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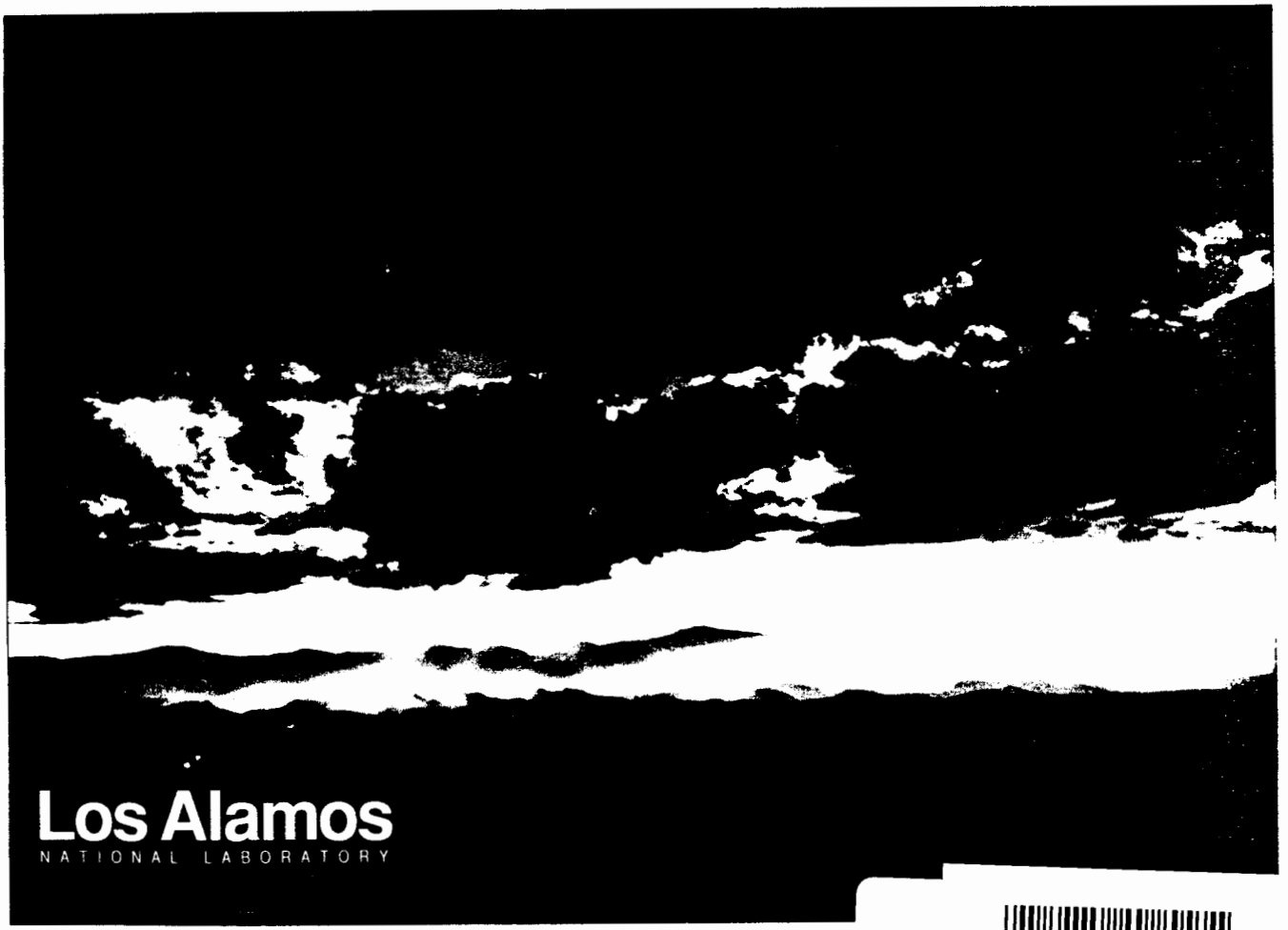

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Biological Assessment for the Mixed Waste Storage and Disposal Facility, Technical Areas 67 and 15, Los Alamos National Laboratory

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EXECUTIVE SUMMARY

Los Alamos National Laboratory proposes to build the Mixed Waste Storage and Disposal Facility, a 29-hectare (72-acre) facility to permanently dispose of solid mixed waste (combined hazardous and radioactive waste). This waste would derive from environmental remediation, research and development, and decommissioning and decontamination activities at the Laboratory. Located within US Department of Energy property on Pajarito Mesa, the proposed facility includes surface storage facilities and disposal pits initially capable of holding 19 100 cubic meters (25 000 cubic yards) of waste. Eventually, the facility could receive 363 000 cubic meters (475 000 cubic yards) of waste. The surface facilities would include access roads, perimeter fencing, utilities, and buildings housing administative offices and decontamination areas.

This report summarizes the results of several surveys conducted by the Biological Resource Evaluation Team (BRET) at the Laboratory within Technical Areas 15 and 67, where the Mixed Waste Storage and Disposal Facility would be located. The purpose of the surveys was: (1) to determine if threatened, endangered, or sensitive species or critical habitat exist within or near the site proposed for the facilities; (2) to identify and characterize sensitive habitats, such as floodplains or wetlands, in the vicinity of the proposed facilities; and (3) to compile data on plant and wildlife species within the proposed site.

The topography of the project area and environs includes the gently-sloping top of Pajarito Mesa, moderately steep to very steep canyon walls, and the relatively level bottoms of upper Threemile and middle Pajarito Canyons. BRET conducted habitat evaluation surveys on the mesa top, along north- and south-facing slopes, in the canyon bottoms, and in a riparian area in Pajarito Canyon. Ten transects were established to identify overstory, shrub, and understory plants and their associations. The habitat evaluation surveys identified three vegetation communities (Rocky Mountain Montane Conifer Forest, Great Basin Conifer Woodland, and Rocky Mountain Riparian-Deciduous Forest) and five vegetation zones (mixed conifer, ponderosa pine, piñon pine-ponderosa, piñon pine-juniper, and riparian) in the vicinity of the project area.

To investigate the potential for threatened, endangered, or sensitive species to utilize the project area, habitats identified in the project area were compared with known habitat types for these species in the Laboratory region. If the habitat requirements of a particular threatened, endangered, or sensitive species were not met, the site was considered unsuitable habitat and no further studies for that species were conducted. This process eliminated from further consideration thirteen species of threatened, endangered, or sensitive plants and six species of threatened, endangered, or sensitive wildlife known to inhabit the Laboratory region. The process also identified habitat for the northern goshawk (*Accipiter gentilis*), the spotted owl (*Strix occidentalis* var. *lucida*), and the spotted bat (*Euderma maculatum*). Surveys in the project area have so far revealed no evidence of any of these species, although only one year of field work is complete and at least one more season will be necessary to

positively establish their presence or absence. This assessment indicates that even if these species are present, simple mitigation measures would ensure that they were not jeopardized by the proposed project.

To identify all wetlands and floodplains near the project area, BRET first consulted National Wetland Inventory maps produced by the US Fish and Wildlife Service and then conducted field surveys. The team found no floodplains or wetlands at the proposed facility site, but there is a National Wetland Inventory-designated palustrine wetland and a floodplain area in Pajarito Canyon just to the north of the site and an additional floodplain area in Threemile Canyon to the south of the proposed site. These areas could be affected by the proposed project.

Changes in the natural environment on Pajarito Mesa caused by the proposed facilities could affect non-listed species and special habitats in a number of ways. The most significant impact from construction would be the removal of 29 hectares (72 acres) of ponderosa pine and piñon-juniper vegetation and the disturbance of soils for pit preparation. Pajarito Mesa comprises valuable habitat for a number of unlisted species, in addition to the threatened goshawk. The operational phase of the project would create noise, increase vehicular traffic, and could release contaminants into the environment. New roads could interfere with the migration patterns of some large mammals, and unmitigated erosion caused by runoff from the new roads and parking lots could adversely impact the wetland area in Pajarito Canyon. Hazardous fuel spills or leaks from vehicles have a potential to damage or eliminate riparian and upland vegetation.

BRET recommends several actions to minimize impacts from the proposed MWSDF project, including erosion prevention measures, retention of vegetated buffer zones around disturbed areas, and careful fuel storage. Rock crevices along canyon slopes should be protected from disturbance to ensure that spotted bat habitat is protected. Minimizing excessive noise and activity during the breeding and nesting season of birds (March-September) would lessen impacts and is especially important for goshawks and spotted owls. Light sources should be designed so that they do not flood a wide area beyond the facilities; such light could have a negative effect on spotted owls. Tree removal should be kept to a minimum on the mesa top and completely avoided in Pajarito and Threemile canyons to preserve potential goshawk and spotted owl nesting sites.

Finally, to monitor potential impacts associated with the operational phase of the MWSDF, BRET recommends establishing a permanent biological monitoring network in the canyons adjacent to the proposed facilities. Such a system would allow BRET to observe the long-term effects of the facility on the surrounding environment.

1. INTRODUCTION

1.1 Project Description

Since its inception, Los Alamos National Laboratory (LANL) has generated a variety of radioactive and chemical wastes. Despite rigorous waste minimization initiatives, waste production continues and LANL waste managers anticipate a need to dispose of approximately 363 000 m^3 (475 000 yd^3) of waste contaminated with both radioactive and hazardous materials, or mixed waste, over the next two decades. Approximately 50% of this mixed waste would consist of soils derived from the remediation of abandoned hazardous materials sites at LANL. The remaining waste would originate from the planned decomissioning and decontamination of obsolete LANL facilities and from research and development activities at LANL.

LANL proposes to build a new waste disposal facility, the Mixed Waste Storage and Disposal Facility (MWSDF), to handle this solid mixed waste. If approved and built, the MWSDF would cover a 29-hectare (72-acre) site on an undeveloped mesa within DOE property. The double-lined disposal pits would initially be capable of holding 19 100 m^3 (25 000 yd^3) of waste. Expansions would accomodate additional waste as necessary up to the expected maximum of 363 000 m^3 (475 000 yd^3).

Development associated with surface facilities would include access roads, security fencing, utility lines, and parking areas. Buildings would house administrative offices; conference, training, and change rooms; areas for decontamination, waste receiving, waste repackaging and temporary waste storage; a warehouse; an access control (security) area; and a monitoring system instrumentation room.

In 1989, LANL began a search for a suitable site for the MWSDF. Sixteen sites were evaluated using a variety of geotechnical, environmental, sociological, and logistical/construction criteria. Two sites met all the search criteria and were the subject of detailed field study. After further review by the project study

team and consultation with geologists, hydrologists, and managers of neighboring Bandelier National Monument, the siting team confirmed a 29-hectare (72-acre) site on Pajarito Mesa as the best location for the MWSDF (Pava 1991).

1.2 Purpose and Scope of this Assessment

This biological assessment (BA) was prepared by the Biological Resources Evaluation Team (BRET) of the Environmental Protection Group at LANL. It evaluates the potential impact of construction and operation of the MWSDF on threatened, endangered, and sensitive species (TES) and floodplains and wetlands in accordance with the following regulations and orders:

- the 1973 Federal Endangered Species Act (ESA) (USFWS 1988)
- the New Mexico's Wildlife Conservation Act (WCA) (NM 1974)
- the New Mexico Endangered Plant Species Act (EPSA) (NM 1985, NMFRC 1992, et seq.)
- Floodplain/Wetland Executive Orders 11990 and 11988 (USFWS 1977a,b)
- Department of Energy (DOE) Order 5400.1 (USDOE 1988)
- the National Environmental Policy Act (NEPA) (USDOE 1992)
- the Clean Water Act (CWA) (USFWS 1993)
- 10 CFR 1022 (DOE Compliance with Floodplain/Wetlands Environmental Review Requirements) (USFWS 1979)

In addition, this BA addresses the potential impact of the proposed MWSDF on non-listed species and recommends mitigation measures to lessen impacts.

1.2.1 Endangered Species

Section 7 of the ESA requires all federal agencies to ensure that their activities and programs do not jeopardize the continued existence of any federally listed threatened or endangered species or its

designated critical habitat. New Mexico's WCA and EPSA require federal agencies to avoid adverse impacts to species that are under state protection. Section 7 of the Federal ESA, as well as New Mexico's WCA and EPSA, is implemented within the framework of NEPA.

There are three possible outcomes of a TES species assessment. It can find that:

1) there are no TES species utilizing habitat in the proposed project area;

2) there are TES species utilizing habitat in the project area or there is habitat that may be suitable for TES species in the project area but the project would cause no adverse impacts to the species; or

3) there is TES species habitat in the proposed project area, and adverse impacts to TES species are expected.

If no adverse impacts are expected from the proposed project, the biological evaluation is reviewed by the appropriate state or federal agency for concurrence. LANL initiates formal consultation with the appropriate state or federal agency if the proposed project is expected to jeopardize any listed species. Consultations can result in project approval, project modifications, the selection of an alternative site, or abandonment of the proposed project.

1.2.2 Floodplains and Wetlands

Two Executive Orders (EOs) provide protection for floodplains and wetlands. EO 11988, "Floodplain Management" (USFWS 1977a), ensures the protection of floodplains and stipulates that before any federally funded project in a floodplain is initiated, the potential effects of the action must be evaluated. EO 11990, "Protection of Wetlands" (USFWS 1977b), requires all federally funded agencies to protect wetlands from loss and/or degradation.

Federal Regulations (10 CFR 1022) outline the procedures for DOE compliance with the floodplain/wetland EOs and provide a means for public review (USFWS 1979). These regulations require

impacts are addressed in NEPA documentation and Federal Register Noutication. If it is determined that floodplains or wetlands would be affected by the proposed project, the floodplain/wetland assessment must determine if the impact would be adverse.

