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CHAPTER 9

VEGETATION RESOURCES

Introduction

Peabody Coal Company's (PCC) Arizona Division operates two surface coal mines on the Black Mesa, Navajo County, Arizona. The Black Mesa and Kayenta mines are located on contiguous leases totaling approximately 64,858 acres of Navajo and Hopi Indian Reservation land with an additional grant of easement right of way of 361 acres on Navajo land.

Peabody began an ongoing vegetation monitoring program in 1979. The program was designed in consultation with the Office of Surface Mining (OSM); the Navajo Tribe; and Espey, Huston and Associates, Inc. (EH&A). The major objectives of the program were to develop baseline vegetation information and to evaluate the progress and success of revegetation.

The initial baseline studies, completed in the fall of 1980, were conducted in the western and northeastern portions of the leasehold and included a two mile buffer area beyond the lease boundary (Figure 1). Quantitative and qualitative vegetation sampling and floristic surveys were conducted by EH&A during October, 1979, and May, July and September, 1980. Thirteen stands of vegetation were quantitatively sampled including: (1) three stands of pinyon-juniper woodland in coal resource areas (the N-7/8, N-10 and N-14 mining areas); (2) two stands of pinyon-juniper woodland on reference areas (vicinity of the N-7/8 and N-14 mining areas); (3) three stands of sagebrush shrubland on coal resource areas (the J-7, J-1/N-6 and N-14 mining areas); (4) four stands of sagebrush shrubland on reference areas (vicinity of the J-7, J-1/N-6, N-7/8 and N-14 mining areas; and (5) one stand of greasewood shrubland along the terrace at Moenkopi Wash. In addition, riparian strand, disturbed areas, aquatic vegetation and plant communities occurring adjacent to the leasehold were described in qualitative terms. The results of these studies were presented in a permit application package submitted to regulatory authorities in January of 1981 (Volume 2, Appendix 4, 1981-1985 Mining Plan).

Vegetation baseline studies were continued in 1981 by Peabody biologists (Figure 1). Additional baseline data was collected in the J-7, J-1/N-6, N-7/8, N-10 and N-14 mining areas previously sampled by EH&A. Baseline studies were started in the J-16 and J-28 mining areas. Ongoing monitoring was continued in the two pinyon-juniper woodland

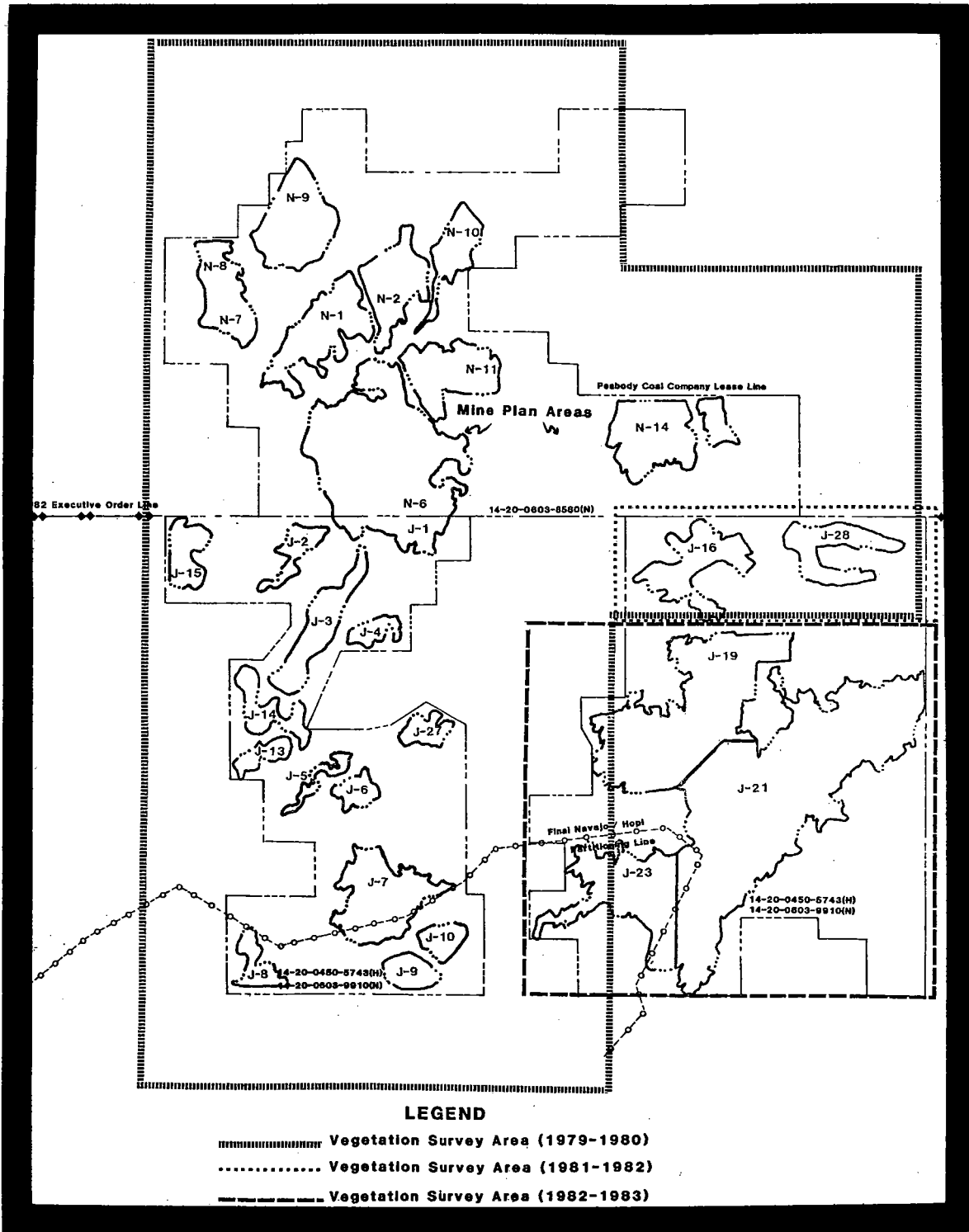


FIGURE 1

Black Mesa Leasehold and Vegetation Survey Areas

and four sagebrush shrubland reference areas. The first comprehensive studies of the reclaimed vegetation were conducted in selected portions of the J-3, J-7, J-27, J-1/N-6, N-1 and N-2 mining areas. The results of these studies were reported to regulatory authorities in the first annual vegetation and wildlife resources report (Arizona Division, Peabody Coal Company, 1982).

Vegetation baseline studies were completed in the J-16 and J-28 mining areas in the spring of 1982. In the fall of 1982, baseline studies were initiated in the then unpermitted southeastern portion of the leasehold referred to as the Mine Plan Modification Area. This area included the contiguous J-19 through J-23 mining areas (Figure 1). Ongoing monitoring was continued in the reference areas and selected reclaimed portions of the J-7, J-27, J-1/N-6, N-1 and N-2 mining areas. With the exception of the data collected in the Mine Plan Modification Area, the results of these studies were reported in the Vegetation Resources 1982 Report (Arizona Division, Peabody Coal Company, 1983).

Vegetation baseline studies in the J-19 through J-23 coal resource areas were completed during the spring of 1983. The results of these and the 1982 studies were submitted as part of a mine plan modification filed with regulatory authorities in July, 1983. A major ramification of that submittal was that sufficient baseline studies were completed to adequately characterize the pre-mining vegetation on the Black Mesa leasehold.

Six reference areas were established in 1979 and 1980 for use as revegetation success standards. Two were located in the pinyon-juniper woodland adjacent to the N-7/8 and N-14 coal resource areas. Four were located in the sagebrush shrubland adjacent to the N-7/8, N-14, J-1/N-6 and J-7 coal resource areas. The reference area at the N-7/8 area included both community types. The size of the reference areas were as follows: N-7/8 (140.8 acres), N-14 pinyon-juniper (230.2 acres), N-14 sagebrush (31.7 acres), J-1/N-6 (45.4 acres) and J-7 (91.1 acres). Within each reference areas, 0.1 acre exclosures were established to monitor livestock grazing effects.

The 0.1 acre exclosures were expanded in 1982 such that each exceeded two acres in size. These expanded exclosures became the permanent reference areas and sampling was discontinued in the larger unfenced areas. This measure was taken in response to Special Stipulation #26 attached to Permit AZ-0001. At the same time, the J-1/N-6 reference area was redesignated as a back-up area and sampling was discontinued. Sampling in the two

pinyon-juniper reference areas was discontinued following the end of the 1982 field season. This measure was taken based upon negotiations with regulatory authorities regarding the suitability of the woodland as a standard for revegetation success. The net result was that revegetation success standards would be based upon the three remaining sagebrush shrubland reference areas. Each would represent the premining vegetation in a specific region of the leasehold unless further studies identified new plant communities.

Ongoing monitoring of the vegetation in the reference areas and selected reclaimed units was continued in 1983 and 1984. The results of these studies were reported in the respective annual resources reports (Arizona Division, Peabody Coal Company, 1984 and 1985). Since 1984, annual spring and fall monitoring of reclaimed areas and periodic spring and fall monitoring of reference areas has been conducted at the Black Mesa and Kayenta Mines. The results of these monitoring and sampling efforts are included in annual reports submitted to the regulatory authority.

The objective of this chapter is to provide vegetation maps, detailed descriptions of the plant communities, and all available data to better characterize and define the spatial and temporal variability of the vegetation resources within and surrounding the Black Mesa leasehold. This necessitates consolidation of vegetation information that has been collected since 1979. The information has been variously reported to regulatory authorities in mining permit applications and annual reports designed to review the results of annual monitoring activities. Detailed vegetation survey summary reports are included as Attachment 1 to this chapter. Vegetation data summaries that were presented in annual vegetation reports submitted to regulatory authorities are not presented in detail in this chapter but may be referenced. Additionally, vegetation studies were conducted in the J-23 transportation corridors and the J-9 Coal Resource Area in 1999/2000 and the remaining Black Mesa leasehold life of mine coal resource areas (LOMCRA) in 2003. These latter studies can be found in Attachments 4, 5, and 6 respectively.

The following sections present: (1) a general description of the study area and review of relevant literature; (2) a description of the vegetation sampling methods; and (3) results and discussion of the vegetation studies. Appropriate sections and attachments address the significance of the pre-disturbance vegetation, important plant species, impact analysis, recommendations for feasible mitigation and enhancement and continuing monitoring activities.

TABLE 18

Seasonal Livestock Carrying Capacity Figures for the
Plant Communities Occurring on the Leasehold¹

<u>Vegetation Community</u>	<u>Season</u>	<u>Livestock Carrying Capacity (ac./AUM)²</u>
Pinyon-Juniper Woodland	Spring	119.0 ± 95.2 (Confidence Limit: t0.05(2), 4 = 2.776)
	Fall	189.2 ± 229.4 (as above)
Sagebrush Shrubland	Spring	10.5 ± 1.7 (Confidence Limit: t0.05(2), 8 = 2.306)
	Fall	13.0 ± 7.7 (as above)
Greasewood Shrubland	Spring	9.6 (n = 1)
Saltbush Shrubland	Spring	5.7 (n = 3; s = 2.01)
	Fall	2.5 (n = 2)
Reclaimed Land ³	Spring	4.2
	Fall	4.2

¹ Total usable forage is derived from Proper Use Factors for sheep (Attachment 2).

² Livestock carrying capacity is expressed as acres required to support one animal unit for one month (Attachment 2).

³ Based on averaged historic reclaimed area monitoring data.

Impact Analysis

The scope of this analysis is limited to direct and indirect impacts on the biotic components of vegetation and wildlife. The approximate remaining acreages of each vegetation community to be disturbed by mining activities on the Black Mesa leasehold are shown in Table 19.

Approximately 21,954 acres will be disturbed or redisturbed during the remaining life of mining activities on the leasehold. The breakdown by native vegetation community type is 14,171 acres of pinyon-juniper woodland, 5848 acres of sagebrush shrubland and 142 acres of saltbush shrubland, 28 acres of greasewood shrubland, and 3 acres of tamarix riparian strand. An additional 1762 acres of land disturbed prior to 2003 will be redisturbed, including an estimated 645 acres of reclaimed land in the J-1, J-3, N-2, N-6, N-10, and N-11 areas.

The loss of wildlife habitat may have varied impacts on wildlife populations. The impacts may be direct or indirect. Removal of the vegetation will result in the direct loss of food, cover and breeding habitat. Noise and related impacts associated with concentrated industrial activities will disturb sensitive wildlife in surrounding areas. Disturbance of the land surface and subsurface creates the potential for impacting surface and ground water quality and quantity, and may affect natural physical shelters.

Mobile wildlife species will not be as severely influenced by the disturbance as less mobile small mammals, strongly territorial birds, reptiles and amphibians. The restricted species can be expected to be extirpated in the disturbance area. The larger and more mobile species will be displaced into surrounding areas, temporarily creating increased competition for the available resources. If the surrounding areas are at or near carrying capacity, populations will be stressed until a new equilibrium is reached. Displaced species which have the capacity to exploit the habitat created by reclamation activities will repopulate developing reclaimed areas, particularly those species adapted to grass/shrubland habitats.

Overall, the fauna in the lease area must be described as relatively sparse; apparently attributable to habitat availability, quality, and condition. The areas that will be disturbed exhibit less value to wildlife in their present state than what would be expected under more pristine conditions. There are extensive tracts of the plant communities throughout the southwestern United States, and since few, if any, vertebrates are wholly dependent upon them, the impact or manipulation of a small percentage can be viewed as negligible. No unique habitats or habitats of high quality will be disturbed.

Table 19

Estimated Life of Mine Disturbance Acreages for Native Vegetation Communities and Other Types in Life Of Mine Coal Resource Areas (LOMCRA) and Reclamation Status of Active Pit Coal Resource Areas as of 11/01/03.

LOMCRA/ Pit Area	Years	Affected Vegetation Communities or Type ¹										Reclamation Status ²					
		PJ	SB	SA	GR	TA	REV	DIS	Total	FGR	TSD	REV	FAC/DIS				
J2/J15	LOM ³	961	519				39	113				1632					
J4	LOM ³	228	223				9	64				524					
J5-6/J13/J14	LOM ³	394	1618		19	3	39	88				2161					
J7	2000-2005		21									21	65	38	688		567
J8	LOM ³	144	583					6				733					
J9	LOM ³	108	362					3				473					
J10	LOM ³	306	126									432					
J16	Mining Complete - Final Reclamation												25	11	1221		227
J19/J19 West	2000-2005	1874	434	20				121				2449	240	148	784		978
	2006-2010	70	124	3				9				206					
	Beyond 2010	16	1									17					
J21	2000-2005	685	225	35				33				978	185	172	2087		1002
	Beyond 2005	455	125	4								584					
J23 ⁴	2006-2010	1529	237					14	1			1781					
	Beyond 2010	1603	444	6								2053					

Table 19 (Cont.)

Estimated Life of Mine Disturbance Acreages for Native Vegetation Communities and Other Types in Life Of Mine Coal Resource Areas (LOMCRA) and Reclamation Status of Active Pit Coal Resource Areas as of 11/01/03.

