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CONTRACTOR REPORT

SAND93—7089

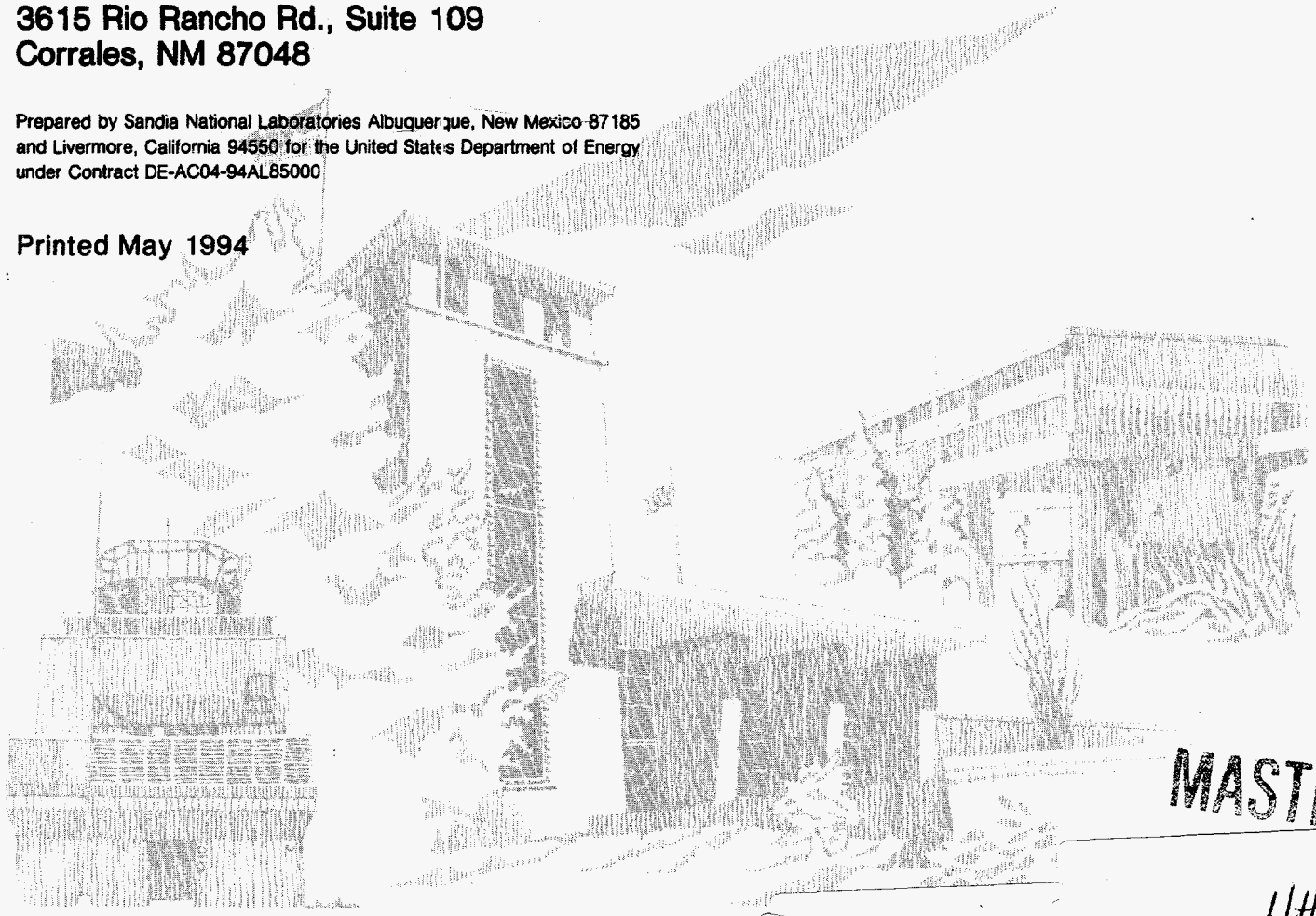
UC—630

Biologic Surveys for the Sandia National Laboratories Coyote Canyon Test Complex—Kirtland Air Force Base Albuquerque, New Mexico

Dr. Robert M. Sullivan
4115 Allen Drive
Kingsville, TX 78363
and
Paul J. Knight
Marron and Associates, Inc.
Environmental Science and Planning
Jemez Professional Building
3615 Rio Rancho Rd., Suite 109
Corrales, NM 87048

Prepared by Sandia National Laboratories Albuquerque, New Mexico 87185 and Livermore, California 94550 for the United States Department of Energy under Contract DE-AC04-94AL85000

Printed May 1994



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SAND93 - 7089

Distribution
Printed: 25 May 1994 Category UC - 630

BIOLOGIC SURVEYS FOR THE SANDIA NATIONAL LABORATORIES COYOTE CANYON TEST COMPLEX KIRTLAND AIR FORCE BASE ALBUQUERQUE, NEW MEXICO

Prepared by:

Dr. Robert M. Sullivan,
4115 Allen Drive
Kingsville, TX 78363
(512) 595-1261

and

Mr. Paul J. Knight,
Marron and Associates, Inc.,
Environmental Science and Planning,
Jemez Professional Building, 3615 Rio Rancho Rd., Suite 109
Corrales, NM 87048
(505) 898-8848

Sandia Task Leader: Jonathan Halpern

Prepared for Departments
2735 - White Sands Cable Dept.
7258 - Risk Management and NEPA

Sandia Contract AB 4892

Abstract

This report provides results of a comprehensive biologic survey performed in Coyote Canyon Test Complex (CCTC), Sandia National Laboratories (SNL), Bernalillo County, New Mexico, which was conducted during the spring and summer of 1992 and 1993. CCTC is sited on land owned by the Department of Energy (DOE) and Kirtland Air Force Base and managed by SNL. The survey covered 3,760 acres of land, most of which is rarely disturbed by CCTC operations. Absence of grazing by livestock and possibly native ungulates, and relative lack of human disturbance has allowed this area to remain in a more natural vegetative state relative to the general condition of private range lands throughout New Mexico, and relative to other grazing lands in central New Mexico. Widely dispersed, low intensity use by SNL as well as prohibition of grazing has probably contributed to abundance of special status species such as grama grass cactus within the CCTC area. This report evaluates threatened and endangered species found in the area, as well as a comprehensive assessment of biologic habitats. Included are analyses of potential impacts and mitigative measures designed to reduce or eliminate potential impacts. Included is a summary of CCTC program and testing activities.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACF	Aerial Cable Facility
ACTC	Aerial Cable Test Capability
ANOVA	analysis of variance
BIOΣTAT	computer program
CCTC	Coyote Canyon Test Complex
CENF	Centrifuge Site
CFR	Code of Federal Regulations
cm	centimeter
cm^3	cubic centimeter
comm.	communication
CS	Centrifuge Site
DFA	discriminate function analysis
DTWI	Drop Tower and Water Impact
DTWIS	Drop Tower and Water Impact Site
eds.	editors
EIS	Environment Impact Statement
GS	Gun Site
KAFB	Kirtland Air Force Base
km	kilometers
LIHE	Light Initiated High-Explosive
LIHES	Light Initiated High-Explosive Site
MANOVA	multivariate analysis of variance
NEPA	National Environmental Policy Act
NMDGF	New Mexico Department of Game and Fish
NTR	North Thunder Range
obs.	observation
pers.	personal
PSL	Physical Science Laboratory
rc	Pearson correlation coefficient
RCRA	Resource Conservation and Recovery Act
rs	Spearman rank correlation
RST	Rocket Sled Track
RSTIA	Rocket Sled Track Impact Area
SNL	Sandia National Laboratories
sq.	square
STR	South Thunder Range
U.S.C.	United States Code
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
var.	variety
WIF	Water Impact Facility
WSRST	West Side Rocket Sled Track

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1.0 EXECUTIVE SUMMARY

This report provides results of a comprehensive biologic survey performed in Coyote Canyon Test Complex (CCTC), Sandia National Laboratories (SNL), Bernalillo County, New Mexico, which was conducted during the spring and summer of 1992 and 1993. CCTC is sited on land owned by the Department of Energy (DOE) and Kirtland Air Force Base and managed by SNL. The survey covered 3,760 acres of land, most of which is rarely disturbed by CCTC operations. Absence of grazing by livestock and possibly native ungulates, and relative lack of human disturbance has allowed this area to remain in a more natural vegetative state relative to the general condition of private range lands throughout New Mexico, and relative to other grazing lands in central New Mexico. Widely dispersed, low intensity use by SNL as well as prohibition of grazing has probably contributed to abundance of special status species such as grama grass cactus within the CCTC area. This report evaluates threatened and endangered species found in the area, as well as a comprehensive assessment of biologic habitats. Included is a summary of CCTC program and testing activities. Based on the biologic assessment contained herein, an Environmental Assessment is being prepared that evaluates the following environmental categories: human and occupational health and safety, air quality, land use, biologic resources, endangered species, cultural resources, noise, economic conditions, energy resources, hazardous and toxic material, explosives storage and handling, and sanitary waste discharge systems. Additive and cumulative effects also are being evaluated. The methodological approach consists of identification of potential environmental issues, determination of possible significance, and providing recommendations to reduce or eliminate potential environmental impacts. This report also covers a survey of two prospective building locations at SNL. The Gamma Irradiation Facility proposed for a location within Technical Area V, and a new Office/Light/Lab/Conference Center proposed for a Technical Area V site now containing parking areas and temporary buildings.

Of six potential threatened, endangered, or sensitive species of plants anticipated, two were documented within the project limits. These are grama grass cactus *(Toumeya papyracantha)*, a State of New Mexico Endangered, Federal C2 species, and U.S. Forest Service Sensitive

species), and the Santa Fe milkvetch *(Astragalus feensis)*, a State of New Mexico Sensitive species with no Federal status. Plants of both species were found in the North and South Thunder Ranges, and grama grass cactus plants were found within the Rocket Sled Track Impact Area and in Technical Area III at sites not directly associated with any specific facility.

A total of 65 grama grass cactus sites were located within the surveyed portions of the CCTC area--herein, a "site" refers to a locality where one or more individual plants of special concern is/are known to occur. The number of individual grama grass cacti found at each site ranged from 1 to 20 individuals. From these 65 sites, a total of 383 individual grama grass cacti were recorded. These localities include 4 sites in the North Thunder Range, 2 sites in the South Thunder Range, 34 sites in the Rocket Sled Track Impact Area, 23 sites in Technical Area III that are not directly associated with any specific facility, and 2 sites west of the Rocket Sled Track Impact Area. Although these sites occurred throughout much of the CCTC area, they were more concentrated along the western buffer zone to the west and south of the Rocket Sled Track. Detailed descriptions of these 65 sites and locations of individual plants are presented in Appendices C and D. Sensitivity of this species is considered to be high on the CCTC area.

There were no threatened, endangered, or sensitive plants within the Centrifuge Site, Drop Tower and Water Impact Site, Gun Site, Light Initiated High-Explosives (LIHE) Site, or immediately adjacent to the Rocket Sled Track. In addition, most of the suitable habitat for rare, threatened, and endangered species within Technical Area III was surveyed. The remaining unsurveyed portions of the facility are small, fragmented patches of habitat that occur between buildings or within fenced boundaries surrounding buildings. Most of these habitat fragments are confined to the northeast quadrant of the facility. Nearly all of these areas are habitat types shown to be of low productivity for species of special concern.

Of the 46 sites discovered in 1992, three (6%) were gone (plants dead or missing) in 1993. None of the extirpated sites occurred in Technical Area III. Approximately 28% of the grama grass cacti identified in 1992 were dead in 1993. Rodents accounted for the largest

amount of damage and destruction of the grama grass cacti at SNL. Between 1992 and 1993, rodents killed 18 and damaged 40 of the 196 plants. Insect borers accounted for the second largest source of damage and destruction of the grama grass cacti at SNL. Between 1992 and 1993, insect borers killed 19 and damaged 3 of the 196 plants. Human activity was responsible for only a small portion of damage and destruction of grama grass cacti in the study area. Only 1.5% of the plants discovered in 1992 were damaged or killed by human actions. Recruitment of seedlings and juveniles between 1992 and 1993 was estimated at approximately 20%.

Between 1992 and 1993, the level of mortality (28%) exceeded the documented level of recruitment (20%). Although data are insufficient to make any long-term predictions as to the success of the grama grass sites at SNL, several points are conclusive: 1) the most pervasive source of destruction to grama grass cactus is caused by rodents; 2) the most lethal attack on individual grama grass cacti plants is from insect borers (nearly 90% fatality); 3) grama grass cacti prefer sand-shrubland habitat dominated by sagebrush and black grama; 4) although grama grass cacti occur in some abundance in Grama-Burro grass and Grama-dropseed grass communities, they were not found in disturbed areas dominated by snakeweed or various species of threeawn and dropseed grasses.

The greatest species richness and density of birds was observed during surveys of the North Thunder Range, particularly in the hilly, extreme southeast corner of the site. Several Federal and State of New Mexico protected species were observed in the CCTC area, including: burrowing owl *(Athene cunicularia)*, great horned owl *(Bubo virginianus)*, red-tailed hawk *(Buteo jamaicensis)*, ferruginous hawk *(Buteo regalis)*, Swainson's hawk *(Buteo swainsoni)*, northern harrier *(Circus cyaneous)*, American kestrel *(Falco sparverius)*, and loggerhead shrike *(Lanius ludovicianus)*.

Similarly, North Thunder Range and South Thunder Range had the greatest density and diversity of small mammals. Small mammals were particularly active in hilly and topographically diverse areas associated with rock outcrops, the grassland-juniper ecotone, and in arroyo habitat. No mammals of special concern were observed in the CCTC area.

The largest densities of reptiles occurred on the South Thunder Range; yet, the largest species diversity occurred on the North Thunder Range because of its relatively greater topographic and vegetation diversity. The only Federal endangered species of reptile observed was the Texas horned lizard *(Phrynosoma cornutum)* (Federal Candidate 2 species)—two individuals were observed on the North Thunder Range. State of New Mexico sensitive species of reptiles included: short-horned lizard *(Phrynosoma douglassi)*, round-tailed horned lizard *(Phrynosoma modestum)*, and massasauga or "swamp" rattle snake *(Sistrurus catenatus)*.

Within the CCTC area, a number of potentially sensitive wildlife habitats were identified, and impacts to vegetation and wildlife species were evaluated. A sensitivity level was assigned to these areas based on the ability of a particular area to support unique or endangered wildlife, a high species diversity, habitat attributes critical to species survival and reproduction of populations, and distribution of highly disturbed sites. Results indicate that areas within the CCTC, which have historically sustained the largest amount of habitat disturbance, also had the fewest native plant and animal species, and were in the poorest condition relative to less disturbed habitat.

Potential impacts to the overall biologic regime were identified and classified into three broad categories: 1) direct impacts, 2) indirect impacts, and 3) cumulative impacts. Recommendations varied from the most highly sensitive areas to the lowest areas of sensitivity. Discovery of such a large number of grama grass cactus sites within an area protected from grazing and public access offers a unique opportunity for monitoring and future research.

2.0 INTRODUCTION

This biologic report has been prepared as an independent technical report in support of a comprehensive Environmental Assessment under preparation by the U.S. Department of Energy. This study summarizes results of biologic field investigations of the Sandia National Laboratories (SNL) Coyote Canyon Test Complex (CCTC), at the west end of Kirtland Air Force Base (KAFB), Bernalillo County, New Mexico (Fig. 1). Boundaries of KAFB encompass an area of about 52,000 acres southeast of Albuquerque. This area is subdivided into two large units that are distinct politically and ecologically. The western unit is approximately 31,000 acres in size, 90% of which is owned by KAFB, and the rest is owned by the Department of Energy (DOE), primarily for use by SNL. The eastern unit is approximately 21,000 acres in size and is withdrawn from the Cibola National Forest by agreements with KAFB and DOE. CCTC activities exert some degree of influence over 3,710 acres of land owned by DOE and KAFB, and, in turn, placed under operational control of SNL. In addition, SNL uses roadways and other land adjoining the 3,760-acre study tract.

Of the total of 3,760 acres potentially affected by CCTC activities, land transformed by past construction and operation (including roads, fences, structures, and test pads) aggregates to some 88 acres. An additional 173 acres are disturbed frequently by test activities involving vehicle movement, explosions, rocket firings, or impact of test articles or fragmentation impacting in the designated safety exclusion zones. Almost 93% (or 3,499 acres) of the existing habitat is rarely disturbed. Table 1 depicts land categories and acreage surveyed for potential biologic impacts, as determined by CCTC activity.

Field surveys completed for this report provide baseline biologic information for the CCTC area of operation. With this baseline data, an evaluation is made of potential impacts on the biologic regime.

This report has been prepared for use as a planning document for evaluating operations of the CCTC and associated test facilities. Methods used herein are in accordance with the 1985

Cibola National Forest Master Plan (and 1991 Proposed Amendment), and New Mexico Department of Game and Fish's recommendations for wildlife baseline study guidelines for construction projects (New Mexico Department of Game and Fish (NMDGF), 1992). Potential impacts are discussed in both a specific and general circumstance.

Information contained in this document was acquired by on-site biologic field surveys; consultation with the U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service (USFS), New Mexico Energy and Natural Resources Department, New Mexico Department of Game and Fish; and literature research. Information on sensitive, threatened, and potentially or actually occurring species in the CCTC area was obtained from the U.S. Fish and Wildlife Service, New Mexico Department of Game and Fish, U.S. Forest Service, and the New Mexico Forestry Division.

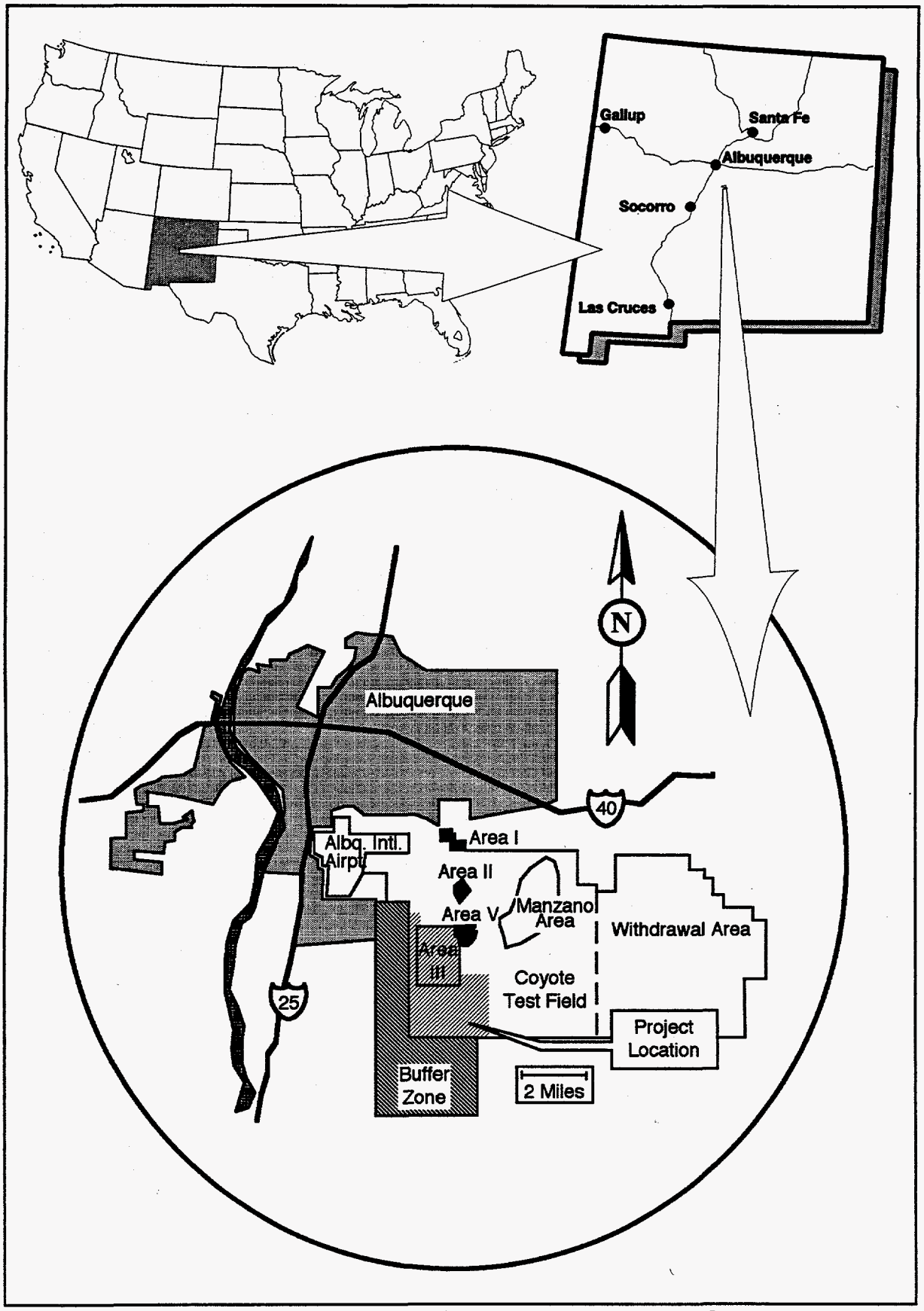

Figure 1. Project location near Albuquerque, NM

Table 1. Summary of land use versus biologic survey areas.

Activity	Transformed acres	Frequently disturbed acres	Rarely disturbed acres	Total potentially affected acres	Biologic survey acres
Rocket Sled Track	20	20	50	90	90
Rocket Sled Track South Use Area	14	6	26	46	46
Rocket Sled Track Laser Tracker Pads	8	20	22	50	50
Rocket Sled Track Safety Exclusion Zone	25	25	1,250	1,300	1,300
Gun Site	3	3	—	6	6
Gun Site Safety Exclusion Zone	—	10	40	50	50
Drop Tower Complex	3	2	1	6	6
LIHE Facility	1	2	3	6	6
Centrifuge Complex	1	3	2	6	6
North Thunder Range	6	19	475	500	500
South Thunder Range	7	38	655	700	700
Areas Samples 10%	—	25	975	1,000	1,000
TOTAL	88	173	3,499	3,760	3,760

3.0 BRIEF PROJECT/ACTIVITY DESCRIPTION

3.1 DESCRIPTION

The CCTC is composed of several individual test sites and facilities operated and controlled by SNL. These sites and facilities are located in SNL Technical Area III, and the adjacent Coyote Canyon Test Field areas to the southeast. Those specific test sites and facilities, and surrounding natural grassland habitat, located on land for which the affected biologic environment is evaluated by this document are:

Technical Area III

- Ten-Thousand-Foot Rocket Sled Track Facility
- Centrifuge Complex
- Light Initiated High-Explosive (LIHE) Facility
- Terminal Ballistics Facility (Gun Site)
- Drop Tower Complex

North and South Thunder Ranges

- South Thunder Range
- Control Building
- Shock Tube Complex
- Bunker Site
- Explosives Assembly Facility
- North Thunder Range
- Firing Site
- Control Building

General testing programs in these facilities since the late 1940s and early 1950s have historically involved use of explosives and propellants to test reliability of weapons, weapon components, and support materials. Types and frequencies of tests that have been conducted within the area of each facility are discussed below as a separate function of the description of each site.

3.2 TEN-THOUSAND-FOOT ROCKET SLED TRACK FACILITY

Portions of the Rocket Sled Track Facility encompassed by the CCTC Environmental Assessment include the 10,000-foot Rocket Sled Track and support facilities located in Technical Area III. This facility consists of a "railroad" type track serving as the platform for rocket-powered sleds and free-flight boosters that are used to accelerate test articles or targets. The Rocket Sled Track is capable of attaining test velocities ranging from automobile speeds to more than six times the speed of sound.

Rocket sleds with test articles or targets attached are fired from the northern end of the track at a point calculated to provide terminal velocity required for a specific test. At a precalculated point at the south end of the track, test articles or targets are impacted into an earthen or concrete barrier, or test articles are ejected into a free-flight trajectory. After the test article/target impact, or test article ejection, the rocket sled and remaining test equipment are impacted against an earthen berm located at the end of the track to terminate the sled's run and to contain fragmentation. In free-flight trajectory tests, test articles impact downrange at predetermined ranges or targets.

3.3 CENTRIFUGE COMPLEX

The Centrifuge Complex consists of two centrifuge units (29-foot and 35-foot) driven by the same hydraulic power supply. The 29-foot centrifuge can accelerate test items up to 300 times the force of gravity. It has a greater dynamic load capacity of the two units at 4,800,000 G-lbs. It is located in an 80-foot diameter pit inside Building 6526. The 29-foot centrifuge can handle test items weighing up to 16,000 pounds. The 35-foot centrifuge can subject test items to forces in excess of 240 times the force of gravity. It has a dynamic load capacity of 2,400,000 G-lbs. It is located outdoors within a bullring-type concrete enclosure that is surrounded by an earthen barrier. The 35-foot centrifuge can handle test items weighing up to 10,000 pounds. Both centrifuges are located in Technical Area III within the same security complex. The Centrifuge Complex is used for producing long interval, continuous high-acceleration loadings on test articles. Previous tests have occasionally involved a high-speed, high-G force release of test articles for impact testing. A vibration shaker can be mounted on the end of the 29-foot centrifuge arm. This allows test articles to

be exposed to a vibration environment in addition to the acceleration from centrifuge rotation. The 29-foot unit has been used for testing articles containing a maximum of 260 pounds of explosive materials. The 35-foot unit is approved to conduct experiments using up to 200 pounds of explosive materials.

3.4 LIGHT INITIATED HIGH-EXPLOSIVE (LIHE) FACILITY

The LIHE facility, not currently in use, is located in the northeast quadrant of Technical Area III. The facility is separated into an office area, a test control area, two individual spray booths, and a test cell area. The LIHE facility is used to prepare and apply a sensitive high-explosive material to surfaces of weapon components, subassemblies, and full assemblies. Explosive material is detonated by a high-intensity light source in the test cell area. Explosive force on a test article is measured to evaluate the effect of a simulated nuclear explosion to a re-entry vehicle or other structure. This work also supports X-ray impulse vulnerability studies to test articles to aid in the design and evaluation of re-entry vehicles.

Explosive wastes from testing processes are eliminated through a Resource Conservation and Recovery Act (RCRA), Part B, approved Thermal Treatment Facility located within the facility security perimeter.

3.5 TERMINAL BALLISTICS FACILITY (GUN SITE)

The Gun Site facility consists of Building 6750, which is the main laboratory and control room for the firing complex. The building houses a small machine shop, office area, control center, small arms ammunition storage and assembly facilities, and an indoor firing range. The indoor firing range is used for the controlled firing of ammunition up to 20 millimeters (mm) in size. The Gun Site also contains two smaller buildings used for propellant assembly and conditioning, and four explosive storage igloos.

The site also contains an outdoor large-caliber firing range, a small-caliber firing range, and a solid rocket motor test stand. The facility has a 155 mm "Long Tom" gun permanently mounted in a revetment located adjacent to Building 6750. Firings on outdoor ranges are

conducted on a range located on the south side of the building and are limited to 300 yards for small calibers. Large-caliber artillery firings have not been conducted on the outdoor range in recent years.

Terminal effects and general ballistic properties of small weapons are studied at the Gun Site. Normal operations include handling and firing of all types of firearms, hand loading ammunition, development and assembly of propellant charges, and providing high-velocity projectiles with predictable performance patterns. Ancillary projects include tests involving controlled firing of small rocket motors and large caliber artillery projectiles.

3.6 DROP TOWER COMPLEX

The Drop Tower Complex consists of a 56-meter (185-foot) tower, a 91-meter (300-foot) tower, and a Water Impact Facility (WIF). The WIF is a man-made lake that measures 57 meters (188 feet) long by 37 meters (120 feet) wide and 15 meters (50 feet) deep. The bottom of the lake is concrete with earthen sides covered with a polyethylene liner. There is also a water tank on the site that is used for small-scale water impact tests. There are five buildings at the facility for storage and fabrication, diving operations, offices, and a control point for test programs.

The Drop Tower facility is used to measure the effect of impacts to different test articles including warheads, fuze system assemblies, torpedoes, and nuclear material shipping containers when they are dropped in a controlled fashion. The 185-foot-tall tower is used for test articles weighing up to 16,000 pounds for free-fall drop tests. A vertical guide wire system on the west side of the tower is used for items weighing up to 1,800 pounds to be dropped in a guided orientation onto a prepared surface.

The 300-foot tower is the primary element of the WIF. The tower is located at the edge of the lake. It can be used to test items weighing up to 3,000 pounds. Test articles can be either free-fall dropped or accelerated into the lake by rocket-assisted pull-down. Rocket-assisted pull-down is accomplished through a 200-foot Rocket Sled Track located adjacent to the water tank. Rocket sleds are accelerated with rocket motors. There is also another water tank

on the site used for small scale-model tests at velocities up to 213 meters (700 feet) per second. Test article accelerations for this small tank are provided by a 4-inch-diameter gas gun.

3.7 NORTH AND SOUTH THUNDER RANGES

A combined complex consisting of approximately 325 acres of land containing firing sites, control and instrumentation buildings and bunkers, an explosive assembly building, and explosive storage igloos has been separated into two parts for ease of identification. Magazine Road divides the two parts: 1) North Thunder Range (NTR) and 2) South Thunder Range (STR). Each is contained within its own security fencing. NTR consists of one firing site, a range control station and instrumentation building (Building 9927), and auxiliary support facilities. STR consists of three active firing sites, several inactive firing sites, a range control station and instrumentation building (Building 9965), instrumentation bunkers associated with individual firing sites, and several auxiliary support buildings. An explosive facility uses explosives to conduct tests on systems and to test new explosive technology. Facilities have the capabilities to create explosive shock, overpressure, and high-velocity target impact environments that are required to simulate actual threats to weapon systems. The following sites in STR are being evaluated in the CCTC Environmental Assessment:

Control Building (Building 9965)
Shock Tubes Complex (Building 9966)
Bunker Site (Building 9964)
Explosives Assembly Facility (Building 9967)
Flyer Plate test site (inactive)

Building 9965 is the headquarters for both ranges. It is located approximately 1219 meters (4,000 feet) west of the Solar Tower. Building 9965 controls the entire range (north and south) during tests and also includes recording instrumentation.

The Shock Tubes Complex consists of a 19-foot, a 12-foot, and two 6-foot-long shock tubes. These cylindrical tubes are used to create and augment a blast front and shock wave

generated by an explosive charge. The test article is placed in, or just outside of, the end of the tube. The explosive charge, or driver, is detonated inside the tube. Blast debris and the test article are recovered in pits or tubes filled with sawdust or absorbent materials placed at the end of the tube.

The Bunker Site consists of a single earth-covered concrete bunker and several open-air sites which have been used for various tests. It has been inactive with regard to large-scale explosive testing in recent years. Control and instrumentation capabilities are intact at the site.

The Flyer Plate Site consists of a fenced perimeter surrounding the remains of an underground bunker. The site was previously used for high-explosive tests conducted within underground bunker units.

Test sites at the Blast Tubes Complex are authorized for detonations of explosives equivalent to a maximum of 4,000 pounds of TNT. However, there have been no tests involving explosive materials exceeding an equivalent of 1,000 pounds of TNT in the past ten years.

The North Thunder Range is actively used for testing minor weapon system components, explosives systems, and conducting explosive technology research. The range consists of Control Building 9927 and the firing pad located adjacent to the building on the north side. Four auxiliary support buildings also are located in the area. The quantity of explosives that may be used is limited to a maximum equivalent of 50 pounds of TNT. An average test involves detonation of an equivalent of 7-8 pounds of TNT. The largest quantity of explosive material used in a test during recent years has been 30 pounds.

4.0 METHODS

Based on maps of existing facilities and on U.S. Geological Survey maps (7.5 minute series, 1:24,000 topographic), the entire biologic survey area includes approximately 3,760 acres of potentially affected habitat (i.e., existing roadways and CCTC facilities). All estimates of area (acreage) for the CCTC facilities are based on maps provided by SNL.

The objective of the biologic survey was to conduct a 100% census along a 100-meter (330-foot) radius of habitat immediately surrounding all buildings and other test facilities at the following locations within Technical Area III (Table 1): 1) Rocket Sled Track (RST) (including grassland habitat within the fenced area west of the site, the main access road running north-south along this fenced area, and four elevated radar tracking pads and their associated dirt access roads), 2) Drop Tower and Water Impact Site (DTWIS), 3) Gun Site (GS), 4) Light Initiated High-Explosives Site (LIHES), and 5) the Centrifuge Site (CS). A 100% survey also was conducted of all habitat within the Safety Exclusion Zone associated with an 18° cone extending from the north end of the Rocket Sled Track to the KAFB boundary with the Isleta Pueblo Indian Reservation (referred to as the Rocket Sled Track Impact Area (RSTIA)), the North Thunder Range (NTR), and the South Thunder Range (STR).

Note: In this biologic survey, we frequently refer to sites outside the CCTC area (i.e., Coyote Springs, Lurance Canyon, Sol se Mete Canyon). These areas are beyond the boundary of CCTC and/or the jurisdiction of SNL and DOE. They are, however, important in terms of biologic resources for species in the CCTC area; therefore, they are referenced only for comparative purposes. Moreover, a discussion of the relevance of these outlying areas to CCTC is essential in the development and use of baseline data for management of the entire area by SNL and the U.S. Forest Service.

4.1 BIOLOGIC SURVEY PERIOD

4.1.1 Biologic Surveys (1992 - 1993).

A biologic assessment for both plants and animals was conducted during the period of 1 April through 31 July, 1992. A supplemental field survey was completed on 1-5 September 1992 to determine the biologic implications of the lesser tracker pads, their associated access roads, and proposed location for two new structures planned for Technical Areas III and V. In addition, a biologic assessment of Technical Area III also was conducted between 29 April and 24 May 1993. Objectives of the 1993 biologic survey were twofold:

First, verify the status and conditions of all grama grass sites (=populations) located during the 1992 survey. The specific objective of the reevaluation was to determine the current condition of all plants at these sites and, if the condition changed, to ascertain the probable cause of the change. All 46 sites discovered in 1992 were relocated in 1993 by use of 7.5 minute topographic maps and a Tremble global positioning devise. Once relocated, the number and condition of plants at each site was recorded, and relevant information on damage of plants or loss of individual plants was collected.

Second, complete a threatened and endangered plant census (100%) of areas in Technical Area III that were not surveyed, or only 10% surveyed during the 1992 field season. This area included all of the northwest and southwest quadrants of Technical Area III and most of the southeast quadrant. Once located, the number and condition of target species and data on habitat and associated vegetation communities were recorded.

Both objectives of the 1993 field season were accomplished within the time frame allowed. The 1993 surveyed area consisted of approximately 950 acres, all of which occurred within the boundaries of Technical Area III; only 10% of this area was surveyed in 1992.

Because surveys encompassed spring and mid-summer flowering and growing seasons for plants (1992, 1993), and nesting and early migratory seasons for birds (1992), it was seasonally timely enough to allow observations of the presence of most species of special concern. It also allowed determination of general habitat characteristics of species associated

with different vegetation and drainage basin conditions within the immediate area of the CCTC and the region of the East Mesa in general.

Suitable habitat for nesting, perching, roosting, and foraging species of vertebrates also was recorded. These data included the presence of different species as discerned by tracks, scat, burrow systems, and nests. Bones in carnivore scat and those found in association with woodrat nests are particularly good indicators of small mammal species composition in the local area. Lists of both plant and animal species were compiled from field surveys conducted during the current biologic assessment, from previously conducted biologic inventories that focused on the surrounding area (Martin and Wagner, 1974; Fischer, 1990; Biggs, 1991; Sullivan, 1993), and from the published literature.

4.2 COMPLETE CENSUS METHOD

One-hundred percent surveys of the 3,760 acres at CCTC (Table 1) were necessary to determine the 1) presence, 2) distribution, and 3) habitat characteristics of all species of special concern listed by Federal and State of New Mexico agencies (U.S. Fish and Wildlife Service, U.S. Forest Service, State of New Mexico Forestry Division, New Mexico Department of Game and Fish). In this survey, the presence, distribution, and habitat characteristics of all species of special concern were documented and mapped. All plant species of special concern found within the boundaries of the right-of-way or within the immediate vicinity of the SNL CCTC facility, were marked by implanting iron rods, flags, and with metal identification tags adjacent to the location of these plants in the event that they might require transplanting. In addition, a literature review was conducted of previous environmental studies of the affected areas, and relevant information was incorporated into the report.

Surveys for endangered plants were timed to take advantage of the peak flowering period. Surveys of all flowering plants were conducted between 20 April and 15 June 1992, and between 26 April and 30 June 1993, using parallel transects back and forth across the CCTC area. Individual surveyors within transects were spaced 12 meters (39 feet) apart, walking in a zig-zag manner. During the supplemental field survey from 1 to 5 September 1992,

individual surveyors within the transects were spaced at 6 meters (1.8 feet) apart. Reduction in spacing between surveyors was implemented because at this time grama grass cacti (and other cryptic species of plants) were long past flower, and the fruiting stage of individual grama grass cactus is much more difficult to locate than are flowers.

Surveyors on the edge of each transect periodically placed pinflags to avoid gaps or overlap of the parallel transects. When endangered plant sites were located, a pinflag was placed in the ground and surveyors wound outward in a spiraling pattern with one going clockwise and the other counter-clockwise from the pinflag. As additional plants were discovered at the site, they were each marked with pinflags. Upon completion of the survey, sites were permanently marked with steel rebar. Two rebar were driven at the center of each site and aligned on an east-west axis. The largest of these rebar (termed the datum) was approximately 1.2 meters (4 feet) tall and was always set on the east end of the axis. The smaller rebar was approximately 0.6 meters (2 feet) tall (termed the subdatum) and was set on the west end of the axis. Each rebar was marked at its apex with red flagging and at its base with a metal tag that identified the site number and the species of concern at that site. Two rebar were used at each site to act as a basis for triangulation, thereby allowing for easy location of plants for future monitoring studies. Because of potential concern of the safety effects of rebar on helicopter landings, five steel rebar were replaced by short (8 - 12 inches) segments of rebar for sites in the southern part of the survey area near the KAFB boundary fence.

