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**OAK RIDGE  
NATIONAL  
LABORATORY**

**MARTIN MARIETTA**

**FALL 1994 WILDLIFE AND VEGETATION SURVEY  
NORTON AIR FORCE BASE, CALIFORNIA**

December 15, 1994

Prepared for  
HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAMS  
ENVIRONMENTAL RESTORATION AND WASTE  
MANAGEMENT PROGRAM  
OAK RIDGE, TENNESSEE 37831  
and  
UNITED STATES AIR FORCE HEADQUARTERS  
AIR FORCE BASE CONVERSION AGENCY  
NORTON OPERATING LOCATION  
SAN BERNARDINO, CALIFORNIA 92409

by the  
OAK RIDGE NATIONAL LABORATORY  
Oak Ridge, Tennessee 37831  
managed by  
MARTIN MARIETTA ENERGY SYSTEMS, INC.  
for the  
DEPARTMENT OF ENERGY  
under Contract No. DE-AC05-84OR21400  
and  
CDM FEDERAL PROGRAMS CORPORATION  
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DEPARTMENT OF ENERGY

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## CONTENTS

ACRONYMS .....	iii
1. INTRODUCTION .....	1
2. PURPOSE .....	1
3. SCOPE .....	4
4. METHODS .....	4
5. RESULTS .....	5
5.1 MAMMALS .....	5
5.2 BIRDS .....	5
5.3 VEGETATION .....	9
5.4 HABITAT ASSESSMENT .....	9
5.4.1 Site 2, Landfill Number 2 .....	9
5.4.2 Industrial Wastewater Treatment Plant Area .....	15
5.4.3 Site 5 .....	17
5.4.4 Reference Area .....	20
5.4.5 Base Urban Areas .....	24
5.4.6 Habitat Assessment—General Conclusions .....	26
6. CONCLUSIONS .....	27
7. REFERENCES .....	27
LIST OF FIGURES	
1. Regional map showing location of Norton Air Force Base .....	2
2. General map of Norton Air Force Base, California. ....	3
3. Vegetation map of Site 2, Norton Air Force Base .....	10
4. Vegetation map of the Industrial Wastewater Treatment Plant (IWTP) area, Norton Air Force Base .....	16
5. Vegetation map of Site 5, Norton Air Force Base .....	18
6. Vegetation map of the Reference Area, Norton Air Force Base .....	21
7. Base Urban Area, Norton Air Force Base .....	25
LIST OF TABLES	
1. Mammals observed at Norton Air Force Base, San Bernardino, California .....	6
2. Birds observed at Norton Air Force Base, San Bernardino, California .....	7
3. Plants observed at Norton Air Force Base, San Bernardino, California .....	11
4. Potential ecological receptors at Norton Air Force Base .....	27

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## ACRONYMS

AFB	Air Force Base
BW	Basewide
DBH	Diameters at breast height
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
GC	Golf Course Area
GCP	Golf Course Pond Area
IRP	Installation Restoration Program
IWTP	Industrial Waste Treatment Plant area
ORNL	Oak Ridge National Laboratory
SAW	Santa Ana River Wash
Site 2	Landfill No. 2, IRP Site 2
Site 5	Former Fire Training Area No. 1, IRP Site 5

## **1. INTRODUCTION**

The fall 1994 wildlife and vegetation surveys were completed October 3-7, 1994, at Norton Air Force Base (AFB), California (Fig. 1). Two biologists from CDM Federal Programs, the U.S. Environmental Protection Agency (EPA) regional biologist and the Oak Ridge National Laboratory (ORNL) lead biologist conducted the surveys.

A habitat assessment of three Installation Restoration Project (IRP) sites at Norton Air Force Base was also completed during the fall survey period. The IRP sites include: Landfill No. 2 (Site 2); the Industrial Wastewater Treatment Plant (IWTP) area; and Former Fire Training Area No. 1 (Site 5) (Fig. 2). The assessments were designed to qualitatively characterize the sites of concern, identify potential ecological receptors, and provide information for Remedial Design/Remedial Action activities. A Reference Area (Santa Ana River Wash) and the base urban areas were also characterized. The reference area assessment was performed to provide a baseline for comparison with the IRP site habitats.

The fall 1994 survey is the second of up to four surveys that may be completed. In order to develop a complete understanding of all plant and animal species using the base, these surveys were planned to be conducted over four seasons. Species composition can vary widely during the course of a year in Southern California, and therefore, seasonal surveys will provide the most complete and reliable data to address changes in habitat structure and wildlife use of the site. Subsequent surveys will focus on seasonal wildlife observations and a spring vegetation survey.

## **2. PURPOSE**

The objectives of the fall 1994 wildlife and vegetation surveys were to gather data to be used for various applications including: (1) the completion of the basewide ERA, (2) determining remedial activities, and (3) determining the distribution of state and federal list plant and animal species on Norton AFB. Data gathering included an inventory of plant and animal species present, the identification of potential ecological receptors, mapping of habitats, and understanding the ecological food web present on or near the IRP sites of concern.

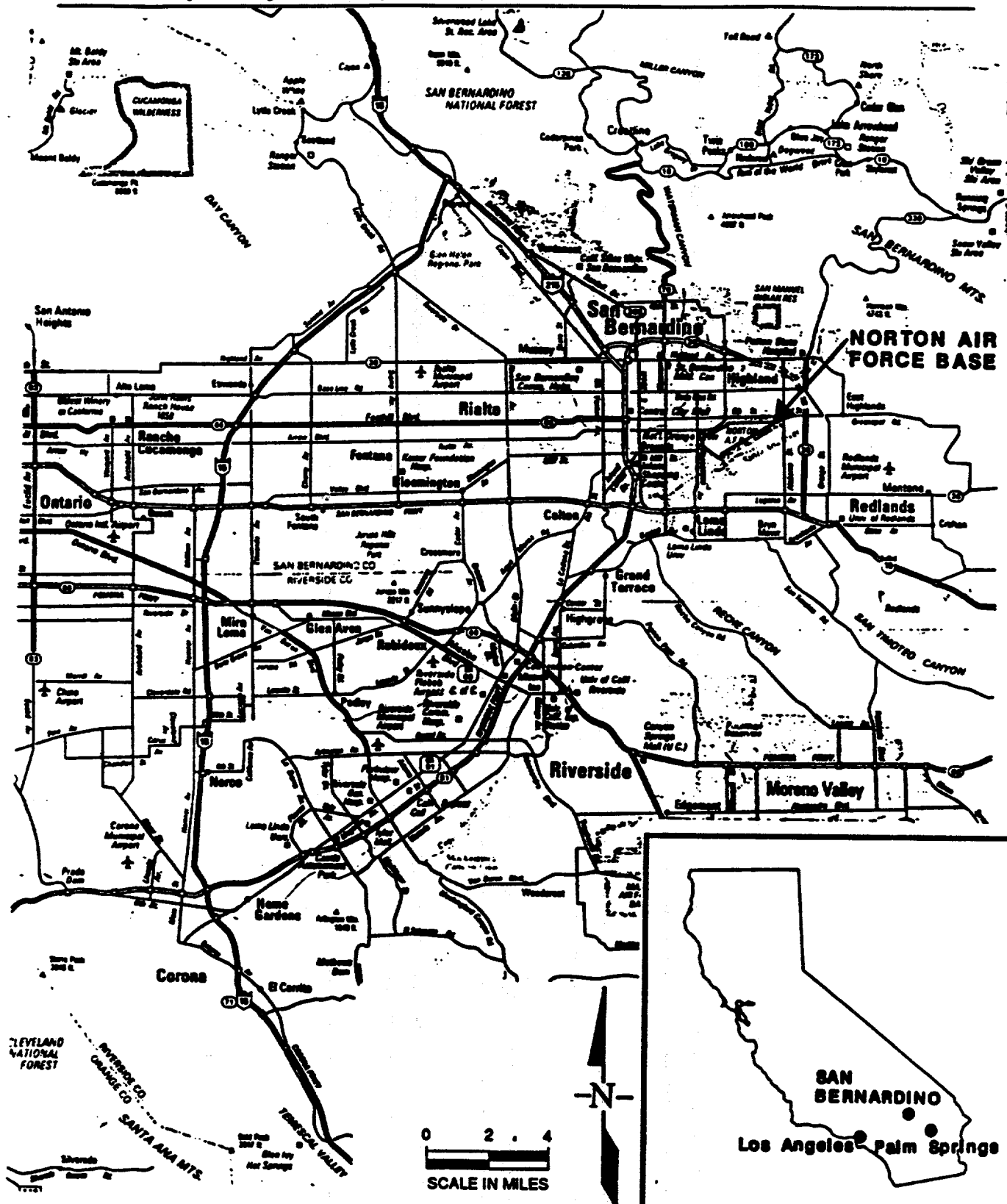


Fig. 1. Regional map showing location of Norton Air Force Base.



