# ATTACHMENT H

# ENVIRONMENTAL PERFORMANCE STANDARDS

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## LIST OF ABBREVIATIONS/ACRONYMS

| | |
|---|---|
| 20.4.1 NMAC | New Mexico Administrative Code, Title 20, Chapter 4, Part 1 |
| AQB | Air Quality Bureau |
| cm | centimeter(s) |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| ESR | LANL's annual environmental surveillance report |
| ft | feet/foot |
| HE | high explosives |
| HEWTF | HE Wastewater Treatment Facility |
| LANL | Los Alamos National Laboratory |
| MDA | Material Disposal Area |
| µg/L | micrograms per liter |
| mg/L | milligrams per liter |
| NMED | New Mexico Environment Department |
| NPDES | National Pollutant Discharge Elimination System |
| OB | open burning |
| OSHA | Occupational Safety and Health Administration |
| pCi/L | picocuries per liter |
| RCRA | Resource Conservation and Recovery Act |
| RDX | cyclonite (hexahydro-1,3,5-trinitro-1,3,5-triazine) |
| SWPP | Storm Water Pollution Prevention |
| TA | technical area |
| TNT | 2,4,6-trinitrotoluene |

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# ATTACHMENT H
# ENVIRONMENTAL PERFORMANCE STANDARDS

## H.1 ENVIRONMENTAL PERFORMANCE STANDARDS [20.4.1 NMAC § 264.601]

The Technical Area (TA) 16 open burning (OB) units are located in a remote area of Los Alamos National Laboratory (LANL). The units are operated and maintained and will be closed in a manner that will continue to ensure protection of human health and the environment, in accordance with the New Mexico Administrative Code, Title 20, Chapter 4, Part 1 (20.4.1 NMAC) § 264.601, revised June 14, 2000 [6-14-00]. Land use patterns in the Los Alamos area are shown on Map 1 in the most recent version of the "Los Alamos National Laboratory General Part A Permit Application." Discussions of the hydrogeology in the region of TA-16, protection of the groundwater/vadose zone, protection of surface water/wetlands and the soil surface, protection of the atmosphere, and routes and pathways of exposure are presented in this attachment.

The TA-16 OB units are designed to facilitate safe handling and treatment of wastes to prevent adverse human health and environmental impacts. Design information and waste management practices for these units are detailed in Attachment G. The waste analysis plan for the OB units is included as Appendix B in the most recent version of the "Los Alamos National Laboratory General Part B Permit Application," hereinafter referred to as the LANL General Part B. A description of emergency response actions to be taken to minimize adverse impacts of unanticipated events is presented in Attachment E of this permit renewal application and Appendix E of the LANL General Part B.

## H.2 HYDROGEOLOGY IN THE REGION OF TA-16

### H.2.1 Geology

TA-16 is immediately underlain by the Pleistocene Bandelier Tuff, which outcrops in a few places on the mesa top and is exposed along canyon walls (LANL, 1999). During late 1998 and 1999, Well R-25 was drilled approximately 1,000 feet (ft) west of the TA-16 OB units. This borehole penetrated the Bandelier Tuff units and the underlying Puye Formation to a depth of 1,942 ft (LANL, 2000). Well R-25 was drilled through 383 ft of the Tshirege Member of the Bandelier Tuff (Broxton et al., 2002). This member is a chemically-zoned ignimbrite that exhibits complex zones of welding and crystallization, and is subdivided into four cooling units.

Tephras and volcaniclastic sediments of the Cerro Toledo interval underlie the Tshirege Member at the R-25 location, where it extends from a depth of 384 ft to 509 ft (Broxton et al., 2002). This formation consists of vitric, tuffaceous, sandy silt, which was likely deposited within a fluvial environment. The Otowi Member of the Bandelier Tuff underlies the Cerro Toledo interval at the R-25 location, and consists of massive, poorly consolidated, vitric, non-welded ash-flow tuff from 509 ft to 843.8 ft (Broxton et al., 2002). The lowermost 6.7 ft of the Otowi Member, which occurs at a depth of 843.8 to 850.5 ft at R-25, is the Guaje Pumice Bed. At this location, the Guaje Pumice Bed deposit consists of stratified pumice beds, lithic beds that include quartzose sandstone, and fine ash beds. At the base of the Otowi Member, the Puye Formation extends from 850.5 ft to the bottom of the borehole at a depth of 1,942 ft (Broxton et al, 2002). The Puye Formation at R-25 is an alluvial fan deposit consisting primarily of coarse clastic rocks derived from dacitic to rhyodacitic units of the Tschicoma Formation that outcrop in the Jemez Mountains.

The TA-16 OB units are located on the mesa top, which is composed of Unit 4l of the Tshirege Member of the Bandelier Tuff (Lewis et al., 2002). Geologic mapping and detailed core descriptions suggest that the TA-16 OB units are underlain by approximately 40 to 50 ft of Unit 4l. This subunit, the basal part of Unit 4, consists of poorly- to moderately-welded, crystal- and pumice-poor ignimbrites. Unit 4l in the vicinity of the TA-16 OB units is underlain by about 7 to 20 ft of Unit 3T, which is a moderately- to densely-welded ignimbrite in this area (Lewis et al., 2002). Below Unit 3T is Unit 3 of the Tshirege Member, which is at least 110 ft thick at nearby Material Disposal Area (MDA) P and extends to below the bottom of Cañon de Valle. Here, it is a non-welded to densely-welded ignimbrite, and locally contains crystal-rich surge deposits (Lewis et al., 2002).

### H.2.2 Structure

The Pajarito fault zone defines the regional setting of the TA-16 OB units. This fault zone is a bounding fault of the Rio Grande rift and is described by Gardner et al. (2001). The main escarpment of the Pajarito fault is west of the TA-16 administrative area along the western boundary of TA-16, and faulting and related deformation extends at least 5,000 ft to the east to the approximate location of the TA-16 OB units. Grabens and monoclinal folds are common

within the Pajarito fault zone, and the tensional upper hinge zones of the monoclines are typically associated with open-fissure networks (Gardner et al., 2001; Lewis et al., 2002).

The TA-16 OB units are located 420 ft south-southeast and 700 ft south, respectively, of MDA P at TA-16. MDA P lies at the transition from a graben structure to the west and a bedrock promontory to the east (Lewis et al., 2002). The TA-9 graben identified by Lewis et al. (2002) is defined just west of MDA P by a series of north-trending faults. The eastern boundary is defined by a pair of faults with down-to-the-west displacement, and the western boundary is defined by a fault with down-to-the-east displacement (Lewis et al., 2002). Within the graben, springs feed the Cañon de Valle stream. Five small faults at MDA P associated with the fracture zone on the west side were identified; however, the lack of stratigraphic markers prevented an estimate of the displacement along these faults. Even so, the displacement was thought to be small because the fault traces averaged only about 16 ft. On the west side of MDA P, the local high-fracture density suggested a small amount of horizontal extension over possible deep-seated normal faults (Lewis et al., 2002).