Floodplains and wetlands receive additional protection by the Clean Water Act (USFWS 1993). Under Section 404 of the CWA, the degradation of wetlands and floodplains is controlled by restricting the discharge of fill into these sensitive areas. Depending on the size of the floodplain or wetland, two types of discharge permits may be issued by the US Corps of Engineers: Nationwide Permits (if the impact is confined to less than 4 hectares, or 10 acres), and Individual Permits (if the impact will affect an area larger than 4 hectares, or 10 acres). Permits must be issued before the proposed activities can be initiated.

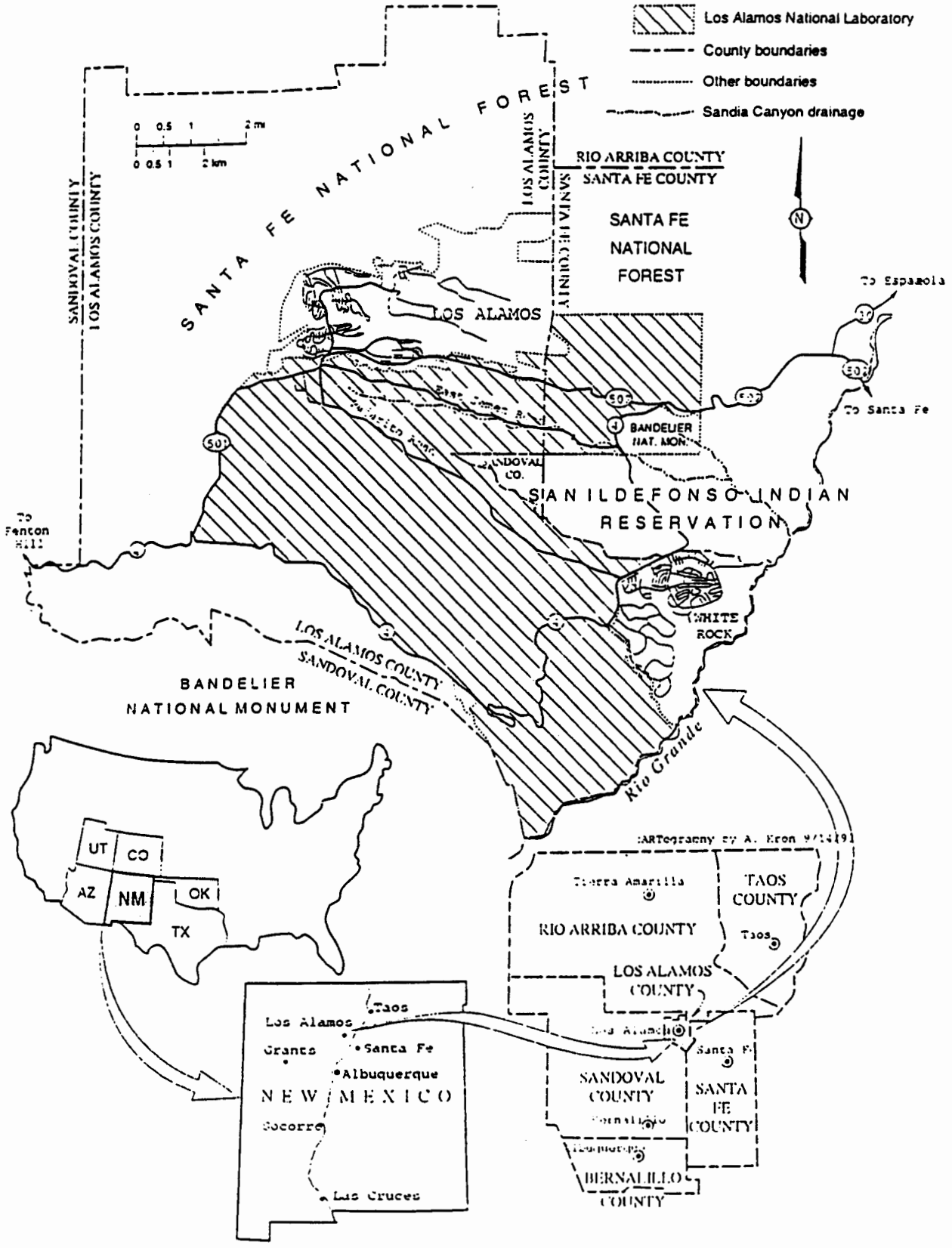
1.2.3 DOE Orders

In addition to the above regulations, DOE Order 5400.1 (USDOE 1988) requires DOE facilities to conduct a pre-operational environmental survey prior to development of any new site, construction of any facility, or start-up of any process that has the potential for significant adverse environmental impact. The survey should begin a minimum of one year, and preferably two years, before start-up to evaluate biotic communities for at least one full cycle of seasons. These baseline data are incorporated into work plans for further site investigation.

2. ENVIRONMENTAL SETTING

2.1 General Setting

The project area is located within the boundaries of DOE property in Los Alamos County, New Mexico, approximately 105 km (65 mi) north of Albuquerque and 48 km (30 mi) northwest of Santa Fe (Fig. 1). The dominant physical feature in the LANL area is the Pajarito Plateau, a broad, dissected plateau comprised of numerous alternating narrow mesas and canyons at the base of the Jemez Mountains. These volcanic mountains lie along the northwest margin of the Rio Grande Rift (Burton 1982).


Los Alamos National Laboratory
County boundaries
Other boundaries
Sandia Canyon drainage
SANTA FE NATIONAL FOREST
SANDOVAL COUNTY
LOS ALAMOS COUNTY
RIO ARRIBA COUNTY
SANTA FE COUNTY
SANTA FE NATIONAL FOREST
LOS ALAMOS
To Española
To Santa Fe
BANDELIER NAT. MON.
SANDOVAL CO.
SAN ILDEFONSO INDIAN RESERVATION
To Fenton Hill
WHITE ROCK
LOS ALAMOS COUNTY
SANDOVAL COUNTY
BANDELIER NATIONAL MONUMENT
Rio Grande
UT
CO
AZ
NM
OK
TX
Tierra Amarilla
TAOS COUNTY
RIO ARRIBA COUNTY
Taos
LOS ALAMOS COUNTY
Los Alamos
Grants
Santa Fe
Albuquerque
NEW MEXICO
Socorro
Las Cruces
SANDOVAL COUNTY
SANTA FE COUNTY
BERNALILLO COUNTY

The plateau is approximately 32-40 km (20-25 mi) in length and 8-16 km (5-10 mi) wide. Elevations on the Plateau vary from approximately 2380 m (7800 ft) above sea level near the mountains to 1890 m (6200 ft) at the plateau's lower edge on the rim of White Rock Canyon. Plateau canyons are 46-91 m (150-300 ft) deep and 91-183 m (300-600 ft) wide.

The bedrock of the plateau comprises Bandelier Tuff, a welded ash formation deposited during volcanic eruptions in the Jemez Mountains roughly 1.1-1.4 million years ago (LANL 1988). The tuff overlays other volcanic layers, which in turn overlay the conglomerate of the Puye Formation (LANL 1988). This conglomerate intermixes with Chino Mesa basalts along the Rio Grande River.

2.1.1 Regional Climate

The climate in the LANL region is a semi-arid, temperate mountain type (Bowen 1990). Climate characteristics in this type are highly variable season to season as well as year to year. For example, precipitation at the Laboratory, including rainfall and water-equivalent snowfall, averages about 46 cm (18 in.) per year, but year to year accumulations have varied by nearly 60 cm (24 in.) over the past 69 years. Precipitation increases with elevation on the Pajarito Plateau so that the western portions of LANL receive considerably more rainfall and water-equivalent snowfall than the lower elevations along the Rio Grande. Precipitation is not evenly distributed through the year, but occurs in two distinct periods. During the summer months (predominantly July and August), air masses from the Gulfs of Mexico and California bring the heaviest precipitation of the year, with rainfall locally concentrated in the vicinity of thunder showers. Winter storms derive from Pacific frontal systems and deliver lesser amounts of precipitation from November through March, much of it in the form of snow.

Temperatures in the Laboratory region are relatively mild and variable. Even though Los Alamos is situated at a relatively low latitude (35°32' North), air temperatures are typically cool because of the area's 2255 m (7400 ft) average elevation. Thin, dry air and clear skies encourage both strong daytime heating

and nighttime cooling, resulting in differences in the daily temperature extremes of as much as 14°C (25°F).

A wide range of temperatures occur in Los Alamos. Winter temperatures typically range from -9°C to -4°C (15°F to 25°F) during the night and from 1°C to 10°C (30°F to 50°F) during the day. Summers usually have relatively warm days and cool nights. Daily afternoon temperatures are typically in the 21°C to 27°C (70 to 80 °F) range, occasionally reaching 32°C (90°F). Even after the warmest days, the relatively thin air, light winds, clear skies, and dry atmosphere cause nighttime temperatures to drop into the 10°-15°C (50-60 °F) range.

2.1.2 Regional Vegetation

Northern New Mexico's semi-arid environments support a diversity of plants whose distribution is in large part determined by elevation. Generally, arid-climate vegetation dominates at low elevations and vegetation adapted to more consistent moisture grows at higher elevations in the mountains. The varied topography and vertical relief of the Jemez mountains and Pajarito Plateau support an especially rich and diverse subset of the regional vegetation. Plains and Great Basin Riparian-Deciduous Forest grow at the lowest elevations in Los Alamos County along the Rio Grande floodplain, about 1524 m, or 5000 ft, above sea level. The trees that characterize this vegetation type, such as cottonwood (*Populus* spp.), willow (*Salix* spp.), and non-native salt cedar (*Tamarix pentandra*) and Russian olive (*Eleagnus angustifolia*), are restricted to areas where water is available at or near the ground surface year-round. Above the Rio Grande floodplain at elevations ranging from about 1700-1890 meters (5600-6200 ft), one-seed juniper (*Juniperus monosperma*) becomes the most common over story species, often intermixed with lesser amounts of piñon pine (*Pinus edulis*). Both of these tree species, typical of the Great Basin Conifer Woodland, are tolerant of a relatively dry climate and together they form an open piñon-juniper woodland at elevations of 1890 to 2100 m (6200 to 6900 ft) on the Plateau.

As the elevation increases towards the Jemez Mountains, the piñon-juniper woodland community gradually intergrades into Rocky Mountain Montane Conifer Forest, where increased precipitation allows ponderosa pine (*Pinus ponderosa*) to become a dominant species at about 2100 to 2290 m (6900 to 7500 ft). White fir (*Abies concolor*) and Douglas fir (*Pseudotsuga menziesii*) grow along the north-facing slopes at intermediate elevations. These species are often intermixed with ponderosa pine and form a mixed-conifer community. Species of the Rocky Mountain Subalpine Conifer Forest and Woodland along the extreme western edge of the county and are more prevalent at the higher elevations of the Jemez Mountains.

Most of the streams in Los Alamos County are ephemeral and do not support wetland vegetation, but permanent flows from springs and laboratory facilities create a small number of permanent or near-permanent streams in some canyons, including Pajarito Canyon adjacent to Area G. Vegetation of the Rocky Mountain Riparian Deciduous Forest and the Plains Interior Marshland grows along this stream.

2.2 Description of the Project Area

The project area is within TA-67 at LANL (Fig. 2). Pajarito Mesa is located in the west central portion of LANL and is bordered by Pajarito Canyon on the north and upper Threemile Canyon on the south. Most of TA-67 and the northeastern panhandle of TA-15 are on the mesa. The topography includes steep canyon cliffs, a relatively level mesa top and canyon bottoms, and gentle to steep talus slopes. Development in the area includes an access perimeter road that extends west to east along the entire length of the mesa and a fire road that runs north-south midway down the mesa top. The Universal Transverse Mercator coordinates (UTMs) for the project area are given in Table 1.

Pajarito Mesa is situated on a series of volcanic ashflow and ashfall tuffs collectively referred to as the Tshirege Member of the Bandelier Formation. At the project site, the member is 262 m (860 ft) thick and includes several distinct layers of welded and unwelded tuff (Merrick/Dames & Moore 1991). There are

- Frijoles--very fine sandy loam
- Pogna--fine sandy loam
- Nyjack--loam
- Rock outcrop--little or no soil development
- Hackroy--sandy loam

TABLE 1. UTM Coordinates for the Project Area

Zone	Easting	Northing
13	482400	1765900
13	487400	1765900
13	487400	1764900
13	482400	1764900

The project area has been designated as a buffer zone for LANL activities since 1989. Previously, parts of the area had hosted a firing site, a burn site, and a gas cylinder storage area. These activities created sites where there may be hazardous and/or radioactive materials at or beneath the soil surface.

2.3 Previous Studies

Prior to the surveys initiated for this study in 1992, only a small number of biological studies had been completed within or near the project area. Some of these studies include information on biological resources, including TES species that may inhabit the project area.