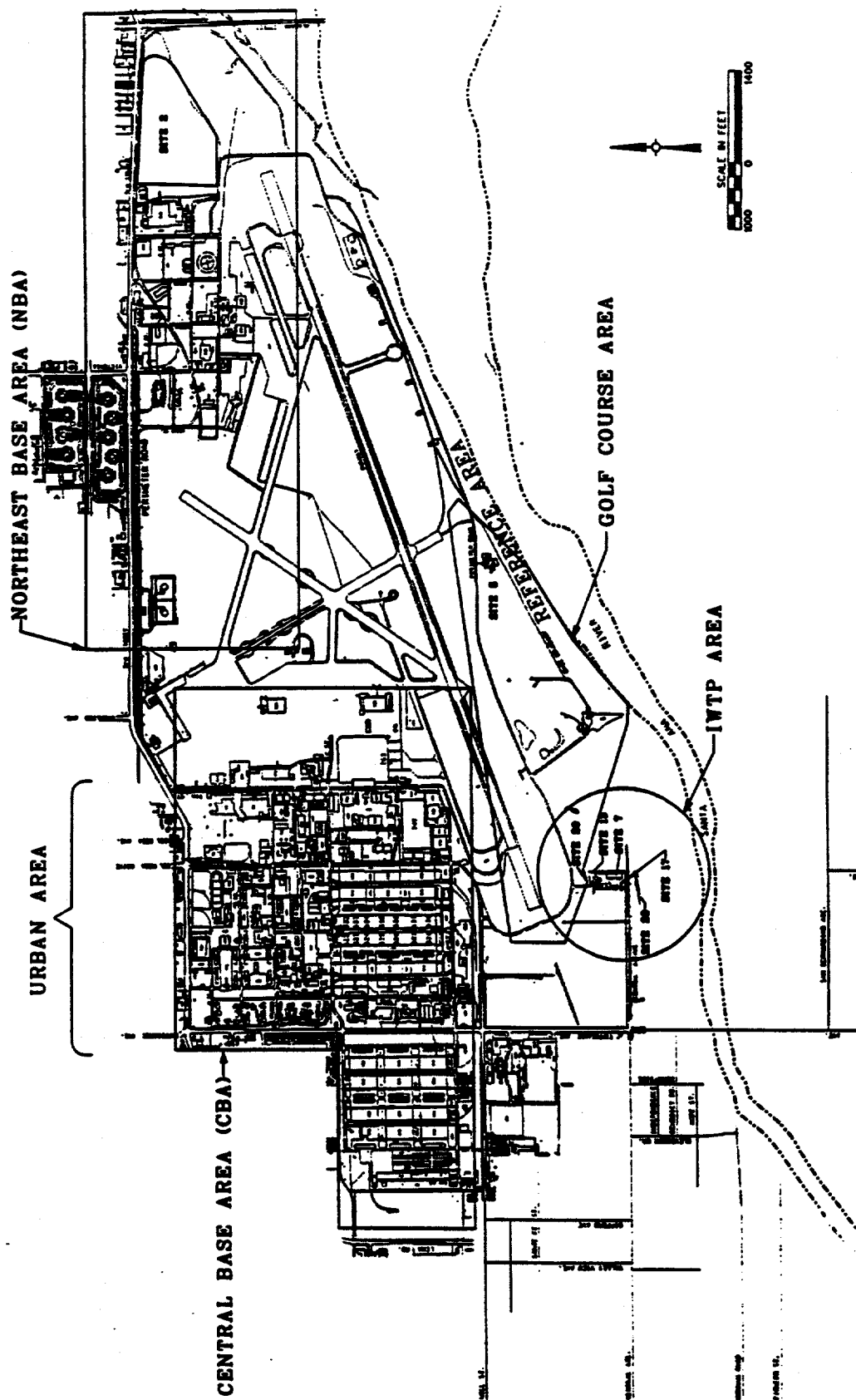


Fig. 2. General map of Norton Air Force Base, California.

### **3. SCOPE**

The focus of the fall 1994 surveys for Norton AFB was at the eastern end of the base and in the southern area of the base, adjacent to the Santa Ana River Wash (SAW). These areas were the focus of the surveys for two reasons: (1) sites within this area (IWTP area, Site 2, and Site 5) were identified as IRP sites with sufficient soil contamination to warrant completing an ERA (CDM Federal 1993, CDM Federal 1994a and 1994b) (Fig. 2), and (2) most endangered and threatened species habitats on the base exist in these areas. The following data were collected during the survey on or near Site 2 and in the southern area of the base (including the IWTP area and Site 5), adjacent to and in the SAW (Fig. 2):

- habitat mapping and assessment;
- vegetation survey;
- bird observation; and
- opportunistic sightings of mammals.

### **4. METHODS**

Qualitative surveys (birds, mammals, and vegetation) were conducted in the eastern portion of the base, east and south of the runway. These surveys were completed by driving and walking through Site 2, the runway aprons, administration roads, golf course area, perimeter road, base area adjacent to the SAW, and the SAW itself (Fig. 2). Results of the surveys were formulated into species lists. The vegetation survey also identified the dominant plant species associated with each habitat observed during the habitat assessment.

A habitat assessment was conducted throughout the base, including the three IRP sites, in and adjacent to the SAW, and the western urbanized portion of the base. The habitat assessment consisted of a visual reconnaissance of the base to identify the location of different habitat types. This was followed by walking through each habitat type to qualitatively assess each habitat. This included the identification of dominant vegetation components, a qualitative assessment of plant species diversity, the observation of topographic gradients, horizontal and vertical stratification among the vegetation and distance between plants. In addition, observations of wildlife interactions within each habitat and a qualitative observation of visual impacts potentially related to site activities or site-related chemicals were also recorded. Individual habitats were then mapped on a base map.

## **5. RESULTS**

During the site survey, inventories of site-specific wildlife and vegetation were conducted along with habitat assessments. The habitat assessments incorporate numerous pieces of data, including a summary of the dominant plant species observed, a list of wildlife observed using each of the habitats encountered, and observations pertaining to vertical and horizontal stratification. Stratification is one of many components that act as an indicator of habitat diversity. Vertical stratification is influenced by factors such as plant height, rock formations, telephone poles, topography (i.e., mounds), soil type, and the presence of surface water bodies. Horizontal stratification is represented by spacing between individual plants or plant clumps, structures, or landscape features. Results of the species inventories and habitat assessments are discussed in Sections 5.1 through 5.4.

### **5.1 MAMMALS**

Mammals observed during the October 3-7 survey period are listed in Table 1. Observations included a longtail weasel and sign of mule deer. The weasel was of the southwest variation (darker head than body and a white bridle across the face) and was observed on the SAW levee between Site 5 and the SAW. Deer tracks were seen at the landfill and in the SAW.

### **5.2 BIRDS**

A total of 46 species of birds were identified during the October 3-7 survey and are listed in Table 2. This compares to 48 species observed during the June 8-10, 1994, Spring 1994 Wildlife Survey (Wade and Barnett 1994). Species observed during the fall 1994 survey that were not seen in the spring were great-blue heron, golden eagle, red-shouldered hawk, ferruginous hawk, belted kingfisher, acorn woodpecker, nuttall's woodpecker, Say's phoebe, violet-green swallow, bushtit, Bewick's wren, western bluebird, yellow-rumped warbler, common yellowthroat, brown towhee, and white-crowned sparrow. This brings the total number of species observed during spring and fall to 64.

Three burrowing owl adults were seen within the same area (loading dock area of the abandoned warehouse buildings) as observed during the spring survey. A few other individuals were also identified along the northern base perimeter road. A golden eagle was identified in the area between Site 5, the Site 2, and the SAW. Both the burrowing owl and the golden eagle are listed as sensitive

Table 1. Mammals observed at Norton Air Force Base, San Bernardino, California

Common name	Scientific name	Site <sup>a</sup>
California ground squirrel	<i>Citellus beecheyi</i>	U, GC, IWTP, Site 2, Site 5
Black-tailed jack rabbit	<i>Lepus californicus</i>	U, Site 2, Site 5, SAW
Desert cottontail	<i>Sylvilagus audubonii</i>	U, IWTP, Site 2, Site 5, SAW
Longtail weasel	<i>Mustela frenata</i>	Site 5, SAW
Coyote	<i>Canus latrans</i>	U, Site 2, Site 5
Botta's pocket gopher (sign)	<i>Thomomys bottae</i>	U, GC, Site 2
Mule deer (tracks)	<i>Odocoileus hemionus</i>	Site 2, SAW

<sup>a</sup>U—Urban

GC—Golf course area

IWTP—Industrial Waste Treatment Plant area

Site 2—Landfill 2, IRP site 2

Site 5—IRP site 5 area

SAW—Santa Ana River Wash

by the California Department of Fish and Game. This designation means they are a species of concern, for which more scientific information is needed to determine its biological status. A pair of ferruginous hawks were seen using the area between Site 5 and the runway area (Fig. 2). The U.S. Fish and Wildlife Service lists these hawks as category 2 candidates for threatened or endangered status. Category 2 means existing information may warrant listing, but substantial biological information to support a proposed ruling is lacking.

Numerous sightings of the red-tailed hawk (many of the western race) were noted throughout the base during the survey including Site 2, Site 5, and the area adjacent the SAW. A pair of cooper's hawks were observed in the SAW and one individual was seen in the olive grove of Site 2. A pair of red-shouldered hawks were identified in the wooded area between the golf course and the SAW. On three separate occasions a pair of American kestrels were seen in the base area adjacent to the SAW.

At least one more wildlife survey, including bird identification, will be completed in the spring of 1995.