### H.2.3 Surficial Deposits

Surficial deposits at TA-16 consist of coarse-grained colluvium on steep hill slopes and along the bases of cliffs, finer-grained alluvial and colluvial sediments with a thin cover of eolian sediments on the flatter parts of mesa surfaces, and alluvial to colluvial fan deposits at the mouths of steeper drainages or on escarpments related to post-Bandelier faulting (LANL, 1999). Deposits in Cañon de Valle and Water Canyon consist of colluvial materials on and at the base of cliffs and canyon walls and fluvial sediments deposited by intermittent streams along the axes of the canyon floors (LANL, 1999).

A wide variety of soil types occur at TA-16 (Nyhan et al., 1978). These include both clayey-skeletal and fine Typic Eutroboralfs from 46 to over 122 centimeters (cm) thick, Tocal very fine sandy loam (28 to 36 cm thick), Frijoles very fine sandy loam (46 to more than 152 cm thick), Pogna fine sandy loam (13 to 30 cm thick), Totavi gravelly loam (0 to 152 cm thick), Sanjue-Arriba complex (46 to 153 cm thick), Typic Ustorthents (15 to 35 cm thick), and Carjo loam (51 to 102 cm thick) (Nyhan et al., 1978). According to Nyhan et al. (1978), soils at the TA-16 Burn Ground consist of Tocal very fine sandy loam, with low to moderate permeability and low water-

holding capacity. Soils at TA-16, which are generally thicker in the western portions of the TA, grade into rock outcrops along the margins of the mesa tops. In the soil zone previously described by Nyhan et al. (1978) as Tocal very fine sandy loam, nine soil profiles were subsequently characterized on the north and south slopes of Cañon de Valle near the TA-16 Burn Ground (McDonald et al., 1996). This work suggests that soil horizons range from 40 to 237 cm in depth, the soils are poorly developed, and they consist of A-R, A-Bw-R, or A-Bw-C soil profiles. The work also indicated that the soils are classified as Lithic Ustorthents, Typic Haplumbredt, Cumulic Haplumbredt, Typic Ustochrept, and Udic Paleoustalf (McDonald et al., 1996).

### H.2.4 Groundwater

Groundwater elevation measurements suggest that groundwater flows from the Jemez Mountains east and southeast toward the Rio Grande, where a portion discharges into the river through seeps and springs. The hydraulic gradient of the regional aquifer averages about 60 to 80 ft per mile within the Puye Formation but increases to 80 to 100 ft per mile along the eastern edge of the Pajarito Plateau as the groundwater enters the less permeable sediments of the Santa Fe Group. In the upper section of the regional aquifer, the rate of movement of groundwater varies, depending on the materials in the aquifer. Groundwater travel time between Well R-25 and a distance equal to that of the nearest water supply well, PM-2, is estimated to range from 50 to 200 years, based on the plateau-wide average groundwater flow rates of between 95 and 345 ft per year determined by Purtymun (1995). Although actual groundwater flow rates and flow direction in the vicinity of Well R-25 are not yet known, modeling efforts are ongoing to refine travel times to the supply wells.

The full range of recharge rates at TA-16 has probably not been identified. However, existing data clearly show that there is a wide range of rates in the mesas and canyons at TA-16. For example, chloride mass balance-based estimates suggest that rates are on the order of only a few millimeters per year in some mesa locations (Newman, 1999). However, the presence of localized saturation and high explosives (HE) contamination below 100 ft in the mesas suggests that recharge rates may be relatively rapid in other locations (LANL, 1998a). In addition, the presence of HE below 700 ft in Well R-25 demonstrates that recharge to the 747-ft-deep intermediate perched aquifer can occur within a 50 year timeframe (Broxton et al., 1999).

There are three main factors that may control rapid recharge. The first factor is the existence of ponded water on the mesas (e.g., historical and current ditches and ponds) and the perennial reach of Cañon de Valle. These localized surface water areas create higher hydraulic heads and higher hydraulic conductivities in the subsurface. The second factor is that strongly welded tuff units occur on the western part of the Pajarito Plateau. These units have low matrix conductivities, but can have high fracture conductivities. Contaminant distributions and tracer studies support the importance of fracture pathways at TA-16 (LANL, 1998a). The third factor is the close proximity of TA-16 to the Pajarito Fault (LANL, 1998a). The fault is considered a possible significant recharge pathway to the regional aquifer and pathways related to faulting could extend into TA-16.

Based on drilling results for the R-25 well at TA-16, located approximately 1,000 ft west of the TA-16 OB units, the depth to the regional aquifer at R-25 is 1,286 ft (Broxton et al., 2002). At the R-25 well, the intermediate perched aquifer was encountered at a depth of 747 ft, followed by an interval of alternating wet and dry conditions to a depth of 1,286 ft, where it is believed that regional saturation is encountered and continues to the total depth (1,942 ft) of the well (Broxton et al., 2002). The upper saturated zone had a static level of 711 ft (Broxton et al., 2002). Groundwater samples collected from R-25 at depths ranging from 747 to 1,942 ft were found to contain HE compounds and their associated degradation products. The two contaminants of most concern are cyclonite (RDX) and 2,4,6-trinitrotoluene (TNT) because they exceeded U.S. Environmental Protection Agency (EPA) health advisory limits (0.61 micrograms per liter [µg/L] for RDX and 2.2 µg/L for TNT) for drinking water (Broxton et al., 2002). Down-gradient drinking water-supply wells were also sampled but found to contain no HE; the closest drinking water-supply well to R-25 is three miles to the east (LANL, 1999). Discharges from past HE-manufacturing activities at TA-16 are believed to be the source of the constituents found in Well R-25.

At the TA-16 Burn Ground, 17 boreholes up to 200 ft deep were drilled in 1987 (Boreholes P-0 through P-16); tuff samples recovered during drilling operations were not saturated (LANL, 1988). In 1997, thirteen moderate-depth boreholes were drilled near the TA-16-260 outfall (Boreholes 16-2655 through 16-2667) and no perennial saturated zone was encountered

(LANL, 1999). Moderate-depth boreholes drilled near Martin Spring and the 90s-Line Pond encountered saturated zones that dried up one month after drilling (LANL, 1999). In 1993, Well SHB-3 on the western side of TA-16 contained perched aquifer water at a depth of 664 ft. The R-25 well contained a thick perched zone that extended from a depth of 747 ft to 1,286 ft, and this zone is hypothesized to correlate with the saturated zone observed in SHB-3 (LANL, 1999).

An extensive near-surface alluvial system is present in Cañon de Valle (LANL, 1999). During the fall of 1997, six alluvial wells were drilled at five locations at TA-16 (LANL, 1999). Four of these well locations are in Cañon de Valle; the remaining well location is in the steam plant drainage area. Depths to tuff ranged from 4 to 6 ft, and all five locations contained saturated intervals at depths starting from 1 to 3 ft (LANL, 1999). These wells are sampled quarterly. However, the wells are sited to measure impacts from the TA-16-260 outfall and are located in Cañon de Valle above the point where the TA-16 Burn Ground runoff enters the canyon. Therefore, these data are not pertinent to the TA-16 Burn Ground.

