LLNL HE Process Area and ultimately in designing remedial actions.

Many of the discussions presented in this report are based on published reports, modified with new information. These reports are:

- Raber and Carpenter, 1983;
- Raber, 1983;
- Steenhoven and Crow, 1986;
- Crow *et al.*, 1986;
- Carpenter *et al.*, 1988;
- Quarterly issues of LLNL's Site 300 Environmental Investigations Quarterly; and
- The Draft California Environmental Impact Report (Draft EIR) prepared for the University of California Board of Regents to support LLNL's contract renewal in 1987 (University of California, 1986).

As background information, this report provides details on the environment, geology, and hydrogeology of parts of Site 300 to facilitate a more thorough understanding of the distribution of contaminants in the HE Process Area. Although our knowledge of the geology and hydrogeology of the HE Process Area is relatively complete, some relationships that affect contaminant distribution remain uncertain. Therefore, investigations will continue and supplementary reports will follow.

Prior to 1985, rinsewater containing low concentrations of HE compounds was discharged from various HE processing facilities into evaporation lagoons. Some of the water infiltrated the soil and rock beneath the lagoons, leaving environmental concentrations of RDX and HMX. The concentrations of RDX and HMX are generally less than 1mg/kg (ppm). Subsequent environmental investigations conducted between 1986 and 1988 resulted in closure of the lagoons in accordance with a closure plan approved by the RWQCB. This closure was completed in October 1989.

In 1985, low concentrations of RDX were detected in ground water near Building 817 in the HE Process Area. The maximum detected concentration of RDX in ground water is 350 µg/L (ppb). Since then, investigations have determined RDX to be present in small areas of two aquifers beneath Buildings 815 and 817. One of the aquifers is a perched aquifer; the other is the water table aquifer in the region. To date, no HE compounds have been detected in the deeper regional confined aquifer at Site 300. Despite intensive investigations, the location of the release site of the RDX remains uncertain.

During our evaluation of the environmental significance of the occurrence, we found that no regulatory drinking water standard for RDX exists. The U.S. Army has sponsored research that resulted in a suggested drinking water criterion (Etnier, 1989) of 105 $\mu\text{g/L}$ (ppb) RDX. This criterion was used as a basis for issuance of a National Pollution Discharge Elimination System (NPDES) permit at the Army Ammunition Plant in Grand Island, Nebraska. Comparison of the concentrations of RDX encountered in ground water samples in the HE Process Area with this criterion indicates that RDX concentrations in perched aquifer ground water are somewhat higher than the 105 $\mu\text{g/L}$ criterion. Concentrations in ground water from the water table aquifer are slightly above to well below the suggested criterion. In recent months, the higher values for RDX detected in sets of duplicate samples have been near or slightly above the suggested drinking water criterion, but the mean is less than the 105 $\mu\text{g/L}$ criterion.

Around the Building 815 Area, trichloroethylene (TCE) has also been detected in ground water from the perched aquifer and the first water table aquifer of the HE Process Area. The area where TCE has been detected overlaps the area containing RDX, but the two areas do not exactly coincide. The release site of the TCE is probably at Building 815, where TCE was used to clean a steam boiler and was stored on a hardstand near the building. In this area, TCE in ground water from the two aquifers exceeds the Federal and California Maximum Contaminant Level (MCL) of 5 $\mu\text{g/L}$ (ppb). The maximum detected TCE concentration is 280 $\mu\text{g/L}$ (ppb) in water from a well installed immediately adjacent to Building 815. No TCE has ever been found in the regional confined aquifer beneath the HE Process Area.

In a forthcoming Feasibility Study (FS), alternative methods of remediation will be considered for ground water containing HE compounds and/or TCE.

Chapter 1. Site Background Information

1.1. Description of Site 300

LLNL, operated by the University of California for the U.S. Department of Energy (DOE), began operations in 1952 to design and test nuclear weapons and research magnetic fusion. Since 1952, LLNL has added other major programs including:

- Applied laser fusion research,
- Laser isotope separation,
- Biomedical and environmental studies, and
- Applied energy technologies.

In 1955, LLNL established Site 300 as an HE test area. Site 300 is located in the southeastern Altamont Hills, which are part of the Coast Range Physiographic Province. The site lies about 15 miles southeast of Livermore and 8.5 miles southwest of Tracy, California. Figure 1.1-1 shows its location relative to LLNL and regional points of reference. Site 300 covers about 11 square miles (6,888 acres) and is primarily located in San Joaquin County (Fig. 1.1-2). About one-sixth of the property, along the western edge, lies in Alameda County. The climate is semiarid, and the topography (Plate 1, see note below) is characterized by moderate to steep hills and deep canyons. Because of these features, cultivation was never practical, and the only prior land use was for sheep and cattle grazing. Plate 2 (see note below) shows the generalized geology of Site 300.

Site 300 operations include four programmatic activities:

- Hydrodynamic diagnostic testing;
- Charged particle-beam research (currently not in operation)
- Physical, environmental, and dynamic testing; and
- HE formulation and fabrication.

Access to Site 300 is restricted.

The General Services Area (GSA) supplies centralized administrative, technical, and crafts support to all operational areas. The location of each area is shown on Figure 1.1-2.

1.2. Description of the HE Process Area

The HE Process Area is in the south-central part of Site 300. Chemical operations include formulation of HE compounds for experiments. Mechanical operations include pressing and machining parts containing HE compounds. The HE Process Area occupies about 285 acres (B. Jahn, LLNL, personal communication, 1989). Plate 3 shows the topography of the area and the locations of active facilities. The steep hills and ravines provide naturally protective sites for the construction of the facilities and explosives storage magazines. These facilities are also designed for maximum personnel safety.

Buildings 812, 814, and 819, located just east of the HE Process Area, serve functions related to it and are included in the discussions in this report. The Building 829 Complex (the HE Burn Pit), located in the northwest part of the HE Process Area, is used for burning HE scrap and waste. Refer to Webster-Scholten and Crow (1989) for the results of an RI of the Burn Pit, not discussed in this report.

Note: Plates 1 and 2 are in pocket folders at the end of this document.

Figure 1.1-1. Location of LLNL and Site 300.

Figure 1.1-2. Location of HE Process Area and other areas of interest at Site 300.

1.3. Summary of Waste Disposal History, HE Process Area

Operations in the HE Process Area use process tap water to fabricate experimental devices containing HE compounds. Water is also used to formulate explosives and to cool and lubricate machining operations.

Until 1985, process rinsewater, containing low concentrations of the HE compounds cyclo-1,3,5-trimethylene-2,4,6-trinitramine (RDX) and cyclo-tetramethylene-tetranitramine (HMX), was discharged into nine shallow lagoons where the rinsewater evaporated and infiltrated the rocks and soil beneath the lagoons. RDX and HMX were developed in the United Kingdom during World War II. RDX is an acronym for Research Department Explosive, and HMX signifies *High Melting Point Explosive*.

The nine lagoons were decommissioned in late 1985, and the HE rinsewater that formerly drained to the lagoons is now diverted to two surface ponds (the HE Surface Impoundments), with double impermeable liners, located south of Building 817 (Plate 3). See Section 3.1.2 for details.

1.4. Previous Investigations

1.4.1. Extent of HE Compounds in Soil and Rock

In 1981, investigations of potential chemical releases within the HE Process Area began with the Hazardous Waste Assessment Project (HWAP). This included a study of the hydrology, geology, and ground water chemistry associated with the lagoons in the HE Process Area (Raber, 1983). The studies included a reconnaissance to determine the scope of potential environmental problems and limited hydrogeological studies of infiltration at several of the HE Process Area rinsewater lagoons (Raber, 1983). The installation of the HE Surface Impoundments in 1984 was accompanied by the drilling of a network of monitoring wells. These monitor wells are the nucleus of the extended network of monitor wells established during later investigations.

Between 1986 and 1988, LLNL investigated the extent of HE compounds in soil and rock beneath the decommissioned lagoons. LLNL drilled 42 exploratory boreholes during this period (see Chapter 8). Analytical data from soil and rock samples are in Appendix A. Chemical analyses of ground water samples are presented in Appendix B. Drillers' logs of the boreholes and monitor wells drilled since July 1, 1988, are in Appendix C. Earlier logs are in Toney and Crow (1989).

In 1988, when these investigations were completed, LLNL proposed a closure plan for the decommissioned lagoons (Carpenter *et al.*, 1988). The report concluded that the decommissioned lagoons did not constitute a significant threat to human health, safety, or the environment, and that they could be closed successfully by backfilling the lagoons and installing impermeable clay caps with additional safeguards such as drainage diversion ditches. The closure plan was accepted by the RWQCB-Central Valley Region with a few modifications. Closure of the decommissioned lagoons was completed in October 1989.

1.4.2. Extent of HE Compounds in Ground Water

In April 1985, the HE compound RDX was first discovered at 37 $\mu\text{g/L}$ (ppb) in ground water collected from monitor well W-817-01, located near Building 817 (Plates 3 and 4). Due to this, LLNL drilled 17 monitor wells in and near the HE Process Area to gather information (see Chapter 8 for detailed results). In October and November 1989, HMX was detected for the first time in monitor well W-817-01 in low concentrations (a mean of 38 $\mu\text{g/L}$ HMX) in ground water from the HE Process Area. More recent samples, collected from this monitor well in the winter and spring of 1990, do not contain HMX. Therefore we are uncertain if HMX is present in this ground water. The concentrations of HE compounds detected in water from these wells is presented in Appendix B; a summary of the RDX concentrations is in Table 8.2-1.

Plate 3. HE Process Area, showing facilities.

1.4.3. Extent of VOCs in Soil and Rock and in Ground Water

Low concentrations of VOCs are present in a limited area near, and south of, Building 815. The VOC detected most often is TCE. TCE was first detected in ground water samples collected during April 1987 (280 ug/L [ppb]). Since then, monitor wells have been drilled that place partial bounds on the area containing TCE. We are continuing our work to establish a bound on the eastern side of the area.

Traces of several other VOCs have also been reported in water samples scattered over several samplings from several monitor wells in the HE Process Area (at concentrations less than federal MCLs). See Chapter 8 for details.

Chapter 2. Environmental Setting

2.1. Areas Surrounding Site 300

2.1.1. Demography

One reason Site 300 was selected as the location for LLNL's high-explosives (HE) testing experiments is because of the sparsely populated surrounding area. Most of the neighboring land owners do not live on their properties. On the basis of residential population, the average density is less than one person per square mile around the perimeter of Site 300.

2.1.2. Land Use

2.1.2.1. Present Uses. Figure 2.1.2-1 shows the land use distribution in the vicinity of Site 300. Major users to the south and east include:

1. Carnegie State Vehicle Recreation Area (SVRA), an outdoor recreational facility for private and commercial offroad motorcycle riding, testing, and racing.
2. SRI International, which operates an explosives test site in the hills south of Carnegie SVRA.
3. The Gallo and the Connolly Ranches, used primarily for cattle grazing.
4. Physics International, a private firm that operates another explosives test facility adjacent to the northeast side of Site 300.
5. California Department of Fish and Game open land, which currently has no public access.

The California Department of Forestry operates the Castle Rock Fire Station, located on the Connolly property on Corral Hollow Road near the southeast corner of the site. Immediately north of Site 300 lies rangeland owned by the Mulqueeny, Yroz, and Vieira families. To the east are other smaller parcels of rangeland. Several private residences are located along Corral Hollow Road, west of Site 300 and the Carnegie SVRA. Surrounding Site 300 on the west, north, and east are farms and ranches used primarily for cattle grazing. These latter properties are generally characterized by absentee ownership.

Permanent residents live on the Connolly Ranch and at the ranger headquarters for the Carnegie SVRA. The Connolly family lives in a house on the ranch property, and the ranger and his family occupy a mobile home located on state property north of Corral Hollow Road.

The Castle Rock Fire Station has no permanent residents. The station, used as a staging area for brush and grass fire fighting in the Altamont Hills and the Diablo Range, is fully-manned with 8 fire-fighters only during the fire season (May–October). At times during the winter, two persons are assigned to the station. The Carnegie SVRA is open to the public for off-road motorcycling. It is the most heavily used area near Site 300; on peak weekends, 500 to 1000 visitors use the SVRA almost entirely on a day-use basis.

2.1.2.2. Historic Uses. The modern history of the Corral Hollow area began during the Mexican period (1800 to 1846), when it served as a major trade route between the Central Valley and San Jose. Throughout most of the 19th century, it was sparsely populated, and economic activities were limited to raising livestock, timber cutting, and coal mining; the latter was only

Legend

- Federal Materials Testing & Research
- Private Materials Testing & Research
- Private Range Land
- Residential Land
- Carnegie State Vehicle Recreation Area

- G= Gallo Ranch
- C= Connolly Ranch
- M= Mulqueeney Ranch
- Y= Yroz Ranch Land
- V= Vieira Ranch Land
- O= Other Ranch Land
- PI= Physics International
- SRI= SRI International

- Castle Rock Fire Station
- Hetch Hetchy Aqueduct
- Interstate 580
- Broadcasting tower

Scale: Feet
0 2000 4000

Figure 2.1.2-1. Land use in the vicinity of Site 300.

marginally productive. However, before the turn of the century, coal and clay mining in the Corral Hollow area were profitable. Several settlements were established in the vicinity of what is now Site 300. Carnegie, the largest of the towns, was located east of Pit 6 (Fig. 1.1-2). Although abandoned in 1912, during its peak period Carnegie had churches, schools, company stores, a hotel, saloons, boarding houses, and company-supplied family housing. An archaeological survey in 1981 (Busby *et al.*, 1981) revealed four aboriginal sites and 21 historical sites within the boundaries of Site 300. Many of the historical sites were associated with the Carnegie development.

2.1.3. Vegetation

The area surrounding and including Site 300 is primarily grassland, although an oak woodland community exists in the hills to the south. Annual grasses cover both Site 300 and the adjacent hills. Isolated scrub oak trees grow on north-facing hills. With the exception of sagebrush, less vegetation is present on hills with southern exposures. Deciduous trees grow along the Corral Hollow creek bed, but vegetation elsewhere is generally limited to seasonal grasses and localized areas of brush. (Table 2.2.3-1 lists the species of vegetation in the vicinity of Site 300.)

2.1.4. Wildlife

Many species of mammals, reptiles, insects, and birds live in the grassland and oak woodland community around Site 300. Mammals consist of rodents, such as mice, gophers, and squirrels, which feed on the plants and grasses. Larger mammals include deer, badger, coyote, fox, and bobcat. Reptiles include several varieties of snakes and lizards. There is a large variety of birds, although their population is limited due to the lack of trees to serve as a shelter from predators. Although some species of birds roost and nest elsewhere, many depend on the Site 300 region for its abundant supply of seeds and insects. (Table 2.2.4-1 lists mammals in the Site 300 area.)

2.1.5. Surface and Ground Water Use

Site 300 lies within the San Joaquin River drainage basin. Except following the largest storms, no water reaches the San Joaquin River from Corral Hollow Creek. Normally, there is little to no surface water at or near Site 300. During very heavy winter storms, rainfall runs off in otherwise dry watercourses (Fig 2.1.5-1). Corral Hollow Creek, the major ephemeral stream of the region, flowed most recently during and after the historically wet winter and spring of 1983. Any streamflow tends to quickly infiltrate the streambed. Ultimately, Corral Hollow and the Elk Ravine drain to the San Joaquin River Basin. The only surface water used in the area surrounding Site 300 is seasonal drinking water for wildlife and cattle.

Local ground water from wells supplies essentially all domestic (except drinking) and livestock water requirements in the vicinity of Site 300. Bottled water is the source of drinking water. Springs, both onsite and offsite, do not represent significant water sources for year-round use. Figure 2.1.5-2 is a map of water-supply wells and seeps in the vicinity of Site 300.

2.1.6. Climate

The climate of the area surrounding Site 300 is generally characterized by mild, rainy winters and hot, dry summers. Sunshine is abundant throughout the year.

During winter, cyclonic storms of the westerlies affect the region and are accompanied by southerly or southwesterly winds and short rainy periods. As barometric lows pass, light snow sometimes falls over the higher elevations. Following passage of the low-pressure front, skies

Figure 2.1.5-1. Intermittent water courses, HE Process Area.

Figure 2.1.5-2. Planimetric map of Site 300 showing locations of water supply wells and springs.

typically clear as the Eastern Pacific High builds inland. Infrequently, strong northerly surface winds with gusts in excess of 60 mph are experienced for 1 to 2 days. During nonrainy periods, fog, which frequently forms in the San Joaquin Valley, may move over the area, particularly during December and January.

Summers are consistently hot and dry, although moist subtropical air occasionally spreads over central California and thunderstorms occur. A sea breeze often develops during the afternoon when modified marine air moves through the passes to the west and is funnelled through Corral Hollow. The velocity of the sea breeze occasionally exceeds 40 mph, but is usually in the range of 10 to 30 mph. A strong breeze can reduce maximum temperatures by 40°F. The breeze persists into the evening and sometimes throughout the night, resulting in significantly cooler mornings. If the marine air layer is sufficiently deep, stratus clouds are advected to within several miles of the western boundary of Site 300.

In contrast, daily temperature, wind speed, and wind direction vary during spring and fall.

2.2. Site 300

2.2.1. Work Force

From 1978 to 1987, the work force at Site 300 averaged 293 people. The work force for 1989 through the beginning of 1990 has been about 270 full-time employees and 30 supplemental employees. Over half of these personnel work in the GSA and are associated with site management, administrative, or support activities. With the exception of the charged particle-beam research program, most of the buildings in the operating areas are staffed by fewer than 10 people.

2.2.2. Land Use

Figures 2.1.2-1 and 2.1.5-2 show the active programmatic and support areas at Site 300.

Programmatic areas include:

- Hydrodynamic test facilities, located in two areas, the East and West Firing Areas.
- Charged particle-beam research, located northwest of the East Firing Area. This operation was not funded for 1990.
- The Environmental Test Facility for tests of physical, environmental, and dynamic properties of nonnuclear explosives assemblies. The major portion of the ETA is located in the southeast corner of the site. Building 854, in the west-central part of the site, is also used for such tests.
- The HE Process Area, the subject of this report. As part of its explosives testing, LLNL performs both chemical and mechanical processes on experimental components containing HE compounds, and assembles nonnuclear explosive test devices in the HE Process Area.

Site 300 explosives test facilities, including explosives mixing, pressing, machining operations and facilities, magazines, and test firing sites, were located so that the rugged topography of the site minimizes explosives test overpressure (shock waves) and maximizes test personnel safety. Personnel safety is a primary concern; therefore, LLNL has developed and continues to operate a very comprehensive safety program to prevent accidents. Remote control of explosives tests and fabrication operations, plus very strict control of access to facilities and the areas immediately surrounding them when high explosives are present, have been

instrumental in setting an excellent safety record. No individual has been injured by explosions since Site 300 began operations in 1955 (J. E. Lane, LLNL, personal communication, 1989).

Support areas include:

- The GSA in the southeastern part of the site, adjacent to Corral Hollow Creek.
- A peripheral buffer zone.

Table 2.2.2-1 lists these activities and their locations.

Table 2.2.2-1. Land use operating areas.

Activity	Location
Hydrodynamic testing	East and West Firing Area
Charged particle beam research (presently inactive)	East Firing Area
Physical, environmental, and dynamic testing	Southeast area of the site West Firing Area
High-explosive formulation	Southeast area of the site
Fabrication	Southeast area of the site

2.2.3. Vegetation

Site 300 is generally a grassland community, with some isolated brush and shallow-rooted trees. It is considered the only natural location for a rare species of wild flower, *Amsinckia grandiflora*. This plant, which grows to a height of about 10 in., was first discovered in the 1880s. It was later thought to be extinct until a small population was discovered at Site 300 in 1938 near the present site of Building 858 (Plate 4) in western Site 300. An additional population was discovered in 1988 near the site's western boundary. The plant meets the criteria for placement on the endangered species list, according to the Endangered Species Act of 1973.

Table 2.2.3-1 lists the plants commonly found within Site 300. Some are native to the area and occur in the surrounding area as well; others were planted as part of the landscaping.

2.2.4. Wildlife

Table 2.2.4-1 lists the wildlife species that reside part or most of the year within Site 300. Because hunting and activities associated with stock raising are prohibited at Site 300, the wildlife population has increased since 1955. No threatened or endangered species of wildlife is known to use this habitat.

A variety of snakes and lizards inhabit Site 300. Bird species include crows, turkey vultures, hawks, eagles, and smaller species. Many insect species also populate the area.

2.2.5. Surface and Ground Water

2.2.5.1. Surface Water. Except during unusually heavy winter storms, there is no permanent surface water at Site 300. The discussion in Section 2.1.5 applies to Site 300 as well as its near vicinity.

Table 2.2.3-1. Vegetation commonly observed at Site 300 (Taylor and Davilla, 1986).

<i>Achillea millefolium</i>	<i>Holocarpha obconica</i>
<i>Achyrochaena mollis</i>	<i>Hordeum leporinum</i>
<i>Allium serra</i>	<i>Juniperus californicus</i>
<i>Amsinckia intermedia</i>	<i>Lasthenia californica</i>
<i>Amsinckia menziesii</i>	<i>Linanthus bicolor</i>
<i>Amsinckia tesillata</i>	<i>Logfia gallica</i>
<i>Artemisia californica</i>	<i>Lotus subpinnatus</i>
<i>Astragalus didymocarpus</i>	<i>Lupinus bicolor</i>
<i>Avena barbata</i>	<i>Lupinus densiflorus lacteus</i>
<i>Brassica geniculata</i>	<i>Lupinus succulentus</i>
<i>Brassica nigra</i>	<i>Marah fabaceus agrestis</i>
<i>Bromus diandrus</i>	<i>Matricaria matricarioides</i>
<i>Bromus madritensis</i>	<i>Melica californica nevadensis</i>
<i>Bromus mollis</i>	<i>Microseris douglasii</i>
<i>Bromus rubens</i>	<i>Microseris lindleyi</i>
<i>Calochortus invenustus</i>	<i>Microseris gracilis</i>
<i>Carduus pycnocephalus</i>	<i>Mimulus guttatus</i>
<i>Caulanthus lasiophyllus</i>	<i>Monolopia major</i>
<i>Centaurea melatenis</i>	<i>Orthocarpus purpurascens</i>
<i>Chlorogalum pomeridianum</i>	<i>Plantago eriopoda</i>
<i>Clarkia purpurea</i>	<i>Poa scabrella</i>
<i>Claytonia parviflora</i>	<i>Polypogon interruptus</i>
<i>Claytonia perfoliata</i>	<i>Pterostegia drymerioides</i>
<i>Collinsia heterophylla</i>	<i>Quercus douglasii</i>
<i>Crassula erecta</i>	<i>Salvia mellifera</i>
<i>Delphinium gypsophilum</i>	<i>Santula bipinnata</i>
<i>Delphinium hesperium</i>	<i>Schismus arabicus</i>
<i>Delphinium patens</i>	<i>Senecio vulgaris</i>
<i>Dichloctemma pulchellum</i>	<i>Silene antirrhinam</i>
<i>Elymus triticoides</i>	<i>Silene gallica</i>
<i>Eremocarpus setigerus</i>	<i>Sitanion hystrix</i>
<i>Eriogonum angulosum</i>	<i>Sonchus aspera</i>
<i>Eriogonum fasciculatum</i>	<i>Sonchus oleraceus</i>
<i>Eriogonum nudum</i>	<i>Stellaria nitens</i>
<i>Erodium botrys</i>	<i>Stipa pulchra</i>
<i>Erodium cicutarium</i>	<i>Stylocline filaginea</i>
<i>Eschscholtzia californica</i>	<i>Stylocline gnaphaloides</i>
<i>Gallium aparine</i>	<i>Trifolium gracilentum</i>
<i>Gilia capitata abortanifolia</i>	<i>Trifolium oliganthum</i>
<i>Gilia tricolor</i>	<i>Trifolium tridentatum</i>
<i>Grindella camporum</i>	<i>Triteleia laxa</i>
<i>Gutierrezia bracteata</i>	<i>Typha latifolia</i>
<i>Hemizonia kelloggii</i>	<i>Vulpia microstachys</i>
<i>Herniaria cinerea</i>	<i>Vulpia myuros</i>

Table 2.2.4-1. Wildlife species observed or expected at Site 300 (Orloff, 1986).

	Observed	Expected
Class: Amphibia		
Tiger salamander (<i>Ambystoma tigrinum californense</i>)	X	
California slender salamander (<i>Batrachoseps attenuatus</i>)	X	
Western spadefoot (<i>Scaphiopus hammondi</i>)		X
Western toad (<i>Bufo boreas</i>)	X	
Pacific treefrog (<i>Hyla regilla</i>)	X	
Red-legged frog (<i>Rana aurora draytoni</i>)	X	
Class: Reptilia		
Long-nosed leopard lizard (<i>Gambella wislizenii</i>)		X
Desert spiny lizard (<i>Sceloporus magister</i>)		X
Western fence lizard (<i>Sceloporus occidentalis</i>)	X	
Sagebrush lizard (<i>Sceloporus graciosus</i>)		X
Side-blotched lizard (<i>Uta stansburiana</i>)	X	
Coast horned lizard (<i>Phrynosoma coronatum</i>)	X	
Western skink (<i>Eumeces skiltonianus</i>)	X	
Gilbert's skink (<i>Eumeces gilberti</i>)	X	
Western whiptail (<i>Cnemidophorus tigris</i>)		X
Northern alligator lizard (<i>Gerrhonotus coeruleus</i>)	X	
Ringneck snake (<i>Diadophis punctatus</i>)		X
Racer (<i>Coluber constrictor</i>)	X	
Coachwhip (<i>Masticophis flagellum</i>)	X	
Alameda striped racer (<i>Masticophis lateralis euryxanthus</i>)	X	
Glossy snake (<i>Arizona elegans</i>)		X
Gopher snake (<i>Pituophis melanoleucus</i>)	X	
Common kingsnake (<i>Lampropeltis getulus</i>)	X	
Common garter snake (<i>Thamnophis sirtalis</i>)	X	
Western black-headed snake (<i>Tantilla planiceps</i>)		X
Western rattlesnake (<i>Crotalus viridis</i>)	X	
Long-nosed snake (<i>Rhinocheilus lecontei</i>)		X
Class: Aves		
Mallard (<i>Anas platyrhynchos</i>)	X	
Turkey vulture (<i>Cathartes aura</i>)	X	
Black-shouldered kite (<i>Elanus caeruleus</i>)	X	
Northern harrier (<i>Circus cyaneus</i>)	X	
Red-tailed hawk (<i>Buteo jamaicensis</i>)	X	
Ferruginous hawk (<i>Buteo regalis</i>)		X
Rough-legged hawk (<i>Buteo lagopus</i>)		X
Golden eagle (<i>Aquila chrysaetos</i>)	X	
American kestrel (<i>Falco sparverius</i>)	X	
Merlin (<i>Falco columbarius</i>)		X
Prairie falcon (<i>Falco mexicanus</i>)	X	
California quail (<i>Callipepla californica</i>)	X	
Killdeer (<i>Charadrius vociferus</i>)	X	
Rock dove (<i>Columba livia</i>)	X	
Band-tailed pigeon (<i>Columba fasciata</i>)		X
Mourning dove (<i>Zenaida macroura</i>)	X	
Common barn owl (<i>Tyto alba</i>)	X	
Western screech owl (<i>Otus kennicottii</i>)		X
Great horned owl (<i>Bubo virginianus</i>)	X	
Burrowing owl (<i>Athene cunicularia</i>)	X	

Table 2.2.4-1. (Continued.)

	Observed	Expected
Short-eared owl (<i>Asio flammeus</i>)	X	
Common nighthawk (<i>Chordeiles minor</i>)	X	
White-throated swift (<i>Aeronautes saxatalis</i>)	X	
Anna's hummingbird (<i>Calypte anna</i>)	X	
Costa's hummingbird (<i>Calypte costae</i>)		X
Calliope hummingbird (<i>Stellula calliope</i>)		X
Rufous hummingbird (<i>Selasphorus rufus</i>)	X	
Allen's hummingbird (<i>Selasphorus sasin</i>)	X	
Lewis's woodpecker (<i>Melanerpes lewis</i>)		X
Acorn woodpecker (<i>Melanerpes formicivorus</i>)		X
Nuttall's woodpecker (<i>Picoides nuttallii</i>)		X
Northern flicker (<i>Colaptes auratus</i>)	X	
Western wood-pewee (<i>Contopus sordidulus</i>)	X	
Western flycatcher (<i>Empidonax difficilis</i>)	X	
Black phoebe (<i>Sayornis nigricans</i>)	X	
Say's phoebe (<i>Sayornis saya</i>)	X	
Western kingbird (<i>Tyrannus verticalis</i>)	X	
Horned lark (<i>Eremophila alpestris</i>)	X	
Cliff swallow (<i>Hirundo pyrrhonota</i>)	X	
Barn swallow (<i>Hirundo rustica</i>)	X	
Scrub jay (<i>Aphelocoma coerulescens</i>)	X	
Yellow-billed magpie (<i>Pica nuttalli</i>)		X
American crow (<i>Corvus brachyrhynchos</i>)		X
Common raven (<i>Corvus corax</i>)	X	
Plain titmouse (<i>Parus inornatus</i>)		X
Bushtit (<i>Psaltiriparus minimus</i>)		X
White-breasted nuthatch (<i>Sitta carolinensis</i>)		X
Rock wren (<i>Salpinctes obsoletus</i>)	X	
Bewick's wren (<i>Thryomanes bewickii</i>)		X
House wren (<i>Troglodytes aedon</i>)		X
Blue-gray gnatcatcher (<i>Poliophtila caerulea</i>)		X
Western bluebird (<i>Sialia mexicana</i>)		X
American robin (<i>Turdus migratorius</i>)		X
Northern mockingbird (<i>Mimus polyglottos</i>)	X	
California thrasher (<i>Toxostoma redivivum</i>)		X
Water pipit (<i>Anthus spinoletta</i>)	X	
Loggerhead shrike (<i>Lanius ludovicianus</i>)	X	
European starling (<i>Sturnus vulgaris</i>)	X	
Orange-crowned warbler (<i>Vermivora celata</i>)		X
Yellow-rumped warbler (<i>Dendroica coronata</i>)		X
MacGillivray's warbler (<i>Oporornis tolmiei</i>)	X	
Western tanager (<i>Piranga ludoviciana</i>)		X
Lazuli bunting (<i>Passerina amoena</i>)	X	
Rufous-sided towhee (<i>Pipilo erythrophthalmus</i>)		X
Brown towhee (<i>Pipilo fuscus</i>)	X	
Rufous-crowned sparrow (<i>Aimophila ruficeps</i>)	X	
Vesper sparrow (<i>Pooecetes gramineus</i>)	X	
Lark sparrow (<i>Chondestes grammacus</i>)	X	
Savannah sparrow (<i>Passerculus sandwichensis</i>)	X	
Fox sparrow (<i>Passerella iliaca</i>)	X	
Song sparrow (<i>Melospiza melodia</i>)		X
Golden-crowned sparrow (<i>Zonotrichia atricapilla</i>)		X
White-crowned sparrow (<i>Zonotrichia leucophrys</i>)		X
Red-winged blackbird (<i>Agelaius phoeniceus</i>)	X	
Tricolored blackbird (<i>Agelaius tricolor</i>)	X	
Western meadowlark (<i>Sturnella neglecta</i>)	X	
Brewer's blackbird (<i>Euphagus cyanocephalus</i>)	X	
Brown-headed cowbird (<i>Molothrus ater</i>)		X

Table 2.2.4-1. (Continued.)

	Observed	Expected
Northern oriole (<i>Icterus galbula</i>)	X	
Purple finch (<i>Carpodacus purpureus</i>)	X	
House finch (<i>Carpodacus mexicanus</i>)	X	
Lesser goldfinch (<i>Carduelis psaltria</i>)		X
Lawrence's goldfinch (<i>Carduelis lawrencei</i>)		X
American goldfinch (<i>Carduelis tristis</i>)	X	
House sparrow (<i>Passer domesticus</i>)	X	
Class: Mammalia		
Virginia opossum (<i>Didelphis virginiana</i>)	X	
Pallid bat (<i>Antrozous pallidus</i>)		X
Brazilian free-tailed bat (<i>Tadarida brasiliensis</i>)	X	
Desert cottontail (<i>Sylvilagus audubonii</i>)	X	
Black-tailed hare (<i>Lepus californicus</i>)	X	
California ground squirrel (<i>Spermophilus beecheyi</i>)	X	
Botta's pocket gopher (<i>Thomomys bottae</i>)	X	
San Joaquin pocket mouse (<i>Perognathus inornatus inornatus</i>)	X	
California pocket mouse (<i>Perognathus californicus</i>)		X
Heermann's kangaroo rat (<i>Dipodomys heermanni</i>)	X	
Western harvest mouse (<i>Reithrodontomys megalotis</i>)	X	
Deer mouse (<i>Peromyscus maniculatus</i>)	X	
Brush mouse (<i>Peromyscus boylii</i>)		X
Desert woodrat (<i>Neotoma lepida</i>)	X	
San Joaquin woodrat (<i>Neotoma fuscipes riparia</i>)		X
California vole (<i>Microtus californicus</i>)	X	
House mouse (<i>Mus musculus</i>)	X	
Coyote (<i>Canis latrans</i>)	X	
Red fox (<i>Vulpes vulpes</i>)		X
San Joaquin kit fox (<i>Vulpes macrotis mutica</i>)		X
Gray fox (<i>Urocyon cinereoargenteus</i>)		X
Raccoon (<i>Procyon lotor</i>)	X	
Long-tailed weasel (<i>Mustela frenata</i>)	X	
Badger (<i>Taxidea taxus</i>)	X	
Western spotted skunk (<i>Spilogale gracilis</i>)	X	
Striped skunk (<i>Mephitis mephitis</i>)	X	
Mountain lion (<i>Felis concolor</i>)		X
Bobcat (<i>Lynx rufus</i>)	X	
Mule deer (<i>Odocoileus hemionus</i>)	X	

Blowdown water from cooling towers at various facilities periodically drains down natural water courses. For example, cooling tower blowdown water from the Advanced Test Accelerator Facility flows down Elk Ravine (Fig. 2.1.5-1). However, this small artificial source of water is totally dependent upon whether the cooling tower is operating.

2.2.5.2. Ground Water. Several shallow water table and confined aquifers are present beneath the site. The better producers among these shallow aquifers contain water of moderately good quality and could be used for domestic or stock water supply. The smaller aquifers have no known use because of generally poor water quality and low production. Plate 5 (see note below) shows the water-level surface of the regional aquifer.

A number of small perched aquifers are present in various parts of Site 300. Water quality in these aquifers is usually poor. There are no known uses for the water in these perched aquifers, because the sustainable yield of these aquifers to wells is less than 1 gpm (Weiss Associates, 1988).

Note: Plate 5 is located at the end of this chapter.

Site 300 operates two wells that produce water for process use and drinking from a thick, moderately permeable sandstone sequence encountered between 300 and 500 ft beneath the land surface at the GSA. A system of pipelines, booster pumps, and intermediate storage reservoirs provides water to storage tanks near operating facilities, which are served by gravity feed pipes.

Since 1955, 20 wells have been drilled for water supply at Site 300, but only two wells (18 and 20) are currently in use (Plate 4). Well 20 was added to the Site 300 water-supply system during December 1989. Well 1, in the East Firing Area, is maintained on standby as a source for emergency fire-fighting water in the remote northern part of the site that would be available if the pipeline system were to be damaged.

The peak site water-supply requirement, used in design of the water system, is 300 gpm (K. C. Oltrogge, LLNL, personal communication, 1989). The peak requirement comes during the summer when temperatures, water use, and water evaporation are high; during the rest of the year, less water is used.

In addition to these wells, small springs, supplied by local small-capacity ground water aquifers, are found at the site (Fig. 2.1.5-2). Except to the north of the site, where springs are used for watering some livestock, springs are not used as drinking- or process-water sources.

Technically detailed discussions of the hydrogeology of the aquifers at Site 300 are included in Chapter 6.

2.2.6. Climatology and Air Quality at Site 300. Data collected at the Site 300 weather station between 1965 and 1975 indicate that the average annual rainfall during that period was 11.39 in. Between 1973 and 1985, the annual rainfall was 10.87 in.; the maximum was 21.16 in. during the heavy rainfall year of 1983; and the minimum was 5.81 in. during the drought year of 1976. All meteorological data are in Appendix D and include climatological summaries of temperature and rainfall for 1976 through 1985. Wind velocity and direction for the year 1987 are shown in Figure 2.2.6-1. In addition, automated equipment at the meteorological station records barometric pressure. These data are maintained in digitized form, available on request.

LLNL has an environmental monitoring program dating from 1955. Air quality parameters measured at Site 300 include concentrations in air of:

- Beryllium;
- Gross alpha and beta radioactivity;
- Radioactivity of the radioisotopes potassium-40, cobalt-60, antimony-125, and cesium-137; and
- The radionuclides uranium and plutonium (Holland and Brekke, 1988).

Since DOE Order 5484.10 was issued in 1979, annual reports including these data (such as Holland and Brekke, 1988) are available to the public.

Figure 2.2.6-1. Wind rose showing the average annual wind speed frequency of occurrence and direction at Site 300 for 1989.

718
1817

819
1716

N 427000

N 424000

N 421000

1920
3029

2021
2920

1011
1514

Legend

- Exploratory borehole
- ☒ Lysimeter
- ⬢ Neutron probe
- ▲ Piezometer
- ⊕ Well
- Spring
- 964.30 ⊕ Well used for contouring and ground water elevation data
- 1106.54 ▲ Piezometer used for contouring and ground water elevation data
- × Abandoned Installation
- 1050 — Water elevation contour (ft above MSL),
dashed where intermediate contours
are used
- 750 Ground elevation contour (ft above MSL)

Note: Water elevation contours are approximate
in areas with few data points.

Scale: Feet

1514
2223

2223
2226

2324 N 420000
2625

N 421000

19 20
30 29

N 418000

30 29
31 32

N 415000

E 1692500

E 1695000

E 1697500

Pit 6

669.00
K6-04

K6-02

666.72 K6-15

666.58 EP6-08

666.53 K6-01

EP6-06

K6-14

663.00

Chapter 3. Overview of the Remedial Investigation

3.1. Summary of Remedial Investigation

LLNL has conducted several environmental investigations in the HE Process Area, which collectively constitute a remedial investigation.

3.1.1. Early History: Investigations of Soil and Rock

Between 1955 and 1985, nine small lagoons adjacent to process facilities in the HE Process Area received discharges of rinsewater from formulation, pressing, machining, and assembly of HE compounds (Plate 4). The rinsewater contained low concentrations of the HE compounds RDX and HMX.

Investigations of the presence of HE compounds in soil and rock near the rinsewater lagoons began in 1981. The results of this work are reported in Raber (1983).

3.1.2. Decommissioning of Lagoons

With the approval of the RWQCB, LLNL decommissioned the lagoons in 1985 and replaced them with the HE Surface Impoundments (Steenhoven and Crow, 1986). The impoundments are evaporation ponds doubly-lined with polyethylene sheets and impermeable compacted clay liners. Five monitor wells (W-817-01, W-817-02, W-817-03, W-817-03A, and W-817-04) and vacuum lysimeters were installed when the ponds were constructed to detect any HE compounds that might leak from them. Depending on the location of the HE facility, rinsewater is either piped directly to the ponds or kept in holding tanks and then transported by a dedicated tanker truck to the HE Surface Impoundments for disposal.

A proposed closure plan for the decommissioned lagoons (Steenhoven and Crow, 1986) was submitted to the RWQCB in 1986. The plan committed LLNL to an investigation of the horizontal and vertical extent of HE compounds, metals, and VOCs in soil and rock in and near the decommissioned lagoons. This work was done in 1986 and 1987.

3.1.3. Closure Plan Investigations of the Decommissioned Lagoons

The geology of the area beneath the decommissioned lagoons is described in Chapter 5. The *Closure Plan for the Decommissioned High Explosives Rinse-Water Lagoons at Lawrence Livermore National Laboratory Site 300* (Carpenter *et al.*, 1988) is the primary source of information about the study, which includes details of each lagoon's investigation.

The nine decommissioned lagoons were investigated by drilling exploratory boreholes (Plate 4) to collect soil samples in and near the lagoons. Soil samples were also collected from the pilot boreholes for monitor wells. The samples were analyzed for HE compounds, VOCs, and metals. Soil analyses are in Appendix A.

The data led to the conclusion that the HE compounds, VOCs, and metals in the soil and rock of the lagoon sites would not migrate if the lagoon sites were made impermeable to direct infiltration of rain water.

Based on the conclusions of the investigation, LLNL developed a closure plan and presented it to the RWQCB. Subsequent to some deliberation, the plan was approved by the RWQCB and used to design the final closure of the lagoons.

3.1.4. Dry Well Investigations

In 1987, dry wells were evaluated near Buildings 814 and 819, adjacent to the HE Process Area. Soil samples were collected from the pilot borehole for monitor well W-814-01, drilled near a dry well east of Building 814. LLNL investigated a dry well southeast of Building 819 with three boreholes drilled adjacent to one another (boreholes 819-01 and 819-03 and the pilot borehole for W-819-02).

In 1989, LLNL conducted an additional investigation of seven abandoned dry wells in the HE Process Area, reported in Lamarre *et al.* (1989b) and a supplementary letter report (Hoffman, 1990). LLNL drilled sample holes (Plate 4) at Building 807, the Building 810 Complex, and the Building 827 Complex. Soil samples were collected from these boreholes and analyzed for HE compounds, metals, and VOCs.

3.1.5. Additional Investigations of Soil and Rock

In 1988 and 1989, additional soil samples were collected from the pilot boreholes for monitor wells W-809-01, W-809-02, W-809-03, W-815-01, W-815-02, W-815-03, W-815-04, and W-815-05 (Plate 4). The samples were analyzed for HE compounds, metals, and VOCs. Samples were also collected from a borehole (813-01) drilled at Building 813 (Plate 4) to evaluate a recently discovered abandoned dry well. These samples were analyzed for HE compounds, metals, and VOCs.

3.1.6. Investigations of Ground Water

In April 1985, the HE compound RDX was detected at 37 ug/L (ppb) in ground water collected from monitor well W-817-01 (Plates 3 and 4). Additional monitor wells have been drilled in the HE Process Area to identify and to bound the horizontal and vertical extent of this compound in the aquifer. These investigations continue (details are in Chapter 8).

In late 1989, HMX was detected in low concentrations (averaging 38 ug/L [ppb]) in ground water from monitor well W-817-01. Samples collected from the monitoring network in early 1990 indicated that no HMX was present above detection limits in well W-817-01 or any other well. Thus, we are uncertain about the presence of HMX, and will continue monitoring.

VOCs have been detected in ground water beneath the HE Process Area, centering near Building 815 (Plates 3 and 4). VOCs were first detected in 1987 at 28 ug/L (ppb). Subsequent investigations have defined nearly the full extent of VOCs in ground water. The chief VOC detected is TCE, although trace amounts of other VOCs have been found in some wells. The investigations continue (details are in Chapter 8).

3.2. Nature and Extent of VOCs and HE Compounds

This study demonstrated that RDX and HMX were present in soil samples collected near the decommissioned lagoons at concentrations mostly less than 1 part per million (ppm), but locally higher in concentration.

Investigations of HE compounds in ground water have determined that RDX is present in low to moderate concentrations (up to 350 ug/L [ppb]) in ground water from two shallow aquifers beneath a limited area near Buildings 815 and 817 (Plate 3). Monitor wells drilled as

part of our investigation bound the area underlain by RDX in the ground water on the north, west, and south. In 1990, monitor wells will be drilled to bound the occurrence on the east. In November 1989, HMX was detected for the first time in monitor well W-817-01. HMX has not been detected in other monitor wells.

In 1987, VOCs were first detected in ground water in well W-815-01, near Building 815. Since then, monitor wells constructed to determine the horizontal and vertical extent of the occurrence have determined that VOCs are present in two shallow aquifers in a small area near and south of Building 815. RDX is present in the perched aquifer near Buildings 815 and 817. The area underlain by VOCs extends from W-809-1 on the north to shallow well W-817-03A on the south (Fig. 8.2). The water table aquifer contains TCE only immediately beneath Building 815 (Fig. 8.4).

During 1987, VOCs were also detected in a perched aquifer beneath Building 814 (Plate 3). The aquifer is stratigraphically higher and hydrologically isolated from the perched aquifer beneath Building 815.

3.3. Assessment of the Situation and Corrective Actions to Date

3.3.1. HE Compounds, Metals, and TCE in Soil and Rock

Exploratory boreholes drilled near the decommissioned lagoons were sampled for HE compounds; metals (Waste Extraction Test [WET] method), described in the California Administrative Code, Title 22 (1985); and VOCs. The investigation (Carpenter *et al.*, 1988) indicated that metals and VOCs in the samples were present only at very low concentrations. Most of the exploratory boreholes contained low to moderate concentrations of RDX and HMX (generally less than 1 mg/kg [ppm]) at shallow depths. These boreholes were drilled deep enough that the bottom samples did not indicate the presence of RDX or HMX, allowing development of a profile of HE compounds in the soil and rock. Moreover, with the exception of one shallow sample, all soil concentrations of HE compounds were below the Designated Level (DL) of 10.5 mg/kg (ppm) RDX for the site (see Appendix H, Section H.2.3), which indicates no impact to the ground water could be demonstrated. LLNL (Carpenter *et al.*, 1988) also concluded that the HE compounds present in the soil and rock were unlikely to be mobilized unless additional surface water infiltrated the areas near the decommissioned lagoons.

From this information, Carpenter *et al.* (1988) concluded that the low concentrations of HE compounds, metals and VOCs found in the soil and rock beneath the decommissioned lagoons did not constitute a hazard to public health, safety, or the environment. In addition, if rain water were not allowed to infiltrate, the RDX and HMX would be unlikely to migrate downward toward aquifers.

We recommended that the lagoons be closed by filling them with local soil, free of HE compounds, and capping them with impermeable clay caps. We also recommended peripheral drains to divert rain water around the caps. The plan was approved, with modifications, by the RWQCB, and the lagoons were closed in October 1989.

3.3.2. RDX and VOCs in Ground Water

Our investigations have defined the horizontal and vertical extent of RDX in ground water, except for an area east of Building 815 which will be investigated late in 1990. RDX is found in a small area beneath Buildings 815 and 817 (Plate 3) in a perched aquifer of limited extent, and in the first water table aquifer beneath the perched aquifer in an area even smaller (Figs. 8.1 and 8.3). The release site(s) have not been conclusively identified.

In the HE Process Area, VOCs are found in a small area beneath and south of Building 815 (Plate 3) in the perched aquifer and the first water table aquifer beneath the perched aquifer (Figs. 8.2 and 8.4). TCE is the only VOC present at concentrations above MCLs. We think the release site is related to the use of TCE as a boiler cleaner in the steam plant that formerly operated at Building 815. No VOCs are found in the confined aquifer, located in the Neroly lower blue sandstone, or in deeper aquifers (Fig. 8.2.2-1). The potential source of TCE at Building 815 has been removed.

Chapter 4. Methods of Investigation

The technical methods employed during our geologic studies include:

- Geologic mapping,
- Subsurface soil and rock sampling from exploratory boreholes,
- Installation of ground water monitor wells,
- Ground water sampling and analysis,
- Routine monitoring of ground water levels, and
- Hydrologic testing.

Investigations continue and will be reported in other reports.

LLNL has prepared written Standard Operating Procedures (SOPs) for drilling boreholes and monitor wells, making water level measurements, collecting soil and water samples, and analyzing samples (Rice *et al.*, 1990). The discussions in this chapter and in Appendix G summarize these SOPs.

4.1. Site Characterization

The geology of part of Site 300 and of the HE Process Area are mapped and shown on Plate 2. Subsurface investigations include drilling exploratory boreholes and construction of monitor wells, which began in 1984. By November 1989, 42 exploratory boreholes and 17 monitor wells had been drilled in and near the HE Process Area, shown in Plate 4.

4.1.1. Geologic Mapping

Geologic mapping and subsurface information provide detailed knowledge of geologic structure in and near the HE Process Area and an understanding of the complex stratigraphy of the Neroly Formation, which contains the major water-bearing units in the HE Process Area. Dibblee (1980a) did a reconnaissance study of the geology of the Midway quadrangle, including Site 300. During LLNL's initial hydrogeologic assessment in 1982 (Raber, 1983), the HE Process Area was mapped geologically. At present, more detailed geologic mapping in and near the HE Process Area is in progress. Although early results are available, the final interpretation will be included in later reports.

4.1.2. Drilling Exploratory Boreholes and Monitor Wells

In all exploratory boreholes and monitor wells, the lithology of the rocks penetrated is described from auger and drill cuttings or from core samples. Geologic logging is done by either a California Registered Geologist or by a well-site geologist working under the supervision of a California Registered Geologist.

Several appendices of this document contain supportive data:

- Appendix A—the results of chemical analyses of borehole and well soil and rock samples.
- Appendix B—similar analyses of ground water samples.

- Appendix C—geologic and geophysical logs of all boreholes and monitor wells drilled in the HE Process Area since July 1988; earlier logs are available in a previously published compendium of Site 300 borehole and monitor well logs (Toney and Crow, 1989), and in a Remedial Investigation report on LLNL dry wells (Lamarre *et al.*, 1989).
- Appendix E—monitor well water levels.
- Appendix F—monitor well construction data.
- Appendix G—analytical and sample handling procedures including QA/QC.

4.1.2.1. General Drilling Protocol. LLNL's general drilling protocol is designed to avoid inadvertent introduction of contaminants into the borehole or well. For example, all downhole drilling equipment—the drill rods, drive samplers, wireline coring equipment, auger flights, and drill bits—are steam cleaned after drilling each borehole or well. No petroleum-based lubricants are used on drilling equipment. The drillers may use minimum necessary amounts of a water-based, antiseize lubricant that contains dispersed copper to prevent destructive galling or seizing of drill-rod and core-barrel screw joints. Chemical analyses of the lubricant used are available, so that trace amounts can be recognized if found in collected samples.

The drill rigs are regularly steam cleaned and are inspected frequently for fluid leaks, such as gasoline, diesel fuel, cooling water, or lubricating oil, and are repaired immediately. All equipment is allowed to air dry before reuse.

4.1.2.2. Exploratory Boreholes: Drilling and Sampling Methods. Between 1984 and 1989, several series of exploratory boreholes were drilled to obtain soil and rock samples as well as information about the subsurface geology.

Exploratory boreholes that are less than 50 ft in depth are usually drilled by a hollow-stem auger. At approximate 5-ft intervals, soil or rock samples are collected from the boreholes, using a standard California split-spoon drive sampler (1.4-in. sample diameter) driven by a 140-lb weight falling 30 in. Samples are collected in steam cleaned or washed stainless-steel, or brass sampling tubes enclosed in the California drive sampler. The split-spoon sampler is cleaned after every drive sample.

After recovery, the tubes are sealed. Samples for analysis for VOCs or metals are sealed in the tubes in two ways: by capping with aluminum foil and sealing with inert duct tape; or by sealing with Teflon tape, plastic end caps, and inert plastic tape. The sealed samples are immediately placed on ice in a portable cooler and later kept under refrigeration until transferred to the analyst. Samples for analysis for HE compounds are collected in the same manner as the samples for VOCs and metals. Because HE compounds are not volatile and thus are not sensitive to storage temperatures, it is not necessary to keep the samples refrigerated while awaiting analysis. If the samples for HE compounds collected from the sampling tubes are less than about 500 g (the optimum sample size), two or more samples are composited and stored in a clean wide-mouth glass jar, using chemically inert duct tape to seal the top.

The augering equipment cannot operate efficiently at depths greater than about 50 ft, given Site 300 drilling conditions. The part of exploratory boreholes deeper than 50 ft is continuously cored, using rotary drilling equipment and a wireline split-tube core barrel (Christensen HQ system). The cores are recovered in stainless steel or brass sleeves (2.375-in. i.d.) inserted in the core barrel. For deeper boreholes and pilot boreholes for monitoring wells, a larger drill is used that cannot deploy an auger. With this drill, coring is continuous from the surface using the wire-line split-tube core barrel. This technique is identical to the one used for deeper parts of augered boreholes, described above.

After recovery, the cores to be submitted for VOC and metals analyses are removed from the core barrel, sealed, and cooled on ice or in the refrigerator. These are processed in the same way as drive samples (see preceding paragraph). In a few dry wells, soil samples have been analyzed for HE compounds. Cores to be retained for future reference study are removed from the core barrel, logged geologically, and stored in core boxes.

While coring, an air-water mist from a compressor is used to keep the core barrel from sticking in the hole and to help lift cuttings. The water used in the mist comes from the Site 300 drinking water supply, which is free of organic contaminants.

After completion, exploratory boreholes are filled and sealed to the land surface with grout.

4.1.2.3. Monitor Wells: Drilling and Sampling Methods. The first monitor wells in the HE Process Area were drilled in late 1984 as part of the monitoring network installed near the HE Surface Impoundments south of Building 817. Subsequently, monitor wells have been drilled to investigate the extent of HE compounds and VOCs in ground water and to obtain stratigraphic information.

The technique of drilling monitor wells is similar to drilling exploratory boreholes, except that monitor wells require extra operations, such as reaming the pilot hole to receive the well casing, installing sand packs and well seals, and well development. In most cases, the first 50 ft is augered; drive samples of soil and rock are collected at approximately 5-ft intervals. These samples are collected to be analyzed for VOCs, HE compounds, and metals. At depths greater than 50 ft, continuous wire-line coring using rotary drilling techniques is used. Air-water mist is employed to keep the bit from sticking and to assist in lifting well cuttings to the surface.

4.1.2.3.1. Monitor Well Completion. Each monitor well is drilled for a specific purpose. In most cases, this is to determine the presence, or to define more precisely the extent, of HE compounds or VOCs in the ground water. To complete the pilot borehole as a well, the completion interval depth of well screen (perforated interval) and length of sandpack are chosen first, based on the hydrogeologic observations made in the pilot hole. The completion is designed to allow maximum possible flow from the aquifer into the well.

Borehole geophysical logs are run in monitor wells of special geologic significance. The standard suite of logs includes specific potential/resistivity, natural gamma radiation, and a caliper log. Additional logs, such as borehole camera logs and sonic logs, have been run in a few cases.

In some cases—for example, if a borehole or well is drilled immediately adjacent to another hole that previously had been cored—the new hole is drilled using standard rotary drilling bits because it is not necessary to obtain core samples. A geologist prepares a geologic log of the drill cuttings.

Unless there are special circumstances, the pilot borehole is reamed to approximately 9 in. in diameter. This provides sufficient annular space to allow installation of 4.5-in. i.d. potable grade PVC casing with sandpack, bentonite seal, and grout seal outside the casing. Some of the early monitor wells were completed with smaller-diameter casing. The sandpack is normally #3 Monterey sand (0.093 to 0.039 in. grain size), i.e., approximately 8 × 16 mesh (Driscoll, 1987; p. 951, Appendix 12.B). A bentonite seal is placed on top of the sandpack, and the well annulus is filled to the surface with grout. Details of each completion are shown on the appropriate well log (Appendix C; Toney and Crow, 1989; and Lamarre *et al.*, 1989b).

4.1.2.3.2. Well Development. Following completion of a monitor well, the well is developed to improve productive capacity by removing drilling fluid, drill cuttings, and other debris from the hole and mud cake from the formation face. First, well water is bailed until it becomes clear. If this is not effective in clearing up the water produced, an air-lift is used, i.e., the well is blown dry and allowed to refill, thus enhancing flow. If these techniques are not

effective, a surge block is used. In a few wells, jetting has been used, i.e., water flow is directed through jets onto the screened interval to clean mud and other debris from the casing screen and formation, thus improving flow. Water levels in monitor wells are in Appendix E.

4.1.3. Analysis of Soil Samples and Ground Water

Soil and ground water samples are analyzed in accordance with EPA and California procedures (see Appendix G). The results of soil and rock sample analyses are in Appendix A, and results of ground water analyses are in Appendix B. The data are discussed in Chapter 7.

4.1.3.1. Samples from Monitor Wells Adjacent to HE Surface Impoundments. Monitor wells W-817-01, W-817-02, W-817-03, W-817-04, and piezometer W-817-03A were constructed in late 1984 to monitor the HE Surface Impoundments (Plate 3). Ground water has been sampled from these wells quarterly, according to requirements established in 1985 by the RWQCB in their Waste Discharge Order 85-188 (1985). Analytical data are presented in Appendix B. Details of the analytical techniques used are given in Appendix G.

4.1.3.2. Samples from Boreholes and Monitor Wells Collected During LLNL's Investigations. In the course of LLNL's investigation in the HE Process Area, boreholes and monitor wells have been drilled. The boreholes were drilled to collect soil samples, and soil samples were collected for analysis during the drilling of monitor wells. Samples have been analyzed for VOCs, HE compounds, and metals. The results are given in Appendix A.

Ground water from the monitor wells is sampled quarterly; all samples are analyzed for VOCs and HE compounds. At least one water sample from each monitor well has been analyzed for metals and general minerals. Tables of analytical data are in Appendix B, and analytical techniques are described in Appendix G.

4.2. Investigations Monitoring Program

4.2.1. Well Purging and Sampling Procedures

Before sampling ground water from monitor wells, the wells are purged according to LLNL SOPs (Rice *et al.*, 1990). All monitor wells with sufficient capacity to produce enough water are pumped to remove three casing volumes to clear the well of stagnant water and to provide a water sample representative of the water in the aquifer adjacent to the well.

A number of wells in the HE Process Area are small producers. In sampling these wells, LLNL follows the Resource Conservation Recovery Act (RCRA) sampling protocol, which states that after being pumped dry, a well that will not yield a full casing volume of water within 2 hours may be sampled after pumping it dry once.

As water flows into the well, it is sampled first for pH, temperature, and conductivity, then for VOCs, and finally samples are collected for other analyses.

4.2.2. Chemical Analysis of Ground Water

4.2.2.1. Wells of the HE Surface Impoundments Monitoring Network. Monitor wells for the HE Surface Impoundments include wells W-817-01, W-817-02, W-817-03, W-817-3, and W-817-04. Piezometer W-817-03A was drilled to a depth of 10 ft; it was installed to monitor a small spring on the southern flank of the hill below the Surface Impoundments. Water from these wells is analyzed according to requirements set forth in Waste Discharge Order

85-188 (RWQCB, 1985). The standards are in Division 4, Chapter 15, Title 22, California Administrative Code. Ground water samples are collected quarterly and analyzed for metals, nitrate, total organic carbon (TOC), total organic halides (TOX), EPA 601, conductivity, pH, and general minerals. Additionally, the samples are analyzed for HE compounds and tritium.

4.2.2.2. Wells of HE Process Area Remedial Investigations. Other monitor wells included in quarterly monitoring for our study, located in and near the HE Process Area, are W-806-06A, W-809-01, W-809-02, W-809-03, W-810-01, W-815-01, W-815-02, W-815-03, W-815-04, W-817-05, and W-817-06A. Immediately adjacent to the HE Process Area, wells W-814-01 and W-819-02 are monitored on the same schedule and for the same substances as those in the HE Process Area proper. Water from these wells is analyzed for VOCs (EPA 601) and HE compounds on a quarterly basis. There is at least one metals analysis and general minerals analysis available for each well.

4.2.3. Disposal of Pumped Water

During ground water sample collection, a specified amount of water is removed from each well to assure that water collected is from the aquifer. In wells known to be contaminated, it is necessary to contain this water. Because all the monitor wells in the HE Process Area that contain water with either RDX or TCE are small producers, the water is collected in 55-gal drums and allowed to evaporate. The total amount of water collected from wells known to contain HE compounds is small. When it becomes necessary to remove this water from the barrels, tests are run to determine if any VOCs are present. If VOCs are detected in the water, air is bubbled through the water in the barrels for 48 hours, which is the standard procedure at Site 300 to remove VOCs from pumped water. When analysis indicates that the water contains HE compounds but no VOCs, it is contained in drums and allowed to evaporate.

Wells that have consistently produced water free of any contaminant are discharged to the ground surface. If possible, discharge is to an asphalted area to allow maximum evaporation before reaching bare ground.

4.2.4. Water Level Data

All water levels from wells in the HE Process Area are measured quarterly and are reported in Appendix E.

4.2.5. Documentation of Samples

Chain-of-custody documents are prepared for all samples. A sample of the form used is included in Appendix G.

4.2.6. Safety Procedures

This investigation has been performed under guidelines outlined in the Environmental Protection Department's *Site Safety Plan for Site 300 Environmental Restoration* (1989), the *Site 300 Safety and Operational Manual* (1988), and the *LLNL Health and Safety Manual* (1989).

4.2.7. Data Management

A database is maintained to store the data generated. There are two sources of analytical data: (1) the monitor wells for the HE Surface Impoundments are sampled under the requirements of RWQCB Waste Discharge Order 85-188; (2) the remainder of the wells in the HE Process Area are not under a regulatory order, but are collected for the purposes of our investigation. Both soil and rock sample analyses and ground water analyses are in the database.

Analytical data from our primary analytical laboratory, Brown and Caldwell Laboratories, are entered into the database electronically via modem and are maintained on the VAX computer system. Other data, such as those from other contract laboratories for VOCs and metals and those from the LLNL laboratory that analyzes samples for HE compounds, are entered manually. The data are verified electronically to identify transmission, transceiving, and input errors. After verification, the data are tabulated and checked to determine if their values are reasonable.

The analytical laboratories provide printed reports of all data. These paper copies are used in verification and are also checked against our chain-of-custody forms for accuracy and completeness. A database containing aquifer test data has recently been added to the Environmental Investigations Quarterly.

All water level data are manually entered and verified.

Extensive graphic and statistical capabilities are available using additional PC programs such as SURFER by Golden Graphics, MINITAB, and SYSTAT.

Chapter 5. Geology

5.1. Regional Geologic Setting

Site 300 is located on the eastern side of the Altamont Hills (a part of the Coast Range Physiographic Province) between the Livermore-Amador and the San Joaquin Valleys (Fig. 5.1-1). The Coast Range Physiographic Province consists of a system of north-northwest trending, fault-bounded, antiformal mountain ranges and synformal valleys. The bedrock consists of igneous, metamorphic, and sedimentary rocks that range in age from Late Jurassic to Pleistocene. The mountain ranges are composed of rocks of Late Jurassic to Tertiary age. Locally, they exceed elevations of 4000 feet. The valleys are filled with late Tertiary to Holocene sediments, mainly derived from the surrounding mountains.

The present physiography and geology of the Coast Ranges are the result of deformation and depositional processes along the tectonic boundary between the North American Plate and the Pacific Plate and that of its predecessors: the Juan de Fuca, the Farallon, and the Kula Plates (Page, 1982).

Rocks exposed in the region surrounding Site 300 may be classified into three general groups:

- Late Tertiary-Quaternary (0 to 5 million years ago [mya]): Alluvium and partly lithified sediments of chiefly continental origin;
- Early to late Tertiary (5 to 65 mya): Neroly, Cierbo, and Tesla Formations; shallow marine and continental sedimentary and volcanoclastic rocks; and
- Late Jurassic-Cretaceous (65 to 150 mya): The basement complex. It is composed of the coeval Great Valley Sequence of marine sedimentary rocks and the Franciscan Assemblage of strongly deformed, sheared, and metamorphosed sedimentary and igneous rocks. The Coast Range Ophiolite Complex, composed chiefly of basalt that is altered regionally to serpentinite, is thought to represent the ocean floor under which the Franciscan Assemblage was subducted. The Ophiolite Complex is in depositional contact with the base of the Great Valley Sequence in various localities in northern California (e.g., Crow, 1979).

The geographic locations of these units are shown in Figure 5.1-1.

The youngest stratigraphic units in the region are predominantly nonmarine sediments that vary from Pliocene to Holocene in age (Dibblee and Darrow, 1981). Older portions of this sequence may be partly lithified; the younger strata are largely unconsolidated. As a result of stress fields associated with active Bay Area faults, even very recent Holocene sediments are folded or ruptured by seismic activity.

Tertiary marine, nonmarine, and volcanoclastic rocks underlie the immediate vicinity of Site 300. These Tertiary rocks are mainly sandstones and mudstones with some conglomerates and tuff beds. The major source of the volcanic component is in the Sierra Nevada (Lerbekmo, 1956; D. W. Carpenter, LLNL, personal communication, 1988) as well as more local centers in the Berkeley Hills and farther south in the Coast Range (Dickenson and Snyder, 1979).

The basement rocks of the region, the Franciscan Assemblage and the coeval Coast Range Ophiolite and Great Valley Sequence, are geologically related and are best understood in the context of plate tectonic theory.

Late Tertiary-Quaternary

Alluvium and continental sediments

Tertiary

Sediments and volcanics (locally non-marine) including Plio-Pleistocene

Jurassic-Cretaceous

Great Valley Sequence

Franciscan Complex

Mesozoic Granite

Figure 5.1-1. Generalized geologic map of the San Francisco Bay area showing the location of Site 300. Key to symbols: SB, Salinian Block; SAF, San Andreas fault; HFZ, Hayward fault zone; EBH, East Bay Hills, CFZ, Calaveras fault zone; MD, Mount Diablo; GFZ Greenville fault zone; AH, Altamont Hills; TOFZ, Tesla-Ortigalita fault zone ; LV, Livermore-Amador Valley (Adapted from Raber and Carpenter, 1983).

The Franciscan Assemblage was deposited on the Pacific Plate and contains several slightly different rock units (terranes) of different geologic age associated with separate subduction events. The Assemblage as a whole has been subducted beneath the North American Plate. It is very strongly deformed, largely by shearing during subduction. It consists of generally coherent blocks of sheared metagraywacke or greenstone (metabasalt) with lesser amounts of chert and limestone, all emplaced chaotically in a matrix of metamorphosed and intensely sheared mudstone and shale (Hsu, 1971). The blocks vary from sand-size fragments to pieces several kilometers in length.

The Franciscan Assemblage is in tectonic contact with the Coast Range Ophiolite and the Great Valley Sequence. Frequently, the zone in which the contact occurs is along the Coast Range Thrust Fault, a prominent feature in the Coast Range.

The Coast Range Ophiolite Complex is interpreted to be the altered ocean floor, located on the upper plate, beneath which the Franciscan rocks were thrust. The Coast Range Ophiolite was originally basalt of various types. Now, it is considered mostly hydrothermally altered at high temperature and pressure to serpentinite. The serpentinite was remobilized during Tertiary time, and has been tectonically intruded into fault zones, shear zones, and the Franciscan Assemblage (McLaughlin, 1978).

The Great Valley Sequence (Kgv) depositionally overlies the Coast Range Ophiolite Complex. It is a very thick deposit of interbedded sandstone and shale (often turbidites), that is strongly folded and slightly deformed. South and east of Site 300 is the Moreno Shale and Panoche Formation, also part of the Great Valley Sequence.

5.2. Geology of Site 300

This section contains a brief summary of the geology of Site 300. A more detailed discussion of the geology specific to this report, is in Section 5.3.

5.2.1. Previous Work

Knowledge of the geology of Site 300 is based on regional geologic mapping by Huey (1948), Raymond (1969), and Dibblee (1980a, b, and c). This geologic information was incorporated in the Draft California EIR prepared for the University of California Board of Regents to support LLNL's contract renewal in 1987 (University of California, 1986). The following summary of Site 300 geology is developed from this information, as modified and supplemented by geologic observations made during hydrogeologic studies conducted by LLNL in recent years (i.e., Raber and Carpenter, 1983; Raber, 1983; Crow *et al.*, 1986; Carpenter *et al.*, 1986, 1988; and several issues of the Site 300 Environmental Investigations Quarterly Reports).

5.2.2. Stratigraphy

The stratigraphy at Site 300 is shown in Figure 5.2.2-1. Plate 2 is a generalized geologic map of Site 300.

Along the southern boundary of Site 300, the channel of Corral Hollow Creek is filled with recent channel gravels. Cobbles up to 12 in. in diameter have been deposited in a matrix of sand and subordinate silt and clay.