LOMCRA/ Pit Area	Years	Affected Vegetation Communities or Type ¹								Reclamation Status ²						
		PJ	SB	SA	GR	TA	REV	DIS	Total	FGR	TSD	REV	FAC/DIS			
J28	LOM ³	983	435	6	9			5	1438							
N6	2000-2005	64	67						131	198	141	1470	1389			
N9	2006-2010	1240	118	67				40	1467							
	Beyond 2010	687			1				699							
N11	2000-2005	173	29						202	195	50	139	658			
N99 North	2000-2005	4						4	143							
	2006-2010	44	1					10	55							
	Beyond 2010	957	36					32	1040							
N12/N99 South	2000-2005	1135	37					312	324	1808						
	2006-2010	511	72					156	188	927						
N14	Mining Complete - Final Reclamation												28	1	1490	498
Total Affected		14,171	5848	142	28	3	645	1117	21,954							

¹ Estimated maximum disturbance acreages for vegetation communities for LOMCRA or remaining maximum disturbance acreages in the active mining areas J7, J19, J21, N6, or N11. PJ = pinyon-juniper; SB = sagebrush shrubland; SA = saltbush shrubland; GR = greasewood shrubland;

Table 19 (Cont.)

Estimated Life of Mine Disturbance Acreages for Native Vegetation Communities and Other Types in Life Of Mine Coal Resource Areas (LOMCRA) and Reclamation Status of Active Pit Coal Resource Areas as of 11/01/03.

TA = Tamarix riparian strand; REV = revegetated areas which may be reaffected by LOMCRA activities; DIS = roads, facilities, or other currently affected lands which may be reaffected by LOMCRA activities.

2 Reclamation status for active mining areas and former mining areas in final reclamation as of 11/01/03.

3 LOM = Life of Mine for coal resource area (beyond 2010 for LOMCRA).

4 Includes J23 haul road corridors.

The entire additional life-of-mine vegetation disturbance will result in the temporary loss of approximately 20,837 acres of native and reclaimed rangeland. On the basis of the carrying capacity figures presented in the previous section, the remaining vegetation disturbance will result in the potential loss of approximately 609 animal unit months (AUMs) of grazing. Revegetation and release of successfully reclaimed lands will compensate for the acreage loss during the life-of-mine. As of 11/01/03, 13,063 pre- and postlaw acres have been reclaimed at the Black Mesa and Kayenta Mines. Based on an average reclaimed land stocking rate of 4.2 ac/AUM, there are approximately 3,110 AUMs of grazing available in a normal precipitation year.

The list of plant species resulting from comprehensive floristic surveys conducted on and adjacent to the Black Mesa leasehold is presented in Table 1. The list includes 278 species. The importance of some of these species as cultural resources of the Navajo and Hopi (medicines, food, building materials, tools, ceremonial items, etc.) has been previously discussed. Culturally significant plants are identified in plant lists that can be found in Attachment 3. Ninety-nine species, genera, or families are listed in the ethnobotanical information compiled by the Navajo Health Authority (79 listed species or genera plus an additional 20 species, genera, or families referenced in the narrative). A supplemental list, prepared by Peabody (Attachment 3), lists 19 additional species or genera that are known to have or are suspected to have ethnobotanical significance. See also Chapter 23 and Appendix B to Chapter 23 for additional discussion regarding culturally significant plants.

Appendix 3 contains 118 species, genera, or families of vascular plants that are of ethnobotanical importance. Several of these species, genera, and families need not be considered in an impact analysis for reasons given in the following paragraphs. The result is a total of 77 species or genera, or approximately 28 percent of the plants found in the floristic surveys which could potentially be impacted by surface mining activities.

It is extremely unlikely that several of the species or genera contained in Attachment 3 will be impacted by surface mining activities on the basis that their regional distribution does not encompass the disturbance areas or they were not present in the comprehensive floristic surveys. These species or genera may include:

Mirabilis oxybaphoides

Gaura coccinea

Chenopodium album

Melilotus indica

Tribulus terrestris

Senecio multicapitatus

Salix laevigata (S. bonplandiana)

Eriogonum rotundifolium

Echinocereus spp.

Lupinus kingii

Mammillaria spp.

Several genera or species contained in Attachment 3 are not of concern in the analysis of impacts because no ethnobotanical uses are indicated or listed, or they are only mentioned in the narrative in disparaging terms. They are:

<u>Symphoricarpus</u> spp.	<u>Tamarix pentandra</u>
<u>Salsola kali</u> (= <u>S. iberica</u>)	<u>Opuntia phaeacantha</u>
<u>Atriplex nuttallii</u>	<u>Echinocereus triglochidiates</u>
<u>Calochortus nuttallii</u>	<u>Sitanion hystrix</u>
<u>Oxytropis</u> spp.	<u>Agropyron smithii</u>

Two species contained in Attachment 3 are not of concern in the analysis of impacts because the scientific names cannot be traced to any known synonyms in the Taxonomy of Arizona (Kearney and Peebles 1960; Lehr 1978). These species are Silene douglasii and Artemisia trifida.

Several species which occur on the leasehold are not of concern although the genera or one family to which they belong are listed as significant in Attachment 3. This assessment is based on notations in the literature which mention ethnobotanical uses of certain species in the genera or family, but do not include the species found on the leasehold (Kearney and Peebles 1960). These include (species represented on the leasehold are in parenthesis):

Labiatae (Hedeoma drummondii; Moldavica parviflora)
Asclepias spp. (A. asperula)
Crypthantha spp. (C. bakeri; C. flavus)
Panicum spp. (P. capillare)

It is highly unlikely that several of the species or genera contained in Attachment 3 will be impacted by surface mining activities because they are associated primarily or exclusively with plant communities that will not be disturbed. These plants include (plant communities in which they occur are in parenthesis and correspond to the community codes in Table 1):

<u>Berberis repens</u> (MC)	<u>Quercus gambelii</u> (MC)
<u>Pinus ponderosa</u> (MC)	<u>Ribes cereum</u> (MC)
<u>Pseudotsuga taxifolia</u> (= <u>P. menziesii</u> ; MC)	<u>Typha</u> spp. (A)
<u>Purshia tridentata</u> (MC)	<u>Scirpus acutus</u> (A)
<u>Populus tremuloides</u> (MC)	<u>Prunus demissa</u> (= <u>P. virginiana</u> ; DL)
<u>Populus fremontii</u> (TA)	<u>Zea mays</u> (cultivated)

The impact of surface mining on the majority of the remaining 77 species or genera of concern can be viewed as negligible. The rationale for this assessment is that these species and genera are

of such common local and/or regional occurrence that the disturbance of the specified acreages on which they occur will not substantially affect the supply (see the Vegetation Survey Summary Reports referenced or included herein). In some cases, the abundance of a species lost to the mining disturbance is offset by its inclusion in the seed mixes and/or plantings used for revegetation purposes (see Chapter 23), its use in revegetation trials with provisions for inclusion in the revegetation plan if successful, or its noted ability to invade the reclaimed lands. These species and genera include (asterisked species have or are being used in the revegetation seed mixes and/or plantings):

<u>Chrysothamnus</u> spp.*	<u>Opuntia</u> spp.
<u>C. nauseosus</u> *	<u>O. whipplei</u>
<u>Aster leuceline</u> (= <u>Leuceline ericoides</u>)	<u>Lappula redowski</u>
<u>Artemisia tridentata</u> *	<u>Amaranthus</u> spp.
<u>Senecio</u> spp.	<u>Pinus edulis</u> *
<u>S. longilobus</u> (= <u>S. douglasii</u> var. <u>longilobus</u>)	<u>Plantago purshii</u>
<u>Gutierrezia sarothrae</u>	<u>Gilia</u> (= <u>Ipomopsis</u>) <u>aggregata</u>
<u>Sarcobatus vermiculatus</u>	<u>Sporobolus cryptandrus</u> *
<u>Chenopodium</u> spp.	<u>S. airoides</u> *
<u>Atriplex confertifolia</u> *	<u>Oryzopsis hymenoides</u> *
<u>A. canescens</u> *	<u>Munroa squarrosa</u>
<u>Medicago falcata</u> *	<u>Hilaria jamesii</u> *
<u>Eriogonum</u> spp.*	<u>Bromus tectorum</u>
<u>Cowania mexicana</u> *	<u>Bouteloua gracilis</u> *
<u>Penstemon barbatus</u> *	<u>Stipa comata</u> *
<u>Lycium pallidum</u> *	<u>Juniperus</u> spp.*
<u>Cleome serrulata</u> *	<u>Lesquerella intermedia</u> *
<u>Sphaeralcea coccinea</u> *	<u>Phoradendron</u> spp.
<u>Allium deserticola</u> (= <u>A. macropetalum</u>)	<u>Cymopterus glomerata</u> (= <u>C. purpureus</u>)
<u>Penstemon eatoni</u> *	<u>Rhus trilobata</u> *
<u>Yucca</u> spp.	<u>Lupinus</u> spp.
<u>Y. angustissima</u> *	<u>Descurainia</u> spp.
<u>Y. baccata</u> *	<u>Ephedra viridis</u> *
<u>Hymenoxys acaulis</u> *	<u>Oxytropis lambertii</u>
<u>Suaeda torreyana</u>	<u>Quercus gambelii</u> *
<u>Thelesperma</u> spp.*	

The impact of surface mining activities on the remaining 28 species or genera of ethnobotanical

concern is somewhat difficult to assess. Impacts could range from slight to substantial depending upon: 1) the local supply and demand for a given species; 2) the proximity of substantial populations of a given species surrounding the leasehold that could not be quantified due to the scope of the vegetation baseline studies; 3) the willingness of residents to travel to obtain materials; 4) the emphasis placed on ethnobotanical plant materials in view of cultural changes occurring on the reservation; 5) substitution of functionally similar species when one is in short supply; and 6) the success of mitigation measures developed for the resource. A discussion of mitigation for the loss of these cultural resources is included in the following section.

Mitigation, Enhancement and Monitoring

Direct and indirect measures for protecting vegetation and wildlife values with regard to the impact mechanisms discussed in the previous section are incorporated into all pertinent aspects of the permit application package. These measures include procedures for identifying, reducing and/or preventing air and surface or groundwater contamination, vegetation and soil loss, solid waste contamination, range and coal fires and noise. These activities are the best currently available practices for protecting wildlife and vegetation values.

Peabody Western Coal Company has stressed the importance of an effective revegetation plan to minimize the impact to wildlife from the land surface disturbances. The revegetation plan is outlined in Chapter 23. The plan is designed to optimize revegetation for the postmining land uses of livestock grazing and wildlife habitat (refer to Chapter 14 for a complete discussion of Land Use). Proposed habitat protection and enhancement procedures which are designed to mitigate unavoidable disturbances are also incorporated into the plan.

In order to better understand the effects of surface mining on the biota within the lease boundary and to evaluate the effectiveness of enhancement procedures, the Arizona Division has instituted an annual biologic monitoring program. Biological data is collected on an annual basis and presented to the regulatory authority during the second quarter following the completion of the annual studies. The methods for collecting the data follow those used to collect the current baseline information.

Possible impacts to specified ethnobotanical resources were identified in the previous section.

A portion of these impacts will be mitigated through the use of selected culturally significant species in the revegetation seed mixes and plantings (Chapter 23). These species were selected for use in the revegetation program because of a high likelihood of successful establishment, compatibility with the postmining land use, benefits to wildlife, and cultural benefits. The following species are included in seeding and planting mixes and have been successfully established to varying degrees in reclaimed areas:

<u>Bouteloua gracilis</u> (Blue Grama)	<u>Chrysothamnus nauseosus</u> (Rubber Rabbitbrush)
<u>Hilaria jamesii</u> (Galleta)	<u>Artemisia tridentata</u> (Big Sagebrush)
<u>Sporobolus cryptandrus</u> (Sand Dropseed)	<u>Juniperus osteosperma</u> (Utah Juniper)
<u>Sporobolus airoides</u> (Alkali Sacaton)	<u>Astragalus calycosus</u> v. <u>scapiosus</u> (Torrey Milkvetch)
<u>Sphaeralcea ambigua</u> (Desert Globemallow)	<u>Pinus edulis</u> (Colorado Pinyon)
<u>Agropyron smithii</u> (Western Wheatgrass)	<u>Astragalus wingatanus</u> (Ft. Wingate Milkvetch)
<u>Linum lewisii</u> (Lewis Flax)	<u>Cowania mexicana</u> (Cliffrose)
<u>Medicago falcata</u> (Alfalfa-prostrate)	<u>Castilleja chromosa</u> (Desert Paintbrush)
<u>Cleome serrulata</u> (Rocky Mt. Bee Plant)	<u>Castilleja linariaefolia</u> (Wyoming Paintbrush)
<u>Oryzopsis hymenoides</u> (Indian Ricegrass)	<u>Cryptantha flavocolata</u> (Roughened Cryptantha)
<u>Atriplex canescens</u> (Fourwing Saltbush)	<u>Happlopappus armerioides</u> (Thrifty Goldenweed)
<u>Atriplex confertifolia</u> (Shadscale)	<u>Linum lewisii</u> (Blue Flax)
<u>Eurotia lanata</u> (Winterfat)	<u>Lithospermum multiflorum</u> (Manyflower gromwell)
<u>Calochortus nutallii</u> (Sego Lily)	<u>Mirabilis multiflora</u> (Colorado Four O'Clock)
<u>Eriogonum alatum</u> (Tall Wildbuckwheat)	<u>Sphaeralcea ambigua</u> (Desert Globemallow)
<u>Eriogonum umbellatum</u> (Sulfur Wildbuckwheat)	<u>Sphaeralcea parvifolia</u> (Littleleaf Globemallow)
<u>Gaillardia pinnatifida</u> (Blanketflower)	<u>Thelesperma megapotamicum</u> (Indian Tea Greenthread)
<u>Grindelia aphanactis</u> (Rayless Gumweed)	<u>Chrysothamnus viscidiflorus</u> (Rabbitbrush)
<u>Helianthus annuus</u> (Annual Sunflower)	<u>Fendlera rupicola</u> (Cliff Fendlerbush)
<u>Hymenoxys acaulis</u> (Stemless Bitterweed)	<u>Fallugia paradoxa</u> (Apache Plume)
<u>Hymenoxys richardsonii</u> (Colorado Rubberweed)	<u>Lycium pallidum</u> (Wolfberry)
<u>Lesquerella intermedia</u> (Bladderpod)	<u>Quercus gambelii</u> (Gambel Oak)
<u>Penstemon barbatus</u> (Scarlet Bugler)	<u>Rhus trilobata</u> (Skunkbush Sumac)
<u>Penstemon eatonii</u> (Firecracker Penstemon)	<u>Shepherdia rotundifolia</u> (Roundleaf Buffaloberry)
<u>Penstemon linarioides</u> (Mat Penstemon)	<u>Yucca angustissima</u> (Narrowleaf Yucca)
<u>Petalostemon candidum</u> (White Prairieclover)	<u>Yucca baccata</u> (Bananaleaf Yucca)
<u>Artemisia frigida</u> (Fringed Sage)	<u>Cercocarpus montanus</u> (Mountain Mahogany)
<u>Ehedra viridis</u> (Green Mormon Tea)	<u>Populus fremontii</u> (Fremont Cottonwood)

Additional mitigation for the impacts on ethnobotanical resources will be partially accomplished

by the direct respreading of topsoil materials ("live" topsoiling) and the natural reinvasion of the reclaimed areas by species native to the leasehold. Peabody intends to direct haul plant growth materials as often as is feasible (Chapter 22). Care is taken to redistribute surface lifts back on the surface of regraded spoils to conserve the seed bank that exists near the surface of the natural soils. This practice and the probable reinvasion of certain species is contributing to the reintroduction of species which are or are not intentionally seeded. Species of ethnobotanical significance that have occurred in quantitative vegetation samples in the reclaimed areas or were noted as incidentals include:

<u>Chrysothamnus nauseosus</u>	<u>Sphaeralcea coccinea</u>
<u>Luecelene ericoides</u>	<u>Opuntia</u> spp.
<u>Artemisia tridentata</u>	<u>Bromus tectorum</u>
<u>Senecio douglasii</u> var. <u>longilobus</u>	<u>Descurainia</u> spp.
<u>Gutierrizia sarothrae</u>	<u>Setaria viridis</u>
<u>Sarcobatus vermiculatus</u>	<u>Amaranthus</u> spp.
<u>Cirsium vulgare</u>	<u>Helianthus petiolaris</u>
<u>Echinochloa crusgalli</u>	<u>Munroa squarrosa</u>
<u>Sporobolus airoides</u>	<u>Lupinus brevicaulis</u>
<u>Plantago purshii</u>	<u>Allium macropetalum</u>

Several additional ethnobotanically significant species have been or will be used in revegetation trials (Chapter 23). For example, successful plantings of barnyard grass (Echinochloa crusgalli), Fremont cottonwood (Populus fremontii), and Typha have been made around approved internally draining ponds. In addition, the Revegetation Plan contains provisions to screen the following ethnobotanically significant species: Chrysothamnus spp., Sarcobatus vermiculatus, Ephedra viridis, Lycium pallidum, Purshia tridentata, Tamarix pentandra, Berberis repens, Quercus gambelli, Eriogonum spp., and Symphoricarpos spp. These trials will be continued depending upon the availability of commercial sources of improved plant materials. Provisions are included in the revegetation trials to incorporate successfully screened species into the revegetation plan either for general or site-specific use.