2.3.1 Plants

A plant survey of TA-67 took place in 1992 (Foxx et al.). Appendix A contains a checklist of identified plant species identified in this study. Jarmie and Rogers (1992) examined two 100-m (330-ft) circular

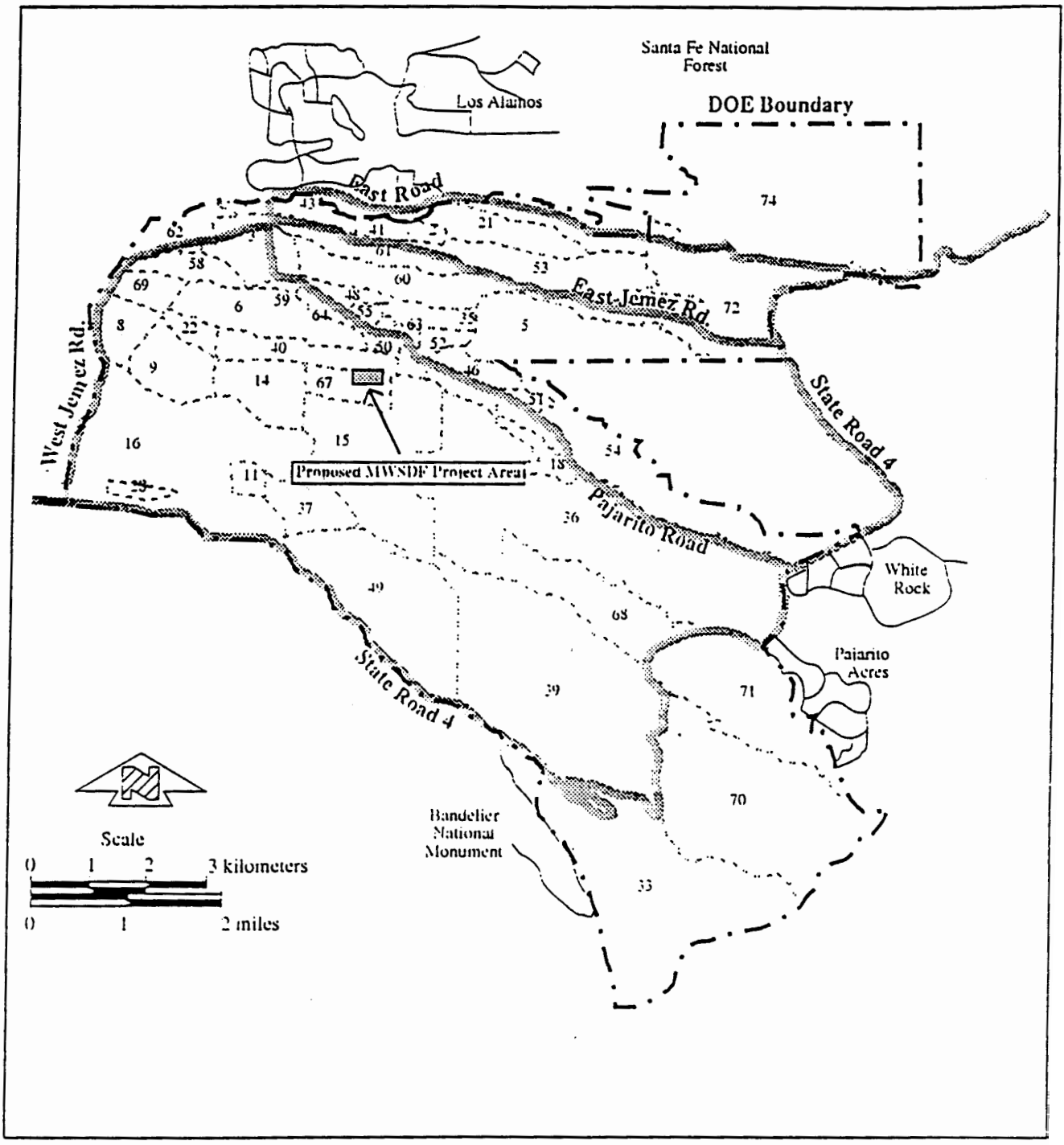


Fig.2. Location of the MWSDF project area at LANL.

plots for fungal and slime mold species, one in piñon-juniper on Pajarito Mesa and the other in mixed conifer of Pajarito Canyon. Appendix B contains a checklist of fungal and slime mold species identified during this survey.

2.3.2 Wildlife

2.3.2.1 Invertebrates

Terrestrial Invertebrates

No invertebrate studies have been completed within the project area, but four species of terrestrial mollusks and at least fifty-seven families of terrestrial insects have been identified on DOE property in Los Alamos County. Many of these inhabit the project area. Genera and species identifications have not yet been confirmed and additional families will probably be identified in the future. Appendix C lists all ant species found within TA-67.

Aquatic Invertebrates

Few studies on aquatic invertebrates have been conducted in Los Alamos County. A study is underway to collect and identify aquatic insects within and adjacent to DOE property: Thirty-three families have been collected to date. Three species of aquatic mollusks have been identified on DOE property and further surveys are expected to yield additional species. A number of these live in the wetland habitats of Pajarito Canyon.

2.3.2.2 Vertebrates

Fish

No fish have been found on DOE property, although fish have been observed in and downstream from Guaje Reservoir, Los Alamos Reservoir, and at the confluence of White Rock Canyon and the Rio Grande below Ancho Springs. There is no fish habitat in the vicinity of the project area.

Reptiles and Amphibians

Biologists have identified seventeen species of lizards and snakes in the LANL region. Most of these reptiles could live in the project area vicinity, although there have been no surveys there for these animals. Seven species of amphibians have been found in the LANL area, and habitat for most of these species occurs within the project area or adjacent canyons. A checklist of the amphibians and reptiles found in Pajarito Canyon is in Appendix D.

Birds

Over 200 bird species, including at least 112 species of breeding birds, have been identified in Los Alamos County (Travis 1992). Thirty-nine of the breeding bird species are residents and fifty-nine are migratory summer residents. A checklist of the birds found in the project area is contained in Appendix E.

Mammals

Twenty-nine species of small mammals have been found in the LANL area. Mule deer and elk are the most visible large mammals of the region. These species generally winter in the lower elevations of the Pajarito Plateau, including many of the mesas and canyons along the central and eastern portions of the county. They generally spend the summer at higher elevations in the Jemez Mountains. However, recent surveys in the Los Alamos County area indicate that growing numbers of large mammals are residing year-round at lower elevations, including the area where the MWSDF would be placed.

In 1992, Raymer and Biggs captured small mammals at transects in Threemile Canyon in TA-15 and TA-18. As part of the same study, Raymer and Biggs also trapped small mammals in upper Pajarito Canyon immediately northwest of the proposed project location. Raskevitz (1992) established pellet transects in the project area to monitor the relative use of the area by mammals of medium and large size. Data from these transects has not been fully analyzed. Mammal species identified during these studies provide a partial mammal checklist for the project area (Appendix F).

2.3.3 Threatened, Endangered, and Sensitive Species

2.3.3.1 Plants

Prior to this assessment, no TES plant surveys had been conducted within the project area.

2.3.3.2 Wildlife

For several years, Kennedy has observed northern goshawks (*Accipiter gentilis*) and Cooper's hawks (*Accipiter cooperii*) on LANL property, gathering data on home range size and activity patterns and characterizing topography, vegetative structure, and composition of nest sites. The study includes information on diet, prey species, and reproductive success. Kennedy has sighted raptors in the general vicinity of the project and believes some of these may have been goshawks, although this has not been confirmed. There have been some unconfirmed sightings of goshawks in the general vicinity of the project area.

3. SURVEY METHODS

BRET initiated three levels of survey within and near the project area. The primary purpose of these surveys was to evaluate habitat and determine if there were any species of concern or sensitive areas that could be affected by the proposed MWSDF.

3.1 Level 1 (Reconnaissance) Surveys

The Level 1 survey is a walk-through of the project area to note general habitats and site features. It is the initial survey of the project area and is designed to determine placement of line transects, presence or absence of water sources and floodplains, and evidence of previous disturbance. The Level 1 survey of the MWSDF project area identified several general vegetation types. These types were used as search criteria in the BRET TES database. The search indicated that, because of the presence of habitat potentially useful to some TES species, Level 2 (habitat evaluation) surveys were required.

3.2 Level 2 (Habitat Evaluation) Surveys

Based on the general descriptions of vegetation from the Level 1 survey, Level 2 surveys were designed to quantitatively define habitat. BRET used the refined habitat descriptions to determine if any habitat that could be used by TES species was present. For this assessment, standard ecological techniques were used to analyze cover, density, and frequency of species in overstory and understory vegetation at the MWSDF site. Information obtained from the vegetation studies was categorized into a hierarchical system of vegetation types for mapping. BRET then compared the vegetation types with specific habitat requirements for threatened, endangered, and sensitive species. If the habitat requirements of a particular TES species were not met, the site was considered unsuitable habitat and no further studies for that species were conducted. Conversely, if any of the habitat could be used by listed species, Level 3 surveys were initiated.

The classification for both upland and wetland vegetation types for the Pajarito Plateau, including known and potential habitat types and phases, is based on descriptions by Brown (1982) and Moir and Ludwig (1979). No attempt was made to designate new habitat types for the MWSDF project area. Vegetation associations in the project area that did not fit within designated habitat types were classified with the habitat types they most closely resembled.

Using this approach, BRET surveyed ten study sites on and around Pajarito Mesa. Sites were chosen to be within areas that would be affected by the MWSDF. All were located within TA-67 and TA-15. At each site, both understory and overstory vegetation components were identified and measured. Transects were numbered in each study site and designated either as understory (u) transects or canopy (c) transects. (See Fig. 3 for transect locations.)

3.2.1 Overstory Evaluation

BRET used the line intercept technique (Lindsey 1955; Woodin and Lindsey 1954) to characterize the overstory in coniferous forests. Transects were established in the habitat and data were collected within a

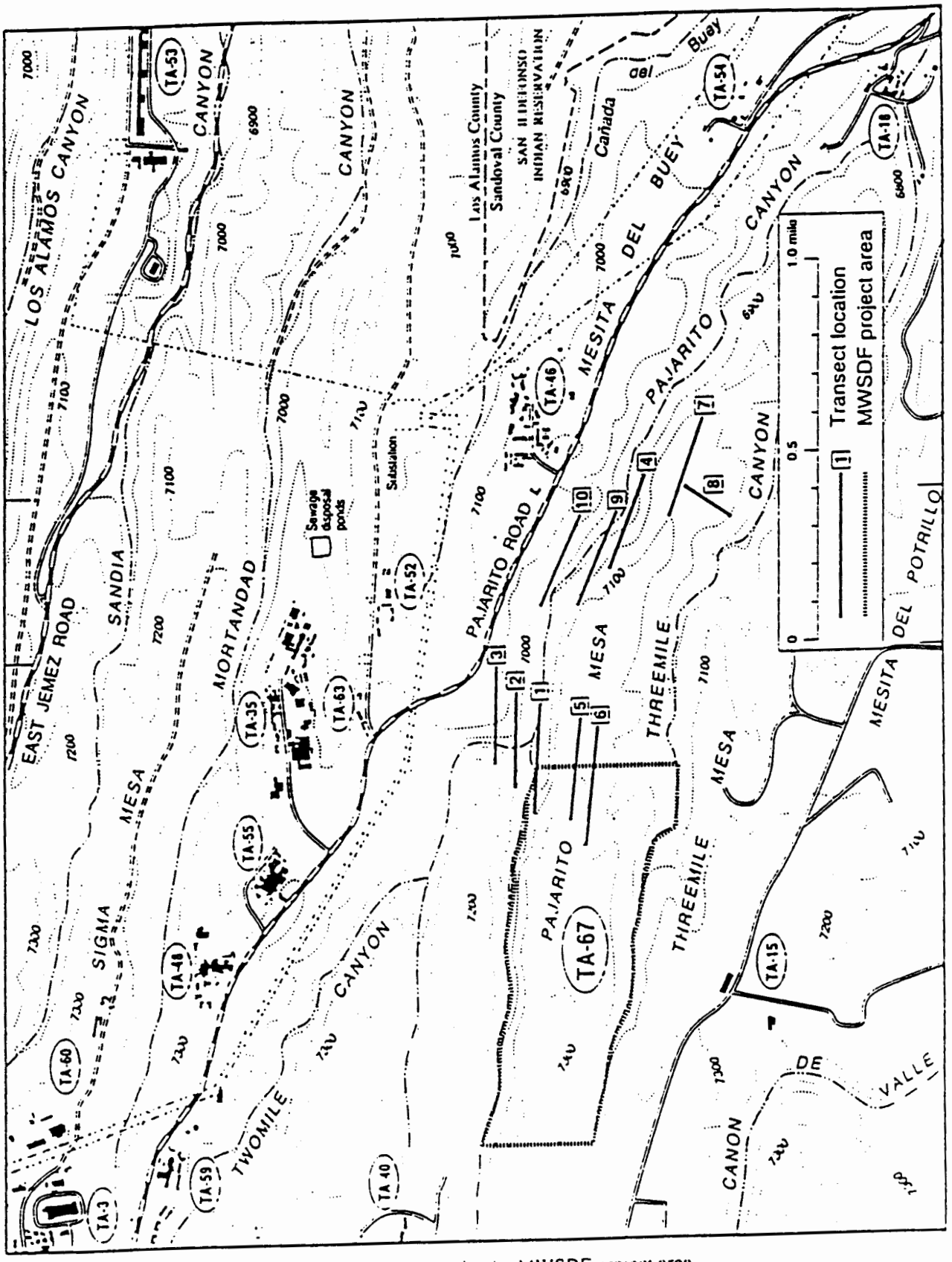


Fig. 3. Locations of transects for the MWSDF project area.

6-m (20-ft) wide strip centered on the 213-m (700-ft) transect line. Within the strip, BRET measured the diameter at breast height (DBH) of all single-stemmed trees and counted all shrub stems greater than 0.9 m (3 ft) in diameter. To determine foliar cover, BRET measured the distance along the centerline of the transect that was covered by a vertical projection of overstory onto the transect. Plant frequency was measured along the transect within rectangular plots measuring 15 m (50 ft) in length.

BRET used a circular plot technique to measure the overstory components within riparian zones and piñon-juniper woodlands. Circular plots were established every 30.5 m (100 ft) along a transect line within the habitat to be evaluated. From a center point on the transect line, basal diameter of all multi-stemmed trees within a 9.1 m (30 ft) -radius was measured. For single-stemmed trees within a 9.1 m (30-ft) radius, DBH was measured. BRET also counted all shrub stems and estimated overstory cover within each quarter of the circular plot.

Analysis also included calculating an importance index for all tree and shrub species within the transects by averaging relative cover, relative density, and relative frequency for each species. The importance index is a measure of species dominance within a transect.

