APPENDIX D2

BASELINE VEGETATION AND WILDLIFE SURVEYS

CEDAR CREEK ASSOCIATES, INC.

United Nuclear Corporation

Baseline Vegetation and Wildlife Surveys

CHURCH ROCK MILL SITE

JULY, 2014

CEDAR CREEK ASSOCIATES, INC.
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United Nuclear Corporation (UNC)

Church Rock Mill Site

BASELINE VEGETATION AND WILDLIFE SURVEYS

1.0 INTRODUCTION

1.1 General

Cedar Creek Associates, Inc. (Cedar Creek) was contracted in 2013 to implement baseline vegetation and wildlife surveys in support of the construction of a proposed repository at United Nuclear Corporation's (UNC) Church Rock Mill Site (Mill site). These surveys were conducted in accordance with the Northeast Church Rock Mine Site Removal Action, Pre-Design Studies Work Plan, Church Rock Mill Site (PDS Work Plan) (MWH, 2013). Assessment of existing vegetation on and in the vicinity of the borrow areas was performed to aid in development of a revegetation plan that establishes long-term, self-sustaining species at the borrow areas and on the repository cover surface. The vegetation assessment consisted of a baseline evaluation of the anticipated disturbance areas (soil borrows) and establishment of additional (site-appropriate) vegetation analog to provide a suitable ecological comparison for eventual revegetation of the future disturbance areas. Concurrently, these analog areas provided an opportunity to quantitatively evaluate specific parameters of the successional communities expected to progress through the lifespan of the repository. Information presented in this report provides a summary of sampling results and pertinent observations stemming from the baseline surveys.

Floral and wildlife surveys were conducted October 19th-23 2013 by or under the direct supervision of Cedar Creek Ecologist (and Project Manager) Mr. Jesse H. Dillon. A description of vegetation and wildlife sampling methodologies is presented in Appendix A and B, respectively. Field guides to sensitive plant and animal species potentially found on the Church Rock Mill Site are presented in Appendix C and D, respectively. Raw data and photos from all baseline surveys can be found in appendix E and F, respectively.

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1.2 Site Description

The Church Rock Mill Site is located approximately 16 miles northeast of Gallup, New Mexico, at an elevation ranging between 7,000 and 7,200 feet above mean sea level. Three communities, reclaimed, grassland, and shrubland, may be disturbed while sourcing construction materials for the repository from the areas shown on Map 1. These areas may require a future reclamation plan.

