This "Affected Environment" chapter describes existing conditions for those elements of the natural, cultural, and social environments that would be affected by the implementation of the actions considered in this EIS.

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3. Affected Environment

Visitor Experience

Increasing visitor access as proposed under the action alternatives would affect how visitors use and experience the preserve. This section describes current visitation and visitor activities provided by the preserve so that changes resulting from the proposed alternatives can be analyzed.

Study Area

The study area for evaluating impacts on visitor experience for implementation-level decisions is the specific proposed visitor contact station / visitor center locations for each action alternative; the study area for programmatic-level decisions encompasses the entire preserve.

Visitation

Increasing visitor access as proposed under the action alternatives would affect how visitors use and experience the preserve.

Access to the preserve prior to federal ownership had been limited to those who owned or worked the ranch and their friends and families. Recreational access during that time was primarily through exclusive hunting opportunities. Ranch managers occasionally organized barbeques and invited locals who supported the ranch. Employees of the USFS and the National Park Service and volunteers from local fire departments, as well as their families, were invited because they provided emergency services. During these occasions, visitors were allowed to explore the area around the movie set near the Valle Grande entrance and fish in the East Fork of the Jemez River. Access for special-interest group tours, such as historical or geological societies, was occasionally granted (VCT 2007b).

Since federal acquisition, public access has increased from a few hundred visitors per year to nearly 25,000 in 2010. Public access and use of the preserve has been managed through interim programs that use the existing ranch infrastructure and temporary buildings, which have limited capacity. Current visitors to the preserve represent only a fraction of the potential visitors (VCT 2010c, 2007b). Table 3-1 demonstrates an increasing visitation trend from 2005 to 2010.

Table 3-1: Annual Visitation and Revenues for the Preserve, 2005–2010

Year	Number of Visitors	Total Revenue
2005	9,220	$652,219
2006	9,938	$794,844
2007	12,405	$749,957
2008	15,238	$735,528
2009	15,581	$609,219
2010	24,784	$709,218

Source: VCT 2007b, 2008, 2009b, 2010c.

In 2009, the VCT added new programs, modified existing programs taking public input into consideration, and initiated an aggressive marketing plan. The VCT's

operations and infrastructure were also improved in 2010. These actions resulted in a substantial increase in 2010 visitation over 2009. The on-site information centers and expanded access to the preserve allowed public access seven days a week from April or May through September or October and weekends from December through March. The information centers and expanded access are closed most of the spring as roads are impassable. The three information centers provide information about the preserve and activities, retail sales for preserve merchandise, and fee processing for other recreation activities on site. This gives visitors the option to make a reservation in advance on the web or reserve their activity on site (VCT 2010d; GAO 2009). Access fees consist of a base fee of $10.00 that is adjusted for added value (e.g., guided interpretive hikes) and age (i.e., reduced for children and seniors) (VCT 2007b).

Visitors to the preserve primarily fall into two categories: casual and dedicated. Casual (spontaneous) visitors are on a restricted schedule and generally are not prepared for extended recreational activities. Dedicated visitors have extended time available and are prepared for recreational activities (VCT 2005c). The programs, infrastructure, and information needs differ between these user groups. In the first five years of its existence, the VCT developed the interim programs described above primarily for the dedicated visitor (e.g., hunting, fishing, and van tours) (VCT 2007b).

The VCT has not systematically gathered information about the characteristics of visitors to the preserve. However, the VCT has gathered information from orders (e.g., reservations for activities and events, fishing lotteries) placed on its website, general visitor surveys, and surveys at special events. From 2005 to 2007, 71% of the orders and 62% of the revenue came from New Mexico residents (table 3-2), and the remainder came from nonresidents (VCT 2007b).

Table 3-2: Orders Placed on the VCT Website 2005–2007

	2005	2006	2007
Number of orders*	5,992	5,891	6,711
New Mexico orders (%)	71	70	73
Total sales	$400,778	$444,112	$446,513
New Mexico sales (%)	59	61	66

Source: VCT 2007b.
Note: Data are for fiscal years (October 1 through September 30).
* Orders include reservations and lotteries for activities and events.

In 2004 the VCT surveyed 99 recreation users and categorized them as anglers, general visitors, or recreation visitors. Anglers, the majority of those surveyed, appreciated the relative solitude most and, to a lesser extent, the "pristine" scenery of the preserve. General visitors identified wildlife as the most important quality, followed by natural beauty. Recreation visitors focused on scenery. Although samples from the general and recreation surveys are too small to identify a pattern, "solitude / few people" was not identified as a particularly valuable or special characteristic of the preserve. When asked about an acceptable number of

encounters, over 80% of the anglers said 0–5; over 70% of the general and recreation visitors said 1–12 (VCT 2005g).

The VCT surveyed anglers specifically in 2009. Most anglers are highly satisfied with their fishing experience at the preserve; on a scale of 0–10, with 10 being highly satisfied, 84% rated their experience 8 or above. Ninety-five percent said they would recommend the preserve's fishing program to friends. Monday was the least popular day of the week, but participation was spread fairly evenly throughout the rest of the week, with Thursdays and Fridays being the most popular. Regarding fees, 88% felt the fee was reasonable. Although many commenters requested reduced fees, one suggested increasing them and others said the price was reasonable. A representative comment held that "opening to the public at no charge would quickly destroy the fishing" (VCT 2009a).

The 2005 *Valles Caldera National Preserve Master Plan for Interpretation* categorizes the preserve's visitors by types of activities (VCT 2005g):

- recreational: people come in large numbers and seek experiences based on their needs and interests
  - "alone" and in place—e.g., artists, anglers
  - "alone" and moving around—e.g., hikers, backpackers, equestrians
  - "knowledge" seekers—e.g., the local community, tourists
  - "convivial" groups—e.g., families, tour groups
  - "casually curious"—e.g., opportunistic travelers
- spiritual pursuits and traditional practices
  - Pueblos
  - others
- education, training, and skills development
- ranching practices
- forest management
- natural resource management
- outdoor recreation management
- site services
  - staff
  - volunteers
  - scientists
- other groups with specialized needs
  - media, journalists
  - VIPs—political figures, etc.

- professional peers
- donors and sponsors

The VCT's interpretive plan also identifies the preserve's primary interpretive audience as New Mexico residents who value personal or private experiences in an apparently pristine environment. This audience is categorized into three groups: (1) those who are drawn to the site by its special resources (e.g., elk hunting and high-quality fishing), (2) those who are willing to pay for personal or private experiences in nature, and (3) those who are acquainted with the site and are curious. These audiences are expected to change over time in the following ways (VCT 2005g):

- Elk hunting and fishing are expected to continue to attract visitors as long as the resource remains high quality.
- The number of visitors seeking private experiences in nature may decline unless a greater variety of experiences is made available.
- Curiosity seekers will decline in number as their curiosity is satisfied.
- Lack of overnight experiences will deter visitors from a distance greater than two hours away.

On Saturday August 26, 2006, the VCT held an open house, when visitors could drive their personal vehicles in the preserve at no cost. The VCT had planned to open a long loop (26 miles) and a short loop (13 miles) between 9:00 a.m. and 4:00 p.m. Over 7 inches of rain fell on the preserve between August 1 and August 25 and damaged parts of the long loop on the west side of the preserve. High water in the East Fork of the Jemez River made the short loop impassable. On the morning of August 25, VCT staff changed the plan for two one-way routes to one two-way route. The two-way route was approximately 16 miles from the main entrance on NM-4 to the San Antonio cabin. The main gate on NM-4 was opened at 8:15 a.m. to allow traffic that had lined up along the highway to enter the preserve. Due to the large volume of traffic and the implementation of two-way traffic, vehicles on the preserve became gridlocked at the History Grove around midday. The VCT closed the main gate at NM-4 at about 1:00 p.m. (instead of the scheduled 4:00 p.m.). Before the main gate was closed, 1,444 vehicles carrying 3,746 passengers entered the preserve; 500–800 vehicles were turned away. While the gate was open, vehicles entered the preserve at a rate of one vehicle every 11 seconds for 4.5 hours. The average number of passengers per car was 2.65. Vehicle density on the 16-mile road from NM-4 to the San Antonio cabin was 91 vehicles per mile (VCT 2007b).

Zip codes were collected from the first 433 (30%) vehicles. Almost 98% were from New Mexico and 79% were from five cities in New Mexico (table 3-3); nine vehicles (2.1%) came from other states (VCT 2007b).

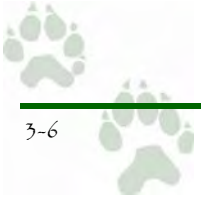


Table 3-3: Cities of Origin of Visitors at the August 2006 Open House

City, State	Number of Vehicles	Percentage of Total Vehicles Polled*
Los Alamos, NM	132	30.5
Albuquerque, NM	128	29.6
Santa Fe, NM	40	9.2
Jemez Springs, NM	22	5.1
Española, NM	22	5.1
Five-city Total	**344**	**79.4**
Other cities in NM	80	18.5
Other states	9	2.1
Total	**433**	**100.0**

Source: VCT 2007b.
Note: Based on zip code data collected from 433 vehicles.
* Total number of vehicles polled = 433.

The VCT had 10 visitor information stations along the route to educate and inform the public about current programs and future opportunities, and to give the public the opportunity to meet and discuss ideas and concerns with the board of trustees and VCT staff members. The VCT distributed approximately 1,500 welcome packets and received 216 comment form replies. Most people learned of the event in a newspaper (48%) or from a friend or relative (19%). Direct advertising may have accounted for up to 26% (email, brochure/poster, and website/Internet). The majority of visitors (68%) had not participated in a previous event and the open house was likely their first time on the preserve. Of these first-time visitors, more than half did not know about the preserve, thought it was closed to the public, or lacked information. The perception of high cost for events was mentioned by 13% of respondents. Nearly one-third of the respondents had participated in at least one prior event (VCT 2007b).

The VCT asked whether people would participate in future events and why; 75% said yes, 22.4% said yes/maybe, and 2.6% said no. People said yes because of the preserve's beauty (59%) and the types of events offered (26%). Of the people who answered yes/maybe, 27% said it depended on the cost and 27% said it depended on the types of events offered. Of those who said no, cost and traffic were the reasons mentioned (VCT 2007b).

The VCT asked people for additional comments. The most frequent responses were requests to have more open houses (13% of respondents), exclamations about the beauty of the preserve (12%), and complaints that there were too many cars and people (11%). Some visitors wanted the VCT to charge an entrance fee (8%), control visitation with an allocation system (7%), and limit vehicles and visitors (6%). Overall, 68% of the visitors had an "exceptional" or "interesting" experience, 14% said it was "okay" or "fair," and 19% said it was "poor." "Poor" experiences could be attributed to the significant traffic jams experienced during the open house (VCT 2007b).

In 2010, the preserve conducted a public survey to obtain information about people's perspectives on recreating at the preserve; 712 people responded. As noted in the "Socioeconomics" section, approximately 52% of survey respondents are unsatisfied with the level of public access on the preserve, and 77% have not participated in recreational activities on the preserve due to limited access. However, respondents overwhelmingly do not favor unlimited access; 80% believe there should be a limit to recreational access on the preserve. The majority favor annual visitation limits of 20,000–50,000 visitors (38.1%) or 50,000–100,000 visitors (27.9%). Approximately 9% favor 100,000–200,000 annual visitation, and 10% favor annual visitation over 200,000. Sixteen percent would like visitation to remain approximately at its current levels. In addition, most visitors do not want to sacrifice the quality of their experience; 66% prefer the quality over quantity. Approximately 53% believe that increased access is less important than possible negative environmental effects associated with it (Gagnon 2011).

Regarding access inside the preserve, 42.5% of survey respondents in 2010 disagree that the preserve should favor the use of shuttle buses over personal vehicles, 35% agree, and 22.1% neither agree nor disagree. The majority (75.5%) of respondents believe that management should develop more paved roads to increase access into and around the preserve, 14.3% disagreed, and 10.3% neither agreed nor disagreed. However, when asked whether they would support use of buses or shuttles if that would decrease the need for additional infrastructure, such as paved roads and parking lots, 57.8% of survey respondents said yes, 29.6% said no, and 12.5% did not know (Gagnon 2011).

As demonstrated by public input, public demand for access to the preserve is high and is not being met by current interim programs. A 2010 report summarizing interviews with members of communities around the Jemez Mountains notes that Los Alamos area participants seek greater access to the preserve and express frustration with management policies that they feel are overly restrictive. However, they also do not favor unrestricted access. They would like to have more control over their experiences in the preserve (Anschuetz and Raish 2010). Such public demand for access and use is expected to increase as the regional population increases (see "Socioeconomics" section) and as additional programs and opportunities are developed by the VCT.

The State of New Mexico and Sandoval County view the Jemez area as a major asset for tourism. With the rapid growth of Albuquerque and the surrounding area, pressure on the resources and infrastructure of public lands in the Jemez area has increased. The *Jemez Valley Corridor Assessment* (MRCOG 2006) prepared by the Mid-region Council of Governments of New Mexico reports that visitors from these cities contribute to most of the traffic along NM-4, which runs through the preserve. Traffic surveillance recorded an increase in the average volume of 1,200

vehicles per day to 2,400 vehicles per day during a holiday weekend along NM-4 south of the preserve.

Recreation

The Valles Caldera Preservation Act does not limit the kinds of recreation that the preserve might support, but its "Findings" suggests several activities that the land would support: "The Baca ranch's natural beauty and abundant resources, and its proximity to large municipal populations, could provide numerous recreational opportunities for hiking, fishing, camping, cross-country skiing, and hunting" (PL 106-248; 16 USC 698v).

The act challenges the VCT to combine elements of the private and public sectors in a unique management regime for public access and use of the preserve. The act required the VCT to provide access for recreation within two years of federal acquisition. The opening of the preserve began in the summer and fall of 2002 with the commencement of interim programs for elk hunting, grazing, and guided hiking. Opportunities for cross-country skiing and snowshoeing became available the following winter. Through the course of 2003 other activities, including unguided hiking, fishing, horse-drawn wagon rides, and van tours, were added (VCT 2007b).

The preserve currently offers a variety of recreation programs ("core activities" described below) and special events (e.g., mountain biking, running marathons, stargazing, outdoor skill clinics, and photo and landscape painting workshops). These programs were established to provide the public access to the preserve after the VCT assumed management (August 2002) without investing large amounts of money on capital improvements. The programs are popular and attendance continues to increase. Visitor capacity and use will continue to be limited by the existing infrastructure (VCT 2007b).

The VCT currently provides core activities, which occur on a regular basis throughout the year, and a variety of special events. Core activities include hunting, fishing, hiking, wagon rides, equestrian trail rides, and van tours from spring through fall, and cross-country skiing, snowshoeing, and sleigh rides in the winter (see tables 3-4, 3-5, and 3-6). These activities are intended primarily for dedicated visitors and require staffing, transportation, facilities, signs, information, and a reservation or lottery system in addition to the physical infrastructure of the preserve (VCT 2007b). In 2009, the preserve added new guided hikes in addition to the unguided and free hikes, as well as some new van tours and improved wildlife, history, archeology, and botany tours. Popular one-hour tours to the headquarters area were offered Thursdays through Mondays. The stargazing program was also expanded (GAO 2009). As shown in table 3-4, participation in public programs increased dramatically from 2003 to 2007.

The VCT continued expanding its offerings, with the participation in visitor programs in 2010 shown in the table below. New services, such as shuttle service to hiking areas within the preserve (as described under "Hiking" below) substantially increased specific visitor activities (VCT 2010d, 2005c).

Table 3-4: Annual Visitor Participation in Public Programs, 2003–2007

	2003[a]	2004	2005	2006	2007
Special events	351	1,674	3,401	5,196	3,984
Fishing	1,735	2,010	1,919	1,585	1,814
Hunting[b]	840	497	1,162	1,332	1,798
Sleigh/wagon rides	598	1,520	891	702	516
Hiking[c]	1,276	1,620	565	446	1,020
Skiing/snowshoeing	64	142	705	0	1,393
Van tours	353	502	379	573	1,607
Equestrian	NA	213	198	104	273
Total	**5,217**	**8,178**	**9,220**	**9,938**	**12,405**

Source: VCT 2007b.

[a] Data for all programs except elk hunting are for fiscal years (October 1 through September 30); data for elk hunting are calendar years (elk hunt access permits are sold in one fiscal year and the hunting occurs in the next fiscal year).

[b] Data for 2004 through 2006 are for elk hunting; data for 2007 are for elk and turkey hunting combined.

[c] Includes estimates of hikers on free trails accessible from NM-4 in 2003 (378) and 2004 (600).

Table 3-5: Annual Visitor Participation in Public Programs, 2010

2010 Program Type	Visitors Participating
Facility rentals	1,258
Fishing	1,746
Hiking	6,205
Hunting	2,076
Information center	6,170
Special events	2,182
Special uses	35
Summer recreation	1,933
Winter recreation	3,179
Total	24,784

Source: VCT 2010d.

During 2011, the VCT moved forward in developing and implementing a more rigorous and defensible visitor counting system. This counting program was implemented in an attempt to be consistent with other public land agencies and their visitor counting techniques. Using advanced counters at 6 locations, and working in consultation with a National Park Service statistician, the number of visitors at the preserve during FY2011 is reasonably estimated to be 97,552 (VCT 2011c).

The 2010 visitor survey mentioned above asked respondents to identify the types of recreational activities they undertook when visiting the preserve, the types of activities they undertook on other public lands, the types of activities they would like to see more widely or frequently allowed on the preserve, and those that they would not like to see on the preserve. Table 3-6 shows the results.

Table 3-6: Recreational Activities Undertaken and Desired at the Preserve

Activity	% Undertaken on the Preserve	% Undertaken on Other Public Lands	% More Desired	% Not Desired
Hiking	45.5	79.2	56.7	1.6
Wildlife viewing	43.5	65.1	43.9	1.3
Campsite camping	n.a.	57.9	39.7	19.6
Fishing	29.2	55.2	36.4	4.1
Winter recreation	21.9	46.2	31.8	4.5
Backpacking	n.a.	43.2	41.1	2.9
Hunting	21.2	40.7	32.1	17.5
Biking	17.7	37.9	29.1	10.4
Lodging	3.6	28.1	17.4	28.8
RV camping	n.a.	25.8	15.0	63.2
Motorsports	n.a.	16.8	10.0	87.7
None (all reduced)	17.5	1.4	5.0	4.1

Source: Gagnon 2011
n.a. = not allowed on the preserve at the time of the survey.

The survey shows that the most popular activities visitors undertaken at the preserve are hiking and wildlife viewing, at 45.5% and 43.5%, respectively. Fishing, winter recreation, and hunting are also popular, at 29.2%, 21.9% and 21.2%, respectively. The majority of respondents do not want motorsports (87.7%) or RV camping (63.2%) allowed on the preserve, which is currently the case. Although 28.1% of respondents used lodging accommodations on other public lands, almost the same percentage (28.8%) do not want that service offered at the preserve. The survey also indicates latent demand; 43.2% of respondents backpacked on other public lands, and 41.1% desire that type of activity at the preserve, where it is currently not allowed. Similarly, campsite camping, which is currently not allowed on the preserve, is a popular activity on other public lands (57.9%) and is requested by 39.7% of respondents (Gagnon 2011).

The demand for some core activities, such as hunting and fishing, exceeds the opportunities available. The lottery system allows the VCT to generate revenue while providing a quality experience at an affordable price. Lotteries also ensure equitable distribution of the available opportunities. The demand for other core activities, such as hiking (guided and unguided) and van tours, is generally met through a reservation system, which ensures that the number of visitors does not exceed the capacity for parking and staffing. Special events, such as mountain biking and marathons, are planned and conducted with the assistance of organized groups and volunteers. Mountain biking routes are focused in the Banco Bonito Staging Area and follow most, but not all, of the equestrian trails (see figure 3-1).

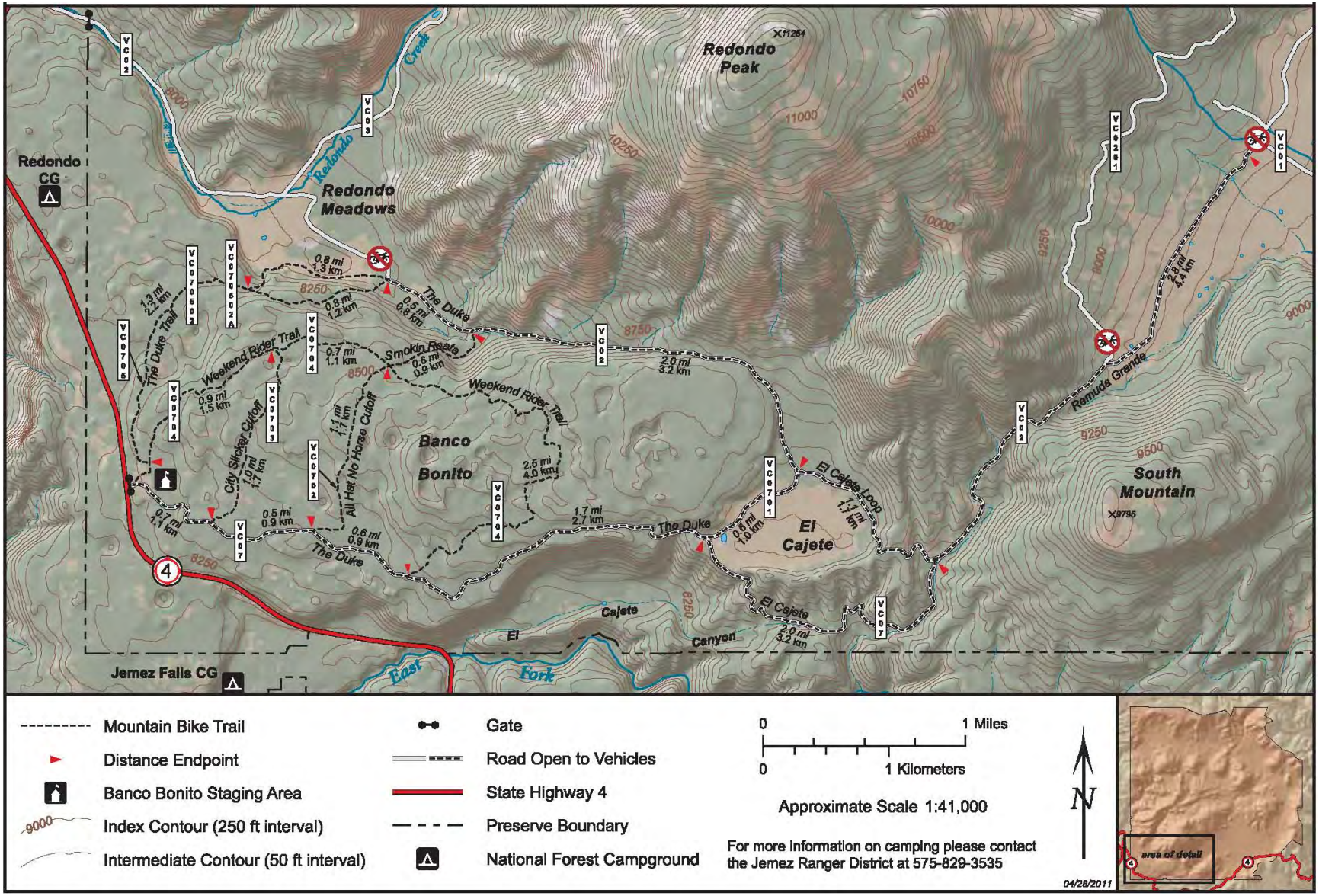


Figure 3-1: Mountain Bike Trails

A lack of infrastructure for visitor services currently imposes a limitation on the VCT's ability to open the preserve. Without suitable parking lots and other staging areas, and without reliable water and wastewater systems, it is difficult to accommodate significant numbers of people in a safe and sanitary manner (VCT 2007b).

The development of the interim recreation program has been guided by public listening sessions held in 2001 and the public comments on the draft *Framework and Strategic Guidance for Comprehensive Management* (VCT 2010f). The public has consistently requested that the VCT provide access while protecting the solitude, natural quiet, and vistas of the preserve, sentiments that are also expressed in the *Framework and Strategic Guidance for Comprehensive Management*. This document established guidelines for visitor programs that have guided VCT management decisions thus far. The VCT is "…committed to developing programs that provide a range of visitor activities in as timely a manner as possible…[and] to developing its programs incrementally, expanding them gradually, so that the quality of experience remains high and so that the capacity of the preserve to sustain the impacts of increasing numbers of people is not compromised" (VCT 2010f). The guidelines are as follows:

- The quality of the visitor experience is more important than the quantity. It may be important to limit the number of people so participants can experience the sense of expansiveness and quiet that the preserve can offer. Programs are to be initiated in a conservative fashion and phased in incrementally.
- Visitor activities must not result in serious or lasting impairment of natural systems.
- Individual activities should be planned with the entire range of preserve programs and responsibilities in mind in order to minimize conflict with landscape stewardship programs or other visitor activities.
- Visitor programs must provide income to the preserve while including options that ensure cost accessibility to all.
- Activities must not conflict with religious and cultural priorities or uses.
- The VCT will consider entering into partnerships to provide visitor opportunities, including cross-boundary activities and joint undertakings with private sector entities.
- The VCT does not have to accommodate all possible uses of public lands, particularly when activities that might conflict with the VCT's management principles may be pursued on adjacent or nearby public lands.
- The VCT will offer flexible programs that can be adjusted in time and space. Restrictions may be applied to avoid conflict with episodic wildlife needs (e.g., elk calving, foraging of certain migrating raptors), weather conditions (e.g., presence or absence of winter snow), or preserve programs (e.g., elk hunts, livestock management, fishing).

- The VCT will consider "quiet times"—respites from all or most visitor disturbances.
- Impacts of visitor activities will be monitored and subsequently modified if needed. Monitoring will include both visitor satisfaction and landscape impacts.

The interim recreational program, based on the guidelines listed above, includes those described in more detail below.

Hunting

Elk and turkey hunting are permitted on the preserve. All elk and turkey hunters receive a welcoming letter, an orientation packet and an access agreement. The VCT requires a liability waiver to be signed by elk and turkey hunters and their guests. Also, each hunter is required to attend an orientation where the hunting rules and regulations are reviewed. Volunteers from the Rocky Mountain Elk Foundation, the National Wild Turkey Federation, the NMDGF, and others donate their time to assist hunters on the youth, mobility impaired, and other antlerless elk hunts. Hunters reported that the elk and turkey hunts were high quality and that they would like to return to hunt again (VCT 2010d).

Elk Hunting

In the 1990s, the caldera was known worldwide for elk hunting. Guided hunts for bull elk, including meals and lodging in the Casa de Baca Lodge (then known as the "Kiva Lodge"), sold for $10,000. The private landowners received permits from the state to take bull and cow elk; these permits could be sold or transferred. They received 265 elk permits in 1998 (Martin 2003). The VCT recognized that elk hunting and viewing are big attractions of the preserve (VCT 2010f) and conducted the first public elk hunt in 2002. Successful elk hunts have been conducted every year since then. The preserve offers some of the best elk hunting in New Mexico (80% success for bull elk hunts on average) and hunter satisfaction is consistently high (VCT 2007b).

The VCT offers opportunities to hunt elk through an on-line lottery system. Elk hunt permits are issued by NMDGF. Each hunter can bring one nonhunting guest and hire a guide (optional) from an authorized list. Hunters and their guests attend a mandatory orientation session prior to the hunt. The distribution of hunters is controlled by assignment to hunting units in the preserve. These hunting units are 3,000 to 6,000 acres in size and are composed of forest and grasslands. Only 1 to 3 hunters are assigned to a hunting unit at any one time. During the hunt, other uses are minimized or prohibited in hunt units (see figure 3-2). This system protects the natural and cultural resources of the preserve and the quality of the hunt, and provides for the safety of staff, visitors, and hunters (VCT 2007b). In order to provide a fair method of access for all hunters, the VCT conducts a lottery for elk hunting permits.

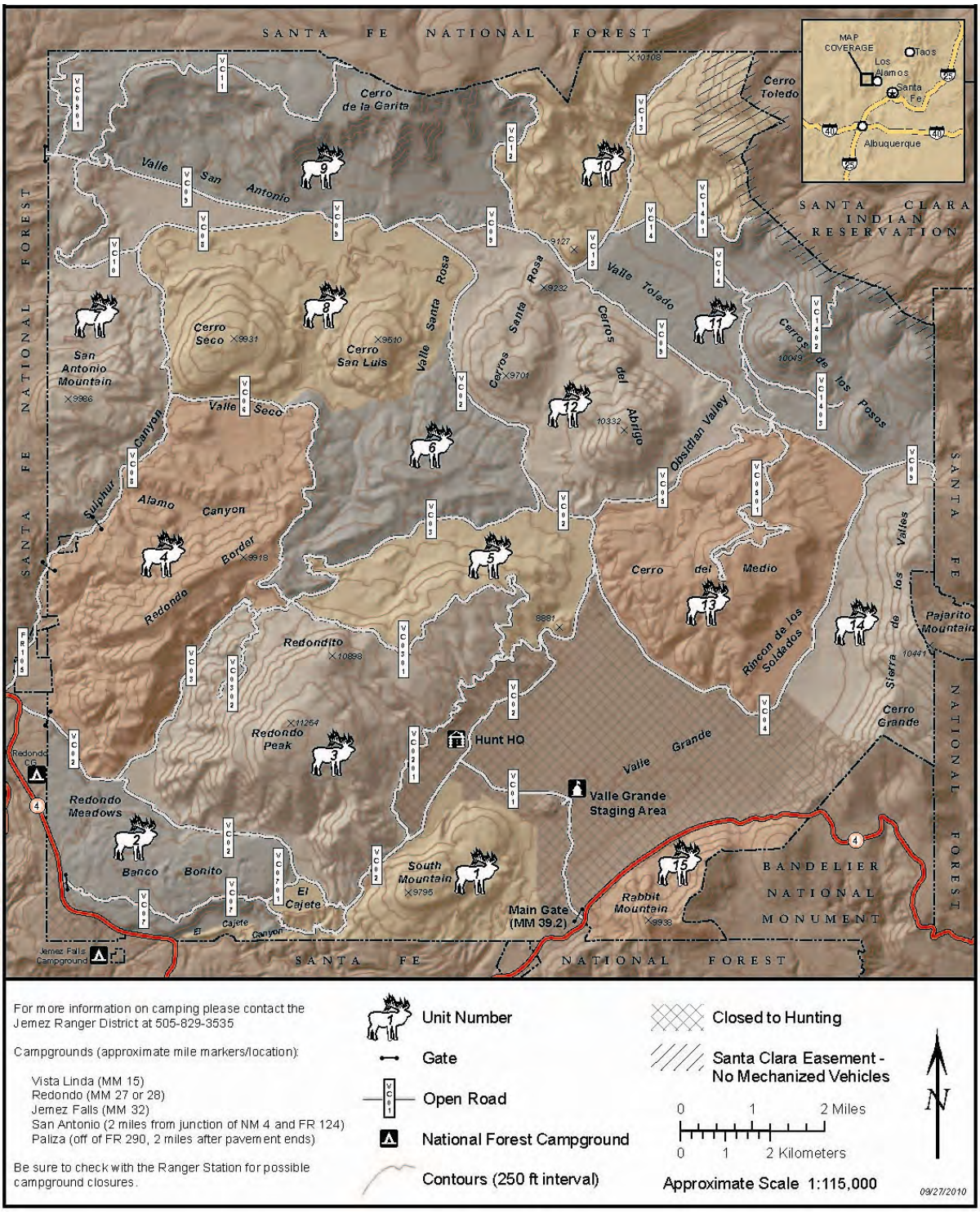


Figure 3-2: Elk Hunting Units

In 2007, elk hunts generated $327,055 in revenues and cost approximately $135,000 to market and conduct. The NMDGF issued 40 antlerless tags for the first two weeks of December because the cow elk harvest objective was not met. All 40 chances were sold within one week. The preserve charged a $300 access fee per hunter, which increased revenues by $12,000 (VCT 2007b).

Turkey Hunting

Unlike big game permits, permits to hunt wild turkey are distributed directly by the VCT, which hosted its first turkey hunt in spring 2007 (VCT 2007b). In 2010, the VCT offered its fourth wild turkey hunt since the property became public land. The Merriam's turkey was offered to the public on a fair chase basis and under low hunting pressure using a bow or shotgun. The VCT continued the turkey hunts, providing two public programs in 2010 for hunting turkey. The "Deluxe Hunt Package" included three days of hunting and fishing, one day of scouting, and four nights of lodging and meals at the Casa de Baca Lodge. Of the eight packages offered in 2010, four were sold and one was auctioned (VCT 2010d).

The second program allowed the public to enter a lottery draw system for 12 preserve access authorizations. One authorization was raffled by the New Mexico Chapter of the National Wild Turkey Federation. The lottery fee was $20 per chance and the drawing included one day of scouting and three days of hunting on the preserve. The hunters selected through the lottery and the one raffle winner were allowed day access only, with one guest at no cost, to hunt and fish (VCT 2010d).

Fishing

The preserve includes over 27 miles of stream habitat suitable for trout (see figure 3-3 and figure 3-4). Although part of this habitat is in a degraded state, many of the reaches are in excellent condition, have the potential to support healthy trout populations, and offer high-quality fishing opportunities (VCT 2010f).

In 2009 the VCT replaced a fishing lottery system with a reservation system on San Antonio Creek to give anglers the chance to reserve their favorite section of the creek. Anglers may only fish the reach for which they have reservations. The VCT began allowing anglers to drive their own vehicles to their assigned fishing area Monday through Friday. VCT staff members transported weekend anglers to San Antonio Creek with vans due to high weekend use. Anglers could also drop in and fish the river if vacancies occurred in the reservation system (GAO 2009).

The VCT allowed up to 10 anglers to fish a 6.5-mile stretch of the East Fork of the Jemez River and 2.8 miles of Jamarillo Creek for the day. East Fork anglers are not permitted to drive private vehicles beyond the Valle Grande Staging Area. Of the 10 available slots, the VCT reserved 4 for registered fishing guides. Reservation fees for all locations were $35 for adults and $25 for youths (16 and under). Volunteers from New Mexico Trout offered fly fishing clinics in 2009, allowing up to 20 participants to fish the headwaters of the East Fork of the Jemez River (GAO 2009).

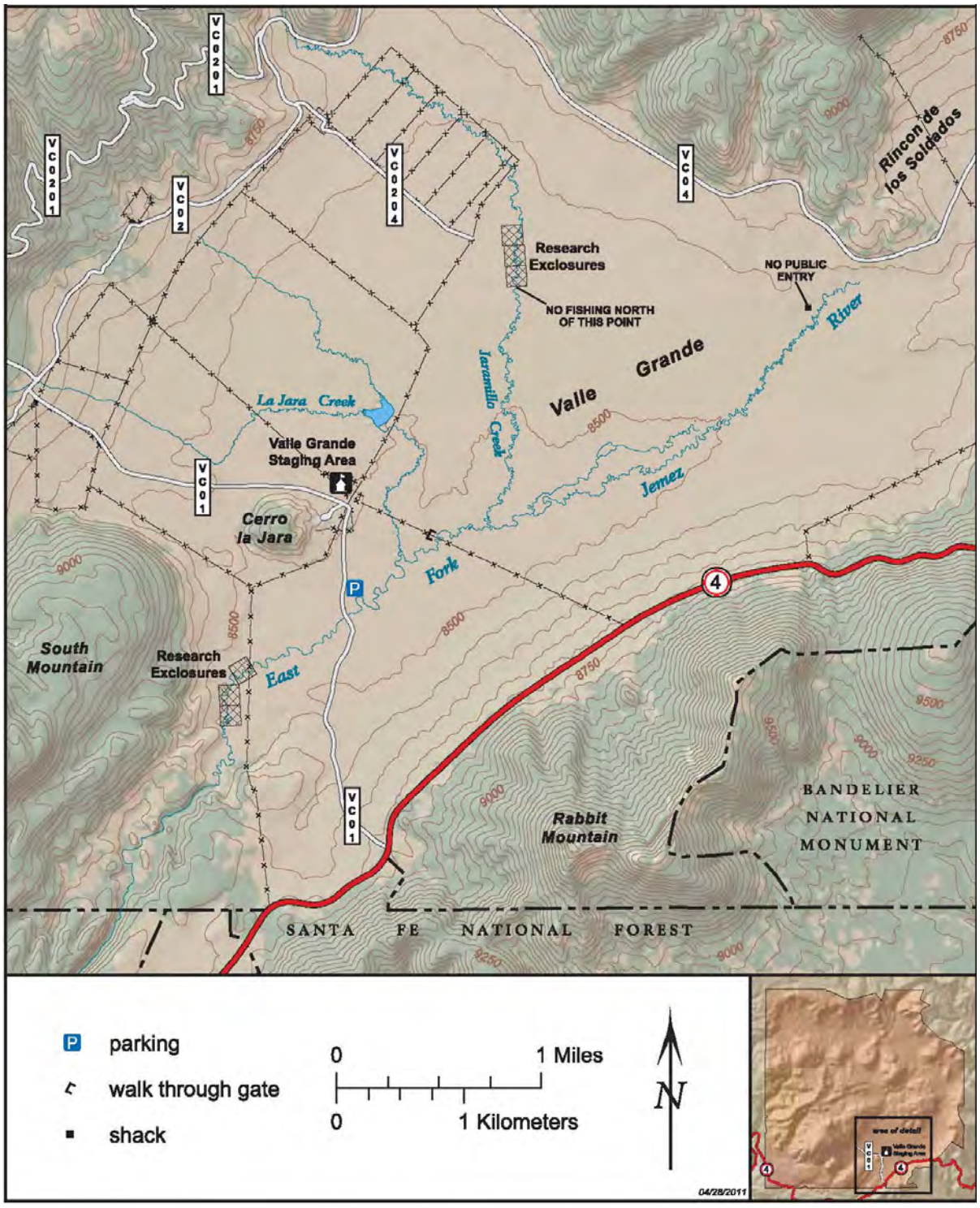


Figure 3-3: Fishing – East Fork of the Jemez River

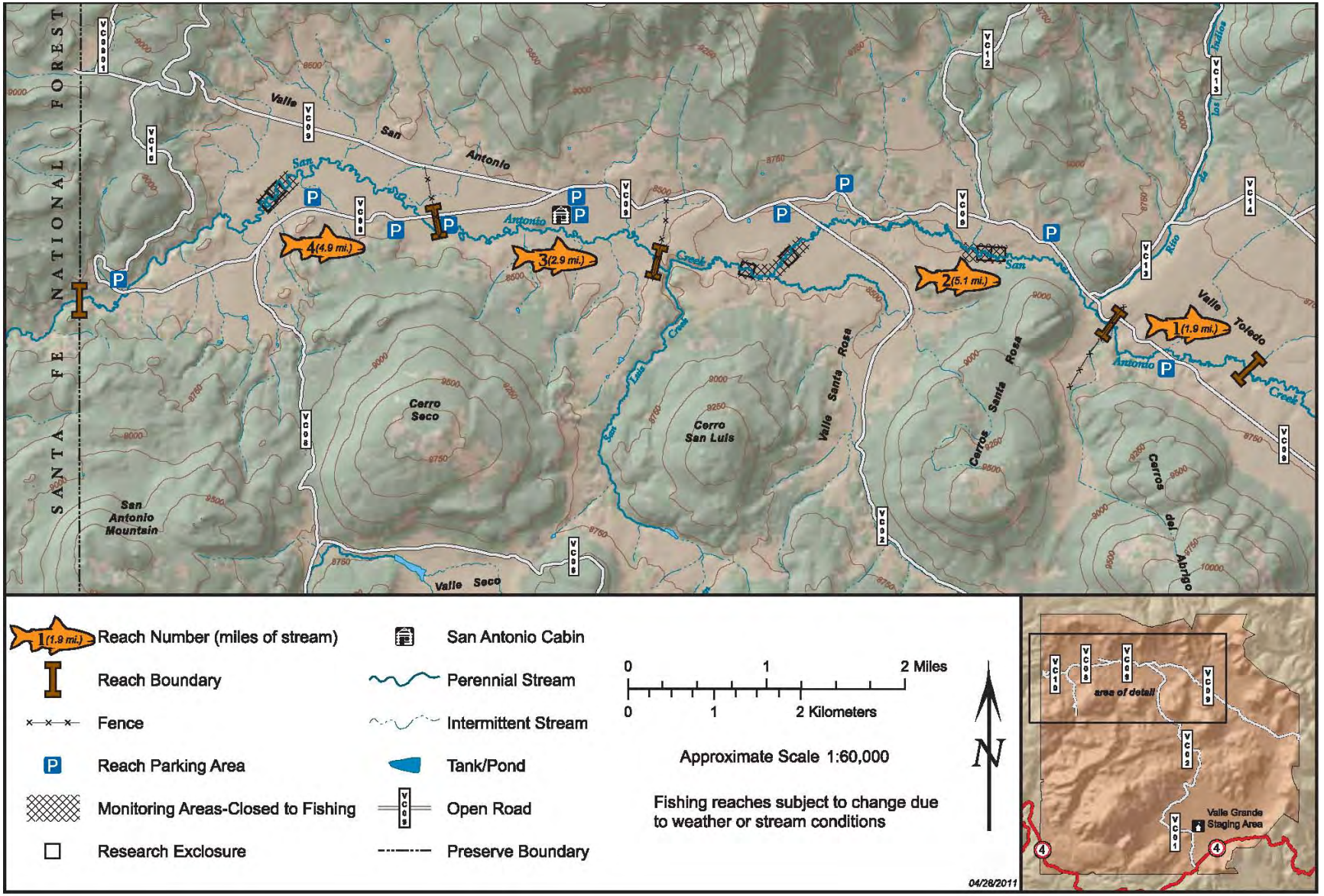


Figure 3-4: Fishing – San Antonio Creek

The VCT surveyed anglers in 2009 about their fishing experience at the preserve. The majority (70%) fished San Antonio Creek, 26% fished the East Fork of the Jemez River, and the remainder fished Jaramillo Creek, which is also accessed from the Valle Grande Staging Area (VCT 2009a). The New Mexico state bag limit of five fish applies to San Antonio Creek, while the East Fork of the Jemez River and Jaramillo Creek are both catch and release. Visitors can also hire a fishing guide permitted by the preserve (VCT 2005c). The majority of respondents were repeat anglers to the preserve; 34% fish the preserve once per year and 42% fish it two to three times per year (VCT 2009a).

Many commenters liked being able to drive their own vehicles to their fishing location, although some requested a dropoff and pickup service or a van shuttle. Several commenters requested better access to the East Fork of the Jemez River, noting that it takes too long to hike to the river. Many wanted no change to the current system (VCT 2009a).

Hiking

Hiking is currently limited to day use on the preserve (VCT 2007b). In 2010, the VCT doubled the total miles of hiking trails to more than 54 (see figure 3-5 and figure 3-6). During that year, over 6,200 visitors hiked on the preserve (VCT 2010d). Reservations are not required to hike on the preserve unless hikers wish to request a hiking shuttle or a guided hike (VCT 2010d). Fees for unguided hikes are $10; for guided hikes, $15 (with discounts for children, seniors, and groups). Hikers have the choice of 14 hiking trails totaling more than 54 miles. Trails range from 1.5-mile loops to 16-mile out-and-back trails. Access to these trails is provided by driving to trail parking or by shuttle provided by the preserve (VCT 2010d). VCT staff members shuttle hikers in vans to trailheads, where the hikers can choose guided or unguided hikes. Sections of existing logging roads are used for hiking trails. Two shuttle routes are provided by the VCT: the Alamo shuttle originates at Banco Bonito, heads west on NM-4, and makes a loop on the west side of the preserve. It includes five shuttle stops. The Alamo shuttle provides access to seven different trails (VCT 2005a):

- Redondo Canyon Overlook
- Redondito
- Jaramillo (July through September only)
- Redondo Border
- Alamo Canyon
- Cerro Seco
- San Antonio Mountain

Figure 3-5: Hiking Trails

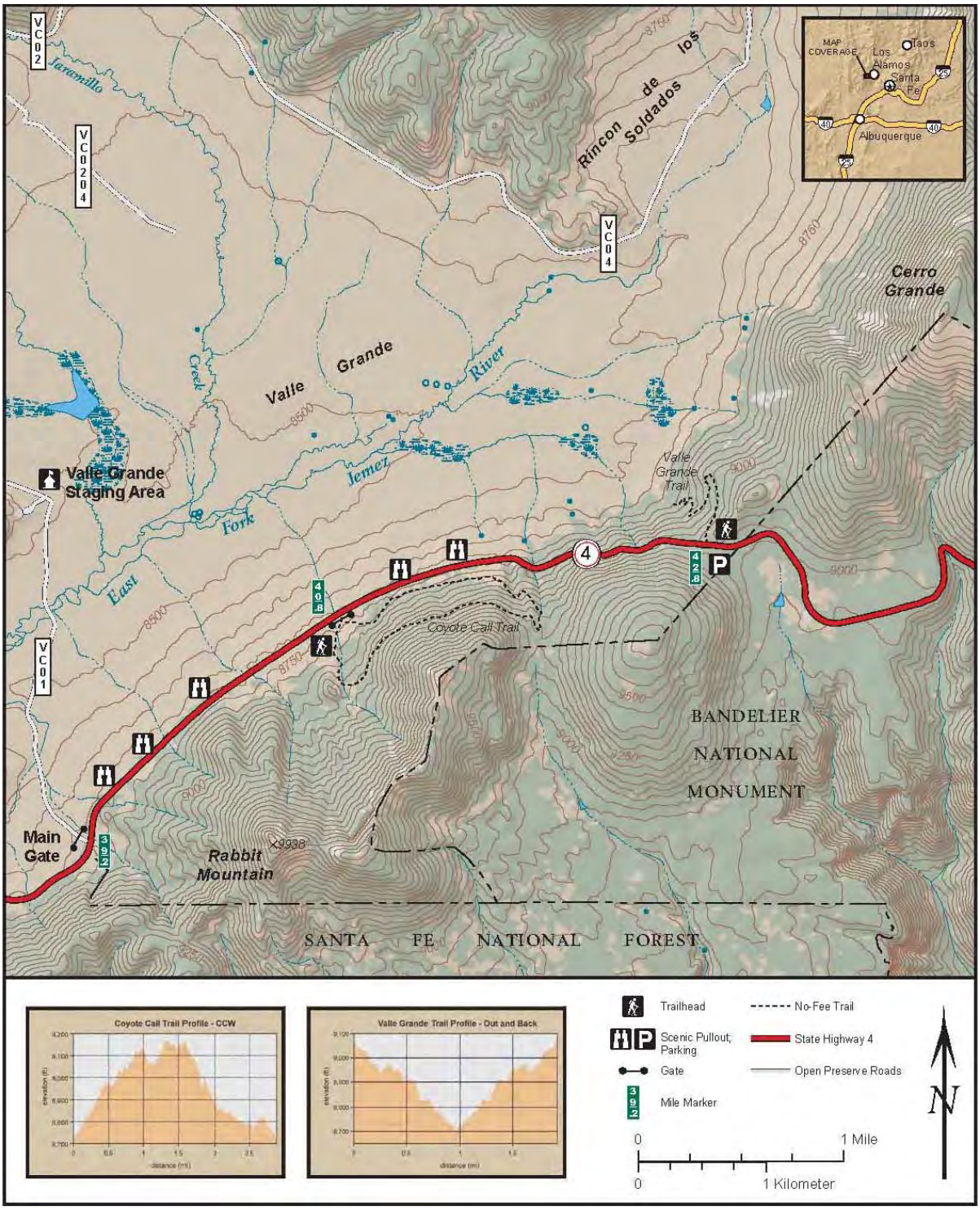


Figure 3-6: Coyote Call Trail

The North Rim shuttle is an out-and-back route from the Valle Grande Staging Area north to the Valle Toledo. This route includes six shuttle stops. The North Rim shuttle provides access to six different trails (VCT 2005a):

- South Mountain
- Redondito
- Jaramillo (July through September only)
- Abrigo
- La Garita
- Los Indios

Shuttle reservations are not required, but a reservation guarantees a seat on the shuttle. Visitors may also sign up at the staging area any day the shuttles are operating (VCT 2005a).

Two free trails are accessible from NM-4 without reservations. Visitors can access the Valle Grande Trail (open spring through fall) by parking at a pullout along the south side of NM-4 at mile marker 43. This trail is 2 miles roundtrip and has an elevation change of 450 feet. The average hiking time is three hours. Visitors can access the Coyote Call Trail (open all year) by parking at a pullout along NM-4 at mile marker 41. This is a 3-mile loop trail with an elevation change of 250 feet. Both hikes are rated easy and offer scenic views of the Valle Grande and the caldera (VCT 2007b).

Mountain biking is allowed on the preserve as a special event, described below.

Horseback Riding

Like hiking, horseback riding is currently limited to day use on the preserve. Equestrian trail rides originate at and are focused in the Banco Bonito Staging Area. Only one trail, the Remuda Grande, accesses VC01, the preserve's main entrance road, and the Valle Grande (see figure 3-7). Equestrians are charged $20 per horse. Horse-drawn wagon rides are offered in the headquarters area. Riders must return to the Banco Bonito Staging Area by 6:00 p.m. for a 6:30 p.m. departure. There are eight equestrian trails staged out of Banco Bonito on old logging roads (VCT 2007b), as detailed in table 3-7.

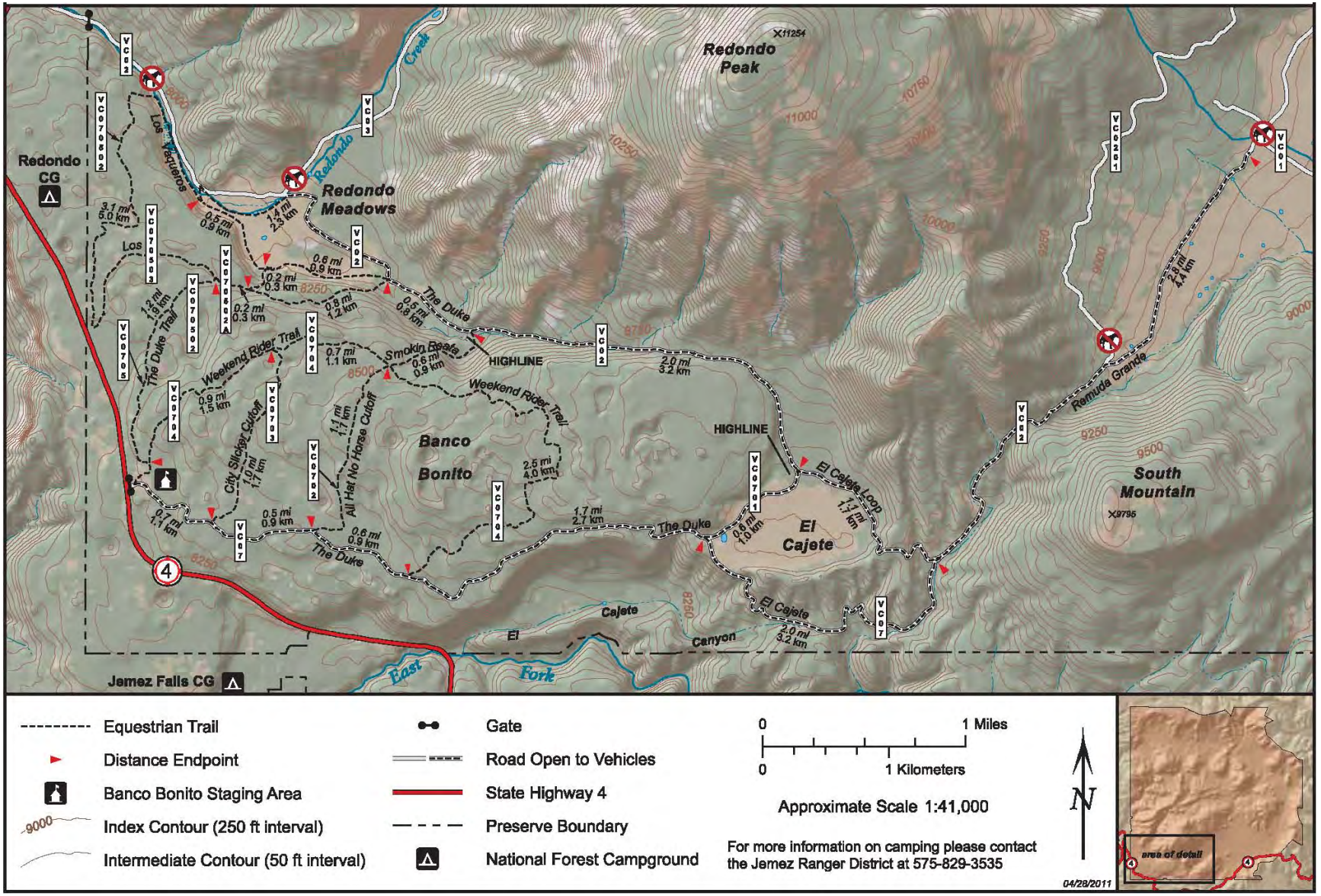


Figure 3-7: Equestrian Trails

Table 3-7: Equestrian Trails

Trail	Route	Distance	Difficulty Level	Time to Complete
Duke (most used equestrian trail)	From Banco Bonito to El Cajete meadow beneath Redondo Peak (loop)	12 miles	Moderate	1 hour
El Cajete Loop	From Duke Trail; begins and ends at El Cajete	3 miles	Moderate	1 hour
Remuda Grande	From El Cajete Loop to headquarters area in Valle Grande (out and back)	Additional 3–4 miles to El Cajete Loop	Moderate to difficult	6 hours with El Cajete Loop
Los Vaqueros	From Banco Bonito to Redondo Meadow; follows Redondo Creek	6 miles	Easy	2.5–3.5 hours
City Slicker	From north side of Duke Trail to south side of Duke Trail	1.0 mile	Easy	<2 hours
All Hat No Horse		1.1 miles		
Weekend Rider		0.9 mile		
Smokin Reata	From Weekend Rider Trail to Duke trail	0.6 mile	Easy	2–3 hours

Source: VCT 2007b.

Winter Activities

Winter recreation on the preserve offers 29 miles of groomed and 8 miles of ungroomed cross-country skiing and snowshoeing trails (see figure 3-8). Along with the largest amount of groomed trails in New Mexico, visitors have over 13,000 acres to break their own trails (VCT 2010d). New Mexico snowfall is highly variable from year to year. In some years several feet of snow accumulates in the preserve's valles, while in others conditions remain dry. An interim winter activities program, started in February 2003, includes unguided cross-country skiing opportunities as well as horse-drawn sleigh rides. Two warm-up huts provide skiers with places for orientation, shelter, and refreshment (VCT 2010f). The access fee is $10 and no reservation is required (VCT 2007b).

The 39 horse-drawn sleigh rides scheduled in 2010 sold out, and additional rides that were added due to the high demand sold out also. The program struggles with challenges in cost containment, primarily in clearing snow from the roads. The lack of adequate infrastructure continues to be the biggest challenge for winter recreation (VCT 2010d).

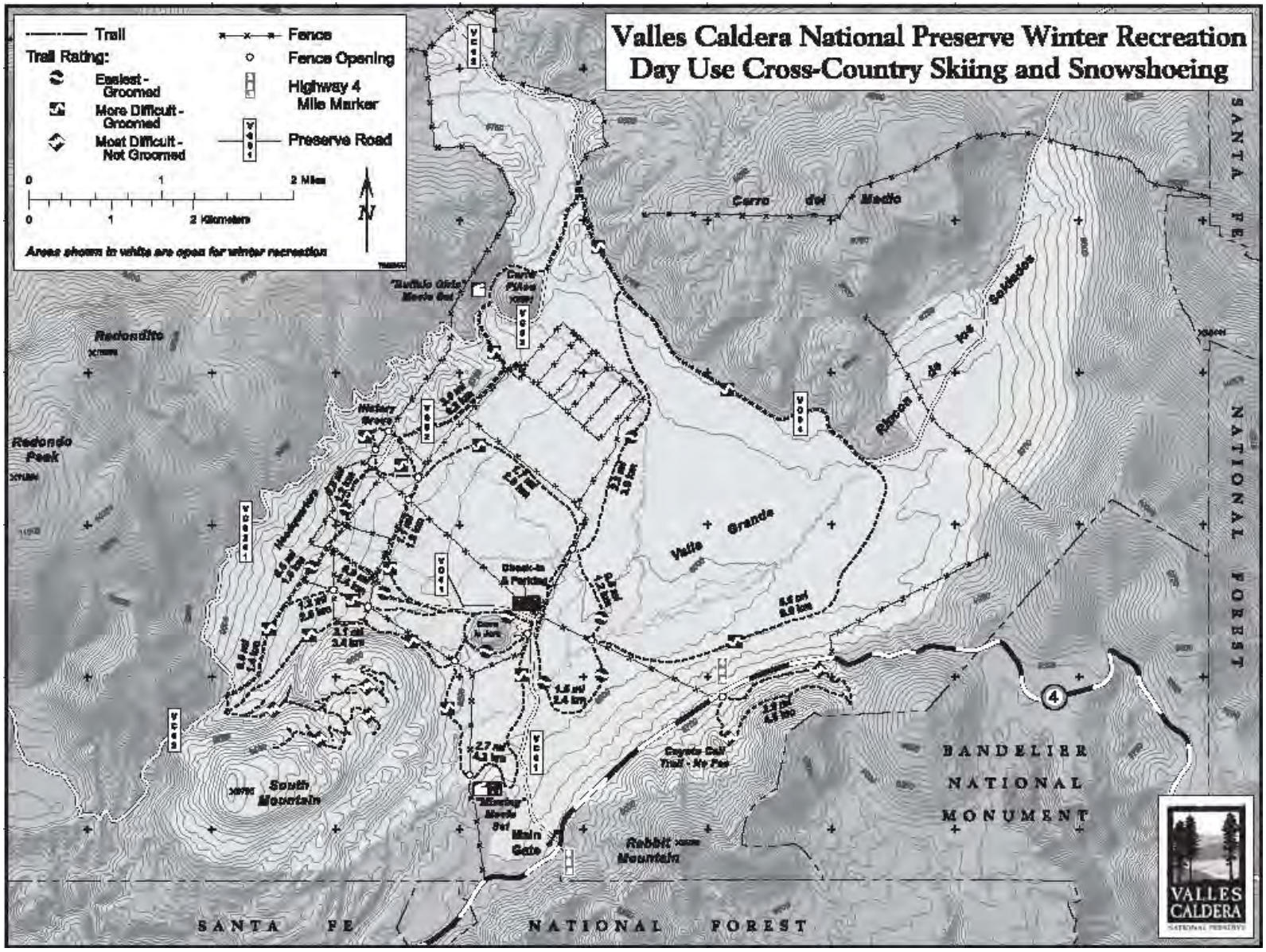


Figure 3-8: Winter Activities

Spontaneous Activities

The VCT provides limited opportunities for spontaneous activities for the casual visitor. Two hiking trails are accessible from NM-4. These trails are free, require no reservation, and are open from spring through fall (Valle Grande) or year-round (Coyote Call).