Certain important factors preclude the mitigation for certain culturally significant plants. First, a large number of species are not adapted to the reclaimed environment. For example, several plants that occur in the pinyon-juniper woodland require shallow, rocky soils. These conditions are typically not present on reclaimed sites by virtue of the reclamation methods employed. Second, commercial sources of improved plant materials are lacking for most of the

culturally significant plants discussed herein. Many undoubtedly possess difficult dormancy or morphological problems which have precluded their selection for improvement or development. Third, several of the culturally significant plants that have been discussed are undesirable for use in the revegetation process because of direct conflicts with postmining land uses. Plants in this last category include weeds (e.g., Cirsium spp.) and poisonous plants (e.g., Stanleya pinnata; Castilleja chromosa). Finally, information regarding the degree of utilization (if any) and the specific species used by residents on the leasehold has not been made available to Peabody.

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Attachment 4

1999 Baseline Vegetation Report
J23 Conveyor Alternatives
Black Mesa Mining Complex

**1999 Baseline Vegetation Report
J23 Conveyor Alternatives**

Black Mesa Mining Complex

September 2000

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Appendix 3 – Field Guide to Target Species in the J23 Project Area

LIST OF MAPS

Drawing No. 85320D J23 Vegetation Project Area and Plant Community
Distribution Map.

INTRODUCTION

In October 1999 ESCO Associates Inc. (ESCO) was directed by Peabody Western Coal Company (PWCC) to conduct a baseline vegetation study of the J23 Conveyor Alternative Routes (Project Area). The Project Area lies in the southcentral portion of the existing Black Mesa Mining Complex leasehold (leasehold) in northeastern Arizona.

The vegetation resources in the Project Area are similar to those described in previous baseline studies conducted in and adjacent to the leasehold (Peabody Coal Company, 1985). They consist of a mosaic of sagebrush and pinyon-juniper vegetation communities at approximately 6800 ft. elevation. Study objectives included a sensitive plant survey, documentation of all plant species encountered, verification of previous vegetation community mapping, and verification of the similarity of the vegetation in the Project Area to the vegetation documented in previous studies using the established sagebrush and pinyon-juniper reference areas. The Project Area was surveyed in October 1999 as well as in May 2000 to cover phenologic variability of target species.

Both rare species identified by the U.S. federal government under provisions of the Endangered Species Act of 1973 and those similarly identified by the Navajo Nation pursuant to Title 17§507 of Navajo Nation Code of the Navajo Nation Councils Resource Committee (Resolution RCF-014-91, 1991).

USFWS Threatened and Endangered Species

The federal definition of an endangered species is any species which is in danger of extinction throughout all or a significant portion of its range (other than a species of the Class Insecta as determined by the Secretary to constitute a pest whose protection under the provisions of The Endangered Species Act of 1973 would present an overwhelming and overriding risk to man).

The federal definition of a threatened species is any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, as determined by the Secretary.

Navajo Endangered Species List (NESL)

The following definitions are taken from the Navajo Endangered Species List ((NESL) issued by the Navajo Nation Department of Fish and Wildlife-NDFW 1997and NDFW 2000).

Group 1 (G1): "Extirpated" (i.e. extinct within a part of a species range) - Those species or subspecies that no longer occur on the Navajo Nation.

Group 2 (G2): "Endangered" - Any species or subspecies which is in danger of being eliminated from all or a significant portion of its range on the Navajo Nation.

Group 3 (G3): "Threatened" - Any species or subspecies which is likely to become endangered within the foreseeable future, throughout all or a significant portion of its range on the Navajo Nation.

Group 4 (G4): "Candidate" - Any species or subspecies for which the Navajo Fish & Wildlife Department does not currently have sufficient information to support their listing as G2 or G3 but has reason to consider them. The NDFW is actively seeking information to determine if they warrant inclusion in a different group or removal from the list. They are not protected under Tribal Code but should be considered in project planning.

METHODS

Sensitive Plant Surveys/Species Lists

The list of sensitive plants searched for during the field survey was compiled from United States Fish and Wildlife Service (USFWS) listings as well as those provided by NDFW (1997). Plants listed as "threatened" or "endangered" by USFWS under the Endangered Species Act, as well as those listed by NDFW in Groups one through four were included in the survey (Table 1). Because both the NDFW and the USFWS Region 2 lists included species with habitat requirements not found in the Project Area as well as species known only from disjunct geographic areas, a literature review was conducted to identify species with a reasonable probability of occurrence. McDougal (1973) as well as Atwood et. al. (1991), Cronquist et. al. (1977), Benson (1969), Bureau of Land Management (1995), and Spackman et. al. (1997) were

used for species-specific ecological information. These references were also used to construct a site-specific field guide (Appendix 3). Subsequent to the field surveys, an amended list of endangered species was produced by the Navajo Nation (NDFW, 2000). Species from the expanded list are noted. Using maps provided by PWCC and plotted over a photographic base with Universal Transverse Mercator (UTM) waypoints (Drawing 1), ESCO personnel walked the entire length of the Project Area. During this pedestrian survey, investigators, walking three or four abreast, searched for evidence of the species listed in Table 1. The teams proceeded along the disturbance area following a zigzag pattern and noted all species encountered. Separate species lists were generated for the sagebrush and pinyon-juniper communities during the fall 1999 survey (Table 2). During the spring 2000 surveys, species lists were compiled (Table 3). Hand-held Global Positioning System (GPS) units were used to ensure the teams maintained proper location and bearing throughout the survey. Would any species of concern have been identified, these units would also have been important in accurately mapping plant species' locations.

Plant Species Listing

Scientific names follow McDougall (1973) where applicable. In cases where scientific names were not found here, nomenclature used by the listing agency (USFWS and NDFW) were used; common names cited may be found in Beetle (1970), Nickerson et. al. (1976), or Soil Conservation Service (1979).

Assessment of Comparability of Project Area Vegetation to Permit Area Vegetation

During the course of the survey, the team leader assessed the comparability of the sagebrush and pinyon-juniper community types to those types within the present Black Mesa permit areas and especially the existing reference areas. This was done via qualitative consideration of total vegetation cover, species composition, slope and aspect (exposure), as well as variation of soil depth and texture. The plant communities of the Project Area had been mapped previously, but given the new photobase used to place community delineation lines, boundaries were checked and realigned slightly (Drawing 1).

RESULTS/DISCUSSION

Rare Plants

Of the ten species identified in Table 1, none were found in the Project Area; although certain species could reasonably be expected to occur based on previous site collection information. None of the rare species identified in Table 1 were encountered. Narrowly defined habitats such as hanging garden seeps or limestone outcrops that are required by some of these plants were likewise not found.

USFWS Threatened and Endangered Species Included in Survey

Sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*), Mancos milkvetch (*Astragalus humillimus*), giant claret cup hedgehog (*Echinocereus triglochidiatus* var. *arizonica*), and Brady's pincushion cactus (*Pediocactus bradyi*) are listed as endangered under the Endangered Species Act (ESA). None of the species were observed in the Project Area, and would not be expected to occur based on habitat requirements.

Sentry milkvetch, known only from the type locality near the south rim of the Grand Canyon at approximately 7000 ft. elevation, grows on limestone pavement. No limestone derived substrate occurs in the Project Area.

Mancos milkvetch occurs in cracks of Point Lookout Sandstone of the Mesa Verde Group between 5000 and 6500 ft. No such formations occur in the Project Area.

Giant claret-cup hedgehog, known from oak woodland and chaparral communities in southern Arizona near the border of Gila and Pinal counties, was not encountered. The closely related Mojave claret-cup (*Echinocereus triglochidiatus* var. *mojavensis*) was fairly common throughout the pinyon-juniper community.

Brady's pincushion cactus, known only from the type locality in Marble Canyon at approximately 4000 ft., was not observed. No other *Pediocactus* species were observed.

Navajo sedge (*Carex specuicola*) is threatened and grows exclusively in "hanging gardens" (densely vegetated seeps found in rock outcrops in the Southwestern deserts). No such environments occur in the Project Area.

Navajo Endangered Species (NDFW 1997 and NDFW 2000) Included in Survey

Group G1

No plants from this group were considered as having a potential for occurrences in the Project Area.

Group G2

Parish's alkali grass (*Puccinellia parishii*) grows in alkaline seeps or flats in drainage bottoms. No such vegetated areas were encountered during the survey. One small, bare, moist area with white crusting indicative of an alkaline environment was observed on a shale outcrop.

Group G3

Cutler's milkvetch (*Astragalus preussii* var. *cutleri*), an endemic of San Juan county, Utah, occurs in desert shrub communities at approximately 3800 ft., considerably below the elevation of the Project Area. Nonetheless, it was deemed that this species could potentially be present in the Project Area for purposes of this survey. Four other milkvetches were observed during the survey (*A. wingatanus*, *A. calycosus*, *A. praelongus*, and *A. crassicaarpus*).

Fickeison plains cactus (*Pediocactus peevlesianus* var. *fickeisoniae*) is known from northern Coconino and Mojave counties and was deemed to have some possibility of occurrence in the Project Area.

Group G4

Desert columbine (*Aquilegia desertorum*) occurs at elevations from 6800 to 8000 ft and is known only from the northern Arizona counties of Coconino and Navajo. No columbines were observed. Although the Project Area is somewhat below this plant's elevational range, it was deemed to have some possibility of occurrence in the Project Area.

Naturita milkvetch (*Astragalus naturitenses*) is known from southwestern Colorado and McKinley County, New Mexico. It occurs on sandstone ledges in the pinyon-juniper community

and along canyon rimrock between 5400 and 6200 ft. of elevation. This species is spring flowering and was deemed to have some possibility of occurrence in the Project Area.

Navajo Endangered Species List (NDFW, 2000)

Additional Species Considered

The following species are additional species present in the expanded Navajo Endangered Species List (NDFW, 2000) that were considered after the field surveys had been completed.

Acoma Fleabane (*Erigeron acomanus*) is found on sandy slopes beneath cliffs of Entrada sandstone in McKinley County, New Mexico. Entrada sandstone is not present in the Project Area which is also a substantial distance from its occurrence in New Mexico.

Alcove Bog-Orchid (*Platanthera zothecina*) is found in seeps associated with hanging gardens and moist stream sites in Northern Arizona, Utah, and Colorado. No hanging garden habitats occur within the Project Area.

Alcove Rock Daisy (*Perityle specuicola*) is found in Hanging Gardens in Grand and San Juan Counties, Utah at elevations between 3,690 and 4,000 ft. The Project Area is more than 2,000 feet higher and no hanging garden habitats area present, so its occurrence there is thought extremely unlikely.

Bluff Phacelia (*Phacelia indecora*) is known to occur in salt desert scrub vegetation at 4,490 ft. in San Juan County, Utah. The difference in elevations of the Project Area and vegetation along with the wide geographic separation make this plant extremely unlikely in the Project Area.

Gooding's Onion (*Allium goodingii*), occurs in neighboring Apache County, but at much higher elevation (9,000 to 9,500 ft).

Navajo Bladderpod (*Lesquerella navajoensis*) is known to occur near Thoreau, New Mexico on Todilto limestone. The dissimilar geology and great distance from the Project Area make this species extremely unlikely to occur in the Project Area.

Navajo Mountain Penstemon (*Penstemon navajoa*) occurs in San Juan County, Utah at elevations between 8,200 and 10,370 ft. amidst ponderosa pine, aspen, and Douglas-fir forests. In addition to occurring at substantially higher elevations than occur in the Project Area, the moisture conditions implicit in the listed vegetation types are not duplicated anywhere in the Project Area.

Mesa Verde Cactus (*Sclerocactus mesa-verdae*) is found in salt desert scrub communities in the Fruitland and Mancos shale formation in San Juan County, New Mexico and Montezuma County, Colorado. The geology of the Project Area does not include such materials and the vegetation is not salt desert scrub, so the occurrence of this species was deemed extremely unlikely.

San Juan Milkweed (*Asclepias sanjuanensis*) is known to occur in Great Basin Grasslands and Pinyon Juniper Woodlands between 5,000 and 6,000 ft. It is very similar (if not synonymous) to *A. ruthiae*, a species previously studied in Utah by the surveyor. None were found during field searches in the Project Area.

Tuba City Milkvetch (*Astragalus sophoroides*) occurs in eastern Coconino County, Arizona between Cameron and The Gap. Information available from the herbarium of Northern Arizona University indicates that the potential distribution of the species is from Leupp to Cameron along the Little Colorado River and then north to The Gap across the Painted Desert. Although the lower reaches of Moenkopi Wash are included in this area, the upper reaches present in the Project Area are more than 30 miles east and approximately 2,000 feet higher than its known occurrences.

Community Comparability

For purposes of assessing the similarity of the Project Area vegetation to that described in previous studies, the sagebrush and pinyon-juniper communities found within the Project Area were determined to be comparable to reference areas previously established at the Black Mesa Mining Complex (J7RASAGE, N7/8RASAGE, N7/8RAPJUN, N14RASAGE, and N14RAPJUN). While no quantitative cover data were collected during the assessment of comparability, it is ESCO's opinion, based on ocular estimate, that total vegetation cover in the Project Area approximates that measured in the reference areas in 1999 and that vegetation is representative of regional sagebrush and pinyon-juniper communities in the existing permit.

Total vegetation cover averaged 33.2 percent in the J7, N7/8, and N14 sagebrush reference areas. Total vegetation cover, including canopy cover, in the N7/8 and N14 pinyon-juniper reference areas averaged 31.8 percent; 12.7 percent was the average vegetation cover excluding canopy cover (ESCO 2000).