The upland part of Site 300 is underlain by Quaternary to Recent unconsolidated colluvium and alluvium, including ravine fills, cobbly terrace alluvium (Qa), and landslide deposits (Qls). These deposits blanket the hills in the southern part of the area; usually they range between 5 and

Geologic Age	Author			
	Huey (1948)	Dibblee (1980)	Habor & Carpenter (1983)	This Investigation
Quaternary	Qal (alluvium)	Qa (alluvium)	Qa (alluvium)	Qa (alluvium)
	Ql (terraces)	Qls (landslides) ----- Unconformity -----	Qls (landslide deposits)	Qls (landslides)
	Qls (landslide)	Qoa (older alluvium)	Qla ₂ , Qla ₁ (terrace alluvium)	Qt (terrace alluvium)
		Unconformity	Unconformity	Unconformity
Tertiary		Tps (non-marine sedimentary rocks, pebble conglomerate, greenish gray clay, low beds of marl and sand)	Tps (non-marine conglomerates, sands, and clays) ----- Unconformity ----- Tnsc ₂ (interbedded siltstone, sandstone, and clay)	Tps (non-marine clay, silt, sand, gravel, dense, green, brown, red) Tpsg (channel deposit, gravel, gravelly sand partly lithified, brown, red)
		Unconformity	Unconformity	Unconformity
	Tnsh (upper Neroly Formation, shales)	Tn (Neroly Formation, non-marine blue to gray sandstone, locally pebbly)	Tngl ₂ (upper conglomerate) Tnbs ₂ (upper blue sandstone) Tnsc ₂ (interbedded sandstone, siltstone, clay, local tuff; massive sandstone at base)	Tngl ₂ (conglomerate, sandstone, claystone) Tnbs ₂ (upper blue sandstone) Tnsc ₂ (interbedded claystone, siltstone, fine sandstone) Tnbs ₁ (lower blue sandstone)
	Tnss (lower Neroly Formation, blue sandstone, conglomerate)		Tngl ₁ (lower conglomerate) ^a (lower blue sandstone) Claystone (lower claystone, siltstone)	Tngl ₁ (lower conglomerate) Tnsc ₁ (lower claystone and siltstone, with interbedded tight, fine-grained silty sandstone) ^b Tnbs ₁ (Neroly deep blue sandstone, fine-grained, 80-100 ft thick, few interbedded claystone) ^b
Cretaceous		Unconformity	Unconformity	Unconformity
	To (Clerbo Formation, sandstone)	Tmes (brackish marine, tan, coarse sandstone, locally pebbly, fossiliferous)	Tmes (Clerbo Formation)	Tmes (Clerbo Formation)
		Unconformity	Unconformity	Unconformity
	Tts (Tesla Formation, sandstone, clay, and coal) ^c	Tts (Tesla Formation, white to tan arkosic sandstone and sandy siltstone, contains pebbly beds and thin coal beds locally) ^c	Tt (Tesla Formation) ^c	Tt (Tesla Formation) ^c
		Unconformity	Unconformity	Unconformity
	Kp (Panoche Formation, sandstone, shale)	Kps (Panoche Formation, light-gray arkosic sandstone with large concretions and minor interbedded micaceous shale)	Kgv (Great Valley Sequence)	Kgv (Great Valley Sequence)

Figure 5.2.2-1 Stratigraphic correlations, LLNL Site 300 (modified from Carpenter *et al*, 1988). For details of stratigraphy, see text. ^a = not present in HE Process Area; ^b = Tnsc₁ and Tnbs₁ possibly repeated by faulting; ^c = exposed southwest of Site 300, may underlie portions of site.

30 ft in thickness. Several major landslides have occurred along steep slopes of high ridges; one prominent landslide is present near Building 854 in the western part of the site (Plate 2). Another large old landslide that includes the area near Buildings 825 and 826 in the northern part of the HE Process Area, was mapped recently. Currently, these landslides are stable.

A small area east of the site is underlain by the Pleistocene Tulare Formation, but the Tulare is not present at Site 300.

The youngest bedrock beneath the Quaternary material is a Pliocene-to-Holocene nonmarine sequence of interbedded and lenticular sands, silts, and clays, distinguished by the presence of pebbles of Franciscan chert, graywacke, and greenstone. An informal name, the Tertiary nonmarine sequence (Tps of Dibblee, 1980a), is used in this report.

In various areas, the Tertiary nonmarine sequence (Tps) varies in thickness from a few feet to more than 50 ft. The sequence includes silty to clayey gravels that were deposited in erratic channels; the channel fills are encased in finer-grained, low permeability clays and silts. Some of these channel fill gravels contain perched ground water.

Underlying the Tertiary nonmarine sequence is the Late Miocene Neroly Formation. The Neroly Formation is characterized by interbedded sandstones, siltstones, and claystones, containing large amounts of volcanic ash; in some areas, volcanic tuff is found. The volcanic ash gives the sandstones a distinctive blue-gray color when dry. The major source of these pyroclastics was in the western Sierra Nevada, where Miocene lava flows are found interbedded with ash-rich sandstones. These sandstones are very similar in appearance to, and correlative with, the Neroly Formation of Site 300 (Lerbekmo, 1956; D. W. Carpenter, LLNL, personal communication, 1988). Other possible sources are volcanic centers in the Coast Ranges, especially in the Berkeley Hills (Dickenson and Snyder, 1979).

Where exposed in outcrop, the thickness of the Neroly Formation is approximately 450 ft. Although the rocks are lenticular, Neroly Formation lithologic units often extend for several miles. Several informal lithologic units can be traced within the site. The upper part of the Neroly is persistent in the northern part of the site, but appears to be irregularly distributed in the southern part. In the south, it consists of silty sandstone and conglomerate interbedded with silt and clay. Exposures in the vicinity of the HE Process Area suggest that an erosion surface formed on top of this sequence prior to deposition of the overlying Pliocene nonmarine sequence (Tps).

The Neroly upper blue sandstone (Tnbs₂) often forms prominent ledges on the hillsides and can be seen at outcrops (e.g., Fig. 5.2.2-2) in much of the site. It is the most identifiable marker bed in the Tertiary section at Site 300. The sandstone is relatively clean, massive, and heavily fractured, with the bluish-gray color characteristic of Neroly sandstones. Locally, this unit contains claystone and siltstone interbeds; claystone rip-up clasts are often found near the base of Tnbs₂.

The Neroly lower siltstone and claystone unit (Tnsc₁) underlies the upper blue sandstone; this unit is a regionally-extensive aquitard at Site 300. Lenticular, predominantly fine-grained silty sandstone beds occur within unit Tnsc₁; locally, these beds yield small amounts of water to monitor wells.

Beneath the lower siltstone and claystone unit lies the Neroly lower blue sandstone (Tnbs₁) (Fig. 5.2.2-2). This unit is characterized by interbedded sandstones and silty claystones. The sandstones, which together contain a confined aquifer, yield water to monitor wells in most of Site 300.

In the southern part of Site 300, additional aquitards and aquifers were penetrated by deep wells W-35C-02 and W-35C-03 (completed as well 20). These rocks do not appear in outcrops at Site 300. Their stratigraphy and structure are discussed in detail in Section 5.3.3.

The Miocene Clerbo Formation (Tmss) underlies the Neroly Formation unconformably. In general, the Clerbo Formation is composed of micaceous, quartz-rich sandstones and carbonaceous shales. The wells and boreholes at Pit 6 near the southern boundary of Site 300 have encountered Clerbo rocks south of the Carnegie Fault, where they dip near-vertically as a result of fault offset and concurrent folding. These sandstones are light gray and clean with little cement; they can also be seen at the outcrop near the Ranger Station to the east of Pit 6. In the northwestern part of the site, Clerbo rocks have been encountered in several boreholes and wells. The rocks are carbonaceous shales and tight sandstones. Extensive clays present in the pore spaces of these Clerbo sandstones may explain the low permeability.

The Eocene Tesla Formation crops out south of the Carnegie Fault near Pit 6, adjacent to the southern boundary of Site 300. It is not clear from subsurface information that Tesla rocks extend very far northeastward, because they have not been identified in deep monitor wells or exploratory boreholes drilled within the part of Site 300 north of the Carnegie Fault.

Piezometer NC7-50, located in the northwestern part of Site 300, is completed in a fault zone that cuts turbidites of the Cretaceous Panoche Formation, a part of the Great Valley Sequence. Panoche Formation sandstones and shales are exposed on a hill northeast of the piezometer location (Plate 2). South of the Carnegie Fault, a major tectonic feature, vertically dipping shales and turbidites of the Great Valley Sequence crop out and are in tectonic contact with the Franciscan Assemblage.

5.2.3. Structural Geology

As shown in Plate 2, bedrock structure at Site 300 is dominated by the Patterson Anticline, which trends west-northwest by east-southeast as it traverses the central part of the site. South of the crest of this anticline, the bedrock sequence dips northeasterly into the trough of a subsidiary syncline with parallel strike.

Two faults are part of the regional structure at Site 300:

- The Carnegie Fault, a major structural discontinuity whose southeasterly strike parallels the upper reach of Corral Hollow Creek; and
- The Elk Ravine Fault, also striking southeast subparallel to the axis of the Patterson Anticline (Plate 2).

The Carnegie Fault has a strong effect on the local structure of the Tertiary rocks at Site 300. South of the Carnegie Fault (Plate 2), steeply dipping to overturned Tertiary sandstones and claystones of the Neroly, Clerbo, and Tesla Formations, overlie strongly folded shales and turbidites of the Cretaceous Great Valley Sequence. These Great Valley Sequence sedimentary rocks are in tectonic contact with metamorphic rocks of the Franciscan Assemblage farther south.

North of the Carnegie Fault, the Tertiary rocks appear to dip generally southward towards the fault. However, a zone north of the Carnegie Fault exhibits moderate faulting, probably caused by compression of the Patterson Anticline against the Carnegie Fault. Recent geologic mapping shows that this zone is wider than previously thought, and thrust faulting has been identified at the Building 827 Complex in the western part of the HE Process Area. Although not yet shown on our geologic map (Plate 2), several thrust faults with WNW-ESE strike were located approximately 3 mi north of the Carnegie Fault, approximately due north of Pit 6. As previously noted, these thrust faults may extend southeasterly to the southeastern part of the HE Process

Neroly Upper Blue Sandstone

Neroly Lower Blue Sandstone

Building 826

Figure 5.2.2-2. Outcrop of Neroly Formation near Building 826 (foreground).

Area, and may have some effect on the hydrogeology of aquifers in that area. We are currently mapping the geology of the southern part of Site 300, and will determine where such faults are present.

The Elk Ravine Fault strikes southeastward in the northern part of the site, in the area between the axis of the Patterson Anticline and the subsidiary syncline to the north. The fault has two or more strands in some localities. The southwestern branch of the Elk Ravine Fault passes beneath Pit 2; the northeastern branch passes beneath Pit 1 (Plate 2). Several north- to east-trending faults that appear to be local in extent have recently been identified in the eastern and southern part of Site 300.

The Elk Ravine fault shows no evidence of Holocene displacement (Raber and Carpenter, 1983; Hoffman, 1988). Geologic mapping in progress adjacent to pit 6 shows evidence of Holocene faulting on a branch of the Carnegie fault.

5.3. Geology of the HE Process Area

Parts of this discussion are excerpted from Carpenter *et al.* (1988), with modifications based on more recent information.

Geologic investigations in the HE Process Area have been limited to the late Tertiary nonmarine sediments (Tps of Dibblee, 1980a) and to the Miocene Neroly Formation. No older rocks are known to crop out in the area, nor have any been encountered in the exploratory boreholes or monitor wells drilled. This includes the 550-ft deep monitor well W-35C-02 immediately to the south of the HE Process Area.

5.3.1. Stratigraphy

Figure 5.2.2-1 shows the stratigraphic relationships in the HE Process Area. Much of the HE Process Area is blanketed by colluvial and ravine fill soils, which consist of gray-brown, silty, and locally gravelly clay (Plate 2). These surficial soils are discontinuously underlain by terrace remnants (unit Qt), which consist chiefly of coarse, cobble-bearing silty gravel. This gravel is derived from the Franciscan Assemblage outcrops in the core of the Diablo Range south of Site 300.

These gravels are lithologically similar to the gravels in the Corral Hollow Creek flood plain deposits south of Site 300 (Section 5.2.1). They appear to represent deposits of ancestral Corral Hollow drainage systems. The terrace remnants primarily underlie more level portions of the HE Process Area. They vary from about 3 to 10 ft thick, but may be as thick as 40 ft, e.g., north of Building 821 (Plates 2 and 4). A pebble conglomerate thought to be part of this unit was encountered beneath colluvium in exploratory boreholes Mag-5 and Mag-5A. These boreholes were drilled near Magazine 5 (Plate 4) on a flat ridgetop west of Building 805.

Beneath these surficial deposits, the HE Process Area is underlain by a folded and faulted sequence of late Tertiary continental and marine strata. Outcrops of these rocks are found in cut slopes at a few localities in the main portion of the HE Process Area, located on the northeast wall of the ravine, northeast of Buildings 825 and 826. Outcrops are also found in the steep canyons west and south of Buildings 827 and 828 (Plates 2 and 4).

The uppermost unit within the Tertiary sequence consists of dense, partially lithified clays, clayey silts, and fine silty sands with lenticular interbeds of coarser silty to clean sands, gravelly sands, and gravels, presumably deposited as channel fills. These strata (Fig. 5.2.2-1) appear to be chiefly of continental origin. They were originally correlated with the upper part of the Neroly Formation (Raber, 1983; Raber and Carpenter, 1983); nevertheless, subsequent investigations indicate that these strata are better correlated with the sequence of Pliocene

nonmarine rocks (map unit Tps) (Fig. 5.2.2-1) (Carpenter *et al.*, 1988). Their distribution in the subsurface may be more extensive than shown on Plate 2.

Remnants of a sequence of interbedded fine pebble conglomerates, sandstones, and claystones (Tngl₂) that overlie the Neroly upper blue sandstone are locally present, but appear to have been largely eroded beneath most of the HE Process Area before deposition of the Pliocene continental sediments.

As shown in Figure 5.2.2-1, the Neroly Formation has been divided into several informal lithologic units (Raber, 1983; Raber and Carpenter, 1983; Carpenter *et al.*, 1988). The upper three units are:

- The Neroly upper blue sandstone (Tnbs₂);
- The Neroly lower siltstone and claystone unit (Tnsc₁), composed of siltstones and claystones with several fine silty to clayey sandstone interbeds; and
- The Neroly lower blue sandstone unit (Tnbs₁), an interbedded sequence of sandstone, siltstone, and claystone with minor tuff.

The Neroly upper blue sandstone and the Neroly siltstone and claystone unit are exposed in the northwest part of the HE Process Area near Buildings 825 and 826 (Fig. 5.2.2-2). They are also exposed in deep canyons east and west of Buildings 827 and 828 (Plate 2). The third unit, the Neroly lower blue sandstone, is exposed only in the lower portion of the deep ravine northwest of Building 828 and on the hillside north of Buildings 825 and 826 (Fig. 5.2.2-2). These units have also been encountered in boreholes of monitor wells in the HE Process Area.

Two newly named informal lithologic units are discussed for the first time in this report. These units, encountered only in the subsurface, are the Neroly deep siltstone and claystone unit (Tnsc₀) and an underlying thick sandstone unit (Tnbs₀).

In the deeper wells W-810-01 and W-819-02 in the HE Process Area, siltstones and claystones were encountered below the Neroly lower blue sandstone. Similar siltstones and claystones were also encountered in wells W-35C-02 and W-35C-03 (completed as water-supply well 20), immediately south of the HE Process Area (Plates 3 and 4). As these wells were drilled deeper, an additional thickness was encountered of very similar siltstone and claystone with thin interbedded sandstones. This overall sequence of rocks forms a discrete lithologic unit which we informally name the Neroly deep siltstone and claystone unit (Tnsc₀). Beneath these claystones and siltstones, well W-35C-02 and well 20 encountered a thick unit of bluish-gray sandstone, the Neroly deep blue sandstone (Tnbs₀). Although the data are inconclusive, the thick sandstone of well 20 is thought to correlate with that of well 18.

An alternative hypothesis about the origin of these Neroly deep units is discussed in Section 5.3.3.

Rocks of the Cierbo Formation are found in the northern part of the site, but Cierbo rocks have not been encountered in the deep wells in and near the HE Process Area.

5.3.2. Structural Geology

The HE Process Area is located on the southern limb of the Patterson Anticline, and beds beneath the area dip about 5 to 10 degrees to the south-southwest. The bedrock sequence is offset by several northeast- to east-trending faults of local extent.

As shown in Plate 2, a short, unnamed fault projects into the northeastern portion of the HE Process Area. Vertical slip has occurred along this fault in beds of the Neroly Formation. The

fault has no geomorphic expression and is buried by Plio-Pleistocene alluvium, indicating that it has been inactive since late Tertiary time.

Recent geologic mapping, discussed previously in Section 5.2.3, indicates that thrust faults are present northwest of the HE Process Area. If this faulting extends to the southeasterly part of the HE Process Area, it may affect the hydrogeology of the aquifers. The significance of these structural features to the hydrogeology and to the behavior of substances in ground water in the HE Process Area has not been fully determined. A more intensive discussion follows in Section 5.3.3.

Recent geologic mapping has also revealed that HE Process Area Buildings 825 and 826 (Plate 4) are located in the lower part of a large, stabilized landslide, similar to those previously identified in the western part of Site 300.

5.3.3. Neroly Formation: Deep Lithologic Units—Stratigraphic vs. Structural Origin

Recently discovered thrust faulting in the southwest part of Site 300 extends as far east as the Building 827 Complex of the HE Process Area. This faulting gives rise to potentially significant hydrogeologic effects which are discussed further in Section 6.2.2.4 on page 6-11. Although the faulting may affect the entire Neroly section, the basal part, encountered only in two deep wells in the south part of the process area, seems most likely to be affected.

Wells W-810-01 and W-819-01, located in the eastern part of the HE Process Area (Plate 3), encountered thin interbeds of tight, silty sandstones and clayey siltstones beneath the Neroly lower blue sandstone unit. A similar sequence was encountered in deep monitor well W-35C-02 and in monitor well W-35C-03 (completed as water-supply well 20), at locations shown in Plate 3. These beds comprise a coherent lithologic unit, which we have named the Neroly deep siltstone and claystone unit (Tnsc₀). Beneath this unit, both wells penetrated a clean sandstone, 100 ft thick, with the typical Neroly bluish-gray color, the Neroly deep blue sandstone (Tnbs₀).

We have interpreted the stratigraphy of the deep Neroly rocks and aquifers in the southern HE Process Area and the adjacent western GSA to be the result of transgressive overlap as sedimentation progressed locally northward over time. Younger beds are thought to have overlapped the older zones that contain the Neroly deep sandstones, siltstones, and claystones; such overlaps are quite common in the stratigraphy of younger sedimentary rocks in California and elsewhere.

The recent discovery of thrust faulting to the northwest suggests a possible alternative explanation. If the thrust fault zones extend eastward to this region, the possibility of repetition of the lithologic units that might result from thrust faults must be considered. If the faults were large enough, these structural effects might account for the added lithologic section.

The concepts of transgressive overlap and of repetition as a result of thrust faulting are difficult to explain; therefore, conceptual sketches of these concepts (Fig. 5.3.3-1) are included to illustrate them.

a) Transgressive overlap

b) Section pre-overthrust

c) Overthrust faulting repeats stratigraphic section

Figure 5.3.3-1. Conceptual sketches (not to scale) showing hypothetical stratigraphic cross-sections. See text, Section 5.2.2. Sketches illustrate a) transgressive overlap, b) stratigraphic section before overthrusting, and c) stratigraphic section after overthrusting, demonstrating repetition of beds. The sketches do not represent actual conditions at Site 300, and are solely to demonstrate alternate explanations of stratigraphy.

Chapter 6. Hydrogeology

This chapter discusses the hydrogeology of the HE Process Area. In general, knowledge of the hydrogeology is necessary to understand the distribution, transport, and fate of HE compounds and VOCs in the ground water of this area. Some aspects of the hydrogeology are not fully understood; therefore, further investigations will follow, to be discussed in the forthcoming FS report.

6.1. Hydrogeology of Site 300

Based on a reconnaissance study done in 1981 and 1982, Raber and Carpenter (1983) presented a preliminary analysis of the hydrogeology of Site 300. More recent investigations of occurrences of VOCs, tritium, and HE compounds are discussed in several additional reports, namely Raber (1983); Carpenter *et al.* (1983, 1988); Buddemeier *et al.* (1985, 1987); Crow *et al.* (1986); Weiss Associates (1988); Toney and Crow (1989); Taffet *et al.* (1989); and several issues of the Site 300 Environmental Investigations Quarterly. Data from these reports were extracted to develop a synthesis of the hydrogeology of Site 300.

6.1.1. Surface Water

The following discussion of surface water hydrology is modified from Taffet *et al.* (1989). There are no perennial surface water bodies at Site 300. Flow in the dry stream channels is intermittent, occurring almost exclusively during heavy rains. During intense storms, there is temporary flow in otherwise dry watercourses. Sheet flow of water across the land surface also may occur. Corral Hollow Creek, the main surface water drainage of the region, flows intermittently; the last occurrence of observable flow in the creek in the vicinity of Site 300 was during and after the wet winter of 1982 and 1983. Cooling tower blowdown from several Site 300 facilities drains down natural watercourses. These small man-made flows may last for several months or years, and they are totally dependent upon operation of the cooling towers.

The specific surface water conditions in the HE Process Area are discussed in Section 6.2.1 of this report. A map of the surface drainage in the vicinity of the HE Process Area is shown in Figure 6.1.1-1.

6.1.2. Ground Water Aquifers and Aquitards

The hydrogeology of Site 300 is summarized in the following paragraphs. The discussion is arranged by the age of the rocks which contain the aquifers and aquitards. A more detailed treatment of the hydrogeology of the HE Process Area is in Section 6.2.2.

The creek gravels of Corral Hollow Creek contain ground water. In the upland part of Site 300, the alluvial cover and the underlying Tertiary nonmarine sequence contain perched aquifers. The layered Tertiary rocks beneath them contain a series of aquifers, separated by very slightly permeable aquitards.

With the exception of the perched aquifers, the depth to water at Site 300 is relatively large. In the southern part of the site, the depth to the first regional aquifer ranges from about 80 ft to more than 300 ft. Depending upon the locality, the unsaturated zone above the regional aquifer is located in the Tertiary nonmarine sequence and in the upper part of the Neroly Formation.

Figure 6.1.1-1. Intermittent water courses, HE Process Area.

The rocks in these formations are generally silty claystones and clayey siltstones, interbedded with clean to silty sandstones. There is interstitial water in these rocks, but it is bound to the sediment grains by capillary attraction and cannot move downward until the rock becomes fully saturated.

6.1.2.1. Perched Aquifers. The Glossary of Geology (American Geological Institute, 1980) defines perched water as unconfined ground water separated from an underlying main body of ground water by an unsaturated zone. Implicit in this definition is the presence of a perching aquitard, which prevents or retards downward motion of ground water in the perched aquifer to the saturated zone.

There are three kinds of perched aquifers at Site 300:

1. Aquifers found in alluvial sediments above bedrock and in the upper few feet of the underlying bedrock,
2. Aquifers found in channel fills of silty and clayey gravel encased in less permeable claystone and siltstone in the Tertiary nonmarine sequence, and
3. A perched aquifer found in fractured claystone of the Neroly lower siltstone and claystone unit (Tnsc₁) at the Building 829 Complex.

Examples of Number 1 are found at Pit 6, in the southwestern part of the site, and at the Pit 7 complex. The Pit 6 perched aquifer is in the alluvial cover above bedrock and in the top of the bedrock itself; the perching horizon is impermeable bedrock. At Pit 7, a perched aquifer is found beneath the stream channel at the axis of the valley. Here, the water level was high in 1983, after several historically wet winters. Since that time, the water level has declined and parts of the aquifer are no longer saturated.

The extent of these perched aquifers is relatively small, and the aquifers are seldom more than 5 ft thick. The alluvial aquifer at Pit 7 is unusual because the alluvium extends from Pit 7 through Doall Ravine to the east for a distance of approximately 2500 ft.

Examples of Number 2 are found in irregularly scattered channel fills located in the Tertiary nonmarine sequence (Tps). These channels are often filled with poorly sorted silty, clayey gravels. Some of these channel fills are saturated. The perching horizon generally is the underlying, less permeable claystone and siltstone beds of the nonmarine sequence. The overall extent of these aquifers is small, permeability is low, and water productivity is generally very low. Typically, flow rates are less than 1 gpm (Weiss Associates, 1988).

A perched aquifer of this kind is found at the Building 834 Complex. It is relatively narrow and extends southerly from the buildings for about 1000 ft. The saturated zone is seldom more than 5 ft thick (Bryn *et al.*, 1990).

Two perched aquifers of the same kind have been found in the HE Process Area. The geographic extent of these perched aquifers is shown in Figure 6.1.2-1. Their hydrogeology is discussed in detail in Section 6.2.2. The aquifers are the perched aquifer of Building 814, stratigraphically higher and distinct from the larger perched aquifer of Building 815. In both aquifers, the saturated thickness is about 5 ft, the permeability is low, and water production is small.

A borehole and two monitor wells at the Building 829 Complex (the HE Burn Pit) encountered perched water in fractured claystone in unit Tnsc₁ about 40 ft below the Neroly upper blue sandstone (Webster-Scholten and Crow, 1989). The saturated thickness is less than 3 ft, the permeability is low, and water production is small.

Figure 6.1.2-1. Limits of perched aquifers, HE Process Area.

6.1.2.2. Regional Aquifers and Interbedded Aquitards. The alluvium of Corral Hollow is a mappable unit. This coarse gravel beneath the Corral Hollow flood plain contains ground water in an unconfined aquifer. Flow is interstitial in the coarse sediment. Recharge is by infiltration from water moving downward from the surface after storms. The water is present primarily in areas where the gravels are relatively thick. The gravel containing the aquifer extends from the head of Corral Hollow Creek, several miles west of Site 300, to a point northeast of the site. The gravel is usually about 20 ft thick, with a probable maximum of 30 ft; usually part of the gravel is above the water table. Boreholes and monitor wells drilled in and near the gravel of Corral Hollow indicate that the thickness of the gravels varies near the edge of the deposit.

The hydrologic relationship of the gravel of Corral Hollow to the underlying bedrock is not completely clear because of insufficient information, but in most localities the saturation is confined to the gravel zone. In areas where the gravel is very clean, well yields can be relatively large, as much as 40 gpm.

The bedrock regional aquifers at Site 300 are all located in the Neroly Formation. At the southern edge of the site, in the western GSA, most aquifers are under confined conditions, i.e., they have artesian head and the water level in monitor wells rises above the top of the aquifer containing the water. Farther to the north, beneath the upland part of the site, the shallowest regional aquifer is usually unconfined, i.e., it is a water-table aquifer. Deeper aquifers are confined. In the following paragraphs, the Neroly sandstone aquifers and the aquitards that separate them are discussed.

The Neroly sandstones are poorly sorted; silt, clay, and volcanic ash reduce interstitial permeability. These sedimentary rocks are more consolidated than the overlying alluvial deposits, although interstitial cement is rare. However, the Neroly rocks are sufficiently brittle, so that fractures will both form and remain open. Hydraulic testing and examination of cores, collected in the Neroly sandstones that contain the aquifers, suggest that much of the water produced from these aquifers moves through fractures; nevertheless, interstitial porous flow may occur in cleaner sandstone beds.

6.1.2.2.1. Neroly Upper Blue Sandstone (*Tnbs₂*). Although it is present beneath much of Site 300, the Neroly upper blue sandstone unit is saturated only under the southeastern part of the HE Process Area and the western GSA immediately to the south (Fig. 6.1.2-2). The sandstone averages 20 to 30 ft in thickness, but not all of the sandstone body is saturated in the HE Process Area. The saturated thickness is approximately 10 to 15 ft. Water yields are generally small, averaging approximately 1 gpm where the rock is not heavily fractured and approximately 5 gpm where fractures are pervasive.

6.1.2.2.2. Neroly Lower Siltstone and Claystone Unit (*Tnsc₁*). Underlying the Neroly upper blue sandstone aquifer is an aquitard composed of silty claystone and clayey siltstone interbedded with tight silty sandstones. At the outcrop, northeast of Building 826 (Fig. 5.2.2-2), this unit is approximately 100 ft thick. Subsurface information indicates that beneath the southeastern part of the HE Process Area, thin interbedded sandstones in the lower half of the unit may produce small amounts of water. A fairly persistent, well-lithified claystone bed in the middle of the unit forms ledges at some small outcrops in the south-central part of the site (e.g., Fig. 5.2.2-2).

6.1.2.2.3. Neroly Lower Blue Sandstone Unit (*Tnbs₁*). The Neroly lower blue sandstone is saturated beneath much of the site. Normally, water in the aquifer is confined, except near the upgradient edge of the aquifer (e.g., in wells W-806-6A and W-817-05). Plate 5 is a piezometric surface map of this aquifer. The aquifer occupies one or more relatively thin (<10 ft) sandstones interbedded with thin claystones; the sandstones act as one aquifer,

Figure 6.1.2-2. Ground water elevations in the Neroly upper blue sandstone aquifer, Site 300, March 1990.

because the thin, interbedded claystones are hydrologically discontinuous. The capacity of the wells depends upon the presence of fractures; when these are plentiful, water production is relatively large. When fractures are absent, water production may be small. Hydraulic tests conducted by Weiss Associates (1988) in several Site 300 monitor wells indicate that in wells where the Tnbs₁ sandstone is thought to be poorly fractured, yields are in the range of 1 to 3 gpm. In some wells, probably with well-developed fractures in the aquifer, yields are higher, i.e., 8 to 15 gpm.

6.1.2.2.4. Neroly Deep Siltstone and Claystone Unit (Tnsc₀): The Deep Aquitard. A thick (about 100-ft) aquitard (Tnsc₀), composed primarily of poorly permeable silty sandstone, clayey siltstone, and claystone underlies the Neroly lower blue sandstone unit. The unit is known chiefly from deep test wells W-35C-02 and W-35C-03, drilled just south of the HE Process Area. This aquitard is discussed in more detail in Section 6.2.

6.1.2.2.5. Neroly Deep Blue Sandstone (Tnbs₀). A thick (50- to 100-ft) sandstone, apparently near the base of the Neroly Formation (Tnbs₀), which produces large amounts of water, was encountered during 1989 while drilling deep test wells W-35C-02 and W-35C-03. This aquifer is also thought to produce water in well 18, a major water-supply well at Site 300. The sandstone cannot be identified in outcrops at Site 300. Also, it is not present in the northern part of the site, where beds correlated with aquitard unit Tnsc₀ rest directly on rocks of the Clerbo Formation. The horizontal extent is not known with certainty, but must be moderately large to have supplied Site 300's water needs for years. Details of the hydrology of this aquifer are discussed in Section 6.2.

6.1.2.2.6. Clerbo Formation. Clerbo rocks that crop out along Corral Hollow Creek near Pit 6, along the southern boundary in the western part of the site, are porous and permeable; however, no well at Site 300 has encountered water in the unit. In the northern part of the site, where the Clerbo Formation has been encountered, the rocks are largely impermeable sands and mudstones, although a few local water-bearing zones have been found by detailed hydrogeologic analysis (Taffet *et al.*, 1989).

6.2. Hydrogeology of the HE Process Area

6.2.1. Surface Water

The HE Process Area is situated on a rugged hillslope deeply dissected by several dry watercourses (Fig. 6.1.1-1). Surface water is apparent only after infrequent, heavy rains.

A small perennial spring is present near a road southeast of the HE Surface Impoundments (Fig. 6.1.2-1). Piezometer W-817-3A is completed at a depth of 5 ft in the aquifer supplying the spring with water. The piezometer is sampled regularly and monitors the source of the spring. Results of the analyses are in Section 6.2.1.1. This section also discusses the perched aquifer of Building 815. Other small springs have been found south of the HE Process Area; their locations may be controlled by faulting.

6.2.2. Ground Water Aquifers and Aquitards

As stated in Chapter 5, the rocks at Site 300, including the HE Process Area, can be correlated sufficiently to identify aquifers extending for a few miles. Figure 5.3.3-1 shows a good example of an outcrop of the upper part of the Neroly Formation adjacent to the northern part of the HE Process Area. Farther to the south, the sandstones are saturated. Figures 6.1.2-1 and 6.1.2-2,

and Plate 5, show the extent of several aquifers in the HE Process Area. A cross section in the Building 817 Area (Figs. 6.2.2-1 and 6.2.2-2) shows the subsurface relationships of three of these aquifers.

6.2.2.1. Perched Aquifers of the HE Process Area. Two perched aquifers are found in the HE Process Area and are located in the Tertiary nonmarine sequence (Tps). Figure 6.1.2-1 shows the extent of these aquifers.

6.2.2.1.1. Perched Aquifer near Building 814. During the drilling of well W-814-01, a perched aquifer was encountered to the northeast of the HE Process Area, southeast of Building 814 (Fig. 6.1.2-1). This aquifer is in a silty sand, stratigraphically younger and considerably higher in the section than the more extensive perched aquifer near Building 815, located several hundred feet southwest.

The zone has not been found in other monitor wells and is apparently limited to the area surrounding the well. Ground water production is small. Water from the aquifer contains trace concentrations of several VOCs. No HE compounds have ever been detected. Periodic monitoring continues.

6.2.2.1.2. Perched Aquifer near Building 815. The second perched aquifer was first identified beneath Building 815 (Fig. 6.1.2-1). It underlies a larger area than the perched aquifer of Building 814. The perched aquifer of Building 815 (Fig. 6.1.2-1) is in a silty sand near the base of the Tertiary nonmarine sequence. In some wells, it contacts the unsaturated top of the Neroly upper blue sandstone (Tnbs₂), as shown in a cross section in Figure 6.2.2-2.

The distribution of the aquifer is irregular. It is present in well W-809-01, but is absent to the south in W-809-03 (Fig. 6.1.2-1). It is present surrounding Building 815 in well W-815-05 and in wells W-815-01 and W-815-03. Piezometer W-817-03A, on the road east of the HE Surface Impoundments, monitors a small spring that discharges water from a zone correlative with the perched aquifer. The spring is thought to be a ground water outcrop of this aquifer. This perched aquifer is also thought to be present farther south, in monitor well W-6CI.

The horizontal and vertical extent of RDX and VOCs in this aquifer and their potential release sites are discussed in Chapter 8.

6.2.2.2. Water Table Aquifer. The Neroly upper blue sandstone (Tnbs₂) is water-saturated beneath the southeastern part of the HE Process Area and the area immediately to the south. Figure 6.1.2-2 shows the extent of this saturated zone and its water table elevations. Although the Neroly upper blue sandstone unit is present under much of Site 300, it is saturated with water only in this area. The Neroly upper blue sandstone crops out on the west wall of the major ravine northeast of the HE Process Area, thought to be one of the recharge areas for the aquifer. In ravines west of the HE Process Area, the Neroly upper blue sandstone also crops out; scattered springs mapped in this ravine may represent discharge areas for this aquifer.

The hydrogeology of the Neroly upper blue sandstone aquifer (Fig. 6.1.2-2) is relatively complex. In the upgradient feather edge of the saturated zone, some of the behavior of the aquifer suggests perched conditions, but evidence is not sufficient for a determination. Under most of the HE Process Area, the aquifer acts as an unconfined water table aquifer. To the south, beneath the western GSA, the saturated zone has an artesian head and therefore, is a confined aquifer.

Figure 6.2.2-1. Map of HE Process Area showing locations of cross section A-A'.

Figure 6.2.2-2. Cross section A-A' through the HE Process Area.

6.2.2.3. Confined Aquifers. Beneath the HE Process Area, there are confined aquifers in several sandstones of the Neroly lower blue sandstone unit (Tnbs₁) that consist of relatively thin interbedded sandstones separated by siltstone and claystone. The Tnbs₁ unit contains water under confining pressure, that appears to increase the downgradient to the southeast. Plate 5 is a piezometric surface map of this aquifer. No RDX or VOCs have ever been found in ground water from the Neroly lower blue sandstone aquifers.

Sandstones in the Neroly lower blue sandstone (Tnbs₁) are saturated beneath much of the site, including most of the HE Process Area. However, in the deep canyons west of Building 827 and 828 (Plate 4), interbedded sandstones crop out in the approximate stratigraphic position of the Neroly lower blue sandstone unit. They are dry at the outcrop, and no springs have been observed. Northeast of Buildings 825 and 826 (Fig. 5.2.2-2), similar dry sandstones also crop out. In both areas, the Neroly lower blue sandstone unit may be unsaturated in the subsurface.

These outcropping sandstones are thought to be part of the Neroly lower blue sandstone unit, encountered in deep wells (W-810-01 and W-819-02) in the HE Process Area. The relationships of the sandstones in the outcrops and in the monitor wells are unclear. Using existing data, we will investigate the stratigraphic relationships of these sandstones in the subsurface to confirm our interpretation in the HE Process Area.

6.2.2.4. Hydrogeology of Deeper Parts of the Neroly Formation. Four wells, two in the eastern part of the HE Process Area (W-810-01 and W-819-02) and two just south of the process area (W-35C-02 and W-35C-03—Well 20), penetrated a siltstone and claystone unit (Tnsc₀) and a thick, clean sandstone approximately 100 ft thick, with the typical Neroly bluish-gray color (Tnbs₀). In well 20, this sandstone produces large amounts of water; pump testing is discussed in Section 6.3.

As discussed in Section 5.3.3, the possible existence of thrust faults may have cut the Neroly section and caused repetition of the lithologic section. The effects of such faulting on hydrogeology would depend on whether the thrust faults cut aquifers, and if the faults had sufficient throw to displace the aquifers to produce hydrologic discontinuities. Any such discontinuities could affect the movement of water and transport of contaminants in the aquifers, either by increasing or decreasing the permeability and flow rates.

In future studies, we will continue to investigate the extent of these faults and their control on hydrogeology.

6.3. Hydraulic Testing

Two hydraulic tests, conducted in and near the HE Process Area, provided some data necessary to fully understand the ground water system in the HE Process Area. Additional testing is planned.

In the summer of 1987, a short pilot pump test was conducted to evaluate the logistics of a full-scale chemical time-series test. The proposed full-scale test was intended to gain hydrologic information about the distribution of RDX in the ground water of well W-17-01. Before the full-scale test could be run, a series of monitor wells drilled near Building 815, to the east of well W-817-01, encountered RDX in ground water. Therefore, the proposed full-scale pump test was superfluous.

A 1-hour test was conducted in well W-817-01. The drawdown curve was difficult to interpret, because a stable pumping rate could not be established; therefore, it was hard to estimate the pumping rate. A rate of 1 gpm was used for the calculation. Well recovery was uninterrupted, and the recovery curve was classified to be of good quality.

Well W-817-01 is a small producer, much like a number of wells completed elsewhere at Site 300 in the Neroly upper and lower blue sandstones where few fractures are present in the aquifer sandstones (Weiss Associates, 1988). The aquifer thickness is 9 ft, the calculated transmissivity is 86 gpd/ft, and the hydraulic conductivity is 9.5 gpd/ft² (4.5 E-4 cm/sec).

Immediately south of the HE Process Area (Fig. 6.1.2-2), three hydraulic tests of Well 20 were conducted in April 1989 (R. Ferry, *in* Lamarre, 1989a, Table C-1). They were completed in the deep Neroly sandstone aquifer. An aquifer thickness of 108 ft was used in the hydraulic calculations. The tests showed that the transmissivity of this well averages 4250 gpd/ft, and the hydraulic conductivity averages approximately 42.3 gpd/ft² (2.3 E-3 cm/sec). As a result of the tests, Ferry (Weiss Associates, personal communication, 1989) stated this well should be capable of producing more than 300 gpm, indefinitely.

In 1987, Weiss Associates (1988) conducted a series of hydraulic tests in the Environmental Test Area (ETA), east of the HE Process Area. These tests were performed in strata of the Pliocene nonmarine sequence (Tps) and in rocks correlated with the Neroly lower blue sandstone unit (Tnbs₁). Results of these tests could be applicable to correlative strata in the HE Process Area. Their use will be investigated in future hydrologic analyses, to be reported in the FS.

Chapter 7. Characteristics of Waste in the HE Process Area

In the HE Process Area, investigations have determined that the HE compounds RDX and HMX and the VOC TCE are the primary waste components.

Other VOCs, fuel compounds and metals have been detected in a few samples from soil and rock, and from ground water. Metals are not present at levels above threshold limit concentrations. With the exception of one analysis for lead and five analyses for barium, no metals have been detected in soils at concentrations higher than DLs (Table 8.1.1-2). Lead was detected at 6.9 mg/L (DL=0.5 mg/L) in one soil sample at Lagoon 825, and barium was detected in concentrations up to 35 mg/L (DL=10 mg/L) in one sample collected from each of Lagoons 806, 807, 817, 825 and 835. These VOCs, fuel compounds, and metals are not found in ground water at concentrations higher than California State Action Levels. Because they are not a threat to public health and safety, we have not discussed them in this chapter.

7.1. Waste Component Mobility

7.1.1. Mobility of RDX

Rosenblatt (1986) presented data about the mobility of RDX. These were based on experimental results at the Louisiana Army Ammunition Plant (LAAP). At this location, the subsurface sediment is porous and permeable Gulf Coast sand, with small amounts of silt and clay. His data indicate that a concentration of 10.1 mg/kg (ppm) in soil will result in a concentration of 0.035 mg/L [35 µg/L (ppb)] in ground water less than approximately 25 ft below the surface (Rosenblatt, 1986, his Table 6, p. 13).

Rosenblatt stated that the concentration of RDX is lower in the ground water than in the soil and rock, which indicates that sorption and dispersion have affected the amount of RDX that passes through the soil. Marshack (1989) termed this phenomenon the attenuation factor. It can be defined as:

$$A = \frac{C_s}{C_w} \quad (\text{Eq. 7-1})$$

where:

A = attenuation factor,

C_s = concentration in soil, and

C_w = concentration in water.

Using this relationship and Rosenblatt's data for the retardation of RDX at the LAAP, we calculate an attenuation factor of approximately 300 for RDX at the LAAP. At that location, the water table is shallow (less than 100 ft), and the sandy soil and rock are relatively clean and permeable.

The hydrogeology at Site 300 is very different. The soil and rock at Site 300 contain sand mixed with large amounts of clay and silt and have relatively low permeability. These rocks have very different physical and chemical properties than the relatively clean sands of the Louisiana coastal plain. The silt and clay contained in the sediment at Site 300 reduce

permeability and porosity. This results in increased sorption and dispersion, two physical processes that reduce the mobility of such organic compounds as RDX and therefore increase the site's attenuation factor. In addition, the saturated zone at Site 300 lies much deeper than that in many localities.

Even though the natural geologic conditions at Site 300 would be expected to produce an attenuation factor greater than at the LAAP, we have decided to be conservative in our calculations and have chosen an attenuation factor of 100 rather than 300. According to Marshack (1987), 100 is an attenuation factor for an average site. See Appendix H for a further discussion of the attenuation factor.

7.1.2. Mobility of HMX

No data about the mobility of HMX were found in the technical literature. Our data (Appendix A) show that HMX concentrations are higher than RDX in the soil and rock near and beneath the closed rinsewater lagoons. The solubility of HMX is 2.4 to 5.0 mg/L, almost 20 times less than that of RDX (42.2 mg/L); see sections 7.2.1.1 and 7.2.2.1. Because of the retention of HMX in soil and rock and its low solubility in water, we think that it is substantially less mobile than RDX.

7.1.3. Mobility of TCE

Studies of the velocity of migration of TCE indicate that it is fairly mobile in natural ground water (Schwille, 1988; Mackay and Vogel, 1985; Thorpe *et al.*, 1990). TCE has a solubility of 1070 mg/L at 20°C (Verscheuren, 1983). The studies have determined the relationship between the rate of flow of ground water and that of TCE.

Retardation can be expressed as a ratio between the mobility of a substance and that of water, as follows:

$$R = \frac{V}{V_c} \quad (\text{Eq. 7-2})$$

where:

R = retardation,

V = average velocity of ground water, and

V_c = the contaminant velocity in ground water.

Literature values for TCE retardation range from 1.04 in porous and fractured media model experiments (Schwille, 1988) to 10.3 in three Norwegian soils (Seip *et al.*, 1986). Retardation factors for TCE calculated from sorption studies conducted at LLNL's Livermore site ranged from 3.7 to 6.4 (Bishop *et al.*, 1989). VOC migration modeling performed for LLNL's Livermore Site Remedial Investigation used a retardation factor of 1.5. This value represented an average literature retardation value for all VOCs detected at the Livermore Site, including TCE (Thorpe *et al.*, 1990). These studies suggest TCE transport in the subsurface is slightly slower than the velocity of water (1.0).

7.2. Waste Component Toxicity

Because toxicity studies of RDX and HMX are few, the data is reviewed here in detail. A summary is presented in this chapter, and details are presented in Appendix H. The toxicity of TCE is well known; thus, it has been briefly summarized here.

Many of the toxicological studies discussed in this section and in Appendix H make use of the term mg/kg in a different sense than that used in the other parts of this report. In the toxicology studies, mg/kg means weight of substance being tested (in mg units) divided by body weight (in kg units). It is used to normalize doses given to individual laboratory animals so that experimental results can be compared. In other parts of this report, the term mg/kg is used to define the concentration of a solid substance in soil or rock. Here, the term mg/L is used to define concentration of a solvent in a solute; for example, in defining the concentration of liquid doses when the weight of the test animal is not considered. This usage is essentially identical to the use of the term elsewhere in this report.

7.2.1. Toxicity of RDX

Etnier (1989) conducted a study to determine a proposed water quality criterion for RDX. As part of her study, she reviewed the toxicological literature and presented a summary in her paper. For this report, her review has been expanded with data obtained from Layton *et al.* (1987).

7.2.1.1. RDX: Chemical Characterization and Toxicity Data. RDX is formulated widely for use as an HE compound. The synthesis is described in Meyer (1981). Military-grade RDX contains 8 to 12 wt% of HMX as a byproduct of the synthesis. RDX is formulated and used at Site 300.

Substance. RDX:

- Chemical name: cyclo-1,3,5-trimethylene-2,4,6-trinitramine (Meyer, 1981).
- Other names: Cyclonite, hexahydro-1,3,5-trinitro-1,3,5-triazine (Etnier, 1989).
- Solubility: 42.2 mg/L (Sikka *et al.*, 1980).
- Vapor Pressure: 0.00054 millibar at 110°C (Meyer, 1981).
- Regulations and Advisories for Drinking Water:

None for RDX in drinking water (see Section 8.2.2.1).

Proposed drinking water criterion (U.S. Army): 105 µg/L RDX (Etnier, 1989), accepted by the EPA as the basis for the NPDES permit for discharge of RDX to a surface stream in Grand Island, Nebraska (Etnier, 1989), issued by the EPA.

- Other standards:

The threshold limit value (TLV) for RDX recommended in 1980 by the American Conference of Governmental Industrial Hygienists (ACGIH) is 1.5 mg/m³. The listing of this value is followed by the notation "skin," which suggests the possibility of absorption through the skin.

However, Rosenblatt (1986) stated that because RDX is not particularly lipid-soluble, dermal absorption is an unlikely route of exposure. Furthermore, Etnier (1989) noted that a review of the literature provided no evidence that RDX can be dermally absorbed.

The short-term exposure limit (STEL) for RDX is 3 mg/m³ in air (ACGIH, 1980).

The California Occupational Safety and Health Act (CAL OSHA) has adopted the ACGIH TLV limit of 1.5 mg/m³ in air. The USSR has a maximum acceptable concentration (MAC) of 1 mg/m³ in air for RDX (Etnier, 1989).

- DLs: The Site 300 DL in soil and rock for RDX is 10.5 mg/kg RDX (value derived in Appendix H, Section H.2.3).

7.2.1.2. Summary of RDX Toxicity Studies. There are no controlled studies of RDX toxicity in humans, although adverse health effects have been documented following instances of accidental inhalation or ingestion. RDX exerts its primary toxic effect on the human central nervous system (CNS); these effects appear to be completely reversible (Etnier, 1989).

In laboratory rats and mice, RDX is metabolized primarily in the liver. RDX does not accumulate in any tissue and is excreted in urine or exhaled as carbon dioxide (Etnier, 1989).

CNS excitation is the most prominent acute effect of RDX in most animals. Other toxic effects include gasping and labored breathing (Etnier, 1989).

Brown (1975), Hart (1976), Levine *et al.* (1983), and Lish *et al.* (1984) studied the effects of subchronic exposure of laboratory rats and mice to RDX. Their results are summarized here; details are in Appendix H.

Brown (1975) studied rats exposed for 12 weeks to RDX. Except at the lowest dose (0.3 mg/kg-d), the treatment was found to induce time- and dose-related biphasic changes in brain monoamine oxidase, cholinesterase, and oxygen uptake.

Hart (1976) conducted a two-year study of the effects of dietary intake of RDX in rats. Tests of hematology, blood chemistry, urinalysis, gross necropsies, organ weight, and histopathological examination resulted in no significant evidence of RDX toxicity; doses were less than 10 mg/kg-d.

Levine *et al.* (1983) conducted a two-year study to evaluate the toxicity of chronic doses of RDX in the diet of Fischer 344 rats. Rats given RDX at 1.5 mg/kg-d and above exhibited anemia, hepatotoxicity, possible CNS involvement, and urogenital lesions. However, the next lowest dose of RDX, 0.3 mg/kg-d, did not elicit any adverse effects. Levine *et al.* (1983) concluded that under the conditions of this study, 0.3 mg/kg-d represented the No-Observed-Effects-Level (NOEL) for RDX.

Lish *et al.* (1984) studied groups of male and female mice fed RDX over a two-year period. Toxic effects included hepatotoxicity, possible CNS involvement, and testicular degeneration in the males. A possible treatment-related increase in serum triglyceride levels was observed in female mice given RDX at 35 mg/kg-d, and elevated serum cholesterol levels were observed in female mice at 35 mg/kg-d, and possibly at 7 mg/kg-d. These effects were not seen in animals that received RDX at 1.5 mg/kg-d.

Toxicity values for the same species may differ among laboratories, depending on the physical form of the RDX, and on the vehicle used to suspend or dissolve it (Schneider *et al.*, 1977).

In laboratory animals, there is no evidence of genotoxicity or developmental/reproductive toxicity.

Three investigations (Hart, 1976; Levine *et al.*, 1983; and Lish *et al.*, 1984) were designed to determine if RDX is carcinogenic. Etnier (1989) reviewed these studies, and her comments appear in the following sections. Hart (1976) and Levine *et al.* (1983) found no evidence of carcinogenicity in rats fed RDX in the diet. Lish *et al.* (1984) studied groups of

male and female B6C3F1 mice fed RDX at doses of 1.5 to 100 mg/kg-d. Initially, the high-dose group received RDX at 175 mg/kg-d, but excessive mortality necessitated a reduction in dose to 100 mg/kg-d. Lish *et al.* (1984) reported that there was a dose-related increase in hepatocellular carcinomas in female mice, but not in males. The increase was not statistically significant. However, the combined incidence of hepatocellular carcinomas and hepatocellular adenomas in female mice in the 7.0 and 35.0 mg/kg-d treatment groups was statistically significant ($p < 0.05$). See Appendix H for details.

Although these data indicate that high doses of RDX may be carcinogenic to mice, they have not been corroborated by other investigators. All other indications are that RDX is not carcinogenic. Short-term tests of genotoxicity have given consistently negative results, and Hart (1976) and Levine *et al.* (1983) found no evidence of carcinogenicity.

Etnier (1989) also concluded that there are insufficient data to determine whether or not RDX is carcinogenic, and that, consequently, drinking water criteria should be based on data from long-term chronic toxicity studies reported by Levine *et al.* (1983).

7.2.1.3. Suggested RDX Drinking-Water Criterion. To date, the EPA has not established a water-quality criterion for RDX, nor is it regulated under the Safe Drinking Water Act by a maximum contaminant level (MCL) or maximum contaminant level goal (MCLG).

In the absence of guidance for water-quality goals for RDX, the U.S. Army Medical Bioengineering Research and Development Laboratory (USABRDL), Ft. Detrick, Maryland, has sponsored studies to determine a drinking-water criterion for RDX (e.g., Rosenblatt, 1986; Etnier, 1989). Rosenblatt (1986, his Table 1, p. 5) suggested a drinking-water criterion for RDX of 35 $\mu\text{g/L}$.

A study of RDX toxicity in rats by Levine *et al.* (1986), summarized above, concluded that 0.3 mg/kg-d represented a NOEL dose. Other studies, by Brown (1975) and Hart (1976), indicated that this NOEL was conservative. Using the value 0.3 mg/kg-d RDX as a NOEL, Etnier (1989) calculated a drinking-water criterion for RDX of 105 $\mu\text{g/L}$ (Appendix H).

Etnier's suggested criterion is well supported because of the rigorous analysis of toxicity data and the use of EPA methodology and is therefore applicable for the Site 300 HE Process Area.

Etnier's drinking-water criterion was used to evaluate contamination by RDX at the Cornhusker Army Ammunition Plant (Cornhusker AAP), Nebraska. It was also the basis for an application by the U.S. Army for an NPDES permit to discharge ground water containing small concentrations of RDX to surface water. We quote Etnier (1989) on the outcome of this application:

The criterion for RDX (105 $\mu\text{g/L}$) was used to set discharge limits for NPDES permits allowing discharge of RDX-contaminated ground water into a creek near the Cornhusker AAP in Grand Island, Nebraska. Based on the water quality criterion calculated for USABRDL, Nebraska and EPA officials stated that the permit discharge levels should pose no threat to humans.

7.2.1.4. Discussion. A maximum RDX concentration of 350 $\mu\text{g/L}$ (monitor well W-815-01, March 1988) was detected in ground water in the perched aquifer of Building 815 in the HE Process Area. The mean concentration of RDX measured since 1987 in wells W-815-01 and W-815-03 is 215 $\mu\text{g/L}$ (Fig. 8.1 and Appendix A).

The water-quality criterion (Etnier, 1989) is quite conservative. To assess the potential effects of higher concentrations of RDX in ground water, the amount of water was calculated

from monitor wells W-815-01 and W-815-03 that would have to be ingested to receive the NOEL dose of RDX.

Etnier (1989) selected a NOEL for RDX in rats of 0.3 mg/kg-day. For a 70-kg human, this is equivalent to 21 mg/day. To receive this quantity of RDX by ingesting water from wells W-815-01 and W-815-03, it would be necessary for an individual to drink 60 L of water per day from the wells for seven days a week, a very unlikely amount. We conclude that at the concentrations of RDX in these two wells, the risk of RDX toxicity from drinking the water is low.

Moreover, these monitor wells are located in a part of the HE Process Area with stringent access control. The wells are in locked enclosures. LLNL monitoring personnel are aware of the concentration of RDX in the water and have instructions not to drink the water from wells containing RDX.

7.2.2. Toxicity of HMX

In the following paragraphs, we present a summary of the toxic effects of HMX. This information is discussed in greater detail in Appendix H.

Wilson (1985) is a primary source of information about the toxicity of HMX. He presents data from acute toxicity, 14-day, and 13-week studies of HMX toxicity in laboratory animals.

7.2.2.1. HMX: Chemical Characterization and Toxicity Data. HMX is a byproduct of RDX synthesis and is present in technical (military) grade RDX at 8 to 12 weight percent. It can be prepared as the sole product by a different method of synthesis (Meyer, 1981) and is used in pure form as an HE compound. HMX is formulated and used at Site 300.

The chemical characteristics and toxic hazard criteria for HMX are summarized in the following paragraphs.

Substance. HMX:

- Chemical name: cyclo-tetramethylene-tetranitramine.
- Other names: octahydro-tetranitro-tetrazocine (Etnier, 1989); Homocyclonite; Octagen.
- Aqueous Solubility:
2.6 mg/L (Spanggord *et al.*, 1982).
5.0 mg/L (Glover and Hoffsommer, 1973).
- Vapor Pressure: 9×10^{-16} torr (Layton *et al.*, 1987). Calculated from vapor pressure-temperature equation.
- Regulations and Advisories for Drinking Water: None for HMX in drinking water.
- Other Standards or Criteria: None.

7.2.2.2. Summary of HMX Toxicity Studies. No studies of HMX toxicity in humans were found.

The literature contains very few studies of HMX toxicity in animals. Most of the information available is from two studies, McNamara *et al.* (1974) and Wilson (1985).

Layton *et al.* (1990, in press) reviewed the literature on HMX; excerpts are cited here. The original of Wilson (1985) was used in preparing this review.

Once in an animal's body, HMX is widely distributed. It has been detected in the heart, CNS, liver, and kidneys of mice and rats (McNamara *et al.*, 1974; Wilson, 1985). Wilson (1985) noted that following oral (500 mg/kg) or intravenous (2.0 mg/kg) administration of HMX to rats, the highest concentrations were found in the liver and kidneys, and the lowest concentrations were found in the brain.

The major toxic effects of HMX administered for 14 days in the diet of rats and mice are to the liver and kidneys. "Significant" effects to livers (enlarged centrilobular cells) were observed in males at dose rates of 150 mg/kg-d HMX and above. Kidney effects (focal atrophy and dilation) were observed in females at dose rates of 270 mg/kg-d HMX or more. Toxic effects were also observed in the CNS and the cardiovascular system (Wilson, 1985).

In a 13-week study, male mice were dosed with HMX at 0 to 200 mg/kg-d, and the females at 0 to 750 mg/kg-d HMX (Wilson, 1985). Laboratory studies of the mice did not reveal any major differences between the treated animals and the control groups. At the highest dose rate (200 mg/kg for males, 250 or 700 mg/kg-d for females) mortality was high (13/20 males, 20/20 females).

Simmon *et al.* (1977) investigated the mutagenicity of HMX in the Ames assay with *Salmonella typhimurium*. HMX did not significantly increase the frequency of reverse mutations in any of the tests.

There are no data on the teratogenicity or carcinogenicity of HMX.

7.2.2.3. No-Observed-Effects-Level (NOEL) Dose. Although Wilson's (1985) data from a 13-week study provides some evidence that HMX may be toxic to mice only at doses greater than 10 mg/kg-d, the lack of statistical analyses of the results precluded selection of this value as a NOEL for HMX.

7.2.2.4. Drinking Water Criterion. Because Wilson's (1985) data do not clearly define a NOEL for HMX, they cannot be used to estimate a drinking water criterion.

7.2.3. Comparison of Toxicity: LD₅₀ Dose, RDX and HMX

Data from acute toxicity tests reported by Etnier (1989) and Wilson (1985) define LD₅₀ doses for RDX and HMX, respectively.

Etnier (1989) reported that Cholakis *et al.* (1980) administered oral doses of RDX in aqueous methyl cellulose-polysorbate to male and female rats and identified a LD₅₀ of 118 mg/kg. Cholakis *et al.* (1980) also reported a LD₅₀ of 80 mg/kg in male and female mice dosed orally with RDX in the same vehicle.

Wilson (1985) administered HMX orally in 0.15% aqueous carboxymethylcellulose to Fischer 344 rats. The LD₅₀ for HMX was 7.36 (6.89–7.83) g/kg. For mice dosed in the same manner, the LD₅₀ for HMX was 2.71 (2.48–2.94) g/kg. Wilson stated that HMX may be considered practically nontoxic to rats, and slightly toxic to mice.

Because the experimental conditions used by Cholakis *et al.* (1980) to evaluate RDX are qualitatively similar to those used by Wilson (1985) to evaluate HMX, their results were compared (Table 7.2.3-1). The data indicate that HMX has a higher LD₅₀ than RDX for both rats and mice. These data indicate that HMX is much less toxic than RDX.

Table 7.2.3-1. RDX and HMX acute toxicity (LD₅₀) dose data.

Species	Route	RDX LD ₅₀ (mg/kg) ^a	HMX LD ₅₀ (mg/kg)	Reference
Rat (male/female)	Oral	118	–	Cholakis <i>et al.</i> (1980)
Rat (male/female)	Oral	–	7360 ^a	Wilson(1985) ^b
Mouse (male/female)	Oral	80	–	Cholakis <i>et al.</i> (1980)
Mouse	Oral	–	2710 ^a	Wilson(1985) ^b

^aThese results are reported as mg/kg. This does not describe a concentration in the solid state, i.e., parts per million. It describes the dose per kilogram of body weight in test groups of laboratory animals.

^bWilson (1985) reported results as g/kg. Data have been converted to mg/kg for purposes of comparison.

7.2.4. Toxicity of TCE (adapted from Taffet *et al.*, 1989)

Substance: TCE:

- Clear, colorless liquid with a characteristic odor.
- Solubility: 1070 mg/L (Verscheuren, 1983).
- Regulations and Advisories for Drinking Water:

Safe Drinking Water Act MCLG, 0.0 µg/L.

Reference concentration for potential carcinogens, 2.8 µg/L per 70 kg.

Aquatic organisms and drinking water, 0 (2.7 µg/L). EPA takes the position that there is no zero risk for a carcinogen, so zero is specified. The concentration in parentheses refers to the 1×10⁻⁶ risk from drinking 2.5 L per day for one year of water containing this concentration, i.e., 2.7 µg/L (Superfund Public Health Assessment Manual).

Adjusted for drinking water only, 0 (2.8 µg/L).

EPA, California DHS MCL, 5 µg/L.

- DL: The Site 300 DL for TCE in soil is 500 µg/kg (Table 8.1.1-1).
- Exposure to TCE:

Vapors may irritate the eyes, nose, and throat.

Prolonged inhalation of moderate concentrations of vapor may cause headaches and drowsiness.

Inhalation of high concentrations may cause narcosis and anesthesia.

Severe acute exposure may cause cardiac failure.

Significant chronic exposure may damage the liver and other organs.

Prolonged repeated skin contact with the liquid may cause irritation and dermatitis.

The Permissible Exposure Limit (PEL) for a Time Weighted Average (TWA) for an 8-h period is 25 ppm in air, according to the California Administrative Code, Title 8, Section 5155.

- Mammalian Inhalation Toxicity:

Mouse: LC₅₀: 49,000 ppm for 30 minutes
8450 ppm for 4 hours
5500 ppm for 10 hours
No effect at 1600 ppm for 4 hours

Rat: LC₅₀: 8000 ppm for 4 hours
No effect at 100 ppm for 8 hours or 730 ppm for 8 hours/day, 6 weeks

Rabbit: No effect at 1200 ppm for 473 hours or 730 ppm for 8 hours/day, 6 weeks

Guinea pig, ape: No effect at 730 ppm for 8 hours/day, 6 weeks

- Mammalian Oral Toxicity:

Rat: 3 to 5 mL/kg

- Toxicity:

Eye irritation at 160 ppm; supportable during 30 minutes: 379 to 372 ppm

Full narcosis: 2500 to 6000 ppm

Severe toxic effects: 2000 ppm = 10,940 mg/m³, 60 minutes

Symptoms of illness: 800 ppm = 4376 mg/m³

Unsatisfactory: >400 ppm = 2188 mg/m³

- Carcinogenicity:

As a potential carcinogen, TCE appears in EPA category group B2:

- sufficient evidence of carcinogenicity in animals;
- inadequate evidence of carcinogenicity in humans.

As a noncarcinogen, TCE has an EPA Rating Value (R_{Ve}) of 5 for oral intake—reversible cellular changes:

- cloudy swelling, hydropic change, or fatty changes.
- An R_{Ve} of 4 for inhalation: hyperplasia, hypertrophy, or atrophy with changes in organ weights.

Chapter 8. Horizontal and Vertical Extent of Contamination

In the HE Process Area, low to moderate concentrations of the HE compounds RDX and HMX are found in soil and rock near decommissioned HE rinsewater lagoons (Plate 4) where rinsewater was formerly discharged. HE compounds are also found in ground water beneath Buildings 815 and 817 (Figs. 8.1, 8.2, and 8.3).

VOCs have been identified in ground water beneath the area near Building 815. TCE (above regulatory standards) and very low concentrations of 1,1-DCA and chloroform (below regulatory standards) have been identified (Figs. 8.2, 8.3, and 8.4).

This chapter presents the information currently available about the extent of contamination and discusses our present understanding of the situation. The release site(s) of the HE compounds have not been identified; therefore, investigations continue.

8.1. HE Compounds, Metals, and VOCs in Soil and Rock

8.1.1. HE Compounds, Metals, and VOCs in Soil and Rock: Regulatory Standards and Designated Levels

A regulatory drinking water standard for RDX does not exist; however, the U.S. Army sponsored research (Etnier, 1989), to develop a suggested drinking water criterion (105 µg/L RDX), which we have used in our evaluation of HE compounds in water. The long-term toxicity data available for HMX were not subjected to statistical analysis and, thus, are not defined rigorously enough to support determination of a proposed drinking water criterion. However, the LD₅₀ dose of RDX and HMX were compared, which indicated that HMX is an order of magnitude less toxic than RDX (Table 7.2.3-1).

DLs are concentrations of waste constituents in soil and rock that provide a site-specific indication of a waste's potential to impair ground water quality. If measured concentrations of contaminants in soil and rock exceed the DLs, the soil or rock is assumed to pose a water-quality threat at the site in question. The DLs for VOCs and metals in soil and rock are shown in Tables 8.1.1-1 and 8.1.1-2.

Using the suggested drinking water criterion (105 µg/L) and the DL methodology of Marshack (1989), the DL in soil and rock for RDX was calculated to be 10.5 mg/kg (ppm) (Appendix H). Only one soil sample in the HE Process Area had a concentration of RDX that exceeded the DL (11 mg/kg [ppm] from 8.0–8.4 ft in B-806-05). Because there is no drinking water criterion for HMX, a DL cannot be determined for it. However, because the toxicity of HMX is much lower than that of RDX, if a drinking water criterion and DL could be determined, they would be much higher than the criterion and DL for RDX.

Soluble Threshold Limit Concentrations (STLCs) are concentrations of metals analyzed using the Waste Extraction Test (WET) and are listed in the California Code of Regulations, Chapter 22. At metals concentrations above these levels, a waste or soil is classified as a hazardous waste for purposes of specifying treatment and disposal requirements. Total Threshold Limit Concentrations (TTLs) are concentrations of metals analyzed using the nitric acid digestion technique and are also listed in the California Code of Regulations,

Figure 8.1. RDX concentrations in the perched aquifer, HE Process Area, first quarter 1990.

Figure 8.2. RDX concentrations in the Neroly upper blue sandstone aquifer, HE Process Area, first quarter 1990.

Figure 8.3. TCE concentrations in the perched aquifer, Building 815 Area, first quarter 1990.

Figure 8.4. TCE concentrations in the Neroly upper blue sandstone aquifer, HE Process Area, first quarter 1990.

Title 22. At metals concentrations above these levels, a waste or soil is classified as a hazardous waste. Table 8.1.1-1 includes the following regulatory standards for VOCs: STLC (for TCE only), Maximum Contaminant Levels (MCLs) or California State Action Levels (SALs), and DLs. Table 8.1.1-2 includes the following regulatory standards for metals: STLCs, TTLCs, MCLs, and DLs.

Table 8.1.1-1. Soluble Threshold Limit Concentrations (STLCs), Maximum Contaminant Levels (MCLs), Department of Health Services recommended State Action Levels (SALs), and Designated Levels (DLs) for VOCs in soil and ground water.

Parameter ^a	STLC ^b (mg/L)	MCL/SAL (µg/L)	DL ^c (µg/kg)
Trichloroethylene	204	5	500
Chloroform	--	100	10,000
1,1-Dichloroethane	--	5	500

^a Only those VOCs that were detected in soil samples are listed.

^b California Administrative Code, Title 22 (California Department of Health Services, 1989).

^c Calculated from MCL or SAL by assuming an attenuation factor of 100 (Marshack, 1987).

Note: "--" indicates no standard has been established.

A Maximum Contaminant Level (MCL) of 5 µg/L (ppb) has been established for TCE in ground water. From this, a Site 300 DL was determined for TCE in soil of 500 µg/kg (ppb) (Table 8.1.1-1).