Data were recorded on each rare plant located within the CCTC area. These data included: 1) site at which the plant occurred, 2) height of plant, 3) width of plant, 4) general condition of the plant, 5) number of flowers, 6) number of fruits, and 7) the vegetation community in which the plant occurred. In addition to these baseline data, an additional parameter, the volume of the plant, was derived using two sets of equations. Plants over 1 centimeter (cm) in diameter were noted to be nearly cone shaped in longitudinal section. They are rounded at the top and conical tapering down to the root crown. Plants less than 1 cm in diameter were nearly cylindrical. These data were compared against flowering and fruiting events in an attempt to estimate plant size and reproductive potential.

4.3 TEN PERCENT SAMPLE METHOD

Because of time and budget constraints, during the 1992 survey period a 10% sample survey was conducted of all peripheral areas immediately surrounding all designated sites in Technical Area III, but which lie beyond the 100-meter (330-foot) radius. This sample effort was concentrated particularly in areas east and west (to the KAFB boundary) of the Rocket Sled Track, but outside the Rocket Sled Track Impact Area, and in that section of the Technical Area III fence line that terminates in the enclosed habitat to the north and south of Magazine Road.

A variety of survey methods that sample outlying areas around proposed construction sites is available, depending upon habitat characteristics. Ten percent floral and faunal surveys of lesser species of plants and animals in the affected areas were conducted by use of line-intercept and strip-census techniques for wildlife assessment; all 10% surveys were stratified by habitat type with at least four transects totaling 1,000 meters (3,000 feet) in length. Starting points and orientation of transect locations were randomly selected, and a minimum of four surveys were conducted. These survey techniques give rapid, accurate, and objective information on relative frequency, density, and cover (dominance) of wildlife species, and they are recommended by the New Mexico Department of Game and Fish (New Mexico Department of Game and Fish, 1992). Selection of transects depended on size of the area, local topography, or special biotic factors.

In accordance with recommendations of the 1985 Cibola National Forest Master Plan and the New Mexico Department of Game and Fish (New Mexico Department of Game and Fish, 1992), all major wildlife communities within the CCTC facilities were surveyed to determine the presence and distribution of lesser faunal and floral species and their sensitive habitats (including travel corridors, foraging areas, nesting sites). Where sensitive species were located and their critical habitats identified, specific recommendations were developed to eliminate or minimize any potentially adverse impacts associated with construction projects, test operations, and the day-to-day operation of various facilities.

Ten percent surveys for endangered or sensitive plants were conducted by using transects 2,000 meters (6,562 feet) long by 50 meters (164.0 feet) wide. Four of these transects were positioned to represent the remainder of habitats within Technical Area III that were not covered by 100% surveys during the 1992 field season. Individual surveyors within the transects were spaced 12 meters (39 feet) apart, walking in a zig-zag manner. When endangered plant sites were located, they were surveyed and marked using the same procedure described for the complete census method.

Note: All habitat in Technical Area III that was surveyed 10% for plant species of special concern during 1992, was resurveyed 100% by walking during the 1993 field season.

4.4 BIRD TRANSECTS

A strip census (line transect) was used to census bird species composition and density in selected regions of the CCTC area—this procedure is used widely by terrestrial vertebrate biologists (Caughley, 1977; Brower et al., 1989; Smith, 1980). Objectives of the strip census sampling procedure were to determine baseline species composition and density estimates of birds in several areas associated with different habitat types found in the CCTC area.

To accomplish this objective, the directional orientation of each strip census was determined by connecting two randomly selected points in each sample area. Targeted sample areas included Grassland and Grassland-Sandsage-Winterfat habitats in each of four generally undisturbed survey areas: 1) North Thunder Range, 2) South Thunder Range, 3) west side of the Rocket Sled Track, and 4) Rocket Sled Track Impact Area. In each of the study sites, two strip census transects were sampled by walking a line 1,000 meters (3,281 feet) long, and recording individuals observed from that line and the distance to each animal observed. Strip censuses were conducted one week apart in the early morning (0700 h), beginning in the second week of April. Birds were sampled at three distance intervals (**x1**=10 meters, **x2**=20 meters, and **x3**=30 meters) that were used to define the width of the strip. Many methods have been suggested for estimating density from strip censuses (Caughley, 1977;

Brower et al., 1989; Smith, 1980). Three of the most commonly used methods, each with somewhat different assumptions, were employed:

D1 (Transect of Indefinite Width): $\mathbf{D1=n(K+1)^2/4LXK(K+2)}$,

where **D1**=density, **n**=total number of animals observed, **K**=3.444 (a constant reflecting the shape of a curve describing the theoretical probability of seeing an animal at varying distances from the line of march); **X**=mean of the right-angle distances from the line; and **L**=total length of the transect [2,000 meters (6562 feet)].

D2 (Transect of Fixed Width): **D2=n1/L(W)**,

where **D2**=density, **n1**=number of birds observed in the first distance interval (**x1**=10 meters) from the line of march used to define the width of the strip, and **W**=a transect width of 20 meters (66 feet), or 10 meters (32.8 feet) on either side of the line of march). The first distance interval is used to define the width of the strip, because it is assumed that all animals will be observed in this strip; whereas, animals might be missed in the 20- to 30-meter (66- to 98 feet) distance intervals.

D3 (No Bounding Distance): **D3=n/2LX**,

a model that assumes that the probability of sighting decreases exponentially with distance; therefore, no bounding distance need be assumed. There are theoretical reasons for suspecting that this model is appropriate when detection depends on visibility rather than on the behavior of the animals (Hoglund et al., 1967; Eberhardt, 1968; Caughley, 1977).

In all density estimates associated with the strip census approach, data recorded are a population index rather than an absolute measure of density. Strip census methods can be quantified to yield density estimates useful in studies where animals are highly mobile, yet often difficult to see until flushed. Strip census methods assume: 1) that there is either a random distribution of individuals over the area sampled or that the transect line is located

randomly in the targeted area, 2) that all members (i.e., of both sexes and all ages) are equally likely to be flushed, 3) that the sighting of one animal does not influence sighting of other animals, and 4) that no animal is counted more than once. This census technique can be applied to birds as well as medium-sized animals (e.g., rabbit, rock squirrel, quail, etc.) in a variety of habitats and gives accurate information on population density.

4.5 FIELD TECHNIQUES FOR SMALL MAMMAL LIVE TRAPPING

Small mammals were surveyed by trapping using Sherman livetraps. A 1,372-meter (4,500-foot) trapline consisting of 300 Sherman livetraps each spaced 5 meters (15 feet) apart was set along a straight line in a designated area. Targeted sample areas included Grassland and Grassland-Sandsage-Winterfat habitats in each of four generally undisturbed survey areas: 1) North Thunder Range, 2) South Thunder Range, 3) west side of the Rocket Sled Track, and 4) Rocket Sled Track Impact Area. All trapping was conducted over a 3-consecutive-day period during the second week of May 1992. Traps were set in the evening, baited with rolled oats, and checked early the following morning. All livetrapping of animals was conducted in accordance with the guidelines established by the Ad Hoc Committee on Acceptable Field Methods in Mammalogy (Acceptable Field Methods in Mammalogy: Preliminary Guidelines Approved by the American Society of Mammalogy, Supplement to Volume 68, No. 4, November 1987, Journal of Mammalogy).

4.6 FIELD TECHNIQUES FOR HERPETOFAUNAL SURVEYS

Lizards and snakes were surveyed by visual observation or by catching by hand. Surveys of lizards and density estimates were made during the day by use of a belt-transect method (Caughley, 1977; Brower et al., 1989; Smith, 1980). A belt-transect is a long strip of terrain in which all individual lizards/snakes are counted. Objectives of the belt-transect sampling procedure were to determine baseline species composition and density estimates of lizards in several areas associated with different habitat types found in the CCTC area.

To accomplish these objectives, the directional orientation of each transect was determined by connecting two randomly selected points in each sample area. Targeted sample areas included the desert grassland and shrubland vegetation types that occur in the CCTC project

area. Specifically, this included areas dominated by Black Grama Grassland, Black Grama Grassland-Juniper, and Black Grama Grassland-Sandsage Shrubland in each of four survey areas: 1) North Thunder Range, 2) South Thunder Range, 3) west side of the Rocket Sled Track, and 4) the Rocket Sled Track Impact Area.

In each survey area, two belt transects (1,000 X 5 meters = 5,000 square meters) were sampled by walking a straight line and recording the species and total number of individuals observed on either side of the center line vector. A total area equal to one hectare was surveyed for each of the four sites (1 hectare = 10,000 square meters). Surveys were conducted in mid-morning (1000 h), when diurnal species become active, beginning in the second week of April.

All numerical estimates associated with the belt-transect method represent a population index rather than an absolute measure of density. The belt-transect method can be quantified to yield density estimates useful in studies where animals are highly mobile, yet often difficult to see until flushed—as is the situation for many diurnal arid-land lizards. Belt-transect methods assume: 1) that there is either a random distribution of individuals over the area sampled or that the transect line is located randomly in the targeted area, 2) that all members (i.e., of both sexes and all ages) are equally likely to be flushed, 3) that the sighting of one animal does not influence sighting of other animals, and 4) that no animal is counted more than once.

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5.0 COMMON PLANTS AND PLANT COMMUNITIES IN THE CCTC AREA

5.1 GENERAL OVERVIEW

The flora within the CCTC area is predominantly Mesa and Desert Grassland and to a lesser degree, Sandsage Scrubland and Chihuahuan Desert Shrubland. Flora exhibit influences from the Great Basin Desert, Rocky Mountains, Chihuahuan Desert, and the Great Plains. Typical plant species occurring in the CCTC area include: 1) grasses—black grama, dropseed, galleta, burrograss, bush and ring muhly; 2) wildflowers—globemallow, spiny aster, spectacle pod, and desert aster; and 3) shrubs (general size category)—sandsage brush, Winterfat, mormon tea, yucca, prickly pear, and snakeweed. Most of the area is occupied by grasslands with sandsage brush communities occurring on deep sandy soils on the west side of the CCTC area and some localized Chihuahuan Desert shrub species restricted to sheltered exposures on the hillsides at the eastern edge of the CCTC.

An estimated 150 to 175 plant species are likely to occur within the CCTC area on an average year. On years more conducive to growth and development of annuals, this number could increase to over 200 species. Initial surveys in the spring of 1992 identified 101 species of vascular plants. This number will increase as the season progresses through summer and fall. Appendix A lists plant species that were documented during the 1992-1993 field surveys and the study site areas in which they occur.

Although number of secondary species changes considerably from site to site, the overall composition of dominant species in the CCTC area remains the same. Frequency and coverage of these dominant species varies among sites. For example, a slight shift from coarse loamy to sandy soil can change a dense black grama grassland with scattered dropseed and sandsage brush into a community where sandsage brush and dropseed dominate with only scattered black grama. These types of subtle changes account for much of the variation in plant communities across the CCTC. A major exception to this pattern occurs in hilly portions of the NTR where a variety of Chihuahuan Desert species (i.e., creosote bush) are established in a sheltered canyon with dry slopes. These Chihuahuan species appear nowhere else in the CCTC area.

5.2 COMMON PLANT COMMUNITIES

Typing of common vegetation is based upon recognizing patterns of dominant species and grouping them into discrete types; however, the transition from type to type is rarely clear-cut, and a large degree of interpretation is required to define the extent and composition of these types. A wide variety of classification systems have been applied to the southwest United States. Most of these are based upon the work by Brown and Lowe (1982), who proposed a digital classification system for the southwestern United States and northwestern Mexico. This system was based upon recognizing large associations such as forest, desert or grassland biomes, and then identifying specific series of dominant species within each biome such as ponderosa pine, piñon pine, or blue grama. This prototype has served as a basis for promulgation of other vegetation classification systems by various government agencies and private organizations. Within this study, a modified system sponsored by the U.S. Forest Service has been used (R. Fletcher, pers. comm.).

The majority of the CCTC area is dominated by grassland vegetation. Specifically, it represents the Mesa and Desert Grassland habitat types. Extreme western portions of the study area fall into shrubland vegetation, specifically Sandsage Shrubland vegetation. One small isolated location in the NTR is more typical of Chihuahuan Desert shrubland. Within each of these habitat types there exists a variety of vegetation communities. These communities are identified by the dominant vegetation types currently present on the sites.

5.2.1 Desert Grasslands.

Most of the vegetation in the CCTC area is composed of elements of the Black Grama Grass Series. Depending upon soil aspect and other habitat conditions, a variety of black grama communities are present. Five of these communities were documented within the CCTC area: 1) *Bouteloua eriopoda* (near monospecific stands), 2) *B. eriopoda-Sporobolus contractus*, 3) *B. eriopoda-Aristida*, 4) *B. eriopoda-Hilaria jamesii*, and 5) *B. eriopoda-Scleropogon brevifolius*.

5.2.1.1 *B. eriopoda* (near monospecific stands) (black grama).—Dense, near-pure stands of black grama occur at the southern end of the STR. Within these areas black grama forms

near-monotypic stands with very few associates and extremely high levels of coverage. These pure stands of black grama were relatively uncommon within the CCTC area.

5.2.1.2 *B. eriopoda-Sporobolus contractus* (black grama-dropseed).—Enclaves of this community cover large portions of the CCTC area. They vary from dense stands of black grama with scattered dropseed and perennial forbs to diffuse black grama stands with a high density of dropseed and an abundance of forbs and subshrubs. This community occurs on flatlands where the soil is a coarse sandy loam.

5.2.1.3 *B. eriopoda-Aristida* (black grama-threeawn).—Within the CCTC area, this community occurs primarily on the limestone hills within the NTR. Soils at these sites are usually coarse with a high percentage of limestone cobbles. Overall coverage is normally low, consisting of patches of black grama and scattered clumps of threeawn.

5.2.1.4 *B. eriopoda-Hilaria jamesii* (black grama-galleta).—Galleta and black grama form large, continuous communities in several portions of the CCTC area. These sites are normally in lowlands with silty-sandy soil. They often occur near low-lying, poorly drained areas, particularly in the Rocket Sled Track Impact Area south of Technical Area III.

5.2.1.5 *B. eriopoda-Scleropogon brevifolius* (black grama-burrograss.—Black grama-burrograss communities occur in large areas in the southwest portion of the CCTC area. This community type is directly associated with natural low-lying, poorly drained areas that occur in the Rocket Sled Track Impact Area. Soils at these sites are normally silty clays that grade into adjacent sandy soils. Vegetative coverage within this community is generally low. Areas are characterized by the presence of open clay flats surrounded by hummocks of near-monotypic stands of burrograss surrounded by discontinuous stands of galleta and black grama.

5.2.2 Shrubland Vegetation.

Two shrubland communities occur within the CCTC area. These are the Sandsage Shrubland, represented by dense stands of sandsage brush, and the Chihuahuan Desert Shrubland, represented by the Creosotebush Series.

5.2.2.1 Sandsage Shrubland.—Sandsage brush covers large areas in the western portion of the CCTC area. It occurs in dense stands in sandy soils west of the Rocket Sled Track. Intervening spaces between sandsage brush are dominated by black grama and dropseed and to a lesser degree by annual and perennial forbs.

5.2.2.2 Chihuahuan Desert Shrubland.—Chihuahuan Desert Shrubland is represented at a single location within the CCTC area. Within the CCTC area, creosotebush occurs at one highly localized site on south-facing hillsides with the northeast portion of the North Thunder Range (SE 1/4 Sec 28, 1,714 meters [5,624 feet] elevation). This site is probably a relic stand of Chihuahuan Desert flora and is characterized by coarse limestone soils, a southern exposure, and generally low vegetative coverage.

6.0 SURVEY RESULTS FOR CCTC AREA

The CCTC area includes eight specific study sites (Fig. 2). Although most of these sites occur in the Grama Grass Vegetation Series, various community types within these series produce significant and visible changes in vegetation. Lists of plants and animals observed in the study areas are provided in Appendices A and B; those species of special concern are discussed in Appendices C and D.

6.1 ROCKET SLED TRACK

The entire 3,048-meter length (10,000 feet) of the Rocket Sled Track (RST) was surveyed (100%) by walking during the biologic assessment. This area also included a 61-meter (200-foot) buffer zone on either side of the center line of the RST trace, for a total of 390 acres. The total 100% coverage included approximately 46 acres (1 acre = 43,560 square feet) located along a north-to-south vector in the Northwest Quadrant of Technical Area III. Also included in the RST site was the grassland habitat within the fenced area west of the site, the main access road running north-south along this fenced area, and four elevated radar tracking pads and their associated dirt access roads. The four access roads ranged from 888 to 699 meters (2,915 - 2293 feet) in length; and 33 m (100 feet) on either side of the centerline of the roadway were surveyed 100% by walking. In addition, a 100% census was conducted of all outlying areas immediately surrounding the 61-meter (200-foot) buffer zone.

Major vegetation associated with the RST area included a combination of woody shrubs, cacti, and grasses, including sandsage brush, fourwing saltbush, yucca, prickly pear, and Winterfat. Major grasses included black grama, dropseed, galleta, and Indian ricegrass.

No species of special concern were observed within the immediate vicinity of the RST, adjacent buildings, or roadways associated with the site, or the elevated radar tracking pads and their associated access roads; however, several species of special concern were observed in the grassland-sagebrush buffer zone surrounding the Rocket Sled Track. These included: 1) grama grass cactus (State of New Mexico Endangered, Federal Category 2, U.S. Forest Service Sensitive), 2) burrowing owl (State of New Mexico Protected raptor), 3) American

kestrel (State of New Mexico Protected raptor), 4) loggerhead shrike (Federal Category 2 and State of New Mexico Protected species), 5) short-horned lizard (State of New Mexico Protected horned lizard), 6) round-tailed horned lizard (State of New Mexico Protected horned lizard), and 7) massasauga (recommended for listing by the State of New Mexico, 13 April 1990).

A large concentration of prairie dogs and active burrow systems, as evidenced by fresh tracks and feces, was observed along the northwest edge of the RST in grassland-sagebrush vegetation. Similarly, prairie dogs and active burrow systems also occur on the South Thunder Range, just north of the Helicopter Landing Pads. Large populations of prairie dogs also are known to occur at several highly disturbed locations within KAFB near Gibson Street.

6.2 DROP TOWER AND WATER IMPACT SITE

Approximately 6 acres (260,000 square feet) surrounding the entire Drop Tower and Water Impact Site (DTWIS) were surveyed (100%) by walking during the biologic assessment. Major vegetation associated with the DTWIS included a combination of cacti, and various species of grasses (prickly pear, dropseed, galleta, and Indian ricegrass). This site also had vegetation typical of highly disturbed areas, probably associated with previous building activities and road construction (Russian thistle, canaigre, globemallow, broom snakeweed, rabbitbrush). The soil at this site is generally sandy, and the existing plant community is composed largely of disclimax black grama-dropseed grassland. In addition to the dominant grass species, a variety of weedy annual species was found around the Drop Tower. The southwest portion of the DTWIS does support intermittent stands of undisturbed black grama grass. This area is suitable habitat for grama grass cactus, but none were present within the boundaries of this site.

No species of special concern were observed within the immediate vicinity of the DTWIS, adjacent buildings, or surrounding roadways associated the area. Several species of special concern, however, were observed in the immediate vicinity of the site or in grassland habitat just east of the site, including: 1) great horned owl (State of New Mexico Protected raptor)

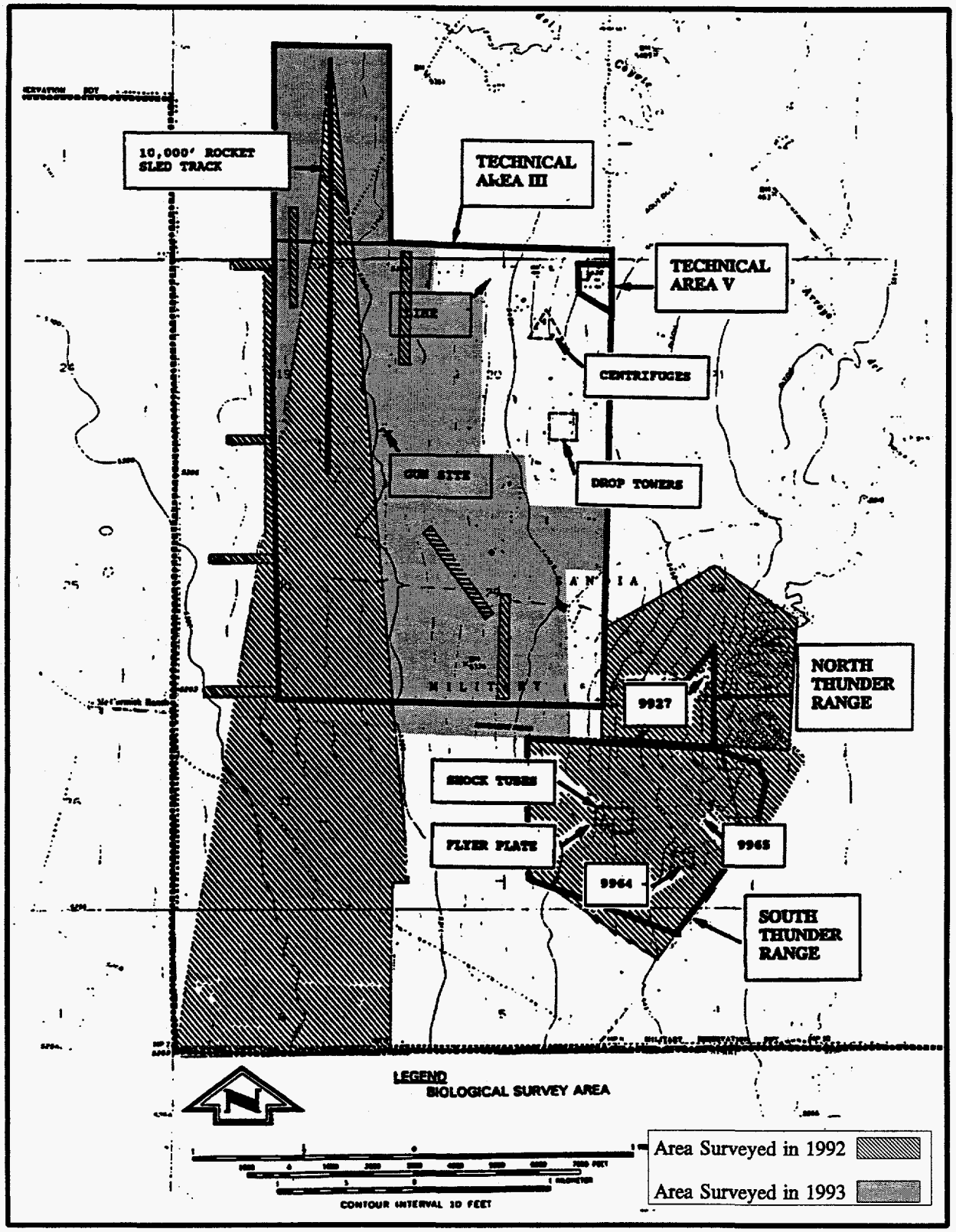

Figure 2. Survey areas in the CCTC area

(pers. comm. CCTC SNL staff member), 2) American kestrel (State of New Mexico Protected raptor), 3) loggerhead shrike (Federal Category 2 and New Mexico Protected species), and short-horned lizard (State of New Mexico Protected lizard).

6.3 GUN SITE

Approximately 6 acres (260,000 square feet) surrounding the immediate Gun Site (GS) building area were surveyed (100%) by walking during the biologic assessment. In addition, a 10% sample survey (1992) and a 100% survey (1993) was conducted of the entire outlying area contained within the GS firing range fence line, comprising about 140 acres. Major vegetation associated with the GS and firing range included a combination of woody shrubs, cacti, and grasses, including sandsage brush, fourwing saltbush, yucca, prickly pear, Winterfat. Major grasses included black grama, dropseed, galleta, and Indian ricegrass. This site also had vegetation typical of highly disturbed areas associated with previous building activities and road construction (Russian thistle, canaigre, globemallow, broom snakeweed, rabbitbrush), particularly along the northern border, paved road, and fence line.

The GS facility is located on flat ground which gently drops off to the southeast. The soil is sandy throughout most of the facility. The vegetation of the GS facility was similar to the eastern edge of the Rocket Sled Track, which includes black grama-dropseed grassland and limited stands of sandsage brush. Although large portions of the GS facility are suitable habitat for grama grass cactus, none was found within the boundaries of this site.

No species of special concern were observed within the immediate vicinity of the GS building, firing range, or roadways; however, several species of special concern were observed in the grassland-sagebrush zone of the firing range, including: 1) loggerhead shrike (Federal Category 2 and New Mexico Protected species), 2) short-horned lizard (State of New Mexico Protected horned lizard), 3) round-tailed horned lizard (State of New Mexico Protected horned lizard), and 4) massasauga (recommended for listing by the State of New Mexico, 13 April 1990).

6.4 LIGHT INITIATED HIGH-EXPLOSIVES (LIHE) SITE

The entire area surrounding the Light Initiated High-Explosives site (LIHE) (approximately 6 acres or 260,000 square feet) was surveyed (100%) by walking during the biologic assessment. Major vegetation associated with this area included a combination of woody shrubs, cacti, and various species of grass (fourwing saltbush, prickly pear, Winterfat, black grama, dropseed, galleta, and Indian ricegrass). This site also had vegetation typical of highly disturbed areas associated with previous building activities and road construction (Russian thistle, canaigre, globemallow, broom snakeweed, rabbitbrush), particularly along the east and southern borders.

The site is level and dominated by sandy soil. Adjacent undisturbed habitats are occupied by black grama-dropseed communities. The LIHE facility supports a large variety of disclimax annual and perennial weedy species. Very little of the existing habitat around the facility is suitable for grama grass cactus, and not surprisingly, none was found within the boundaries or adjacent to this site.

No species of special concern were observed within the immediate vicinity of the LIHE, adjacent buildings, or associated roadways.

6.5 CENTRIFUGE SITE

Approximately 6 acres (260,000 square feet) immediately surrounding the Centrifuge Site (CS) were surveyed (100%) by walking during the biologic assessment. Major vegetation associated with this area included a combination of woody shrubs, cacti, and various species of grass (fourwing saltbush, prickly pear, and Winterfat, black grama, dropseed, galleta, and Indian ricegrass). As with many of the sites in Technical Area III, this site also had vegetation typical of highly disturbed areas associated with previous building activities and road construction (Russian thistle, canaigre, globemallow, broom snakeweed, rabbitbrush), particularly along the east and southern borders of the building adjacent to the road.

Soil at this site is generally sandy. Large portions of the habitat are disturbed to the point where no vegetation is present. Undisturbed portions of the site were composed of disclimax

black grama-dropseed grassland. Although portions of the Centrifuge Site are suitable habitat for grama grass cactus, none were found within the boundaries or adjacent to this site.

No species of special concern were observed within the immediate vicinity of the CS and adjacent area beyond the fenced site, or surrounding roadways associated the area; however, two species of special concern were observed in grassland habitat along the eastern border of the CS, including: 1) the loggerhead shrike (Federal Category 2 and New Mexico Protected species), and 2) the short-horned lizard (State of New Mexico Protected horned lizard).

6.6 ROCKET SLED TRACK IMPACT AREA

For safety reasons, SNL has designated a Safety Exclusion Zone around the Rocket Sled Track that comprises an 18° offset east and west of the Rocket Sled Track centerline. For convenience, this report refers to this Safety Exclusion Zone as an "impact area." The entire Rocket Sled Track Impact Area (RSTIA) (1,300 acres associated with the 18° cone extending from the end of the Rocket Sled Track to the KAFB boundary with the Isleta Pueblo Indian Reservation) was surveyed (100%) by walking during the biologic assessment (Fig. 2). The RSTIA comprised the largest single piece of land in the biologic survey. Its variations in soil composition and habitats supported a variety of plant communities including four grama grass communities *(Bouteloua eriopoda-Sporobolus contractus; B. eriopoda-Aristida; B. eriopoda-Hilaria jamesii; B. eriopoda-Scleropogon brevifolius)*, as well as an extensive stand of sandsage brush. Soil is primarily sandy, but some areas just south of the end of the Rocket Sled Track are low-lying, poorly drained in nature with heavy silt-clay soils.

The entire western side of the Rocket Sled Track is dominated by Sandsage Shrubland; interspersed between sandsage brush are extensive stands of black grama and dropseed. The eastern edge of the Rocket Sled Track is occupied by black grama-galleta grassland. The soils in these areas are also sandy but are of sufficiently different composition to preclude the development of sandsage brush shrublands. There are no grama grass cacti within the 61-meter (200-foot) buffer zone immediately around the Rocket Sled Track; however, grama

grass cactus are abundant in the sandsage brush shrublands to the west of the Rocket Sled Track.

Thirty-five grama grass cactus sites have been documented within the RSTIA inside and outside of Technical Area III. Of this total, 11 sites are inside Technical Area III, and 24 sites are outside the fenced area of Technical Area III. These sites occurred in all of the community types mentioned above. However, the composition of these sites varies among the community types. For example, grama grass cactus sites within the black grama-burrograss communities are generally composed of less than four plants (often only one or two). These plants are usually within close proximity to one another and are generally large adults. Within the sandsage brush shrubland, grama grass cactus sites are often composed of many individuals (often 10 to 20 individuals), which normally represent the full range of population structure from seedlings to senescent adults. The reason for these variations has not yet been defined and will require additional research.

Although no species of special concern were observed within the immediate vicinity of the RSTIA, adjacent buildings, or roadways associated with the site, several species of special concern were observed in the grassland-sagebrush buffer zone surrounding the RSTIA. These included: 1) grama grass cactus (State of New Mexico Endangered, Federal Category 2, U.S. Forest Service Sensitive), 2) American kestrel (State of New Mexico Protected raptor), 3) loggerhead shrike (Federal Category 2 and New Mexico Protected species), 4) the short-horned lizard (State of New Mexico Protected horned lizard), and 5) massasauga (recommended for listing by the State of New Mexico, 13 April 1990).

6.7 NORTH THUNDER RANGE

The entire North Thunder Range (NTR) (approximately 500 acres) was surveyed (100%) by walking during the biologic assessment. This area lies at the southeast edge of Technical Area III and adjacent to Magazine Road. Major vegetation associated with the NTR included a combination of woody shrubs (fourwing saltbush, yucca, Winterfat), cacti (prickly pear), and assorted grasses. The NTR exhibited the greatest diversity of plant species and communities within all of the study sites in the CCTC area. It is the only portion of the

CCTC area with significant topographic relief, as well as the only area with a limestone substrate. As a result, a variety of habitats is present.

At least five distinct plant communities can be attributed to the NTR. These include four in the grama grass series *(Bouteloua eriopoda-Sporobolus contractus*; *B. eriopoda-Aristida*; *B. eriopoda-Hilaria jamesii*; *B. eriopoda-Scleropogon brevifolius)* and one in the Chihuahuan Desert Shrubland Series, represented at a single location in the northeast corner of NTR. The Chihuahuan Desert Shrubland site is dominated by creosotebush. It is most likely a relic stand of desert vegetation persisting in the limited confines of a sheltered south-facing microhabitat. This site is of biologic significance in that it is one of the northeastern-most known natural populations of creosotebush in North America (P. J. Knight, pers. obs.).

Hilltops in the NTR are dominated by black grama-threeawn grassland. Some of the northern-facing portions of these hills support a few isolated junipers *(Juniperus monosperma)*. Vegetation in lowlands at the base of the hill varies from black grama-dropseed in the sandy areas to black grama-galleta and black grama-burrograss.

Four grama grass cactus sites were identified in NTR. The first of these occurs on sandy soils on a quartzite outcrop along the northern boundary of the North Thunder Range. The other three sites were located in sandy-loam soils in the flatlands west of the main access road to the NTR facilities.

Several species of special concern were observed within the NTR and the associated grassland-juniper habitat, including: 1) grama grass cactus (State of New Mexico Endangered, Federal Category 2, U.S. Forest Service Sensitive), 2) Santa Fe milkvetch (State of New Mexico sensitive), 3) red-tailed hawk (State of New Mexico Protected raptor), 4) northern harrier (State of New Mexico Protected raptor), 5) American kestrel (State of New Mexico Protected raptor), 6) loggerhead shrike (Federal Category 2 and New Mexico Protected species), 7) Texas horned lizard (Federal Category 2 and State of New Mexico Protected horned lizard), 8) short-horned lizard (State of New Mexico Protected horned lizard), and 9) round-tailed horned lizard (State of New Mexico Protected horned lizard).

Although the grass cover and habitat quality on the limestone hilltops and hillsides of the NTR were suitable for grama grass cactus, none was found there. Previous grama grass cactus surveys indicate that the plants are rare or absent on limestone soils. However, although the hills of the NTR proved to be unsuitable habitat for grama grass cactus, they do support viable populations of Santa Fe milkvetch. This plant was found to be abundant locally on the east side of these hills near the northeast corner of the NTR.

6.8 SOUTH THUNDER RANGE

The entire South Thunder Range (STR) (approximately 700 acres) was surveyed (100%) by walking during the biologic assessment. This area lies along the southern border of Magazine Road and the northwest border of Isleta Road, and adjacent to the southern border of the North Thunder Range. Major vegetation associated with the STR also included a combination of woody shrubs, cacti, and grasses similar to the North Thunder Range.

Although the STR maintains some contiguous habitat with the North Thunder Range, it has some significant differences. The northern edge and northeast corner of the STR are most similar to the North Thunder Range. Much like the North Thunder Range, this area is composed of low limestone hills. The southern and western portions of South Thunder Range are occupied by a variety of communities either not present or not abundant in the North Thunder Range. These include disclimax grama grasslands; near monospecific stands of black grama; and low-lying, poorly drained that are occupied by black grama-galleta or black grama-burrograss grasslands. Also, the STR is far less diverse than the North Thunder Range. It lacks habitat diversity and in many areas has been subject to past disturbance.

Two grama grass cactus sites are located within STR. One of these occurs in a near-monospecific stand of black grama grass; the other occurs in a disclimax black grama-dropseed grassland. Neither of these sites is large. As with North Thunder Range, the limestone hills were devoid of grama grass cactus, but a population of Santa Fe milkvetch was documented in the hills.

Although no species of special concern were observed within the immediate vicinity of the STR, several species of special concern were observed in the grassland habitat, including: 1) grama grass cactus (State of New Mexico Endangered, Federal Category 2, U.S. Forest Service Sensitive), 2) Santa Fe milkvetch (State of New Mexico sensitive), 3) red-tailed hawk (State of New Mexico Protected raptor), 4) Swainson's hawk (State of New Mexico Protected raptor), 5) ferruginous hawk (Federal Category 2, and State of New Mexico Protected raptor), 6) northern harrier (State of New Mexico Protected raptor), 7) American kestrel (State of New Mexico Protected raptor), 8) loggerhead shrike (Federal Category 2 and New Mexico Protected species), 9) short-horned lizard (State of New Mexico Protected horned lizard), 10) round-tailed horned lizard (State of New Mexico Protected horned lizard), and 11) massasauga (recommended for listing by the State of New Mexico, 13 April 1990).

A large concentration of prairie dogs and active burrow systems, as evidenced by fresh tracks and feces, was observed on the South Thunder Range, just north of the Helicopter Landing Pads. Large populations of prairie dogs also are known to occur at along the northwest buffer zone of the Rocket Sled Track and at several highly disturbed locations within KAFB near Gibson Street.

6.9 SURVEYS OF PROPOSED BUILDING LOCATIONS

The proposed Office/Light Lab/Conference Center would be constructed in an area consisting of an asphalt parking lot adjoining several temporary buildings. There would be no biologic consequences if the proposed building were constructed in this region. Proposed area for construction of the Gamma Irradiation Facility is located within Technical Area V immediately east of the Reactor Building Complex at Building 6590. The biologic survey team did not have access to Technical Area V. However, the proposed building location was surveyed easily by performing a visual inspection through the security fence and along the adjacent roadway. Nearly all of the ground at this proposed construction site is highly disturbed and barren. Only one small portion of the site supports native vegetation. This isolated enclave of vegetation is approximately 15 meters wide (50 feet) and 25 meters long (82 feet). It is dominated by weedy species, such as Russian thistle, summer cypress, and

threeawn grass. It is unlikely that any species of special concern would occur in this small weedy site.

6.10 SURVEY OF TECHNICAL AREA III (1993)

The 1992 field studies of Technical Area III provided sufficient information to predict an assemblage of species of special concern that could occur within the remaining unsurveyed portions of the area. For example, data for 1992 suggested that grama grass cactus was likely to occur in the western portion of Technical Area III; these data also suggested that Santa Fe milkvetch might occur in the eastern half of the study area. In all, approximately 950 acres of Technical Area III was surveyed 100% by walking.

The 1993 survey concentrated on areas identified as most suitable habitat not previously surveyed in 1992. This included the entire western half of Technical Area III, as well as a large part of the southeast quadrant of the facility (Fig. 2). By the end of the 1993 season, nearly all of the potential habitat for rare, threatened, or endangered plant species within Technical Area III was surveyed. The remaining unsurveyed portions of the facility are primarily small fragmented patches of habitat that occur between buildings or within fenced boundaries surrounding buildings. Most habitat fragments are confined to the northeast quadrant of the facility.