In August 2001, six boreholes were drilled in the vicinity of MDA P, which is north of the TA-16 OB units. These boreholes (Boreholes 257, 273, 516, 526, 554, and 557) were drilled to provide continuous core for sample material to investigate the potential for residual contamination in the bedrock and for lithologic and fracture descriptions of the bedrock beneath MDA P. In addition, these boreholes were drilled to provide for geophysical measurements and to measure water levels. All six boreholes were dry, with no water observed during or after drilling; they were filled with grout and abandoned in October 2001. A more detailed summary of these boreholes is presented in Annex III of “Material Disposal Area P Area Closure Certification Report: Material Disposal Area P, 387 Flash Pad, and SWMU 16-016(c)-99” (LANL, 2003).

Three perennial springs and two seeps have been identified within TA-16 (LANL, 1999). All three springs appear to discharge from near the Tshirege Member Unit 3/Unit 4 contact, and their presence suggests the existence of one or more shallow perched zones beneath TA-16.

Recent geophysical studies performed as part of the TA-16-260 corrective measures study suggest that conductive (and possibly water-bearing) zones are more prominent in the western sections of TA-16 (west of MDA P and the TA-16 OB units) and that these zones are localized and sub-vertical. Intermediate-depth (800 to 1,000 ft) boreholes to be drilled in the near future will address this issue.

### H.2.5 Surface Water

Perennial and intermittent surface water exists at many locations at TA-16 due to both natural and anthropogenic sources (LANL, 1999). Surface water occurs primarily as ephemeral streams in the two major canyons adjacent to TA-16; however, perennial water flow does occur in a reach of Cañon de Valle due to spring and seep discharge (LANL, 1993). This reach begins near the TA-16-260 outfall. Its length varies seasonally and, depending on discharges, extends up to approximately 7,000 ft downstream.

The topography in the southern portion of the TA-16 Burn Ground directs runoff into a side canyon of Cañon de Valle, the Fish Ladder drainage. This drainage intersects the Cañon de Valle drainage about a mile downstream of the TA-16 Burn Ground. A possible outfall-associated wetlands, probably as a result of past operations at the TA-16-340 HE Formulation Building, is located southeast of the TA-16 OB units in the Fish Ladder drainage.

### H.2.6 Hydrologic Conceptual Model

In the wetter areas of TA-16 (i.e., before the sumps connected to the TA-16-260 outfall were plugged), surface water run-off (primarily from the outfalls) and infiltration into soil and tuff are hypothesized to be the most important hydrologic transport pathways (LANL, 1999). Run-off can mobilize contaminants and transport them off site or concentrate dispersed surficial contaminants through solution and reprecipitation or sorption processes (LANL, 1999). The principal contaminants at TA-16 are HE and barium; HE is slightly soluble and barium is moderately to strongly soluble, depending on its form. Both may be transported in surface water (LANL, 1999). It is now recognized that the perennial, contaminated reach of Cañon de Valle down gradient from the TA-16-260 outfall is mobilizing contaminants down gradient (LANL, 1999). Surface water run-off from TA-16 either flows from ephemeral streams on the mesa tops into Cañon de Valle and Water Canyon and ultimately into the Rio Grande, or

infiltrates down gradient and recharges perched aquifers in the region (LANL, 1999). Most of the contaminants observed in TA-16 surface waters are attributed to the TA-16-260 outfall (LANL, 1999).

Fluid transport via perched alluvial aquifers to springs and seeps is an important mechanism for contaminant transport at TA-16 (LANL, 1999). Infiltration into the subsurface may occur by porous flow into the soil, alluvium, and bedrock, and by flow through fractures that intersect bedrock surfaces. Water may accumulate within units of the Bandelier Tuff, especially in units overlying more densely welded units, retarding downward transport. Water may also move laterally within the tuff in response to gradients on the welded horizons until it is able to move downward through the tuff or along fractures. More heavily welded units of the tuff may fracture more readily than intervening porous units, thus promoting transport of contaminants through the tuff.

## H.3 PROTECTION OF GROUNDWATER/VADOSE ZONE [20.4.1 NMAC § 264.601(a)]

The TA-16 OB units are located in a semiarid, temperate, mountain climate. In 2002, total precipitation in Los Alamos at the TA-6 station was 11.71 inches, and the average precipitation for the period from 1971 through 2002 was 18.58 inches (TA-6 is located approximately 3,500 ft north of TA-16). In the vicinity of the TA-16 OB units, the regional aquifer is at a depth of 1,286 ft, and the extensive uppermost intermediate perched aquifer is at a depth of 747 ft. Small-scale shallow perched zones, which discharge at the springs, are located at approximate depths of 80 to 110 ft at the Tshirege Member Unit 3/Unit 4 contact. Collectively, the depth to the regional aquifer and the low annual precipitation significantly limit the potential for contaminants resulting from the TA-16 OB operations to migrate through the vadose zone to the regional aquifer, which is the only aquifer in Los Alamos known to be capable of supplying municipal and industrial water users. No drinking water supply wells are located within the boundary of TA-16 or within 3,500 ft of the TA-16 OB units.

A detailed description of the hydrogeology in the TA-16 region is provided in Section H.2. Much of the information presented in that section was obtained from the R-25 well, which was proposed in the site-wide “Hydrogeologic Workplan” (LANL, 1998b). The workplan was developed to address the requirements of the Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments of 1984. It was approved by the

New Mexico Environment Department (NMED) in March 1998. Implementation of the workplan is intended to characterize the hydrogeology of the LANL facility, including TA-16; establish detection monitoring programs; and provide potential monitoring capabilities, should they be deemed necessary and appropriate.

## H.4 PROTECTION OF SURFACE WATER/WETLANDS AND THE SOIL SURFACE [20.4.1 NMAC § 264.601(b)]

As stated previously, net annual precipitation for the Los Alamos area, including the site of the TA-16 OB units, is low. Perennial and intermittent surface waters exist at many locations at TA-16 due to both natural and anthropogenic sources. The locations of these surface waters, including intermittent streams, are shown on Figure A-5 in Attachment A. In Cañon de Valle, perennial water flow occurs in a reach from near the TA-16-260 outfall and extends up to approximately 7,000 ft downstream. The topography in the southern portion of the TA-16 Burn Ground directs runoff into a side canyon of Cañon de Valle, the Fish Ladder drainage, which intersects the Cañon de Valle drainage about a mile downstream of the TA-16 Burn Ground. A possible outfall-associated wetlands is located southeast of the TA-16 OB units in the Fish Ladder drainage.

The TA-16 OB units are part of the University of California/U.S. Department of Energy (DOE) National Pollutant Discharge Elimination System (NPDES) Multi-Sector General Permit for storm water discharges associated with industrial activity (current Permit Numbers NMR05A509 and NMR05A510, effective January 1, 1999). A Storm Water Pollution Prevention (SWPP) Plan, as required by the NPDES Multi-Sector General Permit and the Baseline General Permit, has been developed for the TA-16 Burn Ground. The plan identifies any potential pollutants and provides pollution prevention or control methods to prevent the discharge of pollutants in storm water runoff at the units and the surrounding area. Under the SWPP Plan, the facility is required to implement best management practices to reduce the likelihood of pollutants entering the storm water discharges. The plan includes storm water run-on/runoff measures for active units as well as erosion control (e.g., rock check dams) to prevent dispersion of legacy contamination and sediments (see Figure A-9 in Attachment A). To maintain compliance with the NPDES Multi-Sector General Permit, site inspections and an annual compliance evaluation are conducted at the TA-16 Burn Ground to evaluate the effectiveness of the SWPP Plan. The compliance evaluations are documented in a report that describes any major observations,

incidents of noncompliance with the SWPP Plan, corrective actions, and any observations or changes made with respect to the SWPP Plan.