8.1.2. HE Compounds in Soil and Rock

The distribution of HE compounds has been examined in soil and rock at Site 300 (Carpenter *et al.*, 1988; Appendix A). HE compounds are present at low concentrations in some soil and rock samples collected from beneath the closed rinsewater lagoons, at several of the dry wells, and near facilities where HE compounds have been handled. In areas distant from the immediate vicinity of processing facilities, the soil was found to be free of HE compounds. For example, the borrow pits used to provide fill for the closure of the decommissioned lagoons were free of HE compounds (J. Clarkson, LLNL, personal communication, 1989). The area underlain by HE compounds in soil is small (less than 2 acres total) relative to the size of the HE Process Area (285 acres). Only one soil sample from beneath one lagoon (Lagoon 806) contained RDX at a concentration (11mg/kg [ppm]) slightly above the calculated DL of 10.5 mg/kg (ppm). Therefore, these occurrences of RDX and HMX present no threat to the public safety or health, or to the environment.

8.1.2.1. Release Sites of HE Compounds Beneath the Closed Lagoons.

Until 1985, HE compounds contained in rinsewater from processing facilities were discharged to rinsewater lagoons. There, part of the water infiltrated the soil and rock beneath the lagoons. Thus, the lagoons were release sites for the HE compounds to the environment. The driving force that moved the HE compounds downward from the lagoons was the infiltration of rinsewater. Because discharge of rinsewater ceased when the lagoons were decommissioned in 1985, only infiltrating rain water remained to further move the HE compounds. The impermeable caps installed during formal closure of the lagoons in 1989 exclude rain water from the lagoons, thereby preventing further movement of the HE compounds.

Table 8.1.1-2. Soluble Threshold Limit Concentrations (STLCs), Total Threshold Limit Concentration (TTLCs), Maximum Contaminant Levels (MCLs), and Designated Levels (DLs) for metals concentrations in soil and ground water.

Parameter	STLC ^a (mg/L)	TTLC ^a (mg/kg)	MCL ^b (mg/L)	DL ^c (mg/kg)
Aluminum	—	—	1	10
Antimony	15	500	—	—
Arsenic	5	500	0.05	0.5
Barium	100	10,000	1	10
Beryllium	0.75	75	—	—
Cadmium	1	100	0.010	0.1
Chromium (VI) compounds	5	500	0.05	0.5
Chromium and/or chromium (III) compounds	560	2,500	0.05	0.5
Cobalt	80	8,000	—	—
Copper	25	2,500	—	—
Lead	5	1,000	0.05	0.5
Mercury	0.2	20	0.002	0.02
Molybdenum	350	3,500	—	—
Nickel	20	2,000	—	—
Selenium	1	100	0.01	0.1
Silver	5	500	0.05	0.5
Thallium	7	700	—	—
Vanadium	24	2,400	—	—
Zinc	250	5,000	—	—

^{a,b} California Administrative Code, Title 22 (California Department of Health Services, 1989).

^c Calculated from MCL by assuming an attenuation factor of 100 and dividing by 10, as described by Marshack (1987).

Note: "—" indicates no standard has been established.

8.1.2.2. Release Sites of HE Compounds at Abandoned Dry Wells and Monitor Wells. In the past, HE compounds released during cleaning operations at several facilities in the HE Process Area were released in waste water to dry wells. Some of the waste water infiltrated the soil beneath the dry wells, leaving HE compounds in the soil and rock. Thus, some of the dry wells were the release sites of HE compounds.

Concentrations of HE compounds detected in soil samples from the sample holes in the vicinity of the dry wells did not exceed the DL of 10.5 mg/kg RDX in soil (Carpenter *et al.*, 1988). HE compounds were not detected at depths greater than 12 ft in the sample holes, which indicates a downward limit to vertical infiltration.

Soil samples from most of the pilot boreholes of monitor wells contain little RDX or HMX. Samples from a few monitor wells, namely W-815-01, W-815-02, and W-819-02, detected low concentrations. A sample from well W-810-01 contained HE compounds at 85 ft. The distribution of HE compounds is too irregular to assist in determining a release site.

8.1.3. Metals in Soil and Rock

We examined the distribution of metals (Appendix A) in the soil samples collected from the boreholes in the HE Process Area. Metals analyses conducted on soil samples collected from test boreholes and monitor wells drilled in support of the lagoon closure plan (Carpenter *et al.*, 1989) were done using both the nitric acid extraction and citric acid (WET) method. Excluding the surface sample S-825-L1, all samples (Appendix A) contained lower concentrations of metals than the applicable threshold limit: TTLCs for the samples extracted by nitric acid digestion and STLCs for the sample leached by WET method extraction. The concentration of lead in surface sample S-825-L1 is 6.5 mg/L, and the STLC is 5.0 mg/L. The 6.5 mg/L value also exceeds the DL for lead of 0.5 mg/kg. Other samples (S-825-L2, S-825-L3, and S-825-LB) collected adjacent to S-825-L1, detected lead at concentrations less than the STLC. We do not think the slightly elevated concentration in surface sample S-825-L1 is environmentally significant.

Barium was detected in concentrations up to 35 mg/L in one sample collected from adjacent to each of the following lagoons: 806, 807, 817, and 827; the DL for barium is 10 mg/L. We do not think these single sample analytical results are environmentally significant.

Soil samples collected from the abandoned dry wells and monitor wells contained metals at concentrations less than the STLCs and DLs (Table 8.1.1-2).

8.1.4. VOCs in Soil and Rock

The distribution of VOCs has been examined in soil samples from boreholes in the HE Process Area. Although VOCs were present sporadically in soil samples from the boreholes, the concentrations did not exceed the Site 300 DLs (Table 8.1.1-1).

8.2. HE Compounds and VOCs in Ground Water

The following discussion of the distribution of HE compounds in ground water was developed using reports by D. W. Carpenter and the senior author incorporated in several Site 300 Environmental Investigations Quarterlies subsequent to 1987.

The hydrogeology of the aquifers in this area is discussed in detail in Section 6.2. Four of these aquifers are of interest:

- Two separate perched aquifers of limited extent in the late Tertiary nonmarine sequence (Tps).
- The water table aquifer in the Neroly upper blue sandstone (Tnbs₂).
- The confined aquifer in the Neroly lower blue sandstone (Tnbs₁).

One of the perched aquifers is near Building 814; the other is beneath Building 815. The two deeper aquifers underlie large areas of Site 300.

RDX was first detected in ground water from monitor well W-817-01, completed in the water table aquifer in April 1985. Since then, RDX has been detected in water from two aquifers: the perched aquifer of Building 815; and the first water table aquifer, located in part of the Neroly

upper blue sandstone beneath Buildings 815 and 817. Maximum, minimum and mean concentrations of RDX in ground water are shown on Table 8.2-1.

VOCs were first detected in a ground water sample collected during April 1987 from well W-815-01. Since that time, VOCs have been detected near and south of Building 815 (Figs. 8.3 and 8.4). The primary VOC detected in the ground water is TCE. Water sampled from wells W-814-01 and W-815-03 has consistently contained very low levels of chloroform. 1,1-DCA has been detected in some samples of ground water from well W-815-03. Maximum, minimum and mean concentrations of VOCs are shown on Table 8.2-1.

8.2.1. HE Compounds in Ground Water

8.2.1.1. Perched Aquifer of Building 815: HE Compounds. RDX is found in a small portion of the perched aquifer in the immediate vicinity of Building 815. The RDX concentrations, shown in Figure 8.1 and Appendix B, exceed the suggested drinking water criterion of 105 µg/L (Etnier, 1989). RDX has not been detected in water from other parts of the perched aquifer. This aquifer is either dry or absent in wells surrounding the area containing RDX (Fig. 8.1). Its distribution is somewhat irregular; for example, the perched aquifer is not present in well W-809-03, located between wells W-809-01 and W-815-03.

8.2.1.2. Water Table Aquifer: HE Compounds. The regional water table aquifer is in the Neroly upper blue sandstone aquifer (Section 6.2.2.2). Although the upper blue sandstone is present beneath a wide area of Site 300, it contains a saturated zone only in the southern part of the HE Process Area and the adjacent GSA to the south (Fig. 6.1.2-2).

8.2.1.2.1. RDX. RDX has been detected in ground water collected from wells W-815-02, W-815-04, and W-817-01 (Fig. 8.2). Table 8.2-1 shows the maximum, minimum, and mean RDX concentrations in samples from each well.

The RDX concentrations detected in ground water (Table 8.2-1) from well W-815-04 exceed the suggested drinking water criterion of 105 µg/L (Etnier, 1989) (Fig. 8.2; Appendix B). In well W-817-01, the maximum concentrations of RDX in ground water sampled in the fall of 1989 exceeded the RDX criterion; however, the mean concentrations of RDX of all the samples taken at that time did not exceed the criterion (Table 8.2-1). Previous samples from this well were below the criterion (Appendix B). Samples collected from well W-817-01 in early 1990 were also considerably less than the criterion. We think that the samples collected in the fall of 1989 were anomalous. The concentration of RDX in well W-815-02 has never exceeded the criterion.

The region occupied by RDX is small, lying beneath wells W-815-02, W-815-04, and W-817-01 (Fig. 8.2). To date, the area has been bounded on three sides:

- To the west, W-817-06A produces ground water in which RDX is not detected.
- To the north, the aquifer is dry in W-810-01, and RDX is not detected in ground water sampled from W-809-03.
- To the south, RDX has not been detected in W-817-02, W-817-03, and W-817-04.

During 1990, the limits of RDX will be determined in ground water east of Building 815 by drilling a monitor well(s).

8.2.1.2.2. HMX. In the fall of 1989, HMX was reported in four ground water samples from well W-817-01 (mean concentration, 38 µg/L). Ground water samples collected in early 1990 showed no detectable HMX, so HMX may or may not be present in ground water from well W-817-01. To determine if a trend exists, evaluation of the data from quarterly monitoring samples will continue.

Table 8.2-1. Concentrations of RDX and VOCs in aquifers in the HE Process Area.

	Well	Samples Detections/Total	Substance	Maximum (µg/L)	Minimum (µg/L)	Mean (µg/L)
High Explosive Compounds^a						
Perched aquifer of Building 814	W-814-01	0	ND ^b			
	W-809-01	0	ND			
Perched aquifer of Building 815	W-815-01	9/9	RDX	260	165	216
	W-815-03	9/10	RDX	275	<20	215
	W-815-05	0/1	ND			
	W-817-3A	0	ND			
	W-6CI	0	ND			
First water table aquifer (Tnbs ₂)	W-809-02	0	ND			
	W-809-03	0	ND			
	W-815-02	9/10	RDX	49	<20	31.5
	W-815-04	7/7	RDX	117	35	87
	W-817-01	17/19	RDX	62	<20	39
	W-817-01	2/19	HMX ^c			38
Confined aquifer (Tnbs ₁)	W-817-6A	0	ND			
	W-810-01	0	ND			
	W-817-05	0	ND			
	W-810-01	0	ND			
	W-819-02	0	ND			
Volatile Organic Compounds (VOCs)^d						
Perched aquifer of Building 814	W-814-01	7/7	TCE	2.6	1.2	1.9
	W-814-01	7/7	Chloroform	1.5	0.5	0.88

Table 8.2-1. (Continued.)

Table 8.2-1. (Continued.)							
Well	Samples Detections/Total	Substance	Maximum (µg/L)	Minimum (µg/L)	Mean (µg/L)		
Volatile Organic Compounds (cont.) ^d							
Perched aquifer of Building 815							
W-809-01	6/7	TCE	4.4	<0.5	2.6		
W-815-01	12/12	TCE	280	88	129		
W-815-03	8/8	TCE	36	1.5	14.6		
W-815-03	7/8	1,1-DCA	1.2	<0.5	0.9		
W-815-03	8/8	Chloroform	1.4	0.7	1.2		
W-815-05	0	ND					
W-817-03A	10/10	TCE	150	43	87.2		
W-6CI	3/10 ^e	TCE	1.1	0.6	0.9		
First water table aquifer (Tnbs ₂)							
W-809-02	0	ND					
W-809-03	0	ND					
W-815-02	11/11	TCE	31	9	17		
W-815-04	6/7	TCE	1.9	<0.5	1.3		
W-817-01	0	ND					
W-817-02	0	ND					
W-817-03	11/11	TCE	36	11	23.5		
W-817-04	11/11	TCE	15	2.5	11.5		
W-817-06A	0	ND					
Confined aquifer (Tnbs ₁)							
W-810-01	0	ND					
W-817-05	0	ND					
W-810-01	0	ND					
W-819-02	0	ND					

^aNo RDX detected in confined aquifer wells above detection limit (approx. 20 µg/L).^bNot detected above detection limit.^cNot detected above detection limit when sampled in early 1990.^dNo TCE detected in confined aquifer wells above detection limit (0.5 µg/L).^eTCE detected in four quarterly samples, March 1988 to February 1989. None detected since February 1989.

8.2.1.3. Confined Aquifer Beneath the HE Process Area. HE compounds have never been detected in the confined aquifer.

8.2.2. VOCs in Ground Water

8.2.2.1. Perched Aquifer of Building 814: VOCs. Low concentrations of TCE and chloroform (Table 8.2-1) at less than the MCLs have been detected in ground water from well W-814-01 in the localized perched aquifer near Building 814 (Fig. 6.1.2-1). Neither of these was detected during the first quarter of 1990 (Fig. 8.3).

Both the aquifer and its ground water production appear to be small (Fig. 8.3). We will continue to monitor the well to determine if a trend exists in the behavior of the VOCs found in it.

8.2.2.2. Perched Aquifer of Building 815: VOCs. Means, maximums, and minimums of TCE concentrations in key wells (Fig. 8.3) are summarized in Table 8.2-1; details are given in Appendix B. In ground water from wells W-815-01 and W-815-03, TCE concentrations exceed the MCL for drinking water (5 µg/L). The concentrations of chloroform and 1,1-DCA, present in the ground water beneath the area, are less than the applicable MCL or California State Action Level.

8.2.2.3. Water Table Aquifer: VOCs. Figure 8.4 shows the distribution of VOCs in ground water from wells completed in the water table aquifer. TCE concentrations exceed the MCL in water from wells W-815-02, W-817-03, and W-817-04. Water from well W-815-04 contains TCE at concentrations less than the MCL.

No VOCs have ever been detected in other wells completed in this aquifer.

8.2.2.4. Confined Aquifer Beneath the HE Process Area. The confined aquifer beneath the HE Process Area is in the Neroly lower blue sandstone. Water saturation is widespread in the lower blue sandstone aquifer. The piezometric surface of water in this aquifer is shown in Figure 8.2.2-1.

Neither HE compounds nor VOCs have ever been detected in ground water from this aquifer beneath the HE Process Area.

8.3. Distribution of HE Compounds, Metals, and VOCs in Surface Water

Because of the aridity at Site 300, there are no perennial streams. A few small springs feeding seeps and very small heavily vegetated areas are the only perennial surface water at Site 300.

TCE is discharged by a small spring, monitored by well W-817-03A, on the east side of the HE Surface Impoundments. The discharge is small, and the TCE evaporates from the spring discharge quickly, probably at concentrations much less than the Permitted Exposure Level (25 mg/m³).

No other contaminant compounds are found in surface water in the HE Process Area.

Figure 8.2.2-1. Ground water elevations in Neroly Lower Blue Sandstone aquifer, southeastern part Site 300, March 1990.

8.4. Possible Release Sites for HE Compounds and VOCs in the HE Process Area

8.4.1. Possible Release Sites for RDX

A credible site(s) has not yet been identified for the release of RDX to the saturated water bodies beneath the Building 815-817 area. In the perched aquifer of Building 815, RDX is present in both W-815-01 and W-815-03. The perched aquifer is not present in well W-817-01 (Fig. 8.1).

RDX has also been detected in water from wells W-815-02, W-815-04, and in W-817-01, completed in the water-table aquifer (Fig. 8.2).

Building 817 has long been used for pressing components fabricated from HE compounds. Well W-817-01, which is slightly cross-gradient from Building 817 (Fig. 8.2), has shown a consistently low concentration of RDX since April 1985. Exploratory boreholes (Plate 4) drilled near the decommissioned lagoon near Building 817 (817-D1, 817-H1, 817-L1, and 817-L2) show relatively low concentrations of HE compounds in soil and rock; each was drilled into clean soil below. The use of the building for pressing HE compounds, and the presence of HE compounds in the ground water beneath it, suggest that Building 817 might be a release site. Yet, the highest concentration of RDX is beneath Building 815, and well W-817-01 is hydrologically upgradient from Building 815 (Fig. 8.2). These facts are puzzling because reliable information about the uses of the buildings in the HE Process Area indicates that HE compounds have never been handled in Building 815. This building was purportedly used only as a steam plant to serve the HE Process Area.

Other possible release sites have been considered. Building 809 lies northwest of the occurrences of RDX (Fig. 8.2). Recently we learned that Building 809 has been used for HE fabrication. We will investigate to learn if it is a release site for HE compounds.

Building 810 is used to assemble experimental devices using HE compounds. Well W-810-01 (Fig. 8.2) was drilled to test the possibility of a release site at or near Building 810. Low concentrations of RDX and HMX were found in the soil near Building 810 (Fig. 8.2). During the drilling of well W-810-01, soil sampled from a zone at a depth of 85 ft apparently contained RDX, though samples for a considerable distance above this zone did not. A recent borehole, D-810C-01, drilled about 50 ft south of Building 810, encountered a zone containing oxidized organic matter at a depth of 18 ft. In this borehole (D-810C-01), RDX and HMX were present in samples collected at depths less than 12 ft. Perched ground water from well W-810-01, approximately 300 ft south of the Building 810 Complex, has never contained HE compounds. We plan to conduct additional investigations in 1990 to determine whether these data have any significance.

During July 1989, in an investigation designed to identify a possible release site north of Building 815, two monitor wells (W-809-03 and W-815-05) were drilled (Fig. 8.1). At this time, a small, but deep gully that heads southeast from Building 810 towards Building 815 (Plates 1 and 3) and a larger, and equally deep gully that heads southeast from the northern part of the HE Process Area were found. Hypothetically, their presence suggests a release site northwest of Building 815 might have released RDX to water, which migrates southeastward in the shallow colluvium above the bedrock. This water might infiltrate preferentially to the perched aquifer and to the water-table aquifer near and beneath Building 815.

Samples of water from these two new wells (W-809-03 and W-815-05) contain no HE compounds in either the perched or water-table aquifers (Figs. 8.1 and 8.2), which makes this hypothesis seem unlikely.

Despite these efforts, we cannot identify with any certainty a release site(s) for the RDX detected in the ground water of the HE Process Area. We plan to investigate LLNL records further and to conduct additional investigations aimed at locating a credible source(s). If necessary, these investigations will include exploratory boreholes and new monitor wells. Results will be reported in subsequent reports.

8.4.2. Possible Release Sites for VOCs near Building 814

The concentrations of TCE and chloroform detected in the perched aquifer of Building 814 (Table 8.2-1) are lower than the MCLs for either compound. We do not know the precise location of the release site of these substances; presumably, it is near Building 814. The small size and probable low productive capacity of well W-814-01 in this aquifer indicate it will not be a source of drinking water, and therefore, is not environmentally significant. Nevertheless, we will continue to monitor this well.

8.4.3. Possible Release Sites for VOCs near Building 815

In the perched aquifer of Building 815, VOCs are concentrated in the region immediately beneath Building 815. They also occur in piezometer W-817-03A, which provides a monitoring point east of the HE Surface Impoundments (Fig. 8.3). The data are summarized in Table 8.2-1.

In addition, TCE occurs in lower concentrations in the water table aquifer beneath Building 815 and to the south in monitor wells W-817-03 and W-817-04 (Fig. 8.4).

As stated earlier, investigations indicate that Building 815 was used as a steam plant. Apparently, the steam boiler at Building 815 was cleaned periodically to remove soot, using TCE as a solvent. The TCE was stored in drums on a concrete hardstand south of the building; minor stains were visible on the hardstand. During the investigation, monitor wells W-815-01 and W-815-02 were drilled immediately adjacent to the hardstand. TCE was found in the soil and rock and in the ground water. The highest concentrations of TCE in the HE Process Area are found in water from well W-815-01. TCE was also detected in soil samples collected during drilling of these wells (Appendix A).

Data indicate that TCE found in the ground water beneath Building 815 was released to the environment either during use in cleaning the boiler at Building 815 or during storage at the hardstand south of the building.

Ground water from monitor well W-815-03, also completed in the perched aquifer of Building 815, contains very small concentrations of 1,1-DCA and chloroform. These substances are present in well W-815-03 at concentrations substantially less than the SAL and MCL, respectively, for these substances.

Chapter 9. Effects on Air and Biota

In this chapter, the effects on the air and biota of HE compounds and TCE in soil, rock, and ground water at the HE Process Area are considered. Although a specific study of the effects of HE compounds and TCE on animals and plants has not been done, no apparent effects on either have been found. In addition, an analysis is presented of the amounts of these substances detected in ground water that are available to the surface environment, and the probable effect of these concentrations on the air and biota.

9.1. Effects of HE Compounds (RDX and HMX) on the Air and Biota

In summary:

- RDX and HMX are low in volatility (Chapter 8).
- RDX is moderately to highly toxic (Etnier, 1989).
- The suggested drinking-water criterion is 105 $\mu\text{g/L}$ RDX.
- HMX is virtually non-toxic (Chapter 8).

9.1.1. Effects of HE Compounds on Air Quality

Until 1985, virtually none of the small quantities of RDX and HMX that were discharged to the environment in rinsewater entered the air. This was due to the low volatility of RDX and HMX. Thus, these substances had no significant effect on the air.

RDX and HMX are formulated, pressed, and machined indoors at various buildings in the HE Process Area. As a result of these operations, small particles of HE compounds may enter the indoor air. Because the particles settle to the floor where they are periodically washed down, they are not a significant hazard to environmental air quality or the biota.

9.1.2. Effects of HE Compounds in Soil and Rock

Between 1955 and 1985, rinsewater containing low concentrations of the HE compounds RDX and HMX was discharged to shallow lagoons near various buildings in the HE Process Area. The lagoons were decommissioned in 1985, and the HE Surface Impoundments were opened; rinsewater was then discharged to the impoundments and was no longer discharged to the open environment. In 1986 and 1987, the lagoons were evaluated by drilling boreholes and taking samples to determine the horizontal and vertical extent of HE compounds.

In October 1989, the lagoons were formally closed. As a result, the HE compounds dispersed in the soil beneath and adjacent to the closed lagoons are no longer exposed to the air or available to the biota. Thus, they have no effect on the environment.

9.1.3. Effects of HE Compounds in Ground Water

The HE compound RDX is found in ground water beneath a small area which centers on Building 815 and extends westward to Building 817. The area is limited in size, and the depth to water varies between 50 and 125 ft. The spring east of the HE Surface Impoundments is the only natural discharge of water in the area, and does not contain RDX. Thus, the ground water

containing HE compounds does not reach the ground surface and is not available to the air or biota. The shallowest ground water containing RDX is approximately 50 ft below the land surface and is totally inaccessible to plants or animals.

Therefore, the RDX present in the ground water is not a threat to the biota in the area.

9.2. Effects of TCE on the Air and Biota

9.2.1. Effects of TCE in Soil and Rock

Except in monitor well W-815-01, TCE is detected in soil of the HE Process Area in erratic trace concentrations near the detection limit. TCE was used for boiler cleaning at Building 815 and stored in 55-gal drums on a concrete hardstand south of the building. Presumably, TCE entered the environment through inadvertent spillage either at Building 815 or at the hardstand prior to 1985. In well W-815-01 (adjacent to one of the presumed release sites, the hardstand), concentrations of a few 10 ppb occur in some soil and rock samples at depths below 5 ft. None of these occurrences are near the land surface.

It is likely that soon after release, much of the TCE, which is very volatile, evaporates quickly from the soil surface and immediately underlying soil, and is therefore dispersed in the air at low concentrations. In the HE Process Area, we think TCE in soil and rock does not constitute a hazard to the air or biota.

9.2.2. Effects of TCE in Ground Water

TCE occurs in ground water in several wells in the HE Process Area near Buildings 815 and 817. Except at the spring east of the HE Surface Impoundments, none of this water is accessible at the surface. Moderate amounts of TCE have been detected in a piezometer, W-817-3A, which is located adjacent to the spring. The spring discharges small amounts of water into a small, heavily vegetated area. The TCE evaporates from the spring water into the air quickly after discharge from the ground, probably at concentrations less than the Permitted Exposure Level (PEL) of 25 mg/m³. The other occurrences of TCE are in monitor wells in which the water level is deeper than 50 ft below the ground surface. The water from the wells is not accessible to animals or plants.

Therefore, the concentration of TCE in ground water is so small and evaporation so rapid near the land surface that the TCE presents no threat to the biota.

9.3. Conclusions

We conclude that the amounts of HE compounds and TCE available to the air, the biota from the closed lagoons, and the ground water are too small and too limited in extent to have a significant effect on the air or biota.

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P. Cederwall managed the data collected for this report, and prepared many of the tables.

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Appendix A

Soils Data: HE Compounds, Metals, and VOCs

Table A-1. HE compounds in soil samples from sample holes at the 06/807 Lagoon.

Borehole	Sample No.	Depth (ft)	HE compounds [$\mu\text{g/g}$ (ppm)]		
			HMX	RDX	TNT
B-806-01	B-806-01-1A	4.0-4.4	3.1	0.17	ND
	B-806-01-2A	9.3-9.7	0.97	1.5	ND
	B-806-01-3A	14.5-14.9	0.11	0.001	ND
	B-806-01-4A	19.5-20	0.008	<0.0006	ND
	B-806-01-5A	24.5-24.8	0.020	<0.0006	ND
	B-806-01-6A	29.5-30	0.016	<0.0006	ND
B-806-02	B-806-02-1A	3.0-3.3	2.0	0.06	ND
	B-806-02-2A	5.0-5.5	0.85	0.13	ND
	B-806-02-3A	10.0-10.3	2.1	1.1	0.13
	B-806-02-4A	15.0-15.5	0.043	0.0008	ND
	B-806-02-5A	20.0-20.5	<0.0003	0.0005	ND
	B-806-02-6A	25.0-25.5	<0.0003	<0.0005	ND
	B-806-02-7A	30.0-30.5	<0.0009	<0.0009	ND
B-806-03	B-806-03-1A	2.2-2.5	0.016	<0.0006	ND
	B-806-03-2A	4.7-5.0	0.022	<0.0006	ND
	B-806-03-3A	9.7-10.1	<0.0003	<0.0006	ND
	B-806-03-4A	14.8-15.2	0.020	<0.0006	ND
	B-806-03-5A	19.8-20.3	<0.0003	<0.0006	ND
	B-806-03-6A	24.7-25.2	0.003	0.26	ND
	B-806-03-7A	30.1-30.3	<0.0005	<0.0006	ND
B-806-04	B-806-04-1A	1.0-1.3	0.14	1.4	ND
	B-806-04-2A	5.0-5.3	<0.0009	<0.001	ND
	B-806-04-3A	10.0-10.5	0.14	0.082	ND
	B-806-04-4A	15.0-15.5	0.0013	0.073	ND
	B-806-04-5A	20.0-20.5	0.039	0.25	ND
	B-806-04-6A	25.5-26.0	0.004	<0.0008	ND
	B-806-04-6B	26.0-26.5	<0.0003	<0.0006	ND
	B-806-04-7A	30.0-30.5	<0.0004	<0.0007	ND
B-806-05	B-806-05-1A	8.0-8.4	18	11	ND
	B-806-05-2A	13.2-13.7	<0.0004	<0.0007	ND
	B-806-05-3A	18.3-18.8	<0.0003	<0.0006	ND
	B-806-05-4A	23.5-24.0	<0.0003	<0.0007	ND
	B-806-05-5A	28.5-29.0	<0.0003	<0.0006	ND
	B-806-05-6A	33.6-34.1	<0.0003	<0.0006	ND
	B-806-05-7A	43.0-43.3	<0.0005	<0.0010	ND
	B-806-05-8A	46.0	1.5	<0.0015	ND
B-806-06 ^a	B-806-06-1A	40.5	1.4	<0.0009	ND
	B-806-06-2A	45.0	0.10	<0.0007	ND
	B-806-06-3A	50.0	2.2	<0.0017	ND
	B-806-06-4A	55.0	0.51	<0.0009	ND
	B-806-06-5A	60.0	0.019	<0.0009	ND
	B-806-06-6A	64.0	0.0068	<0.0005	ND

Table A-1. (Continued)

Borehole	Sample number	Depth (ft)	HE compounds [$\mu\text{g/g}$ (ppm)]		
			HMX	RDX	TNT
B-806-06	B-806-06	72.0	<0.0003	<0.0005	ND
	B-806-06	76.0	<0.0003	<0.0005	ND
	B-806-06	81.0	<0.0003	<0.0005	ND
	B-806-06	86.0	<0.0003	<0.0005	ND
	B-806-06	90.0	<0.0003	<0.0005	ND
B-806-6A	B-806-6A-1	141.6-141.8	<0.005	<0.006	ND
	B-806-6A-2	147.4-147.6	<0.005	<0.006	ND
	B-806-6A-3	151.6-151.8	<0.005	<0.006	ND
	B-806-6A-4	156.5-156.7	<0.005	<0.006	ND

ND=Not detected.

Table A-2. HE compounds in soil and rock samples at Lagoon 807A.

Borehole	Sample No.	Depth (ft)	HE compounds [$\mu\text{g/g}$ (ppm)]		
			HMX	RDX	TNT
B-807-A1	B-807-A1-1A	1.0-1.4	<0.11	<0.0008	ND
	B-807-A1-2A	5.0-5.4	<0.0005	<0.0009	ND
	B-807-A1-3A	10.5-10.7	<0.0014	<0.0027	ND
	B-807-A1-4A	15.0-15.5	<0.0003	<0.0007	ND
	B-807-A1-5A	20.0-20.3	0.0018	0.0036	ND
	B-807-A1-6A	25.0-25.5	<0.0004	<0.0008	ND
	B-807-A1-7A	30.0-30.5	<0.0004	<0.0008	ND
B-807-A2	B-807-A2-1A	1.0-1.3	<0.0004	0.24	ND
	B-807-A2-2A	5.5-5.7	<0.0004	1.2	ND
	B-807-A2-3A	10.5-10.7	<0.0004	0.48	ND
	B-807-A2-4A	15.5-15.7	<0.0004	0.20	ND
	B-807-A2-5A	20.0-20.4	<0.0004	0.14	ND
	B-807-A2-6A	25.0-25.5	<0.0004	<0.0005	ND
	B-807-A2-7A	30.0-30.5	<0.0004	<0.0005	ND

ND = Not detected.

Table A-3 HE compounds in soil and rock samples, sample hole B-807-B1, 807B Lagoon.

Borehole	Sample No.	Depth (ft)	HE compounds [$\mu\text{g/g}$ (ppm)]		
			HMX	RDX	TNT
B-807-B1	B-807-B1-1A	1.0-1.2	2.3	0.75	ND
	B-807-B1-2A	4.5-5.0	0.0009	0.055	ND
	B-807-B1-3A	9.5-9.8	0.035	0.012	ND
	B-807-B1-4A	14.5-14.8	<0.0007	<0.0067	ND
	B-807-B1-5A	19.5-19.8	0.21	0.43	ND
	B-807-B1-6A	24.5-24.7	0.0022	<0.0014	ND
	B-807-B1-7A	29.5-30.0	<0.0004	<0.0007	ND

ND = Not detected.

Table A-4. HE compounds in soil and rock samples from sample holes, Building 817 Area.

Sample ID ^a	Sample depth (ft)	HE compounds in micrograms/gram (µg/g) of soil ^b		
		HMX	RDX	TNT
B-817-D1-1A	1.0-1.3	0.0047	<0.0007	<0.001
B-817-D1-2A	5.0-5.7	0.077	0.021	<0.001
B-817-D1-3B	10.7-11.5	<0.0005	0.041	<0.001
B-817-D1-4B	15.7-16.5	<0.0004	<0.0005	<0.001
B-817-D1-5B	22.7-23.0	<0.0004	<0.0006	<0.001
B-817-D1-6B	25.8-26.5	0.10	<0.0006	<0.001
B-817-D1-7B	30.0-30.7	<0.0007	<0.0010	<0.001
B-817-D1-8A	35.0-35.7	<0.0003	<0.0005	<0.001
B-817-H1-1B	4.2-4.4	— ^c	— ^c	— ^c
B-817-H1-2B	9.2-9.4	— ^c	— ^c	— ^c
B-817-H1-3B	14.5-14.7	— ^c	— ^c	— ^c
B-817-H1-4B	20.0-20.2	— ^c	— ^c	— ^c
B-817-H1-5B	25.0-25.3	— ^c	— ^c	— ^c
B-817-H1-6A	29.5-29.8	— ^c	— ^c	— ^c
B-817-H1-7B	35.0-35.2	— ^c	— ^c	— ^c
B-817-H1-8B	39.5-40.0	— ^c	— ^c	— ^c
B-817-H1-9B	44.9-45.1	— ^c	— ^c	— ^c
B-817-H1-10A	49.5-49.8	— ^c	— ^c	— ^c
B-817-H1-11A	55.3-55.6	— ^c	— ^c	— ^c
B-817-H1-12A	60.5-60.7	— ^c	— ^c	— ^c
B-817-H1-13A	66.5-66.7	— ^c	— ^c	— ^c
B-817-H1-14A	70.5-70.7	— ^c	— ^c	— ^c
B-817-H1-15A	74.7-74.9	— ^c	— ^c	— ^c
B-817-H1-16A	81.3-81.6	— ^c	— ^c	— ^c
B-817-H1-17A	86.4-86.6	— ^c	— ^c	— ^c
B-817-H1-18A	92.0-92.2	— ^c	— ^c	— ^c
B-817-H1-19A	97.2-97.4	— ^c	— ^c	— ^c
B-817-H1-20A	102.4-102.7	— ^c	— ^c	— ^c
B-817-L1-1A	5.2-5.4	0.0054	<0.0015	<0.0008
B-817-L1-2A	10.2-10.7	<0.0004	<0.0007	<0.0008
B-817-L1-3A	15.2-15.5	<0.0005	<0.0010	<0.0008
B-817-L1-4B	20.7-21.0	0.0042	<0.0006	<0.0008
B-817-L1-5A	25.2-25.5	0.015	<0.0014	<0.0008
B-817-L1-6A	30.2-30.4	<0.0007	<0.0014	<0.0008
B-817-L1-7A	35.6-36.1	<0.0005	<0.0009	<0.0008
B-817-L2-1A	1.0-1.3	<0.0005	<0.0009	<0.0008
B-817-L2-2B	4.7-4.9	<0.0007	<0.0014	<0.0008
B-817-L2-3B	9.6-9.8	<0.0008	<0.0016	<0.0008
B-817-L2-4B	14.8-15.0	<0.0018	<0.0034	<0.0008
B-817-L2-5B	19.8-20.0	<0.0013	<0.0025	<0.0008
B-817-L2-6A	24.3-24.7	0.023	<0.0010	<0.0008
B-817-L2-7A	29.3-29.6	<0.0003	<0.0006	<0.0008

^a All samples were collected with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Analyses by normal HPLC procedure.

^c No HE compounds detected. Detection limits are approximately

HMX = <0.0008 µg/g of soil,
RDX = <0.0008 µg/g of soil,
TNT = <0.0008 µg/g of soil.

Table A-5. HE compounds in 825 Lagoon and background samples, Building 825/826 Area.

Sample	Depth (ft)	HE compounds [μg/g (ppm)] ^a		
		HMX	RDX	TNT
825 Lagoon ^b				
B-825-01/1A	1.0–1.5	0.09	ND	ND
B-825-01/1B	1.0–1.5	0.01	ND	ND
B-825-01/2a	5.1–5.3	ND	ND	ND
B-825-01/3b	10.4–10.6	ND	ND	ND
B-825-01/4B	15.5–15.7	ND	ND	ND
Background				
B-825-02/1A	1.0–1.2	0.37	ND	ND
B-825-02/2A	4.0	0.18	ND	ND
B-825-02/3B	5.3–5.5	0.02	ND	ND
B-825-02/4A	10.0–10.2	ND	ND	ND
B-825-02/5b	15.5–15.7	ND	ND	ND

^a HPLC analysis performed by LLNL Analytical Chemistry Laboratory.

^b Due to accessibility problems with drill rig, B-825-1 Lagoon sampling borehole was actually drilled immediately to the northeast of the lagoon edge. The background sample was taken ~ 50 ft northwest of the lagoon sample.

ND = Not detected. Detection limits: HMX = 0.01 $\mu\text{g/g}$ soil,
RDX = 0.01 $\mu\text{g/g}$ soil,
TNT = 0.01 $\mu\text{g/g}$ soil.

Table A-6. HE compounds in soil and rock samples from sample holes, Building 826 Area.

Sample ID ^a	Sample depth (ft)	Concentration $\mu\text{g/g}$ of soil ^b		
		HMX	RDX	TNT
B-826-1-1A	2.7-3.1	2.2	<0.0014	<0.0008
B-826-1-2A	6.5-6.7	3.2	0.19	<0.0008
B-826-1-3A	10.0-10.4	2.3	0.11	<0.0008
B-826-1-4A	15.0-15.1	0.23	<0.0011	<0.0008
B-826-1-5A	20.0-20.2	0.13	<0.0011	<0.0008
B-826-1-6A	25.0-25.2	0.27	<0.0013	<0.0008
B-826-1-7B	30.4-30.6	0.32	<0.0016	<0.0008
B-826-1A-1A	30.0-30.3	0.081	<0.0008	<0.001
B-826-1A-2A	35.0-35.4	0.0017	<0.0005	<0.001
B-826-1A-3A	40.0-40.3	0.15	<0.0007	<0.001
B-826-1A-4A	45.0-45.4	0.12	<0.0004	<0.001
B-826-1A-5A	50.0-50.3	<0.0004	<0.0005	<0.001
B-826-2-1A	2.5-3.0	<0.0004	<0.0007	<0.0008
B-826-2-2A	7.5-7.7	<0.0006	<0.0011	<0.0008
B-826-2-3B	12.9-13.1	<0.0007	<0.0014	<0.0008
B-826-2-4B	18.0-18.2	<0.0008	<0.0014	<0.0008
B-826-2-5B	22.9-23.1	<0.0008	<0.0015	<0.0008
B-826-2-6B	28.0-28.2	<0.0008	<0.0015	<0.0008
B-826-2-7B	33.0-33.2	<0.0008	<0.0014	<0.0008

^a All samples were taken with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Analyses by normal HPLC procedure.

Table A-7. HE compounds in soil and rock samples from sample holes, Building 827 Area.

Sample ID ^a	Depth (ft)	HE compounds, µg/g of soil ^b		
		HMX	RDX	TNT
B-827-C1-1A	4.5-5.0	<0.0004	<0.0008	<0.001
B-827-C1-2A	9.5-9.8	<0.0004	<0.0007	<0.001
B-827-C1-3A	14.5-15.0	<0.0003	<0.0006	<0.001
B-827-C1-4A	20.0-20.5	<0.0003	<0.0006	<0.001
B-827-C1-5A	24.8-25.3	<0.0004	<0.0007	<0.001
B-827-C1-6A	29.5-29.8	<0.0005	<0.0010	<0.001
B-827-C1-7A	34.5-35.0	<0.0004	<0.0007	<0.001
B-827-C2-1A	1.5-1.6	<0.0010	<0.0018	<0.001
B-827-C2-2A	5.0-5.5	<0.0004	<0.0007	<0.001
B-827-C2-3B	10.2-10.7	<0.0006	<0.0011	<0.001
B-827-C2-4A	15.1-15.6	<0.0004	<0.0007	<0.001
B-827-C2-5A	20.5-21.0	<0.0004	<0.0007	<0.001
B-827-C2-6B	25.6-25.7	<0.0020	<0.0037	<0.001
B-827-C2-7A	30.0-30.3	<0.0020	<0.0009	<0.001
B-827-C3-1B	1.5-2.0 ^c	<0.0007	<0.0013	<0.001
B-827-C3-2A	5.0-5.8	<0.0009	<0.0016	<0.001
B-827-C3-3B	10.8-11.5	0.16	<0.0027	<0.001
B-827-C3-4A	16.3-16.5	<0.0010	<0.0018	<0.001
B-827-C3-6B	20.5-20.8	<0.0007	0.044	<0.001
B-827-C3-7B	25.3-25.4	<0.0006	<0.0011	<0.001
B-827-C3-8B	30.3-30.4	<0.0009	<0.0016	<0.001
B-827-C4	7.5	0.0011	<0.0008	<0.0008
B-827-C4	12.5	<0.0008	<0.0008	<0.0008
B-827-C4	15.6	0.12	<0.0008	<0.0008
B-827-C4	20.8	<0.0008	<0.0008	<0.0008
B-827-C4	25.5	0.027	<0.0008	<0.0008
B-827-C4	31.0	<0.0008	<0.0008	<0.0008
B-827-C4	35.5	0.0083	<0.0008	<0.0008
B-827-C4	40.1	0.0268	<0.0008	<0.0008
B-827-C4	45.0	<0.0008	<0.0008	<0.0008
B-827-C4	50.5	0.0043	<0.0008	<0.0008
B-827-C4	55.0	<0.0008	<0.0008	<0.0008
B-827-C5	9.5	0.017	<0.0008	<0.0008
B-827-C5	15.5	0.0082	<0.0008	<0.0008
B-827-C5	20.5	0.0051	<0.0008	<0.0008
B-827-C5	25.5	0.0059	<0.0008	<0.0008
B-827-C5	28.7	<0.0005	<0.0008	<0.0008
B-827-C5	35.0	<0.0005	<0.0008	<0.0008
B-827-C5	40.0	<0.0005	<0.0008	<0.0008
B-827-C5	46.2	<0.0005	<0.0008	<0.0008
B-827-C5	52.7	<0.0005	<0.0008	<0.0008
B-827-C5	59.5	<0.0005	<0.0008	<0.0008

^a All samples were collected with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Analyses by normal HPLC procedure.

^c Approximate depth. Sample interval was noted but not sample depth.

Table A-8. HE compounds in soil and rock samples obtained from B-827-E1 and B-827-E2.

Sample ID	Sample depth	HE compounds micrograms/gram ($\mu\text{g/g}$) of soil ^a		
		HMX	RDX	TNT
B-827-E1	1.0 ^b	6.2	0.007	ND
B-827-E1	3.0 ^b	5.2	0.14	ND
B-827-E1	5.0 ^b	1.1	<0.0006	ND
B-827-E1	9.5 ^b	3.2	<0.0008	ND
B-827-E2	7.0-7.2 ^c	0.39	— ^d	ND

^aAnalyses by normal HPLC procedure.

^bSamples from hand auger cuttings, packed in glass jar sealed with duct tape.

^cSample was obtained in a 1-1/2 -in. -o.d. stainless-steel tube filled by hand-driving a 1-1/2 -in.-i.d. split-spoon sampler. Tube ends were covered with aluminum foil and sealed with inert tape.

^dRDX concentration could not be determined because of the presence of another substance with the same retention time as RDX. The substance was determined not to be RDX based upon dissimilar UV spectra.

NOTE: ND = Not detected, detection limit for TNT approximately 0.0008 $\mu\text{g/g}$ gram.

Table A-9. Soil analyses for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
806-08	April 1987	25.5	<0.0005	<0.0005	<0.0008
	April 1987	27.3	<0.0005	<0.0005	<0.0008
	April 1987	28.2	<0.0005	<0.0005	<0.0008
	April 1987	32.4	<0.0005	<0.0005	<0.0008
	April 1987	37.5	<0.0005	<0.0005	<0.0008
	April 1987	41.3	<0.0005	<0.0005	<0.0008
	April 1987	46.7	<0.0005	<0.0005	<0.0008
	April 1987	53.6	<0.0005	<0.0005	<0.0008
	April 1987	55.0	<0.0005	<0.0005	<0.0008
	April 1987	55.6	<0.0005	<0.0005	<0.0008
	April 1987	57.9	<0.0005	<0.0005	<0.0008
	April 1987	58.9	<0.0005	<0.0005	<0.0008
W-809-01	April 1988	10.5	<0.0008	<0.0008	<0.0008
	April 1988	20.5	<0.0008	<0.0008	<0.0008
	April 1988	25.5	<0.0008	<0.0008	<0.0008
	April 1988	30.5	<0.0008	<0.0008	<0.0008
	April 1988	35.5	<0.0008	<0.0008	<0.0008
	April 1988	40.5	<0.0008	<0.0008	<0.0008
	April 1988	45.5	<0.0008	<0.0008	<0.0008
	April 1988	55.8	<0.0008	<0.0008	<0.0008
	April 1988	69.3	<0.0008	<0.0008	<0.0008
W-809-02	April 1988	91.1	<0.0008	<0.0008	<0.0008
	April 1988	101.3	<0.0008	<0.0008	<0.0008
	April 1988	106.2	<0.0008	<0.0008	<0.0008
W-809-03	June 1989	0.0	<0.001	<0.002	<0.001
	June 1989	5.3	<0.001	<0.001	<0.001
	June 1989	10.8	<0.001	<0.001	<0.001
	June 1989	15.5	0.005	<0.001	<0.001
	June 1989	20.5	0.02	<0.001	<0.001
	June 1989	28.1	0.005	<0.001	<0.001
	June 1989	41.0	0.0510	0.013	<0.001
	June 1989	50.8	0.003	<0.001	<0.001
	July 1989	59.5	<0.001	<0.001	<0.001
	July 1989	69.5	<0.001	<0.001	<0.001
	July 1989	81.8	<0.001	<0.001	<0.001
	July 1989	90.2	<0.001	<0.001	<0.001
	July 1989	99.1	<0.001	<0.001	<0.001
	July 1989	108.9	<0.001	<0.001	<0.001
W-810-01	March 1988	5.1	0.0023	<0.0008	<0.0008

Table A-9. Soil analyses for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
	March 1988	10.5	<0.0008	<0.0008	<0.0008
	March 1988	15.5	0.0012	<0.0008	<0.0008
	March 1988	20.3	<0.0008	<0.0009	<0.0008
	March 1988	25.5	<0.0008	<0.0008	<0.0008
	March 1988	30.0	<0.0008	<0.0008	<0.0008
	March 1988	39.8	<0.0008	<0.0008	<0.0008
	March 1988	42.9	0.0011	<0.0008	<0.0008
	March 1988	60.0	<0.0008	<0.0008	<0.0008
	March 1988	70.0	0.0015	<0.0008	<0.0008
	March 1988	87.0	0.0037	0.073	<0.0008
	March 1988	99.8	<0.0008	<0.0008	<0.0008
	March 1988	109.8	<0.0008	<0.0008	<0.0008
	March 1988	110.0	<0.0008	<0.0008	<0.0008
	March 1988	129.8	<0.0008	<0.0008	<0.0008
	March 1988	135.0	<0.0008	<0.0008	<0.0008
	March 1988	155.0	<0.0008	<0.0008	<0.0008
	March 1988	157.0	<0.0008	<0.0008	<0.0008
	March 1988	164.8	<0.0008	<0.0008	<0.0008
	March 1988	165.0	<0.0008	<0.0008	<0.0008
	March 1988	172.0	<0.0008	<0.0008	<0.0008
	March 1988	185.0	<0.0008	<0.0008	<0.0008
	March 1988	191.5	<0.0008	<0.0008	<0.0008
	March 1988	199.5	<0.0008	<0.0008	<0.0008
813-01	July 1989	0.8	<0.001	<0.001	<0.001
	July 1989	5.8	<0.001	<0.001	<0.001
	July 1989	10.5	0.11	<0.001	<0.001
	July 1989	15.8	0.087	<0.001	<0.001
	July 1989	20.8	0.026	0.002	<0.001
	July 1989	30.8	<0.001	<0.001	<0.001
	July 1989	40.8	0.004	<0.001	<0.001
	July 1989	50.8	<0.001	<0.001	<0.001
W-814-01	June 1987	5.8	0.68	0.052	<0.0008
	June 1987	11.3	0.33	0.079	<0.0008
	June 1987	13.8	0.036	0.0063	<0.0008
	June 1987	18.8	0.054	0.026	<0.0008
	June 1987	25.0	<0.0005	<0.0005	<0.0008
	June 1987	30.0	<0.0005	<0.0005	<0.0008
	June 1987	35.0	<0.0005	<0.0005	<0.0008
	June 1987	40.0	<0.0005	<0.0005	<0.0008
	June 1987	45.5	<0.0005	<0.0005	<0.0008
	June 1987	50.8	<0.0005	<0.0005	<0.0008
	June 1987	59.8	<0.0005	<0.0005	<0.0008
	June 1987	70.0	<0.0005	<0.0005	<0.0008
	June 1987	80.0	<0.0005	<0.0005	<0.0008

Table A-9. Soil analyses for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
	June 1987	100.5	<0.0005	<0.0005	<0.0008
	June 1987	110.3	<0.0005	<0.0005	<0.0008
W-815-01	May 1987	0.0	<0.0008	<0.0008	<0.0008
	May 1987	10.5	<0.0008	<0.0008	<0.0008
	May 1987	15.5	<0.0008	<0.0008	<0.0008
	May 1987	20.5	<0.0008	<0.0008	<0.0008
	May 1987	28.0	<0.0008	<0.0008	<0.0008
	May 1987	33.0	<0.0008	<0.0008	<0.0008
	May 1987	37.5	<0.0008	<0.0008	<0.0008
	May 1987	42.5	<0.0008	<0.0008	<0.0008
	May 1987	47.5	<0.0008	<0.0008	<0.0008
W-815-02	June 1987	0.0	<0.0005	<0.0005	<0.0008
	June 1987	67.0	<0.0005	<0.0005	<0.0008
	June 1987	73.5	<0.0005	<0.0005	<0.0008
	June 1987	84.8	<0.0005	<0.0005	<0.0008
	June 1987	96.3	<0.0005	<0.0005	<0.0008
	June 1987	96.3	<0.0005	<0.0005	<0.0008
	June 1987	106.3	<0.0005	<0.0005	<0.0008
	June 1987	106.3	<0.0005	<0.0005	<0.0008
W-815-03	February 1988	6.0	<0.0016	<0.0017	<0.001
	February 1988	10.5	<0.0022	<0.0023	<0.001
	February 1988	13.0	<0.002	<0.0021	<0.001
	February 1988	15.5	<0.0008	<0.0008	<0.001
	February 1988	20.5	<0.0008	<0.0008	<0.001
	February 1988	25.5	<0.0008	<0.0008	<0.001
	February 1988	30.5	<0.0008	<0.0008	<0.001
	February 1988	35.5	<0.0008	<0.0008	<0.001
	February 1988	40.5	<0.0008	0.069	<0.001
	February 1988	45.5	<0.0011	<0.0012	<0.001
W-815-04	March 1988	10.0	0.0042	<0.0008	<0.0008
	March 1988	50.5	<0.0008	<0.001	<0.0008
	March 1988	55.0	<0.0008	0.068	<0.0008
	March 1988	56.8	<0.0005	0.048	<0.0008
	March 1988	65.5	<0.0005	0.061	<0.0008
	March 1988	71.3	<0.0005	0.084	<0.0008
	March 1988	75.8	<0.0005	<0.0008	<0.0008
	March 1988	80.5	<0.0005	0.013	<0.0008
	March 1988	81.3	<0.0005	0.02	<0.0008

Table A-9. Soil analyses for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
	March 1988	87.0	<0.0005	0.024	<0.0008
	March 1988	90.0	<0.0005	<0.0005	<0.0008
	March 1988	100.5	<0.0005	<0.0005	<0.0008
	March 1988	105.5	<0.0005	<0.0005	<0.0008
W-815-05	July 1989	1.3	<0.001	<0.001	<0.001
	July 1989	5.5	<0.001	<0.001	<0.001
	July 1989	10.8	0.028	<0.001	<0.001
	July 1989	15.8	0.005	<0.001	<0.001
	July 1989	20.8	<0.001	<0.001	<0.001
	July 1989	31.0	<0.001	<0.001	<0.001
	July 1989	40.2	<0.001	<0.001	<0.001
	July 1989	47.8	<0.001	<0.001	<0.001
W-817-05	June 1988	5.8	<0.0008	<0.0008	<0.0008
	June 1988	10.8	<0.0008	<0.0008	<0.0008
	June 1988	15.8	<0.0008	<0.0008	<0.0008
	June 1988	20.5	<0.0008	<0.0008	<0.0008
	June 1988	25.0	<0.0008	<0.0008	<0.0008
	June 1988	30.3	<0.0008	<0.0008	<0.0008
	June 1988	35.3	<0.0008	<0.0008	<0.0008
	May 1988	41.0	<0.0008	<0.0008	<0.0008
	May 1988	45.8	<0.0008	<0.01	<0.0008
	May 1988	50.8	<0.0008	<0.0008	<0.0008
	May 1988	56.3	<0.0008	<0.006	<0.0008
	May 1988	60.8	<0.0008	<0.0008	<0.0008
	May 1988	65.8	<0.0008	<0.0008	<0.0008
	May 1988	70.8	<0.0008	<0.0008	<0.0008
	May 1988	75.8	<0.0008	<0.003	<0.0008
	May 1988	80.8	<0.0008	<0.0008	<0.0008
	May 1988	85.8	<0.0008	<0.015	<0.0008
	May 1988	90.5	<0.0008	<0.0008	<0.0008
	May 1988	95.8	<0.0008	<0.01	<0.0008
	May 1988	100.8	<0.0008	<0.007	<0.0008
	May 1988	105.8	<0.0008	<0.04	<0.0008
	May 1988	110.8	<0.0008	<0.007	<0.0008
	May 1988	115.8	<0.0008	<0.003	<0.0008
	May 1988	120.8	<0.0008	<0.01	<0.0008
	May 1988	125.5	<0.0008	<0.001	<0.0008
	May 1988	130.8	<0.0008	<0.0008	<0.0008
	May 1988	135.8	<0.0008	<0.0008	<0.0008
	May 1988	140.8	<0.0008	<0.02	<0.0008
	May 1988	145.8	<0.0008	<0.0008	<0.0008
	May 1988	150.8	<0.0008	<0.0008	<0.0008
	May 1988	157.5	<0.0008	<0.0008	<0.0008

Table A-9. Soil analyses for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
817-06	May 1988	6.0	<0.0008	<0.008	<0.0008
	May 1988	11.0	<0.0008	<0.008	<0.0008
	May 1988	16.0	<0.0008	<0.008	<0.0008
	May 1988	21.0	<0.0008	<0.0008	<0.0008
	May 1988	26.0	<0.0008	<0.008	<0.0008
	May 1988	29.5	<0.0008	<0.0008	<0.0008
	May 1988	35.2	<0.0008	<0.008	<0.0008
	May 1988	40.5	<0.0008	<0.008	<0.0008
	May 1988	46.0	<0.0008	<0.0008	<0.0008
	May 1988	50.8	<0.0008	<0.008	<0.0008
	May 1988	55.0	<0.0008	<0.0008	<0.001
	May 1988	60.0	<0.0008	<0.0012	<0.001
	May 1988	65.0	<0.0008	<0.001	<0.001
	May 1988	70.5	<0.0008	<0.001	<0.001
	May 1988	75.5	<0.0008	<0.0008	<0.001
	May 1988	80.5	<0.0011	<0.002	<0.001
	May 1988	85.0	<0.0006	<0.001	<0.001
	May 1988	90.5	<0.0014	<0.0015	<0.001
	May 1988	95.5	<0.0019	<0.002	<0.001
	May 1988	100.5	<0.0008	<0.0008	<0.001
	May 1988	105.5	<0.0008	<0.0008	<0.001
	May 1988	110.5	<0.0015	<0.0017	<0.001
	May 1988	115.5	<0.0008	<0.0008	<0.001
819-01	November 1986	5.8	1.3128	<0.0008	<0.001
	November 1986	10.8	0.122	<0.0008	<0.001
	November 1986	13.7	0.1484	<0.0008	<0.001
	November 1986	18.5	0.6638	<0.0005	<0.001
	November 1986	24.0	0.0187	0.1193	<0.001
	November 1986	28.4	3.7168	0.0345	<0.001
	November 1986	33.3	0.4211	0.022	<0.001
W-819-03	January 1988	10.0	0.201	<0.0008	<0.0008
	January 1988	15.5	0.054	<0.0008	<0.0008
	January 1988	20.0	0.16	<0.0008	<0.0008
	January 1988	26.3	0.285	0.018	<0.0008
	January 1988	30.7	0.103	0.082	<0.0008
	January 1988	35.3	0.008	0.023	<0.0008
	January 1988	40.3	0.005	0.009	<0.0008
	January 1988	45.7	<0.0008	<0.0008	<0.0008
	January 1988	50.3	<0.0008	<0.0008	<0.0008
	January 1988	55.3	<0.0008	<0.0008	<0.0008
	January 1988	60.3	<0.0008	<0.0008	<0.0008

Table A-9. Soil analyses for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
829-01	November 1986	2.5	3.1234	0.0145	<0.001
	November 1986	4.8	1.7486	0.9049	<0.001
	November 1986	9.7	0.1413	<0.0011	<0.001
	November 1986	14.7	0.0232	<0.001	<0.001
	November 1986	19.3	0.0186	<0.0004	<0.001
	November 1986	24.4	0.3297	<0.0006	<0.001
	November 1986	30.0	1.1624	0.0174	<0.001
	November 1986	34.3	0.224	0.0522	<0.001
	November 1986	39.8	0.0175	<0.0009	<0.001
	November 1986	44.8	0.0587	<0.0008	<0.001
829-02	December 1986	0.0	3.95	0.074	<0.0008
	December 1986	5.1	0.071	0.045	<0.0008
	December 1986	10.2	0.0006	0.017	<0.0008
	December 1986	15.1	0.006	0.12	<0.0008
	December 1986	20.6	0.026	0.033	<0.0008
	December 1986	25.6	0.026	0.016	<0.0008
	December 1986	29.1	0.0003	0.016	<0.0008
	December 1986	35.6	0.0003	0.0003	<0.0008
	December 1986	40.8	<0.0005	<0.0005	<0.0003
	December 1986	45.6	<0.0005	<0.0005	<0.0003
	December 1986	50.9	<0.0005	<0.0005	<0.0003
	December 1986	55.6	<0.0005	<0.0005	<0.0003
	December 1986	60.8	<0.0005	<0.0005	<0.0003
	December 1986	69.8	<0.0005	<0.0005	<0.0003
	December 1986	75.7	<0.0005	<0.0005	<0.0003
	December 1986	80.1	<0.0005	<0.0005	<0.0003
	December 1986	85.2	<0.0005	<0.0005	<0.0003
	December 1986	91.5	<0.0005	<0.0005	<0.0003
	December 1986	94.7	<0.0005	<0.0005	<0.0003
	December 1986	100.7	<0.0005	<0.0005	<0.0003
829-03	February 1987	0.0	0.98	0.18	<0.001
	February 1987	4.3	0.022	0.041	<0.001
	February 1987	9.2	0.25	0.045	<0.001
	February 1987	14.3	0.12	0.027	<0.001
	February 1987	19.2	0.58	0.038	<0.001
	February 1987	24.2	<0.0008	<0.0008	<0.001
	February 1987	29.8	<0.0009	<0.0009	<0.001
	February 1987	35.7	<0.0007	<0.0007	<0.001
	February 1987	40.7	<0.0011	<0.001	<0.001
	February 1987	45.5	<0.0005	<0.0005	<0.001
	February 1987	50.7	<0.0004	<0.0004	<0.001

Table A-9. Soil analyses for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
	February 1987	55.3	0.0012	0.0005	<0.001
	February 1987	60.2	<0.0005	<0.0005	<0.001
	February 1987	65.2	<0.0005	<0.0005	<0.001
	February 1987	70.2	0.0066	<0.0005	<0.001
	February 1987	75.4	0.003	<0.0005	<0.001
	February 1987	80.3	<0.0005	<0.0005	<0.001
	February 1987	85.3	<0.0005	<0.0005	<0.001
	February 1987	90.4	<0.0005	<0.0005	<0.001
	February 1987	95.2	0.0059	<0.0005	<0.001
	April 1987	98.5	0.0056	<0.0005	<0.0009
	April 1987	99.8	0.13	0.0097	<0.0009
	February 1987	100.0	0.037	0.037	<0.001
829-04	March 1987	5.0	0.74	0.018	<0.0008
	March 1987	10.4	<0.0005	<0.0005	<0.0008
	March 1987	15.5	<0.0005	<0.0005	<0.0008
	March 1987	19.4	<0.0005	<0.0005	<0.0008
	March 1987	26.8	<0.0005	<0.0005	<0.0008
	March 1987	31.7	<0.0005	<0.0005	<0.0008
	March 1987	37.9	<0.0005	<0.0005	<0.0008
	March 1987	42.3	<0.0005	<0.0005	<0.0008
	March 1987	48.3	<0.0005	<0.0005	<0.0008
	March 1987	52.6	<0.0005	<0.0005	<0.0008
	March 1987	57.8	<0.0005	<0.0005	<0.0008
	March 1987	64.3	<0.0005	<0.0005	<0.0008
	March 1987	71.5	<0.0005	<0.0005	<0.0008
	March 1987	76.7	<0.0005	<0.0005	<0.0008
	March 1987	81.7	<0.0005	<0.0005	<0.0008
	March 1987	86.6	<0.0005	<0.0005	<0.0008
	March 1987	91.7	<0.0005	<0.0005	<0.0008
	March 1987	96.7	<0.0005	<0.0005	<0.0008
	March 1987	101.0	<0.0005	<0.0005	<0.0008
829-05	January 1987	1.2	0.093	0.038	<0.0005
	January 1987	5.2	<0.0005	<0.0006	<0.0005
	January 1987	10.8	<0.0005	<0.0006	<0.0005
	January 1987	15.4	<0.0005	<0.0006	<0.0005
	January 1987	20.4	<0.0005	<0.0006	<0.0005
	January 1987	25.4	<0.0005	<0.0006	<0.0005
	January 1987	30.8	<0.0005	<0.0006	<0.0005
	January 1987	35.5	<0.0005	<0.0006	<0.0005
	January 1987	40.5	<0.0005	<0.0006	<0.0005
	January 1987	45.5	<0.0005	<0.0006	<0.0005
	January 1987	50.5	<0.0005	<0.0006	<0.0005
	January 1987	54.7	<0.0005	<0.0006	<0.0005

Table A-9. Soil analyses for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
	January 1987	61.5	<0.0005	<0.0006	<0.0005
	January 1987	66.5	<0.0005	<0.0006	<0.0005
	January 1987	72.3	<0.0005	<0.0006	<0.0005
	January 1987	76.9	<0.0005	<0.0006	<0.0005
	January 1987	81.7	<0.0005	<0.0006	<0.0005
	January 1987	87.2	<0.0005	<0.0006	<0.0005
M5-01A	October 1986	0.0	<0.0002	<0.0004	<0.0005
	October 1986	10.8	<0.0002	0.005	<0.0005
	October 1986	15.5	<0.0002	0.0108	<0.0005
	October 1986	21.0	<0.0002	<0.0004	<0.0005
	October 1986	25.5	<0.0002	<0.0004	<0.0005
	October 1986	30.0	<0.0002	<0.0004	<0.0005
	October 1986	32.2	<0.0002	<0.0004	<0.0005
	October 1986	37.2	<0.0002	<0.0004	<0.0005
	October 1986	42.3	<0.0002	<0.0004	<0.0005

Notes:

All analyses performed by HPLC Laboratory, LLNL.

Table A-10. Soil analyses from the Dry Well Investigation for HE compounds (HMX, RDX, and TNT) reported by January 1990.

Well	Date	Depth	HE compounds in $\mu\text{g/g}$ (ppm)		
			HMX	RDX	TNT
D-810A-01	June 1989	1.0	<0.001	<0.001	<0.001
	June 1989	5.0	0.026	<0.001	<0.001
	June 1989	10.0	0.024	0.002	<0.001
	June 1989	17.0	0.027	0.002	<0.001
	June 1989	20.8	0.039	0.002	<0.001
D-810C-01	November 1989	2.3	21	0.006	<0.001
	November 1989	6.0	2.7	0.028	<0.001
	November 1989	12.0	1.2	0.39	<0.001
	November 1989	16.2	<0.001	<0.001	<0.001
	November 1989	19.3	<0.001	<0.001	<0.001
D-827A-01	June 1989	2.5	0.039	0.002	<0.001
	June 1989	5.0	0.006	0.004	<0.001
	June 1989	10.0	<0.0008	0.035	<0.001
	June 1989	16.0	<0.0008	<0.001	<0.001
	June 1989	21.0	<0.0008	<0.001	<0.001
D-827B-01	June 1989	1.0	<0.0008	0.05	<0.001
	June 1989	5.0	<0.0008	0.036	<0.001
	June 1989	11.0	<0.0008	0.002	<0.001
D-827C-01	June 1989	1.0	1.47	<0.001	<0.001
	June 1989	5.0	<0.0008	<0.001	<0.001
	June 1989	12.3	<0.0008	<0.001	<0.001
	June 1989	15.3	<0.0008	<0.001	<0.001
	June 1989	20.3	<0.0008	<0.001	<0.001
D-827D-01	June 1989	5.3	0.02	0.002	<0.001
	June 1989	10.3	<0.001	<0.001	<0.001
	June 1989	17.1	<0.001	<0.001	<0.001
	June 1989	20.3	<0.001	<0.001	<0.001
D-827E-01	June 1989	1.3	<0.001	<0.001	<0.001
	June 1989	6.5	<0.001	<0.001	<0.001
	June 1989	10.9	0.009	0.008	<0.001
	June 1989	15.0	<0.001	<0.001	<0.001
	June 1989	21.0	<0.001	<0.001	<0.001

Notes:

All analyses performed by HPLC Laboratory, LLNL.

Table A-11. Extractable and purgeable priority pollutants in soil samples from sample holes B-806-01, B-806-02, B-806-03, and B-806-04, Lagoon 806/807.

Soil sample location	B-806-1/3b	B-806-1/4b	B-806-1/6b	B-806-3/2b	B-806-3/3b	B-806-3/4b	B-806-3/5b	B-806-3/6b
Sample depth (ft)	14.9-15.4	20.0-20.5	30.0-30.5	5.0-5.5	10.1-10.6	15.2-15.7	20.3-20.8	25.2-25.7
Date sampled	07.24.86	07.24.86	07.24.86	07.25.86	07.25.86	07.25.86	07.25.86	07.25.86
Log No.	07-419-1	07-419-2	07-419-3	07-419-4	07-419-5	07-419-6	07-419-7	07-419-8
EPA Method 8270 (mg/kg)								
B/N,A ext. priority pollutants								
Extraction date	08.09.86	08.09.86	08.09.86	08.09.86	08.09.86	08.09.86	08.09.86	08.09.86
Date analyzed	08.15.86	08.15.86	08.15.86	08.15.86	08.15.86	08.15.86	08.15.86	08.15.86
2,4-Dinitrophenol	<3	<3	<3	<3	<3	<3	<3	<3
2-Methyl-4,6-dinitrophenol	<5	<5	<5	<5	<5	<5	<5	<5
3,3'-Dichlorobenzidine	<4	<4	<4	<4	<4	<4	<4	<4
4-Nitrophenol	<3	<3	<3	<3	<3	<3	<3	<3
Bis (2-ethylhexyl)phthalate	<10	<10	<10	<10	<10	<10	<10	<10
Benzidine	<4	<4	<4	<4	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3	<3	<3	<3	<3
N-Nitrosodi-n-propylamine	<4	<4	<4	<4	<4	<4	<4	<4
N-Nitrosodimethylamine	<8	<8	<8	<8	<8	<8	<8	<8
Other B/N,A ext. priority pollutants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EPA Method 8240 (mg/kg)								
Purgeable priority pollutants								
Extraction date	08.04.86	08.04.86	08.04.86	08.04.86	08.04.86	08.04.86	08.04.86	08.04.86
Acrolein	<2	<2	<2	<2	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2	<2	<2	<2	<2
Other purgeable priority pollutants	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Table A-11. Extractable and purgeable priority pollutants in soil samples from sample holes B-806-01, B-806-02, B-806-03, and B-806-04, Lagoon 806/807. (Continued)

Soil sample location	B-806-3/7a	B-806-2/2b	B-806-2/2b	B-806-2/4b	B-806-2/7b	B-806-4/2b
Sample depth (ft)	29.7-30.1	7.5-17.9	10.8-11.2	15.5-16.0	30.5-30.9	7.0-7.5
Date sampled	07.25.86	07.22.86	07.23.86	07.23.86	07.23.86	07.21.86
Log number	07-419-9	07-375-1	07-375-2	07-375-3	07-375-4	07-375-5

EPA Method 8270 (mg/kg)	
<u>B/N/A ext. priority pollutants</u>	
Extraction date	08.09.86 08.04.86 08.04.86 08.04.86 08.04.86 08.04.86
Date analyzed	08.15.86 08.13.86 08.13.86 08.13.86 08.13.86 08.13.86
2,4-Dinitrophenol	<3 <3 <3 <3 <3 <3
2-Methyl-4,6-dinitrophenol	<5 <5 <5 <5 <5 <5
3,3'-Dichlorobenzidine	<4 <4 <4 <4 <4 <4
4-Nitrophenol	<3 <3 <3 <3 <3 <3
Bis (2-ethylhexyl)phthalate	<10 <10 <10 <10 <10 <10
Benzidine	<4 <4 <4 <4 <4 <4
Dibutylphthalate	<5 <5 <5 <5 <5 <5
Dimethylphthalate	<3 <3 <3 <3 <3 <3
N-Nitrosodi-n-propylamine	<4 <4 <4 <4 <4 <4
N-Nitrosodimethylamine	<8 <8 <8 <8 <8 <8
Other B/N/A Ext. priority pollutants	<0.1 <0.1 <0.1 <0.1 <0.1 <0.1

EPA Method 8240 (mg/kg)	
<u>Purgeable priority pollutants</u>	
Extraction date	08.04.86 08.04.86 08.04.86 08.04.86 08.04.86 08.04.86
Acrolein	<2 <2 <2 <2 <2 <2
Acrylonitrile	<2 <2 <2 <2 <2 <2
Other purgeable priority pollutants	<0.2 <0.2 <0.2 <0.2 <0.2 <0.2

Table A-12. Extractable and purgeable priority pollutants in soil samples from boreholes B-807-A1 and B-807-A2, 807A Lagoon.

