BASELINE DATA REPORT

Section 4.0

Vegetation

January 2011

Revision 1

Submitted To:

New Mexico Mining and Minerals Division
&
U.S. Forest Service (Cibola National Forest)
&
New Mexico Environment Department

Prepared by:

Roca Honda Resources, LLC
4001 Office Court, Suite 102, Santa Fe, NM 87507

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4.0 Vegetation

NMAC 19.10.6.602 D.(13) (c)

Provide a map which delineates existing vegetation types and a description, including cover, density and productivity of the plant communities within the proposed permit area. The description of the vegetation types and plant communities may be based upon data from adjacent areas if vegetation in the permit area has been adversely impacted by previous mining operations or other disturbances. Included in this description shall be the results of an inventory conducted for any sensitive, threatened or endangered plant species within the permit area.

4.1 Introduction

A general account of the plant communities in Sections 9, 10, and 16 is given in this section. Initial vegetation surveys were performed by Permits West, Inc. (PWI) at the Roca Honda permit area from July 31 through August 8, 2006 on Sections 9, 10, and 16 and from September 11 through October 19, 2006 on Sections 9 and 10. These reports are included at the back of this section as Appendix 4-A, Vegetation Survey, Section 16 and Appendix 4-B, Vegetation Survey, Sections 9 and 10. Surveys to measure cover, density, and productivity of the plant communities within the permit area, including access roads, were initiated in spring 2008 and completed in 2010. The results of these surveys are contained in Appendix 4-C, Vegetation Cover, Density and Productivity Surveys, Sections 9, 10,11, 12, 16, and 27. The surveys included an inventory of sensitive, threatened, or endangered plant species. Complete lists of all the species found at the site are tabulated in these reports. A vegetation map of the permit area was also developed from the survey data.

4.2 Existing Vegetation Types

The Roca Honda permit area encompasses Sections 9, 10, and 16 of T13N R8W. Figure 4-1 is a vegetation map which shows the five vegetation types: juniper-savanna, piñon-juniper woodland, ponderosa pine-pinon-juniper, semi-stable dune, and shrub-grassland. More detailed vegetation maps are contained in Appendix 4-C. Jesus Mesa occupies approximately half of Section 9 and slopes into Section 10. The top and upper portion of the mesa is mostly open piñon-juniper woodland with some juniper-savanna and scattered stands and individual ponderosa pine. The perimeter of the mesa consists of sandstone ledges with areas of exposed shale, particularly to the south of the mesa. The landscape southwest, north, and southeast of the mesa is predominantly juniper-savanna and shrub-grassland, with a large area of wooded slopes on the southeast side between the mesa and the lower juniper-savanna and shrub-grassland. These slopes are frequently dissected by drainages that can range from a few to 40 ft deep. There are several areas of semi-stabilized sand dunes that form their own vegetation type.

Within the desert grassland community, the dominant grasses are hairy and blue grama (*Bouteloua hirsute and bouteloua gracilis*), with galleta (*Pleuraphis jamesii*) common throughout and sand dropseed (*Sporobolus cryptandrus*) common in some areas. There are a few areas of little bluestem (*Schizachyrium scoparium* var. *scoparium*) on the southeast side. The ground cover is dominated by garden purslane (*Portulaca oleracea*), changing to kiss-me-quick (*Portulaca pilosa*) in the sandiest areas, with Wislizenus's threadleaf (*Schkuhria pinnata* var.

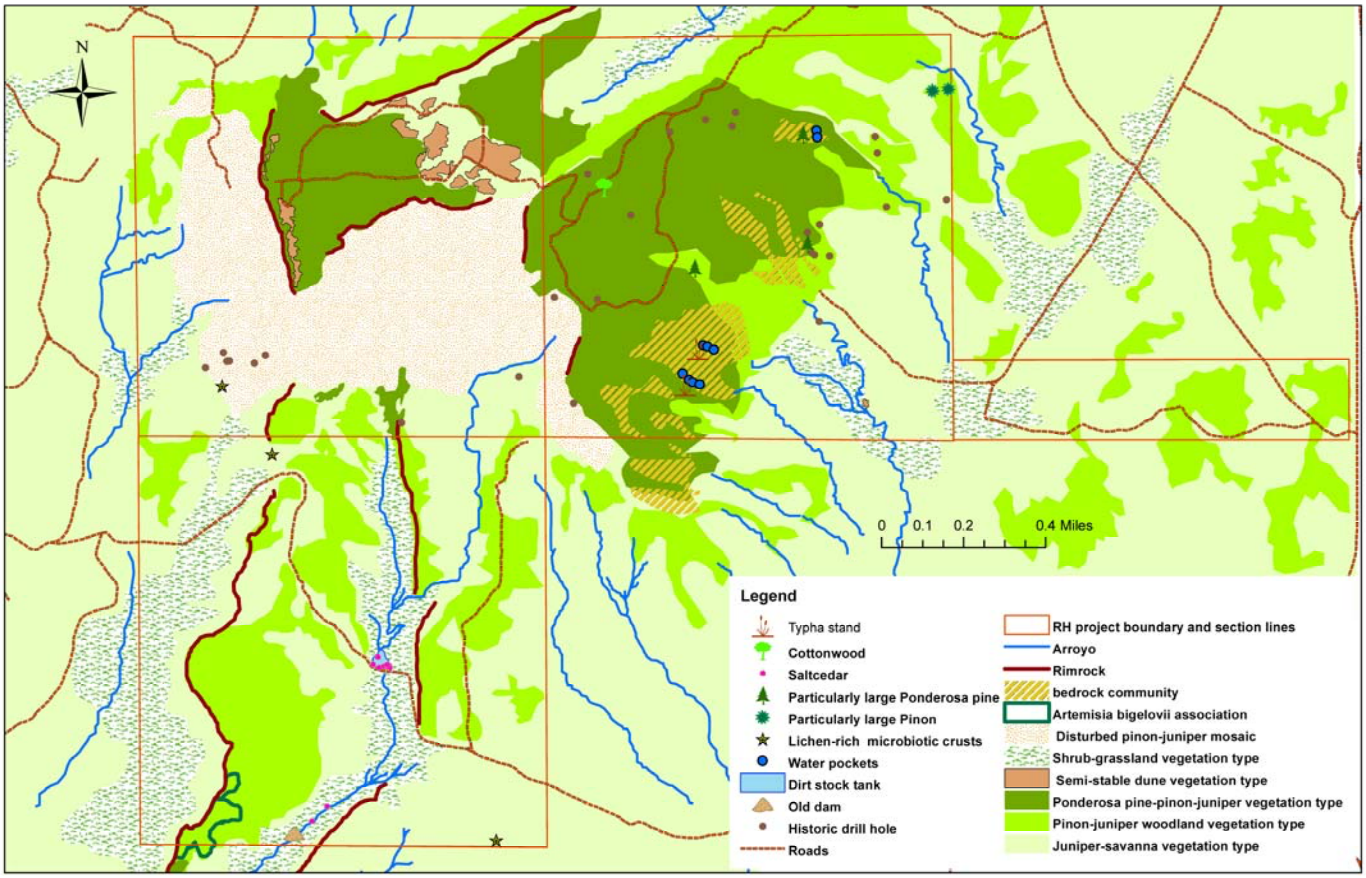


Figure 4-1. Vegetation Classification in the Roca Honda Permit Area

wislizeni) frequent throughout. Dodder (*Cuscuta* sp.) appears to be growing on a large percentage of the garden purslane.

Other common forbs include spiderwort (*Tradescantia occidentalis*), tufted evening-primrose (*Oenothera caespitosa*), and flixweed (*Descurainia sophia*). The southeast corner of the Roca Honda permit area has several areas dominated by Russian-thistle (*Salsola tragus*) with smotherweed (*Bassia hyssopifolia*) and American bugseed (*Corispermum americanum* var. *americanum*). There are widely scattered oneseed juniper (*Juniperus monosperma*), piñon pine (*Pinus edulis*), and four-wing saltbush (*Atriplex canescens*).

The pinon-juniper woodland mostly consists of piñon pine and oneseed juniper. A few ponderosa pines (*Pinus ponderosa*) are on the top of Jesus Mesa and along the southeast drainages. There are some Rocky Mountain junipers (*Juniperus scopulorum*) at the head of the drainage on the north side of Jesus Mesa. Within the pinon-juniper woodland, hairy and blue grama are often the dominant ground cover with cliffrose (*Purshia stansburiana*) and common mountain mahogany (*Cercocarpus montanus*) the most common shrubs. Common forbs include fragrant snakeroot (*Ageratina herbacea*) and thyme-leaf spurge (*Chamaesyce serpyllifolia*). Under the trees, fetid-goosefoot (*Dysphania graveolens*), Colorado four-o'clock (*Mirabilis multiflora*), and Fendler's drymary (*Drymaria glandulosa*) are very common. In the sandiest areas, field wormwood (*Artemisia campestris* var. *caudata*), flat sagebrush (*Artemisia bigelovii*), spectacle-pod (*Dimorphocarpa wislizeni*), kiss-me-quick, spiderwort, and fine-leaf woolywhite (*Hymenopappus filifolius*) are common.

The rocky slopes of Jesus Mesa support a similar plant community of scattered piñon pine and oneseed juniper with hairy and blue grama quite common. Common shrubs include flat sagebrush and cliffrose. New Mexico muhly (*Muhlenbergia pauciflora*), and both plumed and California brickellbush (*Brickellia brachyphylla* and *B. californica*, respectively) are also common. Santa Fe lipfern (*Cheilanthes feei*) and brittle bladder-fern (*Cystopteris fragilis*) are occasional at the bases of the rocks. The few shale slopes are mostly barren, but do support a few piñon pines, oneseed juniper, Colorado four-o'clock, galleta, and a four-wing saltbush. At the rocky rims of the mesa and drainages are black sagebrush (*Artemisia nova*), flat sagebrush, and common mountain mahogany.

The canyons on the southeast side of the mesa reach depths of 30 to 40 ft and support a few ponderosa pines within a piñon-juniper woodland. The most common plants include broom groundsel (*Senecio spartioides* var. *multicapitatus*), tassel-flower brickellbush (*Brickellia grandiflora*), and hairy grama.

There are several small water pockets that apparently gather along some of the drainages off Jesus Mesa. Some of these support small communities of wetland plants. These communities include scratchgrass (*Sporobolus contractus*), mesa dropseed (*Sporobolus flexuosus*), straw-color flat-sedge (*Cyperus strigosus*), sand dropseed, rush (*Juncus* sp.), pale spikerush (*Eleocharis macrostachya*), and even cattail (*Typha domingensis*). The drainages on the west and north sides of the mesa are within sandier soils in a juniper-savanna or shrub-grassland. In these drainages the common plants are hairy and blue grama, rubber rabbitbrush (*Ericameria nauseosa* var. *graveolens*), and sage (*Salvia* prob. *incisa*).

There are occasional stabilized and semi-stabilized sand dunes throughout the permit area, particularly to the west, northwest, and east of Jesus Mesa. These areas support a variety of sand-dependent plants, including sandhill muhly (*Muhlenbergia pungens*), spectacle pod, sand sage (*Artemisia filifolia*), spiderwort, Bigelow's rubber rabbitbrush (*Ericameria nauseosa* var. *bigelovii*), kiss-me-quick, and field wormwood.

Section 16 consists of juniper-savanna and shrub-grassland mixed with piñon-juniper woodland. The largest drainage basin begins from the base of Jesus Mesa and runs south and southwest just east of the center of Section 16. There are smaller drainages generally running southeast from the highest point in Section 16 on unnamed mesa at 7292 ft elevation (mesa 7292). On both the west and east sides of mesa 7292, drainages exist with steep slopes and cliffs up to 50 ft in height.

The area east of mesa 7292 is grazed shrub-grassland or juniper-savanna. The dominant grass is hairy and blue grama, with several areas of ring muhly (*Muhlenbergia torreyi*); however, much of the area is dominated by carpets of garden purslane, with other annuals in abundance. The most common of these annuals are Colorado rubberweed (*Hymenoxys richardsonii* var. *floribunda*), wild potato (*Solanum jamesii*), and both spotted and thyme-leaf spurge (*Chamaesyce maculata* and *C. serpyllifolia*, respectively). Another plant found in abundance is dodder (*Cuscuta* sp.), which is apparently parasitizing the garden purslane.

The rest of the Roca Honda permit area is piñon-juniper woodland with areas of shrub-grassland. Oneseed juniper (*Juniperus monosperma*) is much more common than piñon (*Pinus edulis*), but is usually widely scattered. There are very few understory shrubs, although flat sagebrush is common along the rims of the mesas where there is more exposed bedrock. Cliffrose is occasional along the drainages. Again, garden purslane is quite common, with kiss-me-quick replacing it in sandier areas. Colorado four o'clock is common both under the Utah junipers and in the open.

There is one seasonal dirt stock tank in the center of Section 16. The plants dominating this man-made tank include Mexican fireweed (*Kochia scoparia*), Russian thistle (*Salsola tragus*), and golden crownbeard (*Verbesina encelioides*), rubber rabbitbrush (*Ericameria nauseosa* var. *graveolens*), saltcedar (*Tamarix chinensis*), and foxtail barley (*Hordeum jubatum*).

4.3 Vegetation Cover, Density, and Productivity

Appendix 4-C provides a detailed description of vegetation cover and density in the permit area. The report also provides detailed plant species inventory, and quantitative estimates of vegetation and ground cover, shrub and tree density and grass (herbaceous) productivity.

Briefly, PWI identified five vegetation types on the permit area;

1. Juniper Savanna
2. Piñon-Juniper Woodland
3. Ponderosa Pine-Piñon-Juniper
4. Semi-Stabilized Dune
5. Shrub-Grassland

Each of these vegetation types were mapped and analyzed in significant detail and the results can be found in Appendix 4-C.

4.4 Sensitive, Threatened, or Endangered Species

4.4.1 Federally Listed Threatened and Endangered Plant Species

The U.S. Fish and Wildlife Service (USFWS) lists two federally threatened plant species that occur in McKinley and Cibola Counties, New Mexico. Table 4–1 lists these species with their protection status, habitat requirements, and potential to occur in the Roca Honda permit area. The federally listed species do not have appropriate habitat within the Roca Honda permit area, and no plants of these species were found during surveys.

4.4.2 State of New Mexico Listed Threatened and Endangered Plant Species

There are fifteen plant species listed by the State of New Mexico as Endangered, Threatened, or Species of Concern (SOC) that are known to occur in McKinley and Cibola Counties. Two of these species are federally listed and are addressed in Table 4–1. The remaining thirteen species are listed in Table 4–2. Two of the species have the potential to occur in the Roca Honda permit area: Naturita milkvetch (*Astragalus naturitensis*) and Laguna fame flower (*Talinum brachypodium*). These species are discussed in more detail below.

The permit area contains bedrock exposures of the Point Lookout Sandstone, Crevasse Canyon Formation (Gibson Coal and Dalton Sandstone Members), and Mulatto Tongue of the Mancos Shale. Bedrock is eroded in many places, but sandstone and shale is exposed in some places in ledges and rimrock. This environment provides limited areas of potential habitat for both Naturita milkvetch and Laguna fame flower. Two species of milkvetch were observed within the permit area, but neither matched Naturita milkvetch in habitat or vegetative characters. One species of *Phemeranthis* (formerly included in *Talinum*) was observed. However, both vegetative and floral characteristics are quite different from Laguna fame flower.

Table 4-1. USFWS Listed Endangered, Threatened, or Candidate Plants, McKinley and Cibola Counties, New Mexico

Species/Status	Habitat and Distribution	Potential to Occur in the Permit Area
Erigeron rhizomatus Zuni fleabane Threatened	Nearly barren detrital-clay hillsides with soils derived from shales of the Chinle or Baca Formations (often seleniferous), most often on north or east facing slopes in open piñon-juniper woodlands at 7,300–8,000 ft. Known from McKinley County (NMRPTC 1999 and Roth 2001c).	No appropriate habitat. There are no shales of the Chinle or Baca formations in the permit area. Most of the permit area is below the altitudinal range for this species.
Helianthus paradoxus Pecos sunflower Threatened	Saturated saline soils of desert wetlands. Usually associated with desert springs or the wetlands created from modifying desert springs, and from 3,300–6,600 ft. Known from Cibola County (NMRPTC 1999).	No appropriate habitat. There is one area with saturated soils created by damming a drainage; however, the area is not saline. The permit area is above the altitudinal range of the species.

Table 4-2. State of New Mexico Endangered, Threatened, or Species of Concern Listed Plants McKinley and Cibola Counties

Species/Status	Habitat and Distribution	Potential to Occur in the Permit Area
Astragalus chuskanus Chuska milkvetch SOC	Degraded Chuska Sandstone in openings in montane coniferous forest above 5,500 ft. Known from McKinley County (NMRPTC 1999).	No appropriate habitat. There is no Chuska Sandstone in the permit area.
Astragalus micromerius Chaco milkvetch SOC	Gypseous or limy sandstones in piñon-juniper woodland or Great Basin desert scrub from 6,600–7,300 ft. Known from McKinley County (NMRPTC 1999).	No appropriate habitat. No gypseous or limy sandstone was observed in the permit area.
Astragalus missouriensis var. *acumbens* Zuni milkvetch SOC	Gravelly clay banks and knolls, in dry alkaline soils derived from sandstone, in piñon-juniper woodland from 6,200–7,900 ft. Known from McKinley and Cibola Counties (NMRPTC 1999).	No appropriate habitat. No gravelly clay banks or knolls are present in the permit area. The soils in the permit area are not saline.
Astragalus naturitensis Naturita milkvetch SOC	Sandstone ledges and rimrock along canyons in piñon-juniper woodland from 5,000–7,000 ft. Known from McKinley County (NMRPTC 1999 and Roth 2001a).	Limited areas of potential habitat could exist along the rim and ledges of the low unnamed mesa in the permit area. No *Astragalus* matching this distinctive species was observed.
Erigeron acomanus Acoma fleabane SOC	Sandy slopes and benches beneath sandstone cliffs of the Entrada Sandstone in piñon-juniper woodland; from 6,900–7,100 ft. Known from McKinley and Cibola Counties (NMRPTC 1999 and Roth 2001b).	No appropriate habitat. There is no Entrada in the permit area.
Erigeron svinskii Sivinski's fleabane SOC	Steep barren shale slopes of the Chinle Formation in piñon-juniper woodland and Great Basin desert scrub from 6,100–7,400 ft. Known from McKinley County (NMRPTC 1999 and Roth 2001d).	No appropriate habitat. There is no Chinle Formation cropping out in the permit area.
Helianthus praetermissus *Lost sunflower* *SOC*	Perhaps wet ground based on the collection locality for the only specimen. This species is known only from the type specimen collected in 1851 on the Sitgreaves expedition at the head of the Rio Laguna (now Rio San Jose) at Ojo de la Gallina, Cibola County. This species may have been named from a depauperate specimen of Helianthus paradoxus.	There is wet ground in the permit area associated with a man-made cattle pond; however, the permit area is not near the only known location for the species near the Zuni Mountains.
Penstemon deaveri *Mount Graham beardtongue* *SOC*	Slopes and rocky areas from ponderosa pine forest to above timberline; from 6,500–11,280 ft. Known from Cibola County (NMRPTC 1999).	No appropriate habitat. There are no ponderosa pine forest or plant communities associated with higher elevations in the permit area.
Phacelia serrata *Cinders phacelia* *SOC*	In deep volcanic cinders, primarily associated with volcanic cones, but also in roadcuts and abandoned quarries in open, exposed, sunny locations; near ponderosa pine and piñon-juniper woodlands from 5,900–7,200 ft. Known from Cibola County (NMRPTC 1999).	No appropriate habitat. There are no areas of volcanic cinders in the permit area.
Physaria navajoensis *Navajo bladderpod* *SOC*	Windswept mesa rims of Todilto Limestone in sparse piñon-juniper woodland from 7,200–7,600 ft. Known from McKinley County (NMRPTC 1999 and Roth 2001e).	No appropriate habitat. There is no Todilto Limestone cropping out in the permit area. Most of the permit area is lower than the altitudinal range of the species.

Table 4-2. (Continued)

Species/Status	Habitat and Distribution	Potential to Occur in the Permit Area
Physaria newberryi var. *yesicola* Yeso bladderpod SOC	Nearly barren badlands of sandy gypsum and silty strata of the Yeso Formation in short grass steppe and juniper savanna; from 5,700–6,900 ft. Known from Cibola County (NMRPTC 1999).	No appropriate habitat. There is no Yeso Formation cropping out in the permit area. Most of the permit area is higher than the altitudinal range of the species.
Puccinellia parishii Parish's alkali grass Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes from 2,600–7,200 ft; the species requires continuously damp soils during its late winter to spring growing period. Known from McKinley and Cibola Counties (NMRPTC 1999 and Roth 2001f).	No appropriate habitat. There are no seasonally wet alkaline areas in the permit area.
Talinum brachypodium Laguna fame flower SOC	Very shallow pockets of calcareous silt to clay soils overlying limestone or travertine, or fine silty sand overlying calcareous sandstones; open piñon-juniper woodland with little understory and scattered cacti and shrubs or Chihuahuan desert scrub. Known from Cibola County (NMRPTC 1999).	Limited areas of potential habitat could exist on the low mesa in the permit area. Some of the sandy loam soil does have a high component of silt in it. No plants of this species were observed.

4.5 References

New Mexico Bureau of Geology and Mineral Resources, 2003. *Geologic Map of New Mexico*, New Mexico Bureau of Geology and Mineral Resources, scale 1:500,000.

NMRPTC (New Mexico Rare Plant Technical Council), 1999. New Mexico Rare Plants, Albuquerque, New Mexico, New Mexico Rare Plants Home Page (http://nmrareplants.unm.edu), revised 11 January 2005.

Roth, Daniela, 2001a. Species account for *Astragalus naturitensis*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001b. Species account for *Erigeron acomanus*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001c. Species account for *Erigeron rhizomatus*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001d. Species account for *Erigeron svinskii*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001e. Species account for *Lesquerella navajoensis*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February 2005.

———, 2001f. Species account for *Puccinellia parishii*, Navajo Natural Heritage Program (http://navajofishandwildlife.org/nnhp), revised 15 February, 2005.

Wood, B., 2006a. Strathmore Minerals Corp., Roca Honda Sections 9 & 10, Botanical Report, December 26, 2006.

———, 2006b. Strathmore Minerals Corp., Roca Honda State Section, Botanical Report, October 7, 2006.

______, 2009, Vegetation Baseline Data for Roca Honda Resources, LLC., Roca Honda Project, 2008 Field Season, On State and Federal Lands (Cibola National Forest) Sections 9, 10, and 16, T13N, R8W, McKinley County, New Mexico.

Appendix 4-A

Roca Honda Permit Area
Vegetation Survey
Section 16

PERMITS WEST, INC.
PROVIDING PERMITS for LAND USERS
37 Verano Loop, Santa Fe, New Mexico 87508   (505)466-8120

STRATHMORE MINERALS CORP.
ROCA HONDA STATE SECTION
BOTANICAL REPORT

This report discusses the potential for disturbance to endangered, threatened, and other designated sensitive flora listed by Federal and State of New Mexico agencies that may occur in the project area. The project area encompasses the 640 acres comprising all of Section 16, T13N R8W, McKinley County, New Mexico. Section 16 (see next three figures) is owned by the State of New Mexico and is administered by the New Mexico State Land Office. Strathmore Minerals Corp. holds State General Mining Lease HG-0036-0001.

PROJECT DESCRIPTION

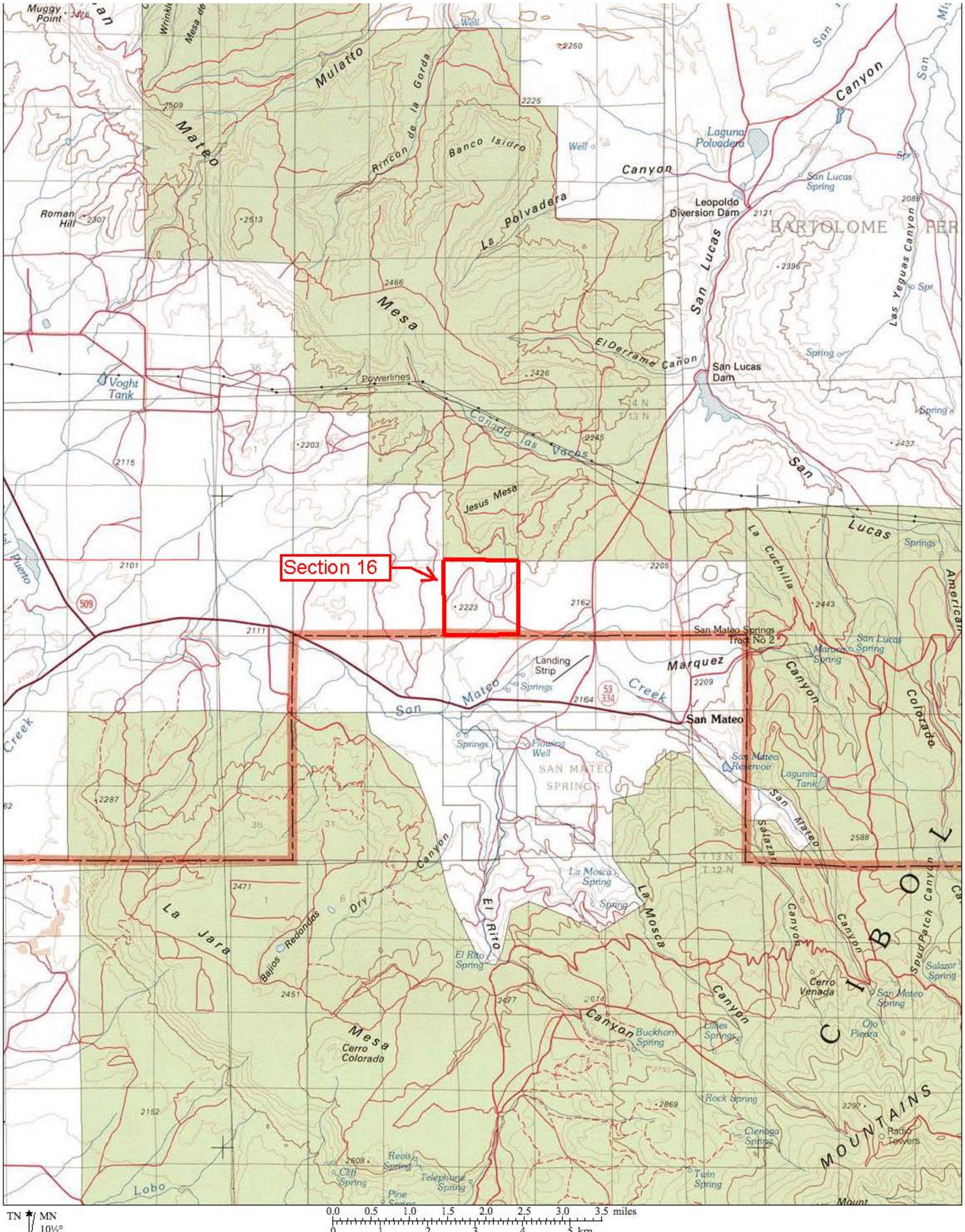
Disturbance: There are several existing dirt roads and jeep trails in the area. Parts of the project area have been test-drilled in the past. The test drill holes are sometimes marked by exposed pipes (see picture at end of report). The majority of the project area has been heavily grazed by cows, with little undisturbed land left.

Compilation of Rare Species Data: Prior to the field work, a list was compiled of the Federal (USDI, USFWS, 2005) and State of New Mexico (NMRPTC, 1999) sensitive plant species known to occur in both McKinley County, in which the project area occurs, and Cibola County, which borders the south side of Section 16.

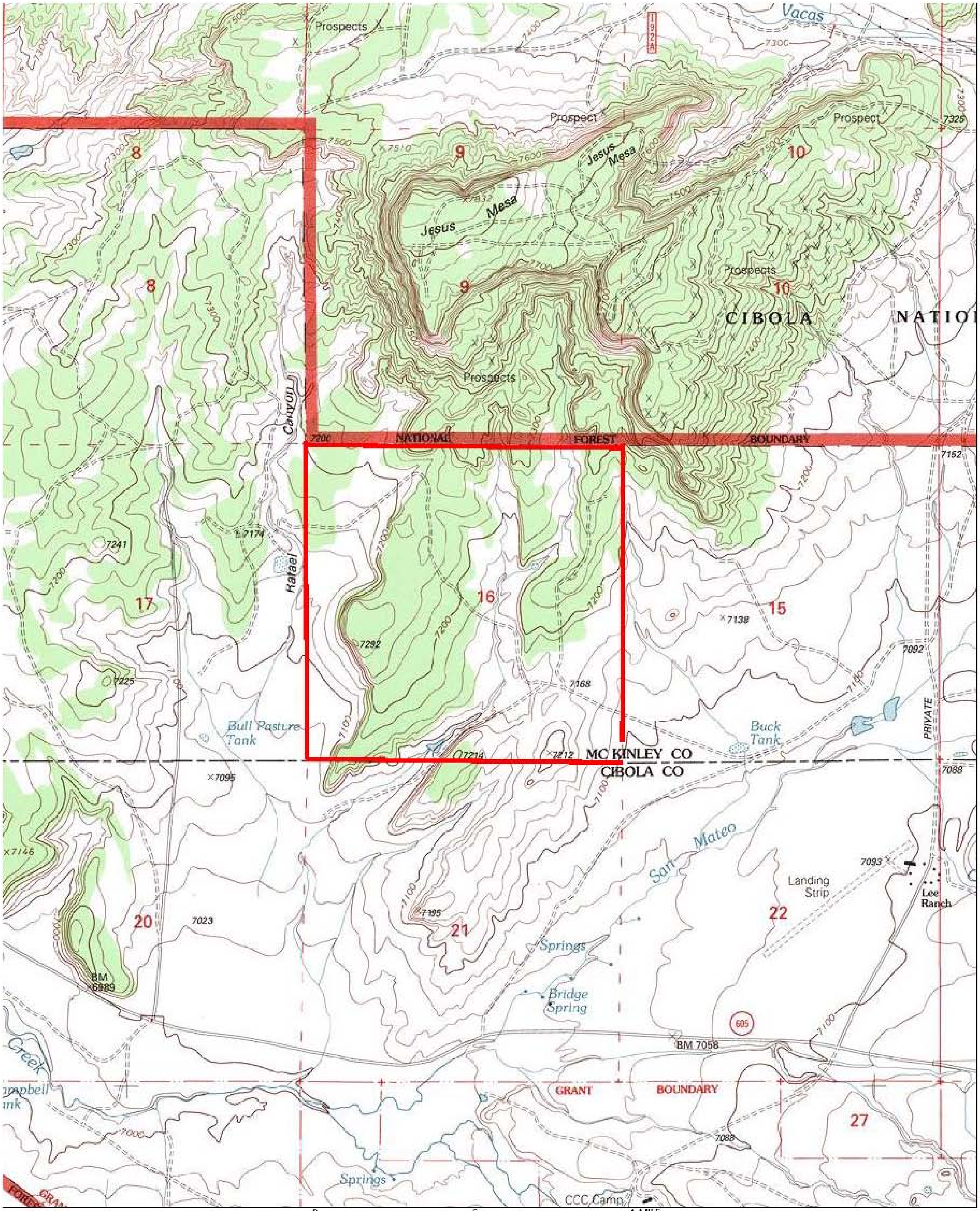
PROJECT AREA

Location: The proposed project is approximately 15 air miles northeast of Grants and 2 air miles northwest of San Mateo. The elevation of the section ranges from 7,070 feet to 7,300 feet. Aspect is generally to the south.

Description: Section 16 consists of heavily grazed desert grassland and very open piñon-juniper woodland (see pictures at end of report). The largest drainage (intermittent) starts from the base of Jesus Mesa and runs south and southwest just east of the center of the project area. There are several smaller drainages (all intermittent) generally running southeast from mesa 7292'. The west side of mesa 7292' and the east side of the major drainage consist of steep slopes and cliffs up to 50 feet in height.



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)



TN MN 10½°

0 .5 1 MILE
0 1000 FEET 0 500 1000 METERS

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Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

PERMITS WEST, INC.
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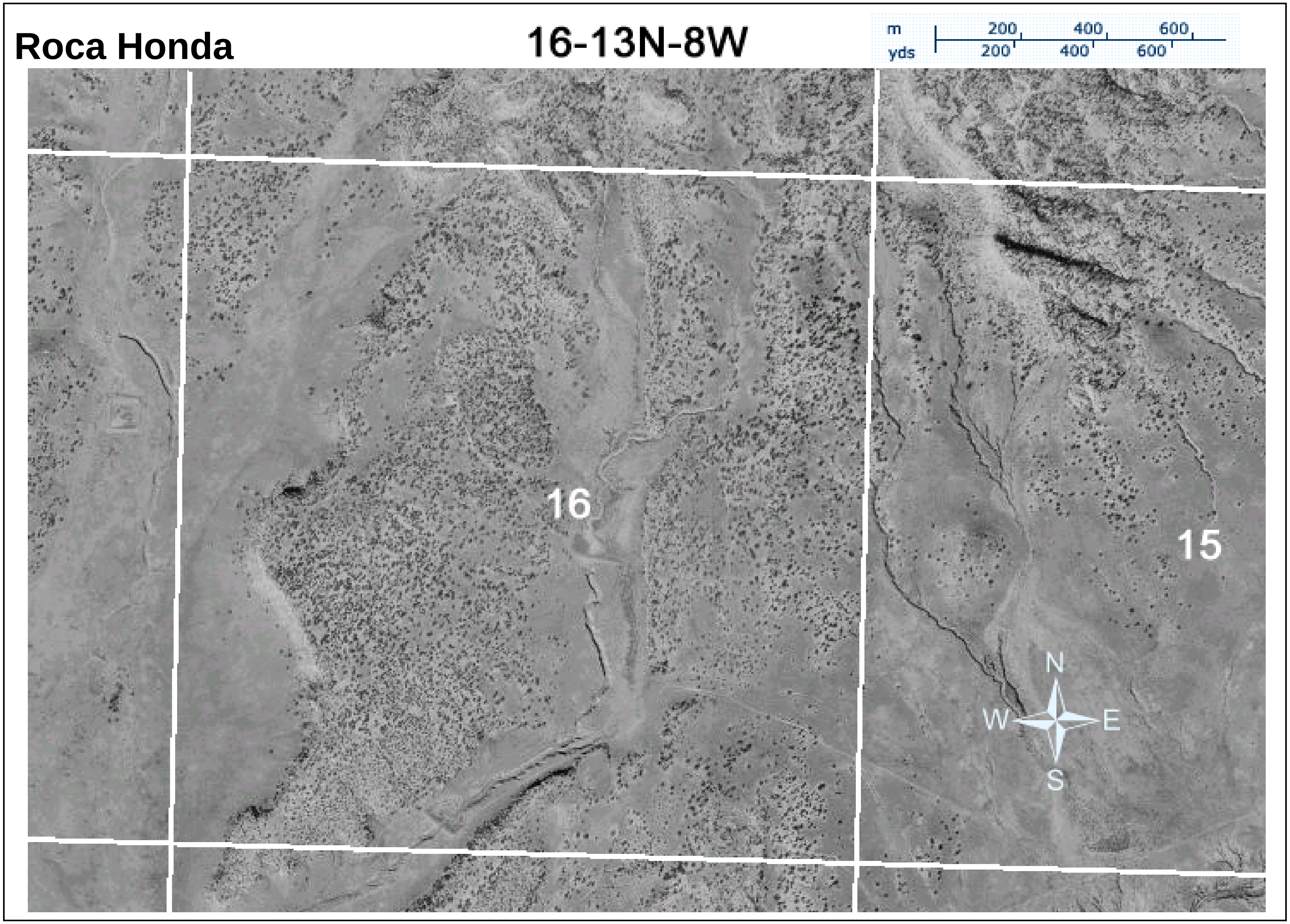
Roca Honda



PERMITS WEST, INC.
PROVIDING PERMITS for LAND USERS

The area east of mesa 7292’ is heavily grazed desert grassland. The dominant grass is hairy grama (*Bouteloua hirsuta*) with several areas of ring muhly (*Muhlenbergia torreyi*). However, much of the area is dominated by carpets of garden purslane (*Portulaca oleracea*) with other annuals in abundance. The most common of these annuals are Colorado rubberweed (*Hymenoxys richardsonii* var. *floribunda*), wild potato (*Solanum ja*mesii), and both spotted and thyme-leaf spurge (*Chamaesyce maculata* and *C. serpyllifolia*, respectively). Another plant in abundance is dodder (*Cuscuta* sp.), apparently parasitizing the garden purslane.

The rest of the project area is very open piñon-juniper woodland with areas of desert grassland. Utah juniper (*Juniperus osteosperma*) is much more common than piñon (*Pinus edulis*), but is usually widely scattered. There are very few understory shrubs, although flat sagebrush (*Artemisia bigelovii*) is common along the rims of the mesas where there is more exposed bedrock. Cliffrose (*Purshia stansburiana*) is occasional along the drainages. Again, garden purslane is quite common, with kiss-me-quick (*Portulaca pilosa*) replacing it in sandier areas. Colorado four o'clock (*Mirabilis multiflora*) is common both under the Utah junipers and in the open.

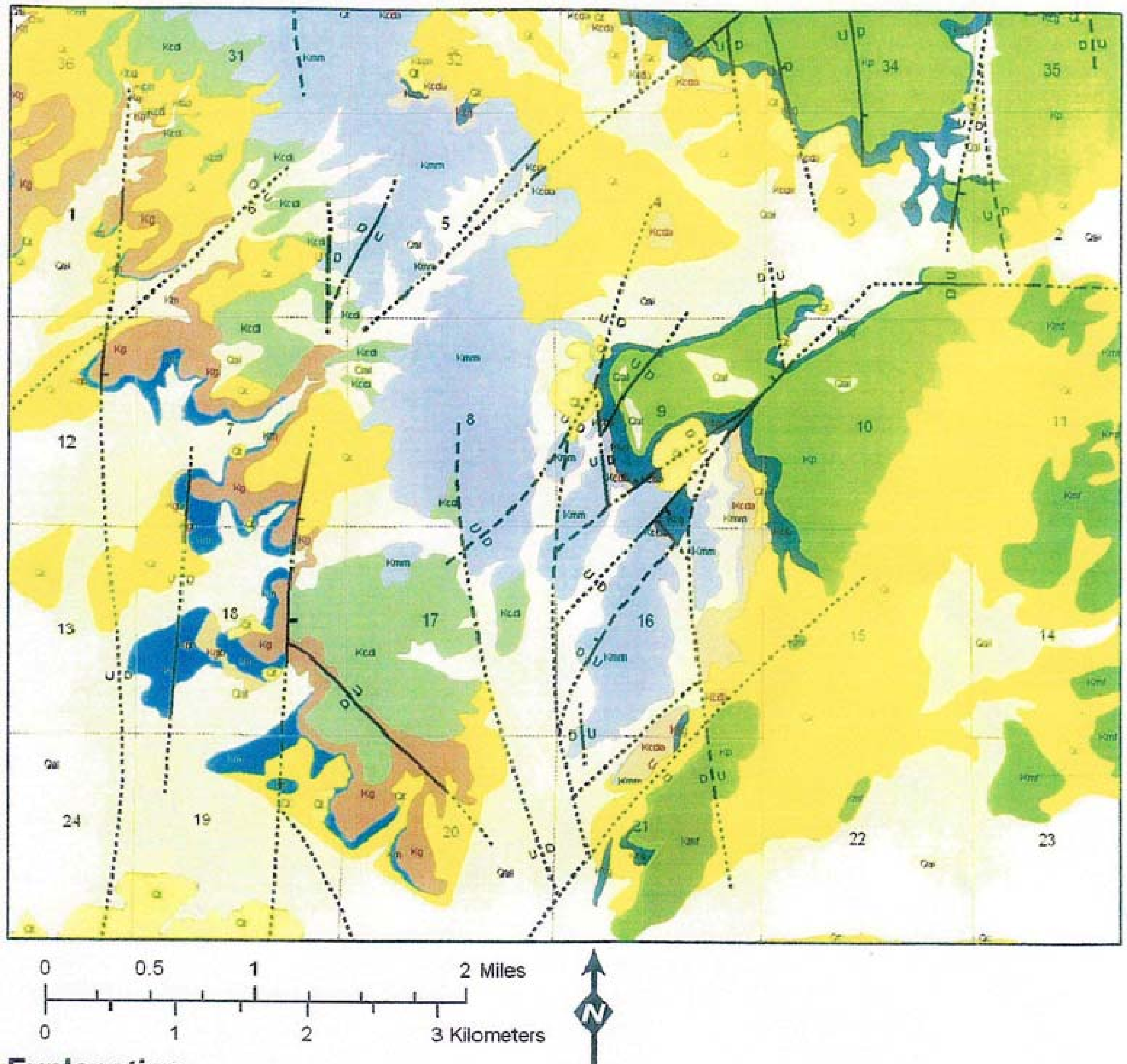
There is one cattle pond that held water at the time of the inspection. The plants dominating this man-made wetland include Mexican fireweed (*Kochia scoparia*), Russian thistle (*Salsola tragus*), and golden crownbeard (*Verbesina encelioides*), with rubber rabbitbrush (*Ericameria nauseosa* var. *graveolens*), saltcedar (*Tamarix chinensis*), and foxtail barley (*Hordeum jubatum*) also present.