In 2007, the VCT offered one-hour van tours on Saturdays and Sundays for $5 per person to visitors driving to the Valle Grande Staging Area from NM-4. The tours focused on the geology, history, or cultural resources of Valle Grande and the headquarters area. The tours were popular and resulted in an increase in total tour participants (VCT 2007b).

Quiet Days

The VCT originally envisioned "quiet days" when disturbances from vehicles and visitor activities would be limited "to give a rest to the landscape and the creatures living there" (VCT 2010f). Generally, Tuesdays and Wednesdays have been the quiet days on the preserve. The VCT has also closed areas to vehicle traffic to limit disturbance to bald eagles that visit the preserve during the winter (VCT 2007b).

Special Events

Special events have included mountain bike rides (see figure 3-1), running events (marathons), star and solar viewing, and custom group tours. The preserve accommodates mountain bikers seeking different experiences. There are four loops available for mountain bike rides ranging in length from 2.5 to 12 miles. All trails are on established logging roads (VCT 2005e).

Clinics and workshops conducted on the preserve include photography, outdoor skills, fly-fishing, and flint knapping (making arrowheads). These events offer a unique experience on public lands in the region, and they are becoming increasingly popular. Special events often include expert instructors or guides, as well as meals and lodging. Other special events include youth clinics and antler collection by youth groups. One-third to one-half of visitors to the preserve participate in special events (VCT 2007b).

Recurring special events for 2010 included the 5th annual Run the Caldera Marathon and Half Marathon, four Cruise the Caldera Mountain Bike Fun Rides (85 miles of trails to choose from), two photo adventures, two moonlight ski and snowshoe events, and ski orienteering. New additions for 2010 included the following (VCT 2010d):

- a New Year's Eve cross-country skiing and snowshoe event with fireworks at midnight
- the addition of a 10K to the Run the Caldera Marathon and Half Marathon

- the Caldera 3-D Archery Shootout (the VCT partnered with the Jemez Pueblo's Walatowa Bowhunters Club for this two-day archery competition)
- two twilight mountain bike rides where riders could explore 12 miles of road
- a three-day Pioneer Endurance Ride, partnered with the American Endurance Ride Conference
- the Caldera Adventure Workshop, a three-day event focused on connecting kids with nature using primitive skills

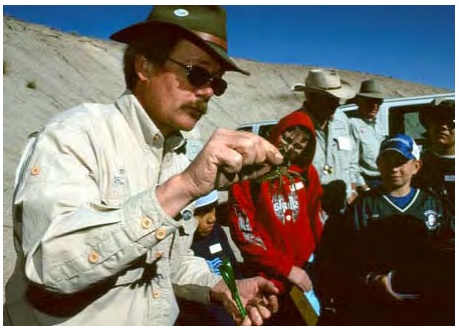
Participation in the 5th annual marathon and associated races almost doubled in 2010, with 535 registrations. The moonlight ski and snowshoe events drew over 600 participants over three nights. The first archery shoot attracted approximately 200 participants (VCT 2010d).

Facility Rentals

Two of the preserve's facilities can be rented for weddings, birthdays, anniversaries, club events, business meetings, company parties, or educational tours. Reservations can be made for the Casa de Baca Lodge, which sleeps 16, and the Bunkhouse, which sleeps 13 (VCT 2007b). The lodge and bunkhouse have received the highest priority for accessibility renovation. The VCT will also incorporate design elements that will improve their overall function and appearance. In 2010 the lodge and bunkhouse were made available for public use and provided 1,012 visitor nights and 246 day visits for public use (VCT 2010d).

Group Tours

Special tour arrangements can be made for groups of 20 or more.



Friends Group Offerings

In 2004, the VCT began looking into the possibility of forming a 501(c)(3) "friends" group. The VCT cannot receive money from private foundations. Los Amigos de Valles Caldera was formed in 2007 to support the preserve for present and future generations through outreach, education, restoration, and collaboration. In addition to the activities sponsored by the VCT, the friends group also offers events to visitors. Events in 2009 included a geology tour, a dendroglyph (symbols carved into tree trunks) tour, hikes, and work days, with costs for the tours.

Science and Education

The VCT created a program in 2003 to guide the development of activities allowed at the preserve. The science and cultural resources program includes three components: inventorying natural resources, monitoring environmental changes resulting from the VCT's programs, and conducting research that will help manage the preserve's resources. This program assists the VCT in complying with federal

environmental requirements. To further enhance and communicate the results of the preserve's science program, the VCT in August 2009 leased a facility in the town of Jemez Springs, 20 miles west of the preserve's main gate, as a new science and education center adjacent to the VCT's administrative headquarters. The facility will accommodate a laboratory, classrooms, offices, a dining hall, and lodging for visitors participating in the center's formal and informal science education programs for all age groups (GAO 2009).

In 2006 and 2007, 43 groups and 1,226 people participated in educational programs on the preserve. Educational activities fall into the following categories: K–12 students, university students, citizen groups, workshops and seminars, interpretive activities, and educational television productions (VCT 2007b).

K–12 Students

Students learn about the preserve through formal and informal programs. In 2006 and 2007, six groups and 281 students and teachers participated in these activities. The Parajito Environmental Education Center brought public school students on field trips to the preserve to learn about the environment in collaboration with the VCT and Los Alamos National Laboratory. In 2006 and 2007, a summer field camp entitled "Nature Odyssey" operated by the Parajito Environmental Education Center provided environmental education to public school students, teaching them about plants, invertebrates, wildlife, riparian environments, and water quality. Two Los Alamos National Laboratory science camps provided instruction to students from the Pueblos of Jemez, Santa Clara, San Ildefonso, and Cochiti (VCT 2007b).

University Students

Students from all over the country have had the opportunity to work and learn in the VCT's science program. In 2006 and 2007, 16 groups and 198 students and teachers participated in these activities. Students have played a role in nearly all major inventory, monitoring, and research programs on the preserve. Universities arrange group tours through the recreation program, mixing the interpretive tours of the recreation staff with their professor's lectures on geology, archeology, hydrology, ecology, and other subjects (VCT 2007b).

Citizen Groups

The public comes to the preserve to learn about the environment and land management issues. In 2006 and 2007, seven community groups consisting of 235 people and three non-governmental organizations (NGOs) consisting of 41 people participated in activities on the preserve. Some of these groups worked in monitoring programs and collected data used by the VCT (VCT 2007b).

Workshops and Seminars

Agencies, museums, universities, NGOs, and private-sector groups increasingly use the preserve as a setting for workshops and seminars. In 2006 and 2007, five agencies and 137 people and six professional societies and 334 people participated in these activities (VCT 2007b).

Interpretive Activities

The VCT's educational and interpretive programs are as yet largely undeveloped (VCT 2010f). Most recreation and special-use activities involve some level of informal interpretation by VCT staff. Through clinics, workshops, and other activities, visitors learn about the history of the preserve and domestic livestock operations, as well as how to fly-fish and hunt, track wildlife, use a compass, and survive in the wilderness. The objectives of interpretive activities are to impart knowledge, establish emotional connections, and alter behaviors (VCT 2005cg).

Van tours are offered from the Valle Grande Staging Area, and include wildlife viewing and interpretive tours about preserve resources. Archeology, art, botany, ecology, geology, history, and wildlife tours were offered in 2009. Fees for van tours vary depending on the length of time, ranging from $20 for two hours to $40 for six hours, with discounts for children, seniors, and groups. Wagon and sleigh rides are also available (VCT 2007b).

Visual Resources

The introduction of new structures and infrastructure, such as parking lots, to the preserve's landscape would affect its scenic qualities. The presence of more personal vehicles and/or shuttles using improved preserve roads, as well as the presence of more visitors, would also affect the preserve's visual resources. This section describes the preserve's existing visual resources so that potential impacts on them can be determined.

Study Area

The study area for evaluating impacts on visual resources for implementation-level decisions includes views of and from the specific proposed visitor contact station / visitor center locations for each action alternative; the study area for programmatic-level decisions encompasses the entire preserve.

Visual Setting

The preserve lies in the Jemez Mountains in north-central New Mexico. The Jemez Mountains are surrounded by a high desert of sagebrush, rabbit brush, juniper, and pinyon pine. This high desert landscape is accentuated by leveled mesas and the deep canyons of the Rio Grande. The Jemez Mountains rise out of this landscape to a height of 11,254 feet above sea level at Redondo Peak. As the elevation increases, the vegetation changes to ponderosa pine, mixed conifers, aspen, and spruce/fir forests. The mountains provide contrast to the more arid landscape of the lower elevations (VCT 2009b).

The introduction of new structures and infrastructure and the presence of more people and vehicles within the preserve would affect its visual resources.

Within this setting, the preserve's unique visual character was formed by its extraordinary geologic origins, which shaped the resulting landscape as shown in figure 3-9. About 1.25 million years ago, an eruption created the 13-mile-wide crater-shaped landscape now known as the Valles caldera. The eruption tapped a vast magma chamber that exploded catastrophically, depleting the magma chamber and creating a void into which the surface landscape collapsed. The enclosed caldera filled with water, forming a large freshwater lake. Within 50,000 years Redondo Peak rose up through the lake bottom, followed by the first of many eruptive flows from ring fractures that formed the dome at Cerro del Medio, followed by Cerro del Abrigo. This process continued counterclockwise around the ring fracture, creating the domes in the northern half of the caldera. Approximately 50,000 years ago, an explosive eruption occurred in the southwest corner, creating the crater known as El Cajete. This eruption produced the broad, sloping landform in the southwest corner of the preserve known as Banco Bonito (see figure 3-9). While not the largest, Valles caldera is one of the most intact calderas in the world (VCT 2007b).

The preserve is known for its scenic beauty, geological features, and diversity of plants (particularly its extensive grasslands) and wildlife. The physical environment ranges from broad open meadows to mountains heavily forested with coniferous trees, creating a unique viewshed in the southwestern United States. The topographic relief of the setting contributes to a widely diverse ecosystem (Anschuetz and Merlan 2007). The preserve's valles are extensive, naturally subirrigated meadows and lush grasslands framed by rolling hills covered with evergreens, which creates a regionally distinctive and visually attractive landscape (VCT 2009b). The preserve's grasslands are one of its most dramatic features. In particular, views of the Valle Grande from NM-4 have "stopping power" that compels travelers on the highway to stop and take in the scene. Figure 3-10 shows the variety of vegetation and landform patterns and features throughout the preserve, including the headquarters area, rock outcrops, and surface water characteristics, primarily the East Fork of the Jemez River and San Antonio Creek.

The preserve's landscape is heavily influenced by human use. As noted in chapter 1 and the "Cultural Resources" section, the land has been used for various resource extraction and ranching activities, which resulted in unnatural visual elements that are now part of the landscape. Logging that occurred on the preserve resulted in the removal of trees on 50 percent of the property and the creation of over a thousand miles of logging roads. In 1964, the Baca Land and Cattle Company filed a lawsuit against the New Mexico Timber Company seeking damages for destructive logging practices (VCT 2007b). However, logging operations continued with growing intensity until 1972 and left a heavy imprint on the forests, soils, and watercourses of the preserve (VCT 2005iVCT 2005i).

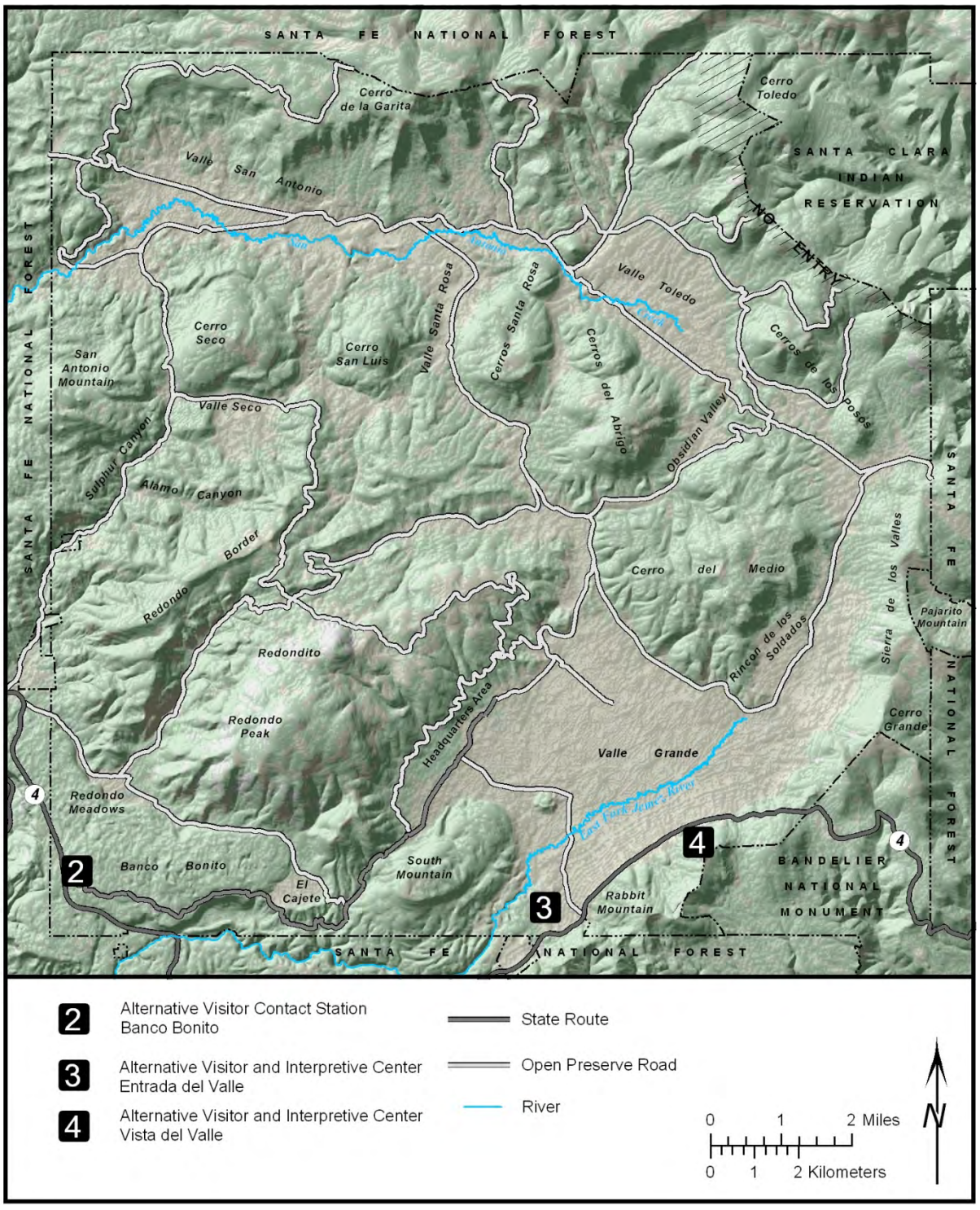


Figure 3-9: Major Landscape Features

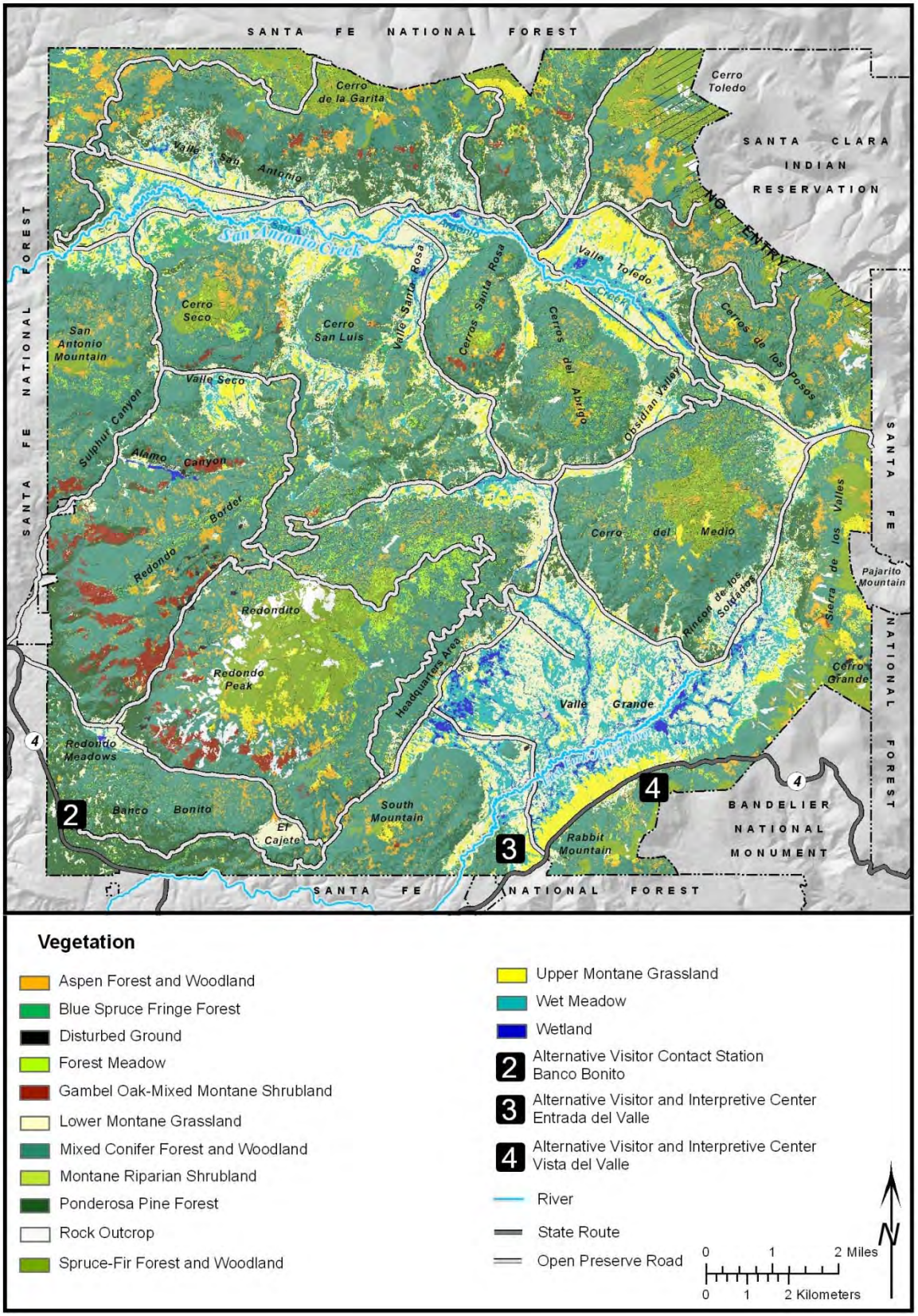


Figure 3-10: Rock Features, Water, and Vegetation

Figure 3-11 shows where logging roads are most concentrated in the preserve. Ranching operations resulted in grazed pastures and the development of associated structures. Straight fence lines extend across grasslands and connect along the edges of evergreen forests and grasslands. Stock tanks dot the landscape, and flattened well drilling pads appear on canyon slopes. Logging roads cutting across the valles and spiraling up the forested domes occupy 12 to 14 linear miles per square mile of land (VCT 2009b).

The scenery of the preserve has continued to change since federal acquisition. Restoration efforts undertaken by the VCT have resulted in positive effects from improved ecological conditions. Roads have been improved to provide safe access and to reduce the impacts on natural resources, especially hydrology (VCT 2007b). However, such improvements have increased the visibility of roads in the existing landscape, an example of which is shown in figures 3-12 and 3-13. The cleanup of accumulated ranch debris has been undertaken around the headquarters area, while landscaping surrounding the historic cabins has been allowed to "go natural" as the VCT defines the linkages between the cultural and natural landscape. Temporary negative effects have resulted from the concentration of portable buildings and vehicles in the Valle Grande Staging Area, which are shown in figure 3-14. Overall, these positive and negative changes have not substantially changed the preserve's visual characteristics (VCT 2009b).

Although the VCT has not conducted visitor surveys directly related to perceptions of scenic views or compiled data specifically addressing existing viewsheds, the USFS addresses the importance of this resource in its 1995 scenery management handbook, titled *Landscape Aesthetics Handbook for Scenery Management*. According to *Landscape Aesthetics*, people need natural-appearing landscapes to serve as psychological and physiological "safety valves," for these reasons:

- The world's urban population pressures are increasing.
- Technology is rapidly advancing.
- Demands for goods and services are increasing.
- People's lives are becoming more complex.
- Urban pressures are demanding more land for development.
- Once plentiful, natural-appearing landscapes are becoming more scarce (USFS 1995).

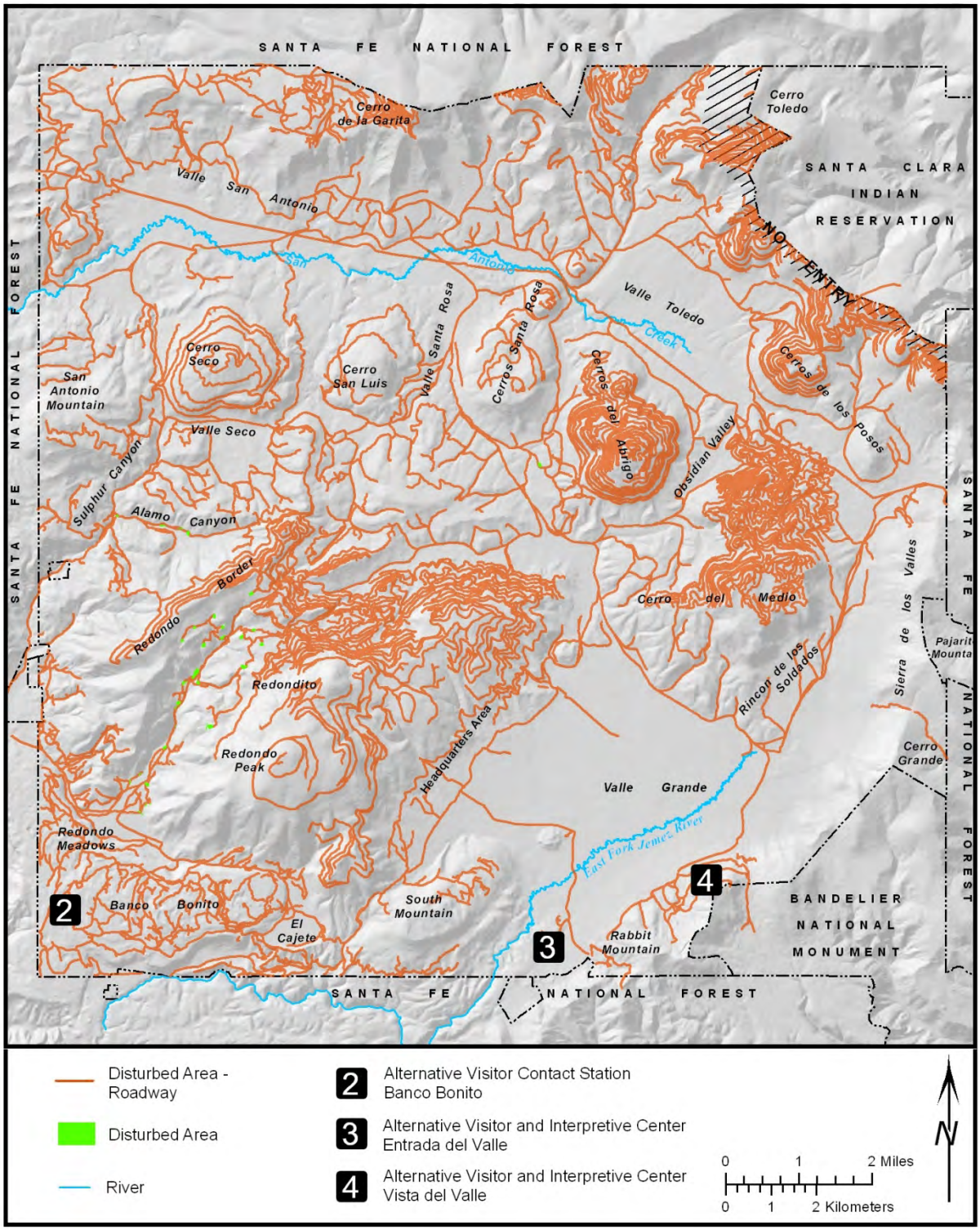


Figure 3-11: Logging/Other Roads and Disturbed Areas

Figure 3-12: Redondito Peak after Logging, 1975

Figure 3-13: Redondito Peak after Regrowth, 2005—Roads Remain Visible

Temporary buildings at the Valle Grande Staging Area.

Visitors parked at the Valle Grande Staging Area during a recreational event.

Recreational activity at Valle Grande Staging Area temporary buildings.

Figure 3-14: Temporary Portable Buildings and Parking Area at the Valle Grande Staging Area

Landscape Aesthetics notes that research has shown that high-quality scenery, especially related to natural-appearing forests, enhances people's lives and benefits society. Research has also shown that the scenic quality and naturalness of the landscape directly enhance human well-being, both physically and psychologically, and contribute to other important human benefits. These benefits include people's improved physiological well-being as an important byproduct of viewing interesting and pleasant natural-appearing landscapes with high scenic diversity (USFS 1995).

Findings from psychological and physiological studies of people under stress, recovering in hospitals, in recreation settings, and in other settings, demonstrate that natural landscape scenes have restorative and other beneficial properties. This is particularly important when contrasted with built urban environments, such as pedestrian malls and commuter traffic routes. Research shows that there is a high degree of public agreement regarding scenic preferences. This research indicates that people value most highly the more visually attractive and natural-appearing landscapes. However, preferences may vary in different regions or cultures (USFS 1995).

Based on guidance from *Landscape Aesthetics* (USFS 1995), the following components of landscape aesthetics were inventoried to describe the existing aesthetic values of the affected environment at the implementation level:

- landscape character: the existing characteristics of the landscape, including its relative scenic attractiveness and historic range
- scenic integrity: the degree of intactness and wholeness of the landscape character
- landscape visibility: the relative importance of various scenes to the public based on distance from an observer

In addition, the visual absorption capability of the preserve's landscapes was identified. Visual absorption capability is a classification system used to indicate the relative ability of a landscape to accept human alteration without the loss of landscape character or scenic integrity. Visual absorption capability is a relative indicator of the potential difficulty, and thus the potential cost, of producing or maintaining acceptable degrees of scenic quality. It can be used to specify the most efficient location for a human alteration or structure on the landscape (i.e., the alternative's implementation-level activities), and to predict achievable scenic condition levels resulting from management activities in a landscape (i.e., the alternative's programmatic-level activities) (USFS 1995).

Landscape Character

Landscape character describes an area's visual and cultural image, and consists of the physical, biological, and cultural attributes that make each landscape identifiable or unique. Landscape descriptions provide an overview of an area's landform patterns, water characteristics, vegetation patterns, and cultural elements. Landscape character also includes descriptions of scenic attractiveness, which is the primary indicator of the intrinsic scenic beauty of a landscape and the positive responses it

invokes in people. The combination of valued landscape elements, such as landform, water characteristics, vegetation, and land use and cultural features, determines the measure of scenic attractiveness (USFS 1995).

- landform patterns and features: the relative occurrence and distinguishing characteristics of landforms, rock features, and their juxtaposition to each other
- surface water characteristics: the relative occurrence and distinguishing characteristics of rivers, streams, lakes, and wetlands
- vegetation patterns: the relative occurrence and distinguishing characteristics of potential vegetative communities and the patterns formed by them
- land use patterns and cultural features: visible elements of historic and present land use that contribute to the image and sense of place.

People regard landscapes having the most positive combinations of variety, unity, vividness, mystery, intactness, coherence, harmony, uniqueness, pattern, and balance as having the greatest potential for high scenic attractiveness (USFS 1995), as described below.

- Variety creates added interest when present in moderation.
- Unity provides a sense of order that translates into a feeling of well-being.
- Vividness is related to variety and contrast, adding clearly defined visual interest and memorability.
- Mystery arouses curiosity and adds interest to a landscape.
- Intactness is related to unity and also indicates wholeness; there are few or no missing parts in the landscape.
- Coherence describes the ability of a landscape to be seen as intelligible rather than chaotic.
- Harmony is related to unity and exhibits a pleasant arrangement of landscape attributes.
- Uniqueness arouses curiosity and often signifies scarcity, rarity, and greater value.
- Pattern includes pleasing repetitions and configurations of line, form, color, or texture, as well as harmony.
- Balance reflects unity and harmony, and displays a state of equilibrium that creates a sense of well-being and permanence.

Scenic Attractiveness

Scenic attractiveness exhibits the combined effects of the natural and cultural forces of a landscape, classified as follows:

1. **Class A:** Distinctive—Areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide unusual, unique, or outstanding scenic quality. These landscapes have strong positive attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance.
2. **Class B:** Typical—Areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide ordinary or common scenic quality. These landscapes have generally positive, yet common, attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance.
3. **Class C:** Indistinctive—Areas where landform, vegetation patterns, water characteristics, and cultural land use have low scenic quality. Often water and rockform of any consequence are missing in class C landscapes. These landscapes have weak or missing attributes of variety, unity, vividness, mystery, intactness, order, harmony, uniqueness, pattern, and balance (USFS 1995).

Landscape character descriptions, including scenic attractiveness, were determined for each alternative for the implementation-level actions as described below. Landscape character descriptions were developed based on data gathered by the VCT, field visits and photographs, and aerial photography.

Historic Range

Changes from existing landscape character should be within historic ranges. The following examples describe desired landscape character and long-range scenic integrity objectives that could apply to the proposed alternatives to describe their historic range:

- naturally evolving: expresses the natural evolution of biophysical features and processes, with very limited human intervention
- natural appearing: expresses predominantly natural evolution, but also human intervention, including cultural features and processes
- cultural: expresses built structures and landscape features that display the dominant attitudes and beliefs of specific human cultures
- pastoral: expresses dominant human-created pastures, meadows, and associated structures, reflecting valued historic land uses and lifestyles
- agricultural: expresses dominant human agricultural land uses producing food crops and domestic products
- historic: expresses valued historic features that represent events and periods of human activity in the landscape (USFS 1995)

Alternative 2 Site

The proposed alternative 2 Banco Bonito site is located in a clearing among evergreen trees about 150 feet from NM-4 in the southwestern corner of the preserve. NM-4 bisects the southern area of the preserve. It is an all-weather, fully maintained, two-lane paved highway that averages 1.6 million travelers annually (VCT 2007b). The location of the proposed visitor contact station would not be easily seen from NM-4. A relatively homogeneous area of evergreen trees, primarily ponderosa pines, surrounds the site, which is primarily flat (figures 3-15 and 3-16). Some stands of mixed conifer forests and woodlands also occur. Most of the trees are mature and large, with no readily discernible age classes or variations in type among them. The area has been thinned, leaving the largest and healthiest trees, removing the smallest and least healthy trees (Rodriguez, pers. comm. 2011b). Groundcover is sparse and consists mainly of grasses. Unpaved parking, a temporary structure, and minor facilities such as picnic tables currently exist at this site. The viewer perceives a natural landscape that has been altered by humans, primarily in the form of the large, cleared dirt area used for parking and visible signs of recent thinning activities. Views are fairly uniform throughout the site. The varying positions of the trees create an undulating horizon line that follows the different tree heights, adding visual interest and texture. There is minimal change in vegetation type, elevation, or landform patterns. The site has no water features, and no obvious cultural elements. A few small rock outcrops exist in the area but are not visible from the visitor contact station location. The site is not readily visible from the highway, and provides views only of the surrounding vegetation. The photographs in figure 3-15 show the proposed location.

The alternative 2 site demonstrates moderate variety, vividness, mystery, and uniqueness for the reasons described above, primarily due to the sameness of the vegetation and a lack of water, rock, and other unique or conspicuous landform features. Intactness is also moderate due to the large, previously disturbed parking area. Unity, coherence, harmony, pattern, and balance are all moderate due to the uniformity of the vegetation that surrounds the site, which provides a sense of order, arrangement, and repetition of line, form, color, and texture. The scenic attractiveness for the proposed alternative 2 site is typical (class B) due to positive yet common attributes of coherence, harmony, pattern, and balance.

Because it is previously disturbed, the alternative 2 site falls within the natural-appearing historic range category. The vegetation that surrounds the site expresses natural evolution, and the disturbed area demonstrates human intervention.

Equestrian trail at Banco Bonito, looking primarily north from the Banco Bonito Staging Area parking lot.

Temporary structure and parking area at Banco Bonito.

Temporary picnic facilities and unpaved parking at Banco Bonito.

Large, unpaved parking area and temporary structure at Banco Bonito.

Figure 3-15: Photographs of Alternative 2 Proposed Visitor Contact Station Site

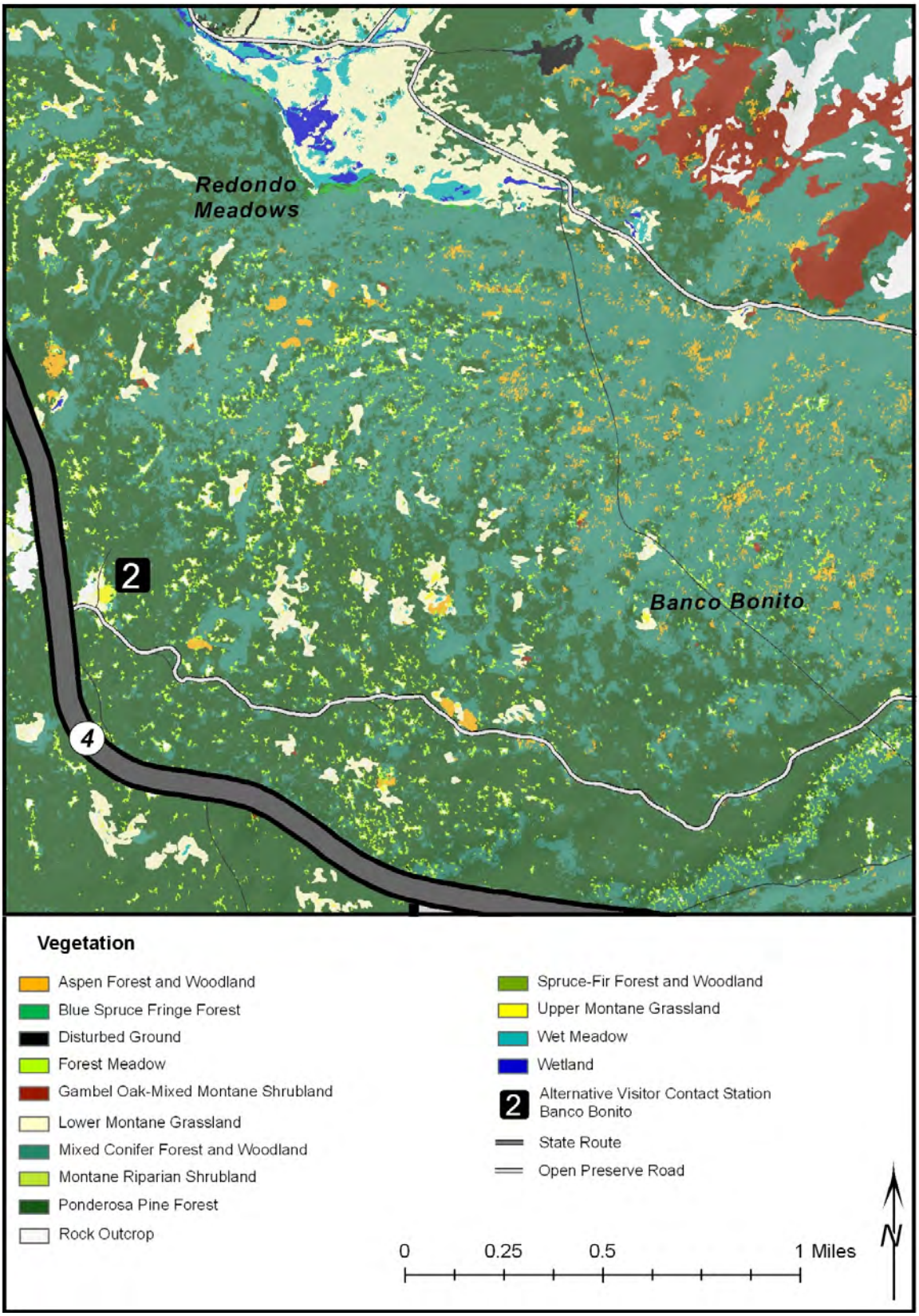


Figure 3-16: Alternative 2 Landscape Character

Alternative 3A and 3B Site

In the southeast corner of the preserve, NM-4 has six turnouts with interpretive signs and sweeping views of Valle Grande, the largest valle in the caldera. NM-4 provides the initial point of contact with the preserve for those traveling between Los Alamos and Jemez Springs, New Mexico, and offers opportunities for wildlife viewing, visitor orientation, and interpretation (VCT 2005iVCT 2005i). The proposed alternative 3A and 3B site, atop a small hill, would provide views of the Valle Grande to the north, as well as other areas of the preserve, as shown in the photos in figure 3-17. The second photo shows a building that was specifically constructed for "The Missing," a movie set in 1886 that was filmed in 2003. The structure is not historic and is not used by the preserve.

The existing landscape character of the proposed alternative 3A and 3B site consists of rolling, hilly terrain covered in grasses (as shown in figure 3-18). The site is primarily undisturbed, with the exception of an old double-track road that approaches the hilltop setting from the north. NM-4 is slightly visible in the distance to the east and southeast. Located in montane grasslands, the landscape at the site is primarily unforested, consisting of grasses and occasional clusters or singular occurrences of evergreen trees. One moderately sized rock outcrop is evident at the site, as well as some smaller outcrops in the near distance.

The hilltop on which the visitor center would be located provides sweeping views in all directions. Looking to the north, the viewer perceives an uninterrupted view of the Valle Grande, consisting of the East Fork of the Jemez River, grasslands, wet meadows, and wetlands, through some thin stands of evergreens in the foreground. Undulating hills and mountains covered with evergreen forests appear in distant views. The differences in elevation, color, line, and texture created by the variety of vegetation and landform patterns provide variety at this location, and the caldera's surrounding mountains and hillsides provide unity and coherence, particularly to the east and west. The hills east, west, and south of the visitor center location, including South Mountain and Rabbit Mountain, provide views of primarily ponderosa pine and mixed conifer forests and woodlands. The contrasting colors and textures in the grasses, rocks, and evergreen trees add clearly defined visual interest and memorability for high levels of vividness, as well as interesting landform patterns. Views of the Valle Grande, an outstanding and rare natural feature, make the landscape unique and lend a sense of mystery to the scene. The undisturbed nature of the site and the relative lack of human-made structures indicates wholeness, thereby creating high levels of intactness. The arrangement of foreground trees and rocks, middleground views of the valles, and distant views of ridgelines creates high levels of harmony and balance.

Looking south to the proposed alternative 3A and 3B visitor center location with old double-track road in foreground and rock outcrop in middleground.

Looking northeast from approach to the proposed alternative 3A and 3B visitor center location; "The Missing" movie set in middleground; Valle Grande beyond movie set.

Rock outcrop near proposed alternative 3A and 3B visitor center location.

Looking north toward the East Fork of the Jemez River across the Valle Grande from the proposed alternative 3A and 3B visitor center location.

Looking northeast across the Valle Grande from the proposed alternative 3A and 3B visitor center location.

Looking east from the proposed alternative 3A and 3B visitor center location. NM-4 travels left to right just below the forested area in the background.

Looking southeast from the proposed alternative 3A and 3B visitor center location. NM-4 can be seen at the left below the forested area.

Looking south from the proposed alternative 3A and 3B visitor center location.

Looking west from the proposed alternative 3A and 3B visitor center location.

Figure 3-17: Photographs of Alternative 3A and 3B Proposed Visitor Center Site

Although cultural features are not noticeably present at the alternative 3A and 3B site, the landform, vegetation patterns, and water features combine to provide outstanding scenic quality. This landscape has strong, positive attributes of variety, unity, vividness, mystery, intactness, coherence, harmony, uniqueness, pattern, and balance. Therefore, scenic attractiveness at this location is rated class A: distinctive.

The alternative 3A and 3B site falls within the naturally evolving historic range category. With little human disturbance, this site expresses the natural evolution of biophysical features and processes.

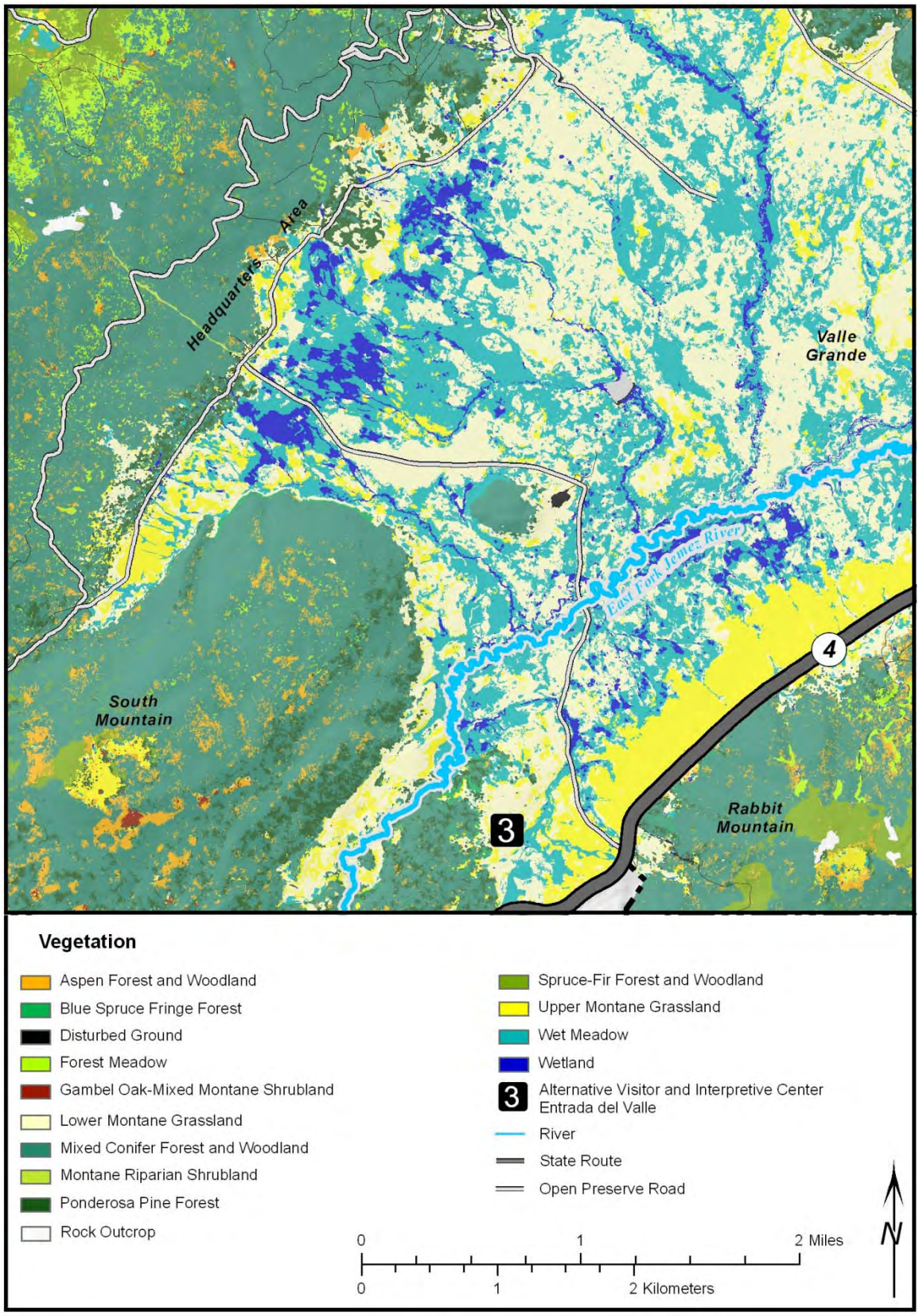


Figure 3-18: Alternative 3A and 3B Landscape Character

Alternative 4A and 4B Site

As mentioned above, NM-4 provides sweeping views of Valle Grande and views of Rabbit Mountain, and offers opportunities for wildlife viewing, visitor orientation, and interpretation (VCT 2005iVCT 2005i). The proposed alternative 4A and 4B site was chosen in proximity to the highway for those reasons (figures 3-19 and 3-20).

The proposed alternative 4A and 4B visitor center would be located south of NM-4 on a hillside that slopes up toward the ridge that forms the boundary with Bandelier National Monument to the south. Like the alternative 3A and 3B site, the alternative 4A and 4B location is primarily undisturbed, with the exception of a trailhead and trail that leads from the highway to the southeast. NM-4 is visible primarily to the northwest. The curvature of the site's hillside blocks most of the highway from view when looking west. The landscape at the site consists of forest meadow grasses and occasional clusters or singular occurrences of evergreen trees, primarily mixed conifer forest and woodland (see figure 3-20).

The hillside on which the site would be located provides sweeping views to the northwest of the Valle Grande beyond some thin stands of evergreens in the middleground. The Valle Grande consists of a variety of vegetation patterns formed by montane grasslands, wet meadows, and wetlands, as well as the East Fork of the Jemez River. Undulating hills and mountains covered with evergreen forests appear in distant views to the west, northwest, and north. Mountains are close to the south, appearing larger. Some small rock outcrops exist but are not prevalent. Similar to the alternative 3A and 3B site, the differences in elevation, color, line, and texture provide variety at this location, and the surrounding caldera's mountains and hillsides provide unity and coherence. The contrasting colors and textures in the grasses and evergreen trees are similar to alternatives 3A and 3B, and create high levels of vividness and interesting landform patterns. Views of the Valle Grande, an outstanding and rare natural feature, make the landscape unique and lend a sense of mystery. The undisturbed nature of the site and the relative lack of human-made structures create high levels of intactness. The arrangement of meadows randomly punctuated by small stands of evergreens before a backdrop of the Valle Grande and distant forested ridgelines creates high levels of harmony and balance.

Approach to the proposed location of the alternative 4A and 4B visitor center from the existing trailhead off NM-4.

Looking east from the entry to the proposed alternative 4A and 4B visitor center location.

Looking southeast from the proposed alternative 4A and 4B visitor center location.

Looking south from the proposed location of the alternative 4A and 4B visitor center.

View of Valle Grande (looking northwest) from the proposed location of the alternative 4A and 4B visitor center. NM-4 travels left to right just beyond the rise on which the middleground trees can be seen. The highway is not visible in the photograph.

View of Valle Grande (north) from the proposed location of the alternative 4A and 4B visitor center. The van pictured approximately left of center indicates the existing trailheads and the location of NM-4, which generally follows the contours of the middleground rise but is not visible in this photograph.

View to the west from the proposed location of the alternative 4A and 4B visitor center.

View of the proposed location of the alternative 4A and 4B visitor center looking southeast across the Valle Grande from the vicinity of the headquarters area.

Figure 3-19: Photographs of Alternative 4A and 4B Proposed Visitor Center Site

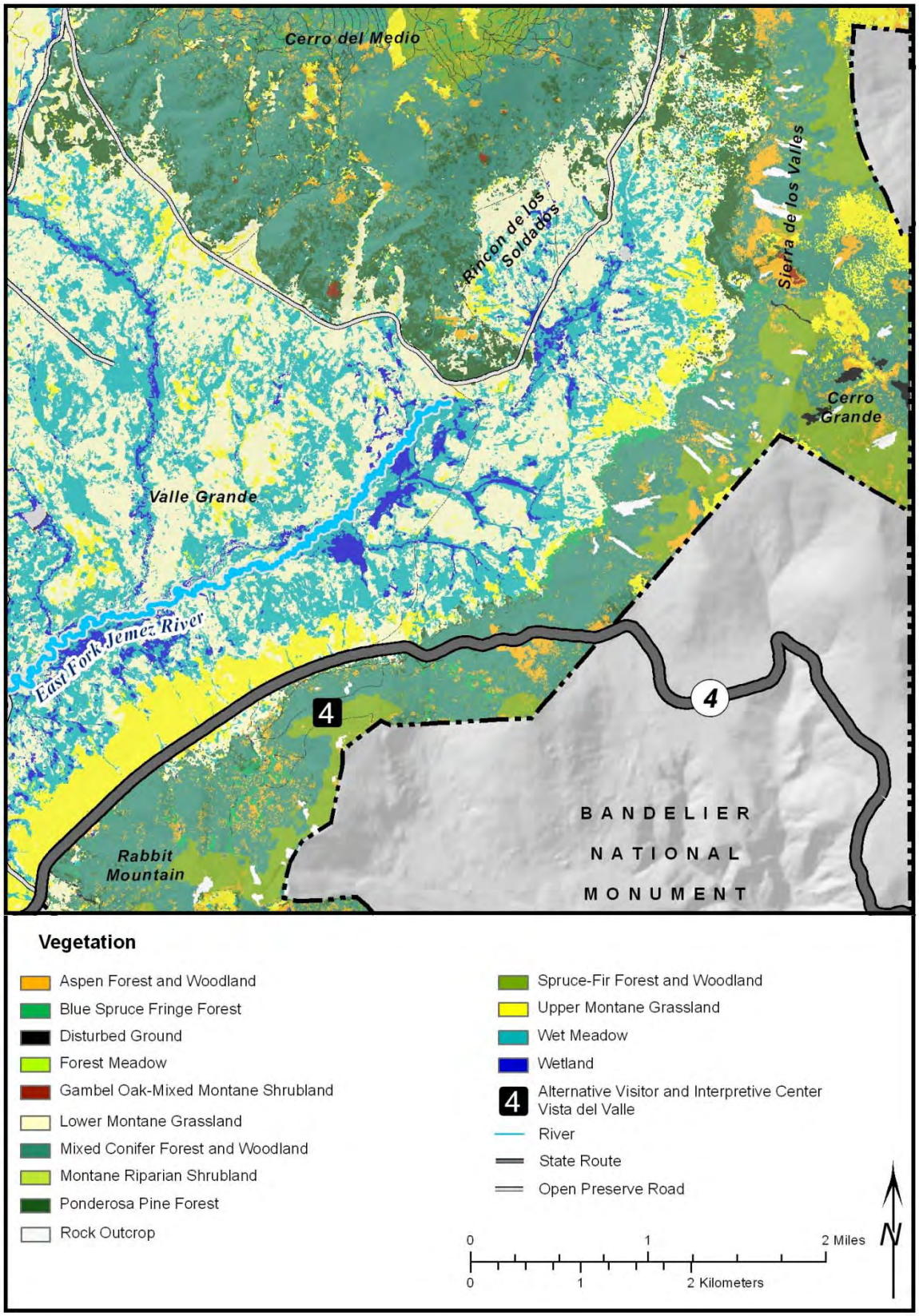


Figure 3-20: Alternative 4A and 4B Landscape Character

Although cultural features are not noticeably present at the alternative 4A and 4B site, the landform and vegetation patterns combine to provide outstanding scenic quality. This landscape has strong, positive attributes of variety, unity, vividness, mystery, intactness, coherence, harmony, uniqueness, pattern, and balance. Therefore, scenic attractiveness at this location is rated class A: distinctive.

This location has the potential to be seen across the Valle Grande when viewed to the southeast from the headquarters area, as shown in the last photograph in figure 3-19. The uninterrupted breadth and depth of the Valle Grande creates a primarily uniform view across the grasslands that is broken only by the distant mountains. This uniformity results in moderate levels of variety and pattern. The Valle Grande is primarily undisturbed, with high degrees of intactness. Unity, vividness, coherence, harmony, and balance are moderate to moderately high. Because the caldera in which the Valle Grande exists is rare, uniqueness and mystery are high. For these reasons, the view of the proposed location of the alternative 4A and 4B visitor center from the headquarters area is class A: distinctive.

The alternative 4A and 4B site falls within the naturally evolving historic range category. With little human disturbance, this site expresses the natural evolution of biophysical features and processes. The photos in figure 3-19 depict these views, as well as the surrounding area.

Scenic Integrity

Scenic integrity is defined by *Landscape Aesthetics* as the degree to which a landscape is visually perceived to be "complete" (USFS 1995). It is the current state of the landscape, considering previous human alterations. Scenic integrity indicates the degree of intactness and wholeness of the landscape character. Degrees of scenic integrity are defined as very high to very low. Integrity is limited to the deviations from or alternations to the existing landscape character that is valued for its aesthetic appeal. Scenic integrity spans a range of six levels of integrity, from very high to unacceptably low.

1. **Very High** (Unaltered)—Very high scenic integrity refers to landscapes where the valued landscape character is intact with only minute, if any, deviations. The existing landscape character and sense of place is expressed at the highest possible level.
2. **High** (Appears Altered)—High scenic integrity refers to landscapes where the valued landscape character appears intact. Deviations may be present but repeat the form, line, color, texture, and pattern common to the landscape character so completely and at such scale that they are not evident.
3. **Moderate** (Slightly Altered)—Moderate scenic integrity refers to landscapes where the valued landscape character appears slightly altered. Noticeable deviations remain visually subordinate to the landscape character being viewed.

4. **Low** (Moderately Altered)—Low scenic integrity refers to landscapes where the valued landscape character appears moderately altered. Deviations begin to dominate the valued landscape character being viewed, but they borrow valued attributes such as size, shape, edge effect, and pattern of natural openings, vegetative type changes, or architectural styles outside the landscape being viewed. They not only appear as valued character outside the landscape being viewed, but are compatible or complimentary to the character within.
5. **Very Low** (Heavily Altered)—Very low scenic integrity refers to landscapes where the valued landscape character appears heavily altered. Deviations may strongly dominate the valued landscape character. They may not borrow from valued attributes such as size, shape, edge effect, and pattern of natural openings, vegetation type changes, or architectural styles within or outside the landscape being viewed. However, deviations are shaped and blended with the natural terrain (landforms) so that elements such as unnatural edges, roads, landings, and structures do not dominate the composition.
6. **Unacceptably Low**—Unacceptably low scenic integrity refers to landscapes where the valued landscape character being viewed appears extremely altered. Deviations are extremely dominant and borrow little, if any, form, line, color, texture, pattern, or scale from the landscape character. Landscapes at this level of integrity need rehabilitation (USFS 1995).

Scenic integrity descriptions were determined for each alternative based on field visits and photographs, aerial photography, and inventories of disturbed areas and other data.

Alternative 2

As described under "Landscape Character," above, the alternative 2 site has been previously disturbed and the presence of the large, unpaved parking lot is visible and predominant in the foreground. The open parking area is an obvious, large, cleared area amid the forested setting. Although this deviation does not dominate the landscape character, it does not borrow valued landscape characteristics such as size, shape, edge effect, and pattern of natural openings. The parking area is not compatible with or complimentary to the natural landscape character. In addition to the parking area, several logging roads exist in the southwest corner of the preserve (figure 3-21). However, these roads are not immediately visible from the location of the proposed visitor center. The disturbed area remains surrounded by evergreen trees on all sides, enclosing the space with features that provide natural edges and characteristics and also serving to screen the existing logging roads. For these reasons, the existing scenic integrity of the alternative 2 site is slightly altered, or moderate, because deviations from the natural landscape are noticeable but generally remain visually subordinate to the landscape character.

Alternatives 3A and 3B

Because the alternative 3A and 3B site is predominantly undisturbed, its landscape integrity is very high (unaltered). As shown in figure 3-22, the existing double-track road to the proposed alternative 3A and 3B site represents the only human-caused disturbance in the immediate vicinity. These very slight deviations do not interfere with the wholeness of the landscape character.