Soil sample location	B-807A1/2b	B-807A1/3a	B-807A1/4b	B-807A2/5b	B-807A1/7b	B-807A2/2a	B-807A2/3a	B-807A2/4a	B-807A2/5b	B-807A2/7b
Sample depth (ft)	7.0-7.4	10.0-10.5	15.5-16.0	20.3-20.8	30.5-31.0	5.0-5.5	10.0-10.5	15.0-15.5	20.4-20.9	30.5-30.9
Date sampled	07.30.86	07.30.86	07.30.86	07.30.86	07.30.86	07.30.86	07.31.86	07.31.86	07.31.86	07.31.86
EPA Method 8240 (mg/kg)										
B/N/A Ext. priority pollutants										
Extraction date	08.09.86	08.09.86	08.09.86	08.09.86	08.09.86	08.11.86	08.11.86	08.11.86	08.11.86	08.11.86
Date analyzed	08.16.86	08.16.86	08.12.86	08.12.86	08.12.86	08.18.86	08.18.86	08.18.86	08.18.86	08.18.86
2,4-dinitrophenol	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
2-methyl-4,6-dinitrophenol	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
3,3'-dichlorobenzidine	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
4-nitrophenol	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Bis (2-ethylhexyl)phthalate	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzidine	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
N-nitrosodi-n-propylamine	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
N-nitrosodimethylamine	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
Other B/N/A Ext. priority pollutants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EPA Method 8270 (mg/kg)										
Purgeable priority pollutants										
Extraction date	08.05.86	08.05.86	08.05.86	08.05.86	08.05.86	08.05.86	08.05.86	08.05.86	08.05.86	08.05.86
Acrolein	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Other purgeable priority pollutants	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Table A-13. Extractable and purgeable priority pollutants in soil samples, sample hole B-807-B1, 807B Lagoon.

Soil sample location ^a	B-807B1/2b	B-807B1/3b	B-807B1/4b	B-807B1/5b	B-807B1/7b
Sample depth (ft)	5.0-5.5	9.8-10.3	14.8-15.3	19.8-20.3	30.0-30.5
Date sampled	07.30.86	07.30.86	07.30.86	07.30.86	07.30.86

EPA Method 8270 (mg/kg)					
<u>B/N,A ext. priority pollutants</u>					
Extraction date	08.09.86	08.09.86	08.11.86	08.11.86	08.11.86
Date analyzed	08.12.86	08.12.86	08.17.86	08.17.86	08.17.86
2,4-dinitrophenol	<3	<3	<3	<3	<3
2-methyl-4,6-dinitrophenol	<5	<5	<5	<5	<5
3,3'-dichlorobenzidine	<4	<4	<4	<4	<4
4-nitrophenol	<3	<3	<3	<3	<3
Bis (2-ethylhexyl)phthalate	<10	<10	<10	<10	<10
Benzidine	<4	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3	<3
N-nitrosodi-n-propylamine	<4	<4	<4	<4	<4
N-nitrosodimethylamine	<8	<8	<8	<8	<8
Other B/N,A ext.					
priority pollutants	<0.1	<0.1	<0.1	<0.1	<0.1

EPA Method 8240 (mg/kg)					
<u>Purgeable priority pollutants</u>					
Extraction date	08.05.86	08.05.86	08.05.86	08.05.86	08.05.86
Acrolein	<2	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2	<2
Other purgeable					
priority pollutants	<0.2	<0.2	<0.2	<0.2	<0.2

Table A-14. Extractable and purgeable priority pollutants in soil and rock samples, sample hole B-817-01.

Sample location ^a	B-817-01	B-817-01	B-817-01	B-817-01	B-817-01	B-817-01
Sample depth (ft)	10.0-10.3	15.0-15.7	21.5-22.3	25.0-25.8	30.7-31.5	35.7-36.5
Date sampled	10.22.86	10.22.86	10.23.86	10.23.86	10.23.86	10.23.86
<hr/>						
B/N/A ext. priority pollutants	EPA method 8270 (mg/kg)					
Date extracted	10.30.86	10.30.86	10.30.86	10.30.86	10.30.86	10.30.86
Date analyzed	11.03.86	11.03.86	11.03.86	11.04.86	11.04.86	11.04.86
1,2,4-trichlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-dichlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-diphenylhydrazine	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-dichlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,4-dichlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4,6-trichlorophenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-dichlorophenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-dimethylphenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-dinitrotoluene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2,4-dinitrophenol	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2,6-dinitrotoluene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-chloronaphthalene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-nitrophenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-chlorophenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-methyl-4,6-dinitrophenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
3,3'-dichlorobenzidine	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
4-bromophenylphenylether	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-chloro-3-methylphenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-chlorophenylphenylether	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
4-nitrophenol	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Acenaphthene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bis(2-ethylhexyl)phthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzidine	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Bis(2-chloroethyl)ether	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bis(2-chloroisopropyl)ether	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bis(2-chloroethoxy)methane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Butylbenzylphthalate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Di-n-octylphthalate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibutylphthalate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0

Table A-14. (Continued)

Sample location*	B-817-01	B-817-01	B-817-01	B-817-01	B-817-01	B-817-01
Sample depth (ft)	10.0-10.3	15.0-15.7	21.5-22.3	25.0-25.8	30.7-31.5	35.7-36.5
Date sampled	10.22.86	10.22.86	10.23.86	10.23.86	10.23.86	10.23.86

	EPA method 8270 (mg/kg)					
Date extracted	10.30.86	10.30.86	10.30.86	10.30.86	10.30.86	10.30.86
Date analyzed	11.03.86	11.03.86	11.03.86	11.04.86	11.04.86	11.04.86
Diethylphthalate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dimethylphthalate	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Fluorene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobutadiene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorocyclopentadiene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Hexachloroethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-c,d)pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isophorone	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
N-nitrosodi-n-propylamine	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
N-nitrosodimethylamine	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0
N-nitrosodiphenylamine	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Naphthalene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pentachlorophenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenol	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Purgeable priority pollutants

	EPA Method 8240 (mg/kg)					
Date extracted	10.22.86	10.22.86	10.23.86	10.23.86	10.23.86	10.23.86
Date analyzed	11.07.86	11.07.86	11.07.86	11.07.86	11.07.86	11.07.86
1,1,1-trichloroethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,2,2-tetrachloroethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1,2-trichloroethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1-dichloroethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,1-dichloroethylene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-dichloroethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,2-dichloropropane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
1,3-dichloropropene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
2-chloroethylvinylether	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Acrolein	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Acrylonitrile	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Bromodichloromethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bromomethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Table A-14. (Continued)

Sample location*	B-817-01	B-817-01	B-817-01	B-817-01	B-817-01	B-817-01
Sample depth (ft)	10.0-10.3	15.0-15.7	21.5-22.3	25.0-25.8	30.7-31.5	35.7-36.5
Date sampled	10.22.86	10.22.86	10.23.86	10.23.86	10.23.86	10.23.86
<hr/>						
Purgeable priority pollutants	EPA Method 8240 (mg/kg)					
Date extracted	10.22.86	10.22.86	10.23.86	10.23.86	10.23.86	10.23.86
Date analyzed	11.07.86	11.07.86	11.07.86	11.07.86	11.07.86	11.07.86
Benzene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorobenzene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Carbon tetrachloride	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chloroethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bromoform	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chloroform	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chloromethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Dibromochloromethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Methylene chloride	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tetrachloroethylene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Trichloroethylene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Trichlorofluoromethane	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Vinyl chloride	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
trans-1,2-dichloroethylene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
trans-1,3-dichloropropene	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

*All samples were collected with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

Table A-15. Purgeable priority pollutants in soil and rock samples,^a hole B-817-H1.

Sample depth (ft)	4.0-4.3	9.0-9.2	14.0-14.5	19.5-20.0	24.5-25.0	29.8-30.3	34.5-35.0	39.5-40.0	44.5-44.9
Date sampled	01.16.87	01.16.87	01.16.87	01.20.87	01.20.87	01.20.87	01.20.87	01.20.87	01.20.87
Date extracted	01.30.87	01.30.87	01.30.87	02.02.87	01.30.87	01.30.87	02.02.87	02.02.87	01.30.87
EPA Method 8010 (mg/kg)									
1,1,2,2-Tetrachloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1,2-Trichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1-Dichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1-Dichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,2-Dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
trans-1,2-Dichloroethene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,2-Dichloropropane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,3-Dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,4-Dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
2-Chloroethylvinylether	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromodichloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromomethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromoform	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Carbon Tetrachloride	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloroform	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Dibromochloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Dichlorodifluoromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Freon 113	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Methylene chloride	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Tetrachloroethene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1,1-Trichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Trichloroethylene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Trichlorofluoromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Vinyle chloride	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
cis-1,3-Dichloropropene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
trans-1,3-Dichloropropene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

^a All samples were taken with a 1-1/2 in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil and sealed with inert tape.

Table A-17. Purgeable halocarbons in soil samples, sample hole B-825-1, 825 Lagoon.

Sample location ^a	B-825-1/3a	B-825-1/4a
Sample depth (ft)	9.9-10.4	15.0-15.5
Date sampled	03.25.86	03.25.86
Date extracted	03.31.86	03.31.86
<hr/>		
1,1,2,2-Tetrachloroethane	<0.0002	<0.0002
1,1,2-Trichloroethane	<0.0002	<0.0002
1,1-Dichloroethane	<0.0002	<0.0002
1,1-Dichloroethane	<0.0002	<0.0002
1,2-Dichlorobenzene	<0.0002	<0.0002
1,2-Dichloroethane	<0.0002	<0.0002
trans-1,2-Dichloroethene	<0.0002	<0.0002
1,2-Dichloropropane	<0.0002	<0.0002
1,3-Dichlorobenzene	<0.0002	<0.0002
1,4-Dichlorobenzene	<0.0002	<0.0002
2-Chloroethylvinylether	<0.0002	<0.0002
Bromodichloromethane	<0.0002	<0.0002
Bromomethane	<0.0002	<0.0002
Bromoform	<0.0002	<0.0002
Chlorobenzene	<0.0002	<0.0002
Carbon tetrachloride	<0.0002	<0.0002
Chloroethane	<0.0002	<0.0002
Chloroform	<0.0002	<0.0002
Chloromethane	<0.0002	<0.0002
Dibromochloromethane	<0.0002	<0.0002
Dichlorodifluoromethane	<0.0002	<0.0002
Freon 113	<0.0002	<0.0002
Methylene chloride	<0.0002	<0.0002
Tetrachloroethene	<0.0002	<0.0002
1,1,1-Trichloroethane	<0.0002	<0.0002
Trichloroethylene	<0.0002	<0.0002
Trichlorofluoromethane	<0.0002	<0.0002
Vinyl chloride	<0.0002	<0.0002
cis-1,3-Dichloropropene	<0.0002	<0.0002
trans-1,3-Dichloropropene	<0.0002	<0.0002

^aSamples were taken with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

Table A-18. Extractable and purgeable priority pollutants in soil and rock samples, sample holes B-826-1 and B-826-2.

Sample location^a	B-826-1^b	B-826-1	B-826-1	B-826-1	B-826-1
Depth (ft)	12.0-12.5	15.1-15.6	20.2-20.7	25.2-25.7	30.0-30.4
Date sampled	08.18.86	08.18.86	08.19.86	08.19.86	08.20.86
EPA Method 8270 (mg/kg)					
<u>B/N,A ext. priority pollutants</u>					
Extraction	08.19.86	08.19.86	08.19.86	08.19.86	08.21.86
Data analyzed	08.27.86	08.27.86	08.27.86	08.27.86	08.27.86
2,4-dinitrophenol	<3	<3	<3	<3	<3
2-methyl-4,6-dinitrophenol	<5	<5	<5	<5	<5
3,3'-dichlorobenzidine	<4	<4	<4	<4	<4
4-nitrophenol	<3	<3	<3	<3	<3
Bis(2-ethylhexyl)phthalate	<10	<10	<10	<10	<10
Benzidine	<4	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3	<3
N-nitrosodi-n-propylamine	<4	<4	<4	<4	<4
N-nitrosodimethylamine	<8	<8	<8	<8	<8
Other B/N,A ext. priority pollutants	<0.1	<0.1	<0.1	<0.1	<0.1
EPA Method 8240 (mg/kg)					
<u>Purgeable priority pollutants</u>					
Extraction	08.21.86	08.21.86	08.21.86	08.21.86	08.21.86
Acrolein	<2	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2	<2
Other purgeable priority pollutants	<0.2	<0.2	<0.2	<0.2	<0.2

Table A-18. (Continued).

Sample location ^a	B-826-2	B-826-2	B-826-2	B-826-2	B-826-2	B-826-2
Sample depth (ft)	7.7-8.1	12.5-12.9	17.5-18.0	22.5-22.9	27.5-28.0	32.5-33.0
Date sampled	08.20.86	08.20.86	08.26.86	08.26.86	08.26.86	08.26.86

EPA Method 8270 (continued) (mg/kg)						
B/N,A ext. priority pollutants						
Extraction	08.25.86	08.25.86	08.25.86	08.25.86	08.25.86	08.27.86
Data analyzed	08.28.86	08.28.86	08.28.86	08.28.86	08.28.86	09.03.86
2,4-dinitrophenol	<3	<3	<3	<3	<3	<3
2-methyl-4,6-dinitrophenol	<5	<5	<5	<5	<5	<5
3,3'-dichlorobenzidine	<4	<4	<4	<4	<4	<4
4-nitrophenol	<3	<3	<3	<3	<3	<3
Bis(2-ethylhexyl)phthalate	<10	<10	<10	<10	<10	<10
Benzidine	<4	<4	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3	<3	<3
N-nitrosodi-n-propylamine	<4	<4	<4	<4	<4	<4
N-nitrosodimethylamine	<8	<8	<8	<8	<8	<8
Other B/N,A ext. priority pollutants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

EPA Method 8240 (mg/kg)						
Purgeable priority pollutants						
Extraction	08.21.86	08.21.86	08.21.86	08.21.86	08.21.86	08.21.86
Acrolein	<2	<2	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2	<2	<2
Other purgeable priority pollutants	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

^a All samples were collected with a 1-1/2-in. i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Samples recovered at <12 ft depth were of insufficient volume and/or quality to be suitable for analysis.

Table A-19. Extractable and purgeable priority pollutants in soil and rock samples, sample holes B-827-C1, B-827-C2, and B-827-C3.

Sample location ^a	B-827-C1	B-827-C1	B-827-C1	B-827-C1	B-827-C1	B-827-C1
Sample depth (ft)	5.0-5.5	9.8-10.3	15.0-15.5	20.5-21.0	29.8-30.3	35.0-35.5
Date sampled	08.27.86	08.27.86	08.27.86	08.27.86	08.27.86	08.27.86

EPA Method 8270 (mg/kg)						
<u>B/N,A ext. priority pollutants</u>						
Extraction date	09.04.86	09.04.86	09.04.86	09.04.86	09.04.86	09.04.86
Data analyzed	09.15.86	09.15.86	09.15.86	09.15.86	09.15.86	09.15.86
2,4-dinitrophenol	<3	<3	<3	<3	<3	<3
2-methyl-4,6-dinitrophenol	<5	<5	<5	<5	<5	<5
3,3'-dichlorobenzidine	<4	<4	<4	<4	<4	<4
4-nitrophenol	<3	<3	<3	<3	<3	<3
Bis(2-ethylhexyl)phthalate	<10	<10	<10	<10	<10	<10
Benzidine	<4	<4	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3	<3	<3
N-Nitrosodi-n-propylamine	<4	<4	<4	<4	<4	<4
N-Nitrosodimethylamine	<8	<8	<8	<8	<8	<8
Other B/N,A ext. priority pollutants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

EPA Method 8240 (mg/kg)						
<u>Purgeable priority pollutants</u>						
Extraction date	09.02.86	09.02.86	09.02.86	09.02.86	09.02.86	09.02.86
Acrolein	<2	<2	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2	<2	<2
Other purgeable priority pollutants	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Table A-19. (Continued)

Sample location ^a	B-827-C2	B-827-C2	B-827-C2	B-827-C2	B-827-C2	B-827-C2
Sample depth (ft)	1.6-2.1	5.5-6.0	10.2-10.7	15.6-16.1	21.0-21.5	30.3-30.8
Date sampled	08.26.86	08.26.86	08.26.86	08.26.86	08.26.86	08.26.86

EPA Method 8270 (mg/kg)						
<u>B/N,A ext. priority pollutants</u>						
Extraction date	09.02.86	09.02.86	09.02.86	09.02.86	09.02.86	09.02.86
Data analyzed	09.10.86	09.10.86	09.10.86	09.12.86	09.12.86	09.12.86
2,4-Dinitrophenol	<3	<3	<3	<3	<3	<3
2-Methyl-4,6-dinitrophenol	<5	<5	<5	<5	<5	<5
3,3'-Dichlorobenzidine	<4	<4	<4	<4	<4	<4
4-Nitrophenol	<3	<3	<3	<3	<3	<3
Bis(2-ethylhexyl)phthalate	<10	<10	<10	<10	<10	<10
Benzidine	<4	<4	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3	<3	<3
N-nitrosodi-n-propylamine	<4	<4	<4	<4	<4	<4
N-nitrosodimethylamine	<8	<8	<8	<8	<8	<8
Other B/N,A ext. priority pollutants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

EPA Method 8240 (mg/kg)						
<u>Purgeable priority pollutants</u>						
Extraction date	09.02.86	09.02.86	09.02.86	09.02.86	09.02.86	09.02.86
Acrolein	<2	<2	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2	<2	<2
Other purgeable priority pollutants	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
<u>Semi-quantified results^b</u>						
C ₇ H ₁₆	40	40	60	40	40	40
Tetrahydrofuran	1	1	1	0.8	0.9	0.6

Table A-19. (Continued)

Sample location ^a	B-827-C3	B-827-C3	B-827-C3	B-827-C3	B-827-C3	B-827-C3
Sample depth (ft)	1.5-1.8	5.8-6.5	10.0-10.8	16.5-17.0	20.0-20.5	30.0-30.3
Date sampled	08.26.86	08.26.86	08.26.86	08.27.86	08.27.86	08.27.86
EPA Method 8270 (mg/kg)						
<u>B/N,A ext. priority pollutants</u>						
Extraction date	09.02.86	09.02.86	09.02.86	09.04.86	09.04.86	09.04.86
Data analyzed	09.12.86	09.12.86	09.15.86	09.15.86	09.15.86	09.15.86
2,4-Dinitrophenol	<3	<3	<3	<3	<3	<3
2-Methyl-4,6-dinitrophenol	<5	<5	<5	<5	<5	<5
3,3'-Dichlorobenzidine	<4	<4	<4	<4	<4	<4
4-Nitrophenol	<3	<3	<3	<3	<3	<3
Bis(2-ethylhexyl)phthalate	<10	<10	<10	<10	<10	<10
Benzidine	<4	<4	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3	<3	<3
N-Nitrosodi-n-propylamine	<4	<4	<4	<4	<4	<4
N-Nitrosodimethylamine	<8	<8	<8	<8	<8	<8
Other B/N,A ext. priority pollutants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
EPA Method 8240 (mg/kg)						
<u>Purgeable priority pollutants</u>						
Extraction date	09.02.86	09.02.86	09.02.86	09.02.86	09.02.86	09.02.86
Acrolein	<2	<2	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2	<2	<2
Other purgeable priority pollutants	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Benzene	<0.2	0.9	0.4	<0.2	<0.2	<0.2
Chloroform	<0.2	<0.2	0.4	<0.2	<0.2	<0.2
Trichlorofluoromethane	<0.2	0.2	0.4	<0.2	<0.2	<0.2
<u>Semi-quantified results</u>						
C ₇ H ₁₆	40	40	30	—	—	—
Tetrahydrofuran	0.8	0.8	0.8	—	—	—

^aAll samples were collected with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^bQuantification based upon comparison of total ion count of the compound with that of the nearest internal standard.

Table A-20 . Purgeable priority pollutants and BTX in soil and rock samples, sample hole B-827-C5, Building 827 area.

Sample location	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5
Depth (ft)	9.0	16.0	20.0	25.0	29.25	35.5	40.5	47.0	53.5	60.25
Date sampled	01.11.88	01.12.88	01.12.88	01.12.88	01.12.88	01.15.88	01.15.88	01.15.88	01.15.88	01.15.88

	EPA Method 8010 (mg/kg)									
<u>Date extracted</u>	01.13.88	01.13.88	01.13.88	01.13.88	01.21.88	01.22.88	01.21.88	01.18.88	01.21.88	01.21.88
1,1,2,2-tetrachloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1,2-trichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1-dichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1-dichloroethylene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,2-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,2-dichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
trans-1,2-dichloroethylene	0.0006	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,2-dichloropropane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,3-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,4-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
2-chloroethylvinylether	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromodichloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromomethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromoform	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Carbon tetrachloride	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloroform	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Dibromochloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Dichlorodifluoromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Freon 113	0.0014	<0.0002	0.0018	0.0026	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Methylene chloride	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0006	<0.0002	<0.0002	<0.0002	<0.0002
Tetrachloroethylene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Table A-20. (Continued)

Sample location	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5
Depth (ft)	9.0	16.0	20.0	25.0	29.25	35.5	40.5	47.0	53.5	60.25		
Date sampled	01.11.88	01.12.88	01.12.88	01.12.88	01.12.88	01.12.88	01.15.88	01.15.88	01.15.88	01.15.88	01.15.88	01.15.88
EPA Method 8010 (mg/kg)												
1,1,1-trichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Trichloroethylene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Trichlorofluoromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Vinyl chloride	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
cis-1,3-dichloropropene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
trans-1,3-dichloropropene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EPA Method 8020 (mg/kg)												
Date extracted	01.13.88	01.13.88	01.13.88	01.13.88	01.21.88	01.22.88	01.21.88	01.18.88	01.21.88	01.21.88	01.21.88	01.21.88
1,2-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,3-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,4-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Benzene	0.0002	0.0004	0.0011	0.0007	<0.0002	<0.0002	<0.0002	0.0004	<0.0002	<0.0002	<0.0002	<0.0002
Ethylbenzene	0.0002	0.0003	0.0006	0.0004	0.0002	0.0003	0.0003	0.0004	0.0002	0.0002	0.0002	<0.0002
Toluene	0.0002	0.0002	0.0002	0.0003	0.0005	0.0008	0.0004	0.0011	0.0005	0.0002	<0.0002	<0.0002
Total xylene isomers	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

^aAll samples were taken with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

Table A-21. Purgeable priority pollutants in soil and rock samples, exploratory hole B-827-E2, 827E Lagoon area. Samples analyzed by EPA Method 8240.

Sample location ^a	B-827-E2	B-827-E2	B-827-E2
Sample depth (ft)	1.0-1.5	5.0-5.5	6.5-7.0
Date sampled	06.22.87	06.22.87	07.10.87
Extraction date	07.02.87	07.02.87	07.15.87

	EPA Method 8240 (mg/kg)		
Purgeable priority pollutants			
1,1,1-Trichloroethane	<0.2	<0.2	<0.2
1,1,2,2-Tetrachloroethane	<0.2	<0.2	<0.2
1,1,2-Trichloroethane	<0.2	<0.2	<0.2
1,1-Dichloroethane	<0.2	<0.2	<0.2
1,1-Dichloroethylene	<0.2	<0.2	<0.2
1,2-Dichloroethane	<0.2	<0.2	<0.2
1,2-Dichloropropane	<0.2	<0.2	<0.2
1,3-Dichloropropene	<0.2	<0.2	<0.2
2-Chloroethylvinylether	<0.2	<0.2	<0.2
Acrolein	<2	<2	<2
Acrylonitrile	<2	<2	<2
Bromodichloromethane	<0.2	<0.2	<0.2
Bromomethane	<0.2	<0.2	<0.2
Benzene	<0.2	<0.2	<0.2
Chlorobenzene	<0.2	<0.2	<0.2
Carbon Tetrachloride	<0.2	<0.2	<0.2
Chloroethane	<0.2	<0.2	<0.2
Bromoform	<0.2	<0.2	<0.2
Chloroform	<0.2	<0.2	<0.2
Chloromethane	<0.2	<0.2	<0.2
Dibromochloromethane	<0.2	<0.2	<0.2
Ethylbenzene	<0.2	<0.2	<0.2
Methylene Chloride	<0.2	<0.2	<0.2
Tetrachloroethylene	<0.2	<0.2	<0.2
Trichloroethylene	<0.2	<0.2	<0.2
Trichlorofluoromethane	<0.2	<0.2	<0.2
Toluene	<0.2	<0.2	<0.2
Vinyl Chloride	<0.2	<0.2	<0.2
trans-1,2-dichloroethylene	<0.2	<0.2	<0.2
trans-1,3-dichloropropene	<0.2	<0.2	<0.2

^aSamples were obtained in 1-1/2-in.-o.d. stainless-steel tubes filled by hand-driving a 1-1/2-in.-i.d. split-spoon sampler. Tube ends were covered with aluminum foil and sealed with inert tape.

Table A-22. Soil analyses in mg/kg (ppm) for volatile organic compounds reported by January 1, 1990.

Borehole	Depth	TCE	PCE	Total 1,2 DCE	1,2 DCA	Benzene	Toluene	Xylenes
Date	(ft)							
D-807-01								
26-JUN-89	3.8	0.0002	0.0004	<0.0002	<0.0002	-	-	-
26-JUN-89	10.5	<0.0002	0.0007	<0.0002	<0.0002	-	-	-
27-JUN-89	17.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
27-JUN-89	21.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
W-809-01								
03-MAR-88	5.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
03-MAR-88	10.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
03-MAR-88	15.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
03-MAR-88	20.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
03-MAR-88	25.0	<0.0002	<0.0002	<0.0002	<0.0002	0.0006	0.0004	<0.0002
03-MAR-88	30.0	<0.0002	<0.0002	<0.0002	<0.0002	0.0005	<0.0002	<0.0002
03-MAR-88	35.0	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	<0.0002
03-MAR-88	40.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
03-MAR-88	45.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
07-MAR-88	69.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0005	<0.0002
W-809-02								
14-MAR-88	96.4	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
W-809-03								
07-JUL-89	0.5	0.0005	<0.0002	<0.0002	<0.0002	-	-	-
07-JUL-89	5.8	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
07-JUL-89	11.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
07-JUL-89	16.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
10-JUL-89	21.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
10-JUL-89	28.6	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
10-JUL-89	41.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
11-JUL-89	50.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
11-JUL-89	61.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
11-JUL-89	70.2	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
12-JUL-89	80.1	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
12-JUL-89	89.1	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
12-JUL-89	98.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
12-JUL-89	108.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
D-810A-01								
28-JUN-89	1.3	0.001	<0.0002	<0.0002	<0.0002	-	-	-
28-JUN-89	5.5	0.0023	<0.0002	<0.0002	<0.0002	-	-	-
28-JUN-89	10.5	0.0021	<0.0002	<0.0002	<0.0002	-	-	-
28-JUN-89	15.3	0.0021	<0.0002	<0.0002	<0.0002	-	-	-
28-JUN-89	21.0	0.0069	<0.0002	<0.0002	<0.0002	-	-	-
D-810C-01								
20-NOV-89	0.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
16-NOV-89	5.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
20-NOV-89	15.4	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
20-NOV-89	17.8	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
20-NOV-89	19.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
W-810-01								
04-FEB-88	4.6	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0003	0.0003
04-FEB-88	10.0	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0003	0.0003
04-FEB-88	15.0	0.0056	0.0002	<0.0002	<0.0002	0.0005	0.0006	0.0012
04-FEB-88	20.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0003
04-FEB-88	25.0	<0.0002	<0.0002	<0.0002	<0.0002	0.0005	0.0003	0.0005
05-FEB-88	33.4	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0005	<0.0002
05-FEB-88	39.2	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0003	<0.0002
05-FEB-88	43.1	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0007	<0.0002
08-FEB-88	52.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002
08-FEB-88	61.2	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0007	<0.0002
08-FEB-88	72.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0004	<0.0002
09-FEB-88	97.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0006	<0.0002
09-FEB-88	108.0	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0003	<0.0002

Table A-22. Soil analyses in mg/kg (ppm) for volatile organic compounds reported by January 1, 1990.

Borehole Date	Depth (ft)	TCE	PCE	Total 1,2 DCE	1,2 DCA	Benzene	Toluene	Xylenes
09-FEB-88	118.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
10-FEB-88	125.3	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0005	0.0017
10-FEB-88	147.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0002	<0.0002
11-FEB-88	173.6	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0004	<0.0002
11-FEB-88	191.3	<0.0002	<0.0002	<0.0002	<0.0002	0.0004	0.0008	<0.0002
11-FEB-88	198.1	<0.0002	<0.0002	<0.0002	<0.0002	0.0004	0.0005	<0.0002
12-FEB-88	203.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
16-FEB-88	213.6	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
17-FEB-88	223.1	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
18-FEB-88	236.2	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
19-FEB-88	258.1	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
22-FEB-88	267.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
23-FEB-88	287.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
D-812C-02								
27-JUN-89	1.8	0.0048	<0.0002	<0.0002	<0.0002	-	-	-
813-01								
26-JUL-89	1.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
26-JUL-89	6.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
27-JUL-89	11.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
27-JUL-89	16.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
27-JUL-89	21.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
27-JUL-89	31.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
27-JUL-89	41.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
27-JUL-89	51.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
W-814-01								
08-MAY-87	6.4	<0.0002	<0.0002	<0.0002	0.0003	-	-	-
08-MAY-87	11.0	<0.0002	0.0002	<0.0002	<0.0002	-	-	-
11-MAY-87	13.3	<0.0002	<0.0002	<0.0002	0.001	-	-	-
11-MAY-87	18.3	<0.0002	<0.0002	<0.0002	0.0041	-	-	-
11-MAY-87	25.3	<0.0002	<0.0002	<0.0002	0.0022	-	-	-
11-MAY-87	30.3	<0.0002	<0.0002	<0.0002	0.0014	-	-	-
11-MAY-87	35.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
11-MAY-87	41.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
12-MAY-87	50.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
12-MAY-87	59.3	<0.0002	<0.0002	<0.0002	0.0004	-	-	-
12-MAY-87	69.5	<0.0002	<0.0002	<0.0002	0.0002	-	-	-
12-MAY-87	79.5	<0.0002	<0.0002	<0.0002	0.0002	-	-	-
13-MAY-87	98.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
14-MAY-87	109.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
W-815-01								
22-APR-87	8.5	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
22-APR-87	10.5	0.0510	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
22-APR-87	12.5	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
22-APR-87	15.5	0.24	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
22-APR-87	17.5	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
22-APR-87	18.0	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
22-APR-87	20.5	0.19	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
22-APR-87	22.5	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
22-APR-87	23.0	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
22-APR-87	27.5	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
22-APR-87	28.0	0.023	<0.0002	<0.0002	<0.0002	0.0009	0.0003	<0.0002
22-APR-87	32.5	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
22-APR-87	33.0	0.052	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
22-APR-87	37.5	0.0039	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
22-APR-87	38.0	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
23-APR-87	42.5	0.021	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
22-APR-87	43.0	<0.2	<0.2	-	<0.2	<0.2	<0.2	-
23-APR-87	47.5	0.011	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
W-815-02								
30-APR-87	67.0	0.0012	<0.0002	<0.0002	<0.0002	-	-	-
30-APR-87	69.0	33 -	<0.2	<0.2	<0.2	-	<0.2	-

Table A-22. Soil analyses in mg/kg (ppm) for volatile organic compounds reported by January 1, 1990.

Borehole	Depth (ft)	TCE	PCE	Total 1,2 DCE	1,2 DCA	Benzene	Toluene	Xylenes
Date								
30-APR-87	73.5	0.0007	<0.0002	<0.0002	<0.0002	-	-	-
30-APR-87	82.0	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
30-APR-87	84.8	0.0006	<0.0002	<0.0002	<0.0002	-	-	-
30-APR-87	90.8	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
01-MAY-87	96.3	0.0002	<0.0002	<0.0002	<0.0002	-	0.0002	<0.0002
01-MAY-87	101.3	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
01-MAY-87	106.3	0.0004	<0.0002	<0.0002	<0.0002	-	0.0006	<0.0002
01-MAY-87	109.3	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
W-815-03								
14-JAN-88	5.0	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0002	<0.0002
15-JAN-88	6.5	0.0004	<0.0002	<0.0002	<0.0002	-	0.0005	0.0013
14-JAN-88	10.0	0.0005	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
14-JAN-88	12.5	0.0024	<0.0002	<0.0002	<0.0002	-	0.0004	<0.0002
14-JAN-88	15.0	0.0091	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
14-JAN-88	20.0	0.021	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
14-JAN-88	25.0	0.0077	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
14-JAN-88	30.0	0.0075	<0.0002	<0.0002	<0.0002	-	0.0002	<0.0002
15-JAN-88	35.0	0.0037	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
15-JAN-88	40.0	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
15-JAN-88	45.0	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
W-815-04								
26-JAN-88	51.0	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0005	0.0004
26-JAN-88	57.0	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0002	<0.0002
26-JAN-88	65.0	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
27-JAN-88	71.8	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
27-JAN-88	76.5	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0004	<0.0002
W-815-05								
21-JUL-89	1.0	<0.0002	0.0034	<0.0002	<0.0002	-	-	-
21-JUL-89	5.8	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
21-JUL-89	11.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
21-JUL-89	16.1	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
21-JUL-89	21.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
21-JUL-89	31.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
24-JUL-89	38.6	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
24-JUL-89	47.6	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
W-817-05								
09-MAY-88	5.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
09-MAY-88	10.3	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
09-MAY-88	15.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
09-MAY-88	20.3	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0004	0.001
09-MAY-88	25.8	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0008
09-MAY-88	30.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
09-MAY-88	35.0	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002
10-MAY-88	40.8	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0007
10-MAY-88	45.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
10-MAY-88	50.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
10-MAY-88	56.0	<0.0002	0.0004	<0.0002	<0.0002	<0.0002	0.0007	0.0019
10-MAY-88	60.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0006
12-MAY-88	65.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0011	0.0003	0.0012
12-MAY-88	70.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	0.0008
12-MAY-88	75.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003
12-MAY-88	80.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	0.0003
12-MAY-88	85.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
12-MAY-88	90.8	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.0011
12-MAY-88	95.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001	0.0003
12-MAY-88	100.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002
12-MAY-88	105.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002
12-MAY-88	110.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	0.0007
12-MAY-88	115.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
12-MAY-88	120.5	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002
12-MAY-88	125.8	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	0.0003
12-MAY-88	130.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0002	0.0002
12-MAY-88	135.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002

Table A-22. Soil analyses in mg/kg (ppm) for volatile organic compounds reported by January 1, 1990.

Borehole Date	Depth (ft)	TCE	PCE	Total 1,2 DCE	1,2 DCA	Benzene	Toluene	Xylenes
12-MAY-88	140.5	<0.0002	<0.0002	0.0003	<0.0002	0.0003	0.0015	0.0025
12-MAY-88	145.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002	0.0005
12-MAY-88	150.5	<0.0002	<0.0002	<0.0002	<0.0002	0.0009	0.0002	0.0008
12-MAY-88	157.3	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003
819-01								
20-OCT-86	5.6	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
20-OCT-86	10.7	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
20-OCT-86	13.5	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
20-OCT-86	19.0	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
21-OCT-86	24.5	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
21-OCT-86	28.9	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
21-OCT-86	34.8	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
W-819-03								
09-DEC-87	10.8	<0.0002	<0.0002	<0.0002	<0.0002	-	0.002	<0.0002
09-DEC-87	15.0	0.0026	<0.0002	<0.0002	<0.0002	-	0.0019	<0.0002
09-DEC-87	20.5	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0011	<0.0002
10-DEC-87	26.7	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
10-DEC-87	31.3	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
10-DEC-87	35.7	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
10-DEC-87	40.7	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
10-DEC-87	46.3	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0005	0.0005
10-DEC-87	51.0	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	0.021
10-DEC-87	60.7	<0.0002	<0.0002	<0.0002	<0.0002	-	<0.0002	<0.0002
825-01								
25-MAR-86	10.4	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
25-MAR-86	15.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
825-02								
26-MAR-86	0.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
D-827A-01								
30-JUN-89	5.8	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
30-JUN-89	10.6	0.0015	<0.0002	<0.0002	<0.0002	-	-	-
30-JUN-89	15.3	0.0002	<0.0002	<0.0002	<0.0002	-	-	-
30-JUN-89	19.8	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
D-827B-01								
26-JUN-89	1.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
26-JUN-89	5.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
26-JUN-89	10.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
D-827C-01								
23-JUN-89	1.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
23-JUN-89	5.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
23-JUN-89	12.5	0.016	<0.0002	<0.0002	<0.0002	-	-	-
23-JUN-89	16.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
23-JUN-89	21.8	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
827-C4								
04-DEC-87	15.0	<0.0002	<0.0002	<0.0002	<0.0002	-	0.0006	0.0007
04-DEC-87	20.0	0.0002	<0.0002	<0.0002	<0.0002	-	0.001	0.001
07-DEC-87	25.0	<0.001	<0.001	<0.001	<0.001	-	0.0011	<0.001
07-DEC-87	30.0	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001
07-DEC-87	35.0	0.003	<0.001	<0.001	<0.001	-	<0.001	<0.001
07-DEC-87	39.6	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001
07-DEC-87	44.5	0.0025	0.0006	<0.0002	<0.0002	-	<0.001	<0.001
07-DEC-87	50.0	0.002	<0.001	<0.001	<0.001	-	<0.001	<0.001
07-DEC-87	55.5	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001

Table A-22. Soil analyses in mg/kg (ppm) for volatile organic compounds reported by January 1, 1990.

Borehole	Depth	TCE	PCE	Total 1,2 DCE	1,2 DCA	Benzene	Toluene	Xylenes
Date	(ft)							
D-827D-01								
22-JUN-89	4.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
22-JUN-89	10.8	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
22-JUN-89	15.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
23-JUN-89	21.2	0.0013	<0.0002	<0.0002	<0.0002	-	-	-
D-827E-01								
21-JUN-89	3.0	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
21-JUN-89	6.8	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
22-JUN-89	10.6	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
22-JUN-89	16.3	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
22-JUN-89	20.5	<0.0002	<0.0002	<0.0002	<0.0002	-	-	-
829-01								
17-OCT-86	2.5	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
17-OCT-86	4.7	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
17-OCT-86	9.5	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
17-OCT-86	14.5	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
17-OCT-86	24.9	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
17-OCT-86	34.0	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
17-OCT-86	34.8	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
17-OCT-86	39.5	<0.2	<0.2	<0.2	<0.2	-	<0.2	-
17-OCT-86	44.4	<0.2	<0.2	<0.2	<0.2	-	<0.2	-

Notes:

- Indicates no analysis performed for this compound.

Table A-23. Metals analyses^a of sludge from four locations in the 806/807 concrete tank, sampled May 1984.

Compound	CAM WET Method (mg/L)				EP Toxicity Procedure (mg/L)			
	Middle of tank	Right front	Left front	Left rear	Middle of tank	Right front	Left front	Left rear
Antimony	<0.1	<0.1	<0.1	<0.1	—	—	—	—
Arsenic	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Barium	4.0	14	5.0	5.7	0.8	1.6	1.5	1.0
Beryllium	<0.01	<0.01	<0.01	<0.01	—	—	—	—
Cadmium	0.04	<0.01	<0.01	<0.01	0.02	<0.02	<0.02	<0.02
Chromium (hexavalent)	<0.01	<0.01	<0.01	<0.01	—	—	—	—
Chromium (trivalent)	0.11	0.05	0.05	0.04	—	—	—	—
Chromium	—	—	—	—	<0.04	<0.04	<0.04	<0.04
Cobalt	<0.02	<0.02	<0.02	<0.02	—	—	—	—
Copper	<0.01	<0.01	<0.01	<0.01	—	—	—	—
Lead	2.5	1.4	0.1	2.1	<0.2	<0.2	<0.2	<0.2
Mercury	<0.001	<0.001	0.002	<0.001	<0.002	<0.002	<0.002	<0.002
Molybdenum	<0.1	<0.1	<0.1	<0.1	—	—	—	—
Nickel	0.24	0.03	0.03	0.03	—	—	—	—
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02
Thallium	<0.1	<0.1	<0.1	<0.1	—	—	—	—
Vanadium	0.2	0.2	<0.2	<0.2	—	—	—	—
Zinc	11	12	9.3	13	—	—	—	—
Fluoride	0.09	0.05	0.06	0.07	—	—	—	—

^aAnalyses by Brown and Caldwell.

NOTE: Dashed(—) = Not included in analysis.

Table A-24. Metals analyses^a of 806/807 tank sludge, 806/807 lagoon sediment, and background sample by three analytical methods, sampled April 1984.

Compound	EP Toxicity Procedure (mg/L)			CAM WET test (mg/L) ^b		Nitric Acid Digestion (mg/kg)		
	806/807 tank sludge	806/807 lagoon sediment	Back-ground soil	806/807 lagoon sediment	Back-ground soil	806/807 tank sludge	806/807 lagoon sediment	Back-ground soil
Arsenic	<0.001	<0.001	<0.001	<0.01	<0.01	<2	11	10
Barium	0.7	0.2	1.1	6.1	9.1	120	190	180
Beryllium	—	—	—	0.01	0.01	<2.0	0.2	0.6
Chromium (trivalent)	<0.02	<0.02	<0.02	0.07	0.18	<4.0	18	22
Cobalt	—	—	—	0.17	0.29	<3.0	9.4	7.5
Copper	—	—	—	<0.01	0.19	44	28	18
Lead	<0.1	<0.1	<0.1	0.2	0.9	34	15	36
Mercury	0.002	<0.001	<0.001	<0.001	<0.001	0.1	0.05	0.02
Nickel	—	—	—	0.30	0.34	<3.0	33	31
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<2	0.5	0.6
Thallium	—	—	—	0.1	0.1	<20.0	5	4
Vanadium	—	—	—	0.7	0.4	<30	37	25
Zinc	—	—	—	1.3	0.77	320	73	53

^a Analyses by Brown and Caldwell.

^b Omitted Sb, Cd, Cr (VI), fluoride salts, Mb, and Se.
NOTE: Dashes (—) = Not included in analysis.

Table A-25. Metals analyses^a of 806/807 Lagoon sediment from three locations, sampled May 1984.

Compound	CAM WET Method (mg/L)			EP Toxicity Procedure (mg/L)		
	1 ft from outfall ^b	2 ft from outfall	10 ft from outfall	1 ft from outfall	2 ft from outfall	10 ft from outfall
Antimony	<0.1	<0.1	<0.1	—	—	—
Arsenic	0.05	<0.02	0.1	<0.01	<0.01	<0.01
Barium	35	20	22	1.1	3.5	0.6
Beryllium	0.01	<0.01	0.01	—	—	—
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (hexavalent)	<0.01	<0.01	<0.01	—	—	—
Chromium (trivalent)	0.15	0.07	0.11	—	—	—
Chromium	—	—	—	<0.02	0.02	<0.02
Cobalt	0.09	0.03	0.16	—	—	—
Copper	<0.01	0.01	<0.01	—	—	—
Lead	<0.1	0.7	0.2	<0.01	0.2	<0.1
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	0.1	<0.1	<0.1	—	—	—
Nickel	0.21	0.33	0.15	—	—	—
Selenium	<0.2	<0.2	<0.2	<0.1	<0.1	<0.1
Silver	<0.01	0.02	<0.01	<0.01	0.03	<0.01
Thallium	<0.1	0.6	<0.1	—	—	—
Vanadium	1.0	0.2	1.5	—	—	—
Zinc	0.96	1.0	1.1	—	—	—
Fluoride	0.31	0.35	0.91	—	—	—

^a Analyses by Brown and Caldwell.

^b The "outfall" is the point of rinsewater discharge into the lagoon.

NOTE: Dashes (—) = Not included in analysis.

Table A-26. Metals in soil and rock samples, nitric acid digestion, sample holes B-806-01 and B-806-02; Lagoon 806/807.

Sample location ^a	B-806-01	B-806-01	B-806-01	B-806-02	B-806-02	B-806-02	B-806-02
Sample depth (ft)	14.9-15.4	20.0-20.5	30.0-30.5	7.5-7.9	10.8-11.2	15.5-16.0	30.5-30.9
Date sampled	07.24.86	07.24.86	07.24.86	07.22.86	07.23.86	07.23.86	07.23.86
Nitric acid digestion ^b	07.31.86	07.31.86	07.31.86	08.01.86	08.01.86	08.01.86	08.01.86

	Metals (mg/kg)						
Antimony	<10	<10	<10	40	<10	<10	<10
Arsenic	<0.2	<0.2	<0.2	0.6	<0.2	<0.2	0.4
Barium	20	36	200	60	24	20	130
Beryllium	1.0	1.0	1.4	0.6	0.4	0.6	1.2
Cadmium	<0.2	<0.2	<0.2	<0.2	0.4	<0.2	<0.2
Chromium	22	24	25	21	43	17	26
Cobalt	13	11	15	17	19	8	14
Copper	24	26	27	29	29	22	28
Lead	18	16	16	15	18	14	18
Mercury	0.02	<0.01	<0.01	0.10	0.03	0.04	<0.01
Molybdenum	<2	<2	<2	<2	<2	<2	<0.2
Nickel	30	8	31	40	75	22	30
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<1	<1	<1	<1	<1	<1	9
Thallium	8	8	10	6	6	6	8
Vanadium	22	98	53	82	4	12	68
Zinc	50	58	63	53	51	40	62

^a Samples were collected with a 1-1/2-in. I.D. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Total Threshold Limit Concentration (TTLIC).

Table A-27. Metals in soil and rock samples, nitric acid digestion, sample holes B-806-03 and B-806-04; Lagoon 806/807.

Sample location ^a	B-806-03	B-806-03	B-806-03	B-806-03	B-806-03	B-806-03	B-806-03	B-806-04	B-806-04	B-806-04	B-806-04
Sample depth (ft)	5.0-5.5	10.1-10.6	15.2-15.7	20.3-20.8	25.2-25.7	29.7-30.1	7.0-7.5	12.5-13.0	15.5-15.8	30.5-31.0	
Date sampled	07.25.86	07.25.86	07.25.86	07.25.86	07.25.86	07.25.86	07.21.86	07.21.86	07.21.86	07.21.86	
Nitric acid digestion ^b	07.31.86	07.31.86	07.31.86	07.31.86	07.31.86	07.31.86	08.01.86	08.01.86	08.01.86	08.01.86	

	Metals (mg/kg)										
Antimony	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1.4
Barium	190	200	210	260	250	340	49	49	85	430	
Beryllium	0.8	0.6	1.0	1.2	1.0	1.0	0.8	0.6	0.4	1.2	
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
Chromium	21	19	23	24	18	13	22	34	31	24	
Cobalt	17	16	11	13	15	11	13	17	13	17	
Copper	26	21	27	27	25	33	33	29	26	29	
Lead	22	18	16	16	16	18	18	20	24	18	
Mercury	0.03	0.01	0.01	0.01	<0.1	<0.01	0.03	0.02	0.02	<0.01	
Molybdenum	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	
Nickel	42	31	27	30	27	26	30	72	67	28	
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Silver	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Thallium	14	6	6	8	8	8	10	8	12	8	
Vanadium	64	68	56	69	68	16	87	16	22	45	
Zinc	50	48	54	57	56	59	55	48	51	63	

^aAll samples were collected with a 1-1/2-in. i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^bTotal Threshold Limit Concentration (TTLC).

Table A-28. Metals in soil and rock samples, CAM WET extraction, sample holes B-806-01, B-806-02, B-806-03, and B-806-04; Lagoon 806/807.

Sample location ^a	B-806-01	B-806-02	B-806-02	B-806-03	B-806-04
Sample depth (ft)	30.0-30.5	7.5-7.9	30.0-30.9	29.7-30.1	30.5-31.0
Date sampled	07.24.86	07.23.86	07.23.86	07.25.86	07.23.86
CAM WET ext. ^{b,c}	09.10.86	09.10.86	09.10.86	09.10.86	09.10.86

CAM WET extraction	Metals (mg/L)				
Antimony	0.2	0.1	0.2	0.2	0.3
Arsenic	0.03	<0.01	0.04	0.02	0.07
Barium	9.6	0.2	6.9	4.1	7.5
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.01	0.07	<0.01	<0.01	<0.01
Chromium	0.02	<0.02	<0.02	<0.02	0.02
Cobalt	<0.05	0.20	0.27	0.10	0.08
Copper	0.17	0.18	0.12	0.35	0.18
Lead	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury	<0.001	<0.001	<0.001	0.001	<0.001
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	<0.05	1.6	<0.05	<0.05	<0.05
Selenium	0.06	<0.01	0.04	0.02	0.03
Silver	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	0.5	<0.2	0.5	0.4	0.5
Zinc	0.16	<0.01	<0.01	0.11	<0.01

^a All samples were collected with a 1-1/2-in. I.D. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Citric acid.

^c Soluble Threshold Limit Concentration (STLC).

Table A-29. Metals in soil and rock samples, sample holes B-807-A1 and B-807-A2, 807A Lagoon.

Sample location ^a	B-807-A1	B-807-A1	B-807-A1	B-807-A1	B-807-A1	B-807-A1	B-807-A2	B-807-A2	B-807-A2	B-807-A2	B-807-A2
Sample depth (ft)	7.0-7.4	10.0-10.5	15.5-16.0	20.3-20.8	30.5-31.0	5.0-5.5	10.0-10.5	15.0-15.5	20.4-20.9	5.0-5.5	
Date sampled	07.30.86	07.30.86	07.30.86	07.30.86	07.30.86	07.30.86	07.31.86	07.31.86	07.31.86	07.31.86	
Nitric acid digest ^b	08.07.86	08.07.86	08.07.86	08.07.86	08.07.86	08.07.86	08.07.86	08.07.86	08.07.86	08.07.86	

	Metals (mg/kg)										
Antimony	20	<10	20	10	10	10	<10	<10	<10	<10	10
Arsenic	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Barium	250	150	41	67	84	380	51	71	78	46	
Beryllium	0.8	1.4	0.6	0.8	1.0	1.0	1.0	1.0	1.2	0.8	
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Chromium	29	26	24	55	24	46	22	22	22	36	
Cobalt	13	16	11	30	13	13	16	14	17	14	
Copper	33	38	20	32	22	30	38	34	40	32	
Lead	24	18	12	22	16	22	18	18	18	20	
Mercury	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Molybdenum	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	
Nickel	39	40	24	83	24	60	40	38	44	70	
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	
Silver	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Thallium	14	12	10	12	12	14	10	12	10	10	
Vanadium	74	58	95	34	84	60	51	61	44	28	
Zinc	57	68	55	61	58	60	63	63	72	52	

^a All samples were collected with a 1-1/2-in. I.D. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Total Threshold Limit Concentration (TTLC).

Table A-30. Metals in soil from sample hole B-807-A1, 807A Lagoon.

Sample location^a	B-807-A1
Sample depth (ft)	10-10.5
Date sampled	07.30.86
CAM WET Extraction (STLC)	
	Metals (mg/L)
Antimony	0.2
Arsenic	0.03
Barium	16
Beryllium	<0.01
Cadmium	<0.01
Chromium	<0.02
Cobalt	0.27
Copper	0.16
Lead	0.2
Mercury	<0.001
Molybdenum	0.3
Nickel	0.35
Selenium	0.05
Silver	<0.01
Thallium	<0.1
Vanadium	0.9
Zinc	0.08

^a All samples were collected with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

Table A-31. Metals in soil and rock samples, sample hole B-807-B1, 807B Lagoon.

Sample location ^a	B-807-B1/2b	B-807-B1/3b	B-807-B1/4b	B-807-B1/5b	B-807-B1/7b
Sample depth (ft)	5.0-5.5	9.8-10.3	14.8-15.3	19.8-20.3	30.0-30.5
Date sampled	07.30.86	07.30.86	07.30.86	07.30.86	07.31.86
Nitric acid digestion ^b	08.07.86	08.07.86	08.07.86	08.07.86	08.07.86

	Metals (mg/kg)				
Antimony	<10	<10	<10	<10	<10
Arsenic	<1	<1	<1	<1	<1
Barium	54	52	52	80	46
Beryllium	1.4	1.0	1.0	1.0	0.8
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	26	24	26	34	24
Cobalt	15	13	15	22	9
Copper	40	32	32	32	22
Lead	24	18	18	18	14
Mercury	<0.01	<0.01	<0.01	<0.01	0.02
Molybdenum	<2	<2	<2	<2	<2
Nickel	46	32	34	64	24
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<1	<1	<1	<1	<1
Thallium	12	12	10	12	10
Vanadium	42	82	81	42	30
Zinc	68	64	63	64	52

^a All samples were collected with a 1-1/2-in. -i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^bTotal Threshold Limit Concentration (TTLC).

Table A-32. Metals in soil and rock samples, sample holes B-817-D1 and B-817-H1.

	B-817-D1	B-817-D1	B-817-D1	B-817-D1	B-817-D1	B-817-D1
Sample location ^a	10.0-10.3	15.0-15.7	21.5-22.3	25.0-25.8	30.7-31.5	35.7-36.5
Sample depth (ft)	10.22.86	10.22.86	10.23.86	10.23.86	10.23.86	10.23.86
Date sampled	10.31.86	10.31.86	10.31.86	10.31.86	10.31.86	10.31.86
CAM WET extraction ^b						

	Metals (mg/L)					
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	<0.01	0.03	<0.01	<0.01	<0.01	<0.01
Barium	4.7	6.0	5.5	2.9	1.5	1.1
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	0.05	0.06	0.06	0.04	0.04	0.035
Chromium	<0.02	0.16	0.59	<0.02	<0.02	<0.02
Cobalt	0.53	0.25	0.29	<0.05	<0.05	<0.05
Copper	0.35	0.37	0.32	0.18	0.13	0.03
Lead	<0.1	0.1	0.2	0.8	0.2	0.2
Mercury	0.002	<0.001	0.002	<0.001	<0.001	<0.001
Molybdenum	<0.1	<0.1	0.13	<0.1	<0.1	<0.1
Nickel	0.65	0.56	0.79	0.08	0.16	<0.05
Selenium	0.05	<0.01	<0.01	0.01	0.02	0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	0.70	0.37	0.20	<0.2	<0.2	<0.2
Zinc	0.15	0.22	0.23	0.06	0.06	0.015

Table A-32. (Continued)

Sample location ^a	B-817-H1	B-817-H1	B-817-H1	B-817-H1	B-817-H1	B-817-H1	B-817-H1	B-817-H1	B-817-H1	B-817-H1
Sample depth (ft)	4.0-4.3	9.0-9.2	14.0-14.5	19.5-20.0	24.5-25.0	29.8-30.3	34.5-35.0	39.5-40.0	44.5-44.9	
Date sampled	01.16.87	01.16.87	01.16.87	01.20.87	01.20.87	01.20.87	01.20.87	01.20.87	01.20.87	01.20.87
CAM WET extraction ^b	02.02.87	02.02.87	02.02.87	02.02.87	02.02.87	02.02.87	02.02.87	02.02.87	02.02.87	02.02.87
Metals (mg/L)										
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	<0.01	0.03	0.01	0.02	0.04	0.07	0.02	<0.01	<0.01	<0.01
Barium	7.0	11	6.0	5.5	5.2	3.1	6.4	2.2	1.6	1.6
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	0.02	0.02	<0.02	<0.02	0.11	0.04	<0.02	<0.02	<0.02	<0.02
Cobalt	0.48	0.36	0.41	0.38	0.28	0.13	0.28	0.43	0.08	0.08
Copper	0.11	0.18	0.17	0.05	0.15	0.04	0.07	0.08	0.10	0.10
Lead	0.4	0.5	0.2	0.4	0.2	<0.1	<0.1	<0.1	0.2	0.2
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.001	<0.001
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	0.51	0.51	0.54	0.30	0.17	<0.05	0.11	<0.05	0.17	0.17
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	0.2	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	1.2	0.5	0.7	0.2	<0.2	<0.2	0.4	0.2	<0.2	<0.2
Zinc	0.05	0.05	0.10	0.02	<0.01	<0.01	<0.01	<0.04	<0.01	<0.01

^a All samples were collected with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Total Threshold Limit Concentration. (TTLC)

Table A-33. Metals in surface samples collected within and adjacent to HE process area rinse-water Lagoon 817.

Sample location ^a	817-L ^b	817-LB ^c
Date sampled	08.12.87	08.12.87
CAM WET extraction ^d	08.21.87	08.21.87
	Metals (mg/L)	
Antimony	<0.1	<0.1
Arsenic	0.04	0.03
Barium	3.5	15
Beryllium	<0.01	0.01
Cadmium	0.01	0.01
Chromium	0.02	0.05
Cobalt	0.13	0.41
Copper	0.37	0.22
Lead	<0.01	0.1
Mercury	<0.001	<0.001
Molybdenum	<0.1	<0.1
Nickel	0.16	0.44
Selenium	<0.01	<0.01
Silver	0.01	0.02
Thallium	<0.1	0.2
Vanadium	0.2	2.1
Zinc	0.57	0.10

^a Samples were obtained with a hand shovel, particles larger than 1/4-in. diam were excluded, and material was then sealed in glass jars using inert tape.

^b Sample was obtained within lagoon.

^c Background sample.

^d Soluble Threshold Limit Concentration.

Table A-34. Metals in soil and rock samples, sample hole B-817-L1, Building 817 area.

Sample location ^a	B-817-L1	B-817-L1	B-817-L1	B-817-L1	B-817-L1	B-817-L1
Sample depth (ft)	12.6-13.1	17.2-17.5	20.2-20.7	25.5-26.0	30.4-30.9	36.1-36.6
Date sampled	08.04.86	08.04.86	08.04.86	08.05.86	08.05.86	8.05.86
Nitric acid digestion ^b	08.12.86	08.12.86	08.12.86	08.12.86	08.12.86	8.12.86
Metals (mg/kg)						
Antimony	<10	<10	<10	<10	<10	<10
Arsenic	<0.2	<0.2	1.1	<0.2	<0.2	<0.2
Barium	72	34	21	28	40	42
Beryllium	1.0	0.8	0.8	1.2	0.6	1.4
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	18	38	39	34	30	17
Cobalt	13	15	14	18	10	15
Copper	36	28	31	28	26	34
Lead	14	20	16	16	15	18
Mercury	0.02	0.02	<0.01	<0.01	0.02	<0.01
Molybdenum	<2	<2	<2	<2	<2	<2
Nickel	30	90	92	32	26	30
Selenium	<0.2	<0.2	<0.2	0.2	<0.2	<0.2
Silver	<1	<1	<1	<1	<1	<1
Thallium	4	8	4	6	4	8
Vanadium	66	32	41	63	72	82
Zinc	56	60	53	56	54	64
Total solids (TS) in %	78.1	78.7	76.7	82.8	NR	79.2
Volatile solids as % of TS	2.5	2.4	2.0	2.8	NR	3.0

^a All samples were taken with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Total Threshold Limit Concentration (TTLIC).

NOTE: NR = Not reported.

Table A-35. Metals in soil and rock samples, sample hole B-817-L2, Building 817 Area.

Sample location ^a	B-817-L2	B-817-L2	B-817-L2	B-817-L2	B-817-L2
Sample depth (ft)	4.3-4.7	9.3-9.6	14.3-14.8	19.3-19.8	29.6-30.1
Date sampled	08.05.87	08.05.86	08.06.86	08.06.86	08.06.86
Nitric acid digestion ^b	08.12.87	08.12.86	08.12.86	08.12.86	08.12.86
Metals (mg/kg)					
Antimony	<10	<10	<10	<10	<10
Arsenic	0.4	1.1	3.2	5.8	<0.2
Barium	360	260	100	56	24
Beryllium	1.0	1.0	0.7	0.2	1.0
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	16	20	12	9.4	46
Cobalt	11	12	9	7	15
Copper	30	54	21	16	36
Lead	20	22	11	12	18
Mercury	<0.01	<0.01	<0.01	0.03	0.05
Molybdenum	<2	<2	<2	<2	<2
Nickel	34	38	26	32	82
Selenium	<0.2	0.8	0.2	0.3	<0.2
Silver	<1	<1	<1	<1	<1
Thallium	8	8	4	6	6
Vanadium	64	76	91	44	32
Zinc	50	54	43	38	62
Total solids (TS) in %	86	85	80	95	79
Volatile solids as % of TS	2.6	2.9	2.3	0.8	3.1

^a All samples were taken with a 1-1/2 in. i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Total Threshold Limit Concentration. (TTLC)

Table A-36. Metals in surface samples collected within and adjacent to Lagoon 825.

Sample location ^a	B-825-L1 ^b	B-825-L2 ^b	B-825-L3 ^b	B-825-LH ^c
Date sampled	08.12.87	09.16.87	09.16.87	08.12.87
CAM WET extraction (reported date) ^d	08.21.87	10.16.87	10.16.87	08.21.87
Metals (mg/L)				
Antimony	<0.1	<0.1	<0.1	<0.1
Arsenic	0.02	<0.020	<0.020	<0.01
Barium	5.6	6.3	6.6	9.0
Beryllium	0.01	<0.01	<0.01	0.03
Cadmium	0.26	0.09	0.11	0.01
Chromium	0.36	0.09	0.12	0.03
Cobalt	0.37	0.39	0.42	0.48
Copper	11	3.9	2.6	0.18
Lead	6.9	1.6	1.1	<0.1
Mercury	<0.001	<0.001	<0.001	<0.001
Molybdenum	<0.1	<0.1	<0.1	<0.1
Nickel	17	0.98	1.2	0.47
Selenium	<0.01	<0.010	<0.010	<0.01
Silver	0.01	<0.01	<0.01	<0.01
Thallium	<0.1	<0.1	<0.1	<0.1
Vanadium	0.2	<0.2	<0.2	0.6
Zinc	51	17	11	10

^a Samples were obtained with a hand shovel, particles larger than 1/4-in. diam removed, and the remaining material sealed in glass jars using inert tape.

^b Sample obtained within lagoon.

^c Background sample.

^d Soluble Threshold Limit Concentration. (STLC)

Table A-37. Metals in surface samples collected within and adjacent to the 826 Lagoon.

Sample location ^a	826-L ^b	826-LB ^c
Date sampled	08.12.87	08.12.87
CAM WET extraction ^d	08.21.87	08.21.87
Metals (mg/L)		
Antimony	<0.1	<0.1
Arsenic	0.25	0.04
Barium	5.9	7.1
Beryllium	0.01	0.01
Cadmium	0.07	<0.01
Chromium	0.56	0.02
Cobalt	0.41	0.44
Copper	2.3	0.25
Lead	0.4	<0.01
Mercury	<0.001	<0.001
Molybdenum	0.6	<0.1
Nickel	0.52	0.47
Selenium	<0.01	<0.01
Silver	0.01	0.01
Thallium	<0.1	<0.1
Vanadium	0.9	0.9
Zinc	26	0.27

^aSamples were obtained with a hand shovel, particles >1/4 in. diam excluded, and remaining material sealed in glass jars using inert tape.

^bSample obtained within lagoon.

^cBackground sample.

^dTotal Threshold Limit Concentration (TTLC).

Table A-38. Metals in soil and rock samples, sample holes B-826-1 and B-826-2.

Sample location ^a	B-826-1 ^b	B-826-1	B-826-1	B-826-1	B-826-1
Sample depth (ft)	12.0-12.5	15.1-15.6	20.2-20.7	25.2-25.7	30.0-30.4
Date sampled	08.18.86	08.18.86	08.19.86	08.19.86	08.20.86
Nitric acid digestion ^c	08.28.86	08.28.86	08.28.86	08.28.86	08.28.86
Metals (mg/kg)					
Antimony	<10	<10	<10	<10	<10
Arsenic	1.3	1.3	<0.2	<0.2	<0.2
Barium	140	200	170	230	170
Beryllium	0.6	0.6	0.6	0.6	0.6
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	30	32	30	33	23
Cobalt	10	13	10	10	15
Copper	28	24	20	24	20
Lead	14	14	12	14	12
Mercury	<0.01	<0.01	<0.01	0.01	<0.01
Molybdenum	<2	<2	<2	<2	<2
Nickel	45	46	35	40	26
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<1	<1	1	<1	<1
Thallium	8	6	8	8	8
Vanadium	58	58	52	60	80
Zinc	48	54	49	54	56
Sample location	B-826-2	B-826-2	B-826-2	B-826-2	B-826-2
Sample depth (ft)	7.7-8.1	12.5-12.9	17.5-18.0	22.5-22.9	27.5-28.0
Date sampled	08.20.86	08.20.86	08.20.86	08.20.86	08.21.86
Nitric acid digestion ^c	08.28.86	08.28.86	08.28.86	08.28.86	08.28.86
Metals (mg/kg)					
Antimony	<10	<10	<10	<10	<10
Arsenic	<0.2	3.0	<0.2	3.2	1.7
Barium	88	150	240	380	140
Beryllium	0.6	0.6	1.0	0.8	0.6
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	9.6	8.0	21	21	36
Cobalt	13	10	9	12	14
Copper	24	32	30	40	31
Lead	12	14	18	20	12
Mercury	<0.01	0.08	0.08	<0.01	0.01
Molybdenum	<2	<2	<2	<2	<2
Nickel	15	14	25	34	26
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<1.0	<1.0	<1.0	<1.0	<1.0
Thallium	8	8	10	14	8
Vanadium	56	88	56	50	82
Zinc	52	32	60	50	61

^a All samples were collected with a 1-1/2-in. i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Samples recovered from B-826-1 at <12 ft depth were of insufficient volume and/or quality to be suitable for analysis.

^c Total Threshold Limit Concentration (TTLC).

Table A-39. Metals in soil and rock samples, sample holes B-827-C1, B-827-C2, and B-827-C3, Building 827 Area.