About half of the project area surface is in the Mulatto Tongue of the Mancos shale. These are generally the higher areas. The lower areas are generally Quaternary alluvial or Aeolian deposits. There are also exposures of the Gibson coal member of the Crevasse Canyon Formation along the north and south lines of the section, Gallup sandstone in the east half of the section, and Point Lookout sandstone in the southeast quarter of the section. A plan view of the surface geology is on the next page.

Soils are dominated by loamy sand and sandy loam with some sandy clay loam present. A couple of areas of broad overland water flow are covered with siltier alluvial deposits. The highest portions of the section are in the Celavar-Atarque complex (soil map unit 305). Slightly lower areas of he section are Mido loamy fine sand (soil map unit 353). Even lower areas are Hagerwest-Bond fine sandy loams (soil map unit 220). Lowest areas of the section are in the Penistaja-Tintero complex (soil map unit 205). More soil information follows on pages 7 and 8.

METHODOLOGY

The project area was surveyed from July 31 through August 8, 2006, by botanists Marian Rohman and Winifred Devlin. All of the days were sunny and warm with occasional thunderstorms in the afternoons. The survey was accomplished by walking parallel transects through the area spaced at 50-75-foot intervals, depending on the habitat and terrain.

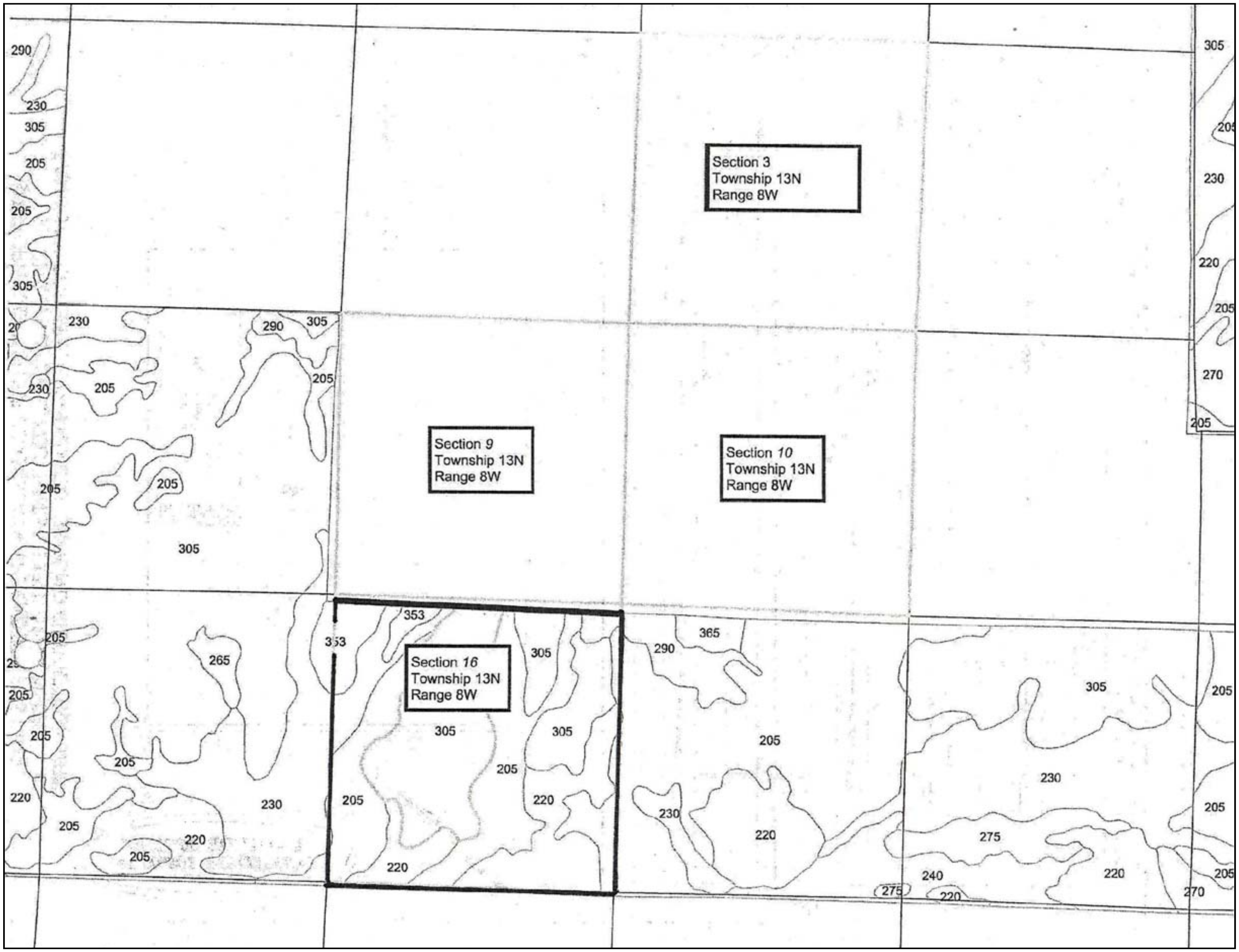


Explanation

- Qt - Talus and landslides
- Qal - Alluvial and eolian deposits
- Qc - Saprolite
- Kmf - Menefee Formation
- Kp - Point Lookout Sandstone
- Kcg - Gibson Coal Member of Crevasse Canyon Fm
- Kcda - Dalton Sandstone Member of C. C. Fm.
- Kcdi - Dilco Coal Member of C. C. Fm.
- Kg - Gallup Sandstone (main body)
- Kgb - Gallup Sandstone
- Kmm - Mancos Shale (Mulatto Tongue)
- Km - Mancos Shale (main body)

Faults

- observed
- concealed
- approximated
- dip direction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305
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230
205
275
240
220
275
220
205
270

Section 16 (T13N; R08W) - Soil Survey

Map Unit Name	MUSYM	% Slopes	Elevation (ft	mean annual precip (inches)	average annual air temp (deg F)	frost free period (days)
Pentistaja-Tintero	205	1-10	6200-7100	10-13	49-53	120-140
Hagerwest-Bond	220	1-8	6500-7200	10-13	49-54	120-140
Sparank-San Mateo-Zia	230	0-3	6300-6900	10-13	49-54	120-140
Rock outcrop-Westmion-Skyvillage	290	30-80	6400-8100	10-13	49-54	120-140
Celavar-Atarque	305	1-8	6500-7500	13-14	49-53	115-135
Mido loamy fine sand	353	1-6	6300-6700	10-13	49-53	120-140

	Pentistaja	Tintero	Hagerwest	Bond	Sparank	San Mateo	Zia	Westmion	Skyvillage	Celavar	Atarque	Mido
% slope	1-5	1-10	1-5	1-8	0-3	0-3	1-3	30-50	30-40	1-8	1-8	1-6
depth to restrictive feature (in.)	none w/in 60 in	none w/in 60 in	20-40	10-20	none w/in 60 in	none w/in 60 in	none w/in 60 in	5-20	5-20	20-40	10-20	none w/in 60 in
drainage class	well	excessive	well	well	well	well	excessive	well	well	well	well	excessive
permeability	moderate	moderately rapid	moderate	moderate	very slow	moderately slow	moderately rapid	slow	moderately rapid	moderate	moderate	rapid
available water capacity	moderate	moderate	low	very low	high	high	moderate	very low	very low	low	very low	low
shrink-swell potential	low	low	low	low	high	moderate	low	high	low	low	low	low
flooding hazard	none	none	none	none	occasional	occasional	rare			none	none	none
seasonal water table min depth	> 6 ft.	> 6 ft.	> 6 ft.	> 6 ft.	> 6 ft.	> 6 ft.	> 6 ft.			> 6 ft.	> 6 ft.	> 6 ft.
runoff class	low	low	medium	high	high	medium	very low	very high	medium	low	high	negligible
Calcium carbonate max	10%	10%	10%	5%	5%	5%	5%	5%	15%	10%	3%	1%
gypsum max	none	none	none	none	none	none	none	1%	none	none	none	none
salinity	non-saline	non-saline	non-saline	non-saline	slightly saline	slightly saline	non-saline	non-saline	non-saline	non-saline	non-saline	non-saline
sodicity	non-sodic	slightly sodic	non-sodic	non-sodic	slightly sodic	slightly sodic	slightly sodic	slightly sodic	non-sodic	slightly sodic	non-sodic	non-sodic
ecological site	loamy	sandy	loamy	shallow sandstone	clayey bottomland	bottomland	sandy	foothills	sandstone	savannah	sandstone	deep sand
Conservation Tree/Shrub Group	4	3	6d	10	4cc	4	3			6d	10	5
land capability	6c	7e	6c	7s	6c	6c	6c	7e	7s	6c	7s	6c

SURVEY RESULTS

Federally Listed Threatened and Endangered Plant Species: The U.S. Fish and Wildlife Service (USFWS) lists two federally threatened plant species that occur in McKinley and Cibola Counties, New Mexico. Table 1 lists these species with their protection status, habitat requirements, and potential to occur in the project area. The Federally listed species do not have appropriate habitat within the proposed project area and no plants of these species were found.

Table 1: Plants listed by the USFWS as Endangered, Threatened, or Candidate that occur in McKinley and Cibola Counties, New Mexico.

SPECIES/STATUS	HABITAT & DISTRIBUTION	POTENTIAL TO OCCUR IN THE PROJECT AREA
Erigeron rhizomatus Zuni fleabane Threatened	Nearly barren detrital clay hillsides with soils derived from shales of the Chinle or Baca formations (often seleniferous); most often on north or east facing slopes in open piñon-juniper woodlands at 7300-8000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001c)	No appropriate habitat: there are no Chinle or Baca formations in the project area. Most of the project area is below the elevational for this species.
Helianthus paradoxus Pecos sunflower Threatened	Saturated saline soils of desert wetlands. Usually associated with desert springs or the wetlands created from modifying desert springs; from 3,300-6,600 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there is one area with saturated soils created by damming a drainage, however, the area is not saline. The project area is above the elevational range of the species.

State of New Mexico Threatened and Endangered Listed Plant Species: There are fifteen plant species listed by the State of New Mexico as Endangered, Threatened, or Species of Concern that are known to occur in McKinley and Cibola Counties. Two of these species are federally listed and are addressed in Table 1. The remaining thirteen species are listed in Table 2. Two of the species have the potential to occur in the proposed project area: Naturita milkvetch (*Astragalus naturitensis*) and Laguna fameflower (*Talinum brachypodium*). These species are discussed in more detail below.

Table 2: Plants listed by the State of New Mexico as endangered, threatened, or species of concern that occur in McKinley and Cibola Counties.

SPECIES/STATUS	HABITAT	POTENTIAL TO OCCUR IN THE PROJECT AREA
Astragalus chuskanus Chuska milkvetch Species of Concern	Degraded Chuska sandstone in openings in montane coniferous forest above 5500 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat: there is no Chuska sandstone in the project area.
Astragalus micromerius Chaco milkvetch Species of Concern	Gypseous or limy sandstones in piñon-juniper woodland or Great Basin desert scrub; from 6600-7300 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat: the sandstone in the project area is not gypseous or limy.
Astragalus missouriensis var. *acumbens* Zuni milkvetch Species of Concern	Gravely clay banks and knolls, in dry alkaline soils derived from sandstone, in piñon-juniper woodland; from 6200-7900 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999)	No appropriate habitat: no gravely clay banks and knolls are present in the project area. The soils in the project area are not saline.
Astragalus naturitensis Naturita milkvetch Species of Concern	Sandstone ledges and rimrock along canyons in piñon-juniper woodland; from 5000-7000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001a)	Limited areas of potential habitat could exist along the rim and ledges of the low unnamed mesa in the project area; no *Astragalus* matching this distinctive species was observed.
Erigeron acomanus Acoma fleabane Species of Concern	Sandy slopes and benches beneath sandstone cliffs of the Entrada Sandstone Formation in piñon-juniper woodland; from 6900-7100 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth 2001b)	No appropriate habitat: there is no Entrada Sandstone Formation in the project area.
Erigeron svinskii Sivinski's fleabane Species of Concern	Steep barren Chinle shale slopes in piñon-juniper woodland and Great Basin desert scrub; from 6100-7400 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001d)	No appropriate habitat: there is no Chinle Formation in the project area.

Helianthus praetermissus Lost sunflower Species of Concern	Perhaps wet ground based on the collection locality for the only specimen. This species is known only from the type specimen collected in 1851 on the Sitgreaves expedition at the head of the Rio Laguna (now Rio San Jose) at Ojo de la Gallina, Cibola County. This species may have been named from a depauperate specimen of *Helianthus paradoxus*.	There is wet ground in the project area associated with a man-made cattle pond; however, the project is not near the only known location for the species near the Zuni Mountains.
Penstemon deaveri Mount Graham beardtongue Species of Concern	Slopes and rocky areas from ponderosa pine forest to above timberline; from 6,500 - 11,280 feet. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are no ponderosa pine forest or plant communities associated with higher elevations in the project area.
Phacelia serrata Cinders phacelia Species of Concern	In deep volcanic cinders, primarily associated with volcanic cones, but also in roadcuts and abandoned quarries in open, exposed, sunny locations; near ponderosa pine and piñon-juniper woodlands; from 5,900 - 7,200 feet. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are no areas of volcanic cinders in the project area.
Physaria navajoensis Navajo bladderpod Species of Concern	Windswept mesa rims of Todilto limestone in sparse piñon-juniper woodland; from 7,200 – 7,600 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001e)	No appropriate habitat: there is no Todilto limestone in the project area. Most of the project area is lower than the elevational range of the species.
Physaria newberryi var. *yesicola* Yeso bladderpod Species of Concern	Nearly barren badlands of sandy gypsum and silty strata of the Yeso Formation in short grass steppe and juniper savanna; from 5,700 - 6,900 feet. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there is no Yeso Formation in the project area. Most of the project area is higher than the elevational range of the species.

Puccinellia parishii Parish's alkali grass Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes; from 2600-7200 feet; the species requires continuously damp soils during its late winter to spring growing period. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth, 2001f)	No appropriate habitat: there are no seasonally wet alkaline areas in the project area.
Talinum brachypodium Laguna fameflower Species of Concern	Very shallow pockets of calcareous silt to clay soils overlying limestone or travertine, or fine silty sand overlying calcareous sandstones; open piñon-juniper woodland with little understory and scattered cacti and shrubs or Chihuahuan desert scrub. Known from Cibola County. (NMRPTC, 1999)	Limited areas of potential habitat could exist on the low mesa in the project area. Some of the sandy loam soil does have a high component of silt in it. No plants of this species were observed.

The project area is situated on eroding bedrock of the Gallup, Gibson, Mancos, and Point Lookout Formations with occasional exposed sandstone or shale ledges and rimrock. This environment provides limited areas of potential habitat for both Naturita milkvetch and Laguna fameflower. Two species of milkvetch were observed within the project area, but neither matched Naturita milkvetch in habitat or vegetative characters. One species of *Phemeranthis* (formerly included in *Talinum*) was observed. However, both vegetative and floral characteristics are quite different from Laguna fameflower.

DISCUSSION

The proposed project will not impact any Federal or State of New Mexico listed plant species.

Signature of Author: ________________________________ **Date: October 7, 2006**
Brian Wood

REFERENCES

Barneby, Rupert C. 1989. *Fabales*. Volume Three, Part B of *Intermountain Flora; Vascular Plants of the Intermountain West, U.S.A.* The New York Botanical Garden. Bronx, New York.

Cronquist, Arthur. 1994. *Asterales*. Volume 5 of *Intermountain Flora; Vascular Plants of the Intermountain West, U.S.A.* The New York Botanical Garden. Bronx, New York.

Cronquist, Arthur, et al. 1977. *The Monocotyledons.* Volume 6 of *Intermountain Flora; Vascular Plants of the Intermountain West, U.S.A.* Columbia University Press for The New York Botanical Garden. Bronx, New York.

Ivey, Robert DeWitt. 2003. Flowering Plants of New Mexico. RD & V Ivey, Publishers, Albuquerque, NM.

New Mexico Bureau of Geology and Mineral Resources. 2003. Geologic Map of New Mexico. 1:500,000. New Mexico Bureau of Geology and Mineral Resources.

New Mexico Rare Plant Technical Council (NMRPTC). 1999. New Mexico Rare Plants. Albuquerque, NM: New Mexico Rare Plants Home Page. http://nmrareplants.unm.edu (Latest update: 11 January 2005).

Roth, Daniela. 2001a. Species account for *Astragalus naturitensis*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001b. Species account for *Erigeron acomanus*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001c. Species account for *Erigeron rhizomatus*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001d. Species account for *Erigeron svinskii*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001e. Species account for *Lesquerella navajoensis*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001f. Species account for *Puccinellia parishii*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Schneider, Al. 2006. Southwest Colorado Wildflowers. online at swcoloradowildflowers.com

USDI, USFWS. 2005.Threatened and Endangered Species System Listings by State and Territory. http://ecos.fws.gov/tess_public/TESSWebpageUsaLists?state=NM

Weber, W. A. and Ronald C. Wittman. 2001. *Colorado Flora* : *Western Slope*. University Press of Colorado. Boulder, Colorado.

PLANTS IDENTIFIED IN SECTION 16, T. 13 N., R. 8 W., McKINLEY COUNTY, NM

(Scientific and common names according to Allred, 2005; identifications based on Barneby, 1989; Cronquist, 1994; Cronquist, et al, 1977; Ivey, 2003; Schneider, 2006; and Weber and Wittman, 2001.

Trees

Juniperus osteosperma	Utah juniper
Pinus edulis	Piñon pine

Shrubs and Subshrubs

Artemisia bigelovii	Flat sagebrush
Artemisia frigida	Fringed sage
Artemisia nova	Black sagebrush
Atriplex canescens	Four-wing saltbush
Cercocarpus montanus	Common mountain mahogany
Ericameria filifolia	Greene's rabbitbrush
Ericameria nauseosa var. *graveolens*	Rubber rabbitbrush
Ericameria nauseosa prob. var. *juncea*	Rubber rabbitbrush
Eriogonum microthecum var. *simpsonii*	Simpson's wild-buckwheat
Fallugia paradoxa	Apache-plume
Gutierrezia sarothrae	Broom snakeweed
Krascheninnikovia lanata	Winterfat
Lycium pallidum	Pale wolfberry
Purshia stansburiana	Cliffrose
Quercus sp.	Oak
Rhus trilobata var. *trilobata*	Skunkbush sumac
Ribes cereum	Wax currant
Tamarisk chinensis	Saltcedar
Tetradymia canescens	Spineless horsebrush
Yucca sp.	Narrow-leaved yucca
Yucca baccata	Banana yucca

Cacti

Coryphantha vivipara	Spinystar (Nipple cactus)
Cylindropuntia imbricata var. *imbriacata*	Cane cholla
Echinocereus triglochidiatus	Claret-cup cactus
Opuntia phaeacantha	Plains prickly-pear
Opuntia prob. *polyacantha*	Starvation prickly-pear

Grasses and Grass-like plants

Achnatherum hymenoides	Indian rice grass
Agrostis sp.	Bentgrass
Aristida purpurea	Purple threeawn

Bouteloua hirsuta	Hairy grama
Cyperus poss. *squarrosus*	Awned flat-sedge
Hesperostipa comata	Needle-and-thread
Hordeum sp.	Barley
Hordeum jubatum	Foxtail barley
Munroa squarrosa	False-buffalograss
Muhlenbergia pungens	Sandhill muhly
Muhlenbergia torreyi	Ring muhly
Pleuraphis (Hilaria) jamesii	Jame's galleta
Sporobolus airoides	Alkali sacaton
Sporobolus cryptandrus	Sand dropseed

Ferns

Cheilanthes feei	Santa Fe lipfern

Forbs

Abronia fragrans	Fragrant sand-verbena
Allionia incarnata	Trailing windmills
Amaranthus poss. *palmeri*	Palmer's amaranth
Ambrosia acanthicarpa	Burr ragweed
Artemisia dracunculus	Tarragon
Artemisia ludoviciana	Wormwood
Asclepias sp.	Milkweed
Astragalus spp.	Milkvetch
Bahia dissecta	Ragged-leaf bahia
Boechera sp.	Rockcress
Brickellia brachyphylla	Plumed brickellbush
Brickellia prob. *californica*	California brickellbush
Carduus nutans	Musk thistle
Castilleja poss. *austromontana*	Rincon Indian-paintbrush
Chaetopappa ericoides	Sand aster
Chamaesaracha coronopus	Green-leaf five-eyes
Chamaesyce sp.	Spurge
Chamaesyce maculata	Spotted spurge
Chamaesyce serpyllifolia	Thyme-leaf spurge
Chenopodium album	Lambs quarter
Cirsium arvense	Canadian thistle
Cirsium prob. *neomexicanum*	New Mexico thistle
Cleome serrulata	Rocky Mountain beeplant
Commelina dianthifolia	Bird-bill dayflower
Commelina erecta var. *angustifolia*	White-mouth dayflower
Convolvulus arvensis	Field bindweed
Cryptantha cinerea	Jame's cat's-eye
Cuscuta sp.	Dodder
Dalea candida	White prairie-clover

Descurainia prob. *obtusa*	Blunt tansy-mustard
Dieteria sp.	Spine-aster (Tansy aster)
Dimorphocarpa wislizeni	Spectacle-pod
Erigeron divergens	Spreading fleabane
Eriogonum cernuum	Nodding wild-buckwheat
Eriogonum jamesii	James' wild-buckwheat
Eriogonum palmerianum	Palmer's wild-buckwheat
Gilia longiflora	Blue trumpets
Grindelia squarrosa	Curly-cup gumweed
Helianthus petiolaris	Plains sunflower
Heterotheca villosa	Hairy goldenaster
Hymenopappus filifolius	Fine-leaf woolywhite
Hymenoxys richardsonii var. *floribunda*	Colorado rubberweed
Ipomopsis longiflora	Blue trumpets
Ipomopsis multiflora	Many-flowered skyrocket
Kallstroemia parviflora	Warty caltrop
Kochia scoparia	Mexican fire-weed
Lappula occidentalis	Spiny sheepbur
Linum (Cathartolinum) sp.	Flax
Mentzelia albicaulis	Whitestem blazingstar
Mirabilis multiflora	Colorado four-o'clock
Mirabilis oxybaphoides	Spreading four-o'clock
Oenothera caespitosa	Tufted evening-primrose
Oenothera coronopifolia	Hairy-throat evening-primrose
Oxalis violacea	Violet wood-sorrel
Peteria scoparia	Rush peteria
Phacelia integrifolia	Gypsum scorpion-weed
Phemeranthis confertiflorus	New Mexico flameflower
Phoradendron juniperinum ssp. *juniperinum*	Juniper mistletoe
Physalis poss. *pubescens* var. *integrifolia*	Husk-tomato
Physalis virginiana	Virginia ground-cherry
Portulaca oleracea	Garden purslane
Portulaca pilosa	Kiss-me-quick
Potentilla sp.	Cinquefoil
Psilostrophe tagetina	Woolly paper-flower
Salsola tragus	Russian-thistle
Salvia prob. *subincisa*	Saw-tooth sage
Sanvitalia abertia	Abert's dome
Senecio sp.	Groundsel
Solanum jamesii	Wild potato
Sphaeralcea coccinea	Scarlet globemallow
Sphaeralcea poss. *parvifolia*	Small-leaf globemallow
Stanleya pinnata var. *pinnata*	Prince's-plume
Stephanomeria sp.	Wire-lettuce
Phemeranthis confertiflorus	New Mexico flameflower

Tiquilia hispidissima	Hairy crinklemat
Townsendia annua	Annual Townsend-daisy
Townsendia incana	Hoary Townsend-daisy (Easter daisy)
Tradescantia occidentalis	Spiderwort
Verbena macdougalii	MacDougal's vervain
Verbesina encelioides	Golden crownbeard
Zinnia grandiflora	Plains zinnia

LOOKING NORTH TOWARD JESUS MESA FROM NORTH OF HILL 7292

LOOKING EAST FROM HILL 7212

LOOKING SOUTH AT PLUGGED DRILL HOLE IN NENE SECTION 16

LOOKING NORTH AT STOCK POND IN CENTER OF SECTION 16

Appendix 4-B

Roca Honda Permit Area
Vegetation Survey
Sections 9 and 10

PERMITS WEST, INC.
PROVIDING PERMITS for LAND USERS
37 Verano Loop, Santa Fe, New Mexico 87508 (505)466-8120

STRATHMORE MINERALS CORP.
ROCA HONDA SECTIONS 9 & 10
BOTANICAL REPORT

This report discusses the potential for disturbance to endangered, threatened, and other designated sensitive flora listed by Federal and State of New Mexico agencies that may occur in the project area. The 1,280 acre project area includes all of Sections 9 and 10, T. 13 N., R. 8 W., McKinley County, New Mexico. Both of the sections (see maps on the next two pages) are administered by the Cibola National Forest.

PROJECT DESCRIPTION

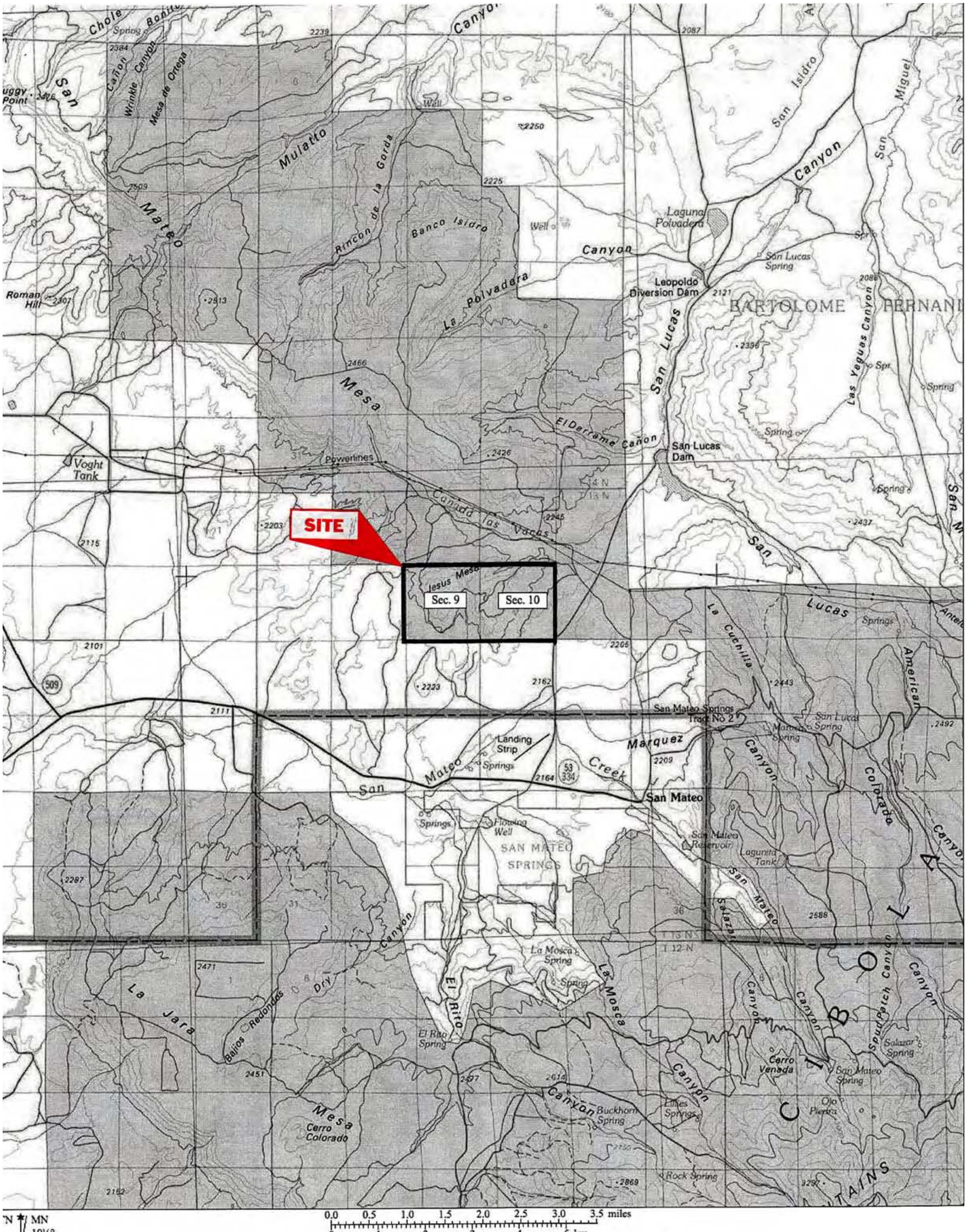
Disturbance: There are numerous existing dirt roads, jeep trails, and drill sites ("Prospects" on the map) in the area (Not all of them are shown on the attached 1980 San Lucas Dam and 1981 San Mateo USGS topographic maps). Much of the project area has been grazed by livestock. Forested areas have been used by firewood cutters.

Compilation of Rare Species Data: Prior to the field work, a list was compiled of the Federal (USDI, USFWS, 2005) and State of New Mexico (NMRPTC, 1999) sensitive plant species known to occur in both McKinley County, in which the project area occurs, and Cibola County, which is a mile south.

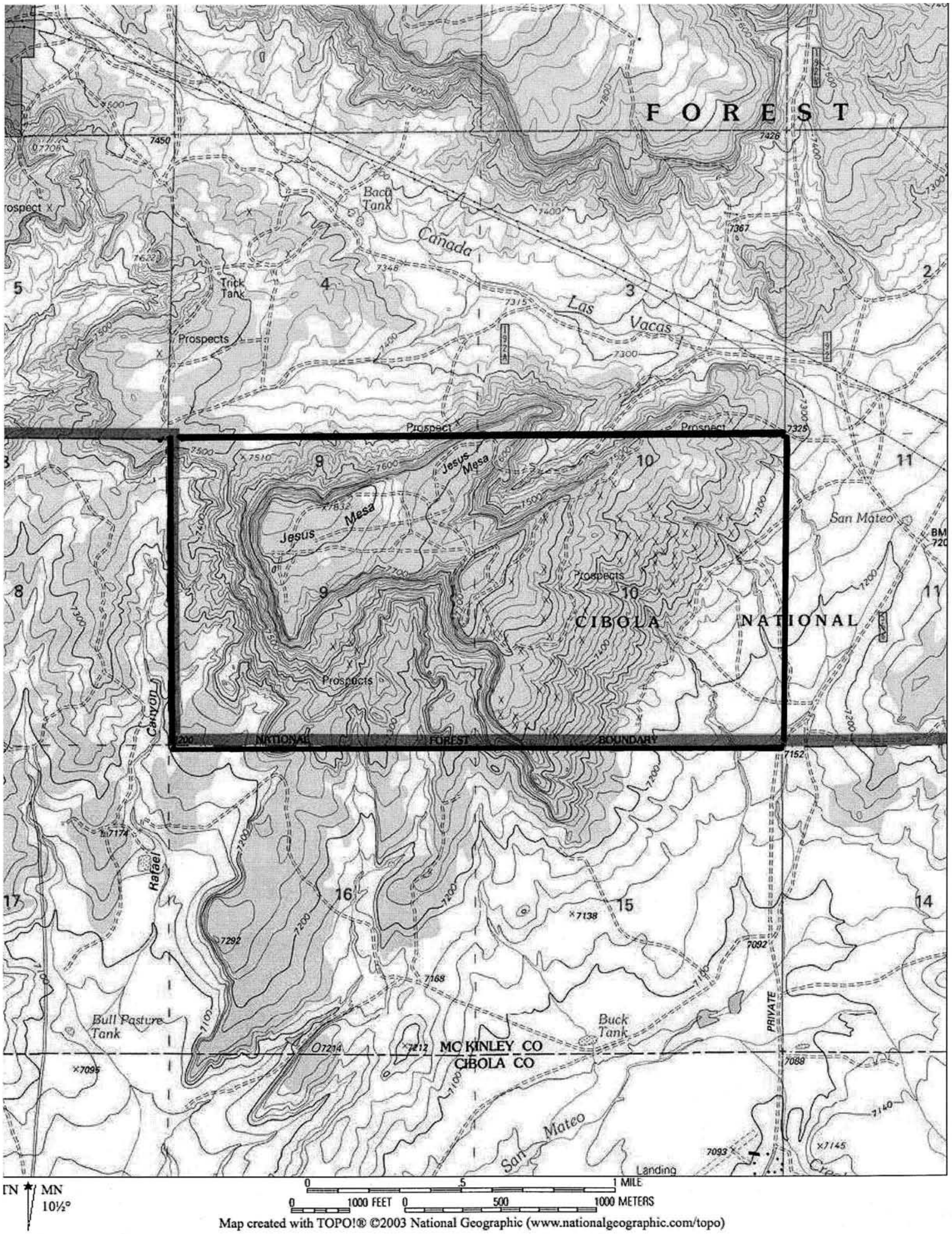
PROJECT AREA

Location: The project area is on Jesus Mesa, which is approximately 17 air miles northeast of Grants and 3 air miles northwest of San Mateo. The elevation of the project area ranges from 7,152 feet to 7,840 feet. Aspect is generally to the south. However, Section 10 has a pronounced dip to the southeast.

Climate: San Mateo is the closest weather station and is at a comparable elevation. Average annual high at San Mateo is 61.7˚ F. Average annual low is 34.6˚ F. July is the hottest month with an average high of 83.1˚ F. January is the coldest month with an average low of 16.0˚ F. Average total precipitation is 8.66 inches. August is the wettest month with an average rainfall of 2.11 inches. Average total snowfall is 9.7 inches. December is the snowiest month with an average snowfall of 3.1 inches.



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)



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Description: Jesus Mesa occupies approximately half of Section 9 and two-thirds of Section 10. The top of the mesa is mostly open piñon-juniper woodland with some desert grassland. The perimeter of the mesa consists of sandstone ledges, with areas of exposed shale, particularly to the south of the mesa. The landscape southwest, north, and southeast of the mesa is predominantly desert grassland, with a large area of wooded slopes on the southeast side between the mesa and the lower grassland. These slopes are frequently dissected by drainages that can range from a few to 40 feet deep. There are several areas of semi-stabilized sand dunes (see picture).

Rafael Canyon is immediately west of the project area and there are several smaller drainages flowing into it from the rocky slopes of the mesa. Canada Las Vacas is north of the mesa. San Mateo Valley is to the south and east. None of the drainages are perennial.

Within the desert grassland community the dominant grass is hairy grama (*Bouteloua hirsuta*), with galleta (*Pleuraphis jamesii*) common throughout and sand dropseed (*Sporobolus cryptandrus*) common in some areas. There are a few areas of little bluestem (*Schizachyrium scoparium* var. *scoparium*) on the southeast side. The ground cover is dominated by garden purslane (*Portulaca oleracea*), changing to kiss-me-quick (*Portulaca pilosa*) in the sandiest areas, with Wislizenus's threadleaf (*Schkuhria pinnata* var. *wislizeni*) frequent throughout. Dodder (*Cuscuta* sp.) appears to be parasitizing a large percentage of the garden purslane. Other common forbs include spiderwort (*Tradescantia occidentalis*), tufted evening-primrose (*Oenothera caespitosa*), and flixweed (*Descurainia sophia*). The southeast corner of the project area has several areas dominated by Russian-thistle (*Salsola tragus*) with smotherweed (*Bassia hyssopifolia*) and American bugseed (*Corispermum americanum* var. *americanum*). There are widely scattered Utah juniper (*Juniperus osteosperma*), piñon pine (*Pinus edulis*), and four-wing saltbush (*Atriplex canescens*).

The woodland mostly consists of piñon pine and Utah juniper. A few ponderosa pines (*Pinus ponderosa*) are on the top of Jesus Mesa (see picture) and along the southeast drainages. There are some Rocky Mountain juniper (*Juniperus scopulorum*) at the head of the drainage on the north side of Jesus Mesa. Within the woodland, hairy grama is often the dominant ground cover with cliffrose (*Purshia stansburiana*) and common mountain mahogany (*Cercocarpus montanus*) the most common shrubs. Common forbs include fragrant snakeroot (*Ageratina herbacea*) and thyme-leaf spurge (*Chamaesyce serpyllifolia*). Under the trees, fetid-goosefoot (*Dysphania graveolens*), Colorado four-o'clock (*Mirabilis multiflora*), and Fendler's drymary (*Drymaria glandulosa*) are very common. In the sandiest areas, field wormwood (*Artemisia campestris* var. *caudata*), flat sagebrush (*Artemisia bigelovii*), spectacle-pod (*Dimorphocarpa wislizeni*), kiss-me-quick, spiderwort, and fine-leaf woolywhite (*Hymenopappus filifolius*) are common.

The rocky slopes of Jesus Mesa support a similar plant community of scattered piñon pine and Utah juniper with hairy grama quite common. Common shrubs include flat sagebrush and cliffrose. New Mexico muhly (*Muhlenbergia pauciflora*), and both plumed and California brickellbush (*Brickellia brachyphylla* and *californica*, respectively) are also common. Santa Fe lipfern (*Cheilanthes feei*) and brittle bladder-fern (*Cystopteris fragilis*) are occasional at the bases of the rocks. The few shale slopes are mostly barren, but do support a few piñon pine, Utah juniper, Colorado four-o'clock, galleta, and a four-wing saltbush. At the rocky rims of the mesa and drainages are black sagebrush (*Artemisia nova*), flat sagebrush, and common mountain mahogany.

The canyons on the southeast side reach depths of thirty to forty feet and support a few ponderosa pines within a piñon-juniper woodland. The most common plants include broom groundsel (*Senecio spartioides* var. *multicapitatus*), tassel-flower brickellbush (*Brickellia grandiflora*), and hairy grama.