During fall 1999 monitoring of the reference areas, 113 species were observed; 112 species were found in the Project Area (Table 2). While individual life forms' species composition varied somewhat between the Project Area and the reference areas, they were quite similar overall.

Soils of the Project Area were generally shallow, sandy, and rocky (coarse fragments greater than 10 percent) in the pinyon-juniper community, and relatively deep, finer-grained, and less rocky (coarse fragments approximately 10 percent or less) in the sagebrush community. The pinyon-juniper soils are derived primarily from sandstone, while those in the sagebrush community are derived from a mixture of sandstone and shale-derived alluvium, colluvium and loess. A similar situation is present in the reference areas as well as the regional vegetation in the existing permit area.

CONCLUSION

None of the listed species were observed in the Project Area during either the October 1999 or the May 2000 surveys. Of the narrow habitat requirements associated with any of the listed species; none were found (i.e. hanging gardens or specific geologic strata).

The sagebrush and pinyon-juniper communities found in the Project Area are comparable in total vegetation cover, species composition, slope, aspect, and soil type, depth and texture to those of the existing permit area and region. The existing reference areas will provide an adequate standard against which reclamation/revegetation success can be evaluated.

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APPENDIX 1
Species Tables

Table 1. Plant Species Listed by USFWS and NDFW Sought During Survey of J23 Conveyor Alternatives, Fall 1999 and Spring 2000, Black Mesa Mine Complex, PWCC

Scientific Name	Common Name	Status
Native Perennial Forbs		
<i>Aquilegia desertorum</i>	desert columbine	G4
<i>Astragalus cremnophylax</i> var. <i>cremnophylax</i>	sentry milkvetch	Endangered
<i>Astragalus humillimus</i>	Mancos milkvetch	Endangered
<i>Astragalus naturitensis</i>	Naturia milkvetch	G4
<i>Astragalus preussii</i> var. <i>cutleri</i>	Cutler's milkvetch	G3
Native Perennial Cool-Season Grass and Grass-like Plants		
<i>Carex specuicola</i>	Navajo sedge	Threatened
<i>Puccinellia parishii</i>	Parish's alkali grass	G2
Succulents		
<i>Echinocereus triglochidiatus</i> var. <i>arizonica</i>	giant claret-cup hedgehog	Endangered
<i>Pediocactus peeblesianus</i> var. <i>fickeisoniae</i>	Fickeison plains cactus	G3
<i>Pediocactus bradyi</i>	Brady's pincushion cactus	Endangered

Table 2. Species Present in Sagebrush and Pinyon-juniper Communities, Black Mesa Mining Complex, PWCC, AZ - Fall 1999

Scientific Name	Synonym	Common Name	Pinyon-juniper	Sagebrush
NATIVE ANNUAL & BIENNIAL FORBS				
<i>Amaranthus retroflexus</i>		amaranth pigweed		X
<i>Aster canescens</i>	MACHAERANTHERA CANESCENS	hoary tansyaster		X
<i>Chenopodium fremontii</i>		Fremont goosefoot	X	
<i>Chenopodium graveolens</i>		ragleaf goosefoot	X	X
<i>Chenopodium leptophyllum</i>		narrowleaf goosefoot		X
<i>Cirsium undulatum</i>		wavyleaf thistle		X
<i>Cleome serrulata</i>		Rocky Mountain bee plant	X	
<i>Descurainia pinnata</i>		pinnate tansy-mustard	X	
<i>Dyssodia papposa</i>		fetid marigold	X	
<i>Eriogonum cernuum</i>		nodding eriogonum		X
<i>Eriogonum rotundifolium</i>		wild buckwheat	X	
<i>Ipomopsis aggregata</i>		skyrocket gilia	X	
<i>Mentzelia nuda</i>	NUTTALLIA NUDA	blazing star	X	
<i>Portulaca oleracea</i>		common purslane		X
<i>Townsendia incana</i>		townsendia	X	
INTRODUCED ANNUAL & BIENNIAL FORBS				
<i>Carduus nutans</i> ssp. <i>macrolepis</i>		musk thistle		X
<i>Chenopodium album</i>		common lambsquarters	X	X
<i>Conringia orientalis</i>		hares ear mustard	X	
<i>Erodium cicutarium</i>		filaree	X	X
<i>Euphorbia</i> sp.		spurge	X	X
<i>Fumaria occidentalis</i>		fumatory	X	
<i>Melilotus officinalis</i>		yellow sweetclover	X	
<i>Salsola iberica</i>		russian thistle		X
<i>Sisymbrium altissimum</i>		tumble mustard	X	
NATIVE ANNUAL GRASSES				
<i>Munroa squarrosa</i>		false buffalograss	X	X
INTRODUCED ANNUAL GRASSES				
<i>Bromus tectorum</i>		cheatgrass	X	

Table 2. Species Present in Sagebrush and Pinyon-juniper Communities, Black Mesa Mining Complex, PWC, AZ - Fall 1999

Scientific Name	Synonym	Common Name	Pinyon-juniper	Sagebrush
Arabis perennans		rock cress	X	
OLIGOSPORUS PACIFICUS				
Artemisia pacifica		common sagewort	X	
Astragalus calycosus var. scaposus		Torrey milkvetch	X	
Astragalus praelongus		stinking milkvetch	X	
Astragalus purshii		Pursh milkvetch	X	X
Astragalus wingatanus		Fort Wingate milkvetch	X	
Castilleja chromosa		desert indian paintbrush	X	
Cryptantha flavoculata		cryptantha	X	
Eriogonum concinnum		tidy fleabane	X	
Eriogonum alatum		winged erogonium	X	
Haplopappus armenoides		thirty goldenweed	X	
Haplopappus nuttallii		Nuttall goldenweed	X	
Haplopappus spinulosus		goldenweed	X	
Hymenopappus filifolius		fineleaf bitterweed	X	
Lepidachyloides pungenis		granite pricklygilia	X	
Leucelene encoides		white aster		X
Lithospermum incisum		puccoon	X	
Lupinus spp.		lupine		X
Mirabilis multiflora		colorado four o'clock	X	X
Mirabilis oxybaphoides		short-calyx four o'clock	X	
Oxybaphus linearis		narrowleaf umbrellawort	X	
Penstemon caespitosus		mat penstemon	X	
Penstemon eatoni		Eaton penstemon	X	
Petardora pumila		rock goldenrod	X	
Phlox longifolia		longleaf phlox	X	
Physaria acutifolia		twinnpod	X	
Psilostrophe sparsiflora		greenstem paperflower	X	
Solidago sparsiflora		fewflowered goldenrod		X
Sphaeralcea coccinea		scarlet globemallow	X	X
Stanleya pinnata		desert plume	X	X
Townsendia exscapa		ground daisy	X	X

Table 2. Species Present in Sagebrush and Pinyon-juniper Communities, Black Mesa Mining Complex, PWCC, AZ - Fall 1999

Scientific Name	Synonym	Common Name	Pinyon-juniper	Sagebrush
INTRODUCED PERENNIAL FORBS				
<i>Lathyrus eucosmus</i>		bush peavine	X	
<i>Marrubium vulgare</i>		horehound	X	X
NATIVE PERENNIAL GRASSES (cool season)				
<i>Agropyron smithii</i>		western wheatgrass		X
<i>Agropyron trachycaulum</i>		slender wheatgrass		X
<i>Carex geophila</i>		ground sedge	X	
<i>Oryzopsis hymenoides</i>		indian ricegrass	X	X
<i>Poa fendleriana</i>		mutton grass	X	
<i>Sitanion longifolium</i>	SITANION HYSTRIX	bottlebrush squirreltail	X	
<i>Stipa columbiana</i>		Columbia needlegrass	X	
<i>Stipa comata</i>		needle-and-thread grass		X
INTRODUCED PERENNIAL GRASSES (cool season)				
<i>Bromus inermis</i>		smooth brome	X	
NATIVE PERENNIAL GRASSES (warm season)				
<i>Aristida fendleriana</i>	A. PURPUREA VAR. LONGISETA	Fendler's three-awn	X	
<i>Bouteloua gracilis</i>		blue grama	X	X
<i>Hilaria jamesii</i>		galleta		X
<i>Muhlenbergia pungens</i>		sandhill muhly	X	
<i>Sporobolus cryptandrus</i>		sand dropseed	X	X
NATIVE SUBSHRUBS				
<i>Artemisia frigida</i>		fringed sagewort	X	X
<i>Ceratoides lanata</i>		winterfat		X
<i>Chrysothamnus depressus</i>		dwarf rabbitbrush	X	
<i>Chrysothamnus greenei</i>		greene rabbitbrush		X
<i>Ephedra viridis</i>		mountain joint-fir	X	
<i>Eriogonum corymbosum</i>		buckwheat	X	
<i>Eriogonum microthecum</i>		slenderbush wild buckwheat	X	
<i>Gutierrezia sarothrae</i>		broom snakeweed	X	X
<i>Senecio douglasii</i> var. <i>longilobus</i>		threadleaf groundsel		X

Table 2. Species Present in Sagebrush and Pinyon-juniper Communities, Black Mesa Mining Complex, PWCC, AZ - Fall 1999

Scientific Name	Synonym	Common Name	Pinyon-juniper	Sagebrush
NATIVE SHRUBS				
<i>Artemisia tridentata</i>		big sagebrush	X	X
<i>Atriplex canescens</i>		four-wing saltbush	X	X
<i>Atriplex confertifolia</i>		shadscale saltbush	X	
<i>Chrysothamnus nauseosus</i>		rubber rabbitbrush	X	X
<i>Chrysothamnus viscidiflorus</i>		sticky-leaved rabbitbrush		X
<i>Cowania mexicana</i>	PURSHIA STANSBURIANA	cliff rose	X	
<i>Forestiera neomexicana</i>		desert olive	X	
<i>Lycium pallidum</i>		rabbitthorn		X
<i>Purshia tridentata</i>		antelope bitterbrush	X	
<i>Rhus trilobata</i>		squawbush	X	
<i>Tetradymia canescens</i>		gray feltthorn	X	
<i>Yucca glauca</i>		small soapweed	X	
INTRODUCED SHRUBS				
<i>Tamarix pentandra</i>		saltcedar	X	
NATIVE TREES				
<i>Juniperus osteosperma</i>		Utah juniper	X	X
<i>Pinus edulis</i>		Colorado pinyon	X	X
<i>Quercus gambelii</i>		Gambel oak	X	
BRYOPHYTES				
Moss spp.		unidentified moss	X	X
LICHENS				
<i>Parmelia chlorocroa</i>	Xanthoparmelia chlorocroa	lichen		X
<i>Usnea</i> spp.		usnea lichen	X	
SUCCULENTS				
<i>Coryphantha vivipara</i>		purple ballcactus	X	X
<i>Echinocereus triglochidiatus</i> var. <i>mojavensis</i>		mojave claret-cup cactus	X	X
<i>Opuntia fragilis</i> var. <i>fragilis</i>		little pricklypear	X	

Table 2. Species Present in Sagebrush and Pinyon-juniper Communities, Black Mesa Mining Complex, PWCC, AZ - Fall 1999

Scientific Name	Synonym	Common Name	Pinyon-juniper	Sagebrush
<i>Opuntia macrorhiza</i>		thickroot pricklypear	X	
<i>Opuntia phaeacantha</i>		whitespine pricklypear	X	X
<i>Opuntia polyacantha</i>		plains pricklypear	X	
<i>Opuntia whipplei</i>		whipple cholla	X	
<i>Sclerocactus whipplei</i>	ECHINOCACTUS WHIPPLEI	whipple's fishhook	X	X
EPIPHYTE(PARASITE)				
<i>Orobanche fasciculata</i>		purple broomrape		X
<i>Phoradendron juniperinum</i>		juniper mistletoe	X	
MUSHROOMS				
Mushroom spp.		unidentified mushrooms	X	X

Table 3. Species Present in Corridor, Alternatives, Black Mesa Complex, PWCC, AZ - Spring 2000

Scientific Name	Synonym	Common Name	Route 1	Route 2	Route 3
<i>Amaranthus graecizans</i>		PROSTRATE PIGWEED			
<i>Aster canescens</i>	MACHAERANTHERA CANESCENS	HOARY TANVASTER			
<i>Chaenactis stevioides</i>		ESTEVE PINCUSHION			
<i>Chenopodium glaucum</i>		GOOSEFOOT			
<i>Cirsium undulatum</i>		WAVYLEAF THISTLE	X	X	
<i>Descurainia pinnata</i>		PINNATE TANSY-MUSTARD			
<i>Eriogonum rotundifolium</i>		WILD BUCKWHEAT			
<i>Ipomopsis aggregata</i>		SKYROCKET GILIA	X		
<i>Lappula redowskii</i>		BLUEBUR STICKSEED	X		
<i>Lupinus brevicaulis</i>		SHORTSTEM LUPINE		X	
<i>Mentzelia albicaulis</i>		BLAZINGSTAR	X		
<i>Phacelia granulata</i>		PHACELIA			
<i>Polygonum ramosissimum</i>		BUSHY KNOTWEED			
<i>Portulaca oleracea</i>		COMMON PURSLANE			X
<i>Townsendia incana</i>		TOWNSENDIA			
INTRODUCED ANNUAL & BIENNIAL FORBS					
<i>Chenopodium album</i>		COMMON LAMBSQUARTER			
<i>Conringia orientalis</i>		HARES EAR MUSTARD			X
<i>Erodium cicutarium</i>		FILAREE			
<i>Euphorbia</i> sp.		SPURGE		X	
<i>Kochia scoparia</i>		FIREWEED SUMMERCYRESS			
<i>Salsola iberica</i>		RUSSIAN THISTLE			
<i>Tragopogon dubius</i>		GOAT'S BEARD			
INTRODUCED ANNUAL GRASSES					
<i>Bromus tectorum</i>		CHEATGRASS			
NATIVE PERENNIAL FORBS					
<i>Arabis perennans</i>		ROCK CRESS			
<i>Asclepias involucrata</i>	ASCLEPIAS MACROSPERMA	EASTWOOD MILKWEED			X
<i>Astragalus calycosus</i> var. <i>scapiosus</i>		TORREY MILKWEED	X	X	
<i>Astragalus crassicaarpus</i>		GROUND-PLUM			X
<i>Astragalus praelongus</i>		STINKING MILKWEED	X		
<i>Astragalus purshii</i>		PURSH MILKWEED			
<i>Astragalus wingatanus</i>		FORT WINGATE MILKWEED			
<i>Brickellia brachyphylla</i>		BRICKELL BUSH			
<i>Calochortus Kennedyi</i>		DESERT MARIPOSA LILY			
<i>Cryptantha flava</i>		YELLOW CRYPTANTHA	X		
<i>Cryptantha flavoculata</i>		CRYPTANTHA			
<i>Cymopterus purpureus</i>		PURPLE WAFER-PARSNIP			
<i>Eriogonum alatum</i>		WINGED ERIOGONUM			
<i>Eriogonum umbellatum</i>		SULFUR WILD BUCKWHEAT		X	
<i>Euphorbia fendleri</i>		FENDLER SPURGE	X		

Table 3. Species Present in Corridor Alternatives, Black Mesa Complex, PWCC, AZ - Spring 2000