The spring of 1993 proved to be cooler than normal, as well as dry and windy. The result was very poor development in the spring flora, as well as poor flower set in species like grama grass cactus. Few plants discovered in 1993 or those revisited from 1992 had flowers or fruits in the last week of April, 1993. In contrast, many of the same plants were flush with flowers in mid-April 1992. A careful investigation of plants indicates that successive killing frosts destroyed the flowers. This investigation also revealed pieces of dried flower parts at the site of the apical meristem. Larger, more vigorous plants were able to bloom and subsequently set fruit in May. Many of the smallest plants did not set fruits. Based on direct observation and comparison with 1992, the 1993 season was poor for growth and reproduction of grama grass cactus.

As a result of the 1993 survey, 19 new grama grass cactus sites were discovered in Technical Area III, with a total of 103 individual grama grass cacti occurring at these sites. No other rare, threatened, or endangered plant species were found in the study area during the 1993 census.

The majority of the grama grass cactus sites found in 1993 are clustered at the extreme western edge of Technical Area III, west of the Rocket Sled Track, and in the south-central part just south and southeast of the Gun Site Facility. The combined 1992 and 1993 surveys have resulted in the discovery of 34 grama grass cacti sites within the confines of Technical Area III, with a total of 299 individual grama grass cactus plants occurring at these sites. All sites discovered during the 1993 census had a maximum potential density of approximately 0.10 plants per acre, and a maximum potential frequency of 2 sites per 100 acres of habitat. These numbers are higher than 1992 (density of <0.008 plants per acres, frequency of 0.8 sites per acre). This disparity in density and frequency can be explained by the large proportion of high quality habitat in the 1993 survey area. In 1992, large tracts of low quality habitat were included within the survey.

All grama grass cacti sites within Technical Area III occur within one of three habitat types: 1) sandy areas dominated by sagebrush and interspersed with black grama grass (Sand-Shrub); 2) open stands of grama grass intermixed with sand dropseed (Grama-Dropseed); and 3) open low-lying, poorly drained areas dominated by burro grass, intermixed at the edges with black grama grass. The majority of grama grass cacti sites (52.6%) were found in the Sand-Shrubland habitat; the remainder were found in the Grama-Dropseed (31.5%) and Grama-Burro (15.7%) grassland habitats, respectively. Grama grass cactus plants were not found in disturbed habitats dominated by threeawn and dropseed grass species.

6.10.1 Status and Condition of the 1992 Grama Grass Cactus Sites.

6.10.1.1 Extirpated Sites.--All 46 of the grama grass cactus sites discovered in the 1992 field season were revisited in 1993. Data were recorded on number, size, condition, and reproductive success of these plants. The key consideration was how sites fared relative to

their 1992 condition. Of the 46 sites discovered in 1992, three of them (Sites 9, 12 and 42, which comprise approximately 6% of the total sites) were extirpated. A review of the sites indicates that plants were extirpated for various causes. For example, cacti at Site 9 were killed by insect borers; cacti at Site 12 were killed by rodents, and cacti at Site 42 were destroyed by construction activities associated with construction of a the KAFB helicopter runway.

6.10.1.2 Number and Condition of Grama Grass Cacti From 1992.—A total of 196 individual grama grass cactus plants were found at 46 different sites in 1992. Only 141 (71.9%) of these plants remained in 1993. Fifty-five of the 1992 plants (28.1%) were either dead or gone in 1993. Of the 141 plants that remained, 43 (30.4%) were damaged. Therefore, 69.6% of the plants discovered in 1992 were either dead or damaged in 1993. Three causes for damage and mortality were identified: 1) infestations of insect borers, 2) herbivory by rodents, and 3) construction activities.

These three sources of destruction accounted for approximately 70% of the individual cacti killed between 1992 and 1993 (insect borers 33%, rodents 32%, human disturbance 5%). Approximately 30% of the individual cacti killed were gone without a trace. It is uncertain if they were killed by insect borers, rodents or some other destructive agent. However, it is certain they were not killed by construction or surface disturbance activities, as these sites were in the same conditions in 1993 as in 1992.

6.10.1.3 Impacts of Rodents.—Rodents (i.e., kangaroo rats and mice, deer mice, prairie dogs) accounted for the largest amount of damage and destruction of the grama grass cacti at CCTC. Between 1992 and 1993, rodents killed 18 and damaged 40 of the 196 individual plants under study. Consequently, rodents either killed or damaged approximately 30% of the plants discovered in 1992. Attack by rodents, although damaging, was not always lethal. In fact, only 31% of the attacks resulted in death. In nearly all instances where plants survived an attack, cacti developed multiple heads, which is the result of destruction of the apical meristem and development of new meristem sites in the remaining caudex of the plant.

It is likely that most of the multiple headed grama grass cacti at CCTC result from prior rodent pruning.

6.10.1.4 Impacts of Insect Borers.—Insect borers accounted for the second largest source of damage and destruction of grama grass cacti at CCTC. Between 1992 and 1993, borers killed 19 (9.7%) and damaged 3 (0.02%) of the 196 individual grama grass plants under study. Consequently, insect borers either killed or damaged approximately 11% of the plants discovered in 1992. Attack by insect borers was far more lethal than cropping by rodents. Over 86% of the plants attacked by borers resulted in death, and the remaining 14% that were damaged were in poor condition, and may eventually die from the infestation. Although borer infestations were not as widespread as rodent damage between 1992 and 1993, borer infestations were far more lethal to grama grass populations.

6.10.1.5 Impacts of Construction Activity.—Human activity was the least exacting of the sources for damage and destruction of grama grass cacti at CCTC. Only 1.5% of the plants discovered in 1992 were damaged or killed by human actions. The only grama grass plants impacted by human actions between 1992 and 1993 were located at Site 42. Site 42 is located in the south-central portion of the Rocket Sled Impact Cone. Activity of equipment related to construction of landing strips ran over the cacti in 1992. By 1993, all the cacti at this site were gone.

6.10.1.6 Recruitment 1992-1993.—In the course of reevaluating the 46 grama grass cactus sites found in 1992, the sites were resurveyed to identify juveniles or seedlings that were not visible in 1992. A total of 67 new plants were identified at these 46 sites. Twenty six of the newly discovered plants were mature individuals, which because of their cryptic nature and position within clumps of foliage were overlooked in 1992. The remaining 41 plants were 2 cm or under in diameter and were deemed to be recruits into the population that were too small to detect in 1992. These 41 plants constitute a recruitment rate of 20% for 1992 to 1993. The rate of recruitment probably varies dramatically depending upon spring and early summer weather conditions.

6.10.1.7 Survey Error and Limits.—Many of the species of cacti that are currently under State and Federal protection are highly cryptic in nature (i.e., grama grass cactus, Wright's fishhook cactus). Either by their size or morphology, they use camouflage of surrounding vegetation to protect themselves against the damaging effects of herbivory and seed predation. The survey techniques implemented in this study have been demonstrated to be effective in identifying populations of grama grass cacti at specific sites or individual groupings. These techniques are designed to take advantage of the visibility of a percentage of grama grass cacti when they occur in large numbers (sites or groupings). In the course of relocating the 46 sites from 1992, several hundred acres of habitat that were previously surveyed in 1992 were resurveyed in 1993. In all of this acreage, no new sites were discovered.

Previous surveys, however, indicate that within sites of cryptic species (i.e., grama grass cacti) some percentage of the plants will be elusive, even to the trained eye. Within known sites, some of these plants will remain undetected during any one survey season, even if surveyors are as close as 1 meter apart. Nonetheless, conditions of vegetation at these sites change from year to year. Successive seasons of survey, and subsequent changes in masking vegetation usually allow for identification of plants that were missed in previous years.

Previous studies also indicate that the rate of non-juvenile plants that go undetected in a one season survey varies from 10-20% among the more cryptic species, and less than 5% for the more obvious individuals. At CCTC, 196 mature plants were found in 1992. Twenty-six additional mature plants were found in 1993. Because the 1993 findings were plants that should have been detected in 1992, the plant population for 1992 was at least 222. The survey of plants that remained undetected in 1992 within known sites was approximately 11.7% of plants. This value corresponds to the 10-20% rate of omission observed in similar surveys within population sites for this species.

6.10.2 Summary of Findings in Technical Area III.

Most of the suitable habitat for rare, threatened, and endangered species within Technical Area III has been surveyed. The remaining unsurveyed portions of the facility are small,

fragmented patches of habitat that occur between buildings or within fenced boundaries surrounding buildings. Most of these habitat fragments are confined to the northeast quadrant of the facility. Nearly all of these areas are habitat types that have been proved (by previous survey in the area) to be of low productivity for rare, threatened, and endangered species documented to occur in the area. The spring of 1993 proved to be quite severe. Numerous late frosts, combined with high winds and dry conditions resulted in low flower and fruit sets among cacti and an overall poorer condition than in 1992.

As a result of the 1993 survey, 19 new grama grass cactus sites were discovered in Technical Area III. A total of 103 grama grass cacti were found at these sites. The majority of the grama grass cactus sites found in 1993 are clustered at the extreme western edge of Technical Area III, west of the Rocket Sled Track, and in the south-central portion, just south and southeast of the Gun Site Facility. Combined 1992 and 1993 surveys have resulted in discovery of 34 grama grass cacti sites within the confines of Technical Area III, with a total of 299 individual grama grass cactus plants inhabiting these sites.

Of the 46, sites discovered in 1992 (including Technical Area III, North and South Thunder Ranges, and the impact cone of the Rocket Sled Track), three of them (Sites 9, 12, and 42 which comprise approximately 6% of the total sites) were gone (plants dead or missing) in 1993. None of the extirpated sites occurred in Technical Area III. Approximately 28% of the grama grass cacti identified in 1992 were dead in 1993. Rodents accounted for the largest amount of damage and destruction of the grama grass cacti at CCTC. Between 1992 and 1993, rodents killed 18 and damaged 40 of the 196 plants. Insect borers accounted for the second largest source of damage and destruction of the grama grass cacti at CCTC. Between 1992 and 1993, insect borers killed 19 and damaged 3 of the 196 plants. Human activity was responsible for only a small portion of damage and destruction of grama grass cacti in the study area. Only 1.5% of the plants discovered in 1992 were damaged or killed by human actions. Recruitment of seedlings and juveniles between 1992 and 1993 was documented at approximately 20%.

Between 1992 and 1993, the level of mortality (approximately 28%) exceeded the documented level of recruitment (approximately 20%). The high mortality rate in relation to recruitment suggests potential declines in population numbers at the site. However, observations of grama grass cacti over the last 20 years suggest that population sites may in the course of their development vary widely and dramatically in the number and condition of individual cacti present. Some investigators suggest that grama grass cacti sites are ephemeral, persisting for 10 or 20 years then eventually succumbing to natural forces such as infestations of borers or rodents. New sites may appear in nearby locations as a result of seed dispersion.

Data are insufficient to make any long-term predictions as to the success of the grama grass sites at CCTC; however, some data from the study are conclusive. For example: 1) most pervasive source of destruction to grama grass cactus is caused by rodents; 2) most lethal attack on individual grama grass cacti plants are from insect borers (nearly 90% fatality); 3) grama grass cacti prefer sand-shrubland habitat dominated by sagebrush and black grama; and 4) although grama grass cacti occur in some abundance in Grama-Burro grass and Grama-dropseed grass communities, they were not found in disturbed areas dominated by snakeweed or various species of threeawn and dropseed grasses.

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7.0 SPECIFIC SURVEYS FOR WILDLIFE

7.1 BIRDS

Targeted survey areas for bird surveys included grassland; grassland-juniper; and the grassland-associated sandsage brush, fourwing saltbush, and winterfat habitat in each of four survey areas receiving the least amount of human disturbance and range alteration. These areas were determined to be: 1) North Thunder Range, 2) South Thunder Range, 3) west side of the Rocket Sled Track, and 4) the Rocket Sled Track Impact Area associated with the 18° cone extending from the north end of the Rocket Sled Track to the KAFB boundary with the Isleta Pueblo Indian Reservation. In each of these four study sites, three sample transects were conducted (by two observers) by walking a line 1,000 meters (3,281 feet) long, and recording individual species of birds (and other wildlife) observed from that line and the distance to each animal (see Section 4.0, METHODS). The three strip censuses were conducted one week apart, in the early morning (0700 h), beginning the second week of April. Total distance walked in the survey was 12,000 meters (3,657 feet), or 3,000 meters (914 feet) in each of the four areas.

Results of the survey are shown in Table 2. By far, the greatest species diversity (richness) and density of birds (insectivorous, perching, and raptoral) were observed during surveys of the North Thunder Range, particularly in the hilly, extreme southeast corner of the site (SE 1/4 Sec 28). This area is characterized by heterogenous topographic relief associated with rocky limestone ledges, hills [1,692 meters - 1,714 meters in elevation (516 - 522 feet)], and arroyos. There is an abundant concentration of potential shelters for small species because of arroyo vegetation, rocky ledges, and scattered junipers, particularly along the southeast edge of the area. This habitat provided limited but suitable habitat for small perching (passerine) and insectivorous birds that comprised the largest segment of the overall species composition. High vegetation diversity appears to provide food and perching sites for many species like the loggerhead shrike, American kestrel, and red-tailed hawk; whereas, this same type of habitat provides nesting sites for displaying territorial species like the black-throated sparrow, lark bunting, sage sparrow, canyon towhee, and meadow lark.

Table 2. Results of specific bird censuses in four different regions of the project area. Total length of each transect was 2,000 meters (6,562 feet). Surveys were conducted along transects using Eberhardt's (1968) model of density per unit area (Caughley, 1977:41; Brower et al., 1989). n = total birds observed and number of individuals in species X = average distance from the transect (line-of-march); D1, D2, and D3 are different estimates of density (birds per square km; see text for details of the methods). Targeted sample areas included grassland and grassland-sandsage brush-winterfat habitat in each of the four survey areas: 1) North Thunder Range, 2) South Thunder Range, 3) west side of Rocket Sled Track, and 4) the potential impact area associated with the 18° cone extending from the north end of the Rocket Sled Track to the KAFB boundary with the Isleta Pueblo Indian Reservation.

Species	North Thunder Range					South Thunder Range					West Rocket Sled Track					Rocket Sled Track Impact Area				
	n	X	D1	D2	D3	n	X	D1	D2	D3	n	X	D1	D2	D3	n	X	D1	D2	D3
sage sparrow	5	14	47	75	89	-	-	-	-	-	5	16	41	50	78	4	13	42	75	80
black-throated sparrow	12	13	118	200	225	7	19	50	50	94	5	12	54	100	104	5	12	54	100	104
scrub jay	2	15	18	25	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
red-tailed hawk	2	30	9	0	16	4	23	23	25	44	-	-	-	-	-	-	-	-	-	-
Swainson's hawk	-	-	-	-	-	5	24	27	25	68	-	-	-	-	-	-	-	-	-	-
lark bunting	2	15	18	25	33	8	19	56	60	106	5	14	47	75	98	8	13	84	150	180
Gambel's quail	5	20	33	0	62	-	-	-	-	-	-	-	-	-	-	4	20	26	25	50
house finch	3	17	23	25	45	-	-	-	-	-	5	10	65	125	125	2	10	26	50	50
killdeer	4	15	35	50	67	7	17	63	75	102	-	-	-	-	-	-	-	-	-	-
lark sparrow	2	15	17	25	33	4	18	30	60	57	7	10	92	175	175	6	12	65	126	129
northern harrier	2	15	17	25	33	5	24	27	25	52	-	-	-	-	-	-	-	-	-	-
common raven	5	26	25	0	48	7	26	35	25	68	5	24	27	25	62	7	25	35	25	68
horned lark	30	27	148	0	281	45	26	229	100	436	15	10	185	350	351	14	10	172	325	327
American kestrel	8	26	40	0	76	4	22	23	25	44	5	20	33	25	63	9	20	59	25	113
loggerhead shrike	9	15	76	125	144	8	26	40	25	76	5	10	47	75	98	9	12	96	176	184
song sparrow	2	15	17	25	33	-	-	-	-	-	7	10	92	175	175	4	18	30	25	57
house sparrow	1	10	13	25	25	-	-	-	-	-	4	10	52	100	100	6	10	79	150	150
brown (canyon) towhee	4	13	42	75	80	-	-	-	-	-	-	-	-	-	-	2	10	26	50	50
Brewer's sparrow	3	13	29	50	56	-	-	-	-	-	3	10	39	75	75	4	10	56	100	100
chipping sparrow	2	15	17	25	33	4	20	26	25	50	4	10	52	100	100	6	10	79	150	150
western meadow lark	16	18	116	175	220	22	20	144	100	275	15	10	197	375	375	11	11	132	250	250
European starling	18	12	84	150	160	16	21	99	50	188	9	11	106	200	203	4	10	52	100	100
mourning dove	13	20	82	0	156	19	28	88	25	167	11	13	114	200	216	14	13	143	250	272

Although no golden eagles *(Aquila chrysaetos)* were observed during the CCTC biologic survey, one individual was observed in September of 1991, along the north side of the Lurance Canyon Road, approximately 11. 3 km (7 miles) from CCTC (Sullivan, 1993). This species was observed feeding in the vicinity of the grassland-juniper arroyo just west of the Burn Site in Lurance Canyon. After securing terrestrial prey, the golden eagle flew northeast in the direction of Burn Site. Although no golden eagles were observed in the immediate vicinity of the CCTC, portions of the rich grassland habitat within the CCTC area (i.e., North and South Thunder Ranges, west border of Rocket Sled Track; Rocket Sled Track Impact Area) could serve as a source of prey diversity (i.e., hares, rabbits, ground squirrels, other smaller mammals, and birds) for resident and migrating raptors in the general area of CCTC. All raptors (falcons, hawks, owls) are protected by the State of New Mexico and the Migratory Bird Act. In addition, the golden eagle is a fully Federally protected species under Public Law 93-205 and U.S.C. Title 50, Part II, that designated the bald eagle as an Endangered species.

7.2 MAMMALS

As in the bird surveys, targeted sample areas for mammal surveys included grassland, grassland-juniper, and the grassland associated with sandsage brush, fourwing saltbush, and winterfat in each of the four survey areas receiving the least amount of human disturbance and range alteration. These included: 1) North Thunder Range, 2) South Thunder Range, 3) west side of the Rocket Sled Track, and 4) the Rocket Sled Track Impact Area. A 30.5-meter (1,500-foot) trapline consisting of 100 Sherman livetraps spaced 4.6 meters (15 feet) apart was set in each of the four targeted sample areas and checked over a period of 3 consecutive days. Results, therefore, are based on a total of 1,200 trap-nights (300 trap-nights at each of four sites). This trapping design resulted in the capture of 231 individual small mammals, representing nine different species, and an overall trapping success of 19.3% (i.e., 231/1,200) over the sum of the trapping interval. The following total numbers of each species were collected (Table 3): deer mice (n=88), piñon mice (n=7), western harvest mice (n=37), northern grasshopper mice (n=16), white-throated woodrats (n=11), silky pocket mice (n=30), Ord's kangaroo rats (n=23), Merriam's kangaroo rats (n=12), and banner-tailed kangaroo rats (n=7). North Thunder Range and South Thunder

Range had a greater density and diversity of small mammals than either the west side of the Rocket Sled Track or the Rocket Sled Track Impact Area. Small mammals were particularly active in hilly and topographically diverse areas associated with rock outcrops, the grassland-juniper ecotone, and in arroyo habitat. Other mammal species observed on the North Thunder Range included mule deer (tracks), rock squirrel, striped skunk (tracks), coyote, bobcat (tracks), desert cottontail, and valley pocket gopher (burrows). In contrast, the South Thunder range generally had larger concentrations of the typical grassland species such as kangaroo rats, pocket mice, western harvest mice, and northern grasshopper mice.

Numerous fresh burrows with tail tracks were observed in this area, suggesting that densities of mice are rather high throughout the South Thunder Range. Other mammal species observed in this area included the rock squirrel, coyote, desert cottontail, blacktailed jackrabbit, and prairie dog. Rabbits and hares tended to concentrate around buildings where structures afforded shelter, and in areas where Russian thistle accumulated in massive concentrations along fence lines. Russian thistle concentrations also provided good cover and shelter for most species of rats and mice, as well as lizards.

Mule deer sign was not common on the CCTC area. In Sol se Mete Canyon, mule deer browse on fourwing saltbush, mountain mahogany, Apache plume, winterfat, and squawbrush (Sullivan, 1993), but only winterfat, fourwing saltbush, and sandsage brush are common on the CCTC. Cover provided by shrubby vegetation contributes to the well-being of mule deer by providing shelter, increasing their chances of escape from predators, and fostering a sense of security—a number of studies indicate that the latter factor may be highly significant in maintaining mule deer in good physical condition (Dasmann, 1971; Sullivan, 1993). However, except for a few scattered junipers on the North Thunder Range, the entire CCTC area has little cover for mule deer.

The biologic unit (territory occupied by an individual mule deer herd) for mule deer over much of its range in New Mexico consists of a winter range, or a group of related winter ranges, and their complementary spring, summer, and fall ranges where the majority of the animals that use the winter range spend the balance of the year. Unglazed grassland-juniper

Table 3. Results of small mammal trapping survey. Species, number (n) and distribution of species for each survey area as percent of total observations. NTR = North Thunder Range, STR = South Thunder Range, WSRST = west side Rocket Sled Track, RSTIA = Rocket Sled Track Impact Area.

Species	NTR	STR	WSRST	RSTIA
deer mouse (n = 88)	28 (32%)	22 (24%)	19 (22%)	19 (22%)
piñon mouse (n = 7)	7 (100%)	—	—	—
western harvest mouse (n = 37)	7 (19%)	20 (54%)	2 (5%)	8 (22%)
northern grasshopper mouse (n = 16)	4 (25%)	8 (50%)	—	4 (25%)
white-throated woodrat (n = 11)	4 (37%)	3 (27%)	1 (9%)	3 (27%)
silky pocket mouse (n = 30)	8 (27%)	10 (33%)	5 (17%)	7 (23%)
Ord's kangaroo rat (n = 23)	7 (30%)	11 (49%)	3 (13%)	2 (8%)
Merriam's kangaroo rat (n = 12)	4 (33%)	4 (33%)	2 (17%)	2 (17%)
banner-tailed kangaroo rat (n = 7)	1 (14%)	4 (57%)	—	2 (29%)
Total individuals per site	70 (30%)	82 (35%)	32 (14%)	47 (21%)

vegetation associated with the foothills surrounding the Lurance Canyon and Sol se Mete Canyon area is an important winter range for mule deer (Biggs, 1991). However, the significance of the CCTC area as a winter range for mule deer appears diminished, probably because of the absence of free water, adequate shrubby species of plants for both food and cover, a high level of human disturbance (i.e., noise, human and vehicle traffic, etc.), and because mule deer are restricted from the area by fencing.

7.3 AMPHIBIANS

Because of the lack of ponds, streams, and other moist habitats, the number of amphibian species was expected to be low in the CCTC area; in fact, no amphibians were observed during the biologic survey. Coyote Spring and Sol se Mete Spring are the only perennial sources of water that are even remotely close to the CCTC area, and these water sources are 5 to 10 miles to the east. Several species of amphibians that may potentially occur in temporary potholes and rain pools in low-lying regions of the CCTC area include the tiger salamander, Woodhouse toad, plains spadefoot toad, western southern spadefoot toad, and red-spotted toad (Fischer, 1990; Biggs, 1991; Sullivan, 1993).

7.4 REPTILES

The largest densities of reptiles occurred on the South Thunder Range, which consisted primarily of large concentrations of the little striped whiptail and lesser earless lizards (Table 4). However, the largest overall species diversity of reptiles occurred on the North Thunder Range, because of its relatively greater topographic and vegetation diversity. The little striped whiptail and lesser earless lizard were the most common species found throughout the CCTC area. These two species were particularly common in the vicinity of open sparsely covered grasslands associated with active kangaroo rat activity.

The little striped whiptail is an avid burrowing species that uses active as well as abandoned kangaroo rat burrows for shelter and shade during the hottest periods of the day. The eastern fence lizard was most common in rocky and hilly habitat associated with the North Thunder Range, but was not found in flat grassland habitat. All other species of snakes and lizards were observed infrequently during the survey period. The massasauga or "swamp rattle

snake" generally occurs in desert grassland, particularly in low areas of rank growth typical of the Rio Grande Valley, and in low plains of mesquite, juniper, and grassland that have been degraded in some areas by overgrazing. This species, however, appears to be fairly common in grassland habitat associated with the CCTC area.

Table 4. Results of belt-transect survey of diurnal snakes and lizards. Species, number (n) and distribution of species for each survey area as percent of total observations. NTR = North Thunder Range, STR = South Thunder Range, WSRST = west side Rocket Sled Track, RSTIA = Rocket Sled Track Impact Area. Number of individuals observed per species represents estimated density (i.e., number of individuals per hectare [per 10,000 square meters]) in a particular area.

Species	NTR	STR	WSRST	RSTIA
Chihuahuan spotted whiptail (n = 13)	2 (15.5%)	4 (30.7%)	4 (30.7%)	3 (23.1%)
Little striped whiptail (n = 329)	46 (14.0%)	167 (50.8%)	61 (18.5%)	55 (16.7%)
Western rattlesnake (n = 3)	1 (33.3%)	—	2 (66.6%)	—
Collared lizard (n = 12)	7 (58.3%)	—	2 (16.7%)	3 (25.0%)
Great Plains skink (n = 7)	2 (28.6%)	2 (28.6%)	2 (28.6%)	1 (14.2%)
Lesser earless lizard (n = 144)	20 (13.9%)	72 (50.0%)	27 (18.7%)	25 (17.4%)
Gopher or bullsnake (n = 13)	3 (23.1%)	5 (38.5%)	3 (23.1%)	2 (15.3%)
Texas horned lizard (n = 1)	1 (100.0%)	—	—	—
Short-horned lizard (n = 7)	2 (28.6%)	3 (42.8%)	1 (14.3%)	1 (14.3%)
Round-tailed horned lizard (n = 8)	2 (25.0%)	4 (50.0%)	2 (25.0%)	—
Eastern fence lizard (n = 9)	9 (100.0%)	—	—	—
Massasauga (n = 7)	—	4 (57.1%)	1 (14.3%)	2 (28.6%)
Tree lizard (n = 7)	7 (100.0%)	—	—	—
Total per site (n = 560)	102 (18.2%)	261 (46.7%)	105 (18.7%)	92 (16.4%)

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8.0 PROTECTED SPECIES - PLANTS

The CCTC area has the potential to support a large number of plant species. Based upon biologic field surveys of habitats within the CCTC area, and after consultation with the USFS, USFWS, and the NMFD, a list of plant species occurring within the CCTC area was compiled (Appendix A). In addition, information on threatened, endangered, or sensitive plant species potentially occurring within the CCTC area also was compiled (Appendix B).

Currently, endangered, and sensitive plant species in New Mexico are classified within various jurisdictional frameworks, including the USFWS Endangered Species Act, New Mexico Endangered Plant Species Act, and the USFS Sensitive Species list. Each agency maintains its own list of species that it considers important for protection or review. Each list has categories distinct from one another. The following is a brief discussion of these categories as they relate to rare species that could occur in the CCTC area.

8.1 FEDERAL STATUS

8.1.1 U.S. Fish and Wildlife Service Lists.

The U.S. Fish and Wildlife Service maintains lists for species that it considers endangered, threatened, proposed endangered, proposed threatened, C1 (Category 1), C2 (Category 2), 3A, 3B and 3C. Species potentially occurring in the CCTC area are Category C2 and 3C; legal designations are as follows:

8.1.1.1 Category 1 Candidate (C1).—Category 1 candidates are species for which there is enough substantial information on biologic vulnerability and threats(s) to support proposals to list them as endangered or threatened.

8.1.1.2 Category 2 Candidate (C2).—Category 2 candidates are species for which additional information is needed to support a proposal to list as threatened or endangered.

Note: These species receive no protection under the Endangered Species Act unless they become listed as threatened or endangered.

8.1.1.3 Category 3 Species.—Category 3 taxa are those species that were once considered for listing as endangered or threatened, but are not currently receiving such consideration. These taxa include the **3A, 3B and 3C** designations.

8.1.1.4 Category 3A Species.—Category **3A** designation comprises taxa for which the U.S. Fish and Wildlife Service has persuasive evidence of extinction. If rediscovered, however, such taxa might warrant high priority for additions to the Endangered Species List.

8.1.1.5 Category 3B Species.—Category **3B** designation comprises names that on the basis of current taxonomic understanding, usually as represented in published revisions and monographs, do not represent taxa meeting the legal definition of a species as defined in the Endangered Species Act.

8.1.1.6 Category 3C Species.—Category **3C** designation is applied to those taxa that have proven to be more abundant or widespread than previously believed and that have no identifiable threats.

8.1.2 U.S. Forest Service Sensitive Species List.

The U.S. Forest Service sensitive rare plant species are those considered sensitive to land use practices within each specific National Forest. Potential impacts to these species on Forest Service land are regulated by Forest management policies. Collection of these species requires a permit issued by the U.S. Forest Service. These lists are generally specific to each National Forest.

8.2 NEW MEXICO STATUS

8.2.1 State of New Mexico Plant Lists.

The New Mexico Forestry Division maintains lists of species that are endangered, sensitive, and/or in review. These legal designations are:

8.2.1.1 Sensitive Plants.—Sensitive and rare plant species occurring in New Mexico are those species that are monitored to determine if they should ever be elevated to endangered species status. Species on this list receive no protection under law.

8.2.1.2 Endangered Plants.—Endangered plant species of New Mexico are those taxa in danger of becoming extinct or in danger of extirpation. The New Mexico Endangered Plant Species Act prohibits collection of these species except in the case of scientific study, and then only under a permit issued by the State of New Mexico.

The law also allows for transplantation of plants (under permit) when feasible and prudent. New Mexico uses a coding system to designate listed species. This code (R-E-D) is defined as follows:

R (Rarity index): 1) rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low; 2) occurrence confined to several populations or to one extended population; 3) occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported.

E (Endangerment index): 1) not endangered, 2) endangered in a portion of its range, 3) endangered throughout its range.

D (Distribution index): 1) more or less widespread outside New Mexico, 2) rare outside New Mexico, 3) endemic to New Mexico.

Example: The Santa Fe milkvetch is designated by New Mexico as Sensitive Code 1-1-3. This code indicates Rarity ("occasionally confined to several populations or to an extended population"), Endangered ("not endangered"), and Distribution Index ("endemic to New Mexico").

8.3 REVIEW OF PLANT SPECIES FOUND IN CCTC AREA

8.3.1 Grama Grass Cactus.

Grama grass cactus *(Toumeya or Pediocactus papyracantha)* is a Federal Category 2 Candidate as well as a State of New Mexico Endangered (R-E-D Code 1-2-2) species. Grama grass cactus is a small cactus, usually not more than 7.5 cm (3 inches) tall (occasionally reaching 20 cm (8 inches) in height). It flowers in April and May with its pale yellow flowers opening in the late afternoon (generally between 2:00 and 6:00 p.m.). It is found throughout central New Mexico ranging from the Ghost Ranch area near Chama, southward to the Alkali Lake Region of Otero County near Dell City, Texas. Its easternmost documented distribution is near Moriarty but it is likely that it could extend eastward to Santa Rosa, New Mexico. Its western range extends to Holbrook, Arizona. This cactus is somewhat unusual in that its spines are modified, becoming papery. These light-brown to gray papery spines twist and bend much like blades of grama grass. The plants normally grow in and among grasses such as blue grama, black grama, and ring muhly, where their papery gray-brown spines blend into the adjacent grass, effectively hiding the plant.

Grama grass cactus has been found in a variety of grassland environments. Originally, it was identified in blue grama grasslands. In recent years it has been found to be abundant in black grama, alkali sacaton, ring muhly, galleta, and dropseed grasslands. It has also been found in gypsophytic plant communities on gypsum deposits as well as in some big sagebrush-grama grass communities. Normally grama grass cactus prefers sandy-gravelly soils between 1,463 and 2,347 meters (4,800 to 7,700 feet) in elevation. It can occur on basalt outcrops with shallow loams soils, on coarse granitic soils, or on silty-clay silts. It is rarely found on sandstone outcrops or limestone soils.

Grama grass cactus populations are somewhat ephemeral, often experiencing great fluctuations in numbers of individual plants. The primary cause for these fluctuations is believed to be infestations of the insect larva of several species of beetles and moths. When population densities at grama grass cactus sites increase, the plants are more vulnerable to such infestations. Some grama grass population sites have been documented to lose as many as 90% of the population in one season due to such infestations (P. J. Knight, pers. obs.).

These infestations usually result in populations where only a few scattered remnant plants survive. Seeds from these remnant plants, as well as seeds present in the soil, often result in recovery of the population. Recovering populations often have a few large plants and tiny seedlings present with almost no mid-sized individuals.

Grama grass cactus is threatened by a variety of non-natural activities. It appears to be highly impacted by cattle grazing. Grazing reduces ground cover, increasing vulnerability to herbivorous mammals such as mule deer, rabbits, hares, and small rodents (i.e., kangaroo rats, woodrats, deer mice). Grazing also results in trampline of the soil and occasionally the plants themselves. Moreover, populations infested by insects that are subsequently subjected to grazing may be extirpated. Grama grass cactus is also highly impacted by habitat destruction associated with urbanization and construction projects. This species also is highly sought after by cactus collectors who can easily collect most of the plants within a population.

Although it occurs sporadically throughout central New Mexico, it has been found at numerous locations in the Albuquerque area, including the northeast heights and, to a lesser degree, on the escarpment on the west side of the Rio Grande Valley. Populations of grama grass cactus are known to occur near Coyote Springs and near the landfill at KAFB (Sullivan, 1993).

8.3.2 Santa Fe Milkvetch.

The Santa Fe milkvetch *(Astragalus feensis)* is currently a New Mexico Sensitive (R-E-D Code 1-1-3) plant species, with no Federal status. Santa Fe milkvetch is a herbaceous species with spreading or prostrate stems that often curve upward at the ends. Flowers are pealike, reddish-purple in color, and rarely more than 1.3 to 1.6 cm (0.6 inches) long. It has a conspicuous pod that is three-angled in cross section and is covered with small hairs. It flowers from late March through May. It is endemic in central New Mexico extending from just north of Santa Fe southward to Belen. Normally, it occurs on dry slopes in grassland or lower piñon-juniper woodland between 1,524 and 2,133 meters (5,000 to 7,000 feet) in elevation. It is often found in rocky areas or where coarse gravelly or sandy-gravel soils

occur. Santa Fe milkvetch usually occurs in locally abundant populations. Such populations have been identified in several locations in Albuquerque, such as in the foothills of the Sandia Mountains as well as the escarpment on the west side of Ceja Mesa just west of Albuquerque. The plants are not threatened except in areas of severe habitat destruction. As with many species of milkvetch, they tend to be somewhat weedy and will often occupy disturbed ground within their range.

8.4 RESULTS OF THE PLANT SURVEY

Of the six potential threatened, endangered, or sensitive species anticipated, two have been documented within the project limits; these included the grama grass cactus (a State of New Mexico Endangered, Federal C2 species, and U.S. Forest Service Sensitive species) and the Santa Fe milkvetch (a State of New Mexico Sensitive species with no Federal status). Plants of both species were found in the North and South Thunder Ranges, and grama grass cactus plants were found within the Rocket Sled Track Impact Area and in Technical Area III at sites not directly associated with any specific facility.

There were no threatened, endangered, or sensitive plants within the Centrifuge Site, Drop Tower and Water Impact Site, Gun Site, Light Initiated High-Explosives (LIHE) Site, or immediately adjacent to the Rocket Sled Track.

8.4.1 Grama Grass Cactus Sites in the CCTC Area.

A total of 65 grama grass cactus sites were located within the surveyed portions of the CCTC area (Fig. 3). Herein, a "site" refers to a locality where one or more individual plants of special concern is/are known to occur. The number of individual grama grass cacti found at each site ranged from 1 to 20 individuals. From these 65 sites, a total of 383 individual grama grass cacti were recorded. These localities include 4 sites in the North Thunder Range, 2 sites in the South Thunder Range, 34 sites in the Rocket Sled Track Impact Area, 23 sites in Technical Area III that are not directly associated with any specific facility, and 2 sites west of the Rocket Sled Track Impact Area. Although these sites occurred throughout much of the CCTC area, they were more concentrated along the western buffer zone to the

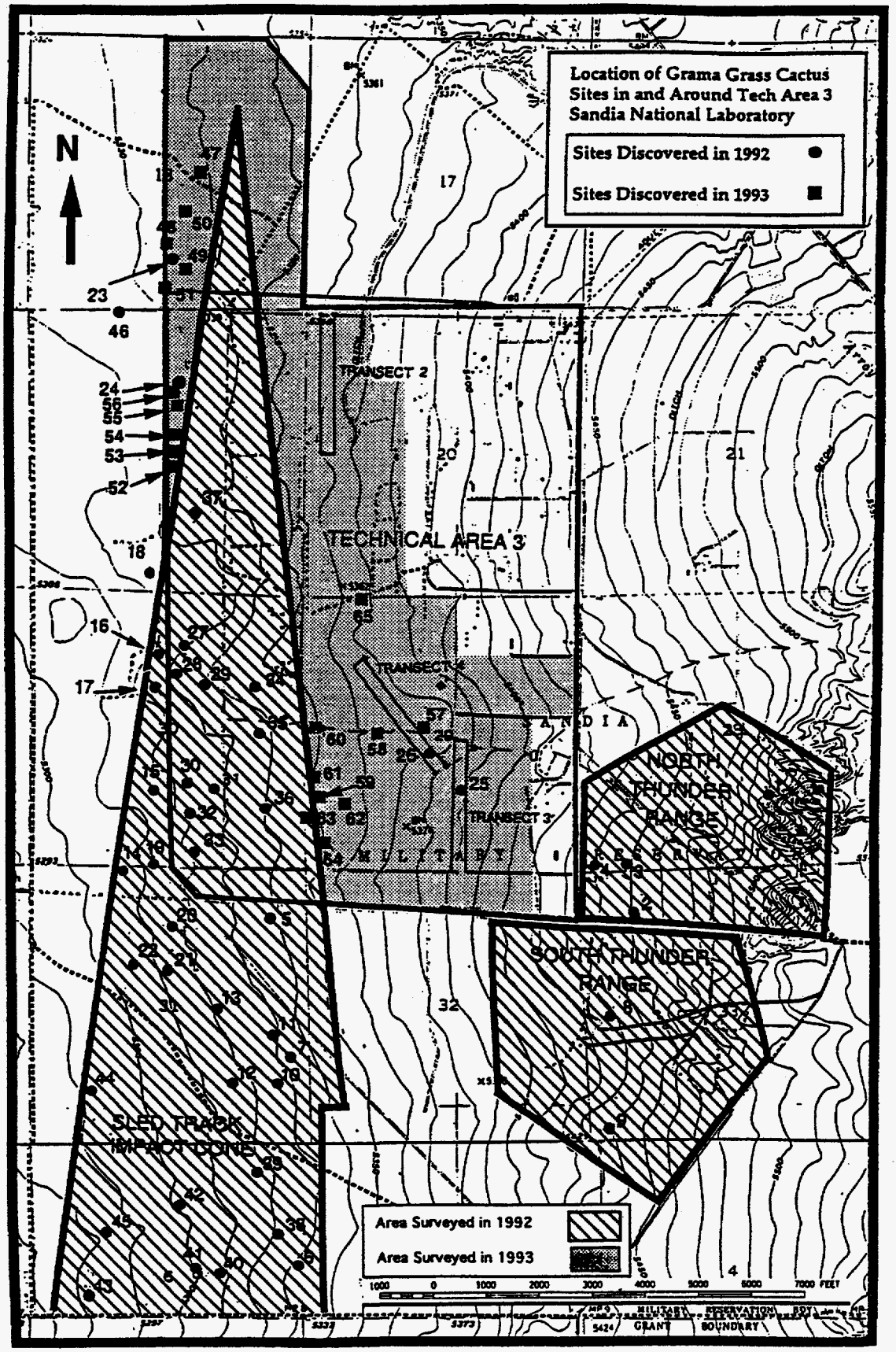

Figure 3. Grama grass cactus sites located within the CCTC area.

west and south of the Rocket Sled Track. Detailed descriptions of these 65 sites and locations of individual plants are presented in Appendices C and D. This species is considered to have a high degree of sensitivity on the CCTC area.