3.2.2 Shrub Layer Evaluation

Woody species were separated into two categories, trees and shrubs, for purposes of analysis. The DBH of trees was recorded while the number of stems were counted for shrubs. Data on all shrubs in the transects are listed in the accompanying tables. All woody species were classified as shrubs if their diameter at breast height was less than 7.6 cm (3 in.) and their height was less than 0.9 m (3 ft).

3.2.3 Understory Evaluation

BRET used the quadrat method with a 20 x 50 cm (7.9 x 19.7 in.) Daubenmire plot (Daubenmire 1959) to measure percent cover of cryptogamic and herbaceous plants, bare soil and litter, and shrubs less than 0.9

m (3 ft) in height. The quadrats were placed on the same transect that was established for overstory evaluation. Percent cover was estimated based on visual observation of each quadrat. Species composition was also estimated by visual inspection of each plot. Quadrats were read along the transect at 3-m (10-ft) intervals for a minimum of 213 m (700 ft) or until the number of species within several successive plots had not increased.

All plants were identified using Hitchcock (1950), Martin and Hutchins (1980), Foxx and Hoard (1984), and Foxx and Tierney (1985). When necessary, voucher specimens were collected and archived in the herbarium at BRET's lab at LANL. Any questionable identifications were clarified by consultation with the University of New Mexico Herbarium in Albuquerque.

3.3 Level 3 (Species Specific) Surveys

Based on the results of the Level 1 and Level 2 surveys and on consultation with experts, Level 3 surveys were initiated only for those species that may find suitable habitat in the project area. This process resulted in the consideration of three species: the Mexican spotted owl (*Strix occidentalis*), the spotted bat (*Euderma maculatum*), and the northern goshawk (*Accipiter gentilis*). The Level 3 surveys involved on-the-ground field studies for the species of concern.

3.3.1 Goshawk Survey Procedure

The goshawk inventory method was based on procedures outlined in Kennedy and Stahlecker (1993). The technique is a broadcast survey using goshawk alarm calls to attract goshawks. Because the steep side slopes of the canyons were difficult to traverse, inventory routes followed the rims of canyons and canyon bottoms. Calling stations were established along the inventory routes at intervals of 150 m (492 ft) during goshawk incubation stage, and at 200-m (656-ft) intervals during early nestling to fledgling dependency stages (Sinton and Kennedy 1993).

Researchers broadcast alarm calls using a modified Sony Sport Walkman and a modified Realistic Musical Powerhorn. Goshawk alarm calls were played at each calling station and data on each raptor sighting, including raptor species, age, sex, and location relative to the calling station, were recorded on data forms. Any vocal or aggressive response from an accipiter led to an intensive nest search in the response area. Each tree in the area was scanned for an active nest until a nest was located. If no nest was found, additional calls were made and an attempt to locate the nest was repeated (Sinton and Kennedy 1993).

3.3.2 Spotted Bat Survey Procedure

To survey for spotted bats, BRET deployed mist nets in areas of highest spotted bat habitat suitability. Because of the high flight patterns of spotted bats, mist nets were placed on 6- to 9-m (20- to 30-ft) poles. Multiple mist nests were placed on each pole. Nets were deployed at dusk and inspected every fifteen minutes. If a bat was found in a net, it was removed and the species, sex, age, reproductive condition, location, net height, direction of entry to the net, and date and time of capture were recorded on data forms. Bats were released after the information was recorded.

3.3.3 Mexican Spotted Owl Survey Procedure

Two techniques were used to survey for the Mexican spotted owl. The first was a reconnaissance survey to evaluate potential spotted owl habitat. This survey concentrated on the canyons adjacent to Pajarito Mesa and involved a visual evaluation of the presence and abundance of habitat components that could be used by spotted owls. This information was used to determine the likelihood for spotted owls to nest in the vicinity of the project area.

The second type of survey used for spotted owls was a broadcast survey. Recorded owl hoots were broadcast at several locations along the edge of South Mesa immediately north of Pajarito Canyon. All owl responses were noted, including information on species and location relative to the calling station.

This survey was not meant to be a complete survey but was intended to gather information on habitat potential.

3.4 Wetlands and Floodplains Surveys

To identify all wetlands and floodplains near the project area, BRET first consulted National Wetland Inventory maps produced by the US Fish and Wildlife Service and then conducted vetgetation surveys in potential wetland areas. BRET used the vegetation data to compile a plant checklist and then consulted *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) to determine which plants were wetland indicator species. If indicator species were present, the area was considered a wetland. BRET did not delineate wetland boundaries during these surveys, but will map them at a later date if they could be affected by construction activities.

4. SURVEY RESULTS

4.1 Level 1 (Reconnaissance) Surveys

During the Level 1 survey, BRET located sampling locations, established the best access routes for future work, and began general observations of wildlife, terrain, and the degree of disturbance at the site. In addition, the reconnaissance surveys identified five general plant communities to use as search criteria in the BRET TES database:

- Mixed conifer
- Ponderosa pine
- Piñon pine-ponderosa
- Piñon pine-juniper
- Riparian

4.1.1 Species Identified in the BRET Database Search

The initial search of the BRET TES database revealed a number of species whose general habitat requirements matched the vegetation types identified in the project area. This list includes plants and animals from state and federal listings.

4.1.1.1 Threatened and Endangered Plants

Federally Listed Species: The database search did not identify habitat in the project area that would be suitable for any federally listed endangered or threatened plant species. However, habitat in the project area may be suitable for four candidate species:

Tufted sand verbena	*Abronia bigelovii*
Wright fishhook cactus	*Mammillaria wrightii*
Santa Fe cholla	*Opuntia viridiflora*
Grama grass cactus	*Toumeya papyracantha*

State Listed Species: Four state-listed endangered plant species met the search criteria:

Wright fishhook cactus	*Mammillaria wrightii*
Santa Fe cholla	*Opuntia viridiflora*
Grama grass cactus	*Toumeya papyracantha*
Checker lily	*Fritillaria atropurpurea*

4.1.1.2 Sensitive Plant Species

Under the Federal Endangered Species Act and New Mexico State statutes, only those plant species that are listed or are candidates for listing are protected. New Mexico also lists those species occurring within the state that are considered rare because of restricted distribution or low density. Rare plants are sensitive to long-term or cumulative land-use impacts and vulnerable to threatening biological or climatic events.

The state monitors the following sensitive species to determine if they should be elevated to endangered status:

Tufted sand verbena	*Abronia bigelovii*
Sessile-flowered false carrot	*Aletes sessiliflorus*
Cyanic milkvetch	*Astragalus cyaneus*
Santa Fe milkvetch	*Astragalus feensis*
Taos milkvetch	*Astragalus puniceus* var
Sandia alumroot	*Heuchera pulchella*
Pagosa phlox	*Phlox caryophylla*

4.1.1.3 Federally and State Listed Wildlife

Federally listed species: Two endangered, one threatened, and three candidate species met the database search criteria:

ENDANGERED SPECIES:

- Peregrine falcon (*Falco peregrinus*)
- Bald eagle (*Haliaeetus leucocephalus*)

THREATENED SPECIES:

- Mexican spotted owl (*Strix occidentalis* var. *lucida*)

CANDIDATE SPECIES:

- Northern goshawk (*Accipiter gentilis*)
- Willow flycatcher (*Empidonax traillii*)
- Spotted bat (*Euderma maculatum*)

State listed species: The following species listed as threatened in New Mexico met the search criteria:

ENDANGERED SPECIES

- Common black hawk (*Buteogallus anthracinus*)

- Willow flycatcher (*Empidonax traillii*)
- Peregrine falcon (*Falco peregrinus*)
- Mississippi kite (*Ictinia mississippiensis*)
- Mexican spotted owl (*Strix occidentalis* var. *lucida*)
- Spotted bat (*Euderma maculatum*)

4.2 Level 2 (Habitat Evaluation) Surveys

4.2.1 Overstory Evaluation

Specific site characteristics (e.g., dominant species, density, cover, and frequency) are discussed and compared in the following sections.

4.2.1.1 North-Facing Slopes

Because north-facing slopes retain moisture better than other slope aspects, vegetation is generally denser on north-facing slopes than other slope aspects in the northern New Mexico region. North-facing slope transects in the project agree with this trend. On a north-facing slope along Pajarito Canyon, ponderosa pine and Douglas fir are codominants. Douglas fir, an indicator of the mixed conifer community, had greater density, cover, and frequency values than the ponderosa pine. Table 2 presents overstory vegetation characteristics in this north-facing transect.

TABLE 2. Overstory Vegetation on a North-Facing Slope

Transect	Species	Average DBH (in.)	Relative Density	Relative Cover	Relative Frequency	Importance Index
3-c	Ponderosa pine	7.81	38.98	42.87	41.67	41.17
	Douglas fir	5.18	61.02	57.13	58.33	58.83

4.2.1.2 South-Facing Slopes

South-facing slopes are normally drier than adjacent north-facing slopes and thus usually have a less dense vegetative cover. BRET surveyed south-facing transects in upper Threemile Canyon at two locations. Ponderosa pine dominated one site while piñon pine dominated the other. One-seed juniper was present in both transects, but only at low densities (Table 3). These transects had the lowest numbers of trees per acre and very low percent cover values (9.93 and 13.10). Average DBHs for all trees in both transects were also low.

TABLE 3. Overstory Vegetation on a South-Facing Slope

Transect	Species	Average DBH (in.)	Relative Density	Relative Cover	Relative Frequency	Importance Index
5-c	One-seed juniper	0.05	9.52	0.00	10.00	6.51
	Piñon pine	4.45	9.52	0.00	20.00	9.84
	Ponderosa pine	3.78	80.96	100.00	70.00	83.65
7-c	One-seed juniper	3.38	20.69	3.80	0.50	27.68
	Piñon pine	6.96	79.31	70.99	66.67	72.32

4.2.1.3 Mesa Tops

BRET evaluated four transects along the top of Pajarito Mesa, all of them north of the fire road. The dominant overstory species were ponderosa pine, piñon pine, and one-seed juniper (Table 4). Although Rocky Mountain juniper was present in two of the transects, only one tree occurred in each. Average DBHs were considerably larger than on the south-facing slopes, and two of the mesa top transects had the greatest density of trees of any of the vegetation transects. Percent cover ranged from 13.06 to 48.73.

TABLE 4. Overstory Vegetation on a Mesa Top

Transect	Species	Average DBH (in.)	Relative Density	Relative Cover	Relative Frequency	Importance Index
1-c	One-seed juniper	6.14	67.57	49.56	40.91	52.68
	Piñon pine	2.50	18.92	23.63	40.91	27.82
	Ponderosa pine	6.11	13.51	26.81	18.18	19.50
2-c	One-seed juniper	7.80	1.52	0.00	4.35	1.95
	Piñon pine	7.50	1.52	0.98	4.35	1.95
	Ponderosa pine	8.70	84.85	78.38	60.87	76.65
	Douglas fir	9.49	12.12	20.64	30.43	19.44
4-c	One-seed juniper	6.37	67.86	35.18	46.67	49.90
	Rocky Mountain juniper	9.00	1.19	20.52	6.67	9.46
	Piñon pine	8.33	30.95	44.30	46.67	40.64
9-c	One-seed juniper	6.30	59.57	23.63	46.67	43.29
	Rocky Mountain juniper	5.40	2.13	15.95	6.67	8.25
	Piñon pine	6.66	31.91	38.21	26.67	32.26
	Ponderosa pine	6.27	6.38	22.21	20.00	16.20

4.2.1.4 Canyon Bottoms.

Both canyon-bottom transects were located in upper Threemile Canyon, just south of Pajarito Mesa. Species found within the canyon bottoms were similar to those on the south-facing slopes and mesa tops (Table 5).

TABLE 5. Overstory Vegetation in a Canyon Bottom

Transect	Species	Average DBH (in.)	Relative Density	Relative Cover	Relative Frequency	Importance Index
6-c	One-seed juniper	2.93	5.13	0.42	17.65	7.73
	Ponderosa pine	11.31	94.87	99.58	82.35	92.27
8-c	One-seed juniper	3.03	58.73	35.64	26.09	40.15
	Piñon pine	6.78	20.63	19.97	26.09	22.23
	Ponderosa pine	11.39	20.63	44.38	47.83	37.62

4.2.1.5 Riparian Zones.

BRET read a transect in a riparian area of Pajarito Canyon along the northern boundary of TA-67. Ponderosa pine here had the largest average DBH (11.54) of any transect (Table 6). Although the percent tree cover was fairly low (14.73), the shrub cover was the highest of all transects.

4.2.2 Shrub Layer Evaluation

4.2.2.1 North-Facing Slopes

TABLE 6. Overstory Vegetation in a Riparian Zone

Transect	Species	Average DBH (in.)	Relative Density	Relative Cover	Relative Frequency	Importance Index
10-c	Piñon pine	0.10	1.72	0.68	11.11	4.50
	Ponderosa pine	11.54	74.14	85.33	66.67	75.3
	Douglas fir	0.91	24.14	13.99	22.22	20.12

BRET read one north-facing slope transect in Pajarito Canyon. It contained the highest number of shrub stems per acre and the second highest percent shrub cover values of all transects (see Table 7).

TABLE 7. Shrub Species on a North-Facing Slope

Transect	Species	Stems/ Acre	Relative Density	Relative Cover	Relative Frequency	Importance Index
3-c	Gambel oak	1257	65.37	88.06	50.00	67.81
	Wax currant	246	12.78	4.17	14.29	10.41
	New Mexico locust	3	0.16	1.01	3.57	1.58
	Mountain mahogany	392	20.39	6.76	21.43	16.19
	Colorado barberry	25	1.29	0.00	10.71	4.00

4.2.2.2 South-Facing Slopes

BRET surveyed two south-facing slopes in Threemile Canyon, both of which had significantly reduced numbers of stems per acre and percent cover when compared to north-facing slopes (Table 8).