Scientific Name	Synonym	Common Name	Route 1	Route 2	Route 3
NATIVE PERENNIAL FORBS (cont.)					
<i>Haplopappus armerioides</i>		THRIFTY GOLDENWEED	X	X	
<i>Haplopappus nuttallii</i>		NUTTALL GOLDENWEED	X		
<i>Haplopappus spinulosus</i>		GOLDENWEED	X		
<i>Hymenopappus filifolius</i>		FINELEAF BITTERWEED	X		
<i>Hymenoxys acaulis</i>		STEMLESS BITTERWEED			
<i>Leptodactylon pungens</i>		GRANITE PRICKLYGILIA	X		
<i>Lesquerella intermedia</i>		BLADDERPOD	X	X	
<i>Leucelene ericoides</i>		WHITE ASTER	X	X	
<i>Mirabilis multiflora</i>		COLORADO FOUR O'CLOCK			
<i>Oenothera coronopifolia</i>		EVENING-PRIMROSE			X
<i>Petradoria pumila</i>		ROCK GOLDENROD	X	X	
<i>Psilostrophe sparsiflora</i>		GREENSTEM PAPERFLOWER	X		
<i>Solidago sparsiflora</i>		FEWFLOWERED GOLDENROD	X	X	X
<i>Sphaeralcea coccinea</i>		SCARLET GLOBEMALLOW	X	X	
<i>Stanleya pinnata</i>		DESERT PLUME	X		
<i>Townsendia exscapa</i>		GROUND DAISY			
INTRODUCED PERENNIAL FORBS					
<i>Marrubium vulgare</i>		HOREHOUND	X		
<i>Nepeta cataria</i>		COMMON CATMIP			
<i>Verbena bracteata</i>		VERVAIN			
NATIVE PERENNIAL GRASSES (cool)					
<i>Agropyron smithii</i>		WESTERN WHEATGRASS	X		
<i>Hordeum jubatum</i>		FOXTAIL BARLEY			
<i>Oryzopsis hymenoides</i>		INDIAN RICEGRASS	X		
<i>Poa fendleriana</i>		MUTTON GRASS	X		
<i>Sitanion longifolium</i>	SITANION HYSTRIX	BOTTLEBRUSH SQUIRRELTAIL	X	X	
<i>Stipa comata</i>		NEEDLE-AND-THREAD GRASS			
NATIVE PERENNIAL GRASSES (warm)					
<i>Aristida fendleriana</i>	A. PURPUREA VAR. LONGISETA	FENDLER'S THREE-AWN			
<i>Bouteloua gracilis</i>		BLUE GRAMA	X	X	
<i>Hilaria jamesii</i>		GALLETA	X	X	X
<i>Muhlenbergia pungens</i>		SANDHILL MUHLY	X		
<i>Muhlenbergia torreyi</i>		RING MUHLY			
<i>Sporobolus airoides</i>		ALKALI SACATON			
NATIVE SUBSHRUBS					
<i>Artemisia frigida</i>		FRINGED SAGEWORT	X		
<i>Ceratoides lanata</i>		WINTERFAT	X	X	X

Table 3. Species Present in Corridor Alternatives, Black Mesa Complex, PWCC, AZ - Spring 2000

Scientific Name	Synonym	Common Name	Route 1	Route 2	Route 3
NATIVE SUBSHRUBS (cont.)					
<i>Chrysothamnus depressus</i>		DWARF RABBITBRUSH	X		
<i>Chrysothamnus greenei</i>		GREENE RABBITBRUSH	X	X	X
<i>Ephedra viridis</i>		MOUNTAIN JOINT-FIR	X		
<i>Eriogonum corymbosum</i>		BUCKWHEAT	X		
<i>Eriogonum microthecum</i>		SLENDERBUSH WILD BUCKWHEAT			
<i>Gutierrezia sarothrae</i>		BROOM SNAKEWEED	X	X	
<i>Senecio douglasii</i> var. <i>longilobus</i>		THREADLEAF GROUNDSEL			
NATIVE SHRUBS					
<i>Artemisia arbuscula</i> ssp. <i>nova</i>		BLACK SAGEBRUSH			
<i>Artemisia tridentata</i>		BIG SAGEBRUSH	X	X	
<i>Atriplex canescens</i>		FOUR-WING SALTBUUSH	X		
<i>Atriplex confertifolia</i>		SHADSCALE SALTBUUSH			
<i>Chrysothamnus nauseosus</i>		RUBBER RABBITBRUSH	X	X	
<i>Chrysothamnus parryi</i>		PARRY RABBITBRUSH			
<i>Coleogyne ramosissima</i>		BLACKBRUSH			
<i>Cowania mexicana</i>	PURSHIA STANSBURIANA	CLIFF ROSE	X		
<i>Lycium pallidum</i>		RABBITTHORN		X	
<i>Purshia tridentata</i>		ANTELOPE BITTERBRUSH	X		
<i>Tetradymia canescens</i>		GRAY FELTTHORN			
<i>Yucca angustissima</i>		SPANISH BAYONET	X		
<i>Yucca glauca</i>		SMALL SOAPWEED		X	
INTRODUCED SHRUBS					
<i>Tamarix pentandra</i>		SALT CEDAR			X
NATIVE TREES					
<i>Juniperus osteosperma</i>		UTAH JUNIPER	X	X	
<i>Pinus edulis</i>		COLORADO PINYON	X	X	
<i>Quercus gambelii</i>		GAMBEL OAK	X		X
LICHEN					
<i>Cladonia</i> sp.		CLADONIA LICHEN			
<i>Parmelia chlorocroa</i>	XANTHOPARMELIA CHLOROCROA	LICHEN			
<i>Usnea</i> spp.		UNIDENTIFIED USNEA LICHEN		X	
SUCCULENT					
<i>Coryphantha vivipara</i>		PURPLE BALLCACTUS	X	X	
<i>Echinocereus triglochidiatus</i> var. <i>mojavensis</i>		MOJAVE CLARET-CUP			
<i>Opuntia macrorhiza</i>		THICKROOT PRICKLYPEAR	X		
<i>Opuntia phaeacantha</i>		PRICKLYPEAR			
<i>Opuntia whipplei</i>		WHIPPLE CHOLLA			
<i>Sclerocactus parviflorus</i>		BARREL CACTUS	X		
<i>Sclerocactus whipplei</i>	ECHINOCACTUS WHIPPLEI	WHIPPLE'S FISHOOK			X
EPIPHYTE(PARASITE)					
<i>Phoradendron juniperinum</i>		JUNIPER MISTLETOE		X	

Table 3. Species Present in Corridor Alternatives, Black Mesa Complex, PWCC, AZ - Spring 2000

Scientific Name	Synonym	Common Name	Route 4	Route 5	Route 6	Route 7
NATIVE ANNUAL & BIENNIAL FORBS						
<i>Amaranthus graecizans</i>		PROSTRATE PIGWEED	X			
<i>Aster canescens</i>	MACHAERANTHERA CANESCENS	HOARY TANSYASTER				X
<i>Chaenactis stevioides</i>		ESTEVE PINCUSHION				X
<i>Chenopodium glaucum</i>		GOOSEFOOT				X
<i>Cirsium undulatum</i>		WAVYLEAF THISTLE		X		X
<i>Descurainia pinnata</i>		PINNATE TANSY-MUSTARD	X			
<i>Eriogonum rotundifolium</i>		WILD BUCKWHEAT			X	X
<i>Ipomopsis aggregata</i>		SKYROCKET GILIA	X	X	X	X
<i>Lappula redowskii</i>		BLUEBUR STICKSEED				X
<i>Lupinus brevicaulis</i>		SHORTSTEM LUPINE				
<i>Mentzelia albicaulis</i>		BLAZINGSTAR				X
<i>Phacelia crenulata</i>		PHACELIA				X
<i>Polygonum ramosissimum</i>		BUSHY KNOTWEED				X
<i>Portulaca oleracea</i>		COMMON PURSLANE				
<i>Townsendia incana</i>		TOWNSENDIA	X			X
INTRODUCED ANNUAL & BIENNIAL FORBS						
<i>Chenopodium album</i>		COMMON LAMBSQUARTER			X	X
<i>Conringia orientalis</i>		HARES EAR MUSTARD				
<i>Erodium cicutarium</i>		FILAREE				X
<i>Euphorbia</i> sp.		SPURGE	X	X		
<i>Kochia scoparia</i>		FIREWEED SUMMERCYPRESS				X
<i>Salsola iberica</i>		RUSSIAN THISTLE				X
<i>Tragopogon dubius</i>		GOAT'S BEARD				X
INTRODUCED ANNUAL GRASSES						
<i>Bromus tectorum</i>		CHEATGRASS	X			X
NATIVE PERENNIAL FORBS						
<i>Arabis perennans</i>		ROCK CRESS				X
<i>Asclepias involucrata</i>	ASCLEPIAS MACROSPERMA	EASTWOOD MILKWEED				
<i>Astragalus calycosus</i> var. <i>scapiosus</i>		TORREY MILKVETCH		X		X
<i>Astragalus crassicaarpus</i>		GROUND-PLUM				
<i>Astragalus praelongus</i>		STINKING MILKVETCH				X
<i>Astragalus purshii</i>		PURSH MILKVETCH				X
<i>Astragalus wingatanus</i>		FORT WINGATE MILKVETCH		X		X
<i>Brickellia brachyphylla</i>		BRICKELL BUSH	X			
<i>Calochortus kennedyi</i>		DESERT MARIPOSA LILY	X			
<i>Cryptantha flava</i>		YELLOW CRYPTANTHA			X	
<i>Cryptantha flavoculata</i>		CRYPTANTHA				X
<i>Cymopterus purpureus</i>		PURPLE WAFER-PARSNIP	X			
<i>Eriogonum alatum</i>		WINGED ERIOGONUM				
<i>Eriogonum umbellatum</i>		SULFUR WILD BUCKWHEAT	X	X		X
<i>Euphorbia fendleri</i>		FENDLER SPURGE	X			

Table 3. Species Present in Corridor Alternatives, Black Mesa Complex, PWCC, AZ - Spring 2000

Scientific Name	Synonym	Common Name	Route 4	Route 5	Route 6	Route 7
NATIVE PERENNIAL FORBS (cont.)						
<i>Haplopappus armerioides</i>		THRIFTY GOLDENWEED	X		X	
<i>Haplopappus nuttallii</i>		NUTTALL GOLDENWEED				X
<i>Haplopappus spinulosus</i>		GOLDENWEED				X
<i>Hymenopappus filifolius</i>		FINELEAF BITTERWEED	X			
<i>Hymenoxys acaulis</i>		STEMLESS BITTERWEED	X			
<i>Leptodactylon pungens</i>		GRANITE PRICKLYGILIA				X
<i>Lesquerella intermedia</i>		BLADDERPOD	X	X	X	X
<i>Leucelene ericoides</i>		WHITE ASTER	X	X	X	X
<i>Mirabilis multiflora</i>		COLORADO FOUR O'CLOCK	X			
<i>Oenothera coronopifolia</i>		EVENING-PRIMROSE		X		X
<i>Petradoria pumila</i>		ROCK GOLDENROD				X
<i>Psilostrophe sparsiflora</i>		GREENSTEM PAPERFLOWER	X			
<i>Solidago sparsiflora</i>		FEWFLOWERED GOLDENROD		X		X
<i>Sphaeralcea coccinea</i>		SCARLET GLOBEMALLOW	X	X	X	X
<i>Stanleya pinnata</i>		DESERT PLUME	X		X	X
<i>Townsendia exscapa</i>		GROUND DAISY			X	
INTRODUCED PERENNIAL FORBS						
<i>Marrubium vulgare</i>		HOREHOUND				
<i>Nepeta cataria</i>		COMMON CATMIP	X			
<i>Verbena bracteata</i>		VERVAIN				X
NATIVE PERENNIAL GRASSES (cool)						
<i>Agropyron smithii</i>		WESTERN WHEATGRASS				
<i>Hordeum jubatum</i>		FOXTAIL BARLEY				X
<i>Oryzopsis hymenoides</i>		INDIAN RICEGRASS	X		X	X
<i>Poa fendleriana</i>		MUTTON GRASS	X		X	X
<i>Sitanion longifolium</i>	SITANION HYSTRIX	BOTTLEBRUSH SQUIRRELTAIL	X	X	X	X
<i>Stipa comata</i>		NEEDLE-AND-THREAD GRASS	X			X
NATIVE PERENNIAL GRASSES (warm)						
<i>Aristida fendleriana</i>	A. PURPUREA VAR. LONGISETA	FENDLER'S THREE-AWN				X
<i>Bouteloua gracilis</i>		BLUE GRAMA	X	X	X	X
<i>Hilaria jamesii</i>		GALLETA	X	X	X	X
<i>Muhlenbergia pungens</i>		SANDHILL MUHLY			X	X
<i>Muhlenbergia torreyi</i>		RING MUHLY	X			
<i>Sporobolus airoides</i>		ALKALI SACATON				X
NATIVE SUBSHRUBS						
<i>Artemisia frigida</i>		FRINGED SAGEWORT				X
<i>Ceratoides lanata</i>		WINTERFAT		X		

Table 3. Species Present in Corridor Alternatives, Black Mesa Complex, PWCC, AZ - Spring 2000

Scientific Name	Synonym	Common Name	Route 4	Route 5	Route 6	Route 7
NATIVE SUBSHRUBS (cont.)						
<i>Chrysothamnus depressus</i>		DWARF RABBITBRUSH			X	X
<i>Chrysothamnus Greenei</i>		GREENE RABBITBRUSH	X	X		X
<i>Ephedra viridis</i>		MOUNTAIN JOINT-FIR		X	X	X
<i>Eriogonum corymbosum</i>		BUCKWHEAT	X		X	X
<i>Eriogonum microthecum</i>		SLENDERBUSH WILD BUCKWHEAT			X	
<i>Gutierrezia sarothrae</i>		BROOM SNAKEWEED	X	X	X	X
<i>Senecio douglasii</i> var. <i>longilobus</i>		THREADLEAF GROUNDSEL	X			
NATIVE SHRUBS						
<i>Artemisia arbuscula</i> ssp. <i>nova</i>		BLACK SAGEBRUSH	X			X
<i>Artemisia tridentata</i>		BIG SAGEBRUSH	X	X	X	X
<i>Atriplex canescens</i>		FOUR-WING SALTBUUSH	X		X	
<i>Atriplex confertifolia</i>		SHADSCALE SALTBUUSH			X	
<i>Chrysothamnus nauseosus</i>		RUBBER RABBITBRUSH	X	X	X	X
<i>Chrysothamnus parryi</i>		PARRY RABBITBRUSH	X			
<i>Coleogyne ramosissima</i>		BLACKBRUSH	X			
<i>Cowania mexicana</i>	PURSHIA STANSBURIANA	CLIFF ROSE	X	X	X	X
<i>Lycium pallidum</i>		RABBITTHORN		X	X	X
<i>Purshia tridentata</i>		ANTELOPE BITTERBRUSH				
<i>Tetradymia canescens</i>		GRAY FELTTHORN				X
<i>Yucca angustissima</i>		SPANISH BAYONET	X			X
<i>Yucca glauca</i>		SMALL SOAPWEED		X	X	
INTRODUCED SHRUBS						
<i>Tamarix pentandra</i>		SALT CEDAR	X		X	X
NATIVE TREES						
<i>Juniperus osteosperma</i>		UTAH JUNIPER	X	X	X	X
<i>Pinus edulis</i>		COLORADO PINYON		X	X	X
<i>Quercus gambelii</i>		GAMBEL OAK				
LICHEN						
<i>Cladonia</i> sp.		CLADONIA LICHEN			X	
<i>Parmelia chlorocroa</i>	XANTHOPARMELIA CHLOROCROA	LICHEN			X	
<i>Usnea</i> spp.		UNIDENTIFIED USNEA LICHEN		X		
SUCCULENT						
<i>Coryphantha vivipara</i>		PURPLE BALLCACTUS		X		
<i>Echinocereus triglochidiatus</i> var. <i>mojavensis</i>		MOJAVE CLARET-CUP	X	X	X	X
<i>Opuntia macrorhiza</i>		THICKROOT PRICKLYPEAR	X		X	X
<i>Opuntia phaeacantha</i>		PRICKLYPEAR		X		X
<i>Opuntia whipplei</i>		WHIPPLE CHOLLA	X		X	X
<i>Sclerocactus parviflorus</i>		BARREL CACTUS	X		X	
<i>Sclerocactus whipplei</i>	ECHINOCACTUS WHIPPLEI	WHIPPLE'S FISHOOK				
EPIPHYTE(PARASITE)						
<i>Phoradendron juniperinum</i>		JUNIPER MISTLETOE		X		

APPENDIX 2

Representative Photos of Sagebrush and Pinyon-juniper Communities



Photograph 1. Pinyon-juniper Community.