Alternatives 4A and 4B

Although the alternative 4A and 4B site is predominantly undisturbed, it is close to NM-4, which represents a disturbed area. More roads (which are closed to motor vehicles) exist near the alternative 4A and 4B site than the alternative 3A and 3B site, but they are not conspicuous from the ground. The valued landscape character appears intact. As shown in the photographs in figure 3-19, NM-4 is not readily evident. Landscape integrity is high (appears altered) due to the proximity of NM-4.

Landscape Visibility

Landscape visibility addresses the relative importance and sensitivity of what is seen and perceived in the landscape. Landscape visibility is a combination of the seen area in relation to the context and types of viewers who see it. Landscape visibility consists of three elements:

1. Seen areas (travelways and use areas)
2. Distance zones
3. Concern levels

In order to determine landscape visibility, specific areas that would be seen from travelways or use areas were determined (known as "seen area mapping"). Landscape areas denoted by specified distances from the observer (known as "distance zones") were also identified to determine landscape visibility. The importance people place on these travelways and use areas were then determined (known as "concern level assignments").

Seen Area Mapping

Important existing travelways and recreation areas that receive high visitor use were identified and mapped. These include NM-4 and the preserve's Level 3 roads, as well as those sections of the East Fork of the Jemez River and San Antonio Creek that are open to fishing. NM-4 would provide views of alternatives 3A/3B and 4A/4B, but likely not alternative 2 due to vegetation density and height. Level 3 roads were mapped because they provide the transportation routes to hunting, fishing, hiking, and winter activities, and are used by the VCT to conduct tours (see figure 3-23).

Figure 3-21: Alternative 2 Landscape Integrity

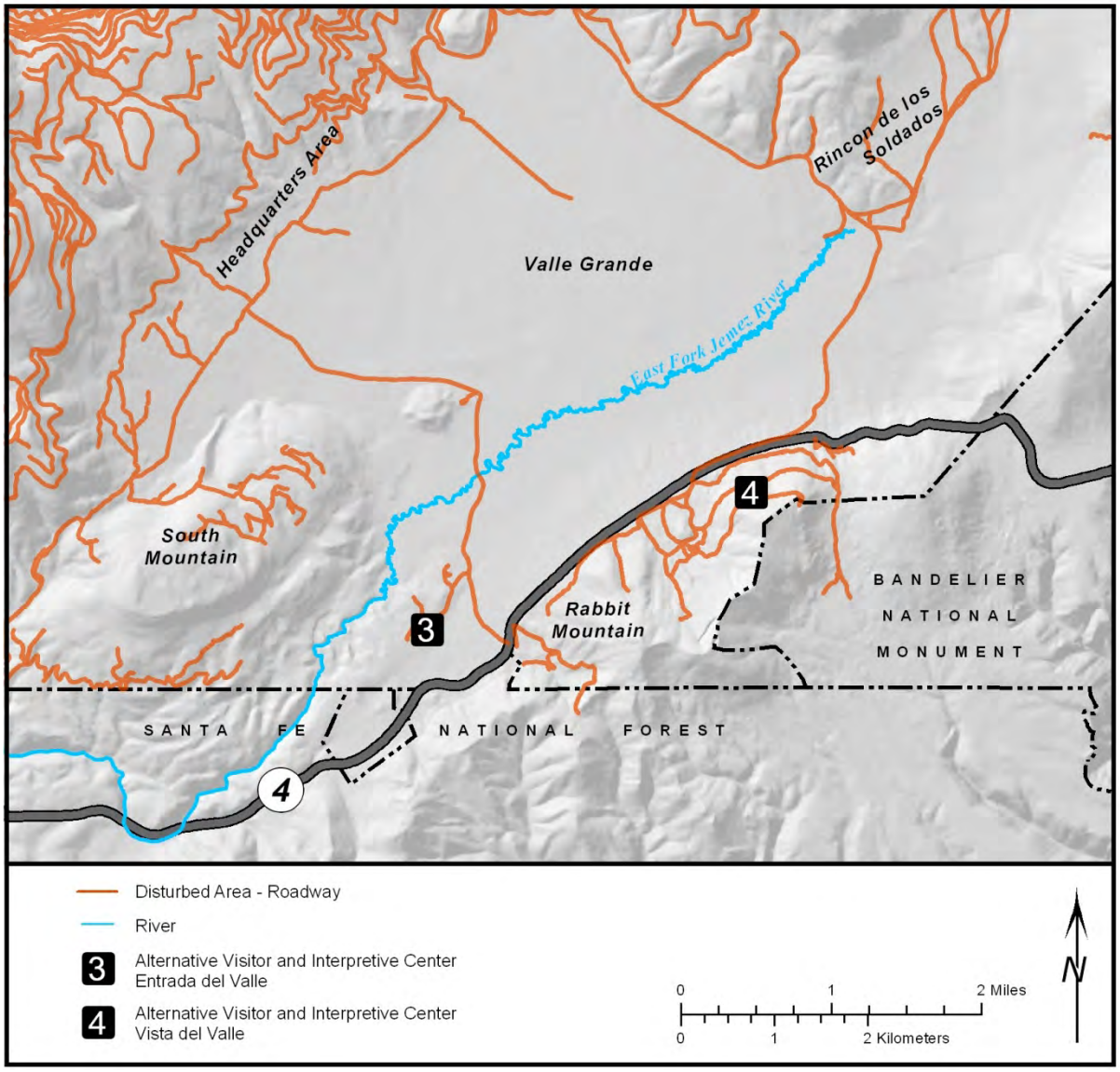


Figure 3-22: Alternative 3A and 3B and Alternative 4A and 4B Landscape Integrity

Figure 3-23: Seen Area Map

Distance Zones

Distance zones were used to determine the seen area from primary roads and fishable streams for foreground, middleground, and background to help determine landscape visibility for this plan. Foreground was considered 2,000 feet

(approximately 3/8 mile), middle ground from 2,001 to 21,120 feet (from 3/8 mile to 4 miles), and anything greater than 21,120 feet (4 miles) was considered background (shown in figure 3-23). However, the distance zones do not account for vegetation, which would reduce the seen area in some areas, potentially considerably (see "Visual Absorption Capability").

Concern Level Assignments

The importance people place on these travelways and use areas was determined to measure the degree of public importance associated with them, divided into three levels:

1. **Level 1:** Most sensitive—Applies to travel routes and recreation areas where substantial public use occurs and where the visual quality is of high concern to typical users. Examples of such routes and areas include public highways, local roads, recreational lakes and rivers, and designated recreational trails and areas that provide a high level of scenic quality.
2. **Level 2:** Moderately sensitive—Applies to travel routes or recreation areas not included in Level 1, where visual quality is of moderate concern to typical users. Examples of these routes and areas may include public highways and local roads, recreational lakes and rivers, and designated recreational trails that provide moderate to high scenic quality but less significant public use.
3. **Level 3:** Less sensitive—Applies to travel routes or recreation areas not included in Levels 1 or 2, where visual quality is of less concern to typical users. Examples may include public highways and low-volume local forest roads, nondesignated trails, and nonrecreational lakes and rivers.

As mentioned above, the preserve's grasslands, particularly Valle Grande, are some of its most dramatic features. Foreground and background views of the Valle Grande are provided from several high-use areas. This includes visitors driving on NM-4 and to the Valle Grande Staging Area. Visitors fishing the East Fork of the Jemez River and anglers driving to San Antonio Creek also experience views of the Valle Grande, as do visitors taking shuttle tours of the preserve and tours of the headquarters area. As shown in the figures in the "Visitor Experience" section, the Valle Grande is open to cross-country skiers and snowshoers in winter, and is the only area in the preserve where such winter activities are currently allowed. Although elk hunters do not hunt in the Valle Grande itself, several designated elk hunting units provide views of the Valle Grande. The same is true for visitors hiking South Mountain, Rabbit Mountain, and Cerros del Abrigo and those hiking past Redondito. These travelways and use areas represent substantial public use and are likely places where visual quality, particularly of Valle Grande, is of high concern to visitors.

San Antonio Creek is very popular with anglers and the North Rim shuttle route (see "Transportation" section) currently follows part of it. Three hunting units provide views into the Valle San Antonio, another grassland, through which the

creek flows. This area also represents substantial public use and is likely a place where visual quality is of high concern to visitors.

In addition to the roads that provide access to the visitor use locations described below, all Level 3 roads provide background views of higher-elevation peaks and hills. These areas currently receive minimal use, but provide views of distant mountains.

Alternative 2

The proposed alternative 2 visitor contact station site is a less sensitive recreation area because the site has been previously disturbed and is not located where views are paramount. Although less scenic than the Valle Grande, the Banco Bonito area has several miles of roads that visitors use for mountain biking and horseback riding.

Alternatives 3A and 3B

The proposed alternative 3A and 3B visitor center site is a moderately sensitive recreation area, which would be visible within the preserve from NM-4 and nearby high-elevation hiking trails.

Alternatives 4A and 4B

The proposed alternative 4A and 4B visitor center site is a moderately sensitive recreation area, which would be situated at the edge of the preserve at the foot of a hill, outside the grasslands.

Visual Absorption Capability

Principles of visual absorption capability that could affect the ability of the preserve's existing landscape to accept human alteration without loss of landscape character or scenic integrity are described below.

- The degree of visual screening provided by landform, rockform, or vegetative cover affects visual absorption capability.
- Variety or diversity of landscape pattern, particularly the amount and extent provided by landform, rockform, water, or vegetative cover, affects visual absorption capability.
- Heavily dissected landform and rockform partially screen and break up the visual continuity of landscape alterations, while smooth landform does not.
- Tall vegetation, such as trees, screens and breaks up the visual continuity of landscape alterations. Short vegetation, such as grasses and low shrubs, does not.
- Heavily patterned and diverse, dense vegetative cover, especially if mixed with waterforms, breaks up the perceived continuity of landscape alterations. Homogeneous vegetative cover and lack of waterforms do not.
- Dense vegetation on flatter slopes provides more screening of landscape alterations than the same vegetative cover on steep slopes.

- Vegetation regeneration potential affects visual absorption capability. Where vegetation quickly reproduces, it can screen and blend human alterations into the landscape more quickly.
- A landscape prone to landslide, soil slippage, and erosion exacerbates the visual impact of landscape alterations. A stable landscape does not (USFS 1995).

The three most important factors in providing visual absorption capability are slope, vegetation cover, and geology, as described below (USFS 1995).

Slope: On steep mountainous terrain, slope is the most important visual absorption capability factor. Slope includes factors related to landform screening, vegetation screening, geologic stability, and soil depth and stability. Therefore, it is the best physical factor of relative visual absorption capability. Since it is not likely to change, slope is the most constant factor of visual absorption capability. Slope is not an appropriate factor for flat landscapes.

Vegetation Cover: On gently rolling landscapes, vegetation cover is the most important visual absorption capability factor. It is also a key factor on hilly or mountainous landscapes. Although vegetation cover can produce a certain level of visual absorption capability, it is the least stable factor. Natural disasters, such as the fires that burned in and near the preserve in 2010, and human activities, such as past logging in the preserve, can easily modify vegetation, altering its visual absorption capability. Vegetation screening is primarily a function of the height and physical structure of the leaves, branches, and stems of individual plants, including trees, shrubs, and herbaceous layers.

Soils and Geology: Soil factors such as mass stability, erosion hazard, and soil color contrast provide visual absorption capability. Geologic formations, such as rock outcrops, slides, and cliffs, can affect visual absorption capability by providing natural openings from which to borrow when designing human alterations.

Data about slope, existing vegetation, and geologic formations were used to identify the visual absorption capability of the preserve's landscapes, as shown in figure 3-24. Tightly spaced topographic lines indicate areas of steep slope; broadly spaced lines indicate relatively flat areas. The preserve's vegetation was classified by height into three categories based on its ability to screen views: high, moderate, and low. High indicates tall vegetation, such as evergreen forests, with the greatest potential to screen views. Moderate indicates medium-height vegetation, such as shrublands and wetlands, with a moderate potential to screen views. Low indicates grasslands and meadows, with the least potential to screen views.

Alternative 2

Vegetation at the Banco Bonito area has high capability for visual absorption, although this ability is susceptible to change. The mountains encircling the caldera, as well as those within it, are steeply sloped, blocking views beyond them. Rock outcrops are fairly limited to the west side of Redondo Peak and the west and north

sides of Redondito. For these reasons, the visual absorption capability at the alternative 2 site is high.

Alternatives 3A, 3B, 4A, and 4B

Figure 3-24 shows that the broad valles, such as Valle Grande, have the lowest potential to screen views due to the lack of slope, tall vegetation, and geologic formations. These areas provide for the most uninterrupted views, with low visual absorption capability. The visual absorption capability at the site for alternatives 3A and 3B is moderate to low, depending on viewer location, as shown in the photographs in figure 3-17. For example, the hill on which the visitor center would be constructed would block views from below, but the building would be visible from NM-4. The visual absorption capability at the alternative 4A and 4B site would be moderate because the building would be located at the base of a slope, as shown in figure 3-19. However, the visual absorption capability would be low looking toward the visitor center from the headquarters area across the Valle Grande.

Visitor Capacity Zoning

In part to address the potential disruption of views, the preserve's *Master Plan for Interpretation* (VCT 2005g) suggests zoning the preserve into low, medium, and high visitor capacity areas. The preserve's valles constitute the low visitor capacity zone because of their views. Any activity occurring in the valles can be seen from many vantage points. The preserve's forest edges constitute the medium visitor capacity zone. This includes the more densely forested southwestern area, with its substantially smaller grassland areas and fewer viewpoints. These areas provide opportunities for more group activities and events. Clear areas, such as those at Banco Bonito, are suitable for medium use, particularly along the forest edges. Such locations are the best for circulation and observation; visitors can see without being seen. Specific areas out of direct view of the visiting public that do not conflict with ecologically sensitive areas constitute the high visitor capacity zone. These include parts of Banco Bonito and the edge of the Valle Grande where it meets NM-4.

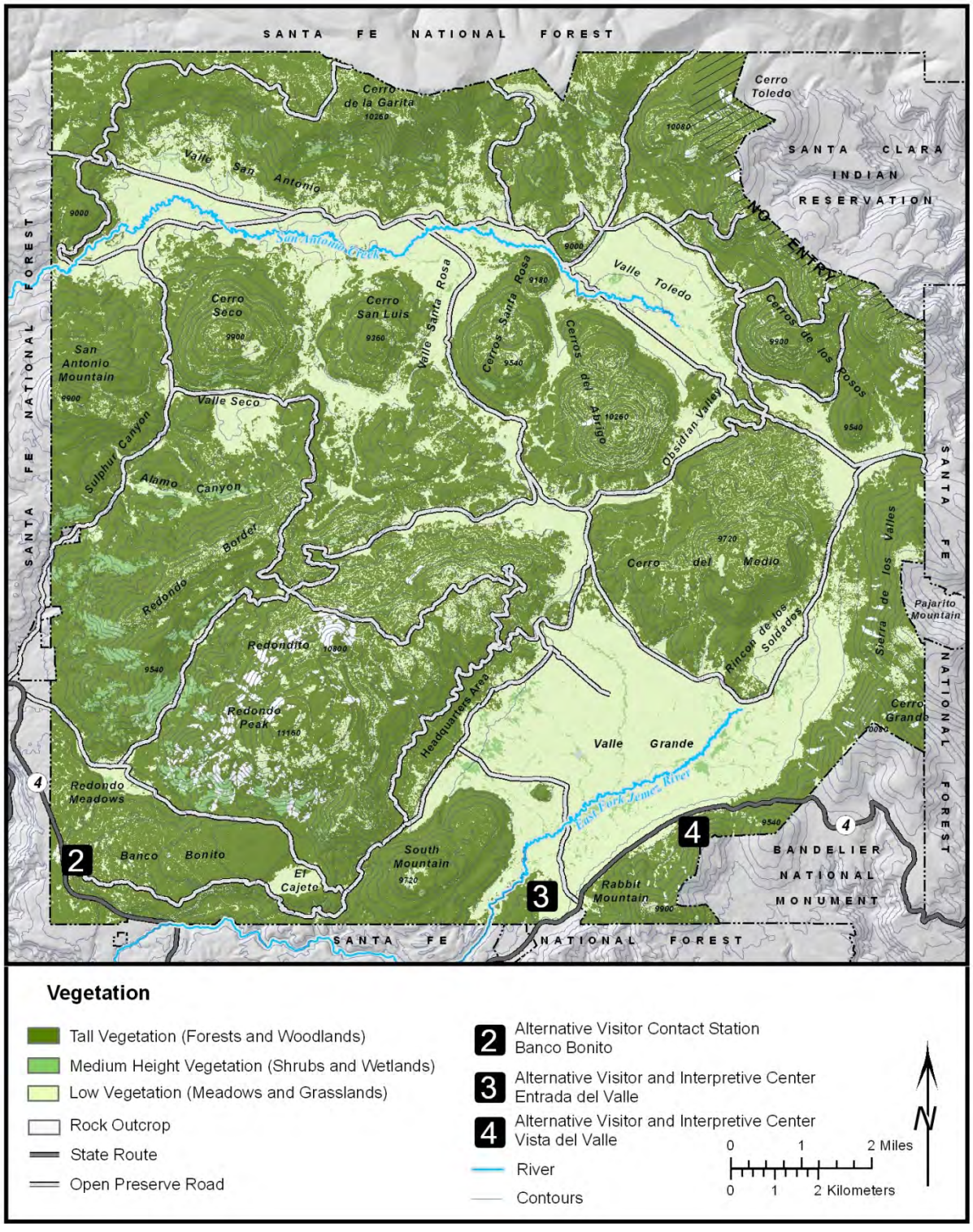


Figure 3-24: Visual Absorption Factors

Summary of Visual Resource Characteristics

Table 3-8 presents an evaluation of visual resources for each of the action alternatives at the implementation level.

Table 3-8: Implementation-level Visual Resource Characteristics Summary

Characteristic	Alternative 2: Banco Bonito	Alternatives 3A/3B: Entrada del Valle	Alternatives 4A/4B: Vista del Valle
Landscape character: scenic attractiveness	Class B: typical	Class A: distinctive	Class A: distinctive
Historic range	Natural appearing	Naturally evolving	Naturally evolving
Scenic integrity	Moderate	Very high	High
Landscape visibility: concern levels	Less sensitive	Moderately sensitive	Moderately sensitive
Visual absorption capability	High	Moderate to low	Moderate; low looking toward the visitor center from the headquarters area
Visitor capacity zone	Medium	Low to medium	Medium

Transportation

The increased public access and use expected under the proposal alternatives would affect transportation to and through the preserve. This section describes the existing roads that could be affected by the proposed actions so that impacts to them can be analyzed.

Study Area

The study area for evaluating impacts to transportation for implementation-level decisions is the specific proposed visitor contact station / visitor center locations for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

NM-4 Corridor

Increased public access and use would affect transportation to and through the preserve.

NM-4 provides access to the preserve for visitors traveling between Los Alamos and Jemez Springs. It traverses the southern portion of the preserve along the base of Rabbit Mountain, and offers opportunities for views of the Valle Grande, wildlife viewing, visitor orientation, and interpretation. NM-4 is an all-weather, hard surface, fully maintained two-lane paved highway. The NMDOT classifies NM-4 as a minor arterial. An arterial is a continuous long-distance travel route that connects urban and rural communities. Approximately 2 miles of NM-4 lies within the southwest corner and 4 miles of it lie within the southeast part of the preserve (VCT 2007b). According to the New Mexico Mid-region Council of Governments, the average weekday traffic volume for NM-4 from its intersection with NM-126 north of Jemez Springs east to Los Alamos County (which includes the preserve) is 800 vehicles in both directions of travel combined (MRCOG 2011).

A traffic analysis report was performed for the preserve in 2005 (VCT 2005b). The report provided level of service (LOS) estimates for the preserve's main entrance intersection with NM-4. LOS is a system that rates the amount of traffic congestion on a roadway, using the letter A to represent the least amount of congestion and F to refer to the greatest amount. LOS levels are characterized as follows:

- LOS A: free flow with low volumes and high speeds
- LOS B: reasonably free flow, but speeds beginning to be restricted by traffic conditions
- LOS C: in stable flow zone, but most drivers are restricted in the freedom to select their own speeds
- LOS D: approaching unstable flow; drivers have little freedom to select their own speeds
- LOS E: unstable flow; may be short stoppages
- LOS F: unacceptable congestion; stop-and-go; forced flow (FHWA n.d.a).

The traffic analysis report estimated year 2005 and 2010 operational performance at the main preserve entrance intersection to be LOS A during the peak hours of an average weekday. The LOS A estimate for 2010 was based on traffic projections along NM-4 between 1,200 and 1,400 vehicles per day. As noted above, the Mid-Region Council of Governments (MRCOG) actually reported a lower average daily traffic volume of only 800 vehicles along NM-4 in 2010. The lower traffic volume indicates that current intersection performance remains LOS A.

The operational performance of NM-4 was estimated for the roadway between NM-126 and NM-501. Conservative estimates of traffic volumes and peak hour traffic volumes were used to estimate that NM-4 operates at LOS B or better during the weekday peak hours. Included in this estimate was the assumption that traffic along NM-4 includes commuters traveling to and from the Los Alamos National Laboratory east of the preserve. This commuting pattern may contribute to higher peak hour traffic volumes than were assumed in the 2005 traffic report. However, it is expected that the existing levels of service along NM-4 seldom exceed LOS B.

As noted in the "Visitor Experience" section, seasonal visitation typically fluctuates as follows:

- About 70% of visitation occurs during the summer recreation season.
- About 20% of visitation occurs during the winter recreation season.
- About 10% of visitation occurs between winter and summer (VCT 2006c).

A traffic study conducted in 2005 for upgrades to the Valle Grande entrance road identified the following characteristics of NM-4:

- Weekday traffic is split 25%/75% for westbound/eastbound traffic during the a.m. peak hour (the time when traffic is the highest).

- Saturday traffic is split 45%/55% for westbound/eastbound traffic during the midday peak hour.
- Sunday traffic is split 55%/ 45% for westbound/eastbound traffic during the midday peak hour.
- The peak hour (i.e., the time when the traffic is the highest) percentage is 7% for both the a.m. and midday peak hours; that is, 7% of the annual average daily traffic (AADT).
- The maximum weekend background (adjacent highway) traffic on NM-4 is approximately 11.1% and occurs between 1:00 p.m. and 2:00 p.m. (VCT 2005b).

There are five ways to access the preserve from NM-4: one main entrance for visitors and four administrative gates. Signs are minimal (VCT 2007b). Currently, six pullouts exist along NM-4, two of which provide accesses to the Valle Grande and Coyote Call hiking trails. No amenities other than some interpretive signs are available at these locations, and parking is limited (VCT 2005b). Three of the remaining six pullouts contain small kiosks with information on the preserve's history and programs (VCT 2007b).

The Valle Grande entrance, the main entrance to the preserve, is located near mile marker 39. Before federal acquisition, approximately 200–300 people visited the Baca Ranch each year. During the preserve's August 2006 open house, nearly 1,500 vehicles entered and left the preserve in one day, as shown in figure 3-25 (VCT 2007b). In 2010, approximately 25,000 people visited the preserve over the course of the year (VCT 2010d).

The main entrance became inadequate for the volumes of traffic that enter the preserve. In summer 2007 the VCT, the NMDOT, and the USFS upgraded the entrance to provide safe access to and from the preserve and increase the safety for motorists traveling on NM-4. The entrance upgrade now meets standards established by NMDOT and the American Association of State Highway and Transportation Officials. The upgrade project footprint is just under 12 acres; 8 acres are on the preserve and about 4 acres are in the NM-4 easement under the jurisdiction of NMDOT. The project included the reconstruction of the entrance and the widening of NM-4 (VCT 2007b), as well as the construction of access and egress lanes and improvements to line of sight to meet state and federal highway safety standards (Rodriguez, pers. comm. 2011a).

Figure 3-25: Traffic Congestion during 2006 Open House

NM-4 is part of the Jemez Mountain Trail, a national scenic byway that is an intersection of roads that includes NM-550 and NM-4. It starts at the Coronado Monument in Bernalillo and encompasses the Jemez State Monument and Valles Caldera National Preserve, and finishes at Bandelier National Monument. The highway provides many opportunities for hiking, fishing, camping, cross-country skiing, or visiting natural hot springs (Sandoval County 2011). The National Scenic Byways Program is part of the FHWA under the USDOT. The program was established to help recognize, preserve, and enhance selected roads throughout the United States. The U.S. Secretary of Transportation recognizes certain roads as national scenic byways based on at least one archeological, cultural, historic, natural, recreational, or scenic quality (USDOT n.d.). Under the program, the federal government may make grants and provide technical assistance to states and Indian tribes to implement projects on highways designated as national scenic byways. Eligible assistance projects include "Construction along a scenic byway of a facility for pedestrians and bicyclists, rest area, turnout, highway shoulder improvement, overlook, or interpretive facility" and "An improvement to a scenic byway that will

enhance access to an area for the purpose of recreation" as long as the action will "protect the scenic, historical, recreational, cultural, natural, and archeological integrity of a highway and adjacent areas" (USDOT n.d.).

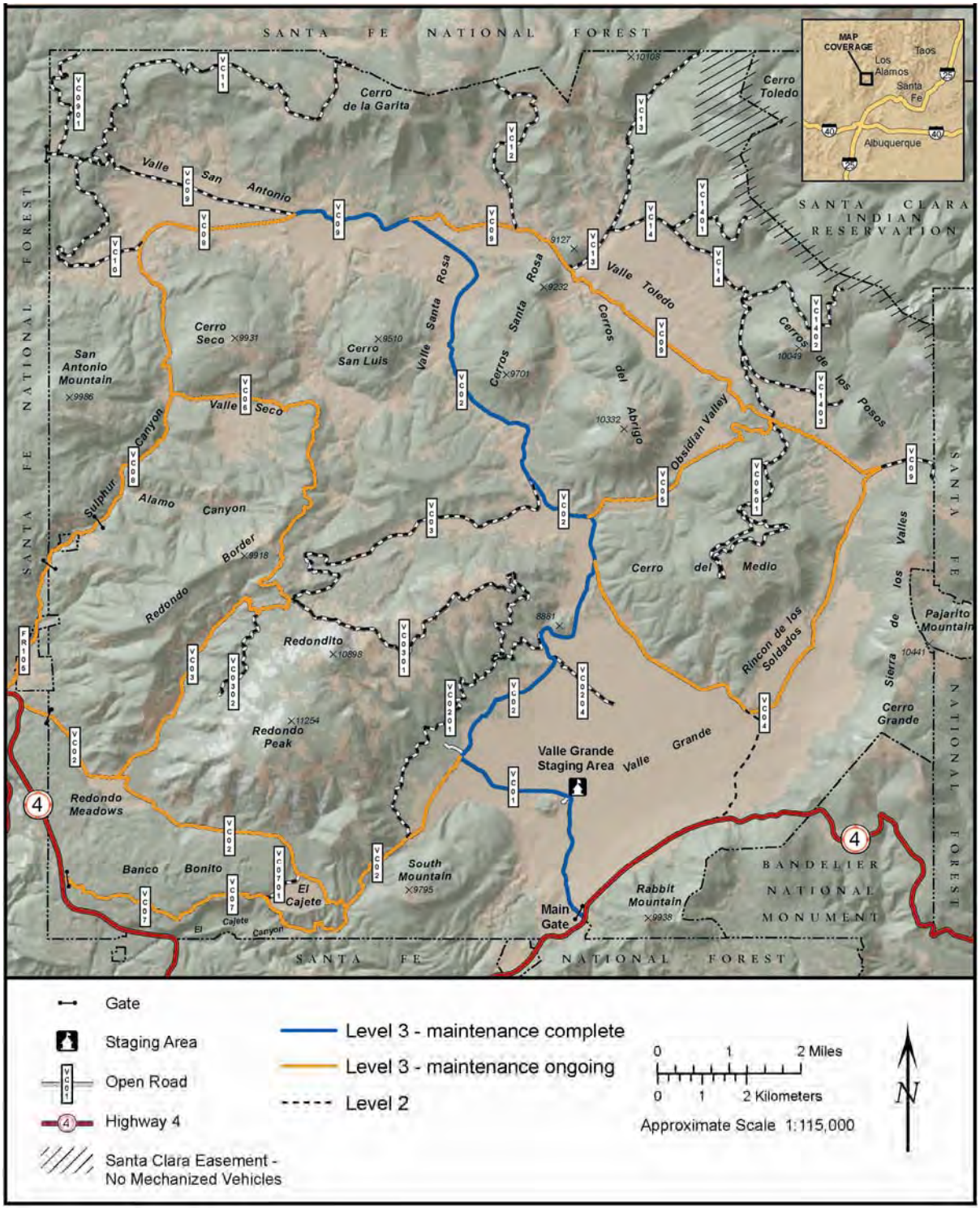
Internal Roads and Transportation

Most of the preserve's roads were built from 1935 to 1962 to facilitate the harvest of forests near the valles. More roads were built from 1963 to 1972 to facilitate clear-cutting. Historically, preserve roads have been the cause of erosion, sediment buildup in preserve streams, intrusion into archeological deposits, and visual disturbance (VCT 2007b).

At the time of purchase, the preserve had more than 1,400 miles of roads, most of which were logging roads (VCT 2010f). At present, the VCT uses a network of public and administrative roads totaling 184 miles (VCT 2007b). Some roads are suitable for use only by high-clearance vehicles, and especially in inclement weather, four-wheel drive is frequently necessary. Preserve road inventories reveal approximately 12 miles of road per square mile of land. The USFS maximum objective is about 2.5 miles of road per square mile of land. USFS engineers estimate that reconstructing preserve roads at their present one-lane width to federal safety standards, improving drainage capabilities, and resurfacing with appropriate native materials could cost as much as $100,000 per mile. The cost would rise as the roads traverse mountainous terrain or penetrate farther into the interior of the preserve, increasing the cost of hauling materials. Costs could double where roads are widened to two lanes. This estimate does not include the cost of archeological assessment and mitigation (VCT 2005i). Figure 3-26 shows the open roads currently used by the VCT in support of public and administrative access the preserve.

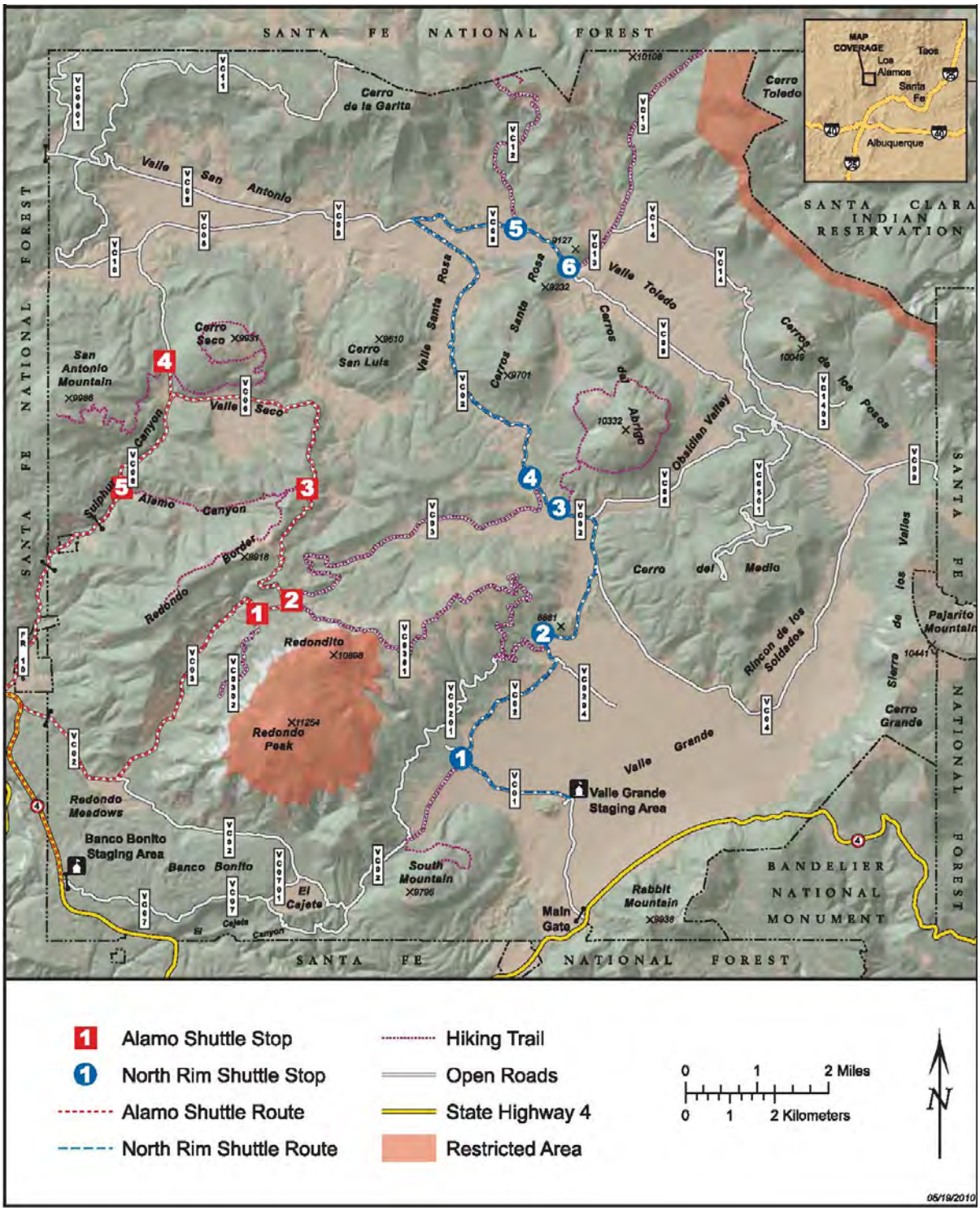
The preserve currently has three staging or parking areas with space for about 200 cars. Lack of parking is a major limitation on the capacity of the preserve's recreation and education programs (VCT 2007b). Currently, visitors can access specific areas of the preserve using private vehicles for San Antonio Creek fishing, elk hunting, turkey hunting, special events (e.g., Photo Adventure Hunt, Endurance Race, 3D Archery Shoot), special group events (e.g., weddings), and volunteering (Rodriguez, pers. comm. 2011a).

VCT staff members also shuttle hikers in vans to trailheads, where hikers can choose guided or unguided hikes. Sections of existing logging roads are used for hiking trails (VCT 2010d). As shown in figure 3-27, two shuttle routes are provided by the VCT: the Alamo shuttle originates at Banco Bonito, heads west on NM-4, and makes a loop on the west side of the preserve. It includes five shuttle stops. The North Rim shuttle is an out-and-back route from the Valle Grande Staging Area north to the Valle Toledo. This route includes six shuttle stops (VCT 2005bd).



Source: VCT 2007b.

Figure 3-26: Preserve Roads



Source: VCT 2005d.

Figure 3-27: Current Shuttle Routes in the Preserve

The preserve's roads are characterized based on how they provide access (arterial, collector, or local) and how they are designed and maintained (maintenance levels), as shown in figure 3-28. Access is defined as follows:

- arterial—provides service to large land areas
- collector—serves smaller areas and connects arterials to local roads
- local—single-purpose road that connects terminal facilities with collectors or arterials (VCT 2007b)

Arterial Road | Collector Road | Local Road

Figure 3-28: Road Type Examples

Minimal signs exist along interior roads. Cultural resources surveys have been completed for 122 miles of roads, including all of the arterial roads. Since 2002, the VCT has upgraded approximately 13 miles of ranch roads to arterial classification to improve safety for administrative and public use, and to mitigate impacts on natural and cultural resources. The road upgrades enhanced the natural hydrology and returned natural flows to approximately 3,000 acres of wetlands (VCT 2007b). These roads (VC01 and VC02, shown in figure 3-27) compose the first half of a long loop (26 miles) that the VCT planned to use during the August 2006 open house (see "Visitor Experience" section). The cost to upgrade the remaining roads of the loop (VC09, VC08, VC06, VC03, and VC02) is estimated at $1.3 million (excluding the cost of cultural resource compliance). Table 3-9 depicts road mileage by class within the preserve.

Table 3-9: Class and Miles of Administrative and Public Roads on the Preserve

Type of Road	Class	Miles
Administrative use roads	Arterial	1.8
	Collector	14.0
	Local	36.9
	Total	52.7
Public open roads	Arterial	87.9
	Collector	34.5
	Local	8.9
	Total	131.3
Total roads on preserve		184.0

Source: VCT 2007b.

In addition to classes, the USFS defines roads on its lands on a scale from 1 to 5 based on specific characteristics, such as surface type, travel speeds, number of lanes, etc. The most developed roads are rated at the highest level (Level 5), and development decreases as the numeric scale decreases. Each level is also assigned a "management strategy," which describes the road management objectives through strategies for managing traffic on roads excluded from the Highway Safety Act. The five road management strategies are described below.

Encourage

The "encourage" objective is to encourage use by high-clearance vehicles (e.g., pickups, trucks, 4-wheel-drive vehicles) and discourage passenger cars through information techniques such as maps and signs.

Accept

The "accept" objective is to accept high-clearance vehicles and discourage passenger cars. The road is passable and adequate for administrative use. Some public use may occur until passage becomes unsafe or resource damage becomes unacceptable. At that point, the management strategy would be changed to "eliminate" or "prohibit" use.

Discourage

The "discourage" objective is to discourage all public use during certain periods. Passage appears feasible at the road entrance, but entrance information is designed to discourage the general public with advisory signs, warnings, and/or barriers.

Eliminate

Under the "eliminate" strategy, all use is eliminated. The road is physically blocked. Barriers include guardrails, logs or boulders, earthen mounds, or trees and brush used to camouflage the road entrance. The strategy does not include gates.

Prohibit

Under the "prohibit" strategy, certain or all users are not allowed to use the road, which is signed and actively enforced under a regulatory order. This strategy allows the use of gates.

The five USFS road levels include the management strategies described above. No Level 5 roads are being proposed at the preserve. Level 4 roads do not exist at the preserve now, but are proposed under the various action alternatives. VC01–VC14 (shown on the maps above) are all Level 3 roads. Roads identified with four digits are Level 2 roads (e.g., VC09 is a Level 3 road; VC0901 is a Level 2 road). Level 1 roads are closed to vehicular traffic (e.g., hiking trails) and are not depicted on the maps above. Level 1–4 roads are described below (USFS 2005).

Level 1

Level 1 roads may be of any type, class, or construction standard but are closed to vehicular traffic. They may be open and suitable for nonmotorized uses, such as hiking. These roads have the following attributes:

- Vehicular traffic is eliminated, including administrative traffic.
- Road is physically blocked or entrance is disguised.
- Not subject to the requirements of the Highway Safety Act.
- Maintenance is done only to minimize resource impacts.
- No maintenance other than a condition survey may be required if no potential exists for resource damage (USFS 2005).

Level 2

Level 2 roads are open for use by high-clearance vehicles. Passenger car traffic is not a consideration. Traffic is normally minor, usually consisting of administrative, permitted, dispersed recreation, or other specialized uses. Appropriate traffic management strategies are either to (1) discourage or prohibit passenger cars or (2) accept or discourage high-clearance vehicles. These roads have the following attributes:

- Roads have low traffic volume and low speed.
- Roads are typically local.
- Roads typically connect collectors or other local roads.
- Dips are the preferred drainage treatment.
- Not subject to the requirements of the Highway Safety Act.
- Surface smoothness is not a consideration.
- Not suitable for passenger cars (USFS 2005).

Level 3

Level 3 roads are open and maintained for travel by "prudent drivers" in a standard passenger car. User comfort and convenience are low priorities. Roads are typically low speed and single lane, with turnouts and spot surfacing. Some roads may be fully surfaced with either native or processed material. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users. These roads have the following attributes:

- Subject to the requirements of Highway Safety Act and the Federal Highway Administration's Manual on Uniform Traffic Control Devices (MUTCD).
- Roads have low to moderate traffic volume.
- Roads typically connect to arterial and collector roads.
- A combination of dips and culverts provide drainage.

- May include some dispersed recreation roads.
- Potholing or washboarding may occur (USFS 2005).

Level 4

Level 4 roads provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated. The most appropriate traffic management strategy is "encourage." However, the "prohibit" strategy may apply to specific classes of vehicles or users at certain times. These roads have the following attributes:

- Subject to the requirements of the Highway Safety Act and MUTCD.
- Roads have moderate traffic volume and speeds.
- Roads may connect to county roads.
- Culverts provide drainage.
- Roads are usually collectors.
- May include some developed recreation roads (USFS 2005).

Currently, no Level 4 roads exist in the preserve.

The VCT will continue routine maintenance of roads currently used on the preserve based on safety, resource conditions and values, capacity, and intended uses. Roads will be managed to conserve, protect, and restore the recreational, ecological, cultural, religious, and wildlife resource values. The VCT will continue to upgrade and sign open roads to USFS and State of New Mexico standards as required by the Valles Caldera Preservation Act of 2000 (VCT 2007b).

Vegetation

This section describes the existing conditions of vegetation on the preserve, including general plant associations, rare plants, noxious weeds, forestry and grazing issues, and riparian and wetland vegetation. Special-status plant species, including threatened and endangered species and USFS sensitive species, are addressed in the "Special-status Species" section.

Study Area

The study area for evaluating impacts on vegetation for implementation-level decisions is the specific proposed visitor contact station / visitor center location for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

Preserve Overview

The preserve is one of the most biologically diverse areas in the Southern Rocky Mountain Ecoregion (southern Wyoming to northern New Mexico). Approximately 65% of the preserve is dominated by forest and 30% is dominated by herbaceous vegetation (including wetlands). The remainder is composed of rock, roads, bare

The alternatives could affect vegetation, including general plant associations, rare plants, noxious weeds, forestry and grazing issues, and riparian and wetland vegetation.

ground, and open water. Descending in elevation, plant associations range from high elevation, subalpine forests through mixed-conifer forests to open foothill pine woodlands, and from high montane (mountain) grasslands to valle floor wetlands (figure 3-29). The preserve supports extensive montane grassland and wetland communities that are relatively rare in the southern Rocky Mountains (VCT 2005iVCT 2005i). These montane grasslands (20,000 acres) and wetlands (6,850 acres) are some of the largest and highest-quality habitats for ecological function and biodiversity in the Southern Rocky Mountain Ecoregion (Muldavin and Tonne 2003). As shown in figure 3-29, most of the preserve's montane grasslands and wetland communities are found in the valles.

Compared to other high-elevation sites in the southern Rocky Mountains and Colorado Plateau, the preserve's vegetation communities are quite diverse. Initial preserve-wide vegetation surveys identified over 550 plant species (Hartman and Nelson 2005), with roughly another 100 species expected to be present but not yet documented. In surveys conducted in 2001, the New Mexico Natural Heritage Program documented 60 distinct plant associations in the preserve. Unusual species that have been documented on the preserve include bog birch (*Betula pumila*) and short-awn mountain ricegrass (*Oryzopsis pungens*), both about 100 miles from the nearest known populations (Barkworth 2007). Particularly unique is an acidic, boggy, wet meadow (or fen) in Alamo Canyon with peat deposits more than 16 feet thick, which contains a record of vegetation and fire activity dating over 9,000 years (VCT 2005iVCT 2005i).

Vegetation Communities

Vegetation communities present on the preserve, which are described below and presented in table 3-10 and figure 3-29, are based on the mapping efforts of Muldavin et al. (2006).

Table 3-10: Vegetation Types on the Preserve

Vegetation Types	Cover (acres)	Cover (% of total)
Spruce/fir forest	7,005	7.9
Mixed-conifer forest and woodland	36,566	40.4
Aspen forest and woodland	5,103	5.8
Ponderosa pine forest	9,241	10.4
Gambel oak / mixed montane shrubland	1,443	1.6
Montane grasslands	19,858	22.4
Wetlands and wet meadows	6,853	7.7
Montane riparian shrubland	14	<0.1
Sparsely vegetated rock outcrop	159	0.2
Felsenmeer rock field	915	1.0
Roads / disturbed ground	1,536	1.7
Open water	56	<0.1
Post-fire bare ground	17	<0.1
Total	**88,765**	**100.0**

Source: Muldavin et al. 2006.

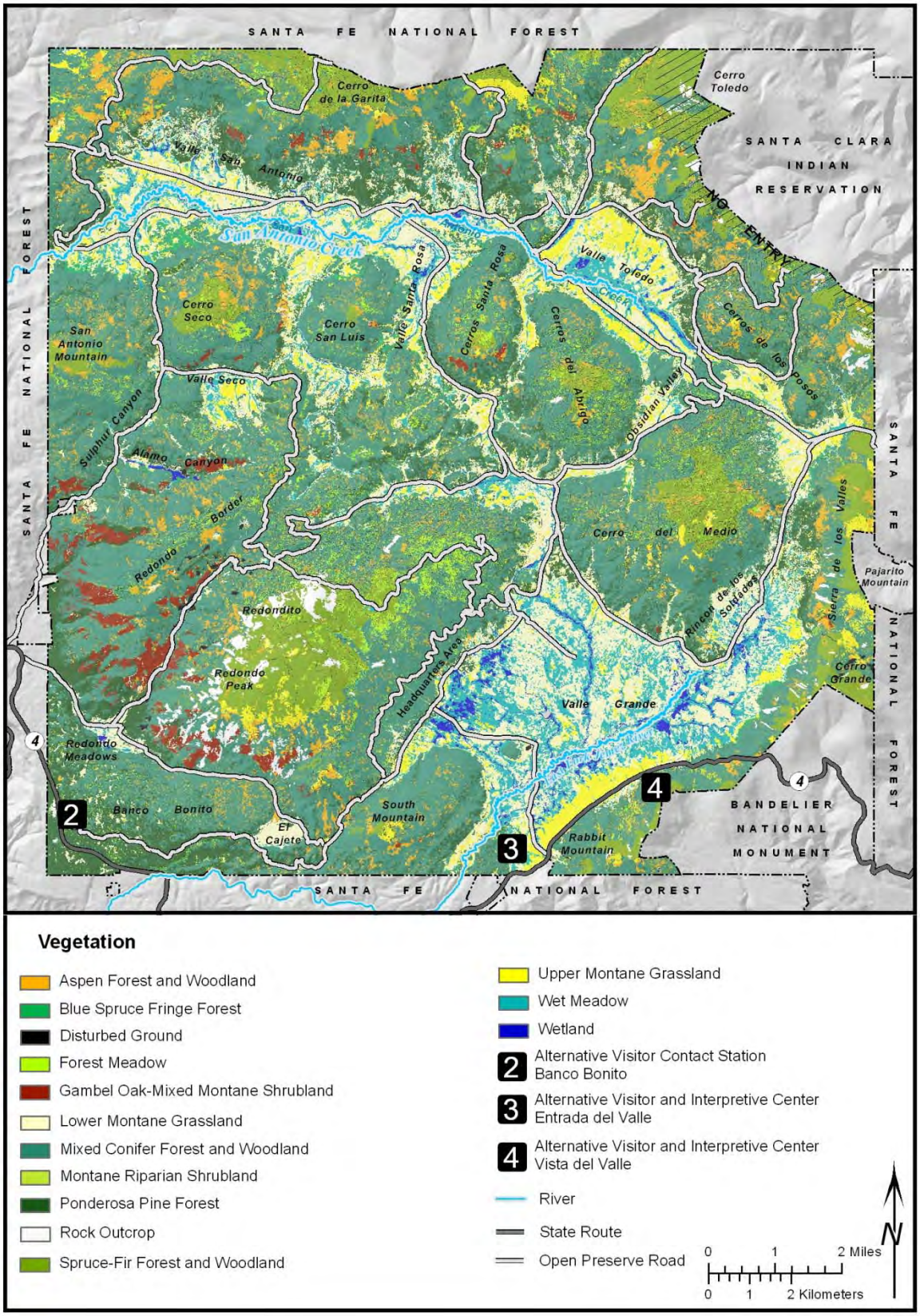


Figure 3-29: Vegetation Map

Forests and Woodlands

Ponderosa pine (*Pinus ponderosa*) is the major tree species below 9,000 feet above sea level. Ponderosa forests ring the valles, except on some north-facing slopes where blue spruce (*Picea pungens*) has become more common (Hogan and Allen 1999; Muldavin and Tonne 2003). Ponderosa pine forests transition into mixed-conifer forests above 10,000 feet, which contain combinations of ponderosa pine, Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), quaking aspen (*Populus tremuloides*), and limber pine (*Pinus flexilis*). Spruce-fir forests dominated by Engelmann spruce (*Picea engelmannii*) and corkbark fir (*Abies lasiocarpa* var. *arizonica*) are found at the highest elevations. Aspen stands occur throughout the forests.

The preserve was extensively logged prior to federal acquisition. Between 1935 and 1972, New Mexico Timber logged more than 36,000 of the caldera's timbered acres, much of it by clear-cutting. Most of the logged lands have since grown back with secondary growth, sometimes in mixes of species different from those that were removed. In the latter part of this period, about a thousand miles of roads were constructed, allowing access into otherwise inaccessible upper-elevation stands. This construction caused widespread erosion. Most such roads have stabilized, but erosion continues in certain problem areas. Although New Mexico Timber harvested most of the preserve's old-growth ponderosa pine, an uncut stand remains in the preserve's headquarters area, occupying about 1.5 miles of a narrow strip between the base of Redondo Peak and the grasslands of the Valle Grande. Many of the large old pines exceed 300 years in age (VCT 2005iVCT 2005i).

More than a century of fire suppression has greatly altered most forests on the preserve, including the old-growth stand in the headquarters area. Parts of this stand support a dense understory of smaller trees, which in the event of fire entering the stand might serve as ladder fuels carrying flames into the canopies of the oldest, tallest pines and Douglas-firs, endangering the stand with crown fire. Many other forested areas in the preserve are similarly overstocked with young, small-diameter trees and remain vulnerable to high-severity, stand-changing fire. Large parts of the forests of the preserve require thinning and fuel reduction treatments if they are to return to a more natural level of resistance to fire and drought stress. The restoration of natural, low-severity surface fires will be essential to improving forest conditions in the preserve (VCT 2005iVCT 2005i).

The forests of the preserve possess considerable potential for sustainable sawtimber production. Soils are highly productive, and most sites are fully stocked or overstocked (i.e., support a high number and density of trees), so that limited thinning operations may produce marketable benefits. The preserve's forests also include a variety of natural forest insects and diseases that sometimes flare up and kill many trees. There is an absence of substantial regeneration of aspen on the preserve, due largely to elk browsing and fire suppression. There is also a historically recent encroachment of trees, especially ponderosa pine and blue spruce, into grassland areas (VCT 2005iVCT 2005i).

Forest types found on the preserve as mapped by Muldavin et al. (2006) are described below.

Rocky Mountain Spruce/Fir Forest

Rocky Mountain spruce/fir forests are high-elevation conifer forests dominated by Engelmann spruce and corkbark fir. Other conifers may be present, but they are clearly subordinate or successional (not reproducing). Aspens are also common to abundant successional trees.

Spruce/Fir Forest and Woodland (Dry Mesic)

Dry mesic[1] spruce/fir forests are found at elevations from 9,500 to 11,250 feet (2,900 to 3,430 meters). Stands grow on cold, mid to upper slopes and ridges on northerly aspects, and on lower slopes to ridges on southerly aspects. Shrubs typically dominate, but on the coldest sites larger vegetation is replaced by soil mosses. Grassy understories occasionally grow adjacent to upper montane grasslands.

Spruce/Fir Forest and Woodland (Moist Mesic)

Moist mesic spruce/fir forests are found at elevations from 9,000 to 10,500 feet (2,750 to 3,200 meters). Stands grow on cold, mid to lower slopes on northerly aspects, and occasionally in lower slope coves of southerly aspects. The understory is dominated by herbs and can be diverse and luxuriant in cover. With the exception of Rocky Mountain maple (*Acer glabrum*), shrubs are not common. Grassy understories occasionally grow adjacent to upper montane grasslands.

Rocky Mountain Aspen Forest and Woodlands

Rocky Mountain aspen forest and woodlands are broadleaf forests dominated by aspen that occur between 8,600 and 10,200 feet (2,630 to 3,110 meters) above sea level. Conifers can be common, particularly in the understory, but do not exceed 25% of canopy cover. Stands are typically considered successional to high-elevation mixed-conifer or spruce/fir forests following fire, but aspen forests can be long-lived and occupy a site for long periods in the preserve, particularly with repeated burning.

[1] Mesic means relating or adapted to a moderately moist habitat.

Aspen Forest and Woodland (Dry Mesic)

Dry mesic aspen forests typically occur from 8,600 to 10,200 feet (2,630 to 3,110 meters) in elevation. Stands grow on cold, mid to upper slopes and ridges on northerly aspects, and on lower slopes to ridges on southerly aspects. Shrubs typically dominate, but on the coldest sites soil mosses replace most vascular vegetation. Grassy understories occasionally grow adjacent to upper montane grasslands.

Aspen Forest and Woodland (Moist Mesic)

Moist mesic aspen forests typically occur from 8,700 to 9,500 feet (2,650 to 2,900 meters). Stands occur on mid to lower slopes on northerly aspects, and occasionally in lower slope canyon bottoms and coves of southerly aspects. The understory is dominated by herbs and can be diverse and luxuriant in cover. With the exception of Rocky Mountain maple, shrubs are typically rare. Grassy understories occasionally occur adjacent to montane grasslands.

Rocky Mountain Mixed-conifer Forest

Mixed-conifer forests occur at mid elevations (8,500 to 10,000 feet [2,600 to 3,050 meters]) co-dominated by a combination of firs and pines: Douglas-fir, white fir, blue spruce, southwestern white pine (*Pinus strobiformis*), limber pine, and ponderosa pine. Ponderosa pine is typically successional and not reproducing. Aspens are also common to abundant successional trees. Blue spruce can form nearly pure stands on the margins of valle grasslands. Engelmann spruce and corkbark fir are absent or clearly subordinate (<25% of the conifer canopy cover).

Mixed-conifer Forest and Woodland (Dry Mesic)

Dry mesic mixed-conifer forests typically are found from 8,300 to 10,000 feet (2,540 to 3,050 meters). Stands grow on mid to upper slopes and ridges on northerly aspects, and on lower slopes to ridges on southerly aspects. Shrubs typically dominate, but grassy understories occasionally grow adjacent to upper montane grasslands.

Mixed-conifer Forest and Woodland (Moist Mesic)

Moist mesic mixed-conifer forests typically are found from 8,600 to 9,800 feet (2,630 to 2,990 meters). Stands grow on mid to lower slopes on northerly aspects, and occasionally in lower-slope canyon bottoms and coves of southerly aspects. The understory is dominated by herbs and can be diverse and luxuriant in cover. With the exception of Gambel oak (*Quercus gambelii*) and Rocky Mountain maple, shrubs are typically rare. Grassy understories occasionally occur adjacent to lower montane grasslands.

Blue Spruce Fringe Forest

Blue spruce fringe forest is found from 8,400 to 9,000 feet (2,550 to 2,750 meters). Nearly pure blue spruce stands grow as narrow belts (fringes) on northerly aspects between valle grasslands and mixed-conifer forests of the mountain slopes. The understory is dominated by herbs and can be diverse and luxuriant in cover. With the exception of common juniper (*Juniperus communis*), shrubs are rare. Grassy understories with similar compositions to adjacent valle grasslands can also exist.

Rocky Mountain Ponderosa Pine Forest and Woodland

Conifer forests dominated by ponderosa pine occupy the lower elevations of the forest zone between valle grasslands and mixed-conifer forests. Other conifers can be present but clearly subordinate in the canopy (<25% of the tree canopy).

Ponderosa Pine Forest and Woodland

Elevations of ponderosa pine forest typically range from 8,100 to 9,300 feet (2,450 to 2,840 meters). On southerly aspects stands extend into valle grasslands or high montane grasslands as "woodland savanna." In contrast, at upper elevations and on northerly slopes stands are commonly successional to mixed-conifer forest. Understories range from shrub to grass dominated. Small inclusions of pinyon pine woodland grow on southerly slopes on the west side of the preserve.

Shrublands

Shrublands are dominated by shrubs, which are woody vegetation up to 16 feet tall.

Rocky Mountain Montane Shrublands

Rocky Mountain montane shrublands are dominated by Gambel oak and New Mexico locust (*Robinia neomexicana*) that are less than 16 feet (5 meters) tall. Trees are usually scattered and occupy less than 10% cover. Stands are typically considered successional to lower-elevation ponderosa and mixed-conifer forests following fire, but Gambel oak shrublands can be long-lived and occupy a site for long periods, particularly with repeated burning.

Gambel Oak / Mixed Montane Shrublands

Gambel oak / mixed montane shrublands typically occurs from 8,300 to 9,400 feet (2,540 to 2,870 meters). These shrublands are dominated by Gambel oak and New Mexico locust that typically grow on southerly aspects of mid to lower mountain slopes and in canyons, often on rocky sites. Understories range from shrub to grass dominated.

Rocky Mountain Montane Riparian Shrublands

Rocky mountain montane riparian shrublands are dominated by thinleaf alder (*Alnus tenuifolia*) that grow along perennial mountain streams. Blue spruce may also be a significant component forming open riparian woodland. Other conifers are typically absent or minor.

Montane Riparian Shrublands

Montane riparian shrublands are found along perennial mountain streams and fen (bog) margins. Elevations typically range from 8,300 to 9,400 feet (2,540 to 2,870 meters). Streamside communities are dominated by thinleaf alder and occasional blue spruces. Understories are forb-rich and luxuriant, and typically have numerous obligate wetland species.