Table 2. Birds observed at Norton Air Force Base, San Bernardino, California

Common name (federal protected status)	Scientific name	Site <sup>a</sup>
Pied-billed grebe	<i>Podilymbus podiceps</i>	GCP
Great egret	<i>Casmerodius albus</i>	GCP
Great-blue heron	<i>Ardea herodias</i>	GCP
Mallard	<i>Anas platyrhynchos</i>	GCP
American coot	<i>Fulica americana</i>	GCP
Killdeer	<i>Charadrius vociferous</i>	U, Site 2, Site 5, SAW
Golden Eagle (sensitive) <sup>b</sup>	<i>Aquila chrysaetos</i>	Site 2, Site 5, SAW
Cooper's hawk	<i>Accipiter cooperii</i>	Site 2, SAW
Red-shouldered Hawk	<i>Buteo lineatus</i>	GC, SAW
Red-tailed hawk	<i>Buteo jamaicensis</i>	U, Site 2, Site 5, SAW
Ferruginous hawk (C2) <sup>c</sup>	<i>Buteo regalis</i>	Site 5, SAW
American kestrel	<i>Falco sparverius</i>	U, GC, Site 2, Site 5
Gambel's quail	<i>Callipepla gambelli</i>	Site 5, SAW
Rock dove	<i>Columba livia</i>	U, Site 2
Mourning dove	<i>Zenaida macroura</i>	U, GC, IWTP, Site 2, Site 5, SAW
Greater roadrunner	<i>Geococcyx californianus</i>	GC, Site 2, SAW
Burrowing owl (sensitive) <sup>b</sup>	<i>Athene cunicularia</i>	U, Site 2
Anna's hummingbird	<i>Calypte anna</i>	U, Site 5
Belted kingfisher	<i>Ceryle alcyon</i>	GCP
Northern flicker	<i>Colaptes auratus</i>	IWTP, Site 2
Acorn woodpecker	<i>Melanerpes formicivorus</i>	U
Nuttall's woodpecker	<i>Picoides nuttallii</i>	GC, SAW
Western kingbird	<i>Tyrannus verticalis</i>	U, GC, IWTP, Site 2
Black phoebe	<i>Sayornis nigricans</i>	U, GCP, GC, IWTP, Site 2, SAW
Say's phoebe	<i>Sayornis saya</i>	GC, SAW
Horned lark	<i>Eremophila alpestris</i>	U, GC, Site 2, Site 5
Violet-green swallow	<i>Tachycineta thalassina</i>	SAW

Table 2 (Continued)

Common name (federal protected status)	Scientific name	Site <sup>a</sup>
Scrub jay	<i>Aphelocoma coerulescens</i>	U, GC, SAW
American crow	<i>Corvus brachyrhynchos</i>	U, GCP, GC, IWTP, Site 2, SAW
Common raven	<i>Corvus corax</i>	U, GC, Site 2, Site 5, SAW
Bushtit	<i>Psaltiriparus minimus</i>	GC, Site 5, SAW
Bewick's wren	<i>Thryomanes bewickii</i>	Site 5, SAW
Western bluebird	<i>Sialia mexicana</i>	GC
American robin	<i>Turdus migratorius</i>	GC
Loggerhead shrike	<i>Lanius ludovicianus</i>	U, Site 2, Site 5, SAW
Northern mockingbird	<i>Mimus polyglottos</i>	U, GCP, GC, IWTP, Site 5, SAW
European starling	<i>Sturnus vulgaris</i>	U, GC, IWTP, Site 2, Site 5, SAW
Yellow-rumped warbler	<i>Dendroica magnolia</i>	GC, IWTP, SAW
Common yellowthroat	<i>Geothlypis trichas</i>	SAW
Brown towhee	<i>Pipilo fuscus</i>	SAW
Lark sparrow	<i>Chondestes grammacus</i>	Site 2, Site 5, SAW
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	IWTP, Site 5, SAW
Western meadowlark	<i>Sturnella neglecta</i>	U, GCP, GC, IWTP, Site 2, Site 5
Red-winged blackbird	<i>Agelaius phoeniceus</i>	GCP, GC
Brewer's blackbird	<i>Euphagus cyanocephalus</i>	GCP, GC, IWTP
House finch	<i>Carpodacus mexicanus</i>	U, GCP, GC, IWTP, Site 2, Site 5, SAW

<sup>a</sup>U—Urban

GCP—Golf course pond area

GC—Golf course area

IWTP—Industrial Waste Treatment Plant area

Site 2—Landfill 2, IRP site 2

Site 5—IRP site 5 area

SAW—Santa Ana River Wash

<sup>b</sup>Sensitive: Designated by the California Department of Fish and Game as a species of concern, for which more scientific information is needed to determine its biological status.

<sup>c</sup>C2—Federal Category 2 Candidate: Taxa which existing information indicates may warrant listing, but for which substantial biological information to support a proposed ruling is lacking.

### 5.3 VEGETATION

Plant species observed during the October 3-7 survey period are listed in Table 3. A total of 39 species were observed during the fall 1994 survey, including numerous individuals of Santa Ana River wooly star, a species designated as endangered at both the federal and state level. This species was observed both on base and in the reference area. The occurrence of Santa Ana River wooly star on the base will be mapped in the spring of 1995. It is also anticipated that additional species will be observed during the spring 1995 survey. At this time, a special effort will be made to look for individuals of the slender-horned spine flower (*Centrostegia leptoceras*). This is another plant species designated as endangered at both the federal and state level which may occur at the site.

### 5.4 HABITAT ASSESSMENT

Habitat assessments were completed for Site 2, the IWTP area, Site 5, the base adjacent to the SAW, and base urban areas (Fig. 2). The following observations (Sect. 5.4.1 through 5.4.5) represent one round of preliminary screening conducted during one season (fall 1994). It is possible that additional vegetative species will be observed during the spring of 1995.

#### 5.4.1 Site 2, Landfill Number 2

Site 2, or Landfill No. 2, is located in the northeast portion of the base along the base boundary east of Building 248 (Fig. 3). This landfill was used between 1958 and 1980 for the disposal of general refuse, as well as industrial wastes including spent solvents, acids, refrigerants, paint strippers, paints, thinners, waste oils, and sludge from the IWTP. The landfill reportedly covered an area of approximately 31 acres. The northern and eastern boundaries of the landfill area are bordered by the base perimeter fence and run parallel to Third Street and Alabama Street, respectively. These areas are characterized by heavy traffic and support commercial, residential, and light industrial uses.

Trench and fill procedures with daily cover were the usual practice at the landfill. In general, the trenches were approximately 300 to 400 yards long, 25 feet wide, and between 20 and 40 feet deep. Contaminants detected in the landfill soil include non-halogenated semivolatiles (ranging from 100  $\mu\text{g/kg}$  for benzo(a) anthracene and 120  $\mu\text{g/kg}$  for pyrene to 4600  $\mu\text{g/kg}$  for bis (2-ethylhexyl)