8.4.2 Methodology for Analyzing Results of Grama Grass Cactus Surveys.

Two external characteristics were measured on each cactus with rulers and calipers to the nearest millimeter (mm), including height and width of the plant. In addition, a third characteristic was scored that included the sum of the number of flowers and fruits on each plant. Characteristics were log-transformed, and all subsequent statistical analyses were performed on covariance matrices using the BIOΣTAT I and II computer packages (Pimentel and Smith, 1986*a*; 1986*b*).

Multivariate analysis of variance (MANOVA) was used to test the null hypothesis of no significant difference in the structural characteristics of plants from each of four major habitat types found in the CCTC area. Habitat types included: 1) Black Grama-Dropseed, 2) Black Grama-Burrograss, 3) Sand Shrubland Series, and 4) Black Grama-Galleta. Principal components analysis using a log-transformation was used to examine correlations between variables and to summarize differences between habitats. Associations between various structural measurements and a calculated volume estimate of each plant (see Section 3.2, Complete Census Method) were tested using Spearman's correlation coefficient (r_s; BIOΣTAT I; Pimentel and Smith, 1986*a*).

8.4.3 Statistical Analysis of Grama Grass Cactus.

Data on number of grama grass plants, height, width, number of flowers, number of fruits, vegetation association, and volume were compiled for all 65 sites found on the CCTC area (Appendix D). Because of the large sample size obtained during the 1992 field season, estimates of various vegetative and reproductive parameters were assumed to be representative of this species throughout the area. Therefore, only the 1992 sample was used in the following statistical analyses (sections 7.4.3 - 7.4.4).

A variety of statistical analyses was performed on these data, including density estimates, frequency, size class distribution, univariate descriptive statistics, single classification analysis of variance (ANOVA), multivariate analysis of variance (MANOVA), and discriminate function analysis (DFA). Data were analyzed to ascertain if there was significant variation in overall structural and reproductive characteristics of grama grass cacti inhabiting different plant communities within the CCTC area.

Density estimates and frequency of plants and sites were calculated for each of areas surveyed. Density and frequency data from North Thunder Range, South Thunder Range, and the Rocket Sled Track Impact Area were derived from 100% surveys. Data for the rest of Technical Area III were derived from 10% sample transects (1992 survey) and are estimates. The lowest density and frequency of individual grama grass cactus plants within the CCTC area occurs in the northeast two-thirds of Technical Area III. Grama grass cacti were absent from the Centrifuge Site, Drop Tower and Water Impact Site, Light Initiated Explosives Area, and the Gun Site. Although grama grass cacti were absent from all areas surveyed in the northeast portion of Technical Area III, there are potential areas of suitable habitat present. Therefore, it is possible that grama grass cacti could occur there.

The density (D=number of plants per acre) followed by the frequency (F=number of sites per 100 acres) of grama grass cactus plants in the areas surveyed are shown below. An asterisk (*) indicates an estimated value based on sample transects and analysis of adjacent surveyed areas: 1) North Thunder Range D=0.035 (F=0.91); 2) South Thunder Range D=0.009 (F=0.36); 3) Rocket Sled Track Impact Area outside Technical Area III in KAFB D=0.127 (F=2.46); 4) Technical Area III west of the Rocket Sled Track and portions of KAFB west of Technical Area III D=0.260 (F=5.16)*; 5) Technical Area III northeastern two/thirds east of Rocket Sled Track D<0.008 (F<0.80)*; 6) Technical Area III southern one-third east of Rocket Sled Track D=0.035 (F=0.91)*.

Based on data from sample transects, a maximum potential density of <0.008 plants per acre and a maximum potential frequency of 0.8 sites per 100 acres of habitat were calculated. The highest density for grama grass cactus occurred in the extreme western edge

of Technical Area III (west of the Rocket Sled Track) and adjacent to KAFB property just west of Technical Area III. Density of plants in this area was estimated at 0.26 plants per acre with a projected frequency of 5.16 grama grass cactus sites per 100 acres. Both density and frequency data substantiate field observations that the greatest number of grama grass cactus sites (and plants) occur in the extreme southwest corner of Technical Area III and adjacent KAFB property west and southwest of Technical Area III. The next largest concentration of plants occurs in the Rocket Sled Track Impact Area south of Technical Area III.

Results of the MANOVA contribute to the conclusions derived from consideration of density data and frequency estimates. A test of the equality of group centroids was significant (MANOVA; $\underline{F}=3.91$ $\underline{d.f.}=[9, 321]$, $\underline{P}< 0.0001$); thus, the null hypothesis of no significant variation in overall structural and reproductive characteristics of grama grass cacti inhabiting different habitat types in the CCTC area was rejected. In the MANOVA, the canonical correlation ($\underline{R}$) between samples and individuals was 0.40 and 0.30 for the first and second vectors, respectively, indicating an overall moderate to low goodness-of-fit of individuals within sites.

Univariate $\underline{F}$-ratios indicated significant ($\underline{P}< 0.01$) inter-site variation between samples in height of plants ($\underline{F}=4.6$), width of plants ($\underline{F}=5.2$), and numbers of fruits and flowers ($\underline{F}=4.1$). Discriminate function analysis resulted in correct assignments of 18%, 14%, 96%, and zero percent of the specimens examined to their respective habitat types (i.e., Black Grama-Dropseed [n=22 plants], Black Grama-Burrograss [n=28 plants], Sand Shrubland Series [n=83 plants], and the Black Grama-Galleta sites [n=5 plants], respectively). Mean height of plants in the four habitat types ranged from 5.8 cm (Black Grama-Burrograss) to 8.8 cm (Black Grama-Galleta); mean width ranged from 2.7 cm (Sand Shrubland Series) to 4.0 cm (Black Grama-Dropseed and Black Grama-Galleta); mean numbers of fruits and flowers ranged from 5.0 cm (Sand Shrubland Series) to 8.0 cm (Black Grama-Galleta), and estimates of volume ranged from 24.3 cm^3 (Sand Shrubland Series) to 89.8 cm^3 (Black Grama-Dropseed). The correlation between volume and each of the other measured structural characteristics was: 1) $\underline{r_c}=0.68$ for height, $\underline{r_c}=0.82$ for width, $\underline{r_c}=0.48$ for flowers, and $\underline{r_c}=0.55$ for fruits.

Although plants from the Sand Shrubland Series averaged smaller than those from other habitats in three of the four measurements (width, flowers, fruits, and volume), the Sand Shrubland Series type habitat contained the largest and most continuous number of sites, as well as the largest number of plants found within any habitat type in the CCTC area.

8.4.4 Implications of Statistical Analysis.

Correlation analysis shows that the width of the grama grass cactus plant is the most reliable trait to correlate against reproductive success in grama grass cacti (reproductive success=flower and fruit production). Subsequently, width was used as the determinant factor in analyzing size class distribution of grama grass cacti within the CCTC area. Analysis of the size class distribution by habitat type showed that plants inhabiting the Sand Shrubland Series exhibited the most normal size distribution, relative to plants found in other habitat categories (Fig. 4). This near-normal ($X^2=13.2$, d.f.=7, P=0.07; G-test statistic=28.9, d.f.=7, P=0.002) suggests long-term stability in habitat conditions of sites within the Sand Shrubland Series of sites compared to skewed or bimodal size distributions in other habitat types (Black Grama-Dropseed, Black Grama-Burrograss, Black Grama-Galleta).

Wide variation in grama grass cactus populations has been documented at numerous sites in New Mexico. In many situations, populations have increased to great densities ($\leq$ 90 cacti per acre). Dense populations can fall prey to a variety of infestations of larval predators of the beetle family Cerambycidae and moth groups (Lepidoptera). Eggs from beetles and moths are deposited on or near plants, and the larva bore into the plants, eating out the core of the plant and emerging at the top, thus leaving the plant to die. These infestations are often cataclysmic with reductions of over 95% of the plants in a population. Therefore, a few remaining plants often develop singly or in small groups, producing seeds that eventually repopulate the site. This kind of population predator/prey relationship may also cause extinction or result in reduced genetic variation in local populations as a result of genetic drift.

Moreover, this kind of population cycle may take years or even decades to complete. Distribution curves of grama grass cacti in Black Grama-Dropseed Community are suggestive

of the recovery stage of this cycle. The Black Grama-Dropseed sites support few large individuals with an increasing number of smaller and smaller plants, including seedlings from the 1991-1992 season. The trimodal peaks in the grama grass cactus sites in the Black Grama-Galleta Community also suggest previous fluctuations in population. This distribution could, however, also reflect temporal gaps in suitable conditions for germination and growth of young plants. During drought years seedlings may die; and in several successive drought years, gaps in the size classes of the population may occur. Successive years of suitable and unsuitable conditions can result in a series of spikes of varying size classes such as the grama grass cactus sites found in the Black Grama-Galleta Community.

Distribution of grama grass cactus sites within the Black Grama-Burrograss Community was represented by a broad range of size classes with peaks at about 2.7 cm in diameter and seedlings less than 0.5 cm in diameter. This distribution, although not normal, reflects a baseline of success in germination and growth. The peak in the center of the curve suggests a particularly good year for reproductive success.

Several conclusions can be drawn from the results of the statistical analysis. First, there is significant variation between grama grass cactus sites in various habitats of the CCTC area. These variations include the density of sites and number of plants from habitat to habitat as well as size and reproductive success. Second, the largest plants occurred in the Black Grama-Dropseed Community type. Third, although grama grass cacti in the Sand Shrubland Series Community were the smallest, they were characterized by: 1) the greatest density and frequency of plants and sites, 2) the most plants within any particular habitat, 3) the greatest number of sites within a habitat type, and 4) the most normal size distribution curve between the *a priori* designated habitat types.

The largest concentrations of grama grass cactus sites occurred in the southwest corner of Technical Area III west and south of the Rocket Sled Track, and on the adjacent KAFB property west and south of the southwest corner of Technical Area III. These plants were predominantly in the Sand Shrubland Community type and to a lesser degree in the Black Grama-Burrograss Community type. The least "significant" habitat for grama grass cactus occurs in the northeastern two-thirds of the Technical Area III. Sample surveys in this area

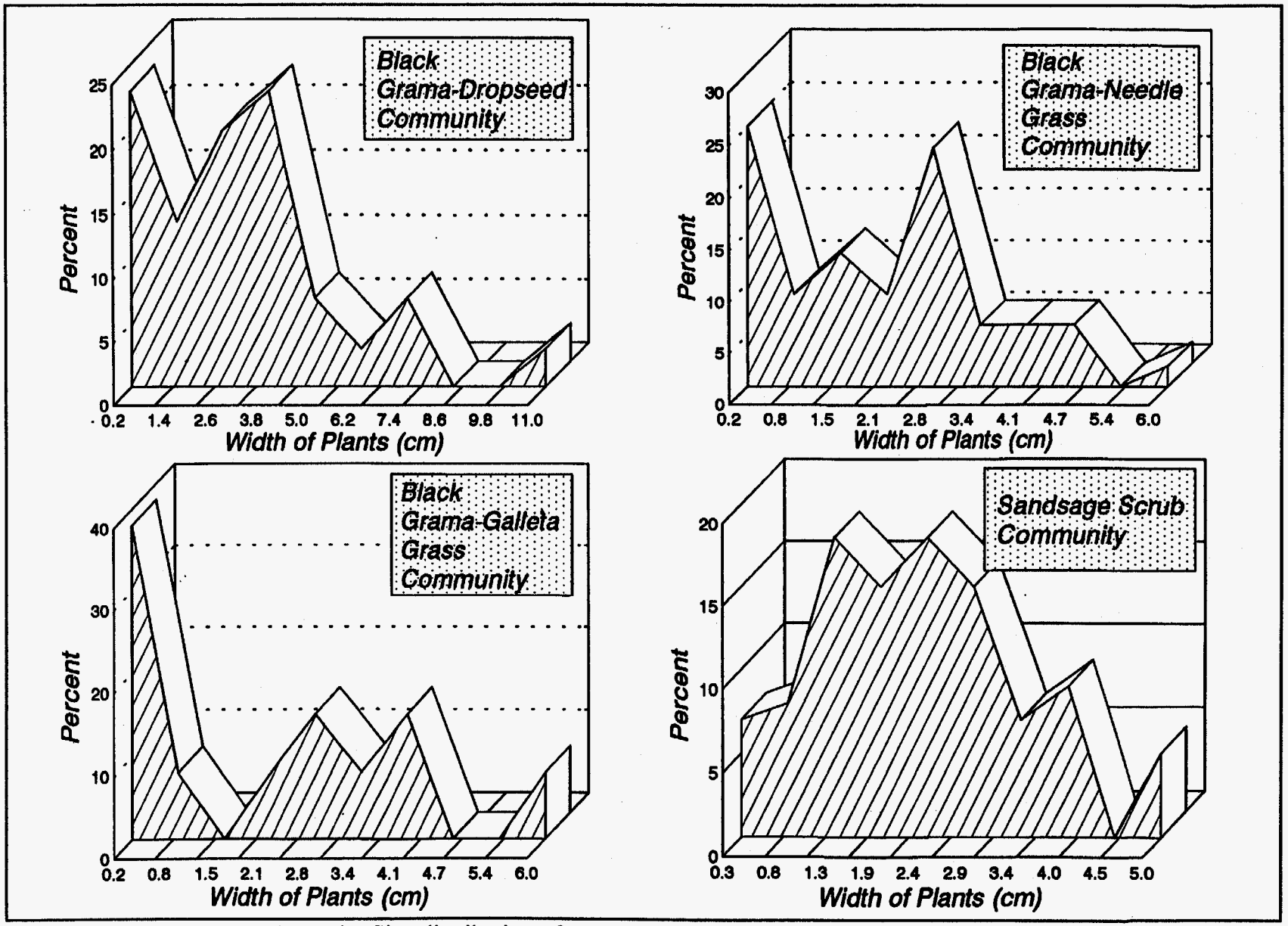

Figure 4. Size distribution of grama grass cactus in relation to habitat type

showed that grama grass cacti are probably quite scarce if present at all. Moving eastward across Technical Area III from the Rocket Sled Track, the vegetation changes: black grama decreases in abundance and weedy grass species such as threeawn increase. It is unclear whether this change in floristic composition is the result of changes in soil, microclimate, or the history of use of the area.

8.4.5 Santa Fe Milkvetch Sites.

Two Santa Fe milkvetch sites have been located within the surveyed portions of the CCTC area. One of these sites is located in the North Thunder Range, the other in the South Thunder Range (Fig. 5). These two sites are discussed in more detail in the following sections.

Santa Fe Milkvetch Site 1.—Site 1 is located along the extreme eastern edge of the North Thunder Range. Specifically, the site is located along the lower slopes of the eastern side of the hill at the east end the North Thunder Range just north of Magazine Road. The soil is coarse sandy-silt derived from limestone bedrock. The associated plant community is dominated by black grama, Indian ricegrass and threeawn. At least a dozen mature Santa Fe milkvetch occur along the eastern edge of North Thunder Range and more occur just outside the eastern boundary of the range.

Santa Fe Milkvetch Site 2.—Site 2 is located along the extreme eastern edge of the South Thunder Range. Specifically, the site is located along the lower slopes of the southern end of a series of low hills just south of Magazine Road. The soil is coarse sandy-silt derived from limestone bedrock. The associated plant community is dominated by black grama, Indian ricegrass and threeawn. Several dozen mature Santa Fe milkvetch occur along the eastern edge of South Thunder Range and more occur just outside the eastern boundary of the range. This site is probably a continuation of Site 1 located in North Thunder Range.

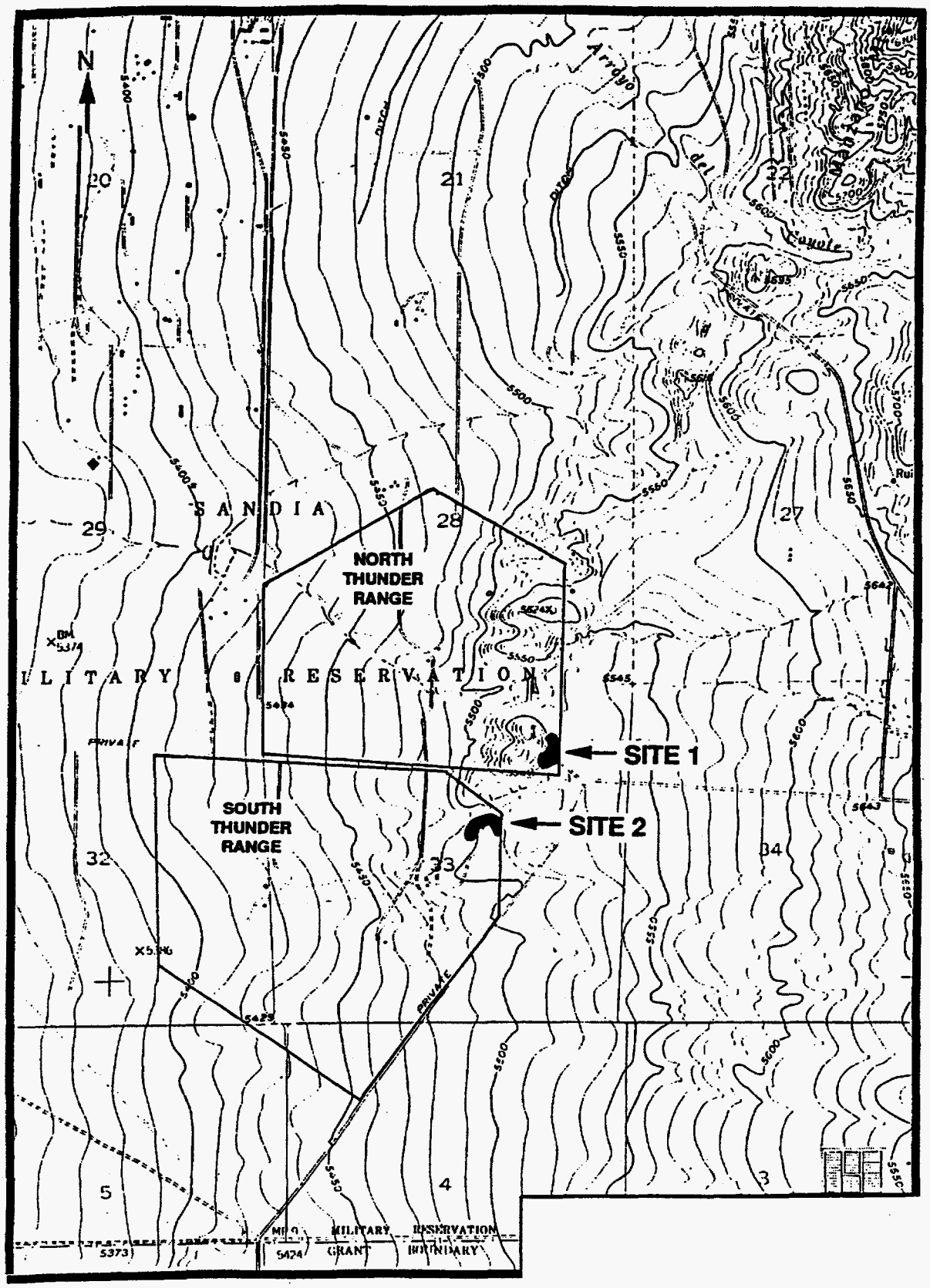

Figure 5. Santa Fe milkvetch sites located within the surveyed CCTC area.

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9.0 PROTECTED SPECIES - ANIMALS

The CCTC area has the potential to support a large number of animal species. Based upon biologic field surveys of habitats within the CCTC area, and after consultation with the USFS, USFWS, and the NMDGF, a list of animal species occurring within the CCTC area was compiled (Appendix E). In addition, information on threatened, endangered, or sensitive animal species potentially occurring within the CCTC area also was compiled (Appendix F).

Currently, endangered, and sensitive animal species in New Mexico are classified within various jurisdictional frameworks, including the USFWS Endangered Species Act, NMDGF endangered species program, and the USFS Sensitive Species list. Each agency maintains its own list of species that it considers important for protection or review. Each list has categories distinct from one another. The following is a brief discussion of these categories as they relate to rare species that could occur in the CCTC area.

9.1 FEDERAL STATUS

The U.S. Fish and Wildlife maintains lists for species that it considers endangered, threatened, proposed endangered, proposed threatened, C1 (Category 1), C2 (Category 2), 3A, 3B and 3C. Species potentially Category C2 and 3C exist within the CCTC area; these legal designations are as follows:

9.1.1 Category 1 Candidate (C1).

Category 1 candidates are species for which there is enough substantial information on biologic vulnerability and threats(s) to support proposals to list them as endangered or threatened.

9.1.2 Category 2 Candidate (C2).

Category 2 candidates are species for which additional information is needed to support a proposal to list as threatened or endangered.

Note: These species receive no protection under the Endangered Species Act unless they become listed as threatened or endangered.

9.1.3 Category 3 Species.

Category 3 taxa are those species that were once considered for listing as endangered or threatened, but are not currently receiving such consideration. These taxa include the **3A, 3B and 3C** designations.

9.1.4 Category 3A Species.

Category **3A** designation comprises taxa for which the U.S. Fish and Wildlife Service has persuasive evidence of extinction. If rediscovered, however, such taxa might warrant high priority for additions to the Endangered Species List.

9.1.5 Category 3B Species.

Category **3B** designation comprises names that on the basis of current taxonomic understanding, usually as represented in published revisions and monograph do not represent taxa meeting the legal definition of a species as defined in the Endangered Species Act.

9.1.6 Category 3C Species.

Category **3C** designation is applied to those taxa that have proven to be more abundant or widespread than previously believed and that have no identifiable threats.

9.2 STATE ENDANGERED

9.2.1 Group 1.

Taxa whose prospects of survival or recruitment within the State are in jeopardy.

9.2.2 Group 2.

Taxa whose prospects of survival or recruitment within the State are likely to become jeopardized in the foreseeable future.

9.3 REVIEW OF ANIMAL SPECIES FOUND IN CCTC AREA

9.3.1 Burrowing Owl.

The burrowing owl *(Athene cunicularia)* is neither a Federal or State of New Mexico Endangered, or Sensitive species; however, all raptors are fully protected by the State of New Mexico and by the Migratory Bird Treaty Act. This species inhabits bare ground, open

desert, and grassland-juniper habitat and nests in abandoned rodent burrows. They modify these burrows by digging and scraping with the beak, wings, and feet.

Burrowing owls were observed in association with disturbed embankments at the north end of the Rocket Sled Track (2 birds), along the fence line at the northwest border of the Rocket Sled Track (6 birds), and the South Thunder Range near the helicopter landing pad (5 birds). One burrow was observed at the west end of the second most northern radar tracking pad directly west of the Rocket Sled Track, but no birds were in it. Sensitivity of this species is considered to be low.

9.3.2 Great Horned Owl.

The great horned owl *(Bubo virginianus)* is a neither a Federal nor State of New Mexico Endangered, or Sensitive species; however, all raptors are fully protected by the State of New Mexico. This species is widely distributed throughout North and South America in a variety of habitats. In the Southwest is a common inhabitant of relatively arid grassland regions, including plains, open spaces, deserts, woodlands, and riparian areas. Prey consists of small-to medium-sized mammals that it hunts primarily from perches such as fence posts, low trees, buildings, or from other elevated vantage points on the ground.

This species was observed by CCTC personnel roosting in man-made structures associated with the Drop Tower and Water Impact facilities. Sensitivity of this species is considered to be low.

9.3.3 Red-Tailed Hawk.

The red-tailed *(Buteo jamaicensis)* is a neither a Federal nor State of New Mexico Endangered, or Sensitive species; however, all raptors are fully protected by the State of New Mexico. This species is the most common and wide spread buteo in North America. Red-tailed hawks are birds of both open and wooded areas, particularly wooded edges, and are often seed perched conspicuously on a treetop, a telephone pole, or other lookouts while hunting. Red-tailed hawks prey mainly on rodents but also on insects and their larvae, fish, and larger mammals, such as rabbits and squirrels. They often pursue prey into dense brush, pirate prey from other raptors, and eat carrion.

Six Red-tailed hawks were observed soaring over the North and South Thunder Ranges. Sensitivity of this species is considered to be low.

9.3.4 Ferruginous Hawk.

The ferruginous hawk *(Buteo regalis)* is a Federal Category 2 Candidate Endangered species and a State of New Mexico protected raptor. This raptor inhabits grassland and unbroken terrain in the Great Plains and arid intermountain regions of western Canada and the United States. This species uses a variety of nesting sites, including ground nests on low hillsides, cutbanks and buttes; trees in open country; and drainage areas and powerline structures. Specific habitat includes plains and open spaces, deserts, woodlands, and riparian areas. The diet of the ferruginous hawk includes primarily rabbits, hares, and ground squirrels. Except for prairie dogs on the South Thunder Range and western border of the Rocket Sled Track, few rabbits, hares, and ground squirrels were observed during the biologic survey.

During the course of the biologic survey, one ferruginous hawk was observed soaring over the South Thunder Range. Sensitivity of this species is considered to be low.

9.3.5 Swainson's Hawk.

The Swainson's hawk *(Buteo swainsoni)* is a neither a Federal nor State of New Mexico Endangered, or Sensitive species; however, all raptors are fully protected by the State of New Mexico. This species is a common inhabitant of the Great Plains and relatively arid areas of grassland in the West, including plains, open spaces, deserts, woodlands, and riparian areas. It builds flimsy nests in shrubs and trees along wetlands and drainages, and in windbreaks in fields around farmsteads. Prey consists of small mammals, birds, large insects, and reptiles that it hunts primarily from perches such as fence posts, low trees, or from elevated vantage points on the ground. This species moves in response to locally high concentrations of prey more than most other species of raptors.

On 17 April 1992 (10:03 a.m.), one adult Swainson's hawk (light-morph) was observed in grassland habitat at the extreme southwest border of the South Thunder Range in the vicinity of a northern elm tree grove. This individual was observed hunting over grassland habitat and later (11:03 AM) it was observed being driven out of the area (harassed) by three

ravens. One northern elm tree had a stick nest in the top of the tree that measured approximately 46 X 61 cm (18 X 24 inches). What appeared to be the same Swainson's hawk was observed on three different occasions during late April in the vicinity of this elm tree. A total of five different birds was observed on the South Thunder Range. Sensitivity of this species is considered to be low.

9.3.6 Northern Harrier.

The northern harrier or marsh hawk *(Circus cyaneous)* has no Federal status, but is a State of New Mexico protected raptor that inhabits plains, fields, open spaces, grasslands, woodlands, and riparian areas. This species nests on the ground in dense cover, or occasionally in deeper, more bulky nests built in shallow water. The northern harrier preys on a variety of animals and regularly detects prey solely by means of its keen hearing.

This species was most commonly observed during the quiet early morning hours gliding or hovering at low altitude over the North and South Thunder Range. A total of 12 birds was observed during the survey. Sensitivity of this species is considered to be moderate.

9.3.7 American Kestrel.

The American kestrel *(Falco sparverius)* is a neither a Federal nor State of New Mexico Endangered, or Sensitive species; however, all raptors are fully protected by the State of New Mexico. The widespread American kestrel is the smallest North American falcon and one of the most common. This species is usually seen hovering or sitting on exposed perches, such as poles, fence lines, wires, or treetops, where it hunts for rodents, insects, birds, lizards, or snakes. Kestrels nest in tree cavities but will readily use holes in cliffs and crevices in buildings as well as nest boxes. This species is a common inhabitant of the Southwest and relatively arid grassland regions of New Mexico, including plains, open spaces, deserts, woodlands, and riparian habitats.

This species is locally abundant in the CCTC project area, particularly in the North and South Thunder Ranges, Rocket Sled Track, Rocket Sled Track Impact Area, and the Drop Tower and Water Impact Site. A total of 49 birds was observed during the survey. Sensitivity of this species is considered to be low.

9.3.8 Loggerhead Shrike.

The loggerhead shrike *(Lanius ludovicianus)* is a Federal Category 2 Candidate species whose status is classified as unknown (U), indicating that additional survey work is required to determine its current distribution, abundance and population trends; the loggerhead shrike has no State status. This species inhabits open spaces, grasslands, deserts, woodlands, and riparian areas. Loggerhead shrikes were commonly observed in the Lurance Canyon area (Sullivan, 1993) and in the immediate vicinity of the CCTC, particularly along the fence line surrounding the North and South Thunder Ranges, west end of Rocket Sled Track, Rocket Sled Track Impact Area, Gun Site, Centrifuge Site, and Drop Tower and Water Impact Area. Individuals commonly perch-hunt from barbed-wire fences that overlook the grassland habitat within the CCTC. A total of 31 birds was seen during the survey. Sensitivity of this species is considered to be low.

9.3.9 Gray Vireo.

The gray vireo *(Vireo vicinior)* is a State of New Mexico Endangered Group 2 species with no Federal status. This species was not observed in the immediate vicinity of the CCTC area. However, one gray vireo was observed on two consecutive days (3-4 October, 1991) in piñon-juniper woodland near the lower drinker tank located at the entrance to the canyon leading to Sol se Mete Spring (Sullivan, 1993), and probably represents only one migrating individual. Sensitivity of this species is considered to be low.

9.3.10 Texas Horned Lizard.

The Texas horned lizard *(Phrynosoma cornutum)* is a Federal Candidate 2 species. Currently, this species has no State of New Mexico status; however, all species of horned lizards are protected in New Mexico and specific permits are required from the New Mexico Department of Game and Fish. The Texas horned lizard is common in desert areas throughout southern and central New Mexico. These horned lizards live in shrubland, desert grassland, and associated juniper woodland. They feed mostly on ants, and occur in areas where ants, particularly seed harvester ants belonging to the genus Pogonomyrmex, are abundant.

Two individuals were observed on the north east section of the North Thunder Range. Two individuals also were observed in the large expanse of grassland-juniper habitat near the intersection of Lurance and Sol se Mete Canyons (Sullivan, 1993). Sensitivity of this species is considered to be low.

9.3.11 Short-Horned Lizard.

The short-horned lizard *(Phrynosoma douglassi)* has no Federal status. Currently, this species also has no State of New Mexico status; however, all species of horned lizards are protected in New Mexico and specific permits are required from the New Mexico Department of Game and Fish to collect these lizards. The short-horned lizard is common in desert areas throughout southern and central New Mexico. These horned lizards live in shrubland, desert grassland, and associated juniper woodland. They feed mostly on ants, and occur in areas where ants, particularly seed harvester ants belonging to the genus *Pogonomyrmex*, are abundant.

Short-horned lizards were widely distributed throughout the CCTC. A total of eight animals was observed on the North and South Thunder Ranges, Rocket Sled Track, southern extension of the Gun Site, Centrifuge Site, Drop Tower and Water Impact Site, and Rocket Sled Track Impact Area. Sensitivity of this species is considered to be low.

9.3.12 Round-Tailed Horned Lizard.

The round-tailed horned lizard *(Phrynosoma modestum)* has no Federal status. Currently, this species also has no State of New Mexico status; however, all species of horned lizards are protected in New Mexico and specific permits are required from the New Mexico Department of Game and Fish to collect these lizards. Round-tailed horned lizards are common in desert areas throughout southern and central New Mexico. These horned lizards live in shrubland, desert grassland, and associated juniper woodland. They feed mostly on ants, and occur in areas where ants, particularly seed harvester ants belonging to the genus Pogonomyrmex, are abundant.

Round-tailed horned lizards also were widely distributed throughout the CCTC, but as in all horned lizards on the CCTC, their abundance was low. A total of five animals was observed

on the North and South Thunder Ranges, Rocket Sled Track, and the southern extension of the Gun Site. Sensitivity of this species is considered to be low.

9.3.13 Massasauga.

The massasauga or "swamp rattler" *(Sistrurus catenatus)* has no Federal status, but the State of New Mexico has recommended it for listing as Endangered (13 April 1990). In the eastern United States, this species is an inhabitant of river bottoms, wet prairies, swamps, and bogs, but also enters dry woodland.. In the west, it occurs in desert grassland, particularly in low areas of rank growth typical of the Rio Grande Valley, and in low plains of mesquite, juniper, and grassland that have been degraded in some areas by overgrazing and associated abusive land uses.

This species appears to be fairly common in grassland habitat associated with CCTC; for example, a total of seven animals was observed on the South Thunder Range, Rocket Sled Track, Gun Site, and Rocket Sled Track Impact Areas. Sensitivity of this species is considered to be low.

10.0 SENSITIVE HABITAT AREAS

Within the CCTC area there, are a number of potentially sensitive areas, including 1) territorial and breeding areas, 2) corridor and foraging areas, and 3) raptor use areas.

10.1 TERRITORIAL AND BREEDING AREAS

Different species of breeding grassland birds were common throughout the CCTC area; however, the greatest diversity of nesting and breeding bird species was evident in the topographically diverse northeast corner of the North Thunder Range (SE 1/4 Sec 28) above the 1,677-meter (5,500-foot) elevational contour, and in association with the ecotone between grassland-juniper and arroyo vegetation. The boundary between grassland-juniper and arroyo vegetation provides abundant cover, perches for territorial display and hunting of insects, nesting sites, and a variety of foraging areas, particularly for small species of passerine birds. There are two east-west draining arroyos in this area, including 1) a minor arroyo located at the extreme northern corner of the North Thunder Range, just north of a small hill approximately 1,845 meters (6,053 feet) in elevation (5,624 feet); and 2) a significantly larger drainage basin associated with the southernmost section of the North Thunder Range, just north of another small hill approximately 1,691 meters (5,550 feet) in elevation and at the edge of the range adjacent to Magazine Road. Based on our observations of individual species and their tracks (Appendix E), both arroyos provide natural travel corridors for several medium-sized mammals (jackrabbit, desert cottontail), occasional mule deer, and their carnivorous predators (coyote, bobcat), as well as important cover and burrowing areas for several of these species.

10.2 FORAGING AREAS

Locations of foraging areas were highly correlated with vegetation diversity, topography, vegetative cover, and travel corridors (as evidenced by visual observation of species, as well as tracks, feces, and burrowing sites). Evidence of foraging by mule deer was uncommon and restricted primarily to grassland, grassland-juniper and the shrubby arroyo vegetation associated with the North Thunder Range. These areas provide cover and the largest diversity of vegetation for browsers and other herbivorous species of wildlife.

No evidence was found suggesting that the CCTC provides critical winter range for mule deer. Absence of a significant source of free water in the immediate vicinity of the CCTC project, significant vehicular traffic, human and aircraft activity, noise associated with blasting, and disturbance resulting from helicopter landing and training operations, particularly in the South Thunder Range, probably preclude all but minor use of the CCTC area by mule deer and smaller herbivores like blacktailed jackrabbits, which also were uncommon.

10.3 RAPTOR USE AREAS

Several species of raptors were reported by CCTC personnel or observed during the biologic field survey, including: 1) burrowing owl, 2) great horned owl, 3) red-tailed hawk; 4) ferruginous hawk, 5) Swainson's hawk, 6) northern harrier, and 7) American kestrel.

During the course of the biologic survey, burrowing owls were sighted in the immediate vicinity of the Rocket Sled Track, where the area around the disturbed embankment at the north end of the track provided an opportunity for residency and nesting in abandoned rodent burrows; six individuals were observed along the western border of the Rocket Sled track at the fence line; and five birds were observed in the South Thunder Range near the helicopter landing pad. A pair of great horned owls were reported nesting in association with the Drop Tower and Water Impact Site (CCTC personnel, pers. comm.). Several red-tailed hawks were observed in the North and South Thunder Ranges. This species was observed primarily in association with grassland-juniper habitat and arroyo vegetation. Rocky ledges and several large junipers surrounded by grassland vegetation in the North Thunder Range provide observation and perching sites for red-tailed hawks that might be foraging on small- to medium-sized mammals (rabbits, hares, prairie dogs, rock squirrels) that inhabit the grassland-juniper and shrubby arroyo vegetation.