TABLE 15. Understory Vegetation in a Canyon Bottom

Transect	Species	Relative Cover	Relative Frequency	Importance Index
6u	Sedge	12.37	11.76	12.07
	Mountain muhly	12.35	10.08	11.22
	Junegrass	9.06	8.40	8.73
	Little bluestem	14.82	10.08	12.45
	Golden aster	7.46	9.24	8.35
	Blue grama	21.42	16.81	19.11
8u	Blue grama	23.73	26.92	25.32
	Mountain muhly	43.06	29.49	36.27
	Golden aster	3.87	7.69	5.78
	Bitterweed	6.15	7.69	6.92

4.2.3.5 Riparian Zone

BRET measured the second-highest value for plant cover of all transects in the Pajarito Canyon riparian area transect. Several understory species that occurred here did not occur anywhere else (Table 16).

TABLE 16. Understory Vegetation in a Riparian Zone

Transect	Species	Relative Cover	Relative Frequency	Importance Index
10u	Bromegrass	6.56	6.52	6.54
	Redtop	43.98	28.26	36.12
	Bluegrass	11.16	9.78	10.47
	Meadowrue	17.74	14.13	15.93
	Bedstraw	8.63	17.39	13.01

4.2.4 Habitat Descriptions

The vegetation surveys identified three primary vegetation communities within and adjacent to Pajarito Mesa: the Rocky Mountain Montane Conifer-Forest, the Great Basin Conifer-Woodland, and the Rocky Mountain Riparian-Deciduous Forest Communities. These communities can be further separated into series and habitat types.

4.2.4.1 Rocky Mountain Montane Conifer-Forest

This community consists of two vegetation series, ponderosa pine and Douglas fir, which can be further divided into habitat types. The following habitat types were surveyed:

- Ponderosa pine/Gambel oak (on Pajarito Mesa)
- Ponderosa pine/Wavyleaf oak (on a south-facing slope in upper Threemile Canyon)
- Ponderosa pine/One-seed juniper (in the bottom of Threemile Canyon)
- Douglas fir/Gambel oak (on a north-facing slope)

4.2.4.2 Great Basin Conifer-Woodland Community

Much of Pajarito Mesa is included within the Great Basin Conifer Woodland community and is in the piñon pine-juniper series. The following piñon pine-juniper habitat types were surveyed:

- One-seed juniper/wavyleaf oak on Pajarito Mesa
- One-seed juniper/Blue grama on Pajarito Mesa and in Threemile Canyon
- Piñon pine/Mountain mahogany on a south-facing slope of Threemile Canyon

4.2.4.3 Rocky Mountain Riparian-Deciduous Forest Community

This wetland vegetation community occurs in the riparian area of Pajarito Canyon and consists of a single habitat type:

- Boxelder maple/Mixed deciduous series in Pajarito Canyon

TABLE 13. Understory Vegetation on a South-Facing Slope

Transect	Species	Relative Cover	Relative Frequency	Importance Index
5u	Little bluestem	20.43	12.88	16.65
	Mountain muhly	15.87	12.12	14.00
	Wormwood	16.48	20.45	18.47
	James hiddenflower	4.56	6.06	5.31
	New Mexico locust	7.96	8.33	8.15
	Desert thoroughwort	10.20	7.58	8.89
	Gambel oak	6.26	6.82	6.54
7u	Blue grama	43.26	36.17	39.72
	Wormwood	1.76	8.51	5.14
	Indian ricegrass	11.65	6.38	9.02
	Snakeweed	8.37	8.51	8.44
	Bluegrass	8.33	8.51	8.42
	Bromegrass	5.01	8.51	6.76

4.2.3.3 Mesa Tops

The dominant grasses in the four transects on Pajarito Mesa were blue grama, mountain muhly, galleta, and big bluestem (Table 14). Some of the big bluestem clumps were the largest that BRET personnel had encountered on LANL property. Dominant forbs and non-grass species included wormwood, bitterweed, prickly pear cactus, snakeweed, and King's lupine.

4.2.3.4 Canyon Bottoms

The two transects in Threemile Canyon both had high species diversity, but percent cover and frequency values were low for most species (Table 15). Four species (mountain muhly, little bluestem, golden aster, and blue grama) accounted for over 50% of the importance indices in both transects.

TABLE 14. Understory Vegetation on a Mesa Top

Transect	Species	Relative Cover	Relative Frequency	Importance Index
1u	Mountain muhly	35.23	14.78	25.00
	Blue grama	39.38	23.48	31.43
	Wormwood	4.23	9.57	6.90
	Bitterweed	8.77	6.82	7.79
2u	Mountain muhly	27.29	48.65	37.97
	Sedge	5.48	10.81	8.14
	Blue grama	10.89	5.41	8.15
	Narrowleaf yucca	5.44	5.41	5.42
	Big bluestem	45.36	16.22	30.79
4u	Blue grama	54.84	44.32	49.58
	Mountain muhly	4.39	7.95	6.17
	Prickly pear cactus	12.08	4.55	8.31
	Bitterweed	5.50	5.68	5.59
	Fleabane daisy	2.23	7.95	5.09
	King's lupine	7.13	9.09	8.11
	Galleta	6.03	6.82	6.43
9u	Blue grama	55.26	33.95	44.61
	Bitterweed	9.99	10.49	10.24
	Wormwood	12.97	15.43	14.20
	King's lupine	8.04	11.73	9.89
	Snakeweed	10.95	6.79	8.87

TABLE 10. Shrub Species in a Canyon Bottom

Transect	Species	Stems/ Acre	Relative Density	Relative Cover	Relative Frequency	Importance Index
6c	Gambel oak	21	28	60.00	20.00	26.67
	Hybrid oak	19	40.00	100.00	80.00	73.33
8c	Hybrid oak	68	12.82	30.00	27.27	23.36
	Apache plume	169	31.79	0.00	9.09	13.36
	Mountain mahogany	272	51.28	70.00	36.36	52.55

4.2.2.5 Riparian Zone

The single transect in the riparian area in Pajarito Canyon showed a shrub diversity higher than any other transect. Five species here had an importance index greater than 10 (Table 11).

TABLE 11. Shrub Species in a Riparian Zone

Transect	Species	Stems/ Acre	Relative Density	Relative Cover	Relative Frequency	Importance Index
10c	Gambel oak	46.0	4.79	15.54	11.06	10.46
	Hybrid oak	15.0	1.60	20.84	11.06	11.17
	Wax currant	41.0	4.26	0.19	3.76	2.73
	Willow	433.0	44.95	18.94	14.82	26.24
	Wild rose	5.0	0.53	0.19	3.76	1.49
	New Mexico locust	3.0	0.27	0.19	3.76	1.41
	Boxelder maple	31.0	3.20	36.92	36.95	25.69
	Colorado barberry	390.0	40.43	7.19	14.82	20.81

4.2.3 Understory Evaluation

Tables 12-16 list the relative cover, relative frequency, and importance index of all understory species with an importance index value greater than 5.00. Understory information was collected on north-facing and south-facing slopes, as well as on canyon bottoms and mesa tops.

4.2.3.1 North-Facing Slopes

The single north-facing transect in Pajarito Canyon had an unusually low total understory plant cover value (Table 12). Mountain muhly was the dominant grass species. Other abundant grass species included blue grass and June grass. Common forbs found on north-facing slopes included pussytoes and bedstraw.

TABLE 12. Understory Vegetation on a North-Facing Slope

Transect	Species	Relative Cover	Relative Frequency	Importance Index
3u	Mountain muhly	24.31	25.85	25.08
	Pussytoes	22.98	8.07	15.53
	Junegrass	6.42	6.46	6.44
	Bedstraw	5.14	8.08	6.61
	Bluegrass	19.17	9.69	14.43

4.2.3.2 South-Facing Slopes

In the two south-facing transects in Threemile Canyon, total percent plant cover was comparable to that found in the north-facing slope transect (Table 13). However, species of importance varied greatly between the two transects. On the south-facing slope, little bluestem was the dominant grass species in the upper elevational transect. Blue grama was dominant at the lower elevation transect. A variety of forbs, including wormwood, snakeweed, James hidden flower, and desert thoroughwort, were found on the south-facing slope.

4.2.2.3 Mesa Tops

Four mesa top transects were evaluated on Pajarito Mesa. These transects showed less shrub diversity and a lower number of shrub stems per acre than either north- or south-facing slopes (Table 9). Various oak species were the dominant shrubs in all three mesa top transects.

TABLE 8. Shrub Species on a South-Facing Slope

Transect	Species	Stems/ Acre	Relative Density	Relative Cover	Relative Frequency	Importance Index
5c	Wavyleaf oak	246	29.48	21.13	16.67	22.43
	Hybrid oak	274	32.84	69.27	33.33	45.15
	Rabbitbrush	124	14.93	0.00	4.17	6.36
	Squawbush	3.11	0.37	0.00	4.17	1.51
	Wax currant	96	11.57	0.00	12.50	8.02
	New Mexico locust	90	10.82	9.60	29.17	16.53
7c	Hybrid oak	549	46.72	64.44	35.29	48.82
	Apache plume	36	3.06	0.99	11.76	5.27
	Rabbitbrush	10	0.87	0.99	11.76	4.54
	Squawbush	67	5.68	13.11	11.76	10.18
	Mountain mahogany	513	43.67	20.47	29.41	31.18

TABLE 9. Shrub Species on a Mesa Top

Transect	Species	Stems/ Acre	Relative Density	Relative Cover	Relative Frequency	Importance Index
1c	Wavyleaf oak	28	8.82	0.00	20.00	9.61
	Gambel oak	215	67.65	100.00	40.00	69.22
	Hybrid oak	34	10.78	0.00	20.00	10.26
	Mountain mahogany	40	12.75	0.00	20.00	10.92
2c	Gambel oak	862	58.07	65.55	57.89	60.50
	Hybrid oak	532	35.85	30.91	21.05	29.27
	Mountain mahogany	90	6.08	3.54	21.05	10.23
4c	Wavyleaf oak	189	30.18	53.97	23.08	35.74
	Hybrid oak	279	44.56	45.03	23.08	37.56
	Squawbush	22	3.51	0.50	15.38	6.46
	Mountain mahogany	136	21.75	0.50	38.46	20.24
9c	Hybrid oak	257	56.25	54.65	44.44	51.78
	Squawbush	70	15.38	18.18	22.22	18.59
	Mountain mahogany	130	28.37	27.17	33.33	29.62

4.2.2.4 Canyon Bottoms

BRET examined two canyon bottom transects in Threemile Canyon. The lowest percent cover and frequency values of all transects were recorded here (Table 10). The high importance index for mountain mahogany in Transect 8c represents an anomalous departure from this trend.

4.3 Level 3 (Species Specific) Surveys

4.3.1 Species Dismissed from Further Consideration

Of the species identified in the database search, BRET eliminated 13 species of plants and 6 species of wildlife from further consideration in this study. These species are not expected to occur in the project area for the reasons given below.

PLANTS

- Tufted sand verbena (*Abronia bigelovii*). This species is restricted to Todilto gypsum and its derivatives. It was eliminated because these soil types do not occur within the project area.

- Wright fishhook cactus (*Mammillaria wrightii*). This small cactus grows in gravelly or sandy hills or plains, desert grasslands, and piñon pine-juniper zones. Although there is potential habitat for this species within the project area, the species was eliminated from further study because numerous surveys in potential habitat throughout LANL did not encounter the species (Foxx and Tierney 1985; Foxx et al. 1992; Banar 1993). The species has not been found within Los Alamos County and was not detected during BRET field surveys.

- Botanists have found the Santa Fe cholla (*Opuntia viridiflora*) only in an urban area of Santa Fe County. These plants appear to be strongly associated with south- and west-facing slopes in piñon pine-juniper woodlands at about 2195 m (7200 ft) (New Mexico Native Plants Protection Advisory Committee 1984). Although the project area includes terrain at this elevation, BRET found no specimens of this cactus during Level 1 or Level 2 surveys and eliminated it from further consideration.

- The grama grass cactus (*Toumeya papyracantha*) lives on sandy soils within basalt outcrops. Within Los Alamos County, it has been found near the community of White Rock. The species was not included in the Level 3 analyses because the project area does not contain the necessary substrate.

- The wood lily (*Lilium philadelphicum* var. *andinum*) occurs in moist mixed conifer communities. In Los Alamos County, wood lilies grow near seeps or streams in well shaded areas. BRET excluded this species from Level 3 study because no wood lilies were found along the stream in Pajarito Canyon during the Level 1 survey and because the riparian areas

- The sessile-flowered false carrot (*Aletes sessiliflorus*) is restricted to rocky canyons and slopes, usually on substrates of basalt or sandstone. This species was not included in further analyses in this study because it is found primarily in south-central New Mexico and has not been reported in Los Alamos County.

- Plank's catchfly (*Silene plankii*) grows in piñon-juniper habitat and is known to inhabit mountains along the Rio Grande. The species is restricted to mountains characterized by steep to sheer, rocky canyons. The plants are found in protected areas that receive little direct sunlight. The species has been found in the Sandia Mountains in Sandoval County, about 100 km (60 mi) south of LANL (Fletcher 1978). This is the population nearest to LANL that has been identified to date. Pajarito Canyon and Threemile Canyon have relatively steep slopes, but the canyon slopes adjacent to Pajarito Mesa are not sheer. The species was not encountered during vegetation surveys on these slopes in 1992 (Foxx et al.). Habitat in this area may be suitable for Plank's catchfly, but erosion control measures outlined in Section 6.3.1 of this assessment will prevent adverse impacts to the habitat.