Sample location ^a	B-827-C1	B-827-C1	B-827-C1	B-827-C1	B-827-C1	B-827-C1
Sample depth (ft)	5.0-5.5	9.8-10.3	15.0-15.5	20.5-21.0	29.8-30.3	35.0-35.5
Date sampled	08.27.86	08.27.86	08.27.86	08.27.86	08.27.86	08.27.86
Nitric acid digestion ^b	09.08.86	09.08.86	09.08.86	09.08.86	09.08.86	09.08.86
Metals (mg/kg)						
Antimony	<10	<10	<10	<10	<10	<10
Arsenic	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Barium	190	130	160	270	48	130
Beryllium	1.0	1.2	0.8	1.0	1.0	0.6
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	19	24	23	19	20	10
Cobalt	13	16	14	17	14	13
Copper	30	32	37	34	24	17
Lead	18	20	19	18	18	14
Mercury	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	6	6	2	6	6	4
Nickel	28	30	28	26	24	12
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<1.0	<1.0	<1.0	1.0	<1.0	<1.0
Thallium	8	8	8	8	10	8
Vanadium	60	90	65	77	66	84
Zinc	64	68	66	66	76	54
Sample location ^a	B-827-C2	B-827-C2	B-827-C2	B-827-C2	B-827-C2	B-827-C2
Sample depth (ft)	1.6-2.1	5.5-6.0	10.2-10.7	15.6-16.1	21.0-21.5	30.3-30.8
Date sampled	08.26.86	08.26.86	08.26.86	08.26.86	08.26.86	08.26.86
Nitric acid digestion ^b	09.08.86	09.08.86	09.08.86	09.08.86	09.08.86	09.08.86
Metals (mg/kg)						
Antimony	<10	<10	<10	<10	<10	<10
Arsenic	2.8	0.6	<0.2	2.2	<0.2	<0.2
Barium	140	100	150	100	110	130
Beryllium	0.8	0.8	1.2	1.0	1.0	0.6
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	24	24	24	28	22	19
Cobalt	12	11	11	18	18	12
Copper	26	22	30	40	40	30
Lead	16	16	18	22	18	18
Mercury	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	<2.0	<2.0	4	6	6	6
Nickel	24	21	28	44	32	20
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Thallium	8	8	8	10	8	8
Vanadium	78	78	52	58	78	56
Zinc	64	60	64	80	68	70

Table A-39. (Continued).

Sample location ^a	B-827-C3	B-827-C3	B-827-C3	B-827-C3	B-827-C3	B-827-C3
Sample depth (ft)	1.5-1.8	5.8-6.5	10.0-10.8	16.5-17.0	20.0-20.5	30.0-30.3
Date sampled	08.26.86	08.26.86	08.26.86	08.27.86	08.27.86	08.27.86
Nitric acid digestion ^b	09.08.86	09.08.86	09.08.86	09.08.86	09.08.86	09.08.86
Metals (mg/kg)						
Antimony	<10	<10	<10	<10	<10	<10
Arsenic	1.4	0.4	2.0	1.0	0.6	0.4
Barium	210	140	150	250	200	84
Beryllium	0.6	0.6	0.4	1.0	0.6	1.2
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	28	24	23	26	40	14
Cobalt	11	11	9	11	16	13
Copper	26	22	20	46	28	36
Lead	20	16	14	22	16	16
Mercury	<0.01	0.01	0.01	<0.01	<0.01	<0.01
Molybdenum	6	6	6	6	<2.0	<2.0
Nickel	34	28	36	38	30	16
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Thallium	10	8	8	12	8	6
Vanadium	56	46	32	85	110	110
Zinc	52	50	44	68	72	62

^a All samples were taken with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Total Threshold Limit Concentration (TTLIC).

Table A-40. Metals in soil and rock samples from holes B-827-C4 and B-827-C5, Building 827 Area.

	B-827-C4	B-827-C4	B-827-C4	B-827-C4	B-827-C4	B-827-C4	B-827-C4	B-827-C4	B-827-C4	B-827-C4	B-827-C4	B-827-C4
Sample location ^a	15.0	20.0	25.0	30.0	35.0	39.6	44.5	50.0	55.5			
Sample depth (ft)	12.04.87	12.04.87	12.07.87	12.07.87	12.07.87	12.07.87	12.07.87	12.07.87	12.07.87			
Date sampled	12.14.87	12.14.87	12.14.87	12.14.87	12.14.87	12.14.87	12.14.87	12.14.87	12.14.87			
CAM WET extraction ^b												
	Metals (mg/L)											
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.020	0.022	0.060	0.041	0.031	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Barium	9.7	4.4	4.8	3.6	1.6	3.7	2.1	1.6	1.4	1.6	1.4	1.4
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cobalt	0.43	0.78	0.16	0.26	0.31	0.70	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	0.32	0.33	0.15	0.28	0.12	0.10	0.10	0.17	0.39	0.17	0.39	0.39
Lead	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	0.29	0.63	<0.05	6.16	0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Silver	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	0.3	0.8	0.5	<0.2	0.8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Zinc	1.0	0.10	0.09	0.25	0.09	0.16	0.10	0.21	0.90	0.21	0.90	0.90

Table A-40. (Continued).

Sample location ^a	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5	B-827-C5
Sample depth (ft)	9.0	15.0	20.0	25.0	29.0	35.25	40.25	47.0	53.25	60.0
Date sampled	01.12.88	01.12.88	01.12.88	01.12.88	01.12.88	01.15.88	01.15.88	01.15.88	01.15.88	01.15.88
CAM WET extraction ^b	01.13.88	01.13.88	01.13.88	01.13.88	01.18.88	01.20.88	01.20.88	01.20.88	01.20.88	01.20.88
Metals (mg/L)										
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Barium	2.5	3.3	3.4	3.2	3.4	6.0	2.2	0.8	0.8	0.7
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	<0.02	<0.02	0.06	0.03	<0.02	<0.02	0.13	<0.02	0.03	0.07
Cobalt	0.08	0.11	0.67	0.51	0.06	<0.05	0.09	0.11	<0.05	0.11
Copper	0.13	0.28	0.09	0.15	0.13	0.17	0.10	0.07	<0.02	<0.02
Lead	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01
Mercury	<0.001	<0.001	0.020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	<0.05	0.08	0.33	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	0.4	0.4	0.4	0.4	0.5	0.2	<0.2	<0.2	<0.2	<0.2
Zinc	0.04	0.49	0.08	0.33	0.14	0.08	0.14	0.20	0.08	0.10
Wet D.I. extract, date	01.16.88	01.16.88	01.16.88	01.16.88	01.18.88	01.20.88	01.20.88	01.20.88	01.20.88	01.20.88
Hexavalent chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

^a All samples were collected with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Soluble Threshold Limit Concentration (STLC).

Table A-41. Metals in surface samples collected within and adjacent to HE Process Area rinse-water lagoons.

Parameter	Sample Designation ^a	
	827-CL ^b	827-CLB ^c
Date Sampled	08.12.87	08.12.87
CAM WET Extraction	08.21.87	08.21.87
Antimony, mg/L	<0.1	<0.1
Arsenic, mg/L	0.03	0.04
Barium, mg/L	6.5	3.1
Beryllium, mg/L	0.01	<0.01
Cadmium, mg/L	0.30	<0.01
Chromium, mg/L	0.74	0.22
Cobalt, mg/L	0.23	0.34
Copper, mg/L	3.9	0.34
Lead, mg/L	3.0	<0.1
Mercury, mg/L	<0.001	<0.001
Molybdenum, mg/L	<0.1	0.1
Nickel, mg/L	0.47	0.36
Selenium, mg/L	<0.01	<0.01
Silver, mg/L	0.01	0.01
Thallium, mg/L	<0.1	0.1
Vanadium, mg/L	0.8	0.8
Zinc, mg/L	12	0.15

^aSamples were obtained with a hand shovel, particles >1/4" diam excluded, and remaining material sealed in glass jars using inert tape.

^bSample obtained within lagoon.

^cBackground sample.

Table A-42. Metals in soil and rock samples from hand auger hole B-827-E2 and from surface samples , 827E Lagoon area.

Sample location ^a	B-827-E2	B-827-E2	B-827-E2	827-EL ^{b,c}	827-ELB ^{b,d}
Sample depth (ft)	1.0-1.5	5.0-5.5	6.5-7.0	— ^c	— ^d
Date sampled	06.26.87	06.26.87	07.10.87	08.12.87	08.12.87
CAM WET extraction date ^e	07.22.87	07.22.87	07.29.87	08.21.87	08.21.87
Metals (mg/L)					
Antimony	0.2	<0.1	<0.1	<0.1	<0.1
Arsenic	0.01	0.02	<0.01	<0.01	<0.01
Barium	5.4	4.9	12	4.4	9.4
Beryllium	0.01	<0.01	0.02	0.03	<0.01
Cadmium	<0.01	<0.01	<0.01	0.02	0.10
Chromium	0.03	0.03	<0.02	1.5	0.04
Cobalt	0.33	0.33	0.16	0.18	0.13
Copper	0.30	0.61	0.63	0.86	0.65
Lead	0.21	<0.01	0.2	<0.1	0.2
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	0.28	0.30	0.59	0.42	0.12
Selenium	<0.01	<0.01	0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	0.3	<0.2	0.8	0.2	0.2
Zinc	0.73	0.45	0.10	2.8	19

^aSamples obtained in 1-1/2-in.-o.d. stainless steel tube filled by hand-driving a 1-1/2-in.-i.d. split-spoon sampler. Tube ends were covered with aluminum foil and sealed with inert tape.

^bSamples obtained with a hand shovel, particles >1/4 in. diam excluded, and remaining material sealed in glass jars using inert tape.

^cSample obtained within lagoon.

^dBackground sample.

^eSoluble Threshold Limit Concentration (STLC).

Table A-43. Metals in soil and rock samples, sample hole B-828-1, Building 828 area.

Sample location ^a	B-828-1 ^b	B-828-1	B-828-1	B-828-1
Sample depth (ft)	15.2-15.7	20.0-20.4	30.6-31.1	35.6-36.0
Date sampled	08.13.86	08.13.86	08.13.86	08.13.86
Nitric acid digestion date ^c	08.21.86	08.21.86	08.21.86	08.21.86
Metals (mg/kg)				
Antimony	<10	<10	<10	<10
Arsenic	<0.2	<0.2	<0.2	<0.2
Barium	560	120	220	520
Beryllium	0.6	0.8	0.6	1.0
Cadmium	<0.2	<0.2	<0.2	<0.2
Chromium	20	18	20	20
Cobalt	11	8	13	13
Copper	30	36	28	50
Lead	14	16	16	18
Mercury	0.04	0.02	0.05	0.04
Molybdenum	<2	<2	<2	<2
Nickel	26	22	24	22
Selenium	<0.2	<0.2	<0.2	<0.2
Silver	<1	<1	<1	<1
Thallium	4	8	4	6
Vanadium	110	36	100	130
Zinc	62	44	60	56

^aAll samples were taken with a 1-1/2-in.-i.d. split spoon sampler advanced by a 140-lb. hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil and sealed with inert tape.

^bSamples recovered at <15 ft depth were of insufficient volume and/or quality to be suitable for analysis.

^cTotal Threshold Limit Concentration (TTLC).

Table A-44. Metals in soil and rock samples, sample hole B-828-2.

Sample location ^a	B-828-2 ^b	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2
Sample depth (ft)	7.2	10.0	15.4	20.5	25.5	30.7	35.5	40.4	45.0
Date sampled	11.30.87	11.30.87	11.30.87	11.30.87	11.30.87	12.01.87	12.01.87	12.01.87	12.01.87
CAM WET extraction date ^c	12.07.87	12.07.87	12.07.87	12.07.87	12.07.87	12.07.87	12.07.87	12.07.87	12.07.87
	Metals (mg/L)								
Antimony	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.14	0.16	0.03	0.26	0.14	0.03	0.03	0.12	0.12
Barium	5.1	5.5	2.5	3.9	3.7	6.9	6.9	4.6	3.8
Beryllium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Chromium	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02
Cobalt	0.71	0.46	0.41	0.08	0.33	0.33	0.11	0.44	0.46
Copper	0.16	0.34	0.04	0.22	<0.02	0.12	0.16	0.22	0.04
Lead	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel 0.83	0.97	0.60	0.15	0.34	0.34	<0.05	0.15	<0.05	<0.05
Selenium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vanadium	1.1	0.9	0.6	0.4	0.4	0.7	0.6	0.9	0.7
Zinc	0.06	0.14	<0.01	<0.01	0.09	0.05	0.07	0.07	0.04

^a All samples were taken with a 1-1/2 in. i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Samples recovered at <7.2 ft depth were of insufficient volume and/or quality to be suitable for analysis.

^c Soluble Threshold Limit Concentration (STLC).

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Table A-45. Soil analyses for metals in mg/L (ppm) by the CAM WET or EP TOX procedure

Location	Date Sampled	Depth ft	Sb	As	Ba	Be	Cd	Cr	Cu	Cu
STLC			15	5.0	100	0.75	1.0	560	80	25
D-807-01										
	26-JUN-89	4.0	<0.06	0.02	5.3	<0.01	<0.04	0.07	0.15	0.11
	26-JUN-89	10.0	<0.06	0.03	4.5	<0.01	<0.04	0.05	0.17	0.26
	27-JUN-89	15.5	<0.06	0.03	4.7	<0.01	<0.04	<0.05	0.3	0.08
	27-JUN-89	20.8	<0.06	0.09	4.9	<0.01	<0.04	<0.05	0.21	0.11
W-809-03										
	07-JUL-89	0.3	<0.06	<0.02	11	<0.01	<0.04	<0.05	0.46	0.23
	07-JUL-89	5.5	<0.06	<0.02	7.9	<0.01	<0.04	<0.05	0.47	0.23
	07-JUL-89	11.0	<0.06	0.04	10	<0.01	<0.04	<0.05	0.4	0.56
	07-JUL-89	15.8	<0.06	0.03	1.7	<0.01	<0.04	<0.05	0.17	0.16
	10-JUL-89	20.8	<0.06	0.05	2.5	<0.01	<0.04	0.05	0.17	0.11
	10-JUL-89	28.4	<0.06	0.1	1.1	<0.01	<0.04	<0.05	0.42	0.18
D-810A-01										
	28-JUN-89	2.3	<0.06	0.08	5	<0.01	<0.04	<0.05	0.4	0.08
	28-JUN-89	6.5	<0.06	0.09	4	<0.01	<0.04	<0.05	0.19	<0.08
	28-JUN-89	11.8	<0.06	0.04	2.7	<0.01	<0.04	<0.05	0.15	<0.08
	28-JUN-89	16.8	<0.06	<0.02	2.3	<0.01	<0.04	<0.05	0.08	0.24
	28-JUN-89	19.3	<0.06	0.02	2.5	<0.01	<0.04	<0.05	0.09	0.14
D-810C-01										
	16-NOV-89	5.8	<0.06	0.05	11	<0.01	<0.04	<0.05	0.11	0.09
	20-NOV-89	10.5	<0.06	0.03	4.9	<0.01	<0.04	<0.05	0.18	0.1
	20-NOV-89	15.6	0.06	0.02	2.6	<0.01	<0.04	<0.05	0.17	<0.08
	20-NOV-89	17.5	<0.06	0.02	7.8	<0.01	<0.04	0.12	0.05	0.39
	20-NOV-89	19.8	<0.06	0.02	6.5	<0.01	<0.04	<0.05	0.15	0.12
812-01										
	30-AUG-88	4.0	-	<0.02	0.23	<0.01	<0.04	<0.05	-	-
	30-AUG-88	5.0	-	<0.02	0.47	<0.05	<0.04	<0.06	-	-
	30-AUG-88	9.0	-	<0.02	0.05	<0.01	<0.04	<0.05	-	-
	30-AUG-88	9.3	0.1	<0.02	1.7	0.26	<0.01	0.02	0.11	10
	30-AUG-88	13.0	-	<0.02	<0.05	<0.01	<0.04	<0.05	-	-
	30-AUG-88	13.3	<0.1	0.04	1.6	<0.01	<0.01	0.03	0.13	3.6
	30-AUG-88	18.0	-	<0.02	<0.05	<0.01	<0.04	<0.05	-	-
	30-AUG-88	18.2	<0.1	0.05	3	<0.01	<0.01	0.05	0.29	1
	30-AUG-88	23.0	-	<0.02	<0.05	<0.01	<0.04	<0.05	-	-
	30-AUG-88	23.3	<0.1	0.04	1.9	<0.01	<0.01	0.07	<0.05	23
812-02										
	31-AUG-88	3.3	<0.1	<0.02	3.9	<0.01	<0.01	<0.02	0.22	0.27
	31-AUG-88	5.0	-	<0.02	0.7	<0.05	<0.04	<0.05	-	-
	31-AUG-88	8.0	-	<0.02	0.06	<0.01	<0.04	<0.05	-	-
	31-AUG-88	8.3	0.1	<0.02	4	0.18	<0.01	<0.02	0.2	0.31
	31-AUG-88	13.0	-	<0.02	0.09	<0.01	<0.04	<0.05	-	-
	31-AUG-88	13.3	<0.1	<0.02	3.3	0.18	<0.01	<0.02	0.18	2.9
	31-AUG-88	18.0	-	<0.02	0.08	<0.01	<0.04	<0.05	-	-
	31-AUG-88	18.3	0.1	0.03	4.5	<0.01	<0.01	0.09	0.24	0.82
	31-AUG-88	23.0	-	<0.02	0.09	<0.01	<0.04	<0.05	-	-
	31-AUG-88	23.3	0.1	0.03	3.4	<0.01	0.02	0.05	0.16	0.79
812-03										
	31-AUG-88	8.0	-	<0.02	0.19	<0.01	<0.04	<0.05	-	-
	31-AUG-88	8.3	0.1	<0.02	3	<0.01	<0.01	0.03	0.2	0.4
	31-AUG-88	13.0	-	<0.02	0.09	<0.01	<0.04	<0.05	-	-
	31-AUG-88	13.3	<0.1	<0.02	4.5	0.2	<0.01	<0.02	0.25	2.7
	31-AUG-88	18.0	-	<0.02	0.07	<0.01	<0.04	<0.05	-	-
	31-AUG-88	18.3	<0.1	0.06	3.3	<0.01	<0.01	<0.02	0.16	4.9
	31-AUG-88	22.0	-	<0.02	0.05	<0.01	<0.04	<0.05	-	-
	31-AUG-88	22.3	<0.1	0.02	3.4	<0.01	<0.01	<0.02	0.11	1.1

for STLC.

Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Location
5.0	0.2	350	20	1.0	5	7.0	24	250	
									D-807-01
<0.3	<0.001	<0.08	0.14	<0.02	<0.02	<0.2	0.2	0.1	
<0.3	<0.001	<0.08	0.21	<0.02	<0.02	<0.2	0.23	0.18	
<0.3	0.002	<0.08	0.13	<0.02	<0.02	<0.2	0.81	0.03	
<0.3	<0.001	<0.08	0.17	<0.02	<0.02	<0.2	1.1	0.08	
									W-809-03
<0.3	<0.001	<0.08	0.41	<0.02	<0.02	<0.2	0.93	0.22	
<0.3	<0.001	<0.08	0.35	<0.02	0.11	<0.2	0.9	0.06	
<0.3	<0.001	<0.08	0.64	<0.02	<0.02	<0.2	0.96	0.1	
<0.3	<0.001	<0.08	0.11	<0.02	<0.02	<0.2	0.33	0.12	
<0.3	<0.001	<0.08	0.1	<0.02	<0.02	<0.2	0.42	0.06	
<0.3	<0.001	<0.08	0.12	<0.02	<0.02	<0.2	0.47	0.01	
									D-810A-01
<0.3	<0.001	<0.08	0.16	<0.02	<0.02	<0.2	1.5	0.04	
<0.3	<0.001	<0.08	0.08	<0.02	<0.02	<0.2	0.94	0.02	
<0.3	<0.001	<0.08	0.08	<0.02	<0.02	<0.2	0.65	<0.01	
<0.3	<0.001	<0.08	0.08	<0.02	<0.02	<0.2	0.38	0.05	
<0.3	<0.001	<0.08	0.08	<0.02	<0.02	<0.2	0.52	0.04	
									D-810C-01
<0.3	<0.001	<0.08	0.07	<0.02	<0.02	<0.2	0.76	<0.01	
<0.3	<0.001	<0.08	0.04	0.02	<0.02	<0.2	0.9	<0.01	
<0.3	<0.001	<0.08	<0.03	<0.02	<0.02	<0.2	0.6	<0.01	
<0.3	0.26	0.14	<0.03	0.02	0.02	<0.2	0.05	<0.01	
<0.3	<0.001	<0.08	0.03	<0.02	<0.02	<0.2	0.46	<0.01	
									812-01
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
2.5	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	<0.2	1.6	
<0.3	<0.0002	-	-	<0.01	0.02	-	-	-	
<0.1	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	<0.2	0.58	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
<0.1	<0.001	<0.1	0.15	<0.01	<0.01	<0.1	0.3	0.15	
<0.3	<0.0002	-	-	<0.01	0.02	-	-	-	
10.8	<0.001	<0.1	<0.05	<0.01	<0.02	<0.1	<0.2	10.97	
									812-02
0.4	<0.001	<0.1	0.05	<0.01	<0.01	<0.1	0.4	0.06	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
0.4	<0.001	<0.1	0.15	<0.01	<0.01	<0.1	0.4	0.05	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
0.4	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	<0.2	0.73	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
<0.1	<0.001	<0.1	0.33	<0.01	<0.01	<0.1	<0.2	0.14	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
<0.1	<0.001	<0.1	0.17	<0.01	<0.01	<0.1	<0.2	0.14	
									812-03
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
<0.1	<0.001	<0.1	0.21	<0.01	<0.01	<0.1	<0.2	0.04	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
14	<0.001	<0.1	0.09	<0.01	<0.01	<0.1	0.4	0.31	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
0.4	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	0.6	0.44	
<0.3	<0.0002	-	-	<0.01	<0.02	-	-	-	
<0.1	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	<0.2	0.15	

Table A-45. Soil analyses for metals in mg/L (ppm) by the CAM WET or EP TOX procedure

Location Date Sampled	Depth ft	Sb	As	Ba	Be	Cd	Cr	Co	Cu
STLC		15	5.0	100	0.75	1.0	560	80	25
<hr/>									
D-812C-02									
27-JUN-89	1.5	<0.06	<0.02	9	<0.01	<0.04	0.13	0.66	0.1
813-01									
26-JUL-89	1.0	<0.06	<0.02	10	<0.01	<0.04	<0.05	0.26	0.12
26-JUL-89	6.0	<0.06	0.03	12	<0.01	<0.04	<0.05	0.09	<0.08
27-JUL-89	10.8	<0.06	0.07	7.6	<0.01	<0.04	<0.05	0.42	0.31
27-JUL-89	16.0	<0.06	0.21	8	<0.01	<0.04	<0.05	0.19	0.06
27-JUL-89	21.0	<0.06	0.04	4.2	<0.01	<0.04	<0.05	0.26	0.15
27-JUL-89	31.0	<0.06	0.03	5.3	<0.01	<0.04	<0.05	0.37	0.23
27-JUL-89	40.8	<0.06	0.03	4.9	<0.01	<0.04	<0.05	0.04	0.15
27-JUL-89	51.0	<0.06	0.03	11	<0.01	<0.04	<0.05	0.19	0.47
W-814-01									
08-MAY-87	5.5	--	--	--	--	<0.01	<0.02	0.07	0.05
08-MAY-87	10.5	--	--	--	--	<0.01	<0.02	0.32	0.05
11-MAY-87	13.5	--	--	--	--	<0.01	<0.02	<0.05	0.15
11-MAY-87	18.5	--	--	--	--	<0.01	<0.02	0.07	0.13
11-MAY-87	25.5	--	--	--	--	<0.01	<0.02	<0.05	0.15
11-MAY-87	30.5	--	--	--	--	<0.01	<0.02	<0.05	0.18
11-MAY-87	35.8	--	--	--	--	<0.01	<0.02	<0.05	0.34
11-MAY-87	40.5	--	--	--	--	<0.01	<0.02	<0.05	0.12
12-MAY-87	50.5	--	--	--	--	0.02	<0.02	0.28	0.18
12-MAY-87	59.5	--	--	--	--	0.04	<0.02	<0.05	0.11
12-MAY-87	69.8	--	--	--	--	<0.01	0.03	<0.05	0.25
12-MAY-87	79.8	--	--	--	--	<0.01	<0.02	<0.05	0.25
13-MAY-87	99.0	--	--	--	--	<0.01	<0.02	0.29	0.31
14-MAY-87	109.8	--	--	--	--	<0.01	<0.02	0.15	0.26
W-815-05									
21-JUL-89	0.8	<0.06	0.07	7.3	<0.01	<0.04	<0.05	0.34	0.89
21-JUL-89	5.3	<0.06	0.05	7.5	<0.01	<0.04	0.13	0.61	15
21-JUL-89	10.5	<0.06	0.1	9.3	<0.01	<0.04	<0.05	0.48	0.53
21-JUL-89	15.5	<0.06	0.11	4.1	<0.01	<0.04	0.05	0.78	0.14
21-JUL-89	20.5	<0.06	0.21	8.8	<0.01	<0.04	0.12	0.49	4.7
21-JUL-89	30.8	<0.06	0.1	5.7	<0.01	<0.04	<0.05	1.2	0.22
819-01									
20-OCT-86	5.6	--	--	--	--	0.12	0.35	0.53	0.1
20-OCT-86	10.7	--	--	--	--	0.03	0.29	0.29	0.2
20-OCT-86	13.5	--	--	--	--	<0.01	0.06	0.21	0.15
20-OCT-86	19.0	--	--	--	--	0.09	1.5	0.49	0.08
21-OCT-86	24.5	--	--	--	--	0.08	0.33	0.57	0.15
21-OCT-86	28.9	--	--	--	--	0.05	0.1	0.17	0.18
21-OCT-86	34.8	--	--	--	--	0.09	0.1	0.41	0.08
W-819-03									
09-DEC-87	10.8	--	--	--	--	<0.01	<0.02	0.19	0.09
09-DEC-87	15.0	--	--	--	--	<0.01	0.09	0.22	0.26
09-DEC-87	20.5	--	--	--	--	<0.01	0.08	0.17	0.38
D-827A-01									
30-JUN-89	2.8	<0.06	0.02	4.3	<0.01	<0.04	<0.05	0.21	0.09
30-JUN-89	7.0	<0.06	0.02	5	<0.01	<0.04	<0.05	0.27	0.19
30-JUN-89	11.8	<0.06	0.02	6	<0.01	<0.04	<0.05	0.25	0.1
30-JUN-89	15.8	<0.06	0.031	2.9	<0.01	<0.04	<0.05	0.2	0.11
30-JUN-89	19.3	<0.06	0.03	1.9	<0.01	<0.04	<0.05	0.21	0.17
D-827B-01									
26-JUN-89	2.8	<0.06	0.02	2.3	<0.01	<0.04	0.05	0.48	0.24
26-JUN-89	7.0	<0.06	0.02	1.8	<0.01	<0.04	<0.05	0.18	0.2
26-JUN-89	10.0	<0.06	0.02	5.5	<0.01	<0.04	0.18	0.16	1.2

for STLC.

Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Location
5.0	0.2	350	20	1.0	5	7.0	24	250	
<0.3	<0.001	<0.00	0.5	<0.02	<0.02	<0.2	0.62	0.14	D-812C-02
<0.3	<0.0001	<0.00	0.24	<0.02	<0.02	<0.2	0.29	0.12	813-01
<0.3	<0.001	<0.00	<0.03	<0.02	<0.02	<0.2	0.37	<0.01	
<0.3	<0.001	<0.00	0.23	<0.02	<0.02	<0.2	1.4	0.08	
<0.3	<0.001	<0.00	0.08	<0.02	<0.02	<0.2	1.7	0.17	
<0.3	<0.001	<0.00	0.09	0.02	<0.02	<0.2	0.8	0.22	
<0.3	<0.001	<0.00	0.34	0.02	<0.02	<0.2	0.6	0.05	
<0.3	<0.001	<0.00	<0.03	0.02	<0.02	<0.2	0.38	<0.01	
<0.3	<0.001	<0.00	0.8	0.02	<0.02	<0.2	0.96	0.09	
<0.1	<0.001	<0.1	0.29	<0.01	<0.01	0.4	<0.2	0.05	W-814-01
<0.1	<0.001	<0.1	0.4	<0.01	<0.01	0.6	0.3	0.05	
<0.1	<0.001	<0.1	0.06	<0.01	<0.01	0.1	0.3	0.12	
<0.1	<0.001	<0.1	0.11	<0.01	<0.01	0.1	<0.2	0.09	
<0.1	<0.001	<0.1	0.11	<0.01	<0.01	<0.1	<0.2	0.28	
<0.1	<0.001	<0.1	0.17	<0.01	<0.01	<0.1	<0.2	0.35	
<0.1	<0.001	<0.1	0.11	<0.01	<0.01	0.2	<0.2	0.21	
<0.1	<0.001	<0.1	0.11	<0.01	<0.01	0.2	0.6	0.1	
<0.1	<0.001	<0.1	0.58	<0.01	<0.01	0.6	0.3	0.15	
<0.1	<0.001	<0.1	0.08	<0.01	<0.01	<0.1	0.3	0.1	
<0.1	<0.001	<0.1	0.11	<0.01	<0.01	0.5	<0.2	0.33	
<0.1	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	0.4	0.17	
0.3	<0.001	<0.1	0.48	<0.01	0.03	0.3	0.4	0.31	
<0.1	0.001	<0.1	0.1	<0.01	<0.01	<0.1	0.2	0.3	
<0.3	<0.001	<0.00	0.3	<0.02	<0.02	<0.2	0.77	1.9	W-815-05
<0.3	<0.001	<0.00	0.64	<0.02	<0.02	<0.2	1.6	0.89	
<0.3	<0.001	0.00	0.47	<0.02	<0.02	<0.2	1.3	0.13	
<0.3	<0.001	<0.00	0.09	<0.02	<0.02	<0.2	0.53	0.08	
0.3	<0.001	<0.00	0.52	<0.02	<0.02	<0.2	1.5	0.84	
<0.3	<0.001	<0.00	0.41	<0.02	<0.02	<0.2	0.67	0.1	
0.3	<0.001	<0.1	0.74	<0.01	<0.01	0.4	<0.2	0.05	819-01
<0.1	<0.001	<0.1	1.3	<0.01	<0.01	<0.1	<0.2	0.15	
<0.1	<0.001	<0.1	1.2	<0.01	<0.01	<0.1	<0.2	0.05	
0.2	<0.001	<0.1	0.34	<0.01	<0.01	0.2	0.2	0.04	
0.1	<0.001	<0.1	0.7	<0.01	<0.01	<0.1	0.37	0.06	
0.1	<0.001	<0.1	0.2	<0.01	<0.01	<0.1	0.37	0.05	
<0.1	0.001	<0.1	<0.05	<0.01	<0.01	<0.1	0.54	0.07	
<0.1	<0.001	<0.1	0.16	<0.1	<0.01	<0.1	<0.2	0.07	W-819-03
<0.1	0.002	<0.1	0.63	<0.1	<0.01	<0.1	<0.2	0.12	
<0.1	0.009	<0.1	<0.05	<0.1	<0.01	<0.1	0.3	0.32	
<0.3	<0.001	<0.00	0.21	<0.02	<0.02	<0.2	0.27	0.03	D-827A-01
<0.3	<0.001	<0.00	0.28	<0.02	<0.02	<0.2	0.5	0.25	
<0.3	<0.001	<0.00	0.21	<0.02	<0.02	<0.2	0.48	<0.01	
<0.3	<0.001	<0.00	0.44	<0.02	<0.02	<0.2	0.55	0.04	
<0.3	<0.001	<0.00	0.28	<0.02	<0.02	<0.2	0.94	0.09	
<0.3	<0.001	<0.00	0.47	<0.02	<0.02	<0.2	0.51	0.42	D-827B-01
<0.3	<0.001	<0.00	0.11	<0.02	<0.02	<0.2	0.12	0.19	
<0.3	<0.001	0.15	0.27	<0.02	<0.02	<0.2	0.19	0.66	

Table A-4B. Soil analyzed for metals in mg/L (ppm) by the CAM WET or EP TOX procedure

Location Date Sampled	Depth ft	Sb	As	Ba	Be	Cd	Cr	Co	Cu
STLC		15	5.0	100	0.75	1.0	560	80	25
<hr/>									
D-827C-01									
23-JUN-89	2.8	<0.06	0.03	2.8	<0.01	<0.04	0.07	0.28	0.16
23-JUN-89	7.0	<0.06	0.02	1.4	<0.01	<0.04	<0.05	0.05	0.11
23-JUN-89	10.5	<0.06	0.03	2	<0.01	<0.04	<0.05	0.15	0.1
23-JUN-89	15.8	<0.06	0.02	1.7	<0.01	<0.04	0.06	0.15	0.09
23-JUN-89	20.8	<0.06	0.03	1.9	<0.01	<0.04	<0.05	0.23	<0.08
<hr/>									
D-827D-01									
22-JUN-89	5.0	<0.06	0.11	3.8	<0.01	<0.04	0.16	0.14	0.32
22-JUN-89	10.5	<0.06	0.03	3.8	<0.01	<0.04	<0.05	0.04	<0.08
22-JUN-89	15.3	<0.06	0.02	4.9	<0.01	<0.04	<0.05	0.61	0.08
23-JUN-89	20.9	<0.06	0.03	5.7	<0.01	<0.04	<0.05	<0.03	0.1
<hr/>									
D-827E-01									
21-JUN-89	1.0	<0.06	0.03	3.9	<0.01	<0.04	0.08	0.2	0.36
21-JUN-89	5.3	<0.06	0.04	2.9	<0.01	<0.04	0.11	0.28	0.16
22-JUN-89	11.5	<0.06	0.02	1.3	<0.01	<0.04	0.05	0.1	<0.08
22-JUN-89	15.5	<0.06	0.02	1.1	<0.01	<0.04	0.06	0.2	0.13
22-JUN-89	20.3	<0.06	0.04	1.2	<0.01	<0.04	0.15	0.12	0.15
<hr/>									
829-01									
17-OCT-86	2.5	-	-	-	-	0.11	0.06	0.45	3.7
17-OCT-86	4.7	-	-	-	-	0.06	0.02	<0.05	0.18
17-OCT-86	9.5	-	-	-	-	<0.01	<0.02	<0.05	0.05
17-OCT-86	14.5	-	-	-	-	<0.01	<0.02	<0.05	<0.08
17-OCT-86	24.9	-	-	-	-	<0.01	<0.02	<0.05	0.03
17-OCT-86	34.0	-	-	-	-	<0.01	<0.02	<0.05	<0.02
17-OCT-86	34.8	-	-	-	-	<0.01	<0.02	<0.05	0.03
17-OCT-86	39.5	-	-	-	-	0.05	0.02	0.41	0.18
17-OCT-86	44.4	-	-	-	-	<0.01	<0.02	0.13	0.15

for STLC.

Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Location
5.0	0.2	350	20	1.0	5	7.0	24	Zn
D-827C-01								
<0.3	<0.001	<0.08	0.09	<0.02	<0.02	<0.2	0.29	0.08
<0.3	<0.001	<0.08	0.03	<0.02	<0.02	<0.2	0.13	0.17
<0.3	<0.001	<0.08	0.05	<0.02	<0.02	<0.2	0.7	0.1
<0.3	<0.001	<0.08	0.05	<0.02	<0.02	<0.2	0.53	0.08
<0.3	<0.001	<0.08	0.05	<0.02	<0.02	<0.02	0.5	0.13
D-827D-01								
<0.3	<0.001	<0.08	0.14	<0.02	<0.02	<0.2	1.1	0.22
<0.3	<0.001	<0.08	0.05	<0.02	<0.02	<0.2	0.48	0.11
<0.3	<0.001	<0.08	0.45	<0.02	<0.02	<0.2	0.63	0.14
<0.3	<0.001	<0.08	<0.03	<0.02	<0.02	<0.2	0.42	0.11
D-827E-01								
<0.3	0.007	<0.08	0.24	<0.02	<0.02	<0.2	0.28	1.3
<0.3	0.002	<0.08	0.2	0.02	<0.02	<0.2	0.31	0.23
<0.3	0.001	<0.08	0.06	<0.02	<0.02	<0.2	0.08	0.11
<0.3	<0.001	<0.08	0.08	<0.02	<0.02	<0.2	0.1	0.14
<0.3	<0.001	<0.08	0.09	<0.02	<0.02	<0.2	0.22	0.31
829-01								
1.3	<0.001	<0.1	0.39	0.02	<0.01	<0.1	0.54	11
0.3	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	0.37	0.15
0.3	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	<0.2	0.31
<0.1	<0.001	<0.1	0.22	<0.01	<0.01	<0.1	<0.2	0.07
<0.1	<0.001	<0.1	0.3	<0.01	<0.01	<0.1	<0.2	0.05
<0.1	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	<0.2	0.02
<0.1	<0.001	<0.1	<0.05	<0.01	<0.01	<0.1	<0.2	0.05
<0.1	<0.001	<0.1	0.26	0.01	<0.01	<0.1	<0.2	0.12
<0.1	<0.001	<0.1	0.17	<0.01	<0.01	<0.1	<0.2	0.08

Notes:

- Indicates no analysis performed for this compound.

Sb Antimony
 As Arsenic
 Ba Barium
 Be Beryllium
 Cd Cadmium
 Cr Chromium
 Co Cobalt
 Cu Copper
 Pb Lead
 Hg Mercury
 Mo Molybdenum
 Ni Nickel
 Se Selenium
 Ag Silver
 Tl Thallium
 V Vanadium
 Zn Zinc

Table A-46. Soil and rock analyses in mg/kg (ppm) for metals using nitric acid digestion

Location	Depth	Sb	As	Ba	Be	Cd	Cr	Co	Cu
Date Sampled	ft								
TTL		500	500	10,000	75	100	2,500	8,000	2,500
<hr/>									
827-E2									
25-JUN-87	1.5	17	0.6	210	0.31	<0.2	16	11	25
25-JUN-87	5.5	<10	0.8	130	<0.2	<0.2	14	8.7	22

for TTLC.

Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Location
1,000	20	3,500	2,000	100	500	700	2,400	5,000	
15	0.02	<2	25	<0.2	<1	3.7	45	47	827-E2
12	0.02	<2	17	<0.2	<1	3.6	41	41	

Notes:

- Indicates no analysis performed for this compound.

Sb Antimony
 As Arsenic
 Ba Barium
 Be Beryllium
 Cd Cadmium
 Cr Chromium
 Co Cobalt
 Cu Copper
 Pb Lead
 Hg Mercury
 Mo Molybdenum
 Ni Nickel
 Se Selenium
 Ag Silver
 Tl Thallium
 V Vanadium
 Zn Zinc

Table A-47. HE compounds in soil and rock samples from sample holes B-828-1 and B-828-2.

Sample ID ^a	Sample depth (ft)	HE compounds in µg/g of soil ^b		
		HMX	RDX	TNT
828-1-1A	5.5-6.0	0.067	0.40	<0.0008
828-1-2A	9.0-9.5	0.14	0.75	<0.0008
828-1-3A	15.0-15.2	0.22	1.2	<0.0008
828-1-4B	20.4-20.6	1.1	5.3	<0.0008
828-1-5A	25.1-25.6	0.074	0.62	<0.0008
828-1-6A	30.1-30.6	0.022	0.36	<0.0008
828-1-7A	35.1-35.6	0.24	0.93	<0.0008
828-2	5.0	9.8	3.0	<0.0008
828-2	7.7	7.6	3.0	<0.0008
828-2	10.0	3.9	3.2	<0.0008
828-2	15.0	1.3	1.8	<0.0008
828-2	20.0	0.69	2.3	<0.0008
828-2	25.0	1.4	3.0	<0.0008
828-2	30.2	0.61	1.1	<0.0008
828-2	35.0	0.51	1.0	<0.0008
828-2	40.0	0.36	0.44	<0.0008
828-2	45.0	0.077	0.054	<0.0008
828-2	50.0	0.027	0.002	<0.0008
828-2	54.0	<0.0008	<0.0008	<0.0008
828-2	59.0	<0.0008	<0.0008	<0.0008

^a All samples were taken with a 1-1/2 -in. -i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Analyses by normal HPLC procedure.

Table A-48. Extractable and purgeable priority pollutants in soil and rock samples, sample hole B-828-1.

Sample location ^a	B-828-1 ^b	B-828-1	B-828-1	B-828-1
Sample depth (ft)	15.2-15.7	20.0-20.4	30.6-31.1	35.6-36.6
Date sampled	08.13.86	08.13.86	08.13.86	08.13.86
EPA Method 8270 (mg/kg)				
<u>B/N/A ext. priority pollutants</u>				
Extraction date	08.19.86	08.19.86	08.19.86	08.19.86
Date analyzed	08.21.86	08.22.86	08.22.86	08.22.86
2,4-dinitrophenol	<3	<3	<3	<3
2-methyl-4,6-dinitrophenol	<5	<5	<5	<5
3,3'-dichlorobenzidine	<4	<4	<4	<4
4-nitrophenol	<3	<3	<3	<3
Bis(2-ethylhexyl)phthalate	<10	<10	<10	<10
Benidine	<4	<4	<4	<4
Dibutylphthalate	<5	<5	<5	<5
Dimethylphthalate	<3	<3	<3	<3
N-nitrosodi-n-propylamine	<4	<4	<4	<4
N-nitrosodimethylamine	<8	<8	<8	<8
Other B/N,A ext. priority pollutants	<0.1	<0.1	<0.1	<0.1
Semi-quantified results ^c				
C ₁₀ H ₂₀ hydrocarbon matrix	—	50	—	—
EPA Method 8240 (mg/kg)				
<u>Purgeable priority pollutants</u>				
Extraction date	08.18.86	08.18.86	08.18.86	08.18.86
Acrolein	<2	<2	<2	<2
Acrylonitrile	<2	<2	<2	<2
Trichloroethylene	7	<0.2	<0.2	<0.2
Other purgeable priority pollutants	<0.2	<0.2	<0.2	<0.2

^aAll samples were taken with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^bSamples recovered at <15 ft depth were of insufficient volume and/or quality to be suitable for analysis.

^cQuantification based upon comparison of total ion count of the compound with that of the nearest internal standard.

Table A-49. Purgeable priority pollutants and BTX in soil and rock samples, sample hole B-828-2.

	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2
Sample location ^a	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2
Sample depth (ft)	7.2 ^b	10.0	15.4	20.5	25.5	30.7	35.5	40.4	45.0	50.5			
Date sampled	11.30.87	11.30.87	11.30.87	11.30.87	11.30.87	12.01.87	12.01.87	12.01.87	12.01.87	12.01.87	12.01.87	12.01.87	12.01.87
EPA Method 8010 (mg/kg)													
Date extracted	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87
1,1,2,2-tetrachloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1,2-trichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1-dichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1-dichloroethylene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,2-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,2-dichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
trans-1,2-dichloroethylene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,2-dichloropropane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,3-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,4-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
2-chloroethylvinylether	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromodichloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromomethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Bromoform	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Carbon tetrachloride	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chloroform	0.0010	0.0027	0.0006	0.0003	<0.0002	<0.0002	0.0010	0.0002	0.0003	0.0004	0.0003	0.0003	0.0004
Chloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Dibromochloromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Table A-49. (Continued)

Sample location ^a	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2	B-828-2
Sample depth (ft)	7.2 ^b	10.0	15.4	20.5	25.5	30.7	35.5	40.4	45.0	50.5
Date sampled	11.30.87	11.30.87	11.30.87	11.30.87	11.30.87	12.01.87	12.01.87	12.01.87	12.01.87	12.01.87
EPA Method 8010 (mg/kg) (continued)										
Dichlorodifluoromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Freon 113	<0.0002	0.0016	<0.0002	0.0008	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Methylene chloride	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Tetrachloroethylene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,1,1-trichloroethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Trichloroethylene	0.0003	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0007	0.0004	<0.0002
Trichlorofluoromethane	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Vinyl chloride	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
cis-1,3-dichloropropene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
trans-1,3-dichloropropene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EPA Method 8020 (mg/kg)										
Date extracted	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.16.87	12.21.87	12.16.87	12.16.87	12.16.87
1,2-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,3-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
1,4-dichlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Chlorobenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Benzene	<0.0002	<0.0002	<0.0002	0.0005	<0.0002	0.0008	<0.0002	<0.0002	<0.0002	0.0003
Ethylbenzene	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Toluene	<0.0002	0.0004	<0.0002	<0.0002	0.0002	0.0004	<0.0002	<0.0002	<0.0002	0.0005
Total xylene isomers	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0018	<0.0002	<0.0002	<0.0002	0.0015

^a All samples were taken with a 1-1/2-in.-i.d. split-spoon sampler advanced by a 140-lb hammer falling 30 in. Samples were encased in stainless steel sleeves, ends covered with aluminum foil, and sealed with inert tape.

^b Samples recovered at 7.2 ft depth were of insufficient volume and/or quality to be suitable for analysis.

Appendix B

**Ground Water Data:
HE Compounds, VOCs, Metals, Etc.**

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
W-806-06A	October 1986	f	<20	<20	<20
	October 1986	f	<20	<20	<20
	February 1987		<20	<20	<20
	May 1987		<20	<20	<20
	July 1987		<25	<20	<25
	August 1987		<30	<30	<30
	October 1987		<20	<20	<20
	January 1988		<10	<15	<15
	May 1988		<15	<30	<20
	June 1988		<20	<20	<20
	August 1988		<20	<20	<20
	October 1988		<20	<30	<40
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
W-809-01	March 1988		<20	<35	<30
	May 1988		<15	<30	<20
	June 1988		<20	<20	<20
	October 1988		<20	<30	<40
	February 1989		<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<30	<30	<30
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
W-809-02	April 1988		<20	<25	<20
	June 1988		<20	<20	<20
	October 1988		<20	<30	<40
	February 1989		<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<30	<30	<30
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
W-809-03	October 1989		<20	<20	<20
	January 1990		<15	<30	<30
W-810-01	March 1988		<20	<35	<30
	June 1988		<20	<20	<20
	October 1988		<20	<30	<40

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
	February 1989		<20	<30	<20
	April 1989		<20	<30	<20
	July 1989		<30	<30	<30
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
W-814-01	February 1988		<20	<20	<20
	June 1988		<20	<20	<20
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
W-815-01	July 1987		<25	190	<25
	November 1987	f	<20	210	<20
	November 1987	f	<20	220	<20
	January 1988	ah	10	200	<20
	January 1988	ah	10	197	<20
	March 1988		<20	350	<20
	June 1988		<20	170	<20
	October 1988		<20	195	<40
	February 1989		<20	260	<20
	April 1989		<20	203	<20
	July 1989		<30	165	<30
	October 1989		<10	135	<10
	January 1990		<15	220	<30
W-815-02	May 1987		<20	<20	<20
	July 1987		30	30	<25
	November 1987	f	<20	35	<20
	November 1987	f	<20	30	<20
	January 1988	f	<8	35	<20
	January 1988	f	<8	25	<20
	March 1988		<15	40	<15
	June 1988		<20	30	<20
	October 1988		<20	40	<40
	February 1989		<20	31	<20
	April 1989		<20	49	<20
	July 1989		<30	36	<30
	October 1989		<10	34	<10
	January 1990		<15	64	<30

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
W-815-03	January 1988		<30	270	<30
	February 1988	a	20	220	<20
	March 1988		<15	275	<15
	June 1988		<20	190	<20
	October 1988		<20	190	<40
	February 1989		<20	156	<20
	April 1989		<20	246	<20
	July 1989		<30	178	<30
	October 1989		13	154	<10
	January 1990		<15	195	<30
W-815-04	February 1988	a	15	35	<20
	March 1988		<15	80	<15
	June 1988		<20	67	<20
	October 1988		<20	110	<40
	February 1989		<20	104	<20
	April 1989		<20	117	<20
	July 1989		<30	98	<30
	October 1989		<10	115	<10
	January 1990		<15	135	<30
W-815-05	July 1989		<20	<20	<20
	October 1989		<20	<20	<20
	January 1990		<15	<30	<30
W-817-01	April 1985		<20	37	<20
	November 1985		<20	30	<20
	March 1986		<30	20	<30
	June 1986		<10	50	<20
	July 1986		<20	54	<26
	October 1986		<30	40	<30
	February 1987		<20	60	<20
	April 1987		<20	45	<20
	August 1987		<30	44	<30
	September 1987	f	<20	55	<20
	September 1987	f	<20	55	<20
	October 1987		<20	40	<20
	January 1988		<10	20	<15
	April 1988	f	<20	<25	<20
	April 1988	ef	<20	25	<20
	July 1988		<20	<20	<20

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
	November 1988		<20	53	<40
	January 1989	g	30	62	<20
	January 1989	gh	27	62	<20
	January 1989	gh	30	62	<20
	January 1989	gh	27	62	<20
	April 1989	ef	<20	45	<20
	April 1989	fh	<20	45	<20
	July 1989		<20	20	<20
	October 1989		32	64	<30
	October 1989	h	37	80	<30
	November 1989		41	103	<30
	November 1989	h	40	105	<30
	January 1990		<15	83	<30
	January 1990	h	<15	83	<30
	January 1990	h	<15	86	<30
	January 1990	h	<15	104	<30
W-817-02	April 1985		<20	<20	<20
	November 1985		<20	<20	<20
	March 1986		<30	<30	<30
	June 1986		<10	<20	<20
	July 1986		<20	<30	<26
	October 1986		<30	<30	<30
	February 1987		<20	<20	<20
	April 1987		<20	<20	<20
	August 1987	f	<30	<30	<30
	August 1987	ef	<30	<30	<30
	October 1987		<20	<20	<20
	January 1988		<10	<15	<15
	April 1988		<20	<25	<20
	July 1988		<20	<20	<20
	November 1988		<20	<30	<40
	February 1989		<20	<20	<20
	February 1989	h	<20	<20	<20
	February 1989	h	<20	<20	<20
	February 1989	h	<20	<20	<20
	April 1989		<20	<20	<20
	July 1989	f	<20	<20	<20
	July 1989	ef	<20	<20	<20
	October 1989	f	<20	<30	<30
	October 1989	ef	<20	<30	<30
	October 1989	fh	<20	<30	<30

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
	October 1989	ef	<20	<30	<30
	November 1989	f	<20	<30	<30
	November 1989	ef	<20	<30	<30
	November 1989	fh	<20	<30	<30
	November 1989	ef	<20	<30	<30
	January 1990		<15	<30	<30
	January 1990	h	<15	<30	<30
	January 1990	h	<15	<30	<30
	January 1990	h	<15	<30	<30
W-817-03	April 1985		<20	<20	<20
	November 1985		<20	<20	<20
	March 1986		<30	<30	<30
	June 1986		<10	<20	<20
	July 1986		<20	<30	<26
	October 1986		<30	<30	<30
	February 1987		<20	<20	<20
	April 1987		<20	<20	<20
	August 1987		<30	<30	<30
	October 1987	f	<20	<20	<20
	October 1987	ef	<20	<20	<20
	January 1988		<10	<15	<15
	April 1988		<20	<25	<20
	July 1988		<20	<20	<20
	November 1988	f	<20	<30	<40
	November 1988	ef	<20	<30	<40
	February 1989		<20	<20	<20
	February 1989	h	<20	<20	<20
	February 1989	h	<20	<20	<20
	February 1989	h	<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<20	<20	<20
	October 1989		<20	<30	<30
	October 1989	h	<20	<30	<30
	November 1989		<20	<30	<30
	November 1989	h	<20	<30	<30
	January 1990	ef	<15	<30	<30
	January 1990	fh	<15	<30	<30
	January 1990	ef	<15	<30	<30
	January 1990	fh	<15	<30	<30
	January 1990	ef	<15	<30	<30
	January 1990	fh	<15	<30	<30

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
	January 1990	ef	<15	<30	<30
	January 1990	fh	<15	<30	<30
W-817-03A	April 1985		<20	<20	<20
	November 1985		<20	<20	<20
	March 1986		<30	<30	<30
	June 1986		<10	<20	<20
	October 1986		<30	<30	<30
	February 1987		<20	<20	<20
	April 1987		<20	<20	<20
	August 1987		<30	<30	<30
	October 1987		<20	<20	<20
	January 1988		<10	<15	<15
	April 1988		<20	<25	<20
	July 1988		<20	<20	<20
	November 1988		<20	<30	<40
	February 1989		<20	<20	<20
	February 1989	h	<20	<20	<20
	February 1989	h	<20	<20	<20
	February 1989	h	<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<20	<20	<20
	October 1989		<20	<30	<30
	January 1990		<15	<30	<30
W-817-04	April 1985		<20	<20	<20
	November 1985		<20	<20	<20
	March 1986		<30	<30	<30
	June 1986		<10	<20	<20
	July 1986		<20	<30	<26
	October 1986		<30	<30	<30
	February 1987		<20	<20	<20
	April 1987		<20	<20	<20
	August 1987		<30	<30	<30
	October 1987		<20	<20	<20
	January 1988	f	<10	<15	<15
	January 1988	ef	<10	<15	<15
	April 1988		<20	<25	<20
	July 1988	f	<20	<20	<20
	July 1988	ef	<20	<20	<20
	November 1988		<20	<30	<40

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
	February 1989	ef	<20	<20	<20
	February 1989	ef	<20	<20	<20
	February 1989	ef	<20	<20	<20
	February 1989	ef	<20	<20	<20
	February 1989	fh	<20	<20	<20
	February 1989	fh	<20	<20	<20
	February 1989	fh	<20	<20	<20
	February 1989	fh	<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<20	<20	<20
	October 1989		<20	<30	<30
	October 1989	h	<20	<30	<30
	November 1989		<20	<30	<30
	November 1989	h	<20	<30	<30
	January 1990		<15	<30	<30
	January 1990	h	<15	<30	<30
	January 1990	h	<15	<30	<30
	February 1990		<15	<30	<30
W-817-05	May 1988	a	<20	50	<20
	July 1988	b	<20	<20	<20
	July 1988	ch	<0.2	<0.2	<0.2
	July 1988	dh	<0.2	<0.2	<0.2
	October 1988		<20	<60	<40
	February 1989		<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<30	<30	<30
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
W-817-06A	May 1988		<20	<20	<20
	June 1988		<20	<20	<20
	October 1988		<20	<30	<40
	February 1989		<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<30	<30	<30
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
W-819-02	January 1987	f	<20	<20	<20

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
	January 1987	f	<20	<20	<20
	March 1987		<20	<20	<20
	May 1987		<20	<20	<20
	August 1987		<30	<30	<30
	October 1987		<20	<20	<20
	February 1988		<10	<15	<15
	April 1988		<20	<25	<20
	June 1988		<20	<20	<20
	July 1988		<20	<20	<20
	October 1988		<20	<30	<40
	February 1989		<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<30	<30	<30
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
W-829-08	May 1987		<20	<20	<20
	January 1988	f	<8	<20	<20
	January 1988	f	<8	<20	<20
	March 1988		<15	<20	<15
	June 1988		<20	<20	<20
	October 1988		<20	<30	<40
	February 1989		<20	<20	<20
	April 1989		<20	<20	<20
	July 1989		<30	<30	<30
	October 1989		<10	<10	<10
	January 1990		<15	<30	<30
SPRING 823	November 1987		<20	<20	<20
W-35C-02	December 1988		<20	<30	<40
W-6CD	July 1987		<25	<20	<25
	January 1988	f	<8	<20	<20
	January 1988	f	<8	<20	<20
	March 1988		<15	<20	<15
W-6CI	July 1987		<25	<20	<25

Table B-1. Ground water analyses for HE compounds (HMX, RDX, and TNT) reported by March 1990.

Well	Date	Notes *	HE compounds in ug/L (ppb)		
			HMX	RDX	TNT
	January 1988	f	<8	<20	<20
	January 1988	f	<8	<20	<20
	March 1988		<15	<20	<15

Notes:

- All analyses performed by HPLC Laboratory, LLNL.
- a Reported results are unreliable for this sample.
- b 40 ml sample analyzed using standard procedures.
- c 460 ml sample evaporated to dryness then analyzed.
- d 500 ml sample freeze-dried then analyzed.
- e Blind sample, sent to the lab without well identity.
- f Intralaboratory duplicate sample.
- g HMX identity suspect.
- h Replicate sample taken during this quarter.

Table B-2. Water analyses (ppm) for metals in ground water samples reported by March 31, 1990.

Installation Date Sampled	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium total	Chromium hexavalent
W-806-06A							
23-OCT-87	0.007	0.19	0.004	<0.0001	<0.0001	0.0025	-
03-DEC-87	-	0.21	-	-	-	-	-
29-JAN-88	<0.1	0.22	<0.1	<0.0001	<0.01	<0.02	-
06-MAY-88	<0.1	0.16	<0.1	<0.0001	0.0001	0.011	-
02-AUG-88	<0.1	0.19	0.1	0.0003	<0.0001	0.0019	-
24-OCT-88	-	-	-	-	-	-	-
W-809-01							
20-OCT-88	-	-	-	-	-	-	-
W-809-02							
20-OCT-88	-	-	-	-	-	-	-
W-809-03							
16-OCT-89	-	-	-	-	-	-	-
W-810-01							
21-OCT-88	-	-	-	-	-	-	-
W-815-01							
11-DEC-87	-	-	-	-	-	-	-
19-OCT-88	-	-	-	-	-	-	-
W-815-02							
11-DEC-87	-	-	-	-	-	-	-
20-OCT-88	-	-	-	-	-	-	-
W-815-03							
20-OCT-88	-	-	-	-	-	-	-
W-815-04							
20-OCT-88	-	-	-	-	-	-	-
W-815-05							
18-OCT-89	-	-	-	-	-	-	-
W-817-01							
24-APR-85	<0.1	0.06	<0.1	<0.01	<0.01	<0.02	<0.01
09-JUL-85	<0.1	0.07	<0.1	<0.01	<0.01	<0.02	-
22-NOV-85	<0.1	0.053	<0.1	<0.01	<0.01	<0.02	-
14-MAR-86	<0.1	0.06	<0.1	<0.01	<0.01	<0.02	-
09-JUN-86	<0.1	0.062	<0.1	<0.01	<0.01	<0.02	-
15-JUL-86	<0.1	0.062	<0.1	<0.01	<0.01	<0.02	-
15-OCT-86	<0.1	0.062	<0.1	<0.01	<0.01	<0.02	-
02-FEB-87	-	-	-	-	-	-	-
09-FEB-87	<0.1	0.052	0.1	<0.01	<0.01	0.0019	-
09-FEB-87	<0.1	0.0510	<0.1	<0.01	<0.01	0.0038	-
27-APR-87	<0.1	0.065	<0.1	<0.01	<0.01	<0.02	-
12-AUG-87	<0.1	0.048	<0.1	<0.01	<0.01	<0.02	-
06-OCT-87	<0.001	0.028	0.023	<0.0001	<0.0001	0.0003	-
16-NOV-87	-	-	-	-	-	-	-
13-JAN-88	<0.1	0.031	<0.1	<0.0001	<0.01	<0.02	-
13-APR-88	<0.1	0.031	<0.1	<0.0001	0.0005	0.0022	-
13-APR-88	<0.1	0.03	<0.1	<0.0001	0.0003	0.001	-
12-JUL-88	<0.1	0.042	<0.1	<0.0001	0.0001	0.0014	-
01-NOV-88	<0.06	0.045	<0.1	<0.0001	<0.04	<0.05	-
10-JAN-89	<0.1	0.047	<0.1	0.0002	0.0005	<0.02	-
10-JAN-89	-	-	-	-	-	-	-
17-APR-89	<0.1	-	<0.1	-	0.0007	-	-
17-APR-89	<0.1	-	<0.1	-	0.0006	-	-
17-APR-89	-	0.043	-	<0.0001	-	<0.02	-

Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Installation Zinc
0.0059	-	<0.001	0.02	<0.0001	0.021	0.032	0.0004	W-806-06A <0.01
0.05	0.12	<0.001	<0.01	<0.0001	<0.05	<0.001	<0.01	<0.01
<0.02	<0.03	0.002	<0.01	<0.0001	<0.05	0.031	<0.01	<0.01
<0.02	0.15	<0.001	<0.01	<0.0001	<0.05	0.033	<0.01	<0.01
<0.02	0.09	-	0.01	-	-	-	-	0.02
<0.08	0.4	-	0.07	-	-	-	-	W-809-01 0.03
<0.08	0.05	-	<0.04	-	-	-	-	W-809-02 <0.01
<0.08	0.19	-	<0.04	-	-	-	-	W-809-03 0.06
<0.02	<0.03	-	0.03	-	-	-	-	W-810-01 0.04
0.04	0.45	-	0.72	-	-	-	-	W-815-01 0.13
<0.08	<0.04	-	0.04	-	-	-	-	0.03
<0.02	0.36	-	<0.01	-	-	-	-	W-815-02 <0.01
<0.08	<0.04	-	0.04	-	-	-	-	0.02
<0.08	0.79	-	0.05	-	-	-	-	W-815-03 0.02
<0.08	<0.04	-	0.04	-	-	-	-	W-815-04 0.03
<0.08	1	-	0.05	-	-	-	-	W-815-05 0.03
-	-	<0.1	-	<0.0001	<0.02	0.043	<0.01	W-817-01 0.07
<0.01	-	<0.1	<0.01	<0.0001	<0.02	0.048	<0.01	0.1
<0.01	-	<0.001	0.01	<0.0001	<0.02	0.056	<0.01	0.05
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.039	<0.01	<0.01
<0.02	-	<0.1	0.01	<0.0001	<0.05	0.028	<0.01	<0.01
<0.02	-	<0.001	-	<0.0001	<0.05	0.007	<0.01	<0.01
0.03	-	<0.1	<0.01	0.0204	<0.05	0.0510	<0.01	0.06
<0.02	-	-	-	-	-	0.047	<0.01	-
<0.02	-	<0.001	<0.01	<0.0001	<0.05	-	-	<0.01
<0.02	-	0.001	<0.01	<0.0001	<0.05	-	-	<0.01
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.055	<0.01	<0.01
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.034	<0.01	0.01
0.0079	-	<0.001	<0.01	<0.0001	<0.001	0.037	0.0002	<0.01
0.0065	<0.03	-	<0.01	-	-	-	-	<0.01
<0.02	0.22	0.003	<0.01	<0.0001	<0.05	0.039	<0.01	<0.01
<0.02	0.07	0.004	<0.01	0.0003	<0.05	0.05	<0.01	0.25
<0.02	0.07	0.017	<0.01	0.0002	<0.05	0.047	<0.01	<0.01
<0.02	<0.03	<0.001	<0.01	<0.0001	<0.05	0.038	<0.01	<0.01
<0.02	<0.04	<0.001	0.05	<0.0001	<0.03	0.038	<0.02	<0.01
<0.08	0.12	0.008	0.04	<0.0001	<0.05	0.043	<0.02	0.09
-	-	0.011	-	-	-	-	-	-
<0.08	<0.04	-	<0.04	<0.0001	<0.05	-	-	<0.01
<0.08	<0.04	-	<0.04	<0.0001	<0.05	-	-	<0.01
-	-	0.005	-	-	-	0.043	<0.01	-

Table B-2. Water analyses (ppm) for metals in ground water samples reported by March 31, 1990.

Installation Date Sampled	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium total	Chromium hexavalent
17-APR-89	-	0.043	-	<0.0001	-	<0.02	-
26-JUL-89	-	0.047	-	<0.0001	-	<0.01	-
26-JUL-89	<0.1	-	<0.1	-	<0.01	-	-
23-OCT-89	<0.06	0.063	<0.05	<0.0005	<0.04	<0.005	-
30-OCT-89	-	0.072	-	<0.0005	-	<0.005	-
06-NOV-89	-	0.068	-	<0.0005	-	<0.005	-
13-NOV-89	-	0.064	-	<0.0005	-	<0.005	-
12-JAN-90	<0.06	0.062	<0.05	<0.0005	<0.04	<0.005	-
17-JAN-90	-	0.047	-	<0.0005	-	<0.005	-
24-JAN-90	-	0.048	-	<0.0005	-	<0.005	-
31-JAN-90	-	0.061	-	<0.0005	-	0.007	-
W-817-02							
24-APR-85	<0.1	0.033	<0.1	<0.01	<0.01	<0.02	<0.01
09-JUL-85	<0.1	0.0510	<0.1	<0.01	<0.01	<0.02	-
22-NOV-85	<0.1	0.026	<0.1	<0.01	<0.01	<0.02	-
18-MAR-86	<0.1	0.041	<0.1	<0.01	<0.01	<0.02	-
09-JUN-86	<0.1	0.047	<0.1	<0.01	<0.01	<0.02	-
15-JUL-86	<0.1	0.044	<0.1	<0.01	<0.01	<0.02	-
15-OCT-86	<0.1	0.044	<0.1	<0.01	<0.01	<0.02	-
02-FEB-87	<0.1	0.044	<0.1	<0.01	<0.01	<0.02	-
02-FEB-87	-	-	-	-	-	-	-
27-APR-87	<0.1	0.044	<0.1	<0.01	<0.01	<0.02	-
14-AUG-87	<0.1	0.041	<0.1	<0.01	<0.01	<0.02	-
14-AUG-87	<0.1	0.041	<0.1	<0.01	<0.01	<0.02	-
07-OCT-87	0.014	0.05	0.014	<0.0001	<0.0001	0.0004	-
07-OCT-87	-	-	-	-	-	0.0008	-
16-NOV-87	-	-	-	-	-	-	-
12-JAN-88	<0.1	0.031	<0.1	<0.0001	<0.01	<0.02	-
13-APR-88	<0.1	0.036	<0.1	<0.0001	0.0001	0.0007	-
12-JUL-88	<0.1	0.038	<0.1	<0.0001	0.0001	0.0015	-
02-NOV-88	-	-	-	-	-	-	-
03-NOV-88	0.5	0.035	<0.1	0.0002	0.0001	<0.02	-
06-FEB-89	<0.01	-	<0.1	-	<0.0001	<0.02	-
06-FEB-89	-	0.039	-	<0.0001	-	-	-
18-APR-89	<0.1	-	<0.1	-	0.0008	-	-
18-APR-89	-	0.044	-	<0.0001	-	<0.02	-
27-JUL-89	-	-	-	<0.0001	-	<0.01	-
27-JUL-89	-	-	-	<0.0001	-	<0.01	-
27-JUL-89	<0.1	-	<0.1	-	<0.01	-	-
27-JUL-89	<0.1	-	<0.1	-	<0.01	-	-
23-OCT-89	<0.06	0.059	<0.05	<0.0005	<0.04	<0.005	-
23-OCT-89	<0.06	0.059	<0.05	<0.0005	<0.04	<0.005	-
30-OCT-89	-	0.068	-	<0.0005	-	<0.005	-
30-OCT-89	-	0.069	-	<0.0005	-	<0.005	-
06-NOV-89	-	0.044	-	<0.0005	-	<0.005	-
06-NOV-89	-	0.056	-	<0.0005	-	<0.005	-
13-NOV-89	-	0.061	-	<0.0005	-	<0.005	-
12-JAN-90	<0.06	0.064	<0.05	<0.0005	<0.04	<0.005	-
18-JAN-90	-	0.047	-	<0.0005	-	<0.005	-
25-JAN-90	-	0.048	-	<0.0005	-	<0.005	-
31-JAN-90	-	0.056	-	<0.0005	-	0.006	-
W-817-03							
24-APR-85	<0.1	0.036	<0.1	<0.01	<0.01	<0.02	<0.01
09-JUL-85	<0.1	0.046	<0.1	<0.01	<0.01	<0.02	-
22-NOV-85	<0.1	0.028	<0.1	<0.01	<0.01	<0.02	-
14-MAR-86	<0.1	0.037	<0.1	<0.01	<0.01	<0.02	-
09-JUN-86	<0.1	0.041	<0.1	<0.01	<0.01	<0.02	-
15-JUL-86	<0.1	0.038	<0.1	<0.01	<0.01	<0.02	-
15-OCT-86	0.3	0.042	<0.1	<0.01	<0.01	<0.02	-
02-FEB-87	<0.1	0.036	<0.1	<0.01	<0.01	<0.02	-
02-FEB-87	-	-	-	-	-	-	-
27-APR-87	<0.1	0.041	<0.1	<0.01	<0.01	<0.02	-
12-AUG-87	<0.1	0.04	<0.1	<0.01	<0.01	<0.02	-
06-OCT-87	<0.001	0.024	0.012	<0.0001	<0.0001	0.0014	-
06-OCT-87	<0.001	0.023	0.012	<0.0001	<0.0001	0.0013	-
16-NOV-87	-	-	-	-	-	-	-
12-JAN-88	<0.1	0.032	<0.1	<0.0001	<0.01	<0.02	-
13-APR-88	<0.1	0.03	<0.1	<0.0001	0.0001	0.0023	-

Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Installation Zinc
-	-	0.006	-	-	-	0.045	<0.01	-
<0.01	<0.04	<0.001	<0.04	-	-	0.034	<0.01	0.03
-	-	-	-	<0.0001	<0.05	-	-	-
<0.08	<0.04	<0.002	<0.04	<0.0001	<0.03	0.026	<0.02	0.21
-	-	<0.002	-	-	-	0.022	<0.01	-
-	-	<0.002	-	-	-	0.032	<0.01	-
-	-	<0.002	-	-	-	0.034	<0.01	-
<0.08	<0.04	<0.002	<0.04	<0.0001	<0.03	0.029	<0.02	0.02
-	-	<0.002	-	-	-	0.031	<0.02	-
-	-	<0.002	-	-	-	0.033	<0.02	-
-	-	0.002	-	-	-	0.03	<0.02	-
W-817-02								
-	-	<0.1	-	<0.0001	<0.02	0.055	<0.01	0.32
<0.01	-	<0.1	<0.01	<0.0001	<0.02	0.057	<0.01	0.37
<0.01	-	<0.001	0.01	<0.0001	<0.02	0.089	<0.01	0.12
<0.02	-	<0.1	<0.01	<0.0001	<0.05	0.024	<0.01	0.14
<0.02	-	<0.1	0.01	<0.0001	<0.05	0.042	<0.01	0.12
<0.02	-	<0.001	-	<0.0001	<0.05	0.026	<0.01	0.06
0.02	-	<0.1	<0.01	<0.0001	<0.05	0.079	0.01	0.11
<0.02	-	<0.1	<0.01	<0.0001	<0.05	0.069	-	0.1
-	-	-	-	-	-	-	<0.01	-
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.074	<0.01	0.06
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.068	<0.01	0.05
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.07	<0.01	0.03
0.0078	-	<0.001	<0.01	<0.0001	<0.001	0.1	0.0005	<0.01
-	-	-	-	-	-	-	-	-
0.0078	<0.03	-	<0.01	-	-	-	-	<0.01
<0.02	<0.03	<0.001	<0.01	<0.0001	<0.05	0.08	<0.01	<0.01
<0.02	<0.03	0.005	<0.01	<0.0001	<0.05	0.091	<0.01	<0.01
<0.02	<0.03	0.002	<0.01	<0.0001	<0.05	0.081	<0.01	<0.01
<0.08	<0.04	-	<0.04	-	-	-	-	0.05
-	-	0.001	-	<0.0001	<0.05	0.077	<0.01	-
<0.08	<0.04	0.002	0.09	<0.0001	<0.05	-	-	1
-	-	<0.001	-	-	-	0.084	<0.01	-
<0.08	0.2	-	<0.04	<0.0001	<0.05	-	-	0.03
-	-	0.007	-	-	-	0.08	<0.01	-
-	-	<0.001	-	-	-	0.074	<0.01	-
-	-	<0.001	-	-	-	0.073	<0.01	-
<0.02	-	-	<0.04	<0.0001	<0.05	-	-	0.06
<0.02	-	-	<0.04	<0.0001	<0.05	-	-	0.12
0.12	<0.04	0.008	<0.04	<0.0001	<0.03	0.057	<0.02	0.09
<0.08	<0.04	0.005	<0.04	<0.0001	<0.03	0.075	<0.02	<0.01
-	-	<0.002	-	-	-	0.047	0.02	-
-	-	<0.002	-	-	-	0.045	<0.01	-
-	-	0.002	-	-	-	0.05	<0.01	-
-	-	<0.002	-	-	-	0.08	<0.01	-
-	-	<0.002	-	-	-	0.087	<0.01	-
<0.08	<0.04	<0.002	<0.04	<0.0001	<0.03	0.085	<0.02	<0.01
-	-	<0.002	-	-	-	0.078	0.0001	-
-	-	<0.002	-	-	-	0.1	<0.02	-
-	-	<0.002	-	-	-	0.089	<0.02	-
W-817-03								
-	-	<0.1	-	<0.0001	<0.02	0.012	<0.01	0.05
<0.01	-	<0.1	<0.01	<0.0001	<0.02	0.009	<0.01	0.11
<0.01	-	<0.001	<0.01	0.0001	<0.02	0.018	<0.01	0.03
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.013	<0.01	0.02
<0.02	-	<0.1	0.01	<0.0001	<0.05	<0.001	<0.01	0.02
<0.02	-	<0.001	-	<0.0001	<0.05	0.003	<0.01	<0.01
0.04	-	<0.1	<0.01	<0.0001	<0.05	0.02	<0.01	0.02
<0.02	-	<0.1	<0.01	<0.0001	<0.05	0.013	-	<0.01
-	-	-	-	-	-	-	<0.01	-
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.016	<0.01	<0.01
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.016	<0.01	<0.01
0.01	-	<0.001	<0.01	<0.0001	<0.001	0.017	0.0003	<0.01
0.0041	-	<0.001	<0.01	<0.0001	<0.001	0.017	0.0003	<0.01
0.0071	<0.03	-	<0.01	-	-	-	-	<0.01
<0.02	0.25	<0.001	<0.01	<0.0001	<0.05	0.018	<0.01	<0.01
<0.02	0.19	0.002	<0.01	0.0003	<0.05	0.023	<0.01	<0.01

Table B-2. Water analyses (ppm) for metals in ground water samples reported by March 31, 1990.