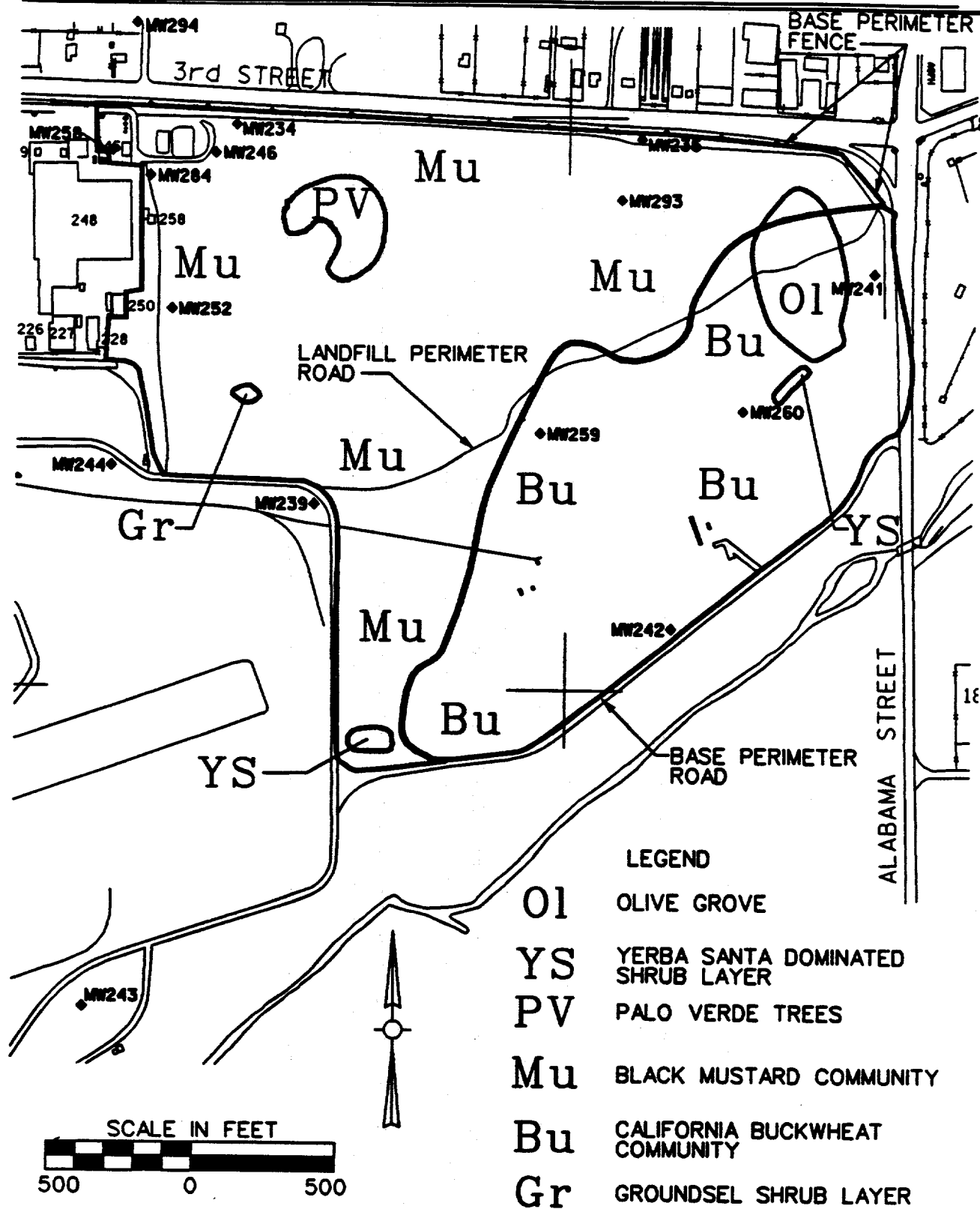


Fig. 3. Vegetation map of Site 2, Norton Air Force Base.



Table 3. Plants observed at Norton Air Force Base, San Bernardino, California

Common name (federal protected status)	Scientific name	Site*
Pine	<i>Pinus sp.</i>	U, GC, IWTP
Juniper	<i>Juniperus sp.</i>	U, GC
Fan Palm	<i>Washingtonia filifera</i>	U, IWTP
Giant reed	<i>Arundo donax</i>	SAW
Slender wild oat	<i>Avena barbata</i>	Site 2
Bunchgrass	<i>Bromus sp.</i>	U, IWTP, Site 2, Site 5
Bermuda grass	<i>Cynodon dactylon</i>	Site 2
Schismus grass	<i>Schismus barbatus</i>	Site 2, SAW
Spanish bayonet	<i>Yucca whipplei</i>	SAW
Cottonwood	<i>Populus fremontii</i> var. <i>fremontii</i>	IWTP, Site 5, SAW
Black willow	<i>Salix gooddingii</i>	Site 5, SAW
Coast live oak	<i>Quercus agrifolia</i>	U, IWTP
California buckwheat	<i>Eriogonum fasciculatum</i> ssp. <i>fasciculatum</i>	IWTP, Site 2, Site 5, SAW
Black mustard	<i>Brassica nigra</i>	U, IWTP, Site 2, Site 5, SAW
Sycamore	<i>Platanus racemosa</i>	SAW
Wild black cherry	<i>Prunus sp.</i>	SAW
Palo verde	<i>Cercidium floridum</i>	Site 2
California broom	<i>Lotus scoparius</i>	Site 2, Site 5
Eucalyptus	<i>Eucalyptus sp.</i>	U, IWTP, Site 2, SAW
Filaree	<i>Erodium sp.</i>	Site 2
California croton	<i>Croton californicus</i>	IWTP, Site 2, Site 5, SAW
Turkey mullein	<i>Eremocarpus setigerus</i>	Site 5
Castor bean	<i>Ricinus communis</i>	U, IWTP, SAW
Prickly pear cactus	<i>Opuntia littoralis</i>	Site 2, Site 5, SAW
Beavertail cactus	<i>Opuntia basilaris</i>	SAW
Valley cholla	<i>Opuntia parryi</i> var. <i>parryi</i>	SAW
Olive tree	<i>Olea europea</i>	IWTP, Site 2

Table 3 (Continued)

Common name (federal protected status)	Scientific name	Site <sup>a</sup>
Oleander	<i>Nerium oleander</i>	U, GC, IWTP
Santa Ana River Wooly Star (endangered) <sup>b</sup>	<i>Eriastrum densifolium ssp. sanctorum</i>	Site 2, Site 5, SAW
Yerba santa	<i>Eriodictyon trichocalyx</i>	Site 2, SAW
Horehound	<i>Marrubium vulgare</i>	SAW
Tree tobacco	<i>Nicotiana glauca</i>	U, Site 5, SAW
Sand bur	<i>Ambrosia acanthicarpa</i>	U, IWTP, Site 2, Site 5
Mulefat	<i>Baccharis glutinosa</i>	IWTP, Site 5, SAW
Telegraph weed	<i>Heterotheca grandiflora</i>	U, IWTP, Site 2, Site 5, SAW
Scale broom	<i>Lepidospartum squamatum</i>	Site 2, Site 5, SAW
Wild lettuce	<i>Lactuca sp.</i>	Site 5, SAW
Groundsel	<i>Senecio flaccidus ssp. douglasii</i>	Site 2, Site 5, SAW
Horseweed	<i>Conyza canadensis</i>	SAW

<sup>a</sup>U—Urban area

GC—Golf course area

IWTP—Industrial Waste Treatment Plant area

Site 2—Landfill 2, IRP site 2

Site 5—IRP site 5 area

SAW—Santa Ana River Wash

<sup>b</sup>Endangered: Designated as endangered by both the federal government and the State of California.

phthalate, PCBs (i.e., Aroclor 1254 ranging from 83 to 87  $\mu\text{g/kg}$ ), and metals (ranging from 0.2 mg/kg for arsenic and beryllium to 125 mg/kg for zinc and 148 mg/kg for lead).

The landfill itself has been disturbed by grading, compaction, and moving of soil and is characterized by an herbaceous layer dominated by black mustard, an opportunistic species common to disturbed areas. Clumps of black mustard range from three inches to one and a half feet high and from one to three feet wide. The spacing interval between the clumps of black mustard varies from two to greater than five feet. The herbaceous understory is characterized by bunchgrasses, sand bur, and groundsel. Incidental occurrences of Santa Ana River wooly star were observed on the landfill.

Open patches of barren, sandy fill were noted throughout the landfill area. Construction debris and landfill trenches provide some limited topographical relief in the area (i.e., gradations up to two feet).

The landfill perimeter is comprised of several vegetation communities. The northeast area of Site 2 is characterized by a grove of introduced European olive trees (Fig. 3). Individual trees within the grove range from 15 to 18 feet high and have diameters at breast height (DBH) ranging from nine to ten inches. The grove consists of several clusters of three to four trees measuring approximately 25 feet in width. Spacing between the clusters range from ten to 25 feet.

The soil here consists mainly of sandy fill material. An understory of schismus grass, fillaree, bunch grasses, and black mustard and incidental occurrences of Santa Ana River wooly star were also noted in the grove area. Limited surficial topographical relief was observed within the grove area. Construction debris, rebar, and scrap metal are located sporadically throughout the olive grove.

The olive grove occupies approximately three acres within Site 2. It is bisected by the landfill perimeter road. The borders to the east, south, and southwest are made up of a California buckwheat community, whereas black mustard dominates to the northwest and northeast (Fig. 3). Numerous birds, including Cooper's hawk and roadrunner, were observed using the grove.

The southern portion of Site 2 is characterized by a shrub community dominated by California buckwheat (Fig. 3). This community is bordered to the northeast by the olive grove, to the north and west by the landfill (dominated by black mustard), and to the east and south by the landfill perimeter road.

The buckwheat shrub layer extends to three feet high and occurs in clumps of one to three feet wide. Spacing between the clumps is three to five feet. The community is characterized by intermittent patches of barren sandy soil and an herbaceous layer comprised of Santa Ana River wooly star, prickly pear cactus, and bunch grasses. Minimal topographical relief was noted. The buckwheat community continues to the south and east until it is interrupted in both directions by the landfill perimeter road.

Also in the southern portion of Site 2, two subcommunities of yerba santa were seen (Fig. 3). In these two areas, both located south of monitoring well MW-260, the dominant shrub layer (California buckwheat) thins, and yerba santa becomes the dominant vegetation type.

The first of these subcommunities occurs approximately ten feet south of MW-260. The yerba santa layer occurs in an area 50 feet wide (northwest to southeast) and 150 feet long (northeast to southwest). The shrub layer is approximately three feet high and shrub clumps are spaced at intervals

ranging from three to ten feet. This area contains intermittent patches of barren soil and a mixture of native and introduced vegetation including telegraph weed, Santa Ana River wooly star, and black mustard.

Another yerba santa cluster is located several hundred feet to the southwest of the first cluster. This subcommunity occurs in an area approximately 80 feet wide (north to south) and approximately 150 feet long (east to west) (Fig. 3). The yerba santa ranges in height to a maximum of three feet. Clusters of the shrub are spaced at one to three foot intervals. The substrate is characterized by intermittent patches of brown sandy soil. The herbaceous layer is comprised of Santa Ana River wooly star, black mustard, and bunch grasses.

The western area of Site 2 is a highly disturbed area characterized by minimal vegetation, a preponderance of construction debris, and evidence of landfill trenching activities. Black mustard, no higher than two and a half feet, dominates the herbaceous layer with subdominance of sand bur, bunch grasses, schismus grass, and croton. The substrate is characterized by intermittent patches of barren sandy fill material.