- The cyanic milkvetch (*Astragalus cyaneus*) inhabits sandy or gravelly hillsides within piñon-juniper vegetation. The species usually grows adjacent to the Rio Grande has not been found in Los Alamos County. Although there is potential habitat for this species within the project area, it was eliminated from further study because numerous surveys in potential habitat throughout LANL did not encounter the species (Foxx and Tierney 1985; Foxx et al. 1992; Banar et al. 1993).

- The Taos milkvetch (*Astralagus puniceus* var. *gertrudis*) is found on dry slopes of piñon pine-ponderosa woodlands. This species was dismissed from further considerations because numerous surveys have failed to find the species anywhere in Los Alamos County.

- The Santa Fe milkvetch (*Astragalus feenis*) is found on dry slopes of piñon pine-juniper woodlands. Numerous plant surveys in the general vicinity of the project area have failed to find this species (Foxx and Tierney 1985; Foxx et al. 1992; Cross 1994; Cross and Bennett 1994; Dunhan in prep.; Banar 1993). The planned facilities would be constructed on the mesa top and would not disturb the canyon slope habitat that this species prefers.

- The Sandia alumroot (*Heuchera pulchella*) occurs in mixed conifer plant communities. It is a cliff-loving plant and normally occurs at elevations between 2438 and 3658 m (8000 and 12000 ft). BRET elected to eliminate this species because the study area is considerably

lower than 2438 m (8000 ft) in elevation and is dominated by piñon-juniper and ponderosa pine plant communities.

- The checker lily (*Fritillaria atropurpurea*) is threatened by habitat destruction and illegal collection. It grows predominantly in moist areas of mixed conifer forests. Such areas are extremely limited in extent in the project area. No checker lilies were found during the BRET field surveys for this study and it was not included in Level 3 analysis.

- The Pagosa phlox (*Phlox caryophylla*) inhabits open slopes in mountain woodlands and forests. The project area is on a relatively level mesa in piñon-juniper and ponderosa pine vegetation. The area lacks the open slopes that the species prefers. Pagosa phlox has not been located anywhere in Los Alamos County and numerous plant surveys in the general vicinity of the project area have failed to find this species (Foxx and Tierney 1985; Foxx et al. 1992; Dunham 1993; Banar 1993; Cross 1994; Cross and Bennett 1994;).

WILDLIFE

The following species are being dismissed from further consideration because they are unlikely to occur in the project area or there is little potential for the proposed project to cause adverse impacts to the species.

- The common black hawk (*Buteogallus anthracinus*) occurs in cottonwood and other woodlands along permanent streams. This medium-sized raptor is primarily affected by destruction of riparian zones. It has been found in small numbers in the Rio Grande Valley. Although limited riparian areas occur along Pajarito Canyon, these consist of small stands of willows and other shrubs and are not dominated by cottonwoods. The common black hawk is most often found in lower elevations than those that occur near the project area and has not been reported from Los Alamos County or any adjacent county recently.

- The broad-billed hummingbird (*Cynanthus latirostris*) has been seen in riparian woodlands in Bandelier National Monument. Breeding primarily in the southern part of the state, the species usually occurs only as vagrants near Los Alamos. Pajarito Mesa is north of the reported sightings. There is a small band of riparian vegetation along the stream in Pajarito Canyon, dominated by a mixed conifer overstory with oaks, willows, boxelder maples, and shrub species. Habitat in Guadalupe Canyon in southern New Mexico, where this

hummingbird is common, is characterized by thick stands of cottonwood, sycamore, and hackberry (Baltosa 1980, 1983). These species are absent in Pajarito Canyon.

- The willow flycatcher (*Empidonax traillii*) breeds throughout central New Mexico and occurs statewide in spring and autumn migrations. It usually requires riparian areas dominated by cottonwood. In the vicinity of Pajarito Mesa, cottonwood does not dominate the narrow riparian zones of Pajarito Canyon.

- The peregrine falcon (*Falco peregrinus*) establishes breeding territories in ponderosa and piñon areas near cliffs in northern New Mexico. Optimal conditions include nearby large "gulfs" of air that assist the peregrines in attacking their prey from above. Although peregrine falcons are found within Los Alamos County, the project area does not include optimal habitat for them. Only two canyons within LANL boundaries—Los Alamos and Pueblo Canyons—have sufficient habitat to support nesting falcons (Johnson 1992).

- The bald eagle (*Haliaeetus leucocephalus*) winters along the Rio Grande, and winter roosts have been observed at Cochiti Lake. Large trees, protected from the wind and near open water, form suitable roosting sites. There are no lakes or perennial streams near Pajarito Mesa.

- The Mississippi kite (*Ictinia mississippiensis*) generally inhabits the lower Rio Grande and Pecos River valleys in riparian zones and shelter belts. This species has not been reported in the Los Alamos area. Riparian areas near the proposed project area are too limited in size and extent to form acceptable habitat for the Mississippi kite.

4.3.2 Species Selected for Level 3 Surveys

The Level 2 survey identified habitat for the northern goshawk (*Accipiter gentilis*), the spotted owl (*Strix occidentalis* var. *lucida*), and the spotted bat (*Euderma maculatum*) in the project area. Species specific surveys were initiated for these species.

4.3.2.1 Spotted Bat

The spotted bat (*Euderma maculatum*) feeds near standing water in riparian, piñon-juniper, ponderosa pine, and spruce-fir habitats. It roosts in cliffs or rock crevices. Some of the habitat components required

searched for spotted bats (*Euderma maculatum*) in numerous areas throughout the Laboratory during the summer of 1993. (Surveying within the project area was restricted because of LANL security concerns.) BRET used mist nets to conduct the bat surveys. The mist net location nearest to the MWSDF project site was near a pond in TA-8, just west of TA-67. Nets were raised at dusk and left up for several hours. Each was checked every few minutes. When a bat became entangled in a net, it was removed, identified to species, sexed, and released. BRET biologists identified bats using Whitaker (1980) and Burt and Grossenheider (1976) protocols. The results of the spotted bat survey are given in Appendix G.

4.3.2.2 Spotted Owl

The Mexican spotted owl (*Strix occidentalis* var. *lucida*) inhabits forested mountains and canyons in the southwestern U.S and northern Mexico (US Fish and Wildlife Review 1990). Its habitat consists of uneven-aged, multistoried forests with closed canopies. The forests on Pajarito Mesa are not characterized by closed canopies. The transects run by BRET have an average canopy cover of only 26.9% and are thus unlikely to be attractive habitat for the owls. Ongoing fieldwork seems to corroborate this conclusion. An initial reconnaissance of the project area and adjacent canyons for owl habitat indicates that the area on the mesa top and immediately adjacent to the project area does not offer nesting habitat for spotted owls (Johnson 1994).

Although nesting habitat is lacking in the project area, a computer model based on canopy cover and topography indicates that west of the proposed construction site, deep, narrow sections of Pajarito Canyon may contain some marginal nesting habitat for this species. Furthermore, the mesa top habitat may be suitable for spotted owl foraging. Disruption of this mesa top or canyon habitat could affect owls nesting nearby and could discourage colonization of the area by spotted owls (Johnson 1994).

4.3.2.3 Goshawk

The northern goshawk (*Accipiter gentilis*) nests primarily in dense, mature, or old growth coniferous forests. Goshawks are known to nest in the northwest quadrant of LANL. Studies by Kennedy (1987) indicate that the highest percentage of nests is in ponderosa pine/Gambel oak habitat.

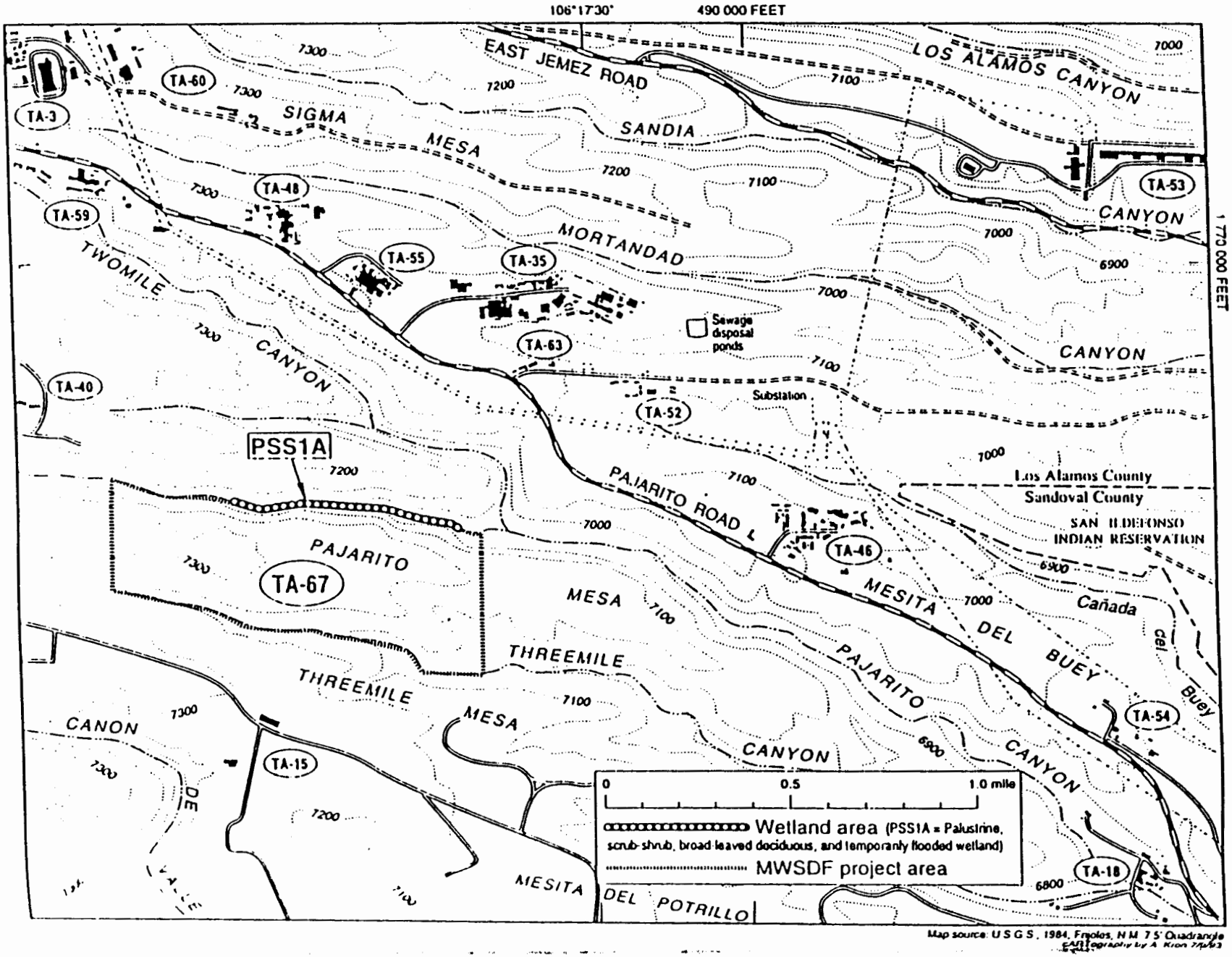
In the summer of 1993, Kennedy walked transects to survey for nothern goshawks in TA-67. She played tapes of bird calls at regular intervals and waited for a response. She found no northern goshawks in TA-67 or its immediate vicinity. However, because of the presence of goshawk habitat, Kennedy recommended that an area of upper Pajarito Canyon be managed for goshawks (Sinton and Kennedy 1993). This stretch of the canyon extends from West Jemez Road to the border of TA-22 and is west of the project area.

4.4 Wetlands and Floodplains Surveys

There are no riparian areas or wetlands at the proposed MWSDF site, but there is a NWI-designated palustrine wetland and a floodplain area in Pajarito Canyon just to the north of the site and an additional floodplain area in Threemile Canyon to the south of the proposed site. The wetlands in Pajarito Canyon are palustrine and temporarily flooded. This area has been broadly mapped by the US Fish and Wildlife Service (Fig. 4) using a hierarchical system described by Cowardin et al. (1979) and based solely on aerial photography. The floodplain areas (Fig. 5) are located in Pajarito and Threemile Canyons.

5. POTENTIAL IMPACTS

The more obvious and severe potential impacts of the proposed MWSDF are discussed below. This discussion concentrates on sensitive species and habitats and is not intended to be an inclusive listing of all possible impacts to the Pajarito Mesa environment.


106°17'30"
490 000 FEET
1 770 000 FEET
EAST JEMEZ ROAD
LOS ALAMOS CANYON
SIGMA MESA
SANDIA
MORTANDAD
CANYON
TWOMILE CANYON
PAJARITO MESA
THREEMILE MESA
MESITA DEL BUEY
PAJARITO CANYON
CANON DE VALLE
MESITA DEL POTRILLO
Cañada del Buey
TA-3
TA-15
TA-18
TA-35
TA-40
TA-46
TA-48
TA-52
TA-53
TA-54
TA-55
TA-59
TA-60
TA-63
TA-67
PSS1A
Sewage disposal ponds
Substation
Los Alamos County
Sandoval County
SAN ILDEFONSO INDIAN RESERVATION
0
0.5
1.0 mile
Wetland area (PSS1A = Palustrine, scrub-shrub, broad-leaved deciduous, and temporarily flooded wetland)
MWSDF project area
Map source: U S G S , 1984, Frijoles, N M 7.5' Quadrangle

5.1 Pre-Construction Impacts

The proposed MWSDF would have an effect on the natural environment during both its construction and operational phases. Initial disturbance of the site would result from seismic hazard investigations, which involve excavation of exploratory trenches on Pajarito Mesa. The trenches would be 30-183 m (100-600 ft) long, 1-1.2 m (3-4-ft) wide, and 1.5-3.3 m (5-10-ft) deep for a total length of approximately 914 m (3000 ft). The total disturbed area is expected to be less than 5574 m^2 (60 000 ft^2).