Only one ferruginous hawk was observed soaring over the South Thunder Range; and Swainson's hawks were observed in grassland habitat at the extreme southwest border of the South Thunder Range. Similarly, northern harriers were observed during quiet early morning hours gliding and hovering at low altitude over the North and South Thunder Ranges. Presumably, these birds were hunting for small grassland mammals and insect prey.

American kestrels were found throughout the CCTC area, particularly in the North Thunder Range, South Thunder Range, the Rocket Sled Track, Rocket Sled Track Impact Area, and the Drop Tower and Water Impact Area. Many of these birds were likely observed repeatedly during the course of the survey. American kestrels were particularly common in association with grassland-juniper and arroyo habitat. In addition, electrical powerlines in the CCTC area, fence lines, and fence posts along the numerous unpaved access roads also provided numerous opportunities for perching, territorial defense, and feeding on insects and small vertebrates (deer mice, pocket mice, little striped whiptails) found in grassland vegetation.

In late September, 1991, Sullivan (1992) reported an observation of one golden eagle in grassland-juniper habitat along the north side of Lurance Canyon Road, one mile west of Building 9832. This species was observed feeding in the vicinity of the arroyo. After securing terrestrial prey, the golden eagle flew northeast in the direction of Burn Site. Canyons, drainages, and other open areas located at the head of Lurance Canyon and Madera Canyon could potentially provide nest sites that would be suitable for use by golden eagles and other large raptors (Sullivan, 1993). Further, it is also possible that the CCTC area may serve as a source of prey for golden eagles or other large raptors (i.e., ferruginous hawk), even though only small resident populations of prairie dogs, and a few rock squirrels, occur on the South Thunder Range and along the western edge of the Rocket Sled Track.

10.4 WATER SOURCES

There are no perennial sources of free water in the CCTC area. However, several sources of water exist within a radius of from five to 12 miles east of the CCTC area (pers. obs.). These sources of perennial water may be important to wildlife species in the CCTC area, particularly larger mammals (deer, coyote, fox) and raptors (hawks, owls, and golden eagle) that have large home ranges. A discussion of these sources of perennial water are included here, in an attempt to provide a complete accounting of critical wildlife resources available to species in and around the CCTC area, and to place these resources in an ecologic perspective.

10.4.1 Springs.

Coyote Springs, the Burn Site Spring, and Sol se Mete Spring provide the only perennial sources of water found near, but not in, the CCTC area. Coyote Springs is approximately 5 miles from CCTC and is on KAFB land; the other two springs are 10 to 12 miles away.

10.4.2 Ephemeral Water Sources.

There are no significant areas of open water in the CCTC area. In fact, in the immediate area of the CCTC there are only five major drainages outside the CCTC area that receive runoff and have small, natural, but ephemeral water catchments. These potential water sources include: 1) upper regions of Coyote Canyon and its associated arroyos, 2) upper regions of Lurance Canyon and its associated arroyos, 3) Sol se Mete Canyon, and 4) Sol se Mete Spring and its associated wildlife drinker-tanks (Sullivan, 1993). These drainages receive the largest amounts of use by wildlife following precipitation periods and presumably snow melt, and in many of these drainages various shrubs and trees provide cover and perching substrates for a variety of passerine birds. These areas are particularly important to many of the more common raptors known to occur in the vicinity that may rely significantly on the nearby CCTC area for obtaining prey (i.e., golden eagle, northern harrier, red-tailed hawk, Swainson's hawk, ferruginous hawk, American kestrel, peregrine falcon). In these drainages, water will remain for longer periods of time if shrubs and trees remain undisturbed because they provide shading.

11.0 PROJECTED BIOLOGIC IMPACTS

It is assumed that this report will be used not only for current and future operation and testing activities at the CCTC area, but also in conjunction with other environmental assessments (i.e., ACF [Sullivan, 1993]), will provide a baseline planning document for future projects at SNL, DOE, and KAFB. Because CCTC activities exert some degree of influence over land owned by DOE and KAFB, this document also can be used as baseline data for management of U.S. Forest Service withdrawal lands associated with the eastern unit of KAFB (see 2.0 INTRODUCTION). Therefore, this section emphasizes those areas that we have identified as potentially sensitive habitat or important wildlife use sites. Impacts to vegetation and wildlife species are considered adverse if: 1) pre-existing wildlife cannot be supported following removal or alteration of vegetation from a CCTC area; 2) project-associated disturbance such as habitat destruction, noise, human presence, project operation, pollution, etc., results in long-term wildlife population decreases that are greater than one breeding season; and 3) severe erosion occurs from removal of vegetation or other disturbance resulting in irreversible effects to the surrounding habitat.

11.1 VEGETATION

Absence of grazing by livestock (and possibly mule deer and even blacktailed jackrabbits), and the relative lack of human disturbance within the CCTC area has allowed this area to remain in a more "stable" and natural vegetative state, relative to the more general condition of range on public lands throughout New Mexico. The widely dispersed, low intensity use by SNL as well as the prohibition of grazing has probably contributed to the abundance of special status species such as grama grass cactus within the CCTC project area. In areas of the CCTC project outside Technical Area III, the high quality condition of the grassland is particularly evident in the density, widespread distribution, breadth of ecologic tolerance, and large variation in phenology of the grama grass cactus found in this area. Similarly, quality of black grama grass and winterfat vegetation appears particularly good, compared to the Lurance and Sol se Mete Canyons area (Sullivan, 1993).

Loss of vegetation along drainages, roadways, and in association with construction sites (particularly in Technical Area III) has resulted in a loss of soil stability and erosion within

the general CCTC area. A good example of this kind of man-made habitat disturbance is the very distinct windswept landscape caused by a long history of helicopter activity and training by KAFB (KAFB land) at the south end of the South Thunder Range.

11.2 WILDLIFE

Plant and wildlife inventories are time specific. Species composition and patterns of distribution observed during one sampling period are biased and likely to change on a seasonal as well as a yearly basis. Moreover, irrespective of the specifics of the environmental setting, plant and wildlife species can be adversely affected by a potentially large number of extraneous factors potentially associated with CCTC activity, including: 1) human disturbance (noise, human presence, powerline and fence entanglement); 2) pollution, 3) restricted access due to man-made barriers (fences, ditches); 4) loss of habitat; 5) and commonly, habitat fragmentation.

Fragmentation of critical habitat can cause species to use less suitable travel corridors and foraging areas, resulting in an overall decrease in species number and diversity. Loss of habitat (foraging nesting, bedding, watering areas, etc.) to new construction can cause adverse impacts to wildlife habitat in the area. Testing and construction activities throughout the grassland-juniper, grassland-sandsage brush ecotones, and arroyo vegetation associated with several drainages, particularly on the CCTC North Thunder Range, can result in adverse impacts to wildlife through loss of valuable cover, foraging, and nesting areas. Projects requiring ground clearing of vegetation along arroyos can cause alteration or loss of travel corridors and cover near foraging habitat.

Therefore, a number of different kinds of disturbances are possible in the CCTC area that can result in both short and long-term impacts to plant and wildlife diversity, and plant and wildlife population size. Similarly, wildfire ignited by testing activities associated with the Rocket Sled Track and its impact areas can cause large-scale destruction of several different habitats and vegetation types nearby.

Although selected testing activity in the CCTC area will cause some degree of noise disturbance, most of these impacts should be temporary or infrequent. Therefore, ongoing

and future testing activity in the CCTC area (not involving habitat destruction) does not appear to pose a threat to populations of sensitive species or their potential habitats. However, adverse impacts to raptors could result from the effects of noise and other disruptive activity if noise levels occur during the breeding or nesting periods. For example, these man-made activities could cause raptors and other groups of birds to abandon their nests and/or young. In addition, these kinds of man-made disturbances may function as a deterrent to foraging activity by raptors in grassland habitat during critical periods of the breeding and nesting cycles, as well as interfering with the raising of young to the fledgling stage. The grassland-juniper and limestone outcrops and ledges in the southeast corner of the North Thunder range (within Section 28) are potential nesting, territorial display, and roosting sites for small passerine birds as well as several species of raptors.

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12.0 GENERAL AREAS OF SENSITIVITY

Following completion of the biologic field survey, literature review, and consultation with State of New Mexico and Federal agencies, varying levels of sensitivity were placed on different regions of the CCTC area. Additional consultation with State and Federal agencies will be necessary if future projects associated with the CCTC are planned, particularly if these projects have the potential to cause destruction of critical wildlife habitat. Updated information on species are necessary, because in many instances information used by one agency is inconsistent with that used by another.

Levels of sensitivity were based on the ability of a particular area to support: 1) unique or Endangered species of plants and animals, 2) a high diversity of wildlife species, and 3) habitat attributes critical to species survival and reproduction of wildlife populations (i.e., foraging and watering areas, travel corridors, display and nesting sites, breeding territories, etc.). Sensitivity levels also were based on the current distribution of highly disturbed sites. Direct observation suggested that those areas that had historically sustained the largest amount of habitat disturbance, also had the fewest native plant and animal species, and were in the poorest condition relative to more undisturbed habitat and range land on the CCTC area (i.e., North Thunder Range). Sensitivity levels ranged from 1 (=high sensitivity) to 4 (=low sensitivity) and were applied to each site in the CCTC area (Fig. 6).

Note: *Our definition of the term "sensitivity" is not intended as a NEPA term or as having a NEPA equivalent term (see 10 CFR 1021, Appendix B Point 4), "sensitive resources"). Instead, sensitivity refers to a term developed specifically by us to illustrate zones or areas on the CCTC modeled in section 11.0 above. Future actions within any sensitive area, as defined above, may or may not affect sensitive resources (i.e., NEPA term) found within or outside the designated area.*

12.1 SENSITIVITY 1 AREAS

A sensitivity value of "1" was applied to areas that, if damaged or destroyed, likely would result in significant loss of important biologic resources. These critical Sensitivity 1 Areas

were designated based on: 1) presence of physically undisturbed habitat, 2) infrequent or absence of human activity, 3) presence of medium to large densities of grama grass cactus, 4) presence of high species diversity of both plants and animals, and 5) high topographic diversity. Loss or disturbance of these areas likely could result in significant reduction in species diversity, reproductive potential, and/or population sizes of resident species.

12.1.1 Designation of Sensitive Areas Based on General Flora.

Most of the CCTC area is typical of the dry bajadas and mesas that surround the middle portion of the Rio Grande Valley. These areas are dominated by a variety of grassland and shrubland communities that are wide ranging and common. Although the CCTC area is generally populated by these common habitats, one portion of North Thunder Range is a particularly good example of these communities as well as a variety of other communities not found elsewhere in the CCTC area.

For example, the presence of a series of low limestone hills in the eastern portion of North Thunder Range provides a variety of physical environments that are found nowhere else in the CCTC area. These hills, surrounded by flat grassland, are effectively island environments. Various aspects and slopes that these hills provide create a varied patchwork of microhabitats for both plants and animals. Consequently, the North Thunder Range exhibits the greatest diversity of floral and faunal communities in the CCTC area. Of particular significance is a small enclave of Chihuahuan Desert shrubland (approximately 2 acres) located on a south-facing slope at approximately 34° 57′ 52″ N, 106° 31′ 46″ W. This site is dominated by creosotebush and represents the northeastern most documented occurrence of this Chihuahuan Desert shrub in North America. Creosotebush and a variety of Chihuahuan Desert species associated with it form a small, but nevertheless unique, community found nowhere else within the CCTC area. Because of the creosotebush site, and the high diversity of plant and animal species in the surrounding hills, this portion of the North Thunder Range has been identified as a Sensitivity 1 Area. It should also be noted that these limestone hills are the only sites where Santa Fe milkvetch (a state sensitive species) was discovered. The Sensitivity 1 designation protects not only this unusual aggregation of

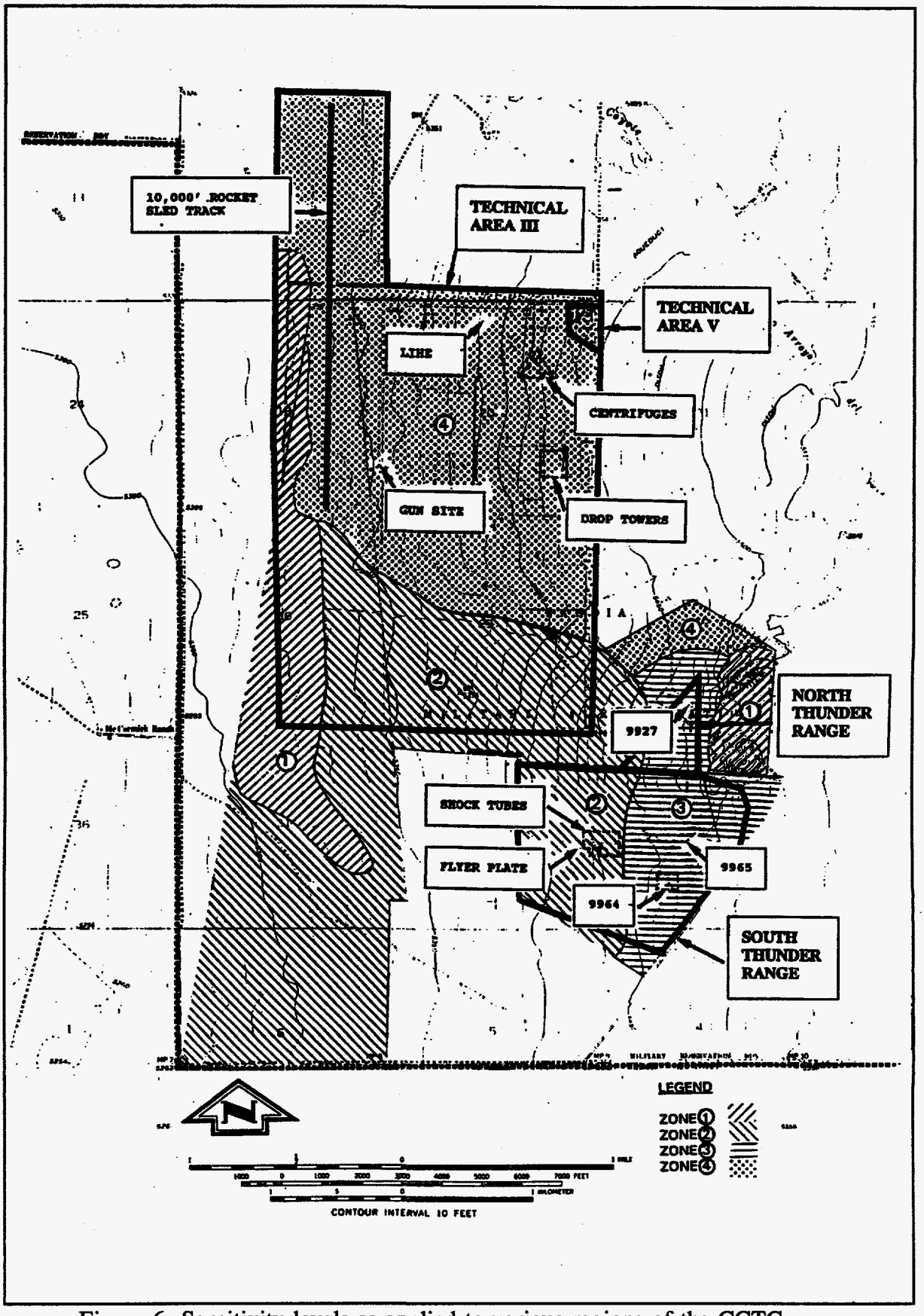

Figure 6. Sensitivity levels as applied to various regions of the CCTC area.

plant communities, but also most of the Santa Fe milkvetch sites and wildlife species diversity in general.

12.1.2 Designation of Sensitive Areas Based on Endangered Plants.

Because published comparative data of other grama grass cactus sites is nearly nonexistent, determination of sensitivity categories was based primarily on comparison of sites found in the CCTC area, and in relation to field observations of other grama grass cactus sites scattered throughout New Mexico. Salient factors that define each sensitivity criterion are summarized in Table 5. The first column in Table 5 depicts the sensitivity rating. The second column indicates if rare plants were documented. The third column is an estimation of continuous potential habitat or actual habitat for grama grass cactus. Areas with a sensitivity value of "1" have at least 400 acres of continuous habitat without any significant break. The value of 400 acres was derived from an estimate of the maximum extent of units of high quality continuous habitat observed within the CCTC area. It should be noted that this value could increase considerably if the areas between the Rocket Sled Track Impact Area and the western boundary of KAFB were included in this study. The last column is observed frequency of rare plant sites within the CCTC area. As with the density value it is based upon field observations of sites within the CCTC area in relation to other grama grass cacti sites considered significant within New Mexico.

Table 5. Ratings and criteria used to designate areas of sensitivity within the CCTC area.

Sensitivity rating	Endangered plants present	Continuous potential habitat	Documented frequency of endangered plants per 100 acres
1	yes	> 400 acres	> 2.0
2	yes	> 400 acres	> 0.20 < 2.0
3	no	> 100 acres but < 400 acres	< 0.20
4	no	< 100 acres	< 0.20

Based on our experience and in discussions with botanists from the U.S. Forest Service (Mr. Reggie Fletcher) and New Mexico Forestry Division (Robert Sivinski), the grama grass cactus sites found within the CCTC area represent one of the largest and best examples of grama grass cacti found anywhere. These sites, unlike many others, have been protected from grazing pressure and other man-made threats. Consequently, they are vigorous and contain some of the largest examples of individual grama grass cacti ever recorded. Because of this fact, portions of the CCTC area in which they occur are considered sensitive.

12.1.3 Designation of Sensitivity 1 Areas.

Habitat sensitivity within the CCTC area is presented in Figure 6. Two critical (Sensitivity 1) areas were identified in the CCTC area. The first of these is located in the extreme western corner of Technical Area III and the adjacent portions of KAFB. This site was identified as the most significant cluster of grama grass cactus within the CCTC area. The second site is located in the eastern quarter of North Thunder Range. This site has been designated because of the diversity of plant and animal communities that occupy the limestone hills in the eastern portion of North Thunder Range. The following sections discuss each of these areas in detail. Grama grass cactus was widespread and abundant throughout large areas of the CCTC area. In all, 45 grama grass cactus sites were identified. It should be noted that these sites vary from as few as one to as many as 14 plants; on average, plants occur in clusters of from three to six in areas less than 50 meters (164 feet) across.

In the southwest portion of Technical Area III and on those sections of KAFB due west and south of the southwest corner of Technical Area III, large numbers of grama grass cacti are arranged in closely spaced clusters. This aggregation of grama grass cacti sites covers approximately 475 acres. The density of grama grass cactus within this area exceeds 0.2 per acre (more than twice the density of the grama grass cactus locations in the rest of the CCTC area); and the frequency exceeds five sites per 100 acres (nearly twice that of other grama grass locations in the CCTC area). Further, this area makes up less than one-sixth of the total area surveyed, but contains more than 50% of the grama grass cacti documented in the CCTC area, and over 45% of the total number of grama grass cactus sites. Because of the large number of plants and their uniform distribution, a critical Sensitivity 1 designation has

been given to this general area. Virtually all of this area falls within the Rocket Sled Track Impact Area.

Additionally, a large area of potential habitat exists west of the 18° Rocket Sled Track Impact Area, of which approximately 239 acres occurs within Technical Area III and the remaining 236 acres occurs within KAFB. It is highly probable that the distribution of grama grass cactus sites documented during this survey also continues westward to the western boundary of KAFB. None of this habitat has been surveyed. It is highly likely that any ground conversion activity within this area will adversely affect populations of grama grass cacti.

12.2 SENSITIVITY 2 AREAS

A sensitivity value of "2" signals habitat with valuable biologic resources. Although of biologic significance, these resources are generally clustered and less continuous than those found in Sensitivity 1 areas. These sensitivity areas are identified as having a combination of undisturbed habitat, medium to high densities of grama grass cactus, and moderate habitat and species diversity. Sensitivity is also based on the amount of habitat available to wildlife in the vicinity of the CCTC area, and on the areas with potential to support sensitive species. Loss or disturbance of these sensitivity areas likely could result in long-term or permanent alterations in population sizes and reproductive potential of grama grass cactus in the CCTC area.

12.2.1 Endangered Plants.

In addition to the grama grass sites discussed in the previous section, 23 additional sites were found scattered throughout the Rocket Sled Track Impact Area, North Thunder Range, South Thunder Range, and in portions of Technical Area III. The grama grass cactus in Sensitivity 2 areas are, in general, more scattered than those found in Sensitivity 1 areas and generally have fewer plants. In many instances, these sites are represented by one or two plants. The Sensitivity 2 zone cover portions of the South Thunder Range (approximately 254 acres), North Thunder Range (approximately 71 acres), southern part of Technical Area III (approximately 595 acres), and the Rocket Sled Track Impact Area (approximately 760

acres). In some areas, such as South Thunder Range and North Thunder Range, the known frequency of grama grass cacti sites is as low as 0.36 to 0.90 sites per 100 acres; these sites are usually less than 50 meters (164 feet) in diameter. It is possible that ground conversion activities in Sensitivity 2 zones could adversely affect grama grass cacti.

12.3 SENSITIVITY 3 AREAS

A sensitivity value of "3" applies to areas where biologic resources are insignificant or have not been documented, but habitat conditions are suitable for survival and reproduction of sensitive species. These areas of moderate sensitivity were identified as having a combination of the following occurring in association with one another—relatively undisturbed habitat, low densities of grama grass cactus, and low levels of plant and animal species diversity.

Sensitivity 3 areas also receive moderate human disturbance well below the level observed in areas of higher sensitivity (Sensitivity 1 and 2 areas). This rating also is based on the amount of this habitat available to wildlife and on the ability of habitat to support sensitive species. Loss of Sensitivity 3 areas could result in short-term impacts like temporary avoidance by wildlife that could result in long-term impacts to wildlife use areas if construction of a large number of projects caused fragmentation of habitat in the vicinity of the CCTC area. These regions of moderate sensitivity for wildlife species encompassed the largest segment of acreage in the CCTC area. This acreage predominantly includes pure stands of native grassland habitat found adjacent to Technical Area III and other areas of disturbed acreage lying next to Technical Area III. These regions afford some foraging and nesting habitat to raptors, insectivorous birds, and herbivorous birds and mammals.

12.3.1 Endangered Plants.

There are no known rare plant, rare animals, or unusual plant communities in Sensitivity Area 3 zones. However, these areas support habitat that is suitable for endangered plants and occur adjacent to areas where such plants are known to occur. All of Technical Area III has been completely surveyed during the course of this study. It is unlikely that any rare plants or animals will occur in them in the immediate future; however, these zones are adjacent to

known locations of rare plants and it is possible that such plants could seed into Sensitivity Area 3 zones in the future.

12.4 SENSITIVITY 4 AREAS

A sensitivity value of "4" was applied to areas where insignificant or no biologic resources have been found, and where habitat conditions for such resources are poor to nonexistent. Areas considered to be of low sensitivity receive little use by plant and wildlife species because they are dominated by ongoing human activity or have been physically altered by human disturbance. These areas include all existing roadways and fence lines within Technical Area III where disturbance extends 50 meters (164 feet) on either side of the centerline. Also included in this category are specific man-made structures that are part of the overall CCTC area. Roadways and fence lines primarily serve to fragment existing habitat, disrupt natural travel corridors, facilitate erosion, and reduce the overall grassland shrub biomass and plant species diversity in the affected area.

Assuming that the CCTC area does not incur additional loss of plant and wildlife habitat, the existing loss of habitat associated with the area encompassed by the fenced sections of Technical Area III presently results in minimal impacts to wildlife habitat, species diversity, and the size of individual species populations. Additionally, except for the area associated with the Gun Site (i.e., firing range south of the Gun Site building), the area west of the Rocket Sled Track, and that part of the Rocket Sled Track Impact Area lying within Technical Area III, future construction activities and human disturbance, within the confines of Technical Area III, should have an insignificant impact on local biotic communities of plants and animals.

12.4.1 Endangered Plants.

No Endangered species of plants or animals, or unusual biotic communities, were observed in Sensitivity Area 4 zones during the 1992 survey. Because most of the areas classified as Sensitivity 4 were subject only to 10% sample surveys during the 1992 field season, it was impossible to say that no rare species occur there. However, as a result of sample transects throughout these areas and careful study of habitats, we hypothesized in 1992 that few if any

rare plant locations would be discovered there. In fact, and as predicted, no additional rare or endangered species of plants were found during the 100% surveys conducted during the 1993 field season.

12.5 OTHER SPECIAL HABITAT AREAS

Another noteworthy range extension also was recorded within the CCTC area. Two isolated Whipple's cholla cactus *(Opuntia whipplei)* were discovered in the southwest corner of the Rocket Sled Track Impact Area at approximately 34° 57′ 34″ N, 106° 33′ 40″ W. This isolated cluster of plants represents the southeasternmost known occurrence of the species (pers. obs.). The next nearest documented occurrences of this species are south of Cuba and west of Gallup, New Mexico, over 80 kilometers (50 miles) north and west of the CCTC area (pers. obs.). This species is an obligate outcrosser. Examination of mature fruits showed the ovules within to be undeveloped and infertile, indicating that the two plants at the site are probably clones. Lack of fertile fruit also suggests that there are no other similar cactus in the immediate area.

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13.0 POTENTIAL IMPACTS AND BIOLOGIC CONSEQUENCES

A variety of potential impacts could adversely affect federal and state endangered or sensitive species and/or unique plant communities on the CCTC area. These impacts can be classified into three broad categories: 1) direct impacts, 2) indirect impacts, and 3) cumulative impacts. These categories are defined in the following sections.

13.1 DIRECT IMPACTS

Direct impacts are those actions that have a direct and often immediate effect upon the resource. These conspicuous actions primarily include ground conversion activities (i.e., construction, fire, chemical spills, etc.). Once identified, direct effects are often easily mitigated.

13.1.1 Surface Disturbance Impacts.

Surface disturbance can include a wide range of activities such as road or site facility construction, installation of utilities, military maneuvers, or any other action that removes the existing plant and animal communities. Such activities can have devastating effects on rare plants and animals. The effects of surface disturbance range from immediate and total removal of the organism, to partial removal or disturbance. Surface disturbance impacts are evident in virtually every portion of the CCTC area. However, human activity was responsible for only a small portion of damage and destruction of individual grama grass cacti in the CCTC area; for example, only 1.5% of the plants discovered in 1992 were damaged or killed by human actions.

13.1.2 Fire.

Most plants that exist in grassland environments have evolved mechanisms for dealing with fire. In the case of grama grass cactus, fire will normally destroy the adults, but populations will recover from seeds in the soil. However, this species is under stress throughout much of its range. Loss of thriving reproductive plants will have a potentially greater and more serious effect than it would on more common grassland species found throughout the Rio

Grande Valley. Evidence of fire was not observed in the CCTC area; however, fires have resulted from past SNL rocket sled testing activity in Sol se Mete Canyon (Sullivan, 1993).

13.1.3 Deposition of Debris, Garbage, or Chemical Spills.

Disposal of unwanted waste can often severely impact the area immediately around a disposal site; this is particularly true with chemical spills. Chemical materials can leach into the soil and kill vegetation in the surrounding area. There is no evidence of chemical spill sites in the CCTC area.

13.1.4 Pesticide and Herbicide Spraying.

Pesticides and herbicides are often used to control insect infestations as well as the spread of unwanted weeds. These agents can often have adverse effects upon rare plants; and direct application of herbicides can result in the immediate death of the plant. Further, use of pesticides near rare plant sites can result in a reduction of pollinators that can lead to lack of pollination and failure of fruit set. There was no evidence of pesticide or herbicide spraying in the CCTC area.

13.1.5 Rural Fugitive Dust.

Construction activities, dirt roads, or any other activity that results in dust generation can result in damage to the local flora. Rural fugitive dust is often deposited on the leaf surfaces of plants adjacent to the dust source. The resulting coating of dust can reduce the photosynthetic capacity of the plant and potentially leave it in a stressed condition. Most CCTC test areas exhibited evidence of fugitive dust on vegetation, particularly along dirt roadways surrounding the facility.

13.1.6 Insect Impacts.

Certain insects, such as members of the Cerambycidae (beetle) family and the Lepidoptera Order (butterflies and moths) can inflict severe damage on grama grass cacti. Larval stages of some of these insects are known to infest grama grass cactus, which usually results in their death. This is a natural phenomenon that is difficult to control. Some insect damage was observed in several grama grass cactus plants. In fact, insect borers accounted for the

second largest source of damage and destruction of the grama grass cacti in the CCTC area. Between 1992 and 1993, insect borers killed 19 and damaged 3 of the 196 individual cactus plants.

13.1.7 Soil Deflation.

Soil deflation can result in loss of all topsoil down to the hardpan layer that exists in many portions of the CCTC area. For example, helicopters can create highly localized down-drafts of air that can deflate soil directly beneath them. In addition, these down-drafts contribute to soil erosion in vegetated areas along the periphery of the landing pad, which may extend as far as 50 meters (164 feet) into existing grassland habitat. This deflation results in the exposure of root systems and in many cases desiccation and death of plants in nearby grassland habitat.

Soil deflation was particularly evident on KAFB land associated with the helicopter landing pad adjacent to the South Thunder Range. This activity has the potential to directly impact the adjacent CCTC area through fragmentation of natural habitat, and because it prevents grama grass cacti from becoming established in areas along the peripheri of the pad, thus preventing colonization of adjacent habitat in the CCTC area.

13.1.8 Herbivory.

Herbivory of rare plants such as grama grass cactus has been documented within the CCTC area. Native herbivores such as rodents (i.e., kangaroo mice and rats, deer mice, prairie dogs) and rabbits are known to eat grama grass cactus. Large mammals such as mule deer can also eat the plants. Rodents accounted for the largest amount of damage and destruction of grama grass cacti in the CCTC area. Between 1992 and 1993, rodents killed 18 and damaged 40 of the 196 individual cactus plants.

13.1.9 Projectile Impact.

A variety of activities within the CCTC area can result in the deposition of projectiles (shrapnel and debris) in known rare plant locations. However, even though these activities apparently have been conducted at these sites for decades, there is no indication that such

projectiles have had an adverse effect upon the distribution or reproduction of rare plants. Evidence of projectile impact was observed in the South Thunder Range, Rocket Sled Track Impact Area, and along the western edge of the Rocket Sled Track.

13.2 INDIRECT IMPACTS

Indirect Impacts include activities that are remote from a site but have the ability to significantly impact the site. We suggest that the potential for indirect impacts be considered in SNL's resource management plan for the CCTC area. Based on our experience some of these indirect impacts include: 1) reduction of predators in the surrounding area that may result in an increase in herbivores; 2) remote construction activities that result in downstream sheetflooding, flooding, or sediment distribution; and 3) application of pesticides in remote areas that affect abundance and availability of pollinators to service rare plants. Indirect impacts are often difficult to identify and, moreover, are difficult to mitigate once they are detected.

13.2.1 Remote Construction Activities.

Remote or construction activities can often have subtle and damaging effects upon rare plants and animals. Any construction in the upper portion of a watershed or in an upland region of the landscape (e.g., North Thunder Range, eastern region of South Thunder Range, road-side ditches, etc.) can alter flow of storm water runoff, resulting in flooding or sediment deposition at a downstream/lowland location that would not normally be affected by such events.

13.2.2 Remote Application of Pesticides or Herbicides.

Bees and many other pollinators have wide ranges of activities—bees are known to travel as far as 5 km (3 miles) from their hives (P. J. Knight, pers. obs.). Use of pesticides in locations remote from a rare plant site, but within the range of the pollinators required by the plant, can cause a significant reduction in the numbers of pollinators visiting the plant, thus decreasing fruit set. Herbicides applied to the upstream portions of the watershed can be transported downstream to remote locations, possibly resulting in adverse impacts on rare plants or unique plant communities.

13.2.3 Predator Control.

Control of predators on or around a rare plant site can result in an increase of herbivores, who may in turn eat plants at the site. Predators such as coyote or lion can have wide ranges and their control at one location may cause indirect affects at other more remote locations.

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Appendix A. List of plants observed in the CCTC area

The following is a list of plants that were observed in the CCTC area. Species marked by an * are of special concern. RST=Rocket Sled Track, DTWI=Drop Tower and Water Impact Site, GS=Gun Site, LIHE=Light Initiated High-Explosive Site, CENF=Centrifuge Site, RSTIA=Rocket Sled Track Impact Area, NTR=North Thunder Range, STR=South Thunder Range; [a] Also known as *Pediocactus papyracanthus* and *Sclerocactus papyracanthus*

Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
sand verbena *(Abronia fragrans)*	X	-	-	-	-	-	-	-
umbrellawort *(Allionia incarnata)*	-	-	-	-	-	-	-	X
red threeawn *(Aristida longiseta)*	X	X	X	X	X	X	X	X
purple threeawn *(Aristida purperea)*	X	X	X	X	X	X	X	-
Bigelow sagebrush *(Artemisia bigelovii)*	-	X	-	-	X	-	X	-
sandsage brush *(Artemisia filifolia)*	X	-	X	-	-	X	-	X
milkvetch *(Astragalus lentiginosus* var. *diphysus)*	X	X	X	-	X	X	X	X
* Santa Fe milkvetch *(Astragalus feensis)*	-	-	-	-	-	-	X	X
Nuttal's milkvetch *(Astragalus nuttallianus)*	-	-	-	-	-	-	X	X
fourwing saltbush *(Atriplex canescens)*	X	-	X	X	-	X	X	X
antelope horns *(Asclepias asperula)*	-	-	-	-	-	-	-	X
baccharis *(Baccharis wrightii)*	-	-	-	-	-	-	X	X
desert marigold *(Baileya multiradiata)*	-	-	-	-	-	X	X	X
black grama *(Bouteloua eriopoda)*	X	-	X	X	-	X	X	X
blue grama *(Bouteloua gracilis)*	-	-	-	-	-	-	X	-
primrose *(Calylopus hartwegii)*	-	-	-	-	-	-	X	X
twin leaf *(Cassia bauhinioides)*	-	-	-	-	-	-	X	-
Fremont's goosefoot *(Chenopodium fremontii)*	X	X	X	-	-	X	X	X
rabbitbrush *(Chrysothamnus nauseosus)*	X	X	X	X	X	X	X	X
New Mexico thistle *(Cirsium neomexicanum)*	-	-	-	-	-	-	X	X

Appendix A. List of plants observed in the CCTC area. (Continued)

Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
golden corydalis *(Corydalis aurea)*	X	X	X	X	X	X	X	X
pincushion cactus *(Coryphantha vivipara)*	X	X	X	-	X	X	X	X
hidden flower *(Cryptantha fulvocanescens)*	-	-	-	-	-	-	X	-
hidden flower *(Cryptantha crassisepala)*	-	-	-	-	-	-	X	-
James's hidden flower *(Cryptantha jamesii)*	X	X	X	X	X	X	X	X
buffalo gourd *(Cucurbita foetidissima)*	-	-	-	-	-	-	X	X
dodder *(Cuscuta megalocarpa)*	-	-	-	-	-	-	X	-
chimaya *(Cymopterus fendleri)*	X	X	X	X	X	X	X	X
feather indigobush *(Dalea formosa)*	-	-	-	-	-	-	X	-
larkspur *(Delphinium virescens)*	-	X	-	-	X	-	X	X
tansy mustard *(Descurania richardsonii)*	-	X	-	X	X	X	X	X
spectacle pod *(Dithyrea wislizenii)*	X	X	X	X	X	X	X	X
dogweed *(Dyssodia acerosa)*	-	-	-	-	-	-	X	X
hedgehog cactus *(Echinocerecus fendleri)*	-	-	-	-	-	X	X	X
mormon tea *(Ephedra torreyana)*	X	-	X	-	-	X	X	X
love grass *(Eragrostis mexicana)*	-	-	-	-	-	-	X	-
trailing fleabane *(Erigeron flagellaris)*	-	-	-	-	-	-	X	-
fleabane *(Erigeron divergens)*	X	X	X	X	X	X	X	X
Fendler's spurge *(Euphorbia fendleri)*	-	-	-	-	-	-	X	X
thymeleaf spurge *(Euphorbia serpyllifolia)*	X	-	X	X	-	-	X	X
winterfat *(Eurotia lanata)*	X	-	X	X	-	X	X	X
blanketflower *(Gaillardia pinnatifida)*	X	X	X	X	-	-	X	X
scarlet gaura *(Gaura coccinea)*	-	-	-	-	-	-	X	-
gilia *(Gilia sinuata)*	-	X	-	-	X	X	X	X

Appendix A. List of plants observed in the CCTC area. (Continued)

Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
blue gilia *(Gilia rigidula* var. *acerosa)*	-	-	-	-	-	X	X	X
broom snakeweed *(Gutierrezia sarothrae)*	X	X	X	X	X	-	X	X
spiny goldenweed *(Happlopappus spinulosus)*	X	X	X	X	X	-	X	X
galleta *(Hilaria jamesii)*	X	X	X	X	X	-	X	X
rush pea *(Hoffmanseggia jamesii)*	X	-	X	-	-	X	X	X
juniper *(Juniperus monosperma)*	-	-	-	-	-	-	X	-
stickseed *(Lappula redowskii)*	-	-	-	-	-	-	X	X
creosotebush *(Larrea tridentata)*	-	-	-	-	-	X	X	-
Fendler's bladderpod *(Lesquerella fendleri)*	-	-	-	-	-	X	X	X
desert aster *(Leucelene ericoides)*	X	X	X	X	X	-	X	X
flax *(Linum aristatum)*	-	-	-	-	-	-	X	X
pale wolfberry *(Lycium pallidum)*	-	-	-	-	-	X	X	-
desert dandelion (*Malacothrix fendleri)*	X	X	X	-	X	-	X	X
blackfoot *(Melampodium leucanthum)*	X	X	X	X	-	-	-	X
whitestem sickleaf *(Mentzelia albicaulis)*	-	-	-	-	-	X	X	X
four-o'clock *(Mirabilis multiflora)*	-	-	-	-	-	-	X	X
bushy muhly *(Muhlenbergia porteri)*	X	X	X	-	X	-	X	X
ring muhly *(Muhlenbergia torreyi)*	X	X	X	X	X	-	X	X
hairy nama *(Nama hispidium)*	-	-	-	-	-	-	X	X
evening primrose (*Oenothera albicaulis)*	X	-	X	X	-	X	-	X
evening primrose *(Oenothera primiveris)*	-	X	-	-	X	-	X	X
club cholla *(Opuntia clavata)*	X	X	X	X	X	X	X	X
prickly pear *(Opuntia cymochila)*	-	-	-	-	-	-	X	X
cane cholla *(Opuntia imbricata)*	X	X	X	X	-	X	X	X

Appendix A. List of plants observed in the CCTC area. (Continued)

Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
prickly pear *(Opuntia phaecantha* var. *phaecantha)*	X	X	X	X	X	X	X	X
prickly pear *(Opuntia polycantha* var. *hystrospina)*	X	-	X	-	-	X	X	X
prickly pear *(Opuntia polycantha* var. *trichiphora)*	X	-	X	-	-	X	X	X
prickly pear *(Opuntia tortispina)*	-	X	-	-	-	-	X	X
Whipple's cholla *(Opuntia whipplei)*	X	-	-	-	-	-	-	-
broomrape *(Orobanche ludoviciana)*	X	X	X	X	X	X	X	X
Indian rice grass *(Oryzopsis hymenoides)*	X	X	X	X	X	X	X	X
* grama grass cactus *(Toumeya papyracantha)*	X	-	-	-	-	X	X	X
desert holly *(Perezia nana)*	-	-	-	-	-	-	X	X
scorpionweed *(Phacelia corrugata)*	X	X	X	X	X	X	X	X
woolly Indian wheat *(Plantago purshii)*	-	X	-	X	X	-	X	X
slender scurfpea (*Psoralea tenuifolia)*	-	X	-	-	X	-	X	-
skunkbush *(Rhus trilobata)*	-	-	-	-	-	-	X	-
canaigre *(Rumex hymenosepalus)*	X	X	X	X	X	X	X	X
Russian thistle *(Salsola kali var. tenuiflora)*	X	X	X	X	X	X	-	X
burrograss *(Scleropogon brevifolius)*	X	X	X	-	-	X	X	X
threadleaf groundsel *(Senecio douglasii)*	-	X	-	-	X	-	X	X
plains bristle grass (*Setaria macrostachya)*	-	-	-	-	-	-	X	-
squirreltail (*Sitanion hystrix)*	X	X	X	X	X	X	X	X
horse nettle *(Solanum elaeagnifolium)*	X	X	X	X	X	X	X	X
narrow-leaf mallow *(Sphaeralcea angustifolia* var. *lobata)*	X	X	X	X	X	X	X	X
red globemallow *(Sphaeralcea coccinea)*	X	-	X	X	-	X	X	X

Appendix A. List of plants observed in the CCTC area (Concluded)

Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
Fendler's globemallow *(Sphaeralcea fendleri)*	-	X	-	-	X	X	X	X
globemallow *(Sphaeralcea incana)*	X	-	X	X	-	X	X	X
spike dropseed *(Sporobolus contractus)*	X	X	X	X	X	X	X	X
sand dropseed *(Sporobolus cryptandrus)*	X	-	X	X	-	X	X	X
mesa dropseed *(Sporobolus flexuosus)*	X	X	X	X	X	X	X	X
skeletonweed *(Stephanomeria pauciflora)*	X	X	X	X	X	X	X	X
New Mexico porcupine grass *(Stipa neomexicana)*	-	-	-	-	-	-	X	X
fluff grass *(Tridens pilosus)*	X	X	X	X	X	X	X	X
Siberian elm *(Ulmus pumila)*	-	X	-	-	X	-	-	X
verbain *(Verbena bracteata)*	-	-	-	-	-	-	X	X
banana yucca *(Yucca bacatta)*	-	-	-	-	-	-	X	-
soapweed yucca *(Yucca glauca)*	X	X	X	X	X	X	X	X

Appendix B. State and federal sensitive species of plants potentially occurring in the CCTC area.