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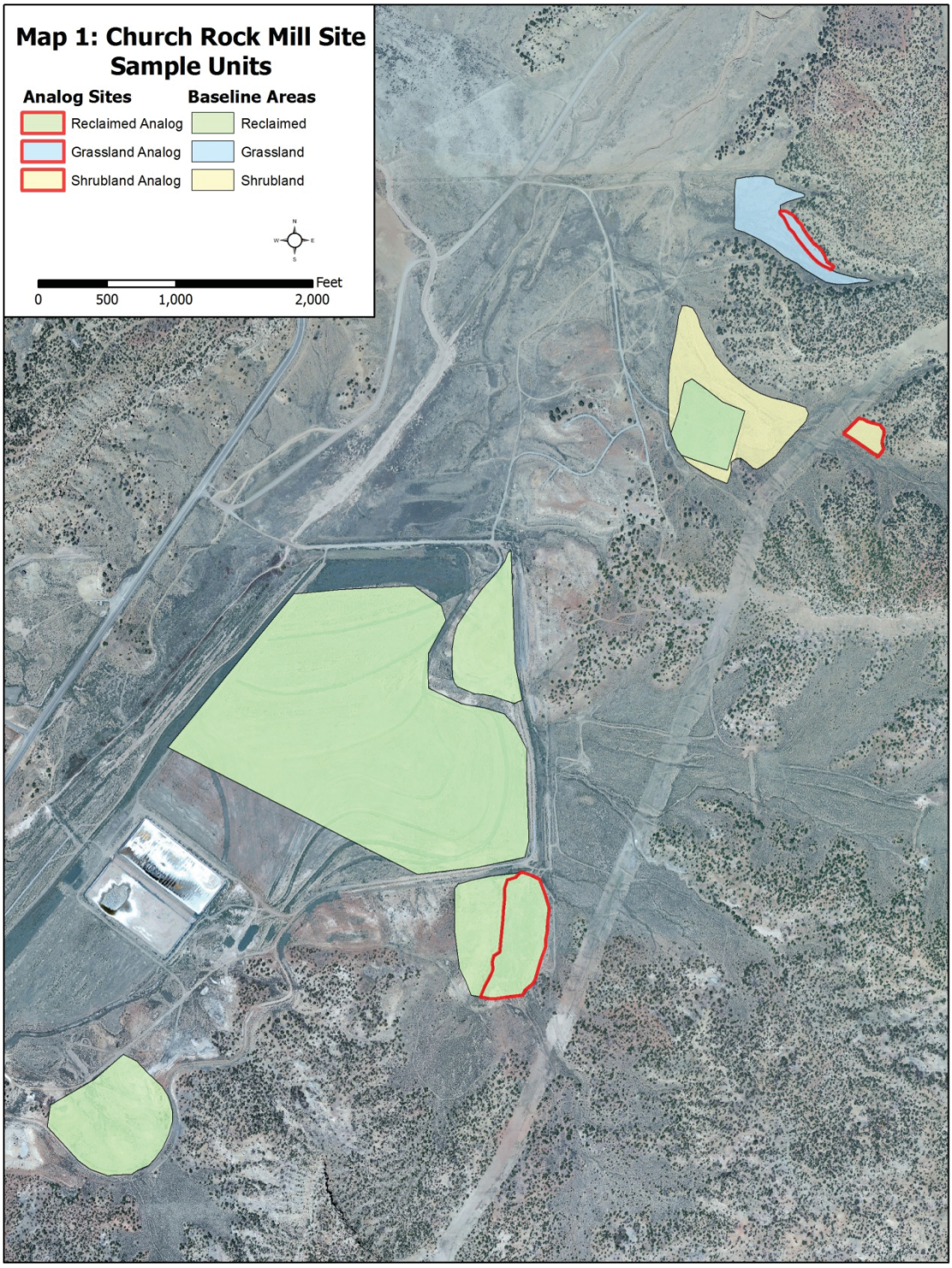

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1.3 Precipitation

Table 1 and the associated chart on the following page exhibit the seasonal precipitation that has occurred at Gallup, New Mexico over the past 12 years. The weather station at Gallup Municipal Airport, New Mexico is sufficiently near the site (approximately 19 miles southwest) to provide a good comparison of long-term trends in precipitation for the area. The average annual precipitation (Jan-Dec) for the past 12 years is 10.20 inches while monthly averages range from 0.24 in June to 2.08 inches in July (Table 1). Eleven-year average winter precipitation is 2.23 inches while spring, summer, and fall averages 1.28, 4.02, and 2.67 inches, respectively.

Precipitation for the 2012/2013 growing season was 1.23 inches in the fall of 2012 (46% of average), 1.62 inches in the winter of 2012/2013 (73% of average), 0.61 inches in the spring of 2013 (48% of average), and 4.83 inches in the summer of 2013 (120% of average). The total precipitation of the 2012/2013 growing season was 8.29 inches (81% of average).