There are several pools along the drainages, many of which support small communities of wetland plants, indicating that they are moist much of the year. The plants within these communities include scratchgrass (*Sporobolus contractus*), mesa dropseed (*Sporobolus flexuosus*), straw-color flat-sedge (*Cyperus strigosus*), sand dropseed, rush (*Juncus* sp.), pale spikerush (*Eleocharis macrostachya*), and even cattail (*Typha* prob. *domingensis*). The drainages on the west and north sides are within sandier soils within a desert grassland. In these drainages the common plants are hairy grama, rubber rabbitbrush (*Ericameria nauseosa* var. *graveolens*), and sage (*Salvia* prob. *incisa*)

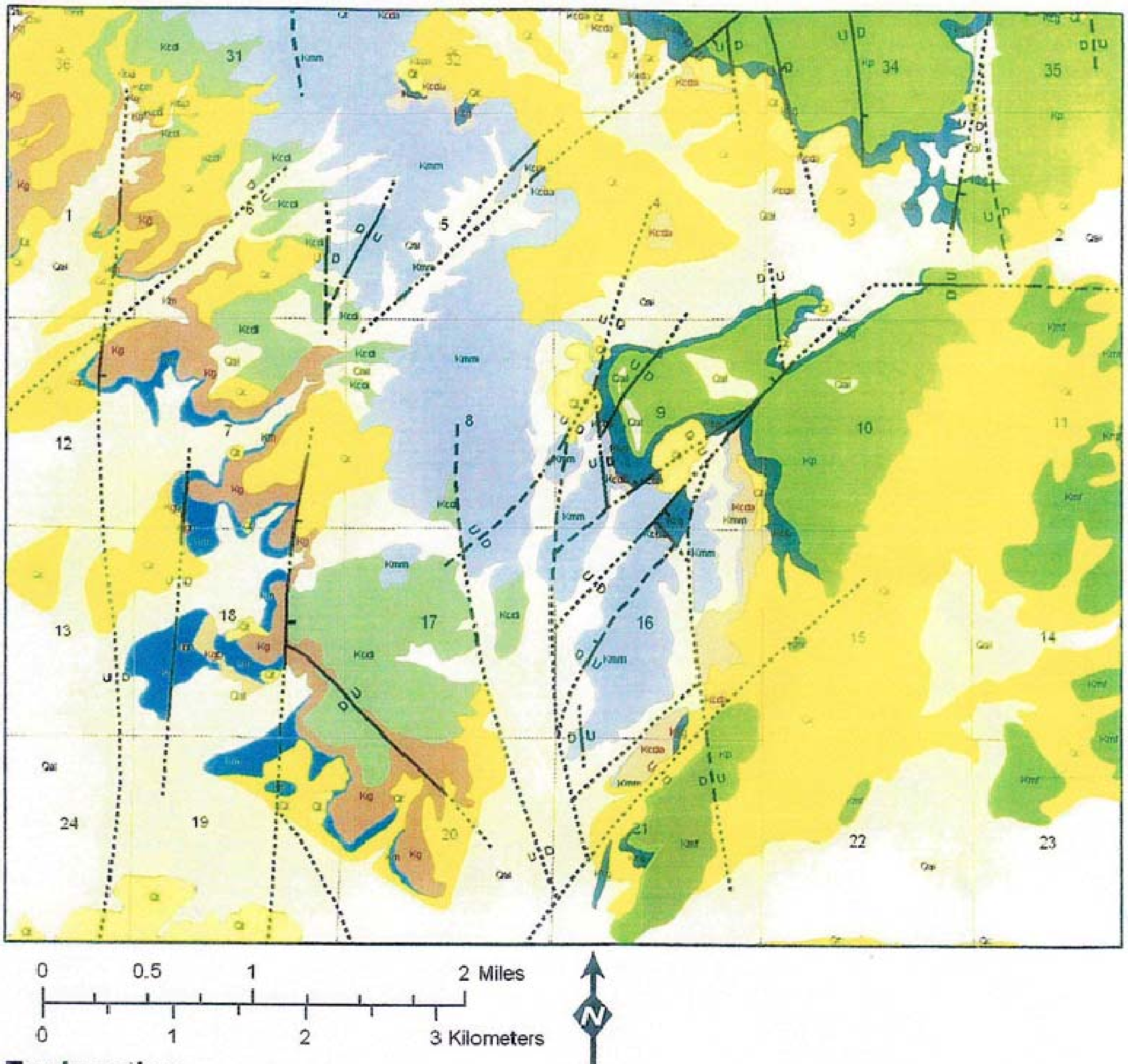
There are occasional stabilized and semi-stabilized sand dunes throughout the project area, particularly to the west, northwest, and southeast of the mesa. These areas support a variety of sand dependent plants, including sandhill muhly (*Muhlenbergia pungens*), spectacle pod, sand sage (*Artemisia filifolia*), spiderwort, Bigelow's rubber rabbitbrush (*Ericameria nauseosa* var. *bigelovii*), kiss-me-quick, and field wormwood.

The highest portion of the project, and the most common surface formation in the project area, is the Point Lookout sandstone. The gray black Gibson coal member of the Crevasse Canyon Formation is below the Point Lookout. Dalton sandstone is below the Gibson coal and is exposed in Section 9. Mancos shale Mulatto Tongue is below the Dalton sandstone and also found in Section 9. A plan view of the surface geology is on the next page.

The southeast-most third of the project area consists primarily of soils derived from the decomposing sandstone. Most of the exposed bedrock is sandstone with infrequent areas of shale, particularly to the south of the mesa. Soils derived from all of these formations are present, but are dominated by loamy sand and sandy loam with some sandy clay loam present. Sand dunes are found on the highest parts of the mesa.

METHODOLOGY

The project area was surveyed from July 31 through August 8, 2006 and from September 11 through October 19, 2006, by botanists Marian Rohman and Winifred Devlin. There were occasional afternoon thunderstorms during the first phase. Most of the days were sunny and warm with a few partly cloudy and windy days during the second phase. The survey was accomplished by walking parallel transects spaced at 50-75-foot intervals, depending on the habitat and terrain.



Explanation

- Qt - Talus and landslides
- Qal - Alluvial and eolian deposits
- Qc - Saprolite
- Kmf - Menefee Formation
- Kp - Point Lookout Sandstone
- Kcg - Gibson Coal Member of Crevasse Canyon Fm
- Kcda - Dalton Sandstone Member of C. C. Fm.
- Kcdi - Dilco Coal Member of C. C. Fm.
- Kg - Gallup Sandstone (main body)
- Kgb - Gallup Sandstone
- Kmm - Mancos Shale (Mulatto Tongue)
- Km - Mancos Shale (main body)

Faults

- observed
- concealed
- approximated
- dip direction

SURVEY RESULTS

Federally Listed Threatened and Endangered Plant Species: The U.S. Fish and Wildlife Service (USFWS) lists two federally threatened plant species that occur in McKinley and Cibola Counties, New Mexico. Table 1 lists these species with their protection status, habitat requirements, and potential to occur in the project area. The Federally listed species do not have appropriate habitat within the proposed project area and no plants of these species were found.

Table 1: Plants listed by the USFWS as Endangered, Threatened, or Candidate that occur in McKinley and Cibola Counties, New Mexico.

SPECIES/STATUS	**HABITAT & DISTRIBUTION**	**POTENTIAL TO OCCUR IN THE PROJECT AREA**
Erigeron rhizomatus Zuni fleabane Threatened	Nearly barren detrital clay hillsides with soils derived from shales of the Chinle or Baca formations (often seleniferous); most often on north or east facing slopes in open piñon-juniper woodlands at 7300-8000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001c)	No appropriate habitat: there are no Chinle or Baca formations in the project area. Most of the project area is below the elevational for this species.
Helianthus paradoxus Pecos sunflower Threatened	Saturated saline soils of desert wetlands. Usually associated with desert springs or the wetlands created from modifying desert springs; from 3,300-6,600 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are no springs in the project area. The project area is over 500' above the elevational range of the species.

State of New Mexico Threatened and Endangered Listed Plant Species: There are fifteen plant species listed by the State of New Mexico as Endangered, Threatened, or Species of Concern that are known to occur in McKinley and Cibola Counties. Two of these species are federally listed and are addressed in Table 1. The remaining thirteen species are listed in Table 2. None of the fifteen species were found.

Table 2: Plants listed by the State of New Mexico as endangered, threatened, or species of concern that occur in McKinley and Cibola Counties.

SPECIES/STATUS	HABITAT	POTENTIAL TO OCCUR IN THE PROJECT AREA
Astragalus chuskanus Chuska milkvetch Species of Concern	Degraded Chuska sandstone in openings in montane coniferous forest above 5500 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat: there is no Chuska sandstone in the project area and no montane coniferous forest.
Astragalus micromerius Chaco milkvetch Species of Concern	Gypseous or limy sandstones in piñon-juniper woodland or Great Basin desert scrub; from 6600-7300 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat: the sandstone in the project area is not gypseous or limy.
Astragalus missouriensis var. *acumbens* Zuni milkvetch Species of Concern	Gravely clay banks and knolls, in dry alkaline soils derived from sandstone, in piñon-juniper woodland; from 6200-7900 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999)	No appropriate habitat: no gravely clay banks and knolls are present in the project area. However, the soils in the project area are not saline.
Astragalus naturitensis Naturita milkvetch Species of Concern	Sandstone ledges and rimrock along canyons in piñon-juniper woodland; from 5000-7000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001a)	No appropriate habitat: there are sandstone ledges and rimrock around the periphery of Jesus Mesa and along the drainages in the southeast portion of the project area. However, the elevation in these areas ranges from 7300 to 7800 feet, ≥300' above the elevational range of the species.
Erigeron acomanus Acoma fleabane Species of Concern	Sandy slopes and benches below Entrada sandstone cliffs in piñon-juniper woodland; from 6900-7100 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth 2001b)	No appropriate habitat: there is no Entrada Sandstone Formation in the project area.

Erigeron svinskii Sivinski's fleabane Species of Concern	Steep barren shale slopes of the Chinle Formation in piñon-juniper woodland and Great Basin desert scrub; from 6100-7400 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001d)	No appropriate habitat: there is no Chinle Formation in the project area.
Helianthus praetermissus Lost sunflower Species of Concern	Perhaps wet ground based on the collection locality for the only specimen. This species is known only from the type specimen collected in 1851 on the Sitgreaves expedition at the head of the Rio Laguna (now Rio San Jose) at Ojo de la Gallina, Cibola County. This species may have been named from a depauperate specimen of *Helianthus paradoxus*.	There is wet ground in the project area associated with small ephemeral pools along drainages; however, the project is not near the only known location for the species near the Zuni Mountains.
Penstemon deaveri Mount Graham beardtongue Species of Concern	Slopes and rocky areas from ponderosa pine forest to above timberline; from 6,500-11,280 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are a few ponderosa pine trees and no alpine areas in the project area.
Phacelia serrata Cinders phacelia Species of Concern	In deep volcanic cinders, primarily associated with volcanic cones, but also in roadcuts and cinder quarries in open, exposed, sunny locations; near ponderosa pine and piñon-juniper woodlands; from 5,900-7,200 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are no areas of volcanic cinders in the project area.

Physaria navajoensis Navajo bladderpod Species of Concern	Windswept mesa rims of Todilto limestone in sparse piñon-juniper woodland; from 7200-7600 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001e)	No appropriate habitat: there is no Todilto limestone in the project area.
Physaria newberryi var. *yesicola* Yeso bladderpod Species of Concern	Nearly barren badlands of sandy gypsum and silty strata of the Yeso Formation in short grass steppe and juniper savanna; from 5,700-6,900 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there is no Yeso Formation in the project area. All of the project area is ≥200' higher than the elevational range of the species.
Puccinellia parishii Parish's alkali grass Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes; from 2600-7200 feet; the species requires continuously damp soils during its late winter to spring growing period. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth, 2001f)	No appropriate habitat: there are no seasonally wet alkaline areas in the project area. Most of the project area is above the elevation range of the species.
Talinum brachypodium Laguna fameflower Species of Concern	Very shallow pockets of calcareous silt to clay soils overlying limestone or travertine, or fine silty sand overlying calcareous sandstones; open piñon-juniper woodland with little understory and scattered cacti and shrubs or Chihuahuan desert scrub. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there are limited areas of fine silty sand. However, the sandstone in the area is not notably calcareous.

The project area is situated on bedrock of the Crevasse Canyon, Mancos, and Point Lookout Formations. This combination of geology, hydrology, habitat types, soils, aspect, and elevation does not provide potential habitat for the sensitive plant species considered threatened, endangered, or species of concern in McKinley and Cibola Counties.

DISCUSSION

The proposed project will not impact any Federal or State of New Mexico listed plant species.

Signature of Author: ____ Brian Wood _______ **Date: December 26, 2006**

Brian Wood

REFERENCES

Allred, Kelly, 2005. *A Working Index of New Mexico Vascular Plant Names*. Range Science Herbarium at New Mexico State University. Las Cruces, New Mexico. http://web.nmsu.edu/~kallred/herbweb/Working%20Index-title.htm

Cronquist, Arthur. 1994. *Asterales*. Volume 5 of *Intermountain Flora; Vascular Plants of the Intermountain West, U.S.A.* The New York Botanical Garden. Bronx, New York.

Cronquist, Arthur, Arthur H. Holmgren, Noel H. Holmgren, James L. Reveal, and Paticia K. Holmgren. 1977. *The Monocotyledons.* Volume 6 of *Intermountain Flora; Vascular Plants of the Intermountain West, U.S.A.* Columbia University Press for The New York Botanical Garden. Bronx, New York.

Cronquist, Arthur, Arthur H. Holmgren, Noel H. Holmgren, James L. Reveal, and Paticia K. Holmgren. 1984. *Subclass Asteridae (except Asteraceae).* Volume 4 of *Intermountain Flora; Vascular Plants of the Intermountain West, U.S.A.* The New York Botanical Garden. Bronx, New York.

Flora of North America Editorial Committee, eds. 1993+. *Flora of North America North of Mexico*. vol. 4. New York and Oxford. @efloras.org.

Hitchcock, A. S., revised by Agnes Chase. 1951. Manual of the Grasses of the United States. United States Department of Agriculture Miscellaneous Publication No. 420. Washington, D.C.

Ivey, Robert DeWitt. 2003. Flowering Plants of New Mexico. R. D. & V. Ivey, Publishers, Albuquerque, NM.

Jercinovic, Gene. 2003. *Wildflowers of the Manzanos*. Self published. Torreon, NM.

Martin, William C. and Charles R. Hutchins. Reprinted 2001a. A Flora of New Mexico. Volume 1. Bishen Singh Mahendra Pal Singh, Dehra Dun, India and Koeltz Scientific Books, Köenigstein, Germany

Martin, William C. and Charles R. Hutchins. Reprinted 2001b. A Flora of New Mexico. Volume 2. Bishen Singh Mahendra Pal Singh, Dehra Dun, India and Koeltz Scientific Books, Köenigstein, Germany

New Mexico Rare Plant Technical Council (NMRPTC). 1999. New Mexico Rare Plants. Albuquerque, NM: New Mexico Rare Plants Home Page. http://nmrareplants.unm.edu (Latest update: 11 January 2005).

Roth, Daniela. 2001a. Species account for *Astragalus naturitensis*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001b. Species account for *Erigeron acomanus*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001c. Species account for *Erigeron rhizomatus*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001d. Species account for *Erigeron svinskii*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001e. Species account for *Lesquerella navajoensis*. Navajo Natural Heritage Program. (http://navajofishandwildlife.org/nnhp) (revised 15 Feb. 2005)

Roth, Daniela. 2001f. Species account for *Puccinellia parishii*. Navajo Natural Heritage Program. (http://navajofishndwildlife.org/nnhp) (revised 15 Feb. 2005)

USDI, USFWS. 2005. Threatened and Endangered Species System Listings by State and Territory. http://ecos.fws.gov/tess_public/TESSWebpageUsaLists?state=NM

Weber, W. A. and Ronald C. Wittman. 2001. *Colorado Flora* : *Western Slope*. University Press of Colorado. Boulder, Colorado.

Western Regional Climate Center, Reno, NV. 2006. *San Mateo, New Mexico (297918) Period of Record Monthly Climate Summary.* (**http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm7918**)

**PLANTS IDENTIFIED IN SECTIONS 9 & 10, T. 13 N., R. 8 W.
McKINLEY COUNTY, NM**

The following scientific and common names are according to Allred, 2005; Cronquist, 1994; Cronquist, et al, 1977; Crohquist, et al, 1984; Flora of North America Editorial Committee, eds. 1993+; Hitchock and Chase, 1951: Ivey, 2003; Martin and Hutchins, 2001a and 2001b; and Weber and Wittman, 2001.

Trees

Juniperus osteosperma	Utah juniper
Juniperus scopulorum	Rocky Mountain juniper
Pinus edulis	Piñon pine
Pinus ponderosa	Ponderosa pine
Populus deltoides	Cottonwood

Shrubs and Subshrubs

Artemisia bigelovii	Flat sagebrush
Artemisia filifolia	Sand sage
Artemisia frigida	Fringed sage
Artemisia nova	Black sagebrush
Atriplex canescens	Four-wing saltbush
Brickellia brachyphylla	Plumed brickellbush
Brickellia californica	California brickellbush
Brickellia grandiflora	Tassel-flower brickellbush
Cercocarpus montanus	Common mountain mahogany
Ericameria filifolia	Greene's rabbitbrush
Ericameria nauseosa var. *graveolens*	Rubber rabbitbrush
Ericameria nauseosa var. *bigelovii*	Bigelow’s rubber rabbitbrush
Eriogonum corymbosum	Crispy wild-buckwheat
Eriogonum leptophyllum	Slender-leaf widl-buckwheat
Eriogonum microthecum var. *simpsonii*	Simpson's wild-buckwheat
Eriogonum umbellatum	Sulphur-weed
Fallugia paradoxa	Apache-plume
Gutierrezia sarothrae	Broom snakeweed
Krascheninnikovia lanata	Winterfat
Lycium pallidum	Pale wolfberry
Nolina microcarpa	Beargrass
Purshia stansburiana	Cliffrose
Quercus sp.	Oak
Quercus gambelii	Gambel's oak
Rhus trilobata var. *trilobata*	Skunkbush sumac
Ribes cereum	Wax currant

Yucca sp.	Narrow-leaved yucca
Yucca baccata	Banana yucca

Cacti

Coryphantha vivipara	Spinystar (Nipple cactus)
Cylindropuntia imbricata var. *imbriacata*	Cane cholla
Echinocereus triglochidiatus	Claret-cup cactus
Opuntia phaeacantha	Plains prickly-pear
Opuntia prob. *polyacantha*	Starvation prickly-pear

Grasses and Grass-like plants

Achnatherum hymenoides	Indian rice grass
Aristida adscensionis	Six-weeks threeawn
Aristida divaricata	Poverty threeawn
Aristida purpurea var. *longiseta*	Red threeawn
Aristida purpurea prob. var. *purpurea*	Purple threeawn
Blepharoneuron tricholepis	Pine dropseed
Bothriochloa prob. *springfieldii*	Springfield’s bluestem
Bouteloua barbata	Six-weeks grama
Bouteloua curtipendula	Side-oats grama
Bouteloua eriopoda	Black grama
Bouteloua hirsuta	Hairy grama
Chloris virgata	Showy windmillgrass
Cyperus strigosus	Straw-color flat-sedge
Eleocharis macrostachya	Pale spikerush
Elymus elymoides	Bottlebursh squirreltail
Elymus smithii	Western wheatgrass
Hordeum sp.	Barley
Juncus sp.	Rush
Lycurus setosus	Bristly wolftail
Monroa squarrosa	False-buffalograss
Muhlenbergia sp.	Muhly
Muhlenbergia asperifolia	Scratchgrass
Muhlenbergia minutissima	Least muhly
Muhlenbergia pauciflora	New Mexico muhly
Muhlenbergia pungens	Sandhill muhly
Muhlenbergia torreyi	Ring muhly
Pleuraphis jamesii	Galleta
Schedonnardus paniculatus	Tumblegrass
Schizachyrium scoparium var. *scoparium*	Little bluestem
Sporobolus sp.	Dropseed
Sporobolus airoides	Alkali sacaton

Sporobolus contractus	Spike dropseed
Sporobolus cryptandrus	Sand dropseed
Sporobolus flexuosus	Mesa dropseed
Typha prob. *domingensis*	Cattail, probably southern

Ferns

Cheilanthes feei	Santa Fe lipfern
Cystopteris fragilis	Brittle bladder-fern

Forbs

Abronia fragrans	Fragrant sand-verbena
Ageratina herbacea	Fragrant snakeroot
Allionia incarnata	Trailing windmills
Amaranthus hybridus	Smooth amaranth
Amaranthus palmeri	Palmer's amaranth
Ambrosia acanthicarpa	Burr ragweed
Ambrosia artemisiifolia var. *elatior*	Annual ragweed
Artemisia campestris var. *caudata*	Field wormwood
Artemisia carruthii	Carruth's sagebrush
Artemisia dracunculus	Tarragon
Artemisia ludoviciana	Wormwood
Asclepias sp.	Milkweed
Astragalus spp.	Milkvetch
Astragalus kentrophyta	Spiny milkvetch
Bahia dissecta	Ragged-leaf bahia
Bassia hyssopifolia	Smotherweed
Castilleja poss. *austromontana*	Rincon Indian-paintbrush
Chaetopappa ericoides	Sand aster
Chamaesaracha coronopus	Green-leaf five-eyes
Chamaesyce maculata	Spotted spurge
Chamaesyce revoluta	Curl-leaf
Chamaesyce serpyllifolia	Thyme-leaf spurge
Chenopodium album	Lambs quarter
Chenopodium fremontii	Fremont’s goosefoot
Chenopodium leptophyllum	Narrowleaf goosefoot
Cirsium poss. *neomexicanum*	New Mexico thistle
Cleome serrulata	Rocky Mountain beeplant
Commelina dianthifolia	Bird-bill dayflower
Conyza canadensis	Horseweed
Corispermum americanum var. *americanum*	American bugseed
Cryptantha cinerea var. *jamesii*	Jame's cat's-eye
Cryptantha fendleri	Fendler’s cat’s-eye

Cuscuta sp.	Dodder
Dalea sp.	Prairie-clover
Dalea candida	White prairie-clover
Descurainia obtusa	Blunt tansy-mustard
Descurainia sophia	Flixweed
Dieteria bigelovii var. *bigelovii*	Bigelow's spine-aster
Dimorphocarpa wislizeni	Spectacle-pod
Draba cuneifolia var. *cuneifolia*	Wedgeleaf Whitlow-grass
Drymaria glandulosa	Fendler’s drymary
Drymaria leptophylla	Canyon drymary
Drymaria molluginea	Slimleaf drymary
Dysphania graveolens	Fetid-goosefoot
Dyssodia papposa	Fetid-marigold
Erigeron sp.	Fleabane
Erigeron pulcherrimus	Basin fleabane
Eriogonum sp.	Wild-buckwheat
Eriogonum alatum	Winged wild-buckwheat
Eriogonum cernuum	Nodding wild-buckwheat
Eriogonum jamesii	James' wild-buckwheat
Eriogonum ovalifolium	Cushion wild-buckwheat
Euphorbia sp.	Spurge
Geranium richardsonii	Richardson’s geranium
Grindelia squarrosa	Curly-cup gumweed
Hedeoma drummondii	Drummond’s false-pennyroyal
Helianthus petiolaris	Plains sunflower
Heterotheca villosa	Hairy golden aster
Hymenopappus filifolius	Fine-leaf woolywhite
Hymenoxys richardsonii var. *floribunda*	Colorado rubberweed
Ipomopsis aggregata	Skyrocket
Ipomopsis longiflora	Blue trumpets
Ipomopsis multiflora	Many-flowered skyrocket
Kallstroemia parviflora	Warty caltrop
Kochia scoparia	Mexican fire-weed
Laennecia schiedeana	Pineland woolwort
Linum lewisii	Prairie flax
Linum puberulum	Plains flax
Machaeranthera tanacetifolia	Tahoka daisy
Mentzelia multiflora	Adonis blazing star
Mirabilis linearis	Ribbon four-o’clock
Mirabilis multiflora	Colorado four-o'clock
Mirabilis oxybaphoides	Spreading four-o'clock
Monarda pectinata	Plains beebalm

Nama hispidum	Purple roll-leaf
Oenothera albicaulis	White-stem evening-primrose
Oenothera caespitosa	Tufted evening-primrose
Oenothera coronopifolia	Hairy-throat evening-primrose
Orobanche ludoviciana subsp. *multiflora*	Louisiana broom-rape
Oxalis violacea	Violet wood-sorrel
Pectis angustifolia	Lemon weed
Peteria scoparia	Rush peteria
Phacelia integrifolia	Gypsum scorpion-weed
Phemeranthis confertiflorus	New Mexico flame flower
Physalis sp.	Ground-cherry
Physalis virginiana	Virginia ground-cherry
Physaria rectipes	Straight bladder pod
Portulaca oleracea	Garden purslane
Portulaca pilosa	Kiss-me-quick
Pseudognaphalium canescens	Wright's rabbit-tobacco
Psilostrophe tagetina	Woolly paper-flower
Psoralidium lanceolatum	Wild scurf-pea
Salsola tragus	Russian-thistle
Salvia prob. *subincisa*	Sage, probably saw-tooth
Sanvitalia abertia	Abert's dome
Schoenocrambe linearifolia	Slim-leaf plains-mustard
Schkuhria pinnata var. *wislizeni*	Wislizenus's threadleaf
Sedum lanceolatum	Rosewort
Senecio spartioides var. *multicapitatus*	Broom groundsel
Silene laciniata var. *greggii*	Cardinal catchfly
Sisymbrium altissimum	Tall hedge-mustard (Jim Hill mustard)
Solanum jamesii	Wild potato
Solanum triflorum	Cut-leaf nightshade
Solidago wrightii var. *adenophora*	Wright's goldenrod
Sphaeralcea sp.	Globemallow
Sphaeralcea poss. *angustifolia*	Copper globemallow
Sphaeralcea coccinea	Scarlet globemallow
Stanleya pinnata var. *pinnata*	Prince's-plume
Stenotus armerioides	Mock goldenweed
Taraxacum officinale	Common dandelion
Thelypodium wrightii	Wright's thelypody
Townsendia annua	Annual Townsend-daisy
Townsendia incana	Hoary Townsend-daisy (Easter daisy)
Tradescantia occidentalis	Spiderwort
Verbesina encelioides	Golden crownbeard
Wyethia scabra	Badland mule's-ears

Xanthisma grindelioides	Ray-less sleep-daisy (Rayless tansy aster)
Xanthisma spinulosum var. *spinulosum*	Lacy sleep-daisy (Lacy tansy aster)
Zinnia grandiflora	Plains zinnia

LOOKING NORTHWEST FROM NESE SEC. 9

LOOKING NORTHEAST AT PONDEROSA PINES NEAR CENTER SEC. 9

LOOKING NORTHWEST FROM NENW SEC. 9

LOOKING NORTH AT SAND DUNE IN NWSW SEC. 9

LOOKING NORTHEAST FROM NWSE SEC. 10

LOOKING EAST TOWARD LA CUCHILLA MESA FROM NESW SEC. 10

LOOKING NORTHEAST FROM SWNW SEC. 10

LOOKING SOUTH TOWARD MOUNT TAYLOR FROM NWSW SEC. 10

Appendix 4-C

Roca Honda Permit Area
Vegetation Cover, Density, and Productivity Surveys
Sections 9, 10, 11, 12, 16, and 27

VEGETATION SURVEY REPORT (BASELINE DATA)
ROCA HONDA RESOURCES, LLC
ROCA HONDA PROJECT
2008 & 2010 FIELD SEASONS

ON STATE, PRIVATE, AND FEDERAL LANDS
(CIBOLA NATIONAL FOREST)
SECTIONS 9, 10, 11, 12, 16, T. 13 N., R. 8 W.
SECTION 27, T. 14 N., R. 8 W.
MCKINLEY AND CIBOLA COUNTIES
NEW MEXICO

JANUARY 17, 2011

PREPARED FOR:

RHR
ROCA HONDA RESOURCES LLC

ROCA HONDA RESOURCES, LLC

PREPARED BY:

PERMITS WEST, INC.
PROVIDING PERMITS for LAND USERS

PERMITS WEST, INC.
SANTA FE, NM

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1.0 VEGETATION

1.1 VEGETATION DATA OVERVIEW

1.1.1 *BACKGROUND*

The general vegetation types encountered at the site have been described previously, and a list of plant species observed in mid-summer at the project site was prepared (Wood 2006a, 2006b).

For the evaluation phase, detailed descriptions were needed. This includes quantitative measurements of cover, density, and productivity of the various plant communities. A vegetation map was also needed. Starting in March 2008, the data gaps in the vegetation characteristics of the Roca Honda site were thoroughly assessed and a study plan was prepared that contained the elements listed in Table 1 below.

Table 1. Data Gaps Identified for Vegetation Type Analysis in March 2008.

DATA GAP	HOW WOULD GAP BE FILLED?
Vegetation map	A vegetation map will be prepared using a combination of aerial photographs, topographic maps and field surveys. The field assessments will involve surveying transect lines to collect quantitative measurements of vegetation cover.
Vegetation productivity measurements	Exclosures will be established and plant samples will be collected and weighed after the growing season to determine productivity of the herbaceous cover.
A complete plant species inventory	A partial plant species inventory has been made. Additional surveys for spring- and fall-flowering species will take place in March, April, May, June, August and September, 2008.
Assessment of the potential impacts of water discharge in an unnamed tributary of San Mateo Wash	A survey of the vegetation in the drainage running from Section 16 to Section 21 and the unnamed tributary of the San Mateo Wash will be made during the spring, summer, and fall of 2008. The potential impacts of water discharge on the vegetation can then be evaluated.

1.1.2 *STATUS OF OBJECTIVES*

The data collected during 2008 are summarized in Table 2 on page 2. Vegetation types and grass productivity of the site have been described in this report and a vegetation map has been prepared. The sites from which data have been used generally reflect the numerical designation of their locations in the field. That is, data from transect 1 was entered first, data from transect 2 entered next, etc. Data to describe ground cover at the project site were entered for transect lines 1 through 52.

Specific objectives and their respective status include:

1. A plant species inventory has been prepared.
2. Descriptions of the existing vegetation types within the permit area are provided. Quantitative estimates are provided for:
    a. Vegetation and ground cover.
    b. Shrub and tree density.
    c. Herbaceous productivity.
3. A map that delineates existing vegetation types has been developed.

Photo points were recorded using Universal Transverse Mercator (UTM) coordinates. Permanent survey markers, such as rebar, were not used because they would be lost during subsequent mining activity.

After the characteristics of these vegetation types have been reviewed, one appropriate vegetation reference area will be selected and clearly delineated in an area either outside the Roca Honda Resources (RHR) Project Area, or within the RHR Project Area in a location that will not be disturbed by mining activity. For additional information regarding potential vegetation reference areas at the Roca Honda project site, see the Attachment to this Vegetation Survey Report.

Table 2. Data collected for vegetation type analysis in 2008 in Sections 9, 10, and 16.

NUMBER/FORM OF DATA COLLECTION	DATA COLLECTED	OBJECT OF DATA COLLECTION
77 transect lines	Biotic and abiotic cover along each transect line	Determine vegetation type and quantitative cover
4 transect lines	Biotic and abiotic cover and topology of transect lines across San Mateo arroyo	Determine profile and cover along the arroyo and potential impact after high volume water flow.
81 transect lines	Number of shrubs within 50 m^2 (164 ft^2) band	Determine shrub density
81 transect lines	Number and size of trees within 50 m^2 (164 ft^2) band	Determine tree density and contribute to woody productivity calculations
243 squares on 81 transects	Individual species and their cover within 100 m^2 (328 ft^2) at 3 predetermined points on transect line	Determine species diversity (species inventory)
48 exclosures	Grass, forb, and shrub dry weights	Productivity
56 trees	Heights of juniper, ponderosa pine and piñon and circumference of ponderosa pine and piñon.	Determine tree sizes (to be determined in conjunction with aerial photographs)
2 relevés	Species and size of water pocket areas	Determine vegetation type and area sizes

1.2 DATA COLLECTION

1.2.1 *DATA COLLECTION PERIODS*

Six trips were made during 2008 to survey for plant species and gather information with which to prepare a vegetation map. The dates and activities during each trip are reported in Table 3 on page 3. Surveys were planned in order to capture both short-lived annuals and perennials for the plant species inventory. Surveys in April and June were appropriate to observe and identify the two sensitive species considered most likely to occur at the project site. Inventory surveys per se were not carried out in July and August in 2008 since surveys for plant species in the project site had already been made at that time in 2006. In 2006, vegetative growth was more abundant and there were many more species than in relatively dry 2008. In 2006, the survey periods were from July 31 through August 8 and from September 11 through October 19 within Sections 9 and 10 (Wood 2006a) and July 31 through August 8 within Section 16 (Wood 2006b).

Table 3. Vegetation survey dates in 2008.

DATE	ACTIVITY
March 22-31	Inventory and sensitive species survey
April 21-26	Inventory and sensitive species survey
May 20-27	Inventory and sensitive species survey
June 20-30	Inventory and quantitative data for vegetation type characterization. Sensitive species survey
July 15-17	Quantitative data for arroyo characterization
Sept. 30-Oct. 5	Quantitative data collection for productivity measurements

Transect lines were surveyed for cover in June 2008. Herbaceous productivity measurements were initiated in March 2008 by erecting exclosures, and sampling occurred in late September/early October 2008. The time period, April through August, was selected since it is the typical growing season of *Bouteloua sp.* (hairy and blue grama grass), which are the dominant grasses at the project site. *Bouteloua* species are warm-season, short-lived, perennial short grasses and biomass production of hairy grama grass positively correlates with precipitation during the growing season (Zlatnik 1999). As a result, a relatively long period (5 months) between setting up the exclosures and harvest was selected to ensure the greatest likelihood that precipitation would occur during the potential growing period. Harvesting the exclosure plots was in fact postponed until late September since there was little precipitation by August.

1.2.2 *MATERIALS AND METHODS*

1.2.2.1 *SURVEYS FOR PLANT SPECIES AND VEGETATION MAPPING*

The entire project site was surveyed on foot by the author/lead botanist of this report, who also developed the vegetation map. The project site was methodically covered several times throughout the growing season. Particular attention was made to find sensitive species, selenium-indicator species, and noxious non-native species. Certain areas were particularly targeted at different times of the year in order to have the best chance of finding sensitive and/or rare species. The lead botanist was always accompanied by one or two additional botanist/ecologists who walked 20-meter (m) (65.6 feet [ft]) to 50 m (164 ft) parallel paths so that the whole area was carefully covered. Notes were associated with GPS coordinates in order to document the vegetation types that occurred throughout the project site.

1.2.2.2 *COVER AND DENSITY MEASUREMENTS*

Data collection for vegetation cover estimates was conducted in June, July and September 2008 (Table 3 above). Vegetation cover was measured using the point intercept method along a 50 m (164 ft) long transect line (Elzinga et al., 2001). The cover that intercepted the line at 1m intervals along the 50 m (164 ft) transect line was measured using an optical device (Figure 1 on page 4). Using this method, the total cover was calculated as the percentage of interceptions ("hits"), relative to the total number of points sampled (for example, see "Rangeland Monitoring in Western Uplands" on ForestandRange.org website at: http://www.forestandrange.org/modules/vegmonitor/mod9/mod9-14.shtml). The cover of individual plant species was estimated by recording the plant species name when intercepted by a point.

During the survey, bare ground was defined as soil alone. Gravel and coarse sand are classified as particles up to 7.6 cm (3 inches); rocks are particles greater than 7.6 cm (3 inches). Litter was dead plant material directly covering the ground, dead perennial vegetative bases, or animal scat, including cow dung. If a small stem or piece of litter was not considered large enough to intercept a raindrop, the "hit" was the ground covering, or lack of covering, below it. Dead annual forbs were considered as litter cover when unattached to the roots and potentially windblown. A dead annual forb that was attached to its root and recognizable to species was recorded as that species. Species were recorded when the sampling point fell on any part of the vegetation. When the canopy of multiple species overlapped, canopy overhung bare ground, litter, or gravel/coarse sand; all the cover-types were recorded. However, to estimate cover, only the uppermost layer was analyzed so that total cover added up to 100%. Basal cover was not measured.

Figure 1. Using an optical laser device to measure cover along a 50-m long transect line.

Transect line percent-cover results are reported as the arithmetic mean, the standard deviation of the mean, the mode[1], and median[2] of the species cover class. All of these values are useful in visualizing the frequency (commonness/rareness) with which the species occurs as well as how much canopy they contribute to cover. For example, the mean value may be a large number while the mode is zero. Therefore, one can conclude that the species is abundant in only some areas and it is not commonly encountered throughout the site.

The point intercept method is objective and fairly rapid. Floyd and Anderson (1987) found that the point intercept method achieved the same level of precision as the line-intercept method while taking one third of the time (Elzinga et al., 2001). In some cases this method can tend to overestimate cover (Korb et al., 2003). On the other hand, an important disadvantage of the method is that species with low cover values are often not effectively sampled because points so rarely intersect them (Korb et al., 2003). The latter problem was mitigated by making visual estimates of relative abundance of each species in 10 m (32.8 ft)

[1] Mode = the most frequently occurring value in a frequency distribution
[2] Median = the middle value of the given numbers *"n"* in their ascending order

squares (100 m²; 1,076 ft² area) at 0 m (0 ft), 25 m (82 ft), and 50 m (164 ft) along the transect lines when describing each community (see Figure 2 below).

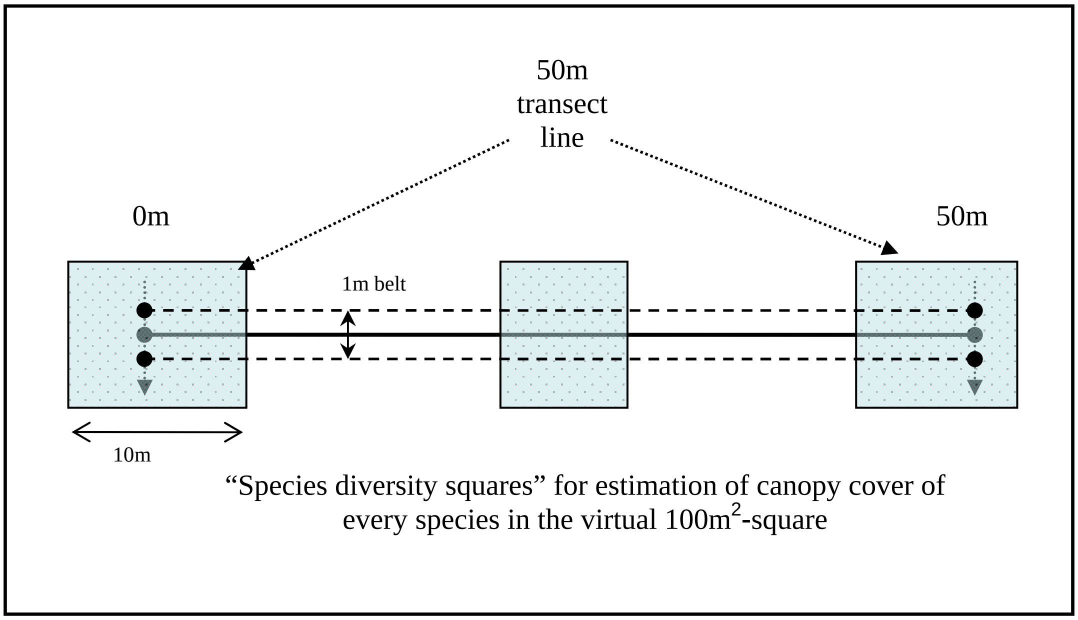

Figure 2. Diagram to show the transect design (not to scale; see text for further details).

All species that were in this 10 m-wide (32.8 ft) square were recorded and their cover estimated, so that 1 m^2 (3.3 ft^2) of vegetative cover equaled 1 percent and 5 square meters equaled 5 percent and so on. In the field, cover over these squares was estimated to within a numeric class that represented a range; less than 1%, 1 to 5 %, 5.1 to 15% etc. (Table 4 below). These cover sampling squares are termed "species diversity squares" in subsequent tables in this report.

Table 4. Cover classes for estimating the canopy cover of each species within the species diversity squares at the beginning, in the mid section, and at the end of each transect line.