Moving east, landfill trenching activities provide some limited topographical relief to the area. Within this area, burrowing owl nests were noted, along with signs of desert cottontail and black-tailed jack rabbit. The black mustard community continues to the east, over the landfill, until the vegetation changes to a California buckwheat community.

In the southwest part of the landfill, a small area of groundsel occurs within the black mustard (Fig. 3). The clumps of groundsel range to three feet high and are spaced at approximately three foot intervals. The soil in this community is comprised of sandy fill material. Landfill trenching activities provide slight topographic relief in this area. This community type extends for approximately 60 feet before returning to the black mustard dominant community.

In the northwest section of the landfill, several individual Palo Verde trees were noted (Fig. 3). These trees range from five to 15 feet high, from four to ten inches DBH, and are spaced more than 100 feet apart. The understory is characterized by black mustard, bunch grasses, and oats. Landfill activities have provided slight topographical relief in this area. The black mustard herbaceous layer continues from the Palo Verde trees 300 feet to the northern extent of the landfill where it is interrupted by the landfill perimeter road. At the extreme northwest of the landfill, there is a 70 foot long row of eucalyptus trees, averaging 8-12 inches DBH.

Overall, wildlife habitat at the landfill is limited. However, it should be noted that the area is used by the California ground squirrel, dessert cottontail, black-tailed jack rabbit and numerous bird species (see Table 2).

#### **5.4.2 Industrial Wastewater Treatment Plant Area**

The IWTP area (Fig. 4) is located in the southeastern section of Norton AFB. The on-site treatment plant operated from 1960 to 1987. Treated wastewater from the plant was discharged and collected in the plant's outfall area, from where it ultimately discharged to the SAW. The 1993 Remedial Investigation (RI) Report (CDM Federal 1993) indicated that arsenic was detected in the outfall area soils at concentrations of 0.2 to 8.1 mg/kg, which are above background levels.

The IWTP area is bordered to the north and west by the base golf course. The boundary to the east is an open field and to the south road construction. The SAW is approximately 1,100 feet south of the IWTP area.

The IWTP area is generally a paved area which is no longer active and is surrounded by a perimeter fence. Bunch grasses, sand bur, and mulefat grow in the sandy fill along the western fence line.

The northern area of the IWTP area is characterized by the introduced, ornamental species of the base golf course such as eucalyptus, live oak, Italian cypress, and fan palm. These ornamental species plus oleander are representative of the golf course landscaping. The golf course turf is predominantly bermuda grass with fescue and bluegrass. The northern area continues approximately 150 feet to the north before it is interrupted by the golf course road. Landscape species were noted along the northeastern fence line of the IWTP. A south running culvert, which appears to collect golf course drainage, is surrounded by an herbaceous layer of three feet in height dominated by sand bur. The herbaceous layer also contains telegraph weed and croton. Limited topographical relief was noted at the northern edge.

The eastern area is highly disturbed and characterized by successional vegetation including trees to the east (Fig. 4). It extends from south to north for approximately 600 feet to its border with the base golf course. It continues from west to east for approximately 1500 feet to the golf course parking lot. The southern boundary of the eastern area is bordered by road construction activities and the SAW. This area is characterized by an herbaceous layer up to two feet high, comprised of opportunistic species common to disturbed areas. Black mustard was noted to be the dominant species

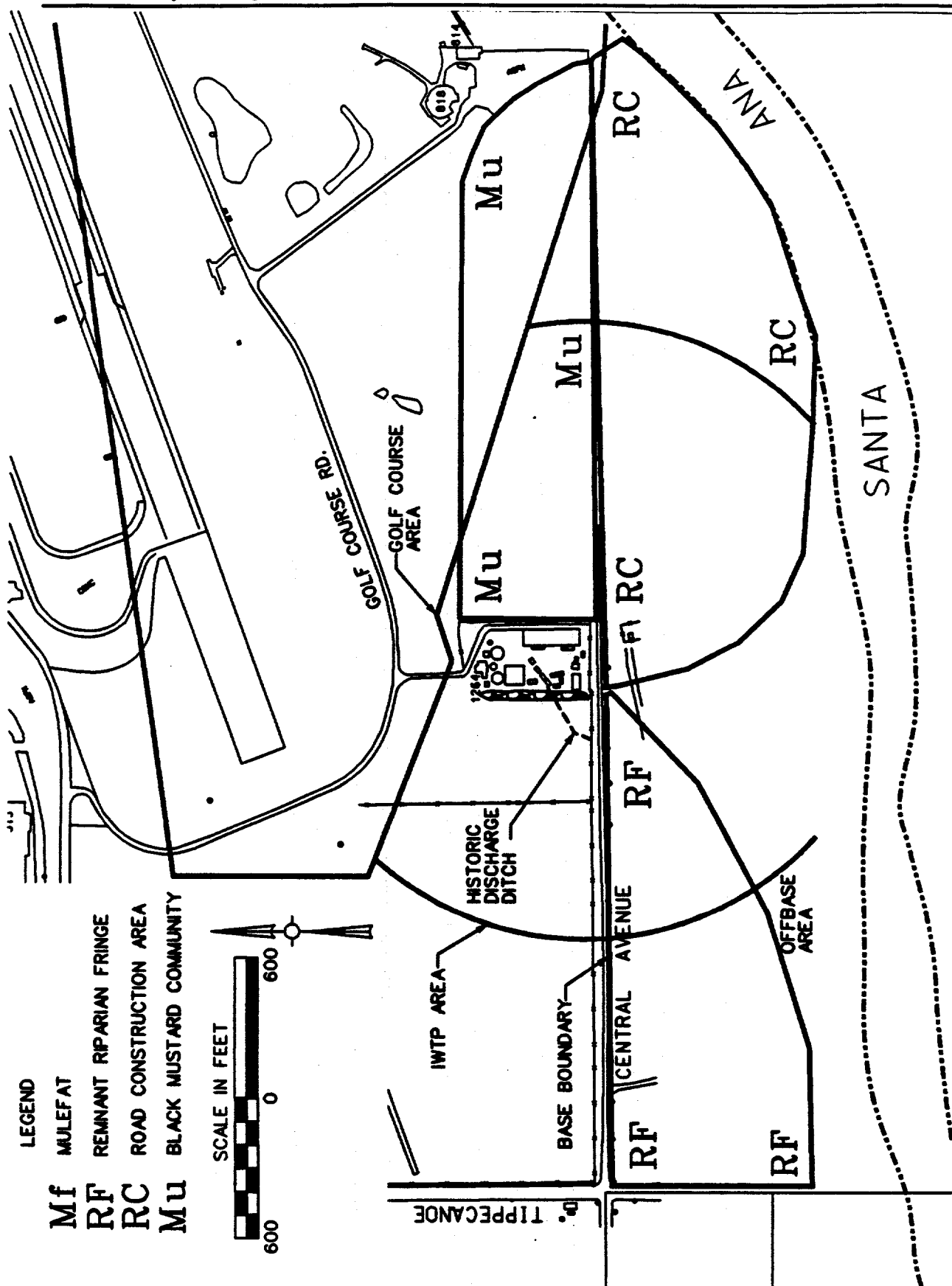


Fig. 4. Vegetation map of the Industrial Wastewater Treatment Plant (IWTP) area, Norton Air Force Base.

with bunch grasses and croton contributing to the understory. Incidental occurrences of California buckwheat ranging from two to three feet high were also noted. The herbaceous layer is underlain by sandy soil. Little topographical relief was observed in the eastern area.

The southern area of the IWTP has been greatly disturbed by road construction activities. Sporadic patches of opportunistic herbaceous species were noted in the area; however, the majority of the area is characterized by barren, devegetated rocky soil with little topographical relief. Species observed include telegraph weed, black mustard, and bunch grasses.

Remnants of the original riparian fringe zone were noted in the southwestern portion of the southern area. The residual fringe zone is dominated by Fremont cottonwoods. These trees range from 20 to 25 feet high and from 10 to 12 inches DBH.

Although the IWTP area is located in a highly impacted and disturbed habitat, various wildlife species (including Botta's pocket gopher and California ground squirrel), have been observed using the forest and field habitats on the edges of the IWTP.

#### **5.4.3 Site 5**

Site 5 is located near the northeast corner of the golf course (Fig. 5). This site is bounded by the pistol range on the west, the southern Perimeter Road on the north, and the SAW on the south and east. The area was used to conduct fire control and abatement exercises from the late 1950s through the 1970s. During the 1970s, fire training exercises were conducted as often as five times a week.

Fire training exercises involved the routine procedure of floating a layer of oil, fuel, or other combustible material on a layer of water within the confines of an unlined berm and repeatedly igniting and extinguishing the material. Prior to 1973, waste fuels, waste oils, and some combustible waste chemicals (e.g., spent solvents) were reportedly used during fire training exercises. After 1973, only uncontaminated JP-4 fuel was used for these exercises. Approximately 500 to 1,000 gallons of fuel were used for each exercise without provisions for containment or collection of residual liquids.