Photograph 2. Mixed Pinyon-juniper and Sagebrush Community.



Photograph 3. Sagebrush Community.



Photograph 4. Sagebrush Community.

APPENDIX 3

Field Guide to Target Species in the J9 Study Area

•

Species: *Astragalus naturitensis* Payson
Common Name: Naturita milkvetch
Synonym: *Astragalus arietinus* var. *stipularis*
Status: G4

Distinguishing Characteristics:

- Low growing, miniature spreading perennial about 10 cm tall.
- Leaves basal, pinnate with 9-15 leaflets, leaves 2-7 mm, clustered, obovate to elliptic, mostly folded, often glabrate above, stipules free.
- Peduncles scapose, 2-7 cm, with 4-9 subcapitate or briefly racemose ascending flowers.
- Flowers 10-15 mm long.
- Calyx 4-8 mm, cylindrical, mixed white and black pubescent, lobes 1-1.5 mm.
- Pods leathery, less than 2 cm long, more than twice as long as wide, widely spreading, covered with short, stiff, flat-lying hairs, straight except for beak, usually red-mottled.

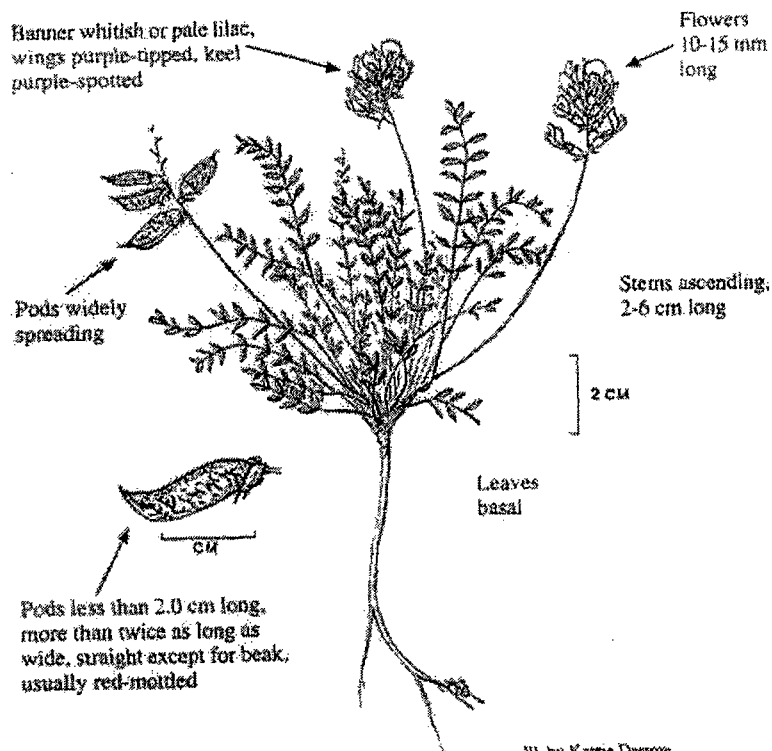
Look Alikes: *A. deterior* is distinguished by yellowish white flowers, *A. desperatus* has smaller flowers and loosely hirsute pods of broader and shorter outline, *A. monumentalis* var. *cottamii* has firm-walled, dorsiventrally compressed, unilocular pods, and *A. humillimus* has persistent, spiny rachises.

Flower Color: banner white, keel purple spotted, and wings reddish purple or purple tipped.

Flowering Period: April to early June.

Fruiting Period: late May to June.

Habitat: Sandstone mesas, ledges, crevices and slopes in pinyon-juniper woodlands. 5,000-7,000 feet in elevation. New Mexico, Utah and Colorado.



Species: *Astragalus preussii* Gray var. *cutleri* Barneby
 Common Name: Cutler's milkvetch or Copper Canyon milkvetch
 Status: G3

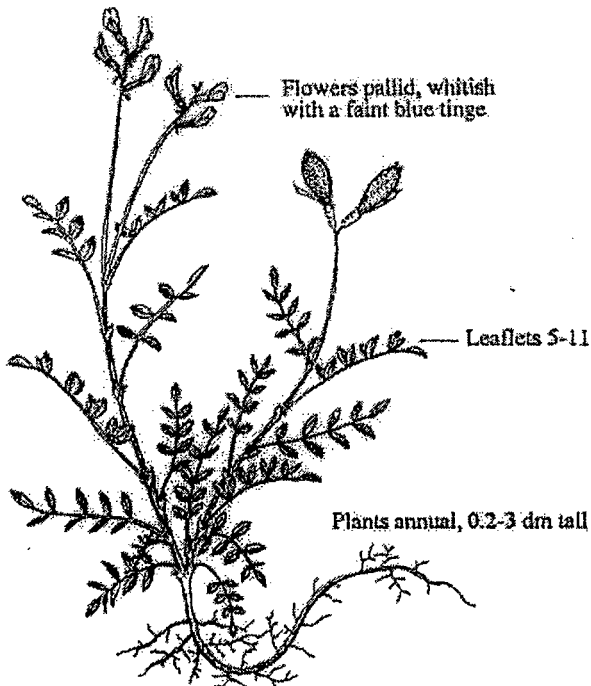
Distinguishing Characteristics:

- Ill scented annual.
- Stems 2-11 cm tall.
- 5-11 leaflets, 7-12 mm wide.
- Racemes 3-17 flowered.
- Fruit 2-7mm, stipitate.
- Monocarpic.
- Largest 12-20 x 7-12mm.

Look Alikes: Looks like other varieties, but differs in its smaller stature, pallid whitish flowers with faint blue tinge, and fewer leaflets. Other varieties are perennial. When fruiting, can look like *A. praelongus*, but pod has no septum.

Flower Color: pale white with faint blue tinge
 Flowering Period: late March to early June.

Habitat: Warm desert shrub community. 1,700 to 6,000 ft. Grand County, Utah



- 1 Racemes 3-17-, in our range not over 11-flowered, the fruiting axis 1-7 (9) cm long; pod stipitate, the stipe (2) 3-7 mm long; Canyonlands and Dixie-Corridor sections of the Colorado Plateau, 1200-1600 m, from Carbon and Grand cos. se. to e. Kane Co., Utah and n. Mohave Co., Ariz.; w. to s. Nev. and se. Calif.
- 2 Plant perennial, the stems (unless drought-inhibited) 1-4 dm tall; leaflets of longer leaves either 17-23, or if fewer then either shorter or narrower than the next, the longest of a plant 6-15 x 3-6 mm; banner usually vivid purple; range as just given var. *preussii*
- 2 Plant monocarpic, the stems 2-11 cm tall; leaflets 5-11, the largest of a plant 12-20 x 7-12 mm; petals whitish, faintly blue-tinged; Copper Canyon near mouth of San Juan River, Grand Co., Utah var. *cutleri* Barneby
- 1 Racemes (except depauperate distal ones) 12-25-flowered, the fruiting axis (4) 6-23 cm long; pod sessile or almost so; rare and local at 650-750 m along the Virgin and Colorado rivers in se. Clark Co. and adj. Mohave Co., Ariz.; to be looked for in the sw. corner of Utah; remotely disjunct on playas in sw. Mojave Desert, Calif. var. *laxiflorus* A. Gray

Species: *Carex specuicola* J. T. Howell
Common Name: Navajo sedge
Status: Threatened

Distinguishing Characteristics:

- Has both 2-branched styles with lenticular achenes and 3-branched styles with trigonous achenes, but 2-branched style is more common.
- Terminal spike usually gynaceandrous, short peduncled or sessile.
- Perigynia nerveless or finely few-nerved, strongly flattened.
- Plant base reddish tinged with dried persistent leaves.

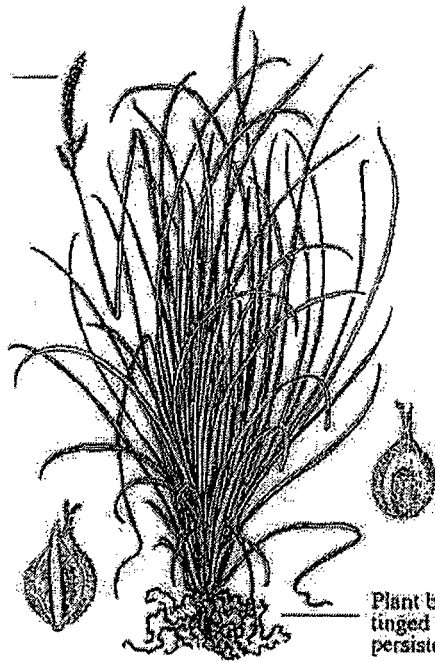
Look Alikes: There are no *Carex* species that occur with *C. specuicola*.
A *Carex* that resembles it from the Rocky Mountains is *C. atrata*.

Flower Color:

Flowering Period: late June-July

Habitat: Known only from collection near Inscription House, Coconino County, Arizona and San Juan County, Utah. Restricted to Navajo Sandstone seeps-springs, pockets, or hanging gardens, ranging from almost inaccessible sheer cliff faces to accessible alcoves from 5,710-5,980 feet in elevation.

Terminal spike usually gynaceandrous, short peduncled or sessile



Perigynia nerveless or finely few-nerved, strongly flattened

Plant base reddish-tinged with dried persistent leaves

Species: *Echinocereus triglochidiatus* var. *arizonica* (Rose) L. Benson
 Common Name: Giant Claret-Cup Hedgehog
 Status: Endangered

Distinguishing Characteristics:

- Plant caespitose, the few branches or stems grow in clumps.
- Stems are 22.5-40 cm long and 7.5-10 cm in diameter.
- Two to four central spines, 2.5 to 40 cm long, grey or pinkish.
- Eight to ten radial spines, appressed, 0.5-1 cm long, light yellow or pinkish-tan, often slightly curved.
- Stem ribs \pm 10, tuberculate.
- Areoles of mature parts of stems with white felt or cobwebby hairs.
- Areoles nearly circular.
- Flowers do not close at night, and stay open for two or three days.
- Flower \pm 5 cm in diameter and \pm 7 cm long.
- Style 2 mm in diameter.
- Fruit red, fleshy at maturity.

Look Alikes: Similar to other varieties, but is most robust. See variety chart. Other *Echinocereus* species are not red in color.

Flower Color: Red
 Flowering Period: May

Habitat: Chaparral and oak woodlands at 3,500 to 4,800ft. Occurs in Arizona in the mountainous area near the line between Gila and Pinal counties.

	A. Var. melanacanthus	B. Var. mojavensts	C. Var. neomexicanus	D. Var. arizonicus	E. Var. gonacanthus	F. Var. triglochidiatus
Stem number	Ultimately numerous, up to 500.	Ultimately numerous, up to 500.	Mostly 5 to 45.	Few.	Few.	Few.
Stem length	1 1/2 to 3 or 6 inches.	1 1/2 to 3 or 6 inches.	8 to 12 inches.	9 inches.	3 to 5 inches.	6 to 12 inches.
Stem diameter	1 to 2 or 2 1/2 inches.	1 to 2 or 2 1/2 inches.	3 to 4 inches.	6 to 10 inches.	2 to 3 inches.	Mostly about 3 inches.
Stem ribs	Mostly 9 or 10, tuberculate.	Mostly 9 or 10, tuberculate.	8-12, mostly 10, not markedly tuberculate.	About 10, tuberculate.	About 8, tuberculate.	5-9, tuberculate.
Spines	Gray, black, pink, or basally tan, or sometimes straw-color, up to 1 to 2 1/2 inches long, nearly straight, rarely angled.	Gray, pink, or at first straw-color, usually up to 1 1/2 to 2 1/4 inches long, striate, smooth or angled.	Tan or pink, becoming light gray, up to 1 1/2 inches long, nearly straight, not angled.	Dark gray, up to 1 to 1 1/2 inches long, nearly straight, not angled.	Gray or tan, 1 to 1 1/2 inches long, nearly straight, 6 or (3-4), 4-angled.	Gray, 3/4 to 1 inch long, nearly straight, 3-angled.
Central spines	1-3, light or dark, spreading or the longest deflexed, up to 1/32 inch in basal diameter.	1-2, light, usually twisting, often striate, about 1/32 inch in basal diameter.	2-4, gray, spreading, 1/48 to 1/24 inch or a little more in basal diameter.	1-3, the longest deflexed, acicular, gradually tapering, with minute striations, up to 1/16 inch in basal diameter.	1 for (0-2), gray, spreading, up to twice as long as the radial, up to 1/20 inch thick, 6-7-angled.	0 (or rarely 1) and then like the radial.
Radial spines	5-11, half as long to sometimes nearly as long as the central.	5-8, half as long to sometimes nearly as long as the central.	9-12, tannish or light gray, about half as long as the central.	5-11, often slightly curved, pinkish-tan, shorter than the central.	5-9, tan or gray, up to 1/24 inch in diameter	3-6, tan or gray, spreading or recurving, up to 1/16 inch thick.
Flower shape & approximate size	Slender, 1 to 1 1/2 inches in diameter, 1 1/2 to 2 or 2 1/2 inches long.	Slender, 1 1/2 to 2 inches in diameter, 1 1/2 to 2 inches long.	Slender, 1 1/2 inches in diameter, 2 to 2 1/4 inches long.	Broad, about 2 inches in diameter, 2 1/2 inches long.	Broad, 2 3/4 inches in diameter, 2 1/2 inches long.	Broad, 2 inches in diameter, 2 to 2 1/2 inches long.
Style (approximate size)	1/24 inch in diameter, equal to or longer than the perianth.	1/24 inch in diameter, equal to or longer than the perianth.	1/24 inch in diameter, about equal to or longer than the perianth.	1/12 inch in diameter, equal to the perianth.		
Geographical distribution	Upland Arizona, Central Utah to southern Colorado and southwestern Texas, southward in Mexico to Durango.	Northwestern Arizona in Mohave County; southeastern California; southern Nevada; southwestern corner of Utah.	Southeastern Arizona, southwestern and southeastern New Mexico; Trans-Pecos Texas; Northwestern Mexico.	Arizona between Superior and Globe.	Northern edge of Arizona, Southcentral and southwestern Colorado; northernmost New Mexico.	Near Ft. Defiance, Arizona; Southernmost Colorado; westcentral and central New Mexico.