PERCENT COVER	CLASS
<1	1
1 to 5	2
5.1-15	3
15.1-25	4
25.1-50	5
50.1-75	6
75.1-95	7
>95	8

Shrubs and trees were counted within 1 m (3.28 ft) of the 50-m (164-ft) transect lines (belt transects) that were used to estimate ground cover. All trees were counted and their heights measured (using a clinometer or measuring stick if shorter than 1 m [3.28 ft]) within 10 m (32.8 ft) each side of the transect line. The data was recorded by species so that tree, full shrub (woody species), and sub-shrub (suffrutescent species) density values could be calculated for each community type. Shrubs were therefore counted within a 50 m^2 (538 ft^2) area and trees within a 500 m^2 (5,382 ft^2).

UTM coordinates of each end of the transect lines were recorded. In the project area the ends were also marked with whiskers and wooden stakes pounded into the ground so that the whiskers were at the level of the soil surface.

1.2.2.3 *PRODUCTIVITY MEASUREMENTS*

There are various methods available to obtain a measure of plant productivity; for example, Leaf Area Index (LAI), measures of above ground biomass, and remote sensing imaging technologies have all been used to measure productivity (Breckenridge et al., 1995, Hunt et al., 2003). The current standard for an accurate measurement of herbaceous plant productivity is to measure above ground biomass by clipping, weighing, oven drying, and re-weighing vegetation that has been growing in an area (exclosure) that has been protected from grazing. This is the method used for the 2008 growing season.

Herbaceous productivity measurements were only made in vegetation types having a significant amount of herbaceous cover; shrub-grassland, juniper savanna and low elevation piñon juniper woodland. Exclosures (1 m by 1 m [3.28 ft. by 3.28 ft.]) were erected in representative areas throughout the project area (see Figure 3 on page 7). At the time when the exclosures were being erected, the project site area also included the southern third of Section 11 and the southwest quarter of the southwest quarter of Section 12. The number of exclosures erected took into account a potential loss of three exclosures due to environmental or ungulate disturbance. However, no exclosures were completely lost although there was evidence of rodent activity in Exclosure 8.

The exclosures were erected during March 28-March 31 2008. The photographs in Figure 4 on page 8 illustrate the design. Exclosures were not erected in shaded areas. The sides were buried several inches to deter burrowing animals. Tops were secured to prevent cattle from grazing inside. During September 30 to October 5, the plant material within the exclosures was harvested. A 40 cm (15.7 in) by 40 cm (15.7 in) sampling square made from half inch-PVC tubing was placed in the center of each exclosure. Only the vegetation within the square was harvested. This was to obtain vegetation that was undisturbed and buffered by vegetation between the edge of the square and edge of the exclosure. Therefore, “edge-effects” on the samples were minimized. All plant material within the designated sample area was clipped to within less than an inch of the ground. Plant material was divided into grasses, shrubs, forbs, and vagrant lichen and stored in separate bags.

Samples were not collected within 24 hours of rainfall. The weather was very dry during this period and samples were collected after 9:00 am. All samples were placed in zip-lock plastic bags, and double bagged with as much air removed as practical. Extra debris (e.g., dirt, rocks, and pellets) were removed. All samples were cooled below the condensation temperature by placing them in an ice chest with ice packs. Samples were stored in a refrigerator or an ice chest packed with fresh ice daily for less than a week. They were then transferred to a deep freeze in a laboratory at the University of Wyoming prior to processing.

Coarse forceps were used to handle all the samples. In the laboratory, before the plant material was taken out of the plastic sample bags for drying and weighing, the bag was placed on a grounded surface to reduce the electrostatic forces. Samples were cut into shorter pieces if necessary prior to drying and spread out uniformly on aluminum drying pans to make sure the drying process was even. Samples were dried at 64° C (147.2° F) for at least 72 hours or to when the samples were measured to have dried to constant weight.

1.2.2.4 *SAMPLING LOCATIONS*

The distribution of vegetation types was estimated from the topographic map and observations made on the ground recorded during the plant inventory surveys.

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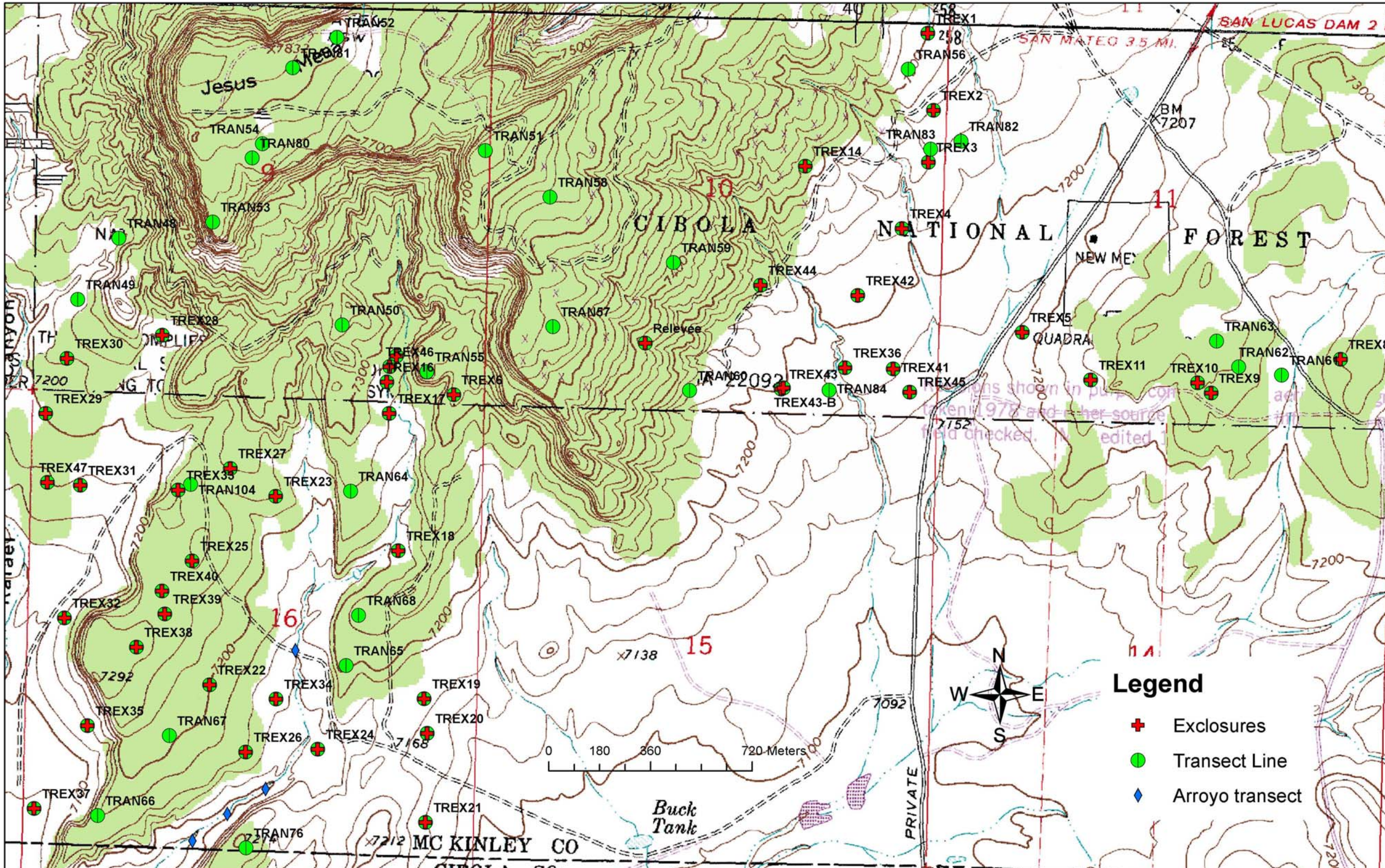
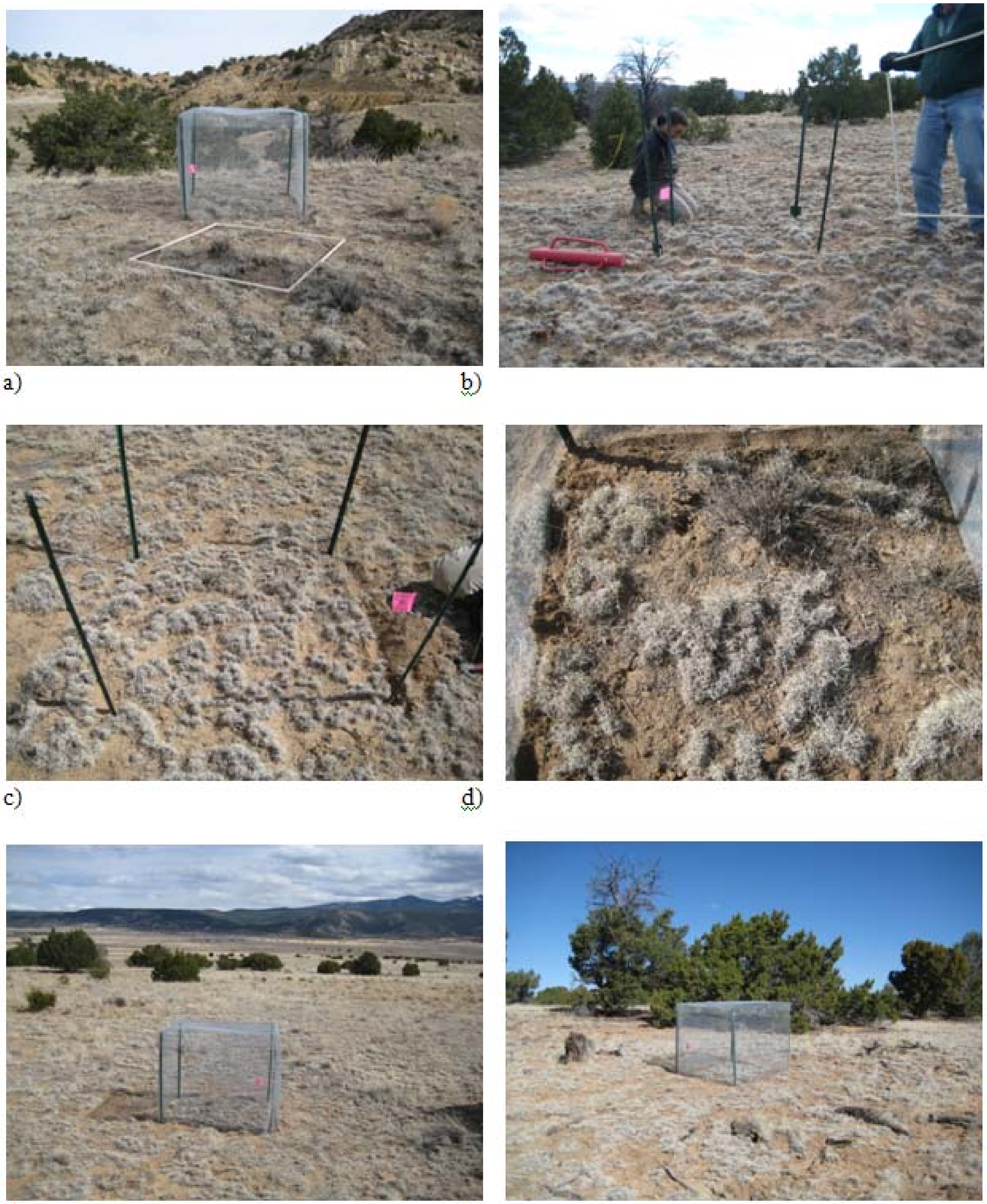


Figure 3. The location of the transect lines and exclosures throughout the project site on USGS topographical map background (7.5'San Mateo).



a) b) c) d) e). f).

Figure 4. Exclosures that were erected at the project site. (a) A completed exclosure and the template frame. The 1 m x 1m frame in the foreground was used as the template for erecting the four support rebars (one at each corner) shown in (b). A narrow trench was dug so the sides of the exclosure were buried (c) and then the trench completely filled in with the soil that was removed so that erosion would be avoided (d). Completed exclosures with "lids" secured by baling wire are shown in (e) and (f).

Eighty one (81) transects were distributed throughout the project site but were more numerous in those areas that were indicated to be potentially impacted by the mining activities. With the exception of one exclosure where no line transect was surveyed, one or more transect lines were surveyed at each exclosure site. A grid was placed over a topographic map of the project site and the grids numbered. The sample (exclosure and transect line) locations were determined by randomly choosing points within each quad with some restrictions: Specific vegetation types for analysis were targeted, and the random point was discarded if it was found to fall outside of the type targeted. For example, if the potential location of a transect line or exclosure destined to describe the juniper savanna fell on a historic exploratory drill hole, the point was discarded and the next random location was used. Another restriction was that the grid system and random number generator were set up so that transects would be distributed approximately evenly throughout the site. An additional restriction in an exclosure's placement was that they were only located in vegetation types with appreciable grass cover. For example, no exclosures were placed on bedrock.

In the field, the transect line was objectively orientated with respect to compass directions. The orientation was according to a list of numbers, between 0 to 360, which was generated using a computerized random number generator (Microsoft Excel – Professional 2003 edition) and each number on the list was used sequentially to orient each transect. A compass was then used to orient the corresponding transect line in the field. Transects were surveyed by two teams of people; 3 people per team.

Eighty one (81) transects were surveyed throughout the project site to characterize the vegetation types (see Figure 3 on page 7). Forty seven (47) transect lines were within 5 m (16.4 ft) of an exclosure. Four (4) of the 81 transect lines were located across the tributary to San Mateo Creek in Sections 16 (4 transects). The topography along these transects was also measured in addition to cover. The remaining transect lines were distributed thus: 20 transects in Section 10; 14 in Section 9; 31 in Section 16; 8 in Section 11; 4 in Section 12. Data was collected for site characterization at each water pocket area in Section 10 using a relevé method (Knapp 1984). In total, 81 transect lines and two relevés were surveyed (Table 2 on page 2).

The relevé method utilizes a delimited plot of vegetation that has fairly homogenous structural and compositional features. Using the relevé method a list of the plants and information on species cover, substrate and other abiotic features in the plot is collected. It is considered a semi-quantitative method since it relies on ocular estimates of plant cover rather than on counts of the "hits" of a particular species along a transect line or on precise measurements of biomass by weighing techniques. This subjective plot placement is particularly useful in describing native vegetation in fragmented landscapes.

1.2.3 *VEGETATION MAP DEVELOPMENT*

The objective of the vegetation mapping effort is to document the state of pre-mining vegetation. In conjunction with surveys on the ground, aerial photographs were used to delineate the vegetation types within the project area. The aerial images were taken by a low flying aircraft using color infrared photography. The images were ortho-rectified having UTM projection and NAD83 datum.

The vegetation map, presented and discussed in detail in Section 1.3.2.1 of this report, was created in ArcGIS 9.3 (ESRI, Redlands, California). The smallest mapping unit for vegetation type was generally one hectare. However, when a feature was ecologically significant, it was added as a point feature to the vegetation map. For example, areas with surface water (e.g., springs, seeps, or ponds) were surveyed and mapped in detail because of the importance of aquatic/wetland features to the ecological functioning of the landscape. Additional features of biological/ecological interest included stands of invasive saltcedar, particularly large trees, the solitary cottonwood at the site, and sizable patches of well-developed microbiotic crusts.

1.3 Vegetation Results

1.3.1 *Plant Species Inventory*

1.3.1.1 *Plant Species Compilation*

The number of species observed at the site indicates that there is a good amount of species diversity. In 2008, the vegetation cover was less dense and the number of plant species observed was fewer than in 2006 (Rohman and Devlin personal communication 2008). The most likely reason is because 2008 was considerably drier than previous years, and the area appeared to be suffering through a significant drought. In several cases, the dried remains of many of the species noted in 2006 could be clearly identified in 2008. For example, the desiccated parts of *Mirabilis multiflora* (Colorado four-o'clock) were abundant but there were relatively few living individuals.

Some areas had obviously been impacted by intense grazing pressure, but it is notable that there were relatively few non-native weed species. In general, the native cover appeared to be healthy and recruitment was evident amongst tree, shrub, and forb species.

In the inventory in Table 5 below, plant species names used are those accepted by Integrated Tasonomic Information System (ITIS). Where the names accepted by ITIS and the Flora of North America differ, the name accepted by the latter is placed in parentheses. For example, ITIS accepts *Chenopodium graveolens* but in the current Flora of North America, *Dysphania* is accepted due to an expanded circumscription that includes all "glandular" taxa previously treated in *Chenopodium* subg. *Ambrosia* (Clements and Mosyakin 2003, ITIS 2009).

Table 5. Plants species inventory for the Roca Honda site.

Table 5. Plants species inventory for the Roca Honda site		
Life form - Species	**Section**	**Common name**
Trees		
Juniperus monosperma	16, 9 & 10	One-seed juniper
Juniperus scopulorum	9&10	Rocky Mountain juniper
Pinus edulis	16, 9 & 10	Piñon pine
Pinus ponderosa	9&10	Ponderosa pine
Populus deltoides	9&10	Cottonwood
Shrubs and Subshrubs		
Artemisia bigelovii	16, 9 & 10	Flat sagebrush
Artemisia filifolia	9&10	Sand sage
Artemisia frigida	16, 9 & 10	Fringed sage
Artemisia nova	16, 9 & 10	Black sagebrush
Atriplex canescens	16, 9 & 10	Four-wing saltbush
Brickellia brachyphylla	9&10	Plumed brickellbush
Brickellia californica	9&10	California brickellbush
Brickellia grandiflora	9&10	Tassel-flower brickellbush
Cercocarpus montanus	16, 9 & 10	Mountain mahogany
Chrysothamnus greenei	16, 9 & 10	Greene's rabbitbrush
Ericameria nauseosa	16, 9 & 10	Rubber rabbitbrush
Ericameria nauseosa var. bigelovii	9&10	Bigelow's rubber rabbitbrush
Ericameria nauseosa var. graveolens	16, 9 & 10	Rubber rabbitbrush
Eriogonum corymbosum	9&10	Crispy wild-buckwheat

TABLE 5. PLANTS SPECIES INVENTORY FOR THE ROCA HONDA SITE		
LIFE FORM - SPECIES	**SECTION**	**COMMON NAME**
Eriogonum leptophyllum	9&10	Slender-leaf wild-buckwheat
Eriogonum microthecum var. simpsonii	16, 9 & 10	Simpson's wild-buckwheat
Eriogonum umbellatum	9&10	Sulphur-weed
Fallugia paradoxa	16, 9 & 10	Apache-plume
Gutierrezia sarothrae	16, 9 & 10	Broom snakeweed
Krascheninnikovia lanata	16, 9 & 10	Winterfat
Lycium pallidum	16, 9 & 10	Pale wolfberry
Nolina microcarpa	10	Beargrass
Purshia stansburiana	16, 9 & 10	Cliffrose
Philadelphus microphyllus	10	Mock orange
Quercus gambelii	9&10	Gambel oak
Quercus grisea	9&10	Gray oak
Quercus xpauciloba	9&10	Wavyleaf oak
Quercus sp.	16	Oak
Rhus trilobata var. trilobata	16, 9 & 10	Skunkbush sumac
Ribes cereum	9&10	Wax currant
Tamarix chinensis[T1]	16	Saltcedar
Tetradymia canescens	16	Spineless horsebrush
Yucca baccata	16, 9 & 10	Banana yucca
Yucca sp.	16, 9 & 10	Narrow-leaved yucca
Cacti		
Escobaria vivipara	16, 9 & 10	Spinystar (Nipple cactus)
Cylindropuntia imbricata var. imbricata	16, 9 & 10	Cane cholla
Echinocereus fendleri	10	Pinkflower hedgehog cactus
Echinocereus triglochidiatus	16, 9 & 10	Claret-cup cactus
Opuntia phaeacantha	16, 9 & 10	Plains prickly-pear
Opuntia polyacantha	16, 9 & 10	Starvation prickly-pear
Grasses and Grass-like plants		
Achnatherum hymenoides	16, 9 & 10	Indian rice grass
Agrostis sp.	16	Bentgrass
Aristida adscensionis	9&10	Six-weeks threeawn
Aristida divaricata	9&10	Poverty threeawn
Aristida purpurea	16, 9 & 10	Purple threeawn
Aristida purpurea var. longiseta	9&10	Red threeawn
Blepharoneuron tricholepis	9&10	Pine dropseed
Bothriochloa springfieldii[T2]	9&10	Springfield's bluestem
Bouteloua barbata	9&10	Six-weeks grama
Bouteloua curtipendula	9&10	Side-oats grama
Bouteloua eriopoda	9&10	Black grama
Bouteloua hirsuta	16, 9 & 10	Hairy grama
Bromus catharticus	10	Rescuegrass
Bromus tectorum[T3]	10	Cheatgrass
Chloris virgata	9&10	Showy windmill grass
Cyperus squarrosus[T4]	16	Awned flat-sedge

TABLE 5. PLANTS SPECIES INVENTORY FOR THE ROCA HONDA SITE		
LIFE FORM - SPECIES	SECTION	COMMON NAME
Cyperus strigosus[T5]	9&10	Straw-color flat-sedge
Eleocharis macrostachya[T6]	9&10	Pale spikerush
Elymus elymoides	16, 9 & 10	Bottlebrush squirreltail
Elymus smithii	9 &10	Western wheatgrass
Hesperostipa comata	16	Needle-and-thread
Hordeum jubatum	16	Foxtail barley
Hordeum sp.	9&10	Barley
Hordeum sp.	16	Barley
Juncus sp.	9&10	Rush
Juncus tenuis[T7]	10	Poverty rush
Koeleria macrantha	16, 9 & 10	Prairie Junegrass
Lycurus setosus	9&10	Bristly wolftail
Monroa squarrosa	9&10	False-buffalograss
Muhlenbergia asperifolia	9&10	Scratchgrass
Muhlenbergia minutissima	9&10	Least muhly
Muhlenbergia pauciflora	9&10	New Mexico muhly
Muhlenbergia pungens	16, 9 & 10	Sandhill muhly
Muhlenbergia sp.	9&10	Muhly
Muhlenbergia torreyi	16, 9 & 10	Ring muhly
Muhlenbergia porteri	16, 9 & 10	Bush muhly
Monroa squarrosa	16	False-buffalograss
Pleuraphis jamesii	9&10	Galleta
Pseudoroegneria spicata	16	Bluebunch wheatgrass
Schedonnardus paniculatus	9&10	Tumblegrass
Schizachyrium scoparium var. scoparium	9&10	Little bluestem
Sporobolus airoides	16, 9 & 10	Alkali sacaton
Sporobolus contractus	9&10	Spike dropseed
Sporobolus cryptandrus	16, 9 & 10	Sand dropseed
Sporobolus flexuosus	9&10	Mesa dropseed
Sporobolus sp.	9&10	Dropseed
Typha domingensis[T8]	9&10	southern cattail
Ferns		
Cheilanthes feei	16, 9 & 10	Santa Fe lipfern
Cystopteris fragilis	9&10	Brittle bladder-fern
Forbs		
Abronia fragrans	16, 9&10	Fragrant sand-verbena
Ageratina herbacea	9&10	Fragrant snakeroot
Allionia incarnata	16, 9 & 10	Trailing windmills
Allium sp.	16, 9 & 10	Wild onion
Amaranthus palmeri	9&10	Palmer's amaranth
Amaranthus hybridus	9&10	Smooth amaranth
Amaranthus palmeri[T9]	16	Palmer's amaranth
Ambrosia acanthicarpa	16, 9 & 10	Burr ragweed
Ambrosia artemisiifolia var. elatior	9&10	Annual ragweed

TABLE 5. PLANTS SPECIES INVENTORY FOR THE ROCA HONDA SITE		
LIFE FORM - SPECIES	**SECTION**	**COMMON NAME**
Artemisia campestris var. caudata	9&10	Field wormwood
Artemisia campestris var. scouleriana (Artemisia campestris ssp. pacifica)	9&10	Pacific wormwood
Artemisia carruthii	9&10	Carruth's sagebrush
Artemisia dracunculus	16, 9 & 10	Tarragon
Artemisia ludoviciana	16, 9 & 10	Wormwood
Asclepias sp.	16	Milkweed
Asclepias macrosperma	16, 9 & 10	Milkweed
Astragalus kentrophyta	9&10	Spiny milkvetch
Astragalus spp.	16, 9 & 10	Milkvetch
Bahia dissecta	16, 9 & 10	Ragged-leaf bahia
Bassia hyssopifolia[T10]	9&10	Smotherweed
Kochia scoparia	16, 9 & 10	Mexican fire-weed
Boechera sp.	16	Rockcress
Brickellia brachyphylla	16	Plumed brickellbush
Brickellia californica	16	California brickellbush
Carduus nutans[T11]	16	Musk thistle
Castilleja spp.	16, 9 & 10	Indian-paintbrush
Chaetopappa ericoides	16, 9 & 10	Sand aster
Chamaesaracha coronopus	16, 9 & 10	Green-leaf five-eyes
Chamaesyce fendleri	16, 9 & 10	Fendler's sandmat
Chamaesyce maculata	16, 9 & 10	Spotted spurge
Chamaesyce revoluta	9&10	Curl-leaf
Chamaesyce serpyllifolia	16, 9 & 10	Thyme-leaf spurge
Chamaesyce sp.	16	Spurge
Chenopodium album	16, 9 & 10	Lambs quarter
Chenopodium fremontii	9&10	Fremont’s goosefoot
Chenopodium graveolens (Dysphania graveolens. Additional syn=Teloxys graveolens)	9&10	Fetid-goosefoot
Chenopodium leptophyllum	9&10	Narrowleaf goosefoot
Cirsium arvense[T12]	16	Canadian thistle
Cirsium neomexicanum[T13]	16, 9 & 10	New Mexico thistle
Cleome serrulata	16, 9 & 10	Rocky Mountain beeplant
Commelina dianthifolia	16, 9 & 10	Bird-bill dayflower
Commelina erecta var. angustifolia	16	White-mouth dayflower
Convolvulus arvensis[T14]	16	Field bindweed
Conyza canadensis	9&10	Horseweed
Corispermum americanum var. americanum	9&10	American bugseed
Cryptantha cinerea	16	James' cryptantha
Cryptantha cinerea var. jamesii	9&10	James' cryptantha
Cryptantha crassisepala	16, 9 & 10	Thicksepal cryptantha
Cryptantha fendleri	9&10	Sanddune cryptantha
Cuscuta sp.	16, 9 & 10	Dodder
Dalea candida	16, 9 & 10	White prairie-clover

TABLE 5. PLANTS SPECIES INVENTORY FOR THE ROCA HONDA SITE		
LIFE FORM - SPECIES	SECTION	COMMON NAME
Dalea sp.	9&10	Prairie-clover
Descurainia obtusa	16, 9 & 10	Blunt tansy-mustard
Descurainia sophia[T15]	9&10	Flixweed
Dieteria bigelovii var. bigelovii	9&10	Bigelow's spine-aster
Dieteria sp.	16	Spine-aster (Tansy aster)
Dimorphocarpa wislizeni	16, 9 & 10	Spectacle-pod
Draba cuneifolia var. cuneifolia	9&10	Wedgeleaf Whitlow-grass
Drymaria glandulosa	9&10	Fendler's drymary
Drymaria leptophylla	9&10	Canyon drymary
Drymaria molluginea	9&10	Slimleaf drymary
Dyssodia papposa	9&10	Fetid-marigold
Erigeron divergens	16	Spreading fleabane
Erigeron pulcherrimus	9&10	Basin fleabane
Erigeron sp.	9&10	Fleabane
Eriogonum alatum	9&10	Winged wild-buckwheat
Eriogonum cernuum	16, 9 & 10	Nodding wild-buckwheat
Eriogonum jamesii	16, 9 & 10	James' wild-buckwheat
Eriogonum ovalifolium	9&10	Cushion wild-buckwheat
Eriogonum palmerianum	16	Palmer's wild-buckwheat
Eriogonum rotundifolium	16, 9 & 10	Roundleaf buckwheat
Eriogonum sp.	9&10	Wild-buckwheat
Euphorbia sp.	9&10	Spurge
Geranium richardsonii	9&10	Richardson's geranium
Gilia longiflora	16	Blue trumpets
Gnaphalium palustre	10	western marsh cudweed
Grindelia squarrosa	16, 9 & 10	Curly-cup gumweed
Hedeoma drummondii	9&10	Drummond's false-pennyroyal
Helianthus petiolaris	16, 9 & 10	Plains sunflower
Heterotheca villosa	16, 9 & 10	Hairy goldenaster
Hymenopappus filifolius	16, 9 & 10	Fine-leaf woolywhite
Hymenoxys richardsonii var. floribunda	16, 9 & 10	Colorado rubberweed
Ipomopsis aggregata	9&10	Skyrocket
Ipomopsis longiflora	16, 9 & 10	Blue trumpets
Ipomopsis multiflora	16, 9 & 10	Many-flowered skyrocket
Kallstroemia parviflora	16, 9 & 10	Warty caltrop
Laënnecia schiedeana	9&10	Pineland horseweed
Lappula occidentalis	16	Spiny sheepbur
Lesquerella sp.	16, 9 & 10	Bladderpod
Linum (Cathartolinum) sp.	16	Flax
Linum lewisii	9&10	Prairie flax
Linum puberulum	9&10	Plains flax
Machaeranthera grindelioides (Xanthisma grindelioides)[T16]	9&10	Rayless tansy aster
Machaeranthera tanacetifolia[T17]	9&10	tanseyleaf tansyaster

TABLE 5. PLANTS SPECIES INVENTORY FOR THE ROCA HONDA SITE		
LIFE FORM - SPECIES	**SECTION**	**COMMON NAME**
Machaeranthera pinnatifida (Xanthisma spinulosus)(Haplopappus spinulosus)[T18]	9&10	Lacy tansy aster
Marrubium vulgare[T19]	10	Horehound
Mentzelia albicaulis	16	Whitestem blazingstar
Mentzelia multiflora	9&10	Adonis blazing star
Mirabilis linearis	9&10	Ribbon four-o'clock
Mirabilis multiflora	16, 9 & 10	Colorado four-o'clock
Mirabilis oxybaphoides	16, 9 & 10	Spreading four-o'clock
Monarda pectinata	9&10	Plains beebalm
Nama hispidum	9&10	Purple roll-leaf
Oenothera albicaulis	9&10	White-stem evening-primrose
Oenothera caespitosa	16, 9 & 10	Tufted evening-primrose
Oenothera coronopifolia	16, 9 & 10	Hairy-throat evening-primrose
Oenothera pallida	16, 9 & 10	Pale evening primrose
Orobanche ludoviciana subsp. multiflora	9&10	Louisiana broom-rape
Oxalis violacea	16, 9 & 10	Violet wood-sorrel
Packera multilobata	16, 9 & 10	
Pectis angustifolia	9 &10	Lemon weed
Penstemon barbatus	16, 9 & 10	beardlip penstemon
Peteria scoparia	16, 9 & 10	Rush peteria
Phacelia integrifolia	16, 9 & 10	Gypsum scorpion-weed
Talinum confertifolium (Phemeranthus confertiflorus) (Phemeranthus parviflorus)[T20]	9 &10	New Mexico flame flower
Phoradendron juniperinum ssp. juniperinum	16	Juniper mistletoe
Physalis pubescens var. integrifolia[T21]	16	Husk-tomato
Physalis sp.	9&10	Ground-cherry
Physalis virginiana	16, 9 & 10	Virginia ground-cherry
Physaria rectipes	9 &10	Straight bladder pod
Plantago patagonica	16, 9 & 10	Woolly plantain
Portulaca oleracea	16, 9 & 10	Garden purslane
Portulaca pilosa	16, 9 & 10	Kiss-me-quick
Potentilla sp.	16	Cinquefoil
Pseudognaphalium canescens	9&10	Wright's rabbit-tobacco
Psilostrophe tagetina	16, 9 & 10	Woolly paper-flower
Psoralidium lanceolatum	9 &10	Wild scurf-pea
Salsola tragus[T22]	16, 9 & 10	Russian-thistle
Salvia prob. subincisa	16, 9 & 10	Sage, probably saw-tooth
Sanvitalia abertii	16, 9 & 10	Abert's dome
Schkuhria pinnata var. wislizeni	9 &10	Wislizenus' threadleaf
Schoenocrambe linearifolia	9 &10	Slim-leaf plains-mustard
Sedum lanceolatum	9 &10	Rosewort
Senecio sp.	16	Groundsel
Senecio spartioides var. multicapitatus	9 &10	Broom groundsel
Silene laciniata var. greggii	9 &10	Cardinal catchfly
Sisymbrium altissimum[T23]	9 &10	Tall tumblemustard

TABLE 5. PLANTS SPECIES INVENTORY FOR THE ROCA HONDA SITE		
LIFE FORM - SPECIES	**SECTION**	**COMMON NAME**
Solanum jamesii	16, 9 & 10	Wild potato
Solanum triflorum	9 &10	Cut-leaf nightshade
Solidago wrightii var. adenophora	9 &10	Wright's goldenrod
Sphaeralcea coccinea	16, 9 & 10	Scarlet globemallow
Sphaeralcea parvifolia	16	Small-leaf globemallow
Sphaeralcea angustifolia[T24]	9 &10	Copper globemallow
Sphaeralcea sp.	9 &10	Globemallow
Stanleya pinnata var. pinnata[T25]	16, 9 & 10	Prince's-plume
Stenotus armerioides	9&10	Mock goldenweed
Stephanomeria sp.	16	Wire-lettuce
Taraxacum officinale	9 &10	Common dandelion
Tetraneuris ivesiana	16, 9 & 10	Ives' fournerved daisy
Thelesperma megapotamicum	16, 9 & 10	Hopi tea greenthread
Thelypodium wrightii	9 &10	Wright's thelypody
Tiquilia hispidissima	16	Hairy crinklemat
Townsendia annua	16, 9 & 10	Annual Townsend-daisy
Townsendia incana	16, 9 & 10	Hoary Townsend-daisy (Easter daisy)
Tradescantia occidentalis	16, 9 & 10	Spiderwort
Verbena macdougalii	16	MacDougal's vervain
Verbesina encelioides	16, 9 & 10	Golden crownbeard
Wyethia scabra	9 &10	Badland mule's-ears
Zinnia grandiflora	16, 9 & 10	Plains zinnia
Non-vascular species[T26]		
Marchantia polymorpha	9 &10	Liverwort
Xanthoparmelia chlorochroa	16, 9 & 10	Lichen
Nostoc commune	16, 9 & 10	Cyanobacteria
Microcoleus vaginatus	16, 9 & 10	Cyanobacteria

[T1] - Invasive - Class C weed (NM)
[T2] - Not conclusively identified to sp.
[T3] - Non-native – invasive weed
[T4] - OBL (Not conclusively identified to sp.)
[T5] - FACW
[T6] - OBL
[T7] - FACW- (wetland status)
[T8] - OBL (wetland status)
[T9] - Not conclusively identified to sp.
[T10] - Introduced
[T11] - Invasive-Class B weed (NM)
[T12] - Invasive-Class A weed (NM)
[T13] - Not conclusively identified to sp.
[T14] - Invasive-Class C weed (NM)
[T15] – Introduced
[T16] - Likely accumulates selenium
[T17] - Likely accumulates selenium
[T18] - Likely accumulates selenium
[T19] - Non-native
[T20] - According to USDA PLANTS database. FNA subscribes to these species being in synonymy. ITIS recognizes Talinum confertifolium and Talinum parviflorum as distinct species and has not endorsed the genus "Phemeranthus"
[T21] - Not conclusively identified to sp.
[T22] – Introduced
[T23] - Introduced
[T24] - Not conclusively identified to sp.
[T25] - Selenium indicator; also accumulates selenium
[T26] - Not conclusively identified to sp.

1.3.1.2 *PLANT SPECIES OF SPECIAL CONCERN*

No sensitive plant species were observed during the surveys in 2008. This is consistent with the previous 2006 survey. The combination of geology, hydrology, habitat types, soils, aspect, and elevation in Sections 9, 10, 11, and 16 does not provide potential habitat for the sensitive plant species considered threatened, endangered, or species of concern that are likely to occur in McKinley and Cibola Counties (Wood 2006a). There are limited areas of potential habitat for two species of concern, *Astragalus* *naturitensis* (naturita milkvetch) and *Talinum brachypodum* (laguna fame flower) within the project area in Section 16 (Wood 2006b). *Astragalus naturitensis* grows on sandstone ledges and rimrock along canyons in piñon-juniper woodland from 1,524 – 2134 m (5,000 - 7,000 ft). Therefore, rim rock areas were targeted for this species. *Talinum brachypodum* grows in shallow pockets of calcareous silt to clay soils overlying sandstones in open piñon-juniper woodland with little understory and scattered cacti and shrubs. Only one species of *Talinum*, *T. confertifolium*, was found and that was in Section 10 under PJ woodland. *Talinum confertifolium* is clearly and easily distinguishable from *T. brachypodum*.

Typically, plant species are most definitively identified if they are in flower and/or in fruit. The plant inventory survey in early May was the most appropriate time to make a search for *Astragalus naturitensis* (flowers late April to May) and in late June for *Talinum brachypodium* (flowers June to August).

Prior to the fieldwork, a list of the Federal (US Fish and Wildlife Service 2007), State of New Mexico (NMRPTC 2008), and USDA Forest Service plant species of concern (Bosch, 2008) that are known to occur within McKinley and Cibola Counties, New Mexico was compiled. In addition, U.S. Department of Agriculture (USDA) Forest Service designated Management Indicator Species (MIS) were also considered. No plant MIS are reported for the Cibola National Forest (deGruyter, 2005). The sensitive species and Species of Special Concern that are most likely to occur at the project site are tabulated in Table 6 below through page 18.

Table 6. Plants listed by the State of New Mexico as endangered, threatened, or species of concern that have been reported as occurring in McKinley and Cibola Counties.

TABLE 6. STATE LISTED ENDANGERED, THREATENED, OR SPECIES OF CONCERN IN MCKINLEY AND CIBOLA COUNTIES		
SPECIES/STATUS	**HABITAT**	**POTENTIAL TO OCCUR IN THE PROJECT AREA**
Astragalus chuskanus Chuska milkvetch Species of Concern	Degraded Chuska sandstone in openings in montane coniferous forest above 5500 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat; there is no Chuska sandstone in the project area.
Astragalus micromerius Chaco milkvetch Species of Concern	Gypseous or limy sandstones in piñon-juniper woodland or Great Basin desert scrub; from 6,600-7,300 feet. Known from McKinley County. (NMRPTC, 1999)	No appropriate habitat; the sandstone in the project area is not gypseous or limy.
Astragalus missouriensis var. acumbens Zuni milkvetch Species of Concern	Gravely clay banks and knolls, in dry alkaline soils derived from sandstone, in piñon-juniper woodland; from 6200-7900 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999)	Minimal appropriate habitat; no gravely clay banks and knolls are present in the project area.
Astragalus naturitensis Naturita milkvetch Species of Concern	Sandstone ledges and rimrock along canyons in piñon-juniper woodland; from 5000-7000 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001a)	Limited areas of potential habitat exist along the rim and ledges of the low unnamed mesa in the project area; no Astragalus matching this distinctive species was observed.
Erigeron acomanus Acoma fleabane Species of Concern	Sandy slopes and benches beneath sandstone cliffs of the Entrada Sandstone Formation in piñon-juniper woodland; from 6900-7100 feet. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth 2001b)	No appropriate habitat; there is no Entrada Sandstone Formation in the project area.