Installation Date Sampled	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium total	Chromium hexavalent
12-JUL-88	<0.1	0.031	<0.1	<0.0001	0.0001	0.0027	-
02-NOV-88	-	-	-	-	-	-	-
02-NOV-88	-	-	-	-	-	-	-
03-NOV-88	0.5	0.034	<0.1	0.0002	<0.0001	<0.02	-
03-NOV-88	0.5	0.033	<0.1	0.0001	0.0002	<0.02	-
06-FEB-89	<0.01	-	<0.1	-	0.0002	<0.02	-
06-FEB-89	-	0.033	-	<0.0001	-	-	-
17-APR-89	<0.1	-	<0.1	-	0.0012	-	-
17-APR-89	-	0.024	-	<0.0001	-	<0.02	-
26-JUL-89	-	0.043	-	<0.0001	-	<0.01	-
26-JUL-89	<0.1	-	<0.1	-	<0.01	-	-
24-OCT-89	<0.06	0.044	<0.05	<0.0005	<0.04	0.009	-
30-OCT-89	-	0.043	-	<0.0005	-	<0.005	-
06-NOV-89	-	0.048	-	<0.0005	-	<0.005	-
13-NOV-89	-	0.048	-	<0.0005	-	<0.005	-
12-JAN-90	<0.06	0.046	<0.05	<0.0005	<0.04	<0.005	-
12-JAN-90	<0.06	0.047	<0.05	<0.0005	<0.04	<0.005	-
17-JAN-90	-	0.044	-	<0.0005	-	<0.005	-
17-JAN-90	-	0.045	-	<0.0005	-	<0.005	-
24-JAN-90	-	0.04	-	<0.0005	-	0.006	-
24-JAN-90	-	0.042	-	<0.0005	-	0.006	-
31-JAN-90	-	0.052	-	<0.0005	-	<0.005	-
31-JAN-90	-	0.05	-	<0.0005	-	0.006	-
W-817-03A	-	-	-	-	-	-	-
16-NOV-87	-	-	-	-	-	-	-
W-817-04	-	-	-	-	-	-	-
24-APR-85	<0.1	0.04	<0.1	<0.01	<0.01	<0.02	<0.01
09-JUL-85	<0.1	0.027	<0.1	<0.01	<0.01	<0.02	-
22-NOV-85	<0.1	0.031	<0.1	<0.01	<0.01	<0.02	-
14-MAR-86	<0.1	0.039	<0.1	<0.01	<0.01	<0.02	-
09-JUN-86	<0.1	0.042	<0.1	<0.01	<0.01	<0.02	-
15-JUL-86	<0.1	0.042	<0.1	<0.01	<0.01	<0.02	-
15-OCT-86	<0.1	0.039	<0.1	<0.01	<0.01	<0.02	-
02-FEB-87	<0.1	0.04	<0.1	<0.01	<0.01	<0.02	-
02-FEB-87	-	-	-	-	-	-	-
27-APR-87	<0.1	0.045	<0.1	<0.01	<0.01	<0.02	-
12-AUG-87	<0.1	0.046	<0.1	<0.01	<0.01	<0.02	-
06-OCT-87	<0.001	0.028	0.01	<0.0001	<0.0001	0.0018	-
16-NOV-87	-	-	-	-	-	-	-
12-JAN-88	<0.1	0.031	<0.1	<0.0001	<0.01	<0.02	-
12-JAN-88	<0.1	0.036	<0.1	<0.0001	<0.01	<0.02	-
13-APR-88	<0.1	0.036	<0.1	<0.0001	0.0001	0.0049	-
12-JUL-88	<0.1	0.042	<0.1	<0.0001	<0.0001	0.0035	-
12-JUL-88	<0.1	0.041	<0.1	<0.0001	0.0001	0.0034	-
02-NOV-88	-	-	-	-	-	-	-
03-NOV-88	0.5	0.038	<0.1	0.0002	<0.0001	<0.02	-
06-FEB-89	<0.01	-	<0.1	-	<0.0001	<0.02	-
06-FEB-89	<0.01	-	<0.1	-	<0.0001	<0.02	-
06-FEB-89	-	0.042	-	<0.0001	-	-	-
06-FEB-89	-	0.04	-	<0.0001	-	-	-
18-APR-89	<0.1	-	<0.1	-	0.0005	-	-
18-APR-89	-	0.039	-	<0.0001	-	<0.02	-
27-JUL-89	-	0.056	-	<0.0001	-	<0.01	-
27-JUL-89	<0.1	-	<0.1	-	<0.01	-	-
23-OCT-89	<0.06	0.061	<0.05	<0.0005	<0.04	<0.005	-
30-OCT-89	-	0.0510	-	<0.0005	-	<0.005	-
06-NOV-89	-	0.056	-	<0.0005	-	<0.005	-
13-NOV-89	-	0.065	-	<0.0005	-	<0.005	-
12-JAN-90	<0.06	0.066	<0.05	<0.0005	<0.04	<0.005	-
18-JAN-90	-	0.05	-	<0.0005	-	<0.005	-
25-JAN-90	-	0.062	-	<0.0005	-	<0.005	-
01-FEB-90	-	0.058	-	<0.0005	-	<0.005	-
W-817-05	-	-	-	-	-	-	-
25-OCT-88	-	-	-	-	-	-	-

Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Installation Zinc
<0.02	<0.03	0.002	<0.01	<0.0001	<0.05	0.018	<0.01	<0.01
<0.08	<0.04	-	<0.04	-	-	-	-	0.03
<0.08	<0.04	-	<0.04	-	-	-	-	0.03
-	-	0.005	-	<0.0001	<0.05	0.016	<0.01	-
-	-	0.007	-	<0.0001	<0.05	0.018	<0.01	-
<0.08	<0.04	0.002	0.08	<0.0001	<0.05	-	-	1
-	-	0.002	-	-	-	0.019	<0.01	-
<0.08	<0.04	-	<0.04	<0.0001	<0.05	-	-	<0.01
-	-	0.004	-	-	-	0.013	<0.01	-
<0.01	<0.04	<0.001	<0.04	-	-	0.021	<0.01	<0.01
-	-	-	-	<0.0001	<0.05	-	-	-
<0.08	<0.04	0.008	<0.04	<0.0001	<0.03	0.02	<0.02	<0.01
-	-	<0.002	-	-	-	0.016	<0.01	-
-	-	<0.002	-	-	-	0.02	<0.01	-
-	-	<0.002	-	-	-	0.024	<0.01	-
<0.08	<0.04	<0.002	<0.04	<0.0001	<0.03	0.022	<0.02	<0.01
<0.08	<0.04	<0.002	<0.04	<0.0001	<0.03	0.022	<0.02	<0.01
-	-	<0.002	-	-	-	0.022	<0.02	-
-	-	<0.002	-	-	-	0.022	<0.02	-
-	-	<0.002	-	-	-	0.025	<0.02	-
-	-	0.017	-	-	-	0.024	<0.02	-
-	-	<0.002	-	-	-	0.023	<0.02	-
-	-	<0.002	-	-	-	0.022	<0.02	-
W-817-03A								
0.012	<0.03	-	<0.01	-	-	-	-	<0.01
W-817-04								
-	-	<0.1	-	<0.0001	<0.02	0.013	<0.01	0.01
<0.01	-	<0.1	<0.01	<0.0001	<0.02	0.012	<0.01	0.06
<0.01	-	<0.001	<0.01	<0.0001	<0.02	0.016	<0.01	0.03
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.012	<0.01	<0.01
<0.02	-	<0.1	0.01	<0.0001	<0.05	<0.001	<0.01	<0.01
<0.02	-	<0.001	-	<0.0001	<0.05	0.004	<0.01	<0.01
0.05	-	<0.1	<0.01	0.0001	<0.05	0.21	0.01	0.13
<0.02	-	<0.1	<0.01	<0.0001	<0.05	0.016	-	0.07
-	-	-	-	-	-	-	<0.01	-
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.021	<0.01	0.03
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.018	<0.01	0.03
0.0058	-	<0.001	<0.01	<0.0001	0.01	0.019	0.0004	<0.01
0.0061	<0.03	-	<0.01	-	-	-	-	<0.01
<0.02	<0.03	<0.001	<0.01	<0.0001	<0.05	0.019	<0.01	<0.01
<0.02	-	<0.001	<0.01	<0.0001	<0.05	0.017	<0.01	<0.01
<0.02	<0.03	0.012	<0.01	0.0003	<0.05	0.0206	<0.01	<0.01
<0.02	<0.03	0.002	<0.01	<0.0001	<0.05	0.019	<0.01	<0.01
<0.02	<0.03	0.001	<0.01	<0.0001	<0.05	0.019	<0.01	<0.01
<0.08	<0.04	-	<0.04	-	-	-	-	0.03
-	-	0.005	-	<0.0001	<0.05	0.016	<0.01	-
<0.08	<0.04	<0.001	0.09	<0.0001	<0.05	-	-	0.75
<0.08	<0.04	0.002	0.09	<0.0001	<0.05	-	-	0.16
-	-	<0.001	-	-	-	0.022	<0.01	-
-	-	<0.001	-	-	-	0.019	<0.01	-
<0.08	<0.04	-	<0.04	<0.0001	<0.05	-	-	<0.01
-	-	0.014	-	-	-	0.027	<0.01	-
<0.02	<0.04	<0.001	<0.04	-	-	0.019	<0.01	<0.01
<0.02	-	-	<0.04	<0.0001	<0.05	-	-	<0.01
<0.08	<0.04	<0.002	<0.04	<0.0001	<0.03	0.017	<0.02	<0.01
-	-	<0.002	-	-	-	0.015	<0.01	-
-	-	<0.002	-	-	-	0.02	<0.01	-
-	-	<0.002	-	-	-	0.023	<0.01	-
<0.08	<0.04	<0.002	<0.04	<0.0001	<0.03	0.019	<0.02	<0.01
-	-	<0.002	-	-	-	0.019	<0.0001	-
-	-	0.003	-	-	-	0.02	<0.02	-
-	-	<0.002	-	-	-	0.02	<0.02	-
W-817-05								
<0.02	0.13	-	<0.01	-	-	-	-	<0.01

Table B-2. Water analyses (ppm) for metals in ground water samples reported by March 31, 1990.

Installation Date Sampled	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium total	Chromium hexavalent
W-817-06A 20-OCT-88	-	-	-	-	-	-	-
W-819-02 13-OCT-87	<0.001	0.003	0.01	<0.0001	<0.0001	0.0001	-
02-FEB-88	<0.1	0.002	<0.1	<0.0001	<0.01	<0.02	-
13-APR-88	<0.1	0.002	<0.1	<0.0001	0.0001	0.0004	-
29-JUL-88	<0.1	<0.002	<0.1	<0.001	<0.0001	<0.0001	-
21-OCT-88	-	-	-	-	-	-	-
W-829-08 08-DEC-87	-	-	-	-	-	-	-
25-OCT-88	-	-	-	-	-	-	-
W-35C-02 12-JAN-89	-	-	-	-	-	-	-
09-FEB-89	-	<0.002	<0.5	-	<0.0001	0.003	-
10-FEB-89	-	-	-	-	-	-	-
W-6CD 11-NOV-88	-	-	-	-	-	-	-
W-6CI 11-NOV-88	-	-	-	-	-	-	-

Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Installation Zinc
<0.08	0.15	-	0.05	-	-	-	-	W-817-06A 0.02
0.0069	-	<0.001	0.01	0.0002	<0.001	<0.001	0.0006	W-819-02 <0.01
<0.02	0.17	<0.001	0.02	<0.0001	<0.05	<0.001	<0.01	<0.01
<0.02	<0.03	0.004	<0.01	0.0002	<0.05	<0.001	<0.01	<0.01
<0.02	<0.03	0.003	<0.01	<0.0001	<0.05	<0.001	<0.01	0.05
<0.02	<0.03	-	<0.01	-	-	-	-	<0.01
<0.02	1.5	-	0.02	-	-	-	-	W-829-08 <0.01
<0.02	0.15	-	<0.01	-	-	-	-	0.06
<0.02	0.05	-	0.18	-	-	-	-	W-35C-02 <0.01
-	-	0.01	-	<0.0001	-	<0.004	<0.0005	-
<0.02	1.3	-	0.06	-	-	-	-	0.07
<0.08	0.48	-	<0.04	-	-	-	-	W-6CD 0.05
<0.08	<0.04	-	0.04	-	-	-	-	W-6CI 0.07

Notes:

- Indicates no analysis performed for this compound.

Table B-3. Ground water analyses (ug/L) for volatile organic compounds reported by March 31, 1990.

Well		1,1	Total			1,1	1,2	1,1,1	Chloro-	Freon
Date	Notes*	DCE	1,2 DCE	TCE	PCE	DCA	DCA	TCA	form	113
W-806-06A										
10-FEB-87		<1	<1	<1	<1	<1	<1	<1	<1	-
22-MAY-87		<1	<1	<1	<1	<1	<1	<1	<1	-
30-JUN-87		<1	<1	<1	<1	<1	<1	<1	<1	-
18-AUG-87		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
18-AUG-87		<1	<1	<1	<1	<1	<1	<1	<1	-
23-OCT-87		<1	<1	<1	<1	<1	<1	<1	<1	-
29-JAN-88		<1	<1	<1	<1	<1	<1	<1	<1	-
06-MAY-88		<1	<1	<1	<1	<1	<1	<1	<1	-
23-JUN-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
02-AUG-88		<1	<1	<1	<1	<1	<1	<1	<1	-
24-OCT-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
19-OCT-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-809-01										
08-MAR-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
02-MAY-88		0.6	<0.5	1.6	<0.5	<0.5	<0.5	<0.5	2.7	<0.5
22-JUN-88		1.3	<0.5	2.4	<0.5	<0.5	<0.5	<0.5	2.9	<0.5
20-OCT-88		1.6	<0.5	3.3	<0.5	<0.5	<0.5	<0.5	3.5	<0.5
07-FEB-89		1.3	<0.5	3.6	<0.5	<0.5	<0.5	<0.5	3.6	<0.5
11-APR-89		0.9	<0.5	3.1	<0.5	<0.5	<0.5	<0.5	2.9	<0.5
12-JUL-89		1.4	<0.5	4.4	<0.5	<0.5	<0.5	<0.5	4.3	<0.5
18-OCT-89		<0.5	<0.5	4.3	<0.5	<0.5	<0.5	<0.5	3	<0.5
16-JAN-90		<0.5	<0.5	4.7	<0.5	<0.5	<0.5	<0.5	3.8	<0.5
W-809-02										
21-APR-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
22-JUN-88	n	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
20-OCT-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
07-FEB-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
10-APR-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JUL-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
18-OCT-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
16-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-809-03										
16-OCT-89		<1	<1	<1	<1	<1	<1	<1	<1	<1
16-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-810-01										
01-MAR-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
23-JUN-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.3	<0.5	<0.5
21-OCT-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
07-FEB-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
11-APR-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-JUL-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
19-OCT-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
18-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-814-01										
18-MAY-87		<0.5	1.3	1.2	<0.5	<0.5	0.7	<0.5	0.6	<0.5
24-SEP-87		<0.5	0.6	2	<0.5	<0.5	<0.5	<0.5	1.2	<0.5
11-DEC-87		<0.5	1.3	2.2	<0.5	<0.5	0.9	<0.5	0.5	1.8
10-MAR-88		<0.5	1.7	1.3	<0.5	<0.5	0.6	<0.5	1	<0.5
20-JUN-88		<0.5	1.2	1.5	<0.5	<0.5	0.5	<0.5	0.5	<0.5
13-APR-89		<0.5	1.5	2.3	<0.5	<0.5	0.8	<0.5	1.3	<0.5
19-JUL-89		<0.5	1.8	2.6	<0.5	<0.5	0.8	<0.5	1.5	<0.5
10-OCT-89		<0.5	0.5	1.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5
17-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-815-01										
23-APR-87	f	<2.5	<2.5	280	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
01-MAY-87	f	<5	<5	140	<5	<5	<5	<5	<5	<5
13-MAY-87	f	2.7	<1	130	<1	<1	<1	<1	1	<1

Table B-3. Ground water analyses (ug/L) for volatile organic compounds reported by March 31, 1990.

Well		1,1	Total			1,1	1,2	1,1,1	Chloro-	Freon
Date	Notes*	DCE	1,2 DCE	TCE	PCE	DCA	DCA	TCA	form	113
20-MAY-87	f	<2.5	<2.5	91	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
22-JUN-87		2	<1	69	<1	<1	<1	<1	<1	-
24-SEP-87		1	<1	120	<1	<1	<1	<1	1	-
11-DEC-87		1	<1	100	<1	<1	<1	<1	<1	-
17-MAR-88	f	1.8	<1	85	<1	<1	<1	<1	<1	<1
22-JUN-88		2.8	<0.5	71	<0.5	0.8	<0.5	<0.5	1.1	<0.5
19-OCT-88		3	<0.5	68	<0.5	0.9	<0.5	<0.5	1.4	<0.5
07-FEB-89	f	1.6	<1	130	<1	<1	<1	<1	1	<1
11-APR-89	f	2	<1	200	<1	<1	<1	<1	1.2	<1
13-JUL-89	f	1.7	<1	180	<1	<1	<1	<1	1.4	<1
17-OCT-89	f	<2	<2	220	<2	<2	<2	<2	<2	<2
11-JAN-90	g	<0.5	<0.5	170	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
11-JAN-90	bg	1.8	<0.4	130	<0.5	<0.4	<0.3	<0.5	1.1	<0.6
W-815-02										
01-MAY-87	f	<5	<5	<5	<5	<5	<5	<5	<5	<5
08-MAY-87		<0.5	<0.5	30	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-MAY-87	f	<2.5	<2.5	31	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
30-JUN-87		<1	<1	19	<1	<1	<1	<1	<1	-
24-SEP-87		<1	<1	24	<1	<1	<1	<1	<1	-
11-DEC-87		<1	<1	9	<1	<1	<1	<1	<1	-
09-MAR-88	h	<0.5	<0.5	18	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
09-MAR-88	eh	<0.5	<0.5	18	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
22-JUN-88		<0.5	<0.5	18	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-OCT-88		<0.5	<0.5	19	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
07-FEB-89		<0.5	<0.5	19	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
11-APR-89		<0.5	<0.5	16	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
11-JUL-89		<0.5	<0.5	11	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
16-OCT-89		<0.5	<0.5	16	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JAN-90		<0.5	<0.5	12	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-815-03										
15-JAN-88		2.3	<0.5	36	<0.5	0.7	<0.5	<0.5	0.9	<0.5
03-FEB-88		0.5	<0.5	1.5	<0.5	<0.5	<0.5	<0.5	0.7	<0.5
10-MAR-88		3.8	<0.5	7.5	<0.5	1.2	<0.5	<0.5	1.7	<0.5
23-JUN-88		3.1	<0.5	7.8	<0.5	0.9	<0.5	<0.5	1.2	<0.5
20-OCT-88		3.2	<0.5	14	<0.5	1.2	<0.5	<0.5	1.4	<0.5
06-FEB-89		2.4	<0.5	14	<0.5	1.2	<0.5	<0.5	1.3	<0.5
10-APR-89		2.6	<0.5	22	<0.5	1.1	<0.5	<0.5	1.3	<0.5
11-JUL-89		2.8	<0.5	14	<0.5	0.8	<0.5	<0.5	1	<0.5
17-OCT-89		<0.5	<0.5	32	<0.5	<0.5	<0.5	<0.5	0.7	<0.5
11-JAN-90		<0.5	<0.5	23	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-815-04										
02-FEB-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
10-MAR-88		<0.5	<0.5	1.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
22-JUN-88		<0.5	<0.5	1.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-OCT-88		0.6	<0.5	1.7	<0.5	<0.5	<0.5	<0.5	0.6	<0.5
06-FEB-89		0.7	<0.5	1.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
10-APR-89		0.5	<0.5	1.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
11-JUL-89		0.7	<0.5	1.4	0.5	<0.5	<0.5	0.5	<0.5	<0.5
16-OCT-89		<0.5	<0.5	1.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
11-JAN-90		<0.5	<0.5	1.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-815-05										
18-OCT-89		<1	<1	18	<1	<1	<1	<1	<1	<1
16-JAN-90		<0.5	<0.5	20	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-817-01										
27-APR-87		<1	<1	<1	<1	<1	<1	<1	<1	-
12-AUG-87		<1	<1	<1	<1	<1	<1	<1	<1	-
06-OCT-87		<1	<1	<1	<1	<1	<1	<1	<1	-
13-JAN-88		<1	<1	<1	<1	<1	<1	<1	<1	-
13-APR-88	h	<1	<1	<1	<1	<1	<1	<1	<1	-
13-APR-88	eh	<1	<1	<1	<1	<1	<1	<1	<1	-
12-JUL-88		<1	<1	<1	<1	<1	<1	<1	<1	-

Table B-3. Ground water analyses (ug/L) for volatile organic compounds reported by March 31, 1990.

Well			Total							
Date	Notes*	1,1 DCE	1,2 DCE	TCE	PCE	1,1 DCA	1,2 DCA	1,1,1 TCA	Chloro- form	Freon 113
01-NOV-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
10-JAN-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-APR-89	h	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-APR-89	eh	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
26-JUL-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8
23-OCT-89		<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-817-02										
27-APR-87		<1	<1	<1	<1	<1	<1	<1	<1	-
14-AUG-87	h	<1	<1	<1	<1	<1	<1	<1	<1	-
14-AUG-87	eh	<1	<1	<1	<1	<1	<1	<1	<1	-
07-OCT-87		<1	<1	<1	<1	<1	<1	<1	<1	-
12-JAN-88		<1	<1	<1	<1	<1	<1	<1	<1	-
13-APR-88		<1	<1	<1	<1	<1	<1	<1	<1	-
12-JUL-88		<1	<1	<1	<1	<1	<1	<1	<1	-
02-NOV-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
06-FEB-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
18-APR-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
27-JUL-89	h	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
27-JUL-89	eh	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
23-OCT-89	h	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
23-OCT-89	eh	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-817-03										
27-APR-87		<1	<1	23	<1	<1	<1	<1	<1	-
12-AUG-87		<1	<1	24	<1	<1	<1	<1	<1	-
06-OCT-87	h	<1	<1	20	<1	<1	<1	<1	<1	-
06-OCT-87	eh	<1	<1	21	<1	<1	<1	<1	<1	-
12-JAN-88		<1	<1	21	<1	<1	<1	<1	<1	-
13-APR-88		<1	<1	25	<1	<1	<1	<1	<1	-
12-JUL-88		<1	<1	26	<1	<1	<1	<1	<1	-
02-NOV-88	h	<0.5	<0.5	25	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
02-NOV-88	eh	<0.5	<0.5	24	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
06-FEB-89		<0.5	<0.5	26	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-APR-89		<0.5	<0.5	36	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
26-JUL-89		<0.5	<0.5	11	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
24-OCT-89		<0.5	-	24	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JAN-90		<0.5	<0.5	24	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JAN-90		<0.5	<0.5	22	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-817-03A										
27-APR-87		2	<1	150	<1	<1	<1	<1	<1	-
12-AUG-87		<1	1	110	<1	<1	<1	<1	<1	-
06-OCT-87		<1	<1	80	1	<1	<1	<1	<1	-
12-JAN-88		<1	<1	78	<1	<1	<1	<1	<1	-
13-APR-88		<1	<1	98	<1	<1	<1	<1	<1	-
12-JUL-88		<1	<1	94	<1	<1	<1	<1	<1	-
02-NOV-88		<0.5	<0.5	93	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
06-FEB-89		<0.5	0.7	49	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-APR-89		<0.5	0.9	77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
26-JUL-89		<0.5	1.2	43	<0.5	<0.5	<0.5	<0.5	0.6	<0.5
23-OCT-89		<0.5	-	81	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
11-JAN-90		<0.5	<0.5	64	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-817-04										
27-APR-87		<1	<1	13	<1	<1	<1	<1	<1	-
12-AUG-87		<1	<1	11	<1	<1	<1	<1	<1	-
06-OCT-87		<1	<1	12	1	<1	<1	<1	<1	-
12-JAN-88	h	<1	<1	10	<1	<1	<1	<1	<1	-
12-JAN-88	eh	<1	<1	10	<1	<1	<1	<1	<1	-
13-APR-88		<1	<1	14	<1	<1	<1	<1	<1	-
12-JUL-88	h	<1	<1	12	<1	<1	<1	<1	<1	-
12-JUL-88	eh	<1	<1	11	<1	<1	<1	<1	<1	-
02-NOV-88		<0.5	<0.5	12	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
06-FEB-89	h	<0.5	<0.5	12	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Table B-3. Ground water analyses (ug/L) for volatile organic compounds reported by March 31, 1990.

Well			Total							
Date	Notes*	1,1 DCE	1,2 DCE	TCE	PCE	1,1 DCA	1,2 DCA	1,1,1 TCA	Chloro- form	Freon 113
06-FEB-89	eh	<0.5	<0.5	15	<0.5	<0.5	<0.5	<0.5	0.8	<0.5
18-APR-89		<0.5	<0.5	12	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
27-JUL-89		<0.5	<0.5	2.5	<0.5	<0.5	<0.5	<0.5	2.8	<0.5
23-OCT-89		<0.5	-	11	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JAN-90		<0.5	<0.5	10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-817-05										
19-MAY-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
25-OCT-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
09-FEB-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-APR-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-JUL-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.3	<0.5	<0.5
26-OCT-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-817-06A										
08-JUN-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
24-JUN-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
20-OCT-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
10-FEB-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-APR-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
13-JUL-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
27-OCT-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
16-JAN-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-819-02										
19-DEC-86		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
06-APR-87		<1	<1	<1	<1	<1	<1	<1	<1	-
30-JUN-87		<1	<1	<1	<1	<1	<1	<1	<1	-
14-AUG-87		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-AUG-87		<1	<1	<1	<1	<1	<1	<1	<1	-
13-OCT-87		<1	<1	<1	<1	<1	<1	<1	<1	-
02-FEB-88		<1	<1	<1	<1	<1	<1	<1	<1	-
13-APR-88		<1	<1	<1	<1	<1	<1	<1	<1	-
24-JUN-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
29-JUL-88		<1	<1	<1	<1	<1	<1	<1	<1	-
21-OCT-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
10-FEB-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-APR-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
18-JUL-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
10-OCT-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
17-JAN-90		<0.5	<0.5	0.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-FEB-90	g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
14-FEB-90	bg	<0.2	<0.4	<0.3	<0.5	<0.4	<0.3	<0.5	<0.5	<0.6
W-829-08										
22-APR-87		<0.5	<0.5	5.2	<0.5	<0.5	<0.5	<0.5	<0.5	1.2
08-DEC-87		<1	<1	<1	<1	<1	<1	<1	<1	-
14-MAR-88		<0.5	<0.5	5.4	<0.5	<0.5	<0.5	<0.5	<0.5	0.9
27-JUN-88		<0.5	<0.5	2.1	<0.5	<0.5	<0.5	<0.5	<0.5	1.2
25-OCT-88		<0.5	<0.5	4.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
10-FEB-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-APR-89		<0.5	<0.5	3.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
13-JUL-89		<0.5	<0.5	5.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12-OCT-89		<0.5	<0.5	4.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
18-JAN-90		<0.5	<0.5	4.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SPRING 823										
23-OCT-87	f	<10	<10	<10	<10	<10	<10	<10	<10	-
16-NOV-87		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-6CD										
15-MAY-87		<1	<1	2.5	<1	<1	<1	<1	<1	<1
20-MAY-87		<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
23-JUN-87		<1	<1	<1	<1	<1	<1	<1	<1	-

Table B-3. Ground water analyses (ug/L) for volatile organic compounds reported by March 31, 1990.

Well	Date	Notes*	Total		TCE	PCE	1,1 DCA	1,2 DCA	1,1,1 TCA	Chloro- form	Freon 113
			1,1 DCE	1,2 DCE							
	24-SEP-87		<1	<1	<1	<1	<1	<1	<1	<1	-
	11-DEC-87		<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	10-MAR-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	28-JUN-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	11-NOV-88		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	14-FEB-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	02-MAY-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	07-JUL-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	27-OCT-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	21-FEB-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
W-6CI	09-MAR-87 f		<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	15-MAY-87		<0.5	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	20-MAY-87		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	23-JUN-87		<1	<1	<1	<1	<1	<1	<1	<1	-
	24-SEP-87		<1	<1	<1	<1	<1	<1	<1	<1	-
	11-DEC-87 f		<1	<1	<1	<1	<1	<1	<1	<1	<1
	10-MAR-88		<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	28-JUN-88		<0.5	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	11-NOV-88		<0.5	<0.5	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	14-FEB-89		<0.5	<0.5	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	02-MAY-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	07-JUL-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	27-OCT-89		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	21-FEB-90		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

- Indicates no analysis performed for this compound.

* Unless otherwise indicated, all analyses performed by Brown and Caldwell, Emeryville, Calif.

a Analysis performed by McKesson Environmental Services, Pleasanton, Calif.

b Analysis performed by Clayton Environmental Consultants, Pleasanton, Calif.
(formerly McKesson Environmental Services).

c Analysis performed by Central Coast Analytical Services, San Luis Obispo, Calif.

d Analysis performed by Brown and Caldwell, Pasadena, Calif.

e Blind sample, sent to lab without well identity.

f Sample dilution necessary for analysis, therefore detection limits increased.

g Interlaboratory duplicate sample.

h Intralaboratory duplicate sample.

i Sample of commercially bottled drinking water.

j Analysis performed by Hazards Control Lab, LLNL.

k Analysis performed by Eureka Laboratories Inc., Sacramento, Calif.

l Sample taken during hydraulic testing.

m Analytical results from this sample are suspect.

n Sample held longer than 14 days before analysis.

Table B-4. Ground water analyses for general minerals and water quality reported by March 31, 1990.

Well Date	Cations (mg/L)				Nitrate	Chloride	Anions* (mg/L)			TDS	Spec		pH
	Sodium	Potassium	Calcium	Magnesium			Sulfate	Carbonate	Bicarbonate		Cond		
W-806-06A													
23-OCT-87	-	-	-	-	-	-	-	-	-	-	1250	8.5	
29-JAN-88	320	8.9	11	2.7	19	160	220	<0.6	280	911	1580	7.8	
06-MAY-88	290	9.4	15	2.7	16	180	200	4.8	260	850	1450	8	
02-AUG-88	320	67	13	2.7	15	180	240	8.4	260	930	1480	8.1	
24-OCT-88	350	12	-	4.1	<0.4	180	230	9.6	270	930	1500	8.4	
W-809-01													
20-OCT-88	320	8	-	14	1.7	280	140	<0.6	330	980	2430	8	
W-809-02													
20-OCT-88	380	16	-	5.6	<0.4	300	210	19	270	1200	2170	8.6	
W-809-03													
16-OCT-89	290	12	-	23	62	230	230	<0.6	300	1000	1700	8.3	
W-810-01													
21-OCT-88	420	12	-	4.8	20	300	360	<0.6	290	1300	2210	7.8	
W-815-01													
11-DEC-87	190	8.5	-	45	71	174	120	<0.6	290	840	1330	7.9	
19-OCT-88	190	8.4	-	30	0.6	190	100	<0.6	290	840	2590	7.9	
W-815-02													
11-DEC-87	260	11	-	23	99	180	130	<0.6	300	940	1460	7.7	
20-OCT-88	210	12	-	32	<0.4	200	150	<0.6	280	880	1690	7.8	
W-815-03													
20-OCT-88	220	6.8	-	24	<0.4	180	130	<0.6	290	740	1540	8	
W-815-04													
20-OCT-88	230	11	-	27	<0.4	190	99	<0.6	280	810	1490	8	
W-815-05													
18-OCT-89	300	6.1	-	14	79	190	86	<0.6	350	800	1390	7.8	
W-817-01													
14-MAR-86	-	-	-	-	-	-	-	-	-	-	1540	-	
09-JUN-86	-	-	-	-	-	-	-	-	-	-	1460	-	
15-JUL-86	-	-	-	-	-	-	-	-	-	-	1400	-	
15-OCT-86	-	-	-	-	-	-	-	-	-	-	1480	-	

Table B-4. Ground water analyses for general minerals and water quality reported by March 31, 1990.

Well Date	Cations (mg/L)			Nitrate	Chloride	Anions* (mg/L)			Bicarbonate	TDS	Spec Cond	pH
	Sodium	Potassium	Calcium			Magnesium	Sulfate	Carbonate				
09-FEB-87	-	-	-	-	-	-	-	-	-	-	1294	-
09-FEB-87	-	-	-	-	-	-	-	-	-	-	1412	-
27-APR-87	-	-	-	-	-	-	-	-	-	-	1500	-
12-AUG-87	-	-	-	-	-	-	-	-	-	-	1452	-
06-OCT-87	-	-	-	-	-	-	-	-	-	-	1600	7.9
16-NOV-87	350	13	-	9.7	120	273	170	<0.6	320	1210	1820	8.1
13-JAN-88	390	12	29	9.5	120	250	180	<0.6	330	1200	2070	8.6
08-MAR-88	-	-	-	-	-	-	-	-	-	-	2040	-
08-MAR-88	-	-	-	-	-	-	-	-	-	-	2020	-
13-APR-88	360	11	29	8.6	48	320	200	<0.6	320	1300	1900	7.7
13-APR-88	350	9.9	30	7.5	48	310	210	<0.6	300	1300	2110	7.7
12-JUL-88	360	11	26	9.3	110	260	170	0.6	320	1200	1850	7.7
01-NOV-88	340	8.6	20	8.9	43	210	150	<0.6	300	1000	1620	8.1
10-JAN-89	310	10	22	8.9	88	210	160	7.2	290	930	1700	7.9
17-APR-89	330	18	22	8.9	110	250	160	9.6	290	1000	1700	7.7
17-APR-89	330	15	22	8.9	110	250	160	7.2	280	1100	1680	7.7
26-JUL-89	280	6.3	22	6.9	90	250	170	<0.6	320	1000	1700	7.9
23-OCT-89	280	9.4	16	6.5	79	200	140	<0.6	300	1000	1570	7.8
30-OCT-89	-	-	-	-	-	-	-	-	-	-	1380	8
06-NOV-89	-	-	-	-	-	-	-	-	-	-	1640	8.1
13-NOV-89	-	-	-	-	-	-	-	-	-	-	1410	7.9
12-JAN-90	270	9	-	6.4	79	170	120	<0.6	300	960	2270	8.3
17-JAN-90	-	-	-	-	-	-	-	-	-	-	1480	8.2
24-JAN-90	-	-	-	-	-	-	-	-	-	-	1450	8
31-JAN-90	-	-	-	-	-	-	-	-	-	-	1270	7.8
W-817-02												
18-MAR-86	-	-	-	-	-	-	-	-	-	-	2700	-
09-JUN-86	-	-	-	-	-	-	-	-	-	-	2610	-
15-JUL-86	-	-	-	-	-	-	-	-	-	-	2520	-
15-OCT-86	-	-	-	-	-	-	-	-	-	-	2730	-
02-FEB-87	-	-	-	-	-	-	-	-	-	-	2405	-
27-APR-87	-	-	-	-	-	-	-	-	-	-	2510	-
14-AUG-87	-	-	-	-	-	-	-	-	-	-	2674	-
14-AUG-87	-	-	-	-	-	-	-	-	-	-	2562	-
07-OCT-87	-	-	-	-	-	-	-	-	-	-	2300	7.7
07-OCT-87	420	-	-	-	-	-	-	-	-	-	-	-
16-NOV-87	420	15	-	22	100	292	490	<0.6	290	1630	2440	8.1
12-JAN-88	410	15	42	20	98	240	470	<0.6	290	1600	2510	7.8
13-APR-88	430	13	49	18	48	290	480	<0.6	280	1600	2470	7.8
12-JUL-88	440	14	46	20	92	300	420	0.6	330	1600	2530	7.5
02-NOV-88	440	13	42	23	45	300	500	<0.6	280	1500	2400	7.7
06-FEB-89	470	13	27	21	97	300	450	<0.6	290	1500	2360	7.7
18-APR-89	460	13	43	20	110	290	420	<0.6	270	2100	2380	7.6
27-JUL-89	-	-	-	-	-	-	-	-	-	-	2200	7.9
27-JUL-89	-	-	-	-	-	-	-	-	-	-	2190	7.9
23-OCT-89	400	14	35	16	84	300	440	<0.6	290	1600	2430	7.6
23-OCT-89	400	14	36	16	84	300	410	<0.6	290	840	1220	7.7
30-OCT-89	-	-	-	-	-	-	-	-	-	-	2290	7.9
30-OCT-89	-	-	-	-	-	-	-	-	-	-	2130	7.8

Table B-4. Ground water analyses for general minerals and water quality reported by March 31, 1990.

Well Date	Cations (mg/L)			Nitrate	Chloride	Anions* (mg/L)			TDS	Spec Cond pH	
	Sodium	Potassium	Calcium			Sulfate	Carbonate	Bicarbonate			
06-NOV-89	-	-	-	-	-	-	-	-	-	2320	8
06-NOV-89	-	-	-	-	-	-	-	-	-	2630	8
13-NOV-89	-	-	-	-	-	-	-	-	-	2210	7.9
12-JAN-90	390	12	-	84	305	370	<0.6	290	1500	2380	8.1
18-JAN-90	-	-	-	-	-	-	-	-	-	2300	7.6
25-JAN-90	-	-	-	-	-	-	-	-	-	2400	7.7
31-JAN-90	-	-	-	-	-	-	-	-	-	2250	7.9
W-817-03											
14-MAR-86	-	-	-	-	-	-	-	-	-	2230	-
09-JUN-86	-	-	-	-	-	-	-	-	-	2230	-
15-JUL-86	-	-	-	-	-	-	-	-	-	2130	-
15-OCT-86	-	-	-	-	-	-	-	-	-	2300	-
02-FEB-87	-	-	-	-	-	-	-	-	-	1981	-
27-APR-87	-	-	-	-	-	-	-	-	-	2210	-
12-AUG-87	-	-	-	-	-	-	-	-	-	2021	-
06-OCT-87	-	-	-	-	-	-	-	-	-	1950	7.9
06-OCT-87	-	-	-	-	-	-	-	-	-	1900	8
16-NOV-87	380	11	-	110	284	260	<0.6	320	1300	1870	8.1
12-JAN-88	380	12	28	110	240	270	<0.6	320	1300	2030	7.8
13-APR-88	360	10	28	47	260	280	<0.6	300	1300	2020	7.8
12-JUL-88	370	11	28	96	280	240	<0.6	300	1300	1950	7.7
02-NOV-88	380	11	43	48	260	300	<0.6	300	1200	2060	8
02-NOV-88	370	10	26	47	260	310	<0.6	300	1200	2070	8
06-FEB-89	390	11	26	100	260	260	<0.6	300	1100	2080	7.7
17-APR-89	370	37	26	110	280	240	<0.6	290	1200	1890	7.6
26-JUL-89	360	6.1	24	91	260	289	<0.6	300	1200	1950	7.9
24-OCT-89	340	15	23	35	230	250	<0.6	290	1200	1930	7.9
30-OCT-89	-	-	-	-	-	-	-	-	-	1710	7.7
06-NOV-89	-	-	-	-	-	-	-	-	-	2070	8.1
13-NOV-89	-	-	-	-	-	-	-	-	-	1850	7.9
12-JAN-90	360	11	-	84	250	240	<0.6	290	1100	1860	8.2
12-JAN-90	360	11	-	84	260	240	<0.6	290	1200	1860	8.2
17-JAN-90	-	-	-	-	-	-	-	-	-	1950	8
17-JAN-90	-	-	-	-	-	-	-	-	-	1940	8
24-JAN-90	-	-	-	-	-	-	-	-	-	1940	8
24-JAN-90	-	-	-	-	-	-	-	-	-	1940	8
31-JAN-90	-	-	-	-	-	-	-	-	-	1910	8
31-JAN-90	-	-	-	-	-	-	-	-	-	1760	8
W-817-03A											
16-NOV-87	330	5.7	-	120	328	34	<0.6	260	1000	1590	8.1
W-817-04											
14-MAR-86	-	-	-	-	-	-	-	-	-	2100	-
09-JUN-86	-	-	-	-	-	-	-	-	-	2150	-
15-JUL-86	-	-	-	-	-	-	-	-	-	2000	-
15-OCT-86	-	-	-	-	-	-	-	-	-	2130	-

Table B-4. Ground water analyses for general minerals and water quality reported by March 31, 1990.

Well Date	Cations (mg/L)			Nitrate	Chloride	Anions* (mg/L)			TDS	Spec Cond	pH
	Sodium	Potassium	Calcium	Magnesium		Carbonate	Sulfate	Bicarbonate			
02-FEB-87	-	-	-	-	-	-	-	-	-	1917	-
27-APR-87	-	-	-	-	-	-	-	-	-	2140	-
12-AUG-87	-	-	-	-	-	-	-	-	-	2017	-
06-OCT-87	-	-	-	-	-	-	-	-	-	1800	7.9
16-NOV-87	350	11	-	11	110	228	280	320	1290	1770	8.1
12-JAN-88	360	11	25	9.5	110	200	300	320	1200	2000	7.9
12-JAN-88	-	-	-	-	-	-	-	-	-	2000	8
13-APR-88	360	9.8	26	8.9	48	220	290	300	1200	2000	7.8
12-JUL-88	360	11	24	10	98	230	280	300	1200	2010	7.5
12-JUL-88	340	10	25	9.9	98	230	270	300	1200	1870	7.8
02-NOV-88	400	10	23	12	47	210	320	300	1200	1890	8.1
06-FEB-89	390	10	23	12	110	220	280	300	1200	1850	7.8
06-FEB-89	390	10	23	12	100	230	270	300	1200	1820	7.8
18-APR-89	380	12	23	11	120	92	330	270	1200	1920	7.8
27-JUL-89	260	5.4	23	7.4	89	240	270	290	1200	1800	8.1
23-OCT-89	380	12	20	9.3	88	230	300	290	1100	1990	7.7
30-OCT-89	-	-	-	-	-	-	-	-	-	1780	7.8
06-NOV-89	-	-	-	-	-	-	-	-	-	2080	8
13-NOV-89	-	-	-	-	-	-	-	-	-	1900	8.1
12-JAN-90	340	10	-	10	88	140	250	290	1200	1880	8.3
18-JAN-90	-	-	-	-	-	-	-	-	-	1850	7.8
25-JAN-90	-	-	-	-	-	-	-	-	-	1890	8
01-FEB-90	-	-	-	-	-	-	-	-	-	1890	8
W-817-05 25-OCT-88	280	8.9	-	3.6	<0.4	160	250	290	900	1540	8.4
W-817-06A 20-OCT-88	280	8.7	-	5.6	<0.4	180	82	330	820	1530	8.3
W-819-02 13-OCT-87	-	-	-	-	-	-	-	-	-	1850	8.4
02-FEB-88	380	15	27	4.2	0.7	190	430	280	1300	2130	7.8
13-APR-88	370	13	28	3.1	7.1	210	460	280	1300	1980	7.9
29-JUL-88	350	94	29	4.3	8.9	200	490	280	1300	2070	7.9
21-OCT-88	390	15	-	4.3	<0.4	210	440	290	1200	2050	8.3
W-829-08 08-DEC-87	510	23	-	67	170	460	320	530	1760	2860	7.7
25-OCT-88	480	22	-	53	1.5	400	330	540	1500	2810	7.6
W-35C-02 12-JAN-89	250	18	-	0.9	<0.4	70	180	240	780	1240	9
10-FEB-89	220	6.5	-	1	<0.4	72	190	240	730	1080	7.7

Table B-4. Ground water analyses for general minerals and water quality reported by March 31, 1990.

Well Date	Cations (mg/L)			Nitrate	Anions* (mg/L)			TDS	Spec Cond	pH
	Sodium	Potassium	Calcium		Chloride	Sulfate	Carbonate			
W-6CD 11-NOV-88	280	5	-	2.2	0.7	160	13	270	920	1400 8.4
W-6CI 11-NOV-88	310	5.7	-	2.5	<0.1	180	17	260	880	1440 8.4

* The carbonate anion concentration is calculated from the carbonate alkalinity determination reported by the analytical laboratory. The bicarbonate anion concentration is calculated from the bicarbonate alkalinity determination reported by the analytical laboratory. The bicarbonate calculation is reported with only two significant digits.

Appendix C

Well Logs

Appendix C.

Logs of wells drilled subsequent to July 1988 are included in this section; logs of wells drilled prior to this date are located in the following reports:

Lamarre, A. L., T. L. Phillips, and N. B. Crow (1989b), *Remedial Investigation of Dry Wells, Lawrence Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCID-21774).

Hoffman, F. (1990), *Remedial Investigation of Dry Wells, Lawrence Livermore National Laboratory Site 300*, personal communication to Michael J. Higgins, Regional Water Quality Control Board-Central Valley Region, January 29, 1990.

Toney, K. C., and N. B. Crow (1989), *Logs of Wells and Boreholes Drilled During Hydrogeologic Studies at Lawrence Livermore National Laboratory Site 300, June 1, 1982-June 30, 1988*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCID-21536).

Analytical Notes: No HE compounds were identified in soil samples from 143, 162.7, 203.3, 229.8, and 250.7 feet.

Drilling Method: 5.25-inch tricone bit, air-mist rotary, 0-38 feet
12-inch tricone bit, air-mist rotary, 0-38 feet; set 10-inch casing
5.25-inch tricone bit, air-mist rotary, 38-112 feet;
set 4.5-inch temporary casing
4.25-inch continuous wireline coring, air-mist rotary, 112-271.1 feet
9.825-inch tricone bit, air-mist rotary, 38-271.1 feet;
set 6-inch casing
4.25-inch continuous wireline coring, 271.1-542.5 feet
5.825-inch tricone bit, air-mist rotary, ream, 271.1-496.8 feet
4-inch I.D. PVC casing with 0.020-inch slots at 396.3-496.8 feet

Estimates of gravels, sands, and fines are field visual estimates.

Notation of Bedding and Fractures: [Depth(s)/dip(s)/comments]

NTONITE

CEMENT-CAL SEAL GROUT

FRACTURE ZONE

LOG: MONIT

Geologic Logging: L. Glick, Weiss Associates, Emeryville, CA
Well Location: West of the General Services Area, Site 300
Coordinates: N: 414,305.8, E: 1,708,690.6
Elevation (shiner): 571.72 feet
Drilling: G. Hickmon, P. C. Exploration, Inc., Roseville, CA
Dates Drilled: 11/29/88 to 2/6/89
Sampling Methods: Logged from outtings, 0-112 feet
Christensen Coring System, 112-542.5 feet
Ground Water: After sealing off 0-38 feet, water encountered at 85 feet
10/6/89, water at 60.34 feet
Geophysical Logging: Geo-Hydro Data, Inc., Tehachapi, CA
Recoveries and RQDs over 100% are assigned to the corresponding core run.
Recovery histograms show percent recovery and inferred recovery locations.
DA means drill ahead; NR means no recovery.

BLADDER PUMP	↓ HQ WIRELINE CORE RUN	IN
SUBMERSIBLE PUMP	■ ANALYTICAL SOIL SAMPLE	#1
WATER ENCOUNTERED	???? APPROXIMATE CONTACT	S/
STATIC WATER LEVEL	///// GRADATIONAL CONTACT	B/

J-35C-02 (CONTINUED)

Core Analytical soil samples
every Fractures
100 RGD

SITE
300

Lithology

Lithologic descriptions and/or remarks

red-brown, dry, 20% fine sand, and <5% clay below 54.3 feet

(55.1-58) SILTSTONE, gray-green, dry, poorly to moderately indurated, 10-15% clay, 5-10% very fine sand, low estimated permeability
slight reddish coloration below 56.5 feet

(58-71) CLAYSTONE, red-brown, dry to damp, poorly to moderately indurated, 10-15% silt, low estimated permeability

green, dry to damp, poorly indurated siltstone interbed with 10-15% fine sand at 63-64.2 feet

blue-green, dry to damp, poorly indurated, poorly sorted, silty sandstone interbed with 20% silt, 5-10% clay, and low estimated permeability at 65-66.4 feet

light gray siltstone interbed with 10-15% very fine sand, low to moderate estimated permeability at 68-68.8 feet

(71-73.6) SILTY CLAYSTONE, green-gray, dry to damp, moderately to well indurated, 15-25% silt, <5% very fine sand, low estimated permeability

(73.6-83.3) SANDY SILTSTONE, green-gray, dry to damp, poorly to moderately indurated, 15% very fine sand, 5% clay, low estimated permeability
5-10% clay below 76.5 feet

brown to amber (silica ?) pieces to 0.4 inch near 79 feet

blue-gray, damp, moderately to well indurated with 15% fine sand and a low to moderate estimated permeability at 83-83.3 feet

(83.3-85) SILTY SANDSTONE, blue-gray, damp, moderately to well indurated, very fine to fine grained, 20% silt, moderate estimated permeability

(85-87.7) SANDSTONE, blue-gray, moist to wet, moderately indurated, moderately sorted, medium grained, 10-15% silt, contains red clasts and white (silica ?) chips, moderate to high estimated permeability; Fractures suggested by easy drilling

first water encountered at 85 feet after sealing off 0-38 foot interval hole produces approximately 5 gpm at drilling depth 86.3 feet

(87.7-109.5) SILTY CLAYSTONE to CLAYSTONE, mottled red-brown and green-gray, poorly to moderately indurated, 20% silt, low estimated permeability
15% silt and 10-15% very fine sand below 89 feet

5-10% very fine sand below 94 feet
predominantly green-gray below 95 feet

<5% sand and 10-15% silt below 98 feet

5-10% very fine sand below 103 feet

predominantly red-brown and <5% sand below 106 feet

(109.5-114.1) SANDSTONE, gray to blue gray, moderately indurated, fine to medium grained, 5-10% silt, contains green mudstone rip-up clasts, moderate estimated permeability; upper contact from geophysics

(114.1-121.4) SILTSTONE, light gray, moderately indurated, <5% clay, possible red chert or volcanic clasts, low estimated permeability
[118.5/45°/healed fracture; 119.7/35°/attitude of contact]
mottled light green and light gray clayey siltstone at 117.7-118.8 feet
gray, fine grained silty sandstone with 20% silt and low to moderate estimated permeability at 118.8-119.7 feet

(121.4-124.4) SANDY SILTSTONE, medium gray, moderately indurated, 15% very fine sand, low estimated permeability
[fractures: 122.9 and 123/40°/healed, 124.2/45°, and 124.7-125/20°/partially open; irregular bedding and very mottled below 123.1 feet]

(124.4-126.5) CLAYEY SILTSTONE, mottled green-gray and pink-gray, moderately indurated, 15-25% clay, low estimated primary permeability, low to moderate estimated fracture permeability
light to medium gray, poorly to moderately indurated siltstone interbed with 5-10% very fine sand and minor cross-bedding at 126.1-126.5 feet

(126.5-129.9) SANDSTONE, blue-gray, moderately indurated, medium to coarse grained, <5% silt, bedding or cross-bedding dips 36-40°, moderate to high estimated permeability
mottled light to medium gray mudstone interbed at 129-129.6 feet

(129.9-132.9) SILTSTONE, mottled light and medium gray, moderately indurated, <5% very fine sand, low estimated permeability; sharp, subhorizontal, irregular upper contact

(132.9-138.3) SILTY SANDSTONE, medium gray, moderately indurated, very fine grained, 20-30% silt, subvertical zones of medium sand (filled burrows ?), moderate estimated permeability
light blue-gray siltstone interbed with 10-15% very fine sand and irregular 15-20° dip at 133.9-134.7 feet; poorly indurated rubbly (fracture ?) zone with 10-15% silt at 134.8-135.6 feet
[fractures: 134-134.5/25°/with pyrite and 137-137.3/subvertical/partially open]
sandy siltstone mottled with silty sandstone at 136.7-137 feet; medium grained with 5-10% silt at 137.4-137.6 feet

LOG: MONITOR WELL

LOG: MONITOR

WELL W-35C-02 (CONTINUED)

SITE
300

Depth		% Core recovery	Fractures	Analytical soil samples	Lithology	Lithologic descriptions and/or remarks
Station		0 100 RQD				
145						(138.3-145.4) Interbedded light gray SILTSTONE and medium gray SILTY SANDSTONE, poorly to moderately indurated, fine grained, laminated to medium bedded, cross-bedded, bedding dips 10°; low to moderate estimated permeability; dominantly sandstone at 138.9-139.4 feet; dominantly siltstone at 141-141.3 and 143.2-143.8 feet; dominantly silty sandstone at 142.9-143.2 and 143.8-144.1 feet; some green coloration in siltstone at 141.4 feet [fracture zone at 138.3-138.9 feet, 142-142.3/20°/fracture with pyrite; thin bedded with minor cross-beds at 143.2-143.8 feet]
150						(145.4-149.7) SILTSTONE, light gray, moderately indurated, 5-10% very fine sand, mottled, some voids, irregularly laminated, low estimated primary permeability, low to moderate estimated fracture permeability [subhorizontal silty sandstone interbeds at 145.7-145.9 feet randomly oriented fractures at 146.1-146.4 feet] medium grained sandstone interbeds with a moderate estimated primary permeability at 147.8-147.9, 148.1-148.4, and 148.8-149.7 feet [148.1/15°/closed fracture; 148.8-149.5/subhorizontal/fractures]
155						(149.7-152) CLAYEY SILTSTONE, light gray with green and purple hues, moderately indurated, 15% clay, <5% very fine sand, low estimated permeability [150.3-151/90°/closed fracture]
160						(152-170.4) SANDSTONE, dark gray, dries blue-gray, poorly to moderately indurated, moderately sorted, medium grained, <5% silt, moderate estimated permeability coarse grained and moderate to high estimated permeability at 152.3-152.5 feet [152.6-153.6/30° 45°/partially closed fracture; fracture zone at 154.4-155.2 feet; 161.2-161.7/mostly 45°/fractures throughout] fine to medium grained at 156.5-158.4 and below 160.7 feet; medium to coarse grained at 158.4-160.7 feet; very thin interbed with clayey siltstone clasts to 1.6 inches dip 10-15° at 161.1 feet; small mica flakes at 162-172 feet; thin to medium bedded, bedding dips 10° at 163 feet
165						brown mudstone lamination at 168.5 feet some thin green mudstone laminations below 170.1 feet
170						(170.4-180.2) CLAYSTONE, green and gray-red, poorly to moderately indurated, 5-10% silt, low estimated primary permeability, moderate estimated fracture permeability dark gray, moderately indurated, and 5-15% silt at 170.4-170.8 feet; mottled green and gray-red, moderately to well indurated and 20% silt at 170.8-171.1 feet; mottled green and purple-gray at 173-180.2 feet [fractures: 177.4 and 178.5-178.8/90°/with slickensides and 179.9-180.2/90°; 177-180.2/90° 45°, subhorizontal/many small fractures]
175						(180.2-182) SANDSTONE, medium to light gray, moderately indurated, medium grained, 5-10% silt, moderate estimated permeability poorly indurated silty sandstone interbed with 15-20% silt at 181.5-181.8 feet
180						(182-183.1) SILTY CLAYSTONE, green-gray, 15-20% silt, low estimated primary permeability, low to moderate estimated fracture permeability light gray siltstone interbed at 182.2-182.3 feet
185						(183.1-186.2) CLAYEY SILTSTONE, mottled green and light gray, poorly indurated, 20-25% clay, some minor fractures, low estimated primary permeability, moderate estimated fracture permeability 5-10% very fine sand at 185.2 feet; sand content increases below 185 feet
190						(186.2-189.8) SILTY SANDSTONE, light blue-gray, moderately indurated, 40-45% silt, low estimated permeability 15% silt at 187.2-187.5 feet; mottled, less indurated, 20-25% silt, and irregular bedding at 187.5-189.8 feet
195						(189.8-199.7) CLAYEY SILTSTONE, light gray, moderately indurated, 20-25% clay, slightly micaceous, low estimated permeability very fine grained silty sandstone interbed with 20-30% silt and low to moderate estimated permeability at 192.5-192.9 feet medium gray, fine to medium grained silty sandstone interbeds with 15-20% silt and a moderate estimated permeability at 193.7-194, 194.1-194.4, and 195.3-196.5 feet
200						5% very fine sand below 198.5 feet
205						(199.7-201.1) SILTY SANDSTONE, mottled light gray, moderately indurated, fine to medium grained, 15-20% silt, low to moderate estimated permeability
210						(201.1-203.1) CLAYEY SILTSTONE, green and purple-gray, moderately indurated, 30-40% clay, low estimated permeability
215						(203.1-205.1) SILTY SANDSTONE, green-gray, poorly to moderately indurated, fine grained, 15-40% silt, moderate estimated permeability dark green-gray, poorly indurated sandy siltstone interbed with 15-25% very fine sand, moderate estimated primary (and fracture ?) permeability at 203.1-203.5 feet
220						(205.1-213.2) CLAYEY SILTSTONE, green- and purple-gray, dry to damp, poorly to moderately indurated, 15-25% clay, thin wavy bedding, low estimated primary permeability, low to moderate estimated fracture permeability light to medium gray, moderately indurated, very fine to fine grained silty sandstone interbed with 15-20% silt, mica flakes, green mudstone clasts, and low to moderate porosity at 207.6-208.8 feet [fractures at 205.1-207.5 feet; possible fractures at 209.8-210.7 feet; driller indicates fractured material near 211 feet]
225						(213.2-219.1) SILTY SANDSTONE to SANDSTONE, blue-gray, moderately indurated, poorly sorted, very fine to fine grained, 20-25% silt, no apparent bedding, low estimated permeability fine to medium grained with 15-20% silt below 214.9 feet; 10-15% silt below 215.8 feet
						(219.1-222) SILTSTONE to SANDY SILTSTONE, black and red-brown, poorly to moderately indurated, low estimated primary permeability, moderate estimated fracture permeability light to medium gray, moderately indurated clayey siltstone interbed with 20-30% clay and a low estimated permeability at 219.1-219.4 feet; green and 15-25% very fine sand below 220.1 feet; 30-40% sand below 221 feet [fractures: 219.3/15° 219.4/10° 219.9/5°/open ? and 220.2/30°] fractures with slickensides: 220.4/20°, 220.9/30°, 221.1/5°, 20°, and 221.4/5°]

LOG: MONITOR WELL

J-35C-02 (CONTINUED)

Core Analytical soil samples

every Fractures

100 ROD

Lithology

Lithologic descriptions and/or remarks

SITE
300

90		(222-241.9) SILTY SANDSTONE and SANDSTONE, green-gray, drab, light gray-blue, moderately indurated, very fine to medium grained, 10-20% silt, micaceous, some worm tubes? low to moderate estimated primary and fracture permeability; mottled above 225.3 feet; possible conglomerate interbed at 225.3-225.5 feet; carbon material and random whitish mudstone? clasts near 225.3 feet; medium gray and 10% silt below 227 feet [fractures: 224.30°/partially open, 227.3-227.5/50°/closed, 227.7/5°, 228.5/45°/with slickensides, 229.7-229.9/90°, 233.5/30°/fracture with slickensides, and 236-237/90°/possible fractures; 238.6/10°/bedding] fine to medium grained below 231.1 feet; mostly fine grained sandstone with 10-20% silt and with pockets of less indurated sandstone below 232 feet greenish hue and thinly laminated at 235.4-235.6 feet; fairly well indurated near 235 feet; siltstone interbed at 236.8-236.9 feet; very fine to fine grained below 238.6 feet; moderately indurated below 240.3 feet; fine to medium grained below 240.5 feet
75		(241.9-243.9) SILTSTONE, mottled green, moderately indurated, 10-15% very fine to fine sand, low estimated permeability; upper contact dips 30° sandy siltstone interbed with 20-30% fine to very fine sand at 241.9-242.2 feet [fracture zone with slickensides at 243.7-243.9 feet]
125		(243.9-254.3) interbedded SANDSTONE, SANDY SILTSTONE, and SILTY SANDSTONE, green-gray, drab, blue-gray, poorly to moderately indurated, very fine to medium grained, <5% bitite flakes, moderate estimated permeability; upper contact dips 25-35° in fracture zone silty sandstone with 30-40% silt at 243.9-245.6 feet; sandy siltstone with 25-35% very fine to fine sand at 245.6-247.2 feet; fine to medium grained sandstone with 10-15% silt at 247.2-248.8 feet [249.3-249.7/80°/fracture; bedding dips 20° near 249.5 feet; 252.3-252.5/50°/fracture with slickensides] sandy siltstone with 15-25% very fine to fine sand at 249.1-249.9 feet; medium to coarse grained sandstone with 5% silt at 249.9-252.2 feet; moderate to high estimated permeability near 250.2 feet; fine to medium grained at 250.4-250.5 feet; moderately indurated sandy siltstone with 20-30% fine sand, low to moderate estimated permeability at 252.2-254.1 feet; fine to medium grained sandstone at 254.1-254.3 feet
92		(254.3-255.6) SILTSTONE, green-gray, moderately indurated, 5-10% very fine sand, minor claystone clasts to 0.08 inch, low estimated permeability sandy siltstone interbed with 15% fine sand at 255.1-255.6 feet
53		(255.6-261.6) SANDSTONE, blue-gray, moderately indurated, poorly sorted, fine to medium grained, 5-10% silt, moderate estimated permeability green-gray, moderately indurated, sandy siltstone interbed with 25% fine sand at 257.5-258.2 feet; subhorizontal interlayered fine to medium grained sandstone beds at 258.8-261.1 feet; medium grained with <5% silt below 261.1 feet
no record		(261.6-265.1) CLAYEY SILTSTONE, green and gray-green, poorly to moderately indurated, 15% clay, <5% very fine sand, low estimated primary permeability, low to moderate? estimated fracture permeability [closed fractures: 263.2/70° and 263.9/50°]
57		(265.1-270.6) CLAYSTONE, red, green, and marbled red and green, moderately indurated, finely disseminated mica flakes, low estimated permeability purple-red/maroon below 267.4 feet [fractures: 268.6-268.8/25° and 269.8-270.3/25°]
77		(270.6-279) CLAYEY SILTSTONE, green and gray-green, moderately indurated, friable, 15% clay, low estimated primary permeability, low to moderate? estimated fracture permeability [fractures: 272.4/30°/with slickensides and 278.9/45°/fracture possible water-producing bubbly fracture zone at 274.5-277 feet] 10% fine sand at 274.6-274.8 feet; 10-20% clay at 274.5-277 feet
134		(279-280.5) SANDY SILTSTONE, mottled gray and green, moderately indurated, fine sand content increases downward from 10% to 45%, low estimated permeability
55		(280.5-286.1) SILTY SANDSTONE, medium gray, moderately indurated, moderately to poorly sorted, fine grained, 20-30% silt, micaceous, low to moderate estimated permeability [fractures: 282-283.6/85°/closed, 282.5-282.8/65°, and 284.8/45°] 3 gpm estimated production at drilling depth 282 feet; interlayered fine to medium grained silty sandstone at 282-286.1 feet
93		(286.1-293.1) SANDSTONE as at 280.5-286.1 feet, except: medium to coarse grained, 5-10% silt, and a moderate estimated permeability [288.3/45°/fracture] sparse white (carbonate?) filled voids to 0.4 inch at 288.9-289.3 feet; sandy siltstone interbed with 15-20% fine sand and a low to moderate estimated permeability at 292.7-293.1 feet
35		(293.1-295) CLAYEY SILTSTONE, light gray, moderately indurated, 20% clay, low estimated permeability fine to medium grained and cross-bedded sandstone interbed at 294.3-294.4 feet; sandy siltstone interbed with 20-30% sand at 294.4-295 feet
100		(295-303.3) SILTY SANDSTONE, medium gray, drab, light blue-gray, moderately indurated, very fine to fine grained, 15-20% silt, low to moderate estimated primary permeability, moderate estimated fracture permeability [fracture zone at 295.8-296.3 feet; 296.4-296.7/90°/fracture] green and purple-gray siltstone interbeds with wavy laminations at 297.9-298.1, 298.7-300.1, and 300.2-300.4 feet; medium to coarse grained at 298.1-298.2 and below 301.3 feet; medium grained at 298.2-298.7 and 300.4-301.4 feet
29		(303.3-304.8) CONGLOMERATE, well rounded volcanic pebbles to 0.8 inch, low estimated permeability
72		(304.8-310.9) SANDSTONE, medium gray, moderately indurated, medium to coarse grained, 10-15% silt, 3% black pebbles to 0.4 inch, moderate estimated permeability silty sandstone interbed with 40% silt at 305.5-306.4 feet; water flows from hole at drilling depth 307 feet; very fine to fine grained with 5% silt at 309.2 feet; very fine grained and cross-bedded at 310.3-310.6 feet [307.8-307.9/45°/closed fracture; intensely fractured at 308.4-308.9 feet; silt filled (burrow/fracture?) at 310.7-310.9 feet]
92		(310.9-312.4) SILTSTONE, purple- and green-gray, moderately indurated, 5% very fine sand, minor laminations, low estimated permeability
80		
40		
35		