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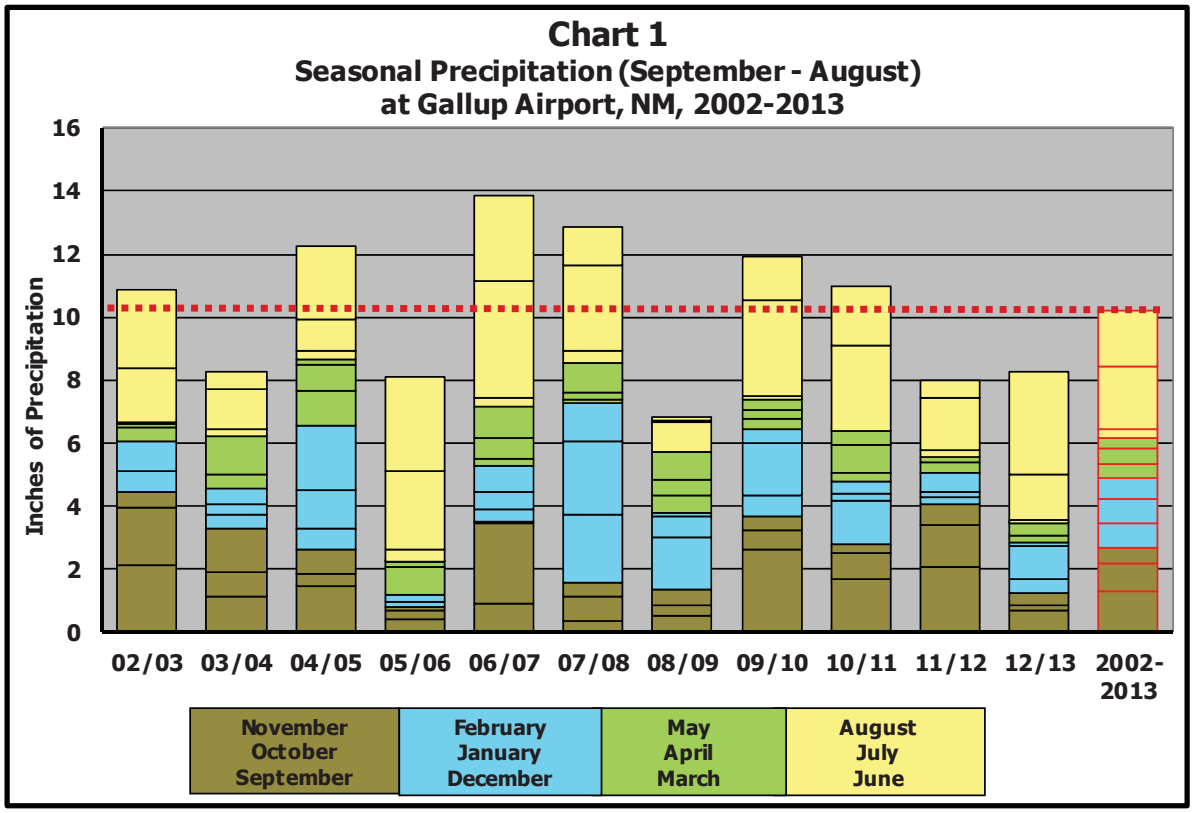
Table 1 - Annual Precipitation at Gallup Airport, NM, 2002 - 2013

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
2002	0.17	0.13	0.17	0.64	0.06	0.00	3.20	1.73	2.13	1.80	0.55	0.62	**11.20**
2003	0.01	0.97	0.41	0.10	0.07	0.01	1.70	2.50	1.12	0.79	1.37	0.44	**9.49**
2004	0.37	0.50	0.44	1.22	0.00	0.18	1.29	0.53	1.49	0.38	0.75	0.66	**7.81**
2005	1.22	2.05	1.1	0.86	0.16	0.27	1.01	2.32	0.39	0.28	0.14	0.13	**9.93**
2006	0.26	0	0.85	0.18	0.01	0.37	2.49	3.02	0.92	2.55	0.06	0.36	**11.07**
2007	0.57	0.84	0.19	0.70	0.97	0.27	3.73	2.72	0.35	0.80	0.40	2.20	**13.74**
2008	2.28	1.27	0.1	0.20	0.97	0.38	2.67	1.24	0.55	0.31	0.51	1.66	**12.14**
2009	0.67	0.10	0.55	0.51	0.85	0.93	0.08	0.12	2.64	0.57	0.47	0.67	**8.16**
2010	1.64	0.45	0.33	0.31	0.30	0.14	3.00	1.41	1.70	0.80	0.29	1.38	**11.75**
2011	0.23	0.41	0.27	0.88	0.45	0.00	2.69	1.86	2.05	1.33	0.69	0.19	**11.05**
2012	0.20	0.60	0.33	0.16	0.00	0.21	1.70	0.55	0.70	0.16	0.37	0.47	**5.45**
2013	1.02	0.13	0.21	0.38	0.02	0.12	1.44	3.27	1.83	0.78	1.28	0.15	**10.63**
2002-2013 Avg.	**0.72**	**0.62**	**0.41**	**0.51**	**0.32**	**0.24**	**2.08**	**1.77**	**1.32**	**0.88**	**0.57**	**0.74**	**10.20**