TABLE 6. STATE LISTED ENDANGERED, THREATENED, OR SPECIES OF CONCERN IN MCKINLEY AND CIBOLA COUNTIES		
SPECIES/STATUS	**HABITAT**	**POTENTIAL TO OCCUR IN THE PROJECT AREA**
Erigeron svinskii Sivinski's fleabane Species of Concern	Steep barren shale slopes of the Chinle Formation in piñon-juniper woodland and Great Basin desert scrub; from 6100-7400 feet. Known from McKinley County. (NMRPTC, 1999; Roth, 2001d)	No appropriate habitat; there is no Chinle Formation in the project area.
Helianthus praetermissus Lost sunflower Species of Concern	Possibly wet ground, based on the collection locality for the only specimen. This species is known only from the type specimen collected in 1851 on the Sitgreaves expedition at the head of the Rio Laguna (now Rio San Jose) at Ojo de la Gallina, Cibola County. This species may have been named from a depauperate specimen of *Helianthus paradoxus*.	There is wet ground in the project area associated with a man-made cattle pond; however, the project is not near the only known location for the species near the Zuni Mountains.
Penstemon deaveri Mount Graham beardtongue Species of Concern	Slopes and rocky areas from ponderosa pine forest to above timberline; from 6,500-11,280 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat; there are no ponderosa pine forest or plant communities associated with high elevations in the project area.
Phacelia serrata Cinders phacelia Species of Concern	In deep volcanic cinders, primarily associated with volcanic cones, but also in road cuts and abandoned quarries in open, exposed, sunny locations; near ponderosa pine and piñon-juniper woodlands; from 5,900-7,200 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat; there are no areas of volcanic cinders in the project area.
Physaria navajoensis Navajo bladderpod Species of Concern	Windswept mesa rims of Todilto limestone in sparse piñon-juniper woodland; from 7,200-7,600 ft (NMRPTC, 1999; Roth, 2001e)	No appropriate habitat; there is no Todilto limestone in the project area.
Physaria newberryi var. yesicola Yeso bladderpod Species of Concern	Nearly barren badlands of sandy gypsum and silty strata of the Yeso Formation in short grass steppe and juniper savanna; from 5,700-6,900 ft. Known from Cibola County. (NMRPTC, 1999)	No appropriate habitat: there is no Yeso Formation in the project area. Most of the project area is higher than the elevational range of the species.
Puccinellia parishii Parish's alkali grass Endangered	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes; from 2,600-7,200 feet; the species requires continuously damp soils during its late winter to spring growing period. Known from McKinley and Cibola Counties. (NMRPTC, 1999; Roth, 2001f)	Very little appropriate habitat. The survey conducted at an appropriate time of year failed to find any individuals or habitat typical of other known sites.
Talinum brachypodium Laguna fameflower Species of Concern	Very shallow pockets of calcareous silt to clay soils overlying limestone or travertine, or fine silty sand overlying calcareous sandstones; open piñon-juniper woodland with little understory and scattered cacti and shrubs or Chihuahuan desert scrub. Known from Cibola County. (NMRPTC, 1999)	Limited areas of potential habitat could exist on the low mesa in the project area. Some of the sandy loam soil does have a high component of silt in it. No plants of this species were observed during surveys conducted at an appropriate time of year.

1.3.1.3 SELENIUM ACCUMULATORS

Plant species known to accumulate selenium that occur within the project site are identified in Table 5 on pages 10-16. Only *Stanleya piñata* (prince's plum) is an indicator plant for selenium rich soils. Some *Machaeranthera* (tansy aster) and *Astragalus* (milkvetch) species are selenium accumulators when they grow in selenium-rich soils. However, *A. kentrophyta* (spiny milkvetch) has not been reported to be an accumulator. *Krascheninnikovia lanata* (winterfat) and *Atriplex canescens* (four-wing saltbush) will accumulate selenium if growing on selenium rich soils but neither is recognized as selenium indicator species.

1.3.1.4 INVASIVE NON-NATIVE SPECIES (WEEDS)

The only noxious weeds observed in 2008 were saltcedar (*Tamarix* species) and cheatgrass (*Bromus tectorum*). These non-native species are both considered to be a Class C noxious weed by the state of New Mexico (Gonzalez 2009). "Class C weeds are species that are widespread in the state. Management decisions for these species should be determined at the local level based on feasibility to control and level of infestation" (Gonzalez 2009). Saltcedar trees were observed in the central area of Section 16 at the stock pond and infrequently along the arroyo that leads from this area to San Mateo Creek. Less than five (5) *Bromus tectorum* plants were observed in the area beside the water pocket in Section 10.

In 2006, two additional species of noxious weeds were observed; Canada thistle (*Cirsium arvense*) and musk thistle (*Carduus nutans*). Both these species were observed in drainage areas in Section 16.

Canada thistle is considered a Class A noxious weed while Musk thistle is considered a Class B noxious weed by the state of New Mexico (Gonzalez 2009). "Class A weeds are species that currently are not present in New Mexico or have limited distribution; preventing new infestations of these species and eradicating existing infestations is the highest priority" and "Class B weeds are species that are limited to portions of the state. In areas that are not infested, these species should be treated as Class A weeds. In areas with severe infestations, management plans should be designed to contain the infestation and stop any further spread" (Gonzalez 2009).

The New Mexico State Noxious Weed List was revised in April 2009 but it must be considered that the species recognized as noxious and the management guidelines for noxious weeds may change in the near future (Wanstall 2010). For example, field bind weed (Convolvulus arvense), observed at the Roca Honda site in 2008, was listed as a Class C weed in 1999 (Dubois 1999) but not in 2009. In contrast, Bromus tectorum was not listed as a noxious weed in 1999 but was in 2009 (Dubois 1999, Gonzalez 2009).

1.3.2 VEGETATION TYPES AND MAPPING UNITS AT THE PROJECT SITE

1.3.2.1 VEGETATION MAP

Aerial photographs of the Roca Honda project site were taken in 2008. In conjunction with field observations, these photographs were used to delineate the vegetation communities within the project area. The vegetation map (see Figure 5 on page 20) shows the distribution and extent of the vegetation types observed at the site. Shapefiles for the permit boundary line, fences, and contour lines were provided by RHR. These files have been used for the maps developed in vegetation descriptions.

Historic exploratory drill holes were numerous throughout the site. There was no "typical" vegetation type in these areas but they all tended to have been (re)colonized to various extents by *Juniper monosperma, Pinus edulis, Ericameria nauseosa, Gutierrezia sarothrae*, *Aristida purpurea* (three-awn), *Grindelia squarrosa*, and *Senecio multicapitatus*. It appeared that the more recently disturbed areas tended to have fewer shrubs than older sites. Tree species were between 15 cm (5.9 in.) to approximately 1.5 m (4.9 ft) high. Grass cover was generally low. *Schizachyrium scoparium* var. *scoparium* (little bluestem) was particularly common and abundant at historic exploratory drill holes and on the trails

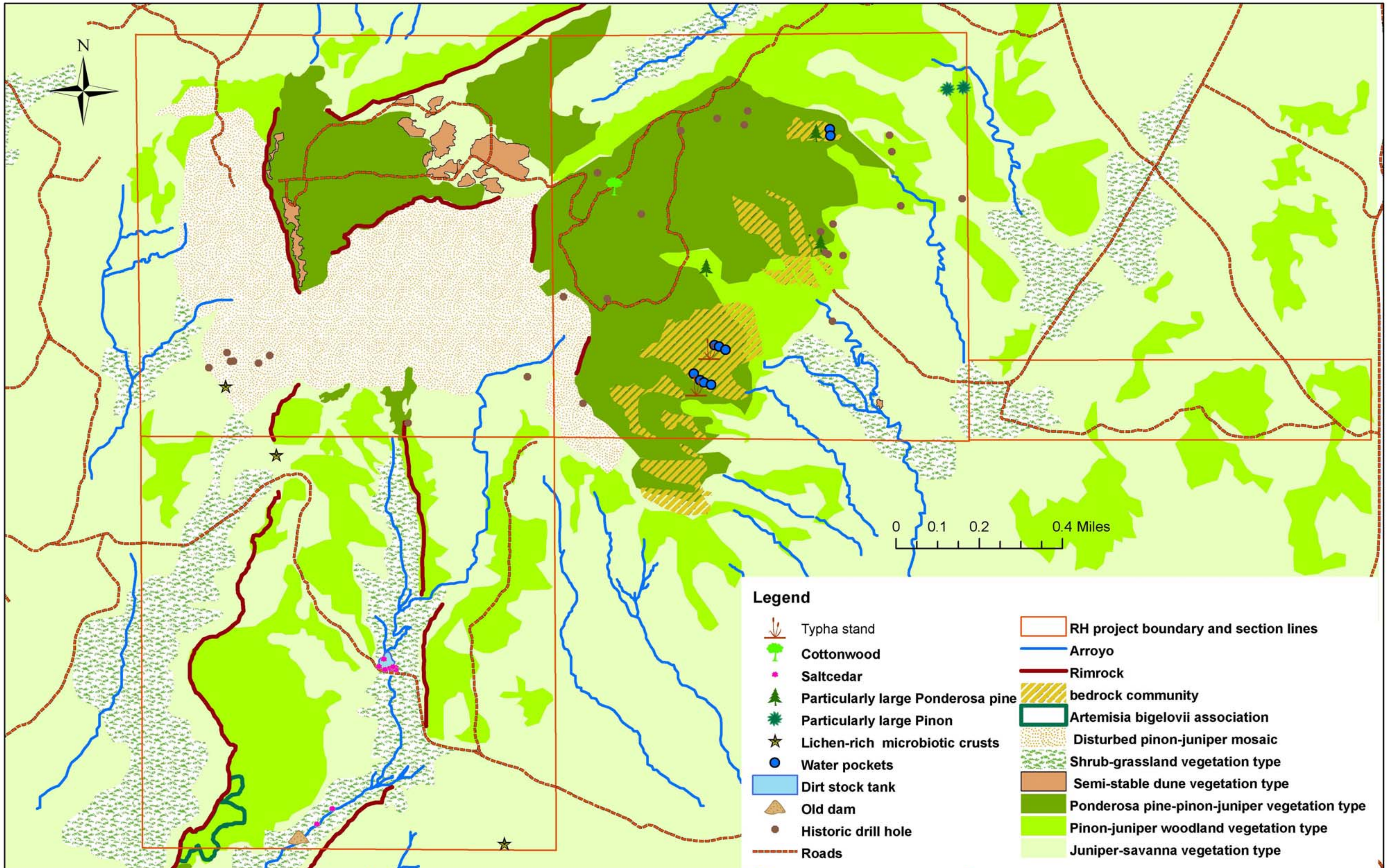


Figure 5. Roca Honda Vegetation Map.

linking them in Section 10. The abundance of *Schizachyrium scoparium* at these sites and its absence from undisturbed areas suggested that seeds of this species were planted in these areas sometime over the past few decades. The historic exploratory drill holes that were encountered during the field survey are marked on the map in Figure 5 on page 20. In some areas, it appeared that there might have been some kind of general disturbance in the past but it could not be distinguished as a drill hole and the area was not marked. A large area in Section 9 has been marked on the vegetation map as “disturbed”. Although clearly disturbed with scant understory in many places, the vegetation consisted mostly of native species. On the basis of cover and plant species, most areas on the lower slopes could not be clearly distinguished from the Juniper savanna vegetation type that was common through the project area.

1.3.2.2 *DESCRIPTIONS OF VEGETATION COVER AND MAPPING UNITS*

The vegetation type descriptions and maps carefully document the vegetation types encountered and provide a solid basis for appreciating the pre-mining vegetation within the RHR project site. The vegetation communities at the Roca Honda site have a complex structure. Superficially, the vegetation at the Roca Honda project site is consistent with the grama-galleta steppe and juniper-piñon woodland mosaic described by Bailey (1978). At higher physiognomic hierarchical levels, all vegetation types at the site can be classified as either juniper savanna, piñon juniper woodland (Figure 6 below), ponderosa pine- piñon-juniper mixed woodland, semi-stable dune, or shrub-grassland. Within these five broad vegetation types, there were numerous and highly variable patches of plant species that are locally unique, which can be described at a floristic level; for example, piñon-juniper woodland with an understory of *Artemisia bigelovii*.

Figure 6. View of piñon-juniper woodland at Roca Honda site.

There are also abundant and diverse non-vascular species, especially lichens, on the project site. The most common lichen that contributed significantly to the carbon balance in some areas was a *Xanthparmelia* species, probably *X. chlorochroa*. This species was identified from gross morphological characteristics only and no microscopic or chemical analyses were made. This lichen is a relatively large and easily identified species and its biomass was included when measuring productivity at the site.

A variety of lichen species were observed growing on the soil (terricolous), rocks (saxicolous) and trees (corticolous). Well-developed microbiotic crusts are distributed throughout the project site. Within these crusts, terrestrial lichen species included those of the genera *Collema, Psora, and Dermatocarpon*. Other non vascular plants that contributed to the microbiotic cover included species of two cyanobacteria; *Microcoleus*, likely *M. vaginatus*, and *Nostoc*, likely *N. communis*. It appeared that the latter was less abundant and widespread than *Microcoleus* which formed relatively dense patches in some areas. Cyanobacteria provide nitrogen as well as carbon to the soil. Other than for the vagrant lichen *X. chlorochroa* which was obvious and easily harvestable, no attempts were made to consider the productivity of microbiotic crust.

The areas occupied by the various vegetation types in the project site are summarized in Table 7 below. Each of the five vegetation types is described in detail the following sections. The "vegetation type" concept used in this report may be likened to USDA Forest Service "ecological types" (USDA Forest Service 1991).

Table 7. Vegetation type and its acreage within the Roca Honda project site.

VEGETATION TYPE AND *MAPPING UNITS	PERMIT AREA (777 HECTARES; 3 SECTIONS)	
	Total Hectares	% of Project Area
Juniper savanna	275	35
Piñon-juniper woodland	152	20
a. *Artemisia bigelovii*	3	(0.4)[1]
b. Bedrock plant community	3.4	(0.4)
Ponderosa pine-piñon-juniper woodland	151	19
a. Bedrock plant community	16.5	(2)
i. Water pocket sites	0.1	--
Semi-stabilized dunes	7	1
Shrub-grassland	75	10
a. Standing water (ephemeral pond)	0.3	(0.4)
**Disturbed piñon-juniper woodland and Juniper savanna mosaic*	116	15

[1] - Figures in parentheses are included in the parent vegetation type.
** - Not a vegetation type, simply a mapping unit.*

Quantitative measures of cover obtained through transect line survey are tabulated in each section. Results are presented for the following categories: Percent cover for each plant species grouped according to life form (tree, shrub and subshrub, grass, forb, succulent and microbiotic); percent litter; percent rock; percent gravel; percent bare ground. These parameters all help in estimating the potential to provide wildlife habitat and forage for livestock grazing.

The cover of bare ground, litter, and grass on each transect line is diagrammatically represented as bar charts on the map in Figure 7 on page 23. Heights are relative and the labeled values adjacent to each chart indicate percent grass cover. The green column indicates the percent cover of grass on each transect. Production measurements are graphically portrayed in Figure 8 on page 24 using stacked bar charts. Bar heights are relative and the labeled values adjacent to each stacked chart indicate green grass productivity (kg/ha)Green grass is represented by the turquoise color, brown or dried grass by the orange color and *Xanthoparmelia chlorochroa* by lilac. The height of the bars indicates the relative contribution of the three materials to the total biomass harvested within the 40 cm x 40 cm (15.7 in. x 15.7 in.) sampling square within each exclosure.

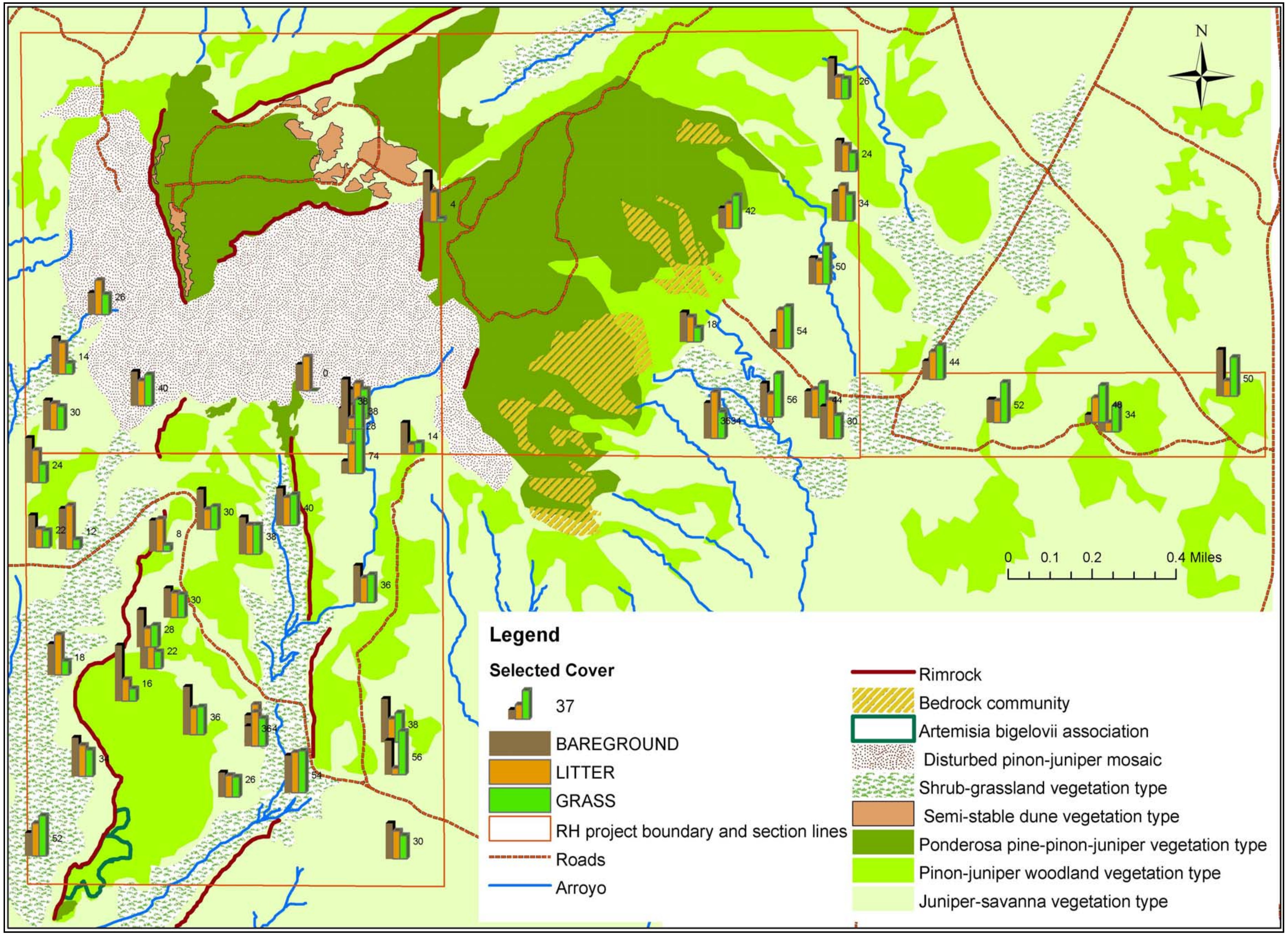


Figure 7. Vegetation map with bar charts shown at transect locations indicating the percent cover of grass, bare ground, and litter on each transect line.

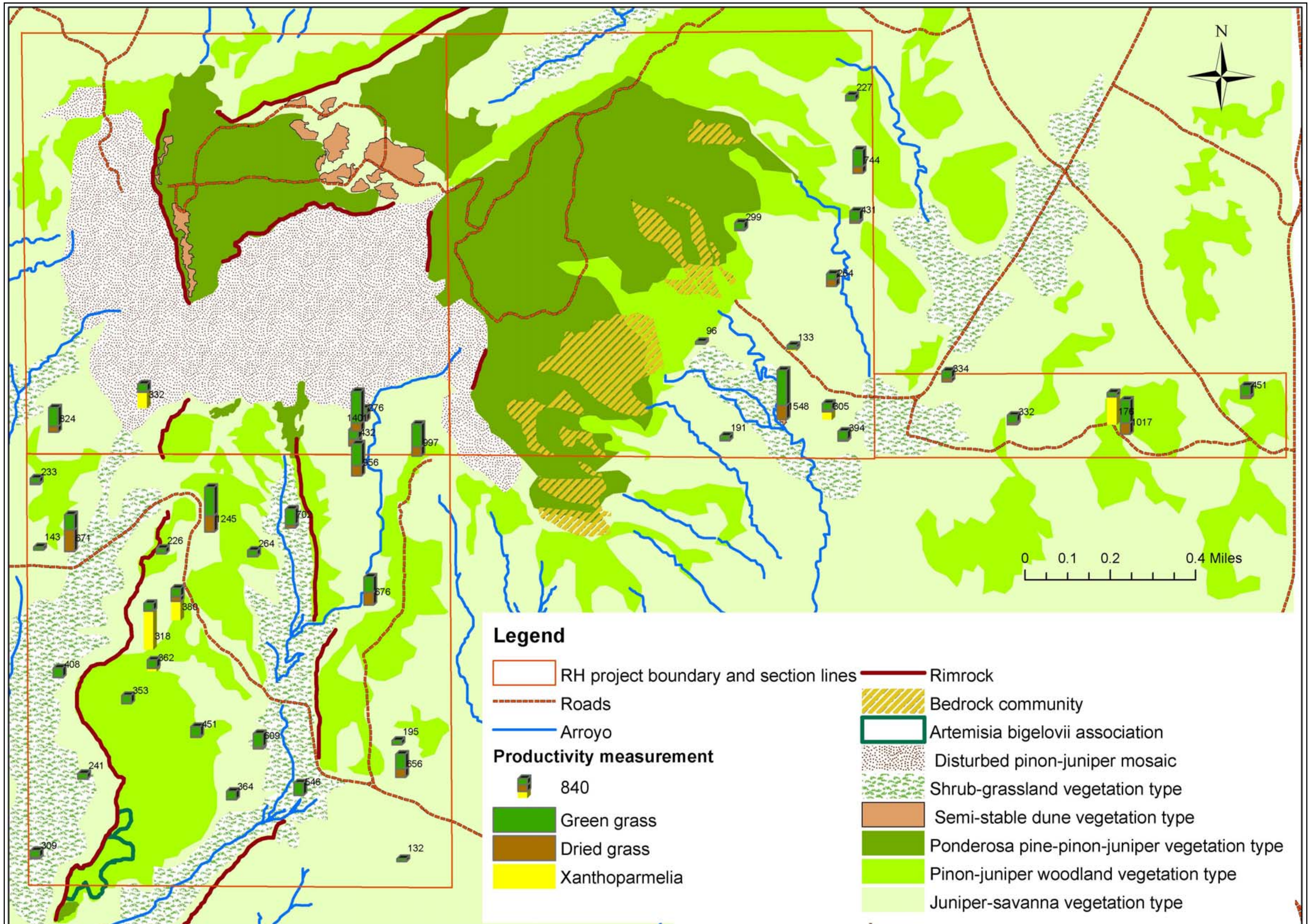


Figure 8. Map displaying the measured biomass (kg/ha) of green grass, dried grass and Xanthoparmelia within exclosures at the end of the growing season.

The estimated areas that are occupied by each of the vegetation types within the project site in Sections 16, 10, and 9 are listed in Table 8 on page 26. The areas of the vegetation types potentially affected by mining are estimated from the map provided in the BDR, Section 6.0, Topsoil, and a shapefile provided to the author by Permits West Inc in 2009. These estimates may not be accurate as the project develops further and may need to be updated. Total area (in hectares) of each vegetation type potentially affected by mining and associated activities and the percent of each vegetation type potentially affected by mining and associated activities is reported in Table 9 on page 26. Values for grass, forb and shrubs represent canopy cover.

SURVEY RESULTS AND TESTS OF ADEQUACY

Transect lines were surveyed in all vegetation types throughout the project area in order to prepare a vegetation map and document the plant species diversity of the site. At the current time, the community where the most disturbances will take place is the Juniper savanna vegetation type. Piñon Juniper (PJ) woodland (Figure 9 at right) and shrub grassland vegetation types are also likely to be disturbed in the northern part of Section 16. These three vegetation types are reported in Table 9 on page 26.

Figure 9. Snag in piñon-juniper woodland at Roca Honda project site.

Some areas of semi-stabilized dune vegetation exist at the site. However, these are small areas (generally less than 0.25 acres [0.1 ha]), and soil conditions after disturbance are unlikely to be suitable for replicating this vegetation type. These areas are, therefore, only described as a basis for describing the current status of the site and making an accurate vegetation map and are not included in Table 9 on page 26. The variation from one small sandy site to another is substantial, and the plant species tend to vary. However, *Muhlenbergia pungens* is the dominant grass species at these sites, and *Artemisia campestris* is a common forb.

The Ponderosa Pine community is not expected to be significantly disturbed during the mining phase, and revegetation is unlikely to be necessary. Similar to the surveys in the dune areas, the cover surveys in this vegetation type were made only to support preparation of the vegetation map; it is not reported in Table 9 on page 26.

Variability in ground cover and plant species composition is high across the site, and the vegetation types intergrade with one another. Preliminary examination of the data suggested that all areas at elevations lower than the ponderosa pine vegetation type might all be lumped into a piñon juniper grassland vegetation type. Total vegetation cover was no different between the three vegetation types (see Table 9 on page 26). However, on testing the data for differences between the mean and median cover values, the three vegetation types (piñon juniper woodland, juniper savanna and shrub-grassland) described on the basis of community observations were determined to be warranted, although substantial overlap exists.

Table 8. Total and potentially affected hectares (ha) of each vegetation type and mapping unit.

PROJECT SITE AREA	VEGETATION TYPE					MAPPING UNIT	
	Piñon juniper woodland	Juniper savanna	Shrub-grassland	Semi-stabilized dunes	Ponderosa pine-piñon-juniper woodland	Pools and standing water	Disturbed piñon - Juniper mosaic
Total ha (all sections)	152	279	75	7	151	0.31	118
Area (ha) potentially affected by mining (restricted to Sec 16 and 10)	27	85	18	0	0.1	0.3	0
% area potentially impacted by mine (restricted to Sec 16 and 10)	18	31	24	0	<1	97	0
Sec. 16 ha	77	124	58	0	<0.1	0.3	0
Sec. 16 area (ha) potentially affected by mining	23	47	11	N/A	<0.1	0.3	N/A
Sec. 16 % area potentially impacted by mining	30	38	19	N/A	100	100	N/A
Sec. 10 ha	53	81	13	0.1	105	0.01	7
Sec. 10 ha potentially impacted by mining	4	38	8	0	<1	0	0
Sec. 10 % area potentially impacted by mining	7	48	56	0	<1	0	0
Sec. 9 ha	22	71	4	7	46	0	109
Sec. 9 ha potentially impacted by mining	0	4	0	0	0	0	2
Sec. 9 % area potentially impacted by mining	0	6	0	0	0	0	1.8

Table 9. Average ground cover (%) within the vegetation types and the results of the sample adequacy tests for each class of ground cover.

		PERCENT							
		Total Vegetation cover	Bare ground	Bare ground + gravel + rock	litter	Grass	Forb	Shrub	Microbiotic crust & Xanthopar-melia
Juniper savanna	Mean	47	23	26	28[1]	35[2]	1	6	5
n = 28	St. dev.*	12	11	10	10	14	1	6	7.5
	Number of samples required*	19 (raw data)	21	15	11	16	567	146	>100
Piñon juniper woodland	Mean	37	34	36	27[1]	25[1]	0.4	3	9
n = 21	St. dev	14	13	13	9	12	1	5	11
	Number of samples required*	6	11	11	8	18	36	108	126
Shrub grassland	Mean	40	23	24	36[2]	29[1,2]	2	9	0.2
n = 12	Standard deviation	14	10	10	9	16	3	5	0.6
	Number of samples required*	11	14	12	4	34	79	28	13

[1, 2]: Those values supersripted by the same superscript number are statistically the same at the 95% confidence level (See text for discussion).
**: St. dev. = Standard deviation*

The percent grass cover in the Juniper savanna vegetation type was statistically the same as that in the shrub grassland type and both were statistically significantly higher than that of the PJ woodland at the 95.0% confidence level.

Shrub cover in Juniper savanna and PJ woodland were statistically the same and the shrub cover in Juniper savanna and shrub grassland were statistically the same. However, there is a statistically significant difference in the shrub cover in PJ woodland and shrub grassland at the 95% confidence level. Since the P-value of the F-test is less than 0.05, there is a statistically significant difference in the means of bare ground between the three vegetation types at the 95% confidence level. Juniper savanna and shrub grassland are similar whereas Juniper savanna is statistically different from PJ woodland, which is statistically different to shrub grassland. Litter cover in Juniper savanna was similar to that in shrub grassland and both have significantly greater litter cover than PJ woodland.

Revegetation guidelines (Attachment 2 of Mining Act Reclamation Bureau 1996) indicate that equation (1) should be used to determine the number of samples required to adequately sample vegetation cover in the vegetation types that were likely to be disturbed and require re-vegetation. Adequate sampling entails making sufficient measurements of a given parameter in order to obtain a mean value that is within 10% of the populations' true mean value with a 90% statistical confidence level.

$$nmin = \frac{T^2S^2}{(dx)^2} \quad \text{(Equation 1:2:1)}$$

Where:

nmin = the minimum number of sample points needed in a given vegetation type
S = the sample deviation
t = the two-tailed t statistic at the appropriate number of degrees of freedom
d = the acceptable amount of inherent variability to be identified between the sample mean and the true population mean = 0.1
x = the sample mean

This test to determine the sample adequacy for total vegetation cover in the Juniper savanna vegetation type could be performed on the raw percentage data since the values of total vegetation cover fell between 30 to 70% (Hofmann and Ries 1990). These values also belonged to a normal distribution as tested by calculating skewness and kurtosis of the data (Statgraphics Plus software statistics package). However in most other cases, some data was out of that range and the data was transformed as accepted in the literature (Hofmann and Ries 1990). A square root transformation of each observation is generally used to normalize a non-normal distribution (Li 1964). Two additional transformations, the square root of each observation plus one half or the square root of each observation plus 1 have been found statistically appropriate where there are "0" and small number values (Steel and Torrie 1980, Snedecor 1956). For observations in this study, the transformation used was the square root of each observation plus 1. The actual percent cover values are presented in the data tables in this report.

With the variance levels at the site, fewer than the number of samples actually collected in the Juniper Savanna and piñon juniper vegetation types were required to determine the true mean cover values for total vegetation, grass canopy cover, bare ground and litter (Table 9 on page 26). For both vegetation types, the number of samples required to achieve this level of confidence for forb and shrub canopy cover is greater than the sampling number measured because the density of these life forms are particularly variable throughout the site (see standard deviation values in Table 9 on page 26). An adequate number of samples were collected to achieve 90% confidence that the measured total vegetation cover was the true mean of the population. However, for all other parameters, more samples, in some cases only one or two, are statistically required for a 90 percent level of confidence.

Mean, mode, and median values of cover (percent) for all the main vegetation types are reported in Table 10 on page 28. The areas covered by these vegetation types in the project area (Sections 9, 10, and 16) are indicated in Figure 3 on page 7.

Table 10. Mean, variance of the mean, mode and median values (%) of the various life form canopy and other cover classes along transect lines within the primary vegetation types.

		PERCENT													
Vegetation type	Para-meter	Total vegetation cover	litter	Grass	Shrub	Forb	*Xantho-parmelia*	Moss & microbiotic crust	Bare ground	Gravel	Rock	Total tree canopy	Juniper Canopy	Pinus edulis canopy	Pinus ponderosa canopy
Juniper-savanna	Mean (n=28)	46.8	28.1	34.7	5.7	1.0	0.6	3.9	22.9	1.9	1.1	0.9	0.8	0.1	0.0
Juniper-savanna	Standard deviation	11.9	10.0	14.2	6.1	1.6	1.4	7.2	10.5	3.7	2.7	2.7	2.7	0.4	0.0
Juniper-savanna	Median	44.0	27.0	34.0	4.0	0.0	0.0	2.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0
Juniper-savanna	Mode	42.0	20.0	34.0	4.0	0.0	0.0	0.0	38.0	0.0	0.0	0.0	0.0	0.0	0.0
Pinon juniper (PJ)	Mean (n=21)	37.0	26.9	24.9	3.1	0.4	3.4	5.1	33.9	1.1	1.1	7.8	4.9	3.0	0.0
PJ	Standard deviation	13.7	9.2	11.7	5.0	1.4	5.4	9.7	12.8	2.5	3.1	12.2	8.9	7.6	0.0
PJ	Median	38	26.0	26.0	0.0	0.0	0.0	2.0	34	0.0	0.0	2.0	0.0	0.0	0.0
PJ	Mode	30	26.0	30.0	0.0	0.0	0.0	0.0	36	0.0	0.0	0.0	0.0	0.0	0.0
Shrub-grassland	Mean (n=12)	40.2	36.3	29.3	8.8	1.8	0.0	0.2	22.5	1.0	0.0	0.0	0.0	0.0	0.0
Shrub-grassland	Standard deviation	14.5	8.5	16.3	4.9	3.0	0.0	0.6	9.6	1.3	0.0	0.0	0.0	0.0	0.0
Shrub-grassland	Median	41.0	36.0	33.0	9.0	0.0	0.0	0.0	22.0	0.0	0.0	0.0	0.0	0.0	0.0
Shrub-grassland	Mode	#N/A	36.0	44.0	10.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.0
Ponderosa pine (Pipo)	Mean (n= 9)	19.3	25.6	2.7	8.2	0.4	0.4	7.6	20.2	16.7	18.2	8.7	2.9	5.8	2.9
Pipo	Standard deviation	13.2	13.0	5.2	7.6	0.9	1.3	6.5	11.9	10.9	14.1	8.6	3.9	7.2	5.3
Pipo	Median	12.0	22.0	0.0	6.0	0.0	0.0	6.0	18.0	16.0	16.0	8.0	0.0	2.0	0.0
Pipo	Mode	10.0	18.0	0.0	20.0	0.0	0.0	2.0	16.0	#N/A	16.0	0.0	0.0	0.0	0.0
Semi -stable (SS) Dune	Mean (n=7)	38.9	22.0	21.4	9.7	0.9	0.0	6.9	38.3	0.6	0.3	4.9	2.9	2.0	0.0
SS Dune	Standard deviation	15.7	13.2	17.2	11.0	1.6	0.0	13.1	10.5	1.0	0.8	6.6	6.7	3.5	0.0
SS Dune	Median	44	24	14	6	0	0	2	38	0	0.0	2	0	0	0
SS Dune	Mode	#N/A	8	#N/A	6	0	0	0	#N/A	0	0.0	0	0	0	0

The variability in shrub species and densities in all of the vegetation types is considerable as indicated by the standard deviation and emphasized by the range encountered (Tables 11, 12, 13, 14, and 15; below and on pages 30 and 31). The estimate of the average number of plants per hectare is to some extent illusory since shrubs tend to exist as somewhat isolated individuals or in relatively dense stands. Therefore, it is important to note the standard deviation of the mean, the mode and median values when visualizing how the plants are distributed across the site. Adequacy testing either raw or data transformed to meet the requirements for normality indicated that in most cases the number of samples were prohibitively large. This has been often discussed in the literature. However this large sampling range provides very good guidance as to how a revegetation effort needs to be structured.

Re-vegetation efforts should focus on replicating the mosaic of species within the vegetation types and should not aim to achieve a constant level of shrub coverage. Rather, the revegetation effort needs to make small patches of shrubs at appropriate densities within a grass and forb matrix (Tables 11, 12, 13, 14, and 15; below and on pages 30 and 31).

Unless otherwise written in Tables 11, 12, 13, 14, and 15, below and on pages 30 and 31, the 6 letter acronym for the species name is the heading in the table columns. The full species name is a footnote to the individual tables.

Table 11. Total shrub and sub-shrub densities by species in juniper savanna vegetation type.

	TOTAL SHRUBS	GUT SAR	KRA LAN	ART BIG	ART FIL	ERI NAU BIG	ATR CAN	LYC PAL	OPUNTIA SPP.	CLY IMB	CHR GRE	ECH TRI
Average per 50m²	67	52.9	1.1	3.2	2.7	0.8	4.1	0.1	0.7	0.0	1.2	>1
Range per 50m²	12-146	2 - 145	0-26	0-86	0-67	0-4	0-17	0-1	0-2	0-1	0-7	0-1
std dev	42	41.3	4.9	16	12.6	1.2	5.2	0.3	1.1	0.2	2.3	0.2
Average per 100 m²	135	106	2	6	5	2	8	0	1	0	2	0
Average per hectare	13,479	10579	221	636	536	164	814	14	136	7	236	7
Number of transects in which species occurred (%)	100	100	11	14	14	43	68	7	36	4	29	4
Nmin[T1]	32	51	131	>300	>300	31	82	3	25	2	63	2

[T1] - Nmin=The number of samples of a given parameter that are required to estimate a mean value that is within 10 percent of the populations' true mean value with a 90 percent statistical confidence level.

Gutierrezia sarothrae; Krascheninnikovia lanata; Artemisia bigelovii; Artemisia filifolia; Ericameria nauseosa var. bigelovii; Atriplex canescens; Lycium pallidum; Cylindropuntia imbricata,; Chrysiothamnus greenei; Echinocereus triglochidiatus.

Table 12. Total shrub and subshrub density and densities by species in Piñon Juniper vegetation type.

	Total shrubs	Gutsar	Kra lan	Art big	Eri nau big	Atr can	Lyc pal	Opuntia spp.	Chr gre
Average per 50 m^2	52	44.9	2.0	1.7	0.5	1.3	0.1	0.8	0.7
Range per 50 m^2	4-203	2-199	0-42	0-32	0-4	0-7	0-3	0-3	0-13
Std dev	51	50.9	9.2	7.0	1.1	2.4	0.7	1.0	2.8
Average/100 m^2	104	90	4	3	1	3	0	2	1
Average/hectare	10,419	8,981	400	333	105	257	29	162	143
Number of transects in which species occurred (%)	100	100	5	14	24	38	5	48	10
Nmin[T1]	56	93	274	196	29	63	13	22	82

[T1] - Nmin=The number of samples of a given parameter that are required to estimate a mean value that is within 10 percent of the populations' true mean value with a 90 percent statistical confidence level.

Gutierrezia sarothrae; Kraschenінnikovia lanata; Artemisia bigelovii; Ericameria nauseosa var. bigelovii; Atriplex canescens; Lycium pallidum; Chrysiothamnus greenei.

Table 13. Shrub densities in Shrub grassland vegetation type.

	Total	Gutsar total	Kra lan	Eri nau big	Atr can	Lyc pal	Opu	Cly imb	Chr gre
Average per 50 m^2	132.6	94.6	25.6	2.2	8.9	0.4	0.3	0.4	0.3
Range per 50 m^2	28 - 321	0 - 256	0 - 140	0 - 22	0 - 49	0 - 5	0 - 2	0 - 3	0 - 3
Std dev	97	95	48	6	17	1	1	1	1
Average per 100 m^2	265	189	51	4	18	1	1	1	1
Average per hectare	26,517	18,917	5117	433	1,783	83	50	83	50
Number of transects in which species occurred (%)	100	100	50	25	58	8	17	17	8
Nmin	56	80	47	4	14	1	1	1	1

Gutierrezia sarothrae; Krascheninnikovia lanata; Artemisia bigelovii; Ericameria nauseosa var. bigelovii; Atriplex canescens; Lycium pallidum; Cylindropuntia imbricata,;Chrysiothamnus greenei.

Table 14. Shrub densities in semi-stabilized dune vegetation type.

Community	Total	Gut Sar	Art Big	Art Fil	Art Cam	Eri Nau Big	Atr Can
Average number per 50 m^2	97.9	30.9	0.1	1.1	55.9	5.3	1.4
Range	24 - 220	3-83	0-1	0-8	0 - 202	0 - 15	0 - 8
Std dev	83	30	0	3	95	6	3
Average per 100 m^2	196	62	0	2	112	11	3
Average number per ha	19,571	6,171	29	229	11,171	1,057	286
Number of transects in which species occurred (%)	100	100	14	14	29	57	29
Community	**Lyc Pal**	**Opu**	**Eri Jam**	**Chr Gre**	**Yuc Ang**	**Cer Mon**	**---**
Average number per 50 m^2	0.4	0.1	1.4	0.7	0.3	0.1	---
Range	0 - 2	0 - 1	0 - 10	0 - 5	0 - 2	0 - 1	---
Std dev	1	0	4	2	1	0	---
Average per 100 m^2	1	0	3	1	1	0	---
Average number per ha	86	29	286	143	57	29	---
Number of transects in which species occurred (%)	29	14	14	14	14	14	---

Gutierrezia sarothrae; Krascheninnikovia lanata; Artemisia bigelovii; Artemisia filifolia; Artemisia campestris; Ericameria nauseosa var. bigelovii; Atriplex canescens; Lycium pallidum; Eriogonum jamesii; Chrysiothamnus greenei; Yucca angustissima; Cercocarpus montanus.