Fig. 3.4. The documented distribution of *Echinocereus triglochidiatus*, according to its varieties.

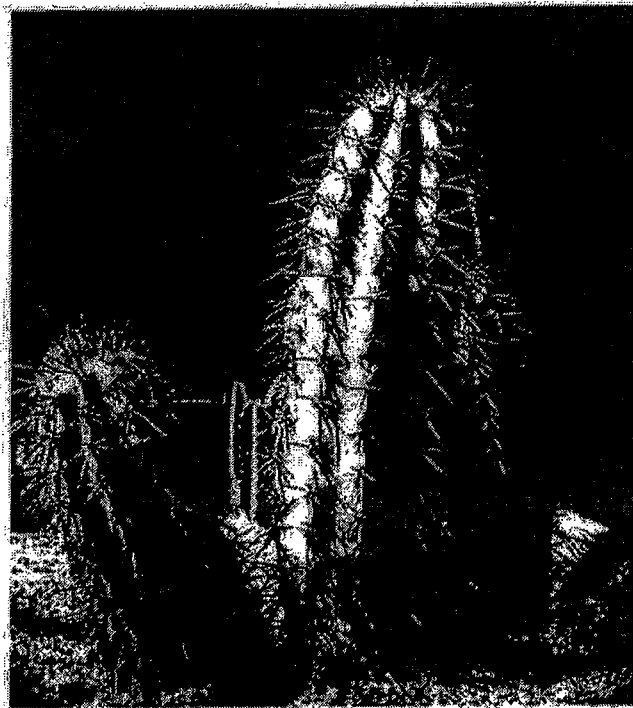
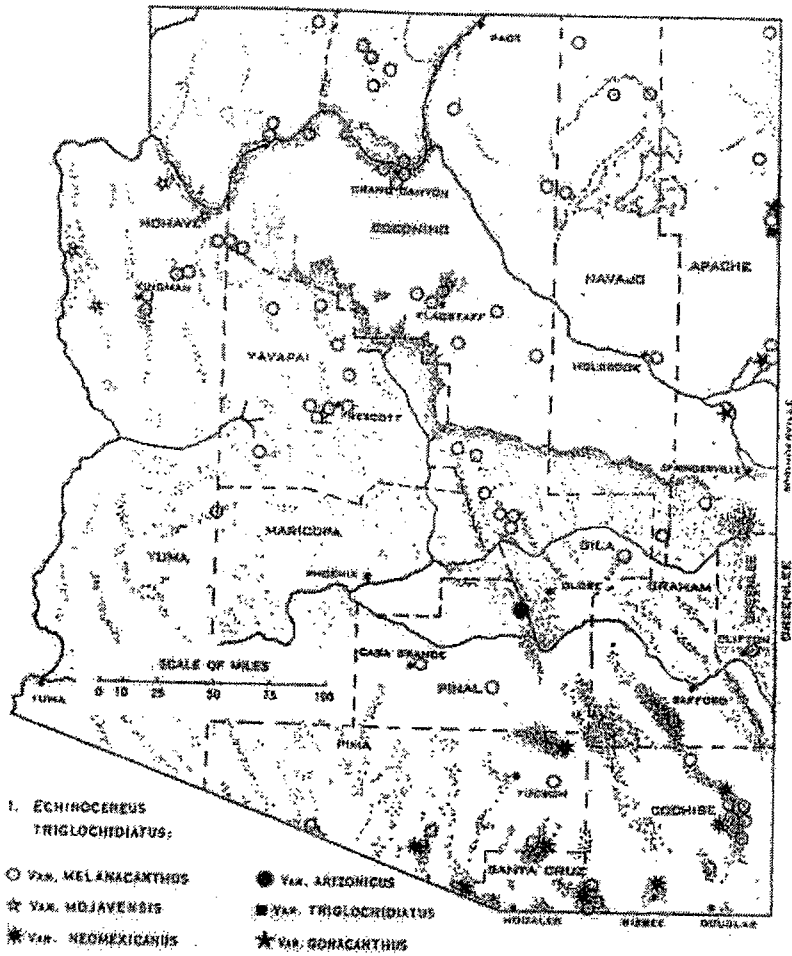
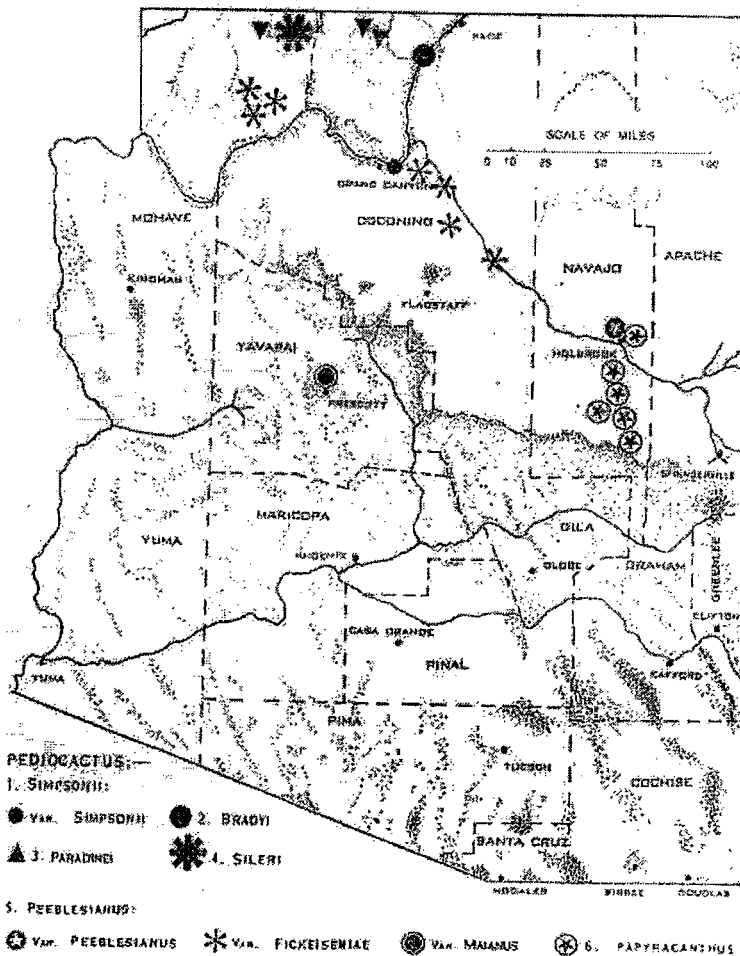


Fig. 634. Red-flowered hedgehog cactus, *Echinocereus triglochidiatus* var. *arizonicus*, plant in cultivation at Sacaton, Pinal Co., Arizona. (Robert H. Peebles)

Fig. 8.3. The documented distribution of the Arizona species of *Pediocactus*.



KEY TO THE SPECIES

1. Spines not strongly flattened, needlelike, circular to elliptic in cross section; stems globular, depressed-globular, obovoid, or short-cylindrical, their length little greater than their diameter or rarely twice as great.
2. Surface of the spine smooth, often more or less polished, rarely finely canescent.
3. Sepaloid perianth parts and the few (if any) scales on the superior floral tube either minutely toothed or short-fimbriate or entire and often undulate; seed black, 1/16 to 1/8 inch long; petaloid perianth parts pink and white, white, magenta, or yellow; areole not more than 3/4 inch in diameter; spines slender, not more than 1/32 inch in diameter.
4. Central spines none or, if (commonly) present, rigid, gently curving or straight, in mature plants at least distally reddish-brown or reddish, 5/16 to 1/2 or 1 1/16 inches long, 1/72 or 1/48 to 1/32 inch in diameter; petaloid perianth parts marginally either pink or magenta or white with pink middles or wholly yellow.
5. Central spines present (except in juvenile plants or the lower areoles persisting on adult stems), straight, 5 to 8 or 11 (or in young plants as few as 3) per areole; ovary with a few scales; radial spines almost straight, spreading irregularly, 1/4 to 3/4 or 3/4 inch long; stems 1 to 5 or 6 inches long, 1 to 4 or 5 inches in diameter; scales of the floral tube toothed or often short-fimbriate; seed about 1/12 inch long; fruit not stalked; seed tessellate-tuberculate.

1. *Pediocactus Simpsonii*, page 160

5. Central spines none (or rare); ovary practically lacking scales; radial spines slightly recurved, like the teeth of a comb along the elliptic or elongate areole, 1/4 to 3/4 inch long; stems at maturity only 1 to 2 or 2 1/2 inches in diameter, often barely protruding above ground; scales of the floral tube minutely toothed; fruit basally constricted into a short stalk; seed papillate and with larger mounds on the surfaces.

2. *Pediocactus Bradyi*, page 181

4. Central spines flexible and hairlike, bending or curving irregularly or straight; uniformly colored, white or ashy gray, turning in age to straw- or cream-color, 1 to 1 5/16 inches long, about 1/96 to 1/72 inch in diameter; petaloid perianth parts white or with pink midribs.

3. *Pediocactus Paradinei*, page 181

3. Sepaloid perianth parts and the scales of the floral tube long-fimbriate; seed gray, 1/16 to 1/5 inch long; petaloid perianth parts yellow or yellow with maroon veins; areole about 1/4 inch in diameter; spines rather stout, 1/32 to 1/24 inch in diameter.

4. *Pediocactus Sileri*, page 183

2. Surface of the spine and the tissue beneath spongy-fibrous; sepaloid perianth parts and the scales of the ovary, when present, scarious-margined, never fimbriate.

5. *Pediocactus Peeblesianus*, page 184

1. Spines strongly flattened, several times broader than thick, puberulent; stems elongate, their length at least twice their diameter.

6. *Pediocactus papyracanthus*, page 186

Species: *Pediocactus bradyi* L. Benson
Common Name: Brady's pincushion cactus
Status: Endangered

Distinguishing Characteristics:

- Stems solitary or rarely two, 3.8-6.2 cm long, 2.5-5 cm in diameter.
- Areoles elliptic, densely white or yellow-villous.
- Spines obscuring stem.
- Flowers borne terminally on or contiguous with spiniferous areoles.
- Tubricles not grooved.
- Central spines none (2 cases reported 1 or 2 central spines of darker color than radials).
- Radial spines white or tan, 14-15 per areole, glabrous, smooth, tapering gradually from bulbous bases, nearly circular in cross section.
- Flower 1.5 - 3 cm in diameter, 1.5 - 2 cm long.
- Petaloid perianth parts pale straw-yellow, oblanceolate, lower sepaloids green with purplish red midrib, upper sepaloids with green midrib and pale yellow margins.
- Is difficult to see as it blends into rocks.
- May retreat into ground during dry season.

Look Alikes: *Mammalaria* spp. have lateral flowers
Coryphantha spp. have grooved tubricle
other *Pediocactus* spp. have central spines

Flower Color: yellow, fruit green becoming brown
Flowering Period: April

Habitat: Known only from type locality -4000 ft. in Marble Canyon, Coconino County.

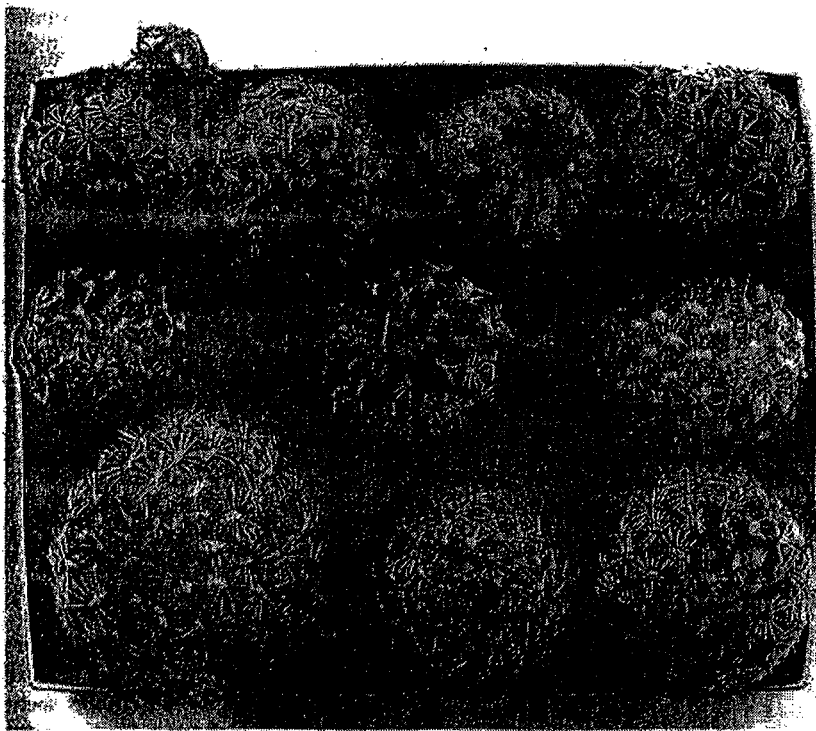


Fig. 793. *Pediocactus bradyi*, plants of the type collection in fruit.

Species: *Pediocactus peeblesianus* var. *fickeiseniae*
 Common Name: Fickeisen plains cactus
 Status: G3

Distinguishing Characteristics:

- Stem unbranched or with 2-4 branches, up to 2.5 - 3.8 cm long, 2.5 - 3.8 cm in diameter.
- Highly variable, single, long central spine, ashy white to pale gray, flexible, turned upward.
- 8 and occasionally 7 radial spines, straight, spreading irregularly, of varying sizes, 3-6 mm long, 0.25-0.5 mm in diameter.
- Fruit greenish, changing to tan during drying at maturity.

Look Alikes: Other *P. peeblesianus* varieties - see key.

Flower Color: yellow to yellowish-green, sometimes pale or white with a pink or green mid-rib.
 Flowering Period:

Habitat: Exposed layers of rock on the margins of canyons or hills in the desert at about 4,000-5,000 feet in elevation. Navajoan Desert and the Great Plains Grassland. Northern Arizona from northeastern Mohave County to the vicinity of the Colorado and Little Colorado Rivers in the Grand Canyon region and southeastward in Coconino County.

TABLE 17. CHARACTERS OF THE VARIETIES OF *PEDIOCACTUS PEEBLESIANUS*

	A. Var. <i>fickeiseniae</i>	B. Var. <i>Malanus</i>	C. Var. <i>Peeblesianus</i>
Relative size	Larger in all parts.	Larger in all parts.	Smaller in all parts.
Stem	Unbranched or with 2 to 4 branches, up to 1 or 1½ or 2½ inches long, 1 to 1½ inches in diameter.	Unbranched, about 2½ inches long, 1½ inches in diameter.	Unbranched, up to 1 inch long, ¾ to ¾ or 1 inch in diameter.
Central spine	1, erect and prominent for small or absent in young plants, clearly differentiated from the radials, highly variable.	None.	None; the upper radial spine often longer than the others and up to ¼ or even 5/16 inch long.
Radial spines	Usually 6 but sometimes 7, straight, spreading irregularly, of varying sizes, ¼ to ¼ inch long, 1/96 to 1/48 inch in diameter.	6, the three lower stout, about ½-inch long, 1/24 inch in diameter, the lowest one curving strongly; the upper as long but more slender; the 2 upper lateral ones much smaller.	Usually 4 but in some areas, sometimes 3 or 5, recurving, with the appearance of a cross; the lower ones usually ¼ to 3/16 or ¼ inch long, 1/72 to 1/24 inch in diameter.
Geographical distribution	Arizona from northeastern Mohave County to the Grand Canyon region and the vicinity of the Little Colorado River, Coconino County.	Arizona near Prescott, Yavapai County.	Arizona near Joseph City and Holbrook, Navajo County.