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2.0 VEGETATION COMMUNITIES

Five vegetation communities exist in the vicinity of the Mill Site.

Reclaimed	A previously disturbed ecosystem which has been revegetated through either natural or anthropogenic means.
Grassland	A native ecosystem which is characterized by deep soils and is physiognomically dominated by grasses.
Shrubland	A native ecosystem which is characterized by deep soils and is physiognomically dominated by shrubs.
Piñon Juniper	A native ecosystem which is characterized by thin soils and is physiognomically dominated by trees.
Disturbed Bottomland	A bottomland ecosystem which is characterized by deep soils and riparian vegetation. Riparian vegetation has elevated water requirements which are typically met with a water table close to the surface.

Through literature review, field investigation, and analysis, Cedar Creek has identified the following three vegetation communities that are projected to colonize the repository over the next 1,000 years: reclaimed (early-successional), grassland (mid-successional), and shrubland (late-successional or climax community). The Piñon Juniper community, which prefers thin soils, was eliminated as a potential ecological scenario on the repository because the soils profile (as currently proposed) can be considered a deep soil. The Disturbed Bottomland community was eliminated as a potential ecological scenario on the repository because of the elevated water requirement of the vegetation. The repository will be designed to shed any water that falls directly onto it, and with diversion channels to divert any water that flows toward it. Reclaimed, Grassland and Shrubland communities inhabit all the potential borrow sources (Map 1). These areas were sampled for baseline evaluation to quantify the floral and faunal resources and provide a logical target for eventual revegetation.

Though specific timeframes are very difficult to predict and are often affected by environmental conditions such as climate, and land management activities such as grazing, the projected communities are expected to inhabit the repository for the following timeframes:

- Reclaimed: 0 - 50 Years
- Grassland: 25 - 100 Years
- Shrubland: 50 - 1,000 Years

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2.1 Analog Area Selection

The Grassland and Shrubland Analog area(s) to be used to characterize ecological scenarios for the repository cover were selected from undisturbed areas in the vicinity of the project area, whereas the Reclaimed Analog was selected from a reclaimed area. Preferred analog areas can be characterized as "ecologically and topographically similar" to the eventual rehabilitated landform and are based on three main considerations, as follows:

1. The analog area(s) is representative vegetation communities projected to inhabit the cap.
2. The analog area(s) occupy topography and aspects that are representative of the majority of reclaimed areas.
3. The analog area(s) exhibit similar physical soil conditions as reclaimed areas and therefore, should be an "approximate ecological equivalent".

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3.0 VEGETATION RESULTS

Ground cover data, woody plant density, and production were collected from the Reclaimed, Grassland, and Shrubland Baseline and Analog sites. Each analog and baseline site was evaluated with 15 samples with each sample consisting of a 10-meter ground cover transect, a co-located woody plant density belt (2m x 50m), and ½ m^2 production quadrat (Appendix A - Figure 1). Map 2 displays the vegetation sample points. All sampled variables and analyzed parameters are summarized and presented in the main report text or with the raw data in Appendix E. Furthermore, photos of each sampling area were collected to document conditions of the evaluation areas at the time of sampling in October, 2013 and can be found in Appendix F.