Table 15. Shrub densities in ponderosa pine woodland vegetation type.

Community	Total	Gutsar total	Art Big	Art Cam	Eri Nau Big	Atr Can
Average number per 50 m^2	84.0	46.0	20.5	1.0	6.0	3.8
Range	36 - 149	10 - 105	0 - 75	0 - 7	0 - 47	0 - 28
Std dev	42.0	33.9	25.3	2.4	16.6	9.8
Average per 100 m^2	169	91	41	2	12	8
Average number per ha	16875	9125	4100	200	1175	750
Number of transects in which species occurred (%)	100	100	62.5	25	12.5	25
Community	**Eri Jam**	**Cer Mon**	**Quercus sp.**	**Bri Gra**	**Yuc Bac**	**Opuntia spp.**
Average number per 50 m^2						
Range	0.3	3.0	0.1	0.3	0.6	3.0
Std dev	0 - 2	0 - 6	0 - 1	0 - 2	0 - 2	0 - 7
Average per 100 m^2	0.7	2.5	0.4	0.7	0.9	2.7
Average number per ha	1	6	0	1	1	5
Number of transects in which species occurred (%)	50	62.5	25	50	12.5	500

Gutierrezia sarothrae; Artemisia bigelovii; Artemisia campestris; Ericameria nauseosa var. bigelovii; Atriplex canescens; Eriogonum jamesii; Cercocarpus montanus; Brickellia grandiflora; Yucca baccata.

1.3.2.3 *DESCRIPTIONS OF INDIVIDUAL VEGETATION TYPES AND MAPPING UNITS*

JUNIPER SAVANNA VEGETATION TYPE

This is the most ubiquitous vegetation type at lower elevations and it intergrades with other vegetation types without sharp boundaries. A savanna is defined a grassland dotted with trees or as a matrix of trees and grasses in a wet-dry climate where most precipitation falls during a single time period. In savannas the grasses are usually mixed with forbs and shrubs while the trees are scattered individually or in small clumps. As in this case, savannas can be a transitional zone occurring between woodland regions and grassland regions.

The juniper savanna vegetation type at the Roca Honda project site consists of *Juniperus monosperma* (one-seeded juniper) dispersed in intermittently grazed grasslands dominated by C4 perennial grasses, mostly *Bouteloua gracilis* (blue grama grass) but also with substantial patchy cover by *Pleuraphis jamesii* (galleta grass), *Muhlenbergia torreyi* (ring muhly), and *Bouteloua hirsuta* (hairy grama grass). *Pinus edulis* (piñon) individuals are sporadically present at this vegetation type where it interfaces with piñon-juniper woodland. The cover of grass, total microbiotics (including *Xanthoparmelia*), shrubs, and total vegetative cover along each transect line is graphically described in Figure 10 below. There are no statistically significant correlations between high levels of microbiotic crust or shrub cover and low grass cover. Forbs were infrequent and often not encountered along the transect line, and they are not included in the graph.

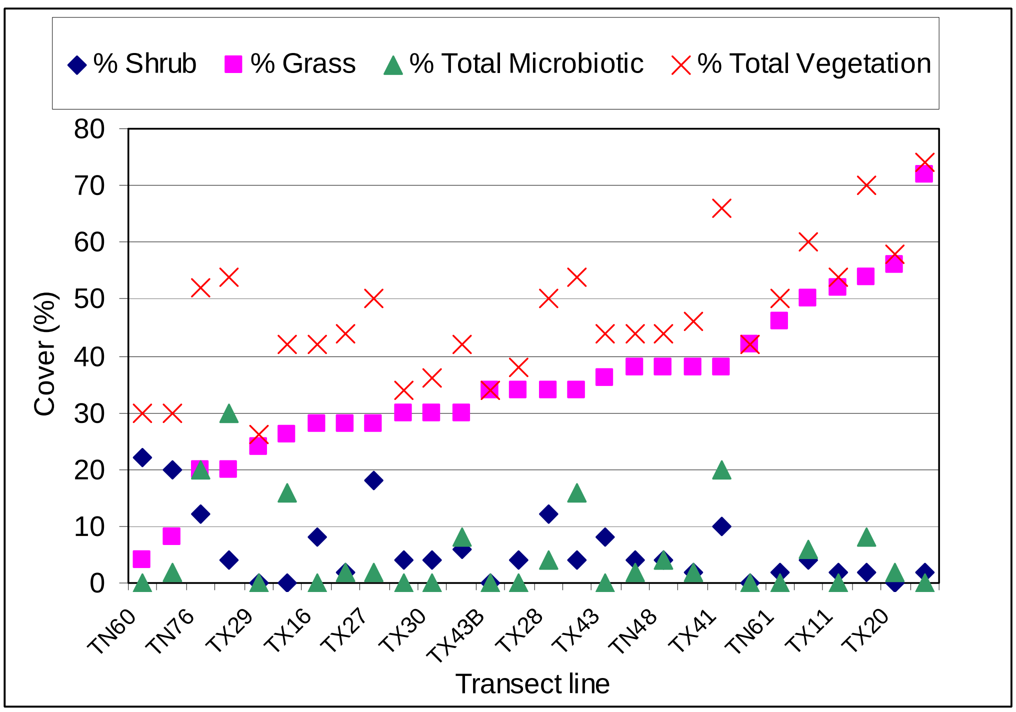


Figure 10. Graphical representation of percent canopy cover measured on transects in Juniper Savanna.

Shrubs were thinly dispersed throughout the juniper savanna, becoming more common at the interface with what was best categorized as shrub-grassland. Individuals and small or large stands of shrubs were dispersed throughout the grasses in this vegetation type. *Atriplex canescens* (four-wing saltbush) was common throughout the project site. *Artemisia filifolia* was common in Section 10. Small stands of *Lycium pallidum* were in areas with sandy soils and were noticed to be often associated with small mammal burrows. The percent cover of the various species is listed in Tables 16 and 17 below and on pages 34 - 35. The number of diversity squares and the percentage of the total in which an individual species was observed are listed in Table 11 on page 29. A species observed in 42 squares means it is observed in 50% of the squares and is thus very common even though it may only be observed as a trace (<<1%) in vegetation cover. A total of 28 transect lines and 84 species - diversity squares were surveyed in this vegetation type.

Gutierrezia sarothrae (snakeweed) was very common and was the most abundant shrub or subshrub at the project site (Table 18 on page 36). In many areas, there were abundant small-sized individuals of less than 6 cm (2.4 in) high and taking up less than 4 cm^2 (0.62 in^2). Depending on the location, there may be none of these small plants while in other areas, they comprised as many as 76% of those shrubs counted. This high level of *G. sarothrae* recruitment may indicate high grazing pressure. After normalizing[3] the data, the number of transects that are needed to estimate total shrub frequency with 90 percent confidence is 32. For individual species, the number of transect lines range from 3.2 for *Lycium pallidum*, 25 for *Opuntia* species, 28 for *Ericameria nauseosa*, to 51 for *Gutierrezia sarothrae*.

The most common forb in 2008 appeared to be *Senecio spartioides* var. *multicapitatus* (broom groundsel). *Dimorphocarpa wislizeni* (spectacle-pod), *Hymenopappus filifolius* (fine-leaf woollywhite), *Chaetopappa ericoides* (sand aster), *Chamaesyce maculata* (spotted spurge) and *C. serpyllifolia* (thyme-leaf spurge) were also common forbs that were quite abundant in some areas. *Chenopodium graveolens* (fetid-goosefoot) was frequent under the tree canopies.

Table 16. Percent cover of individual species in the juniper savanna vegetation type measured using the point-intercept method along 50-m transect lines.

TABLE 16. PERCENT COVER OF INDIVIDUAL SPECIES				
VEGETATION CANOPY COVER	MEAN % COVER	STD. DEV	MAX % COVER	MIN % COVER
Trees				
Juniper monosperma	2.3	7.3	38.0	0.0
Pinus edulis	0.3	1.5	8.0	0.0
Grasses				
Aristida purpurea	0.3	1.5	8.0	0.0
Bouteloua gracilis	27.2	15.3	70.0	2.0
Elymus elymoides (Sitanion hystrix)	0.1	0.4	2.0	0.0
Hesperostipa comata	0.3	0.9	4.0	0.0
Pleuraphis jamesii	3.4	5.7	18.0	0.0
Muhlenbergia torreyi	0.6	2.3	12.0	0.0
Sporobolus cryptandrus	1.0	1.9	6.0	0.0
Shrubs				
Artemisia bigelovii	0.1	0.4	2.0	0.0
Artemisia filafolia	0.5	1.9	10.0	0.0
Artemisia nova	0.3	1.8	10.0	0.0
Atriplex canescens	0.6	1.6	6.0	0.0
Chrysothamnus greenei	0.1	0.4	2.0	0.0
Ericameria nauseosa	0.1	0.7	4.0	0.0

[3] transforming the values by adding one to each observation and taking the square root of the value

Table 16. Percent cover of individual species				
Vegetation canopy cover	**Mean % cover**	**Std. dev**	**Max % cover**	**Min % cover**
Eriogonum jamesii	0.1	0.4	2.0	0.0
Gutierrezia sarothrae	3.7	5.4	22.0	0.0
Krascheninnikovia lanata	0.2	0.8	4.0	0.0
Forbs				
Cryptantha crassisepala	0.3	1.1	6.0	0.0
Dimorphocarpa wislizeni	0.1	0.5	2.0	0.0
Eriogonum cernuum	0.1	0.4	2.0	0.0
Eriogonum sp.	0.1	0.4	2.0	0.0
Hymenopappus filifolius	0.1	0.5	2.0	0.0
Chaetopappa ericoides	0.2	0.8	4.0	0.0
Plantago patagonica	0.1	0.4	2.0	0.0
Salsola tragus	0.1	0.5	2.0	0.0
Senecio multicapitatus	0.1	0.4	2.0	0.0
Microbiotics				
Microbiotic crust	3.7	6.9	30.0	0.0
Xanthoparmelia chlorochroa	0.8	1.9	8.0	0.0

Table 17. Cover of individual species using ocular estimation of cover over a 100 m^2 area at 0m, 25m, and 50m along the transect line (see text for protocol) within juniper savanna vegetation type.

Table 17. Ocular estimation of cover			
Life Form/Species	**Present in number of squares**	**Present in percent of total squares**	**Mean canopy cover (%) estimate in one square**
Trees			
Juniperus monosperma	26	31	<1
Pinus edulis	11	13	<1
Shrubs			
Gutierrezia sarothrae	81	96	1-5
Atriplex canescens	55	66	1-5
Ericameria nauseosa var. bigelovii	23	27	<1
Chrysothamnus greenei	15	18	<1
Lycium pallidum	11	13	<<1
Artemisia filifolia	10	12	<1
Krascheninnikovia lanata	7	8	
Artemisia bigelovii	6	7	<1
Artemisia nova	3	4	
Succulents			
Opuntia species	30	36	<1
Cylindropuntia imbricata	5	6	<1

TABLE 17. OCULAR ESTIMATION OF COVER			
LIFE FORM/SPECIES	PRESENT IN NUMBER OF SQUARES	PRESENT IN PERCENT OF TOTAL SQUARES	MEAN CANOPY COVER (%) ESTIMATE IN ONE SQUARE
Grasses			
Bouteloua sp.	83	99	25-50
Pleuraphis jamesii	31	37	1-5
Muhlenbergia torreyi	23	27	<1
Aristida purpurea	40	48	<1
Hesperostipa comata	12	14	<1
Sporobolus cryptandrus	35	42	<1
Achnatherum hymenoides	14	17	<1
Elymus elymoides ssp. elymoides	13	16	<<1
Sporobolus contractus	5	6	<<1
Sporobolus airoides	6	7.1	<<1
Forbs			
Hymenopappus filifolius	42	50	<1
Dimorphocarpa wislizeni	35	42	<1
Chaetopappa ericoides	34	41	<1
Salsola tragus	32	39	<1
Sphaeralcea coccinea	21	25	<1
Plantago patagonica	18	21	<1
Ipomopsis longiflora	16	19	<<1
Dieteria sp. (Machaeranthera sp)	14	17	<<1
Machaeranthera sp.	14	17	<1
Cryptantha crassisepala	13	16	<1
Machaeranthera pinnatifida	12	14	<1
Eriogonum rotundifolium	12	14	<1
Oenothera pallida	11	13	<<1
Tradescantia occidentalis	11	13.1	<1
Eriogonum cernuum	10	11.9	<1
Descurainia sp.	9	10.7	<<1
Senecio spartioides var. multicapitatus	8	9.5	<1
Hymenoxys richardsonii var. floribunda	8	9.5	<<1
Cryptantha sp.	8	9.5	<1
Ipomopsis longiflora	7	8.3	<1
Boechera fendleri	7	8.3	<1
Ipomopsis multiflora	7	8.3	<<1
Abronia fragrans	7	8.3	<<1
Psilostrophe tagetina	6	7.1	<1
Mirabilis multiflora	6	7.1	<1
Mentzelia sp.	5	6	<1

Table 18. Shrub and tree density in juniper savanna vegetation type estimated from a 50 m^2 (50mx1m) band transect.

SHRUB AND TREE SPECIES	ESTIMATED NUMBER OF INDIVIDUALS PER HECTARE	STANDARD DEVIATION
Juniper monosperma	386	490
Pinus edulis	150	247
Gutierrezia sarothrae	10,579	8,251
Artemisia bigelovii	29	151
Artemisia filifolia	536	2,529
Artemisia nova	636	3,247
Ericameria nauseosa	164	244
Atriplex canescens	814	1,046
Lycium pallidum	14	52
Chrysothamnus greenei	236	459
Krascheninnikovia lanata	221	985
Opuntia spp.	136	211
Cylindropuntia imbricata	7	38
Echinocereus triglochidiatus	7	38
Total shrubs and succulents	13,429	8,444

PIÑON JUNIPER WOODLAND VEGETATION TYPE

The *Pinus edulis* (piñon) and *Juniperus monosperma* (juniper) trees form open to very open stands, with their crowns not usually touching. PJ woodland vegetation type is common along the ridges and at lower elevations on southeasterly facing slopes. The forb and grass layer is often sparse. Understory plants tend to be widely spaced with stands of shrubs in the gaps within the tree canopy. In some areas, microbiotic crusts composed of various species of cyanobacteria, lichen, and moss (all discernable with the naked eye) cover the soil surface in this vegetation type.

Frequent understory shrub species include *Atriplex canescens*, *Chrysothamnus greenei*, and *Gutierrezia sarothrae*. *Cercocarpus montanus*, *Purshia stansburiana*, *Fallugia paradoxa* and *Yucca* species were less common. *Opuntia* species (pricklypear) and *Echinocereus triglochidiatus* (kingcup or claret cup cactus) individuals were common succulent species. A few *Echinocereus fendleri* individuals were encountered in this vegetation type in Section 10. The most common grasses were *Bouteloua* species, *Achnatherum hymenoides*, and *Elymus elymoides*. *Lycurus setosus* and *Schizachyrium scoparium* were common in this vegetation type in Section 10. The percent cover is listed in Tables 19 and 20 on pages 37-39, and the shrub densities are described in Table 21 on page 39. The cover of grass, total microbiotics (including *Xanthoparmelia*), shrubs and total vegetative cover along each transect line is graphically described in Figure 11 on page 40. There are no statistically significant correlations between high levels of microbiotic crust or shrub cover and low grass cover, Forbs were infrequent and often not encountered along the transect line, and they are not included in the graph.

After normalizing the data, the number of transect lines that would be needed to estimate shrub frequency for individual species with 90 percent confidence ranges from 12 lines for *Lycium pallidum*, 62 for *Atriplex canescens* to 114 for *Gutierrezia sarothrae*. The number of transects that would be needed to estimate total shrub frequency with 90 percent confidence would be 96. This is because the numbers of plants are generally few and highly variable, and the shrubs tend to form small patches across the landscape.

There were 21 transect lines and 63 species-diversity squares surveyed in this vegetation type. The cover was measured using the point-intercept method along 50-m transect lines. Total ground cover includes coarse sand and gravel.

Table 19. Percent cover of individual species in the piñon juniper woodland vegetation type.

SPECIES	MEAN	STDDEV	MAX	MIN	MODE	MEDIAN
Trees						
Juniperus monosperma	4.9	8.9	38	0	0	0
Pinus edulis	3.0	7.6	32	0	0	0
Grasses						
Aristida purpurea	0.4	0.8	2	0	0	0
Bouteloua gracilis	22.5	11.6	46	4	16	24
Pleuraphis jamesii	1.0	2.5	10	0	0	0
Muhlenbergia torreyi	0.3	0.7	2	0	0	0
Sporobolus cryptandrus	0.8	1.6	6	0	0	0
Shrubs						
Artemisia bigelovii	0.2	0.9	4	0	0	0
Atriplex canescens	0.2	0.9	4	0	0	0
Chrysothamnus greenei	0.2	0.6	2	0	0	0
Gutierrezia sarothrae	2.5	4.9	16	0	0	0
Forbs						
Cryptantha crassisepala	0.3	1.3	6	0	0	0
Chaetopappa ericoides	0.1	0.4	2	0	0	0
Microbiotics						
Microbiotic crust	5.0	9.3	42	0	0	2
Moss	0.2	0.6	2	0	0	0
Xanthoparmelia chlorochroa	3.4	5.4	16	0	0	0

Table 20. Cover of individual species using visual estimation of cover over a 100 m^2 area at 0m, 25m, and 50m along the transect line within the piñon-juniper woodland vegetation type.

Table 20. Visual estimation of cover within piñon-juniper woodland vegetation type			
Species	**Present in number of square**	**Present in percent of total squares**	**Mean cover (%) estimate in one square**
Trees			
Juniperus monosperma	46	69.7	1-5%
Pinus edulis	27	40.9	1-5%
Shrubs and succulents			
Gutierrezia sarothrae	62	93.9	1-5%
Atriplex canescens	16	24.2	<1
Ericameria nauseosa var. bigelovii	14	21.2	<1
Artemisia bigelovii	12	18.2	<1
Lycium pallidum	4	18.2	<1
Cacti and succulents			
Opuntia spp.	15	22.7	<1
Cylindropuntia imbricata	6	6.1	<1
Echinocereus fendleri	1	1.5	<<1
Grasses			
Bouteloua sp.	64	97	25-50%
Sporobolus cryptandrus	26	39.4	<1
Aristida purpurea	31	47	<1
Pleuraphis jamesii	19	28. 8	<1
Muhlenbergia torreyi	16	24.2	<1
Elymus elymoides	7	10.6	<<1
Forbs			
Chaetopappa ericoides	41	62.1	<1
Tradescantia occidentalis	5	7.6	<1
Dimorphocarpa wislizeni	26	39.4	<1
Salsola tragus	15	22.7	<1
Boechera fendleri	16	24.2	<1
Arabis sp.	6	9.1	<1
Sphaeralcea coccinea	7	10.6	<1
Machaeranthera pinnatifida[T1]	5	7.6	<1
Hymenopappus filifolius	4	6.1	<<1
Ipomopsis longiflora	8	12.1	<<1
Mirabilis multiflora	13	19.7	<<1
Cryptantha crassisepala	6	9.1	<<1
Descurainia sp.	8	12.1	<<1
Gilia longiflora	3	4.5	<<1
Ipomopsis multiflora	19	28.8	<<1
Phacelia sp.	2	3.0	<<1
Astragalus sp.	7	10.6	<<1

Table 20. Visual estimation of cover within Piñon-Juniper woodland vegetation type			
Species	**Present in number of square**	**Present in percent of total squares**	**Mean cover (%) estimate in one square**
Chamaesyce fendleri	5	7.6	<<1
Heterotheca villosa	2	3	<<1
Hymenoxys richardsonii	2	3	<<1
Mirabilis sp.	1	1.5	<<1
Plantago patagonica	1	1.5	<<1
Linus puberulum	1	1.5	<<1
Senecio flaccidus	1	1.5	<<1
Lappula redowskii	4	6.1	<1
Eriogonum sp.	2	3	<1
Eriogonum jamesii	6	9.1	<1
Eriogonum rotundifolium	2	3	<1
Eriogonum cernuum	3	4.5	<1
Lesquerella sp.	3	5	<1
Chenopodium graveolens	17	25.8	<1
Tradescantia occidentalis	5	7.6	<1
Machaeranthera sp.	5	7.6	<1
Orobanche fasciculata	2	3	<<1
Orobanche ludoviciana	2	3	<<1
Sphaeralcea sp.	3	4.5	<<1
Physalis sp.	2	3	<<1
Unidentified forbs (vegetative)	2	3	<<1

[T1]: *(Xanthisma spinulosus)*

Table 21. Shrub and tree density in piñon juniper woodland vegetation type estimated from a 50 m^2 (50m x 1m) band transect.

Shrub and tree species	Estimated number of individuals per hectare	Standard deviation
Juniper monosperma	755	520
Pinus edulis	745	803
Gutierrezia sarothrae	11,182	14,321
Ericameria nauseosa	364	1234
Atriplex canescens	245	466
Lycium pallidum	27	128
Chrysothamnus greenei	136	557
Krascheninnikovia lanata	382	1791
Artemisia bigelovii	318	1362
Cylindropuntia imbricata	9	43
Opuntia spp.	155	195

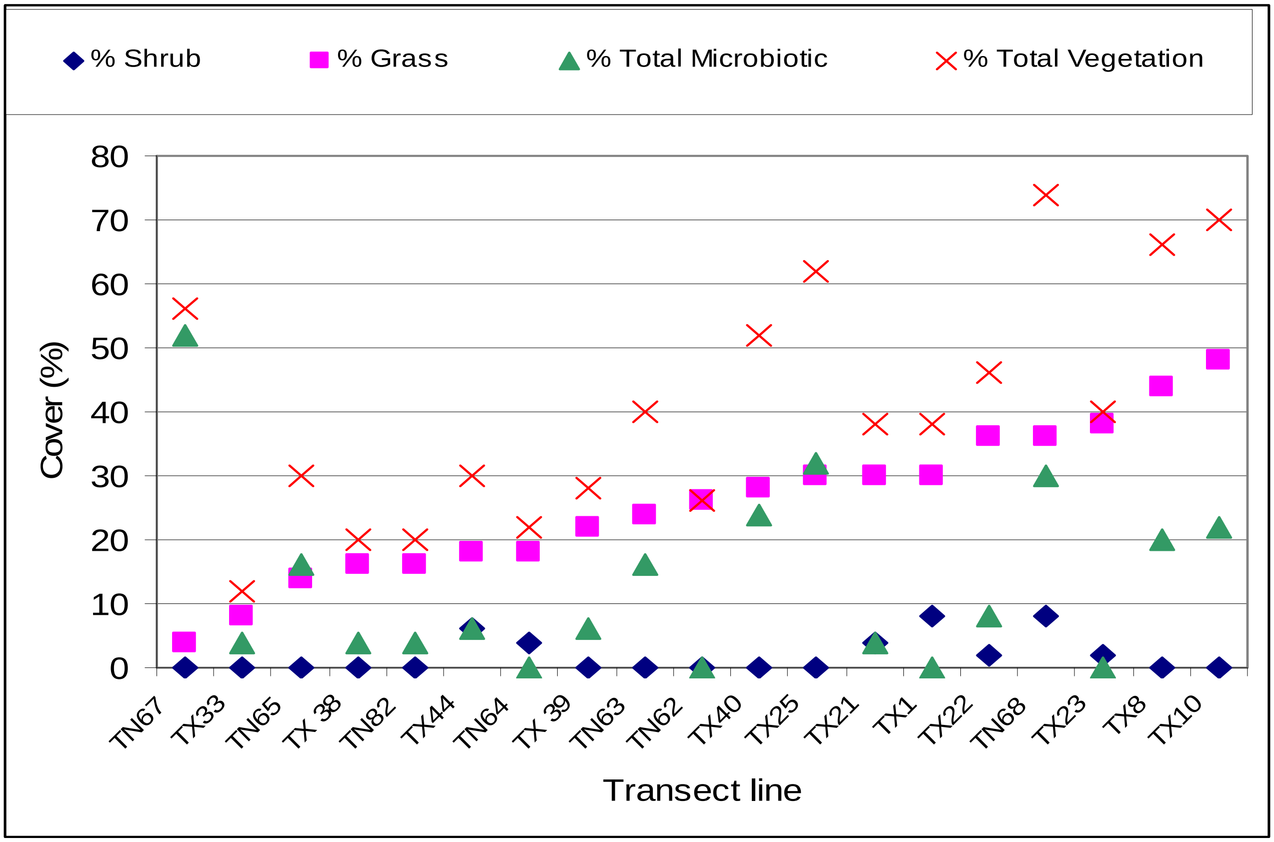


Figure 11. Graphical representation of percent cover measured on transects in Piñon Juniper woodland.

The PJ woodland vegetation type can be further divided at the floristic level to a PJ-*Artenisia bigelovii* association and by substrate as PJ woodland on bedrock.

a. Artemisia bigelovii

Artemisia bigelovii shrub was dominant in areas with fairly widely spaced (20 - 30 m [65.6 - 98.4 ft.]) piñon-juniper on a sandy clay soil with patches of exposed bedrock. Few other vascular plants grew in this association. Microbiotic crusts with high proportions of cyanobacteria covered the soil with little herbaceous understory. In addition to the area in Section 16 that is delineated on the insert map (Figure 5 on page 20), small patches of less than an acre were distributed under widely spaced piñon-juniper canopy at lower elevations on the south-easterly facing slopes in Section 10 (e.g. in the vicinity of Exclosure/Transect 44 indicated on Figures 3 and 7 on pages 7 and 23).

b. Bedrock

PJ woodland frequently grew in areas with high amounts of rock and/or bedrock where the vegetation was concentrated within gaps in the rocks. This was especially true in Section 10, where bedrock with deep drainage channels extended over large areas. *Quercus gambelii*, *Quercus grisea*, *Quercus undulatus*, *Rhus trilobata* var. *trilobata*, *Ribes cereum*, and *Yucca baccata* were common shrubs in these areas. Patches of *Geranium richardsonii* (wild geranium) were common in the drainages in the bedrock. One large *Marrubium vulgare* (horehound) individual was observed in this area. This is an introduced species.

However, the observation is notable because this large individual was the only one observed within the whole project site and its presence lends support to the perception that the bedrock formation provides unique habitat conditions for several different species. See the descriptions under "ponderosa pine-piñon-juniper woodland" for more details.

DRAINAGE BOTTOM/WASH MAPPING UNIT

In general, plant species found in the drainages reflect the surrounding vegetation. The wash bottoms are generally either sandy or rocky. Both substrates obviously influence the extent of vegetation cover.

Atriplex canescens and *Ericameria nauseosa* are common shrubs in the drainage bottoms (Figure 12 at right). *Salsola tragus, Kochia scoparia, Mentzelia multiflora* (blazingstar) and *Verbena macdougalii* (MacDougal's vervain) are common forbs that can be abundant in patches. *Pascopyrum smithii* (western wheat grass) and *Muhlenbergia porteri* were the most common grasses in the drainages.

Detailed and quantitative information has been gathered for tributaries to San Mateo Creek. The results of the surveys made across the arroyo in Section 16 are presented in *Section 1.3.2.6* of this report.

Figure 12. Chamisa (*Ericameria nauseosa)* at Roca Honda site.

PONDEROSA PINE-PIÑON-JUNIPER MIXED WOODLAND VEGETATION TYPE

Ponderosa pine-piñon -juniper mixed woodland is found at higher elevations on the mesa top and south-easterly facing slopes in Sections 9 and 10. The trees (*Pinus ponderosa, Pinus edulis, Juniperus monosperma*) tend to form open stands, with crowns not usually touching. This vegetation type is distinctive from the PJ woodland since there are frequent solitary and small stands of ponderosa pine. The ponderosa pines form an additional and higher canopy layer to the piñon and juniper, which may be significant for wildlife habitat. Although it is unconventional to use the term woodland, rather than forest, when describing vegetation types that include ponderosa pine, it is used here to reflect the generally open canopy cover. Forests are differentiated from woodlands by the extent of canopy coverage. In a forest, the branches and foliage of separate trees typically meet or interlock, although there can be gaps of varying sizes within an area referred to as forest. However, the tree dispersion pattern in Sections 9 and 10 is more appropriately regarded as woodland since the trees are spaced further apart so that there is a more continuously open canopy, which allows more sunlight to penetrate to the ground between them.

Canopy cover and ground cover is described in Table 22 on page 42. Canopy cover of individual species is described in Table 23 on page 42 and tree and shrub density is reported in Table 24 on page 42. Tree canopy is above the immediate ground level cover and the values are not included in "total vegetation cover" in Table 22 on page 42.

Dominant understory species include *Cercocarpus montanus, Purshia stansburiana, Quercus gambelii, Artemisia bigelovii, Quercus grisea, Quercus undulatus, Rhus trilobata* var. *trilobata, Ribes cereum* and *Yucca baccata*. Thickets of *Quercus gambelii* (Gambel oak) and *Quercus xpauciloba* (wavyleaf oak) are common. There are some *Juniperus scopulorum* (Rocky Mountain juniper) at the head of the drainage on the north side of Jesus Mesa (Wood 2006a). *Cheilanthes feei* (Santa Fe lipfern) and *Cystopteris fragilis* (brittle bladder-fern) are occasional in the nooks between rocks. Stands of little bluestem (Schizachyrium *scoparium var. scoparium*) were common on slopes in Section 10 (north diagonal half portion of Section 10).

Table 22. Percent cover in ponderosa pine-piñon-juniper mixed woodland (9 transects).

	Percent (%)									
	Total veg. cover	Litter	Grass canopy	Shrub canopy	Forb canopy	Moss, lichen and micro- biotic crust	Bare ground	Gravel	Rock	Tree canopy
Mean (n=9)	19.3	26.6	2.7	8.2	0.4	8	20.2	16.7	18.2	8.7
Std. dev	13.2	13	5.2	7.6	0.9	7	11.9	10.9	14.1	8.6
Median	12	22	0.0	6	0.0	6	18	16.0	16	8.0
Mode	10	18	0.0	20	0.0	2	16	#N/A	16	0.0

Table 23. Percent cover of individual species in ponderosa pine-piñon-juniper mixed woodland (9 transects).

Species	Mean	STDDEV	MAX	MIN	MODE	MEDIAN
Grasses						
Aristida purpurea	0.2	0.7	2	0	0	0
Bouteloua gracilis	1.8	4.1	12	0	0	0
Pleuraphis jamesii	0.4	1.3	4	0	0	0
Sporobolus cryptandrus	0.2	0.7	2	0	0	0
Shrubs						
Artemisia bigelovii	3.3	5.6	14	0	0	0
Atriplex canescens	0.2	0.7	2	0	0	0
Cercocarpus montanus	1.3	2.2	6	0	0	0
Gutierrezia sarothrae	0.2	0.7	2	0	0	0
Quercus undulatus	2.2	4.8	14	0	0	0
Krascheninnikovia lanata	0.9	2.7	8	0	0	0
Forbs						
Heterotheca villosa	0.2	0.7	2	0	0	0
Eriogonum jamesii	0.2	0.7	2	0	0	0
Trees						
Juniperus monosperma	2.9	3.9	10	0	0	0
Pinus edulis	4.7	7.2	20	0	0	0
Pinus ponderosa	2.9	5.9	16	0	0	0
Microbiotics						
Microbiotic crust	7.6	6.5	18	0	2	6
Xanthoparmelia chlorochroa	0.4	1.3	4	0	0	0

Table 24. Average number of trees and shrubs per hectare in ponderosa pine-piñon-juniper mixed woodland (9 transects).

Species	Mean number/hectare	Standard deviation
Ponderosa pine	100	286
Pinus edulis	2,175	1,202
Juniperus monosperma	625	377
Artemisia bigelovii	4,100	5,063
Gutierrezia sarothrae	9,125	6,784
Ericameria nauseosa	1,175	3,323
Atriplex canescens	750	1,965
Cercocarpus montanus	625	495
Quercus undulatus	25	71
Brickellia grandiflora	50	141
Opuntia species	500	535
Yucca baccata	125	183
Artemisia campestris	200	490
Artemisia carruthii	150	424

Within this community, there was a bedrock formation that extends across both PJ woodland and ponderosa pine- piñon-juniper woodland vegetation types (see Figure 5 on page 20). See also the brief discussion under subsection "*b*" in the PJ woodland vegetation type.

a. Bedrock

Ostensibly, the bedrock in Section 10 is covered by either a ponderosa pine-piñon-juniper woodland (higher elevations) or piñon-juniper woodland (lower elevations) with a sparse understory of mainly shrubs. This area has been delineated on the vegetation map because it provided unique habitats and certain plant species were restricted to the drainages in the bedrock under the ponderosa pine- piñon-juniper woodland cover (Figure 5 on page 20). Species restricted to the drainages included *Typha domingensis, Juncus tenuis, Nolina greenei* (woodland beargrass), *Philadelphus microphyllus, Brickellia grandiflora, Solidago wrightii*, and *Marchantia polymorpha* (liverwort).

Initially, the *Nolina* species was identified as *N. texana*, but upon further examination it was determined to be *N. greenei*. *Nolina greenei* was resurrected for the plants of *Nolina* that occur in central New Mexico. They are similar to *N. texana* with respect to the inflorescence contained within the leaves, persistent elongated bracts, and seeds that burst the ovary wall and remain attached. They differ primarily in their broader, slightly serrulate leaves (although some leaves may be entire), copper-colored seeds, and an open woodland-grassland habitat. *Marchantia polymorpha*, a liverwort, is most often found on moist or wet mineral soils and is known to tolerate and accumulate heavy metals (Mathews 1993).

b. Water Pockets

Several water pockets were intermittently distributed up at least two of the deep drainages in Section 10. These water pockets are seasonally wet or dry. Discussions of individual water pockets that follow are intended as examples only.

Water pockets are cavity-like seasonal pools eroded in sandstone by runoff from steep slopes. The drainages in the bedrock formation in the southwest quarter of Section 10 contained several water pockets. Two were within 50 m (164 ft.) of each other in the same drainage. The lower one was surrounded by bedrock and had no vascular plants associated with it. Algae were observed growing in the water. Two other water pockets were primarily in bedrock but some soil had accumulated in them, which supported a variety of vascular plants. The water pocket locations are marked on the vegetation map in Figure 5 on page 20. *Typha domingensis* (southern cattail), an obligate (OBL)[4] wetland species (US Fish and Wildlife Service 1988, 1993), was a dominant species at both these water pockets. This species was selected over the other possibility, *T. latifolia*, on the basis of the combination of sizes of the various plants' parts. However, in several cases, the combination of measurements did not provide a basis for a conclusive identification. Both species are native. A few individual *Typha* plants extended up and down the drainage from these sites. *Juncus tenuis* (FACW-[5]) was also near these water pockets and extended in discrete patches both up and down the drainages from the water pockets. *Cyperus strigosus* (straw-color flat-sedge; FACW) and *Eleocharis macrostachya* (pale spikerush; OBL), were observed in this area in 2006. The leaves of these species may well have been in the drainages in 2008 but it was likely too dry for any vigorous flowering stands to develop. In this case, they may have been obscured by the stands of *Juncus* and other grasses that also included *Sporobolus contractus* (scratchgrass) and *Sporobolus flexuosus* (mesa dropseed). Downstream in the canyon from one of the water pockets, several small

[4] - OBL: Obligate Wetland species occur almost always (estimated probability 99%) under natural conditions in wetlands.
[5] FACW-: Facultative Wetland species usually occur in wetlands (estimated probability 67%-99%), but are occasionally found in non-wetlands.

stands of *Carex praegracilis* (clustered field sedge) were observed in the stream bed. The National Indicator wetland status of *Carex praegracilis* is FACW+[6] in NM (U.S. Fish and Wildlife Service 1993).

There were two main water pockets (Figure 13 at right), arbitrarily designated Water Pocket A and Water Pocket B. Water Pocket A is located in an oval depression, of approximately 4 m (13.1 ft.) in diameter, in the stream bed. The water pocket is partially covered by a rock overhang. In July, there was little water in the Water Pocket A whereas in May, water submerged the soil in which the cattails grew. Moss covered some of the walls in the overhang. No vascular plants occurred directly beneath the rock overhang. The cattails canopy covered approximately 75% of the area outside of the rock overhang. Five cattails stems were flowering. Species at Water Pocket A included: *Typha domingensis* in standing water and also on soil and *Hordeum jubatum* (FACW-), *Artemisia ludoviciana* (UPL[7]), *Thelypodium wrightii* (not on the National list), *Descurainia obtusa* (not on the National list) and *Descurainia incana ssp. viscosa*; (not on the National list) were on soil adjacent to the pool of water. The vegetation communities on the cliffs on each side of Water Pocket A included *Cercocarpus montanus*, *Nolina microcarpa*, *Brickellia grandiflora*, *Heterotheca villosa* and *Penstemon barbatus*. The oval depression in the streambed that includes Water Pocket B is approximately 7.7 m (25.3 ft.) in diameter. Depending upon seasonal precipitation, water may cover half the soil while the remainder is elevated. Water was present in Water Pocket B in July. Cattails canopy occupies approximately 40% of the area. There were 26 cattails stems but only one was flowering. Species at Water Pocket B included *Typha domingensis* in standing water and on soil and, on elevated soil adjacent to the pool of water, *Artemisia biennis* (FACW), *Bromus ciliatus* (FAC[8]), *Poa palustris* (FAC), *Taraxacum officinale* (FACU[9]), *Poa fendleriana* (UPL),

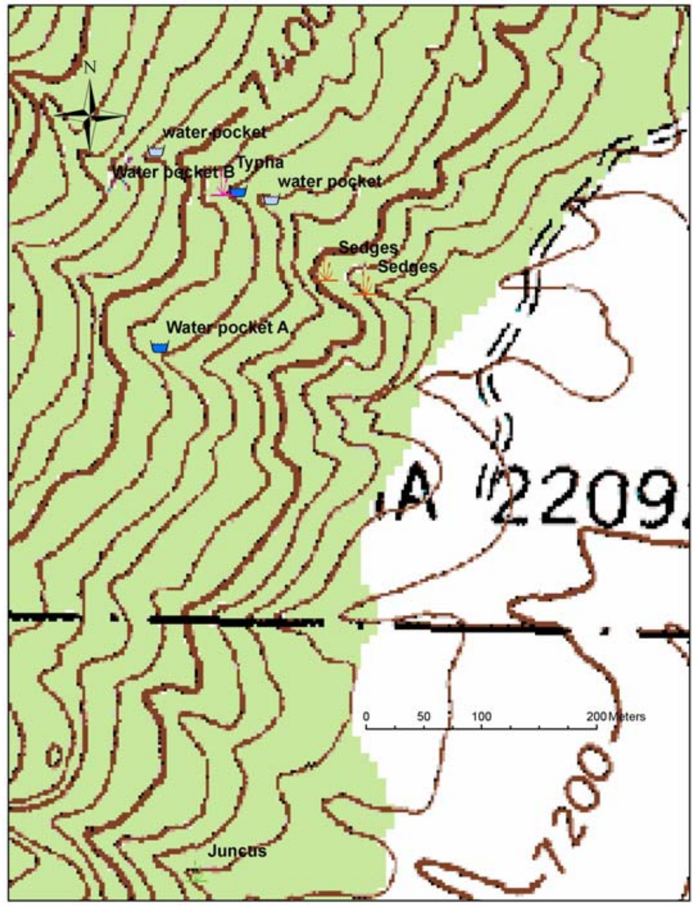


Figure 13. Water pockets located in the southwest quarter of Section 10 at the Roca Honda site.