Storm water from the TA-16 Burn Ground flows into the Fish Ladder Drainage and can become contaminated by mobilizing either material deposited during current OB operations or contamination remaining from past practices, referred to as legacy contamination. Modeling of current OB operations, described in Supplement H-1, demonstrates that only very low levels of contaminants are released (or deposited) during current operations. Other impacts to soils from ongoing operations are minimized through the waste management practices described in Section G.2 of Attachment G and with the storm water run-on and runoff controls described in Section 2.7 of this permit renewal application. The other, more likely, source of potential storm water contamination is legacy contamination. Supplement 4-1 describes past operations at SWMUs and resultant contamination.

Contaminants in stormwater down gradient of the TA-16 Burn Ground are measured at station E257, which is part of LANL's Storm Water Monitoring Station Network. Station E257, shown on Figure H-1, became operational in July 2002. LANL collects samples quarterly to meet the permit conditions in the NPDES Multi-Sector General Permit and to include in LANL's annual environmental surveillance report (ESR). Because 2002 was a drought year, sufficient runoff for sampling occurred only in the third calendar year quarter. The first sample, taken on September 4, 2002, was analyzed for the specific constituents required by the NPDES Multi-Sector General Permit. The second sample, taken on September 9, 2002, was analyzed for the constituents of interest for the ESR, mainly trace radioactive and non-radioactive metals. Although most of the analytes are not RCRA-regulated, all the data are presented for informational purposes in Tables H-1 and H-2. Additional storm water data will be posted on the LANL website as it becomes available. The NPDES-required stormwater data are provided to EPA quarterly in Discharge Monitoring Reports. The ESR results are published annually.

The Fish Ladder Drainage has also been affected by an existing and a closed NPDES-permitted outfall. The existing outfall is the HE Wastewater Treatment Facility (HEWTF), located adjacent to the TA-16 Burn Ground. The HEWTF primarily treats HE-contaminated wastewater from HE-processing buildings. The second outfall is the inactive TA-16-340 outfall [Solid Waste

Management Unit 16-003(o)]. TA-16-340 was an HE-formulation building and discharged solvent-contaminated waste to the Fish Ladder Drainage for many years. Its operations are described in Supplement 4-1. LANL's Environmental Restoration Project has collected water quality samples both at a seep within the drainage and at the confluence of the Fish Ladder Drainage and Cañon de Valle. The data are presented in Table H-3. These data represent impacts from NPDES-permitted sources and contain constituents that are not regulated by RCRA; they are included in this attachment for informational purposes and to describe the surface water quality in the vicinity of the TA-16 Burn Ground.

## H.5 PROTECTION OF THE ATMOSPHERE

The predominant exposure pathway for open burning of reactive wastes is inhalation of airborne products of complete and incomplete combustion. The NMED's Air Quality Bureau (AQB) regulates the air emissions from the TA-16 OB units under a permit issued under 20.2.60 NMAC, "Open Burning" (current Permit No. TA-16-OB-2003, effective January 1, 2003). To obtain a permit under 20.2.60 NMAC, LANL submitted a permit application containing the following information (which also satisfies 20.4.1 NMAC requirements) for this pathway:

- The type and quantity of material to be burned. This meets the requirements of 20.4.1 NMAC § 264.601(c)(1) [6-14-00];
- The methods that will be used to ignite, maintain, and control the burning. This meets the requirements of 20.4.1 NMAC § 264.601(c)(3) [6-14-00]; and
- An ambient air quality impacts analysis at the nearest off-site receptor modeled with a Gaussian plume model using site-specific meteorology, topography, and worst-case emissions estimates. This meets the requirements of 20.4.1 NMAC § 264.601(c)(4) [6-14-00].

The NMED AQB's open burning program recognizes that engineering controls are not available to prevent air emissions of hazardous constituents from OB units. Instead, the program evaluates the methods of burning and relies on burning under good atmospheric dispersion conditions to minimize hazardous emissions impacts. Thus, this program also meets the requirements of 20.4.1 NMAC § 264.601(c)(2) [6-14-00]. Burning must take place under atmospheric conditions (e.g., stability and wind speed/direction) that favor dispersion. However, winds cannot be so high that significant amounts of ash would become windborne. Figures A-6

and A-7 in Attachment A of this permit renewal application show the wind roses for TA-6 and TA-49, where the wind observation towers closest to the TA-16 OB units are located.

In 1990, the National Park Service, the NMED, and LANL began joint operation of an ambient air quality monitoring station at the nearest off-site receptor, Bandelier National Monument. This monitoring site operated for three (3) years. NMED's AQB determined, based on the monitoring information and the impacts assessment, combined with knowledge of local air quality conditions, that air quality standards would not be exceeded. Air quality standards are set to protect human health (primary standards) and welfare (secondary standards). Secondary standards take into account the health and ecological impacts to domestic animals, wildlife, crops, vegetation, and physical structures. The open burning program meets the requirements of 20.4.1 NMAC § 264.601(5), (6), and (7) [6-14-00]. The AQB requires no monitoring of open burning at the TA-16 Burn Ground.

## H.6 ROUTES AND PATHWAYS OF EXPOSURE

Two populations could potentially receive exposures from waste or residuals managed at the TA-16 OB units: 1) the on-site workers and environment; and 2) the off-site public and environment. They could be impacted through three routes of exposure:

- dermal (skin or other covering),
- ingestion (eating or drinking), and
- inhalation (breathing).

Although typical pathways include air, soil, and water, the only realistic pathway for ongoing operations at the TA-16 OB units is air, as discussed below. Legacy contamination from past uses of the area is being addressed through the RCRA corrective action process, which will include a formal risk assessment.

### H.6.1 Dermal Exposure

Dermal exposure occurs when chemicals directly contact an organism's skin or other covering. This route is potentially important for workers because they can be exposed when they handle wastes or residues. The Occupational Safety and Health Administration (OSHA) is the federal

agency responsible for protecting workers. OSHA requires that three types of controls be considered: protective equipment; administrative controls; and engineering controls. Protective equipment and administrative controls are the primary controls for worker protection at the TA-16 OB units. Engineering controls are used to prevent migration of wastes and residues from the units to the environment.

Workers at the TA-16 OB units are required to wear protective equipment when handling waste or residues. The type and level of protective equipment are chemical and hazard specific. Typically, for a low hazard waste, coveralls, safety glasses, gloves, and steel-toed shoes or boots are worn. For a higher hazard waste, goggles, face shields, respirators, rubber aprons, or other protective clothing are donned, as needed. This required use of protective equipment prevents any direct contact with waste, eliminating dermal exposure as an important route of exposure for workers.