Floristic surveys of the baseline and analog areas resulted in the identification of a total of 41 taxa, including: 13 grass-like species, 16 forbs, 2 noxious weeds, and 10 trees, shrubs, sub-shrubs, or succulents. Of these 41, 37 were of sufficient distribution as to be intercepted by sampling metrics. All observed species are listed below in Table 1.

According to the New Mexico rare plants database, none of the identified species of concern (including state and federal threatened and endangered species as well as tracked rare species) have historically been found in the immediate vicinity of the project area. The taxa of primary concern and their habitats are indicated in Appendix C of this report. Site-specific field efforts have verified that no rare, threatened or endangered plant species occur on or near the project area. All rare, threatened or endangered taxa were searched for, but with negative results.

Noxious weeds were found on the East and West Borrow. If these sites are selected as a borrow source, the noxious weeds will need to be aggressively managed prior to construction to avoid further invasion of current and future reclamation areas.

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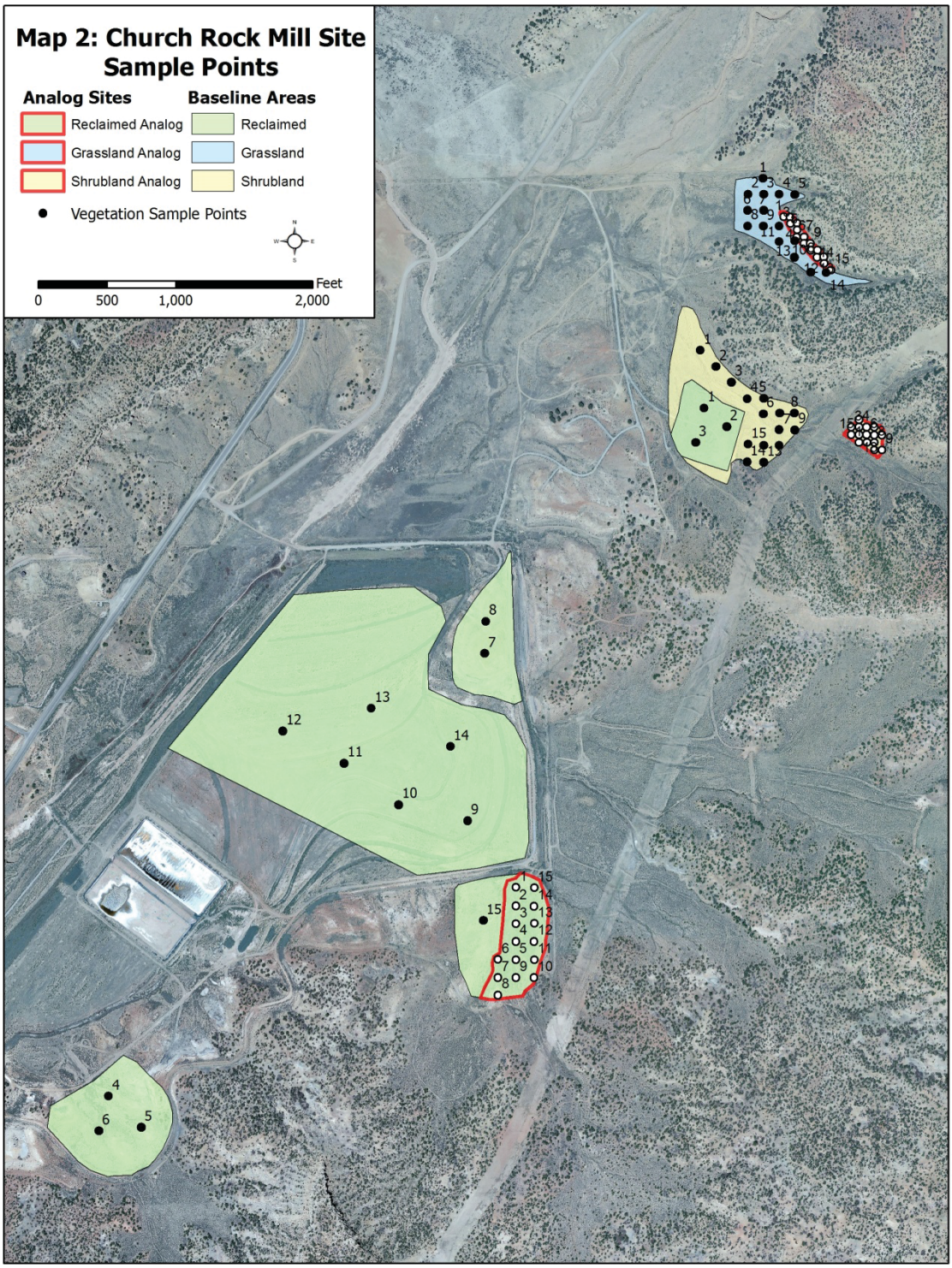