[6] FACW+: Species are even more likely in wetlands than FACW species but cannot be classed as totally obligate since some exceptions occur.
[7] UPL: Obligate Upland species occurs in wetlands in another region, but occurs almost always (estimated probability 99%) under natural conditions in non-wetlands in the regions specified.
[8] FAC: Facultative species equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
[9] FACU: Facultative Upland species usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found on wetlands (estimated probability 1%-33%).

Descurainia incana ssp. viscosa, Heterotheca villosa (not on the National list) and *Thelypodium wrightii* were observed.

Cheatgrass (*Bromus tectorum*) also grew near the water pockets, especially Water Pocket B. The cheatgrass population was not dense but it is of ecological concern because there is the possibility that this aggressive non-native weed could out-compete the native species at these fragile water pocket sites.

RIMROCK MAPPING UNIT

Rimrock is an outcrop of a horizontal layer of resistant rock at the edge of a plateau or mesa, generally forming a cliff or ledge (Bates and Jackson 1984). This is not strictly a vegetation type since the vegetation was part of either PJ woodland or ponderosa pine-piñon-juniper woodland (see insert map in Figure 5 on page 20). However, the rimrock areas were delineated on the vegetation map because they can provide unique habitat for some plant species. For example, *Astragalus naturitensis* (Naturita milkvetch) grows only on sandstone ledges and rimrock. Not all cliff edges were delineated on the map because large portions of the cliffs at the project site have already been substantially disturbed by naturally-occurring mass movement events (rock fall, rock slides, differential erosion) and are not suitable habitat for species requiring "rimrock."

SEMI-STABILIZED DUNE VEGETATION TYPE

Areas of semi-stabilized dunes have been marked on the vegetation map (Figure 5 on page 20). *Muhlenbergia pungens* (sandhill Muhly) is a distinctive member of this vegetation type. It was also not found outside of this vegetation type. The most common shrub was *Ericameria nauseosa*. In Section 9 on the mesa top, thickets of *Quercus gambelii* (Gambel oak) were common in this vegetation type. The cover on the transect lines surveyed in this vegetation type is described in Tables 25, 26 and 27, below and on pages 46 - 47. Shrub densities are reported in Table 28 on page48. There were 7 transect lines and 21 species- diversity squares in this vegetation type. The cover was measured using the point-intercept method along 50-m transect lines.

On the mesa top in the northeast quarter of Section 9, the sandy areas were dominated by *Artemisia campestris* (field sagewort). The taxonomic treatments of the subspecies of *A. campestris* are various because this species is morphologically variable and prone to introgression. The subspecies in Section 9 was identified as *A. campestris* ssp. *pacifica* using the Flora of North America (Shultz 2006).

Table 25. Percent cover in semi-stabilized dune vegetation type using the point-intercept method along 50-m transect lines.

	PERCENT (%)					
	Total vegetation cover	Litter	Grass canopy	Shrub canopy	Forb canopy	Xantho-parmelia
Mean (n=7)	38.9	22.0	21.4	9.7	0.9	0.0
Stddev	15.7	13.2	17.2	11.0	1.6	0.0
Median	44	24	14	6	0	0
Mode	#N/A	8	#N/A	6	0	0

	PERCENT (%)				
	Moss, lichen and microbiotic crust	Bare ground	Rock	Gravel	Tree canopy
Mean (n=7)	6.9	38.3	0.3	0.6	4.9
stddev	13.1	10.5	0.8	1.0	6.6
Median	2	38	0	0	2
Mode	0	#N/A	0	0	0

Table 26. Percent canopy cover of individual species in the semi-stabilized dune vegetation type.

LIFE FORM, SPECIES	PERCENT (%) CANOPY COVER					
	Mean	Std. dev	max	min	mode	median
Trees						
Juniperus monosperma	2.9	6.7	18	0	0	0
Pinus edulis	2.0	3.5	8	0	0	0
Grasses						
Bouteloua gracilis	12.0	10.6	28	2	4	6
Muhlenbergia pungens	8.0	11.7	34	0	6	4
Achnatherum hymenoides	0.6	1.0	2	0	0	0
Sporobolus cryptandrus	0.6	1.0	2	0	0	0
Hesperostipa comata	0.3	0.8	2	0	0	0
Shrubs						
Atriplex canescens	2.6	5.1	14	0	0	0
Gutierrezia sarothrae	1.1	1.6	4	0	0	0
Lycium pallidum	0.3	0.8	2	0	0	0
Opuntia spp.	0.3	0.8	2	0	0	0
Ericameria nauseosa	4.0	6.1	16	0	0	0
Artemisia filifolia	1.1	3.0	8	0	0	0
Cercocarpus montanus	0.3	0.8	2	0	0	0
Forbs						
Hymenopappus filifolius	0.9	1.6	4	0	0	0
Microbiotics						
Microbiotic crust	6.9	13.1	36	0	0	2

Table 27. Canopy cover of individual species using visual estimation of cover over a 100 m^2 area at 0m, 25m, and 50m along transect lines within the semi-stabilized dune vegetation type.

TABLE 27. PERCENT CANOPY COVER OF INDIVIDUAL SPECIES USING VISUAL ESTIMATION	
SPECIES	PERCENT (%) CANOPY COVER
Juniperus monosperma	1-5%
Pinus edulis	<1
Shrubs	
Gutierrezia sarothrae	1-5%
Artemisia bigelovii	<1
Atriplex canescens	<1
Chrysothamnus greenei	<1
Ericameria nauseosa var. *bigelovii*	<1
Cercocarpus montanus	<1

TABLE 27. PERCENT CANOPY COVER OF INDIVIDUAL SPECIES USING VISUAL ESTIMATION	
SPECIES	PERCENT (%) CANOPY COVER
Purshia stansburiana	<1
Yucca sp.	<1
Grasses	
Bouteloua sp.	5.1-15%
Muhlenbergia pungens	1-5%
Achnatherum hymenoides	<1
Hesperostipa comata	<1
Aristida purpurea	<1
Sporobolus cryptandrus	<1
Pleuraphis jamesii	<1
Elymus elymoides ssp. *elymoides*	<1
Forbs	
Dimorphocarpa wislizeni	<1
Hymenopappus filifolius	<1
Senecio spartioides var. *multicapitatus*	<1
Artemisia sp.	<1
Cryptantha crassisepala	<1
Ipomopsis multiflora	<1
Salsola tragus	<1
Boechera sp.	<1
Descurainia sp.	<1
Eriogonum alatum	<1
Eriogonum jamesii	<1
Heterotheca villosa	<1
Chaetopappa ericoides	<1
Linum puberulum	<1
Machaeranthera sp.	<1
Eriogonum cernuum	<1
Phacelia sp.	<1
Chamaesyce fendleri	<1
Ipomopsis longiflora	<1
Mentzelia sp.	<1
Orobanche ludoviciana subsp. *multiflora*	<<1
Sphaeralcea coccinea	<1
Microbiotics	
Microbiotic crust	1-5
Xanthoparmelia chlorochroa	<1

Table 28. Shrub and tree density in the semi-stabilized dune vegetation type estimated from a 50 m^2 (50m x 1m) band transect.

Shrub and Tree Species	Estimated Number of Individuals per Hectare	Standard Deviation
Juniper monosperma	543	538
Pinus edulis	314	195
Cercocarpus montanus	29	76
Lycium pallidum	86	157
Artemisia filifolia	229	605
Artemisia campestris	11,171	19,093
Gutierrezia sarothrae	6171	6079
Ericameria nauseosa	1057	1295
Atriplex canescens	286	598
Artemisia bigelovii	29	76
Yucca sp. (narrow leaved)	57	151
Chrysothamnus greenei	143	378
Eriogonum jamesii	286	756
Opuntia spp.	29	76

Disturbed Piñon-Juniper Mosaic Mapping Unit

Much of the cliff sides and lower west and southwest facing slopes in Section 9 have experienced substantial disturbance within the last 60 years, although there are small areas of relict undisturbed vegetation. Varying amounts of (re)colonization have occurred over much of the disturbed area, and there is a mosaic of native shrubs, grasses and forbs amongst widely spaced piñon and juniper trees. Little microbiotic crust occurs in this area. Species that were particularly common in the area included: *Ericameria nauseosa*, *Chrysothamnus greenei*, *Bouteloua curtipendula*, and *Kochia scoparia*.

Essentially the lower slopes can be classified as juniper savanna or shrub grassland vegetation types depending upon the area. The slopes have progressively more bare ground and talus as the elevation increases. As such, the upper slopes were too steep and unstable to survey.

Due to quantitative similarities between the results (percent cover) of the transect line surveys in the disturbed piñon-juniper mosaic mapping unit to other vegetation types, it was determined that the data could be legitimately pooled. As such, percent cover values in the disturbed PJ mosaic mapping unit were incorporated either into juniper savanna or shrub-grassland vegetation types as appropriate.

Shrub-Grassland Vegetation Type

Vegetation types initially classified as grasslands at the project site have been revised (Wood 2006a, Wood 2006b). Because there are numerous large stands of shrubs and also many isolated individuals within the grassland matrix, this vegetation type is described as shrub-grassland and has been delineated as such in the vegetation map (Figure 5 on page 20). This vegetation type is typically found in a drainage area and on either side of arroyos where it intergrades with juniper savanna and PJ woodland within the project site.

The grass stands can be subdivided into two main types according to composition: *Bouteloua gracilis* (blue grama), with *Pleuraphis jamesii* (galleta), and *Sporobolus cryptandrus* (sand dropseed) (Wood 2006a); and *Bouteloua gracilis* with *Muhlenbergia torreyi* (ring muhly) (Wood 2006b). Relatively small areas where *Bouteloua hirsuta* (hairy grama) was a dominant grass were also observed. *Achnatherum hymenoides* (Indian ricegrass) and *Elymus elymoides* (squirreltail) were common, but never abundant in any area throughout this vegetation type. The percent canopy cover is described in Tables 29 and 30 on pages 49-51. The vegetation canopy cover and microbiotic crust is graphically represented in Figure 14 on page 49. Grass cover was dominant except on two transects lines where shrub cover was highest. A total of 12 transect lines and 36 species-diversity squares were surveyed in this vegetation type.

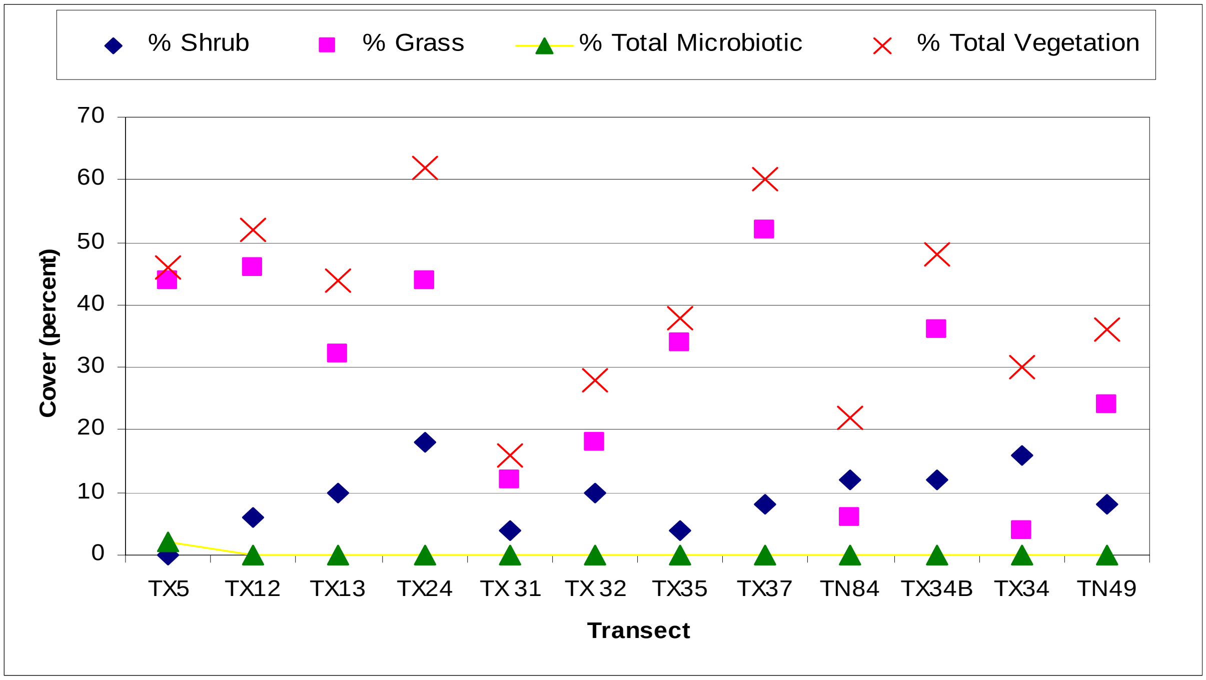


Figure 14. Graphical representation of percent canopy cover measured on transect lines in shrub grassland.

Table 29. Percent cover of individual species in the shrub-grassland vegetation type measured using the point-intercept method along 50-m transect lines.

SPECIES	PERCENT (%)					
	Mean	Std dev	Max	Min	Mode	Median
Grasses						
Bouteloua gracilis	26.2	16.5	50	0	32	32
Elymus elymoides	0.2	0.6	2	0	0	0
Pleuraphis jamesii	1.2	1.8	4	0	0	0
Muhlenbergia torreyi	1.2	3.5	12	0	0	0
Sporobolus cryptandrus	0.7	1.8	6	0	0	0
Shrubs						
Atriplex canescens	2.3	5.0	14	0	0	0
Chrysothamnus greenei	0.2	0.6	2	0	0	0
Ericameria nauseosus	0.8	2.3	8	0	0	0
Gutierrezia sarothrae	5.3	5.8	16	0	0	2
Krascheninnikovia lanata	0.5	0.9	2	0	0	0
Lycium pallidum	0.2	0.6	2	0	0	0
Forbs						
Cryptantha crassisepala	1.5	3.1	10	0	0	0
Salsola tragus	0.2	0.6	2	0	0	0
Townsendia annua	0.2	0.6	2	0	0	0
Microbiotics						
Microbiotic crust	0.2	0.6	2	0	0	0

Table 30. Cover of individual species using visual estimation of cover over 100 m^2 areas at 0m, 25m, and 50m along transect lines within the shrub-grassland vegetation type.

TABLE 30. COVER OF INDIVIDUAL SPECIES USING VISUAL ESTIMATION WITHIN SHRUB-GRASSLAND			
SPECIES	PRESENT IN NUMBER OF SQUARE	PRESENT IN PERCENT OF TOTAL SQUARES	MEAN COVER (%) ESTIMATE IN ONE SQUARE
Trees			
Juniperus monosperma	0	0	0
Pinus edulis	0	0	0
Shrubs and succulents			
Gutierrezia sarothrae	33	91.7	5.1-15
Atriplex canescens	19	52.8	1-5
Krascheninnikovia lanata	13	36.1	<<1
Opuntia spp.	11	30.6	<1
Ericameria nauseosa var. bigelovii	6	16.7	<1
Cylindropuntia imbricata	6	16.7	<1
Escobaria vivipara	2	5.6	<<1
Lycium pallidum	2	5.6	1-5
Chrysothamnus greenei	1	2.8	<<1
Grasses			
Bouteloua sp.	33	91.7	15.1-25
Muhlenbergia torreyi	23	63.9	1-5
Elymus elymoides ssp. *elymoides*	16	44.4	1-5
Sporobolus cryptandrus	22	61.1	<1
Aristida purpurea	10	27.8	<1
Pleuraphis jamesii	9	25	<1
Hesperostipa comata	4	11.1	<1
Achnatherum hymenoides	4	11.1	<1
Unidentified grass	2	5.6	<<1
Schedonnardus paniculatus	2	5.6	<1
Sporobolus airoides	1	2.8	<<1
Agropyron sp.	1	2.8	<<1
Sporobolus contractus	1	2.8	<<1
Forbs			
Salsola tragus	27	75.0	1-5
Sphaeralcea coccinea	11	30.6	<1
Chaetopappa ericoides	10	27.8	<1
Hymenopappus filifolius	8	22.2	<1
Townsendia sp.	3	8.3	<1
Cryptantha crassisepala	17	47.2	<1
Eriogonum rotundifolium	10	27.8	<1
Lappula occidentalis	12	33.3	<1
Machaeranthera pinnatifida	7	19.4	<1
Chenopodium album	6	16.7	<1
Abronia fragrans	4	11.1	<1
Senecio spartioides var. *multicapitatus*	2	5.6	<<1
Plantago patagonica	2	5.6	<<1
Annual *Atriplex sp.*	3	8.3	<<1
Dimorphocarpa wislizeni	3	8.3	<<1
Erigeron sp.	3	8.3	<<1
Sphaeralcea parviflora	1	2.8	<<1
Oenothera pallida	2	5.6	<<1
Psilostrophe tagetina	2	5.6	<<1

TABLE 30. COVER OF INDIVIDUAL SPECIES USING VISUAL ESTIMATION WITHIN SHRUB-GRASSLAND			
SPECIES	PRESENT IN NUMBER OF SQUARE	PRESENT IN PERCENT OF TOTAL SQUARES	MEAN COVER (%) ESTIMATE IN ONE SQUARE
Bahia dissecta	1	2.8	<<1
Chamaesyce fendleri	1	2.8	<<1
Cymopterus sp.	1	2.8	<<1
Descurainia sp.	1	2.8	<<1
Helianthus sp.	1	2.8	<<1
Mentzelia sp.	1	2.8	<<1
Phacelia sp.	1	2.8	<<1
Physalis sp.	1	2.8	<<1
Bassia scoparia	4	11.1	<<1
Cryptantha sp.	3	8.3	<<1
Eriogonum cernuum	3	8.3	<<1
Achillea lanulosa	2	5.6	<<1

The species and size of the shrub stands vary considerably. As has been mentioned previously in the report, the density of shrubs is also highly variable throughout the project site. The most common shrub species included *Atriplex canescens* (four-wing saltbush), *Ericameria nauseosa* (rabbitbrush), *Krascheninnikovia lanata* (winterfat), and *Lycium pallidum* (wolfberry). *Fallugia paradoxa* (Apache plume) was infrequent. *Artemisia filifolia* (sand sagebrush) was both common and abundant in parts of Section 10 but not elsewhere within the project site. *Cylindropuntia imbricata* (cholla cactus) individuals were infrequent within the project site. *Cylindropuntia imbricata* was common in the shrub-grassland vegetation type in Section 12, which is now outside the current project site but was included in the surveys in 2008. Because of its former inclusion in the project area, three exclosures and transects were surveyed there in 2008. That information on the vegetation cover is still useful in characterizing shrub-grassland. However, because of the proportion that these transects contribute to the total, the number of *Cylindropuntia* individuals in the current project site may be over estimated (Table 31 below). After normalizing the data, the number of transects that would be needed to estimate total shrub frequency with 90 percent confidence would be 56. For individual species, the number ranges from less than 10 for *Lycium pallidum*, *Opuntia* species, and *Ericameria nauseosa*, and 14 for *Atriplex canescens* to 80 for *Gutierrezia sarothrae*. This range results because the numbers of snakeweed plans were highly variable, especially the small plants, and the frequency with which the other species were encountered was low. There are no trees in this vegetation type.

Table 31. Shrub and shrub density in the shrub-grassland vegetation type estimated from a 50 m^2 (50m x 1m) band transect.

SHRUB AND SUCCULENT SPECIES	NUMBER OF INDIVIDUALS PER HECTARE	
	Mean	Standard deviation
Lycium pallidum	83	289
Chrysothamnus greenei	50	170
Gutierrezia sarothrae	18,917	18,973
Krascheninnikovia lanata	5,117	9,585
Ericameria nauseosa	433	1,262
Atriplex canescens	1,783	3,499
Opuntia spp.	50	124
Cylindropuntia imbricata	83	99
Total shrubs and succulents	**26,517**	**19,481**

a. Standing water (dirt stock tank)

A dirt stock tank in the central part of Section 16 is delineated on the vegetation map (Figure 5 on page 20). This is a man-made cattle tank that naturally accumulates water from the drainages that lead into it. Nine saltcedar (*Tamarix chinensis*) trees are growing around the tank. Other plants dominating this man-made wetland include *Kochia scoparia* (Mexican fireweed), *Salsola tragus* (Russian thistle), and *Verbesina encelioides* (golden crownbeard). *Ericameria nauseosa* var. *graveolens* (Rubber rabbitbrush) and *Hordeum jubatum* (foxtail barley) are also present. This area is further described in *Section 1.3.2.6* of this report, which describes the results of the transect lines across the principal tributary of San Mateo Creek.

1.3.2.4 *Ecological Condition of the Project Site*

Observations that followed the NRC guidelines on the ecological condition of the sites were recorded (National Research Council 1994, Pyke et al. 2002, Pellans et al. 2005). It was a dry year relative to 2006 and, not unexpectedly, plant species diversity was lower than that observed in the 2006 survey (Wood 2006a, Wood 2006b). There were relatively few invasive non-native species present at the site.

Plants of most species were observed to have flowers and/or seeds and, in general, the vegetation appeared to be reproducing and represent sustainable communities. Overall, plant mortality and decadence did not appear to be more than typical for the region. Shrubs appeared to be generally long lived with infrequent dead individuals. The only exception may be the *Lycium pallidum* (wolfberry) stands. Individuals in these stands had relatively little evidence of reproduction and many apparently-dead individuals were observed. Most grass stands showed a moderate level of die back but also some new growth.

In the vegetation types where mining disturbance is expected, total vegetation cover including microbiotic crusts averages 42%. Microbiotic crusts were well developed in some areas but their composition was variable. In several areas, they consisted of cyanobacteria, which are generally early successional species while in others, lichen and/or moss species were common. The latter take much longer to form and likely represent a more late successional community. In some areas, the vagrant lichen, *Xanthoparmelia*, forms a substantial cover (Table 19 on page 37). On a weight per area basis, this lichen sometimes contributed a significant percent of the above-ground biomass. Where this lichen occurred, it averaged 38% of the above ground biomass but ranged from 4% (exclosure 47) to 89% (exclosure 10; Figure 8 on page 24). Litter cover and bare ground were also variable across the site. The mean in the vegetation types where direct mining disturbance is anticipated is 30% for litter and 26% for bare soil. Litter depth averaged less than 0.5 inches (1.3 cm) and accumulated most frequently under shrubs and trees.

Erosional pedestals at the base of grasses and shrubs were evident throughout the project area. They averaged about 2.54 cm (1 inch) high among vegetation types; ranging from moderate (1.3 cm; 0.5 in.) to severe (approximately 6.9 cm [~2.7 in.]). Rill formation was generally low but in areas where water flow was unimpeded, they were more evident. Similarly, gully formation was especially evident in drainage regions. Gulley depth and width ranged from less than 30 cm (1 ft.) wide and less than 7.6 cm (3 in.) deep to significant arroyos. Downcutting apparently occurring in both shallow drainages and larger arroyos was evident.

1.3.2.5 *Productivity Measurements*

Grass is the most abundant herbaceous cover. In some areas the vagrant lichen, *Xanthoparmelia chlorochroa*, also contributed significant amounts to the above ground biomass. Both grass and lichen were only collected from the sampling square (40 cm x 40 cm; 15.7 in. x 15.7 in.) in the middle if the 1 m^2 (10.8 ft^2) exclosure so that edge effects from the exclosure fence would be avoided. Forbs were very few as indicated by the cover measurements. Therefore, all forbs in the exclosures were collected and they were collected from 1 m^2. Since only herbaceous cover was in the study design shrubs were not purposely included in the exclosures. However, when present, the current year's growth was trimmed from any shrub (principally these were small *Gutierrezia sarothrae*) found within the 1 m^2 (10.8 ft^2) exclosure.

When the plant material was harvested from the exclosures, an estimate of the percent cover inside the sampling square (40 cm x 40 cm [15.7 in. x 15.7 in.]) was made. These estimates were compared to the percent cover measured along the transect line (Table 32 on page 54). In general, there was more cover inside the exclosures than outside suggesting that grazing has an impact on the production even during a drought year. In some cases, the difference was negligible (e.g. Exclosure 1 in PJ woodland; Table 32 on page 54) whereas in others it was highly significant (e.g. Exclosure 5 in shrub-grassland; Table 32 on page 54). The extent and pattern of the differences between measurements inside and outside the exclosures suggest that they are related to grazing pressure intensities. For example, the differences tended to be larger in shrub-grassland than in PJ woodland (see Table 32 on page 54). It is reasonable to assume that cattle are more likely to congregate and spend longer periods of time in moister shrub-grassland in the valleys than on the slopes in PJ woodland where there is less herbaceous material. At the 95.0% confidence level, the percent grass cover of shrub grassland was statistically significantly similar to that of the Juniper savanna and both were higher than that in the PJ woodland. Therefore, herbaceous productivity in juniper savanna and shrub-grass land would be expected to be similar.

Material from the central sample area of the exclosure was divided according to whether it was grass, forb, vagrant lichen or shrub. The grass tissue was further subdivided at harvest into green grass and brown grass. The various samples were placed in separate bags and dried and weighed separately. It is apparent that the green grass represented the herbaceous (grass) production in the current year but most of the brown grass was likely to have also been current year production since it was such a dry year. In addition, the prior year's growth in the central area of the exclosure was clipped when the exclosures were established, but the grasses were sorted on the basis of color for completeness. In general, there was very little brown tissue as can be seen as the difference between "total grass" weight and "green grass" weight (Table 33 on page 55). Units have been given in kg/ha and lbs/acre for ease of comparison with published reports in the literature.

The productivity at the site is described in Table 33 on page 55. Range managers consider grass production to be most important since it provides forage for domestic animals. However, when considering the ground cover biomass, lichens contribute significantly to carbon and nitrogen cycling and aid in preventing soil erosion. Terricolous lichen biomass measurements are typically very difficult and can be confounded by adhering soil. However, at the project site, the macro vagrant lichen *Xanthoparmelia* was common and was abundant in many areas, especially in Section 16. Where it occurred within the exclosures, *Xanthoparmelia* was collected and weighed after drying. No significant amount of soil adhered to the lichen, and it could be handled just like vascular plant tissue.

In PJ woodland, *Xanthoparmelia chlorochroa* was only present in 5 of the 13 exclosures but could be particularly dense in the areas where it occurred (Table 33 on page 55). It averaged 39 percent of the cover by dry weight with a minimum value of 3.6 percent. In one instance, it comprised 87 percent of the weight of the vegetation that covered the ground surface (19.6 g [0.69 oz.] of a total of 22.6 g [0.8 oz.]). When considering only the five transects on which *Xanthoparmelia* occurred, the mean weight per sampling square was 14.5 g/1,600 cm^2 (0.5 oz./248 in^2). However, its weight represents the accumulation of mass over several years. Growth rates in lichens are not well documented. *Xanthoparmelia* species apparently grow more rapidly than other lichen species, but most research has been conducted on *saxicolous* species indicating that they grow in all directions at just over 2 mm (0.08 in.) per year (Benedict 2008). *Xanthoparmelia* was less abundant in juniper savanna and essentially absent from the other vegetation types.

Bouteloua species, *Pleuraphis jamesii* and *Muhlenbergia torreyi*, in various proportions, comprised the grass samples in all the exclosures except for those in the semi-stabilized dune vegetation type.

Table 32. The estimated percent grass and *Xanthoparmelia chlorochroa* cover within the exclosure compared to that on the transect line within the vicinity of the exclosure.

Vegetation type	Exclosure number	Percent (%) cover		Vegetation type	Exclosure number	Percent (%) cover	
		Exclosure estimate[1]	On transect			Exclosure estimate[1]	On transect
PJ woodland	1	32	26	Jun savanna[2]	3	43	34
PJ woodland	8	70	50	Jun savanna	4	62	50
PJ woodland	8	65	50	Jun savanna	9	70	34
PJ woodland	10	85	58	Jun savanna	11	48	52
PJ woodland	21	35	30	Jun savanna	14	48	42
PJ woodland	22	40	36	Jun savanna	15	55	38
PJ woodland	23	48	38	Jun savanna	16	72	28
PJ woodland	25	56	30	Jun savanna	17	83	74
PJ woodland	33	35	8	Jun savanna	18	68	36
PJ woodland	38	60	16	Jun savanna	19	48	38
PJ woodland	39	70	22	Jun savanna	20	70	56
PJ woodland	40	55	28	Jun savanna	26	50	26
PJ woodland	44	35	18	Jun savanna	27	35	30
PJ woodland	28	70	40	Jun savanna	29	45	24
Shrub-grassland	5	92	44	Jun savanna	30	60	30
Shrub-grassland	24	75	54	Jun savanna	41	63	44
Shrub-grassland	31	95	12	Jun savanna	42	35	54
Shrub-grassland	32	60	18	Jun savanna	43	30	36
Shrub-grassland	34	64	4	Jun savanna	43B	---	34
Shrub-grassland	34B[4]	----	36	Jun savanna	45	47	30
Shrub-grassland	35	45	34	Jun savanna	47	28	22
Shrub-grassland	37	75	52	Jun savanna	2	70	24
Shrub-grassland	48	35	35	Dune[3]	6	62	14
Sec. 12[5]	7	55	26	Dune	36	90	56
Sec. 12[5]	12	80	48	Dune	46	95	38
Sec. 12[5]	13	60	34				

1: Estimated within the 40 cm x 40 cm (15.7 in. x 15.7 in.) square within the exclosure.
2: Juniper savanna.
3: Semi-stabilized dunes.
4: "B" indicates a second transect was surveyed in the vicinity of this exclosure.
5: Shrub-grassland or PJ woodland vegetation types in Section 12.

Table33. Grass and macro-lichen (*Xanthoparmelia*) biomass estimated for four different vegetation types at the Roca Honda project site.

VEGETATION TYPE	#*	SAMPLE	MEASURED G/SAMPLING SQUARE (1,600CM^2)	KG/HA		LBS/ACRE
			Mean	Mean	Std dev	Mean
PJ woodland	13	Green (current year) grass	4.1	289	118	257
PJ woodland	13	Total grass	4.8	333	147	271
PJ woodland	13	*Xanthoparmelia* (lichen)	5.6	348	570	310
PJ woodland	13	Total	10.4	681	604	606
Juniper savanna	21	Green (current year) grass	7.7	481	326	429
Juniper savanna	21	Total grass	11.2	698	518	621
Juniper savanna	21	*Xanthoparmelia* (lichen)	0.4	23	74	20
Juniper savanna	21	Total	11.5	721	497	642
Semi-stabilized dunes	3	Green (current year) grass	21.04	1,315	285	1,171
Semi-stabilized dunes	3	Total grass	28.3	1,770	384	1,576
Shrub-grassland	8	Green (current year) grass	7.6	478	177	425
Shrub-grassland	8	Total grass	10.5	653	429	582
Sec. 12	3	Green (current year) grass	7.0	437	102	389
Sec. 12	3	Total grass	9.0	565	110	503

**: # = Number of exclosures*

In addition to *Bouteloua* species, *Muhlenbergia pungens* was a dominant grass species in the samples in the semi-stabilized dune vegetation type.

Herbaceous forage production ranged from a mean of 333 kg/ha (297 lbs/ac) (in PJ woodland) to 1,770 kg/hectare (1,580 lbs/ac) (in the semi-stabilized dunes). The juniper savanna and shrub-grassland vegetation types at this project site have many similarities to a short grass steppe vegetation type in Colorado and a *Bouteloua-Aristida* shortgrass prairie in northern Mexico. Average forage production over a 51 year period was reported to be 75 g/m^2 (0.25 oz/ft^2) (or 750 kg/ha [669 lbs/ac] on an ungrazed short-grass steppe site in north-central Colorado where *Bouteloua gracilis* was the dominant grass species (Milchunas et al. 1994). Herbaceous (*Bouteloua hirsuta* and *Aristida* spp.) production was 600 kg/ha (536 lbs/ac) on a native shortgrass prairie community in northern Mexico (Corronado and Romo 2001). These values are comparable to the mean production value of 698 kg/ha (623 lbs/ac) estimated within the juniper savanna and 658 kg/ha (588 lbs/ac) in the shrub-grassland at this project site. Since 2008 was a dry year, lower than average herbaceous production is to be expected.

Current year forb productivity was low, as indicated by the canopy cover surveys. Only 12 of the 48 exclosures contained native forbs. Forbs in two exclosures were the non-native weed, *Salsola tragus* (tumbleweed) and were not included in the estimate of forb productivity. In areas where forbs occurred, average production of forbs was 46[10] kg/ha (41 lbs/ac) with a standard deviation of 87 kg/ha (78 lbs/ac) in

[10] Values are rounded up to nearest whole number.

2008. However, forbs only occurred at 25 percent of the sites, so total forb production was only approximately 12 kg/ha (10.5 lbs/ac) in 2008.

Shrubs occurred in 11 of the 48 exclosures. These were very small plants and included in the plot by chance. Only the current year's growth was trimmed, dried and weighed. Results are included for complete data disclosure but no conclusions can be made as to shrub productivity at the site. *Gutierrezia sarothrae* (snakeweed) was found in eight of the exclosures and *Krascheninnikovia lanata* in three exclosures. *Eriogonum jamesii* (James' buckwheat) was found in one exclosure. *Eriogonum jamesii* can be classified as a sub-shrub or a forb and is included with the shrubs in this report. In areas where the shrubs and sub-shrubs occurred, average production was 41 kg/ha (36.6 lbs/acre) with a standard deviation of 51 kg/ha (45.5 lbs/ac) in 2008. However, forbs only occurred at 23 percent of the sites so total production was only approximately 9 kg/ha (8 lbs/ac) in 2008.

The variability across the site and within the vegetation types was considerable (please see standard deviation values in Table 33 on page 55). Although significant differences did occur between the vegetation types for grass cover, rather than grass production being related to vegetation type, it also appeared to be substantially influenced by the micro-environment where it was collected. For example, in all vegetation types, grass grew more abundantly in areas where water collected. The data was not normally distributed and so the data was transformed by taking the square root of each value. The data from all vegetation types was then pooled to determine the average grass production across the site. Sample adequacy based on normally distributed data was then examined.

A total of 48 samples were taken to estimate the herbaceous productivity of the site. As indicated previously, green grass was separated from brown-colored grass. Most of the brown grass was the current year's growth but the grass was separated according to color to give a minimum and maximum estimate of one season's productivity. The equation to test sample adequacy as described previously in this report was used. Forty one samples were estimated to be adequate to measure green grass production with a 90% level of precision, while 48 samples were estimated as required when the productivity of total grass was assessed. Forty five (45) samples were estimated as sufficient when grass and *Xanthparmelia* was summed together (Table 34 below).

Table 34. Herbaceous productivity measured using 48 exclosures distributed throughout the project site where grass formed a significant proportion of the ground cover.

AREA	#*	SAMPLE	KG/HA		LBS/ACRE	NMIN**
			Mean	Std dev	Mean	----
Project site	48	Green (current year) grass	289	232	258	41
Project site	48	Total grass	368	319	345	48
Project site	48	Total grass + Xanthoparmelia	427	236	397	45

**: # = Number of exclosures*
***: Nmin = estimated after the data was transformed by taking the square root of each value.*

1.3.2.6 *TREE CHARACTERISTICS*

Three species of tree were common at the site; piñon (*Pinus edulis*), juniper (*Juniper monosperma*) and ponderosa pine (*Pinus ponderosa*). Only one cottonwood was observed at the site. It was at a relatively high elevation in Section 10 and probably represented a remnant from a time when cottonwoods were more numerous up the damp canyons.

Salt cedar, or tamarisk, was encountered infrequently at the site. Approximately five tamarisk (*Tamarix chinensis*) trees are growing at a livestock pond in Section 16. This area is marked on the map (Figure 7 on page 23). These trees are between 3 to 7.6 m (10 to 25 ft) tall. Individuals are also scattered infrequently in the tributary drainage bottom that runs southward from the livestock pond towards San

Mateo Creek. Tamarisk is an invasive tree species. Currently, the trees are at a sufficiently low density so they could easily be eliminated from the site.

The numbers of piñon, ponderosa and juniper trees were measured within the 10-m (32.8-ft) belt transects (500 m^2 [5,382 ft^2]). Tree density is reported in Table 35 below. It is important to note that these measurements include seedlings and saplings less than 50 cm (1.6 ft) tall so the value represents a denser stand of trees than is apparent on the ground or observable by aerial photography. The distribution of trees was also patchy and in some areas the patches were significantly denser than in others even within the same vegetation type. The mean density of piñon in the piñon juniper woodland vegetation type may be skewed towards the high end because there were 16 piñons found in one belt transect. There appeared to be considerable recruitment occurring at this site.

Table 35. Density of juniper (Jumo), piñon (Pied) and ponderosa pine (Pipo) trees in the vegetation types at the Roca Honda project site.

	Juniper Savanna		PJ Woodland		Shrub Grassland		Ponderosa Pine Woodland			Semi Stabilized Dunes	
	Jumo	Pied	Jumo	Pied	Jumo	Pied	Jumo	Pied	Pipo	Jumo	Pied
Average number per 50 m^2	2	1	4	4	0	0	3	11	1	3	2
Range	0 - 11	0 - 2	0 - 9	0 - 16	0	0	0 - 7	0 - 20	0 - 4	0 - 7	0 - 3
std dev	2	1	3	4	0	0	2	6	1	3	1
Average number per 100 m^2	4	2	8	8	0	0	6	22	1	5	3
Average number per hectare	386	150	771	771	0	0	625	2175	100	543	314
Average number per acre	156	61	312	312	0	0	253	880	40	220	127
Percent of transects in which species occurred	75	46	93	86	0	0	100	100	25	62.5	87.5

Heights and diameter of the trunk at breast height of piñon and ponderosa trees and heights of juniper trees were measured within the 10-m (32.8-ft) belt transects (Figures 15, 16, and 17 on pages 58 and 59). Piñon pines did not typically have multiple stems. The juniper trees generally did have multiple stems and no measures of trunk size were made.

Less than one percent of trees were small in stature due to repeated browsing by animals and damage from other causes. Typically, trees were small because they were seedlings or saplings. There was, therefore, evidence of considerable piñon and juniper recruitment throughout the site (Figures 15 and 17 on pages 58 and 59). Some sapling and seedling ponderosa pines were observed but they were not as abundant as piñon and juniper seedlings and saplings (Table 36 on page 59).

The heights of fifty-six (56) additional trees considered "average" by the field technician were measured in Sections 9, 10, and 16 to determine size. These data were collected in addition to the measurements along the transect line to ensure some information was collected on the tree size in case only a few trees were located within the belt transects. Size measurements for the piñon and ponderosa pine are as defined by the American Forester organization. The UTM coordinates of each tree was marked so the canopy could be measured by aerial photography. Canopy diameter was then measured on aerial photos. These measurements were taken to support the vegetation map and provide a baseline on which to evaluate change during development. The results are reported in Table 37 on page 60. Other than considering specific trees "average" size, trees were otherwise randomly selected throughout all the sections within the project area. Values in Table 37 on page 60 are rounded to whole numbers.