WELL W-35C-02 (CONTINUED)

Depth		% Core recovery	Analytical soil samples Fractures	Lithology	Lithologic descriptions and/or remarks
315		35			(312.4-316.4) SANDSTONE, medium gray, poorly to moderately indurated, very fine to medium grained, 5-10% silt, thinly bedded, cross-bedded, moderate estimated permeability mostly medium grained below 313.4 feet; purple-gray siltstone interbed at 314.3-315.1 feet; very fine to fine grained silty sandstone interbed with 25% silt and a low to moderate estimated permeability at 315.1-316.4 feet
320		68			(316.4-322.3) SILTSTONE, purple-gray, occasional green-gray layers, moderately indurated, <10% fine sand, low estimated permeability local sandy siltstone interbeds with 15-40% very fine to fine sand at 317-318.4 feet; poorly indurated, fine to medium grained silty sandstone at 318.4-318.9 feet; interbedded silty sandstone and siltstone at 318.9-320.1 feet; medium grained sandstone interbed at 320.1-320.2 and 321.8-321.9 feet; up to 20% very fine sand in siltstone below 320.2 feet
325		50			(322.3-324.3) SANDSTONE, medium gray, moderately indurated, fine to medium grained, 5-15% silt, minor interbeds of green-gray cross-bedded siltstone to 1.2 inches thick, moderate estimated permeability
330		36			(324.3-326.1) SILTY SANDSTONE, light to medium gray, moderately indurated, fine to medium grained, 20-40% silt, abundant carbon material, low estimated permeability moderate estimated permeability at 325-325.5 feet
335		92			(326.1-327) SILTY CLAYSTONE, purple-gray, moderately indurated, 15-25% silt, some carbon material, low estimated permeability
340		60			(327-329.4) SILTY SANDSTONE, light gray, moderately indurated, very fine grained, 35-40% silt, some fine sand, rare organic material, low estimated permeability silty claystone interbed at 329-329.3 feet; very well indurated gray-red claystone with silica ? pods at 329.3-329.4 feet
345		28			(329.4-330.9) CLAYEY SILTSTONE, light gray, moderately indurated, 20-25% clay, low estimated permeability
350		75			(330.9-334.3) SANDSTONE, medium gray, moderately indurated, fine to medium grained, 5-10% silt, low estimated permeability siltstone interbed at 331.5-331.6 feet; moderately well to very well indurated silty sandstone with 35% silt at 332.9 and 333.7-334.3 feet [333.5-333.8/90° fracture with pyrite]
355		82			(334.3-336.4) CLAYEY SILTSTONE, purple- and green-gray, moderately to well indurated, 15% clay, 10-15% silt, thinly laminated, low estimated permeability fine to medium grained sandstone interbed with 10-15% silt at 334.8-335.3 feet; minor pyrite and cross-bedding at 336.9-338.9 feet
360		90			(336.4-338.9) SANDSTONE, medium gray, moderately indurated grained, 10-15% silt, moderate estimated permeability
365		42			(338.9-344.7) CLAYEY SILTSTONE, light gray, moderately indurated, 30% clay, minor organic material, wavy laminations, low estimated permeability
370		80			(344.7-353.6) MUDSTONE, light gray, moderately to well indurated, 40-45% silt, stem and pod fossils, low estimated permeability poorly to moderately indurated, friable, abundant organic material at 345.6-346.2 feet; reddish and purple-gray at 347 feet; 10-15% very fine to fine sand at 347.4-347.8 feet [subhorizontal thin laminations and minor soft sediment deformation near 348 feet; (carbonate ?) filled fractures: 348/20°, 348.2/5°, and 348.4/10°; 349.2-349.3/85° fracture with slickensides] organic layer at 351.5 feet; green-gray claystone interbed with 15% fine sand at 351.7-351.8 feet; 20-25% sand below 353.2 feet
375		50			(353.6-363) SILTY SANDSTONE, blue-gray to medium gray, well to moderately indurated, medium grained, 20-30% silt, abundant claystone clasts to 1.2 inches, common organic material, low estimated permeability 35-40% silt at 356.2-356.8, 15-25% silt below 356.8 feet [357.2/10° medium bedded; 361.7/subhorizontal (desiccation ?) fracture filled with (carbonate ?)]
380		42			(363-366.2) SILTY CLAYSTONE, purple- to brown-gray, moderately indurated, 15-20% silt, low estimated permeability; plant fossils at upper contact green silty claystone below 363.7 feet bright light green, soft claystone interbed at 365.2-365.3 feet [fracture zone at 364.7-365.5 feet; fracture zone with slickensides and 15% fine sand at 365.5-366.2 feet]
385		80			(366.2-367.3) SILTY SANDSTONE, green-gray, poorly to moderately indurated, poorly sorted, 35-40% silt, low estimated permeability
390		67			(367.3-373.8) SILTY CLAYSTONE, green, poorly indurated, moderate estimated primary and fracture permeability 15-20% silt at 367.3-368.8 feet; light green, very soft claystone interbed at 368.8-370.7 feet [fracture zone at 372.2-372.4 feet]
395		100			(373.8-379.7) SILTY SANDSTONE, green-gray, moderately indurated, fine grained, 30-45% silt, low estimated permeability [374.3-374.5/45° mudstone filled (desiccation ?) fracture] light to medium gray, moderately indurated clayey siltstone interbed with 20% clay at 377.2-378.3 feet
400		57			(379.7-381.9) SILTY CLAYSTONE, red-gray, some green-gray, moderately indurated, 25% silt, irregularly shaped laminations, low estimated permeability green-gray, fine grained silty sandstone at 378.3 feet [380.1/10-15° white (carbonate ?) veins] clayey siltstone interbed with up to 15% fine sand at 381.1-381.7 feet
405		85			(381.9-384.9) interbedded CLAYSTONE, SILTSTONE, and SILTY SANDSTONE, low estimated permeability clayey siltstone at 382.2-382.3 feet; fine grained silty sandstone at 381.9-382.2, 382.3-383.1 and 384.3-384.5 feet; silty claystone at 383.1-383.4 and 384.5-384.8 feet; siltstone at 383.4-384.3 feet; sandy siltstone at 384.8-384.9 feet
410		65			(384.9-386.1) SILTY SANDSTONE, medium gray, moderately indurated, 15-20% silt, low to moderate estimated permeability silty claystone interbed at 385.9-386.1 feet
415		65			(386.1-387.8) SILTY SANDSTONE, light gray, dry to damp, moderately indurated, very fine grained, 15-20% silt, 0-15% clay, thinly bedded, minor cross-bedding, low estimated permeability very fine to fine grained and no clay below 387.4 feet

LOG: MONITOR

LOG: MONITOR WELL

W-35C-02 (CONTINUED)

Core Analytical soil samples

Every Fractures

100 RQD

Lithology

Lithologic descriptions and/or remarks

SITE
300

	0		(387.6-390) SILTSTONE, light to medium gray, dry to damp, moderately indurated, low estimated permeability; claystone interbed at 389.6-390 feet
	0		(390-394.2) CLAYEY SILTSTONE, purple-gray and medium gray, 15-20% clay, low estimated permeability; greenish, no clay, and 0-15% fine sand below 392.2 feet
	0		(394.2-396.4) SILTY SANDSTONE, light gray, moderately indurated, poorly sorted, fine to medium grained, 20% silt, moderate estimated permeability
NR	0		(396.4-416.5) SANDSTONE, dark gray, dries blue-gray, poorly to moderately indurated, poorly sorted, medium to coarse grained, 5-10% silt, minor biotite flakes, moderate to high estimated permeability; hole produces approximately 15 gpm at drilling depth 397 feet; much core washed away at 397-420 feet; hole produces approximately 25 gpm at drilling depth 402 feet
	20		
	60		(416.5-419.5) SILTY SANDSTONE, brown-gray, poorly to moderately indurated, very fine grained, 35-45% silt, volcanic clasts to 0.6 inch, moderate estimated permeability; irregular cemented upper contact; contacts from geophysics
	0		medium gray, moderately indurated siltstone interbed with <15% very fine sand at 418.9-419.5 feet
	38		(419.5-490.6) SANDSTONE, local silty sandstone, medium gray, moderately well to poorly indurated, medium to coarse grained, 5-20% silt, moderate to high estimated permeability
	10		poorly to moderately indurated silty sandstone with 15-20% silt at 423.3-423.7 feet; medium grained, normally graded silty sandstone with 15-20% silt at 424.2-425.1 feet; medium grained silty sandstone with 20-30% silt at 425.6-426.4 feet
	10		coarse grained, poorly indurated, and 5-10% silt below 426.4 feet; well indurated and medium grained below 428.6 feet; much core washed away at 427-432, 437-447, and 452-491 feet
	78		poorly indurated, medium to coarse grained, and 5-10% silt below 432 feet
NR	0		medium grained silty sandstone with 15-20% silt at 436.1-436.2 feet
	54		
NR	0		
	65		
NR	0		[(carbonate ?) filled fractures: 445/45°, 445/0°, and 445.2/10°] well indurated with (carbonate ?) cement at 444.8-445.2 feet
NR	0		

LOG: MONITOR

WELL W-35C-02 (CONTINUED)

SITE
300

II Section	Depth	% Core recovery	Fractures RQD	Analytical soil samples	Lithology	Lithologic descriptions and/or remarks
	475		0			
	480		NR			
	485		44			rare pebbles to 1.2 inches at 489.3 Feet; subangular volcanic clasts to 0.2 inch at 489.8 Feet; silty sandstone with 30% silt at 490.4-490.6 Feet
	490		68			(490.6-492.6) SANDY SILTSTONE, green-gray, moderately indurated, 15-20% fine sand, 5-10% clay, micaceous, low estimated permeability
	495		102			(492.6-494) SILTY SANDSTONE, medium gray, moderately indurated, moderately well sorted, very fine to fine grained, 30-35% silt, low to moderate estimated permeability
	500		100			(494-496.4) CLAYEY SILTSTONE, gray, moderately indurated, 15-20% clay, 15% very fine sand, low estimated permeability
	505		90			(496.4-498.2) SANDSTONE, medium gray, dries blue-gray, moderately indurated, fine grained, 5-10% silt, massive, moderate estimated permeability
	510		48			poorly indurated and medium grained below 496.8 Feet fracture zone at 496.9-498.2 Feet
	515		82			(498.2-499.2) SANDY SILTSTONE, medium gray, moderately indurated, 30-40% very fine sand, minor pyrite, low estimated permeability
	520		78			(499.2-500.7) SILTY SANDSTONE, medium gray, moderately indurated, very fine to fine grained, 30-40% silt, low to moderate estimated permeability
	525		51			(500.7-503.9) SILTSTONE, light gray, moderately indurated, low estimated permeability; upper contact dips 30°
	530		119			(503.9-515.6) SANDSTONE, gray, dries blue-gray, moderately to moderately well indurated, medium grained, 5-10% silt, moderate estimated permeability
	535		75			moderately indurated, medium to coarse grained, and moderate to high estimated permeability below 506.1 Feet gray siltstone interbeds at 508.2-509.1 and 514.4-515.1 Feet
	540		83			fine to medium grained at 515.1-515.6 Feet
	545					(515.6-517.3) CLAYEY SILTSTONE, gray to brown-gray, moderately indurated, 15% clay, low estimated permeability
						(517.3-519.3) SILTY SANDSTONE, medium gray, moderately indurated, fine grained, 35-45% silt, low to moderate estimated permeability
						(519.3-521.5) CLAYEY SILTSTONE, gray, moderately indurated, 15% clay, minor rip-up clasts, low estimated permeability; irregular upper contact dips 65°
						(521.5-524.3) SILTY SANDSTONE, medium gray, moderately indurated, moderately to well sorted, fine grained, 35-45% silt, low to moderate estimated permeability
						sandy siltstone interbed at 522.5-523 Feet; poorly to moderately indurated, fine to medium grained, and 15% silt below 523 Feet
						(524.3-526.2) SANDY SILTSTONE, medium gray, moderately indurated, 25-35% fine sand, moderate estimated permeability
						(526.2-527.2) SILTY SANDSTONE, medium gray, moderately indurated, fine grained, 15-20% silt, moderate estimated permeability
						(527.2-529.2) CLAYEY SILTSTONE, light gray, moderately indurated, 15% clay, low estimated permeability
						(529.2-530.4) CLAYSTONE, gray, poorly to moderately indurated, low estimated permeability
						(530.4-534.7) SILTSTONE, purple-gray, moderately to moderately well indurated, local interbeds with rip-up clasts and green-gray mottling, low estimated permeability
						(534.7-537.7) CLAYEY SANDSTONE, gray, moderately well indurated, very fine to fine grained, 15% clay, low estimated permeability
						(537.7-538.7) SILTSTONE, light gray to brown-gray, 10-15% clay, low estimated permeability
						(538.7-539.9) SILTY CLAYSTONE, gray, 25% silt, low estimated permeability
						clayey siltstone interbed at 539.7-539.9 Feet
						(539.9-541.6) SANDY SILTSTONE, gray, moderately indurated, 40% fine sand, low estimated permeability
						(541.6-542.5) SILTY SANDSTONE, gray, moderately indurated, fine grained, 35% silt, low to moderate estimated permeability
						TD = 542.5'

LOG: MONITOR WELL

Geologic Logging: L. Gillock, Weiss Associates, Emeryville, CA

Well Location: West of the General Services Area, Site 300

Coordinates: N: 414,027.8; E: 1,708,675.9

Elevation (ahiner): 574.03 feet

Geophysical Logging: Geo-Hydro Data, Inc., Tehachapi, CA
and Welenoo, Bakersfield, CA

Drilling: G. Hickman, P. O. Exploration, Inc., Roseville, CA

Dates Drilled: 2/13/89 to 4/1/89

Analytical Notes: No soil samples submitted for chemical analysis.

Ground Water: 4/12/89, water at 50.2 feet

Drill

Sam

Est

BLADDER PUMP

SUBMERSIBLE PUMP

WATER ENCOUNTERED

STATIC WATER LEVEL

ANALYTICAL SOIL SAMPLE

NEAT CEMENT GROUT

CEMENT-CAL SEAL GROUT

INDEX TO SYMBOLS

W-35C-03

Logging Method: 28-inch blade bit, mud rotary, 0-38 feet
 24-inch steel casing, 0-36 feet
 21-inch tricone bit, mud rotary, 38-342.5 feet
 18-inch steel casing and pressure grout, 0-342.5 feet
 15-inch tricone bit, mud rotary, 342.5-525.8 feet
 4.25-inch continuous wireline coring, 525.8-537.8 feet
 15-inch tricone bit, mud rotary, ream, 528.8-532.8 feet
 10-inch steel casing with 0.040-inch wirewrap screen at 387-517 feet

Logging Methods: Logged from cuttings, 0-525.8 feet
 Christensen HQ Wireline Coring System, 525.8-537.8 feet
 Notes on gravels, sands, and fines are field visual estimates.

8
 *O SAND
 SAND PACK
 BENTONITE

===== SLOTTED CASING
 [X] SLOUGH MATERIAL
 ???? APPROXIMATE CONTACT
 ///// GRADATIONAL CONTACT

Core
 recovery
 100 RQD

Lithology

Lithologic descriptions and/or remarks

SITE
 300

	(0-0.9) SANDY GRAVEL, [GM], light brown, dry, very loose, 35% medium sand, 20% silt, high estimated permeability, [F111]
	(0.9-21) QUATERNARY ALLUVIAL DEPOSITS
	(0.9-3.5) GRAVELLY SILT, [ML], gray-brown, damp, medium stiff, 20% pebbles to 0.8 inch, 10-20% clay minor roots yellow-brown, medium stiff to stiff, 35% pebbles, and 10% fine to medium sand below 2 feet
	(3.5-5) SANDY SILT, [ML], gray- to purple-brown, dry to damp, medium stiff to stiff, 15-20% fine to medium sand, moderate porosity some pebbles below 4 feet
	(5-9) GRAVELLY SILT, [ML], as at 3.5-5 feet except: 15% sand and 15-20% pebbles pebble content increases slightly at 7 feet
	(9-11.5) SILTY SAND, [GM], gray-brown to purple-brown, 30% silt, 20-25% quartzite and volcanic pebbles, and 5-10% clay driller indicates soft clay interbed at 10.5-11.5 feet
	(11.5-14.5) SANDY GRAVEL, [GM], medium brown, dry to damp, medium dense, 35% fine sand, 20% silt, <5% clay 20% sand and 10-15% silt below 12 feet
	(14.5-19.2) SANDY GRAVEL, [GM], as at 11-14.5 feet except: <5% silt 10-15% sand below 16 feet
	(19.2-21) CLAYEY SILT, [ML], light yellow-brown, dry to damp, soft to medium stiff, 30% clay, low estimated permeability
	(21-537.8) TERTIARY SEDIMENTARY ROCKS
	(21-28) SILTY CLAY, [CL], pale green, dry to damp, medium stiff to stiff, 20% silt, low estimated permeability light red-brown clay interbed at 26-27 feet red-brown and light green silty clay at 27-28 feet
	(28-32) CLAYSTONE, medium brown, dry, moderately indurated, <10% silt, low estimated permeability light green, dry to damp claystone at 31-32 feet
	(32-40) SILTY CLAYSTONE, red-brown and light green, dry, 15-20% silt, <10% very fine sand, low estimated permeability no sand at 33.5-36 feet 5-10% very fine sand below 36 feet green, moderately indurated sandy siltstone interbed at 37.5-38 feet blue-green to green-brown silty claystone with 35% silt at 38-40 feet
	(40-41.7) CLAYEY SILTSTONE, green-brown, dry to damp, poorly to moderately indurated, 40% clay, 10% fine sand, low estimated permeability
	(41.7-44.5) SANDY SILTSTONE, blue-gray and green, dry to damp, moderately indurated, 25% fine sand, 10% clay, low estimated permeability blue-gray, moderately indurated silty sandstone interbed with 15-20% silt at 42-42.5 and 43.5-44 feet, 15-20% very fine sand at 44-44.5 feet
	(44.5-51.5) SILTSTONE, blue-gray and light gray, poorly indurated, 10% clay, <5% very fine sand, low estimated permeability 5-10% very fine sand at 47-48 feet 15% fine sand and predominantly blue gray below 48 feet blue-green gray at 49-50.5 feet slightly more indurated at 50.5-51.5 feet
	(51.5-56) CLAYEY SILTSTONE, brown to purple-brown, poorly indurated, 15-20% clay, low estimated permeability

LOG: MONITOR

WELL W-35C-03 (CONTINUED)

SITE
300

Well fracture	Depth	% Core recovery	0 100 RQD	Lithology	Lithologic descriptions and/or remarks
X	55				(56-64.5) CLAYSTONE, red-brown, moderately indurated, low estimated permeability
X	60				50% green claystone interlayers with 10-15% fine sand at 61-63.5 feet blue-gray, moderately indurated silty sandstone interbed with 15% silt and low to moderate estimated permeability at 63.5-64 feet
X	65				(64.5-73) interbedded SILTY CLAYSTONE, SILTSTONE, SANDY SILTSTONE, and SILTY SANDSTONE, low estimated permeability blue-gray to gray siltstone at 64.5-65.5 red-brown silty claystone at 65.5-68 feet light green sandy siltstone at 68-68.5 and 69.5-70 feet blue-gray silty sandstone at 68.5-69.5 feet gray-green siltstone at 70-70.4 and 71.5-73 feet light green silty claystone at 70.4-71.5 feet
X	70				
X	75				(73-81) SILTY SANDSTONE, dark gray-green, moderately indurated, 15% silt, low estimated permeability blue-green poorly indurated sandy siltstone interbed with 15% fine sand at 74-75.5 feet some possible sandy siltstone interbeds at 75.5-81 feet
X	80				
X	85				(81-84) SILTSTONE, gray- to blue-green, moderately indurated, <10% very fine sand, low estimated permeability
X	90				(84-90.5) SANDSTONE, blue-gray, moderately indurated, very fine to fine grained, 10-15% silt, moderate estimated permeability gray-green, poorly indurated, sandy siltstone interbed with 15-25% fine sand, <5% clay, and low estimated permeability at 87-89 feet
X	95				
X	100				(90.5-98.8) CLAYEY SILTSTONE, gray- to blue-green, poorly indurated, 20-25% clay, 10-15% fine sand, low estimated permeability sandstone interbeds (as at 84-90.5 feet) at 92.5-94 and 96-97 feet
X	105				
X	110				(98.8-106.5) SILTY SANDSTONE, blue-gray, moderately indurated, very fine to fine grained, 15-20% silt, moderate estimated permeability; upper contact from driller, lower contact from geophysics fine to medium grained sandstone interbed with <10% silt at 103-105 feet
X	115				
X	120				(106.5-109.5) SILTSTONE, gray-green, moderately indurated, 10-15% very fine sand, possible sandstone interbeds, low estimated permeability
X	125				(109.5-114.2) SANDSTONE, blue-gray, poorly to moderately indurated, 10-15% silt, moderate porosity, moderate estimated permeability; contacts from geophysics
X	130				(114.2-124) SILTSTONE, light gray, dry to damp, moderately to well indurated, low estimated permeability geophysics indicate possible sandstone interbed at 116.5-119.9 feet
X	135				green-gray to gray, moderately indurated, clayey siltstone interbed with 20% clay and a low estimated permeability at 119.9-120.5 feet
X	140				(124-130.5) CLAYEY SILTSTONE, light purple-gray, moderately to well indurated, 15-20% clay, 10% fine sand, low estimated permeability green and 10-15% fine sand below 128 feet
X	145				
X	150				(130.5-150.5) SILTSTONE, purple-gray to gray, moderately to well indurated, <10% silt, low estimated permeability sandy siltstone interbed with 15% fine sand at 131-132.5 feet low to moderate porosity at 132.5-140 feet

LOG: MONITOR WELL 1

J-35C-03 (CONTINUED)

SITE
300

Core
recovery
100 RQD

Lithology

Lithologic descriptions and/or remarks

gray to dark gray, fine grained sandstone interbeds with <10-15% silt and a moderate estimated permeability at 138.5-140, 141-142, and 146.5-148 Feet

gray to light gray, moderately indurated silty claystone with 20-25% silt at 145-146.5 Feet
damp to moist ? at 146.5-148 Feet

10-15% very fine sand below 148 Feet

(150.5-162) SANDSTONE, dark gray, moderately indurated, medium grained, <10% silt, 3-5% red chert or volcanic grains, moderate to high estimated permeability

up to 15% red chert or volcanic grains below 157 Feet

(162-165.1) SILTY SANDSTONE, as at 150.5-162 Feet, except: 15% silt possible green sandy siltstone interbed at 164.3-165.1 Feet

(165.1-193) SILTY CLAYSTONE, brown-gray to green, poorly indurated, 20% silt, 10% fine sand, low estimated permeability

30% silt and 10% very fine sand below 169 Feet

blue-green and 45% silt below 171 Feet

purple-gray, moderately indurated claystone interbed at 175.4-176 Feet
green silty claystone with 45-50% silt below 176 Feet

light gray to gray, moderately indurated silty claystone with 25% silt below 188.5 Feet

5-10% fine sand at 191-193 Feet

(193-203) CLAYSTONE, as at 165.1-193 Feet, except: <10% silt

10-15% silt at 202.5-203 Feet

(203-211.5) CLAYEY SILTSTONE, purple- and green-gray, poorly indurated, 25% clay, 10% very fine sand, low estimated permeability

blue-gray, moderately indurated sandstone interbed with 10-15% silt and a moderate estimated permeability at 206-207 Feet

(211.5-258.5) SANDSTONE and SILTY SANDSTONE, gray to blue gray, moderately indurated, 10-15% silt, 1-3% red chert or volcanic grains, high estimated permeability

20% silt and 10% clay below 216 Feet

LOG: MONITOR

WELL W-35C-03 (CONTINUED)

SITE
300

Well fracture	Depth	% Core recovery 0 100 RQD	Lithology	Lithologic descriptions and/or remarks
X	220			poorly indurated, medium to coarse grained, 15% silt, and 5% red grains below 219 Feet
X	225			
X	230			
X	235			Fine grained sandstone at 232-242.5 Feet
X	240			
X	245			green-gray, moderately indurated siltstone interbed with a low estimated permeability at 242.5-243.5 Feet medium grained sandstone at 243.5-250.5 Feet
X	250			medium gray, moderately indurated sandy siltstone interbed with 15% very fine sand and a low estimated permeability at 248-249 Feet Fine to medium grained sandstone at 250.5-254.5 Feet
X	255			blue-green gray, poorly indurated, fine to medium grained silty sandstone interbed with 35% silt and low estimated permeability at 254.5-255.5 Feet medium grained sandstone with <15% silt at 255.5-257.5 Feet
X	260			Fine to medium grained sandstone with <15% silt at 257.5-258.5 Feet (258.5-262) CLAYEY SILTSTONE, green and gray-green, poorly indurated, 15-20% clay, low estimated permeability
X	265			(262-268) CLAYSTONE, green and red, moderately to poorly indurated, low estimated permeability; contacts from driller and cuttings
X	270			(268-277) SILTSTONE to CLAYEY SILTSTONE, green-gray to purple-gray, moderately indurated, 10-15% clay, low estimated permeability blue-green, clayey siltstone with 25% clay and 10-15% very fine sand below 272 Feet
X	275			green, poorly indurated sandy siltstone interbed with 25-30% fine sand and a low estimated permeability at 276-277 Feet
X	280			(277-323) SANDSTONE, medium gray to blue-gray, moderately indurated, <10% silt, 1% red chert or volcanic clasts, <1% green clasts, moderate estimated permeability
X	285			
X	290			
X	295			light gray, moderately indurated, laminated siltstone interbed with 10% very fine sand and a low estimated permeability at 291-293 Feet dark gray to blue gray, fine grained sandstone with 10-15% silt and 5-10% red grains below 293 Feet
X	300			

LOG: MONITOR WELL

J-35C-03 (CONTINUED)

Core
recovery

100 RQD

Lithology

Lithologic descriptions and/or remarks

SITE
300

fine to medium grained sandstone with 3% red grains below 303 feet

light gray to purple-gray, moderately indurated siltstone with a low estimated permeability at 306.5-308 feet
sandstone with <10% silt and a moderate to high estimated permeability below 308 feet

very hard drilling suggests possible conglomerate interbed at 319.5-320 feet; green, poorly indurated silty claystone interbed with 20% silt at 321.5-322 feet; medium gray, moderately indurated, very fine to fine grained silty sandstone interbed with 15% silt, 1% red grains and a moderate estimated permeability at 322-323 feet

(323-329.5) SILTSTONE, black and purple-gray, moderately indurated, low estimated permeability
Fossils with pyrite overgrowths near 325 feet

(329.5-333) CLAYEY SILTSTONE, green and green-gray, moderately indurated, 30% clay, low estimated permeability
green, poorly indurated claystone interbed at 331-331.5 feet
purple-gray clayey siltstone with 15-20% clay at 331.5-333 feet

(333-344) SILTY CLAYSTONE, green and purple-gray, moderately indurated, 40% silt, low porosity, low estimated permeability

stem Fossils near 340 feet

(344-354.5) SANDSTONE, dark gray, moderately indurated, fine to medium grained, 10-15% silt, 3% red grains, moderate porosity, moderate estimated permeability

(354.5-359) CLAYSTONE, light green-gray, poorly indurated, <10% silt, low estimated permeability

(359-362) SANDSTONE, dark gray, poorly indurated, fine to medium grained, <10% silt, 3% red grains, moderate to high estimated permeability; From lack of cuttings
fine grained sandstone at 361-361.5 feet; medium grained sandstone below 361.5 feet

(362-368) CLAYSTONE, green, sticky; from driller

(368-371) SILTSTONE, gray, moderately indurated, 10-15% clay, low estimated permeability

(371-374) SANDSTONE, dark gray to black, poorly indurated, 3-5% red grains, moderate to high estimated permeability

(374-381) CLAYSTONE, green, poorly indurated, 10-15% silt, low estimated permeability

LOG: MONITOR

WELL W-35C-03 (CONTINUED)

SITE
300

Well function	Depth	% Core recovery		Lithology	Lithologic descriptions and/or remarks
		0	100		
	385				(381-386) SILTSTONE, gray, moderately indurated, 10-15% clay, low estimated permeability
	390				(386-391) SILTY SANDSTONE, light gray, moderately indurated, medium grained, 15-20% silt, moderate estimated permeability
	395				(391-482) SANDSTONE, black, poorly indurated, medium to coarse grained, high estimated permeability
	400				
	405				
	410				
	415				medium gray, moderately indurated siltstone interbeds with a low estimated permeability at 412-413.6 Feet
	420				
	425				
	430				
	435				rough drilling suggests conglomerate or well indurated sandstone interbed at 435-435.2 and 435.5-436 Feet fine to medium grained sandstone with 3% red grains at 437-440 Feet
	440				coarse grained sandstone with 5% red grains at 440-443.5 Feet
	445				fine to medium grained sandstone with 1-3% red grains at 443.5-445 Feet medium to coarse grained sandstone with 3-5% red grains and 1% green grains at 445-461.5 Feet
	450				
	455				

LOG: MONITOR WELL

J-35C-03 (CONTINUED)

Core Recovery	RQD	Lithology	Lithologic descriptions and/or remarks
			<p>Fine to medium grained sandstone with 1-3% green grains and 3-5% red grains below 461.5 Feet</p> <p>medium to coarse grained sandstone below 464 Feet</p> <p>slightly coarser grained below 471 Feet</p> <p>pyrite grains near 475 Feet</p> <p>rough drilling suggests pebbly interbed at 477.5-477.7 Feet</p>
			<p>(482-488) SILTSTONE, light gray, moderately indurated, low estimated permeability; upper contact from geophysics</p> <p>gray, moderately indurated, fine grained silty sandstone interbed with 15% silt and low to moderate estimated permeability at 484-485.5 Feet</p> <p>gray, poorly to moderately indurated siltstone with 10-15% clay and low porosity below 485.5 Feet</p>
			<p>(488-507.5) SANDSTONE, medium gray to black, poorly indurated, pyrite specks, moderate to high estimated permeability</p> <p>medium gray, moderately indurated, very fine to fine grained silty sandstone interbed with 20% silt and a low to moderate estimated permeability at 490.5-491 Feet</p> <p>black, medium to coarse grained sandstone with 5% red grains and high estimated permeability below 491 Feet</p> <p>medium gray, poorly to moderately indurated siltstone interbed with 10-15% clay and low estimated permeability at 494-496 Feet; interbed contacts from geophysics</p> <p>fine to medium grained sandstone at 503.5-507 Feet</p> <p>fine grained sandstone below 507 Feet</p>
			<p>(507.5-511) SILTSTONE, medium gray, moderately indurated, low estimated permeability; upper contact from geophysics, lower contact from driller</p>
			<p>(511-518) SILTY SANDSTONE, medium gray, poorly to moderately indurated, very fine grained, 20% silt, moderate estimated permeability</p> <p>brown, poorly indurated silty claystone interbed with 35-40% silt and a low estimated permeability at 513-513.5 Feet</p> <p>fine grained silty sandstone with 15% silt and a low to moderate porosity and estimated permeability below 513.5 Feet</p>
			<p>(518-521) SILTY CLAYSTONE, light to medium gray, poorly indurated, 30-35% silt, <5% very fine sand, low estimated permeability</p>
			<p>(521-526) CLAYSTONE, light gray to purple-gray, poorly indurated, 10-15% silt, 10% very fine sand, low estimated permeability</p>
			<p>(526-537.8) SILTY SANDSTONE, medium gray, moderately indurated, very fine grained, 20-40% silt, 5% red clasts, low estimated permeability</p> <p>gray sandy siltstone interbed with 20-45% very fine sand at 526-526.7 Feet</p> <p>medium gray to purple-gray, micaceous siltstone interbed with 10-15% clay, <5% very fine sand, and wavy laminations at 529.4-530.8 Feet</p> <p>green-gray, poorly to moderately indurated, very fine to medium grained silty sandstone with 1-2% red grains and moderate estimated permeability below 530.8 Feet; interbed contact at 530.8 Feet dips 15°</p> <p>medium grained silty sandstone below 532 Feet</p> <p>7% red grains below 532.8 Feet</p> <p>fine to medium grained below 535.7 Feet</p> <p>medium gray, moderately to well indurated clayey siltstone interbed with 20% clay and a low estimated permeability at 536.5-537.2 Feet</p> <p>poorly indurated silty sandstone with <1% red grains and a moderate to high permeability below 537.2 Feet</p>

TD = 537.8'

SITE
300

DR WELL W-809-03

Drilling Method: 9-inch hollow stem auger, 0-50 Feet

4.25-inch continuous wireline coring, air-mist rotary, 50-118.5 Feet

9-inch tri-cone bit, air-mist rotary, ream, 0-112.1 Feet

4.5-inch I.D. PVC casing with 0.020-inch slots at 96.7-111.7 Feet

Analytical Notes: No VOC constituents (excluding TCE which is shown on log and chloroform and Freon 11, which may be laboratory artifacts) were identified in soil at or above the detection limit of 0.0002 mg/kg. No soluble metals were identified above the STLC in soil samples from 0.2, 5.5, 11, 15.7, 20.7, and 28.3 Feet. The detection limits for HMX and RDX are <0.001 mg/kg except as noted. ND indicates none detected.

Estimates of gravels, sands, and fines are field visual estimates.

Notation of Bedding and Fractures: [Depth(s)/dip(s)°/comment(s)]

INDEX TO SYMBOLS

SAND

ND PACK

NTONITE

SLOUGH MATERIAL

SLOTTED CASING

???? APPROXIMATE CONTACT

///// GRADATIONAL CONTACT

INTERSECTING FRACTURES

CLOSED FRACTURES

OPEN FRACTURES

FRACTURE ZONE

Depth (ft)	% Core recovery Blobs 0 100 (RQD)	Fractures	HMX mg/kg	RDX mg/kg	TCE mg/kg	Analytical soil samples	
						Lithology	Lithologic descriptions and/or remarks
0	DA	3/6/6	ND	<0.002	0.0005	(0-0.8) CLAYEY SILT, [ML], brown, dry, medium stiff, 20% clay, moderate estimated permeability; [Fill]	SITE 300
						(0.8-11.2) COLLUVIUM	
-5	DA	1/3/9	ND	ND	ND	(0.8-4) SILTY SAND, [SM], brown, dry, medium dense, very fine grained, 15-20% silt, moderate porosity, moderate estimated permeability	
						(4-5.8) CLAY, [CL], brown, dry, medium stiff, 10-15% silt, low estimated permeability	
-10	DA	3/42/49	ND	ND	ND	(5.8-9) SILTY SAND, [SM], yellow-brown, dry to damp, medium dense, medium to coarse grained, 15% silt, moderate porosity, moderate estimated permeability	
						10-15% pebbles to 0.1 inch at 5.8-6.5 Feet	
-15	DA	3/26/50+	0.005	ND	ND	(9-11.2) CLAYEY SILT, [ML], brown, dry to damp, very stiff, 20% clay, low estimated permeability	
						(11.2-118.5) TERTIARY SEDIMENTARY ROCKS	
-20	DA	5/41/50+	0.020	ND	ND	(11.2-22) Interbedded SANDSTONE to SILTY SANDSTONE and CONGLOMERATE, yellow-brown, dry to damp, moderately indurated, coarse sand, well rounded pebbles with minor angular (chert?) pebbles to 0.2 inch, 10-15% silt, moderate porosity, low to moderate estimated permeability	
-25	DA	5/35/50+	0.005	ND	ND	silty sandstone with 20% silt below 13 Feet; sandy siltstone interbed with fine sand at 15.3-15.7 Feet; coarse grained silty sandstone at 15.3-15.7 Feet; conglomerate with pebbles to 0.3 inch at 15.7-16 Feet; very coarse grained silty sandstone with minor reddish (Fe-oxide?) stains and rare carbonate or gypsum below 16 Feet; conglomerate with pebbles to 0.6 inch at 18.5-19, 19.7-19.8, and 20.9-22 Feet	
-30						(22-27) CLAYSTONE, green-brown, moist, moderately indurated, 10-15% silt, low estimated permeability	
						10% medium sand, minor Fe-oxide stains, and mica flakes below 23.5 Feet; very minor water production at drilling depth 26 Feet	
-35						(27-32.5) SANDY SILTSTONE, brown, damp to moist, 20-25% fine to medium sand, low estimated permeability	
						(32.5-37.5) SILTY CLAYSTONE, green-brown, damp to moist, 15-20% silt, low estimated permeability	
						(37.5-39) GRAVELLY CLAYSTONE, green-brown, damp to moist, 15% well rounded pebbles to 0.2 inch, low estimated permeability	

LOG: MONITOR WELL W-80

9-03 (CONTINUED)

SITE
300

Fractures				Analytical soil samples	
Lower 100'	HMX mg/kg	RDX mg/kg	TOE mg/kg	Lithology	Lithologic descriptions and/or remarks
19/41	0.051	0.013	ND		(39-41.2) SANDY SILTSTONE, pale green-brown, damp, 15-20% fine sand, 10-15% clay, low estimated permeability
					(41.2-42.5) SILTY SANDSTONE, gray-brown to yellow-brown, damp, fine grained, 15-20% silt, moderate porosity, moderate estimated permeability
					(42.5-50.4) CLAYSTONE, brown, damp, 10-15% silt, low estimated permeability gravelly claystone interbeds with 15-25% well rounded pebbles to 0.6 inch at 42.5-43.5, 46-47, and 50-50.4 feet
33	0.003	ND	ND		(50.4-53.5) SANDY CONGLOMERATE, brown, damp, moderately to well indurated, well rounded pebbles to 0.2 inch, 45% sand, moderate porosity, moderate estimated permeability
401					(53.5-61.4) SILTY SANDSTONE to SANDSTONE, light brown, damp, poorly to moderately indurated, coarse grained, abundant Fe-oxide stains, moderate porosity, moderate estimated permeability silty sandstone with 35% silt at 53.5-54.2 feet; sandy siltstone interbed with 20-25% coarse sand at 54.2-55.3 feet; silty sandstone with 20-25% silt at 55.3-58.5 feet sandstone with <15% silt at 58.5-61.4 feet moderate to well indurated at 60-61.4 feet
581	ND	ND	ND		(61.4-108.5) SANDSTONE, dark brown, dries steel-gray, moist, moderately to well indurated, coarse to medium grained, 5% silt, 3% red (volcanic ?) grains, 1% green (olivine or pyroxene ?) grains, moderate to high porosity and estimated permeability [Fractured and rubbly (poorly indurated) at 61.4-61.9 feet] 0.4 inch diameter, well rounded andesite clast at 62.5 feet moderately to poorly indurated with rare (carbonate or gypsum ?) pods below 68.5 feet brown claystone rip-up clasts at 78.6, 79.8-80, and 82.1 feet [Fractures dip 15° at 79.2, 81, and 81.4 feet] claystone rip-up clasts at 84.1 and 85 feet; very thin claystone interbed at 84.2 feet; very coarse grained below 85.6 feet; gravelly sandstone interbed with 30% pebbles to 0.8 inch at 86-86.2 feet coarse to very coarse grained with rip-up clasts at 88.3-89.5 feet; gravelly sandstone and gravelly claystone rubble at 89.5-89.7 feet; medium to coarse grained at 89.7-90.4 feet; fine grained and thinly bedded sandstone at 90.4-91 feet; fine grained and massive sandstone below 91 feet [Fractures: 90.7-90.9/90°, 90.9-91.2/90° and subhorizontal, 90.7/15°, 93.6/45°, 94.2/15°, 95.4/5°, 96/10°, 97/25°/closed] medium grained sandstone with 3% red (volcanic ?) grains below 97.1 feet claystone rip-up clasts subparallel to bedding at 98.5 feet; abundant claystone rip-up clasts subparallel and at various angles to bedding at 99.7-100.3 feet [Fractures: 98.4/30°/healed, 101.6/50°, 102.2-102.8/90°, 103.6/45°, 104.9/45° and 10°, 106/15°, and 106.8/45°; 105.2-108.5/subhorizontal/thinly bedded] light brown sandy siltstone interbed at 103-103.1 and 105.2 feet; fine to medium grained sandstone at 103.5-104.1 and below 105.2 feet; claystone interbed with very irregular upper contact and subhorizontal lower contact at 105.8-106.1 feet; claystone has sandstone infillings at 105.8-106.1 feet
201	ND	ND	ND		(108.5-110.5) SILTY SANDSTONE, dark brown, damp, moderately indurated, fine grained, 20% silt, thin bedded, low porosity, low estimated permeability [Fractures: 109.9/45°/healed and 110.2-110.4/partially open] claystone rip-up clasts at 110.2 feet
301					(110.5-111.7) SILTY CLAYSTONE, light brown, damp, moderately indurated, 20% silt, abundant Mn-oxide stained subvertical fractures, upper contact has silty sandstone filling vertical cracks, low estimated permeability
401					(111.7-114.3) SANDY SILTSTONE, light gray, damp, moderately indurated, 20% fine sand, low estimated primary permeability, moderate estimated fracture permeability 30% fine sand below 113.8 feet [Fractures with white (gypsum or carbonate ?) precipitate: 111.6-112.5/90°/healed ?, 113-113.5/90°, and 113.5-113.9/90° to 70°]
501	ND	ND	ND		(114.3-118.5) SILTSTONE, gray with some green-gray, dry to damp, 5-15% clay, low estimated primary permeability, moderate to high estimated fracture permeability [subvertical (healed ?) fractures: 114.3-114.5/green coatings and 115.2-116.2/green and white coatings] gray claystone interbeds at 117-117.1, 117.4-117.6, 117.8-117.9, and 118.0-118.1 feet; green siltstone at 117.1-117.2, 117.3-117.4, and 117.6-117.8 feet TD = 118.5 feet

LOG: BORE

Geologic Logging: L. Glick, Weiss Associates, Emeryville, CA
 Borehole Location: Approximately 40 feet west of Building 813,
 south of intersection of Route 3 and Route 5, Site 300
 Drilling: D. Wagster, P. C. Exploration, Inc., Roseville, CA
 Dates Drilled: 7/26 to 8/1/89
 Drilling Method: 9-inch hollow stem auger, 0-50 feet
 Cement grout, 0-16(?) feet; slough, 16(?) - 51.5 feet
 Sampling Methods: 1.4-inch I.D. split spoon sampler, 0-51.5 feet
 Sampler advanced by 140-pound weight falling 30 inches.
 Arrows show locations of drive sampling.

HOLE 813-01

Ground Water: Not observed during drilling.

Analytical Notes: No VOCs (except for methylene chloride, a common laboratory artifact, which was identified at 0.0003 mg/kg in a soil sample from 11 feet) were identified above 0.0002 mg/kg. No soluble metals were identified above their STLC in soil or rock samples from 1, 6, 10.7, 16, 21, 31, 40.7, and 51 feet. ND means none detected.

Recovery histograms show percent recovery and recovery locations. Estimates of gravels, sands, and fines are field visual estimates.

geologic descriptions and/or remarks

TIARY SEDIMENTARY ROCKS

Y SILT, [ML], light brown, dry, medium stiff, 35% medium sand, 15% pebbles to 2 inches, moderate permeability
pebbles to 0.2 inch at 0-0.5 feet; caliche at 1.3 feet

DSTONE to SILTY SANDSTONE, white to light gray, dry, moderately indurated, 10-15% silt, minor mica, moderate porosity, moderate estimated permeability
brown with 15-20% silt and 10% pebbles below 6.3 feet

silt below 10.3 feet

LTSTONE, brown, dry to damp, 10-15% clay, low to moderate estimated permeability

LTY SANDSTONE, yellow-brown, dry to damp, 15-20% silt, some Fe-oxide stains, moderate estimated permeability

EY SILTSTONE, light brown, dry to damp, 20% clay, low estimated permeability

Y SILTSTONE, light brown, dry to damp, 15% fine to medium sand, low estimated permeability below 20 feet

STONE, brown, dry to damp, 10-15% silt, <5% fine sand, low estimated permeability with 25% silt below 25 feet

silt below 27 feet

LTY SANDSTONE, yellow-brown, dry to damp, fine grained, 40% silt, moderate porosity, moderate estimated permeability

CLAYEY SILTSTONE, brown, dry to damp, 20% clay, low estimated permeability green-gray to white with minor red (Fe-oxide) stains at 30.5 feet

LTY CLAYSTONE, gray-brown, dry to damp, 15-20% silt, 5-10% pebbles to 1/8 inch, low permeability at 36-38 and 38.5-40 feet

siltstone interbed with 15% very fine sand at 40-40.4 feet
very fine sand, no pebbles, and Fe-oxide stains below 40.4 feet
sand below 42 feet

EY SILTSTONE, brown, damp to moist, 15-20% clay, low estimated permeability

EL, well rounded volcanic pebbles to 1.2 inches

LTY CLAYSTONE, brown, damp to moist, 20% silt, low estimated permeability

SILTY SANDSTONE, light yellow-brown, to light gray, dry to damp, fine to medium grained, Fe- and Mn-oxide stained nodules, moderate estimated permeability
indurated at 50.4-50.6 feet

-t

Appendix D

Meteorological Data:

Site 300

Table D-1. 1980 Site 300 rainfall (inches per day).

Day	Month											
	JAN-	FEB-	MAR-	APR-	MAY	JUN-	JUL-	AUG-	SEP-	OCT-	NOV-	DEC-
1	0.02	-	-	-	-	-	-	-	-	-	-	-
2	-	-	0.21	-	-	-	0.49	-	-	-	-	-
3	-	-	0.01	-	-	-	-	-	-	-	-	0.34
4	-	-	-	0.16	-	-	-	-	-	-	-	0.10
5	-	-	0.20	0.24	-	-	-	-	-	-	-	-
6	-	-	0.24	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-
8	0.17	-	-	-	-	-	-	-	-	-	-	-
9	0.35	-	-	-	0.05	-	-	-	-	-	-	-
10	0.30	-	-	-	-	-	-	-	-	-	-	-
11	0.25	-	-	-	-	-	-	-	-	-	-	-
12	0.11	-	-	-	-	-	-	-	-	-	-	-
13	0.43	-	-	-	-	-	-	-	-	-	-	-
14	0.03	0.22	-	-	-	-	-	-	-	-	-	-
15	0.11	0.24	-	-	-	-	-	-	-	-	-	-
16	0.01	0.38	-	-	-	-	-	-	-	-	-	-
17	0.28	0.07	-	-	-	-	-	-	-	-	-	-
18	-	0.21	-	-	-	-	-	-	-	-	-	-
19	-	0.44	-	-	-	-	-	-	-	-	-	-
20	-	0.37	-	0.02	-	-	-	-	-	-	-	-
21	-	0.07	-	0.08	-	-	-	-	-	-	-	0.15
22	-	0.05	-	0.17	-	-	-	-	-	-	-	0.02
23	-	-	-	-	0.06	-	-	-	-	-	0.12	-
24	-	-	-	-	-	-	-	-	-	-	-	0.06
25	-	-	0.20	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	0.21	-	-	-	-	-	-	-	-	-	-
28	-	-	-	0.02	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	0.03
30	-	-	-	-	-	-	-	-	-	-	-	0.46
31	-	-	0.01	-	-	-	-	-	-	-	-	0.07
	2.06	2.26	0.87	0.69	0.11	0.00	0.49	0.00	0.00	0.00	0.12	0.61

TOTAL: 1980 Rainfall 7.21 in.

Dash (-) = No measurable rainfall

Table D-2. 1981 Site 300 rainfall (inches per day).

Day	Month											
	JAN-	FEB-	MAR-	APR-	MAY	JUN-	JUL-	AUG-	SEP-	OCT-	NOV-	DEC-
1	-	-	0.30	-	-	-	-	-	-	-	-	-
2	-	-	0.09	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	0.22	-	-	-	-	-	-	0.13	-	-
5	-	-	-	-	-	-	-	-	-	-	0.12	-
6	-	-	-	-	-	-	-	-	-	-	0.02	0.01
7	0.01	-	-	-	-	-	-	-	-	0.01	-	0.01
8	-	0.28	-	-	-	-	-	-	-	-	-	0.04
9	-	0.04	-	-	-	-	-	-	-	-	-	0.04
10	-	0.03	-	-	-	-	-	-	-	0.01	-	-
11	-	0.01	-	-	-	-	-	-	-	-	0.50	0.06
12	-	-	0.12	-	-	-	-	-	-	-	1.30	0.03
13	-	0.04	0.28	-	-	-	-	-	-	-	-	-
14	-	0.06	-	-	-	-	-	-	-	-	-	-
15	0.02	-	0.20	-	-	-	-	-	-	-	-	-
16	0.01	-	-	-	-	-	-	-	-	-	0.09	-
17	0.01	-	-	-	-	-	-	-	-	-	0.05	-
18	-	-	0.14	0.37	0.15	-	-	-	-	-	-	0.17
19	-	0.01	0.34	0.15	-	-	-	-	-	-	-	0.03
20	0.02	-	0.02	-	-	-	-	-	-	-	-	0.11
21	-	-	0.16	-	-	-	-	-	-	-	0.12	-
22	0.22	-	-	-	-	-	-	-	-	-	0.02	-
23	0.07	-	-	-	-	-	-	-	-	-	0.04	-
24	-	0.09	-	-	-	-	-	-	-	-	0.03	-
25	-	0.12	0.10	-	-	-	-	-	-	-	-	-
26	0.53	-	0.05	-	-	-	-	-	-	-	0.08	-
27	0.86	-	-	-	-	-	-	-	-	0.08	0.26	-
28	0.62	0.01	-	-	-	-	-	-	-	0.54	-	0.75
29	0.14	-	-	-	-	-	-	-	-	0.01	-	0.20
30	2.51	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	0.01
	5.02	0.69	2.02	0.52	0.15	0.00	0.00	0.00	0.00	0.78	2.63	1.46

TOTAL: 1981 Rainfall 13.27 in.

Dash (-) = No measurable rainfall

Table D-3. 1982 Site 300 rainfall (inches per day).

Day	Month											
	JAN-	FEB-	MAR-	APR-	MAY	JUN-	JUL-	AUG-	SEP-	OCT-	NOV-	DEC-
1	0.33	-	0.26	0.06	-	-	-	-	-	-	-	-
2	-	-	0.16	-	-	-	-	-	-	-	-	0.01
3	0.30	-	-	0.16	-	-	-	-	-	-	-	-
4	0.69	-	-	0.10	-	-	-	-	-	-	-	0.01
5	0.13	-	-	0.04	-	-	-	-	-	-	-	0.01
6	-	-	-	0.01	-	-	-	-	-	-	-	-
7	0.01	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	0.03	-
9	-	-	0.18	-	-	-	-	-	-	-	0.91	-
10	-	-	0.25	0.41	-	-	-	-	-	-	0.04	-
11	-	-	0.43	0.07	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	0.20	-	-	-	-	-	-	-	-	-	-
14	-	0.37	0.20	-	-	-	-	-	-	-	-	-
15	-	0.99	-	-	-	-	-	-	0.04	-	-	-
16	-	0.02	0.21	-	-	-	-	-	0.27	-	0.01	-
17	0.04	-	0.34	-	-	-	-	-	0.59	-	0.14	-
18	0.02	-	0.10	-	-	-	-	-	0.02	-	0.89	-
19	0.25	-	-	-	-	-	-	-	-	-	0.04	-
20	-	-	-	-	-	-	-	-	-	-	-	0.09
21	-	-	-	-	-	-	-	-	-	0.01	-	0.01
22	-	-	-	-	-	-	-	-	-	-	0.30	0.95
23	-	-	-	-	-	-	-	-	0.45	-	0.05	0.27
24	-	-	-	-	-	-	-	-	0.12	-	-	-
25	-	-	-	-	-	-	-	-	0.70	0.55	-	-
26	0.04	-	0.06	-	-	-	-	-	-	0.03	-	-
27	-	0.01	0.19	-	-	-	-	-	-	-	0.01	-
28	0.35	-	0.02	-	-	-	-	-	-	-	0.11	-
29	-	-	0.19	-	-	0.29	-	-	-	0.07	0.30	-
30	-	-	0.53	-	-	0.03	-	-	-	0.31	0.42	-
31	-	-	1.21	-	-	-	-	-	-	-	-	-
	2.15	1.59	4.33	0.85	0.00	0.32	0.00	0.00	2.19	0.97	3.25	1.35

TOTAL: 1982 Rainfall 17.00 in.

Dash (-) = No measurable rainfall

Table D-4. 1983 Site 300 rainfall (inches per day).

Day	Month											
	JAN-	FEB-	MAR-	APR-	MAY	JUN-	JUL-	AUG-	SEP-	OCT-	NOV-	DEC-
1	-	-	0.25	-	-	-	-	-	-	0.03	-	-
2	-	-	0.21	-	-	-	-	-	-	-	-	-
3	-	-	0.27	-	-	-	-	-	-	-	-	0.29
4	-	-	-	-	-	-	-	-	-	-	-	-
5	0.01	0.11	0.19	-	0.02	-	-	-	-	-	-	-
6	0.01	0.64	0.17	-	-	-	-	-	-	-	-	-
7	-	0.22	-	-	-	-	-	-	-	-	-	-
8	-	0.07	-	-	-	-	-	-	-	-	0.08	-
9	-	-	-	-	-	-	-	-	-	-	0.18	0.32
10	-	-	0.76	-	-	-	-	-	-	-	0.99	0.08
11	-	0.05	-	-	-	-	-	-	-	-	-	0.31
12	-	0.11	0.42	-	-	-	-	-	-	-	0.02	-
13	-	0.06	0.50	-	-	-	-	-	-	-	0.32	-
14	-	-	-	-	-	-	-	-	-	-	-	0.02
15	0.01	-	-	-	-	-	-	-	-	-	-	-
16	0.25	-	0.10	-	-	-	-	-	-	-	0.20	-
17	-	-	0.16	-	-	-	-	-	-	-	0.49	-
18	0.37	0.37	0.02	0.10	-	-	-	-	-	-	-	-
19	0.11	-	-	0.02	-	-	-	0.63	-	-	0.15	-
20	-	-	0.07	0.23	-	-	-	-	-	-	0.55	-
21	0.04	-	-	-	-	-	-	-	-	-	-	-
22	1.51	-	0.18	-	-	-	-	-	-	-	0.02	0.70
23	-	-	0.12	-	-	-	-	-	-	-	0.90	0.10
24	0.02	0.15	0.36	0.07	-	-	-	-	-	-	-	0.44
25	-	-	-	0.21	-	-	-	-	-	-	-	0.10
26	0.96	0.35	0.10	-	-	-	-	-	-	-	-	0.08
27	0.11	0.49	0.22	0.65	-	-	-	-	-	-	-	-
28	0.43	0.75	-	0.26	-	-	-	-	-	-	-	-
29	0.03	-	-	0.16	-	-	-	-	0.02	0.19	-	-
30	-	-	-	0.07	-	-	-	-	0.57	0.04	-	0.20
31	-	-	-	-	-	-	-	-	-	-	-	0.02
	3.86	3.37	4.10	1.77	0.02	0.00	0.00	0.63	0.59	0.26	3.90	2.66

TOTAL: 1983 Rainfall 21.16 in.

Dash (-) = No measurable rainfall

Table D-5. 1984 Site 300 rainfall (inches per day).

Month												
Day-JAN-	-FEB-	-MAR-	-APR-	-MAY	--JUN-	-JUL-	-AUG-	-SEP-	-OCT-	-NOV-	-DEC-	
1	-	-	-	0.10	-	-	-	-	-	0.03	-	
2	-	-	-	-	-	-	-	-	-	-	-	0.17
3	-	-	-	-	-	-	-	-	-	-	-	0.01
4	-	-	-	-	-	-	-	-	-	-	-	-
5	0.01	-	-	-	-	-	-	-	-	-	-	0.02
6	0.01	-	-	-	-	-	-	-	-	-	0.20	-
7	0.01	-	-	-	-	-	-	-	-	-	0.30	-
8	0.03	-	-	0.08	-	-	-	-	-	-	0.33	-
9	0.05	0.21	-	-	-	-	-	-	-	-	-	0.20
10	0.01	-	-	0.02	-	-	-	-	-	-	0.15	0.07
11	0.01	0.02	-	-	-	-	-	-	-	0.34	0.01	-
12	-	0.12	-	-	-	-	-	-	-	-	0.21	-
13	-	-	0.11	-	-	-	-	-	-	-	0.29	-
14	-	-	0.03	-	-	-	-	-	-	-	-	-
15	0.02	-	0.07	-	-	-	-	-	-	-	0.03	0.37
16	0.16	-	0.15	-	-	-	-	-	-	0.49	0.19	-
17	-	-	-	-	-	-	-	-	-	-	0.12	-
18	-	-	-	0.16	-	-	-	-	0.02	-	0.04	0.03
19	-	-	-	0.06	-	-	-	-	-	-	-	0.01
20	-	-	-	-	-	-	-	-	-	-	0.01	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	0.10	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	0.24	0.01
25	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	0.25
27	-	-	-	-	-	-	-	-	-	-	0.48	-
28	-	-	-	-	-	-	-	-	-	-	0.09	-
29	-	-	-	-	-	-	-	-	-	0.12	-	0.01
30	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-
	0.41	0.35	0.36	0.42	0.00	0.00	0.00	0.00	0.02	0.95	2.69	1.15

TOTAL: 1984 Rainfall 6.35 in.

Dash (-) = No measurable rainfall

Table D-6. 1985 Site 300 rainfall (inches per day).

Day	Month											
	JAN-	FEB-	MAR-	APR-	MAY	JUN-	JUL-	AUG-	SEP-	OCT-	NOV-	DEC-
1	-	0.10	0.06	-	-	-	-	-	-	-	-	0.25
2	-	-	0.01	-	-	0.20	-	-	-	-	-	0.05
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	0.02	-	-	-	-	-	-	-	-	0.02
5	-	-	0.06	-	-	-	-	-	-	-	-	0.05
6	-	-	0.12	-	-	-	-	-	-	0.01	-	-
7	0.39	-	0.05	-	-	-	-	-	0.01	-	-	0.13
8	0.01	0.64	-	-	-	-	-	-	0.03	-	-	0.03
9	0.08	-	-	-	-	-	-	-	0.02	0.08	0.31	-
10	-	-	0.26	-	0.01	-	-	-	-	-	0.04	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	0.23	-	-	-	-	-	-	0.01	-
17	-	-	-	0.24	-	-	-	-	-	-	-	-
18	-	-	0.08	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	0.32	-	-
21	0.01	-	-	-	-	-	-	-	-	0.42	-	-
22	0.01	-	-	-	-	-	-	-	-	-	-	-
23	0.02	-	-	-	-	-	-	-	-	-	0.28	-
24	-	-	-	-	-	-	-	-	-	-	0.41	-
25	-	-	-	-	-	-	-	-	-	-	0.05	-
26	-	-	0.57	-	-	-	-	-	-	-	-	-
27	-	-	0.43	-	-	-	-	-	-	-	-	-
28	0.18	-	0.14	-	-	-	-	-	-	-	0.38	-
29	-	-	-	-	-	-	-	-	-	-	0.68	0.61
30	-	-	-	-	-	-	-	-	-	-	-	0.19
31	-	-	-	-	-	-	-	-	-	-	-	0.01
	0.70	0.74	1.80	0.47	0.01	0.20	0.00	0.00	0.06	0.83	2.16	1.34

TOTAL: 1985 Rainfall 8.31 in.

Dash (-) = No measurable rainfall

Table D-7. 1986 Site 300 rainfall (inches per day).

Day	Month											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-	0.37	-	-	-	-	-	-	-	0.03	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	0.15	0.22	-	-	0.03	-	-	-	-	-	-	-
4	0.05	-	-	-	0.01	-	-	-	-	-	-	-
5	0.07	0.03	-	0.02	-	-	-	-	-	-	-	0.16
6	-	-	-	0.08	-	-	-	-	-	-	-	-
7	-	-	-	0.42	-	-	-	-	-	-	-	-
8	-	-	0.10	-	-	-	-	-	-	-	-	-
9	-	-	0.59	-	-	-	-	-	-	-	-	-
10	-	-	0.97	-	-	-	-	-	-	-	-	-
11	-	0.04	0.21	-	-	-	-	-	-	-	-	-
12	-	0.16	0.13	-	-	-	-	-	-	-	-	-
13	0.01	0.06	0.31	-	-	-	-	-	-	-	-	0.01
14	0.06	0.39	-	-	-	-	-	-	-	-	-	0.01
15	-	0.53	0.51	0.10	-	-	-	-	-	-	-	0.11
16	0.08	0.16	0.12	0.01	-	-	-	-	-	-	-	-
17	0.02	0.25	-	-	-	-	-	-	0.09	-	-	-
18	-	1.00	-	-	-	-	-	-	-	-	-	0.05
19	0.01	0.20	-	-	-	-	-	-	-	-	-	0.19
20	-	-	-	-	-	-	-	-	-	-	-	0.11
21	-	0.01	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	0.24	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	0.01	-	-	0.01
28	-	-	-	-	-	-	-	-	-	-	0.02	-
29	0.12	-	-	-	-	-	-	-	-	-	-	-
30	0.23	-	-	-	-	-	-	-	-	-	-	0.01
31	0.27	-	-	-	-	-	-	-	-	-	-	0.01
	1.07	3.42	2.94	0.63	0.04	0.00	0.00	0.00	0.34	0.00	0.02	0.67

TOTAL: 1986 Rainfall 9.13 in.

Dash (-) = No measurable rainfall

Table D-8. 1987 Site 300 rainfall (inches per day).

Day	Month											
	JAN-	FEB-	MAR-	APR-	MAY	JUN-	JUL-	AUG-	SEP-	OCT-	NOV-	DEC-
1	0.03	-	-	-	-	-	-	-	-	-	-	0.11
2	0.01	0.34	-	-	-	-	-	-	-	-	-	-
3	0.29	-	-	0.02	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	0.27
5	-	-	0.48	-	-	-	-	-	-	-	0.02	0.02
6	0.26	-	-	-	-	-	-	-	-	-	-	0.21
7	-	-	-	-	-	-	-	-	-	-	-	0.27
8	-	-	-	-	-	-	-	-	-	-	-	0.15
9	-	0.08	-	-	-	-	-	-	-	-	-	-
10	0.01	0.35	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	0.11	-	-
12	-	0.64	0.19	-	-	-	-	-	-	-	-	-
13	-	0.87	-	-	-	-	-	-	-	-	0.14	-
14	-	0.01	0.12	-	-	-	-	-	-	-	-	-
15	-	0.17	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	0.08
17	-	-	-	-	-	-	-	-	-	-	0.26	-
18	-	-	-	-	-	-	-	-	-	-	0.01	-
19	-	-	-	-	-	-	-	-	-	-	0.01	-
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	0.14	0.22	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	0.06
23	0.16	-	0.19	-	-	-	-	-	-	0.1	-	-
24	0.12	-	-	-	-	-	-	-	-	-	-	0.06
25	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	0.27	-	-
28	0.27	-	-	-	-	-	-	-	-	1.11	-	-
29	-	-	-	0.08	-	-	-	-	-	-	-	0.03
30	0.19	-	-	-	-	-	-	-	-	-	0.09	0.46
31	-	-	-	-	-	-	-	-	-	-	-	0.07
	1.34	2.60	1.20	0.10	0.00	0.00	0.00	0.00	0.00	1.59	0.53	1.79

TOTAL: 1987 Rainfall 9.15 in.

Dash (-) = No measurable rainfall

Table D-9. 1988 Site 300 rainfall (inches per day).

Day	Month											
	JAN-	FEB-	MAR-	APR-	MAY-	JUN-	JUL	AUG	SEP-	OCT-	NOV-	DEC-
1	0.01	-	0.07	-	-	-	-	-	-	-	-	-
2	0.18	-	-	-	-	-	-	-	-	-	-	-
3	0.04	-	-	-	-	-	-	-	-	-	-	-
4	0.14	-	-	-	-	-	-	-	-	-	-	-
5	0.01	-	-	-	0.01	-	-	-	-	-	-	-
6	-	-	-	-	0.1	0.13	-	-	-	-	-	-
7	0.06	-	-	-	0.13	0.06	-	-	-	-	-	-
8	0.01	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	0.02	-	-	-	-	-	-	-	-	-	-	-
11	0.03	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	0.01	-
13	-	-	-	0.07	-	-	-	-	-	-	0.12	-
14	-	-	-	0.34	-	-	-	-	-	0.01	-	-
15	0.19	-	-	-	-	-	-	-	-	-	-	-
16	0.25	-	-	-	0.16	-	-	-	-	-	0.10	-
17	0.69	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	0.01	-	-	-	-	-	-	-	0.12
20	-	-	-	0.35	-	-	-	-	-	-	-	0.64
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	0.13	-	-	-	-	-	-	-	0.18
23	-	-	-	0.03	-	-	-	-	-	-	0.59	-
24	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	0.07
28	-	-	-	-	0.06	-	-	-	-	-	-	0.12
29	0.05	0.21	-	-	-	-	-	-	-	-	-	-
30	-	-	-	0.03	-	-	-	-	-	-	-	0.06
31	-	-	-	-	-	-	-	-	-	-	-	-
	1.68	0.21	0.07	0.96	0.46	0.19	0.00	0.00	0.00	0.01	0.93	1.54

TOTAL : 1988 Rainfall 6.04 in.

Dash (-) = No measurable rainfall

Table D-10. 1989 Site 300 rainfall (inches per day).

Day	Month											
	JAN-	FEB-	MAR-	APR-	MAY	JUN-	JUL-	AUG-	SEP-	OCT-	NOV-	DEC-
1	-	0.05	0.10	0.04	-	-	-	-	-	-	-	-
2	-	-	0.30	0.01	-	-	-	-	-	-	-	-
3	-	0.40	-	-	-	-	-	-	-	-	-	-
4	-	0.02	0.03	-	-	-	-	-	-	-	-	-
5	0.20	-	0.12	-	-	-	-	-	-	-	-	-
6	0.02	-	0.04	-	-	-	-	-	-	-	-	-
7	0.02	-	-	-	-	-	-	-	-	-	-	-
8	-	0.25	0.07	-	-	-	-	-	-	-	-	-
9	0.01	0.18	-	-	-	-	-	-	-	-	-	-
10	0.03	0.01	0.26	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	0.03	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	0.30	-	-	-	-	-	0.27	-	-	-
17	-	-	-	-	-	-	-	-	0.01	-	-	-
18	-	-	0.03	-	-	-	-	-	0.02	-	-	-
19	-	-	0.01	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	0.02	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	0.13	-	-	0.06	0.02	-	-	-	-	0.40	-	-
24	-	-	0.03	0.10	-	-	-	-	-	0.08	0.16	-
25	-	-	0.18	-	-	-	-	-	-	-	0.79	-
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	0.51	-	-	.12
29	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-
	0.41	0.91	1.50	0.21	0.02	0.00	0.00	0.00	0.81	0.50	0.95	.12

TOTAL: 1989 Rainfall 5.43 in.