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Table 2 Church Rock Mill - Vegetation Cover - 2013

Plant Species Observed

		Area ——>	Reclaimed Baseline	Grassland Baseline	Shrubland Baseline	Reclaimed Analog Area	Grassland Analog Area	Shrubland Analog Area
Grasses								
P	*Achnatherum hymenoides*	Indian Ricegrass	X			X	X	
P	*Agropyron smithii*	Western Wheatgrass	X	X	X	X		X
P	*Aristida purpurea*	Purple Three-awn	X					
P	*Bouteloua curtipendula*	Sideoats Grama	X				X	
P	*Bouteloua gracilis*	Blue Grama	X	X	X		X	X
P	*Elymus elymoides*	Squirreltail	X	X	X	X	X	
P	*Hilaria jamesii*	Galleta	X				X	
P	*Hordeum jubatum*	Foxtail Barley	X					
A	*Munroa squarrosa*	False Buffalograss	X	X	X			
P	*Psathyrostachys juncea*	Russian Wildrye	X					
P	*Sporobolus airoides*	Alkali Sacaton	X					
P	*Sporobolus cryptandrus*	Sand Dropseed	X		X	X		
A		Unidentified Annual Grass				X		
Forbs								
A	*Amaranthus hybridus*	Slim Amaranth	X					
P	*Asclepias subverticillata*	Horsetail Milkweed				X		
P	*Aster sp.*	Aster sp.	X			X		
A	*Bassia scoparia*	Burningbush	X	X	X	X		
B Nw	*Carduus nutans*	Musk Thistle	X					
A	*Chamaesyce serpyllifolia*	Thymeleaf Sandmat	X	X		X	X	
A	*Chenopodium album*	Lambsquarters			X		X	X
P	*Eriogonum sp.*	Buckwheat sp.	X		X			
A	*Erodium cicutarium*	Redstem Stork's Bill	X	X				
A	*Helianthus sp.*	Helianthus spp.				X		
P	*Phoradendron macrophyllum*	Colorado Desert Mistletoe		X				
A	*Portulaca oleracea*	Little Hogweed		X	X	X	X	
A	*Salsola tragus*	Russian Thistle	X	X	X	X	X	X
A	*Sisymbrium altissimum*	Tall Tumblemustard	X					
P	*Sphaeralcea coccinea*	Scarlet Globemallow		X				
P	*Symphyotrichum falcatum*	White Prairie Aster				X		
P		Unidentified Perennial Forb	X	X				
Shrubs, Sub-shrubs, Cacti & Trees								
P	Artemisia dracunculus	Tarragon				X		
P	*Artemisia tridentata*	Big Sagebrush		X	X			X
P	*Atriplex canescens*	Fourwing Saltbush	X		X	X	X	X
P	*Ceratoides lanata*	Winterfat		X			X	X
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush	X	X	X	X	X	
P	*Gutierrezia microcephala*	Threadleaf Snakeweed		X	X		X	X
P	*Gutierrezia sarothrae*	Broom Snakeweed	X		X		X	X
P	*Opuntia polyacantha*	Plains Pricklypear		X				
P	*Pinus edulis*	Two-needle Piñon					X	X
P Nw	*Tamarix sp.*	Tamarisk	X					
P	*Tetradymia glabrata*	Littleleaf Horsebrush	X					