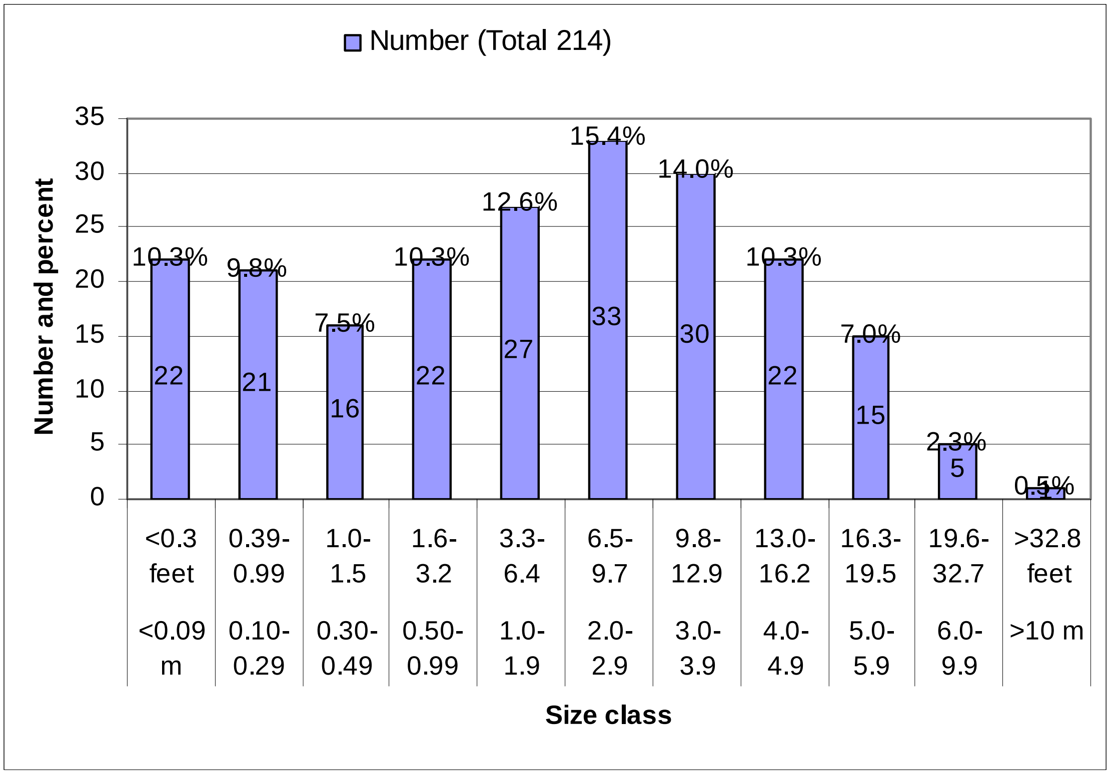


Figure 15. Heights of piñon trees observed within the belt transects.

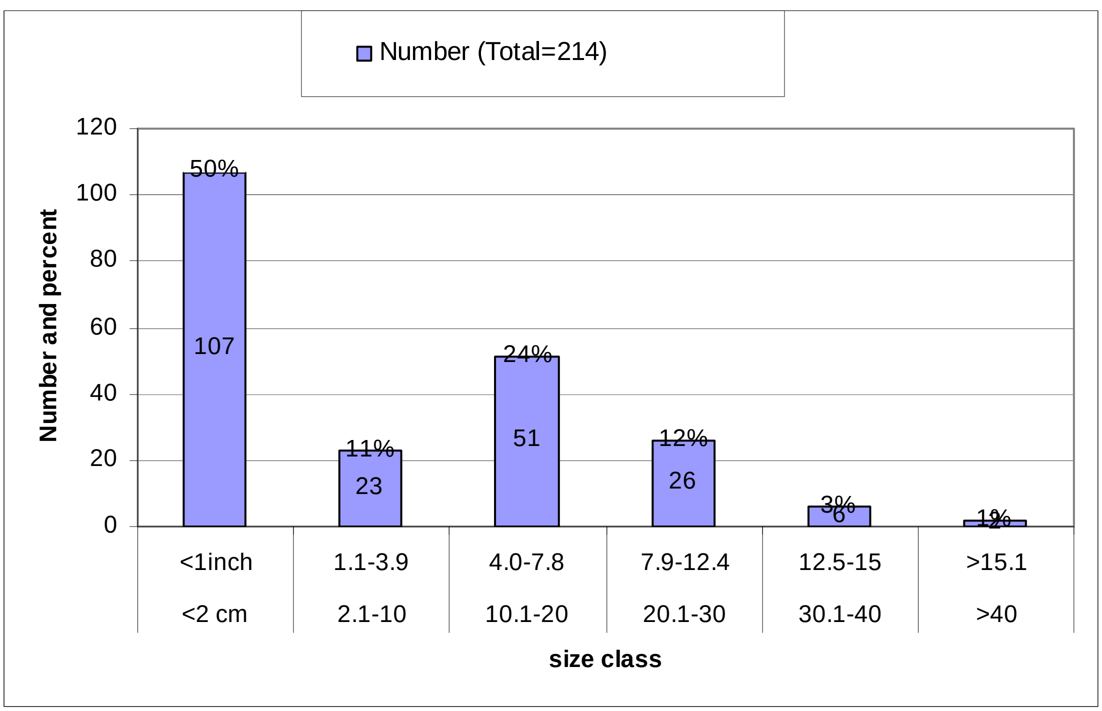


Figure 16. Diameter of the trunk at breast height (Dbh) of piñon trees within the belt transects.

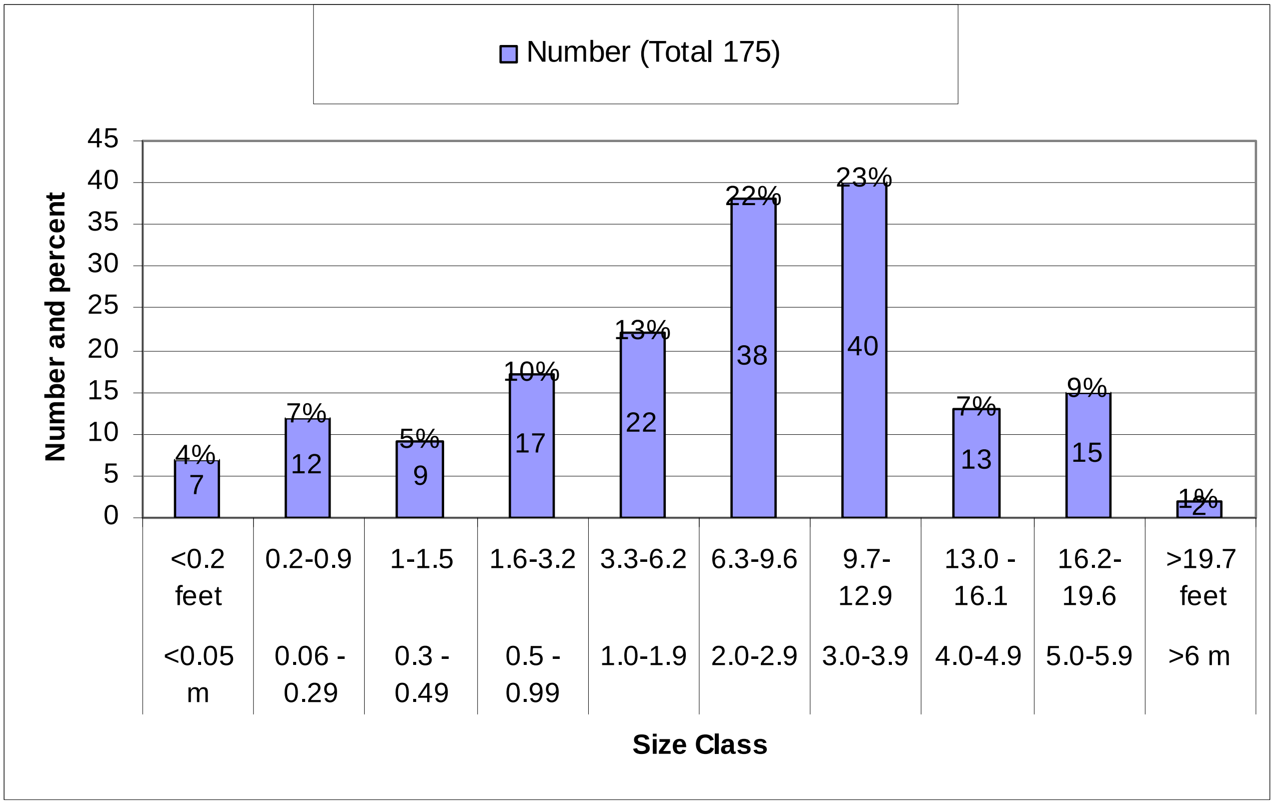


Figure 17. Heights of juniper trees observed within the belt transects.

Table 36. Heights and diameter at breast height (DBH) of ponderosa pines in the belt transect areas.

PONDEROSA PINE TREE – ARBITRARY NUMBER	HEIGHT (M)	HEIGHT (FEET)	DBH (CM)
1	21.6	70.9	37.6
2	21.1	69.1	59.8
3	16.7	54.9	24.2
4	16.5	54.3	24.2
5	12.8	42.0	30.6
6	11.6	38.0	59.8
7	8.2	26.8	35.0
8	5.2	17.0	28.0
9	4.4	14.3	36.6
10	3.9	12.9	21.3
11	0.3	0.8	Not measured

Table 37. Sizes of trees that were considered of a representative size by the field technician.

SPECIES	VALUE	HEIGHT		DBH		CANOPY DIAMETER		CIRCUMFERENCE		POINTS*
		m	ft	cm	inches	m	ft	cm	inches	
Pipo	Mean n=20	7	23	34	13	5	18	106	42	69
Pipo	Stddev	3	11	11	4	1	5	36	14	25
Pipo	Range	4 - 20	13-67	17- 70	54-221	3-9	11-31	54-221	21-87	41-161
Pied	Mean n=18	6	19	33	13	5	15	103	41	64
Pied	Stddev	2	6	15	6	2	6	48	19	24
Pied	Range	3-9	10 - 30	16-58	6 - 26	2-7	7-24	50-213	19-84	34-116
Jumo	Mean n=18	4	15	N/A	N/A	6	19	N/A	N/A	---
Jumo	Stddev	1	5	N/A	N/A	2	5	N/A	N/A	---
Jumo	Range	2-6	7-22	N/A	N/A	3-8	10-19	N/A	N/A	---

**Points= sum of (trunk circumference (at 4.5 ft [1.4 m]) in inches, tree height in feet, and one-quarter of the average crown spread in feet. (see http://www.americanforests.org/resources/bigtrees/)*

Sizes of the trees at the Roca Honda site are comparable to those reported in the literature for New Mexico (Dick-Peddie 1993, Ladyman et al. 1993). There was obviously a range of sizes and ages for both piñon and juniper. Proportionally, fewer young/small ponderosa pines were observed than for juniper and piñon. The correlation between DBH and height for pinon was 0.79 and ponderosa pine 0.81.

None of the trees are as large as the largest size trees posted by American Forest (2009). The largest *Pinus edulis* was reported to be growing in Arizona and have a 2.24 m (88 in) circumference, 12.2 m (40 ft) height and a crown spread of 11.6 m (38 ft) (American Forests 2009). The largest tree in New Mexico was reported to have a diameter of 172 cm (5.6 ft), a height of 21 m (69 ft), and a crown spread 16 m (52.5 ft) (American Forests 1996). The largest ponderosa pine was reported to have a circumference of 6.25 m (246 in) , a height of 59 m (194 ft) , a spread of 19.5 m (64 ft) achieving 456 points (American Forest 2009).

1.3.2.7 *CHARACTERISTICS OF THE TRIBUTARY TO SAN MATEO CREEK*

Four transects were surveyed in Section 16 along this tributary. One transect line was surveyed across the channel at the livestock pond in Section 16 and then three additional ones across the channel south of the livestock pond (Figure 18 on page 61).

The channel edges were not well defined at the exit of livestock pond (Transect Arroyo-7; Figure 18 on page 61). The channel tended to merge with the surrounding vegetation without any clear delineation but was estimated to be approximately 50 m (164 ft) across. The depth at the channel at this point was less than 30 cm (11.8 in) (Figure 18 on page 61). None of the herbaceous species indicated that it was a wetland. Grass species included *Muhlenbergia torreyi* (ring muhly) and species of *Agropyron* (wheatgrass). Tamarisk trees were well developed and were sprouting vigorously. This species tends to grow in wet areas but it does not have specific wetland indicator status in New Mexico (USDA, NRCS 2010).

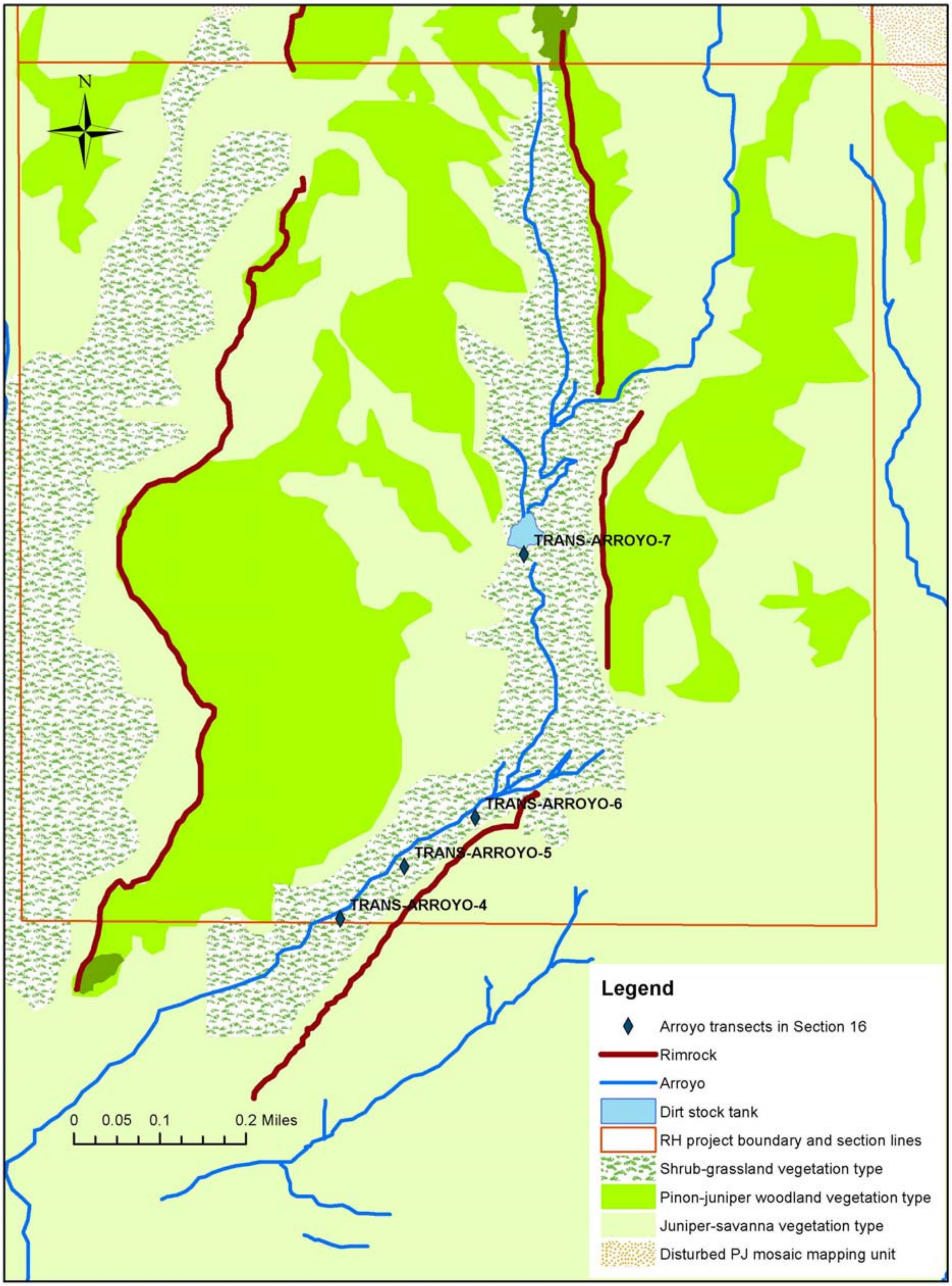


Figure 18. Locations of the transect lines across the main drainage from the dirt stock tank in Section 16.

Artemisia dracunculus was the only forb on the transect line. Tamarisk vegetation occupied approximately 12 percent of the transect line with a well developed litter layer under their canopy. The ground cover was 6 percent shrub, 2 percent forb canopy, 38 percent grass canopy, 52 percent litter and 2 percent bare ground and gravels (Table 38 below).

Table 38. Ground cover along the transect line at the stock pond (AR-7).

TRANSECT	PERCENT (%)						
	Tamarisk canopy	Bare ground	Litter	Shrub canopy	Forb canopy	Grass canopy	Moss and cryptogams
AR-7	12	2	52	6	2	38	0

There are numerous interwoven deep channels immediately south of the stock pond but further south there is just one main channel along which the three subsequent transects were surveyed.

South of the stock pond, the channel averages 20 m (65.6 ft) wide and 17.5 m (57.4 ft) deep. A schematic to show channel depth is in Figure 19 below. The diagram in Figure 19 below illustrates the unequal depths and widths that are encountered along the channel. The width of the channel at the top differs from that at the bottom at the three points at which the channel characteristics were measured. This likely indicates a variation in soil types. Vegetation cover may also influence the rate of erosion. Channel depth also varied between the west and east sides at each location. The differences in widths and depths ranged from 0.3 m (1 ft) to almost 1.2 m (4 ft).

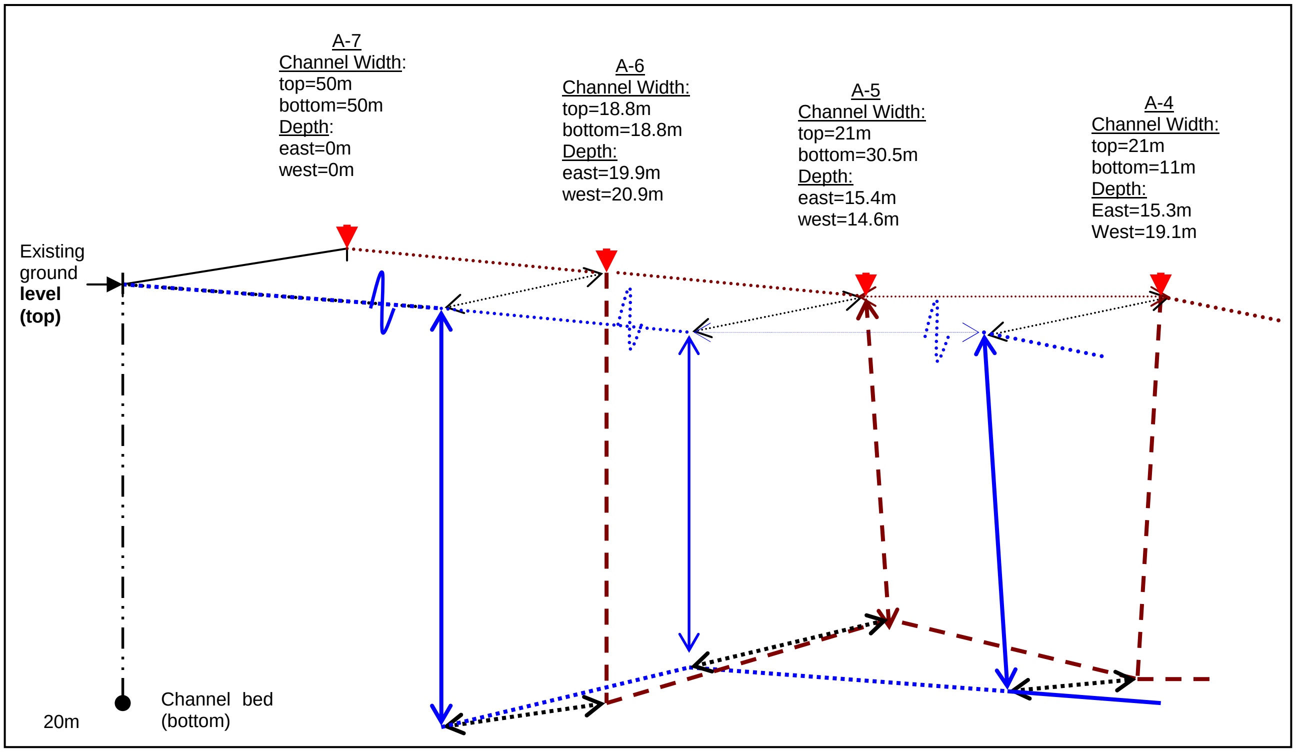


Figure 19. Dimensions of the arroyo measured at four points along it in Section 16.

Ground cover was measured at 25-m (82-ft) intervals on each side of the channel (Table 39 below) and in the channel bottom. There were no species either in the channel or along each side of it to indicate wetland characteristics. Vegetation was similar at each side of the channel. The heights and densities of shrubs and the heights of the grasses were greater in the channel bottom.

Table 39. Ground cover 25 m on either side of the channel at each transect line location.

TRANSECT #	PERCENT (%)						
	Total Vegetation cover	Bare ground	Shrub canopy	Forb canopy	Grass canopy	Moss and cryptogams	Litter
AR-4	34	24	0	8	26	0	42
AR-5	34	30	4	6	24	0	36
AR-6	30	20	20	2	8	0	50
Mean	33	25	8	5	19	0	43
Stddev	2	5	11	3	10	0	7

In the channel bottom, *Ericameria nauseosa* (rabbitbrush) and *Atriplex canescens* (fourwing salt bush) were common shrubs and *Pseudoroegneria spicata* (bluebunch wheatgrass), and other *Elymus* species were the most common grasses. *Atriplex canescens* was relatively dense in the drainage bottom at transect locations A-4 and A-5: 12 per 100 m^2 (1,076 ft^2) and 36 per 100 m^2 (1,076 ft^2), respectively.

The most abundant grass species on each side of the channel were *Bouteloua gracilis* and *Pleuraphis jamesii*. The only forbs observed were *Kochia scoparia* and *Salsola tragus*, both non-native species. There is approximately 25 percent bare soil on the ground either side of the channel (Table 39 above).

The channel, immediate sides and the surrounding area appears to be highly erodible. Although the depth of the soil beneath the channel bottom is unknown, it appears that substantial soil remains and bedrock has not yet been reached. The ground cover that exists would provide only slight erosion protection for moderate volumes of water. Since there is no vegetation on the steep slopes, significant downcutting and channel width expansion is likely to occur if moderate volumes of water travel down the channel.

1.4 FIELD DATA COLLECTION FORMS

The "Overview of Plant Community Form" (Table 26 on page 46) includes general vegetation composition, the dominant plant species, characteristic topography, soil types, average slope, aspect, and interspersion with, or relationship to, other community types. The "Transect Data Collection Form" (Table 27 on pages 46-47) captures data from the point-intercept method.

Plant community forms that were used for data collection are displayed in Table 40 on pages 64-65. Additionally, an example of the Transect Data Collection Form Using Point-intercept Method is provided as Table 41 on page 66.

Table 40. Overview of Plant Community Form.

Map Site #		UTM Northing		UTM Easting		Date	
Surveyor name(s)							
Community type:							
Erosion:							
Disturbance:							
Topography:							
Average slope(s):	%	%					
Soil types:							
Aspect:							
Interspersion with or relationship to other community types:							
General vegetation composition:							

Square Plot 1

To determine relative abundance (dominance):					
Plant species	**%**	**Plant species**	**%**	**Plant species**	**%**

Form 1 – Page 1 of 2

PERMITS WEST
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Table 40. Overview of Plant Community Form (Continued).

Map Site #	UTM Northing	UTM Easting	Date

Square Plot 2

To determine relative abundance (dominance):					
Plant species	%	Plant species	%	Plant species	%

Square Plot 3

To determine relative abundance (dominance):					
Plant species	%	Plant species	%	Plant species	%

Trees and Shrubs

Tree species	Number in 20-m × 50-m belt
Shrub, sub-shrub, succulent species	**Number in 1-m × 50-m belt**

Form 1 – Page 2 of 2

Table 41. Transect Data Collection Form Using Point-intercept Method.

Site #:		**Date:**		**Surveyors**	
Site location:					
Community:					
Notes:					
Transect orientation:					
Transect coordinates:	**Northing:**	**Easting:**		**Northing:**	**Easting:**

Cover/Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
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1.5 REFERENCES

American Forests 1996. The 1996-1997 National Register of Big Trees. Washington, DC: American Forests. The big tree register (2009.04.13) available online: http://www.americanforests.org/resources/bigtrees/.

Bates, RL and JA Jackson. 1984. Dictionary of Geological Terms. 3rd edition. Anchor Books - Doubleday, New York, New York, USA.

Benedict, JB. 2008. Experiments on Lichen Growth, III. The Shape of the Age-Size Curve. Arctic, Antarctic, and Alpine Research 40(1):15-26.

Bosch, M. 2007. Forest Service Sensitive Species Summary. Forest Service designated Sensitive Species and T and E species. USDA Forest Service, Watershed, Fish, Wildlife, Air, and Rare Plants Program, Washington D.C., USA. Documents available online at: http://www.fs.fed.us/biology/tes/index.html [accessed: February 19, 2009].

Breckenridge, R.P., W.G. Kepner, and D.A. Mouat. 1995. "A Process for Selecting Indicators for Monitoring Conditions of Rangeland Health," Environmental Monitoring and Assessment, 36: 45–60.

Clemants, S.E. and S.L. Mosyakin. 2003. Dyspania. Flora of North America 4: 261, 267, 268.

Coronado, MHE and RLC Romo. 2001. Producción de forraje y carne en pastizales resembrados con gramíneas introducidas (Forage production, Weeping lovegrass, Wilman lovegrass, Cattle weight gains) Técnica Pecuaria en México 39(2): 139-152.

deGruyter, B. 2005. Management indicator species, Cibola National Forest. Revised March 4, 2005. (3/12/2002 version prepared by L.D. Cosper). Internal report, USDA Forest Service, Cibola National Forest and Grasslands.

Dick-Peddie, WA. 1993. Ecology and Diversity if Pinon-Juniper Woodland in New Mexico. In: Managing Pinion-Juniper Ecosystems for Sustainability and Social Needs; proceedings of the symposium 1993 April 26-30; Santa Fe, New Mexico. Gen. Tech. Rep. RM-236. Aldon, Earl F.; Shaw, Douglas W., technical coordinators. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.. 169 p.

DuBois, FA. 1999. Memorandum - New Mexico Noxious Weed List available online at: http://www.nmda.nmsu.edu/animal-and-plant-protection/noxious-weeds/noxious20weed_memo_list.pdf [accessed February 23, 2009] in Noxious Weed Information for New Mexico available online at: http://www.nmda.nmsu.edu/animal-and-plant-protection/noxious-weeds [accessed February 23, 2009].

Elzinga, C, D Salzer, J Willoughby, and J Gibbs, 2001. Monitoring Plant and Animal Populations, Blackwell Scientific Publishing, Boston, Massachusetts.

Floyd, DA, and JE Anderson. 1987. "A Comparison of Three Methods for Estimating Plant Cover," The Journal of Ecology, 751 (1): 221–228.

Gonzalez, I. Miley. 2009. Memorandum to General Public, subject: New Mexico Noxious Weed List Update. Available online: http://www.emnrd.state.nm.us/FD/documents/weedlist2009_final.pdf ; New Mexico Noxious Weed List. Update April 2009 Available online: http://www.emnrd.state.nm.us/FD/documents/weedlist2009_final.pdf.

Hunt, Jr., ER, JH Everitt, JC Ritchie, MS Moran, DT Booth, GL Anderson, P. Clark, and MS Seyfried. 2003. “Applications and Research Using Remote Sensing for Rangeland Management,” Photogrammetric Engineering & Remote Sensing, 69(6): 675–693.

Hughes, D. 1996. Restoring native riparian vegetation. In: Desired Future Conditions for Southwestern Riparian Ecosystems: Bringing interests and concerns together. General Technical Report RMGTR- 272. U.S. Department of Agriculture, Forest Service, Fort Collins, CO.

ITIS. 2009. Chenopodium graveolens Willd. Taxonomic Serial No.: 20611 Available on line at: http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=20611 [accessed: February 19, 2009].

Knapp R. 1984. Handbook of vegetation Science Vol 4. Sampling methods and taxon analysis in vegetation science: relevé surveys, floristic analysis of plant communities. Publisher Dr W Junk Publishers, The Hague, The Netherlands.

Korb, JE, WW Covington, and PZ Fulé, 2003. “Sampling Techniques Influence Understory Plant Trajectories After Restoration: An Example from Ponderosa Pine Restoration,” Restoration Ecology, 11(4): 504–515.

Ladyman, JAR, Muldavin, E. and R. Fletcher. 1993. Pattern and Relationships of Terrestrial Cryptogam Cover in Two Pinon-Juniper Communities in New Mexico. In: Managing Pifion-Juniper Ecosystems for Sustainability and Social Needs; proceedings of the symposium 1993 April 26-30; Santa Fe, New Mexico. Gen. Tech. Rep. RM-236. Aldon, Earl F. ; Shaw, Douglas W ., technical coordinators. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.. 169 p.

Matthews, RF. 1993. Marchantia polymorpha. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). In: Fire Effects Information System, available online: http://www.fs.fed.us/database/feis/ [accessed: February 27 2009].

Milchunas, DG, JR Forwood and WK Lauenroth. 1994. Productivity of long-term grazing treatments in response to seasonal precipitation. J. Range Management 47: 133-139.

Mining Act Reclamation Bureau 1996. CLOSEOUT PLAN GUIDELINES FOR EXISTING MINES. April 30, 1996. Mining and Minerals Division, New Mexico Energy, Minerals and Natural Resources Department, 2040 S. Pacheco St., Santa Fe, New Mexico Available online at: http://www.emnrd.state.nm.us/MMD/MARP/Documents/MARP_Closeout_Plan_Guidelines_Main_Text.pdf.

Neill, W.M. 1990. Control of Tamarisk by cut-stump herbicide treatment. In: Tamarisk control in Southwestern United States. Special Report 9. Cooperative National Park Resources Studies Unit. p. 91-98.

National Research Council 1994. Rangeland Health: New Methods to Classify, Inventory, and Monitor Rangelands. National Research Council Board on Agriculture Committee on Rangeland Classification. National Academy Press, Washington DC. Available online: http://www.nap.edu/openbook.php?record_id=2212&page=R1.

Pellant, M., Shaver, P., Pyke, D.A., Herrick, J.E., 2005, Interpreting Indicators of Rangeland Health-Version 4: Bureau of Land Management, National Science and Technology Center Technical Reference 1734-6, pp. 122.

Pyke DA, Herrick JE, Shaver P and Pellant M 2002. Rangeland health attributes and indicators for qualitative assessment. Journal of Range Management 55 (6): 584-597.

Shultz, LM. 2006. Artemisia L. Pages 503-534 in Flora of North America, Editorial Committee (editors), Flora of North America, North of Mexico, Volume 19, Magnoliophyta: Asteridae, part 6: Asteraceae, part 1. Oxford University Press, New York, New York.

USDA Forest Service. 1991. FSH 2090.11 - WO Amendment 2090.11-91-1; Effective 4/26/91.

USDA, NRCS. 2010. The PLANTS Database (http://plants.usda.gov, 18 October 2010). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

U.S. Fish and Wildlife Service. 1993. Supplement to list of plant species that occur in wetlands. Supplement to U.S. Fish & Wildlife Service Biological Report 88 (26.9).

Wanstall, J. 2008. Memorandum: State Noxious Weed List Updating Procedure. Available on line at: http://www.nmda.nmsu.edu/animal-and-plant-protection/noxious-weeds/State%20Noxious%20Weed%20List%20Update.html [accessed February 23, 2009].

Wilsey BJ and HW Polley. 2006. Aboveground productivity and root–shoot allocation between native and introduced grass species. Oecologia (2006) 150:300–309.

Wood, B. 2006a. Strathmore Minerals Corp., Roca Honda Sections 9 & 10, Botanical Report, December 26, 2006.

———. 2006b. Strathmore Minerals Corp., Roca Honda State Section 16, Botanical Report, October 7, 2006.

Zlatnik, E. 1999. "*Bouteloua hirsuta*" In: Fire Effects Information System, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer), available online at http://www.fs.fed.us/database/feis/ [accessed February 7, 2008].

ATTACHMENT:

POTENTIAL VEGETATION REFERENCE AREAS AT ROCA HONDA PROJECT SITE

INTRODUCTION

Transect lines were surveyed for canopy cover throughout the site. These lines were located in support of preparing a vegetation map before it was known which areas within the project site were going to be disturbed by mining activity. The lines were placed in the various vegetation types encountered within the project area.

Two of the vegetation types, Juniper savanna and shrub grassland, intergraded and were similar with respect to total cover characteristics: (i) total vegetation cover (grass, forb, shrub and microbiotic cover; tree canopy excluded), (ii) the sum of bare ground, gravel and rock cover, and (iii) litter cover. Revegetation efforts will focus on restoring a generalized matrix of native grasses, forbs and shrubs on the landscape rather than specifically attempting to recreate both the juniper savanna and shrub-grassland now present. Therefore combining these two vegetation types is appropriate since tree canopy cover and specific species composition are the main factors that separate the types.

A total of 35 transects in these two vegetation types were distributed across Sections 16, 9, 10 and 11. Fifteen (15) transect lines are in areas where no mining disturbance is planned. The remaining 20 transect lines will most likely be disturbed by mining activity.

Reference areas may be established to include those transect lines that will be undisturbed by mining activity.

ANALYSIS OF DATA THAT SUPPORTS THE USE OF VEGETATION REFERENCE SITES WITHIN THE PROJECT AREA

Ground cover

Total vegetation canopy and microbiotic cover, total bare ground plus gravel plus rock, and litter cover were compared between the transect lines in areas anticipated to be disturbed by mining and those that are scheduled to be undisturbed. Table A1 below shows summary statistics for the two samples of total vegetation cover, inorganic ground cover and litter cover.

Table A1. Summary Statistics for total vegetation (vascular plant canopy and microbiotic) cover, total inorganic (bare ground, gravels and rock) cover and litter.

Table A1. Summary statistics for total vegetation		
Value	**Will not be disturbed**	**Within or near the disturbance zones**
Number of transect lines	15	20
Average total vegetation cover	43.3	44.6
Variance - total vegetation cover	186.1	188.7
Stnd deviation - total vegetation cover	13.6	13.7
Minimum - total vegetation cover	16.0	22.0
Maximum - total vegetation cover	62.0	74.0
Stnd. Skewness - total vegetation cover	-0.84	0.89
Stnd. Kurtosis - total vegetation cover	-0.48	-0.28
Median - total vegetation cover	46	43

Table A1. Summary statistics for total vegetation		
Value	**Will not be disturbed**	**Within or near the disturbance zones**
Average – total inorganic cover	27.2	24.7
Variance – total inorganic cover	104.5	118.4
Stnd deviation – total inorganic cover	10.2	10.9
Minimum – total inorganic cover	8.0	2.0
Maximum – total inorganic cover	44.0	46.0
Stnd. Skewness – total inorganic cover	-0.420	-0.228
Stnd. Kurtosis – total inorganic cover	-0.409	-0.101
Median - total inorganic cover	28	25
Average - litter cover	29.5	30.7
Variance - litter cover	129.981	107.484
Stnd deviation - litter cover	11.5	10.4
Minimum - litter cover	8.0	8.0
Maximum - litter cover	52.0	46.0
Stnd. Skewness - litter cover	0.101	-0.535
Stnd. Kurtosis - litter cover	-0.142	-0.514
Median - litter cover	30	32

Standardized skewness and standardized kurtosis can be used to determine whether the samples come from normal distributions. Values of these statistics outside the range of -2 to +2 indicate significant departures from normality, which would tend to invalidate the statistical tests that compare the standard deviations. In this case, both standardized skewness values and both standardized kurtosis values for all samples are within the range expected if the samples came from a normal distribution. Therefore, confidence levels can be constructed for each sample mean and the T-test can be used to compare sample means between the cover values.

Confidence intervals were constructed for each mean and the difference between the means. A T-test was also run to determine the likelihood that the means of both samples were not statistically different from each other. No differences between the standard deviations of the two samples were detected so that all tests can assume equal variances.

The confidence interval for the difference between the means of total vegetation cover extends from -10.7843 to 8.25095. Since the interval contains the value 0.0, there is not a statistically significant difference between the means of the two samples at the 95.0% confidence level. The T-tests also support this conclusion; t = -0.270763 and P-value = 0.7883. P values below 0.05 would have indicated significant differences between the two means. An F-test was used to compare the variances of the two samples and indicated that there is not a statistically significant difference between the standard deviations of the two samples at the 95.0% confidence level. Median values for each population were also compared using the Mann-Whitney (Wilcoxon) W test. This test is constructed by combining the two samples, sorting the data from smallest to largest, and comparing the average ranks of the two samples in the combined data. There is not a statistically significant difference between the medians at the 95.0% confidence level.

The confidence interval for the difference between the means of inorganic cover (bare ground, gravels and rock) extends from -4.87085 to 9.87085 (Table A2 below). Since the interval contains the value 0.0, there is not a statistically significant difference between the means of the two samples at the 95.0% confidence level. The T-tests (T = 0.690056; P-value = 0.494984) also arrived at the same conclusion. P-values below 0.05 indicate significant differences between the two means. An F-test was used to compare the variances of the two samples and indicated that there is not a statistically significant difference between the standard deviations of the two samples at the 95.0% confidence level. Median values for each population were also compared using the Mann-Whitney (Wilcoxon) W test. There was no statistically significant between the median values of the two samples (Table A1 on pages 71-72) at the 95.0% confidence level.

Table A2. Confidence intervals for each mean and the difference between the means.

Value	95.0% confidence interval
for mean of total vegetation cover along undisturbed Transects	43.3 +/- 7.6
for mean of total vegetation cover along potentially disturbed transects	44.6 +/- 6.4
for the difference between the means of total vegetation cover assuming equal variances	-1.27 +/- 9.52
for mean of inorganic cover along potentially undisturbed lines	27.2 +/- 5.7
for mean of inorganic cover along potentially disturbed lines	24.7 +/- 5.1
for the difference between the means of inorganic cover samples with equal variances	2.5 +/- 7.4
for mean of litter cover along potentially undisturbed lines	29.5 +/- 6.3
for mean of litter cover along potentially disturbed lines	30.7 +/- 4.9
for the difference between the means of litter cover samples with equal variances	-1.23 +/- 7.52

The confidence interval for the difference between the means of litter cover extends from -8.75096 to 6.28429. Since the interval contains the value 0.0, there is not a statistically significant difference between the means of the two samples at the 95.0% confidence level. The T-tests also arrived at the same conclusion; T = -0.333781, P-value = 0.740657. P-values below 0.05 indicate significant differences between the two means. An F-test to compare the variances of the two samples was run and the results were consistent with the confidence intervals constructed for each standard deviation and for the ratio of the variances, which indicated that there is not a statistically significant difference between the standard deviations of the two samples at the 95.0% confidence level. Median values for each population were also compared using the Mann-Whitney (Wilcoxon) W test. There was no statistically significant difference between the median values of the two samples (Table A1 on pages 71-72) at the 95.0% confidence level.

Adequate sampling entails making sufficient measurements of a given parameter in order to obtain a mean value that is within 10 percent of the populations' true mean value with a 90 percent statistical confidence level.

$$nmin = \frac{T^2S^2}{(dx)^2} \quad \text{(Equation 1:2:1)}$$

Where:

nmin = the minimum number of sample points needed in a given vegetation type

S= the sample deviation

t = the two-tailed t statistic at the appropriate number of degrees of freedom

d = the acceptable amount of inherent variability to be identified between the sample mean and the true population mean = 0.1

x = the sample mean

Using Equation 1 and the results from all 35 transect lines, the minimum number (*nmin*) of transect lines required to obtain a mean value that is within 10 percent of the populations' true mean value with a 90 percent statistical confidence level for total vegetation cover is 27, for litter *nmin* is 36 and for total inorganic cover (bare ground, gravel and rock) *nmin* is 48. The higher numbers required for litter and inorganic ground cover reflect the higher variability and the fact that some values fell outside the 30 to 70% threshold that is cited to indicate that data transformation is necessary (Hofmann and Ries 1990, Li 1964, Steel and Torrie 1980, Snedecor 1956). When the data was transformed by taking the square root of the value plus one, *nmin* was recalculated to be 14 for inorganic cover and 10 for litter cover.

Conclusion

Statistically valid designated reference sites can be established within the project area for the life of the project and for use during the reclamation period. Two areas, the first consisting of 137 acres encompassing 7 transects in Section 16, and the second consisting of 80 acres encompassing 8 transects in Section 11 have been identified as potential vegetation references areas.