Sources are from Weniger (1988), A Handbook of Rare and Endemic Plants of New Mexico (1984), the 1992 Inventory of Rare and Endangered Plants of New Mexico (R. Sivinski and K. Lightfoot, eds.), New Mexico Forestry Division and Resources Conservation Division Energy, Minerals, and Natural Resources Department State Forester.

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1. **Wright's fishhook cactus** *(Mammillaria wrightii* var. *wrightii)*

   Status: Federal (none); State Endangered (R-E-D Code: 1-2-2)

   Habitat: Great Basin Conifer Woodland: Cold-adapted evergreen woodland at intermediate elevations; short stature trees of piñon and juniper. Plains and Great Basin Grassland: mostly short-grass plains of grama, wheatgrass, threeawn, muhly, galleta, and buffalo grass; dominated by broom snakeweed when continuously grazed by livestock; usually below 2,500 meters (7,500 feet) in elevation. Semidesert Grassland: hot, dry, grassy plains, such as black grama, dropseed, tobosa, and burrograss, mesquite, and soaptree yucca.

   Sensitivity: Low/none (not present in CCTC, but reported in Lurance Canyon [Sullivan, 1993]).

   Additional Information: Wright's fishhook cactus is a small cactus, usually less than 7.5 cm (3 inches) across, and is somewhat depressed globose in shape. It usually has 10 to 15 straight spines and one or two small hooked spines at the tip of each tubercle. It flowers in August and September supporting large (2.5 to 7.5 cm [1 to 3 inches] wide) bright purple to magenta flowers. There are several varieties of Wright's fishhook cactus, but *M. w.* var. *wrightii* is the only variety expected within the CCTC area. Wright's fishhook cactus ranges from north-central New Mexico into Texas and westward into Arizona.

   Wright's fishhook cactus normally occurs on gravelly or sandy hills or plains ranging from desert grassland to piñon-uniper woodland at an elevation of 1,463 and 2,286 meters (4,800 to 7,500 feet). Within the Albuquerque area it has been found in coarse-soiled grama grasslands at the base of the Sandia Mountains, extending southward into the Four Hills Area. It is more likely to occur near the base of the mountains rather than the open sandy bajada that lies below. Numerous individuals of this species occur in the vicinity of the Live Firing Range west of the Aerial Cable Facility (Biggs, 1991; Sullivan, 1993). It is threatened by habitat destruction as well as collection by cactus enthusiasts. The large showy flowers produced by this species make it particularly desirable in the horticultural trade.

2. **Button cactus** *(Epithelantha micromeris)*

   Status: Federal (none); State Endangered (R-E-D Code: 1-2-1)

   Habitat: Chihuahuan Desert Scrub: hot, dry plains with widely scattered shrubs typically of creosotebush, tarbush, mesquite, acacia, and yucca with warm-season grasses, forbs, and cacti in shrub interspaces; widespread throughout Southwest, usually at elevations below 1,833 meters (5,500 feet). Semidesert Grassland: hot, dry plains of warm-season grasses such as black grama, dropseed, tobosa, and burrograss mesquite, and soaptree yucca. Interior Chaparral: relatively dense

shrub association on desert mountain slopes. Diverse composition, with Chihuahuan, Sonoran, and Great Basin desert affinities (i.e., scrub live oak, manzanita, mountain mahogany, silktasses, sotol, catclaw. Lower slopes of mountains in Southwest, exposed ridges, hillsides, river beds, and associated arroyos.

Sensitivity: Low (not present in the CCTC area surveyed)

Additional Information: The button cactus occurs in deserts of Mexico, in southern Arizona, in the Trans-Pecos region of Texas, and in southern and central New Mexico. It is a small cactus, barely reaching 4 cm (1.5 inches) in diameter, and densely covered with small white spines. Its bright red to carmine flowers are clearly visible in mid-spring. Its microhabitat is one of small fissures and cracks in the limestone bedrock where it is sheltered and harvests runoff moisture from the surrounding rock. It is primarily a species of the Chihuahuan Desert, adapted to dry limestone ledges, rock outcrops, and benches. In New Mexico it is infrequent, occurring on limestone or gypsum outcrops at an elevation ranging from 1,219 to 1,829 meters (4,000 to 6,000 feet). Button cacti have not been collected in the Albuquerque area, and have been documented only in the Sierra Lucero range located just west of Belen (P. J. Knight, pers. obs.). Limestone hills within the CCTC area are suitable habitat for this species. In addition to the locations in the Sierra Lucero, button cacti have been documented in Eddy, Otero, Lincoln, Chavez, Doña Ana, and Socorro counties and other parts of Valencia County. In the southern part of New Mexico, this plant is often locally abundant, forming large populations that may extend over hundreds of acres. The primary threat to this species is from cactus collectors who ravage populations once they are located.

3. **White-flowered visnagita** *(Neolloydia intertexta* var. *dasyacantha)*

Status: Federal (None); State Endangered (R-E-D Code 1-2-1)

Habitat: Chihuahuan Desert Scrub: hot, dry plains with widely scattered shrubs typically of creosotebush, tarbush, mesquite, acacia, and yucca with warm-season grasses, forbs, and cacti in shrub interspaces; widespread throughout Southwest, usually at elevations below 1,833 meters (5,500 feet). Semidesert Grassland: hot, dry plains of warm-season grasses, such as black grama, dropseed, tobosa, and burrograss; mesquite; and soaptree yucca.

Sensitivity: Low (not present in area surveyed)

Additional Information: The white-flowered visnagita cactus normally has a solitary stem densely covered with interwoven spines. It usually ranges from 2.5 to 18 cm (3 to 7 inches) tall, but specimens over a foot in height have been recorded (R. M. Sullivan and R. A. Smartt, pers obs.). It normally has 3 or 4 pinkish central spines and from about 16 to 25 radial spines per aerole. Each of these spines can range from 1 to 1.5 cm (0.5 to 0.75 inches) long. Its white to pale pink flowers open in April with a small greenish-tan fruit appearing in late spring and often persisting into early summer. The white-flowered visnagita cactus normally occurs on coarse soils or rocky slopes, often on soils derived from rhyolite or volcanic materials.

There are two varieties of this species within New Mexico, but only *N. i.* var. *dasycantha* is expected to occur in the general Albuquerque area. This variety extends up the Rio Grande drainage as far north as Albuquerque and eastward as far as the Tularosa Basin; however, it is peripheral and scarce in the Albuquerque area. The primary threat to this species is considered collection by cactus enthusiasts, and to a lesser degree habitat destruction, primarily associated with overgrazing by livestock.

4. **Dune unicorn plant** *(Proboscidea sabulosa)*

Status: Federal (3C); State (Sensitive: R-E-D Code 1-1-2)

Habitat: Semidesert Grassland: hot, dry plains of warm-season grasses such as black grama, dropseed, tobosa, and burrograss. Mesquite and soaptree yucca also occur and may become dominant when grassland is continuously grazed. Chihuahuan Desert Scrub: Hot, dry plains with widely scattered shrubs typically of creosotebush, tarbush, mesquite, acacia, and yucca with warm-season grasses, forbs and cacti in shrub interspaces. Widespread throughout elevations below 1,676 meters (5,500 feet).

Sensitivity: Low (none observed in survey area)

Additional Information: The dune unicorn plant is a widespread regional endemic, first described from the Trans-Pecos area of Texas. In recent years its range in the eastern plains has been extended north to Clovis and in the Rio Grande Valley north to the Sevillita Wildlife Refuge south of Belen. It has never been reported as far north as Albuquerque, but some of the sandier portions of the CCTC area could provide suitable habitat for this species, which normally requires deep sandy areas, usually in small dunes.

Dune unicorn plant is a herbaceous plant that reaches approximately 1 meter (40 inches) in height. It has large rounded or heart-shaped leaves that are sticky to the touch. It flowers from July through August and produces cream-colored petals that are conspicuously marked with reddish spots or pale blotches on the inside. Lobes of the petals are reddish purple. The most distinctive feature of the plant is its unusual fruit that, when ripe, is woody and has two large pronounced claw-like appendages that curve outward, reaching a length of 15 cm (6 inches). The dune unicorn plant normally occurs in deep sandy soil between 1,067 and 1,524 meters (3,500 to 5,000 feet) in elevation. It has been reported from the sand dunes along Interstate 25 just south of Belen. There are no known threats to this species. But it is uncommon throughout its range and could be locally affected by loss of habitat.

Appendix C. Locality and description of each grama grass cactus site found within the CCTC area.

Grama Grass Cactus Site 1.—Site 1 is located in the northeast portion of the North Thunder Range at approximately 34° 58′ 29″ N, 106° 31′ 21.9″ W. Specifically, it is located at the northwestern base of a hill, just south of an east-west tending arroyo and just west of a small rocky knob composed of quartzite boulders. The site is located in an open black grama grassland community dominated by black grama, sand dropseed, winterfat, and broom snakeweed. The site has an aspect of approximately 280° and a 10% slope. The soil is a sandy-gravel loam with conspicuous chunks of quartzite pebbles present. Six grama grass cacti were located at the site; these included one seedling, one juvenile, and four mature plants.

Grama Grass Cactus Site 2.—Site 2 is located in the southwest portion of the North Thunder Range at approximately 34° 58′ 6″ N, 106° 31′ 48″ W. Specifically, it is located just north of Magazine Road. The site occurs in black grama grassland dominated by black grama, sand dropseed, winterfat, and broom snakeweed. It occurs on nearly flat ground. The soil is a sandy loam. Four grama grass cacti were located at this site, three adults and one seedling.

Grama Grass Cactus Site 3.—Site 3 is located in the southwest portion of the North Thunder Range at approximately 34° 58′ 16″ N, 106° 31′ 51″ W. Specifically, it is located several hundred yards north of Magazine Road. The site occurs in black grama grassland dominated by black grama, sand dropseed, winterfat, and broom snakeweed. It occurs on nearly flat ground, and the soil is a sandy loam. One adult grama grass cactus plant was located at this site.

Grama Grass Cactus Site 4.—Site 4 is located in the southwest portion of the North Thunder Range at approximately 34° 58′ 15″ N, 106° 31′ 58″ W. Specifically, it is located several hundred yards north of Magazine Road. The site occurs in black grama grassland dominated by black grama, sand dropseed, winterfat, and broom snakeweed. It occurs on nearly flat ground. The soil is a sandy loam. Two large adult grama grass cactus plants were located at this site.

Grama Grass Cactus Site 5.—Site 5 is located in the eastern portion of the Rocket Sled Track Impact Area just south of Magazine Road at approximately 34° 58′ 6″ N, 106° 31′ 13″ W. Specifically, it is located approximately 100 meters south of Magazine Road. The site occurs in an open burrograss-galleta grassland. Species diversity and grass cover are low. Much of the area is composed of near-pure stands of burrograss mixed with galleta, with small intervening lowland areas that have virtually no vegetative coverage. The soil is silty to silt-clay. Two adult grama grass cactus plants were located at this site.

Grama Grass Cactus Site 6.—Site 6 is located in the eastern portion of the Rocket Sled Track Impact Area at approximately 34° 56′ 59″ N, 106° 33′ 5″ W. Specifically, it is located approximately 200 meters north of the KAFB boundary with the Isleta Reservation fence. It occurs on nearly flat ground. The soil is a sandy loam. The site occurs in black

grama-sand dropseed grassland community dominated by black grama, sand dropseed, and galleta. One adult grama grass cactus was located at this site.

Grama Grass Cactus Site 7.—Site 7 is located in the eastern portion of the Rocket Sled Track Impact Area approximately midway between Magazine Road and the KAFB boundary with the Isleta Reservation at approximately 34° 57′ 38″ N, 106° 33′ 8″ W. It occurs on nearly flat ground and the soil is a sandy loam. The site occurs in black grama-sand dropseed grassland community dominated by black grama, sand dropseed, and galleta. Four mature grama grass cacti were located at this site.

Grama Grass Cactus Site 8.—Site 8 is located in the central portion of the South Thunder Range at approximately 34° 57′ 47″ N, 106° 31′ 50″ W. Specifically, it is located near the center of the South Thunder Range just northeast of one of the existing facilities. The site occurs in black grama grassland dominated by black grama, with sand dropseed and burrograss. Four grama grass cacti were located at this site. Two were juveniles; the remaining plants were mature individuals. One of the mature plants was extremely large (19 cm tall) and extremely old.

Grama Grass Cactus Site 9.—Site 9 is located in the southern portion of the South Thunder Range at approximately 34° 57′ 24″ N, 106° 31′ 54″ W. Specifically, it is located approximately 200 meters north of the southern fence of the South Thunder Range. The site occurs in a dense, near monospecific stand of black grama grassland. One large mature grama grass cactus was located.

Grama Grass Cactus Site 10.—Site 10 is located in the eastern portion of the Rocket Sled Track Impact Area about midway between Magazine Road and the KAFB boundary with the Isleta Reservation at approximately 34° 57′ 35″ N, 106° 33′ 7″ W. Specifically, it is located in the east central portion of the Rocket Sled Track Impact Area south of Magazine Road. The site occurs in open burrograss-galleta grassland. Species diversity and grass cover are low. Much of the area is composed of near-pure stands of burrograss mixed with galleta, with small intervening lowland areas that have virtually no vegetative coverage. Soil is silty to silt-clay. Three mature grama grass cacti were observed at this site.

Grama Grass Cactus Site 11.—Site 11 is located in the eastern portion of the Rocket Sled Track Impact Area about midway between Magazine Road and the KAFB boundary with the Isleta Reservation at approximately 34° 57′ 41″ N, 106° 33′ 11″ W. Specifically, it is located in the east central portion of the Rocket Sled Track Impact Area south of Magazine Road. The site occurs in open burrograss-galleta grassland. Species diversity and grass cover is low. Much of the area is composed of near-pure stands of burrograss mixed with galleta, with small intervening lowland areas that have virtually no vegetative coverage. The soil is silty to silt-clay. Two mature grama grass cacti were located at this site.

Grama Grass Cactus Site 12.—Site 12 is located in the central portion of the Rocket Sled Track Impact Area about midway between Magazine Road and the KAFB boundary with the

Isleta Reservation at approximately 34° 57′ 34″ N, 106° 33′ 20″ W. The site occurs in open burrograss-galleta grassland. Species diversity and grass cover are low. Much of the area is composed of near-pure stands of burrograss mixed with galleta, with small intervening lowland areas that have virtually no vegetative coverage. The soil is silty to silt-clay. Two mature grama grass cacti were located at this site.

Grama Grass Cactus Site 13.—Site 13 is located in the north-central portion of the Rocket Sled Track Impact Area at approximately 34° 57′ 49″ N, 106° 33′ 23″ W. Specifically, it is located in the north central portion of the Rocket Sled Track Impact Area about a third of the way south from Magazine Road to the KAFB boundary with the Isleta Reservation. The site occurs in open burrograss grassland. Species diversity and grass cover are low. Much of the area is composed of near-pure stands of burrograss mixed with galleta, with small intervening lowland areas that have virtually no vegetative coverage. The soil is silty to silt-clay. Fourteen grama grass cacti were located at this site, five large individuals and nine seedlings.

Grama Grass Cactus Site 14.—Site 14 is located in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 17″ N, 106° 33′ 45″ W. Specifically, it is located just west of the southwest corner of Technical Area III. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. One large mature grama grass plant was located at this site.

Grama Grass Cactus Site 15.—Site 15 is located in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 27″ N, 106° 33′ 40″ W. Specifically, it is located just west of the western fence boundary of Technical Area III. The site is dominated by sandsage brush mixed with black grama and ring muhly. The soil is a sandy loam. Nine mature grama grass cacti were located at this site.

Grama Grass Cactus Site 16.—Site 16 is located in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 52″ N, 106° 33′ 38″ W. Specifically, it is located just west of the western fence boundary of Technical Area III. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Four grama grass cacti were located at this site. These included three mature individuals and one seedling.

Grama Grass Cactus Site 17.--Site 17 is located in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 59″ N, 106° 33′ 40″ W. Specifically, it is located just west of the western fence boundary of Technical Area III. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Two mature grama grass cacti were located at this site.

Grama Grass Cactus Site 18.—Site 18 is located just outside the 18° cone of the Rocket Sled Track Impact Area at approximately 34° 59′ 9″ N, 106° 33′ 39″ W. Specifically, it is located just west of the western fence boundary of Technical Area III. The site is

dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Two mature grama grass cacti were located at this site.

Grama Grass Cactus Site 19.—Site 19 is located in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 18″ N, 106° 33′ 40″ W. Specifically, it is located just west of the southwest corner of Technical Area III. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. One large mature grama grass plant was located at this site.

Grama Grass Cactus Site 20.—Site 20 is located in the western portion of the Rocket Sled Track Impact Area just south of Magazine Road at approximately 34° 58′ 3″ N, 106° 33′ 38″ W. Specifically, it is located due south of the southwest corner of Technical Area III, south of Magazine Road. The site occurs in open burrograss and sand dropseed grassland. Species diversity and grass cover are low. Much of the area is composed of near-pure stands of burrograss mixed with galleta, with small intervening lowland areas that have virtually no vegetative coverage. The soil is silty to silt-clay. Seven grama grass cacti were located at the site, five mature plants and two juveniles.

Grama Grass Cactus Site 21.—Site 21 is located in the western portion of the Rocket Sled Track Impact Area just southwest of Magazine Road at approximately 34° 57′ 3″ N, 106° 33′ 36″ W. Specifically, it is located southwest of the southwest corner of Technical Area III. The site occurs in open black grama, sand dropseed, and galleta grassland. The soil is sandy-silt. Three grama grass cacti were located at this site, two mature individuals and one seedling.

Grama Grass Cactus Site 22.—Site 22 is located in the western portion of the Rocket Sled Track Impact Area just southwest of Magazine Road at approximately 34° 58′ 2.1″ N, 106° 33′ 46″ W. Specifically, it is located southwest of the southwest corner of Technical Area III. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Eleven mature grama grass cacti were located at this site.

Grama Grass Cactus Site 23.—Site 23 is located in the extreme western portion of Technical Area III west of the Rocket Sled Track Impact Area at approximately 35° 0′ 10″ N, 106° 33′ 33″ W. Specifically, it is located just east of the western fence boundary of Technical Area III, near the northern end of the Rocket Sled Track. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. One mature grama grass cactus was present at this site.

Grama Grass Cactus Site 24.—Site 24 is located in the extreme western portion of Technical Area III, west of the Rocket Sled Track Impact Area at approximately 43° 59′ 47″ N, 106° 33′ 34″ W. Specifically, it is located just east of the western fence boundary of Technical Area III, near the northern end of the Rocket Sled Track. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Four mature grama grass cacti were present at this site.

Grama Grass Cactus Site 25.—Site 25 is located in the southeast portion of the Technical Area III approximately 34° 58′ 29″ N, 106° 32′ 29″ W. Specifically, it is located approximately one-third of a mile north of the southern fence boundary of Technical Area III. The site occurs in black grama grassland dominated by black grama, sand dropseed, winterfat, and broom snakeweed. It occurs on nearly flat ground. The soil is a sandy loam. One mature grama grass cactus was located at this site.

Grama Grass Cactus Site 26.—Site 26 is located in the southeast portion of the Technical Area III approximately 34° 58′ 37″ N, 106° 32′ 36″ W. Specifically, it is located approximately one-half mile north of the southern fence boundary of Technical Area III. The site occurs in an open burrograss and sand dropseed grassland. Species diversity and grass cover are low. Much of the area is composed of near-pure stands of burrograss mixed with galleta, with small intervening lowland areas that have virtually no vegetative coverage. The soil is silty to silt-clay. One mature grama grass cactus was located at this site.

Grama Grass Cactus Site 27.—Site 27 is located in the extreme western portion of Technical Area III in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 54″ N, 106° 33′ 35″ W. Specifically, it is located just southwest of the southern end of the Rocket Sled Track. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Fourteen grama grass cacti were located at this site, eleven mature plants and three seedlings.

Grama Grass Cactus Site 28.—Site 28 is located in the extreme western portion of Technical Area III in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 53″ N, 106° 33′ 34″ W. Specifically, it is located just southwest of the southern end of the Rocket Sled Track. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Three mature grama grass cacti were located at this site.

Grama Grass Cactus Site 29.—Site 29 is located in the extreme western portion of Technical Area III in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 54″ N, 106° 33′ 28″ W. Specifically, it is located nearly south of the southern end of the Rocket Sled Track. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Three grama grass cacti were located at this site, two mature plants and one seedling.

Grama Grass Cactus Site 30.—Site 30 is located in the extreme southwestern portion of Technical Area III in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 33″ N, 106° 33′ 29″ W. Specifically, it is located just north of the southwest corner of Technical Area III. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Thirteen grama grass cactus were located at this site, eleven mature plants and two seedlings.

Grama Grass Cactus Site 31.—Site 31 is located in the extreme southwestern portion of Technical Area III in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 30″ N, 106° 33′ 24″ W. Specifically, it is located just northeast of the southwest corner of Technical Area III. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Seven grama grass cactus were located at this site, all mature plants.

Grama Grass Cactus Site 32.—Site 32 is located in the extreme southwestern portion of Technical Area III in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 26″ N, 106° 33′ 30″ W. Specifically, it is located just northeast of the southwest corner of Technical Area III. The site is dominated by sandsage brush mixed with black grama and galleta. The soil is a sandy loam. Eight mature grama grass cacti were located at this site.

Grama Grass Cactus Site 33.—Site 33 is located in the extreme southwestern portion of Technical Area III in the western portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 20″ N, 106° 33′ 28″ W. Specifically, it is located just northeast of the southwest corner of Technical Area III, and just north of the southern Technical Area III fence line. The site is dominated by sandsage brush mixed with black grama and galleta. The soil is a sandy loam. Three grama grass cactus were located at this site, all mature plants.

Grama Grass Cactus Site 34.—Site 34 is located in the southwestern portion of Technical Area III in the eastern portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 49″ N, 106° 33′ 14″ W. Specifically, it is located just southeast of the end of the Rocket Sled Track. The site is dominated by black grama, sand dropseed, winterfat, and broom snakeweed. The soil is a sandy loam. Four mature grama grass cactus were located at this site.

Grama Grass Cactus Site 35.—Site 35 is located in the southwestern portion of Technical Area III in the eastern portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 40″ N, 106° 33′ 15″ W. Specifically, it is located just southeast of the end of the Rocket Sled Track. The site occurs in open burrograss-galleta grassland. Species diversity and grass cover are low. Much of the area is composed of near-pure stands of burrograss mixed with galleta, with small intervening lowland areas that have virtually no vegetative coverage. The soil is silty to silt-clay. Three grama grass cacti were located at this site, all mature plants.

Grama Grass Cactus Site 36.—Site 36 is located in the southwestern portion of Technical Area III in the eastern portion of the Rocket Sled Track Impact Area at approximately 34° 58′ 26″ N, 106° 33′ 19″ W. Specifically, it is located southeast of the end of the Rocket Sled Track and just north of the southern fence line of Technical Area III. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Nine mature grama grass cacti were located at this site.

Grama Grass Cactus Site 37.—Site 37 is located in the extreme western portion of Technical Area III west of the Rocket Sled Track Impact Area at approximately 34° 59′ 21″ N, 106° 33′ 32″ W. Specifically, it is located just east of the western fence boundary of Technical Area III just northwest of the southern end of the Rocket Sled Track. The site is dominated by sandsage brush mixed with black grama. The soil is a sandy loam. Three mature grama grass cacti were present at this site.

Grama Grass Cactus Site 38.—Site 38 is located in the southeast portion of the Rocket Sled Track Impact Area at approximately 34° 57′ 6″ N, 106° 33′ 10″ W. Specifically, it is located approximately 420 meters (0.25 miles) north of the Isleta Indian Reservation fence line approximately 535 meters (0.33 miles) northeast of the extreme southeast corner of the Rocket Sled Track Impact Area. The site was dominated by burrograss and black grama; soil is a clay loam. Two mature grama grass cacti were present at this site.

Grama Grass Cactus Site 39.—Site 39 is located in the southeast portion of the Rocket Sled Track Impact Area at approximately 34° 57′ 18″ N, 106° 33′ 16″ W. Specifically, it is located approximately 805 meters (0.5 mile) north of the Isleta Indian Reservation boundary near the southeast corner of the Rocket Sled Track Impact Area. The site was dominated by burrograss and black grama; soil is a clay loam. One mature grama grass cactus was present at this site.

Grama Grass Cactus Site 40.—Site 40 is located in the south-central portion of the Rocket Sled Track Impact Area just east of the new paved access road to a helicopter landing pad at approximately 34° 56′ 57″ N, 106° 33′ 22″ W. Specifically, it was located approximately 268 meters (1/6 mile) north of the Isleta Indian Reservation boundary and 15 meters (50 feet) east of the edge of the right-of-way for the access road to the helicopter landing pad. The site was dominated by a dense stand of black grama with scattered winterfat; soil is sandy. Five mature grama grass cacti were present at this site.

Grama Grass Cactus Site 41.—Site 41 is located in the south-central portion of the Rocket Sled Track Impact Area just west of the new paved access road to a helicopter landing pad at approximately 34° 56′ 57″ N, 106° 33′ 25″ W. Specifically, it is located approximately 268 meters (1/6 mile) north of the Isleta Indian Reservation boundary and 150 feet west of the edge of the right-of-way for the access road to the helicopter landing pad. The site was dominated by a dense stand of black grama with scattered winterfat; soil is sandy. Seven mature grama grass cacti were present at this site.

Grama Grass Cactus Site 42.—Site 42 is located in the south-central portion of the Rocket Sled Track Impact Area just south of the new helicopter landing strip at approximately 34° 57′ 9″ N, 106° 33′ 31″ W. Specifically, it is located approximately 805 meters (0.5 miles) north of the Isleta Indian Reservation boundary and 100 feet south of the edge of the right-of-way for the helicopter landing strip. The site was dominated by burrograss, threeawn and black grama, and the soil is sandy. Three mature grama grass cacti were present at this site.

Grama Grass Cactus Site 43.—Site 43 is located in the extreme southwest portion of the Rocket Sled Track Impact Area just west of the helicopter fire station facility at approximately 34° 56′ 53″ N, 106° 33′ 55″ W. Specifically, it is located just north of the Isleta Indian Reservation boundary and 33 meters (100 feet) west of the helicopter training facility. The site was dominated by burrograss, threeawn, dropseed, and black grama; soil is sandy. Seven mature grama grass cacti were present at this site.

Grama Grass Cactus Site 44.—Site 44 is located in the extreme west-central portion of the Rocket Sled Track Impact Area just east of the western edge of the cone at approximately 34° 57′ 33″ N, 106° 33′ 55″ W. Specifically, it is located approximately 1,062 meters (0.66 miles) north of the Isleta Indian Reservation boundary. The site was dominated by black grama and sandsage brush; soil is sandy. Four mature grama grass cacti were present at this site.

Grama Grass Cactus Site 45.—Site 45 is located in the southwest portion of the Rocket Sled Track Impact Area just northeast of the helicopter training facility at approximately 34° 57′ 5″ N, 106° 33′ 49″ W. Specifically, it is located just east of a newly created runway approximately 0.33 miles north of the Isleta Indian Reservation boundary. The site was dominated by burrograss, galleta, and black grama; soil is sandy. One mature grama grass cactus was present at this site.

Grama Grass Cactus Site 46.—Site 46 is located just south of northernmost laser radar tracker pad just west of Tech Area III, at approximately 35° 00′ 00″ N, 106° 33′ 51″ W. Specifically, it is located approximately 25 meters (8.3 feet) south of the southwest corner of the assess road that loops around the most northerly laser tracker pad. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Four grama grass cacti were located at this site, three of which were mature plants, and one was a juvenile.

Grama Grass Cactus Site 47.—Site 47 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 35° 00′ 27″ N, 106° 33′ 28″ W. Specifically it is located just to the southwest of the vertex of the Rocket Sled cone of impact at western edge of Tech Area III. The site is dominated by black grama and sand dropseed. Soil was a sandy loam. Three mature grama grass cacti were located at this site.

Grama Grass Cactus Site 48.—Site 48 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 35° 00′ 14″ N, 106° 33′ 34″ W. Specifically it is located just to the southwest of the vertex of the Rocket Sled cone of impact at western edge of Technical Area III. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Five mature grama grass cacti were located at this site.

Grama Grass Cactus Site 49.—Site 49 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 35° 00′ 10″ N, 106° 33′ 33″ W. Specifically it is located just to the southwest of the vertex of the Rocket Sled cone of impact

at western edge of Technical Area III. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Five mature grama grass cacti were located at this site.

Grama Grass Cactus Site 50.—Site 4 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 35° 00′ 21″ N, 106° 33′ 30″ W. Specifically it is located just to the southwest of the vertex of the Rocket Sled cone of impact at western edge of Tech Area III. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Two mature grama grass cacti were located at this site.

Grama Grass Cactus Site 51.—Site 51 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 35° 00′ 6″ N, 106° 33′ 32″ W. Specifically it is located just to the southwest of the vertex of the Rocket Sled cone of impact at western edge of Technical Area III. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. One mature grama grass cactus was located at this site.

Grama Grass Cactus Site 52.—Site 52 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 34° 59′ 31″ N, 106° 33′ 35″ W. Specifically it is located just to the south-southwest of the vertex of the Rocket Sled cone of impact at western edge of Technical Area III. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Nine mature grama grass cacti were located at this site.

Grama Grass Cactus Site 53.—Site 53 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 34° 59′ 33″ N, 106° 33′ 35″ W. Specifically it is located just to the south-southwest of the vertex of the Rocket Sled cone of impact at western edge of Technical Area III. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Eight mature grama grass cacti were located at this site.

Grama Grass Cactus Site 54.—Site 54 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 34° 59′ 36″ N, 106° 33′ 34″ W. Specifically it is located just to the south-southwest of the vertex of the Rocket Sled cone of impact at western edge of Technical Area III. The site is dominated by sand sagebrush mixed with black grama. The soil was a sandy loam. One mature grama grass cactus was located at this site.

Grama Grass Cactus Site 55.—Site 55 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 34° 59′ 42″ N, 106° 33′ 32″ W. Specifically it is located just to the south-southwest of the vertex of the Rocket Sled cone of impact at western edge of Technical Area III. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Two mature grama grass cacti were located at this site.

Grama Grass Cactus Site 56.—Site 56 is located just west of the Rocket Sled Track in the western portion of Technical Area III, at approximately 34° 59′ 45″ N, 106° 33′ 35″ W. Specifically it is located just to the south-southwest of the vertex of the Rocket Sled cone of impact at western edge of Technical Area III. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Fourteen mature grama grass cacti were located at this site.

Grama Grass Cactus Site 57.—Site 57 is located in the southeast portion of Technical Area III, at approximately 34° 58′ 41 ″ N, 106° 32′ 38″ W. Specifically it is located just to the northwest of the waste treatment facility in the southeast corner of Technical Area III. The site occurs in an open false needlegrass galleta grass grassland. Soil was a sandy loam. Three mature grama grass cacti were located at this site.

Grama Grass Cactus Site 58.—Site 58 is located in the southeast portion of Technical Area III, at approximately 34° 58′ 41 ″ N, 106° 32′ 49″ W. Specifically it is located west-northwest of the waste treatment facility in the southeast corner of Technical Area III. The site occurs in an open false needlegrass galleta grass grassland. Soil was a sandy loam. Three mature grama grass cacti were located at this site.

Grama Grass Cactus Site 59.—Site 59 is located in the southeast portion of Tech Area III, at approximately 34° 58′ 28 ″ N, 106° 33′ 16″ W. Specifically it is located in the extreme western half of the southeast quadrant of Tech Area III in the impact area of the Gun Site Facility, just to the east of the impact cone of the Rocket Sled Track. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. One mature grama grass cactus was located at this site.

Grama Grass Cactus Site 60.—Site 60 is located in the southeast portion of Technical Area III, at approximately 34° 58′ 41 ″ N, 106° 32′ 59″ W. Specifically it is located in the extreme south western corner of the southeast quadrant of Technical Area III in the impact area of the Gun Site Facility, just to the east of the impact cone of the Rocket Sled Track. The site occurs in an open false needlegrass galleta grass grassland. Soil was a sandy loam. Eleven mature grama grass cacti were located at this site.

Grama Grass Cactus Site 61.—Site 61 is located in the southeast portion of Technical Area III, at approximately 34° 58′ 32 ″ N, 106° 33′ 5″ W. Specifically it is located in the extreme western half of the southeast quadrant of Technical Area III in the impact area of the Gun Site Facility, just to the east of the impact cone of the Rocket Sled Track. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Eleven mature and two juvenile grama grass cactus was located at this site.

Grama Grass Cactus Site 62.—Site 62 is located in the southeast portion of Technical Area III, at approximately 34° 58′ 27 ″ N, 106° 32′ 56″ W. Specifically it is located in the extreme south western half of the southeast quadrant of Technical Area III in the impact area of the Gun Site Facility, just to the east of the impact cone of the Rocket Sled Track. The

site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Two mature grama grass cactus was located at this site.

Grama Grass Cactus Site 63.—Site 63 is located in the southeast portion of Technical Area III, at approximately 34° 58′ 24 ″ N, 106° 33′ 10″ W. Specifically it is located in the extreme southwestern corner of the southeast quadrant of Technical Area III in the impact area of the Gun Site Facility, straddling the impact cone of the Rocket Sled Track. The site is dominated by sand sagebrush mixed with black grama. Soil was a sandy loam. Three mature and two juvenile grama grass cactus was located at this site.