The 1993 Remedial Investigation (CDM Federal 1993) identified lead (ranging from 2.6 to 5760 mg/kg), semivolatiles (ranging from  $\mu\text{g/kg}$  for fluoranthrene and 14  $\mu\text{g/kg}$  for naphthalene to 970  $\mu\text{g/kg}$  for pyrene and 5100  $\mu\text{g/kg}$  for naphthalene), arsenic (ranging from 0.27 to 29.5 mg/kg), and dioxins (ranging from  $2.5 \times 10^{-7}$  to 0.010  $\mu\text{g/kg}$ ) in the soil at Site 5.

The habitat surrounding Site 5 has been highly impacted by site activities (grading, soil removal, etc.). At the time of the fall 1994 habitat assessment, no remnants of native vegetation were observed.

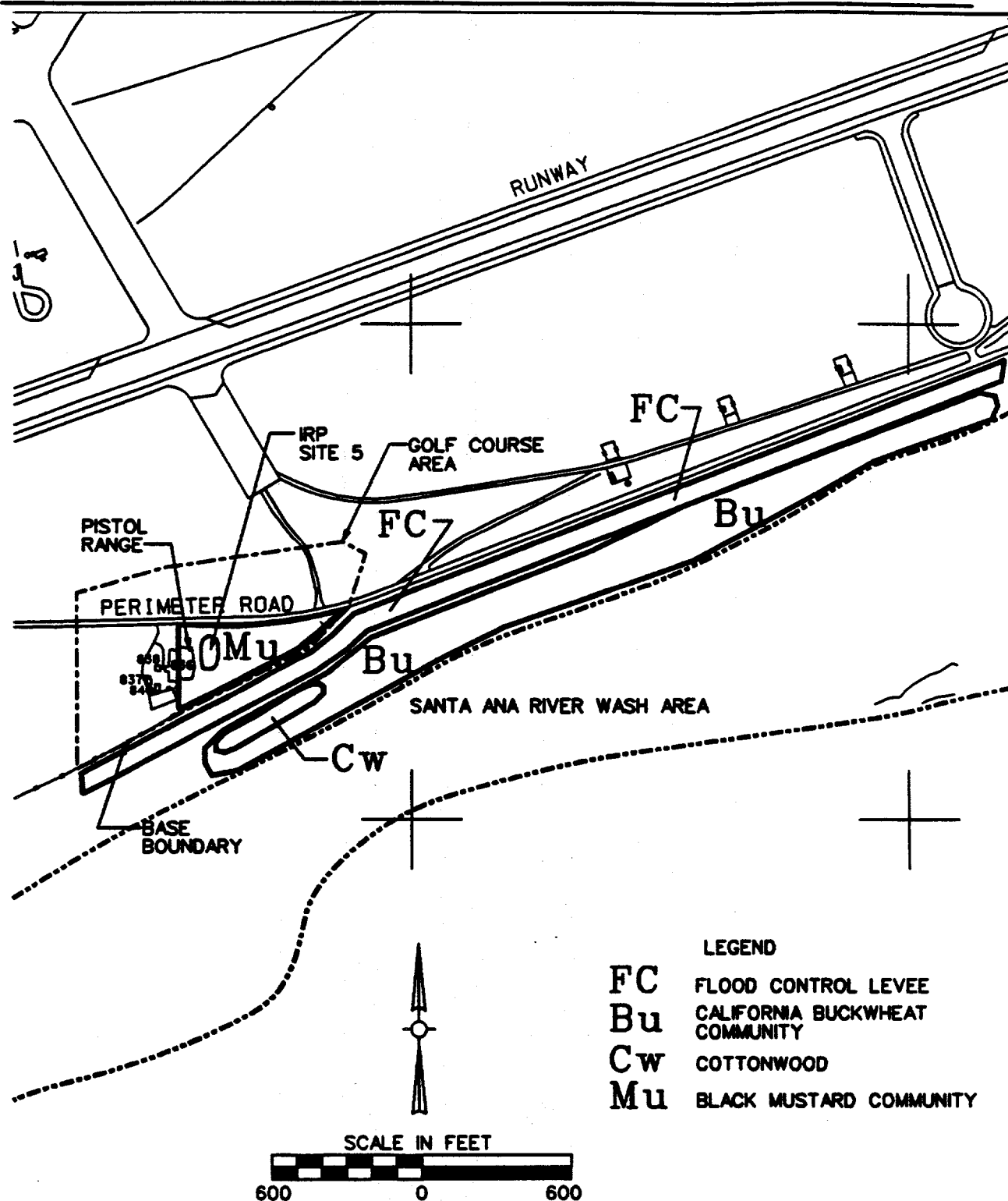


Fig. 5. Vegetation map of Site 5, Norton Air Force Base.



The area surrounding the site is largely devoid of vegetation with barren sandy fill noted throughout the area. Opportunistic species, common to disturbed areas, such as black mustard, sand bur, and turkey mullein were identified in the herbaceous layer.

The northern area of the site lies adjacent to the perimeter road. It is characterized by an herbaceous layer of approximately two feet high dominated by black mustard. The herbaceous layer also contains sand bur and turkey mullein. Tree tobacco grows along the northern perimeter. Level sandy fill and small gravel underlay the herbaceous layer.

The western area of the site borders the base firing range. The site is separated from the firing range by a steeply sloped berm which is constructed of sandy fill material. The berm's slope is covered with an herbaceous layer dominated by black mustard in association with sand bur, croton, telegraph weed, and turkey mullein. At the base of the berm slope, the area has been filled and flattened. This lot area extends to the east and south for approximately 200 feet in both directions.

The eastern area, bordered to the west by the lot area, continues along the base perimeter road to the north and parallels the Santa Ana flood control levee to the south. The northeastern section of this area is characterized by a black mustard dominated herbaceous community. Telegraph weed, croton, and sand bur were also noted in this community which extends to two feet in high. The herbaceous layer is underlain by stony, sandy fill material.

The southern portion of the site extends approximately 250 feet to the south before intersecting the Santa Ana flood control levee. This area is characterized by an herbaceous layer dominated by black mustard with occurrences of tree tobacco, sand bur, croton, and telegraph weed. Incidental occurrences of California buckwheat, three feet in height, were noted. The SAW is approximately 100 to 150 feet south of the flood control levee.

Approximately 500 feet southeast of Site 5, a topographic depression created by the Santa Ana flood control levee and past road construction activities was observed (Fig. 5). The topographical depression, which runs parallel to the golf course, contains remnants of a marginally impacted wash community. The depression extends approximately 1,000 yards from west to east and approximately 200 feet north to south.

The eastern area of the topographical depression is characterized by a shrub layer dominated by California buckwheat. The shrub layer extends to four feet high with interval spacing between the plants of one to five feet. The understory is characterized by an herbaceous layer of bunch grasses, Santa Ana River wooly star, and prickly pear cactus. The herbaceous layer is underlain by slightly

undulating white sandy soil and small gravel. A few individual Fremont cottonwoods were also observed in this area.

A slight slope was noted within the topographical depression with the elevation increasing from south to north. Along the northern edge the vegetation is denser and more varied. California buckwheat is the dominant shrub layer with heights to three and a half feet while spacing intervals decrease to one to two feet. The understory is characterized by telegraph weed, groundsel, and prickly pear cactus. Incidental occurrences of scale broom were also observed in this area. While the buckwheat community remains the dominant vegetation type in the topographic depression, the plants become more widely spaced in a southerly direction. The western area of the topographical depression, as in the eastern area, is dominated by California buckwheat.

In the extreme northwest corner, a stand of trees (dominated by Fremont cottonwood) was observed. Tree height ranged from approximately 15 to 25 feet with diameters from 8 to 12 inches DBH. A canopy closure of approximately 40 percent was noted. Black willows were also identified within this stand. The extreme western portion of the area is noticeably devoid of vegetation and impacted by road construction activities.

Signs of use of the northern sections of the area by desert cottontail, black-tailed jack rabbit, California ground squirrel, and western side blotch lizard were noted. Raptors and songbirds such as hawks, shrikes, meadowlarks, larks, and sparrows also use this area (see Table 2).

#### **5.4.4 Reference Area**

As part of the field survey, a reference area was selected for a comparative wildlife and vegetation survey and habitat assessment. The reference wash area is located in the southeastern section of the base along the SAW (Fig. 6). It borders the base Perimeter Road to the north and the Santa Ana river to the south.

The reference area is relatively undisturbed and contains a remnant plant community that is representative of the original vegetation type found in this area (i.e., alluvial fan scrub).

In an effort to thoroughly evaluate the reference area, four transects were located between the base area and the wash, within the reference area (Fig. 6). Transects were walked from the southern extent of the reference area, approximately five to ten feet above the wash, to its northern boundary, eight feet below the perimeter road.