A bog birch / water sedge / stiff clubmoss plant association has been identified as part of the fen complex in Alamo Canyon. Although bog birch is prevalent in the Rocky Mountains and northward, this is the only known location for it in New Mexico. Along with bog birch and water sedge (*Carex aquatilis*), this association is typified by a cover of stiff clubmoss (*Lycopodium annotinum*) that forms mats in the water channel. Other obligate wetland species that are present include tufted hairgrass (*Deschampsia cespitosa*), rough bentgrass (*Agrostis scabra*), and Canada reedgrass (*Calamagrostis canadensis*). The association lies at about 8,680 feet (2,650 meters) along a low gradient portion of Alamo Creek adjacent to a large fen dominated by tufted hairgrass (Muldavin et al. 2006).

Herbaceous Vegetation

Herbaceous vegetation (non-woody plants) on the preserve is dominated by graminoids (grasses and sedges) and forbs (an herb that is not a grass); trees or shrubs have less than 10 percent canopy cover. The preserve's sprawling, open grasslands that define its valles account for about a quarter of the area of the preserve. The ecological communities found within them are diverse, and additional grassland types occur on the slopes of the preserve's mountains, even up to the summits (VCT 2005iVCT 2005i). Soil characteristics, cold air drainage, hydrology, fire, and grazing contribute to the maintenance of the grasslands that span the valles in the caldera (Allen 1989; Coop and Givinish 2007). High-elevation grasslands that were historically maintained, at least in part, by fire also grow on upper, south-facing slopes in the mixed-conifer and spruce/fir zones (Allen 1989). Types of herbaceous vegetation found on the preserve as mapped by Muldavin et al. (2006) are described below.

Rocky Mountain Montane Grasslands

Rocky Mountain montane grasslands are dominated by upland bunch grasses (grown in clumps rather than forming sod). Scattered conifers and aspens can be found on sites that have had infrequent fire or as remnants following fire or logging. Despite their abundance on the preserve, montane grasslands are relatively uncommon in

New Mexico. Other than in the Jemez Mountains, they are found only at the highest elevations of the Sangre de Cristo Mountains, along with scattered occurrences in the Sacramento Mountains and in the Gila Mountains.

Upper Montane Grasslands

Upper montane grasslands occur at elevations of 8,400 to 10,500 feet (2,560 to 2,870 meters). At lower elevations, these grasslands are found along the upper alluvial fan piedmonts of valles, and occasionally in the valley floor. At the highest elevations they occupy south-facing slopes and ridges.

Lower Montane Grasslands

Lower montane grasslands occur at elevations of 8,400 to 9,000 feet (2,560 to 2,750 meters). These grasslands are found along the alluvial fan piedmont slopes extending into the valle bottoms, often below a band of upper montane grasslands. They occasionally grow on mountain foot slopes or in isolated mountain valleys. Shrubs such as woolly cinquefoil (*Potentilla hippiana*) can be common, but not abundant.

Forest Meadows

Forest meadows generally are found at elevations from 8,900 to 10,500 feet (2,560 to 3,175 meters). These include grasslands associated with post-burn and post-logging high-elevation forests. Scattered remnant trees are common. They are most common on mountaintops and ridgelines.

Rocky Mountain Wet Meadows and Wetlands

Rocky Mountain wet meadows and wetlands include herbaceous vegetation of valley bottoms and swales dominated by grasses, rushes, and sedges, many of which are wetland-associated species.

Montane Wet Meadow

Montane wet meadows typically are found at elevations from 8,400 to 9,000 feet (2,560 to 2,740 meters). Herbaceous vegetation is dominated by a combination of wetland and upland species. Stands most commonly grow on valley bottoms that are not part of the active floodplain (terraces and lower alluvial slopes). They can extend up drainageways and in springy areas of the surrounding valle slopes.

Montane Wetlands

Montane wetlands are found at elevations typically ranging from 8,100 to 8,700 feet (2,450 to 2,640 meters). Herbaceous vegetation is dominated by wetland-associated species. Stands grow along valley bottom drainageways that are part of the active floodplain. They can extend up drainageways and into springy areas of the surrounding valle terraces and alluvial piedmont slopes. Montane wetlands can also have small inclusions of aquatic vegetation (narrowleaf bur-reed [*Sparganium angustifolium*] plant association).

These diverse communities (142 species have been recorded so far) are dominated by graminoid species adapted to wetland conditions, mostly sedges (*Carex* spp.) and rushes (*Juncus* spp.). Muldavin and Tonne (2003) identified 15 obligate and 13 facultative wetland species. In addition, most of these communities are on sites subject to periodic flooding, or where the soils can become saturated at some point during the year in most years (most of the wet meadows and wetlands are associated with hydric Vastine soils). These communities are likely wetlands according to the criteria in the *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (USACE 2010).

Woody perennial species, such as willows (*Salix* spp.) and alders (*Alnus* spp.), which are common along many western streams, are absent or very rare along the streams in the preserve valles. It is uncertain whether this is a function of hydrological and soil conditions or past overgrazing.

Rare Plants

No plants protected by the U.S. Endangered Species Act are known to exist in the preserve (Hartman and Nelson 2005; USFWS 2009a). One USFS sensitive plant species is found in the preserve (Hartman and Nelson 2005; USFS 2007b). This species is addressed in the "Special-status Species" section. However, a number of plant species that are rare or unusual, but not included on any government-protected list, exist on the preserve. These species are described in table 3-11. This category is not protected by any federal or state laws, and is based largely on the information available to and the opinions of the New Mexico Native Plant Society (New Mexico Native Plant Society pers. comm. 2010).

Table 3-11: Rare Plants Documented on the Preserve

Species	Common Name	Habitat	Location Notes
Cerastium brachypodum	shortstalk chickweed	Moist ravines	Not known elsewhere in the Jemez Mtns
Corallorrhiza wisteriana	spring coralroot	Foothills and montane, early spring	Northernmost location in state with one record from San Pedro Parks
Cryptogramma acrostichoides	American rockbrake	Rocky cliffs and slides, montane to alpine	Known from only two locations in the Jemez Mtns: Redondo Peak and Pajarito Mountain

Species	Common Name	Habitat	Location Notes
Cymopterus alpinus	alpine oreoxis	Tundra, open areas	Commonly found only above treeline; example of a relic from the last ice age
Epilobium saximontanum	Rocky Mountain willowherb	Moist mountain meadows and streamsides	Not uncommon in state, but not listed elsewhere in Jemez Mtns
Erigeron lonchophyllus	shortray fleabane	Wet meadows	Found in only one other NM location (McKinley County)
Gentiana aquatica	moss gentian	Wet meadows	Not listed elsewhere in Jemez Mtns; uncommon in the state
Geum rivale	purple avens	Swamps, wet meadows, subalpine	Other records only for high mountains; perhaps a relic from ice age
Luzula comosa	Pacific woodrush	Subalpine streamsides	Not listed elsewhere in Jemez Mtns; only two in University of New Mexico Herbarium, found in Sierra and San Miguel Counties
Muhlenbergia sinuosa	marshland muhly	Moist soil of canyon bottoms, riparian	Northernmost location by over 100 miles
Parnassia palustris	mountain grass of Parnassus	Wet meadows, streamsides	Found elsewhere in state only at higher elevations; uncommon
Potentilla concinna	Rocky Mountain cinquefoil	Alpine open areas or cliffs	Only other records from high mountains
Potentilla diversifolia	varileaf cinquefoil	Alpine open areas or cliffs	Only other records from high mountains
Potamogeton alpinus	alpine pondweed	All potamogeton are in ponds	Only one other location in state
Potamogeton gramineus	variableleaf pondweed	Ponds	Only two other locations in state
Potamogeton richardsonii	Richardson's pondweed	Ponds	Only one other location in state
Rosa acicularis	prickly rose	Characteristic species of boreal forests	Not listed elsewhere in Jemez Mtns
Sagittaria cuneata	arumleaf arrowhead	Ponds and slow streams	Uncommon in Jemez Mtns
Salix lasiandra	Pacific willow	Streamsides, middle altitudes	Found in only one other NM location (McKinley County)
Scutellaria galericulata	marsh skullcap	Wet meadows, swales	Three herbarium specimens from Colfax, Sandoval, and Rio Arriba Counties*
Stellaria calycantha	northern starwort	Wet forests, meadows, willow swamps	Only specimens in NM herbaria are from the preserve*
Stellaria umbellata	umbrella starwort	Usually found near treeline	Not listed elsewhere in Jemez Mtns
Viola pedatifida	prairie violet	Rocky outwash sites	Found in nearby Los Alamos County but very rare

Source: New Mexico Native Plant Society 2010.

* Herbarium references include Museum of Southwestern Biology at the University of New Mexico and the NMSU Center for Natural History Collections.

Weeds and Problem Species

In general, invasive or noxious weeds are not currently a major problem on the preserve, although 20 species of state-listed noxious weeds have been documented. The New Mexico Department of Agriculture (NMDA) classifies noxious weeds into three categories: class A, class B, and class C. Class A species are weeds not

currently present in New Mexico or that have limited distribution. Preventing new infestations of these species and eradicating existing infestations is the highest priority. Class B weeds are limited to the northern portions of the state. In areas with severe infestations, management should be designed to contain the infestation and stop any further spread (NMDA 2009). Class C weeds are widespread in the state. Management decisions for these species should be determined at the local level, based on feasibility of control and level of infestation (NMDA 2009).

Hand, mechanical, and chemical treatments have been used to control the spread and eradicate known populations of weeds in the preserve (VCT 2007b). The preserve's extensive network of old roads, arroyos, abandoned salt grounds, and other high-impact locations provide receiving areas for weeds to become established. Eleven discrete concentrations of Canada thistle (*Cirsium arvense*), only one of which exceeds an acre in size, have been identified in the preserve. In addition, Canada thistle, musk thistle (*Carduus nutans*), and bull thistle (*Cirsium vulgare*) are found along roads and turnouts and in disturbed areas in the preserve. Due to the potential of these weeds to spread, herbicide treatments were implemented over approximately 5 acres beginning in 2003. Inventories found additional populations in 2005 and 2006, so the program is continuing (VCT 2007b).

The State Department of Agriculture Noxious Weed Act of 1998 lists the Canada thistle as a class A weed with a limited distribution; eradication is the highest priority. Canada thistle is a deep-rooted perennial that reproduces successfully from seeds and root sprouts. Entire plants can regrow from a root fragment. Dense patches can form, and the plant produces phototoxins that inhibit the growth of other plants. Canada thistle is an aggressive colonizer that can cover a 6-foot-diameter area within one to two years from a single plant (VCT 2007b). Musk thistle is a class B weed; the management priority is to contain infestations. Bull thistle is a class C weed that is widespread; suppression is encouraged. The Federal Noxious Weed Act of 1974 encourages the elimination or containment of these weeds. Musk and bull thistles are typically biennials, but they may also complete their life cycle in one year. Reproduction occurs entirely from seeds. An average plant can produce 10,000 seeds in a year. They can quickly colonize disturbed areas where there are few native plants to prevent germination.

Grazing and Vegetation

The VCT operates the preserve as a working ranch consistent with the goals stated in the Valles Caldera Preservation Act of 2000. Toward this end, the VCT continues programs for domestic livestock grazing and management of the preserve's ranch infrastructure. The VCT allocates 60% of the forage produced annually to remain on site in support of sustaining ecosystem services. A portion of the remaining 40% is allocated for domestic livestock grazing or other purposes based on the annual conditions and expected use by the preserve's elk herd (VCT 2009b). Based on an assessment of slope, distance to water, and available forage, approximately 31% of the preserve is considered suitable for the allocation of forage for sustainable use by livestock and native wildlife (TEAMS 2007). The remaining 69% is not suitable for allocation due to limited forage, limited quantifiable information about the forage,

and, to a lesser degree, steep slopes and a lack of nearby water sources. The highest potential herbaceous productivity is located in the broad grassy valles. Climate, especially moisture, is the limiting factor of forage production in the majority of sites, and vegetation growth rates vary widely depending on the timing and form of annual precipitation. As a result, average biomass production can change significantly in a relatively short time. For example, overall forage production doubled between a dry year in 2002 and a wet year in 2007 (VCT 2009b).

Fish and Wildlife

The alternatives include activities that could affect fish and wildlife directly, through injury or mortality during construction, or indirectly, through modification of habitat. An increase in visitation to and recreational use of the preserve could also impact fish and wildlife.

The alternatives proposed in this plan include activities, such as construction, that could affect fish and wildlife either directly, through injury or mortality during construction, or indirectly, through modification of habitat. An increase in visitation to and recreational use of the preserve could also impact fish and wildlife. This section describes the types of fish and wildlife that could be affected so that potential impacts on them can be adequately analyzed. The "Special-status Species" section contains descriptions of plant and animal species that have special state or federal designations based on rarity or other need for special protection. This "Fish and Wildlife" section focuses on fish and wildlife species that do not have such protections or designations, but are vital components of the preserve's ecosystem.

The preserve supports a great diversity of animals that live in various habitats (see the "Vegetation" section for more information). Inventories conducted from 2001 to 2006 identified 69 species of mammals, 102 birds, 6 reptiles, 3 amphibians, and 6 fish. While inventories of insects are ongoing, 134 species of aquatic insects were collected in streams and wetlands in 2003 to 2004 (Vieira and Kondratieff 2004), and 54 species of butterflies were identified in surveys in 2001 (Kleintjes 2001). Beyond elk, preserve wildlife was poorly documented until baseline studies began in 2001. These studies have included identifying the type and distribution of plants, mammals, birds, reptiles, amphibians, fish, fungi/lichens, aquatic insects, and many groups of beneficial and harmful insects (VCT 2009b). Ongoing studies in 2010 included a cooperative biodiversity study between the preserve, the USDA Systematic Entomology Laboratory, and the Smithsonian Institution for the inventory of beneficial and pest insect species on the preserve, volunteer breeding bird surveys, a survey of Gunnison's prairie dogs, bald eagle monitoring, and a survey for short-horned lizards (VCT 2010d).

Scientific studies have shown that wildlife can be adversely affected by sounds that intrude on their habitats. Although the severity of the impacts varies depending on the species and other conditions, research has found that wildlife can suffer adverse physiological and behavioral changes from intrusive sounds. Some sound characteristics have been associated with suppression of the immune system and increased levels of stress-related hormones in animals (NPS 2011).

Study Area

The study area for evaluating impacts on fish and wildlife for implementation-level decisions is the specific proposed visitor contact station / visitor center location and

vicinity for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

Fish

Overview

The preserve's streams contain a variety of native fish, as well as introduced rainbow and brown trout. These waters previously contained Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*) (Anschuetz and Merlan 2007), a candidate species for federal listing under the Endangered Species Act described in more detail in the "Special-status Species" section. Approximately 27 miles of streams in the preserve offer habitat suitable for trout, out of a total of approximately 75 miles of perennial streams. Stream and fish surveys of the preserve's two major streams/rivers (East Fork of the Jemez River and San Antonio Creek) have been conducted (Simino 2002; Goodman 2003), as well as twice-yearly fish sampling at permanent monitoring stations in the lower, middle, and upper reaches of each of these two streams (2003–2009).

Four native fish species are found on the preserve (VCT 2010c):

- Rio Grande sucker (*Catostomus plebeius*)
- Rio Grande chub (*Gila pandora*)
- Fathead minnow (*Pimephales promelas* Rafinesque)
- Longnose dace (*Rhinichthys cataractae*)

Three nonnative species are found on the preserve:

- Rainbow trout (*Oncorhynchus mykiss*)
- Brown trout (*Salmo trutta*)
- White sucker (*Catostomus commersonii*)

The Rio Grande sucker and Rio Grande chub are USFS sensitive species and are described in the "Special-status Species" section.

East Fork of the Jemez River

The East Fork of the Jemez River provides 21.4 miles of fish habitat, with fish inhabiting the river from its headwaters to its mouth. There are four perennial tributaries, of which two have names—La Jara Creek and Jaramillo Creek (Simino 2002). Fisheries data are available only for Jaramillo Creek, where only trout have been found (Aquatic Consultants, Inc. 2003).

Riparian conditions along the East Fork of the Jemez River and its tributary, Jaramillo Creek, are improving in the perennial reaches from below the headwater springs to the preserve's southern boundary (TEAMS 2007), which improves instream habitat conditions for fish. In the intermittent reaches above the springs, riparian conditions have not improved and are classified as "functioning-at-risk" (TEAMS 2007).

San Antonio Creek

San Antonio Creek provides 30.5 miles of fish habitat, with fish inhabiting the creek from its headwaters to its mouth (Goodman 2003). This creek has four perennial tributaries: Sulphur Creek, San Luis Creek, Rito de los Indios, and an unnamed tributary. No fisheries data is available for the tributaries, but fish are unlikely to exist in Sulphur Creek, which is a naturally acidic creek with sulfur springs and geothermal activity (Vieira and Kondratieff 2004). Fish presence is assumed in the other three tributaries.

The main stem of San Antonio Creek was likely altered considerably prior to the 1960s. Although the condition of this creek appears to be improving based on monitoring, it is not properly functioning for trout habitat along most of its length, according to USFS habitat standards. According to the 2002 stream survey, physical parameters that were not properly functioning included relative sediment content in riffles, the density of large woody debris, pool development, temperature, and width-to-depth ratio (Goodman 2003).

Reptiles and Amphibians

Amphibian surveys conducted in 2002 found abundant chorus frogs (*Pseudacris maculata*) and tiger salamanders (*Ambystoma tigrinum*) (Cummer, Christman, and Wright 2003). Northern leopard frogs (*Rana pipiens*), abundant as recently as the 1970s along Redondo Creek, appear to have been extirpated from the preserve, as is the case across much of the region, perhaps due to the spread of disease (VCT 2005iVCT 2005i). Jemez Mountain salamanders (*Plethodon neomexicanus*) exist on the preserve and are discussed under "Special-status Species." In addition, two lizard and three snake species have thus far been found on the preserve (VCT 2005iVCT 2005i).

Birds

Overview

Bird surveys conducted in 2001 and 2002 found at least 107 species on the preserve, of which 92 showed evidence of breeding locally. Uncommon species recorded include Wilson's snipe (*Gallinago delicata*), savannah sparrow (*Passerculus sandwichensis*), eastern meadowlark (*Sturnella magna*), and ruby-crowned and golden-crowned kinglets (*Regulus calendula* and *R. satrapa*). Representative raptor species found include northern goshawk (*Accipiter gentilis*), golden eagle (*Aquila chrysaetos*), bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falco peregrinus*). The abundance of fish and the presence of elk carcasses attract significant numbers of bald eagles in the fall, which feed and roost on the preserve for weeks (Fettig, Rustay, and Henderson 2003; VCT 2005iVCT 2005i).

Below elevations of 8,500 feet, representative bird species include blue grouse (*Dendragapus obscurus*); Merriam's turkey (*Meleagris gallopavo merriami*); several raptors (hawks and owls); American robin (*Turdus migratorius*); house wren (*Troglodytes aedon*); woodpeckers; nighthawk (*Chordeiles minor*); white-throated swift (*Aeronautes saxatalis*); western meadowlark (*Sturnella neglecta*); chickadee (*Poecile*

sp.); golden and bald eagle; and several species of hummingbirds, sparrows, and warblers (Fettig, Rustay, and Henderson 2003; VCT 2005iVCT 2005i).

Between 8,500 and 12,000 feet above sea level, representative birds include northern goshawk, Steller's jay (*Cyanocitta stelleri*), dark-eyed junco (*Junco hyemalis*), several kinglet species (*Regulus* spp.), and mountain bluebird (*Sialia currucoides*), as well as multiple species of grouse, woodpeckers, hummingbirds, sparrows, and warblers (VCT 2009b).

Migratory birds are protected under the Migratory Bird Treaty Act, discussed in the "Special-status Species" section.

Species of Interest

The following section describes species that have a higher level of interest from a management perspective, but do not have a separate state or federal status. Generally, this includes species managed as game animals.

Merriam's Turkey

This upland game bird primarily uses ponderosa pine and pine/oak, as well as the transition habitats between ponderosa and pinyon/juniper woodland habitats and ponderosa and mixed conifer. There are three essential habitat components for Merriam's turkey: surface water, roosting trees, and openings for summer brood areas (Kamees 2002).

Merriam's turkeys prefer to roost in tall, mature or over-mature ponderosa pines with relatively open crowns and large horizontal branches starting at 20 to 30 feet (6 to 9 meters) from the ground. Trees with a diameter at breast height of over 14 inches are used as roosts. Preferred roost sites are often located just below a ridgeline. Hens (females) normally nest within 0.5 mile of water (Boeker and Scott 1969). Although no surveys have been completed on the preserve, turkeys are numerous and frequently seen by VCT personnel (Moser 2009).

Blue Grouse

The blue grouse is native to New Mexico and is found most commonly in the mountainous area of the north-central portions of the state. The Sangre de Cristo, San Juan, and Jemez Mountains are principal areas of this species (Biota Information System of New Mexico [BISON-M] 2009).

Structural diversity is a major determinant of habitat suitability for blue grouse. Structure of habitat is more important than species composition. Important forest cover types include spruce/fir, Douglas-fir, and ponderosa pine. Mixed-species forests are probably the most important habitat type in high-elevation sites (BISON-M 2009).

Blue grouse forage in conifer trees, on the forest floor, along ridgetops, and in openings. Major food items in the spring are needles, buds, and new cones of conifers. In the summer and fall, they feed mainly on grasses, forbs, and fruits of low-growing plants. During the winter, they eat mostly conifer needles (BISON-M 2009).

Blue grouse selectively feed and roost in the oldest and largest Douglas-fir trees available. Douglas-fir trees repeatedly used in winter and between winters are typically those growing under stressful conditions such as on dry, steep, talus slopes, and have endured stresses such as lightning strikes or boulder impacts (Remington and Hoffman 1996). VCT personnel have observed blue grouse on the preserve, but no formal surveys have been completed (Moser 2009).

Mammals

Overview

Below elevations of 8,500 feet, representative mammals that are found on the preserve include elk (*Cervus elaphus nelsoni*), mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), Gunnison's prairie dog (*Cynomys gunnisoni*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), cottontail (*Sylvilagus* sp.), woodrat (*Neotoma* sp.), weasel (*Mustela* sp.), beaver (*Castor canadensis*), badger (*Taxidea taxus*), black bear (*Ursus americanus*), mountain lion (*Puma concolor*), and several species of small mammals including squirrels, chipmunks, voles, and mice. Between elevations of 8,500 and 12,000 feet, mammals include elk, mule deer, black bear, gray fox (*Urocyon cinereoargenteus*), and several species of weasels, squirrels, chipmunks, mice, and shrews (VCT 2007).

Coyotes are common on the preserve. Black bears, mountain lions, and bobcats are rarely observed, but their populations are presumed to be viable and proportionate to available habitat, given the abundance of prey and the absence of recent hunting pressure (VCT 2005iVCT 2005i).

Many other smaller mammals are also present, including the isolated Jemez Mountains population of Goat Peak pika (*Ochotona princeps nigrescens*), a federal sensitive species described further in the "Special-status Species" section. The preserve also supports substantial numbers of Gunnison's prairie dog, another federal sensitive species, which is relatively common throughout the grasslands of the caldera and is described further under "Special-status Species" (VCT 2005iVCT 2005i).

The last beavers in the caldera were observed along Indian Creek in the 1990s. Eventually, if woody vegetation can be restored to key riparian habitats and if substantial stands of aspen can be reestablished, the reintroduction of beaver may become practical (VCT 2005iVCT 2005i).

Species of Interest

Rocky Mountain Elk

Elk hunting and viewing are among the greatest attractions at the preserve. Elk management will likely always be a major issue on the preserve for the VCT and the NMDGF (VCT 2005iVCT 2005i). Therefore, this species is of interest to the VCT.

Elk use a variety of habitats, including most forest types, during the course of their lives. Weather, time of day, and quantity and quality of forage influence their habitat use. Elk forage on a variety of plants, which vary based on habitat used and season.

They consume largely green grass in the spring, adding more forbs and woody vegetation in summer, dried grass and woody vegetation in fall, and shrubs and conifers in winter. Elk generally rut (mate) beginning in September and calve (give birth) from mid-May to mid-June. Elk tend to inhabit lower elevations in winter than the rest of the year. Movements to lower elevations from high-elevation summer ranges are likely driven by snow depth and lack of abundance or quality of forage. However, elk may stay in the same area year-round when conditions are suitable (NMDGF 2009b).

Elk were extirpated from the Jemez Mountains by 1900, but following the transplants of 49 elk in 1947 and an additional 58 in 1964, they are now abundant and conspicuous, especially in the preserve (VCT 2005iVCT 2005i). The population trend for the Rocky Mountain elk is stable to increasing in New Mexico. Since 1995, the NMDGF has conducted aerial elk counts over the Jemez Mountains. The most recent population estimate in the Jemez Mountains is 5,500 to 8,400 (Liley, pers. comm. 2008).

The preserve is a core breeding ground for elk in the Jemez Mountains, with an estimated 3,500 elk living on the preserve in the summer (Liley, pers. comm. 2008). Although deep winter snows drive many elk to lower elevations on nearby lands, in dry winters, large numbers remain on the preserve year-round (VCT 2005iVCT 2005i). The entire preserve is classified as critical summer range, winter range, and calving area habitat. Historically, elk used the west side of the preserve and wintered to the south and west; however, elk now concentrate on the east and north sections of the preserve, which are in or associated with the large grassland valles, and winter to the north and east (TEAMS 2007).

The recent Los Conchas fire likely expanded favorable habitat by restoring meadow habitats on the forested domes on the eastern third of the preserve, although it is too recent to quantify this supposition.

Mule Deer

Mule deer inhabit most forest types with good forage and cover. They use a variety of habitats during the course of their lives. Mule deer use higher elevations in the spring and summer, and migrate down to lower elevations in the fall and winter. They browse on a wide variety of woody plants, and graze on grasses and forbs. No formal surveys have been completed for deer on the preserve. However, VCT personnel rarely observe deer on the preserve, so the VCT believes the number present to be quite low (Parmenter, pers. comm. 2009).

Once considered plentiful in the preserve, mule deer are now scarce. The decline of mule deer is a regionwide phenomenon and, while not fully understood, is usually attributed to a combination of factors including overhunting, territorial competition with elk, increased predation by coyotes, and a decrease in the early successional shrubby vegetation that is a mainstay of their diet. The last three of these factors may account for the low deer numbers in the preserve. It is unknown whether deer numbers are continuing to decline or have stabilized at low levels (VCT 2005i).

Black Bear

Black bears are highly mobile and readily disperse long distances across many types of habitat. Bears prefer mixed deciduous/coniferous forests with a thick understory. When inactive, they occupy dens under fallen trees, in ground-level or above-ground-level tree cavities or hollow logs, in underground cave-like sites, or in dense cover. The black bear is an opportunistic omnivore and has a variable diet of plants and animals (vertebrate and invertebrate), commonly including fruits, insects, animal carcasses, and garbage (Moser 2009).

No surveys have been completed for bears on the preserve, but they are frequently observed by VCT personnel (Parmenter, pers. comm. 2009). An estimated 33 to 66 individuals are believed to exist within the boundaries of the preserve (Winslow 2008).

Mountain Lion

Mountain lions inhabit rough, broken foothills and canyon country, often in association with montane forests, shrublands, and pinyon/juniper woodlands (Fitzgerald, Meaney, and Armstrong 1994). Mountain lions tend to avoid people, but can and do live close to humans. They tend to be more active when there is less human presence, and are most active during the night, with peak activity at dawn and at dusk (NMDGF n.d.a). The diet of mountain lions consists mainly of hoofed mammals, such as deer and elk. A large population of lions has been documented on Bandelier National Monument (BISON-M 2009), which is adjacent to the preserve, so that migration between the two areas is likely. VCT personnel have observed mountain lions on the preserve, but no formal surveys have been completed. It is estimated that five to eight individuals exist within the preserve's boundaries (Winslow 2008).

Coyote

Coyotes are found in a wide range of habitats, from open prairies to heavily forested regions, and even in cities. Coyotes are highly mobile and readily disperse 50 to 99 miles (80 to 160 kilometers) or more across many types of habitats; populations tend to encompass huge areas (NatureServe 2009). Dens, commonly used in subsequent years, are generally located in a burrow, at the base of a tree, in a hollow log or rock crevice, or under a building (Moser 2009).

VCT personnel have documented coyotes on the preserve, but no formal population estimates have been completed. A recent study by Gifford et al. (2008) was conducted to describe the ecology and natural history of the coyote on the preserve. Preliminary diet assessment based on fecal analysis suggests that the coyote diet on the preserve consists primarily of rodents, followed by insects and then elk. Preliminary habitat use analysis suggests a late summer avoidance of forest and preference for wet meadows (Gifford et al. 2008).

Bobcat

Bobcats are found in various habitats, including deciduous/coniferous woodlands and forest edges, brush, deserts, and other areas with thick undergrowth. When inactive, they occupy rocky clefts, caves, hollow logs, or spaces under fallen trees. The young are born in a den in a hollow log or space under a fallen tree, or in a rock shelter (NatureServe 2009). Bobcats prey extensively on cottontail and jackrabbits. They also eat a variety of rodents. No surveys for bobcats have been conducted on the preserve, but occasional observations by personnel confirm their presence (Moser 2009).

Gray Fox

The gray fox is common and widespread in open terrain, woodland, and lower forest zones. Gray foxes are perhaps most common in pinyon/juniper and oak woodlands, but seem to be absent from grasslands that lack rock outcrops or at least some encroachment of juniper. The species is essentially absent from well-developed mixed coniferous and spruce/fir forest. Gray foxes use brush and brushy woods in most areas (Moser 2009).

The gray fox is an opportunistic omnivore. Diet often chiefly depends on rabbits and other small mammals in winter, and insects and fruit in summer. VCT personnel have observed gray foxes on the preserve, but no formal surveys have been completed (Moser 2009).

Special-status Species

Special status species could be affected during construction, habitat modification, or by increased visitation and use.

This section describes the existing conditions of special-status species on the preserve. These plant and animal species are those that have been assigned special designations by a government agency due to their rarity or are otherwise protected by federal or state law. These agencies include the USFWS, USFS, and NMDGF. As with non-special-status fish and wildlife, special-status species could be affected by activities such as construction, either directly through injury or mortality, or indirectly through modification of habitat. An increase in visitation to and recreational use of the preserve could also impact special-status species.

This section provides information about federal and state-listed threatened and endangered species, USFS sensitive species, and other species and habitat types that relate to other federal protections (e.g., migratory birds and bald eagles).

Study Area

The study area for evaluating impacts on special-status species for implementation-level decisions is the specific proposed visitor contact station / visitor center location for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

Federal Threatened and Endangered Species

The criteria for determining federal threatened and endangered plant and animal species are provided by the Endangered Species Act of 1973, which is administered

by the National Oceanic and Atmospheric Administration Fisheries Service (NOAA–Fisheries) and the USFWS. The goals of the Endangered Species Act include species conservation, ecosystem conservation, and species recovery. Section 4 of the act allows for the listing of species as threatened or endangered based on habitat loss or degradation, overuse, disease or predation, inadequacy of existing regulation mechanisms, or other human-caused factors. Section 4(d) allows for the promulgation of regulations to provide for the protection and conservation of listed species. Species are classified under the Endangered Species Act as follows (USFWS 2011a):

- An **endangered species** is an animal or plant species listed under the Endangered Species Act that is in danger of extinction throughout all or a significant portion of its range.
- A **threatened species** is an animal or plant species listed under the act that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
- A species **proposed** for listing is any species of animal or plant that is proposed in the Federal Register for listing under the act, but for which the final decision has not yet been made.
- A **candidate** species is a plant or animal for which the USFWS has sufficient information on its biological status and threats to propose it as endangered or threatened under the act, but for which the development of a proposed listing regulation is precluded by other higher-priority listing activities.

Five animal species currently listed as threatened or endangered under the Endangered Species Act are known to exist or have historically existed in Sandoval or Rio Arriba County (USFWS 2009a):

- Rio Grande silvery minnow (*Hybognathus amarus*)—endangered
- Least tern (interior population) (*Sterna antillarum athalassos*)—endangered
- Mexican spotted owl (*Strix occidentalis lucida*)—threatened
- Southwestern willow flycatcher (*Empidonax traillii extimus*)—endangered
- Black-footed ferret (*Mustela nigripes*)—endangered

Three additional species are candidates for listing:

- Rio Grande cutthroat trout (*Oncorhynchus clarkii virginalis*)
- Yellow-billed cuckoo (*Coccyzus americanus*)
- New Mexico meadow jumping mouse (*Zapus hudsonius luteus*)

No species are currently proposed for listing in these counties.

When species listed or proposed for listing under the Endangered Species Act may be impacted by a proposed project, applicants are required to consult with the USFWS (USFWS and NOAA–Fisheries 1998).

No plant species are known to exist in Sandoval or Rio Arriba County that are listed as endangered or threatened, candidate, or proposed for listing under the Endangered Species Act (USFWS 2009a).

Although a species may be present in these counties, it may not be present in the preserve. The presence or absence of a species in the preserve, described below, is based on the presence or absence of suitable habitat, surveys, recorded sightings, and literature review.

Species Eliminated from Analysis

Of the five species listed above as federal threatened and endangered that exist or have historically been present in Rio Arriba or Sandoval County, all but the Mexican spotted owl can be eliminated from further analysis because the preserve either does not have suitable habitat or is not within the historic or current range of the species.

Of the three species listed above as federal candidates, the yellow-billed cuckoo is eliminated from further analysis in this EIS (as described below), while the Rio Grande cutthroat trout and the New Mexico meadow jumping mouse are discussed further.

The following species are eliminated from further analysis in this EIS for the following reasons:

- **Rio Grande silvery minnow.** This endangered fish species is currently only found in one reach of the Rio Grande River, and this reach is outside the preserve (USFWS 2007).
- **Least tern.** The rare inland population of this shorebird uses bare or sparsely vegetated beaches, sandbars, islands, and salt flats associated with rivers and reservoirs (USFWS 1985). This type of habitat does not exist on the preserve.
- **Southwestern willow flycatcher.** This songbird requires extensive riparian habitat with dense patches of trees or shrubs and slow to still water at or near nesting habitat (USFWS 2005). As described in the "Vegetation" section of this EIS, the preserve's riparian areas have very few trees and shrubs. Therefore, no suitable habitat is present. The preserve is not located within designated critical habitat for the southwestern willow flycatcher (USFWS 2005).
- **Black-footed ferret.** Although this species historically was present in New Mexico, there are currently no known populations in the state (USFWS 2009a). The species only exists in very large prairie dog towns, and the USFWS only requires ferret surveys for colonies of greater than 200 acres (USFWS 1989). No prairie dog towns that large are present on the preserve.
- **Yellow-billed cuckoo.** This species occurs primarily in riparian areas with trees, usually cottonwoods, and dense understory vegetation (BISON-M 2009). This type of habitat is not present on the preserve.

Species Retained for Analysis

Mexican Spotted Owl—Federal Threatened

The Mexican spotted owl, a federal threatened species, can be found in the forested mountains and canyons of central Colorado and southern Utah, south through Arizona and New Mexico into Central Mexico. The owl's distribution in this range is not contiguous but occurs in patches of suitable habitat. Mexican spotted owls commonly use mixed-conifer forests throughout most of their range. Mixed-conifer forests are generally dominated by Douglas-fir and/or white fir, with codominant species including southwestern white pine, limber pine, and ponderosa pine. The understory often consists of the species listed above, as well as broadleaved species such as Gambel oak, maples, boxelder (*Acer negundo*), and New Mexico locust. Habitat-use patterns vary throughout the range and with respect to owl behavior (e.g., nesting versus foraging). Much of this variation in habitat use could be attributed to differences in regional patterns of habitat and prey availability (USFWS 1995).

Forests used for nesting and roosting usually contain mature or old-growth stands with complex structure. In addition, the stands are typically uneven-aged, multistoried, and have high canopy closure (USFWS 1995). Nest trees are typically large and mature. Douglas-fir is the most common species of nest tree. However, tree species used for nesting vary somewhat between areas and habitat types. Douglas-fir is also the most commonly used species for roosting. In the Jemez Mountains, most nests are on cliff ledges or cavities in narrow, steep-walled canyons in mixed-conifer and ponderosa pine forest, at elevations between 6,500 and 10,000 feet where little human disturbance occurs (Keller 2009a; USFWS 1995; Wargo 2006).

Steep-walled, rocky canyonlands are used by Mexican spotted owls for nesting, roosting, and foraging. Such habitat includes landscapes dominated by vertical-walled rocky cliffs in complex watersheds, including many tributary side canyons. The owls nest and roost primarily on cliff faces using protected caves and ledges, and forage in canyon bottoms, on cliff faces and benches, and along canyon rims and adjacent lands (USFWS 2004).

Mexican spotted owls are nocturnal and thus hunt primarily at night. Their diet consists of a variety of prey, but they most commonly eat small- and medium-sized rodents such as woodrats, mice, and voles. They may also consume bats, birds, reptiles, and arthropods (an invertebrate having jointed limbs, a segmented body, and an exoskeleton; e.g., crustaceans, insects, spiders, and centipedes) (USFWS 1995).

No Protected Activity Centers (PACs) or Critical Habitat Units (CHUs) for Mexican spotted owl are located within the preserve. Owl PACs are delineated around known owl sites. Critical habitat refers to specific geographic areas that are essential for the conservation of a threatened or endangered species and that may require special management considerations. A critical habitat designation only

applies to situations where federal funding, authorization, or permits are involved (USFWS 2004).

The USFWS requires consultations only on activities that would affect those areas that contain the physical and biological features necessary for the species' survival, also known as primary constituent elements (PCEs) (USFWS 2004). The PCEs essential to the conservation of the owl include those physical and biological features that support nesting, roosting, and foraging. The USFWS identifies PCEs for the Mexican spotted owl as follows (USFWS 2004):

1. PCEs related to forest structure:
    a. a range of tree species, including mixed-conifer, pine/oak, and riparian forest types, composed of different tree sizes reflecting different ages of trees, 30% to 45% of which are large trees with a trunk diameter at breast height (dbh) of 12 inches or more
    b. a shade canopy created by the tree branches covering 40% or more of the ground
    c. large dead trees (snags) with a dbh of at least 12 inches
2. PCEs related to maintenance of adequate prey species:
    a. high volumes of fallen trees and other woody debris
    b. a wide range of tree and plant species, including hardwoods
    c. adequate levels of residual plant cover to maintain fruits and seeds and allow plant regeneration
3. PCEs related to canyon habitat include one or more of the following:
    a. the presence of water (often providing cooler temperatures and often higher humidity than the surrounding areas)
    b. clumps or stringers of mixed-conifer, pine/oak, pinyon/juniper, and/or riparian vegetation
    c. a canyon wall containing crevices, ledges, or caves
    d. a high percentage of ground litter and woody debris

There is approximately 36,560 acres of habitat in the Preserve that contains at least some of the PCEs important for nesting, roosting, or foraging by Mexican spotted owls (vegetation map shown in figure 3-29), although the large and mature Douglas-fir favored as nest trees are lacking. Based on the presence of potentially suitable habitat (figure 3-30), the VCT conducted formal surveys following regional protocol methodologies in 2005, 2006, and 2009 (Keller 2009a; Moser 2009). No Mexican spotted owls have been documented on the preserve. This could be due to elevation which is at the upper limits of the owl's range, lack of suitable cliffs, or the lack of specific habitat characteristics (large, old trees, large snags, and downed logs) with the mixed conifer forests (Moser 2009).

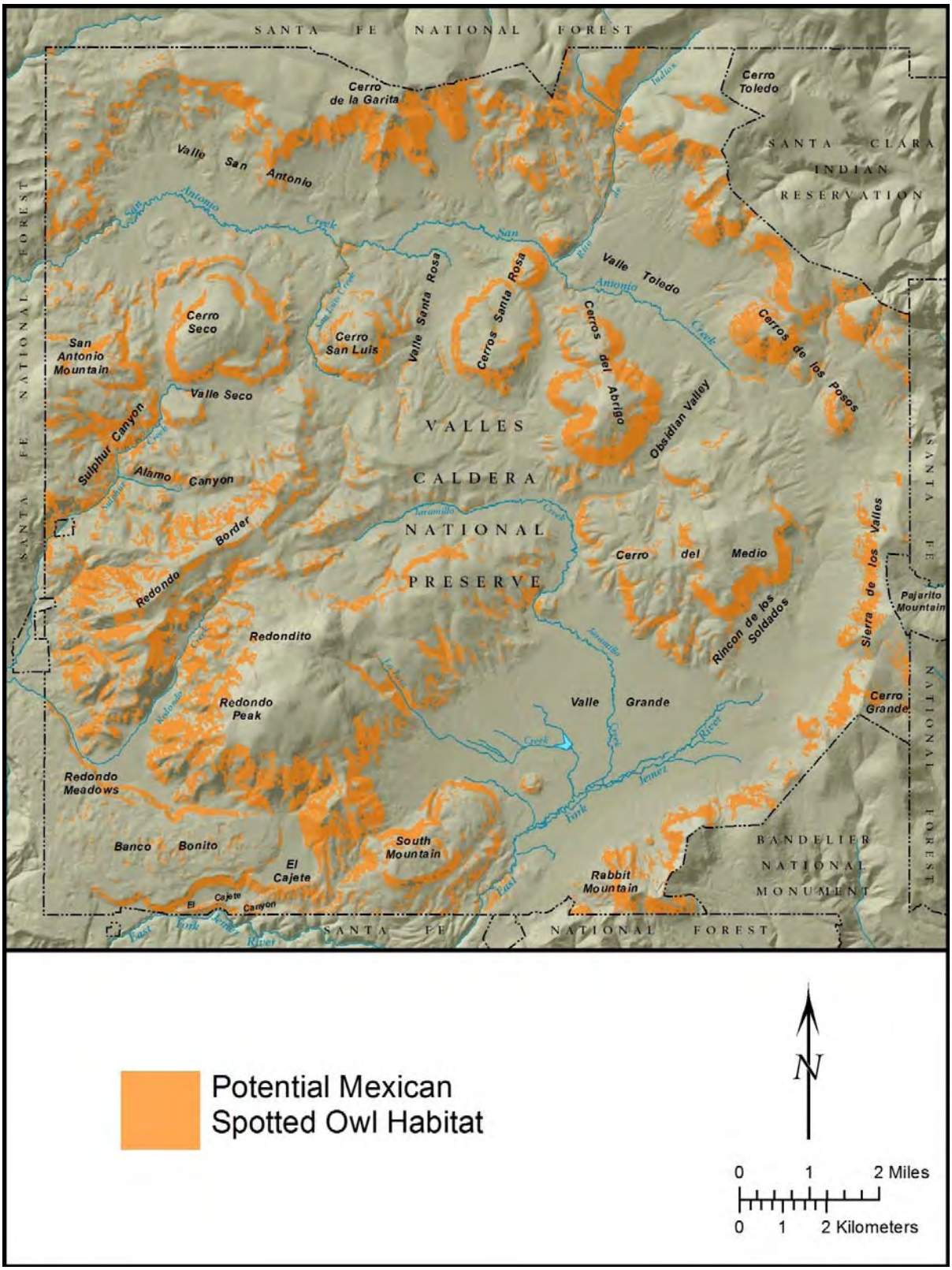


Figure 3-30: Potential Mexican Spotted Owl Habitat

Rio Grande Cutthroat Trout—Federal Candidate

The Rio Grande cutthroat trout, a federal candidate species, is one of 14 subspecies of cutthroat trout. This subspecies has been found in a variety of habitat types, from rivers to small tributaries. The Rio Grande cutthroat trout requires a variety of habitat types for different life stages. Suitable gravel is required for spawning, and juvenile trout need slower waters for development. As adults increase in size they tend to move into the faster-moving waters of main-stem rivers, while also relying on pools and woody debris for refugia (Pritchard and Cowley 2006).

Historically, the range of the Rio Grande cutthroat trout is thought to have included the Rio Grande drainage of Colorado, New Mexico, and Texas; the Pecos River drainage of Colorado, New Mexico, and Texas; and the Canadian River drainage of Colorado and New Mexico. The historic range may also have included the headwaters of the Rio Conchos in Mexico (Hendrickson et al. 2002). Currently, this trout is found in tributaries of the Rio Grande in Colorado and New Mexico, the Carnero and Sanguache drainages in Colorado, tributaries of the Canadian River in Colorado and New Mexico, and tributaries of the Pecos River in New Mexico (Pritchard and Cowley 2006).

The Rio Grande cutthroat trout has been extirpated from its historic range by a number of factors. Currently, the greatest threat comes from nonnative trout such as brook, brown, and rainbow trout, and other forms of cutthroat trout. These introduced species can lead to increased competition and predation, as well as interbreeding with rainbow trout and nonnative cutthroat trout. Other threats to the Rio Grande cutthroat trout include migration barriers, overfishing, habitat disturbance, and disease (Pritchard and Cowley 2006).

Historically, the Rio Grande cutthroat trout was found in streams throughout the preserve, but the species is no longer present. The stocking of nonnative trout in the late 1800s and early 1900s was probably the main cause of the extirpation (DeVault 2009, 2011).

New Mexico Meadow Jumping Mouse—Federal Candidate

The New Mexico meadow jumping mouse, a federal candidate species, is an extreme habitat specialist that relies on riparian areas that have tall, dense herbaceous vegetation, especially sedges, on perennially moist soil. Tall dense sedge on moist soil appears to be the key microhabitat used by New Mexico meadow jumping mouse, regardless of the community type (Frey 2006). Suitable habitat in the Jemez Mountains contains permanent streams, moderate to high soil moisture, and dense, diverse streamside vegetation of grasses, sedges, and forbs (Morrison 1985; BISON-M 2009). Some recent studies have noted possible declines in populations where jumping mice have historically been found (Frey 2005).

This mouse breeds from June through August, nesting on the ground surface or beneath brush, logs, or stumps. It has a home range of 0.5 to 2 acres. The New Mexico jumping mouse feeds on seeds, insects, and fruits; when seeds are unavailable or limited, insects may compose of up to half of its diet (Zwank, Najera, and Cardenas 1997). The presence of beaver dams could aid in creating the moist

soils needed for suitable habitat for the mouse (Frey 2006). Although the preserve has historically had beavers in Sulphur and Indios Creeks, none currently exist on the preserve. A restoration project to restore beaver to Indios Creek is ongoing (Parmenter, pers. comm. 2008).

The meadow jumping mouse requires dense vegetation for population persistence, and its scarcity may be related to livestock overgrazing in streamside habitats. Periodic severe flooding may also contribute to its rarity. In more mesic areas (northerly facing slopes, along streams) the subspecies may be favored by the thinning of forests and similar ecological changes (BISON-M 2009). No surveys have been completed in the preserve, although wildlife data received from the adjoining Santa Fe National Forest show two locations of this species along the San Antonio Creek in the preserve (Moser 2009).

Federally Protected Eagle Species

The Bald and Golden Eagle Protection Act (16 USC 668–668c) prohibits anyone from taking bald or golden eagles, including their parts, nests, or eggs. The act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle … [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb" (USFWS n.d.).

Bald Eagle

Breeding bald eagles are rare in New Mexico and no nests are known to exist in the Jemez Mountains. Wintering bald eagles begin to arrive in October and leave by May, with peak numbers occurring during the coldest period of January. The location and abundance of wintering bald eagles is dependent on food, availability of appropriate roosting and foraging habitat, and human disturbance. Location and abundance can vary from year to year. In general, bald eagle concentrations occur around reservoirs and along rivers, with a scattering of birds in terrestrial habitat (Johnson 2003). There are no large water bodies in or near the preserve to provide breeding habitat.

Winter use by bald eagles on the preserve occurs mainly along San Antonio Creek, although individuals can be observed during the day at numerous locations throughout the preserve. Most individuals seen away from water are feeding on elk carcasses left as a result of human hunting activities on the preserve. Eagles typically use the trees near the creek as overnight roosts (Parmenter 2008).

Golden Eagle

The golden eagle is listed by the VCT as a bird species found breeding on the preserve (Fettig 2003). Habitat for golden eagles includes generally open country, prairies, alpine tundra, open wooded country, and barren areas, especially in hilly or mountainous regions. Golden eagles nest on rock ledges of cliffs or in large trees. Pairs may have several alternate nests, and may use same nest in consecutive years or shift to alternate nests used in different years. This raptor feeds mainly on small

mammals (e.g., rabbits, marmots, and ground squirrels). Golden eagles may also eat insects, snakes, birds, juvenile hoofed mammals, and carrion, and rarely attack large, healthy, mature mammals (e.g., deer). They hunt while soaring or from a perch (the latter technique especially used by young), and commonly forage in early morning and early evening (NatureServe 2011).

Federally Protected Migratory Birds

The Migratory Bird Treaty Act is an international treaty to protect migratory bird species. Bird migration is the regular seasonal journey undertaken by many species of birds. The routes followed by migratory birds are numerous. The birds protected under this statute are many of the most common species, as well as birds listed as threatened or endangered (USDA 2009). For these reasons, it is assumed that any bird in the preserve that makes seasonal migrations is covered under the Migratory Bird Treaty Act.

State Threatened and Endangered Species

This section describes species listed under the New Mexico Endangered Species Act. Some of these species may also be listed at the federal level.

Wildlife

The BISON-M was queried for state-listed threatened and endangered animal species documented to occur in Sandoval or Rio Arriba County (BISON-M 2011). Table 3-12 lists the species resulting from that query.

Table 3-12: State Threatened and Endangered Animal Species Documented as Present in Sandoval and Rio Arriba Counties

Common Name	Scientific Name	State Status
Fish		
Rio Grande silvery minnow	*Hybognathus amarus*	Endangered
Amphibians		
Boreal toad	*Anaxyrus boreas boreas*	Endangered
Birds		
White-tailed ptarmigan	*Lagopus leucurus*	Endangered
Common blackhawk	*Buteogallus anthracinus*	Threatened
Neotropic cormorant	*Phalacrocorax brasilianus*	Threatened
Boreal owl	*Aegolius funereus*	Threatened
Bald eagle	*Haliaeetus leucocephalus*	Threatened
American peregrine falcon	*Falco peregrinus anatum*	Threatened
Arctic peregrine falcon	*Falco peregrinus tundrius*	Threatened
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered
Broad-billed hummingbird	*Cynanthus latirostris magicus*	Threatened
Costa's hummingbird	*Calypte costae*	Threatened
Gray vireo	*Vireo vicinior*	Threatened
Brown pelican	*Pelecanus occidentalis carolinensis*	Endangered

Common Name	Scientific Name	State Status
Baird's sparrow	*Ammodramus bairdii*	Threatened
Least tern	*Sterna antillarum athalassos*	Endangered
Mammals		
American marten	*Martes americana origenes*	Threatened
New Mexico meadow jumping mouse	*Zapus hudsonius luteus*	Endangered
Spotted bat	*Euderma maculatum*	Threatened
Invertebrates		
Wrinkled marshsnail	*Stagnicola caperata*	Endangered

Source: BISON-M 2011.

Of these 20 state threatened or endangered animal species, most have not been documented on the preserve or are very unlikely to occur based on a lack of suitable habitat. The bald eagle has been discussed under "Federally Protected Eagle Species." Two species (American peregrine falcon and American marten) that have been documented on the preserve or have suitable habitat present are discussed under the "USFS Sensitive Species" section. One (New Mexico meadow jumping mouse) was discussed under the "Federal Threatened and Endangered Species" section. Three species (boreal owl, wrinkled marshsnail, and spotted bat) have been documented in the preserve or suitable habitat is present. These species are described in more detail below. The remaining 13 species are eliminated from further analysis because they have been extirpated from the state, the species have not been observed in the preserve, or no suitable habitat or very limited suitable habitat exists in the preserve.

Boreal Owl—State Threatened

In the western United States, boreal owls occupy subalpine forests composed of fir, Engelmann spruce, and aspen. Boreal owls reach the southernmost distribution of the species in the mature, multilayered spruce-fir forest of New Mexico, usually at elevations of 10,000 feet or higher (New Mexico Aviation Conservation Partners n.d.). In 1996, NMDGF surveys found this species to be resident in very small numbers in spruce-fir and similar habitats in the San Juan, Sangre de Cristo, and Jemez Mountains (BISON-M 2011). The boreal owl tends to occur at higher elevations in summer, and may move to lower elevations for the winter. It roosts in dense cover by day and in cool microsites in summer, and frequently changes roost sites (Moser 2009).

Boreal owls may forage day or night, although most hunting occurs at night (Moser 2009). Prey consists primarily of small mammals (often *Microtus* and *Clethrionomys*; also *Sorex* and *Peromyscus*), and sometimes birds and insects (Hayward and Hayward 1993).

Boreal owls nest in secondary tree cavities excavated by woodpeckers and flickers, and sometimes, where natural cavities are limited, in artificial nest boxes. Nest sites may be used in consecutive years. Nests are initiated from mid-April to late May or early June, and initiation is often influenced by prey availability (Moser 2009). The

number of young produced is usually four to six, and the young fledge at four to five weeks (Hayward and Hayward 1993).

Although no formal surveys have been conducted on the preserve, the boreal owl is thought to be present in the preserve (Moser 2009).

Spotted Bat—State Threatened

The spotted bat is found in patchy distribution throughout the western United States. Spotted bats have been captured from British Columbia to Central Mexico. These bats are considered to be secure globally and in the United States, although the population is deemed to be declining (NatureServe 2011). In New Mexico, this bat has been found in about 20 locations (NMDGF 2009c); however, the survey method used (mist netting) is not considered to be an effective way to sample for this species (Luce and Keinath 2007).

The spotted bat has been recorded in very diverse habitats up to 10,000 feet above sea level (BISON-M 2011; Geluso 2008). This species is more dependent on roost availability and water than on vegetation types. The ideal roost sites for this species are cliffs, rock outcrops, or caves that are near water (streams, ponds, and tanks) and open areas for foraging on insects. Most of the bats captured in the Jemez Mountains were mist-netted over streams or water holes in ponderosa or mixed-conifer forest (BISON-M 2011).

This species of bat feeds primarily on moths, and will typically travel approximately 4 to 6 miles (6 to 10 kilometers) from roosting sites to foraging areas (Wai-Ping and Fenton 1989). The species prefers moths that are found only in association with lentic (still water) vascular hydrophytes (a plant growing in waterlogged soil) (Luce and Keinath 2007). Consequently, the reduction or elimination of these host plants could affect the prey base of spotted bats. Hydrophytic plants are typically associated with wetlands and wet meadows, which do exist in the preserve.

Potential threats to the spotted bat include the modification or loss of foraging areas by the removal or changing of riparian habitat and/or the alteration of native shrub and grasslands (BISON-M 2011; Luce and Keinath 2007). Management activities that can affect the foraging sites of this species are livestock and wildlife grazing, vegetation treatments, fire, and even-age forestry management (a group of forest management practices employed to achieve a group of closely related forest trees that are nearly the same age). Grazing of livestock and wildlife in riparian areas can alter the function and species composition of these areas through overuse, compaction of the soil, and trampling of banks (which causes sediment loading into streams) (Schmidt 2003). This alteration of riparian areas reduces the quality of prey and drinking sites for the spotted bat.

Habitat for the bat can be improved through prescribed fire and timber harvest, which would create open meadows within 3 to 6 miles of water (Schmidt 2003). No burning or other vegetation management is recommended within a 1.5-mile (2.5-kilometer) radius of known roosts (Luce and Keinath 2007.)

Spotted bats have not been observed on the preserve, but suitable habitat is present.

Wrinkled Marshsnail—State Endangered

This mollusk is widespread over much of North America, but populations in New Mexico are isolated from the remainder of its range. It occurs in a wide range of seasonal and perennial aquatic habitats, including vegetated ditches, marshes, streams, and ponds (BISON-M 2011).

Currently, the wrinkled marshsnail is known from only a few locations in New Mexico, including vernal grassland pools in the Valle Grande (NMDGF 2009c). Individuals have been documented on the preserve near Cerro la Jara. No comprehensive surveys for this species have been conducted on the preserve (Moser 2009).

Plants

Five state-listed plant species are identified by New Mexico and are listed on the USDA Plants Database for Sandoval and Rio Arriba Counties (New Mexico State Forestry Division 1995; USDA NRCS n.d.). Of the five, only the wood lily (*Lilium philadelphicum*) is documented by the VCT as present on the preserve (VCT 2005).

Wood Lily

The wood lily has limited populations in New Mexico. It is a wetland plant that is sensitive to wetland damage and alteration. It has a large bulb, and collecting of this attractive plant is a threat. Its habitat associations include riparian, ponderosa pine, mixed-conifer, and spruce/fir. The wood lily can be found in canyons above 7,500 feet and usually grows in areas of old-growth conifers. The presence of the wood lily has been documented on Los Alamos County, Bandelier National Monument, and Santa Fe National Forest lands (Hathcock, Hansen, and Keller 2010).