Grama Grass Cactus Site 64.—Site 64 is located in the southeast portion of Technical Area III, at approximately 34° 58′ 20 ″ N, 106° 33′ 2″ W. Specifically it is located in the extreme southwestern corner of the southeast quadrant of Technical Area III in the impact area of the Gun Site Facility, straddling the impact cone of the Rocket Sled Track. The site is dominated by sand sagebrush mixed with black grama. The soil was a sandy loam. Two mature and one juvenile grama grass cactus was located at this site.

Grama Grass Cactus Site 65.—Site 65 is located in the extreme northwest portion of the southeast quadrant of Technical Area III, at approximately 34° 59′ 6 ″ N, 106° 32′ 50″ W. Specifically it is located in the extreme northern edge of the southeast quadrant of Technical Area III just to the east of Gun Site Facility. The site is dominated by black grama and sand dropseed . Soil was a sandy loam. Two mature grama grass cacti were located at this site.

Appendix D. Raw data for grama grass cactus.

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
1	1992	1	5	3.5	2	1	Black Grama-Dropseed	X					
1	1993	1	5	3.5	0	5	Black Grama-Dropseed	X					
1	1992	2	5	2	0	0	Black Grama-Dropseed	X					
1	1993	2	0	0	0	0	Black Grama-Dropseed			X	X		
1	1992	3	5	1.5	0	0	Black Grama-Dropseed	X					
1	1993	3	1	0.5	0	0	Black Grama-Dropseed		X			X	
1	1992	4	1	0.5	0	0	Black Grama-Dropseed	X					
1	1993	4	0	0	0	0	Black Grama-Dropseed			X	X		
1	1992	5	1.5	0.7	0	0	Black Grama-Dropseed	X					
1	1993	5	0	0	0	0	Black Grama-Dropseed			X			X
1	1992	6	6	2	1	0	Black Grama-Dropseed	X					
1	1993	6	0	0	0	0	Black Grama-Dropseed			X			X
2	1992	1	3	1.5	2	3	Black Grama-Dropseed	X					
2	1993	1	0	0	0	0	Black Grama-Dropseed			X		X	
2	1992	2	12	6	4		Black Grama-Dropseed	X					
2	1993	2	0	0	0	0	Black Grama-Dropseed			X		X	
2	1992	3	6	2		7	Black Grama-Dropseed	X					
2	1993	3	0	0	0	0	Black Grama-Dropseed			X		X	
2	1992	4	1	0.5			Black Grama-Dropseed	X					
2	1993	4	0	0	0	0	Black Grama-Dropseed			X		X	

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
2	1992	6	Not identified in 1992				Black Grama-Dropseed						
2	1993	6	2.5	0.5	0	0	Black Grama-Dropseed	X					
2	1992	6	Not identified in 1992				Black Grama-Dropseed						
2	1993	6	2.5	0.5	0	0	Black Grama-Dropseed	X					
2	1992	7	Not identified in 1992				Black Grama-Dropseed						
2	1993	7	2	0.4	0	0	Black Grama-Dropseed	X					
3	1992	1	6.5	3	3	4	Black Grama-Dropseed	X					
3	1993	1	6.5	4	12	0	Black Grama-Dropseed	X					
4	1992	1	7.5	8	5	1	Black Grama-Dropseed	X					
4	1993	1	7.5	4.5	4	5	Black Grama-Dropseed	X					
4	1992	2	4.5	4	3	1	Black Grama-Dropseed	X					
4	1993	2	9	4.5	10	0	Black Grama-Dropseed	X					
4	1992	3	Not identified in 1992				Black Grama-Dropseed						
4	1993	3	2	0.4	0	0	Black Grama-Dropseed	X					
4	1992	4	Not identified in 1992				Black Grama-Dropseed						
4	1993	4	1.5	0.3	0	0	Black Grama-Dropseed	X					
5	1992	1	7	3	2	2	Black Grama-Burro Grass	X					
5	1993	1	1	1.5	0	0	Black Grama-Burro Grass		X			X	

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
5	1992	2	6	1.5	2	5	Black Grama-Burro Grass	X					
5	1993	2	0	0	0	0	Black Grama-Burro Grass				X	X	
6	1992	1	12	1.5	1	0	Black Grama-Dropseed	X					
6	1993	1	9	2	3	0	Black Grama-Dropseed		X			X	
7	1992	1	5	3.5	0	4	Black Grama-Dropseed	X					
7	1993	1	3	3	1	0	Black Grama-Dropseed		X			X	
7	1992	2	6	3.5	2	1	Black Grama-Dropseed	X					
7	1993	2	0	0	0	0	Black Grama-Dropseed		X			X	
7	1992	3	9	4	0	4	Black Grama-Dropseed	X					
7	1993	3	8.5	3.5	3	3	Black Grama-Dropseed	X					
7	1992	4	8	4.5	3	8	Black Grama-Dropseed	X					
7	1993	4	9	2	3	0	Black Grama-Dropseed	X					
8	1992	1	19	5	8	5	Black Grama-Dropseed	X					
8	1993	1	0	0	0	0	Black Grama-Dropseed			X			X
8	1992	2	6	0.5			Black Grama-Dropseed	X					
8	1993	2	0	0	0	0	Black Grama-Dropseed			X	X		
8	1992	3	1.5	0.4			Black Grama-Dropseed	X					
8	1993	3	0	0	0	0	Black Grama-Dropseed			X	X		

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
8	1992	4	2	0.4			Black Grama-Dropseed	X					
8	1993	4	0	0	0	0	Black Grama-Dropseed			X	X		
9	1992	1	15	4.5	2	8	Black Grama	X					
9	1993	1	0	0	0	0	Black Grama			X	X		X
10	1992	1	3	2		4	Black Grama-Burro Grass	X					
10	1993	1	3	3	1		Black Grama-Burro Grass		X			X	
10	1992	2	6	3.5	1	9	Black Grama-Burro Grass	X					
10	1993	2	0	0	0	0	Black Grama-Burro Grass		X			X	
10	1992	3	7.5	5	8	7	Black Grama-Burro Grass	X					
10	1993	3	8.5	3.5	3	3	Black Grama-Burro Grass	X					
11	1992	1	5	0.8			Black Grama-Burro Grass	X					
11	1993	1	0	0	0	0	Black Grama-Burro Grass			X	X		
11	1992	2	10	4	8	4	Black Grama-Burro Grass	X					
11	1993	2	0.5	0.5			Black Grama-Burro Grass		X			X	
11	1992	3	Not identified in 1992				Black Grama-Burro Grass						
11	1993	3	2	0.5			Black Grama-Burro Grass	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
12	1992	1	5	3		2	Black Grama-Burro Grass	X					
12	1993	1	0	0	0	0	Black Grama-Burro Grass		X	X	X		
12	1992	2	5.5	2	5	3	Black Grama-Burro Grass	X					
12	1993	2	0	0	0	0	Black Grama-Burro Grass			X	X	X	
13	1992	1	9	3	1	9	Black Grama-Burro Grass	X					
13	1993	1	2	3			Black Grama-Burro Grass		X			X	
13	1992	2	8	3	8		Black Grama-Burro Grass	X					
13	1993	2	0	0	0	0	Black Grama-Burro Grass			X		X	
13	1992	3	5	2			Black Grama-Burro Grass	X					
13	1993	3	6	3.5	4		Black Grama-Burro Grass	X					
13	1992	4	6	2	7	1	Black Grama-Burro Grass	X					
13	1993	4	6	2.5	4		Black Grama-Burro Grass	X					
13	1992	5	5	1.5			Black Grama-Burro Grass	X					
13	1993	5	5	2	4		Black Grama-Burro Grass	X					
13	1992	6	0.8	0.2			Black Grama-Burro Grass	X					
13	1993	6	0	0	0	0	Black Grama-Burro Grass			X	X		
13	1992	7	1	0.2			Black Grama-Burro Grass	X					
13	1993	7	1	2	4		Black Grama-Burro Grass	X					
13	1992	8	0.4	0.2			Black Grama-Burro Grass	X					
13	1993	8	0.8	0.3			Black Grama-Burro Grass	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
13	1992	9	0.8	0.2			Black Grama-Burro Grass	X					
13	1993	9	0	0	0	0	Black Grama-Burro Grass			X	X		
13	1992	10	0.9	0.3			Black Grama-Burro Grass	X					
13	1993	10	1	0.5			Black Grama-Burro Grass	X					
13	1992	11	1.5	0.3			Black Grama-Burro Grass	X					
13	1993	11	3	0.4			Black Grama-Burro Grass	X					
13	1992	12	1.5	0.3			Black Grama-Burro Grass	X					
13	1993	12	2.5	0.4			Black Grama-Burro Grass	X					
13	1992	13	0.8	0.2			Black Grama-Burro Grass	X					
13	1993	13	0	0	0	0	Black Grama-Burro Grass			X	X		
13	1992	14	6	3	7	3	Black Grama-Burro Grass	X					
13	1993	14	3	0.5			Black Grama-Burro Grass	X					
13	1992	15	Not identified in 1992				Black Grama-Burro Grass						
13	1993	15	3	0.5			Black Grama-Burro Grass	X					
13	1992	16	Not identified in 1992				Black Grama-Burro Grass						
13	1993	16	0.2	0.2			Black Grama-Burro Grass	X					
13	1992	17	Not identified in 1992				Black Grama-Burro Grass						
13	1993	17	0.2	0.2			Black Grama-Burro Grass	X					
14	1992	1	10	5	3	10	Sand Shrub Series	X					
14	1993	1	11	5	9		Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
15	1992	1	6	2		3	Sand Shrub Series	X					
15	1993	1	6	2.5	4		Sand Shrub Series	X					
15	1992	2	6	2		2	Sand Shrub Series	X					
15	1993	2	6	2.5	1	1	Sand Shrub Series	X					
15	1992	3	8	3	3	5	Sand Shrub Series	X					
15	1993	3	6	2	2		Sand Shrub Series	X					
15	1992	4	5.5	2.5		4	Sand Shrub Series	X					
15	1993	4	5.5	2.5	3		Sand Shrub Series	X					
15	1992	5	5.5	5		13	Sand Shrub Series	X					
15	1993	5	0	0	0	0	Sand Shrub Series			X			X
15	1992	6	3.2	2	1	1	Sand Shrub Series	X					
15	1993	6	0	0	0	0	Sand Shrub Series			X			X
15	1992	7	7	1.5			Sand Shrub Series	X					
15	1993	7	0	0	0	0	Sand Shrub Series		X				X
15	1992	8	4	2		2	Sand Shrub Series	X					
15	1993	8a	4	1.5	1		Sand Shrub Series	X					
15	1993	8b	4	1.5	2		Sand Shrub Series	X					
15	1992	9	10	5	3	5	Sand Shrub Series	X					
15	1993	9	11	3.5	1		Sand Shrub Series		X			X	
15	1992	10	Not identified in 1992				Sand Shrub Series						
15	1993	10	2	0.5			Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
15	1992	11	Not identified in 1992				Sand Shrub Series						
15	1993	11	3	1	1		Sand Shrub Series	X					
15	1992	12	Not identified in 1992				Sand Shrub Series						
15	1993	12	4.5	1	1		Sand Shrub Series	X					
15	1992	13	Not identified in 1992				Sand Shrub Series						
15	1993	13	3	0.5	0	0	Sand Shrub Series	X					
15	1992	14	Not identified in 1992				Sand Shrub Series						
15	1993	14	2	0.5			Sand Shrub Series	X					
15	1992	15	Not identified in 1992				Sand Shrub Series						
15	1993	15	2	0.5			Sand Shrub Series	X					
15	1992	16	Not identified in 1992				Sand Shrub Series						
15	1993	16	3	1	2		Sand Shrub Series	X					
15	1992	17	Not identified in 1992				Sand Shrub Series						
15	1993	17	6	2	4		Sand Shrub Series	X					
15	1992	18	Not identified in 1992				Sand Shrub Series						
15	1993	18	3	1.5	3		Sand Shrub Series	X					
15	1992	19	Not identified in 1992				Sand Shrub Series						
15	1993	19	4	1.5	1		Sand Shrub Series	X					
15	1992	20	Not identified in 1992				Sand Shrub Series						
15	1993	20	3	1.5	0	0	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
16	1992	1	6.5	3		5	Sand Shrub Series	X					
16	1993	1	4	2	0	0	Sand Shrub Series		X				X
16	1992	2	16	5	4	12	Sand Shrub Series	X					
16	1993	2	12	4	0	0	Sand Shrub Series		X				X
16	1992	3	6	2.5	3		Sand Shrub Series	X					
16	1993	3	0	0	0	0	Sand Shrub Series			X	X		
16	1992	4	1	0.3			Sand Shrub Series	X					
16	1993	4	0	0	0	0	Sand Shrub Series			X	X		
17	1992	1	7	3.5		5	Sand Shrub Series	X					
17	1993	1	0	0	0	0	Sand Shrub Series			X			X
17	1992	2	5.5	2.5		4	Sand Shrub Series	X					
17	1993	2	5.5	3		4	Sand Shrub Series	X					
18	1992	1	3.5	1.75		2	Sand Shrub Series	X					
18	1993	1	4	2.5	3		Sand Shrub Series	X					
18	1992	2	3	1.5		2	Sand Shrub Series	X					
18	1993	2	4	2.5	4		Sand Shrub Series	X					
19	1992	1	8	3.5		9	Sand Shrub Series	X					
19	1993	1	3	3.5	10		Sand Shrub Series		X			X	

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
19	1992	2	Not identified in 1992				Sand Shrub Series						
19	1993	2	5	1.5	2		Sand Shrub Series	X					
20	1992	1	3	1		2	Black Grama-Burro Grass	X					
20	1993	1	3	2.5	2	2	Black Grama-Burro Grass	X					
20	1992	2	6	4	3	11	Black Grama-Burro Grass	X					
20	1993	2	7	5	14	6	Black Grama-Burro Grass	X					
20	1992	3	2	0.5			Black Grama-Burro Grass	X					
20	1993	3	0	0	0	0	Black Grama-Burro Grass			X			
20	1992	4	5	3		6	Black Grama-Burro Grass	X					
20	1993	4	5	4	5	5	Black Grama-Burro Grass	X					
20	1992	5	4.5	2.5		4	Black Grama-Burro Grass	X					
20	1993	5	4.5	3	4	3	Black Grama-Burro Grass	X					
20	1992	6	2	0.6			Black Grama-Burro Grass	X					
20	1993	6	3	1	1		Black Grama-Burro Grass	X					
20	1992	7	4	2.5	2	2	Black Grama-Burro Grass	X					
20	1993	7	3.5	1.5			Black Grama-Burro Grass		X			X	
20	1992	8	Not identified in 1992				Black Grama-Burro Grass						
20	1993	8	0.5	0.3			Black Grama-Burro Grass	X					
20	1992	9	Not identified in 1992				Black Grama-Burro Grass						
20	1993	9	0.5	0.4			Black Grama-Burro Grass	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
20	1992	10	Not identified in 1992				Black Grama-Burro Grass						
20	1993	10	0.5	0.3			Black Grama-Burro Grass	X					
20	1992	11	Not identified in 1992				Black Grama-Burro Grass						
20	1993	11	0.5	0.3			Black Grama-Burro Grass	X					
20	1992	12	Not identified in 1992				Black Grama-Burro Grass						
20	1993	12	0.5	0.3			Black Grama-Burro Grass	X					
20	1992	13	Not identified in 1992				Black Grama-Burro Grass						
20	1993	13	2.5	0.5			Black Grama-Burro Grass	X					
21	1992	1	10	4	3	6	Black Grama-Dropseed	X					
21	1993	1	12	4	5	1	Black Grama-Dropseed	X					
21	1992	2	1	0.2			Black Grama-Dropseed	X					
21	1993	2					Black Grama-Dropseed				X		
21	1992	3	4.5	2.5	1	4	Black Grama-Dropseed	X					
21	1993	3	62	3.5	2	2	Black Grama-Dropseed	X					
22	1992	1	4.5	2		3	Sand Shrub Series	X					
22	1993	1	4	2.5	0	0	Sand Shrub Series		X			X	
22	1992	2	8	1.5		1	Sand Shrub Series	X					
22	1993	2	8	2.5	3	1	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
22	1992	3	7	3.5	3	5	Sand Shrub Series	X					
22	1993	3	8	3.5	6		Sand Shrub Series	X					
22	1992	4	7	4	3		Sand Shrub Series	X					
22	1993	4	0	0	0	0	Sand Shrub Series			X			X
22	1992	5	4	1			Sand Shrub Series	X					
22	1993	5	5	2	2		Sand Shrub Series	X					
22	1992	6	5.5	1.75	2		Sand Shrub Series	X					
22	1993	6	6	1.75	2		Sand Shrub Series	X					
22	1992	7	5.5	1.75	1	2	Sand Shrub Series	X					
22	1993	7	5.5	2	5		Sand Shrub Series	X					
22	1992	8	5	3	1	3	Sand Shrub Series	X					
22	1993	8	5.5	3.5	5		Sand Shrub Series	X					
22	1992	9	10	4	7	8	Sand Shrub Series	X					
22	1993	9	10	3.5	8		Sand Shrub Series	X					
22	1992	10	9	3.5	3	8	Sand Shrub Series	X					
22	1993	10			0	0	Sand Shrub Series		X				X
22	1992	11	6	2	2	1	Sand Shrub Series	X					
22	1993	11	5	0.75			Sand Shrub Series	X					
22	1992	12	Not identified in 1992				Sand Shrub Series						
22	1993	12	3	1.5	2		Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
23	1992	1	4	1.5		1	Sand Shrub Series	X					
23	1993	1	4	2	3		Sand Shrub Series	X					
24	1992	1	5.5	3	2	3	Sand Shrub Series	X					
24	1993	1	5	3	2	2	Sand Shrub Series	X					
24	1992	2	4	1.5	1	1	Sand Shrub Series	X					
24	1993	2	5	4	3	1	Sand Shrub Series	X					
24	1992	3	4	1.5	1	1	Sand Shrub Series	X					
24	1993	3	4	2	2	2	Sand Shrub Series	X					
24	1992	4	5.5	4	3	4	Sand Shrub Series	X					
24	1993	4	6	4	7		Sand Shrub Series	X					
25	1992	1	3	3	8		Black Grama-Dropseed	X					
25	1993	1					Black Grama-Dropseed				X	X	
25	1992	2	Not identified in 1992				Black Grama-Dropseed						
25	1993	2	5	3.5	3		Black Grama-Dropseed	X					
25	1992	3	Not identified in 1992				Black Grama-Dropseed						
25	1993	3	7.5	3	1		Black Grama-Dropseed	X					
25	1992	4	Not identified in 1992				Black Grama-Dropseed						
25	1993	4	5	2	1		Black Grama-Dropseed	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
26	1992	1	8	4.5	1	9	Black Grama-Burro Grass	X					
26	1993	1	6.5	5	10		Black Grama-Burro Grass	X					
26	1992	2	Not identified in 1992				Black Grama-Burro Grass						
26	1993	2	3	0.5			Black Grama-Burro Grass	X					
26	1992	3	Not identified in 1992				Black Grama-Burro Grass						
26	1993	3	1.5	0.3			Black Grama-Burro Grass	X					
27	1992	1	5	2.75		6	Sand Shrub Series	X					
27	1993	1	0	0	0	0	Sand Shrub Series		X				X
27	1992	2	6	2.5		4	Sand Shrub Series	X					
27	1993	2	5	2.5		3	Sand Shrub Series	X					
27	1992	3	4.5	2		3	Sand Shrub Series	X					
27	1993	3	5	2.5	3	3	Sand Shrub Series	X					
27	1992	4	8	4		12	Sand Shrub Series	X					
27	1993	4	5	4			Sand Shrub Series		X			X	
27	1992	5	4	1.5		2	Sand Shrub Series	X					
27	1993	5	3	2	2		Sand Shrub Series		X			X	
27	1992	6	2	1.5			Sand Shrub Series	X					
27	1993	6	1.5	1.5			Sand Shrub Series		X			X	
27	1992	7	1.75	0.8			Sand Shrub Series	X					
27	1993	7	1	0.5			Sand Shrub Series		X			X	

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
27	1992	8	2	0.4			Sand Shrub Series	X					
27	1993	8	0	0	0	0	Sand Shrub Series			X	X		
27	1992	9	5	2		1	Sand Shrub Series	X					
27	1993	9	0	0	0	0	Sand Shrub Series			X	X		
27	1992	10	9	4		6	Sand Shrub Series	X					
27	1993	10	9	5		4	Sand Shrub Series		X			X	
27	1992	11	6	3	5	3	Sand Shrub Series	X					
27	1993	11	7	3.5	6	3	Sand Shrub Series	X					
27	1992	12	6	3		3	Sand Shrub Series	X					
27	1993	12	6	3	1	5	Sand Shrub Series	X					
27	1992	13	3	2	2	2	Sand Shrub Series	X					
27	1993	13	3.5	1.5		3	Sand Shrub Series	X					
27	1992	14	4	1.5	3		Sand Shrub Series	X					
27	1993	14	0	0	0	0	Sand Shrub Series			X	X		
28	1992	1	5	4		7	Sand Shrub Series	X					
28	1993	1	4	4	3		Sand Shrub Series	X					
28	1992	2	4	3	5	3	Sand Shrub Series	X					
28	1993	2	0	0	0	0	Sand Shrub Series			X		X	
28	1992	3	3	1.5		3	Sand Shrub Series	X					
28	1993	3	0	0	0	0	Sand Shrub Series			X	X		

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
28	1992	4	Not identified in 1992				Sand Shrub Series						
28	1993	4	4	2.5	4		Sand Shrub Series	X					
28	1992	5	Not identified in 1992				Sand Shrub Series						
28	1993	5	2	1.5	1		Sand Shrub Series		X			X	
28	1992	6	Not identified in 1992				Sand Shrub Series						
28	1993	6	5	2.5	2	3	Sand Shrub Series	X					
28	1992	7	Not identified in 1992				Sand Shrub Series						
28	1993	7	3	1.5	1	1	Sand Shrub Series	X					
28	1992	8	Not identified in 1992				Sand Shrub Series						
28	1993	8	3	1.5		4	Sand Shrub Series	X					
29	1992	1	5	2.5		3	Sand Shrub Series	X					
29	1993	1	5	3		6	Sand Shrub Series	X					
29	1992	2	4	2.5	1	2	Sand Shrub Series	X					
29	1993	2	4	2.5	3		Sand Shrub Series	X					
29	1992	3	2	0.4			Sand Shrub Series	X					
29	1993	3	2	1.5		2	Sand Shrub Series	X					
29	1992	4	Not identified in 1992				Sand Shrub Series						
29	1993	4	3	2	3		Sand Shrub Series	X					
29	1992	5	Not identified in 1992				Sand Shrub Series						
29	1993	5	4	2.5	2	4	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
29	1992	6	Not identified in 1992				Sand Shrub Series						
29	1993	6	2.5	2.5	1		Sand Shrub Series		X			X	
30	1992	1	7	2.5		5	Sand Shrub Series	X					
30	1993	1	7	3	3	2	Sand Shrub Series	X					
30	1992	2	5.5	2.5	1	2	Sand Shrub Series	X					
30	1993	2	7	3	2	2	Sand Shrub Series	X					
30	1992	3	9	4	3	7	Sand Shrub Series	X					
30	1993	3	0	0	0	0	Sand Shrub Series			X			X
30	1992	4	6.5	2.5	3	3	Sand Shrub Series	X					
30	1993	4	0	0	0	0	Sand Shrub Series			X			X
30	1992	5	1	0.3			Sand Shrub Series	X					
30	1993	5	0	0	0	0	Sand Shrub Series			X		X	
30	1992	6	3	1.75		2	Sand Shrub Series	X					
30	1993	6	3	1.5	0	0	Sand Shrub Series		X			X	
30	1992	7	7	1.5		2	Sand Shrub Series	X					
30	1993	7	6	2	3		Sand Shrub Series		X			X	
30	1992	8	7	1.5			Sand Shrub Series	X					
30	1993	8	3	2	0	0	Sand Shrub Series		X			X	
30	1992	9	8	2.5	1	3	Sand Shrub Series	X					
30	1993	9	0	0	0	0	Sand Shrub Series			X		X	

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
30	1992	10	11	3	4	3	Sand Shrub Series	X					
30	1993	10	3	1.5			Sand Shrub Series		X			X	
30	1992	11	1.5	0.5			Sand Shrub Series	X					
30	1993	11	2	0.7			Sand Shrub Series	X					
30	1992	12	4	2.5	2	4	Sand Shrub Series	X					
30	1993	12	3	2.5	0	0	Sand Shrub Series		X			X	
30	1992	13	5	3	3	6	Sand Shrub Series	X					
30	1993	13	0	0	0	0	Sand Shrub Series			X			X
30	1992	14	Not identified in 1992				Sand Shrub Series						
30	1993	14	4	1.5		1	Sand Shrub Series	X					
30	1992	15	Not identified in 1992				Sand Shrub Series						
30	1993	15	3	1			Sand Shrub Series	X					
30	1992	16	Not identified in 1992				Sand Shrub Series						
30	1993	16	2	1			Sand Shrub Series	X					
31	1992	1	3	1		1	Sand Shrub Series	X					
31	1993	1	2	0.7			Sand Shrub Series		X			X	
31	1992	2	3.5	1.25		1	Sand Shrub Series	X					
31	1993	2	2	0.7			Sand Shrub Series		X			X	
31	1992	3	6	2.5		5	Sand Shrub Series	X					
31	1993	3	6	2.5	2	5	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
31	1992	4	7	3	3	5	Sand Shrub Series	X					
31	1993	4	7.5	3	5	5	Sand Shrub Series	X					
31	1992	5	4	0.5		1	Sand Shrub Series	X					
31	1993	5	4	1.5	1	1	Sand Shrub Series	X					
31	1992	6	3.5	0.75			Sand Shrub Series	X					
31	1993	6	0	0	0	0	Sand Shrub Series			X	X	X	
31	1992	7	3	0.75			Sand Shrub Series	X					
31	1993	7	3.5	1.5		1	Sand Shrub Series	X					
31	1992	8	Not identified in 1992				Sand Shrub Series						
31	1993	8	4	2.5	3	2	Sand Shrub Series	X					
31	1992	9	Not identified in 1992				Sand Shrub Series						
31	1993	9	5.5	1.5	2		Sand Shrub Series	X					
31	1992	10	Not identified in 1992				Sand Shrub Series						
31	1993	10	3.5	2	4	1	Sand Shrub Series	X					
32	1992	1	6	2		3	Sand Shrub Series	X					
32	1993	1	5.5	3		2	Sand Shrub Series	X					
32	1992	2	8	3.5	2	4	Sand Shrub Series	X					
32	1993	2	0	0	0	0	Sand Shrub Series			X			X
32	1992	3	2.5	0.75			Sand Shrub Series	X					
32	1993	3	2	1.5	1	1	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
32	1992	4	3	1.75		2	Sand Shrub Series	X					
32	1993	4	2	0.5			Sand Shrub Series		X			X	
32	1992	5	4	0.5			Sand Shrub Series	X					
32	1993	5	2.5	0.5			Sand Shrub Series	X					
32	1992	6	6	1.5		2	Sand Shrub Series	X					
32	1993	6	4	2		2	Sand Shrub Series		X			X	
32	1992	7	3	0.75			Sand Shrub Series	X					
32	1993	7	0	0	0	0	Sand Shrub Series			X	X	X	
32	1992	8	8	3.5		6	Sand Shrub Series	X					
32	1993	8	10	3.5	2	6	Sand Shrub Series	X					
32	1992	9	Not identified in 1992				Sand Shrub Series						
32	1993	9	6	3.5		4	Sand Shrub Series	X					
33	1992	1	3	2.5			Sand Shrub Series	X					
33	1993	1	0	0	0	0	Sand Shrub Series			X		X	
33	1992	2	6	3		6	Sand Shrub Series	X					
33	1993	2	0	3			Sand Shrub Series		X			X	
33	1992	3	6	3.5	2	6	Sand Shrub Series	X					
33	1993	3	2	3.5			Sand Shrub Series		X			X	

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
34	1992	1	15	11	7	16	Black Grama-Dropseed	X					
34	1993	1	0	0	0	0	Black Grama-Dropseed			X			X
34	1992	2	10	3.5		6	Black Grama-Dropseed	X					
34	1993	2	10.5	3.5	8	3	Black Grama-Dropseed	X					
34	1992	3	5	0.75			Black Grama-Dropseed	X					
34	1993	3	5	1.5			Black Grama-Dropseed	X					
34	1992	4	7	8	7	14	Black Grama-Dropseed	X					
34	1993	4	0	0	0	0	Black Grama-Dropseed		X			X	
34	1992	5	Not identified in 1992				Black Grama-Dropseed						
34	1993	5	6	2.5	3	2	Black Grama-Dropseed	X					
35	1992	1	4	3	1	5	Black Grama-Burro Grass	X					
35	1993	1	4	3	3		Black Grama-Burro Grass	X					
35	1992	2	3	1.75		3	Black Grama-Burro Grass	X					
35	1993	2	0	0	0	0	Black Grama-Burro Grass			X			X
35	1992	3	10	3.5	6	6	Black Grama-Burro Grass	X					
35	1993	3	9	4.5	10		Black Grama-Burro Grass	X					
35	1992	4	Not identified in 1992				Black Grama-Burro Grass						
35	1993	4	4	2	3		Black Grama-Burro Grass	X					
35	1992	5	Not identified in 1992				Black Grama-Burro Grass						
35	1993	5	2	1	2		Black Grama-Burro Grass	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
35	1992	6	Not identified in 1992				Black Grama-Burro Grass						
35	1993	6	12	5	5	5	Black Grama-Burro Grass	X					
35	1992	7	Not identified in 1992				Black Grama-Burro Grass						
35	1993	7	5	1.5	2		Black Grama-Burro Grass	X					
35	1992	8	Not identified in 1992				Black Grama-Burro Grass						
35	1993	8	5	2.5	2		Black Grama-Burro Grass	X					
35	1992	9	Not identified in 1992				Black Grama-Burro Grass						
35	1993	9	2	2	3		Black Grama-Burro Grass	X					
35	1992	10	Not identified in 1992				Black Grama-Burro Grass						
35	1993	10	6	3.5	9		Black Grama-Burro Grass	X					
35	1992	11	Not identified in 1992				Black Grama-Burro Grass						
35	1993	11	5	3.5	2	6	Black Grama-Burro Grass	X					
35	1992	12	Not identified in 1992				Black Grama-Burro Grass						
35	1993	12	4	2.5	4		Black Grama-Burro Grass	X					
35	1992	13	Not identified in 1992				Black Grama-Burro Grass						
35	1993	13	12	5	5	5	Black Grama-Burro Grass	X					
36	1992	1	5	2.25	1	3	Sand Shrub Series	X					
36	1993	1	7	2.5		5	Sand Shrub Series	X					
36	1992	2	5	1.5		2	Sand Shrub Series	X					
36	1993	2	5.5	2.5		3	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
36	1992	3	5	2.25	2	2	Sand Shrub Series	X					
36	1993	3	5.5	2.5		3	Sand Shrub Series	X					
36	1992	4	3.5	3			Sand Shrub Series	X					
36	1993	4	0	0	0	0	Sand Shrub Series			X	X		
36	1992	5	13	5	3	10	Sand Shrub Series	X					
36	1993	5	0.5	2			Sand Shrub Series		X			X	
36	1992	6	7	3.5		7	Sand Shrub Series	X					
36	1993	6	8	2.5		6	Sand Shrub Series	X					
36	1992	7	5.5	2.5	1	4	Sand Shrub Series	X					
36	1993	7	5.5	2.5		3	Sand Shrub Series	X					
36	1992	8	5	2.5	1	2	Sand Shrub Series	X					
36	1993	8	8	4	5	3	Sand Shrub Series	X					
36	1992	9	8	4	2	6	Sand Shrub Series	X					
36	1993	9	0	0	0	0	Sand Shrub Series			X			X
36	1992	10	Not identified in 1992				Sand Shrub Series						
36	1993	10	6	3	3	2	Sand Shrub Series	X					
36	1992	11	Not identified in 1992				Sand Shrub Series						
36	1993	11	3	1		1	Sand Shrub Series	X					
36	1992	12	Not identified in 1992				Sand Shrub Series						
36	1993	12	3.5	0.7			Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
36	1992	13	Not identified in 1992				Sand Shrub Series						
36	1993	13	3	0.7			Sand Shrub Series	X					
36	1992	14	Not identified in 1992				Sand Shrub Series						
36	1993	14	3.5	3	3	1	Sand Shrub Series	X					
36	1992	15	Not identified in 1992				Sand Shrub Series						
36	1993	15	4	2	2		Sand Shrub Series	X					
37	1992	1	5	3	1	6	Sand Shrub Series	X					
37	1993	1	5	2.5		4	Sand Shrub Series	X					
37	1992	2	4	1.5	1	1	Sand Shrub Series	X					
37	1993	2	2	1			Sand Shrub Series		X			X	
37	1992	3	9	2.5	5		Sand Shrub Series	X					
37	1993	3	0	0	0	0	Sand Shrub Series			X			X
37	1992	4	Not identified in 1992				Sand Shrub Series						
37	1993	4	5	3		4	Sand Shrub Series	X					
38	1992	1	6	6		13	Black Grama-Burro Grass	X					
38	1993	1	7	6	10		Black Grama-Burro Grass	X					
38	1992	2	5	2	1	1	Black Grama-Burro Grass	X					
38	1993	2	5	3	4		Black Grama-Burro Grass	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
39	1992	1	7	4.5		8	Black Grama-Burro Grass	X					
39	1993	1	8	4.5	6	1	Black Grama-Burro Grass	X					
39	1992	2	Not identified in 1992				Black Grama-Burro Grass						
39	1993	2	3	1.5	3		Black Grama-Burro Grass	X					
40	1992	1	13	6	3	15	Black Grama-Galletta	X					
40	1993	1	14	6	14		Black Grama-Galletta	X					
40	1992	2	7	2			Black Grama-Galletta	X					
40	1993	2	7	2.5	2	1	Black Grama-Galletta	X					
40	1992	3	7	2.5			Black Grama-Galletta	X					
40	1993	3	7	2.5	5		Black Grama-Galletta	X					
40	1992	4	11	4		6	Black Grama-Galletta	X					
40	1993	4	12	3.5	4		Black Grama-Galletta	X					
40	1992	5	8	3.5		5	Black Grama-Galletta	X					
40	1993	5	8	3.5	5	5	Black Grama-Galletta		X			X	
41	1992	1	5	2.5		4	Black Grama-Galletta	X					
41	1993	1	5.5	3	3	4	Black Grama-Galletta	X					
41	1992	2	1	0.2			Black Grama-Galletta	X					
41	1993	2	0	0	0	0	Black Grama-Galletta			X	X		

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
41	1992	3	1.5	0.3			Black Grama-Galletta	X					
41	1993	3	0	0	0	0	Black Grama-Galletta			X	X		
41	1992	4	7	4.5	7	14	Black Grama-Galletta	X					
41	1993	4	0	0	0	0	Black Grama-Galletta			X	X		
41	1992	5	6	2.5	3	2	Black Grama-Galletta	X					
41	1993	5	0	0	0	0	Black Grama-Galletta			X	X		
41	1992	6	5.5	0.75			Black Grama-Galletta	X					
41	1993	6	5.5	2	1	1	Black Grama-Galletta	X					
41	1992	7	2	0.3			Black Grama-Galletta	X					
41	1993	7	2.5	1	1		Black Grama-Galletta	X					
42	1992	1	5	2.75		5	Black Grama-Burro Grass						
42	1993	1	0	0	0	0	Black Grama-Burro Grass				X		
42	1992	2	4	3.5		8	Black Grama-Burro Grass	X					
42	1993	2	0	0	0	0	Black Grama-Burro Grass				X		
42	1992	3	3	1.5			Black Grama-Burro Grass	X					
42	1993	3	0	0	0	0	Black Grama-Burro Grass				X		
43	1992	1	4	4		6	Black Grama-Burro Grass	X					
43	1993	1	5	4	3	4	Black Grama-Burro Grass	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
43	1992	2	2	0.3			Black Grama-Burro Grass	X					
43	1993	2	2	0.5			Black Grama-Burro Grass	X					
43	1992	3	2	0.3			Black Grama-Burro Grass	X					
43	1993	3	1	0.5			Black Grama-Burro Grass		X			X	
43	1992	4	1.5	0.3			Black Grama-Burro Grass	X					
43	1993	4	2	0.5			Black Grama-Burro Grass	X					
43	1992	5	5	1.5		3	Black Grama-Burro Grass	X					
43	1993	5	4.5	2.5	3		Black Grama-Burro Grass		X			X	
43	1992	6	3	1.5			Black Grama-Burro Grass	X					
43	1993	6	3	1.5	1		Black Grama-Burro Grass		X			X	
43	1992	7	3.5	1			Black Grama-Burro Grass	X					
43	1993	7	1.5	1.5	1		Black Grama-Burro Grass		X			X	
44	1992	1	8	4		7	Sand Shrub Series	X					
44	1993	1	4	4			Sand Shrub Series		X			X	
44	1992	2	4	1			Sand Shrub Series	X					
44	1993	2	4	1.5	1		Sand Shrub Series	X					
44	1992	3	4	1.5		2	Sand Shrub Series	X					
44	1993	3	0	0	0	0	Sand Shrub Series			X	X	X	
44	1992	4	4	1			Sand Shrub Series	X					
44	1993	4	0	0	0	0	Sand Shrub Series			X	X	X	