Administrative controls also protect workers from all routes of exposure. Wastes are typically handled in small amounts for safety purposes. For instance, the maximum amount of liquids that can be treated at the TA-16-388 Flash Pad is approximately 100 gallons, but this waste type is usually burned in batches of 5 to 25 gallons to maximize worker safety and minimize exposure. Workers leave the area as soon as the waste is staged and occupy a protective shelter (the TA-16-389 Control Building) during burning. The Control Building is located a minimum of 300 ft from the nearest OB unit. Burns are ignited remotely from this shelter and workers observe the burns by remote cameras. They may not approach the unit until they can visually verify the destruction of HE or determine by thermocouple data that HE has been completely decomposed.

The dermal route becomes important for the on-site environment and off-site public and environment only if the pathways are contaminated and contaminants are transported away from the TA-16 OB units to receptors. The remote location of the units decreases this risk; only a major spill that could not be cleaned up quickly could potentially migrate from the units. The release potential is managed by minimizing the amounts of wastes handled. In the event of a spill, solid HE would contact the soil surface and would be removed immediately. While up to

1,000 pounds of bulk HE can be managed, it is rare that this amount is handled at one time; burns more typically involve less than 100 pounds of explosive. Large pieces of HE-contaminated equipment (e.g., a lathe or an HE oven) may be handled, but these have low levels of contamination and are easily retrieved if dropped. Solids and liquids are handled in separate structures of the TA-16 OB units; thus, there is no opportunity for them to commingle and be transported in a liquid waste stream.

Engineering controls have been installed at the OB units to prevent migration of wastes or residues into the environment. They primarily include precipitation covers and secondary containment. The precipitation covers are used as follows:

- The TA-16-388 Flash Pad is covered between burns unless sampling, ash removal, or waste staging requires that the cover be moved. Two types of covers may be used. One type is a large retractable cover (see Figures G-3 and G-4 in Attachment G); the second includes tarps or other types of covers (e.g., a removable cover similar to that used at the TA-16-399 HE Burn Tray).

- The TA-16-399 HE Burn Tray is covered between burns, unless an ash sample is being taken, ash is being removed, or HE is being staged. A moveable cover (see Figure G-5 in Attachment G) or tarp may be used.

Secondary containment is provided for the TA-16-388 Flash Pad. The secondary containment is designed to prevent any downward or lateral migration of potential leakage from/through the concrete pad. The base of the flash pad is 12 inches thick with integrally-poured 8-inch-thick walls. The entire flash pad is contained in a 45 mil Hypalon liner (6 inches below the bottom of the pad and curved up to ground level on all 4 sides, 2 ft out from the pad perimeter). The pad was designed and constructed with a quarter-inch drop/ft towards the back of the pad to contain precipitation in case an unexpected rain event occurs during flashing. For safety purposes, the pad cannot be approached for 8 hours after a burn unless it can be visually confirmed that all HE is destroyed. Water build-up on the pad as a result of precipitation is removed with the HE wastewater (vacuum) truck and treated at the HEWTF. HE-contaminated solvents are burned on the flash pad in a stainless-steel tray, inside a second tray which provides additional containment. The containment devices are visually inspected for cracks or other signs of leaking daily during operation or weekly if no operations occur that week.

The combination of having only a small amount of chemicals at risk at any one time, the ability to rapidly respond to spills, and engineered controls ensures that there is no realistic pathway for dermal exposure of off-site receptors.

### H.6.2 Ingestion

Ingestion may be an important route of exposure if foodstuffs or drinking water becomes contaminated. The contamination may occur from deposition of airborne contaminants, uptake of pollutants from soil by plants, or from contact of pollutants with water. On-site workers are not affected because food and drink may not be consumed in the vicinity of the treatment units (both an OSHA and DOE requirement). Crops are not grown on site. The nearest locations where crops may be grown are in gardens in the communities of Los Alamos and White Rock, which are approximately 2.5 and 6 miles away, respectively. Off-site soil and water contamination are not viable pathways for the same reasons discussed under dermal exposure; transport off site is limited by administrative and engineering controls. Small amounts of air pollutants generated during burning could be carried from the site and deposited on foodstuffs and water. However, the modeling discussed in Supplement H-1 shows that deposition from TA-16 Burn Ground operations is minimal. This potential release pathway is reviewed and mitigated, if necessary, when air quality standards and burning conditions are set, as described in the following discussion of the inhalation exposure route.

### H.6.3 Inhalation

As with the other pathways, OSHA requires workers to be protected from unhealthy exposure to air emissions and publishes occupational exposure standards. Worker exposure is kept below these standards through the use of protective equipment and administrative controls, as described under the dermal route of exposure.

Airborne exposure to the public and environment is regulated by NMED's AQB under 20.2.60 NMAC, "Open Burning." The AQB's open burning program evaluates the methods of burning and relies on burning under good atmospheric dispersion conditions to minimize hazardous emissions impacts. The AQB requires that a source estimate emissions from the burning of wastes, model impacts, and compare the impacts to federal and New Mexico primary and secondary air quality standards. Primary standards set limits to protect public health, including

the health of “sensitive” populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. These standards take into account not only direct impacts from air pollutants but also from deposition of pollutants on the surfaces, uptake into plants, and other indirect impacts. Thus, these standards already account for human health and ecological risks.

Air quality standards are based on short-term (1-, 3-, 8-, or 24-hours) or long-term (monthly or annual) averages of pollutant concentrations. Because burning at the TA-16 OB units is intermittent and is almost always completed within an hour, the short-term averages are more restrictive. This influences the type of model and the input to the models. Depending on the source characteristics, the Laboratory currently uses one of two EPA-approved Gaussian plume models: SCREEN3 or ISC3.

The basic input parameters required for the models are:

- The source term for each pollutant (emission factors) in pounds per hour;
- Type of emission point (area source, volume source, or point source);
- Emission point dimensions;
- Emission point height above ground;
- Gas flow rate out of the emission point;
- Emission gas temperature;
- Ambient air temperature;
- Location, size, and height of adjacent buildings (to account for plume cavitation effects);
- Wind speed;
- Atmospheric stability (the vertical temperature structure of the atmosphere);
- Ceiling (inversion) height (how high above the ground the mixing depth extends);
- Receptor distance (the distance from the emission point that impacts are estimated, any distance or array of distances can be specified); and
- Receptor height above or below the emission point.

The meteorological information remains constant for modeling impacts from both of the TA-16 OB units, but the source term will depend on the types and maximum amounts of material burned at each unit. The physical information for the units will also vary. Because short-term air quality standards are the most restrictive for this source, “event” rather than “long-term” modeling is performed. The time to complete each burn will vary by unit and the waste being treated, but it is rarely more than an hour. Therefore, only 1- and 3-hour impacts are modeled, unless otherwise requested by the AQB. The models are run in the “rural” mode.

SCREEN3 uses simplified worst-case meteorological input that is designed to overestimate impacts. For instance, actual wind speeds and directions are not input. Instead, the wind is assumed to blow directly toward receptors at a low speed for the entire modeling period. EPA estimates that SCREEN3 overestimates impacts by 110% for 3-hour modeling, 142% for 8-hour modeling, 250% for 24-hour modeling, and 1250% for annual modeling (EPA, 1992). The advantage of using SCREEN3 is that modeling is simple and fast.