USFS Sensitive Species

A USFS sensitive species is a plant or animal species identified by the USFS regional forester for which species viability (ability to persist) is a concern, because of significant current or predicted downward trends, either in population numbers or density or in habitat capability, that would reduce a species' existing distribution (USFS 2007b, 2007c). There are 35 animal and 11 plant species on the regional forester's sensitive species list that are present in the Santa Fe National Forest (USFS 2007b, 2007c) and have the potential to be present on the preserve. However, these species have not been documented on the preserve or are very unlikely to occur based on a lack of suitable habitat. These species, which include several plants, birds, mammals, and one clam, are therefore eliminated from further consideration in this analysis.

Table 3-13 identifies the USFS sensitive species (USFS 2007b, 2007c) either that are likely to occur on the preserve, or for which potential habitat exists in or adjacent to the preserve. These species are discussed in more detail below, with the exception of the New Mexico meadow jumping mouse, Rio Grande cutthroat trout,

bald eagle, boreal owl, spotted bat, and wood lily, which have been discussed previously.

Table 3-13: USFS Sensitive Species Requiring Analysis

Common Name	Scientific Name
Plants	
Wood lily	*Lilium philadelphicum*
Fish	
Rio Grande chub	*Gila pandora*
Rio Grande cutthroat trout	*Oncorhynchus clarkii virginalis*
Rio Grande sucker	*Catostomus plebeius*
Amphibians	
Jemez Mountains salamander	*Plethodon neomexicanus*
Northern leopard frog	*Rana pipiens*
Birds	
Bald eagle	*Haliaeetus leucocephalus*
Boreal owl	*Aegolius funereus*
Northern goshawk	*Accipiter gentiles*
American peregrine falcon	*Falco peregrinus anatum*
Mammals	
New Mexico meadow jumping mouse	*Zapus hudsonius luteus*
Dwarf shrew	*Sorex nanus*
Water shrew	*Sorex palustris navigator*
Goat Peak pika	*Ochotona princeps nigrescens*
Gunnison's prairie dog	*Cynomys gunnisoni*
Southern red-backed vole	*Clethrionomys gapperi*
Long-tailed vole	*Microtus longicaudus*
American marten	*Martes americana origenes*
Ermine	*Mustela erminea muricus*
Spotted bat	*Euderma maculatum*

Source: USFS 2007b, 2007c; Moser 2009.

Rio Grande Chub

The Rio Grande chub is a small fish averaging 5.5 inches in length that is found in both rivers and lakes. There is limited information on the habitat preferences of the Rio Grande chub. The fish have been found in pools with overhanging banks and brush, and seem to prefer sand over cobble substrate (DeVault 2009, 2011).

Rio Grande chubs spawn in riffles, and likely breed from March through June (Rees, Carr, and Miller 2005). A stream survey in the Santa Fe and Carson National Forests documented Rio Grande chubs in many streams, but only in reaches with a gradient of less than 2% at elevations between 5,600 and 9,200 feet (Calamusso and Rinne 1996). Historically the Rio Grande chub was abundant and widespread throughout the Rio Grande Basin, the Pecos River Basin, and the San Luis Closed Basin (Rees, Carr, and Miller 2005). The Rio Grande chub has been documented in several streams on the preserve. A 2001 survey of the East Fork of the Jemez River

found Rio Grande chubs present in all reaches (Simino 2002), and a 2002 snorkel survey of San Antonio Creek also found Rio Grande chubs present in all reaches (Goodman 2003). Although electro-fishing surveys in 2003, 2004, and 2005 found Rio Grande chubs present in the East Fork of the Jemez River, they were not found in San Antonio Creek (Aquatic Consultants, Inc. 2003, 2004, 2005). The Rio Grande chub's absence in the later surveys does not indicate that it is now absent from San Antonio Creek. Rio Grande chubs, along with other native species, were moved from the East Fork of the Jemez River to San Antonio Creek in 2007 in an effort to increase the native fish assemblage. The fish dispersed from the release site but the success of the reintroduction is not yet known (Parmenter, pers. comm. 2008).

Rio Grande Sucker

The Rio Grande sucker is usually found in low-gradient, low-velocity streams. Specimens have been collected in pool, riffle, and glide habitat types. The historic range of the Rio Grande sucker included the Rio Grande Basin of Colorado and New Mexico, the Mimbres River, and six rivers in Mexico. This fish has been introduced and populations have been established in the Rio Hondo, the Gila River basin, and the San Francisco River drainage. However, a survey of the Carson and Santa Fe National Forests found a decline in the range and abundance of the Rio Grande sucker (Calamusso and Turner 2002).

The Rio Grande sucker's abundance and condition can be negatively impacted by the deposition of fine sediments (Swift-Miller, Johnson, and Muth 1999), because this fish usually favors larger, coarser substrate. Competition from introduced fish, especially the white sucker, has been a major factor in the decline in abundance of the species. Other factors contributing to the decline include habitat destruction and alteration, decreased water flow, and increased water temperature (Rees and Miller 2005).

The Rio Grande sucker is native to and still present in the preserve's streams (Rees and Miller 2005). A 2001 survey of the East Fork of the Jemez River documented Rio Grande suckers present in all reaches (Simino 2002). A 2002 snorkel survey of San Antonio Creek documented Rio Grande suckers present in the lower reaches of San Antonio Creek (Goodman 2003). Although electro-fishing surveys in 2003, 2004, and 2005 documented it in the East Fork of the Jemez River, none were found in San Antonio Creek (Aquatic Consultants, Inc. 2003, 2004, 2005). However, a substantial increase in Rio Grande sucker was found in the lower reach of the river in 2010 (DeVault 2011).

In the past, NMDGF stocked San Antonio Creek with rainbow trout twice a year (Goodman 2003), and the East Fork of the Jemez River has also been routinely stocked with rainbow trout. Stocking of brown trout began in the 1930s, if not before (Simino 2002). These streams are no longer stocked, and these nonnative trout species are naturally reproducing (Parmenter, pers. comm. 2008). As part of an effort to increase the assemblage of native fish, Rio Grande suckers (along with other native species) were moved from the East Fork of the Jemez River to San Antonio Creek in 2007. Several suckers were found during subsequent surveys in the lower reach of the creek. Current habitat conditions, along with competition

and predation from other fish species, could limit suitability of the preserve's streams for Rio Grande suckers. However, conditions are improving for this species, potentially leading to an increase in Rio Grande sucker (DeVault 2011).

Jemez Mountains Salamander

The Jemez Mountains salamander is primarily found in habitats between 7,200 and 9,600 feet above sea level in specific microhabitat conditions. The preferred microhabitat is characterized by relatively high humidity and soils that contain deep, igneous, subsurface rock that is fractured vertically and horizontally to allow the species to retreat underground to below the frost line. Habitats where pumice is the dominant subsurface structure are generally not occupied. Jemez Mountains salamanders are rarely encountered aboveground. Much of the life cycle occurs underground, with surface activity occurring inside rotted coniferous logs or under rocks during a brief period of the summer (typically June through August) when conditions are warm and wet. Suitable habitat is coniferous forest dominated by Douglas-fir, blue spruce, Engelmann spruce, ponderosa pine, or white fir. Other trees in the area may include aspen, Rocky Mountain maple, New Mexico locust, oceanspray (*Holodiscus discolor*), and various shrubby oaks (*Quercus* spp.) (Moser 2009).

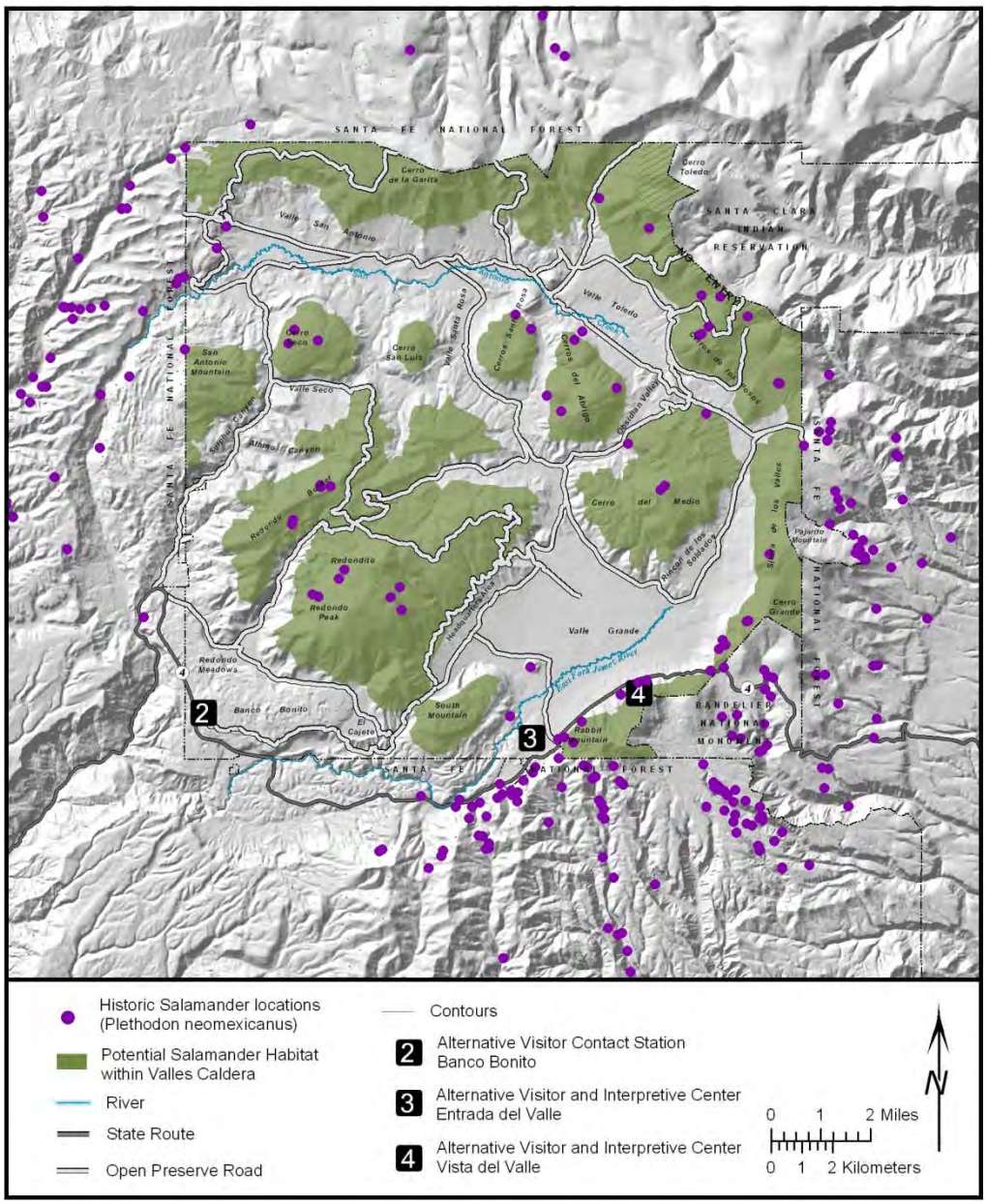
Breeding likely occurs in the spring, with eggs laid beneath the soil surface in interstitial (small, narrow) spaces between fractured rocks, in rotted root channels, or in the burrows of rodents or large invertebrates. Ants of at least three species make up approximately 74% of the salamander's diet. Other important prey items include beetles, mites, spiders, earthworms, and other small invertebrates found in rotting logs and under rocks. Forest management practices that lead to drier habitat conditions are thought to negatively affect Jemez Mountains salamander abundance and limit detection. These woodland salamanders lack lungs and gills, and exchange gases almost entirely through cutaneous (skin) respiration. Thus, Jemez Mountains salamanders seek moist microenvironments and are sensitive to forestry treatments that modify the prevailing temperature, humidity, soil moisture, soil surface cover, and soil porosity (Moser 2009).

Threats to the species include activities that may impact individuals or populations and/or alter habitat conditions in the following manner (Moser 2009):

- Ground disturbance such as excavation, churning, compaction, or any activity that reduces interspaces and subsurface channels
- Vegetation modification to the extent that ground surface microclimate is made drier or otherwise altered through increased exposure to sun and wind
- Suppression of populations of ants and other surface-dwelling invertebrates, which are the primary prey base of this salamander

Individual Jemez Mountains salamanders are very difficult to detect because of their fossorial (burrowing) habits and specific moisture requirements. Even when environmental conditions are ideal for surface activity, it is believed that only a small

percentage of the individuals that are present at a site are active at the surface and therefore detectable. Therefore, surveys likely substantially underestimate actual numbers. Surveys were conducted on the preserve from July to September of 2002. Jemez Mountain salamanders were detected at 3 of 10 locations. Approximately 41,500 acres of potential habitat has been identified on the preserve. The majority of the suitable habitat is in denser mixed-conifer forest where forage is sparse, and on steeper slopes (Moser 2009). Figure 3-31 shows locations of and potential habitat for this salamander.



Source: VCT 2010g.

Figure 3-31: Locations and Potential Habitat for the Jemez Mountain Salamander in and Surrounding the Preserve

Northern Leopard Frog

The northern leopard frog is typically associated with streams and rivers, although it also occupies lakes, marshes, and irrigation ditches. Much of the river valley habitat of these frogs has been modified by human activities, including draining of wetlands, channelization and damming of rivers, and the development of irrigation systems (Degenhardt, Painter, and Price 1996). In New Mexico, the frogs occur at elevations of approximately 3,500 to 11,000 feet. Their habitats include cattail marshes, beaver ponds, and other water sources with aquatic vegetation. Breeding can occur at any time of year following heavy rainfall or in higher elevations later in the season. Egg masses are attached to emergent vegetation or lie at the bottom of the water body in shallow, slow-moving or still water (AmphibiaWeb 2008). In New Mexico, Scott and Jennings (1985) reported eggs and small tadpoles of this species from April through July and September through October. Threats to local populations include alterations in wet areas, stocking of predatory fish, local extinctions as water dries up during years of low precipitation, and predation and competition by bullfrogs (Moser 2009).

Food habits of northern leopard frogs are unknown but likely include a wide variety of invertebrate prey. This frog may forage long distances from water in upland habitat during wet periods (Degenhardt, Painter, and Price 1996).

Potential habitat is present along riparian corridors in the preserve. No surveys have been completed in the preserve, although wildlife data received from the adjoining Santa Fe National Forest show four locations of this species in the preserve, and three historical locations have been documented in the preserve (Moser 2009).

Northern Goshawk

The northern goshawk is a forest generalist that uses a variety of forest types, forest ages, structural conditions, and succession stages (Reynolds et al. 1992). The principal forest types occupied by goshawks in the southwest are ponderosa pine, mixed conifer, and spruce/fir. Goshawks seem to prefer mature forests with large trees on moderate slopes with open understories (Squires and Reynolds 1997). The northern goshawk reaches the southern limits of its breeding range in the highlands of Arizona, New Mexico, and possibly western Texas southward to at least Jalisco, Mexico. The small New Mexico population occurs locally in mature coniferous forests of mountains and high mesas (Moser 2009).

Northern goshawks occupy a variety of habitats, including mature coniferous and deciduous forests. Nest sites are generally in stands of larger trees with dense canopy cover. Northern goshawks eat a wide variety of small mammals and birds. They hunt in openings and in forested stands with an open understory that allow for catching prey in flight (USFWS 2009b).

Northern goshawks nest in coniferous, deciduous, or mixed-pine forests, depending on availability. A nest area is composed of the nest tree and stand(s) surrounding the nest that contain prey handling areas (perches where individual birds consume prey), perches, and roosts. Reynolds et al. (1992) stated that nest areas are often on

mesic sites. However, La Sorte et al. (2004) found that aspect was not a factor in nest location; rather, the average nest site was centered in a forested area with small nonforested areas dispersed around the perimeter of the territory (La Sorte et al. 2004). The forested area around the nest site corresponded well with the size of a post-fledging family area (Reynolds et al. 1992). Numerous studies have documented that goshawk nest sites are associated with characteristics of mature forest structure, such as high canopy closure, mature trees, and open understories (La Sorte et al. 2004; Reynolds et al. 1992; Squires and Reynolds 1997).

A goshawk's nesting home range is about 6,000 acres. A breeding pair usually occupies its nest area from early March until late September. The nest area is the center for all activity associated with breeding, from courtship through the fledging of young (Reynolds et al. 1992). A nest tree is usually one of the largest trees in the nest area. Most territories contain several alternate nest trees, and most goshawks have two to four alternate nest areas in their home range. Alternate nest areas may be used in different years, and some may be used for decades (VCT 2009b).

Suitable breeding, roosting, and foraging habitat is available on the preserve in the mixed-conifer and ponderosa pine forests (Moser 2009). Goshawk surveys conducted in 2009 documented at least three pairs present on the preserve. Although nests could not be located, the presence of the birds in pairs indicates the likelihood of nesting (Keller 2009b).

American Peregrine Falcon

American peregrine falcon usually inhabit open country, preferably where there are rocky cliffs with ledges overlooking rivers, lakes, or other open water and an abundance of birds. Nesting habitat includes cliffs or platforms near water and an abundance of prey. Peregrines are primarily aerial hunters. Small to medium-sized birds are usually captured in flight; birds too large to be carried are knocked to the ground. They occasionally also prey on mammals, insects, and fish (Moser 2009).

In New Mexico, breeding habitat is available locally on cliffs in mountain and river canyons statewide. Peregrine falcons most often occur where elevations are between 6,500 and 8,600 feet, but may be found from 3,500 to 9,000 feet (Moser 2009). Data from NMDGF show that although productivity in the state had recovered from historic lows by the 1980s, productivity began trending lower after 1984 (Moser 2009).

Peregrines nest on the cliffs just to the west of the preserve and use areas in the preserve as foraging habitat (Parmenter, pers. comm. 2008; Keller 2009c). Cliffs on the eastern and western boundaries of the preserve represent marginal potential for peregrine nesting. Peregrine surveys conducted in 2009 documented one peregrine foraging over the Valle Grande, but no use of potential nesting areas (Keller 2009c).

Dwarf Shrew

The dwarf shrew lives in the white fir / Douglas-fir zone from approximately 7,000 to 9,000 feet above sea level. The preferred habitat is talus (rocky slopes) and other rocky areas, primarily in subalpine coniferous forest. Various other habitats include

sedge marsh, subalpine meadow, dry brushy slopes, arid shortgrass prairie, dry stubble fields, and pinyon/juniper woodland (BISON-M 2008). At higher elevations breeding begins in late June to early July. Two litters are produced each year, with the second one occurring in early September. At lower elevations breeding may begin earlier (NatureServe 2009).

The dwarf shrew feeds primarily on insects, spiders, and other small invertebrates such as worms, mollusks, and centipedes; but may also consume vegetable matter as well as some small vertebrates, including salamanders (NatureServe 2009). Although no formal surveys have been conducted, dwarf shrews have been observed in the preserve (Hope, pers. comm. 2008).

Water Shrew

As the name suggests, water shrews are closely associated with water. They are often found around streams and other aquatic habitats, especially in areas of high humidity surrounded by heavy vegetation, logs, and rocks. Streambanks often provide favorable cover that may include boulders, large stones, tree roots, overhanging ledges, willow, alder thickets, and spruce. They are also found in lakes, bogs, and other lentic (still water) habitats (NatureServe 2008).

Water shrews consume both terrestrial and aquatic invertebrates. The primary aquatic organisms consumed include stoneflies, mayflies, and caddisflies, which are most abundant in streams with a fast current and cobble substrate (Orrock et al. 2000). The water shrew breeds from February through August. Nest sites are near water in underground burrows, rafted logs, beaver lodges, and other areas that provide shelter (NatureServe 2008). Common predators include fish such as trout, bass, and pickerel; mink; otter; weasels; snakes; and occasionally hawks and owls (NatureServe 2009).

In New Mexico, water shrews have been documented only in the Sangre de Cristo, San Juan, and Jemez Mountains, where they occur in the vicinity of permanent streams, seldom below 8,000 feet. Although no formal surveys have been conducted, water shrews have been observed in the preserve (Hope, pers. comm. 2008).

Goat Peak Pika

In New Mexico, the Goat Peak pika is confined to talus slides and boulder fields in alpine and subalpine areas. In the Jemez Mountains, Goat Peak pikas have been documented on Goat, Santa Clara, and Pelado Peaks (outside the preserve), where they live in lava rocks as low as 9,000 feet (BISON-M 2008). Pikas do not hibernate, but are active beneath the snow all winter, foraging out from snow burrows in talus (Smith and Weston 1990). They breed from late April to early July, and nest under rocks and rock outcrops using grasses, forbs, sticks, and leaves for nest material. Loss of suitable Goat Peak pika habitat can occur by increasing moisture in dry areas, which promotes the invasion of vegetation that fills the talus slopes (NatureServe 2009). No formal surveys have been conducted for pikas, but they are thought to be present on the preserve (Moser 2009).

Gunnison's Prairie Dog

Populations of Gunnison's prairie dog are found in two separate ranges: at higher elevations, referred to as montane populations, and at lower elevations, referred to as prairie populations. The montane habitat found in the northeastern portion of its range (central and south-central Colorado and north-central New Mexico) consists primarily of higher-elevation, cooler, and moister plateaus, benches, and intermountain valleys. This habitat composes 35% to 40% of the species' total current range (USFWS 2008). Gunnison's prairie dogs occupy grass and shrub vegetation types in low valleys and mountain meadows in this habitat. Gunnison's prairie dogs feed most extensively on grasses, forbs, and sedges, but they will also eat insects when necessary (State of New Mexico 2008).

Diseases such as plague have been known to devastate prairie dog colonies. Prairie dog populations have declined since the settlement period due to poisoning and habitat loss (State of New Mexico 2008; USFWS 2008). This species is common on the preserve (Parmenter, pers. comm. 2008), but no large colonies exist (Moser 2009).

Southern Red-backed Vole

The southern red-backed vole is common in mature lodgepole pine stands or in mixed spruce/fir forests with good cone production and an abundance of surface litter including stumps, logs, and exposed roots of fallen trees. In such habitats, red squirrels (*Sciurus vulgaris*) are often abundant and red-backed voles frequently use the middens (piles of leftover food scraps) of these squirrels for cover and as a food source. Other habitats include grassy meadows, willow riparian areas, talus, and krummholz (wind-blown, stunted trees that grow just above the tree line) (Fitzgerald, Meaney, and Armstrong 1994; Frey, Fraga, and Bermudez 1995). Grass communities are generally unsuitable habitat for southern red-backed voles, probably due to a lack of food and cover. These voles forage by grazing or browsing on the ground or in herbaceous vegetation, snags, stumps, rocks, or logs, feeding on the ectomycorrhizal fungi (fungi that form a symbiotic relationship with a plant, forming a sheath around the root tip of the plant) found in older coniferous stands that also provide the woody debris for cover (Buskirk 2002).

This vole breeds from late winter to early fall. The nest sites can be in secondary cavities in live or dying trees, holes in the ground, stumps, or logs, or under rocks. Voles use nests of other animals made from grass, sticks, leaves, and moss. The nests are close to ground level (Moser 2009).

Although no surveys have been conducted for this species in the preserve, southern red-backed voles have been documented in the preserve in association with rocks and blue spruce (Swickard, Haas, and Martin 1972).

Long-tailed Vole

Long-tailed voles are usually found near or along the banks of streams where there is grass or brush, in meadows, on hillsides covered with chaparral or grass, and in

rock slides, willow thickets, or sometimes sagebrush within a half mile of water (Frey, Fraga, and Bermudez 1995; BISON-M 2008).

Long-tailed voles feed mostly on green vegetation, as well as on fruits and seeds. During winter, the bark, buds, and twigs of most locally common trees and shrubs, including spruce, aspen, oak, and snowberry, are also consumed. Fescues, sedges, yarrow, and Oregon-grape are also commonly used (Fitzgerald, Meaney, and Armstrong 1994; Frey, Fraga, and Bermudez 1995). Nests are typically in underground burrows or under logs and rocks, and young are born from late April through September. This species is largely dependent on well-developed mesic meadows (Frey, Fraga, and Bermudez 1995).

No formal surveys for the long-tailed vole have been completed in the preserve. However, wildlife data received from the adjoining Santa Fe National Forest show 14 locations of this species in the preserve (Moser 2009).

American Marten

American martens inhabit forests of spruce, fir, and associated trees in northern New Mexico. Optimum habitat consists of mature, old-growth spruce/fir communities with more than 30% canopy cover, a well-established understory of fallen logs and stumps, and lush shrub and forb vegetation supporting suitable prey (BISON-M 2008). Martens occur in spruce/fir forests and marginal alpine habitat in the San Juan and Sangre de Cristo Mountains. Objects on the forest floor, including logs, rock piles, stumps, windthrow trees (trees uprooted or broken by wind), and slash (unwanted tree branches, tops, stumps, and leaves that are removed during logging) are thought to be important in providing winter access to subnivean (under the snow) rodent populations (Moser 2009).

Martens breed in late summer and early fall, and bear offspring in the spring. The birthing site is usually under the snow or in old squirrel nests. They eat insects, mice, voles, red squirrels, pikas, and snowshoe hares (*Lepus americanus*). They also feed on carrion. During certain times of the year (mostly in the fall), a significant portion of their diet is composed of berries (Moser 2009).

Martens typically hunt along the edge of meadows surrounded by forests (Buskirk 2002). Home ranges for martens range from 0.4 to 5.0 square miles and are influenced by the fluctuation of small mammal prey abundance (Buskirk 2002). Marten populations may fluctuate by a factor of more than 10 in response to fluctuations of prey populations (Buskirk 2002). Current research indicates that martens are adaptable to human presence. Marten attraction to human structures has been observed due to the presence of mice and voles taking advantage of created habitat and forage found in and adjacent to human-made structures (Moser 2009).

No martens were detected during surveys conducted in August and September 2002 on the preserve (Moser 2009), but suitable habitat is present on the preserve.

Ermine

The ermine is a species of weasel occurring at high altitudes (7,800 to11,000 feet above sea level) in northern New Mexico. It occurs in association with small rodent populations in forest-edge, grassland, shrub, wet meadow, and riparian areas, avoiding dense forests. Ermines den in a hollow log or under a log, stump, roots, brushpile, or rocks (NatureServe 2009).

Ermines have been documented in the Valle Grande (Swickard, Haas, and Martin 1972). Wildlife data from the adjoining Santa Fe National Forest include 11 locations of this species in the preserve (Moser 2009).

Geology and Soils

Actions proposed under the alternatives would affect geology and soils through construction activities, e.g., clearing, grading, and excavating for visitor contact station / visitor center buildings, as well as for the development of parking lots, upgrades to existing roads, and the development of new trails and campgrounds. Geology and soils also have the potential to affect the actions proposed under each alternative, e.g., swelling soils and susceptibility to erosion can have adverse impacts on the structural integrity of buildings. This section describes the existing geology and soil types in the study area so these types of possible impacts can be determined.

Study Area

The study area for evaluating impacts on geology and soils for implementation-level decisions is the specific proposed visitor contact station / visitor center location for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

Geologic History

Geology and soils would be affected through construction activities. Geology and soils also have the potential to affect the proposed actions, e.g., from swelling soils and susceptibility to erosion.

The volcanic mass underlying the Jemez Mountains of northern New Mexico has been active for at least the past 4 million years, and is the largest and most powerful such formation in the region. The events that define the present landscape began approximately 1.22 million years ago, when the Jemez volcanic province renewed its volcanic activity. A field of multiple volcanic vents in the caldera erupted, spewing vast quantities of ash and magma. The ejection of so much material emptied the vast underground magma chamber. Devoid of structural support, the landscape collapsed, the floor of the land sinking to form the caldera, a giant, roughly circular bowl 13 to 14 miles across and bounded by a knife-edged rim of mountains. This collapsed volcanic field is the Valles caldera, which represents one of the best exposed examples of caldera formation (VCT 2005i) and the type of site where the concept of caldera resurgence was first developed (Smith and Bailey 1968).

At various times lakes have filled parts of the caldera, and the soils that formed from the sediments that collected beneath their waters help account for the grasslands of the valles (VCT 2005i). Within 50,000 years, Redondo Peak rose up through the lake bottom. As new magma filled the collapsed magma chamber, domes formed at the fracture around the ring of the caldera collapse—first at Cerro del Medio and

followed by Cerros del Abrigo. This activity continued counterclockwise around the ring fracture, creating the domes in the northern half of the caldera (VCT 2007b). At the center of the caldera rose Redondo, a large resurgent dome, a feature that builds inside a previously formed crater or caldera by the upswelling of unextruded magma (USGS n.d.). One of the lakes that formed within the caldera also shaped lands beyond its boundaries. About half a million years ago, the waters of a lake filling the Valle Grande breached the southern rim of the caldera, and the escaping waters flowed faster the more they opened the breach, widening and deepening their channel and eventually becoming an erosive flood. The result was the formation of the Cañon de San Diego, the narrow, steep-walled canyon through which the Jemez River flows today (VCT 2005i). Additional flows and formations of domes on the south and west prevented the drainage of water, forming lakes in what are now known as the Valle Grande and Valle San Antonio (VCT 2007b).

Approximately 50,000 years ago, an explosive eruption occurred in the southwest corner of the preserve, creating the crater known as El Cajete. The resulting pyroclastic flow (a mixture of solid to semi-solid fragments and hot, expanding gases that flows down the flank of a volcano) produced Battleship Rock, where the waters from the Valle San Antonio meet the East Fork of the Jemez River. This eruption also produced the broad, sloping landform in the southwest corner known as the Banco Bonito (VCT 2007b).

Soils

Soil is produced and maintained by interactions between living organisms, rock, air, water, and sunlight. Minerals and organic matter compose the solid part of soils; water and dissolved substances occupy the pore spaces between solids. Although these components are present in all soils, their abundance and distribution vary greatly. These differences affect a soil's capacity to support life and its response to recreational impacts (Hammitt and Cole 1998).

Soils generally consist of sand, silt, and/or clay particles. A soil described as "sandy" contains at least 70% of relatively large sand particles. A clay soil contains at least 35%–40% clay particles. Soils with about equal proportions of sand, clay, and silt are called loams. Many intermediate classes exist, such as silty clay loam. The way soil responds to impacts depends to a large extent on its type. Sandy soils hold more air and less water than other types, drain readily, and tend to be excessively dry. Clay and silt soils hold more water but less air than sandy soils. Clay soils can remain waterlogged for long periods of time, providing poor aeration for plant growth. Loams generally have the best balance of water availability, drainage, and aeration (Hammitt and Cole 1998).

The soils of the preserve mirror its volcanic geology. The preserve's soils are categorized as moist, cold soils on mountain slopes and valleys, which fall into two general groups: Cosey-Jarmillo-Tranquilar, which are very deep soils in mountain valleys, and Redondo-Palon-Calaveras, which are very deep soils on mountainside slopes and summits (figure 3-32). The general characteristics of these two groups are described below, based on the 2008 *Soil Survey of Sandoval County Area, New Mexico*, developed by the USDA Natural Resources Conservation Service (USDA

NRCS 2008). More detailed descriptions related to locations of proposed facilities for each alternative follow.

Cosey-Jarmillo-Tranquilar

Very deep soils on mountain slopes and stream terraces

Cosey-Jarmillo-Tranquilar slopes range from 1% to 20%. The vegetation on this unit consists mainly of grasses and shrubs. Elevation is 8,000 to 9,200 feet above sea level. The average annual precipitation is 20 to 25 inches, the average annual air temperature is 42°F to 45°F, and the average frost-free period is 60 to 90 days (USDA NRCS 2008).

This unit is about 30% Cosey and similar soils, 24% Jarmillo and similar soils, and 21% Tranquilar soils. The remaining 25% is made up of components of minor extent. Cosey soils are on mountain slopes. These soils are very deep, well drained, and moderately slowly permeable. They formed in slope alluvium (material such as sand, silt, or clay deposited on land by streams) and colluviums (soil material and/or rock fragments moved by creep, slide, or local wash and deposited at the base of steep slopes). The surface layer is silt loam about 15 inches thick. The upper 13 inches of the subsoil is gravelly loam. The lower subsoil to 60 inches or more is very gravelly sandy clay loam over extremely cobbly clay loam (USDA NRCS 2008).

Jarmillo soils are on stream terraces. These soils are very deep, well drained, and moderately permeable. They formed in lacustrine sediments (material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised), alluvium, and colluvium. The surface layer is loam about 13 inches thick. The subsoil is loam, fine sandy loam, clay loam, and very fine sandy loam to a depth of 60 inches or more (USDA NRCS 2008).

Tranquilar soils are on stream terraces. These soils are very deep, somewhat poorly drained, and very slowly permeable. They formed in clayey lacustrine deposits. The surface layer is silty clay loam about 8 inches thick. The subsurface layer is silty clay loam about 5 inches thick. The upper 21 inches of the subsoil is clay. The lower subsoil to a depth of 60 inches or more is also clay (USDA NRCS 2008).

Other components in this unit are Cajete, Jarola, and Vastine soils (USDA NRCS 2008).

Redondo-Palon-Calaveras

Very deep soils on mountain slopes

Redondo-Palon-Calaveras slopes range from 5% to 80%. The slopes in this unit are the main limitation for most uses. Vegetation consists mainly of trees. Elevation is 8,500 to 11,000 feet. The average annual precipitation is 25 to 30 inches, the average annual air temperature is 38°F to 42°F, and the average frost-free period is 45 to 60 days (USDA NRCS 2008).

This unit is about 33% Redondo and similar soils, 23% Palon and similar soils, and 22% Calaveras and similar soils. The remaining 22% is composed of components of minor extent (USDA NRCS 2008).

Redondo soils are on mountain slopes. These soils are very deep, well drained, and moderately rapidly permeable. They formed in colluvium. The surface layer is coarse sandy loam about 2 inches thick. The subsurface layer is coarse sandy loam about 13 inches thick. The upper 7 inches of the subsoil is coarse sandy loam. The lower subsoil is gravelly coarse sandy loam, very gravelly coarse sandy loam, extremely gravelly coarse sandy loam, and extremely cobbly coarse sandy loam to a depth of 60 inches or more (USDA NRCS 2008).

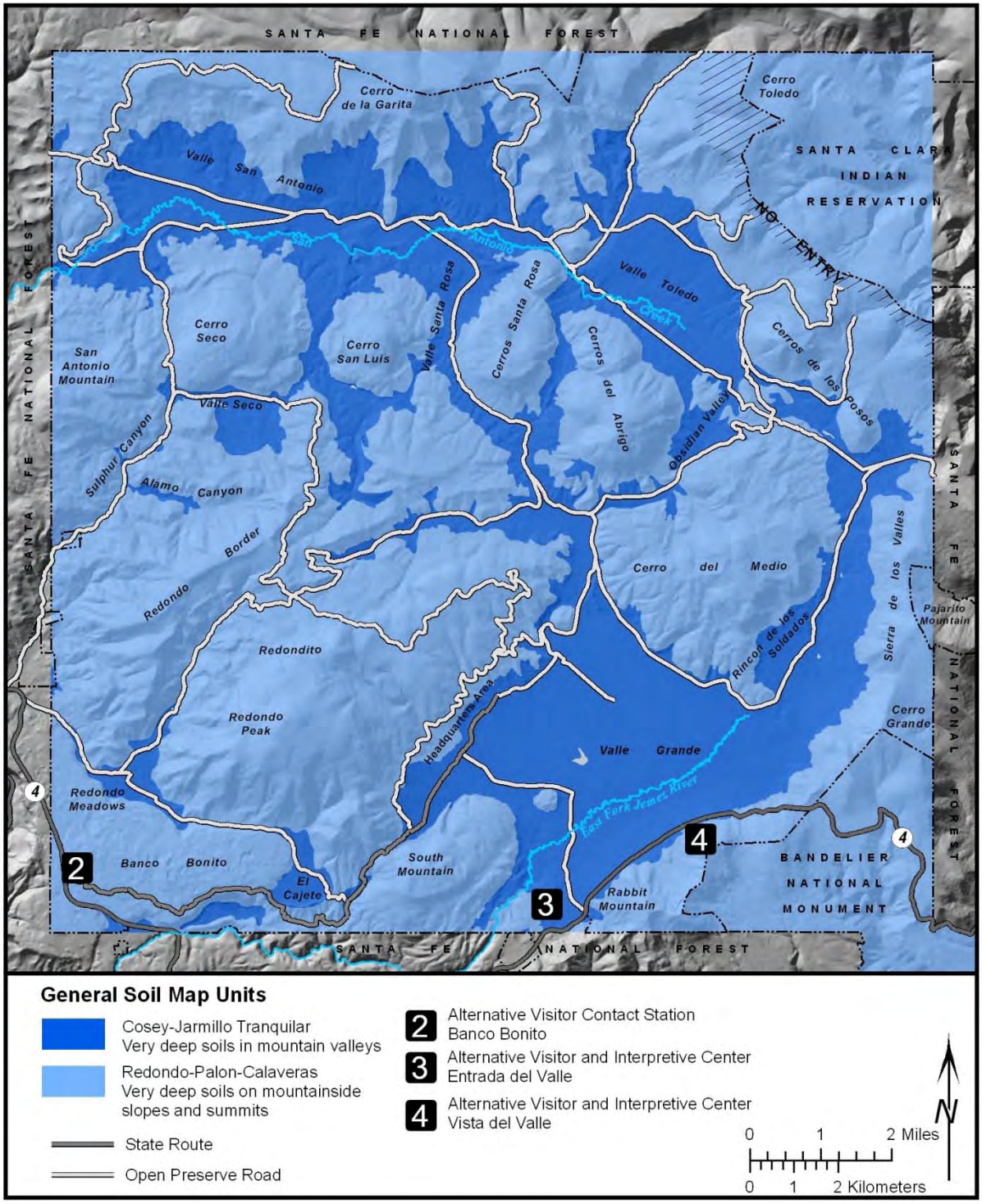
Palon soils are on mountain slopes. They formed in colluvium and slope alluvium. These soils are very deep, well drained, and moderately rapidly permeable. The surface layer is very cobbly sandy loam and extremely cobbly sandy loam about 8 inches thick. The subsurface layer is extremely cobbly sandy loam about 22 inches thick. The subsoil is very cobbly sandy loam with sandy clay loam to a depth of 60 inches or more (USDA NRCS 2008).

Calaveras soils are on mountain slopes. These soils are very deep, well drained, and moderately permeable. They formed in colluvium. The surface layer is silt loam about 11 inches thick. The upper 19 inches of the subsoil is silt loam and very cobbly loam. The lower part is extremely cobbly coarse sandy loam and extremely cobbly loamy sand to a depth of 60 inches or more (USDA NRCS 2008).

Other soils and miscellaneous areas in this unit are Cypher, Osha, Sedmar, Tocal, and Totavi soils, rubble land, and rock outcrop (USDA NRCS 2008).

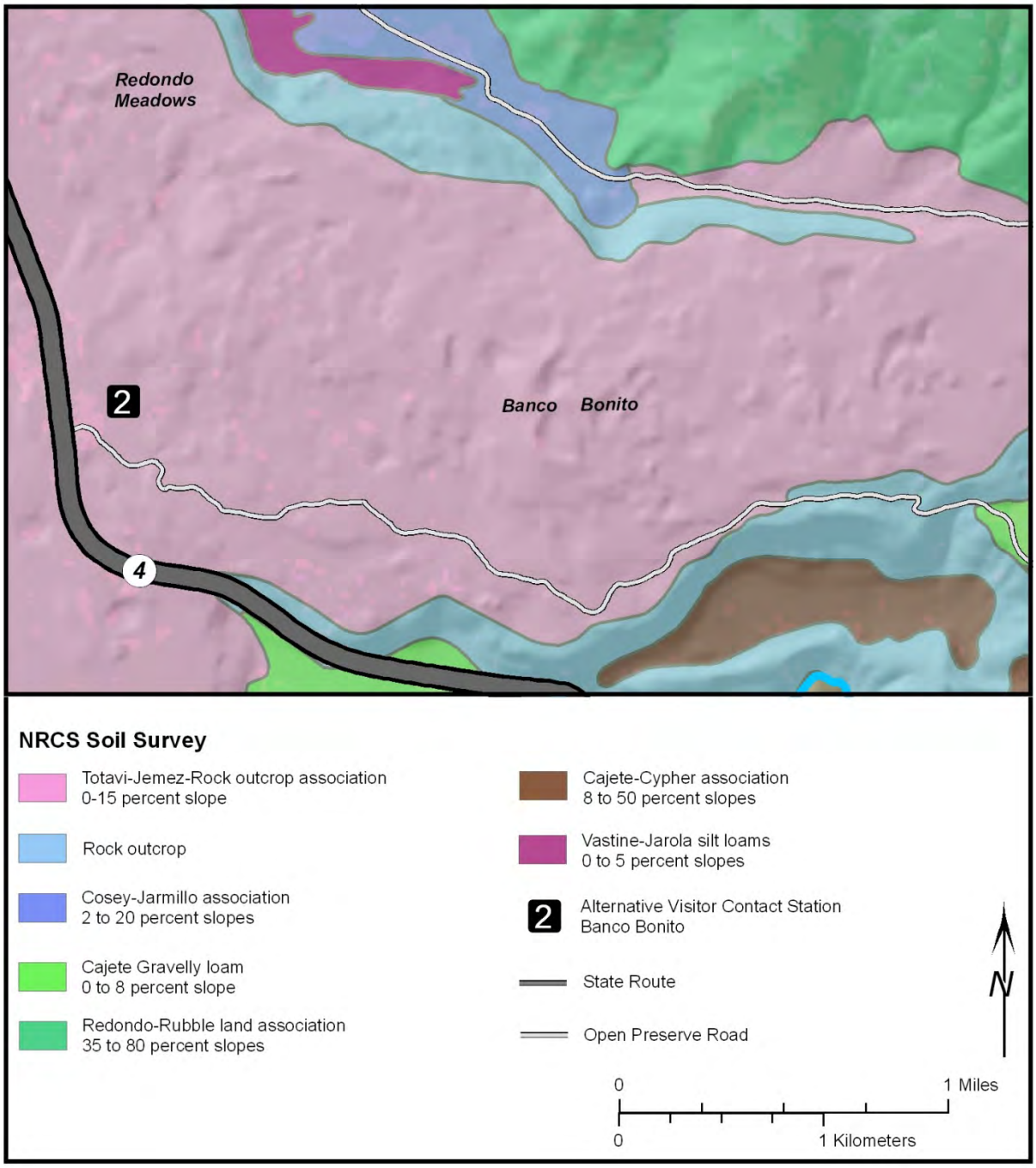
Soil Map Unit Descriptions

The two general soil groups mentioned above are further divided into specific soil map units, each with distinct properties. The following figures depict these divisions for the areas around the proposed visitor contact station / visitor center for each of the proposed action alternatives (figures 3-33 through 3-35).



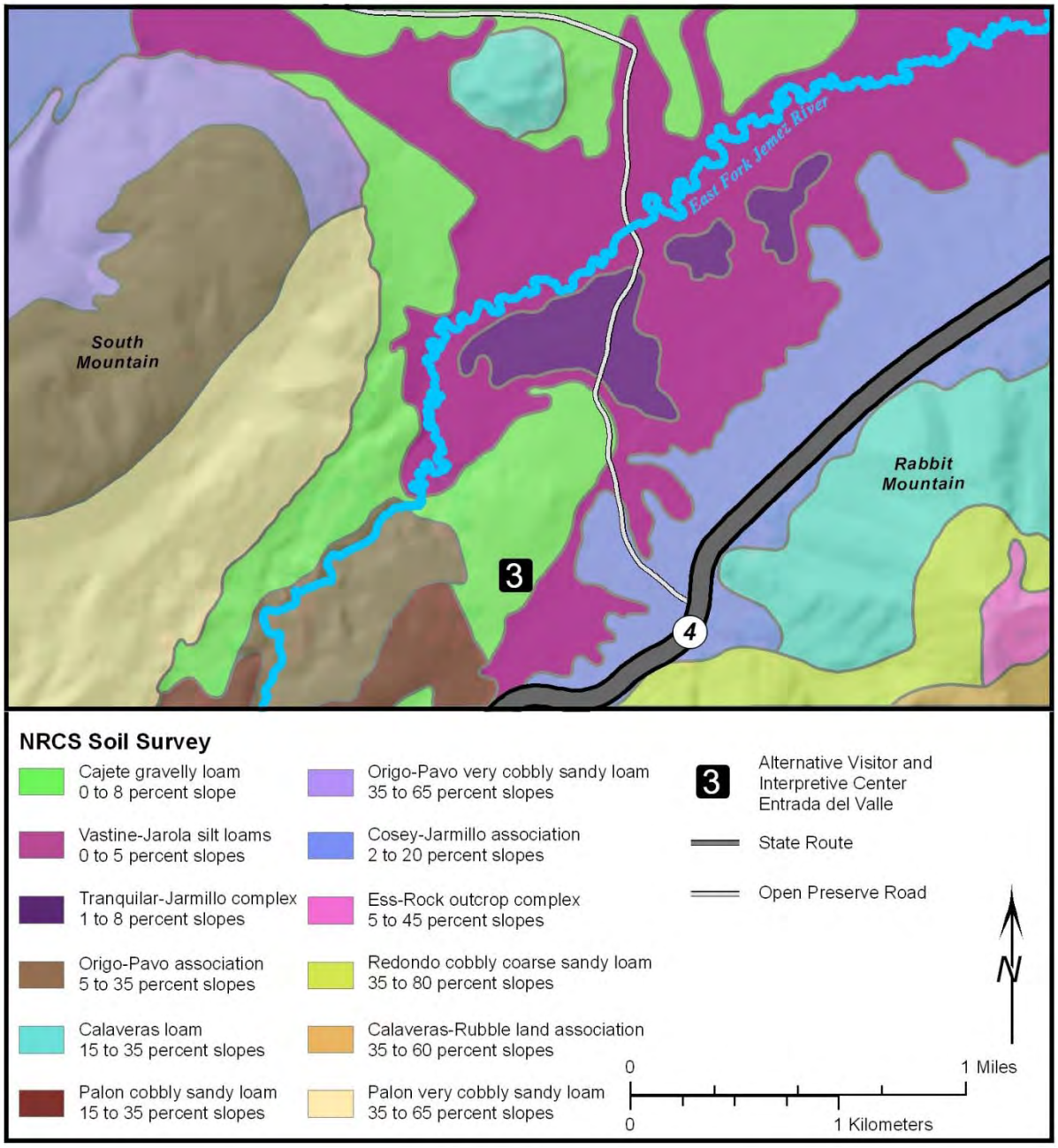
Source: USDA NRCS 2008.

Figure 3-32: General Soil Groups Preserve-wide



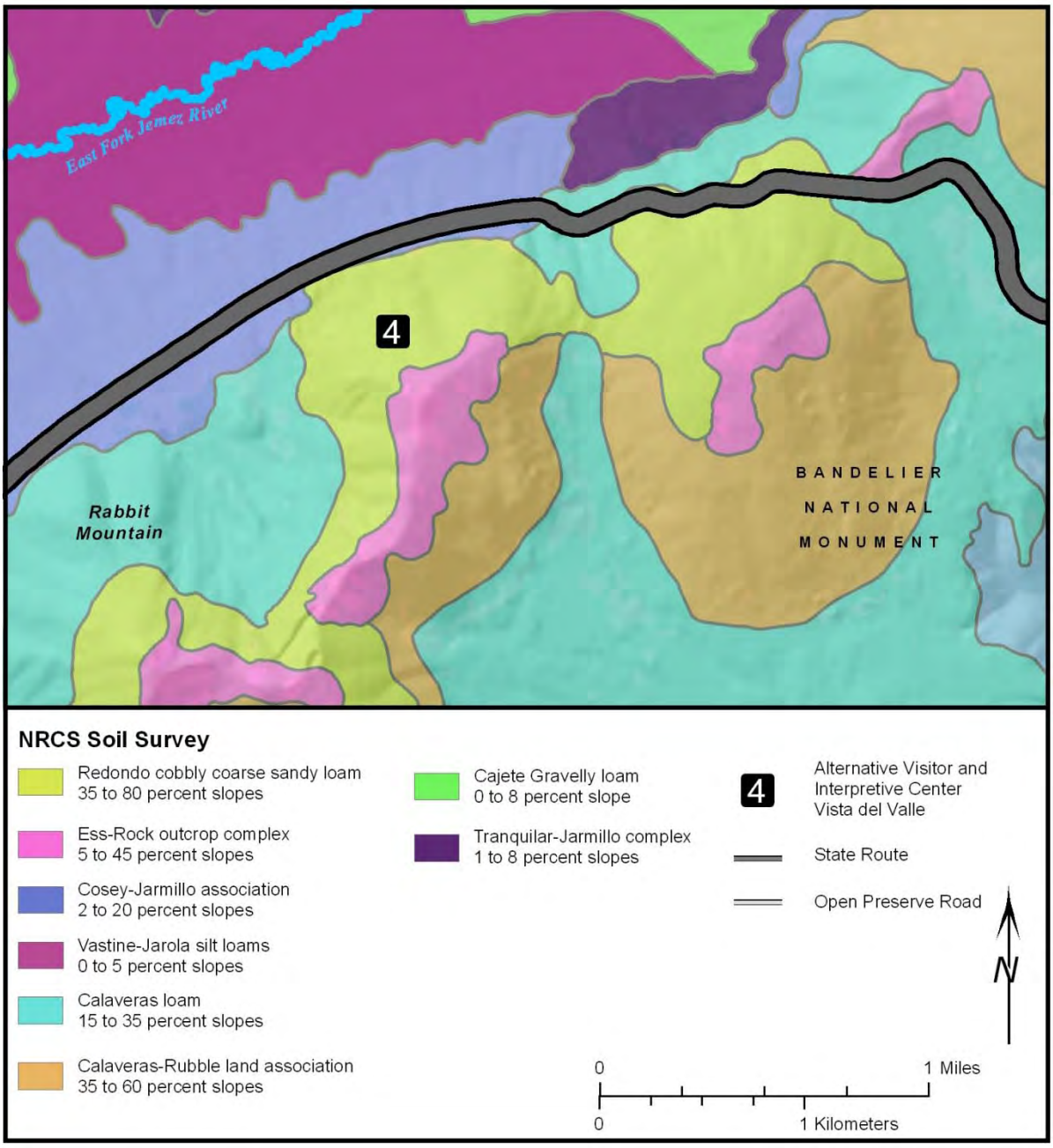
Source: USDA NRCS 2008.

Figure 3-33: Alternative 2 Soil Map Units



Source: USDA NRCS 2008.

Figure 3-34: Alternative 3A and 3B Soil Map Units



Source: USDA NRCS 2008.

Figure 3-35: Alternative 4A and 4B Soil Map Units

Soil Limitations and Suitability for Infrastructure

Table 3-14 shows the characteristics of each soil unit potentially affected by the construction of a visitor center / visitor contact station and supporting facilities under each action alternative. The effects these characteristics can have on the construction and maintenance of the facilities are described in more detail below.

The limitations of these soils and their properties are further described related to the use and construction of small commercial buildings, roads and parking areas, and septic tanks in table 3-15. The information indicates the dominant soil condition, which should be verified by on-site investigation. The numbers in parentheses range from 0.01 to 1.00, with the larger value indicating the greatest limitation (USDA NRCS 2008).

Small commercial buildings are defined as structures that are less than three stories high with no basements. Soil properties that affect load-supporting capacity include the depth to water table, ponding, flooding, subsidence, shrink/swell potential, and compressibility. Properties that affect the ease and amount of excavation include flooding, depth to water table, ponding, slope, depth to bedrock, hardness of bedrock, and the amount and size of rock fragments (USDA NRCS 2008). Not all characteristics listed above apply to the affected soils, in which case, the condition is not mentioned further.

Local roads as defined by the NRCS have an all-weather surface that can carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a surface of flexible material (asphalt), rigid material (concrete), or gravel with a binder. This description could apply to the preserve's definitions of Level 3 and/or Level 4 roads (see the "Transportation" section). The ratings are based on the soil properties that affect the ease of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or a cemented pan, hardness of bedrock or cemented pan, depth to water table, ponding, flooding, the amount of large stones, and slope. The properties that affect the traffic-supporting capacity are soil strength, subsidence, shrink/swell potential, the potential for frost action, depth to water table, and ponding (USDA NRCS 2008). Not all characteristics listed above apply to the affected soils, in which case, the condition is not mentioned further.

Table 3-14: Soil Map Units Description

	Alternative 2: Banco Bonito	Alternatives 3A/3B: Entrada del Valle		Alternatives 4A/4B: Vista del Valle	
Soil Map Unit	SMU 88: Totavi-Jemez-Rock outcrop association, 0%–15% slopes*	SMU 308: Cajete gravelly loam, 0%–8% slopes	SMU 301 (small nearby section): Vastine-Jarola silt loams, 0%–5% slopes	SMU 86: Redondo cobbly coarse sandy loam, 35%–80% slopes	SMU 304 (nearby) Cosey-Jarmillo association, 2%–20% slopes
Components	Totavi and similar soils: 45% Jemez and similar soils: 30% Rock outcrop: 15%* Minor components: 10%	Cajete and similar soils: 85% Minor components: 15%	Vastine and similar soils: 45% Jarola and similar soils: 40% Minor components: 15%	Redondo and similar soils: 85% Minor components: 15%	Cosey and similar soils: 45% Jarmillo and similar soils: 40% Minor components: 15%
Type of soil	Totavi Soils	Cajete Soils	Vastine Soils	Redondo Soils	Cosey Soils
Landscape	Plains	Mountains	Valleys	Mountains	Mountains
Landform	Stream terraces, valley floors, closed depressions	Mountain slopes, stream terraces, hills	Stream terraces, flood plains	Mountain slopes	Mountain slopes
Position on landform	Toe slopes, base slope	Foot slopes, mountain base	Toe slopes, base slope	Back slopes, mountain flank	Back slopes, mountain flank
Slope	0%–5%; east–west	0%–8%; east–west	0%–3%; east–west	35%–80%; east–west	2%–20%; east–west
Depth class	Very deep	Very deep	Very deep	Very deep	Very deep
Drainage class	Somewhat excessively drained	Well drained	Poorly drained	Well drained	Well drained
Slowest permeability	Moderately rapid	Moderate	Moderate	Moderately rapid	Moderately slow
Available water capacity	Low	Low	Low	Very low	Moderate
Shrink/swell potential	Low	Low	Low	Low	Moderate
Flooding hazard	Rare	NA	Rare	NA	NA
Seasonal high water table depth	NA	NA	About 12 to 36 inches	NA	NA
Runoff class	Very low	Low	High	Medium	Low
Type of soil	**Jemez Soils**	—	**Jarola Soils**	—	**Jarmillo Soils**
Landscape	Hills	—	Mountains	—	Mountains
Landform	Plateaus	—	Stream terraces	—	Stream terraces
Position on landform	Shoulders, nose slope	—	Toe slopes, base slope	—	Toe slopes, base slope

	Alternative 2: Banco Bonito	Alternatives 3A/3B: Entrada del Valle		Alternatives 4A/4B: Vista del Valle	
Slope	5%–15%; east–west	—	1%–5%; east–west	—	2%–20%; east–west
Depth class	Moderately deep	—	Very deep	—	Very deep
Depth to restrictive feature	20 to 40 in. to bedrock	—	NA	—	NA
Drainage class	Well drained	—	Poorly drained	—	Well drained
Slowest permeability	Moderately slow	—	Moderately slow	—	Moderate
Available water capacity	Low	—	Moderate	—	Moderate
Shrink/swell potential	Moderate	—	Moderate	—	Low
Flooding hazard	NA	—	Rare	—	NA
Seasonal high water table depth	NA	—	About 12–36 in.	—	NA
Runoff class	High	—	High	—	Medium

Source: USDA NRCS 2008.

* No facilities would be built on a rock outcrop; therefore, characteristics are not included.

Table 3-15: Soil Map Units Suitability

Alternative and Soil Type	Suitability for Use in: Commercial Building	Local Roads and Streets	Shallow Excavations (Utility Lines, Parking Lots)	Septic Tank Absorption Field
Alternative 2: Banco Bonito SMU 88: Totavi-Jemez-Rock outcrop association, 0%–15% slopes	Totavi: very limited due to flooding (1.00) Jemez: very limited due to slope (1.00), depth to hard bedrock (0.71), and shrink/swell potential (0.50)	Totavi: somewhat limited due to flooding (0.40) Jemez: somewhat limited due to depth to hard bedrock (0.71), shrink/swell (0.50), frost action (0.50), and slope (0.16)	Totavi: very limited due to cutbanks caving (1.00) Jemez: very limited due to depth to hard bedrock (1.00), slope (0.16), and cutbanks caving (0.10)	Totavi: very limited due to filtering capacity (1.00), bottom layer seepage (1.00), and flooding (0.40) Jemez: very limited due to depth to bedrock (1.00), slow water movement (1.00), and slope (0.16)

Alternative and Soil Type	Suitability for Use in: Commercial Building	Local Roads and Streets	Shallow Excavations (Utility Lines, Parking Lots)	Septic Tank Absorption Field
Alternatives 3A/3B: Entrada del Valle SMU 308: Cajete gravelly loam, 0%–8% slopes	Cajete: not limited	Cajete: somewhat limited due to frost action (0.50)	Cajete: very limited due to cutbanks caving (1.00)	Cajete: very limited due to bottom layer seepage (1.00)
SMU 301 (small nearby section): Vastine-Jarola silt loams, 0%–5% slopes	Vastine: very limited due to flooding (1.00) and depth to saturated zone (0.39) Jarola: very limited due to flooding (1.00), shrink/swell potential (0.50), and depth to saturated zone (0.39)	Vastine: very limited due to frost action (1.00), flooding (0.40), and depth to saturated zone (0.19) Jarola: somewhat limited due to shrink/swell (0.50), frost action (0.50), flooding (0.40), and depth to saturated zone (0.19)	Vastine and Jarola: both very limited due to depth to saturated zone (1.00 each) and cutbanks caving (1.00 each)	Vastine and Jarola: both very limited due to depth to saturated zone (1.00), bottom layer seepage (1.00), slow water movement (0.46), and flooding (0.40)
Alternatives 4A/4B: Vista del Valle SMU 86: Redondo cobbly coarse sandy loam, 35%–80% slopes	Redondo: very limited due to slope (1.00) and large stone content (0.53)	Redondo: very limited due to slope (1.00), large stones (0.53), and frost action (0.50)	Redondo: very limited due to slope (1.00), large stones (0.53), and cutbanks caving (0.10)	Redondo: very limited due to slope (1.00), bottom layer seepage (1.00), and large stones (0.53)
SMU 304 (nearby): Cosey-Jarmillo association, 2%–20% slopes	Cosey and Jarmillo: both very limited due to slope (1.00 each)	Cosey: somewhat limited due to frost action (0.50), slope (0.37), and low strength (0.22) Jarmillo: somewhat limited due to frost action (0.50) and slope (0.37)	Cosey: very limited due to cutbanks caving (1.00) and slope (0.37). Jarmillo: somewhat limited due to slope (0.37) and cutbanks caving (0.10)	Cosey: very limited due to slow water movement (1.00) and slope (0.37) Jarmillo: very limited due to bottom layer seepage (1.00) and slope (0.37)

Source: USDA NRCS 2008.