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
45	1992	1	7	4		7	Black Grama-Galletta	X					
45	1993	1	6	4.5	5	0	Black Grama-Galletta	X					
46	1992	1	8	3			Sand Shrub Series	X					
46	1993	1	0	0	0	0	Sand Shrub Series			X			X
46	1992	2	7	2.5			Sand Shrub Series	X					
46	1993	2	5	3	3	2	Sand Shrub Series	X					
46	1992	3	7	1.5			Sand Shrub Series	X					
46	1993	3	3.5	1.5	3		Sand Shrub Series	X					
47	1992	1	Not identified in 1992				Dropseed-Black Grama						
47	1993	1a	5	3	3	0	Dropseed-Black Grama	X					
47	1993	1b	5	3	4	0	Dropseed-Black Grama	X					
47	1993	1c	4	3	1		Dropseed-Black Grama	X					
47	1992	2	Not identified in 1992				Dropseed-Black Grama						
47	1993	2	3	2		3	Dropseed-Black Grama	X					
48	1992	1	Not identified in 1992				Black Grama-Dropseed						
48	1993	1	7	4	1	4	Black Grama-Dropseed	X					
48	1992	2	Not identified in 1992				Black Grama-Dropseed						
48	1993	2	4	3		3	Black Grama-Dropseed	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
48	1992	3	Not identified in 1992				Black Grama-Dropseed						
48	1993	3	3	1	0	0	Black Grama-Dropseed		X				
48	1993	4	Not identified in 1992				Black Grama-Dropseed						
48	1993	4	3	1.5		1	Black Grama-Dropseed	X					
48	1992	5	Not identified in 1992				Black Grama-Dropseed						
48	1992	5	7.5	3	0	0	Black Grama-Dropseed		X				X
49	1992	1	Not identified in 1992				Black Grama-Dropseed						
49	1993	1	8.5	3.5	2	4	Black Grama-Dropseed	X					
49	1992	2	Not identified in 1992				Black Grama-Dropseed						
49	1993	2	4.5	2	3		Black Grama-Dropseed	X					
49	1992	3	Not identified in 1992				Black Grama-Dropseed						
49	1993	3	6	2.5	2		Black Grama-Dropseed	X					
49	1992	4	Not identified in 1992				Black Grama-Dropseed						
49	1993	4	3	1.5			Black Grama-Dropseed	X					
49	1992	5	Not identified in 1992				Black Grama-Dropseed						
49	1993	5	4	3.5	3	4	Black Grama-Dropseed	X					
50	1992	1	Not identified in 1992				Black Grama-Dropseed						
50	1993	1	11.5	4.5	9		Black Grama-Dropseed	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
50	1992	2	Not identified in 1992				Black Grama-Dropseed						
50	1993	2a	4.5	2.5	2		Black Grama-Dropseed		X				X
50	1993	2b	7	2.5	3		Black Grama-Dropseed		X				X
50	1993	2c	3	2	0		Black Grama-Dropseed		X				X
51	1992	1	Not identified in 1992				Black Grama-Dropseed						
51	1993	1a	4	4		1	Black Grama-Dropseed	X					
51	1993	1b	4	4	2		Black Grama-Dropseed	X					
52	1992	1	Not identified in 1992				Sand Shrub Series						
52	1993	1	6	1.5	1		Sand Shrub Series	X					
52	1992	2	Not identified in 1992				Sand Shrub Series						
52	1993	2	3.5	2.5	1	2	Sand Shrub Series	X					
52	1992	3	Not identified in 1992				Sand Shrub Series						
52	1993	3	6.5	4	3	5a	Sand Shrub Series	X					
52	1992	4	Not identified in 1992				Sand Shrub Series						
52	1993	4	6	1.5	0	2	Sand Shrub Series	X					
52	1993	5	Not identified in 1992				Sand Shrub Series						
52	1993	5	5.5	1.5	2	1	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
52	1992	6	Not identified in 1992				Sand Shrub Series						
52	1993	6a	8	2	2		Sand Shrub Series	X					
52	1993	6b	8	2.5	2		Sand Shrub Series	X					
52	1992	7	Not identified in 1992				Sand Shrub Series						
52	1993	7	9	4	2	1	Sand Shrub Series	X					
52	1992	8	Not identified in 1992				Sand Shrub Series						
52	1993	8	5.5	3	3		Sand Shrub Series	X					
52	1992	9	Not identified in 1992				Sand Shrub Series						
52	1993	9	3.5	2	1		Sand Shrub Series	X					
52	1992	10	Not identified in 1992				Sand Shrub Series						
52	1993	10	4	3	2		Sand Shrub Series	X					
52	1992	11	Not identified in 1992				Sand Shrub Series						
52	1993	11	3.5	1.5		2	Sand Shrub Series	X					
52	1992	12	Not identified in 1992				Sand Shrub Series						
52	1993	12	4	0.5	0	0	Sand Shrub Series	X					
52	1992	13	Not identified in 1992				Sand Shrub Series						
52	1993	13	5	1.5	2	2	Sand Shrub Series	X					
52	1992	14	Not identified in 1992				Sand Shrub Series						
52	1993	14	5	2	1	2	Sand Shrub Series	X					
52	1992	15	Not identified in 1992				Sand Shrub Series						
52	1993	15	4	2.5		2	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
52	1992	16	Not identified in 1992				Sand Shrub Series						
52	1993	16	7	2	2	1	Sand Shrub Series	X					
52	1992	17	Not identified in 1992				Sand Shrub Series						
52	1993	17	9	3	9		Sand Shrub Series	X					
52	1992	18	Not identified in 1992				Sand Shrub Series						
52	1993	18	7	2.5	1	1	Sand Shrub Series	X					
52	1992	19	Not identified in 1992				Sand Shrub Series						
52	1993	19	3	1	3		Sand Shrub Series	X					
53	1992	1	Not identified in 1992				Sand Shrub Series						
53	1993	1	4	2		3	Sand Shrub Series	X					
53	1992	2	Not identified in 1992				Sand Shrub Series						
53	1993	2	5	1.75	2		Sand Shrub Series	X					
53	1992	3	Not identified in 1992				Sand Shrub Series						
53	1993	3	4	2	2	2	Sand Shrub Series	X					
53	1992	4	Not identified in 1992				Sand Shrub Series						
53	1993	4	4	1.5			Sand Shrub Series	X					
53	1992	5	Not identified in 1992				Sand Shrub Series						
53	1993	5	4	2	1	2	Sand Shrub Series	X					
53	1992	6	Not identified in 1992				Sand Shrub Series						
53	1993	6	2	0.5	1		Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
53	1992	7	Not identified in 1992				Sand Shrub Series						
53	1993	7	3	1.5	1		Sand Shrub Series	X					
53	1992	8	Not identified in 1992				Sand Shrub Series						
53	1993	8a	13	2.5	1		Sand Shrub Series	X					
53	1993	8b	13	2.5	4		Sand Shrub Series	X					
54	1992	1	Not identified in 1992				Sand Shrub Series						
54	1993	1	8	3.5	4		Sand Shrub Series	X					
55	1992	1	Not identified in 1992				Sand Shrub Series						
55	1993	1	3	1	1		Sand Shrub Series	X					
55	1992	2	Not identified in 1992				Sand Shrub Series						
55	1993	2	4	3	3	2a	Sand Shrub Series	X					
56	1992	1	Not identified in 1992				Sand Shrub Series						
56	1993	1	6	2.5	1	3a	Sand Shrub Series	X					
56	1992	2	Not identified in 1992				Sand Shrub Series						
56	1993	2	5	2	2	1a	Sand Shrub Series	X					
56	1992	3	Not identified in 1992				Sand Shrub Series						
56	1993	3	5.5	3	4	0	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
56	1992	4	Not identified in 1992				Sand Shrub Series						
56	1993	4	7.5	1.5	2	1	Sand Shrub Series	X					
56	1992	5	Not identified in 1992				Sand Shrub Series						
56	1993	5	5	1.5	2		Sand Shrub Series	X					
56	1992	6	Not identified in 1992				Sand Shrub Series						
56	1993	6	3	1			Sand Shrub Series	X					
56	1992	7	Not identified in 1992				Sand Shrub Series						
56	1993	7	5	3	4		Sand Shrub Series	X					
56	1992	8	Not identified in 1992				Sand Shrub Series						
56	1993	8	3	1.5	1	1	Sand Shrub Series	X					
56	1992	9	Not identified in 1992				Sand Shrub Series						
56	1993	9	4.5	2.5	1	2	Sand Shrub Series	X					
56	1992	10	Not identified in 1992				Sand Shrub Series						
56	1993	10	5	2		2	Sand Shrub Series	X					
56	1992	11	Not identified in 1992				Sand Shrub Series						
56	1993	11	7	1.5	2		Sand Shrub Series	X					
56	1992	12	Not identified in 1992				Sand Shrub Series						
56	1993	12	5	1.5	2		Sand Shrub Series	X					
56	1992	13	Not identified in 1992				Sand Shrub Series						
56	1993	13a	5	2		2	Sand Shrub Series	X					
56	1993	13b	5	2		2	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
56	1992	14	Not identified in 1992				Sand Shrub Series						
56	1993	14	8	2.5	4		Sand Shrub Series	X					
56	1992	15	Not identified in 1992				Sand Shrub Series						
56	1993	15	3	1.5		3	Sand Shrub Series	X					
57	1992	1	Not identified in 1992				Black Grama-Burro Grass						
57	1993	1	8	4	4	3	Black Grama-Burro Grass	X					
57	1992	2	Not identified in 1992				Black Grama-Burro Grass						
57	1993	2	7.5	5	5	3	Black Grama-Burro Grass	X					
57	1992	3	Not identified in 1992				Black Grama-Burro Grass						
57	1993	3	9	5	4	3	Black Grama-Burro Grass	X					
58	1992	1	Not identified in 1992				Black Grama-Burro Grass						
58	1993	1	11	7.5	4	8	Black Grama-Burro Grass	X					
58	1992	2	Not identified in 1992				Black Grama-Burro Grass						
58	1993	2	5	1	1		Black Grama-Burro Grass	X					
58	1992	3	Not identified in 1992				Black Grama-Burro Grass						
58	1993	3	7	5	4	8	Black Grama-Burro Grass	X					
59	1992	1	Not identified in 1992				Sand Shrub Series						
59	1993	1	12	3	2	5	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
60	1992	1	Not identified in 1992				Black Grama-Burro Grass						
60	1993	1	8	2	2	2	Black Grama-Burro Grass	X					
60	1992	2	Not identified in 1992				Black Grama-Burro Grass						
60	1993	2	3	1.5	1		Black Grama-Burro Grass	X					
60	1992	3	Not identified in 1992				Black Grama-Burro Grass						
60	1993	3	3	2	1	2	Black Grama-Burro Grass	X					
60	1992	4	Not identified in 1992				Black Grama-Burro Grass						
60	1993	4	6	3	3	4	Black Grama-Burro Grass	X					
60	1992	5	Not identified in 1992				Black Grama-Burro Grass						
60	1993	5	4	3	1	5	Black Grama-Burro Grass	X					
60	1992	6	Not identified in 1992				Black Grama-Burro Grass						
60	1993	6	6	4	5	9	Black Grama-Burro Grass	X					
60	1992	7	Not identified in 1992				Black Grama-Burro Grass						
60	1993	7	7	3.5	3	8	Black Grama-Burro Grass	X					
60	1992	8	Not identified in 1992				Black Grama-Burro Grass						
60	1993	8	3	2	2	3	Black Grama-Burro Grass	X					
60	1992	9	Not identified in 1992				Black Grama-Burro Grass						
60	1993	9	6	3	1	4	Black Grama-Burro Grass	X					
60	1992	10	Not identified in 1992				Black Grama-Burro Grass						
60	1993	10	3	2	2		Black Grama-Burro Grass	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
60	1992	11	Not identified in 1992				Black Grama-Burro Grass						
60	1993	11	6	4	2	3	Black Grama-Burro Grass	X					
61	1992	1	Not identified in 1992				Sand Shrub Series						
61	1993	1	3	3		3	Sand Shrub Series	X					
61	1992	2	Not identified in 1992				Sand Shrub Series						
61	1993	2	3.5	1.5	1		Sand Shrub Series		X			X	
61	1992	3	Not identified in 1992				Sand Shrub Series						
61	1993	3	2.5	1.5			Sand Shrub Series		X			X	
61	1992	4	Not identified in 1992				Sand Shrub Series						
61	1993	4	7	2.5	2	2	Sand Shrub Series	X					
61	1992	5	Not identified in 1992				Sand Shrub Series						
61	1993	5	3	1.5		2	Sand Shrub Series	X					
61	1992	6	Not identified in 1992				Sand Shrub Series						
61	1993	6	5	2.5		4	Sand Shrub Series	X					
61	1992	7	Not identified in 1992				Sand Shrub Series						
61	1993	7	2	0.5			Sand Shrub Series	X					
61	1992	8	Not identified in 1992				Sand Shrub Series						
61	1993	8	3	1.5		1	Sand Shrub Series	X					
61	1992	9	Not identified in 1992				Sand Shrub Series						
61	1993	9	5	1.5		2	Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Continued)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
61	1992	10	Not identified in 1992				Sand Shrub Series						
61	1992	10	3	2			Sand Shrub Series	X					
61	1992	11	Not identified in 1992				Sand Shrub Series						
61	1993	11	2	2	4	1	Sand Shrub Series	X					
61	1992	12	Not identified in 1992				Sand Shrub Series						
61	1993	12	3	2	1		Sand Shrub Series	X					
61	1992	13	Not identified in 1992				Sand Shrub Series						
61	1993	13	3	2.5	3		Sand Shrub Series	X					
61	1992	14	Not identified in 1992				Sand Shrub Series						
61	1993	14	5	2.5	2	2	Sand Shrub Series	X					
62	1992	1	Not identified in 1992				Sand Shrub Series						
62	1993	1	9.5	4.5	10	4	Sand Shrub Series	X					
62	1992	2	Not identified in 1992				Sand Shrub Series						
62	1993	2	3	2.5	1	4	Sand Shrub Series	X					
63	1992	1	Not identified in 1992				Sand Shrub Series						
63	1993	1	3	1			Sand Shrub Series		X			X	
63	1992	2	Not identified in 1992				Sand Shrub Series						
63	1993	2	1	0.2			Sand Shrub Series	X					

Appendix D. Raw data for grama grass cactus. (Concluded)

Plant Specific Data								Condition				Cause	
Site	Year	Plant #	Height	Width	# Fl.	# Fr.	Vegetation Association	Heal.	Dam.	Dead	Gone	Rodent	Borer
63	1992	3	Not identified in 1992				Sand Shrub Series						
63	1993	3	3	2			Sand Shrub Series	X				X	
63	1992	4	Not identified in 1992				Sand Shrub Series						
63	1993	4	2	1.5			Sand Shrub Series		X			X	
63	1992	5	Not identified in 1992				Sand Shrub Series						
63	1993	5	4	2.5		2	Sand Shrub Series	X					
64	1992	1	Not identified in 1992				Sand Shrub Series						
64	1993	1	2	1.5	1		Sand Shrub Series	X					
64	1992	2	Not identified in 1992				Sand Shrub Series						
64	1993	2	8	2.5	3	3	Sand Shrub Series	X					
64	1992	3	Not identified in 1992				Sand Shrub Series						
64	1993	3	3	2	1	1	Sand Shrub Series	X					
65	1992	1	Not identified in 1992				Black Grama-Dropseed						
65	1993	1	3.5	3		5	Black Grama-Dropseed	X					
65	1992	2	Not identified in 1992				Black Grama-Dropseed						
65	1993	2	3.5	1			Black Grama-Dropseed	X					

Appendix E. List of animals observed in the CCTC area.

The following is a list of animals that were observed in the CCTC area by visual observation and/or observations of tracks or other sign. Species marked by an * are of special concern. RST=Rocket Sled Track, DTWI=Drop Tower and Water Impact Site, GS=Gun Site, LIHE=Light Initiated High-Explosive Site, CENF=Centrifuges, RSTIA=Rocket Sled Track Impact Area, NTR=North Thunder Range, STR=South Thunder Range.

Group/Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
MAMMALS:								
coyote *(Canus latrans)*	X	-	-	-	-	-	X	X
Gunnison's prairie dog *(Cynomys gunnisoni)*	X	-	-	-	-	-	-	X
Merriam's kangaroo rat *(Dipodomys merriami)*	X	-	X	-	-	X	X	X
Ord's kangaroo rat *(Dipodomys ordii)*	X	-	X	-	-	X	X	X
banner-tailed kangaroo rat *(Dipodomys spectabilis)*	X	-	X	-	-	X	-	X
bobcat *(Felis rufus)*	-	-	-	-	-	-	X	-
blacktailed jackrabbit *(Lepus californicus)*	X	-	-	-	-	-	X	X
striped skunk *(Mephitis mephitis)*	X	-	-	-	-	X	X	X
white-throated woodrat *(Neotoma albigula)*	X	-	X	-	X	X	X	X
mule deer *(Odocoileus hemionus)*	X	-	-	-	-	X	X	X
northern grasshopper mouse *(Onychomys leucogaster)*	X	-	X	-	-	X	X	X
silky pocket mouse *(Perognathus flavus)*	X	-	X	-	-	X	X	X
rock pocket mouse *(Perognathus intermedius)*	X	-	X	-	-	X	X	X
brush mouse *(Peromyscus boylii)*	-	-	X	-	-	X	X	X
rock mouse *(Peromyscus difficilis)*	-	-	-	-	-	X	X	-
deer mouse *(Peromyscus maniculatus)*	X	X	X	X	X	X	X	-
piñon mouse *(Peromyscus truei)*	-	-	-	-	-	-	X	-
western harvest mouse *(Reithrodontomys megalotis)*	X	-	-	-	-	X	X	X
rock squirrel *(Spermophilus variegatus)*	-	-	-	-	-	X	X	X
desert cottontail *(Sylvilagus auduboni)*	X	-	X	-	-	X	X	X
badger *(Taxadia taxis)*	X	-	-	-	-	-	-	-
valley pocket gopher *(Thomomys bottae)*	X	-	-	-	-	-	X	-
BIRDS:								
sage sparrow *(Amphispiza belli)*	X	-	-	-	-	X	X	X

Appendix E. List of animals observed in the CCTC area. (Continued)

Group/Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
black-throated sparrow *(Amphispiza bilineata)*	-	-	-	-	-	X	X	X
burrowing owl *(Athene cunicularia)*	X	-	-	-	-	-	-	-
scrub jay *(Aphelocoma coerulescens)*	X	-	-	-	-	-	X	-
* great horned owl *(Bubo virginianus)*	-	X	-	-	-	-	-	-
* red-tailed hawk *(Buteo jamaicensis)*	X	-	X	-	-	X	X	X
* ferruginous hawk *(Buteo regalis)*	-	-	-	-	-	-	-	X
* Swainson's hawk *(Buteo swainsoni)*	X	-	X	-	-	-	X	X
lark bunting *(Calamospiza melanocorys)*	X	-	-	-	-	X	X	X
Gambel's quail *(Callipepla gambelii)*	X	-	X	-	-	X	X	X
scaled quail *(Callipepla squamata)*	X	-	-	-	-	X	-	X
house finch *(Carpodacus mexicanus)*	-	-	-	-	-	X	X	X
turkey vulture *(Cathartes aura)*	X	-	X	-	X	X	X	X
killdeer *(Charadrius vociferus)*	X	-	-	-	-	-	X	X
lark sparrow *(Chondestes grammacus)*	X	-	-	X	-	X	X	X
* northern harrier *(Circus cyaneus)*	X	-	-	-	-	-	X	X
rock dove *(Columba livia)*	X	-	X	-	-	X	X	X
common raven *(Corvus corax)*	X	-	-	-	-	X	X	X
Chihuahuan raven *(Corvus cryptoleucus)*	X	-	-	-	-	X	X	X
western flycatcher *(Empidonax difficilis)*	-	-	-	-	-	-	X	X
horned lark *(Eremophila alpestris)*	X	-	-	-	-	-	X	X
* American kestrel *(Falco sparverius)*	X	X	-	-	-	X	X	X
roadrunner *(Geococcyx californianus)*	X	-	-	-	-	-	X	X
gray-headed junco *(Junco caniceps)*	-	-	-	-	-	-	X	-
Oregon junco *(Junco oreganus)*	-	-	-	-	-	-	X	-
* loggerhead shrike *(Lanius ludovicianus)*	X	X	-	-	-	X	X	X
song sparrow *(Melospiza melodia)*	X	-	X	-	-	X	X	X
northern mockingbird *(Mimus polyglottos)*	X	-	X	-	-	X	X	X
house sparrow *(Passer domesticus)*	-	-	-	-	-	-	X	-
common poorwill *(Phalaenoptilus nuttallii)*	-	-	-	-	-	-	X	X

Appendix E. List of animals observed in the CCTC area. (Continued)

Group/Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
brown (canyon) *towhee (Pipilo fuscus)*	X	-	-	-	-	-	X	X
Say's phoebe *(Sayornis saya)*	-	-	-	-	-	-	X	X
western bluebird *(Sialia mexicanus)*	-	-	-	-	-	-	X	X
Brewer's sparrow *(Spizella breweri)*	-	-	-	-	-	-	X	-
chipping sparrow *(Spizella passerina)*	-	-	-	-	-	-	X	X
western meadowlark *(Sturnella neglecta)*	X	-	X	-	-	X	X	X
European starling *(Sturnus vulgaris)*	X	X	X	X	X	X	X	-
American robin *(Turdus migratorius)*	X	-	-	X	-	X	X	X
mourning dove *(Zenaida macroura)*	X	-	X	-	-	X	X	X
REPTILES:								
Chihuahuan spotted whiptail *(Cnemidophorus exsanguis)*	X	-	X	-	-	X	X	X
little striped whiptail *(Cnemidophorus inornatus)*	X	X	X	X	X	X	X	X
desert grassland whiptail *(Cnemidophorus uniparens)*	X	-	X	-	-	-	X	X
plateau striped whiptail *(Cnemidophorus velox)*	-	-	X	-	-	-	-	X
western rattlesnake *(Crotalis viridis)*	X	-	-	-	-	X	X	X
collared lizard *(Crotophytus collaris)*	-	-	-	-	-	-	X	-
many-lined skink *(Eumeces multivirgatus)*	-	-	-	-	-	-	X	X
Great Plains skink *(Eumeces obsoletus)*	X	-	X	-	-	X	X	X
long-nosed leopard lizard *(Gambelia wislizenii)*	-	-	-	-	-	-	X	X
lesser earless lizard *(Holbrookia maculata)*	X	-	-	-	-	X	X	X
coachwhip *(Masticophis flagellum)*	X	-	-	-	-	-	X	X
striped whipsnake *(Masticophis taeniatus)*	-	-	X	-	-	-	X	X
gopher snake or bullsnake *(Pituophis melanoleucus)*	X	-	X	-	X	X	X	X
* Texas horned lizard *(Phrynosoma cornutum)*	-	-	-	-	-	-	X	-
* short-horned lizard *(Phrynosoma douglassi)*	X	-	X	-	-	X	X	X
* round-tailed horned lizard *(Phrynosoma modestum)*	X	-	X	-	-	X	X	X
long-nosed snake *(Rhinocheilus lecontei)*	-	-	-	-	-	-	-	X
eastern fence lizard *(Sceloporus undulatus)*	-	-	-	-	-	-	X	-
* massasauga *(Sistrurus catenatus)*	X	-	X	-	-	-	X	X

Appendix E. List of animals observed in the CCTC area. (Concluded)

Group/Species	RST	DTWI	GS	LIHE	CENF	RSTIA	NTR	STR
tree lizard *(Urosaurus ornatus)*	X	-	X	-	-	-	X	-
side-blotched lizard *(Uta stansburiana)*	X	-	-	-	-	-	X	-
AMPHIBIANS: (Species not observed in the CCTC area, but are expected to occur there.)								
tiger salamander *(Ambystoma tigrinum)*—breeds in temporary pools, especially at higher elevations								
Great Plains toad *(Bufo cognatus)*—breeds in temporary rain pools in grassland areas								
red-spotted toad *(Bufo punctatus)*—breeds in temporary pools/intermittent streams, grassland areas								
Woodhouse toad *(Bufo woodhousei)*—breeds in temporary rain pools in grassland areas								
Central Plains spadefoot toad *(Scaphiopus bombifrons)*—breeds in temporary pools in grassland areas								
western spadefoot toad *(Scaphiopus multiplicatus)*—breeds in temporary pools in grassland areas								

Appendix F. State and Federal sensitive species of animals potentially occurring in the CCTC area.

Sources are from the Handbook of Species Endangered in New Mexico, NMDGF 1990; and the USFWS Federal Register, 21 November 1991, Part VIII, Department of the Interior, USFWS, 50 CFR Part 17: Endangered and Threatened Wildlife and Plants; Animal Candidate Review for Listing as Endangered or Threatened Species, Proposed Rule.

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1. **Spotted bat** *(Euderma maculatum)*

   Status: Federal (Category 2—Candidate); State (Endangered—Group 2)

   Habitat: Remote areas, selecting specialized roosting sites with streams, nearby cliffs, or steep hillsides with loose rocks

   Sensitivity: Low (not seen or reported from the CCTC survey area)

   Additional Information: The spotted bat has been found in New Mexico from the vicinity of the Rio Grande Valley westward, occurring most regularly in the Jemez, San Mateo, and Mogollon Mountains and on Mount Taylor (Fenton et al., 1983; 1987). These highland localities presumably encompass key habitat characteristics for the spotted bat. In Bernalillo County, the spotted bat is known to occur less regularly, and its regular occurrence is unlikely in recent times (1960 or later), as indicated by unsubstantiated or questionable reports (Handbook of Species Endangered in New Mexico, 1990).

   Spotted bats have been reported in a wide variety of habitats, from riparian and piñon-juniper woodlands to ponderosa pine and spruce-fir forests (Findley, 1987). In remote areas, bats select specialized roosting sites with streams, nearby cliffs, or steep hillsides with loose rocks. Most recorded observations in New Mexico are in or near forested areas with extensive and rocky cliffs. Spotted bats roost in crevices in cliffs or under loose rocks or boulders, and rocky areas seem to be an important key element of the habitat wherever these bats are found (Easterla, 1965, 1973; Ross, 1961). Spotted bats may summer in forested areas and migrate through lower elevations at other seasons (Hoffmeister, 1986). Lactating females have been taken in New Mexico from late June to mid-July, indicating that young are born in early summer (Findley, 1987). Limiting environmental factors for this species are unknown, although pesticide poisoning is likely a major mortality factor.

   There are no records of the spotted bat in the vicinity of the CCTC, Lurance Canyon, or Sol se Mete Canyon (Sullivan, 1993). Because of the lack of key mixed conifer forest habitat and because of the absence of extensive rock ledges and boulders in the immediate CCTC area, no effort was made to survey for the presence of this species. Although key geological habitat characteristics for the spotted bat are not evident in the immediate area, these habitat characteristics are somewhat approximated among the escarpments and foothills at the north side of Lurance Canyon and at the head of Lurance Canyon east of the Burn Site (Sullivan, 1993). Additionally, some potential cliff habitat occurs along the upper west side (2,333 meters or 7,000 feet) of

Sol se Mete Canyon south of the Aerial Cable Facility (Sullivan, 1993). This species could potentially exist in the CCTC area during the non-summer months for purposes of obtaining insect prey as a food source (Hoffmeister, 1986).

2. **Greater western mastiff bat** *(Eumops perotis californicus)*
   Status: Federal (Category 2—Candidate); State (none)
   Habitat: Roosts in buildings, crevices in cliffs, trees, and mine tunnels
   Sensitivity: Low (none seen or reported from the CCTC survey area)

3. **Black-footed ferret** *(Mustela nigripes)*
   Status: Federal (Endangered—Category 1); State (none)
   Habitat: Grassland vegetation in association with active prairie dog towns
   Sensitivity: Low (not seen or reported from the CCTC area surveyed, but active prairie dog towns only observed in the South Thunder Range and the Rocket Sled Track)
   Additional Information: The black-footed ferret is an inhabitant of prairie dog towns. Ferrets prey on Gunnison's prairie dogs and use their burrows for shelter and denning. In general, black-footed ferrets are secretive and rarely observed. Ferrets are only seen with regularity when females with young are located. This species is primarily nocturnal except for occasional early morning activity of young. Females den in prairie dog burrows and bring young above ground in early July. Young remain in the prairie dog town until they disperse in September or early October. Ferrets are less active in winter and are probably solitary except during the breeding season in early spring (Hillman and Clark, 1980).

   Large populations of prairie dogs are found at several highly disturbed locations within KAFB near Gibson Street (Sullivan, 1993), South Thunder Range, and western border of the Rocket Sled Track (present survey). This species is a key prey item for black-footed ferrets. Most records of black-footed ferrets for New Mexico are from within the range of Gunnison's prairie dog (Findley et al., 1975). Bailey (1931) recorded ferrets from the vicinity of San Mateo and Bluewater, and Aldous (1940) collected a ferret at Agua Fria.

4. **Occult little brown bat** *(Myotis lucifugus occultus)*
   Status: Federal (Category 2—Candidate); State (none)
   Habitat: Montane forest-dweller, roosts in natural caves, mine tunnels, hollow trees, or buildings
   Sensitivity: Low (not seen or reported from the CCTC survey area)

5. **Baird's sparrow** *(Ammodramus bairdii)*
   Status: Federal (Category 2—Candidate); State (Endangered—Group 2)

Habitat: Desert grasslands, prairies, mountain meadows
Sensitivity: Low (not seen or reported in the CCTC area surveyed)
Additional Information: Baird's Sparrow sightings normally occur during migration in the eastern plains and southern lowlands, mainly in autumn—with vagrants elsewhere. It nests in lightly grazed pastures, undisturbed prairie, moist meadows, and dry rangeland. The only reliable winter record is from the Roswell area (Handbook of Species Endangered in New Mexico, 1990). Recent records are mainly in the Animas Valley (Hidalgo Co.), which is assumed to represent an area of key critical habitat for the species. Other reliable reports in areas where the species may occur are from Dry Cimarron Valley (Union Co.) and near Nutt (Luna Co.).

Baird's sparrow is a retiring sparrow found in shrubby short-grass habitats. It is usually flushed before it is observed, only to fly a short distance and drop down out of sight in grassland vegetation (Handbook of Species Endangered in New Mexico, 1990). In New Mexico this species has been found in a variety of habitats, ranging from desert grasslands in the south to prairies in the northeast and mountain meadows in the San Juan and Sangre de Cristo Mountains to an elevation of 3,600 meters (11,812 feet) (Handbook of Species Endangered in New Mexico, 1990:F-580). Migrants arrive as early as the first week of August. By November most sparrows appear to have moved out of New Mexico.

In Bernalillo County, Baird's sparrow is known to occur less regularly, and its regular occurrence is unlikely in recent times (1960 or later), as indicated by unsubstantiated or questionable reports (Handbook of Species Endangered in New Mexico, 1990). There are no records of Baird's sparrow in the immediate vicinity of the CCTC. Although extensive surveys were conducted in the grassland-juniper habitat along the northwest boundary of the ACS project area along Lurance Canyon, no individuals of this species were observed (Sullivan, 1993). This species was not observed in the CCTC survey.

6. **Great horned owl** *(Bubo virginianus)*
Status: Federal (none); State (Protected raptor)
Habitat: Plains, open spaces, woodlands, riparian areas, forests
Sensitivity: Low (not observed but reported in vicinity of Drop Tower and Water Impact Site)

7. **Southwestern willow flycatcher** *(Empidonax traillii extimus)*
Status: Federal (Category 1—Candidate); State (Endangered—Group 2)
Habitat: Riparian, piñon-juniper, ponderosa pine, spruce-fir forest
Sensitivity: Low (not seen in CCTC area surveyed)

Additional Information: The southwestern willow flycatcher is a rather small flycatcher has a breeding range that extends from southern California and Baja California eastward through Arizona, southern Utah, central New Mexico, and Trans-Pecos Texas. In New Mexico, the species occurs statewide during the spring and autumn migration (Handbook of Species Endangered in New Mexico, 1990). This species breeds in the Chama, Rio Grande, Zuni, San Francisco, Gila, and possibly the Hondo River Basins, and in the San Juan and western Sangre de Cristo Mountains. Areas of key breeding habitat encompass Zuni (McKinley Co.), Corrales (Sandoval Co.), upper Elephant Butte Lake (Sierra Co.), Glenwood-Pleasanton (Catron Co.), and Cliff-Rock (Grant Co.). This species is known or is highly likely to occur in Bernalillo County (Handbook of Species Endangered in New Mexico, 1990).

Willow flycatchers are generally restricted to riparian woodlands during the breeding season (Hubbard, 1987). Key habitats are typically dominated by cottonwoods, often in association with an understory of small trees or tall shrubs and surface water. The range in elevation for breeding willow flycatchers in New Mexico is from 1,121 to 2,696 meters (3,678 to 8,846 feet) in elevation, with occurrences above 2,121 meters (7,000 feet) in elevation confined to the northern highlands. Breeding birds generally spend much of their time beneath the overstory canopy in willows or other plants including salt-cedar in the Rio Grande Valley. Willow flycatchers are present in New Mexico through late July, therefore the biologic survey of the CCTC area was timely for this species.

Breeding populations of this species in many areas are presumed to have been reduced because of loss of riparian habitat (Unitt, 1987)—a situation that led to the listing of this subspecies as endangered. The breeding population in New Mexico is estimated at 100 pairs, and numbers of birds have declined in the lower and perhaps middle Rio Grande Valley (Handbook of Species Endangered in New Mexico, 1990).

8. **American peregrine falcon** *(Falco peregrinus anatum)*

Status: Federal (Endangered—Category 1); State (Endangered—Group 1)

Habitat: Areas of steep rocky cliffs in close proximity to water; preferred habitat contains dense bird populations in conjunction with large gulfs of air such as occurs in canyons

Sensitivity: Low (not seen or reported in the CCTC area surveyed, but possible presence in Lurance Canyon and Sol se Mete Canyon areas [Sullivan, 1992])

Additional Information: Historically, the peregrine falcon bred throughout much of North America. The subspecies *F. p. anatum* breeds south of the arctic tundra region of North America, southward to Mexico. In New Mexico this subspecies breeds locally in mountainous areas, and it occurs in migration and winter essentially statewide, but primarily east of the eastern plains

(Handbook of Species Endangered in New Mexico, 1990). In New Mexico, breeding territories of the peregrine falcon center on wooded and forested cliffs that provide strong up-drafts of air in which the species can forage. Jays, woodpeckers, swifts, mourning doves, and pigeons are commonly taken as prey by peregrine falcons in New Mexico. A decline in the population of peregrine falcons in New Mexico is associated with ingestion of pesticides. This decline, however, appears to have leveled off by the late 1970's. At present the small breeding population appears to be stable in New Mexico (Handbook of Species Endangered in New Mexico, 1990).

This species is known to occur in Bernalillo County and all of the surrounding counties. This species, therefore, could potentially exist within the CCTC area. Peregrine falcons normally nest on steep cliffs in wooded or forested areas. This general type of habitat exists among the escarpments and foothills along the north side of Lurance Canyon and at the head of Lurance Canyon east of the Burn Site. Additionally, rather extensive cliff habitat occurs along the upper west side (2,333 meters; 7,000 feet) of Sol se Mete Canyon south of the Aerial Cable Facility. Many of the smaller species of birds that are typical prey-species for the peregrine falcon also occur and are abundant in the CCTC area. Although the region associated with Lurance Canyon provides "marginal" nesting habitat, the grassland-juniper habitat in Lurance Canyon and the predominantly grassland and grassland-sagebrush habitat within the CCTC could provide some foraging habitat for the species.

No peregrine falcons were observed in the CCTC area at any time during the biologic survey period from April through July. Moreover, they were not observed in the vicinity of Lurance Canyon during the Aerial Cable Facility biologic survey that was conducted from early October to November, 1991 (Sullivan 1993).

9. **Mexican spotted owl** *(Strix occidentalis lucida)*

Status: Federal (Proposed Threatened); State (Endangered—Group 2)

Habitat: Caves, cliff ledges, witches'-broom, stick nests of other species, old growth forest with steep canyons, mixed conifer forest preferred, but found in piñon-juniper, pine-oak, ponderosa pine

Sensitivity: Low (not seen or reported in the CCTC area surveyed, but possible presence in Lurance Canyon and Sol se Mete Canyon areas [Sullivan, 1992])

Additional Information: The Mexican spotted owl *(Strix occidentalis lucida)* is a Federal Threatened species and a State of New Mexico Endangered Group 2 species. The proposal to list the Mexican spotted owl as a threatened species was published in the Federal Register, Volume 56, page 56344, November 4, 1991 (U.S. Department of the Interior, Fish and Wildlife Service). This species has been recorded in all New Mexico national forests at elevations from 1,233 to 3,333 meters (3,700 to 10,000 feet). Habitat consists of caves,

cliff ledges, witches'-broom, and stick nests of other avian species in mature and old growth forest associated with steep canyons. The preferred vegetation type is mixed conifer; however, they can be found in piñon-juniper woodland, and pine-oak and ponderosa pine forests.

Although key geological habitat characteristics for the Mexican spotted owl are not evident in immediate area, these habitat characteristics are somewhat approximated among the escarpments and foothills at the north side of Lurance Canyon, at the head of Lurance Canyon east of the Burn Site, along upper elevations of Sol se Mete Spring Canyon, and in the small area of Ponderosa pine-piñon-oak woodland along the upper elevations of the East Anchor Access Road (Sullivan, 1993).

There are no records of the Mexican spotted owl in the immediate vicinity of the CCTC, and this species was not observed during the Aerial Cable Facility biologic survey of Lurance Canyon and Sol se Mete Canyon (Sullivan, 1993). No effort was made to survey for the presence of this species in the CCTC area because of the lack of key mixed conifer forest habitat and because of the absence of extensive rock ledges and boulders in the immediate CCTC area.

10. **Gray vireo** *(Vireo vicinior)*

Status: Federal (none); State (Endangered—Group 2)
Habitat: Shrubland and woodland habitat
Sensitivity: Low (not seen or reported in the CCTC area surveyed, but present in Lurance Canyon and Sol se Mete Canyon areas [Sullivan, 1992])

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