Fig. 802 (above). *Pediocactus peeblesianus* var. *fickeiseniae*, the type collection, showing the extreme variation in spines to be found in a single population of this variety.

Species: *Puccinellia parishii* Hitchc.
Common Name: Parish's alkali grass
Status: G2

Distinguishing Characteristics:

- Annual dwarf grass.
- Culms 10cm, leaf blades flat to slightly involute, up to 1 mm wide; panicle narrow, few flowered, branches strongly ascending.
- Spikelets several flowered; 3-5 mm long.
- Glumes unequal; broad, strongly nerved, scarious margined.
- Palea as long as the lemma or a little shorter.
- Lemmas pubescent on nerves; firm, obtuse; about 2 mm long.

Look Alikes: *P. fasciculata* and *P. airoides*. Both perennial; if hairy, hairs not confined to nerves.

Flower Color:

Flowering Period: June to September

Habitat: Shato, Navajo, Tuba, and Coconino counties. 5,000-6,000ft. Marshy ground. Usually saline soil.

Drawing No. 85320D

**J23 Vegetation Project Area and Plant Community
Distribution Map.**

Attachment 5

1999 Baseline Vegetation Report
J9 Coal Resource Area and J9 Haul Road Corridor
Black Mesa Mining Complex

**1999 Baseline Vegetation Report
J9 Coal Resource Area and J9 Haul Road Corridor**

Black Mesa Mining Complex

September 2000

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Drawing No. 85320C J9 Vegetation Study Area and Plant Community
Distribution Map.

INTRODUCTION

In October 1999 ESCO Associates Inc. (ESCO) was directed by Peabody Western Coal Company (PWCC) to conduct a baseline vegetation study of the J-9 Coal Resource Area and Haul Road Corridor (Project Area). The Project Area lies in the southwestern portion of the existing Black Mesa Mining Complex leasehold in northeastern Arizona.

The vegetation resources in the Project Area are similar to those described in previous baseline studies conducted in and adjacent to the Black Mesa leasehold (Peabody Coal Company, 1985). They consist of a mosaic of sagebrush and pinyon-juniper vegetation communities at approximately 6400 ft. elevation. Study objectives included a sensitive plant survey, documentation of all plant species encountered, verification of previous vegetation community mapping, and verification of the similarity of the vegetation in the Project Area to the vegetation documented in previous studies using the established sagebrush and pinyon-juniper reference areas. The Project Area was surveyed in October 1999 as well as in May 2000 to cover phenologic variability of target species.

Both rare species identified by the U.S. federal government under provisions of the Endangered Species Act of 1973 and those similarly identified by the Navajo Nation pursuant to Title 17§507 of Navajo Nation Code of the Navajo Nation Council's Resource Committee (Resolution RCF-014-91, 1991).

USFWS Threatened and Endangered Species

The federal definition of an endangered species is any species which is in danger of extinction throughout all or a significant portion of its range (other than a species of the Class Insecta as determined by the Secretary to constitute a pest whose protection under the provisions of The Endangered Species Act of 1973 would present an overwhelming and overriding risk to man).

The federal definition of a threatened species is any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, as determined by the Secretary.

Navajo Endangered Species List

The following definitions are taken from the Navajo Endangered Species List (NDFW 1997).

Group 1 (G1): "Extirpated" (i.e. extinct within a part of a species range) - Those species or subspecies that no longer occur on the Navajo Nation.

Group 2 (G2): "Endangered" - Any species or subspecies which is in danger of being eliminated from all or a significant portion of its range on the Navajo Nation.

Group 3 (G3): "Threatened" - Any species or subspecies which is likely to become endangered within the foreseeable future, throughout all or a significant portion of its range on the Navajo Nation.

Group 4 (G4): "Candidate" - Any species or subspecies for which the Navajo Department of Fish & Wildlife does not currently have sufficient information to support their listing as G2 or G3 but has reason to consider them. The NDFW is actively seeking information to determine if they warrant inclusion in a different group or removal from the list. They are not protected under Tribal Code but should be considered in project planning.

METHODS

Sensitive Plant Surveys/Species Lists

The list of sensitive plants searched for during the field survey was compiled using United States Fish and Wildlife Service (USFWS) listings as well as those provided by NDFW (1997). Plants listed as "threatened" or "endangered" by USFWS under the Endangered Species Act, as well as those listed by NDFW in Groups one through four were included in the survey (Table 1). Because both the NDFW and the USFWS Region 2 lists included species with habitat requirements not found in the Project Area as well as species known only from disjunct geographic areas, a literature review was conducted to identify species with a reasonable probability of occurrence. McDougal (1973) as well as Atwood et. al. (1991), Cronquist et. al. (1977), Benson (1969), Bureau of Land Management (1995), and Spackman et. al. (1997) were used for species-specific ecological information. These references were also used to construct

a site-specific field guide (Appendix 3). Subsequent to the field surveys, an amended list of endangered species was provided by the Navajo Nation (NDFW 2000). Additional species from this list were also reviewed for potential occurrence in the study area and are separately discussed below.

Using maps provided by PWCC and plotted over a photographic base with Universal Transverse Mercator (UTM) waypoints (Drawing 1), ESCO personnel walked the entire length of the proposed disturbance area. During this pedestrian survey, investigators, walking three or four abreast, searched for evidence of the species listed in Table 1. The teams proceeded along the disturbance area following a zigzag pattern and noted all species encountered. Separate species lists were generated for the sagebrush and pinyon-juniper communities during the fall 1999 survey (Table 2). During the spring 2000 surveys, species lists were compiled for the J9 Study Area (Table 3). Hand-held Global Positioning System (GPS) units were used to ensure the teams maintained proper location and bearing throughout the survey. Would any species of concern have been identified, these units would also have been important in accurately mapping plant species' locations.

Plant Species Listing

Scientific names follow McDougall (1973) where applicable. In cases where scientific names were not found here, nomenclature used by the listing agency (USFWS and NDFW) were used; common names cited may be found in Beetle (1970), Nickerson et. al. (1976), or Soil Conservation Service (1979).

Assessment of Comparability of Project Area Vegetation to Permit Area Vegetation

During the course of the survey, the team leader assessed the comparability of the sagebrush and pinyon-juniper community types to those types within the present Black Mesa permit areas and especially the existing reference areas. This was done via qualitative consideration of total vegetation cover, species composition, slope and aspect (exposure), as well as variation of soil depth and texture. The plant communities of the project area had been mapped previously, but given the new photobase used to place community delineation lines, boundaries were checked and realigned slightly (Drawing 1).

RESULTS/DISCUSSION

Rare Plants

Of the ten species identified in Table 1, none were found in the Project Area; although certain species could reasonably be expected to occur based on previous site collection information. None of the rare species identified in Table 1 were encountered. Narrowly defined habitats such as hanging garden seeps or limestone outcrops that are required by some of these plants were likewise not found.

USFWS Threatened and Endangered Species Included in Survey

Sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*), Mancos milkvetch (*Astragalus humillimus*), giant claret cup hedgehog (*Echinocereus triglochidiatus* var. *arizonica*), and Brady's pincushion cactus (*Pediocactus bradyi*) are listed as endangered under the Endangered Species Act (ESA). None of the species were observed in the Project Area, and would not be expected to occur based on habitat requirements.

Sentry milkvetch, known only from the type locality near the south rim of the Grand Canyon at approximately 7000 ft. elevation, grows on limestone pavement. No limestone derived substrate occurs in the Project Area.

Mancos milkvetch occurs in cracks of Point Lookout Sandstone of the Mesa Verde Group between 5000 and 6500 ft. No such formations occur in the Project Area.

Giant claret-cup hedgehog, known from oak woodland and chaparral communities in southern Arizona near the border of Gila and Pinal counties, was not encountered. The closely related Mojave claret-cup (*Echinocereus triglochidiatus* var. *mojavensis*) was fairly common throughout the pinyon-juniper community.

Brady's pincushion cactus, known only from the type locality in Marble Canyon at approximately 4000 ft., was not observed. No other *Pediocactus* species were observed.

Navajo sedge (*Carex specuicola*) is threatened and grows exclusively in "hanging gardens" (densely vegetated seeps found in rock outcrops in the Southwestern deserts). No such environments occur in the Project Area.

Navajo Endangered Species (NDFW 1997) Included in the Field Survey

Group G1

No plants from this group were considered as having a potential for occurrence in the Project Area.

Group G2

Parish's alkali grass (*Puccinellia parishii*) grows in alkaline seeps or flats in drainage bottoms. No such vegetated areas were encountered during the survey. One small, bare, moist area with white crusting indicative of an alkaline environment was observed on a shale outcrop.

Group G3

Cutler's milkvetch (*Astragalus preussii* var. *cutleri*), an endemic of San Juan county, Utah, occurs in desert shrub communities at approximately 3800 ft., considerably below the elevation of the study area. Nonetheless, it was deemed that this species could potentially be present in the study area for purposes of this survey. Four other milkvetches were observed during the survey (*A. wingatanus*, *A. calycosus*, *A. praelongus*, and *A. crassicaarpus*).

Fickeison plains cactus (*Pediocactus peevlesianus* var. *fickeisoniae*) is known from northern Coconino and Mojave counties and was deemed to have some possibility of occurrence in the Project Area.

Group G4

Desert columbine (*Aquilegia desertorum*) occurs at elevations from 6800 to 8000 ft and is known only from the northern Arizona counties of Coconino and Navajo. No columbines were observed. Although the Project Area is somewhat below this plant's elevational range, it was deemed to have some possibility of occurrence in the Project Area.

Naturita milkvetch (*Astragalus naturitenses*) is known from southwestern Colorado and McKinley County, New Mexico. It occurs on sandstone ledges in the pinyon-juniper community and along canyon rimrock between 5400 and 6200 ft. of elevation. This species is spring flowering and was deemed to have some possibility of occurrence in the Project Area.

Navajo Endangered Species List (NDFW 2000)
Additional Species Considered

The following species are additional species present in the expanded Navajo Endangered Species List (NDFW 2000) that were considered after the field surveys had been completed.

Acoma Fleabane (*Erigeron acomanus*) is found on sandy slopes beneath cliffs of Entrada sandstone in McKinley County, New Mexico. Entrada sandstone is not present in the Project Area which is also a substantial distance from its occurrence in New Mexico.

Alcove Bog-Orchid (*Platanthera zothecina*) is found in seeps associated with hanging gardens and moist stream sites in Northern Arizona, Utah, and Colorado. No hanging garden habitats occur within the Project Area.

Alcove Rock Daisy (*Perityle specuicola*) is found in Hanging Gardens in Grand and San Juan Counties, Utah at elevations between 3,690 and 4,000 ft. The Project Area is more than 2,000 feet higher and no hanging garden habitats area present, so its occurrence there is thought extremely unlikely.

Bluff Phacelia (*Phacelia indecora*) is known to occur in salt desert scrub vegetation at 4,490 ft. in San Juan County, Utah. The difference in elevations of the Project Area and vegetation along with the wide geographic separation make this plant extremely unlikely in the study area.

Gooding's Onion (*Allium goodingii*), occurs in neighboring Apache County, but at much higher elevation (9,000 to 9,500 ft).

Navajo Bladderpod (*Lesquerella navajoensis*) is known to occur near Thoreau, New Mexico on Todilto limestone. The dissimilar geology and great distance from the Project Area make this species extremely unlikely to occur in the Project Area.

Navajo Mountain Penstemon (*Penstemon navajoa*) occurs in San Juan County, Utah at elevations between 8,200 and 10,370 ft. amidst ponderosa pine, aspen, and Douglas-fir forests. In addition to occurring at substantially higher elevations than occur in the Project Area, the

moisture conditions implicit in the listed vegetation types are not duplicated anywhere in the Project Area.

Mesa Verde Cactus (*Sclerocactus mesa-verdae*) is found in salt desert scrub communities in the Fruitland and Mancos shale formation in San Juan County, New Mexico and Montezuma County, Colorado. The geology of the Project Area does not include such materials and the vegetation is not salt desert scrub, so the occurrence of this species was deemed extremely unlikely.

San Juan Milkweed (*Asclepias sanjuanensis*) is known to occur in Great Basin Grasslands and Pinyon Juniper Woodlands between 5,000 and 6,000 ft. It is very similar (if not synonymous) to *A. ruthiae*, a species previously studied in Utah by the surveyor. None were found during field searches in the Project Area.

Tuba City Milkvetch (*Astragalus sophoroides*) occurs in eastern Coconino County, Arizona between Cameron and The Gap. Information available from the herbarium of Northern Arizona University indicates that the potential distribution of the species is from Leupp to Cameron along the Little Colorado River and then north to The Gap across the Painted Desert. Although the lower reaches of Moenkopi Wash are included in this area, the upper reaches present in the Project Area are more than 30 miles east and approximately 2,000 feet higher than its known occurrences.

Community Comparability

For purposes of assessing the similarity of the Project Area vegetation to that described in previous studies, the sagebrush and pinyon-juniper communities found within the Project Area were determined to be comparable to reference areas previously established at the Black Mesa Mining Complex (J7RASAGE, N7/8RASAGE, N7/8RAPJUN, N14RASAGE, and N14RAPJUN). While no quantitative cover data were collected during the assessment of comparability, it is ESCO's opinion, based on ocular estimate, that total vegetation cover in the Project Area approximates that measured in the reference areas in 1999 and that vegetation is representative of regional sagebrush and pinyon-juniper communities in the existing permit. Total vegetation cover averaged 33.2 percent in the J7, N7/8, and N14 sagebrush reference areas. Total vegetation cover, including canopy cover, in the N7/8 and N14 pinyon-juniper

reference areas averaged 31.8 percent; 12.7 percent was the average vegetation cover excluding canopy cover (ESCO 2000). Photos from the sagebrush community (Photos 1 and 2) are compared to the J7 Sagebrush Reference Area shown in photos 3 and 4. Photos from the pinyon-juniper community (Photos 5 and 6) are compared to the N7/8 Pinyon-juniper Reference Area shown in Photos 7 and 8.

During fall 1999 monitoring of the reference areas, 113 species were observed; 112 species were found in the Project Area (Table 2). While individual life forms' species composition varied somewhat between the Project Area and the reference areas, they were quite similar overall.

Soils of the project area were generally shallow, sandy, and rocky (coarse fragments greater than 10 percent) in the pinyon-juniper community, and relatively deep, finer-grained, and less rocky (coarse fragments approximately 10 percent or less) in the sagebrush community. The pinyon-juniper soils are derived primarily from sandstone, while those in the sagebrush community are derived from a mixture of sandstone and shale-derived alluvium and loess. A similar situation is present in the reference areas as well as the regional vegetation in the existing permit area.

CONCLUSION

None of the listed species were observed in the Project Area during either the October 1999 or the May 2000 surveys. Of the narrow habitat requirements associated with any of the listed species; none were found (e.g. hanging gardens or specific geologic strata).

The sagebrush and pinyon-juniper communities found in the Project Area are comparable in total vegetation cover, species composition, slope, aspect, and soil type, depth and texture to those of the existing permit area region. The existing reference areas will provide an adequate standard against which reclamation/revegetation success can be evaluated.

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