5.2 Construction-Related Impacts

The most apparent and pronouced impact of the project would be the loss of 29 hectares (72 acres) of ponderosa pine-piñon-juniper habitat during construction. Besides eliminating valuable habitat, this could cause an increase in erosion on the mesa top and in the canyon bottom. This could affect the stream and wetlands in Pajarito Canyon.

5.2.1 Wetlands and Floodplains

Construction near wetlands or floodplains could cause the following impacts:

- Excessive disturbance to the vegetation and soil surface on the mesa top or on steep canyon slopes could alter water flow, widen channels, and initiate changes in wetlands.
- Disturbance of stream channels or small drainages leading to wetlands could cause partial or complete loss of wetlands.
- Hazardous fuel spills or leaks from vehicles could degrade water quality in riparian areas, causing damage or loss of vegetation.

5.2.2 Threatened, Endangered, and Sensitive Species

5.2.2.1 Spotted Bat

Biologists have not found spotted bats within LANL boundaries, but all habitat components necessary to support them are present. The primary threat to spotted bat habitat posed by the MWSDF is the destruction of roosting sites (rock crevices) near the mesa edge.

5.2.2.2 Spotted Owl

Although no spotted owls have been encountered in the project area, there is some marginal nesting and foraging habitat in the vicinity. Foraging habitat on the mesa top would be diminished by the removal of 29 hectares (72 acres) of ponderosa pine vegetation. This habitat loss could also decrease the abundance of prey species in the area. In addition, excessive noise during the breeding and nesting season (March-September) could disturb spotted owls nesting nearby and could discourage colonization of the area by spotted owls. An increase in light pollution caused by lights at the facilities could decrease nighttime spotted owl prey activity and availability. Light could also have an impact on spotted owls by increasing the activity of great horned owls, which prey on spotted owls.

5.2.2.3 Goshawk

Biologists have not searched systematically for goshawks in the project area. However, some of the habitat components for goshawks can be found there. Excessive noise and the operation of heavy equipment during the goshawk mating and nesting season (March-August) could disturb nesting goshawks. In addition, goshawks could be affected by destruction of habitat used by their prey species.

5.2.3 Nonsensitive Species

5.2.3.1 Plants

The proposed project could damage damage soils and associated vegetation in a number of ways.

Trenching for seismic studies

or damage plants. Erosion and changes in drainage patterns would destroy some vegetation and change vegetative patterns. Damage to riparian areas could cause partial or complete loss of wetlands, which could result in further loss of riparian vegetation.

5.2.3.2 Wildlife

Excessive disturbance, especially during critical periods, could result in one or more of the following:

- Disruption or elimination of established migration corridors and foraging areas
- Entrapment of animals in construction excavations
- Direct removal of nesting, perching, cover, and similar habitats
- Nest abandonment, which would result in nesting failure
- Interference with critical periods, such as the breeding period
- Contamination of flora, fauna, or water sources from fuel spills or leaks from vehicles and machinery, during construction or operational phases

6. MITIGATION

6.1 General

BRET should be notified as soon as project schedules are established to allow time for surveys and for accurate and effective mitigation measures to be defined. BRET must conduct some of the necessary biological fieldwork at specific times of the year or over an extended period. A failure to provide advance notice of construction or pre-construction activities may cause considerable delay in approval.

All construction must be planned to limit the initiation or exacerbation of erosion, especially on steep canyon walls. Such erosion could severely affect the wetlands in Pajarito Canyon. There are several shallow drainages on the mesa top that also must be protected from excessive disturbance. Fuel spills or leaks from vehicles could also adversely affect riparian and upland vegetation.

Project planners should leave vegetation buffer zones around all areas where vegetation is removed. These buffer zones would provide a screen of vegetation to minimize the visual impacts of facilities. More importantly, buffer zones would preserve important ecotones for wildlife and plant species. Buffers should be at least 15 m (50 ft) wide.

6.2 Wetlands and Floodplains

Construction activities should be planned to eliminate any impacts on wetlands and floodplains. Wetland boundaries must be delineated prior to the commencement of any activity that has a potential to affect wetlands. After two years, the wetland delineation is no longer considered valid and must be redone. In addition, as mentioned above, erosion on the mesa tops must be minimized to avoid unnecessary inputs of sediments to the wetlands.

6.3 Threatened, Endangered, and Sensitive Species

6.3.1 Plants

If the project is confined to Pajarito Mesa, no mitigation for TES plant species is necessary. However, measures should be taken to minimize erosion. Erosion control measures should be initiated during construction and should continue during project operation. This should include reseeding of the area after construction is complete. To minimize the efffects of erosion and to reduce the input of sediments into streams and wetlands in adjacent canyons, a vegetation buffer of at least 15 m (50 ft) should be maintained along the mesa edge.

6.3.2 Wildlife

6.3.2.1 Spotted Bat

There is some marginal spotted bat habitat in the northern part of TA-67. In order to protect this habitat, BRET must be notified prior to any activities that would disturb the slopes of Pajarito Canyon. A biologist

from BRET must conduct a survey of all potential roost sites in rock crevices in the affected area before such an activity is initiated. Disturbance of these areas should be avoided.

6.3.2.2 Spotted Owl

To protect habitat that may be useful to spotted owls, project personnel should:

- minimize disturbance of vegetation, especially mature trees in Pajarito and Threemile canyons;
- prohibit all construction and pre-construction activities during the spotted owl breeding and nesting season (March-September);
- arrange all light sources during construction and operation of facilities so that light is not increased in the canyon areas;
- schedule activities that create loud noises (operation of heavy equipment, blasting, etc.) so that they take place outside of spotted owl breeding and nesting periods (March-September); and
- provide for long-term monitoring of potential spotted owl habitat in Pajarito and Threemile canyons.

6.3.2.3 Goshawk

No goshawks were found in the project area. However, adjacent canyon areas may provide some suitable nesting habitat. In order to preserve this habitat, the following mitigation measures are necessary:

- schedule use of heavy equipment for all construction and preconstruction activities for September through February, when goshawks are not breeding or nesting
- provide for long-term monitoring of potential goshawk habitat in Threemile and Pajarito Canyons

State Endangered Group 1: any wildlife species or subspecies whose prospects for survival in New Mexico are in jeopardy.

State Endangered Group 2: any wildlife species or subspecies whose prospects of survival or recruitment in New Mexico are likely to be in jeopardy within the foreseeable future. These species are protected by State law.

State Endangered Plant (E1): any species that is listed as threatened or endangered under the provisions of the Federal Endangered Species Act, or is proposed for protection under the tenets of the act.

State Endangered Plant (E2): a species that is rare throughout its entire range and of such limited distribution and population size that unregulated collection could jeopardize its survival in New Mexico.

State Endangered Plant (E3): a species that may be widespread in its distribution and may occur in adjacent states or Mexico, but whose numbers are being reduced to such a degree that within the foreseeable future the survival of this species in New Mexico will be jeopardized.

State Sensitive Plant: a plant species whose numbers or occurrences are low in the state. These species are monitored by the state to see if their status needs to be upgraded to endangered. Currently, state sensitive plants are not protected by state law.

TES Species Database: a database maintained by LANL that lists and provides habitat information on all state and federal endangered and threatened species in Los Alamos County and surrounding counties.

Wetlands: those areas that are inundated by surface or ground water with a frequency sufficient to support (and under normal circumstances do or would support) a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflow, mud flats, and natural ponds.

Critical habitat: habitat that is essential to a species; loss of critical habitat appreciably decreases the likelihood of survival and recovery of a TES species or a portion of its population.

Federal Candidate Species: taxa for which the USFWS has enough information on biological vulnerability and to support listing the species as endangered or threatened.

Federal Candidate (C2) Species: taxa that may be eligible for listing as endangered or threatened, but for which conclusive data on biological vulnerability are not currently available.

Federally Endangered Species: any species that is in danger of extinction throughout all or a significant portion of its range.

Federally Proposed as Endangered: taxa proposed for listing as endangered. Proposed species receive full protection of the Endangered Species Act.

Federally Proposed as Threatened: taxa proposed for listing as threatened. Proposed species receive the protection of the Endangered Species Act.

Federally Threatened Species: any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Floodplain: an area with a one percent or greater chance of being inundated by floods in any given year.

Level 1 Survey: a reconnaissance survey to gather general, non-quantitative data about an area. Information gathered includes a general description of habitat types, level of disturbance, and the presence or absence of water.

Level 2 Survey: a detailed, quantitative survey used to evaluate critical habitat.

Level 3 Survey: a survey to obtain detailed information on a specific threatened or endangered species, or on a floodplain or wetland.

Riparian: the area along streams, lakes, or other wet areas. These areas are only marginally protected by State and Federal law.

State Endangered Species: a species that is listed on the endangered list prepared by the New Mexico state government.

8. SUMMARY OF PERTINENT REGULATIONS

Executive Order 11990 (Protection of Wetlands) calls for avoiding "to any extent possible, the long and short term adverse impacts associated with the destruction or modification of wetlands...[and] direct or indirect support of new construction in wetlands...."

Executive Order 11998 (Floodplain Management) was initiated to "protect lives and property with the need to restore and preserve natural and beneficial floodplain values...."

National Environmental Policy Act declares a national policy to encourage a productive and enjoyable harmony between humans and the environment. Section 102 requires "that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations...."

Section 404 Clean Water Act regulates discharge of dredged or fill materials into navigable waters, after notice and opportunity for public hearings.

The Endangered Species Act declares the intention of Congress to conserve threatened and endangered species and the ecosystems on which those species depend.

The Migratory Bird Treaty Act protects wild birds from collection and maiming. All wild birds are covered by the act except resident game birds, English sparrows, starlings, and feral pigeons.

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10. APPENDICES

Appendix A: Plant Checklist for TAs 15 and 67

FAMILY	SCIENTIFIC NAME	CODE	COMMON NAME
ACERACEAE	*Acer negundo*	Acne	Boxelder maple
ANACARDIACEAE	*Rhus radicans*	Rhra	Poison ivy
	Rhus trilobata	Rhtr	Squaw bush
BERBERIDACEAE	*Berberis fendleri*	Befe	Fendler barberry
BORAGINACEAE	*Cryptantha jamesii*	Crja	James hiddenflower
CACTACEAE	*Opuntia* sp.	Opux	Prickly pear cactus
COMPOSITAE	*Achillea lanulosa*	Acla	Yarrow
	Antennaria parvifolia	Anpa	Pussytoes
	Artemisia carruthii	Arca	Wormwood
	Artemisia dracunculus	Ardr	False tarragon
	Artemisia ludoviciana	Arlu	Wormwood
	Bahia dissecta	Badi	Wild chrysanthemum
	Chrysopsis foliosa	Chfo	Golden aster
	Chrysothamnus nauseosus	Chna	Chamisa, Rabbitbrush
	Circium sp.	Cirx	Thistle
	Erigeron divergens	Erdi	Fleabane daisy
	Erigeron flagellaris	Erfl	Spreading fleabane
	Erigeron philadelphicus	Erph	Common fleabane
	Eupatorium herbaceum	Euhe	Desert thoroughwort
	Gutierrezia sarothrae	Gusa	Snakeweed
	Hymenoxys argentea	Hyar	Perky Sue
	Hymenoxys richardsonii	Hyri	Bitterweed
	Pericome caudata	Peca	Taperleaf
	Senecio fendleri	Sefe	Fendler's senecio
	Thelesperma trifidum	Thtr	Greenthread
CUPRESSACEAE	*Juniperus monosperma*	Jumo	One-seeded juniper
	Juniperus scopulorum	Jusc	Rocky Mountain juniper
CYPERACEAE	*Carex* sp.	Carx	Sedge
EUPHORBIACEAE	*Euphorbia* sp.	Eupx	Spurge
FAGACEAE	*Quercus gambelii*	Quga	Gambel oak
	Quercus sp.	Quex	Hybrid oak
	Quercus undulata	Quun	Wavyleaf
GRAMINEAE	*Agrostis alba*	Agal	Red top
	Agrostis pallustris	Agpa	Creeping bent
	Andropogon scoparius	Ansc	Little bluestem
	Aristida longiseta	Arlo	Red three-awn grass
	Bouteloua gracilis	Bogr	Blue grama
	Bromus sp.	Brox	Bromegrass
	Hilaria jamesii	Hija	Galleta
	Hordeum sp.	Horx	Barley grass

	Koeleria cristata	Kocr	Junegrass
	Lycurus phleoides	Lyph	Wolftail
	Muhlenbergia montana	Mumo	Mountain muhly
	Oryzopsis micrantha	Ormi	Littleseed rice grass
	Oryzopis hymenoides	Orhy	Indian rice grass
	Panicum capillare	Paca	Witchgrass
	Poa sp.	Poax	Bluegrass
	Sitanion hystrix	Sihy	Bottlebrush squirreltail
JUNCAEAE	*Juncus* sp.	Junx	Rush
LEGUMINOSAE	*Lotus wrightii*	Lowr	Deervetch
	Lupinus caudatus	Luca	Lupine
	Lupinus kingsii	Luki	King's lupine
	Robinia neomexicana	Rone	New Mexico locust
	Thermopsis pinetorum	Thpi	Big golden-pea
	Vicia americana	Viam	American vetch
LILIACEAE	*Allium cernuum*	Alce	Nodding onion
	Yucca angustissima	Yuan	Narrowleaf yucca
	Yucca baccata	Yuba	Banana yucca
LINACEAE	*Linum neomexicana*	Line	New Mexico yellow
PINACEAE	*Pinus edulis*	Pied	Pinyon pine
	Pinus ponderosa	Pipo	Ponderosa pine
	Pseudotsuga menziesii	Psme	Douglas-fir
PLANTAGINACEAE	*Plantago purshii*	Plpu	Wooly Indian wheat
POLEMONIACEAE	*Ipomopsis aggregata*	Ipag	Scarlet trumpet
POLYPODIACEAE	*Cystoperis fragilis*	Csfr	Brittle fern
PRIMULACEAE	*Androsace septentrionalis*	Anse	Rock-jasmine
RANUNCULACEAE	*Clematis pseudoalpina*	Clps	Rocky Mountain clematis
	Pulsatilla ludoviciana	Pulu	Pasque flower
	Thalictrum fendleri	Thfe	Fendler meadowrue
ROSACEAE	*Cercocarpus montanus*	Cemo	Mountain mahogany
	Fallugia paradoxa	Fapa	Apache plume
	Fragaria americana	Fram	Wild strawberry
	Potentilla sp.	Ponx	Cinquefoil
	Rosa sp.	Rosx	Wild Rose
	Rosa woodsii var. *fendleri*	Rowo	Fendler's rose
RUBIACEAE	*Galium* sp.	Galx	Bedstraw
SALICACEAE	*Salix* sp.	Salx	Willow
SAXIFRAGACEAE	*Heuchera parvifolia*	Hepa	Alumroot
	Ribes cereum	Rice	Wax currant
VIOLACEAE	*Viola* sp.	Viox	Violet