Dash (-) = No measurable rainfall

Table D-11. Site 300 temperature, 1976-1988.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	For the year
1976													
Highest	64	70	75	76	95	98	97	94	95	85	79	64	98
Mean Daily Maximum	56.8	57.7	61.7	62.8	77.4	81.1	86.6	79.9	82.1	76.2	63.9	57.4	70.4
Mean Daily	51.5	52.8	53.6	55.6	69.0	73.5	78.9	73.0	74.8	70.5	59.3	53.4	63.8
Mean Daily Minimum	46.2	47.8	45.4	58.4	60.5	65.9	71.1	66.0	67.5	64.7	54.6	49.4	57.3
Lowest	38	30	35	41	50	53	60	58	58	55	44	44	30
1977													
Highest	57	71	72	79	82	95	94	97	94	80	71	67	97
Mean Daily Maximum	50.5	59.4	58.5	70.3	64.0	83.1	85.2	85.1	81.8	72.2	62.3	56.5	69.9
Mean Daily	47.3	55.2	53.5	63.5	58.1	75.2	77.9	77.6	74.5	66.2	57.3	52.5	63.6
Mean Daily Minimum	44.0	50.9	48.5	56.7	52.3	67.3	70.5	70.1	67.2	60.1	52.3	48.5	57.4
Lowest	38	41	44	48	47	55	58	58	59	50	42	41	38
1978													
Highest	63	65	68	71	86	95	95	101	92	87	73	63	101
Mean Daily Maximum	56.3	54.8	60.1	61.1	74.2	80.3	85.1	86.5	78.5	78.6	59.8	50.7	68.8
Mean Daily	52.4	51.0	55.6	55.7	66.6	71.0	77.3	78.4	71.6	71.8	55.5	47.3	62.8
Mean Daily Minimum	48.5	47.1	51.1	50.2	59.1	61.7	69.5	70.3	64.7	65.0	51.2	53.9	56.9
Lowest	41	43	45	43	49	54	55	57	55	53	44	38	41
1979													
Highest	58	63	67	69	87	91	95	95	97	83	65	69	97
Mean Daily Maximum	50.1	53.7	58.0	62.6	72.7	82.0	84.2	83.5	84.0	71.6	58.3	56.9	68.1
Mean Daily	47.0	50.0	53.4	56.4	65.0	74.1	76.4	75.8	76.3	65.5	54.0	52.2	62.1
Mean Daily Minimum	43.8	46.3	48.8	50.1	57.2	66.3	68.6	68.0	68.6	59.4	49.6	47.5	56.2
Lowest	38	40	42	44	47	51	55	57	55	51	45	39	38

Table D-11. Site 300 temperature, 1976-1988. (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	For the year
1980													
Highest	67	65	65	76	86	94	100	98	91	97	80	68	100
Mean Daily Maximum	54.3	57.7	57.4	64.7	69.4	76.1	86.3	86.5	81.3	78.3	65.5	58.0	69.6
Mean Daily	50.6	53.4	52.7	58.6	61.8	68.0	78.7	77.2	74.2	70.7	59.2	51.6	63.0
Mean Daily Minimum	46.9	49.1	47.9	52.4	54.1	59.9	71.1	67.9	67.1	63.1	53.0	45.3	56.5
Lowest	40	44	40	44	47	50	57	55	57	51	46	34	34
1981													
Highest	66	66	62	85	90	99	98	102	92	80	70	58	102
Mean Daily Maximum	53.2	56.5	54.9	65.6	76.5	88.2	90.4	87.2	84.4	68.5	58.4	49.9	69.5
Mean Daily	48.7	52.4	51.3	59.7	67.0	79.0	80.9	77.7	75.2	61.8	54.7	47.4	63.0
Mean Daily Minimum	44.1	58.4	47.8	53.7	57.5	69.7	71.5	68.2	66.0	55.0	51.0	45.0	56.5
Lowest	33	42	41	46	46	53	61	53	51	48	41	39	33
1982													
Highest	52	66	62	78	93	94	98	100	95	85	65	61	100
Mean Daily Maximum	46.5	55.6	53.9	62.9	76.2	76.8	87.2	87.5	78.9	71.2	54.1	51.4	66.9
Mean Daily	42.2	50.1	48.4	56.3	66.3	66.7	78	78.7	71.8	64.6	49.8	46.7	60
Mean Daily Minimum	37.9	44.6	43	59.6	56.8	56.5	68.8	69.9	64.6	58	45.5	42	53.1
Lowest	29	33	35	35	45	47	54	57	53	45	35	31	29
1983													
Highest	59	64	62	69	85	90	97	97	96	79	71	55	97
Mean Daily Maximum	49.9	55.1	55.3	58.4	69.6	78.1	85.2	85.2	82.2	72.8	57.4	50.5	66.3
Mean Daily	44.8	50.4	52.1	53.3	64.1	70.2	73.3	77.1	75.1	67.4	54.6	49.2	61.0
Mean Daily Minimum	39.7	45.7	48.8	48.2	58.6	62.3	65.7	68.9	68.0	62.0	51.8	47.9	55.6
Lowest	31	42	44	43	46	52	54	58	57	57	45	40	31

Table D-11. Site 300 temperature, 1976-1988. (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	For the year
1984													
Highest	58	59	66	70	90	87	91	92	90	77	63	51	92
Mean Daily Maximum	46.8	51.6	57.7	59.1	71.2	76.3	86	83.9	82.9	64.3	52.8	46.2	64.9
Mean Daily	45.6	48.9	54.9	54.6	67	70.7	81.2	78	77.2	59.8	51.3	43.8	61.2
Mean Daily Minimum	44.5	46.3	52.1	50	62.9	65.1	76.4	72.1	71.6	55.3	49.7	41.4	57.3
Lowest	41	43	45	45	47	50	60	60	58	47	45	33	33
1985													
Highest	55	71	68	87	84	101	100	96	89	92	72	62	101
Mean Daily Maximum	46.1	57.6	55.6	70.3	71.1	87.5	90.9	85.4	74.5	70.8	54	54.4	68.2
Mean Daily	42.1	51.5	49.6	62.3	61.7	77.4	80.7	75.8	66.3	63.3	49.3	47.3	60.6
Mean Daily Minimum	38.1	45.4	43.5	54.3	42.3	67.3	70.5	66.1	48.1	55.7	44.5	40.1	53.0
Lowest	30	32	35	43	45	47	53	53	50	42	33	29	29
1986													
Highest	66	73	76	87	96	103	101	103	103	88	80	62	103
Mean Daily Maximum	59	62	66	69	79	86	92	95	80	76	67	53	74
Mean Daily	54	57	60	61	70	76	81	85	71	69	60	48	66
Mean Daily Minimum	49	52	54	54	61	66	70	74	62	61	54	43	58
Lowest	38	42	44	47	48	54	55	61	53	53	45	34	34
1987													
Highest	63	65	75	91	98	102	99	103	100	94	68	67	103
Mean Daily Maximum	52	58	60	75	80	86	83	89	85	77	61	54	72
Mean Daily	46	52	55	66	70	76	73	78	75	70	57	51	64
Mean Daily Minimum	41	47	49	58	59	65	64	67	66	63	53	49	57
Lowest	29	39	39	45	48	51	53	53	55	54	45	40	29

Table D-11. Site 300 temperature, 1976-1988. (Continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	For the year
1988													
Highest	64	69	84	86	98	100	109	108	108	90	76	68	109
Mean Daily Maximum	55	62	68	69	74	84	96	92	88	79	62	55	74
Mean Daily	51	56	60	61	65	74	86	81	78	71	56	50	66
Mean Daily Minimum	46	50	52	54	56	62	76	61	69	63	51	45	58
Lowest	38	40	44	44	46	48	60	55	52	51	44	33	33

Appendix E

Water Levels in Monitor Wells: Site 300

Table E-1. Water elevation for installations in the HE Process Area.

Location	Date of Measurement	Depth to Water (ft)	Water Elevation (ft/MSL)	Notes	Location	Date of Measurement	Depth to Water (ft)	Water Elevation (ft/MSL)	Notes
W-806-06A	06/06/88	126.16	695.14			09/06/89	137.93	653.89	
	07/07/88	126.24	695.07						
	08/05/88	126.42	694.88		W-809-03	09/06/89	99.48	646.59	
	09/01/88	126.28	695.03						
	10/06/88	126.35	694.96		W-810-01	04/05/88	236.94	604.09	
	11/03/88	126.43	694.88			05/03/88	237.03	604.00	
	12/05/88	126.53	694.78			06/06/88	238.94	602.09	
	01/11/89	126.62	694.69			07/07/88	236.85	604.18	
	02/08/89	126.43	694.88			08/05/88	237.67	603.36	
	03/02/89	126.09	695.22			09/01/88	237.70	603.33	
	04/04/89	126.47	694.84			10/06/88	238.35	602.68	
	05/11/89	126.32	694.99			11/04/88	238.26	602.77	
	06/08/89	126.47	694.84			11/29/88	238.10	602.93	
	07/07/89	126.72	694.59			01/11/89	238.00	603.03	
	08/10/89	126.78	694.53			02/10/89	237.86	603.17	
	09/06/89	126.70	694.61			03/02/89	237.43	603.60	
W-806-07	11/03/88			DRY		04/10/89	237.47	603.56	
	12/05/88			DRY		05/09/89	237.76	603.27	
	01/11/89			DRY		06/08/89	238.00	603.03	
	02/08/89			DRY		07/07/89	238.43	602.60	
	03/02/89			DRY		08/10/89	238.73	602.30	
	04/05/89			DRY		09/06/89	238.96	602.07	
	05/11/89			DRY	W-814-01	03/02/88	110.21	698.62	
	06/08/89			DRY		04/05/88	110.25	698.58	
	07/07/89			DRY		05/03/88	110.21	698.62	
	08/08/89			DRY		06/02/88	110.26	698.57	
	09/06/89			DRY		07/07/88	110.29	698.54	
W-809-01	04/05/88	67.18	723.05			08/04/88	110.33	698.50	
	05/03/88	69.72	720.51			09/06/88	110.39	698.44	
	06/02/88	67.46	722.77			10/06/88	110.43	698.40	
	07/07/88	67.42	722.81			11/04/88	110.49	698.34	
	08/04/88	67.65	722.58			11/30/88	110.45	698.38	
	09/01/88	67.64	722.59			01/12/89	110.51	698.32	
	10/06/88	67.63	722.60			02/10/89	110.57	698.26	
	11/03/88	67.65	722.58			03/03/89	110.58	698.25	
	11/29/88	67.73	722.50			04/12/89	110.31	698.52	
	01/11/89	67.78	722.45			05/11/89	110.30	698.53	
	02/08/89	67.80	722.43			06/07/89	110.35	698.48	
	03/02/89	67.77	722.46			07/07/89	110.38	698.45	
	04/05/89	67.78	722.45			08/09/89	110.46	698.37	
	05/11/89	67.54	722.69			09/06/89	110.33	698.50	
	06/08/89	67.52	722.71		W-815-01	03/01/88	48.59	672.52	
	07/07/89	67.72	722.51			04/05/88	48.68	672.43	
	08/10/89	67.79	722.44			05/03/88	48.70	672.41	
	09/06/89	67.65	722.58			06/02/88	48.80	672.31	
W-809-02	04/06/88	136.98	654.84			07/07/88	48.76	672.35	
	05/03/88	137.13	654.69			08/04/88	48.85	672.26	
	06/02/88	137.15	654.67			09/01/88	49.00	672.11	
	07/07/88	137.08	654.74			10/06/88	49.24	671.87	
	08/04/88	137.24	654.58			11/03/88	49.30	671.81	
	09/01/88	137.17	654.65			11/29/88	49.65	671.46	
	10/06/88	137.32	654.50			01/11/89	49.99	671.12	
	11/03/88	137.60	654.22			02/08/89	49.89	671.22	
	11/29/88	137.75	654.07			03/02/89	49.54	671.57	
	01/11/89	137.95	653.87			04/11/89	49.62	671.49	
	02/08/89	137.72	654.10			05/11/89	49.60	671.51	
	03/02/89	137.12	654.70			06/08/89	49.62	671.49	
	04/10/89	137.54	654.28			07/07/89	50.01	671.10	
	05/11/89	137.70	654.12			08/10/89	50.44	670.67	
	06/08/89	137.72	654.10			09/06/89	50.25	670.86	
	07/07/89	138.04	653.78						
	08/10/89	137.97	653.85						

Table E-1. Water elevation for installations in the HE Process Area.

Location				Location			
Date of Measurement	Depth to Water (ft)	Water Elevation (ft/MSL)	Notes	Date of Measurement	Depth to Water (ft)	Water Elevation (ft/MSL)	Notes
W-815-02				W-817-01			
03/01/88	81.49	640.86		03/02/88	133.24	640.87	
04/05/88	81.80	640.55		04/05/88	132.40	641.71	
05/03/88	81.79	640.56		05/03/88	133.52	640.59	
06/02/88	82.02	640.33		06/02/88	133.99	640.12	
07/07/88	82.08	640.27		07/07/88	134.12	639.99	
08/04/88	82.23	640.12		08/04/88	134.35	639.35	
09/01/88	82.36	639.99		09/01/88	134.50	639.61	
10/06/88	82.54	639.81		10/17/88	134.68	639.43	
11/03/88	82.77	639.58		11/03/88	134.89	639.22	
11/29/88	83.09	639.26		11/29/88	135.12	638.99	
01/11/89	83.27	639.08		01/11/89	135.19	638.92	
02/08/89	83.26	639.09		02/08/89	135.00	639.11	
03/02/89	82.95	639.40		03/02/89	134.69	639.42	
04/11/89	83.29	639.06		04/14/89	135.20	638.91	
05/11/89	83.45	638.90		05/11/89	135.00	639.11	
06/08/89	83.52	638.83		06/08/89	135.04	639.07	
07/07/89	83.80	638.55		07/07/89	135.00	639.10	
08/10/89	84.04	638.31		08/10/89	135.06	639.05	
09/06/89	83.82	638.53		09/06/89	135.66	638.45	
W-815-03				W-817-02			
03/01/88	41.10	681.36		04/05/88	104.65	597.11	
04/05/88	41.21	681.25		05/03/88	104.93	596.83	
05/03/88	41.22	681.24		06/02/88	105.13	596.63	
06/02/88	41.22	681.24		07/07/88	105.16	596.60	
07/07/88	41.17	681.29		08/04/88	105.52	595.98	
08/04/88	41.28	681.18		09/01/88	105.47	596.29	
09/01/88	41.33	681.13		10/07/88	105.79	595.97	
10/06/88	41.50	680.96		11/07/88	105.89	595.87	
11/03/88	41.60	680.86		12/05/88	106.12	595.64	
11/29/88	41.69	680.77		01/11/89	106.50	595.26	
01/11/89	41.75	680.71		02/10/89	106.70	595.06	
02/08/89	41.60	680.86		03/02/89	105.77	595.99	
03/02/89	41.31	681.15		04/14/89	106.26	595.50	
04/10/89	41.59	680.87		05/11/89	106.26	595.50	
05/11/89	41.60	680.86		06/08/89	106.35	595.41	
06/08/89	41.48	680.98		07/07/89	106.83	594.93	
07/07/89	41.87	680.59		08/09/89	107.00	594.76	
08/10/89	42.03	680.43		09/06/89	107.15	594.61	
09/06/89	41.80	680.66					
W-815-04				W-817-03			
03/01/88	76.65	646.00		03/01/88	93.20	580.71	
04/05/88	76.98	645.67		04/05/88	94.19	579.72	
05/03/88	76.93	645.72		05/03/88	94.19	579.72	
06/02/88	77.14	645.51		06/02/88	94.43	579.48	
07/07/88	77.17	645.48		07/07/88	93.71	580.20	
08/04/88	77.36	645.29		08/04/88	93.30	580.63	
09/01/88	77.42	645.23		09/01/88	92.87	581.04	
10/06/88	77.59	645.06		10/07/88	92.85	581.06	
11/03/88	77.86	644.79		11/03/88	93.23	580.68	
11/29/88	78.14	644.51		11/29/88	94.07	579.84	
01/11/89	78.29	644.36		01/11/89	94.68	579.23	
02/08/89	78.41	644.24		02/08/89	94.73	579.18	
03/02/89	77.96	644.69		03/02/89	94.42	579.49	
04/10/89	78.30	644.35		04/14/89	95.56	578.35	
05/11/89	78.50	644.15		05/11/89	95.21	578.70	
06/08/89	78.47	644.18		06/08/89	95.53	578.38	
07/07/89	78.76	643.89		07/07/89	95.99	577.92	
08/10/89	78.79	643.86		08/09/89	96.24	577.67	
09/06/89	78.71	643.94		09/06/89	96.34	577.57	
W-815-05				W-817-03A			
09/06/89	30.21	682.00		03/01/88	5.17	672.83	
				04/05/88	5.53	672.47	
				05/03/88	6.22	671.78	
				06/02/88	7.75	670.25	
				07/07/88	8.51	669.49	
				08/04/88	9.52	668.28	

Table E-1. Water elevation for installations in the HE Process Area.

Location	Date of Measurement	Depth to Water (ft)	Water Elevation (ft/MSL)	Notes	Location	Date of Measurement	Depth to Water (ft)	Water Elevation (ft/MSL)	Notes
	09/01/88	10.59	667.41		W-819-02	03/03/88	223.74	598.38	
	10/07/88	11.60	666.40			04/05/88	223.75	598.37	
	11/03/88	10.93	667.07			05/03/88	223.89	598.23	
	11/29/88	9.33	668.67			06/06/88	223.91	598.21	
	01/11/89	8.22	669.78			07/07/88	223.78	598.34	
	02/08/89	7.74	670.26			08/05/88	224.94	597.18	
	03/02/89	7.30	670.70			09/06/88	225.15	596.97	
	04/14/89	7.01	670.99			10/06/88	225.74	596.38	
	05/11/89	6.79	671.21			11/04/88	225.51	596.61	
	06/08/89	6.71	671.29			11/29/88	225.12	597.00	
	07/07/89	6.91	671.09			01/12/89	225.18	596.94	
	08/09/89	7.32	670.68			02/09/89	225.02	597.10	
	09/06/89	8.01	669.99			03/02/89	224.62	597.50	
W-817-04	03/02/88	69.82	613.37			04/12/89	224.66	597.46	
	04/05/88	69.92	613.27			05/11/89	225.23	596.89	
	05/03/88	69.84	613.35			06/07/89	225.54	596.58	
	06/02/88	69.99	613.20			07/07/89	225.96	596.16	
	07/07/88	69.82	613.37			08/08/89	226.21	595.91	
	08/04/88	70.12	612.55			09/06/89	226.92	595.20	
	09/01/88	70.23	612.96		W-829-06	03/03/88	95.92	976.37	
	10/07/88	70.39	612.80			04/06/88	95.85	976.44	
	11/03/88	70.51	612.68			05/04/88	95.73	976.56	
	11/29/88	70.61	612.58			06/02/88	95.83	976.46	
	01/11/89	70.79	612.40			07/07/88	95.91	976.38	
	02/08/89	70.75	612.44			08/05/88	95.92	976.37	
	03/02/89	70.57	612.62			09/06/88	95.78	976.51	
	04/14/89	71.06	612.13			10/10/88	96.05	976.24	
	05/11/89	71.00	612.19			11/04/88	96.31	975.98	
	06/08/89	71.14	612.05			11/29/88	96.44	975.85	
	07/07/89	71.33	611.86			01/12/89	96.46	975.83	
	08/10/89	71.55	611.64			02/08/89	96.26	976.03	
	09/06/89	71.28	611.91			03/02/89	95.78	976.51	
W-817-05	06/02/88	127.12	637.21			04/14/89	96.25	976.04	
	07/07/88	127.80	636.53			05/12/89	96.07	976.22	
	08/04/88	127.85	636.48			06/08/89	96.01	976.28	
	09/01/88	127.76	636.57			07/07/89	96.28	976.01	
	10/17/88	128.04	636.29			08/08/89	96.45	975.84	
	11/03/88	128.30	636.03			09/06/89	95.94	976.35	
	11/29/88	128.65	635.68		W-829-08	03/03/88	98.08	976.67	
	01/11/89	128.71	635.62			04/06/88	98.07	976.68	
	02/08/89	128.45	635.88			05/04/88	97.80	976.95	
	03/02/89	128.05	636.28			06/02/88	98.08	976.67	
	04/14/89	128.30	636.03			07/07/88	98.08	976.67	
	05/11/89	128.30	636.03			08/05/88	98.07	976.68	
	06/08/89	128.27	636.06			09/06/88	97.98	976.77	
	07/07/89	128.35	635.98			10/10/88	98.17	976.58	
	08/10/89	128.38	635.95			11/04/88	98.43	976.32	
	09/06/89	128.05	636.28			11/29/88	96.59	976.16	
W-817-06A	07/07/88	111.02	657.44			01/12/89	98.57	976.18	
	08/04/88	109.48	658.98			02/08/89	98.30	976.45	
	09/01/88	109.36	659.10			03/02/89	97.84	976.91	
	10/17/88	109.56	658.90			04/12/89	97.89	976.86	
	11/03/88	109.87	658.59			05/12/89	98.16	976.59	
	11/29/88	109.76	658.70			06/08/89	98.03	976.72	
	01/11/89	109.83	658.63			07/07/89	98.33	976.42	
	02/08/89	109.74	658.72			08/08/89	98.25	976.50	
	03/02/89	109.59	658.87			09/06/89	97.93	976.82	
	04/13/89	109.48	658.98		W-35C-02	05/09/89			NA
	05/11/89	109.59	658.87			06/06/89			NA
	06/08/89	109.59	658.87			07/06/89	33.87	538.93	
	07/07/89	109.85	658.61			08/08/89	71.36	501.44	
	08/10/89	109.84	658.62			09/06/89	75.36	497.44	
	09/06/89	109.74	658.72						

Appendix F

Well Construction Data: HE Process Area, Site 300

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Table has facing pages.

Table F-1. Well construction data for installations in and near the High Explosives (HE) Area.

Well designation	Type	Northing	Easting	Shiner elevation (ft/MSL)	POM elevation (ft/MSL)	Depth of screened interval (ft)	Depth of sand pack interval (ft)
W-806-06A	MW	416393.4	1706329.4	818.64	821.31	141.00 - 161.00	133.00 - 162.50
W-806-07	PIE	416394.2	1706319.6	818.18	821.18	51.00 - 57.00	42.00 - 60.00
W-809-01	MW	416097.4	1707619.1	788.23	790.23	51.40 - 70.80	47.80 - 72.00
W-809-02	MW	416106.7	1707623.7	789.15	791.82	135.00 - 150.00	117.00 - 152.00
W-809-03	MW	415931.7	1707590.2	743.40	746.07	96.60 - 111.60	93.60 - 112.10
W-810-01	MW	416034.3	1707195.4	838.37	841.03	269.30 - 289.50	249.00 - 291.00
W-814-01	MW	416009.7	1708099.3	806.16	808.83	93.40 - 108.00	91.50 - 113.50
W-815-01	MW	415694.0	1707782.4	718.11	721.11	43.00 - 48.00	41.50 - 48.80
W-815-02	MW	415683.3	1707774.2	719.35	722.35	100.00 - 115.00	91.00 - 116.00
W-815-03	MW	415807.1	1707727.3	719.45	722.46	34.20 - 39.00	31.00 - 41.00
W-815-04	MW	415798.8	1707716.8	719.65	722.65	84.50 - 99.00	83.50 - 100.00
W-815-05	MW	415855.8	1707816.7	709.55	712.21	22.50 - 32.50	19.00 - 33.00
W-817-01	MW	415546.7	1707334.4	772.11	774.11	121.00 - 144.00	112.50 - 145.00
W-817-02	MW	414972.6	1707721.8	699.76	701.76	98.50 - 132.50	86.50 - 136.00
W-817-03	MW	415017.2	1707967.8	671.90	673.91	85.00 - 119.50	76.50 - 120.00
W-817-03A	PIE	415043.9	1707959.3	675.00	678.00	4.50 - 9.50	2.00 - 9.50
W-817-04	MW	415189.7	1707899.8	680.52	683.19	60.00 - 95.00	52.50 - 99.00
W-817-05	MW	415749.5	1707056.9	761.66	764.33	143.00 - 153.00	139.50 - 153.00
W-817-06A	MW	415698.0	1707134.6	765.80	768.46	102.00 - 117.00	98.00 - 120.00
W-819-02	MW	416278.6	1707976.9	819.12	822.12	259.10 - 288.00	255.30 - 289.00
W-829-06	PIE	417202.1	1703238.5	1069.29	1072.29	76.00 - 98.00	70.50 - 99.00
W-829-08	MW	417238.7	1703252.2	1071.75	1074.75	89.50 - 109.50	83.50 - 109.50
W-35C-02	MW	414305.8	1708690.4	570.13	572.80	396.30 - 496.80	244.00 - 542.50
W-35C-03	SUP	414350.3	1708675.9	574.01	—	387.00 - 517.00	307.00 - 537.80
W-6CD	MW	414506.0	1708729.9	577.04	580.04	78.25 - 137.00	76.50 - 137.00
W-6CI	MW	414504.5	1708720.5	577.49	580.51	56.00 - 60.80	53.00 - 63.00

Type: MW, Monitor Well; PIE, Piezometer; SUP, Supply Well.

Table F-1. (Continued.)

Well diameter I.D. (in.)	Casing depth (ft)	Pump Intake depth (ft)	Maximum sustainable yield (gpm)	Pump type	HP/ voltage	Date completed notes
4.50	161.00	157.03	1.6	GRUNDFOS SP1-9	1/2HP/220V	02-Oct-86
4.50	57.00	N/A	N/A	NO PUMP	N/A	21-Aug-86
4.50	74.30	74.00	0.5	WELL-WIZZ	N/A	10-Mar-88
4.50	155.00	154.53	0.3	WELL-WIZZ	N/A	21-Mar-88
4.50	112.10	111.10		WELL-WIZZ	N/A	20-Jul-89
4.50	294.50	291.54	2.5	GRUNDFOS SP1-16	1/2HP/220V	01-Mar-88
4.50	112.80	108.03	0.3	WELL-WIZZ	N/A	14-May-87
4.50	48.00	43.50		WELL-WIZZ	N/A	27-Apr-87
4.50	115.00	112.00	2.4	GRUNDFOS SP1-9	1/2HP/220V	05-May-87
4.50	45.00	43.29	0.4	WELL-WIZZ	N/A	19-Jan-88
4.50	104.80	101.80	2.0	GRUNDFOS SP1-9	1/2HP/220V	08-Feb-88
4.50	32.50	32.35		WELL-WIZZ	N/A	26-Jul-89
4.50	144.00	140.00		GRUNDFOS SP1-9	1/3HP/110V	30-Oct-84
4.50	132.50	140.00		GRUNDFOS SP1-9	1/3HP/110V	06-Nov-84
4.50	119.50	110.99		GRUNDFOS SP1-9	1/3HP/110V	01-Nov-84
4.50	9.50	N/A	N/A	NO PUMP	N/A	07-Nov-84
4.50	95.00	86.03		GRUNDFOS SP1-9	1/3HP/110V	09-Nov-84
4.50	158.00	156.03	2.3	GRUNDFOS SP1-9	1/2HP/220V	24-May-88
4.50	122.00	120.04	0.3	WELL-WIZZ	N/A	16-Jun-88
4.50	288.00	286.00	2.3	GRUNDFOS SP1-22	3/4HP/220V	19-Dec-86
4.50	98.00	N/A	N/A	NO PUMP	N/A	18-Dec-86
4.50	109.50	105.00	0.4	WELL-WIZZ	N/A	14-Jan-87
4.00	496.80	N/A	N/A	NO PUMP	N/A	06-Feb-89
10.00	522.00	370.00	350	PEERLESS	75HP/480V	01-Apr-89
4.50	137.00	134.00	3.0	GRUNDFOS SP1-9	1/2HP/220V	16-Mar-87
4.50	60.80	58.98	1.8	GRUNDFOS SP1-9	1/2HP/220V	17-Mar-87

Appendix G

**Analytical and Sample
Handling Procedures—Laboratory QA/QC**

Appendix G. Analytical and Sample Handling Procedures—Laboratory QA/QC

This appendix includes analytical protocols for soil and rock samples and for ground water samples collected in the HE Process Area of Site 300. This information supplements the discussion in Chapter 4. It also summarizes the LLNL SOPs.

G.1. Chain-of-Custody Procedures

A sample of LLNL's Chain-of-Custody Form is included at the end of this appendix. In summary, the procedure is as follows:

- Chain-of-custody documents are prepared for all samples.
- All transfers are recorded and the completed forms stored in binders for retrieval.
- Samples are clearly labeled with the name of the well, the type of sample, the depth at which it was collected, the date, the name of the collector, and any individuals who transported the sample between the place of collection and the place of analysis.

G.2. Analyses Used in the HE Process Area

G.2.1. Analysis of Soil and Rock Samples

Soil samples are analyzed by California-certified contract analytical laboratories for VOCs and metals. There is no state certification program for analysis for HE compounds.

The samples are analyzed for VOCs according to EPA Method 8010 (EPA 8010). In some cases, EPA Method 8240 (EPA 8240) has been used. This procedure includes analyses for more substances, but does not have as low a detection level as EPA 8010.

Soil samples are analyzed for metals according to the WET specified in Section 66700, Title 22, California Administrative Code (1985), which uses a leach solution acidified to pH 5 with citric acid.

G.2.2. Analysis of Ground Water Samples

Ground water samples from the HE Process Area are analyzed by California-certified contract laboratories for two sets of analyses.

The monitoring network for the HE Surface Impoundments is sampled quarterly in compliance with Waste Discharge Order 85-188 (RWQCB, 1985). Ground water from the wells is sampled and analyzed for metals, nitrate, TOC, TOX, EPA 601, conductivity, pH, and general minerals. The water is also analyzed for tritium and HE compounds (TNT, RDX, and HMX).

Ground water from the monitor wells drilled in the course of our remedial investigations is analyzed quarterly for VOCs and HE compounds. VOCs are analyzed according to EPA Method 601 (EPA 601). At times, we have analyzed samples using EPA Methods 602 and 624 (EPA 602, EPA 624). These methods provide additional information, but with a lower detection limit.

G.3. Analytical Methods for Soil and Rock Samples: VOCs and Metals

G.3.1. Soil Analysis: VOCs

- Method: EPA 8010, 8020, 8024 (Code of Federal Regulations [CFR], 1987).
- Container: Steel or brass core tube, sealed at ends.
- Preservation: Cooler or refrigerator at 4°C.
- Field Handling: Kept in cooler with ice or under refrigeration until analyzed.

G.3.2. Soil Analysis: Metals

- Method: EP Toxicity (EPA, 1986); WET (California Administrative Code, Title 22, 1989).
- Container: Steel or brass core tube, sealed at ends.
- Field Handling: No refrigeration required; for convenience, kept in cooler until delivered to laboratory.

G.3.3. Soil Analysis: HE Compounds

- Method: High pressure liquid chromatography (HPLC) technique developed at LLNL by J. E. Clarkson (personal communications, 1988, 1989). Soil sample is disaggregated and leached in tetrahydrofuran, an organic solvent for HE compounds. Leachate is evaporated to dryness, taken up in 5 mL of methanol, and introduced to the chromatograph. The chromatogram is interpreted to establish concentrations of TNT, RDX, and HMX.
- Container: Steel or brass core tube, sealed at ends. If sample recovered is too small (less than approximately 500 mg), two or more drive samples may be composited to attain a weight of 500 g. The composited sample is stored in a clean, wide-mouthed jar; the cap is sealed with inert duct tape.
- Field Handling: No refrigeration required; for convenience, kept in cooler until delivery to laboratory.

G.4. Analytical Methods for Water Samples

G.4.1. Analyses for HE Surface Impoundment (Waste Discharge Order 85-188)

G.4.1.1. VOCs (CFR, 1987)

- Method: EPA 601, EPA 602, EPA 624.
- Bottles: 40-mL borosilicate glass bottle with Teflon-faced silicone septum in a screw-top cap.

- Preservation: Refrigeration at 4°C. EPA Method 624 requires preservation with hydrochloric acid to pH 2 for aromatic hydrocarbons.
- Field Handling: Bottles are immediately placed in a cooler with ice.

G.4.1.2. Metals (CFR, 1987)

- Method: Lead, EPA 293.2; beryllium, EPA 210.2 (CFR, 1987).
- Bottles: 500 mL polyethylene.
- Preservation: 5 mL 70% nitric acid, added immediately upon return to the laboratory.
- Field Handling: Bottles are triple-rinsed and retained in a cooler for convenience.

G.4.1.3. Gross Radioactivity (Taffet *et al.*, 1989)

- Method: Gross alpha ASTM D 1943-81 (American Public Health Association [APHA], 1987); Gross beta ASTM 1890-81 (APHA, 1987).
- Bottles: 1-L polypropylene.
- Preservation: 5 mL 70% nitric acid, added immediately upon return to laboratory.
- Field Handling: Bottles are triple-rinsed and retained in a cooler for convenience.

G.4.1.4. Tritium (Taffet *et al.*, 1989)

- Method: LLNL technique for analysis of tritium in ground water (Garrison *et al.*, 1985).
- Bottles: 30-mL scintillation vials.
- Preservation: None.
- Field Handling: No special precautions.

Routine analysis of ground water for tritium is done by liquid-scintillation counting. Low-level samples are electrolytically enriched before counting, and a single 5-mL aliquot of the enriched water is analyzed. For more details, see Taffet *et al.*, 1989, p. E-3.

G.4.2. Analysis of Ground Water Samples for Remedial Investigations

G.4.2.1. VOCs (CFR, 1987)

- Method: EPA 601, EPA 602, EPA 624.
- Bottles: 40-mL borosilicate glass bottle with Teflon-faced silicone septum in a screw-top cap.
- Preservation: Refrigeration at 4°C. EPA Method 624 requires preservation with hydrochloric acid to pH 2 for aromatic hydrocarbons.
- Field Handling: Bottles are immediately placed in a cooler with ice.

G.4.2.2. Metals

- Method: WET (California Administrative Code, Title 22, 1985).
- Bottles: 1-L plastic bottle.
- Preservation: 5 mL 70% nitric acid, added immediately upon return to laboratory.
- Field Handling: No refrigeration required. If samples will not arrive immediately at laboratory, acidify in field.

G.4.2.3. General Minerals Analysis

- Method: Cations by inductively coupled plasma (ICP) spectrography; anions by various EPA-approved wet chemistry techniques; TDS by weight; pH and conductivity by standard instruments.
- Bottles: 2 1-L plastic bottles (see note under Field Handling).
- Preservation: Added immediately upon arrival at laboratory. Nutrients require acidification to pH 2 with sulfuric acid; cations require acidification to pH 2 with nitric acid.
- Field Handling: If sample will not arrive at laboratory immediately, an additional 500-mL plastic bottle is collected for nutrients analysis. Both samples are acidified as required in the field.

G.4.2.4. HE Compounds

- Method: HPLC technique developed at LLNL by J. E. Clarkson (personal communications, 1988, 1989). Water sample is introduced directly to the chromatograph. The chromatogram is interpreted to establish concentrations of TNT, RDX, and HMX.
- Bottles: For convenience, a 40-mL borosilicate glass bottle with Teflon-faced silicone septum in a screw-top cap is used.
- Preservation: None required. For convenience, refrigerated until delivery to laboratory.

**Lawrence Livermore
National Laboratory
ENVIRONMENTAL RESTORATION
DIVISION, L-528**

P.P. Box 808, Livermore, California 94550

Analysis Requestor/ Data Recipient (circle one):

W. Isherwood-1	cc: Dreesen
W. Isherwood-2	cc: Mallon
W. Isherwood-3	cc: Boegel
A. Lamarre-1	cc: Mcllvride
A. Lamarre-2	cc: Henry
A. Lamarre-3	cc: Boegel

Sampled By _____ Company Name _____

[illegible]

Signature

Relinquished by

Received by

Relinquished by

Received by

Relinquished by

Received by

1. N = Normal Turnaround, F = 1-Week Turnaround,
R = 24-Hour Turnaround

2. Sample Type Codes: W = Water, S = Soil, VPR = Vapor, O = Other (specify).

Container Type Codes: V = VOA Bottle, P = Plastic Bottle,
G = Glass Bottle, T = Brass Tube, B = Bag,
O = Other (specify).

3. Analyze/Hold: A = Analyze, HOLD (spell out) = DO NOT ANALYZE UNLESS REQUESTED.

Revision 1.8 June 90

Pink: Leave with ERD

Yellow: Analytical Lab

White: Return to ERD

Appendix H

RDX and HMX Toxicology and Regulatory Criteria

Appendix H. RDX and HMX Toxicology

This appendix contains details of RDX and HMX toxicology and the calculations required to determine a proposed drinking water criterion and DL in soil for RDX.

The toxicity data available, about the lethal doses for 50% of a laboratory animal population (LD₅₀) for RDX and HMX, allow a qualitative comparison of the toxicities of RDX and HMX (Fig. 8.1). However, Wilson (1985), whose report is the major source of information about toxicity of HMX, did not report statistical analyses of data from studies of subchronic toxicity of HMX. For this reason, the data do not support determination of a NOEL dose. Because the drinking water criterion for HMX is calculated from the NOEL dose, we are not able to determine either a drinking water criterion or a DL for HMX.

Many of the toxicological studies discussed in this appendix make use of the concentration term mg/kg in a different sense than that used in other parts of this report, primarily in studies of concentrations of solids in soil and rock. In the toxicology studies, mg/kg means weight of the substance being tested (in mg units) divided by body weight (in kg units). It is used to normalize doses given to individual laboratory animals, with normal variations in weight between individuals in a test group, so that experimental results can be compared. In other parts of this report, the term mg/kg is used to define the concentration of a solid substance relative to soil or rock.

In the toxicological reports reviewed here, the term mg/L is used to define concentration of a solute in a solvent, for example, in defining the concentration of liquid doses when the weight of the test animal is not considered. This usage is essentially identical to the usage of the term in the other parts of this report.

H.1. Toxicology and Pharmacology of RDX

Etnier (1989) included a review of the toxicology of RDX in her article which discusses the establishment of a drinking-water criterion for RDX. We have summarized the review for this report; for additional detail, see Etnier (1989). Layton *et al.* (1987) also reviewed the literature for RDX; a part of our review is excerpted from that report.

H.1.1. Toxicokinetics

Following ingestion, RDX is slowly absorbed from the gastrointestinal tract and from across the surface of the lungs. Studies show no clinical evidence of dermal absorption (Etnier, 1989).

In laboratory animals, RDX is metabolized primarily in the liver; no intermediate metabolites have been identified. RDX does not accumulate appreciably in any tissue and is excreted in urine or exhaled as carbon dioxide (Etnier, 1989).

H.1.2. Human Toxicity

There are no controlled studies of RDX toxicity in humans, although accidental inhalation or ingestion of RDX has resulted in adverse health effects (Etnier, 1989). RDX exerts its primary toxic effect on the human central nervous system (CNS); these effects appear to be completely reversible (Etnier, 1989). Chronic RDX intoxication has been observed in munitions industry workers, where exposure resulted primarily from inhalation of RDX particles (Etnier, 1989).

An unusually high incidence among workers at a munitions plant of systemic lupus erythematosus (SLE), an immune system disorder of unknown etiology, prompted an epidemiologic study to determine if there was a correlation between exposure to explosives and onset of this disease. The epidemiologic study by Hathaway and Buck (1977) covered three plants in which individuals were exposed to RDX or to mixtures of RDX and other explosives. There were no analyses of concentrations of explosives in air. Hathaway and Buck (1977) found no statistically significant differences in blood chemistry or in the presence of antinuclear antibodies (which produce lupus symptoms) between exposed and unexposed workers.

H.1.3. Animal Toxicity

H.1.3.1. Acute Toxicity. As in humans, CNS excitation is the most prominent acute effect of RDX in most animals. Other toxic effects include gasping and labored breathing (Etnier, 1989).

Etnier (1989) summarized lethality data for RDX for various species and routes of exposure. In the rat, LD₅₀ values for RDX range from 44 to 300 mg/kg, indicating moderate to high toxicity (Etnier, 1989). Oral LD₅₀ values for the same species may differ among laboratories, depending on the physical form of the RDX and on the vehicle used to suspend or dissolve it (Schneider *et al.*, 1977). In addition, males and females of the same species may respond differently to RDX exposure (Etnier, 1989).

Sunderman (1944), in an attempt to learn whether RDX was affecting the CNS, found that Nembutal, an antispasmodic drug, prevented convulsions and death in rats.

When studies were evaluated of the neurobehavioral toxicity of acute RDX exposure, a dose-related response in schedule-controlled behavior, flavor-aversion conditioning, motor activity, and agility at 12.5 mg/kg (McPhail *et al.*, 1984, 1985) was found.

H.1.3.2. Subchronic and Chronic Exposure Studies. Brown (1975) studied rats exposed for 12 weeks to 0.3, 2.5, 6.5, or 12.5 mg/kg-d RDX. Etnier (1989) does not report the dose route. Except at the lowest dose, the treatment was found to induce time- and dose-related biphasic changes in brain monoamine oxidase, cholinesterase, and oxygen uptake. None of these effects were found in rats dosed with 0.3 mg/kg-d. This level was reported as a subchronic NOEL (Brown, 1975).

Hart (1976) conducted a two-year study of the effects of dietary intake of RDX in rats at levels of 0, 1.0, 3.1 and 10 mg/kg-d. Tests of hematology, blood chemistry, urinalysis, gross necropsies, organ weight, and histopathological examination resulted in no significant evidence of RDX toxicity. Among RDX-treated animals, no significant increase in the incidence of neoplasms was observed when compared to controls.

Levine *et al.* (1983) conducted studies to evaluate the toxicity of chronic doses of RDX. In the two-year study, RDX mixed with 3 to 10% HMX (corresponding to the composition of military-grade RDX) was administered in the diet of Fischer 344 rats at doses of 0.3, 1.5, 8.0, and 40.0 mg/kg-d. Rats given RDX at 1.5 mg/kg-d and above exhibited anemia, hepatotoxicity, possible CNS involvement, and urogenital lesions. However, the next lowest dose of RDX, 0.3 mg/kg-d, did not elicit any adverse effects. Thus under the conditions of this study, Levine *et al.* (1983) concluded that 0.3 mg/kg-d represented the NOEL for RDX. No evidence of carcinogenicity was found during this study.

Lish *et al.* (1984) studied groups of male and female mice fed RDX at doses of 1.5, 7.0, 35.0, and 100.0 mg/kg-d over a two-year period. Etnier (1989) reviewed a draft version of this report and cited it as Levine *et al.* (1984). Layton *et al.* (1990, in press) reviewed the final report and cited it as Lish *et al.* (1984). We cite it here as Lish *et al.* (1984). The RDX contained 1 to 11% HMX as an impurity, which corresponds to the mixture in military-grade RDX. Initially, the

high-dose group received RDX at 175 mg/kg-d, but increased mortality necessitated a reduction in dose to 100 mg/kg-d. The major toxic effects included hepatotoxicity, possible CNS involvement, and testicular degeneration. A possible treatment-related increase in serum triglyceride levels was observed in female mice given RDX at 35 mg/kg-d. Elevated serum cholesterol levels were observed in female mice at 35 mg/kg-d, and possibly at 7 mg/kg-d. These effects were not seen in animals that received RDX at 1.5 mg/kg-d. Based on these observations, Lish *et al.* (1984) determined that under the conditions of this study, the NOEL was 1.5 mg/kg-d of RDX. Lish *et al.* (1984) reported that there was a dose-related increase in hepatocellular carcinomas in female mice that was not statistically significant. However, the combined incidence of hepatocellular carcinomas and hepatocellular adenomas was statistically significant ($p < 0.05$) for female mice in the 7.0 and 35.0 mg/kg-d treatment groups.

H.1.4. Genotoxicity and Developmental/Reproductive Toxicity

Etnier (1989) stated that no evidence of genotoxicity or developmental/reproductive toxicity was found in various short- and long-term studies (e.g., Simmon *et al.*, 1977; Stilwell *et al.*, 1977; Cotruvo *et al.*, 1978; Cholakakis *et al.*, 1980; and Isbister *et al.*, 1984).

H.1.5. Carcinogenicity

The carcinogenicity of RDX has been studied during investigations of chronic RDX-toxicity by Hart (1976), Levine *et al.* (1983), and Lish *et al.* (1984). Refer to Section 1.1.3 for a review of the noncarcinogenic effects of chronic treatment.

Hart (1976) conducted a two-year study of the effects of dietary intake of RDX in rats at levels of 0, 1.0, 3.1, and 10 mg/kg-d. Among RDX-treated animals, no significant increase in the incidence of neoplasms was observed when compared to controls.

Levine *et al.* (1983) conducted studies to evaluate the toxicity of chronic doses of RDX. In the two-year study, RDX, mixed with 3 to 10% HMX (corresponding to the composition of military-grade RDX), was administered in the diet of Fischer 344 rats at doses of 0.3, 1.5, 8.0, or 40.0 mg/kg-d. No evidence of carcinogenicity was found in animals from any of the treatment groups (Levine *et al.*, 1983).

Lish *et al.* (1984) studied groups of male and female B6C3F1 mice fed RDX at doses of 1.5, 7.0, 35.0, and 100.0 mg/kg-d over a two-year period. The RDX contained 1 to 11% HMX as an impurity, which corresponds to the mixture in military-grade RDX. This study was performed in the same laboratory as the study reported by Levine *et al.* (1983). Lish *et al.* (1984) reported a dose-related increase in hepatocellular carcinomas in female mice that was not statistically significant. However, the combined incidence of hepatocellular carcinomas and hepatocellular adenomas was statistically significant ($p < 0.05$) for the female mice in the 7.0 and 35.0 mg/kg-d treatment groups.

Although these data indicate that high doses of RDX may be carcinogenic to mice, they have not been corroborated by other investigators. According to all other indications, RDX is not carcinogenic. Short-term tests of genotoxicity have given consistently negative results (e.g., Simmon *et al.*, 1977). Hart (1976) and Levine *et al.* (1983) found no evidence of carcinogenicity. We quote the following indented passage from Etnier's (1989) conclusions:

... the absence of an adequate dose-response curve, the high mortality rate recorded at the highest concentration tested, and contamination with HMX, as well as the absence of any other supporting data in the study by Lish *et al.* (1984) preclude the development of a carcinogenicity-based risk assessment for humans based on these data. Furthermore, no evidence of carcinogenicity was apparent in a 24-month rat study performed in the same laboratory with the same mixture of RDX/HMX (Levine *et al.*, 1983).

Etnier (1989) concluded that data are insufficient to indicate that RDX is carcinogenic, and that drinking water criteria should be based on the long-term chronic toxicity studies of Levine *et al.* (1983).

H.2. Calculation of Drinking Water Criterion

Carcinogenicity data from human or animal tests are insufficient to derive a water quality criterion based on a nonthreshold, low-dose extrapolation procedure. There are also no human studies suitable for estimating a NOEL. Therefore, Etnier (1989) based calculations of a human health criterion on the long-term studies in rats that were administered RDX (mixed with 3 to 10 percent of HMX) in the diet at concentrations of 0.3, 1.5, 8.0, and 40.0 mg/kg-d (Levine *et al.*, 1983). These criterion are discussed in detail in the following paragraphs. Etnier also reviewed other studies in which a NOEL was reported.

H.2.1. No-Observed-Effects-Level (NOEL) Dose

Several reports (Brown, 1975; Levine *et al.*, 1983; and Lish *et al.*, 1984) have identified NOEL doses of RDX. These reports are discussed in Section F.1.1.3, and the discussion of toxicity is not repeated here. The information about NOEL doses is summarized.

Brown (1975) studied rats exposed to RDX in the diet for 2 to 12 weeks at 0.3, 2.5, 6.5, and 12.5 mg/kg-d RDX. Toxic effects did not occur in rats dosed with 0.3 mg/kg-d RDX, but did occur in rats at higher doses. The lowest level, 0.3 mg/kg-d RDX, was reported as a NOEL under the conditions of this study.

Levine *et al.* (1983) reported studies of chronic exposure of rats to RDX. Rats given RDX at 1.5 mg/kg-d and above exhibited toxic effects. However, the next lowest dose of RDX, 0.3 mg/kg-d, did not elicit any adverse effects, and Levine *et al.* (1983) concluded that, under the conditions of this study, 0.3 mg/kg-d represented the NOEL for RDX.

Lish *et al.* (1984) studied groups of male and female mice fed RDX at doses of 1.5, 7.0, 35.0, and 100.0 mg/kg-d over a two-year period. The RDX contained 1 to 11% HMX as an impurity, which corresponds to the mixture in military-grade RDX. Toxic effects occurred at doses above 1.5 mg/kg-d. These effects were not seen in animals that received RDX at 1.5 mg/kg-d. Based on these observations, Lish *et al.* (1984) determined that under the conditions of this study, 1.5 mg/kg-d represented the NOEL for RDX.

On the basis of the toxicity studies that defined apparent NOELs for RDX, Etnier (1989) selected the lowest value of 0.3 mg/kg-d RDX from a long-term study (Levine *et al.*, 1983) as the most conservative NOEL.

H.2.2. Derivation of the Water-Quality Criterion and Designated Level for RDX

Etnier (1989) used the same methodology outlined to estimate water-quality criteria for protecting human health (U.S. Environmental Protection Agency [EPA], 1980) to estimate a water-quality criterion for RDX.

Using the NOEL value selected, 0.3 mg/kg-d RDX, and an uncertainty factor of 100, an acceptable daily intake (ADI) for a 70-kg human can be calculated as follows:

$$ADI = \frac{70 \text{ kg} \times \text{NOEL (mg/kg-d)}}{\text{uncertainty factor}} = 0.21 \text{ mg/d} \quad (\text{Eq. H-1})$$

where:

an uncertainty factor of 10 was used to account for interspecies variability, and an additional factor of 10 is used to adjust for intraspecies variability (EPA, 1987).

Given an ADI of 0.21 mg/d, the human health criterion for RDX in drinking water can be calculated from the expression:

$$C = \frac{ADI - (DT + IN)}{2 \text{ L/d} + (0.0065 \text{ kg/d} \times 1 \text{ L/kg} \times BCF)} \quad (\text{Eq. H-2})$$

where:

- C = Water quality criterion, mg/L;
DT = Dietary nonfish intake, assumed to be 0 mg/d;
IN = Inhalation intake, assumed to be 0 mg/d;
1 L/kg = Conversion factor (a close approximation);
2 L/d = Daily water intake;
0.0065 kg/d = Daily dietary fish intake; and
BCF = Bioconcentration factor, assumed to be 4.7 (dimensionless)
by Bentley *et al* (1977).

Using EPA methodology (EPA, 1980), Etnier (1989) calculated a suggested ambient water-quality criterion for RDX of 103 µg/L, which protects the health of the general population as well as sensitive individuals who ingest RDX-contaminated water and fish. This value was adjusted to 105 µg/L for ingestion of drinking water alone.

H.2.3. Determination of Designated Level (DL) for RDX

DLs are concentrations of waste constituents that provide a site-specific indication of the waste's potential to impair ground water quality. If measured concentrations of contaminants in soil and rock exceed the DLs, the soil or rock is assumed to pose a water quality threat at the site in question. Site 300 DLs for metals and TCE are shown earlier in Chapter 8, Tables 8.1.1-1 and 8.1.1-2.

The DL is determined by:

1. Specifying the bodies of water potentially affected by the waste.
2. Selecting the water quality goals that protect the potential beneficial uses of the water.
3. Determining the magnitude of environmental attenuation that would be expected to occur at the site.

The nearest body of water to be protected in the HE Process Area is the first regional water-bearing zone. It lies at least 100 ft beneath the land surface, except in the immediate vicinity of Building 815, where depth to the regional water table aquifer is slightly less. For RDX, the water quality goal selected is Etnier's (1989) suggested drinking water criterion of 105 µg/L.

The DL was determined by using Marshack's (1989) technique. We selected the RDX drinking water criterion, 105 µg/L (ppb) RDX, as our water quality goal. The attenuation factor used was 100, the value Marshack (1987) proposed for an "average" site. We calculated the DL

for RDX by multiplying the drinking water criterion for RDX (105 µg/L) by the attenuation factor (100). Therefore the DL is 10.5 mg/kg (ppm) RDX.

The attenuation factor used is clearly very conservative for Site 300, where permeability and porosity are much lower than at the LAAP. The depth to ground water at Site 300 is generally substantially greater than at the LAAP. Higgins (1988) agrees that "the hydrogeology in the HE Process Area will attenuate pollutant migration much more than the 'average' attenuation."

H.3. Toxicology and Pharmacology of HMX

The literature contains very few studies of HMX toxicity. Much of our information is from Layton *et al.* (1987). We reviewed Wilson's (1985) report itself.

McNamara *et al.* (1974) studied the toxicity of HMX dissolved in the organic solvents dimethylsulfoxide (DMSO), cyclohexanone, and acetone. Details are specified in Section 2.1.1.1. The solvents were used because of the low solubility of HMX in water. However, it is not likely that dry HMX, or HMX in an aqueous solution, would elicit the same adverse effects because of the limited absorption and low aqueous solubility of the explosive.

Most of Wilson's (1985) studies were made with HMX in aqueous solution, or with small amounts of organic solvents. Wilson (1983) reported many of his results without stating the results of statistical testing. We have complete confidence only in the results accompanied by statistical tests at a specified level of confidence. Some of Wilson's (1985) results are reported as quantitative values, but no confidence level is specified. Wilson reported a second set of his results in qualitative terms, such as "significantly" and "slight increase." We have less confidence in these two sets of data and treat them with caution.

Wilson (1985) reported other data in conditional language; these data appear to be estimates made only to bracket dose ranges for use in subsequent studies of HMX. We consider these values to be estimates only and do not compare them with other results.

H.3.1. Pharmacology and Toxicology

H.3.1.1. Toxicokinetics

H.3.1.1.1 Absorption. Wilson (1985) measured HMX levels in the plasma of mice and rats that had received a single oral dose of radiolabeled HMX. A peak plasma concentration of 6 to 10 mg/L was observed after an oral dose of 500 mg/kg. The time course was similar in both species, and peak concentrations in plasma were reached 6 h after ingestion. According to Wilson (1985), the plasma level was "extremely low in relation to dose" and the quantity of HMX in the plasma did not increase "significantly" with dose. However, Wilson (1985) did not report the level of statistical significance.

McNamara *et al.* (1974) found substantial differences in the toxicity of HMX to dogs, depending upon the route of exposure. In general, dermal applications of HMX (17.5 mg/kg in acetone, 21.9 mg/kg in cyclohexanone, and 289.0 mg/kg in DMSO) did not produce consistent and predictable physiological alterations. Intravenous administration of HMX (1.55 or 1.1 mg/kg in DMSO) caused changes in electroencephalograph (EEG) and electrocardiograph (EKG) readings, blood pressure, and heart rate. Absorption of HMX by rats and guinea pigs appears to be similar to that in dogs. At high concentrations in lipophilic solvents (i.e., 1.0 mL HMX [33 percent in DMSO]) HMX can penetrate the skin in amounts great enough to cause death in rabbits. Some deaths in guinea pigs also were recorded after single dermal applications of 465 to 546 mg/L HMX, presumably in DMSO (McNamara *et al.*, 1974).

H.3.1.1.2 Distribution. Reports of organ toxicity (McNamara *et al.*, 1977; Wilson, 1985) following exposure to HMX indicate that this substance can reach the heart, CNS, immune system, liver, and kidneys. Wilson (1985) also noted that following oral (500 mg/kg) or intravenous (2.0 mg/kg) administration of HMX to rats, the highest concentrations were found in the liver and kidneys, and the lowest concentrations, in the brain.

H.3.1.1.3 Metabolism and Elimination. Wilson (1985) reported that fecal elimination (75 to 80% of the dose recovered in the feces) was the dominant route of excretion after oral administration of ¹⁴C-HMX at doses of 500 mg/kg to rats and mice over a four-day period. When ¹⁴C-HMX was given intravenously to rats at a dose of 2.0 mg/kg over a four-day period, urinary excretion (61%) was predominant. Wilson (1985) stated that these data imply that HMX is poorly absorbed after oral dosing.

H.3.2. Human Toxicity

We found no studies of HMX toxicity in humans.

H.3.3. Animal Toxicity

H.3.3.1. Acute Toxicity. McNamara *et al.* (1974) reported that, at high concentrations in lipophilic solvents (i.e., 1.0 mL HMX [33 percent in DMSO]), a single application of HMX can penetrate the skin in amounts great enough to cause death in rabbits. Some deaths in guinea pigs also were recorded after single dermal applications of 465 to 546 mg/L HMX.

H.3.3.1.1 Acute toxicity (LD₅₀) in rats and mice. Wilson (1985) presented results of several acute toxicity (LD₅₀) studies in rats and mice. We report four tests in rats and mice and two in rabbits.

1. In a study of acute HMX oral toxicity, Wilson (1985) administered HMX by gavage as a suspension in 0.5% aqueous carboxymethylcellulose to Fischer 344 rats. The median oral lethal dose (LD₅₀) with 95% confidence limits for rats were calculated to be:

Males:	6.49 (5.98-6.99) g/kg
Females:	7.59 (6.88-8.31) g/kg
Males and females:	7.36 (6.89-7.83) g/kg

Wilson (1985) stated that HMX may be considered practically nontoxic to rats.

2. Wilson (1985) administered HMX by gavage as a suspension in 0.5% aqueous carboxymethylcellulose to B6C3F1 mice. The LD₅₀ with 95% confidence limits were calculated to be:

Males:	1.96 (1.69-2.22) g/kg
Females:	3.81 (3.43-4.20) g/kg
Males and females:	2.71 (2.48-2.94) g/kg

Wilson (1985) considers HMX to be slightly toxic to mice.

3. Wilson (1985) administered an intravenous dose of HMX (in DMSO) to Fischer 344 rats. Wilson calculated the LD₅₀ to be:

Males	25.1 (23.0-27.4) mg/kg
Females	38.1 (32.3-43.9) mg/kg

Wilson did not state explicit confidence levels for these data.

4. Wilson (1985) applied HMX as a suspension in physiological saline solution under an occlusive dressing to the abraded skin of Fischer 344 rats. He reported that: "The ... LD₅₀ dose is greater than 5.0 g/kg body weight."

H.3.3.1.2 *Acute toxicity in rabbits.*

1. HMX was applied as a suspension in physiological saline solution or in carboxymethylcellulose under an occlusive dressing to the skin of rabbits. Wilson (1985) stated that:

The percutaneous median lethal doses (with 95% confidence limits) were calculated to be:

Males (nonabraded):	634 (532-736) mg/kg
Males (abraded):	674 (562-785) mg/kg
Females (nonabraded):	719 (596-842) mg/kg
Females (abraded):	1337 (415-1759) mg/kg
Males and females (nonabraded/abraded):	982 (861-1103) mg/kg

2. Wilson (1985) reported the results of acute HMX toxicity in rabbits. HMX was administered by gavage as a suspension in 0.5% aqueous carboxymethylcellulose. Wilson stated: "In males, the oral LD₅₀ might be between 100 and 250 mg/kg (ppm), while in females it might be less than 50 mg/kg." Wilson reported no statistical analysis of these results.

On the basis of the test of dermal toxicity, we conclude that HMX has low toxicity in rabbits.

H.3.3.2. Subchronic Toxicity. Wilson (1985) conducted subchronic (13-week) toxicity studies of RDX in the diet of rats and mice. Male rats were given 50, 150, 450, 1350, and 4000 mg/kg-d HMX, and for female rats the doses were 50, 115, 270, 620, and 1500 mg/kg-d HMX. "Significant" effects to livers (enlarged centrilobular cells) were observed in males at dose rates of 150 mg/kg-d HMX and above. Kidney effects (focal atrophy and dilation) were observed in females at dose rates of 270 mg/kg-d HMX or more. Wilson did not provide statistical levels of significance for these data.

In another 13-week study, male mice were given at 0, 5, 12, 30, 75, and 200 mg/kg-d HMX, and the females, 0, 10, 20, 90, 250, and 750 mg/kg-d HMX (Wilson, 1985). Laboratory studies of the mice did not reveal any major differences between the treated animals and the control groups. At the highest dose rate (200 mg/kg for males, 250 or 700 mg/kg-d), mortality was high (13/20 males, 20/20 females).

Wilson (1985) did not identify a NOEL for either rats or mice, and no statistical tests were reported for comparisons between the control groups and the treatment groups.

H.3.3.2.1 *Hepatic Effects.* Wilson (1985) reported centrilobular degeneration of the liver of male rats fed a high dose (an average of 8504 mg/kg-d) of HMX for 14 days. In the same study, female rats fed somewhat smaller doses (1280 to 3474 mg/kg-d of HMX) exhibited hepatocyte hyperplasia.

Wilson (1985) also reported "significant increases" in levels of alkaline phosphatase in rats fed high dosages of HMX (4000 mg/kg-d in males, 1500 mg/kg-d in females) in the diet relative to controls; However, after 7 weeks, only the females continued to have abnormally high levels of the enzyme. In a 90-day experiment, Wilson found that a "significant" number of male rats

fed high dosages of HMX (between 450 and 4000 mg/kg-d) developed enlarged centrilobular liver cells. Wilson also found that alanine aminotransferase and alkaline phosphatase activity were "slightly depressed" in male rats treated with moderate doses (5 to 200 mg/kg-d) of HMX. Mice that died before the completion of a 14-day treatment period with HMX (100 to 5000 mg/kg-d) had a dose-related increase in the incidence of hepatocellular hyperplasia (Wilson, 1985).

H.3.3.2.2 Renal Effects. Wilson (1985) found that blood urea levels were "significantly" elevated and that elevated levels of albumin occurred in both male and female rats given HMX in their diet at 1500 mg/kg-d for 13 weeks. Male rats fed 4000 mg/kg-d of HMX excreted abnormal amounts of albumin in their urine after five weeks of treatment. Localized atrophy of the kidney tubules was noted in female rats fed 270 to 1500 mg/kg-d of HMX for 13 weeks. Female rats also exhibited a dose-related increase in kidney weight.

H.3.3.2.3 Dermal Effects. Wilson (1985) indicated that a suspension of HMX in physiologic saline solution (to a concentration of 60%) was "mildly irritating" to the skin of rabbits.

H.3.3.2.4 Ocular Effects. Wilson (1985) reported that dry HMX, or HMX in distilled water (60% suspension), was "practically non-irritating" to the eyes of rabbits.

H.3.3.2.5 Cardiovascular Effects. McNamara *et al.* (1974) reported vascular collapse and death in dogs after a single intravenous dose of 40 mg/kg of HMX in DMSO.

H.3.3.2.6 Central Nervous System Effects. Wilson (1985) reported that mice of both sexes given 5 to 750 mg/kg-d HMX in the diet for 13 weeks had slightly higher brain weights than untreated controls.

H.3.3.2.7 Hematological Effects. During weeks 5 and 12 of a 13-week feeding study, Wilson (1985) observed a decrease in hemoglobin levels in high-dose male and female rats (4000 and 1500 mg/kg-d). In the 12th week, animals of both sexes developed a "slight increase" in the levels of methemoglobin and had a reduced red blood cell count.

H.3.3.2.8 Immune System Effects. Wilson (1985) found no evidence that HMX caused allergic sensitization in animals. Female rats fed HMX daily for 14 days (Wilson, 1985) displayed lymphocyte depletion in the thymus and spleen. The daily dose was not clearly specified; although the rats belonged to the group exposed to 9000 mg/kg-d, the author reported that the actual average dose was 3055 mg/kg-d. Similar abnormalities were observed in female rats that died before the end of the 14-day treatment period. These animals had received doses of either 1280 or 3474 mg/kg-d. A dose-related depletion of thymic and splenic cells was also found in mice given 100 to 5000 mg/kg-d of HMX over 14 days. These effects apparently were found only in animals that died before the end of treatment.

H.3.4. Genotoxicity or Developmental/Reproductive Toxicity

Simmon *et al.* (1977) evaluated the mutagenicity of compounds found in rinse water from munitions plants. HMX was tested in the rinse water both before any treatment and again after the rinse water was treated with chlorine for purification. HMX (0.25 mL) was tested in the Ames assay with *Salmonella typhimurium*, and in a separate series of tests, HMX (0.005 to 0.25 mL) was allowed to react with 10 to 1000 mL of chlorine before testing of *S. typhimurium*. HMX did not significantly increase the frequency of reverse mutations in any of the tests.

H.3.5. Teratogenicity and Carcinogenicity

There are no data on the teratogenicity or carcinogenicity of HMX.

H.4. HMX: Drinking Water and Designated Level Assessments

H.4.1. No-Observed-Effects-Level (NOEL) Dose

Wilson (1985) did not identify a NOEL for HMX in his 13-week studies of subchronic toxicity in rats and mice, and he failed to provide any statistical analysis of the significance of his results. This lack of statistical testing of the data precludes selection of a NOEL from his data.

H.4.2. Drinking Water Criterion

Because the data do not support determination of a NOEL, calculation of a drinking-water criterion is not possible.

H.4.3. Designated Level Assessment

Because it is not possible to determine a drinking water criterion, we cannot determine a DL.

Site 300

Carnegie
(Site)

BM 539

33

34

HOLLOW

Carnegie
(Site)

BM 539

33

34

HOLLOW

Pit 7 Complex

1000 1200 1400 1600 1800 2000

Plate 2. Topographic map

Plate 2. Topographic map of Site 300 and surroundings.

Scale : Miles

Scale : Feet

Scale : Meters

Contour interval in T.3S. is 20 feet
Contour interval in T.4S. is 40 feet

Lithologic Units

Qa	Qls
----	-----

Surficial deposits

Qa; alluvium
Qls; landslide debris

Unconformity

Qot
Qoa

Older alluvium

Qot; younger terrace alluvium
Qoa; older alluvium, dissected, locally deformed

Unconformity

Tps
Tpc

Nonmarine sedimentary rocks

Tps; weakly indurated light gray pebble conglomerate, sandstone, greenish clay, and gray mudstone, beds of marl and sand.

Local Unconformities

Tpc; mostly greenish clay, with minor amounts of conglomerate and sandstone

Tn

Neroly Formation

Tn; continental-estuarine blue to gray sandstone, locally pebbly, interbeds of claystone siltstone and conglomerate

Holocene

Pleistocene

QUATERNARY

Pliocene

TERTIARY

Site 300

stone-coarse, locally
pebbly, fossiliferous

Unconformity

Tts

Tesla Formation

Tts; shallow marine fine-grained sandstone and siltstone, white to tan arkosic sandstone and sandy siltstone; contains pebbly beds and thin coal beds locally

Econo

Unconformity

Great Valley Sequence

Km

Moreno shale

Km; marine clay shale

Kps

Great Valley Sequence

Panoche Formation

**Kps; marine and light gray
arkosic sandstone,
with large concre-
tions and some inter-
bedded micaceous
minor clay shale**

Upper Crobeaceous

CRETACEOUS

**Coast Range Thrust
(Fault contact)**

18

1c

Franciscan Assemblage

(Pervasively sheared, slightly metamorphosed marine sedimentary sequence)

fs; sandstone (gray-wacke), and interbedded micaceous shale

fc; varicolored chart

Jurassic and/or Lower Cretaceous

JURASSIC AND/OR CRETACEOUS

Legend

Geologic Symbols

Plate 1. Geologic map of Site 300 and surroundings (modifi

dashed where gradational
or approximately located

Fault

dashed where inferred; dotted where con-
cealed; queried where existence doubtful;
double arrows indicate strike-slip movement;

U - upthrown side

D - downthrown side relatively

anticline

syncline

Axis of fold

arrow on axis indicates
direction of plunge

Inclined

Inclined
(approximate)

vertical

overturned

foliation

Strike and dip of strata

spring

sandstone bed

fossil locality

microfossil
locality

geologic map of Site 300 and surroundings (modified from Dibblee 1980a, b, c & d).

END

DATE FILMED

12 / 12 / 90