Note: The numbers in parentheses range from 0.01 to 1.00, with the larger value indicating the greatest limitation (USDA NRCS 2008).

SMU = soil map unit.

Not limited = soil has features that are very favorable for the specified use.

Slightly limited = soil has features that are favorable for the specific use. Limitations are minor and can be easily overcome.

Somewhat limited = soil has features that are moderately favorable for the specified use. Limitations can be overcome or minimized with special planning, design, or installation.

Very limited = soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without substantial soil reclamation, special design, or expensive installation features.

Shallow excavations are defined as trenches or holes dug to a maximum depth of 5 or 6 feet for utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting. Depth to the seasonal high water table, flooding, and ponding may restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and shrink/swell potential influence the resistance to sloughing (USDA NRCS 2008). Not all characteristics listed above apply to the affected soils, in which case, the condition is not mentioned further.

Septic tank absorption fields are defined as areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 60 inches is evaluated. The ratings are based on the soil properties that affect the absorption of the effluent, the construction and maintenance of the system, and public health. Permeability, depth to water table, ponding, depth to bedrock, and flooding affect absorption of the effluent. Stones and boulders, ice, and bedrock interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Soils that are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the distribution lines may not adequately filter the effluent, particularly when the system is new. As a result, the groundwater may become contaminated (USDA NRCS 2008). Not all characteristics listed above apply to the affected soils, in which case, the condition is not mentioned further.

Table 3-16 describes water features used in land use planning that involve engineering considerations. Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The four hydrologic soil groups are as follows (USDA NRCS 2008):

1. **Group A.** Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
2. **Group B.** Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
3. **Group C.** Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

4. **Group D.** Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink/swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission. None of the soils at the proposed alternative locations fall into this group.

Table 3-16: Soil Map Units Water Features

Alternative and Soil Type	Hydrologic Group	Ponding	Flooding
Alternative 2: Banco Bonito			
SMU 88: Totavi-Jemez-Rock outcrop association, 0%–15% slopes	Totavi: A Jemez: C	Duration: ND Frequency: None	Duration: ND Frequency: Rare
Alternative 3: Entrada del Valle			
SMU 308 , Cajete gravelly loam, 0%–8% slopes	Cajete: B	Duration: ND Frequency: None	Duration: ND Frequency: None
SMU 301 (small nearby section): Vastine-Jarola silt loams, 0%–5% slopes	Vastine: B Jarola: C	Duration: ND Frequency: None	Duration: ND Frequency: Rare
Alternative 4: Vista del Valle			
SMU 86: Redondo cobbly coarse sandy loam, 35%–80% slopes	Redondo: B	Duration: ND Frequency: None	Duration: ND Frequency: None
SMU 304 (nearby): Cosey-Jarmillo association, 2%–20% slopes	Cosey and Jarmillo: B	Duration: ND Frequency: None	Duration: ND Frequency: None

Source: USDA NRCS 2008.
SMU = soil map unit.
ND = no data provided.

Table 3-16 also indicates the duration and frequency of ponding. Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. No duration data is available for the affected soils. Frequency for ponding of the affected soils is none, meaning that ponding is not probable (USDA NRCS 2008).

Flooding is the temporary inundation of an area caused by overflowing streams or runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding. The duration and frequency of flooding at the proposed alternative sites are shown in table 3-16. No duration data is available for the affected soils. Frequency for the affected soils is none or rare. None means that flooding is not probable; rare means that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1%–5% in any year) (USDA NRCS 2008).

Erosion is the wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep. Erosion can be accelerated as a result of animal or human activities, such as construction, or as a result of a catastrophe in nature, such as a fire, that exposes the surface. Surface erosion does not appear active in the preserve's upper hill slopes even in heavily

roaded areas. Generally, soil losses are considered most extreme on steep slopes when groundcover is lost due to disturbance (Elliot, Hall, and Graves, 1998, as cited in VCT 2010e). However, the preserve's roads have limited soil erosion on the steep hill slopes of the domes, likely from the combined effects of surface rock armoring against erosion loss and high infiltration rates diffusing erosive surface flows (VCT 2010e). Table 3-17 shows the susceptibility of the affected soils in the vicinity of the proposed visitor centers / visitor contact station to water erosion; values range from 0.02 to 0.69. The higher the value, the more susceptible the soil. Susceptibility to wind erosion is indicated as a range from 1 to 8, with 1 being the most susceptible and 8 the least (USDA NRCS 2008). Slope, drainage, and climate all influence erosion. Erosion is likely to be more serious on steep slopes where water tends to channelize and in climates with infrequent but intense rainfall. The most erosive soils have homogeneous textures, such as those high in silt or fine sands and low in organic matter (Hammitt and Cole 1998).

Table 3-17: Soil Map Units Water and Wind Erosion Susceptibility

Alternative and Soil Type	Water Erosion	Wind Erosion
Alternative 2: Banco Bonito		
SMU 88: Totavi-Jemez-Rock outcrop association, 0-15% slopes	Totavi: 0.24 Jemez: 0.37	Totavi: 3 Jemez: 5
Alternative 3: Entrada del Valle		
SMU 308: Cajete gravelly loam, 0%–8% slopes	Cajete: 0.20	Cajete: 6
SMU 301 (small nearby section): Vastine-Jarola silt loams, 0%–5% slopes	Vastine: 0.43 Jarola: 0.43	Vastine: 6 Jarola: 5
Alternative 4: Vista del Valle		
SMU 86: Redondo cobbly coarse sandy loam, 35%–80% slopes	Redondo: 0.10	Redondo: 5
SMU 304 (nearby): Cosey-Jarmillo association, 2%–20% slopes	Cosey: 0.43 Jarmillo: 0.43	Cosey: 5 Jarmillo: 5

Source: USDA NRCS 2008.
Note: Water erosion values range from 0.02 to 0.69; higher value = more susceptible. Wind erosion values range from 1 to 8; lower value = most susceptible.
SMU = soil map unit.

Geothermal Resources

The preserve contains a hot, but relatively small, liquid-dominated geothermal resource underlain by a potent magmatic heat source (Goff 2002), and attempts have been made to harness this geothermal potential for electricity generation. The preserve's hot springs and fumaroles have characteristics similar to those at electricity-producing geothermal systems: (1) acid, sulfate-rich hot springs and hydrogen sulfide–rich fumaroles at the top of the system (Sulphur Springs) and (2) neutral, chloride-rich hot springs at the sides (Soda Dam). Although reservoir waters in the preserve are 410°F to 572°F (210°C to 300°C), with maximum measured temperatures in underlying rocks at 644°F (340°C) at 2 miles (10,560 feet) depth, the fluids are extremely localized. A cooperative geothermal demonstration project started in 1978 sponsored by the USDOE, Union Oil Company, and the Public Service Company of New Mexico resulted in only 20 megawatts of geothermal reservoir capacity in the preserve, compared to the 400 megawatts that was anticipated, due to extensive drilling problems (VCT 2007b).

Finding undiscovered hot fluid to power more than 20 megawatts is expected to be challenging. Although the shallow heat contained in the rocks is immense, extracting large quantities of hot fluids from them has been exceptionally difficult. The geothermal reservoir displays extremely poor hydraulic conductivity, leading to uncertainty as to whether it can produce a sufficient volume of fluids at the required pressures to power a geothermal plant (Goff 2002). No wells to intersect geothermal fluids have been drilled in the preserve since 1988 (VCT 2007b).

The composition and properties of soil and rock can affect heat transfer rates and needed to be considered when installing a geothermal heat pump. Soils with good heat transfer properties require less piping to gather heat than soil with poor heat transfer properties. Areas with extensive hard rock or shallow soils may affect system design (USDOE 2011b).

The presence of moisture increases conductivity, because water is a good conductor (CIPCO Energy Library n.d.). Although moisture content is a major factor, sand or clay do not need to be heavily saturated to provide good conductivity (McQuay Air Conditioning 2002).

Soil moisture at the preserve varies seasonally. The regional climate is semiarid continental. Cyclonic storms associated with the polar jet stream bring snow in the winter and rain in the spring and fall. April through June is usually dry. The majority (60%) of the precipitation comes in the summer months in the form of convectional "monsoon" storms. Periodic El Niño events bring increased winter and spring precipitation, while interspersed La Niña events cause droughts (Allen 2004, cited in VCT 2007b). The rock mantle on the moderate to steep hill slopes increases water availability as well. Many of the domes have surfaces that increase water holding capacity by providing a heterogeneous medium, including finer-textured silt and clay. The volcanic domes have sandy loam textures and a rocky, skeletal soil matrix that facilitates drainage (VCT 2010e).

The southwestern corner of the preserve consists of ash-dominated soils. The ash has little nutrient value, but holds moisture (Garrison-Johnston et al. 2005, cited in VCT 2010e) Most of the preserve's soils contain ash, although the soils in the southwest corner have ash layers thicker than 7 inches in the upper part of the soil profile (VCT 2010e).

Heat transfer properties can be evaluated based on three primary groups of soils (CIPCO Energy Library n.d.):

1. coarse-grained sands and gravels
2. fine-grained silts and clays
3. loam mixtures of sand, silt, and clay

Most soil is a combination of fine and coarse grain. Table 3-18 shows the thermal properties for sand and clay soils, which range from 0.3 to 1.9 British thermal units per hour per foot (Btu/hr/ft). The numbers represent high-density soils when they are primarily dry (5% moist). Conductivity and diffusivity decline as density declines (McQuay 2002).

Table 3-18: Soil Thermal Conductivity

Soil Category	Thermal Conductivity (Btu/hr/ft)[a]	Thermal Diffusivity (ft^2/day)[b]
Coarse 100% sand	1.2–1.9	0.96–1.5
Fine grain 100% clay	0.6–0.8	0.48–0.64

Source: McQuay 2002.

[a] Thermal conductivity describes a material's ability to conduct heat.

[b] Thermal diffusivity describes the rate at which heat flows through a material.

The typical profiles for the potentially affected soils are shown in table 3-19. A GHP would require a trench at least 4 feet deep. Therefore, the deepest profile (60 inches) can be used to determine soil types that would affect heat transfer and conductivity.

As mentioned above, heat transfer properties are based on the degree of sand, silt, and clay in a soil. Table 3-20 shows the content of these elements in the soils located at the proposed building sites for each alternative. Data is provided at the lowest depth calculated, no more than 60 inches belowground. The percentages of each type can vary greatly closer to the surface. For example, Cajete, described as a loam, consists almost exclusively of sand at the lowest depths measured, but is a somewhat even mix of sand, silt, and clay near the surface, more consistent with the definition of a loam (USDOE 2011b).

Soils 60 inches deep at the proposed alternative 2 site would generally be composed primarily of sand, particularly if the Totavi series is more prevalent than the Jemez. Soil Map Unit 308 soils at the proposed alternative 3A/3B site would consist almost exclusively of sand. Nearby Soil Map Unit 301 soils would be sandy loam. Soil Map Unit 86 soils at the proposed site of alternatives 4A/4B would range between a sand or a loam, depending on the mixture. Soil Map Unit 304 soils near the proposed alternative 4A/4B site would be loam. The range of the mixture would vary from more clayey to more sandy.

Table 3-19: Soil Typical Profiles

	Alternative 2: Banco Bonito	Alternative 3: Entrada del Valle		Alternative 4: Vista del Valle	
Map unit	SMU 88: Totavi-Jemez-Rock outcrop, 0%–15% slopes	SMU 308: Cajete gravelly loam, 0%–8% slopes	SMU 301: Vastine-Jarola silt loams, 0%–5% slopes	SMU 86: Redondo cobbly coarse sandy loam, 35%–80% slopes	SMU 304: Cosey-Jarmillo association, 2%–20% slopes
Soils	**Totavi Soils** 0–12 in.; sandy loam 12–60 in.; loamy sand **Jemez Soils** 0–6 in.; loam 6–13 in.; loam 13–19 in.; clay loam 19–27 in.; sandy clay loam 27–60 in.; bedrock	**Cajete Soils** 0–7 in.; gravelly loam 7–15 in.; gravelly loam 15–33 in.; very gravelly sandy loam 33–45 in.; very gravelly sand 45–49 in.; extremely gravelly sand 49–60 in.; very gravelly sand	**Vastine Soils** 0–4 in.; silt loam 4–11 in.; loam 11–24 in.; loam 24–60 in.; very gravelly loamy sand **Jarola Soils** 0–9 in.; silt loam 9–11 in.; silt loam 11–17 in.; silty clay loam 17–21 in.; clay loam 21–42 in.; gravelly sandy clay loam 42–60 in.; very gravelly sandy loam	**Redondo Soils** 0–8 in.; cobbly coarse sandy loam 8–13 in.; very cobbly coarse sandy loam 13–34 in.; extremely cobbly coarse sandy loam 34–60 in.; extremely cobbly coarse sandy loam	**Cosey Soils** 0–9 in.; silt loam A9–15 in.; silt loam 15–28 in.; gravelly loam 28–34 in.; very gravelly sandy clay loam 34–60 in.; extremely cobbly clay loam **Jarmillo Soils** 0–17 in.; silt loam 17–33 in.; sandy loam 33–60 in.; sandy loam

Source: USDA NRCS 2008.

Table 3-20: Soil Composition 60 Inches below Surface

Alternative and Soil Type	Percent Sand	Percent Silt	Percent Clay
Alternative 2: Banco Bonito			
SMU 88: Totavi-Jemeza-Rock outcrop association, 0%–15% slopes	Totavi: 75%–90% Jemez*: 45%–65%	Totavi: 0%–20% Jemez: 10%–25%	Totavi: 5%–10% Jemez: 20%–35%
Alternative 3: Entrada del Valle			
SMU 308 Cajete gravelly loam, 0%–8% slopes	Cajete: 90%–00%	Cajete: 0%–10%	Cajete: 0%–5%
SMU 301 (small nearby section): Vastine-Jarola silt loams, 0%–5% slopes	Vastine: 75%–95% Jarola: 55%–75%	Vastine: 0%–15% Jarola: 10%–30%	Vastine: 5%–10% Jarola: 5%–15%
Alternative 4: Vista del Valle			
SMU 86: Redondo cobbly coarse sandy loam, 35%–80% slopes	Redondo: 55%–75%	Redondo: 15%–30%	Redondo: 5%–10%
SMU 304 (nearby): Cosey-Jarmillo association, 2%–20% slopes	Cosey: 20%–40% Jarmillo: 30%–75%	Cosey: 20%–40% Jarmillo: 10%–40%	Cosey: 28%–35% Jarmillo: 5%–15%

Source: USDA NRCS 2008.
SMU = soil map unit
* Data for Jemez available only to 27 inches.

Water

The proposed alternatives could affect the preserve's water resources as a result of the construction of facilities (e.g., runoff generated during construction activities in the short term and runoff that could occur from the introduction of potentially impervious surfaces in the long term). Increased visitor use would also affect water resources, particularly groundwater, if it is used to supply water for consumption and restrooms. Groundwater would also be affected by generation of wastewater. The alternatives could also affect, and be affected by, the floodplains that exist in the preserve. This section describes the existing water resources in the study area so these types of possible impacts can be determined.

Study Area

The study area for evaluating impacts on water resources for implementation-level decisions is the specific proposed visitor contact station / center location and vicinity for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

Watershed Overview

The preserve is in the Jemez Watershed, or the lands that ultimately drain into the Jemez River (VCT 2009b). A watershed is an area of land and water defined by a boundary such that all surface drainage within the boundary converges to a single point, usually the exit point, where the collected waters leave the watershed. Ridges of higher land separate watersheds from each other (Virginia Department of Conservation and Recreation [VADCR] 2011). With minor exceptions, the

Water resources could be affected from the construction and use of facilities (e.g., runoff). Groundwater would be affected if it is used for water supply, and by generation of wastewater.

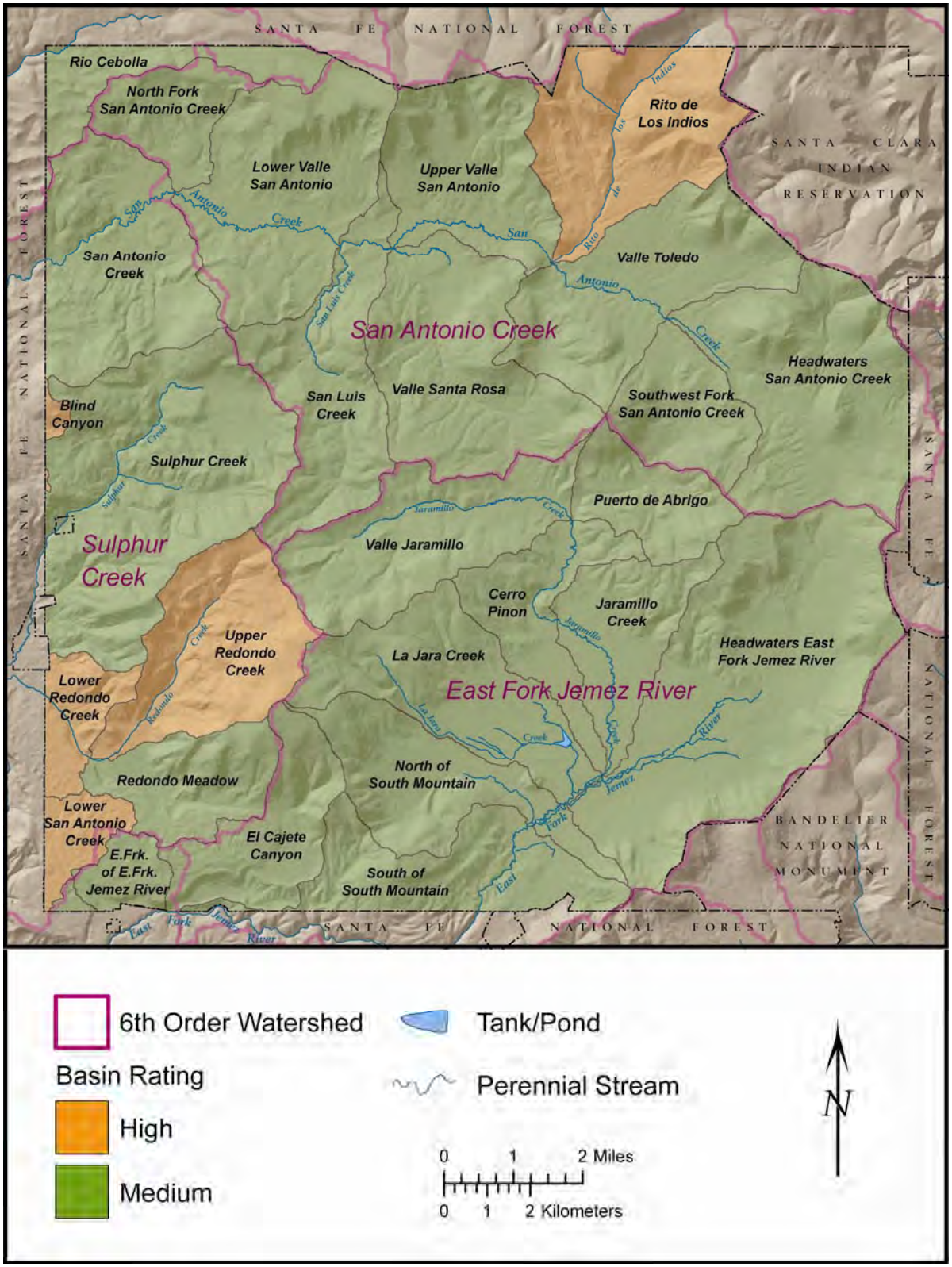
headwaters of the streams that flow out from the preserve are contained within its boundaries, making the preserve a self-contained watershed unit (figure 3-36). With no other lands and no other land managers upstream from the preserve, any changes in the quality of water leaving the preserve or in the ecological condition of its aquatic and riparian communities are wholly attributable to the interplay of human activities, ecological succession, geology, climate, and other natural processes occurring in the preserve (VCT 2005i).

The quality of water in streams and rivers is an indicator of the health of the watershed and the ecosystem. Working within a smaller watershed is preferred for monitoring the effects resulting from land-use practices (VCT 2009b). To meet this intent, federal hydrologic units were identified to subdivide watersheds into smaller sizes, known as "orders." Sixth-order watershed delineations are widely used as a geographical identifier for water-related data and issues (U.S. Geological Survey [USGS] Hydrological Unit Code [HUC] 14-digit watersheds) (VADCR 2011). The preserve's sixth-order watersheds were subdivided into 44 smaller subbasins, and each of these received an overall rating. Results indicated that all subbasins of the sixth-order watersheds in the preserve are in good to fair condition, showing a moderate departure from the reference condition. Most showed an upward trend in condition. The areas indicated as "high" on figure 3-36 indicate conditions at or near the reference condition; "medium" indicates moderate departure from the reference condition (VCT 2009b).

Nearly 75 miles of perennial stream originate in the forests and wind through the valles of the preserve. The headwaters of the East Fork of the Jemez River and San Antonio Creek arise in the preserve. These tributaries converge below Battleship Rock in San Diego Canyon (outside the preserve) to form the Jemez River, a tributary to the Rio Grande (VCT 2007b).

Surface Waters

The preserve's surface waters are shown on the map in figure 3-36. Some of these surface water sources could be used to support the alternatives, including La Jara, Jaramillo, and Redondo Creeks, as well as San Antonio Creek and the East Fork of the Jemez River. The only surface-water drinking system in the preserve is at the headquarters area, and it provides drinking water to the existing cabins and lodge. The system flows to a treatment unit and then a 30,000-gallon storage tank. This system is not permitted by the state as a public water system. Due to flow variability and freezing of the creek, water is not provided year-round. Doing so would require the development of an intake structure to gather and treat the water (Griffin 2009).



Note: "High" indicates conditions at or near the reference condition; "medium" indicates moderate departure from the reference condition (VCT 2009b).

Figure 3-36: Preserve Watershed Management Units

The preserve has set a goal that water quality would meet standards for designated use as established by the New Mexico Environment Department and indicated by measures of total maximum daily loads (TMDLs), or the amount of pollutant a stream or river can assimilate, as indicated by the following (VCT 2009b):

1. Temperature—3-day average (water temperature is a crucial parameter for fish health and development)
2. Temperature—7-day average
3. Maximum temperature / duration of exceedances
4. Turbidity, dissolved oxygen, pH

In 2001 and 2003, the New Mexico Environment Department (NMED) measured pollutant loads in the East Fork of the Jemez River, Jaramillo Creek, Redondo Creek, Rito de los Indios, San Antonio Creek, La Jara Creek, and Sulphur Creek. Pollutant loads were compared to the TMDL, the total amount of pollutants that a stream can assimilate naturally and still meet state water quality standards. Streams with loads that exceed the TMDLs are classified as "impaired." The East Fork of the Jemez River, Jaramillo Creek, Redondo Creek, and San Antonio Creek exceed TMDLs for temperature and turbidity (suspended materials usually derived from soil erosion). These conditions resulted primarily from the degradation of watersheds during 20th century forestry and livestock operations, coupled with a large increase in the elk population in the 1980s and 1990s. All preserve streams exceed the standard for aluminum, which has a natural source in volcanic rocks (VCT 2007b).

Shortly after federal acquisition of the preserve in 2000, members of the New Mexico Cadre of the Creeks and Community Strategy (Cadre) assessed the watersheds of the preserve. The Cadre used the Proper Functioning Condition (PFC) method of the Accelerated Cooperative Riparian Restoration and Management, a collaborative effort among the Bureau of Land Management, the USFS, and the USDA Natural Resource Conservation Service. The report identified a large number of stream reaches in the preserve as either nonfunctioning or functioning at risk (McWilliams et al. 2000; McWilliams 2001). The watersheds were reevaluated using the same methods in 2006. After six years of VCT management, watershed condition significantly improved (McWilliams 2006) due to reduced livestock stocking rates and a shortened grazing period. With more riparian shading, stream water temperatures on the East Fork of the Jemez River decreased between 2001 and 2006. In 2001 temperatures exceeded TMDLs on 76 days; in 2006, temperatures exceeded TMDLs on 61 days (a 20% decline) (VCT 2007b).

Streambank characteristics, such as width-to-depth ratios, average temperatures, and stream-bottom attributes showed a measurable improvement from 2002 to 2006. Water quality assessments completed in 2006 by the NMED acknowledge the general upward trend but found that water quality continued to be impaired, with exceedances in temperature and turbidity (NMED 2006b), as shown in table 3-21.

Table 3-21: Results of the 2003 and 2006 New Mexico Stream Pollution Surveys

Stream	Designated Uses	Impairment	Potential Sources
East Fork of the Jemez River (preserve boundary to headwaters)	HQCWAL, DWS, FC, IRR, LW, WH, SC	Temperature (2006) Turbidity (2003) Aluminum Dissolved oxygen pH	Natural sources, recreational sources, grazing, silviculture harvesting, streambank modifications and/or destabilization, upstream impoundments, wildlife other than waterfowl
Jaramillo Creek (East Fork of the Jemez to headwaters)	HQCWAL, DWS, FC, IRR, LW, WH, SC	Temperature (2006) Turbidity (2006) Aluminum	Highway/road/bridge runoff (nonconstruction), natural sources, rangeland grazing, streambank modifications and/or destabilization, wildlife other than waterfowl
La Jara Creek (East Fork of the Jemez to headwaters)	HQCWAL, DWS, FC, IRR, LW, WH, SC	Aluminum	Natural sources
San Antonio Creek (below Warm Springs)	HQCWAL, DWS, FC, IRR, LW, WH, SC	Temperature (2003) Turbidity (2003) Aluminum	Natural sources
Rito de los Indios (above San Antonio Creek)	HQCWAL, DWS, FC, IRR, LW, WH, SC	Aluminum	Natural sources
Sulphur Creek (preserve boundary to headwaters)	Limited aquatic life, WH, LW, SC	pH (2003) Conductivity (2003) Aluminum	Natural sources
Redondo Creek (above preserve boundary)	HQCWAL, DWS, FC, IRR, LW, WH, SC	Temperature (2003) Turbidity (2003) Aluminum	Natural sources

Source: NMED 2006b.

HQCWAL = high-quality coldwater aquatic life; DWS = drinking water source; FC = fish culture; IRR = irrigation; LW = livestock watering; WH = wildlife habitat; SC = secondary contact; 2006 = TMDLs written in 2006; 2003 = TMDLs written in 2003.

East Fork of the Jemez River Watershed Management Unit

Early surveys conducted after federal acquisition revealed that the East Fork of the Jemez River was not properly functioning for habitat characteristics or for channel condition and dynamics criteria, except for pool quality and streambank condition (Simino 2002). In 2004, a total of 1.8 miles of the East Fork of the Jemez River was classified as properly functioning and 5.2 miles as nonfunctioning (USFS 2004b). The remainder was classified as functioning at risk. The National Riparian Service Team rated the lower segment of the East Fork of the Jemez River below the main access to the preserve headquarters as functioning at risk with an upward health trend rather than nonfunctioning (National Riparian Service Team 2002; McWilliams 2001). The East Fork of the Jemez River Stream Inventory (Simino 2002) noted pool formation concerns and excessive amounts of long riffles and altered width-to-depth ratios and stream types. Hydrologists and soil scientists found that high sediment loads, loss of undercut banks, and straightening of channels were causing structural and functional problems to the stream system.

The East Fork of the Jemez River was revisited in 2006 and PFC surveys showed that changes were occurring in this stream system. The perennial segments of the river had improved from below the headwaters to the southern boundary of the preserve. The installation of an appropriately designed bridge along the headquarters road is likely responsible for the improved conditions. Unlike the lower reaches of the East Fork of the Jemez River, the spring area did not appear to be responding to management action conducted over six years. The intermittent segment below the stock tank and above the nonriparian segment appeared to be of concern as well. In 2000, this segment was in proper functioning condition. However, in 2006 this segment was found to be functioning at risk and with a downward trend. Areas of concern around the spring and the intermittent segment below the stock tank seem to be reflective of drought and herbivory, as noted by responses associated with the elk enclosure fence (McWilliams 2006).

A number of water quality issues have been documented on the East Fork of the Jemez River over time (NMED 2006a). Using benthic organisms (a type of aquatic life that lives on or just beneath the bottom of a sea or lake or in the intertidal zone) as an indicator of water quality, this stream was issued a rating of moderately impaired (Simino 2002), and the NMED Surface Water Quality Bureau has documented specific concerns regarding state water quality standards (Simino 2002; State of New Mexico 2002). Water quality impairments were reported in 2000 along the lower reach below the confluence with Jaramillo Creek for temperature, total suspended solids, fecal coliform, and stream-bottom sediments (VCT 2002). In its 2002 report, the NMED cited two exceedances regarding turbidity between the confluence with San Antonio Creek and its headwaters, but temperature, fecal coliform, and stream-bottom sediments were not cited as concerns (State of New Mexico 2002). Summer water temperatures have historically been generally warm and have exceeded the recommended maximum of 73°F (23°C) (or 68°F [20°C] for a four-hour duration). The pH of the stream is neutral to basic and can exceed 8.8. Ammonia and aluminum levels also can exceed water quality standards (Vieira and Kondratieff 2004).

Benthic invertebrate surveys were performed during 2000 (Simino 2002); the dominant organisms found were primarily tolerant and can survive in altered aquatic habitat. The East Fork of the Jemez River had a low number of taxa (23), probably due to the homogeneity of the substrate (fine materials) and thermal consistency (Simino 2002). Pool habitat had been reduced by high levels of fine sediment, and riffle habitat had excessive amounts of fine materials. Trout spawning habitat throughout this reach had been greatly reduced due to sedimentation (VCT 2002).

Jaramillo Creek Watershed Management Unit

Jaramillo Creek, a narrow and deep tributary to the East Fork of the Jemez River, is a meandering first-order stream (i.e., no other stream feeds into it) that predominantly runs through Valle Grande and Valle Jaramillo. A total of 4.3 miles of Jaramillo Creek, starting at the East Fork of the Jemez River, was classified as being in proper functioning condition during surveys conducted shortly after federal acquisition. The remainder of Jaramillo Creek up to the headwaters was classified as

functioning at risk (USFS 2004b). Surveys conducted in 2006 showed that the length of stream channel at risk had been reduced over the prior six years (McWilliams 2006).

Gravel and silt are the dominant bed substrate; some areas have cobbles. The upper headwaters consist of seeps and natural wetland areas. The dominant substrates of these seeps are mud, silt, and inundated meadow vegetation. Prior to entering the Valle Grande, the creek is fed by a spring. Cobble and sand, with some boulders, dominate the substrate, and aquatic mosses are also present. The spring tributary is shallow, and the tops of most cobbles are exposed (Vieira and Kondratieff 2004).

A benthic survey found Jaramillo Creek to be nonimpaired, having the largest number of taxa (31) and the most diversity of organisms in the preserve (Spann, McWilliams, and Jacobi 2000). Temperature, turbidity, and aluminum levels have been found to be impaired.

La Jara Creek Watershed Management Unit

La Jara Creek, tributary to the East Fork of the Jemez River, was classified as functioning at risk (USFS 2004b). The dominant bed substrate includes cobbles and gravel. This stream is higher gradient, with faster current and shallower depth, than most streams on the preserve (VCT 2009b).

La Jara Creek had a fair diversity of benthic organisms (27 species), but was sampled at a lower frequency than other small creeks. According to NMED (2010), aluminum levels in La Jara Creek may exceed chronic water quality standards due to natural sources present in local volcanic rock formations.

San Antonio Creek Watershed Management Unit—Upper Section

Early surveys indicated that a total of 6.2 miles, mostly in the upper sections of San Antonio Creek (above the confluence with Rito de los Indios), was classified as in proper functioning condition. The remaining 13.3 miles of San Antonio Creek was determined to be functioning at risk (including the section crossing the Sulphur Creek watershed) (USFS 2004b). The parameters that were not properly functioning included relative sediment content in riffles, the density of large woody debris, pool development, width-to-depth ratio, and streambank condition (Goodman 2003).

Surveys conducted in 2006 showed some improvement in stream condition. San Antonio Creek has shown an increase in riparian wetland species along the bank and an improved rating at the lower end of the stream as it exits the preserve. The upper end of San Antonio Creek from the headwaters of the Valle Toledo to below the confluence with the Rito de los Indios was well above the minimum required for proper functioning condition, as were the intermittent reaches around and above the stock tank. Several small head cuts associated with bogs above the stock tank have the potential to continue upstream and could pose a future threat to the headwaters (McWilliams 2006).

In 2000, the majority of San Antonio Creek did not meet state water quality standards for its designated uses because of temperature, total suspended solids,

fecal coliform, and stream-bottom sediments (VCT 2002). However, in 2002 NMED found that conditions had improved somewhat, citing only temperature and turbidity as concerns between the confluence with the East Fork of the Jemez River and the headwaters of San Antonio Creek (State of New Mexico 2002). Five stream temperature stations were strategically placed along the length of San Antonio Creek. The stations recorded water temperatures every four hours between June 11 and November 24, 2002. The water temperature data were compared to both USFS and NMED standards. The USFS standards classified San Antonio Creek as not properly functioning for salmonid (trout) development at all sites except station 5, located near the headwaters. The NMED standards classified two of the five sites as not properly functioning for water quality (State of New Mexico 2002).

In 2003 NMED found that San Antonio Creek was generally in accordance with standards based on surveys at two sites, although summer water temperatures had exceeded the recommended 73°F (23°C) maximum (or 68°F [20°C] for a four-hour duration), the pH of the stream was neutral to basic and often exceeded 8.8, and ammonia and aluminum levels occasionally exceeded water quality standards (Vieira and Kondratieff 2004).

Using benthic invertebrate surveys, Spann, McWilliams, and Jacobi (2000) rated San Antonio Creek as slightly impaired. The dominant organisms found were primarily those tolerant of altered aquatic habitat (VCT 2002). San Antonio Creek was found to have moderate diversity, with 32 species (Vieira and Kondratieff 2004).

Rito de los Indios Watershed Management Unit

Rito de los Indios, located in the Rito de los Indios subwatershed, is a spring-generated, four-mile-long tributary to San Antonio Creek. This stream is very shallow, with the tops of most substrates exposed (Vieira and Kondratieff 2004). Water temperatures remain cool throughout the summer. The dominant bed substrate includes gravel and cobble, and large woody debris can be found throughout the creek channel in the forested reaches.

Earlier surveys characterized 2.6 miles of Rito de los Indios as functioning at risk and 1.4 miles as being in proper functioning condition (USFS 2004b). The reach above the confluence with San Antonio Creek was assessed as impaired due primarily to the amount of sands and silts in the gravels.

In 2006, the watershed management unit had improved, and degraded channels had begun to stabilize. Rito de los Indios also showed improvement in species composition on the banks and expansion of riparian wetland vegetation both toward the stream and into the floodplain. The entire length of the Rito de los Indios watershed management unit was considered to be in proper functioning condition or better (McWilliams 2006).

Benthic invertebrate surveys performed during 2000 indicated that the stream reach was nonimpaired (Spann, McWilliams, and Jacobi 2000). Among the running water habitats, small creeks with well-developed riparian vegetation (such as Rito de los Indios) were the most diverse and had the highest number of benthic species (Vieira and Kondratieff 2004).

San Antonio Creek Watershed Management Unit—Lower Section

The lower section of San Antonio Creek in the preserve is located in the San Antonio subbasin of the Sulphur Creek sixth-order watershed. This section of San Antonio Creek is approximately 2.5 miles long, all of which is functioning at risk.

Sulphur Creek Watershed Management Unit

The acidic, 5.6-mile-long Sulphur Creek showed very low benthic diversity (6 species), receiving a rating of "least diverse" (Vieira and Kondratieff 2004). Sulphur Creek is a second-order stream (created by two first-order streams joining) named for its high sulfur content. Its acidity (pH of 2 to 4) makes it one of the most unique habitats on the preserve. Most of the drainage is characterized by geothermal activity and sulfur springs (Vieira and Kondratieff 2004).

The stream length of herbaceous and limited shrub riparian vegetation has increased since 2000. Earlier the riparian/wetland vegetation extended to a point just above the confluence with Alamo Creek. Today the riparian/wetland vegetation has extended its range to the stock tank at the lower end of the Valle Seco. Acidic deposition along Sulphur Creek is natural and, although this stream has been cited for exceedances regarding conductivity and pH (State of New Mexico 2002), this stream has been rated as being in proper functioning condition (McWilliams 2006).

Alamo Creek Watershed Management Unit

Alamo Creek is a small stream approximately 2.1 miles in length that feeds into Sulphur Creek at lower elevations. It is characterized by geothermal activity and sulfur springs. The primary substrate of the first-order tributary is cobble and gravel, and the entire streambed is covered in a white precipitate. This tributary and pools feeding it are geothermally active (Vieira and Kondratieff 2004, as cited in VCT 2009b). The acidic wetlands complex in Alamo Canyon showed the least benthic diversity (no species) of all sampled (Vieira and Kondratieff 2004, as cited in VCT 2009b). Alamo Creek has been rated as being in proper functioning condition (McWilliams 2006, as cited in VCT 2009b).

Redondo Creek Watershed Management Unit

Redondo Creek is approximately 5.4 miles long. A benthic survey in 2004 documented 39 species, which is the most of any stream on the preserve (Vieira and Kondratieff 2004). The lowest site sampled was at the Redondo gate along the preserve's western boundary, where the cool-water, first-order creek runs predominantly through meadow habitat, with some conifers on hill slopes and riparian vegetation along the banks. The substrate consists of cobble and sand, with coarse woody debris present on the streambed and along the margins. Riparian vegetation is better developed at upper sites. Cobble and gravel substrate dominate these upper sites, and coarse woody debris is more prevalent than at the Redondo gate site. While temperatures and ammonia levels typically remain at or below water quality standards, aluminum standards are often exceeded (Vieira and Kondratieff 2004). Exceedances for temperature and turbidity were also documented for Redondo Creek in 2002 (State of New Mexico 2002).

One segment of this stream was rated as functioning at risk with an upward trend, and two segments were rated as being in proper functioning condition (McWilliams 2006). There are concerns about Redondo Creek in Redondo Meadow below the road junction of VC02 and VC03 and extending for approximately a half mile to the northwestern end of the meadow. This segment could be a candidate for site-specific action to speed recovery. The old drill pads have stabilized and the riparian/wetland areas are improving, with a robust shrub component.

Wetlands

The USEPA describes wetlands as the link between the land and the water, further identifying them as "transition zones where the flow of water, the cycling of nutrients, and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soils, and vegetation—making these areas very important features of a watershed" (USEPA 2002). Wetlands are defined under the Clean Water Act as "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (Environmental Laboratory 1987). Wetlands have three general diagnostic characteristics:

1. hydrophytic (water loving) vegetation
2. hydric soils
3. wetland hydrology

The preserve includes a number of unique aquatic and wetland features, ranging from warm and extremely acidic geothermal waters to numerous springs, seeps, and boggy wetlands. These water-rich environments, combined with the preserve's many creeks and streams, provide a foundation for the ecological diversity and productivity that characterize the preserve.

Wetlands are scattered throughout the valles of the preserve, especially in the Valle Grande, Valle San Antonio, and Valle Toledo (figure 3-37). The majority of these wetlands are in the montane wet meadow and montane wetland vegetation communities, as described by Muldavin et al. (2006) in the "Vegetation" section of this chapter. These wetlands are generally classified as palustrine emergent by the Cowardin et al. (1979) system. Additional wetlands are associated with the montane riparian shrublands vegetation community.

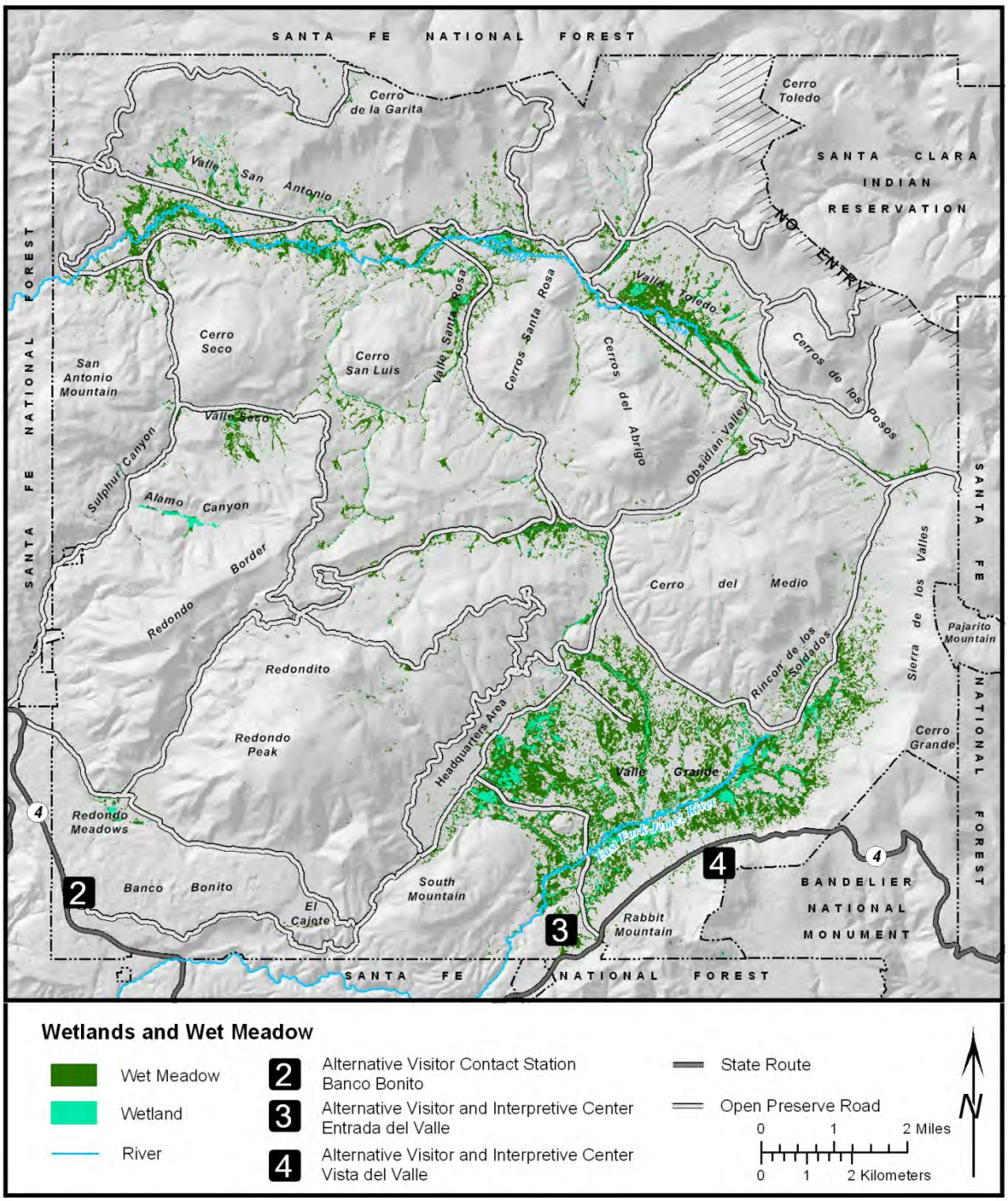


Figure 3-37: Wetlands

Groundwater

New Mexico's groundwater is concentrated in five areas, with a large portion of the state having no easy access to groundwater (Bechdol, Pham, and Martinez 2009). The preserve is underlain by the Rio Grande Aquifer System, which is a network of hydraulically connected alluvial aquifers located along the Rio Grande Valley and nearby valleys. New Mexico does not have an ambient groundwater quality monitoring program. Information on water quality is generated by area-specific studies conducted by the Ground Water Bureau of the NMED and others, including the USGS (Bechdol, Pham, and Martinez 2009). One such study was conducted for the Espanola basin surrounding Santa Fe, but this study did not extend into the Jemez Mountains. According to point-of-diversion data from the New Mexico Office of the State Engineer, approximately 28 points of diversion are located in the preserve, most of which provide water for livestock but several of which also provide water for domestic use (figure 3-38).

The inherent character of a caldera offers only low-volume, shallow (less than 500 feet) water wells, with deeper wells encountering the toxic water created by volcanic action. Subsurface water in the preserve has characteristics such as high concentrations of sulfur and arsenic, which make it undesirable for drinking water (Griffin 2009).

Floodplains

FEMA has mapped floodplains along several of the major streams in the preserve, including San Antonio Creek, Jaramillo Creek, and the East Fork of the Jemez River in Valle Grande. Approximately 2,280 acres of the preserve fall within a mapped 100-year floodplain. Seventy-five percent of these floodplains are in the Valle Grande (see figure 3-39).

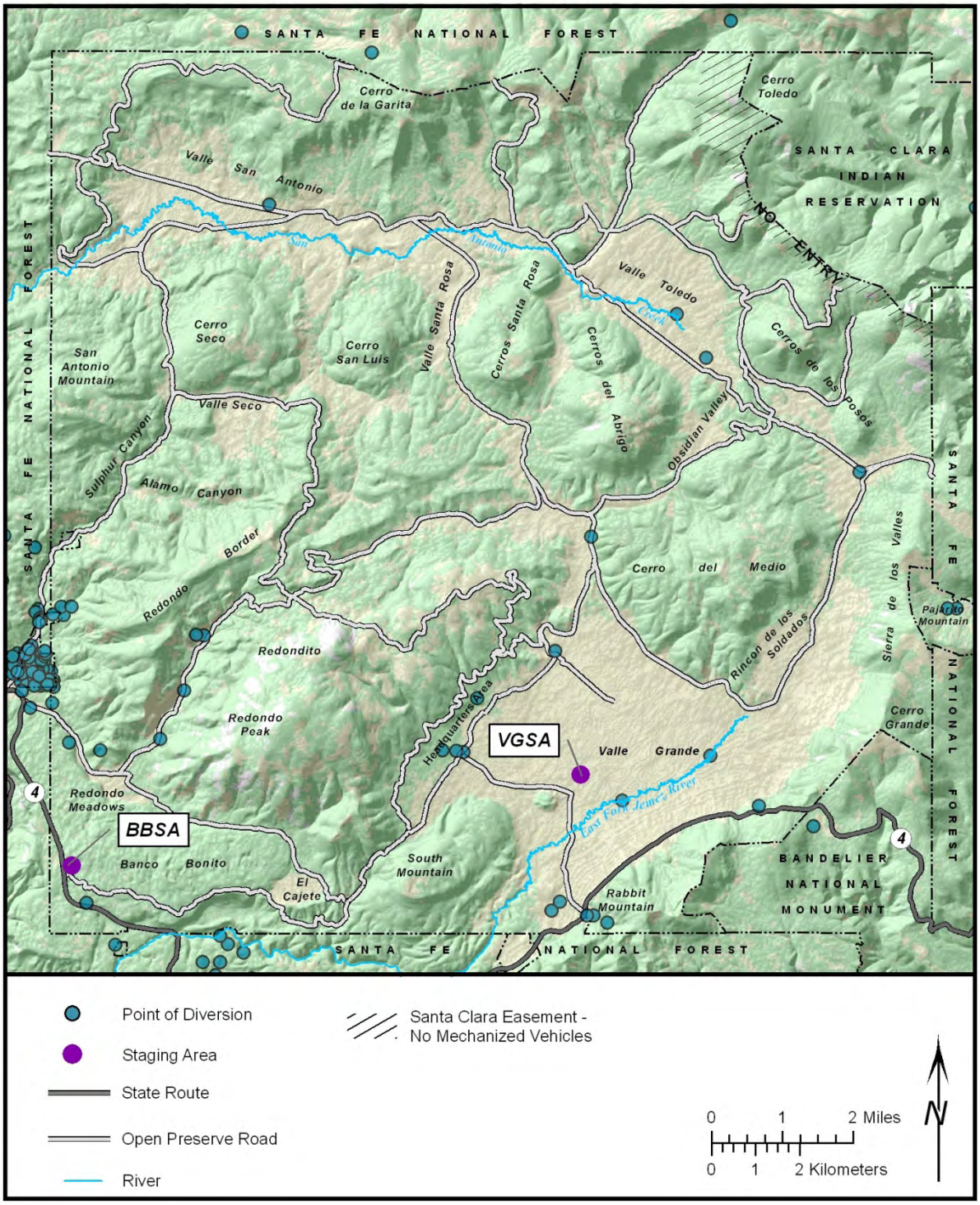


Figure 3-38: Groundwater Points of Diversion

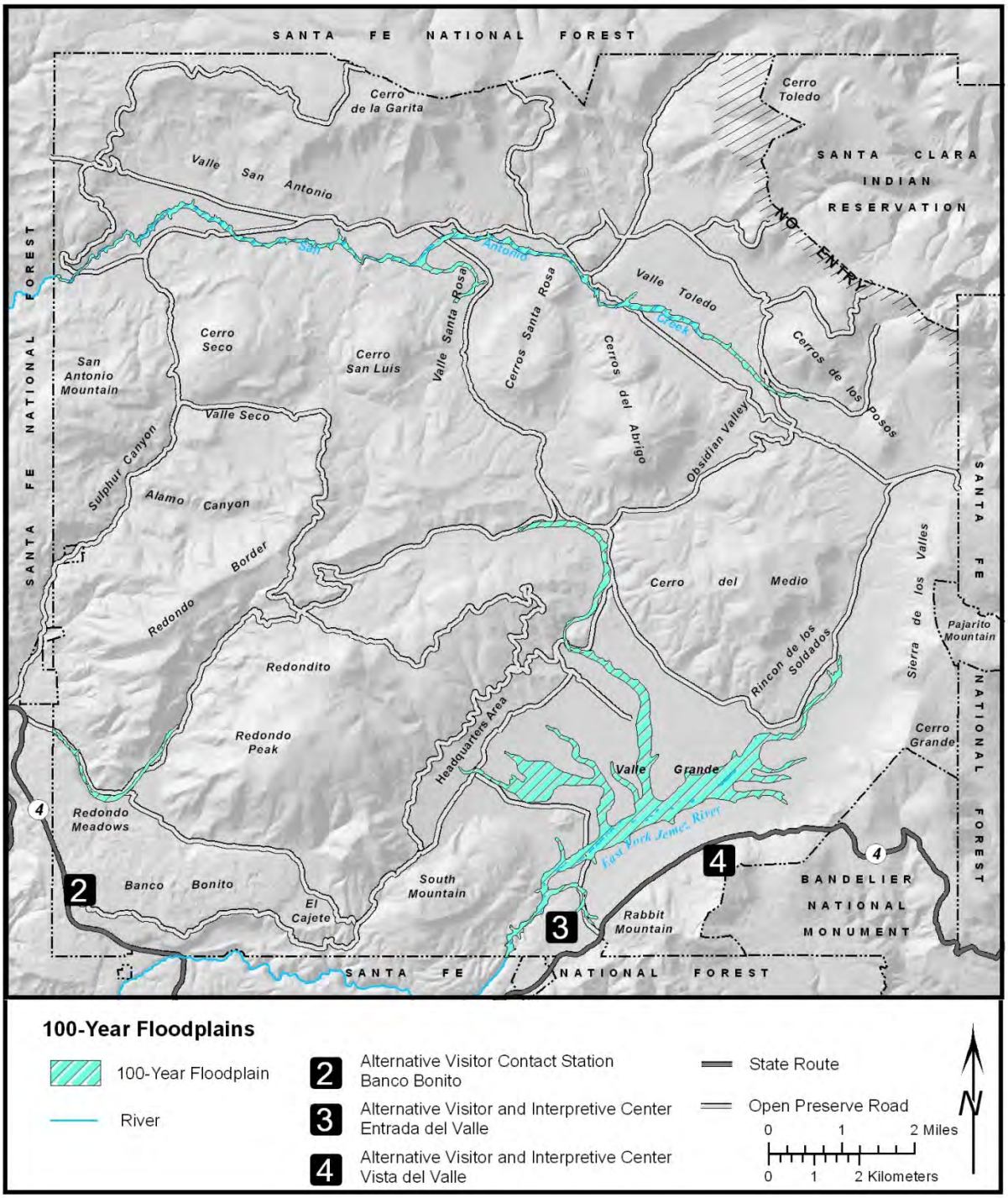


Figure 3-39: 100-year Floodplains

Natural Sounds

Part of the reason people enjoy recreating outdoors is to experience the sounds of nature. The preserve's existing natural sounds could be affected by sound-generating activities expected under the proposed alternatives, including the no-action alternative. These effects would arise primarily from noise produced by visitors at visitor center or visitor contact station locations and recreation areas, as well as noise from local highways and from road use in the preserve in the long term. Short-term construction activities would also produce noise. Noise is an interpretation that the magnitude of a sound has reached unacceptable levels, durations, or qualities in a particular context or setting (USFS and USEPA 1980). Noise-generating activities could affect visitors and wildlife. This section describes how sound is measured and also describes the preserve's existing natural sounds.

Study Area

The study area for evaluating impacts on natural sounds for implementation-level decisions is the specific proposed visitor contact station / visitor center location for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

Sound Fundamentals

The preserve's existing natural sounds could be affected by noise produced by visitors at visitor centers, visitor contact stations, and recreation areas, noise from local highways and from road use in the preserve, and short-term construction activities.

Sound is a physical disturbance in the air created by vibration. The disturbance propagates away from what is vibrating, like ripples propagating away from a pebble dropped into a still pond (USFS and USEPA 1980). Sound is measured in a logarithmic scale using units called decibels (dB). Sound is composed of various frequencies, but the human ear does not respond to all frequencies. The A-weighted decibel scale is commonly used to describe noise levels because it emphasizes the frequencies of human hearing. Sound levels measured using an A-weighted decibel scale are generally expressed as dBA (Federal Highway Administration [FHWA] 2010). Table 3-22 shows a range of decibel levels for recognizable sounds.

Because sound is a physical quantity, it can be measured. Its three primary parameters are described below (USFS and USEPA 1980):

- amplitude: measured in decibels; determines loudness
- frequency: measured in Hertz (Hz; cycles per second); determines pitch
- duration: measured in seconds, minutes, hours, or days; is elapsed time

The appropriateness of a sound depends on a person's expectations for a particular setting. The USFS developed a range of appropriateness for human-related sounds in recreation areas through the provision of a diverse set of opportunities. These opportunities fall into four categories, as described below (USFS and USEPA 1980).

Table 3-22: Common Sounds and Their Associated Noise Levels

Source	Level
Normal breathing	10 dBA
Rustling leaves	20 dBA
Whisper	20–30 dBA
Quiet rural area at night	32–35 dBA
Ambient (background) noise in an average home	50 dBA
Normal conversation at 3 feet	60–65 dBA
Vacuum cleaner	60–82 dBA
Freeway traffic at 165 feet	70 dBA
Noisy urban area during daytime	70-80 dBA
Garbage disposal at 3 feet	80 dBA
Pick-up truck (55 mph at 50 feet)	80–82 dBA
Chainsaw	85 dBA
Rock concert	90–115 dBA
Jet flyover at 1,000 feet	110 dBA
Apollo space shuttle liftoff	188 dBA

Source: CPUC 2009; Michael Minor and Associates 2001.