If the open burning source shows acceptable impacts with SCREEN3, no further modeling is performed. Otherwise, a more reasonable estimate of impacts is made with ISC3. The basic difference between SCREEN3 and ISC3 is that ISC3 uses actual facility wind rose data (wind direction, length of time in that direction, and wind speed).

Model selection and input must be approved by the AQB. The AQB reviews the results of modeling, assures that no standards will be exceeded, and places restrictions on the meteorological conditions under which burning can occur.

Restrictions may also be placed upon burns if fire danger is high. High fire danger occurs after prolonged dry periods when fuel moisture is very low and fine dead fuels ignite readily. If burns are conducted during high fire danger periods, special precautions, such as having the fire department stand by, are taken.

A report submitted annually to the NMED AQB summarizes burn location, burn type, burn date, fuel type, and fuel quantity. An estimate of total annual air emissions is also provided.

LANL has minimized the air impacts by both reducing the amount of waste burned and reengineering the units to burn more effectively and with lower emissions. The biggest source of air emissions in the past was from wood used as the fuel for flashing and for destroying HE in oils and solvents. In 1999, this practice was discontinued and propane was substituted. This change resulted in reduction of air emissions by an order of magnitude. With the change to propane, oils and solvents could be burned using propane burners positioned above the waste. This increases the destruction efficiency of vapors. Other significant reductions occurred by modifying processes to filter and reuse water contaminated with HE. Pollution prevention is an ongoing program at the Laboratory.

## H.7 REFERENCES

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## Table H-1

## NPDES Surface Water Sampling Data from Sampling Station E257 (9/4/02)

| Analyte | Result | Unit of Measure | Preparation Code |
|---|---|---|---|
| Silver | U | | UF |
| Arsenic | U | | UF |
| Cadmium | U | | UF |
| Cyanide (Total) | 0.00537 | milligrams per liter (mg/L) | UF |
| Chemical Oxygen Demand | 227 | mg/L | UF |
| Mercury | U | | UF |
| Magnesium | 3.72 | mg/L | UF |
| Ammonia – as Nitrogen | 0.36 | mg/L | UF |
| Lead | 27 | micrograms per liter (ug/L) | UF |
| Selenium | U | | UF |

U = The analyte is classified as “non-detected”.
UF = Unfiltered sample.

## Table H-2

## ESR Surface Water Sampling Data from Sampling Station E257 (9/9/02)

| Analyte | Result | Unit of Measure | Preparation Code |
|---|---|---|---|
| Max TSS | 1110 | milligrams per liter (mg/L) | UF |
| Tritium | U | | UF |
| Lead-210 | U | | F |
| Strontium-90 | U | | F |
| Lead-210 | 7.79 | picocuries per liter (pCi/L) | UF |
| Strontium-90 | 0.432 | pCi/L | UF |
| Americium-241 | U | | F |
| Polonium-210 | U | | F |
| Plutonium-238 | 0.191 | pCi/L | F |
| Plutonium-239/240 | U | | F |
| Thorium-228 | U | | F |
| Thorium-230 | U | | F |
| Thorium-232 | U | | F |
| Uranium-234 | 0.0852 | pCi/L | F |
| Uranium-235/236 | U | | F |
| Uranium-238 | U | | F |
| Americium-241 | U | | UF |
| Polonium-210 | 1.15 | pCi/L | UF |
| Plutonium-238 | U | | UF |
| Plutonium-239/240 | U | | UF |
| Thorium-228 | U | | UF |
| Thorium-230 | U | | UF |
| Thorium-232 | 0.0826 | pCi/L | UF |
| Uranium-234 | 0.863 | pCi/L | UF |
| Uranium-235/236 | U | | UF |
| Uranium-238 | 0.878 | pCi/L | UF |
| Radium-228 | U | | F |
| Radium-228 | 2.26 | pCi/L | UF |
| Radium-226 | 0.544 | pCi/L | F |
| Radium-226 | 3.38 | pCi/L | UF |
| Actinium-228 | U | | F |
| Americium-241 | U | | F |
| Barium-133 | U | | F |
| Beryllium-7 | U | | F |
| Bismuth-211 | U | | F |

## Table H-2 (Continued)

## ESR Surface Water Sampling Data from Sampling Station E257 (9/9/02)

| Analyte | Result | Unit of Measure | Preparation Code |
|---|---|---|---|
| Bismuth-212 | U | | F |
| Bismuth-214 | U | | F |
| Cadmium-109 | U | | F |
| Cerium-139 | U | | F |
| Cerium-141 | U | | F |
| Cerium-144 | U | | F |
| Cobalt-57 | U | | F |
| Cobalt-60 | U | | F |
| Chromium-51 | U | | F |
| Cesium-134 | U | | F |
| Cesium-137 | U | | F |
| Europium-152 | U | | F |
| Europium-154 | U | | F |
| Iron-59 | U | | F |
| Gross gamma | U | | F |
| Mercury-203 | U | | F |
| Iodine-133 | U | | F |
| Potassium-40 | U | | F |
| Manganese-54 | U | | F |
| Sodium-22 | U | | F |
| Niobium-95 | U | | F |
| Neptunium-237 | U | | F |
| Neptunium-239 | U | | F |
| Protactinium-231 | U | | F |
| Protactinium-233 | U | | F |
| Protactinium-234M | U | | F |
| Lead-211 | U | | F |
| Lead-212 | U | | F |
| Lead-214 | U | | F |
| Radium-223 | U | | F |
| Radium-224 | U | | F |
| Radium-226 | U | | F |
| Radium-228 | U | | F |
| Rhodium-106 | U | | F |
| Radon-219 | U | | F |
| Ruthenium-103 | U | | F |
| Ruthenium-106 | U | | F |
| Antimony-124 | U | | F |
| Antimony-125 | U | | F |
| Selenium-75 | U | | F |

## Table H-2 (Continued)

## ESR Surface Water Sampling Data from Sampling Station E257 (9/9/02)

| Analyte | Result | Unit of Measure | Preparation Code |
|---|---|---|---|
| Tin-113 | U | | F |
| Strontium-85 | U | | F |
| Thorium-227 | U | | F |
| Thorium-231 | U | | F |
| Thorium-234 | U | | F |
| Thallium-208 | U | | F |
| Uranium-235 | U | | F |
| Uranium-238 | U | | F |
| Yttrium-88 | U | | F |
| Zinc-65 | U | | F |
| Zirconium-95 | U | | F |
| Actinium-228 | U | | UF |
| Americium-241 | U | | UF |
| Barium-133 | U | | UF |
| Beryllium-7 | U | | UF |
| Bismuth-211 | U | | UF |
| Bismuth-212 | U | | UF |
| Bismuth-214 | U | | UF |
| Cadmium-109 | U | | UF |
| Cerium-139 | U | | UF |
| Cerium-141 | U | | UF |
| Cerium-144 | U | | UF |
| Cobalt-57 | U | | UF |
| Cobalt-60 | U | | UF |
| Chromium-51 | U | | UF |
| Cesium-134 | U | | UF |
| Cesium-137 | U | | UF |
| Europium-152 | U | | UF |
| Europium-154 | U | | UF |
| Iron-59 | U | | UF |
| Gross gamma | U | | UF |
| Mercury-203 | U | | UF |
| Iodine-133 | U | | UF |
| Potassium-40 | U | | UF |
| Manganese-54 | U | | UF |
| Sodium-22 | U | | UF |
| Niobium-95 | U | | UF |
| Neptunium-237 | U | | UF |