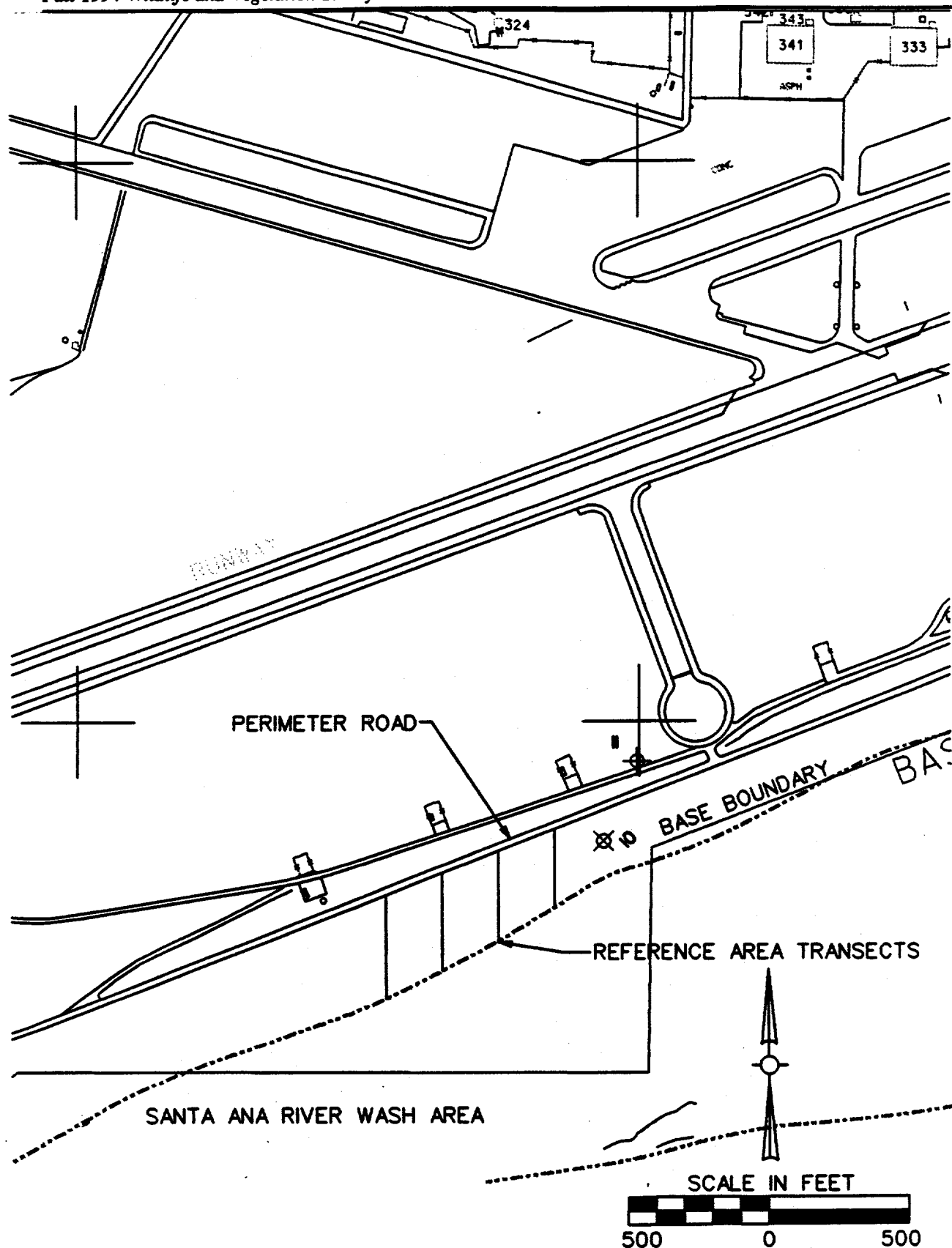


Fig. 6. Vegetation map of the Reference Area, Norton Air Force Base.

Transect 1 was initiated in the southwest corner of the reference area. At the transect's starting point, an herbaceous layer of groundsel is the dominant vegetation type. The groundsel shrubs are spaced at intervals ranging from one to three feet. This herbaceous layer, approximately one foot high, extends to the north in a corridor 30 feet wide, running south to north. The understory is sparsely vegetated with a substrate of gravel deposits and sandy soils.

Moving north along the transect and up a gentle slope of approximately five degrees, the vegetation community changes into a California buckwheat dominated shrub layer. The shrub layer, which is up to three and a half feet high, is spaced at intervals of one to three feet. The understory of this community is characterized by an herbaceous layer dominated by Santa Ana River wooly star. Incidental occurrences of scale broom and valley cholla were noted. The understory within the buckwheat community is underlain by sandy soils, gravel deposits, and gently undulating terrain.

The northernmost point of Transect 1 is characterized by scale broom which occurs up to six and a half feet high with interval spacing of two to five feet and a scattered understory of prickly pear cactus. California buckwheat occurs sporadically in the shrub layer. The scale broom community is slightly higher in elevation than the California buckwheat community (up to 3 feet). The substrate is characterized by large gravel. Field observations indicate that vegetative species diversity increases from south to north.

Transect 2 was located approximately 200 feet east of Transect 1. The initiation point for Transect 2 is characterized by an herbaceous layer dominated by groundsel. This shrub layer continues northward in a corridor approximately 60 to 65 feet in width. The groundsel ranges up to two feet high and is spaced at two to four feet intervals with an understory of Santa Ana River wooly star. The substrate is composed of gravel deposits and gently undulating terrain.

As seen in Transect 1, the ground slopes approximately 2 degrees in a northward direction. With the slight increase in slope, the vegetative community changes into a shrub layer dominated by California buckwheat. The buckwheat range up to three feet high and are spaced at intervals of one to three feet. Incidental scale broom was also noted in the shrub layer. The understory was characterized by an herbaceous layer dominated by Santa Ana River wooly star.

Again, as in Transect 1, the slope of the land surface increases in a northerly direction. With the increase in elevation, the vegetative community changes to a scale broom/California buckwheat dominated shrub layer. The shrub layer ranges from three to seven feet high with spacing intervals from one to three feet. The understory is characterized by valley cholla and Santa Ana River wooly star with large gravel in the soil.

Transect 3 was initiated 200 feet east of Transect 2. The initiation point for Transect 3 was characterized by an herbaceous layer dominated by the groundsel. This layer extends to 2 feet high and is spaced at intervals of two to four feet. The gently undulating sandy soil is intermixed with gravel deposits. The understory includes incidental occurrences of Santa Ana River wooly star and prickly pear cactus. The groundsel extends northward in a 45 feet wide corridor.

As previously described, the land elevation increases in a northerly direction. However, the increase in slope was noticeably less in Transect 3 than in the previous two transects. As elevation increases, the vegetative community transitions into a shrub layer dominated by California buckwheat. The buckwheat community extends to three and a half feet high and is spaced at intervals from three and half to seven feet. The community extends northward in a corridor approximately 200 feet wide and is associated with incidental occurrences of Santa Ana River wooly star. Its substrate is characterized by sandy soil.

The vegetation in Transect 3 once again changes as land elevation increases. The northern extent of the transect is characterized by a shrub layer dominated by scale broom. The scale broom community extends to six feet high with clumps spaced at three foot intervals with an understory of California buckwheat.

While Transect 3 contained similar vegetative communities to that of Transects 1 and 2, the vegetation in each community type is noticeably thinner, and the substrate contains patches of barren sandy soil.

Transect 4 was initiated 200 feet east of Transect 3. The initiation point for Transect 4 is characterized by a shrub layer dominated by California buckwheat which extends up to three and a half feet high. Clumps of the buckwheat are spaced at intervals of one to three feet. The understory is characterized by an herbaceous layer dominated by Santa Ana River wooly star with incidental occurrences of prickly pear cactus. This vegetative community continues northward for 20 feet before being interrupted by a dirt access road.

A slight increase in elevation results in a change in the vegetative community, with an herbaceous layer co-dominated by Santa Ana River wooly star and groundsel. The herbaceous layer extends to two and a half feet and is spaced at intervals of two to three feet. The herbaceous layer continued northward in a corridor approximately 60 feet wide. Its substrate is characterized by sandy soil and gravel deposits. Continuing northward and up in elevation, the vegetation changes to California buckwheat as the dominant shrub layer with heights from two and a half to three feet. The shrub clumps are thinly spaced at intervals from one to ten feet with incidental occurrences of Santa

Ana River wooly star. The California buckwheat dominated shrub layer continues 120 feet to the north before being interrupted by the perimeter road. A single cottonwood tree, approximately 20 feet high and ten inches DBH, was noted at the northernmost point of the transect.

Transect 4 is located in a disturbed area impacted by the installation of a monitoring well approximately 50 feet east of the transect line.

Generally, the western sections of the reference area (Transect 1 and 2) are characterized as areas supporting greater plant species diversity than the remainder of the reference area.

The eastern section of the reference area is apparently impacted by biotic and mechanical stresses (i.e., soil compaction and grading). Both transects in the eastern section are less vegetated than the western transects.

The southern extent of all four transects is noted to be thinly vegetated with low species diversity. One explanation could be the low nutrient availability of younger river deposits.

Conversely, the northern extent of all four transects were noted to be the most densely vegetated and diverse areas. These areas could represent older river deposits with a higher nutrient availability able to support a higher species diversity.

Field observation of signs and animals indicated use of the area by deer, coyote, desert cottontail, black-tailed jack rabbit, side-blotch lizard (*Uta stansburiana*), beetles, grasshoppers, and numerous bird species (Table 2).

#### **5.4.5 Base Urban Areas**

A screening assessment of the base urban areas was conducted in an effort to informally characterize the flora and fauna common to those areas. Base areas were characterized by parcel designation (Fig. 7). It should be noted that all habitats in this area have been highly impacted by base urban activities.