Modern Opportunities

"Modern opportunity" sounds are typically considered "noisy." A variety of both mechanical and nonmechanical sounds is acceptable at levels close to that found in urban residential environments. Sounds may be of long duration and frequent occurrence, and may occasionally be heard during late hours of the night. Sounds that reach well beyond the sound source are considered acceptable (USFS and USEPA 1980). Activities and facilities proposed under the alternatives that fall under this category include the following at the implementation level:

- traffic on NM-4

Semi-modern Opportunities

"Semi-modern opportunity" sounds have the same sources as modern opportunity areas, but the loudness, repetitiveness, and duration are noticeably less. Sound impacts are occasionally evident beyond the general area of their source (USFS and USEPA 1980). Activities and facilities proposed under the alternatives that fall under this category include the following implementation- and programmatic-level elements:

- the visitor contact station / visitor centers and connected infrastructure and facilities, including parking, group staging areas, and restrooms
- the use of Level 3 roads by personal vehicles or shuttle buses (see "Transportation" section for description of road levels)
- transportation infrastructure, including parking areas not associated with the visitor contact station / visitor centers
- infrastructure to disperse visitor use

Semi-primitive Opportunities

"Semi-primitive opportunity" sounds are primarily natural. Human-related sounds occur less often than in the semi-modern category, last for a shorter period of time, and are infrequent during the night. Sound impacts are generally confined to the general area of their source (USFS and USEPA 1980). Activities and facilities proposed under the alternatives that fall under this category include the following programmatic-level elements:

- the use of personal vehicles on Level 2 roads
- hiking
- hunting
- fishing
- biking
- horseback riding
- guided tours
- special events
- camping in campgrounds

Primitive Opportunities

Sounds under the "primitive opportunity" category are generally not human-related and are primarily natural background sounds, such as wind or water. In the most primitive areas, both mechanical and unnatural, nonmechanical sounds are inappropriate. Sounds do not extend beyond the immediate area of their source (USFS and USEPA 1980). Human-related sounds generated by activities and facilities proposed under the alternatives that fall under this category include the following programmatic-level elements:

- the use of Level 1 roads by hikers and bikers
- backpacking
- snowshoeing
- cross-country skiing

Even though the presence of a variety of sounds may be acceptable in a given situation, there are norms regarding the duration, repetitiveness, and timing of such sounds. For example, for some modern opportunities, the sound of a chainsaw or motorcycle may be entirely appropriate. However, the sound from either can be interpreted as lasting too long or happening too often, or being heard at the wrong time (USFS and USEPA 1980).

Sound Propagation

Several factors affect how loud a particular sound seems to a listener. As sound waves travel through the air, they lose energy (i.e., the amplitude decreases) through the mechanisms described below (USFS and USEPA 1980). The degree of

impact also depends on the listener, existing sound levels, and when the noise event occurs. Topographic features and structural barriers that absorb, reflect, or scatter sound waves can increase or decrease noise levels (USFS 2007a).

Spherical Spreading Loss

Noise levels depend on the distance from the noise source and the attenuation provided by the surrounding environment (Caltrans 1998). Spherical spreading is the loss of energy that occurs when sound waves spread over a larger and larger area. The loudness of a sound decreases as the distance between the sound source and the listener increases. Doubling the distance causes a reduction, or loss, in loudness of approximately 6 dB (USFS and USEPA 1980). At distances greater than 50 feet from a sound source, every doubling of distance across a "soft surface" such as vegetation produces a 7.5 dB reduction in sound (Caltrans 1998).

Atmospheric Absorption Loss

Atmospheric absorption is the loss caused by the sound waves imparting energy to the molecules of the atmosphere as the sound travels through the air. This energy loss varies with temperature, elevation (air pressure), relative humidity, and the frequency content of the particular sound. Atmospheric absorption causes the greatest reduction in the perceived loudness of a sound at distances greater than 0.25 mile (USFS and USEPA 1980). Atmospheric absorption loss is greatest at high frequencies and in hot, dry air (Arizona Department of Transportation 2005). Relative humidity describes how close the air is to being saturated. If the relative humidity is 100%, the air is saturated. If the relative humidity is 50%, the air contains half the water vapor required for it to be saturated (North Carolina State University n.d.). The prediction of atmospheric absorption is very complex, because each of these variables affects energy loss in a different way (USFS and USEPA 1980).

Five weather monitoring stations are located throughout the preserve and have been recording annual weather data since 2005. The data show that the driest month is typically June; spring months can also be dry at the headquarters area and near San Antonio Creek. There is no clear pattern for the wettest months or seasons (VCT 2011b).

Foliage and Ground Cover Loss

Trees and shrubs that are between a sound source and listener absorb some acoustic energy, as does the porous surface of the forest floor. The amount of sound absorbed by various types of trees and shrubs varies only slightly (USFS and USEPA 1980). Vegetation can provide a noticeable noise reduction, but to do so it must be at least 15 feet high, 100 feet wide, and dense enough to completely obstruct the line of sight between the source and the receiver. This type of vegetation may provide up to 5 dBA of noise reduction. Taller, wider, and denser areas of vegetation may provide greater noise reduction. The maximum reduction that can be obtained is approximately 10 dBA (FHWA 2010). Evergreens provide a better vegetative screen than deciduous trees (New York State Department of Environmental Conservation [NYSDEC] 2000, 21). At distances of less than 75 feet, even if foliage restricts visibility, the acoustic energy loss is negligible. Beyond

distances of approximately 350 feet, the loss due to foliage does not increase (USFS and USEPA 1980).

Land Forms and Structures

Sound levels can be accentuated or focused by certain features, causing noise at specified locations. For example, canyons or cliffs can cause echoes or reflect sound (NYSDEC 2000).

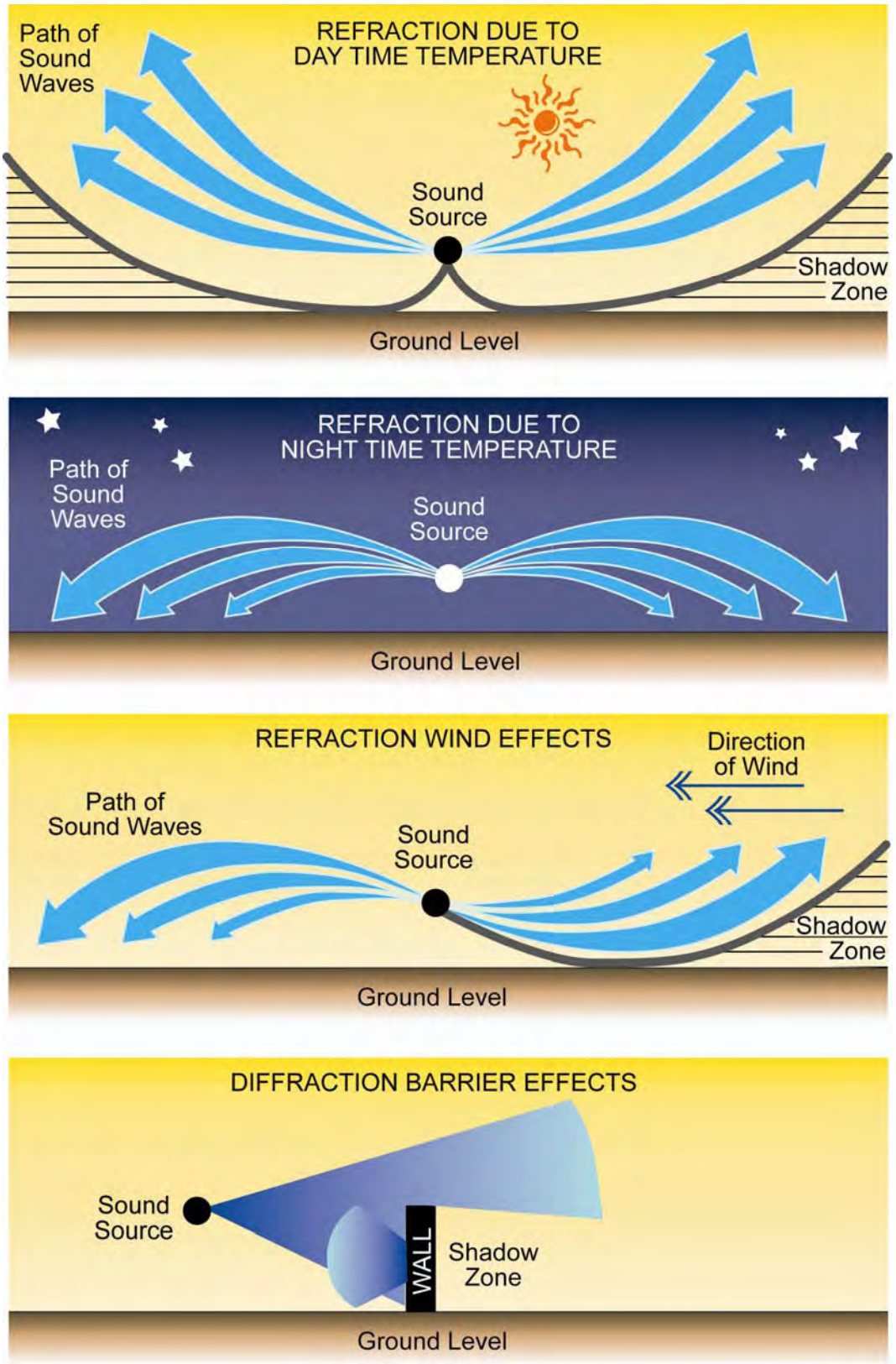
Long-distance Loss

If more than approximately 350 feet exists between a sound source and listener, refraction and diffraction affect sound transmission. Refraction occurs whenever sound waves encounter atmospheric conditions, such as temperature change and wind, that change the speed of sound. Diffraction is the scattering of sound waves around a barrier (USFS and USEPA 1980). See figure 3-40 for a representation of the effects of sound wave refraction and diffraction as a result of temperature, wind, and barriers.

Temperature Effects: As sound waves encounter an atmospheric condition that changes the speed of sound, the waves "bend" toward the direction of lower speed. For example, if the air near the ground is warmer than the air above it, sound waves will bend up toward the cooler air because the speed of sound decreases with a decrease in temperature. At some distance from the bending sound waves, a shadow zone is created. A shadow zone is similar to an optical shadow; sound waves would not directly reach a listener in the shadow zone. Therefore, the sound would seem to be less loud. Sound waves also bend due to differences in day and night temperatures. As temperatures drop toward the ground at night, sound waves bend down (USFS and USEPA 1980).

Fog can occur in valleys as a result of radiative cooling, when cool nights and clear skies allow the ground to cool. A temperature inversion often develops near the ground under such circumstances, when the ground radiates and cools much faster than the overlying air. Colder air on surrounding mountain slopes sinks to and accumulates in valley floors, where the air drops below the dew point and fog forms (Warren Wilson College 2008). This "valley fog" is a common occurrence at the preserve, indicating a temperature inversion, with colder air near the ground (similar to nighttime).

July is consistently the hottest month at all the preserve's weather stations. The coldest temperatures occur December through February. Warmer temperatures are typically recorded on the valle floors, and cooler temperatures at higher elevations (VCT 2011b).



Source: USFS and USEPA 1980.

Figure 3-40: Sound Transmission Refraction and Diffraction Effects

Wind Effects: The wind also causes sound wave refraction. If the sound waves and wind are traveling in the same direction, the wind speed adds to the speed of the sound waves, and vice-versa. Since wind speed generally increases with altitude, sound traveling downwind will bend toward the earth and sound traveling upwind will bend upward (USFS and USEPA 1980). In the daytime, colder, denser air settles downward and forces warm air up the mountain slopes, resulting in "valley wind." At night, air in contact with the mountain slope is cooled and becomes heavier, sinking along the slope and producing "mountain wind," flowing like water down the mountain slope. Mountain winds are usually stronger than valley winds, especially during summer (Weather Explained 2011). As with temperature refraction, wind refraction creates shadow zones, but only upwind of the sound source. An upwind listener in the shadow zone would not hear the sound as being as loud as a downwind listener an equal distance from the source (USFS and USEPA 1980).

In most cases, when winds blow during summer, the dominant forest background sound is the rustling of leaves and tree needles due to the horizontal and vertical movement of air through tree canopies. Because winter winds generally have lower velocities, background sound levels in forest settings are 10 to 15 dBA higher in summer (USFS and USEPA 1980). However, at the preserve the highest wind speeds occur during spring, usually in April. The slowest wind speeds occur during summer months. The highest wind speeds are recorded at the weather station near the headquarters area near preserve road VC02 just south of the intersection with VC01 (VCT 2011b).

Barrier Effects: The scattering of sound waves around a barrier is called diffraction. The amount of scatter depends on the amplitude and frequency of the sound, the size of the barrier, the distance from the sound source to the barrier, and the distance from the listener to the barrier. Typically, the higher the barrier or closer the barrier to the sound source or listener, the more it reduces the level of sound at the listener locations. Raising the barrier or moving it closer to the source creates a larger shadow zone. Because sound waves are subject to diffraction, some sound penetration into the shadow zone formed by the barrier can be expected (USFS and USEPA 1980).

Human and Wildlife Response to Changes in Noise Levels

It is widely accepted that the average human ear cannot perceive noise level changes of less than 3 dBA. A change of 5 dBA is readily perceptible and an increase or decrease of 10 dBA is perceived as being twice or half as loud, respectively (Minnesota Pollution Control Agency 1999). Noise may interfere with human activities, such as sleep, verbal communication, and tasks requiring concentration. Noise may also cause annoyance, hearing damage, and other health-related problems. The degree of disturbance from unwanted sound depends on the amount and nature of the intruding noise and the type of activity occurring where the noise is heard. Because individuals have different sensitivity to noise, the degree of disturbance also depends on the person experiencing the noise. For example, if regions of the preserve are dedicated to enjoying the tranquility and serenity of the natural environment, sounds from vehicular use or hunting would be distracting.

However, if these activities are consistent with the purpose of a particular region of the preserve, these sounds would be considered appropriate. For these reasons, noise is a subjective term requiring consideration of which sounds are appropriate or necessary throughout the preserve, and which sounds are inappropriate (NPS 2010).

Studies of the effects of sound on visitors to national parks have found that visitors consistently rate many natural sounds such as birds, animals, wind, and water as very pleasing. As a result, the presence of unwanted, uncharacteristic, or inappropriate sounds can degrade the visitors' experience. Uncharacteristic sounds or sound levels affect visitors' perceptions of solitude and tranquility and can generate high levels of annoyance. Visitor evaluations of annoyance are affected by many factors, including the setting in which the sounds occur, the visitors' recreational activities, and their expectations of quiet and solitude. The characteristics of the sound also contribute to levels of annoyance. Annoyance is related to the rate of occurrence, duration, and sporadic nature of sounds (NPS 2010).

Studies have shown that, in addition to their effects on humans, intrusive noises and other human-induced noises can result in adverse physiological and behavioral changes in wildlife communities. For example, some sound sources have been associated with increased stress levels, as well as the suppression of the immune system, in wildlife. Additionally, increases in ambient noise levels may interrupt communication networks between insects, birds, and mammals that are necessary for survival and reproduction. Specifically, wildlife communications may signify mating calls, danger from predators, and territorial claims (NPS 2010).

Construction Noise

Noise from construction equipment can vary from intermittent to fairly continuous. Assuming that a truck (90 dBA), scraper-grader (87 dBA), moveable crane (82 dBA), tractor (85 dBA), and two power saws (78 dBA) are operating in the same area, peak construction period noise would generally be about 93 dBA at 50 feet from the construction site (USEPA 1971, cited in USFS 2007a). As the distance from the noise source doubles (beyond 50 feet), the decibel level would decrease by 7.5 dBA. Therefore, using this scenario, peak construction noise would be approximately 40 dBA at a distance of 6,400 feet (1.2 miles) from the source.

Existing Sound Sources

Because the preserve is primarily undeveloped, few sources of human-made sound currently exist in the preserve. Natural sounds include sounds made by insects, rustling leaves, bird and animal calls, and sounds from atmospheric conditions, including thunder, rain, and wind. Although the preserve has no sound monitoring data, wind is likely less audible in the Banco Bonito setting (alternative 2) due to the surrounding vegetation. Sounds from water flowing through the East Fork of the Jemez River can be heard at the Entrada del Valle location (alternatives 3A/3B). Because elk concentrate on the east and north sections of the preserve, which are in or associated with the large grassland valles (VCT 2010g), sounds from bugling elk are likely audible at the Entrada del Valle location (alternatives 3A/3B) and the Vista

del Valle location (alternatives 4A/4B) as the sound propagates across the Valle Grande.

Human-caused sounds affecting the environment include noise from trucks, buses, and automobiles traveling NM-4, which is likely less audible at the Banco Bonito location (alternative 2) than at the other proposed alternative locations due to noise attenuation from the surrounding vegetation. This highway traffic noise would be intermittent but ongoing. Other human-caused sources of noise include visitors recreating on the preserve and maintenance and operations activities performed by preserve staff. These noise sources are also intermittent but ongoing. Aircraft flying overhead causes additional intermittent, recurring sounds.

The level of highway traffic noise from NM-4 depends on three things: (1) traffic volume, (2) traffic speed, and (3) the number of trucks. Generally, the loudness of traffic noise is increased by heavier traffic volumes, higher speeds, and greater numbers of trucks. Vehicle noise is a combination of the noises produced by the engine, exhaust, and tires. The loudness of traffic noise can also be increased by defective mufflers or other faulty equipment on vehicles. Any condition (such as a steep incline) that causes heavy laboring of engines will also increase traffic noise levels. In addition, other factors affect the loudness of traffic noise, as described above. For example, as a person moves away from a highway, traffic noise levels are reduced by distance, terrain, vegetation, and natural and manmade obstacles. Traffic noise is not usually a serious problem for people who live more than 500 feet from heavily traveled freeways or more than 100 to 200 feet from lightly traveled roads (FHWA n.d.b).

Highway traffic noise is never constant. The noise level is always changing with the number, type, and speed of the vehicles that produce the noise (FHWA n.d.b):

- Two thousand vehicles per hour sound twice as loud as 200 vehicles per hour.
- Traffic at 65 miles per hour sounds twice as loud as traffic at 30 miles per hour.
- One truck at 55 miles per hour sounds as loud as 10 cars at 55 miles per hour.

NM-4 is an all-weather, hard surface, fully maintained, two-lane paved highway. The NMDOT classifies NM-4 as a minor arterial. An arterial is a continuous long-distance travel route that connects urban and rural communities. Approximately 2 miles of NM-4 lies within the southwest corner and 4 miles lies within the southeast part of the preserve (VCT 2007b). According to the New Mexico Mid-region Council of Governments, the average weekday traffic volume for NM-4 from its intersection with NM-126 north of Jemez Springs east to Los Alamos County (which includes the preserve) is 800 vehicles in both directions (MRCOG 2011).

Currently, recreational noise occurs primarily at the existing temporary staging areas at Banco Bonito and the Valle Grande. Most of this noise occurs during peak visitation, which takes place on summer weekends, and only when access is

permitted. Since 2008, the preserve has been open seven days a week from April through September for summer recreation and events, and fewer days the rest of the year to accommodate hunting and winter activities (GAO 2009). The VCT provides a variety of core recreational activities, which occur on a regular basis throughout the year, as well as special events. Core activities include hunting, fishing, hiking, wagon rides, equestrian trail rides, and van tours from spring through fall, and cross-country skiing, snowshoeing, and sleigh rides in the winter. These activities require staffing and transportation (VCT 2007b). The types of noises created by these recreational activities vary widely, from the sound of visitors and preserve staff talking to each other, to the sound of vans traveling the preserve's roads, to noises made by firearms used for hunting, all of which vary by type, season, and loudness.

The Valle Grande is the only area in the preserve closed to all hunting, both elk and turkey. Elk hunting in New Mexico with firearms generally occurs during the month of October, with some antlerless hunts in November. Turkey season is April and October (NMDGF n.d.b). These seasons fall outside the preserve's primary peak visitation season, which is summer. As noted in the "Visitor Experience" section, the distribution of hunters is controlled by assignment to hunting units in the preserve. Only one to three hunters are assigned to a hunting unit at any one time. During the hunt, other uses are minimized or prohibited in hunt units (VCT 2007b). Therefore, noise from hunting primarily affects hunters themselves, who likely find the sound appropriate for their activity. Similarly, visitors engaged in other noise-producing activities also likely find the sound appropriate.

There are no specific turkey hunt units because the location of the birds and therefore accessibility can vary considerably from year to year. VCT employees scout the area and then make recommendations to the hunters (Rodriguez, pers. comm. 2011b).

For these reasons, the majority of the preserve currently falls under the "Primitive" recreational opportunities category, where sounds are generally not human caused but are primarily natural background sounds, as described above. The staging areas currently fall under the "Semi-primitive" category, where sounds are primarily natural and are generally confined to the general area of their source. Areas of the preserve along NM-4, such as near the proposed alternative 4A/4B visitor center, would range from "Modern," where sounds are noisy and a variety of both mechanical and nonmechanical sounds are acceptable, to "Semi-modern," where sound sources would be the same but the loudness, repetition, and duration are noticeably less. The range would vary based on the day (weekend vs. weekday), time of day, and season.

Cultural Resources

The proposed alternatives could affect the preserve's archeological resources through clearing, grading, and excavation activities. Archeological and historic resources can also be impacted through theft, vandalism, or unintended disturbance and damage from overuse. Lands of the caldera hold cultural importance for nearby Pueblos, and impacts related to development and public access could affect those areas.

The preserve's cultural resources include archeological, historic, and ethnographic resources. The proposed alternatives could affect the preserve's archeological resources through clearing, grading, and excavation activities associated with constructing a visitor contact station or visitor center and parking lots, new trails, and campgrounds, and improving existing roads. Archeological and historic resources can also be impacted through theft, vandalism, or unintended disturbance and damage from overuse if visitors are provided access to important cultural resource sites. Similarly, lands of the caldera hold cultural importance for nearby Pueblos, and impacts related to development and public access could affect those areas. This section describes the preserve's cultural resources and why they are important, so potential impacts on these resources can be determined for each alternative.

In addition to considering impacts on cultural resources as part of this NEPA analysis, the VCT is also required to comply with Section 106 of the National Historic Preservation Act (NHPA) for this project. The NHPA requires federal agencies to take into account the effects of their actions on historic properties for any federal undertaking. Historic properties are defined as properties that are included in the National Register of Historic Places (NRHP) or that meet the criteria (i.e., "eligible") for listing in the NRHP, the official list of America's historic places worthy of preservation. An effect on a historic property is "an alteration to the characteristics of a historic property qualifying it for inclusion or eligibility for the National Register of Historic Places" (36 CFR 800.16). If an effect is expected (discussed in chapter 4), the VCT must enter into state and tribal consultation. During NHPA analysis, if the VCT determines that its undertaking would have no potential to affect historic properties, the agency has no further Section 106 obligations (Advisory Council on Historic Preservation 2002).

Study Area

The study area for evaluating impacts on cultural resources for implementation-level decisions is the specific proposed visitor contact station / visitor center location for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

Archeology

The archeological record of the preserve yields evidence of human use of the caldera throughout the span of North American prehistory. The caldera offers an extensive record of prehistoric peoples. This includes the encampments repeatedly used over decades or even centuries, obsidian "quarries" (areas of tool manufacture often extending tens of acres in size), and dense concentrations of structures known as "field houses" found at the extreme upper limit of agricultural potential.

The earliest occupation of the American Southwest began during the Paleoindian period from over 12,000 to about 7,500 years ago (10,000–5500 BC). These early sites can be difficult to find because the deposits in which they occur are buried or have eroded over time, or because artifacts from the period are mixed in with

those from subsequent human use at the same locations (Parmenter, Steffen, and Allen 2007). Paleoindian spear points and other flaked stone tools are often made from high-quality lithic (stone) materials, such as chert and obsidian, which have been transported over long distances. The most distinctive of these early artifacts, the finely-made Clovis and Folsom points, have been found as isolated artifacts at a dozen or more locations in and around the Jemez Mountains. Other distinctive Paleoindian point types have been found in the preserve (Steffen et al. 2009; Pinson, Decker, and Hughes 2009). Although no probable Paleoindian campsites have yet been discovered in the preserve, the grasslands and river terraces in the broad valles of the caldera, as well as high-elevation saddles and ridges used as prehistoric transportation routes, are ideal locations for such sites (VCT 2007b).

During the Archaic period (5500 BC through AD 500), the subsistence base shifted from wide-ranging hunting and gathering to a focus on harvesting and processing region-specific plant resources such as seeds and nuts. Ground stone artifacts used in processing plant resources became common for the first time. Flaked stone artifacts often were made of locally available materials; distinctive tool types include a variety of dart points (VCT 2007b).

Numerous archeological sites on the preserve are dated to the Middle and Late Archaic, suggesting that human use increased progressively throughout the Archaic. Excavations in the 1980s and 1990s associated with geothermal and associated power line projects contributed substantially to what is known about the Archaic period in the Jemez Mountains. The numerous large and small scatters of stone tools and debris in the caldera represent a range of uses, from locations used briefly to make stone tools or prepare specific resources (such as game or fish), to small, seasonal camps, to expansive sites that were occupied repeatedly over centuries (VCT 2007b).

Although domesticated maize (corn) entered the Southwest during the Archaic period, dependence on cultivated plants and horticultural practices did not occur until the Ancestral Pueblo period (AD 500–1550). Pottery first appears then, initially as utilitarian ceramics and then in a diverse range of decorated types, including the black-on-white ceramics common throughout the Jemez Mountains. Small chipped stone points suitable for use on arrows first appear at this time. The characteristic round subsurface "pithouses" distinctive to the period before AD 1000 are not known in the preserve (VCT 2007b).

After AD 1000, a shift to aboveground habitation structures appears to coincide with the beginning of agricultural intensification and increased permanence in settlement that continued throughout the period and characterizes the historic pueblos across the Southwest. Small masonry structures known as "field houses," which are ubiquitous in the Jemez area and on the Pajarito Plateau, occur in the preserve on Banco Bonito only, where they are found in abundance. These one- and two-room masonry structures probably were associated with prehistoric agriculture that was possible only at the lower elevations in this area. It is likely that the south-facing, gently sloping landforms on Banco Bonito (below 8,450 feet) offered the only conditions in the preserve suitable for maize agriculture, which may explain why there are no pueblos (i.e., large multi-room settlements, such as on the Jemez Plateau or at Bandelier National Monument) in the caldera.

Large field house with remnants of standing walls at Banco Bonito.

However, the restricted distribution of field houses and absence of pueblo structures is not an indication that Ancestral Pueblo people were not using the higher elevations of the caldera. Rather, sedentary agricultural people in late prehistory probably used the caldera much as it is used today—as an area visited or occupied briefly by most people of the region. While ceramic sherds are a small fraction of the total artifacts present on the preserve, the decorated sherds that have been recovered represent distinctive ceramic types characteristic of many of the cultural groups in the region. Plants may have been cultivated at other locations in the caldera, but these would have been quite different from those that supported Puebloan populations, who relied on maize/beans/squash agriculture (VCT 2007b). Other resources in the caldera, such as tool stone, game, and sacred areas, would have been accessed throughout the Ancestral Pueblo period seasonally, as they had been throughout prehistory.

Historic Period

The historic period in the region began after 1540 when Spaniards first explored the Jemez Mountains. In 1598, Spaniards entered several of the Pueblos, and Spanish missions were established in the Pueblos around New Mexico (including Jemez Pueblo) in the 1600s. After the Pueblo Revolt and reconquest by De Vargas (1680–1692), missions and settlements started again in the Jemez region and a land-grant system was set up to encourage settlement. Settlers brought domesticated livestock and horses and, by the late 1700s, Hispanic settlers and Puebloan Indians were herding cattle and sheep in the valles of the caldera (VCT 2007b).

By the 1830s livestock production had developed in New Mexico to the point that large herds of sheep were exported annually south to Chihuahua, Mexico, and west to California. By that time, the grasslands of the preserve were receiving substantial use. However, the high mountain country was contested terrain. Hispanic ranchers, such as the Baca family of Peña Blanca—the same family that in 1860 would acquire

title to the caldera as Baca Location No. 1— together with Indian herders from nearby Pueblos, had to protect their livestock from the raiding parties of other tribes, notably Navajos, who roamed the region (VCT 2005i). Therefore, pastoral use of the land was risky: Apaches, Navajos, and Utes who hunted in the Jemez Mountains raided herds into the late 1800s (VCT 2007b). In many years up to and through the middle of the 19th century, grazing was probably successful in the remote valles of the caldera. In others, however, hostilities may have prevented grazing of any major scale from taking place (VCT 2005i).

Anglo-American trappers hunted and trapped in the caldera in the 1800s, but the first detailed record of Anglo-Americans occurred in 1851 when a route between Santa Fe and a camp on the northeast portion of the Valle Grande was created. Hay was cut and sent back to Santa Fe to feed livestock owned by the U.S. Army, which had moved into New Mexico Territory in 1846 at the beginning of the war with Mexico for control of the territory (the area became a U.S. territory in 1848). The camp was used seasonally until Navajo raiders attacked it in 1851, forcing its abandonment (VCT 2007b).

Modern livestock operations developed rapidly in northern New Mexico after the arrival of the railroads in the late 1870s and 1880s connected the region to distant markets. The preserve and surrounding areas soon saw heavy use, and by the last decade of the 19th century, if not sooner, tens of thousands of sheep grazed the valles annually through the snowless part of the year. Many of the sheep herders were partidarios—livestock sharecroppers who tended the sheep of a patron and were compensated by a share of the increase of the herd while it was in their care (VCT 2005i).

A legal claim to the caldera occurred in 1860 when the heirs of Luis Maria Cabeza de Baca (who died in 1827) gave up their land grant around Las Vegas, New Mexico, in exchange for five tracts of land in New Mexico Territory as part of a land dispute settlement arranged by the U.S. Congress. The first area the family selected was a square of 99,289 acres around the caldera, which subsequently became known as "Baca Location No. 1." The Baca family began using the land in 1876 when the property boundaries were finalized. The numerous heirs divided the land for raising sheep and stock, but most sold their land claims. By 1881, only a handful of Baca family members still held claims, while other land entrepreneurs who had purchased claims on unclear terms argued over boundary rights. Legal battles (and occasional violent disputes) continued until 1899 when the New Mexico Supreme Court tried to settle the matter by ordering that Baca Location No. 1 be sold at public auction and the proceeds divided among the claimants. Attorney Frank Clancey purchased the land for $16,548 and immediately sold it again to the "Valles Land Company" run by businessmen Mariano and Fredrico Otero, two of the former claimants (VCT 2007b).

By 1909 the Oteros had built a dispensa, or commissary, in the headquarters area of the ranch, from which they provided supplies to herders (VCT 2005i). The Oteros continued cattle ranching and sheep herding, and began mining sulfur at Sulphur Springs on the west side of the property. They opened a hot spring resort that

continued until 1977. They also built the first roads and cabins for office and living quarters. In 1909, they sold the Baca Location to the Redondo Development Company of Pennsylvania, but retained grazing rights on the property. Redondo Development began logging, but completed only small-scale cutting due to transportation difficulties. The company continued leasing land for grazing until two Española businessmen, Frank and George Bond, leased the grazing rights of the Baca Location from the Redondo Development Company in 1918 (Dennison, Steely, and Corbett 2007). The Bonds ultimately acquired title to the property by 1926, although the Redondo Development Company retained logging rights (Dennison, Steely, and Corbett 2007). The Bonds grazed thousands of sheep and built cabins for their families and hired help. They produced millions of tons of wool and dominated the market in New Mexico until World War II when the wool market weakened (VCT 2007b).

Meanwhile, the Redondo Development Company sold its timber rights in 1935 to Firesteel Lumber, who immediately sold the rights to the New Mexico Land and Timber (later named New Mexico Timber Company). The company began logging operations on the Banco Bonito in 1935, just after the Civilian Conservation Corps constructed a road (now NM-4) that made transportation of logs much easier. They set up a logging camp in Redondo Meadows and later in the north portion of the property. They continued logging until the early 1970s, cutting trees on 50% of the property and creating over a thousand miles of logging roads (VCT 2007b). These operations continued with growing intensity until 1972 and left a heavy imprint on the forests, soils, and watercourses of the preserve (VCT 2005i).

When Frank Bond died in 1945, his son Franklin began running more cattle than sheep; by 1960, sheep had been replaced by cattle. By this time, the Bond family wanted to sell the property, expressing interest in the federal government as a potential buyer, an idea that conservationists and legislators had hoped for since the late 1800s. The plan was disrupted in 1963 when the property was sold for $2.5 million to the Baca Land and Cattle Company, run by wealthy Texas oilman James Patrick Dunigan. The Dunigan family converted the ranch to a yearling operation, receiving steers in May after snowmelt and shipping them in September before the cycle of snowfall began again. As the elk population throughout the Jemez Mountains increased in the last decades of the 20th century, the Dunigan family developed a vigorous and well-known trophy elk-hunting program. Dunigan built cabins and a guest lodge at the north edge of Valle Grande, maintaining the land as a cattle ranch and elk hunting location (VCT 2007b). The family also successfully attracted the interest of filmmakers and advertisers, who set their stories and products amid the scenery of the caldera. Today three movie sets remain in the caldera, one of which was used in the production of the motion picture *The Missing* in March 2003 (VCT 2005i).

In 1964, the Baca Land and Cattle Company filed a lawsuit against New Mexico Timber Company seeking damages for destructive logging practices, which eventually resulted in the transfer of timber rights to Dunigan by 1972. In 1973 Dunigan made a deal with Union Geothermal Company to drill several locations on the west side in hopes of harnessing geothermal steam for a power plant.

Approximately 40 wells have been drilled into the rocks and fluid reservoirs miles beneath the surface of the land. Half of these wells were drilled beginning in 1973 in an effort led by Union Oil Company, later in partnership with the Department of Energy and Public Service Company of New Mexico, to develop a geothermal plant generating at least 50 megawatts of electricity. However, by 1984 the caldera's resources were determined to be capable of supporting only a 20-megawatt generating station (VCT 2007b). The plan was then terminated because of Native American concerns about impacts on springs and aquifers outside the caldera and disturbance to sacred land around Redondo Peak, and ultimately due to the lack of sufficient steam to generate the desired power. Today the leveled and cleared drill pads that mark the location of the geothermal wells remain conspicuous features of Redondo and Sulphur Canyons (VCT 2005i).

By the late 1970s, Dunigan wanted to preserve the land for the public and began negotiations for sale of the land with the USFS and National Park Service. Dunigan's death in 1980 disrupted the process; his sons maintained the property primarily as a cattle ranch until 2000, when they sold it to the federal government and it became the Valles Caldera National Preserve (VCT 2007b). The regional ties to the ranching culture and the caldera lands are a major reason that the Valles Caldera Preservation Act instructs the VCT to operate the preserve as a "working ranch" (VCT 2005i).

Components of historic ranching found throughout the preserve include corrals, fences, roads and routes, and water improvements. Many of these same constructions are in use today as part of contemporary ranching infrastructure. Of particular interest are the corrals and cabins located in the north end of the Valle Grande known as the Baca Ranch Headquarters Area historic district. This area and the buildings and features in it will be nominated to the NRHP as a historic district. Some of the structures have been in continuous use for 100 years, while others were put into use in the last 5 years. The average age of all facilities is about 60 years and the overall condition is fair to good (VCT 2007b). Other historic features are hidden throughout the landscape, including crosses carved in old-growth pine trees and signatures carved in aspen trees that represent early 20th century Hispanic sheepherding (VCT 2009b).

The land bears the human-made features of its historic legacy scattered through the preserve, including gravel pits that yielded materials for road construction in the Baca Location. A pipeline also crosses the preserve through the valles San Antonio, Toledo, and Los Posos, bringing natural gas to Los Alamos from the San Juan Basin of northwestern New Mexico (VCT 2005i).

Ethnography

People have used the preserve for a variety of purposes and in a variety of ways for thousands of years. The lands of the caldera hold great cultural significance for nearby Pueblos, which for centuries have been drawn to the caldera to enact pilgrimages, initiations, ritual hunts and collections, and other sacred activities. Native Americans used the preserve for hunting; gathering medicinal plants, wild grains, and other vegetal foodstuffs; and collecting useful materials such as obsidian.

Numerous archeological sites in the preserve give evidence of these uses, which the oral histories told by the elders of neighboring Pueblos also confirm. Various types of wood gathered from the caldera yielded tool handles, baby cradles, rabbit sticks, and clubs. Grasses were cut and fashioned into baskets and brushes. Alder and other tree barks provided dyes. Minerals such as manganese and iron supplied pigment for painting ceramics (Anschuetz and Merlan 2007). According to oral tradition, neighboring Pueblos have long used specific locations in the caldera for cultural and religious purposes. In carrying out their cultural duties, these Pueblos express their belief that they bear a responsibility to respect and perpetuate the vitality of the land through their religious practices (VCT 2005i).

Human use of the caldera grew more intensive with the introduction of domestic livestock to the region. The Pueblos of northern New Mexico took up raising sheep, goats, and cattle, and made tending and using those animals an integral part of their economies. Oral history preserves the memory that the Valle Grande served as pastureland for Indian cattle, sheep, and horses. Elders from Jemez Pueblo remember that the Pueblo's war captains were responsible for ensuring that the Pueblo's horses grazed in different areas to avoid overgrazing. The raising of domestic livestock also became even more central to Hispanic communities in the region (VCT 2005i).

The Valles Caldera Preservation Act specifically authorizes the use of the preserve by Native Americans for religious and cultural purposes. The VCT's policy on tribal access and use allows "pueblos and Indian tribes that have a cultural affiliation to the preserve to have access to the preserve and to allow those pueblos and Indian tribes use of the lands within the preserve for cultural and religious practices" (VCT 2004c). The VCT allows access for the use, collection, gathering, and transport of plants, minerals, wildlife and other resources, and the restoration, repatriation, preservation, and protection of sites for ceremonial activities. A Pueblo or Tribal Governor, or the executive branch of a Pueblo or Indian tribe, makes a request for access and use to the preserve manager. Under federal management, the preserve is restoring to these communities access that was restricted under private ownership.

Many individuals in surrounding communities have deep personal ties to the preserve. They may have worked on the land during the era of logging and road building. They may have spent their childhoods fishing and exploring while their parents or grandparents cared for livestock or performed other work. The VCT respects their requests to visit the preserve and values their knowledge of places and people, which contributes to understanding the history of the landscape. People are creating new ties to the landscape as they hold their personal life events, including weddings and family reunions, on the preserve (VCT 2007b).

Cultural Resource Inventory and Evaluation

An important component of federal cultural resource management practices are mandates to inventory the resource base and evaluate the cultural resources for their eligibility for listing on the NRHP, discussed above. "Historic properties" specifically refers to those cultural resources that meet the criteria for eligibility for

listing on the NRHP, regardless of whether they are formally listed or nominated for listing.

Section 110 of the National Historic Preservation Act outlines the stewardship responsibilities of federal agencies for historic properties owned or in their control, including proactive inventory and eligibility evaluation. The criteria for evaluation for listing on the NRHP (36 CFR 60.4) are the qualities of significance in American history, architecture, archeology, engineering, and culture in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and

- that are associated with events that have made a significant contribution to the broad patterns of our history
- that are associated with the lives of persons significant in our past
- that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction
- that have yielded, or may be likely to yield, information important in prehistory or history

Between 2000 and 2003, the VCT operated under the Region 3 USFS programmatic agreement for the treatment of cultural resources, which provided an alternative standard NHPA compliance procedure for certain classes of undertakings where effects on historic properties and resulting protection and treatment are similar and repetitive. After the creation of the VCT Cultural Resources Program (Compliance Process) in 2003, an independent cultural resources compliance process was initiated to provide procedures for NHPA compliance. The VCT is finalizing formal procedures for NHPA compliance in consultation with the New Mexico State Historic Preservation Office and the Advisory Council on Historic Preservation. The VCT also consults with more than 30 Pueblos and Tribes that have potential cultural affiliations or historic connections with the preserve and surrounding lands. Tribal consultation elicits comments, concerns, and collaboration from Pueblos and Tribes for VCT planning and projects (VCT 2007b).

Cultural Resource Surveys in the Preserve

Little was known about the cultural resources in the preserve at the time of federal acquisition. Between 1981 and 2000, 3,325 acres (3.6%) had been surveyed at a planning level. Since acquisition, an additional 9,700 acres (11%) have been surveyed at a compliance level (Steffen 2011). Planning-level surveys identify the presence of cultural resources, but are not currently considered sufficient to document compliance with Section 106 of the National Historic Preservation Act. Compliance-level surveys identify the presence and absence of cultural resources and are sufficient to document Section 106 compliance.

Between federal acquisition in 2000 and the end of fiscal year (FY) 2010, over 575 historic and archeological sites were documented (table 3-23), including one NRHP-eligible district (the Baca Ranch Headquarters Area historic district). Many of the archeological sites are considered eligible for listing as well.

Table 3-23: Historic and Prehistoric Resources Documented through 2010

Cultural Component	Number of Sites
Lithic scatters	326
Obsidian quarries	31
Rock shelters	20
Field houses	95
Other prehistoric sites	14
Historic standing cabins	13
Historic artifact scatters	27
Other historic sites (e.g., corrals, fences, cabin ruins)	84
Total*	610

* The total is higher than the number of sites (575) because some sites have multiple components.
Source: Steffen 2011.

The VCT has conducted compliance surveys in advance of all projects with the potential for ground disturbance (e.g., road maintenance and upgrades, earthen tanks, a potable water system, facilities development and maintenance, forest thinning and fire use, watershed restoration, and interim programs such as livestock grazing and hiking trails). Current knowledge of the types and condition of cultural resources on the preserve is influenced by the nature and placement of these surveys. Because inventories have been conducted mostly for specific preserve projects and programs, these surveys have tended to overrepresent roads that are in use, areas of current intensive use (e.g., Cerro la Jara, the historic district, and Redondo Meadows), and large-project areas (e.g., Banco Bonito forest thinning and Valle Toledo prescribed burn) (VCT 2007b).

Areas with a high probability for the presence of undocumented prehistoric and historic sites include the saddles between volcanic domes and along the forested edges of the valles. In addition, locations of cultural significance to Native American communities (called traditional cultural properties) occur throughout the preserve, and are common on the tops of high mountains and domes, atop ridges, or along the rim of the caldera (Steffen 2011). Planning for public access trails and facilities will include advance cultural resource inventories so that potential impacts on archeological sites and traditional cultural properties can be considered.

To address the gaps in project surveys, "non-project" inventories have also been conducted that contribute to fulfilling VCT obligations under Section 110 of the National Historic Preservation Act, including surveys on Cerro del Medio and Banco Bonito in 2005. The 2005 survey in the Valle Toledo prior to and after the prescribed grassland fire was designed, in part, to pursue Section 110 goals of knowledge building and preservation. In 2007, 2008, and 2009, non-project surveys were conducted at Vista del Valle near Rabbit Mountain, on the south side of the Valle Grande (Decker 2009, 2010), which is the vicinity of alternatives 4A and 4B. Additional non-project surveys were completed in the Entrada del Valle area, in the vicinity of alternatives 3A and 3B, including north and west of the main entrance, around the nearby cabin built for the movie *The Missing*, and along the south side of

South Mountain. The latter areas included surveys in 2008 and 2009 by the University of New Mexico archeological field school (Pinson 2009, 2010). These non-project surveys areas were chosen to provide contiguous block survey coverage in areas where there was little prior knowledge and where it was anticipated that future planning would be pursued for projects such as public access.

The caldera is renowned for vast obsidian quarries. These obsidian quarries pose challenges to interpretation because they cover large areas and contain vast quantities of obsidian artifacts accumulated over several millennia of continuous use. Intensive and extensive field investigations at large and small sites are needed to accurately detect patterns of changing prehistoric obsidian procurement and use over time.

Obsidian deposits exposed to surface.

The biggest challenge in understanding the preserve's archeological record is interpreting the function and age of the most common type of site found in the preserve: the numerous large and small obsidian artifact scatters (often called "lithic scatters"). The sites could represent complex habitation activities or simpler specialized or brief activities. The artifact assemblages at these sites were created while tool makers worked obsidian collected at geological deposits located on Cerro del Medio, San Antonio Creek, and Rabbit Mountain. People throughout prehistory valued and exploited the abundance, high quality, and large nodule size of this volcanic glass. Obsidian scatter sites can be associated with any cultural group and they often lack artifacts that are distinctive to one or another of the cultural periods. Thus these obsidian scatter sites may represent use 500 years ago, 10,000 years ago, or everything in between (Steffen 2011). Cultural resources surveys conducted through 2010 are depicted in figure 3-41 below.

One large (>83 acres) lithic scatter, site LA 26917, is an example of the richness and potential complexity of the subsurface archeological sites in the caldera. This site was excavated for the VCT by the University of New Mexico Office of Contract Archeology in 2007 as part of ongoing investigations focused on understanding the process by which the site transformed from a place where people lived to how it appears to us today (Worman et al. 2009). The site is now interpreted to be a large settlement or village occupied during the Archaic period over 4,000 years ago. The excavations produced nearly 9,000 lithic artifacts, the vast majority of which were made from the locally available obsidian. Investigations at this site and at other locations in the caldera provide an understanding of the archeological patterning on the landscape to better interpret the archeological record for the public and determine suitable approaches to preservation of surface artifact scatters and subsurface deposits.

In 2006, the VCT evaluated 18 of the historic buildings to establish priorities for preservation based on significance, integrity, and level of deterioration. Of the four standards for the treatment of historic properties—preservation, rehabilitation, restoration, and reconstruction—developed by the Secretary of the Interior for federal agencies, Dennison, Steely, and Corbett (2007) recommended preservation as the most appropriate for the historic buildings. The buildings do not need major restoration, nor do they require reconstruction of missing historic elements. Seven structures are recommended eligible for the NRHP, as is a portion of the the Baca Ranch Headquarters Area as a historic district. The historic and cultural significance of buildings depends on their relationship to cultural and historic themes (e.g., ranching, logging, and geothermal exploration), geographical location (the historic district), and chronological context (Dennison, Steely, and Corbett 2007).

Four family-owned ranching eras provide context for the construction and use of the historic or significant structures on the preserve: (1) the Baca Era (1860–1899), (2) the Otero Era (1899–1917; Otero Cabin, Commissary Cabin, Salt Barn), (3) the Bond Era (1917–1962; Bond Cabin, Ranch Foreman's House, San Antonio Cabin and Barn, Lightning Shack, Greer/Cowboy Cabin, Red Office Building), and (4) the Dunigan Era (1963–1998; Kiva Lodge, A-frame cabins, movie set cabins, horse paddocks and barn, various sheds and outbuildings). Many of the buildings constructed before 1963 have historic significance, and one building constructed after 1963 (the Kiva Lodge) is considered significant. Certain structures in the historic district may not be eligible as individual structures, but they contribute to the character and significance of the historic district (Dennison, Steely, and Corbett 2007).

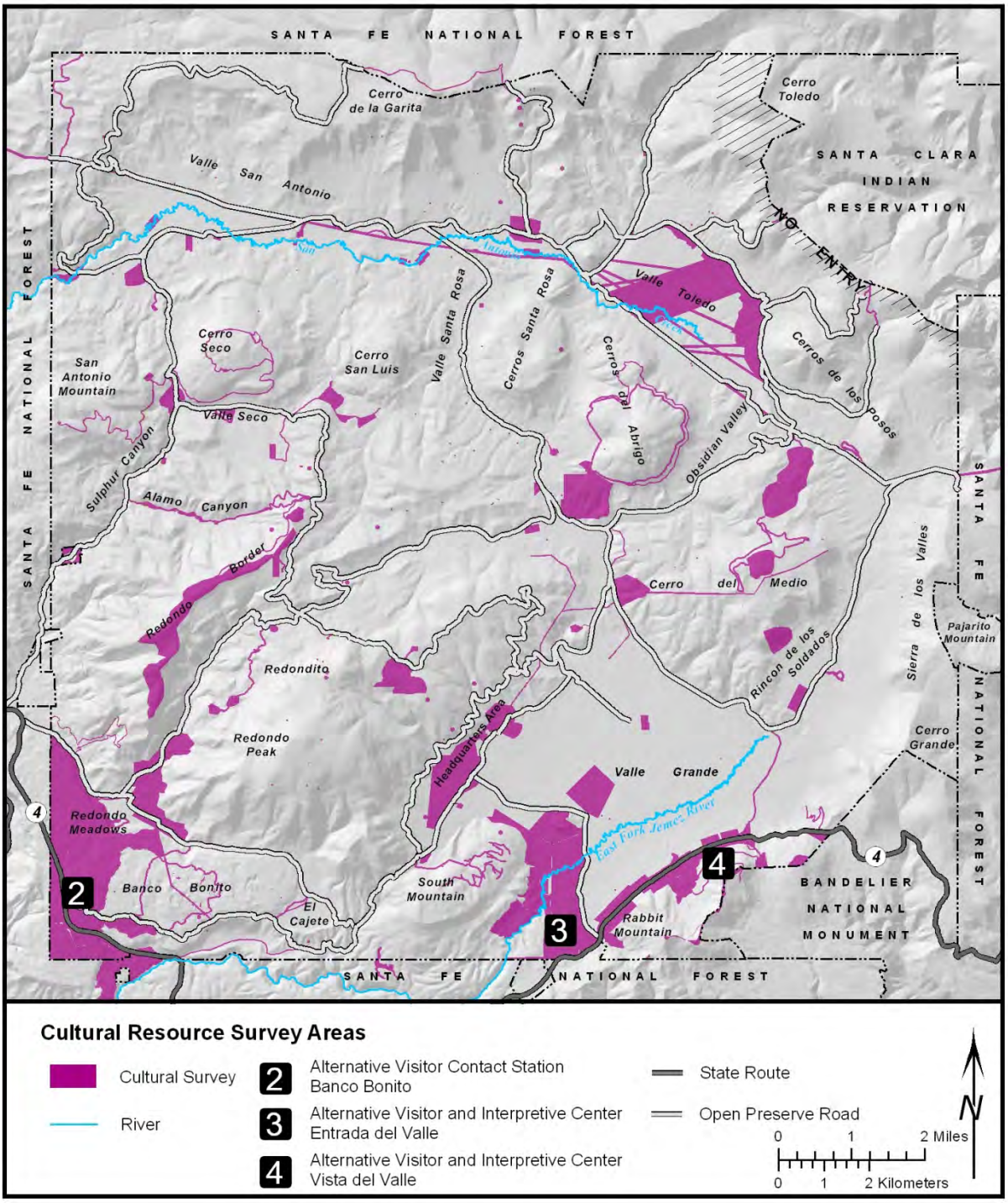


Figure 3-41: Cultural Resource Survey Areas as of Fall 2010

Alternative 2: Banco Bonito Visitor Contact Station

Ten previous cultural resource surveys have been conducted using surface pedestrian methods in or near the alternative 2 area. Based upon the results of these surveys, 13 known archeological sites are located in or near the project area (table 3-24). Most of the sites are prehistoric field houses (small masonry structures associated with prehistoric farming), although nearby sites also possess other agricultural features such as terraces and grid gardens (Civitello 2011). One site is the disturbed remains of a modern-era staging area for logging operations.

Table 3-24: Archeological Sites In or Near the Alternative 2 Location

Site No.	Site Type	NRHP Eligibility Recommendation
LA133536	Field house	Eligible
LA137393	Field house	Eligible
LA137394	Field house	Eligible
LA137395	Field house	Eligible
LA137396	Field house	Eligible
LA148634	Field house	Eligible
LA148635	Rock alignment	Eligible
LA148636	Field house	Eligible
LA148321	Historic/modern sawmill	Not eligible
LA162542	Field house	Eligible
LA162545	Field house	Eligible
LA169946	Field house	Eligible
LA169953	Field house	Eligible

Source: Civitello 2011.

Most of the field houses on Banco Bonito are located on ridges or slight rises adjacent to lands suitable for prehistoric farming. Field house elevations on Banco Bonito in the preserve range from 8,000 feet to 8,450 feet above sea level, which is the upper limit for maize agriculture, where the increased moisture outweighs the risk of a shorter growing season. Other agricultural features constructed to maximize farming success, such as terraces and grid gardens, are also present on Banco Bonito. Although ground visibility obscures surface assemblages at field houses, work completed in Banco Bonito and the surrounding Jemez Plateau has shown that these field houses most often date to the Paliza Phase of the Classic Period (AD 1325–1425) and most likely represent short durations of seasonal occupation and use. The field houses on Banco Bonito help provide an understanding of the period of agricultural intensification for ancestral Puebloans that occurred during late prehistory, including the adaptation techniques concurrent with agricultural intensification in such a marginal, high-altitude environment (Civitello 2011).

Evidence of 20th century logging also exists on Banco Bonito, often as isolated finds, but also as a large historic/modern sawmill and staging area, known as site

LA148321. This site is in the large meadow that is now the parking area at the Banco Bonito Staging Area. No artifacts predating 1970 were found at the site, although it is probable that the area was used for staging during periods after logging started on Banco Bonito (1930s) due to its level terrain and access to NM-4 (Civitello 2011).

Alternatives 3A and 3B: Entrada Del Valle Visitor Center

The Entrada del Valle alternatives are located in an area that was a major transportation route through the caldera during the historic period and possibly the prehistoric period. Six previous cultural resource surveys have been conducted in or near the alternative 3A/3B area. The entire project area has been surveyed by surface pedestrian survey methods. Eleven known archeological sites are located in or near the project area (table 3-25). Most sites are lithic scatters, although some also possess ceramic artifacts and several possess historic trash and livestock-related features. One site possesses an associated rock shelter (Civitello 2011).

Table 3-25: Archeological Sites In or Near the Alternative 3A/3B Location

Site No.	Site Type	NRHP Eligibility Recommendation
LA136371	Historic fence line	Not eligible
LA140138	Lithic and historic artifact scatter with rock enclosures	Eligible
LA140139	Lithic scatter	Eligible
LA156814	Moderate-density lithic scatter	Eligible
LA161922	Lithic artifact scatter with rock shelter	Eligible
LA169963	Lithic scatter and historic features with check dams	Eligible
LA169964	Lithic and historic artifact scatter with check dams	Eligible
LA169965	Lithic scatter	Eligible
LA169966	Lithic and historic artifact scatter with corral	Eligible
LA169967	Lithic scatter	Eligible
LA169968	Lithic scatter	Eligible

Source: Civitello 2011.

The lithic scatters in the project area are characterized by light and moderately dense assemblages of obsidian debris with occurrences of informal and formal tools, including distinctive dart points that date to the Archaic period. A rock shelter and rock enclosures are associated with two of the lithic scatters. Historic trash and livestock corrals/pens are also associated with some of the sites in the project area. The historic trash most often dates from the early 20th century through the mid-20th century (Civitello 2011).

Alternatives 4A and 4B: Vista Del Valle Visitor Center

Seven previous cultural resource surveys have been conducted using standard surface pedestrian survey methods near the alternative 4A and 4B area. Eleven known archeological sites existing in or near the area, including lithic scatters and lithic/ceramic scatters, with one associated rock shelter and one modern stock tank (table 3-26) (Civitello 2011).

Table 3-26: Archeological Sites In or Near the Alternative 4A/4B Location

Site No.	Site Type	NRHP Eligibility Recommendation
LA140136	Lithic scatter	Eligible
LA151598	Lithic and ceramic scatter	Eligible
LA151599	Lithic scatter	Eligible
LA151600	Lithic scatter	Eligible
LA151601	Lithic scatter	Eligible
LA158218	Lithic scatter and ceramic scatter	Eligible
LA162570	Lithic scatter	Eligible
LA162571	Lithic scatter and rock shelter	Eligible
LA162572	Lithic scatter	Eligible
LA162573	Lithic scatter and modern stock tank	Eligible
No data available	Lithic scatter	Eligible

Source: Civitello 2011.

The proposed alternative would be located at the base of Rabbit Mountain, which possesses naturally occurring prehistoric obsidian suitable for tool use. Small pebbles and cobbles of obsidian naturally occur throughout the base of Rabbit Mountain. Prehistoric quarry archeological sites, while not located in the alternative 4A/4B area, are located on other areas of Rabbit Mountain in the preserve. Although the preserve's archeological record is dominated by obsidian artifact scatters, other archeological site types and cultural features attest to the complexity of the cultural landscape that characterizes the area. The ceramic scatters (LA151598 and LA158218) located in the alternative 4A/4B area are particularly notable and important due to the rarity of Ancestral Pueblo and historic era Pueblo sites on the preserve outside of Banco Bonito. LA151598 and LA158218 possess surface and/or subsurface ceramic artifact assemblages, as well as lithic artifact assemblages. Most ceramic artifacts are Tewa type and date to the late prehistoric period (from AD 1500) and Spanish Colonial period through to possibly the late 19th century. Ceramic artifacts are uncommon in the preserve outside of Banco Bonito (Civitello 2011).

Socioeconomics

Socioeconomics is the study of the interrelation between economics and social behavior. Social analysis helps identify desired conditions for social, economic, and ecological environments, and the effects of management activities on social systems in and adjacent to a project area. Economic analysis describes the effects management activities may have on economic conditions in the area. The implementation of the planned access and use plan would affect the area's economic activity through temporary construction employment, long-term operations and maintenance, and increased tourism, with associated impacts on the social life of local residents. This section describes the current state of the socioeconomic environment so that the effects of implementing the alternatives can be understood.

The quantitative data that follow describe a variety of economic and social variables, such as basic demographics, employment, and personal income.

Study Area

The socioeconomic study area is defined as the three-county area surrounding the preserve, including Sandoval County, Rio Arriba County, and Los Alamos County (figure 3-42). Additional detail is also provided in this section on the communities of Los Alamos and Jemez Springs, which may be affected by changes in visitation at the preserve.