## Table H-2 (Continued)

## ESR Surface Water Sampling Data from Sampling Station E257 (9/9/02)

| Analyte | Result | Unit of Measure | Preparation Code |
|---|---|---|---|
| Neptunium-239 | U | | UF |
| Protactinium-231 | U | | UF |
| Protactinium-233 | U | | UF |
| Protactinium-234M | U | | UF |
| Lead-211 | U | | UF |
| Lead-212 | 11.8 | pCi/L | UF |
| Lead-214 | 11.2 | pCi/L | UF |
| Radium-223 | U | | UF |
| Radium-224 | U | | UF |
| Radium-226 | U | | UF |
| Radium-228 | U | | UF |
| Rhodium-106 | U | | UF |
| Radon-219 | U | | UF |
| Ruthenium-103 | U | | UF |
| Ruthenium-106 | U | | UF |
| Antimony-124 | U | | UF |
| Antimony-125 | U | | UF |
| Selenium-75 | U | | UF |
| Tin-113 | U | | UF |
| Strontium-85 | U | | UF |
| Thorium-227 | U | | UF |
| Thorium-231 | U | | UF |
| Thorium-234 | U | | UF |
| Thallium-208 | U | | UF |
| Uranium-235 | U | | UF |
| Uranium-238 | U | | UF |
| Yttrium-88 | U | | UF |
| Zinc-65 | U | | UF |
| Zirconium-95 | U | | UF |
| Gross alpha | U | | F |
| Gross beta | 6.52 | pCi/L | F |
| Gross alpha | 206 | pCi/L | UF |
| Gross beta | 317 | pCi/L | UF |

F = Filtered sample.
UF = Unfiltered sample.
U = The analyte is classified as “non-detected”.

## Table H-3

## Fish Ladder Seep Surface Water Sampling Data

| Analyte | Sample Value in Micrograms per Liter | Qualifier (see Footnotes) |
|---|---|---|
| Confluence of Cañon de Valle and Fish Ladder Canyon (12/13/99) | | |
| Barium | 120 | |
| Iron | 4300 | |
| Uranium | 0.333000004 | |
| Total Phosphorus | 110 | |
| Alkalinity-$HCO_3$ | 52000 | |
| Sodium | 12000 | |
| Calcium | 9300 | |
| Magnesium | 3700 | |
| Potassium | 3500 | |
| Manganese | 190 | |
| Sulfate | 2700 | |
| Fluoride | 170 | |
| Tritium | 24 | |
| Aluminum | 6500 | |
| Chloride | 12000 | |
| Nickel | 4 | J |
| Boron | 42 | J |
| Cobalt | 1.700000048 | J |
| Vanadium | 7.300000191 | J |
| Lead | 2.700000048 | J |
| Chromium | 3.700000048 | J |
| Arsenic | 3.199999809 | J |
| Beryllium | 1.100000024 | J |
| Iron | 2000 | |
| Magnesium | 3200 | |
| Manganese | 14 | |
| Calcium | 8700 | |
| Sodium | 11000 | |
| Potassium | 3000 | |
| Aluminum | 3400 | |
| Barium | 71 | J |
| Cobalt | 1.399999976 | J |
| Vanadium | 3.5 | J |
| Boron | 10 | J |
| Chromium | 2 | J |

## Table H-3 (Continued)

## Fish Ladder Seep Surface Water Sampling Data

| Analyte | Sample Value in Micrograms per Liter | Qualifier (see Footnotes) |
|---|---|---|
| Confluence of Cañon de Valle and Fish Ladder Canyon (3/29/00) | | |
| Potassium | 4400 | |
| Zinc | 38 | |
| Vanadium | 16 | |
| Sodium | 11000 | |
| Perchlorate | 7.78000021 | |
| Fluoride | 422 | |
| Chloride | 14000 | |
| Barium | 150 | |
| Uranium | 0.495000005 | |
| Sulfate | 2470 | |
| Alkalinity-$HCO_3$ | 44000 | |
| Manganese | 65 | |
| Magnesium | 4200 | |
| Iron | 13000 | |
| Calcium | 7900 | |
| Lead | 5.599999905 | |
| Nickel | 6.800000191 | J |
| Beryllium | 1.299999952 | J |
| Chromium | 9.300000191 | J |
| Cobalt | 2.099999905 | J |
| Copper | 5.199999809 | J |
| Selenium | 4.099999905 | J+ |
| Aluminum | 18000 | J+ |
| Barium | 120 | |
| Zinc | 31 | |
| Iron | 10000 | |
| Lead | 4 | |
| Magnesium | 3700 | |
| Calcium | 7400 | |
| Sodium | 11000 | |
| Potassium | 4000 | |
| Vanadium | 13 | |
| Manganese | 46 | |
| Nickel | 5.5 | J |
| Arsenic | 3.299999952 | J |
| Beryllium | 1 | J |

## Table H-3 (Continued)

## Fish Ladder Seep Surface Water Sampling Data

| Analyte | Sample Value in Micrograms per Liter | Qualifier (see Footnotes) |
|---|---|---|
| Chromium | 7.699999809 | J |
| Cobalt | 2.5 | J |
| Copper | 4.300000191 | J |
| Antimony | 4 | J |
| Aluminum | 15000 | J+ |
| Confluence of Cañon de Valle and Fish Ladder Canyon (4/25/01) | | |
| Fluoride | 236 | |
| Tritium | 155.519989 | |
| Sulfate | 23000 | |
| Chloride | 5130 | |
| Barium | 343 | |
| HMX | 2.700000048 | |
| RDX | 0.939999998 | |
| Sodium | 9640 | |
| Alkalinity-$HCO_3$ | 38000 | |
| Zinc | 24.5 | |
| Calcium | 14100 | |
| Manganese | 82.69999695 | |
| Aluminum | 5180 | |
| Boron | 51.79999924 | J |
| Chromium | 4.400000095 | J |
| Lead | 1.399999976 | J |
| Beryllium | 0.569999993 | J |
| Potassium | 4860 | J |
| Nickel | 2.599999905 | J |
| Vanadium | 6 | J |
| Magnesium | 3900 | J |
| Iron | 3240 | J- |
| Nitrate-Nitrite as N | 93.69999695 | J- |
| Aluminum | 4310 | |
| Manganese | 42.09999847 | |
| Sodium | 9580 | |
| Barium | 345 | |
| Calcium | 14700 | |
| Vanadium | 4.800000191 | J |
| Zinc | 8.5 | J |
| Nickel | 1.5 | J |
| Selenium | 1.899999976 | J |