*Complied soley from 1992 field data

APPENDIX B: Fungi and Slime Molds of TA-67

FAMILY	SCIENTIFIC NAME	COMMON NAME	HABITAT
CREPIDOTACEAE	*Crepidotus herbarum*		Canyon bottom, mixed conifer
TRICHOLOMATACEAE	*Flammulina velutipes*	Velvet stem	Canyon bottom, mixed conifer
GEASTRACEAE	*Geastrum saccatum*	Earthstar	Mesa top, pinon-juniper
GOMPHIDIACEAE	*Gomphidius oregonensis*	Insidious gomphus	Canyon bottom, mixed conifer
HELLVELLACEAE	*Helvella elastica*		Canyon bottom, mixed conifer
RUSSULACEAE	*Lactarius deliciosus*		Canyon bottom, mixed conifer
RETICULARIACEAE	*Lycogala epidendrum*	Slime mold	Mesa top, pinon-juniper
PLUTEACEAE	*Pluteus cervinus*	Fawn mushroom	Canyon bottom, mixed conifer
POLYPORACEAE	*Polyporus arcularius*		Mesa top, pinon-juniper
POLYPORACEAE	*Polyporus sp.*		Canyon bottom, mixed conifer
RUSSULACEAE	*Russula sp.*		Canyon bottom, mixed conifer
BOLETACEAE	*Suillus granulatus*		Canyon bottom, mixed conifer

Appendix C: Ant Species within TA-67

SUBFAMILY	SCIENTIFIC NAME	HABITAT TYPE	AUTHORITY
DOLICHODERINAE	*Acanthomypos interjectus*	Ponderosa	Mayr
	Brachymyrmex depilis	Ponderosa	Emery
	C. sansabeanus	P-j and ponderosa	Buckley
	C vicinus	P-j and ponderosa	Mayr
	F. argentea	Disturbed	Wheeler
	F. neogagates	P-j and disturbed	Emery
	F. pergandei	Disturbed	Emery
	F. podzolica	P-j and disturbed	Francoeur
	F. subnuda	Ponderosa	Emery
	L. pallitarsis	Ponderosa	Provancher0
	L. sitiens	P-j and ponderosa	Wilson
	Polyergus breviceps	Ponderosa	Emery
MYRMICINAE	*Crematogaster cerasi*	Ponderosa	Fitch
	C. colei	Disturbed	Buren
	Leptothorax muscorum	Ponderosa	Nylander
	L. nitens	Disturbed	Emery
	L. obliquicanthus	Disturbed	Cole
	Monomorium cyaneum	Disturbed	Wheeler
	Pheidole ceres	Ponderosa, disturbed, and burned ponderosa	Wheeler
	P. wheelerorum	P-j and disturbed	Mackay
	Pogonomyrmex occidentalis	P-j and ponderosa	Cresson
	Solenopsis molesta	P-j and disturbed	Say
MYRMICINAE	*Leptothorax crassipilis*	R	Wheeler
	L. muscorum	P-R	Nylander
	L. nitens	P-R	Emery
	L. texanus texanus	P-R	Wheeler
	L. tricarinatus	P-R	Emery
	Monomorium cyaneum	P-R	Buckley
	Myrmecina americana	P-R	Emery
	Myrmica emeryana	P-R	Forel
	Myrmica hamulata	P-R	Weber
	Pheidole ceres	P-R	Wheeler
	P. wheelerorum	P-R	MacKay
	Pogonomyrmex occidentalis	P-R	Cresson
	Solenopsis molesta	P-R and R	Say
	Stenamma occidentale	P-R	M R Smith
DOLICHODERINAE	*Tapinoma sessile*	P-R	Say
	Acanthomyops latipes	P-R	Walsh
	Camponotus laevigatus	P-R	F Smith
	C. vicinus	P-R	Wheeler
	F. densiventris	P-R	Linnaeus
	F. hewitti	P-R	Wheeler
	F. lasioides	P-R	Emery
	F. limata	P-R	Wheeler
	F. neorufibarbis	R	Emery
	F. obscuripes obscuripes	P-R	Forel

SUBFAMILY	SCIENTIFIC NAME	HABITAT TYPE	AUTHORITY
	F. obscurivrnitris clivia	P-R	Creighton
	F. occulta	P-R	Francoeur
	F. planipilis	P-R	Creighton
	F. podzolica	P-R	Francoeur
	Lasius alienus	P-R	Foerster
	L. crypticus	P-R	Wilson
	L. flavus	P-R	Fabricius
	L. neoniger	P-R	Emery
	L. niger	P-R	Linnaeus
	L. pallitarsis	P-R	Provancher
	L. subumbratus	P-R	Viereck
	Liometopum apiculatum	P-R	Mayr
	L. luctuosom	P-R	

Appendix D: Reptiles and Amphibians of Pajarito Canyon

FAMILY	SCIENTIFIC NAME	COMMON NAME	LOCATION
AMBYSTOMATIDAE	*Ambystoma tigrinum*	Tiger salamander	Pajarito Canyon
BUFONIDAE	*Bufo punctatus*	Red-spotted toad	Pajarito Canyon
	Bufo woodhousei	Woodhouse toad	Pajarito Canyon
COLUBRIDAE	*Elphae guttata*	Corn snake	Pajarito Canyon
	Thamnophis elegans	Western terrestrial garter snake	Pajarito Canyon
HYLIDAE	*Hyla arenicolor*	Canyon treefrog	Pajarito Canyon
	Pseudocris triseriata	Striped chorus frog	Pajarito Canyon
IGUANIDAE	*Crotophytus collaris*	Collared lizard	Pajarito Mesa
	Sceloporus undulatus	Eastern fence lizard	Pajarito Canyon
PELOBATIDAE	*Scaphiopus multiplicatus*	Southern spadefoot	Pajarito Canyon
TEIIDAE	*Cnemidophorus velox*	Plateau striped whiptail	Pajarito Canyon

APPENDIX E: Nesting Birds Of The TA-67 Vicinity (after Travis 1992)

FAMILY	SCIENTIFIC NAME	COMMON NAME	NESTING STATUS
ACCIPITRIDAE	*Buteo jamaicensis*	Red-tailed hawk	Probable
APODIDAE	*Aeronautes saxatalis*	White-throated swift	Possible
CAPRIMULGIDAE	*Phalaenoptilus nuttallii*	Common poorwill	Probable
COLUMBIDAE	*Zenaida macroura*	Mourning dove	Probable
CORVIDAE	*Aphelocoma coerulescens*	Scrub jay	Confirmed
	Corvus corax	Common raven	Confirmed
	Cyanocitta stelleri	Steller's jay	Possible
	Nucifraga columbiana	Clark's nutcracker	Confirmed
EMBERIZIDAE	*Chondestes grammacus*	Lark sparrow	Confirmed
	Coccothraustes verpertina	Evening grosbeak	Probable
	Junco hyemalis	Dark-eyed junco	Possible
	Pheucticus melancephalus	Black-headed grosbeak	Confirmed
	Pipilo erythophthamlus	Rufuous-sided towhee	Confirmed
	Pooecetes gramineus	Vesper sparrow	Probable
	Spizella passerina	Chipping sparrow	Confirmed
	Vermivora celata	Ornage-crowned warbler	Probable
	Vermivora virginiae	Virginia's warbler	Confirmed
FALCONIDAE	*Falco sparverius*	American kestrel	Probable
FRINGILLIDAE	*Carduelis pinus*	Pine siskin	Probable
	Carpodacus casinii	Cassin's finch	Probable
	Carpodacus mexicanus	House finch	Confirmed
	Loxia curvirostra	Red crossbill	Possible
HIRUNDINIDAE	*Tachycineta thalassina*	Violet-green swallow	Probable
ICTERIDAE	*Molothrus ater*	Brown-headed cowbird	Confirmed
MUSCICAPIDAE	*Catharus guttatus*	Hermit thrush	Probable
	Myadestes towsendi	Townsend's solitaire	Possible
	Sialia currucoides	Mountain bluebird	Confirmed
	Sialia mexicana	Western bluebird	Confirmed
	Turdus migratorius	American robin	Probable
PARIDAE	*Parus gambeli*	Mountain chickadee	Probable
	Parus inornatus	Plain titmouse	Probable
	Psaltriparus minimus	Bushtit	Confirmed
PARULIDAE	*Dendroica coronata*	Yellow-rumped warbler	Confirmed
	Dendroica graciae	Grace's warbler	Confirmed
PICIDAE	*Colaptes auratus*	Northern flicker	Possible
	Melanerpes formicivorus	Acorn woodpecker	Possible
	Picoides villosus	Hairy woodpecker	Possible
SITTIDAE	*Sitta carolinensis*	White-breasted nuthatch	Confirmed
	Sitta pygmaea	Pygmy nuthatch	Confirmed
STRIGIDAE	*Bubo virginianus*	Great horned owl	Probable
SYLVIDAE	*Polioptila caerulea*	Blue-gray gnatcatcher	Possible
THRAUPIDAE	*Piranga ludoviciana*	Western tanager	Probable
TROCHILIDAE	*Selasphorus platycercus*	Broad-tailed hummingbird	Possible
TROGLODYTIDAE	*Troglodytes aedon*	House wren	Probable
TYRANNIDAE	*Contopus sordidulus*	Western wood-pewee	Probable

FAMILY	SCIENTIFIC NAME	COMMON NAME	NESTING STATUS
	Empidonax hammondii	Hammond's flycather	Confirmed
	Empidonax wrightii	Gray flycatcher	Confirmed
	Myiarchus cinerascens	Ash-throated flycatcher	Probable
	Sayornis saya	Say's phoebe	Confirmed
VIREONIDAE	*Vireo solitarius*	Solitary vireo	Confirmed

APPENDIX F: Mammals Of The Project Area*

FAMILY	SCIENTIFIC NAME	COMMON NAME	STUDY*
CANIDAE	*Canis latrans*	Coyote	TA 67 pellets
	Urocyon cineroargenteus	Gray fox	Assumed present
CERVIDAE	*Cervus canadensis*	Elk	TA 67 pellets
	Odocoileus hermionus	Mule deer	TA 67 pellets
CRICETIDAE	*Microtus longicadtus*	Longtail vole	TA 18 small mammal trapping
	Peromyscus boylei	Brush mouse	TA 15 small mammal trapping
	Peromyscus maniculatus	Deer mouse	TA 15 small mammal trapping
	Reithrodontomys megalotis	Western harvest mouse	TA 18 small mammal trapping
ERETHIZONTIDAE	*Erethizon dorsatum*	Porcupine	TA 67 pellets
FELIDAE	*Lynx rufus*	Bobcat	Assumed present
LEPORIDAE	*Sylvilagus* sp.	Cottontail rabbit	TA 67 pellets
MUSTELIDAE	*Mephitis mephitis*	Striped skunk	Assumed present
PROCYONIDAE	*Procyon lotor*	Raccoon	Assumed present
SCIURIDAE	*Eutamius minimus*	Least chipmunk	TA 15 small mammal trapping
	Eutamius quadrivittatus	Colorado chipmunk	TA 15 small mammal trapping
	Citellus variegatus	Rock squirrel	Assumed present
	Sciurus aberti	Abert's squirrel	Assumed present
SORICIDAE	*Sorex vagrans*	Vagrant shrew	TA 18 small mammal trapping
URSIDAE	*Ursus americanus*	Black bear	Assumed present

* Data from Raymer (1992) and Raskevitz (1992)

Appendix G: Bats of Los Alamos National Laboratory and Bandelier National Monument*

SCIENTIFIC NAME	COMMON NAME	NRF	RAF	MALE	JUV	UNK	TOTAL
Antrozous pallidus	Pallid bat	0	4	4	0	2	10
Eptesicus fuscus	Big brown bat	1	2	7	0	0	10
Lasionycteris noctivagans	Silver-haired bat	0	0	15	0	0	15
Lasiurus cinereus	Hoary bat	0	0	11	0	0	11
Myotis californicus	California myotis	0	2	2	0	0	4
Myotis evotis	Long-eared myotis	2	2	2	0	1	7
Myotis leibii	Small-footed myotis	0	0	5	0	0	5
Myotis thysanodes	Fringed myotis	1	6	4	2	0	13
Myotis volans	Long-legged myotis	1	1	4	1	0	7
Myotis yumanensis	Yuma myotis	0	4	1	0	0	5
Pipistrellus hesperus	Western pipistrelle	0	0	1	0	0	1
Plecotus townsendii	Townsend's big-eared bat	0	0	1	0	0	1
Tadarida brasiliensis	Brazilian free-tailed bat	0	1	3	0	1	5

* Compiled from data in 3/D Environmental Services (1992)