Population Growth

The preserve is located primarily in Sandoval County, with a small portion in Rio Arriba County. Because of Sandoval County's strong agricultural ties, many residents rely heavily on ranching operations for both income generation and to maintain historical and cultural activities associated with the ranching way of life. In addition, like many rural areas across the United States, natural resource–based recreation is becoming an increasingly popular source of economic stimulus. Sandoval County encompasses 3,716 square miles and includes six incorporated communities: Bernalillo, Cuba, Corrales, Jemez Springs, Rio Rancho, and San Ysidro (VCT 2010f). The village of Jemez Springs is located on NM-4, which provides direct access by motor vehicle to the preserve. The village had a population of 375 in 2000 and decreased to 250 in 2010 (U.S. Census Bureau 2010c). The population of Sandoval County grew by an estimated 43% from 2000 to 2010, compared with a statewide growth of 12% (U.S. Census Bureau 2010c) (table 3-27). The Bureau of Business and Economic Research (BBER) predicts a 70% increase in the population of the county from 2010 to 2035 (BBER 2008).

Table 3-27: Estimated Population and Growth Rate

Location	2000	2010 Estimate	% Change
Sandoval County	89,908	128,541	43.0
Rio Arriba County	41,190	41,154	−0.1
Los Alamos County	18,343	18,423	0.4
Three-county area total	149,441	188,118	25.9
New Mexico	1,819,046	2,033,875	11.8
United States	281,421,906	309,050,816	9.8

Source: U.S. Census Bureau 2010b, 2010c; BBER 2011b.

The proposed actions would affect the area's economic activity through temporary employment, long-term operations and maintenance, and increased tourism, with associated impacts on the social life of local residents.

Rio Arriba County is located in north-central New Mexico and borders Colorado to the north. Only a small portion of the preserve lies within the boundaries of Rio Arriba County. However, management activities on the preserve may affect the economic condition of local communities in the county. Many cattle ranchers, who could potentially benefit from opportunities to graze on the preserve, reside in the county, and visitors traveling to the preserve may pass through the county, purchasing goods and services from local businesses. In addition to economic ties, the preserve supports a variety of cultural and heritage symbols for local residents. Communities in Rio Arriba County include Abiquiu, Alcalde, Canjilon, Chama, Dulce, El Rito, Embudo, Espanola, San Juan Pueblo, Santa Clara Pueblo, Tierra Amarilla, and Truchas. The population of Rio Arriba County decreased slightly from 2000 to 2010 (U.S. Census Bureau 2010c) (table 3-27). The Bureau of Business and Economic Research predicts a 7% increase in the population of the county from 2010 to 2035. Predicted growth in adjacent counties (2010 to 2035) varies considerably: Los Alamos, 5%; Santa Fe, 17%; and Bernalillo, 64% (BBER 2008).

Los Alamos County borders the preserve to the east. Similar to Rio Arriba County, management activities on the preserve may affect the economic condition of local communities in Los Alamos County. Los Alamos County is the smallest county in New Mexico, encompassing 109 square miles (Los Alamos County 2011). The county includes two communities: the townsite of Los Alamos and the community of White Rock, which are home to nearly all of the county's 18,000 residents. The townsite of Los Alamos is located on NM-501, which intersects NM-4 and provides direct access by motor vehicle to the preserve. Therefore, the townsite of Los Alamos may be more susceptible to changes in access and use in the preserve. The population of Los Alamos County has remained steady over the last decade, increasing by approximately 0.4% between 2000 and 2010 (BBER 2011b).

The closest major metropolitan areas to the preserve are Albuquerque (approximately a 1.75-hour drive over 53 miles) and Santa Fe (approximately a 1.2-hour drive over 50 miles). According to the U.S. Census Bureau, the 2008 estimated population for Albuquerque is 521,999, up from 448,607 in 2000—a 16.4% increase. Similarly, the 2008 estimate for Santa Fe increased to 71,831 from 62,203 in 2000—a 15.5% increase (U.S. Census Bureau n.d.).

Source: VCT 2009b.

Figure 3-42: Regional Map of Valles Caldera National Preserve

Economy

Employment

Impacts in the affected economy may be indicated by one or more of the following measures: employment, income, and revenues contributed to state and local governments. The most recent U.S. Census Bureau data for employment in the socioeconomic study area is for the year 2000. Given the changes in population and possible changes to industry composition, a secondary data source is used to report employment and income for the local region. The New Mexico Department of Workforce Solutions (NMDWS) publishes county-level employment and average weekly wages distributed by North American Industry Classification System (NAICS) industries, including both full-time and part-time workers.

The average employment in the three-county area is 56,717 jobs; approximately 50% of that employment is in Sandoval County (28,798 jobs) and, despite being its being the smallest county in the state, approximately 30% of that employment is in Los Alamos County (17,474 jobs). Table 3-28 reports total employment by industry at the two-digit NAICS code level. The largest employing sector in Sandoval and Rio Arriba Counties is the government, with 7,243 and 4,606 jobs, respectively. In proportional terms, the government is a much larger employer in Rio Arriba County, with 44% of the total employment versus 25% in Sandoval County. Other important sectors for overall employment in Sandoval County include manufacturing, at 15%; retail trade, at 12%; and accommodation and food services, at 11%. Other large employing sectors in Rio Arriba County are health and social services, at 16%, and retail trade, at 12%. Employment in Los Alamos County is dominated by the scientific and technical services industry, at 65% of total employment, based largely on the presence of the Los Alamos National Laboratory (Los Alamos County 2011). The lab employed an estimated 1,129 people in Los Alamos County in fiscal year (FY) 2009 (BBER 2011a). Los Alamos County has the highest weekly wages in the state, at $1,563 (NMDWS 2011). Sandoval County is ranked seventh in the state at $787 per week and Rio Arriba County is ranked eighteenth at $540 per week.

Table 3-28: County Employment by Sector

Employment Category	Sandoval	Rio Arriba	Los Alamos	Total
Agriculture, forestry, fishing, and hunting	69	51	—	120
Mining	54	72	—	126
Utilities	119	132	0	251
Construction	1,827	338	263	2,428
Manufacturing	4,203	196	38	4,437
Wholesale trade	1,250	84	93	1,427
Transportation and warehousing	277	95	—	372
Retail trade	3,380	1,272	374	5,026
Information	884	81	57	1,022
Finance and insurance	865	194	304	1,363

Employment Category	Sandoval	Rio Arriba	Los Alamos	Total
Real estate and rental	336	38	90	464
Professional, scientific, and technical services	647	151	11,417	12,215
Management of companies	24	—	—	24
Administrative and waste services	1,517	258	1,157	2,932
Educational services	288	52	117	457
Health and social services	1,673	1,633	880	4,186
Arts, entertainment, and recreation	553	—	113	666
Accommodation and food services	3,094	962	488	4,544
Other services	495	172	222	889
Government	7,243	4,606	1,852	13,701
Total	28,798	10,445	17,474	56,717

Source: NMDWS 2011.

Note: Employment figures represent the quarterly average.

The transition from an agricultural to a manufacturing-based economy has stimulated much of the population growth in Sandoval County (table 3-27). Although the region was historically agricultural, manufacturing enterprises such as Intel Corporation have opened production facilities and drawn workers to the area. The local area is also rich in natural amenities, which make it a highly desirable location for many residents. Nearby counties whose primary economic driver is agriculture have not experienced such an increase in population. Agricultural jobs have declined in recent years, which has slowed growth in many rural communities (VCT 2010f).

Unemployment in Sandoval and Rio Arriba Counties is slightly higher than the state and slightly lower than national levels, whereas unemployment in Los Alamos County is significantly lower than both the state and national levels, as shown in table 3-29.

Table 3-29: Unemployment Statistics

County	Unemployment Rate (%)
Sandoval County	8.4
Rio Arriba County	8.5
Los Alamos County	3.0
New Mexico	7.4
United States	9.2

Source: U.S. Bureau of Labor Statistics 2011.

Income

Another indicator of the overall health of the local economy is household income. The three counties have very different annual median household incomes. Estimates for 2009 indicate that Sandoval County has a strong median household income ($57,378) compared to the New Mexico state average ($42,830), whereas the median household income in Rio Arriba County ($39,723) is slightly less than the

state average (U.S. Census Bureau 2010c). Median household income in Los Alamos County ($106,148) far exceeds both state ($42,830) and nationwide ($50,221) averages.

Total personal income for each economic sector by two-digit NAICS code is shown in table 3-30 for each county. Total income is the sum of employee compensation, proprietors' income, and other property income. Similar to the distribution of employment, Sandoval County generates the greatest amount of income (46%) in the socioeconomic study area, with Los Alamos County close behind at 39%. The sector responsible for generating the most income in the three-county area is the scientific and technical industry (34%), based largely on the presence of the Los Alamos National Laboratory in Los Alamos County. As shown in table 3-28, this sector accounts for approximately 22% of employment in the area, suggesting that the scientific and technical industry pays well. The government generates 21% of the total income in the three-county area, representing nearly half of the total income in Rio Arriba County. Government employers in Rio Arriba County include the USFS and the Los Alamos National Laboratory. The sector responsible for generating the most income in Sandoval County is manufacturing, which generates 27% of total income, but only 15% of total jobs. One of the larger manufacturing employers in the county is Intel Corporation (VCT 2009g).

Table 3-30: Total Income by Two-digit NAICS Code (U.S. $ Thousands)

Income Type	Sandoval	Rio Arriba	Los Alamos	Total
Agriculture, forestry, fishing, and hunting	455	2,114	—	2,569
Mining	13,202	9,728	—	22,930
Utilities	9,633	9,705	—	19,338
Construction	149,928	25,816	19,570	195,314
Manufacturing	449,824	10,358	—	460,182
Wholesale trade	55,785	6,594	5,417	67,796
Transportation and warehousing	13,845	7,575	147	21,567
Retail trade	111,900	45,529	13,969	171,398
Information	51,675	2,590	3,275	57,540
Finance and insurance	42,024	11,522	19,966	73,512
Real estate and rental	15,607	2,098	4,558	22,263
Professional, scientific, and technical services	69,149	—	1,129,801	1,198,950
Management of companies	1,423	—	—	1,423
Administrative and waste services	67,601	13,558	—	81,159
Educational services	14,238	5,545	9,685	29,468
Health and social services	66,988	73,855	51,806	192,649
Arts, entertainment, and recreation	11,545	1,259	1,908	14,712
Accommodation and food services	64,379	18,986	9,928	93,293
Other services	59,704	20,409	16,624	96,737
Government	391,453	239,256	119,286	749,995
Total	1,660,358	506,497	1,405,940	3,572,795

Source: U.S. Department of Commerce, Bureau of Economic Analysis 2009.

Visitor Spending

The New Mexico Tourism Department (NMTD) surveyed visitors to statewide visitor information centers from October to December 2008. The closest centers to the preserve were the La Bajada Visitor Information Center near I-25 west of Santa Fe, and the Santa Fe Visitor Information Center in Santa Fe. The top two most common destinations were Santa Fe and Albuquerque. Statewide, the majority of visitors (92%) were Americans, with the largest number coming from Texas (18%), followed by California, Colorado, New Mexico, and Arizona. About one in four visitors were making their first trip to New Mexico. The Bajada Visitor Information Center had the most New Mexico visitors. The largest number of foreign visitors was from Canada (46%). Overall average party size was 2.0 adults; 9% of respondents traveled with children, with an average of 2.0 children per party. The average age of respondents was 56 (NMTD 2009).

The average visitor spent 3.2 nights in the state. The length of stay was greatest for visitors surveyed at the La Bajada and Santa Fe Visitor Information Centers. The length of stay was greater for hotel guests with definite lodging plans. The majority of visitors (47%) stayed in hotels, compared to 12% who stayed with friends and relatives, 11% who stayed in RVs, and 5% who camped. Thirteen percent of visitors were passing through and did not spend the night (NMTD 2009).

Total spending in New Mexico among all visitors averaged $660 per trip and $103 per person per night, not counting day trips. The Santa Fe Visitor Information Center, along with Chama to the north, ranked the highest for spending (NMTD 2009).

Overall, visitors' median household income was $69,442, and visitors to the Santa Fe Visitor Information Center had one of the highest median incomes (over $80,000). Median income was higher for those visitors with definite lodging plans than those without (NMTD 2009).

Nearby units of the national park system that offer similar experiences can provide insight into potential visitation trends for the preserve. Bandelier National Monument abuts the preserve's eastern boundary and features many Ancestral Pueblo archeological sites, scenery, and a wide range of plants and animals. Bandelier's cliff dwellings "are some of the most interesting and distinctive archeological remnants to be found in North America" (Great Outdoor Recreation Pages [GORP] 2011). At Bandelier, visitors can explore kivas, cliff dwellings, cave rooms, the Long House Ruin, petroglyphs, pictographs, and a ceremonial cave—cultural features not found at the preserve. The monument also includes over 23,000 acres of designated wilderness (GORP 2011). However, like at the preserve, a variety of outdoor activities are available, including hiking short or long trails, cross-country skiing, bird-watching, horseback riding on specific trails, and camping. Ranger-guided walks and programs are also offered. In the past 10 years (2000–2010), visitation to Bandelier has declined slightly, from 248,276 visitors in 2000 to 234,896—a 5% decrease (NPS n.d.).

Chaco Culture National Historic Park is located northwest of Albuquerque and Santa Fe, New Mexico. The park preserves Chacoan greathouse sites and nearly 4,000 recorded archeological sites. Visitation has been sporadic in the past 10 years, with dramatic decreases occurring in 2008 through 2010. Visitation was 83,337 in 2000, the second highest in the 10-year period. This number fell by more than half in 2008 to 37,180, dropping further in 2010 to 34,226, representing an overall 10-year decrease of 58% (NPS n.d.). The park's northern and southern access routes include 13, 20, and 33 miles of dirt roads, respectively. These sections of road are infrequently maintained, and can become impassable during inclement weather. Chaco is also not located near major cities or towns (NPS 2009). Therefore, visiting the park requires pre-planning; it is not a typical spontaneous recreation destination.

Petroglyph National Monument, located on the west side of Albuquerque, protects a variety of cultural and natural resources, including volcanoes, archeological sites, and an estimated 20,000 carved images. The monument offers several hiking trails to view natural features and petroglyphs. Visitation has followed a steadily increasing trend in the past 10 years, from 61,170 in 2000 to 105,643 in 2010—a 73% increase (NPS n.d.). The increase in visitation to Petroglyph National Monument could be connected to its immediate proximity to Albuquerque, whose population has been increasing. Bandelier and Chaco in particular are more remote and require farther driving from Albuquerque and Santa Fe.

Results of visitor surveys to Bandelier National Monument and Chaco Culture National Historic Park indicate overall high satisfaction with recreational activities (98% and 96%, respectively) and facilities (91% and 95%). The value received for the entrance fee was also rated high (88% and 97%, respectively). Visitors were less satisfied at Petroglyph, decreasing from a baseline average of 2005–2007 (University of Idaho 2009). The preserve would likely draw from the same pool of visitors as Bandelier; Bandelier's visitor surveys may provide insight into expectations for the preserve.

Local and nonlocal visitors to Santa Fe National Forest, which surrounds the majority of the preserve, spent a total of $56,590,000 on visits to the forest in 2007. This included lodging, restaurant meals, groceries, gas and oil, other transportation, activities, admissions and fees, and souvenirs/other. The average total trip spending per party was $320. The majority of visitors (61%) were local (within 50 miles) day users, followed by nonlocal (greater than 50 miles from the national forest) day users (13%). Roughly the same amount of local and nonlocal visitors stayed overnight in the national forest as those who stayed outside the national forest. Of those visitors who stayed overnight, most (33%) rented a private home, followed by those who stayed with friends or family (23%), those who stayed at a campground in the national forest (21%), those who used undeveloped camping in the national forest (14%), and those who stayed in a forest service cabin (4%). The remainder stayed at other campgrounds, lodging, or their own homes (USFS Natural Resource Manager 2010).

Revenue Generation on the Preserve

Revenue generation and visitation have steadily increased on the preserve over recent years (table 3-31) in part due to a variety of interim programs that have been introduced and refined over the short history of VCT management. Recent visitor use and revenue generation numbers indicate a strong potential to generate revenue through visitation, despite the absence of permanent facilities and minimal marketing efforts. In 2002 the preserve hosted only 690 visitors; this number grew to almost 25,000 in 2010 (VCT 2010d). These visitation numbers are based on the number of people who actually participate in an activitiy on the preserve. In 2011 the VCT began to count visitors using statistical methods similar to other public lands. Using advanced counters at 6 locations, and working in consultation with a National Park Service statistician, the number of visitors at the preserve during FY2011 was estimated to be 97,552. This method counted all visitors not just those who participated in an activity (VCT 2011c).

Visitation is expected to continue increasing upon implementation of a new marketing campaign and development of new facilities at the preserve (Entrix 2009).

Table 3-31: Annual Visitation and Revenues for the Preserve, 2005–2010

Year	Number of Visitors	Total Revenue (U.S. $)
2005	9,220	652,219
2006	9,938	794,844
2007	12,405	749,957
2008	15,238	735,528
2009	15,581	609,219
2010	24,784	709,218

Source: VCT 2007b, 2008, 2009g, 2010d.

The steady increase in visitation suggests that there is a growing demand for the types of recreational, cultural, and educational programs offered by the preserve. There has been an annual average increase in visitation of just under 24% per year in the years between 2005 and 2010. The VCT continues to evaluate the preserve's interim programs, which have been in a developmental and experimental stage, to determine which programs are most suitable for continuation in the future. The preserve's recreation programs were expanded into nine areas for 2010: facility rentals, fishing, hunting, summer recreation, hiking, information center, special events, special uses, and winter recreation (VCT 2010d). Many programs are minimal given the limited current infrastructure. The exceptions are the hunting and fishing programs, both of which are much more developed than the other programs and have limited capacity for expansion (Entrix 2009). More information on visitor programs is presented in the "Visitor Experience" section of this EIS.

A breakdown of the recent revenue generation by source is provided in table 3-32. The "miscellaneous" category includes donations, cattle grazing leases, grants, and facility rentals, which generated around $130,000 in 2009 and 2010. Preserve operations on the whole experienced serious drops in revenue generation and visitation in 2009, resulting in a complete evaluation of recreational activities and

opportunities by VCT management and staff (VCT 2010d). As a result, new programs were added, existing programs were modified, and an aggressive marketing plan was put in place. Approximately $4.4 million in revenue funding was invested in the preserve's operations and infrastructure in 2010–2011. Print, radio, brochure, web, and face-to-face marketing combined for more than 7.5 million "impressions," or exposures to marketing advertisements, compared with a little more than 2 million in 2009. This resulted in a very successful turnaround in 2010, with a 59% increase in visitation and a 15% increase in revenue from 2009. The preserve also experienced an 80% increase in recreation volunteer hours from 2009, which allowed for many activities and improvements not covered in the budget.

Table 3-32: Annual Revenues by Public Program Source for the Valles Caldera National Preserve 2005–2010 (U.S. $)

Program	2005	2006	2007	2008	2009	2010
Hunting[a]	285,625	317,365	350,556	368,776	319,547	276,944
Fishing	71,645	60,415	67,392	68,913	34,868	60,281
Summer Recreation	—	—	—	45,811	42,882	52,801
Winter Recreation	—	—	—	19,170	7,930	33,940
Other Events	109,449	76,656	93,828	40,425	23,825	42,880
Concession Sales	9,558	48,496	42,513	54,743	55,052	104,089
Subtotal (Public)	**475,277**	**502,932**	**554,289**	**597,838**	**484,104**	**570,935**
Commercial Rental[b]	5,000	45,095	6,810	—	—	3,500
Grazing	39,654	0	5,800	58,584	—	—
Miscellaneous[c]	131,288	246,817	183,058	35,148	125,115	134,783
Total	**652,219**	**794,844**	**749,957**	**691,570**	**609,219**	**709,218**

Source: VCT 2007b, 2008, 2009g, 2010d.

[a] Data for 2005 through 2006 are for elk hunting; data for 2007 are for elk and turkey hunting combined.

[b] Includes rental fees for commercial film and photography events.

[c] Includes donations, sales of livestock, direct grants, facilities rental, etc.

Commercial uses on the preserve include filming, magazine advertising photo shoots, and services such as catering or commercially offered tours or events. Two Public Broadcasting Service television shows were produced on the preserve. The New Mexico Museum of Natural History, Albuquerque, produced "Sacred Fires, Sleeping Monsters," which presented the geologic history of the preserve, including the role of volcanic obsidian as a source for human weapons and tools. The University of Arizona produced "The Desert Speaks," which featured the preserve's scientific studies on the impacts of climate change in the Southwest. The preserve was used for several commercial filming and photography activities in 2006, including still pictures for magazine and catalog advertisements and one major motion picture. These activities generated $45,095 in revenues (VCT 2007b). As shown in table 3-32, revenue in this area has declined since 2007. However, the preserve had one commercial photo shoot in 2010, and several film scouts indicated that they will

include the preserve in their recommendations for future filming locations (VCT 2010d).

Public Attitudes, Beliefs, and Values

As mentioned above, social analysis helps identify the effects of management activities on social systems in and adjacent to a project area. Social analysis information includes (1) information inquiry and/or formal scoping of public attitudes, beliefs, and values (see chapters 2 and 5); (2) a synthesis of media reports and other secondary data; and (3) primary data collection.

Several newspaper articles have been published in recent years calling for increased public access to and support of a new management approach for the preserve, particularly management by the National Park Service. These articles generally describe the "primary source of controversy" faced by the preserve as public access. An organization called Caldera Action, a "watchdog group," advocates "for increased access and the restoration and protection of the Valles Caldera National Preserve" (Caldera Action 2009). According to the group's executive director, the group wants to "take this property back to the citizens who own it," and has been working towards transfer of the preserve to the National Park Service (Menicucci 2009). The New Mexico Wildlife Federation also advocates for the transfer of the property to the National Park Service, noting that "the preserve limits rather than expands public access" (New Mexico Wildlife Federation 2010). As mentioned in chapter 2, Senate Bill 1689 was proposed to implement that transfer, in part to address the "desire for increased public access" to the preserve (Bingaman 2010).

In 2010, the preserve conducted a public survey to obtain information about people's perspectives on recreating at the preserve; 712 people responded. The following survey questions and responses provide information about public attitudes, beliefs, and values regarding the preserve and access to it (Gagnon 2011):

Since acquisition of the preserve from private ownership in 2000, the preserve has offered adequate access to the public:

- 52.2% strongly disagree or disagree
- 17.7% neither agree nor disagree
- 30.2% strongly agree or agree

Are you satisfied with the level of recreation access experience on the preserve?

- 52.2% strongly disagree or disagree
- 14.6% neither agree nor disagree
- 30.0% strongly agree or agree

What circumstances have prevented you from participating in more, or any, recreational activities on the preserve?

- Limited access: 77.6%

- Limited activities: 40.8%
- Finances: 26.5%
- Lack of information about the preserve: 20.7%

Should there be a limit to recreational access on the preserve?

- Yes: 80.0%
- No: 20.0%

Increasing access to the preserve is more important than the possible negative environmental problems associated with it.

- 52.8% strongly disagree or disagree
- 18.5% neither agree nor disagree
- 28.7% strongly agree or agree

Do you believe a balanced use of the preserve is possible, including livestock grazing, protection of cultural and religious sites, recreation, firewood collection, etc.?

- Yes: 71.7%
- No: 18.0%
- Don't know: 10.3%

What management objective should have the highest priority on the preserve?

- All objectives should be equally weighed: 33.1%
- Ecological restoration and/or resource protection: 31.4%
- Recreation: 26.1%
- Grazing: 4.3%
- Science and research: 2.9%
- Cultural and religious protection: 1.5%
- Revenue generation: 0.7%

Do you prefer the quality or quantity of your recreational experience?

- Quality: 66.0%
- Quantity: 34.0%

Would you be willing to pay an increased fee for a higher quality recreation experience on the preserve?

- Yes: 67.6%
- No: 32.4%

Environmental Justice

In 1994, President Clinton issued Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority and Low-income Populations" (59 Federal Register [FR] 7629 [Section 1-201]). This order requires that "each federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities, on minority populations and low-income populations." The Council on Environmental Quality (CEQ) has oversight of Executive Order 12898 and NEPA, and provides the following definitions to provide guidance on determining the potential presence of environmental justice populations:

This section describes the existing minority, low-income, and Native American populations that could be affected by the actions proposed under the alternatives so that potential impacts on those populations can be determined.

> ***Low-income population:*** *Low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.*
>
> ***Minority population:*** *Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50% or (b) the minority population percentage of the affected area is meaningfully greater[2] than the minority population percentage in the general population or other appropriate unit of geographic analysis. (CEQ 1997b)*

The CEQ guidance on environmental justice also notes that Executive Order 12898 "makes clear that its provisions apply fully to programs involving Native Americans" (CEQ1997b).

In describing how human health and environmental impacts may affect such populations, CEQ's guidance states:

> *Agencies should recognize that the impacts within minority populations, low-income populations, or Indian tribes may be different from impacts on the general population due to a community's distinct cultural practices. For example, data on different patterns of living, such as subsistence fish, vegetation, or wildlife consumption and the use of well water in rural communities may be relevant to the analysis. (CEQ 1997b)*

This section describes the existing minority, low-income, and Native American populations that could be affected by the actions proposed under the alternatives so that potential impacts on those populations can be determined.

Study Area

The study area for evaluating impacts on environmental justice populations is defined as the socioeconomic study area, which is the three-county area

[2] For purposes of this analysis, "meaningfully greater" is defined as 50 percent higher than the minority population percentage in the general population (State of New Mexico).

surrounding the preserve, including Sandoval County, Rio Arriba County, and Los Alamos County (see figure 3-42 in the "Socioeconomics" section). Additional detail is also provided in this section on the communities of Los Alamos and Jemez Springs, which are the nearest population centers to the preserve.

Minority Populations

As defined by the CEQ, a minority is an individual who is Black, Hispanic, Asian or Pacific Islander, or American Indian or Alaska Native (CEQ 1997b). Minority data for New Mexico, the three-county study area, and Jemez Springs and Los Alamos for 2005–2009 are presented in table 3-33.[3] The majority of the individuals in the three-county region are White (73%). However, based on the CEQ definition of a minority population, and using New Mexico minority population percentages as the "general population" threshold, there are American Indian, Asian, and Hispanic populations in the study area. Approximately 72% of the population in Rio Arriba County identify themselves as Hispanic or Latino, which far exceeds the 50% threshold for a minority population. The American Indian population in Sandoval and Rio Arriba Counties (14% each) is meaningfully greater than the population in New Mexico (9%), and the Asian population in the community of Los Alamos (8%) is meaningfully greater than the population in New Mexico (1%) (U.S. Census Bureau 2010a).

Table 3-33: Minority Populations

Jurisdiction	Black	American Indian / Alaska Native	Asian	Native Hawaiian / Pacific Islander	Hispanic / Latino (of any race)
Jemez Springs	0%	2%	0%	0%	13%
Los Alamos	0%	0.5%	8%	0%	13%
Sandoval County	2%	14%	1%	0.1%	32%
Rio Arriba County	0.4%	14%	0.1%	0%	72%
Los Alamos County	0.5%	0.4%	7%	0%	15%
New Mexico	2%	9%	1%	0%	45%

Source: U.S. Census Bureau 2010a.

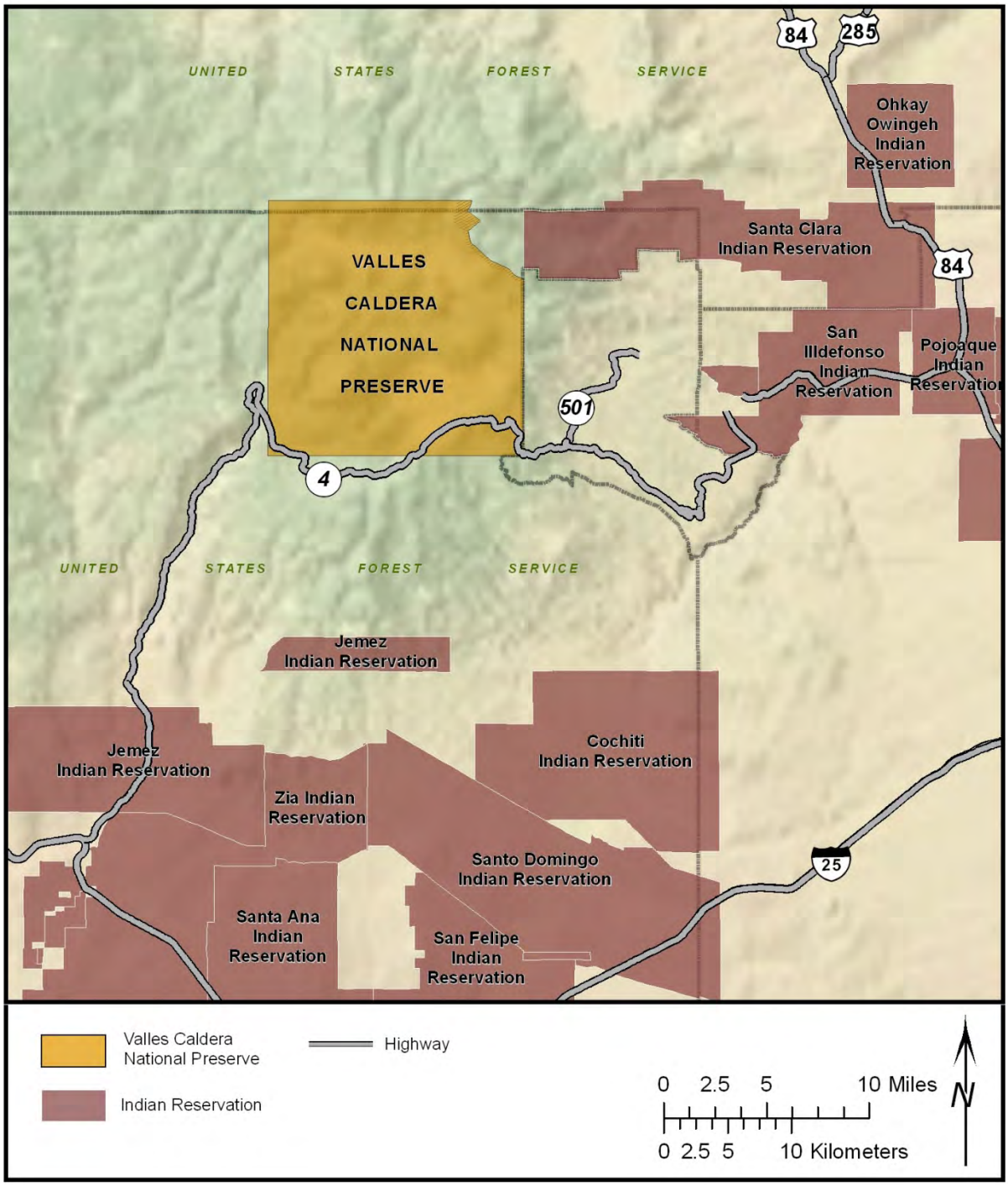
These data are strongly supported by enrollment data from surrounding school districts. Data from the 2008–2009 school year indicate that over 50% of total enrollment is Hispanic in the Jemez Mountain, Espanola, and Bernalillo public school districts. American Indian students constitute 32% of total enrollment in the Jemez Mountain School District, 41% in the Bernalillo School District, and 50% in the Jemez Valley School District. Asian students constitute nearly 6% of total enrollment in the Los Alamos School District, which is reflective of the elevated population percentages in Los Alamos (table 3-33) (New Mexico Public Education Department [NMPED] 2010).

[3] 2010 10-year census data is not yet available for the study area. Population estimates from the 2005–2009 American Community Survey are used rather than 2000 decennial census data.

American Indians and Latinos have a strong history in Sandoval County (VCT 2010f). Many are still actively tied to the agricultural community. The Santa Fe National Forest and the preserve are important resources for many minority residents trying to sustain agricultural operations. The Santa Clara Indian Reservation, home to the Santa Clara Pueblo, shares the northeastern border of the preserve (figure 3-43). The Pueblo has a population of over 10,000, with an estimated 13% of American Indian descent and an estimated 73% of Hispanic or Latino descent (U.S. Census Bureau 2010a). Native American groups consider the preserve a sacred place (VCT 2010d) and have occupied the preserve for generations. Certain landscape features (including mountains, water, caves, volcanoes, calderas, lava rock, shrines, trails, plants, animals, and minerals) serve as focal points for physical and metaphysical interaction. These communities understand themselves to be integral parts of a living historical/ecological process in which the people are as much a part of the land as the land is part of the people. The preserve is more than a geographic place that communities visited to obtain various material resources; it is an essential part of peoples' histories and cultural identities (Anschuetz and Merlan 2007).

Communities interact with the preserve through off-site references in stories, songs, and prayers and periodic on-site visits. Direct visits include game hunting, plant gathering, mineral and other resource collecting, and ceremonial pilgrimages. Hunting, gathering, and collecting expeditions, which might appear to relate solely to economic activity, may include a mix of important social and ceremonial action. The significance of the preserve does not depend on permanent residence; large-scale, land-altering activity; or public ceremonial display. Temporary, small-scale expeditions for hunting, gathering, collecting, and pilgrimage to this place are important to many communities for maintaining and reaffirming their cultural identities. As a landscape feature, the preserve represents an essential stage and symbol of a living cultural process (Anschuetz and Merlan 2007).

Pueblos and Indian tribes with a cultural affiliation to the preserve are given access to the preserve and are allowed to use the lands for cultural and religious practices. Authorized uses may include the use, collection, gathering, transporting, or taking of plants, minerals, wildlife, and other resources or the restoration, repatriation, preservation, and protection of sites to perform ceremonial activities in accordance with traditional rules of practice (VCT 2004c).



Source: Environmental Systems Research Institute 2010.

Figure 3-43: Location of Native American Reservations near the Preserve

Low-income Populations

The term "low-income" refers to a household income that is at or below the annual poverty threshold established by the U.S. Census Bureau (U.S. Department of Health and Human Services 2011). The poverty guidelines are issued each year in the Federal Register and are based on the U.S. Census Bureau poverty thresholds.[4] U.S. Census Bureau data on these established poverty levels for the three-county study area and the communities of Los Alamos and Jemez Springs were used to determine whether low-income populations live in the study area.

According to income estimates for 2005–2009, 18% of individuals in New Mexico are living below the poverty level (table 3-34). This proportion remained unchanged from the 2000 decennial (10-year) census. Poverty levels in Sandoval County are lower, at 11%, and Rio Arriba County is slightly higher, at 19%. Los Alamos County is substantially lower than the statewide average, at 3%. Income estimates for 2005–2009 for the communities of Los Alamos and Jemez Springs are not available. However, data from the 2000 decennial census indicate that 4% and 21% of individuals in those communities, respectively, are living below the poverty level. Approximately 23% of the Santa Clara Pueblo population is living below the poverty level (U.S. Census Bureau 2010a).

Table 3-34: Population below Poverty Level

Jurisdiction	2009 Total Persons	2009 Percent Population	1999 Total Persons	1999 Percent Population
Jemez Springs	ND	ND	103	21%
Los Alamos	ND	ND	429	4%
Sandoval County	13,819	11%	10,847	12%
Rio Arriba County	7,630	19%	8,303	20%
Los Alamos County	560	3%	534	3%
New Mexico	359,030	18%	328,933	18%

Source: U.S. Census Bureau 2010c, 2000.
ND = no data available.

Data from surrounding school districts for the 2008–2009 school year indicate that nearly all the schools close to the preserve are considered "high poverty" based on the proportion of students eligible for the Free/Reduced Lunch Program. Approximately 64% and 78% of students enrolled in Jemez Valley and Jemez Mountain public schools, respectively, are eligible for free or reduced-cost lunches. Those percentages increase to 97% and 100% for students enrolled in Bernalillo and Espanola public schools, respectively (NMPED 2010).

Limited English Proficiency

According to Executive Order 13166, "Improving Access to Services for Persons with Limited English Proficiency," each federal agency shall prepare a plan to

[4] To protect the privacy of low-income communities, poverty level dollar amounts are not included in this EIS but can be obtained at http://www.census.gov/hhes/www/poverty/data/threshld/index.html.

improve access to its federally conducted programs and activities by people who are not proficient in the English language, or by limited English proficient (LEP) people. USDA guidance on implementing Executive Order 13166 is pending. However, the VCT has committed to providing free language-assistance services to LEP individuals whom they encounter or whenever an LEP person requests assistance services.

Data from the U.S. Census Bureau indicate that approximately 24% of the three-county study area speak Spanish as a primary language, and of that group, approximately 4% speak English less than "very well." Rio Arriba County contains the highest percentage of potential LEP people, with approximately 9% of its population speaking English less than "very well." Individuals that speak languages other than English or Spanish at home and speak English less than "very well" each constitute less than 1% of the population (U.S. Census Bureau 2010a).

Approximately 16% of students enrolled in New Mexico public schools are enrolled in the English Language Learners (ELL) program. ELL enrollment numbers for the Jemez Mountain (58%), Espanola (27%), and Bernalillo (37%) public schools exceed the statewide average (NMPED 2010).

Carbon Footprint and Air Quality

The proposed alternatives have the potential to increase the preserve's carbon footprint through increased electricity, heating, and cooling use in the visitor contact station / visitor centers, and through increased transportation to and through the park, including the use of gasoline by personal vehicles. and/or shuttles.

The term "carbon footprint" pertains to greenhouse gases (GHGs), which are gases that trap heat in the atmosphere. Some GHGs, such as carbon dioxide (CO_2), occur naturally and are emitted into the atmosphere through natural processes and human activities. Other GHGs are created and emitted solely through human activities (USEPA 2011a). Human activities have added GHGs to the atmosphere mainly through the burning of fossil fuels and clearing of forests, which also affects air quality. The total set of GHG emissions caused directly and indirectly by an individual, event, organization, or product is referred to as its carbon footprint (Carbon Trust 2009).

Calculating an organization's carbon footprint can be an effective tool for ongoing energy and environmental management. An organization's full footprint encompasses a wide range of emissions sources, from the direct use of fuels to indirect impacts such as employee travel or emissions from other organizations in the supply chain. A basic footprint covers direct emissions and emissions from electricity, which are the simplest to manage. Major emissions sources include the following (Carbon Trust 2009):

- On-site fuel usage
- On-site electricity usage
- Use of transportation

The proposed alternatives have the potential to increase the preserve's carbon footprint through increased electricity, heating, and cooling use in the visitor contact station / visitor centers, and through increased transportation to and through the park, including the use of gasoline by personal vehicles and/or shuttles, which would also affect air quality. The information needed to calculate a basic carbon footprint can be obtained from utility meters and recorded distances traveled by an

organization's vehicles. These figures for fuel, electricity, and transport can then be converted to CO_2 by using standard emissions factors (Carbon Trust 2009). This section describes how the preserve's carbon footprint can be measured, as well as describing its existing carbon footprint and sustainability efforts as a baseline to compare the alternatives.

The proposed alternatives have the potential to impact air quality largely due to transportation associated with substantially increased visitation. Motor vehicles run on fossil fuels, emitting pollutants that are a major cause of poor air quality in varying amounts depending on the type of vehicle, its speed and operating condition (i.e., whether it is warmed up), and the length of the trip. In addition, other factors, such as local topography, meteorological conditions, and other sources of emissions, interact with vehicle emissions to affect regional air quality. Air quality is regulated under the Clean Air Act Amendments of 1990 (CAAA) (Public Law 101-549, 42 U.S.C. 7401, et seq.). To comply with the requirements of the Clean Air Act, the Environmental Protection Agency (EPA) developed national ambient air quality standards (NAAQS) that set allowable concentration and exposure limits for six pollutants—known as "criteria pollutants"—considered harmful to public health, including carbon monoxide (CO); volatile organic compounds (VOC); oxides of nitrogen (NO_x); particulate matter[5] (PM-10); lead (Pb); and sulfur dioxide (SO_2). The NAAQS are expressed as average concentrations of pollutants over a period of time. Highway vehicles are the largest source of transportation-related emissions for nearly all of these pollutants (TRB 1995).

The proposed alternatives have the potential to impact air quality due to substantially increased visitation.

Study Area

The study area for evaluating impacts on carbon footprint and air quality includes GHG emissions in the preserve, such as electricity use at the proposed visitor contact station or visitor center, and transportation-related GHG and criteria pollutant emissions, such as fuel consumed by shuttle buses or vans and by visitors driving in the preserve. The study area for indirect impacts extends outside the preserve to varying degrees to account for visitor miles traveled, transportation of purchased goods and generated waste, etc.

Greenhouse Gases

The dominant factor affecting U.S. emissions trends is CO_2 emissions from fossil fuel combustion, which increased by 21.8% from 1990 to 2007. CO_2 enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees, and wood products, and also as a result of other chemical reactions (e.g., the manufacture of cement) (USEPA 2011a). Human activities, such as using electricity generated from fossil fuel power stations, burning gas for heating, or driving motor vehicles, produce CO_2 emissions. The provision of products or services also indirectly creates CO_2 emissions, because energy is required for their production, transport, and disposal (Carbon Trust 2009). Unlike other forms of vehicle pollution, CO_2 emissions cannot be reduced by pollution control

[5] Particulate matter consists of tiny airborne particles (under ten microns), such as dust, soot, and smoke.

technologies. They can only be reduced by burning less fuel or by burning fuel that contains less carbon (USDOE 2011a). However, CO_2 is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle (USEPA 2011a).

To help identify and address direct and indirect emission sources, three scopes have been defined for GHG accounting and reporting purposes. Together the three scopes provide a comprehensive accounting framework for managing and reducing direct and indirect emissions (World Resources Institute and World Business Council for Sustainable Development [WRI and WBCSD] 2004).

1. Scope 1: Direct GHG emissions. Direct GHG emissions occur from sources that are owned or controlled by an organization; for example, emissions from combustion in owned or controlled boilers, furnaces, motor vehicles, etc.
2. Scope 2: Electricity—indirect GHG emissions. Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the organization. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.
3. Scope 3: Other indirect GHG emissions. Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the organization, but occur from sources not owned or controlled by an organization. Some examples are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services.

The USFS, along with the USDA, plans to reduce Scope 1 and 2 emissions by 21% and Scope 3 emissions by 7% by 2020, relative to an FY 2008 baseline (USFS 2010c).

Scope 1: Direct GHG Emissions

Emissions for Scope 1 can be gathered from stationary and mobile combustion sources, and fugitive emissions (WRI and WBCSD 2004).

Stationary Combustion Sources: Stationary combustion includes combustion of fuels in stationary equipment such as boilers, furnaces, burners, turbines, heaters, incinerators, engines, and flares. The majority of the 38 facilities on the preserve were present at the time of federal acquisition. Some of the structures have been in continuous use for 100 years, while others were placed in use in the last 5 years. The facilities support resource programs and public use by providing work and meeting space, storage and repair areas, visitor information, operational bases, utility support, employee housing, and rental facilities. In order to heat these facilities, the preserve purchases approximately 5,200 gallons of propane annually (Trujillo, pers. comm. 2011b), which yields 379.7 tons/year of CO_2 emissions (CarbonFund.org 2011).

Mobile Combustion Sources: The VCT operates motor vehicles for a variety of activities, including the maintenance of preserve infrastructure (e.g., maintaining fences, repairing facilities, and repairing roads and trails), the management of natural resources (e.g., noxious weed control and fire management), the management of programs such as grazing, and the oversight of scientific research. The VCT also operates motor vehicles related specifically to visitor activities, such as conducting guided tours. The VCT led 1,607 guided tours (representing 6.5% of visitors) in 2009, using vans. The Alamo shuttle route is approximately 20 miles round trip, and the North Rim shuttle route is approximately 23 miles round trip, for an average of 21.5 miles. According to the USDOE, passenger vans get 12 to 15 miles per gallon (assuming a 2005 model), with a carbon footprint ranging from 1.0 to 14.3 tons/year of CO^2 emissions, respectively, based on 15,000 miles of driving per year (USDOE 2011a). Assuming that each route represents the equivalent of one tour and that there was equal demand for both tours (i.e., 803.5 guided tours conducted for each route), the VCT drove tour vans in the preserve approximately 34,551 miles in 2009. The additional 19,551 miles over the 15,000 baseline used by the USDOE represents a 77% increase, resulting in an additional 1.3 to 18.6 tons/year, for a total of 2.3 to 32.9 tons/year of CO^2 emissions for conducting 1,607 guided van tours over 34,551 miles. For the purposes of this analysis, it is assumed that the VCT vans are in the middle of that range, which would be approximately 15.3 tons/year. In addition, VCT staff members drive 15 to 20 miles round trip to the nearest gas station to refuel vehicles.

Visitors also access the preserve using their own personal motor vehicles. Visitation was 24,784 in 2010. Because the VCT can control the number of vehicles and travel distance permitted in the preserve, this combustion source is considered within the realm of Scope 1. Currently, visitors can access specific areas of the preserve using private vehicles only for fishing San Antonio Creek, elk and turkey hunting, special events hosted by the VCT (e.g., Photo Adventure Hunt, Endurance Race, 3D Archery Shoot), and special group events (e.g., weddings) (DeVall, pers. comm. 2011). All other visitors currently are not allowed to drive beyond the Valle Grande Staging Area in their own vehicles (VCT 2007b). Table 3-35 shows the approximate distance traveled by visitors in the preserve, based on the locations of specific activities (which can vary widely) and the percentage of visitors that participated in the activities in 2009.

Table 3-35: Approximate Distance Traveled by Visitors in Preserve, 2009

Activity	Approx. Round-trip Distance Driven	Percentage of Visitors
Fishing San Antonio Creek	20–23 miles	4.9
Hunting elk and turkey	8–52 miles	8.4
Special events	4–26 miles	16.1
Subtotal: percentage driven for specific activities		29.4
Visitors driving to staging area only	4 miles	70.6

Source: VCT 2009.

The VCTestimates that approximately 75,000 to 100,000 miles are driven annually within the preserve under the current program for public access and use. This estimate includes VCT vans used to transport people within the preserve for special events, and use of personal vehicles for hunting, fishing, and other special events (Rodriguez, pers. comm 2012c). Based on Corporate Average Fuel Economy (CAFE) standards, the required average fuel economy for a vehicle manufacturer's entire fleet of passenger cars and light trucks for each model year, the average fuel economy for cars sold in 2001 (the average age of passenger vehicles in the U.S.) is about 27.5 miles per gallon (USDOT 2012). When multiplied by as much as 100,000 miles driven by visitors in the preserve annually, the total carbon footprint from current visitation is approximately 33 tons of CO^2 emissions per year (CarbonFund.org 2011).

Fugitive Emissions: Fugitive emissions result from intentional or unintentional releases, e.g., equipment leaks from joints, seals, packing, and gaskets; hydrofluorocarbon emissions during the use of refrigeration and air conditioning equipment; and wastewater treatment (WRI and WBCSD 2004). Accurate emissions data can usually be calculated from fuel use data, such as for stationary and mobile combustion sources, which is not the case for fugitive emissions. For that reason, fugitive emission controls are described in a context of level of effort.

Currently, maintenance personnel identify and repair any equipment leaks on facilities operated by the VCT. A maintenance schedule requires personnel to routinely conduct inspections of equipment leaks, thereby minimizing emissions from unintentional leaks.

Scope 2: Electricity—Indirect GHG Emissions

VCT staff work in offices located in Jemez Springs, rather than on site in the preserve. Electricity demand at the Jemez Springs site is not expected to change under the action alternatives and therefore was not estimated for this EIS. The current estimated annual electricity usage on the preserve itself is approximately 53,578 kilowatts (Trujillo, pers. comm. 2011c), which yields 649.4 tons/year of CO^2 emissions (CarbonFund.org 2011).

Total Estimated Scope 1 and 2 Emissions

A summary of the total estimated CO^2 emissions for Scopes 1 and 2, as described in this section, is shown in table 3-36.

Table 3-36: Total Estimated Carbon Dioxide Emissions (Tons/Year)

Source	Scope	Estimated CO2 Emissions (Tons/Year)
Propane for heating	1	379.7
Guided van tours and visitor vehicles	1	33
Electricity	2	649.4

Source: Trujillo, pers. comm. 2011b, c; Rodriguez, pers. comm. 2012c.

Scope 3: Other Indirect GHG Emissions

Scope 3 is considered optional, but provides an opportunity to focus on accounting for and reporting those activities that are relevant to an organization's goals and represent large potential emissions reductions, and for which reliable information is available. Experts suggest focusing on one or two major GHG-generating activities (WRI and WBCSD 2004). Activities relevant to this plan include the following:

- the transportation of purchased materials, goods, and/or fuels used for implementation of the alternatives
- the transportation of waste generated by implementation of the alternatives (e.g., disposal of waste generated in operations and disposal of products at the end of their life)

Accounting for Scope 3 emissions does not involve a complete GHG life-cycle analysis of all products and operations, but includes identifying those categories that are relevant (WRI and WBCSD 2004).

No services are currently provided that require purchase and/or transportation of food or materials (e.g., souvenirs) for visitors. Therefore, materials, goods, and fuels are typically purchased to conduct monitoring, maintenance, and visitor recreation activities, such as guided tours. Where possible, the VCT purchases local goods and services. The VCT has also implemented a recycling program. At the Valle Grande Staging Area, the VCT recycles cardboard, aluminum, and plastic. Future plans include recycling paper. At the Jemez Springs offices, the VCT recycles paper, aluminum, plastic, glass, cardboard, and tin, although some is generated by local residents and not VCT operations.

People driving from their homes to visit the preserve also produce GHG emissions. Based on a 2010 visitor survey, visitors from a total of 32 states came to the preserve, from as far away as New Hampshire and Hawaii. However, the survey results showed that the vast majority (84.2%) of visitors were from New Mexico. Texas represented the next highest number, at 3.9%, followed by California at 2.5%, Colorado at 1.5%, and Arizona at 0.7% (Gagnon 2011). Many of the out-of-state visitors may have included a visit to the preserve as part of a broader itinerary including other sites, such as Bandelier National Monument, in which case GHG emissions would be minimal given the national monument's proximity to the preserve. For analysis purposes, it is assumed that the percentage of visitors from New Mexico would not substantially change under the action alternatives.

Based on zip code data collected during the open house the preserve held in 2006, the majority of New Mexico visitors are from Los Alamos and Albuquerque—30.5% and 29.6%, respectively (see "Visitor Experience" section) (VCT 2007b). Fewer than 10% of New Mexico visitors were from Santa Fe, Jemez Springs, and Espanola. Therefore, it is assumed for this analysis that the majority of New Mexico visitors would be from the preserve's region.

Air Quality

The preserve is within the 5,000-square mile Albuquerque-Mid Rio Grande Intrastate Air Quality Control Region (AQCR) 152. Natural factors affecting air quality in the AQCR include spring dust storms and frequent winter inversions. Air quality on the preserve can be assessed in the smaller airshed defined by the fire weather zone 102 in north central New Mexico. The highest number of good to excellent ventilation days occurs during spring and summer, with the greatest number of poor ventilation days occurring during autumn and winter as a result of inversions (when warm air traps pollutants in cooler air below). While the actual number of days where ventilation is excellent versus poor varies annually, the seasonal distribution of conditions is fairly constant (VCT 2010h).

NMED conducts emissions inventories for New Mexico counties for nitrogen dioxide (NO_2) SO_2, PM-10, and PM-2.5. Over the past five years, NO_2 and SO_2 emissions have decreased statewide and are below NAAQS. PM-10 has been well below the NAAQS since 1990 for Sandoval County, and PM-2.5 is below the NAAQS for the county. Ozone for Sandoval County is below the NAAQS, and has been trending that way since 1990 (NMED 2010b). Thus, the preserve is in attainment for all criteria pollutants. According to the EPA, mobile source emission control is responsible for greatly reducing mobile source air pollution during the last 30 years. Technological advances in vehicle and engine design, together with cleaner, higher-quality fuels, have reduced emissions so much that EPA expects the progress to continue, even as people drive more miles and use more power equipment every year. However, increased use of motor vehicles could eventually work against the improvements gained by making individual vehicles or engines cleaner (EPA 2012).

Under the Clean Air Act, areas designated for the most stringent degree of protection from future degradation of air quality are designated as Class I. The Clean Air Act designates as mandatory Class I areas national parks over 6,000 acres and national wilderness areas and national memorial parks over 5,000 acres. The preserve is not a unit of the National Park Service and contains no wilderness areas; therefore, the preserve is not designated as a Class I area. Class I areas within the vicinity of the preserve include the wilderness at Bandelier National Monument to the east and San Pedro Parks Wilderness to the north (NMED 2003).

Preserve Management and Operations

The proposed actions would affect preserve staff and management activities by potentially adding duties related to operations and maintenance, such as shuttle, road, and visitor contact station / visitor center operations and maintenance. Other tasks would also increase, such as trash collection, law enforcement, and additional

administrative duties such as paying utilities and managing contractors. This section describes the preserve's existing management and operations in order to evaluate the proposed alternatives.

Study Area

The study area for evaluating impacts on management and operations for implementation-level decisions is the specific proposed visitor contact station / visitor center location for each action alternative; for programmatic-level decisions, the study area encompasses the entire preserve.

Staffing

The proposed actions would affect preserve staff and management activities by potentially adding staff duties.

As established in the Valles Caldera Preservation Act, nine members serve as the VCT board of trustees. Of these nine, seven members are appointed by the President of the United States. These seven cannot be federal employees (VCT 2005h). Five of the seven must be residents of New Mexico. Members are selected for their expertise in defined areas and serve a four-year term. In addition, the supervisor of the Santa Fe National Forest and the superintendent of Bandelier National Monument serve as voting members on the board. Board members may serve up to eight consecutive years. The preserve is managed by 22 permanent, full-time staff who fall into three categories: administrative (seven employees), management (nine employees), and science and research (six employees) (VCT 2005h). Preserve staff manage infrastructure (facilities, utilities, communications, roads, trails, corrals, fences, and tanks), natural resources (forests and forage), programs (grazing), and processes (fire) (VCT 2007b). Seasonal and part-time employees augment staff during peak season as needed, and volunteers contribute valuable services. In addition, Los Amigos de Valles Caldera, a "friends" group, was formed in 2007 to support the preserve through outreach, education, restoration, and collaboration. The friends group hosts volunteer work days at the preserve, as well as tours for visitors (VCT 2005h).

Management Activities

Preserve staff members maintain historic and modern temporary structures and facilities, maintain miles of fences, implement fire management activities, implement noxious weed control activities, manage livestock grazing (which is leased), manage science program activities, and plan and manage visitor activities. In addition, staff members create plans and conduct surveys and monitoring in compliance with federal environmental regulations (VCT 2007b).

Prior to federal acquisition, the preserve was a working landscape with a functioning livestock operation. The preserve's facilities have a wide variety of uses, ranging from workspaces to visitor facilities to living quarters. The majority of these facilities are located in and around the Valle Grande. Most facilities are between 50 and 100 years old, and require a high amount of annual maintenance to keep them functional due to their age. The maintenance backlog (deferred maintenance) is estimated at about $1.2 million. Problems include the structural integrity of foundations, roofs, roof trusses, floor joists, and chimneys; outdated electrical, mechanical, and ventilation systems; poor site drainage; and rodent and bat hazards. Deferred

maintenance is needed to prevent ongoing deterioration and to bring these buildings up to standards to allow their use by VCT staff and the public (VCT 2007b).

At the time of acquisition, facilities on the preserve did not have potable water. The USFS constructed a water treatment facility that replaced the old water distribution system, serving buildings in the headquarters area by piping water from springs. Potable water is available in all buildings in the headquarters area, although the source is surface water and often freezes in the winter, occasionally runs dry in the summer, and flows with sediment, requiring frequent cleaning and replacement of all filters. While potable, the water supply is somewhat unreliable, limiting the use of the buildings and requiring regular maintenance (VCT 2007b).

The VCT implemented hazardous fuels reduction activities (forest thinning and slash disposal) in two areas at risk from wildfire in the southwest corner of the preserve along NM-4 (Banco Bonito) and the area around the headquarters area. Currently, all unplanned ignitions (natural or human-caused) on the preserve are managed as wildfires, meaning unplanned, unwanted fires that include human-caused fires, escaped prescribed fires, and other fires where the objective is suppression. The current VCT fire management plan requires the suppression of all unplanned ignitions and allows prescribed fires under the appropriate environmental analysis and documentation. The VCT is currently considering a 10-year plan for the restoration and management of its natural systems (VCT 2010b), which would greatly expand both prescribed-fire and forest-thinning activities if approved. The plan also proposes allowing lightning-caused fires to perform their natural role in the preserve's fire-adapted ecosystems under some circumstances.

Invasive weeds are found along roads and turnouts and in disturbed areas on the preserve. Due to the potential for these weeds to spread, the VCT implemented herbicide treatments over approximately 5 acres beginning in 2003. Hand, mechanical, and chemical treatments have been used to control the spread of these weeds and to eradicate known populations. The objective was to eliminate 70% or more of the infestations by the end of the first year and eradicate them by November 2006. Inventories found additional populations in 2005 and 2006, so the program is continuing (VCT 2007b). The proposed restoration and management plan would continue the eradication of current noxious weeds and would establish a protocol to respond quickly to any new invaders.

Because vehicular traffic is currently limited, road maintenance activities are focused on the different maintenance needs of the existing roads.

Currently, visitors sign up for recreation activities, such as hiking or hunting, on the preserve's website. Visitors can also sign up on the website for van tours provided by VCT staff, focused on natural or cultural resource topics. VCT staff members also organize specific special events, such as the Primitive Skills Gathering.