Parcels D and F are located in the northeast section of the base. Both parcels consist of mostly paved and concrete areas. There are several base buildings located on both parcels which are no longer used. Landscape species such as oleanders, fan palms, coast live oaks, eucalyptus, and junipers line the streets.

Open field and areas no longer maintained for weed control support opportunistic species such as sand bur, black mustard, castor bean, and telegraph weed.

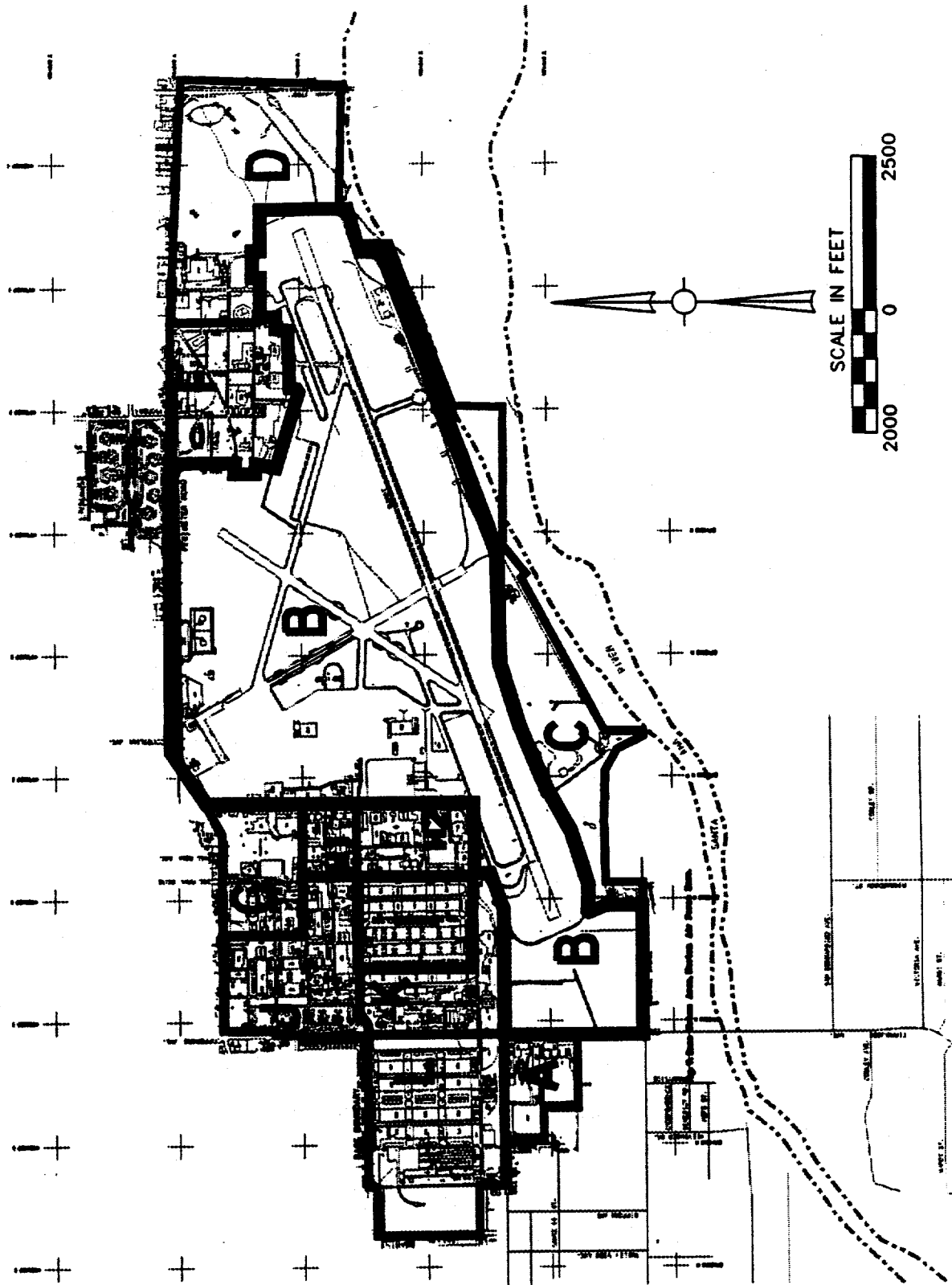


Fig. 7. Base Urban Area, Norton Air Force Base.

The central base consists of parcels J, G, H1, H2, and K. Base housing, warehousing operations, and offices were all once located within these parcels. Many of the existing buildings are no longer used by the base; however, the areas are still maintained for weed control. Mowing and irrigation activities were observed at the time of the assessment.

Landscape and ornamental species were identified throughout the central base parcels. These include coastal live oak, fan palms, pine, and oleander. Most buildings had maintained grass lawns. Burrowing owls have been documented in the area (Wade and Barnett 1994).

Parcels A and L are located in the western section of the base. These parcels consist mainly of abandoned warehousing buildings and paved or concrete surfaces. Vegetation is limited to opportunistic species lining the base roads and base perimeter fence. These species included tree tobacco, black mustard, bunch grasses, and sand bur.

Bird species observed in the base urban areas include dove, woodpecker, kingbird, phoebe, jay, crow, raven, starling, and mockingbird (Table 2).

#### **5.4.6 Habitat Assessment—General Conclusions**

Norton Air Force Base is built on fill material that has covered a portion of the original Santa Ana River floodplain. A flood control levee has also been constructed out of fill material along the southern portion of the base. These actions have replaced the native soil and have increased the elevation of the soil substrate. Both actions probably inhibit the natural succession of vegetation that originally occurred prior to the base and the flood control levee construction. In addition, Sites 2 and 5 have been impacted from clearing, grading, and compaction of soil. These factors also inhibit the natural succession process.

The existence of the levee to the south of the base may result in an adverse effect on the population of Santa Ana River wooly star that currently exists on the base. These early successional species are dependent on soil scouring that occurs during periodic flooding in order to remain viable. In the absence of scouring (due to the presence of the flood control levee and the current elevation of the base), the wooly star is replaced by other species as succession progresses. Regular mowing (rather than the natural scouring process) in the eastern part of the base may be one factor resulting in the maintenance of the vegetation in an early successional stage in this area.



## 6. CONCLUSIONS

One result of the fall 1994 survey was the identification of the potential ecological receptors as shown in Table 4. This table has been refined since the spring 1994 survey. These animals are potential ecological receptors because they are key components of the Norton AFB ecological food chain, they use habitats on or near the IWTP area and Sites 2 and 5 (sites warranting the preparation of an ERA), and there is sufficient toxicological data available for these species or acceptable surrogate species. The list of receptors may change after subsequent wildlife surveys [winter of 1994 (if necessary) and spring of 1995] are completed. Site-specific food webs will be constructed and detailed in the ERA. To develop a site conceptual model, this information will be combined with information regarding contaminant sources, release mechanisms, ecological receptors, and routes of exposure.

**Table 4. Potential ecological receptors at Norton  
Air Force Base**

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California ground squirrel ( <i>Citellus beecheyi</i> )
Desert cottontail ( <i>Sylvilagus audubonii</i> )
Coyote ( <i>Canis latrans</i> )
American kestrel ( <i>Falco sparverious</i> )
Gambel's quail ( <i>Callipepla gambelli</i> )
Burrowing owl ( <i>Athene cunicularia</i> )
Western meadowlark ( <i>Sturnella neglecta</i> )
Western fence lizard ( <i>Sceloporus occidentalis</i> )

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## 7. REFERENCES

- Burt, W. H., and R. P. Grossenheider. 1976. *A Field Guide to the Mammals*, Peterson Field Guide Series, Houghton Mifflin, Boston.
- CDM Federal. 1993. *Final Remedial Investigation Report, Installation Restoration Program Sites, Operable Unit (15 Sites)*, Norton Air Force Base, San Bernardino, California, March 17.
- CDM Federal. 1994a. *Final Remedial Investigation Report, Addendum No. 1, Installation Restoration Program Sites, Operable Unit*, Norton Air Force Base, San Bernardino, California, June 16.

- CDM Federal. 1994b. *Final IRP Sites 2 and 10, Landfill Investigation, Data Report, Addendum No. 2 to the IRP Sites Operable Unit (15 Sites) Remedial Investigation Report*, Norton Air Force Base, San Bernardino, California, June 16.
- Fish and Wildlife Service. 1990. *Planning Aid Report, Biological Resources—Norton Air Force Base Closure*, U.S. Department of the Interior, Fish and Wildlife Service, Southern California Field Station, Laguna Niguel, Calif., December 20.
- MacMahon, J. A. 1985. *Audubon Nature Guide Series: Deserts*, Alfred A. Knopf, New York.
- National Geographic Society. 1983. *Field Guide to the Birds of North America*, ed. S. L. Scott, National Geographic Society, Washington, D.C.
- Peterson, R. T. 1990. *Western Birds*, Peterson Field Guides, Houghton Mifflin, Boston.
- Wade, M. C. and R. Barnett. 1994. *Spring 1994 Wildlife Survey, Norton Air Force Base, California*, ORNL/TM-12798, Oak Ridge National Laboratory, Oak Ridge, Tennessee. August 17.

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