## Table H-3 (Continued)

## Fish Ladder Seep Surface Water Sampling Data

| Analyte | Sample Value in Micrograms per Liter | Qualifier (see Footnotes) |
|---|---|---|
| Magnesium | 3900 | J |
| Boron | 47.5 | J |
| Potassium | 4980 | J |
| Chromium | 2.400000095 | J |
| Iron | 2580 | J- |
| Fish Ladder Seep (3/3/98) | | |
| Strontium | 39.5 | |
| Iodide | 50 | |
| Sodium | 7370 | |
| Barium | 417 | |
| Aluminum | 5870 | |
| Zinc | 26.79999924 | |
| Alkalinity-$HCO_3$ | 11000 | |
| Iron | 5700 | |
| Calcium | 5430 | |
| Cesium | 700 | |
| RDX | 5.400000095 | |
| Lead | 4.800000191 | |
| HMX | 3.420000076 | |
| Lithium | 18.10000038 | |
| Manganese | 74.40000153 | |
| Total Organic Carbon | 14000 | |
| Sulfate | 9000 | |
| Fluoride | 100 | |
| Chloride | 4500 | |
| Silicon Dioxide | 15000 | |
| Boron | 32 | J |
| Cobalt | 1.399999976 | J |
| Magnesium | 1840 | J |
| Potassium | 3060 | J |
| Nickel | 4.599999905 | J |
| Copper | 6.599999905 | J |
| Vanadium | 12.30000019 | J |
| Dichloroethene [cis-1,2-] | 9 | J- |
| Tetrachloroethene | 10 | J- |
| Acetone | 25 | J- |
| Alkalinity-$HCO_3$ | 14000 | |
| Iron | 17700 | |
| Zinc | 59 | |

## Table H-3 (Continued)

## Fish Ladder Seep Surface Water Sampling Data

| Analyte | Sample Value in Micrograms per Liter | Qualifier (see Footnotes) |
|---|---|---|
| Sulfate | 10000 | |
| Fluoride | 100 | |
| Chromium | 10.39999962 | |
| Calcium | 7620 | |
| Total Organic Carbon | 22000 | |
| Chloride | 4000 | |
| RDX | 5.909999847 | |
| Manganese | 1260 | |
| Lead | 14.60000038 | |
| HMX | 4.159999847 | |
| Silicon Dioxide | 14200 | |
| Sodium | 7700 | |
| Aluminum | 14000 | |
| Cesium | 500 | |
| Lithium | 25.79999924 | |
| Strontium | 57.70000076 | |
| Barium | 979 | |
| Cobalt | 12.89999962 | J |
| Copper | 13 | J |
| Magnesium | 3210 | J |
| Nickel | 9.199999809 | J |
| Selenium | 3.700000048 | J |
| Vanadium | 33.09999847 | J |
| Arsenic | 8.300000191 | J |
| Molybdenum | 6.300000191 | J |
| Boron | 49.70000076 | J |
| Potassium | 4610 | J |
| Tetrachloroethene | 12 | J- |
| Acetone | 27 | J- |
| Dichloroethene [cis-1,2-] | 9 | J- |
| Magnesium | 2200 | |
| HMX | 16 | |
| Barium | 360 | |
| Calcium | 8700 | |
| Potassium | 2800 | |
| Iron | 1200 | |
| RDX | 2.200000048 | |
| Zinc | 22 | |
| Manganese | 130 | |
| Aluminum | 1300 | |

## Table H-3 (Continued)

## Fish Ladder Seep Surface Water Sampling Data

| Analyte | Sample Value in Micrograms per Liter | Qualifier (see Footnotes) |
|---|---|---|
| Alkalinity-$HCO_3$ | 10000 | |
| Sodium | 12000 | |
| Sulfate | 31700 | |
| Dichloroethene [cis-1,2-] | 27 | |
| Trichloroethene | 10 | |
| Uranium | 0.323000014 | |
| Chloride | 21500 | |
| Nitrate-Nitrite as N | 110 | |
| Perchlorate | 17.10000038 | |
| Tritium | 120 | |
| Tetrachloroethene | 42 | |
| Fluoride | 96 | |
| Cobalt | 1.399999976 | J |
| Boron | 55 | J |
| Chromium | 1.799999952 | J |
| Silver | 0.75 | J |
| Vanadium | 3.799999952 | J |
| Copper | 3.199999809 | J |
| Beryllium | 0.150000006 | J |
| Nickel | 2.200000048 | J |
| Antimony | 3.299999952 | J |
| Sodium | 13000 | |
| Potassium | 2700 | |
| Manganese | 53 | |
| Magnesium | 2100 | |
| Iron | 410 | |
| Calcium | 8700 | |
| Barium | 330 | |
| Aluminum | 470 | |
| Vanadium | 1.799999952 | J |
| Boron | 56 | J |
| Zinc | 19 | J |
| Cobalt | 1.599999905 | J |
| Chromium | 0.49000001 | J |
| Nickel | 1.799999952 | J |
| Silver | 0.699999988 | J |
| Copper | 2 | J |

## Table H-3 (Continued)

## Fish Ladder Seep Surface Water Sampling Data

| Analyte | Sample Value in Micrograms per Liter | Qualifier (see Footnotes) |
|---|---|---|
| Fish Ladder Seep (4/17/01) | | |
| Calcium | 14900 | |
| Aluminum | 13000 | |
| Tetrachloroethene | 1.200000048 | |
| Tritium | 167.3600006 | |
| Chloride | 13700 | |
| Zinc | 44.59999847 | |
| Fluoride | 256 | |
| Sulfate | 15500 | |
| Manganese | 131 | |
| Sodium | 11900 | |
| HMX | 13.89999962 | |
| RDX | 4.5 | |
| Nickel | 6.400000095 | J |
| Vanadium | 18.60000038 | J |
| Magnesium | 4500 | J |
| Beryllium | 0.50999999 | J |
| Cobalt | 1.899999976 | J |
| Arsenic | 3.400000095 | J |
| Boron | 54.29999924 | J |
| Potassium | 4650 | J |
| Chromium | 7.900000095 | J |
| Trichloroethene | 0.25 | J |
| Copper | 18.5 | J |
| Iron | 8260 | J- |
| Lead | 5.699999809 | J- |
| Aluminum | 10800 | |
| Sodium | 10500 | |
| Calcium | 9500 | |
| Manganese | 87.59999847 | |
| Zinc | 27 | |
| Vanadium | 14.30000019 | J |
| Beryllium | 0.449999988 | J |
| Copper | 7.199999809 | J |
| Potassium | 2610 | J |
| Nickel | 4.400000095 | J |
| Chromium | 6.199999809 | J |
| Selenium | 1.399999976 | J |
| Arsenic | 2.400000095 | J |

## Table H-3 (Continued)

## Fish Ladder Seep Surface Water Sampling Data

| Analyte | Sample Value in Micrograms per Liter | Qualifier (see Footnotes) |
|---|---|---|
| Boron | 53.20000076 | J |
| Magnesium | 3090 | J |
| Lead | 4.199999809 | J- |
| Iron | 6360 | J- |

J = The analyte is classified as detected but the reported concentration value is expected to be more uncertain than is usual.
J- = The analyte is classified as detected but the reported concentration value is expected to be more uncertain than is usual with a potential negative bias.
J+ = The analyte is classified as detected but the reported concentration value is expected to be more uncertain than is usual with a potential positive bias.