Total Counts by Lifeform:													
Annual Grass	Perennial Grasses	1	11	1	3	1	4	1	4	0	5	0	2
Annual Forbs	Perennial Forbs	6	3	5	3	4	1	5	3	4	0	2	0
Noxious Weeds		2		0		0		0		0		0	
Shrubs, Sub-shrubs, Cacti and Trees		4		5		5		3		6		6	
Total Species Encountered		**27**		**17**		**15**		**16**		**15**		**10**	

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

3.1 Reclaimed Baseline

Table 3 and Chart 2 indicate that at the time of the evaluation, total plant cover within the reclaimed baseline was 43.4% with an average perennial cover of 17.13%. Rock, litter, and bare ground exposure were 4.1%, 24.6%, and 27.9% respectively. Annual and biennial forbs provided the majority of floral cover (21.9%) followed by shrubs, sub-shrubs, cacti, and trees (10.5%), and then perennial grasses (6.1%). Dominant taxa were burningbush (*Bassia scoparia*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and Russian thistle (*Salsola tragus*) with 13.1%, 7.7%, and 6.5% cover, respectively. Review of Table 4 and Chart 3 reveals that woody plant density in this area averaged 941.6 stems per acre with an average of 938.9 shrubs per acre and 2.7 noxious weeds per acre. The dominant woody species were rubber rabbitbrush with 760.8 plants per acre and fourwing saltbush (*Atriplex canescens*), with 121.4 plants per acre. Table 5 and Chart 4 exhibit the current annual production of the reclaimed baseline area with 660.8 pounds per acre of total production; of which, 249.3 pounds per acre was perennial. Dominant life forms in terms of production were native and introduced annual and biennial forbs, shrubs, and native perennial grasses with an average of 315.5, 128.7, and 120.6 pounds per acre, respectively.

3.2 Grassland Baseline

Table 3 and Chart 2 indicate that at the time of the evaluation, total plant cover in the grassland baseline area was 69.9% with an average perennial cover of 52.5%. Rock, litter, and bare ground exposure were 0.1%, 13.6%, and 16.5%, respectively. Perennial grasses provided the majority of floral cover (45.5%), followed by annual and biennial forbs (17.1%), and shrubs, sub-shrubs, cacti and trees (6.7%). Dominant taxa were blue grama (Bouteloua gracilis), Russian thistle, rubber rabbitbrush, and little hogweed (*Portulaca oleracea*) with 44.4%, 9.5%, 3.20%, and 3.07%, respectively. Review of Table 4 and Chart 3 indicates woody plant density in the area averaged 768.9 stems per acre, with an average of 766.2 shrubs per acre and 2.7 succulents per acre. The dominant woody plants were rubber rabbitbrush, big sagebrush (*Artemisia tridentate*), and winterfat (*ceratoides lanata*), with 704.1, 40.5, and 13.5 plants per acre, respectively. Table 5 and Chart 4 exhibit the current annual production of the grassland baseline with 785.7 pounds per acre of total production of which 642.4 pounds per acre was perennial production. Dominant life form categories in terms of production are native perennial grasses, annual and biennial forbs, and shrubs with an average of 574.0, 143.3, and 68.4 pounds per acre, respectively.

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3.3 Shrubland Baseline

Table 3 and Chart 2 indicate that total plant cover in the Shrubland Baseline area at the time of the evaluation was 36.5% with an average perennial cover of 30.9%. Rock, litter, and bare ground exposure were 2.9%, 20.5%, and 40.2%, respectively. Shrubs, sub-shrubs, cacti and trees provided the majority of floral cover (17.9%), followed by perennial grasses (12.9%), and annual and biennial forbs (3.9%). Dominant taxa were big sagebrush, blue grama, broom snakeweed (*Gutierrezia sarothrae)*, and burningbush with 12.3%, 12.2%, 4.3%, and 2.0%, respectively. Review of Table 4 and Chart 3 revealed woody plant density in the area averaged 1,230.2 woody plants per acre, consisting entirely of big sagebrush. Table 5 and Chart 4 exhibit the current annual production of the Shrubland Baseline with 372.7 pounds per acre of total production of which 372.0 pounds per acre was perennial production. Dominant life form categories in terms of production are perennial grasses, shrubs, and sub-shrubs with an average of 210.7, 115.3, and 46.0 pounds per acre, respectively.

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Table 3 Church Rock Mill - Vegetation Cover - 2013

Baseline Areas - Average Cover Summary

		Area ——>	Reclaimed Baseline	Grassland Baseline	Shrubland Baseline
Grasses					
P	*Achnatherum hymenoides*	Indian Ricegrass	**1.73**	-	-
P	*Agropyron smithii*	Western Wheatgrass	0.93	**1.07**	0.27
P	*Aristida purpurea*	Purple Three-awn	0.27	-	-
P	*Bouteloua curtipendula*	Sideoats Grama	**1.40**	-	-
P	*Bouteloua gracilis*	Blue Grama	**1.33**	**44.40**	**12.20**
P	*Elymus elymoides*	Squirreltail	0.20	-	0.07
P	*Hilaria jamesii*	Galleta	0.20	-	-
A	*Munroa squarrosa*	False Buffalograss	**1.00**	0.27	**1.67**
P	*Sporobolus cryptandrus*	Sand Dropseed	0.07	-	0.33
Forbs					
A	*Amaranthus hybridus*	Slim Amaranth	0.53	-	-
P	*Aster sp.*	Aster sp.	0.20	-	-
A	*Bassia scoparia*	Burningbush	**13.07**	**1.93**	**2.00**
B Nw	*Carduus nutans*	Musk Thistle	**3.40**	-	-
A	*Chamaesyce serpyllifolia*	Thymeleaf Sandmat	**1.07**	0.13	-
A	*Chenopodium album*	Lambsquarters	-	-	0.27
P	*Eriogonum sp.*	Buckwheat sp.	-	-	0.20
A	*Erodium cicutarium*	Redstem Stork's Bill	0.27	**2.47**	-
P	*Phoradendron macrophyllum*	Colorado Desert Mistletoe	-	0.13	-
A	*Portulaca oleracea*	Little Hogweed	-	**3.07**	**1.00**
A	*Salsola tragus*	Russian Thistle	**6.53**	**9.53**	0.60
A	*Sisymbrium altissimum*	Tall Tumblemustard	0.40	-	-
P	*Sphaeralcea coccinea*	Scarlet Globemallow	-	0.07	-
P		Unidentified Perennial Forb	0.33	0.13	-
Shrubs, Sub-shrubs, Cacti & Trees					
P	*Artemisia tridentata*	Big Sagebrush	-	**1.53**	**12.33**
P	*Atriplex canescens*	Fourwing Saltbush	**2.60**	-	0.13
P	*Ceratoides lanata*	Winterfat	-	0.07	-
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush	**7.73**	**3.20**	0.13
P	*Gutierrezia microcephala*	Threadleaf Snakeweed	-	**1.87**	**1.00**
P	*Gutierrezia sarothrae*	Broom Snakeweed	0.07	-	**4.27**
P	*Tetradymia glabrata*	Littleleaf Horsebrush	0.07	-	-
			Mean		
		Total Plant Cover	**43.40**	**69.87**	**36.47**
		Rock	4.13	0.07	2.87
		Litter	24.60	13.60	20.47
		Bare ground	27.87	16.47	40.20
		Total Non-Noxious Vegetative Cover	**40.00**	**69.87**	**36.47**
		Total Perennial Cover	**17.13**	**52.47**	**30.93**
Summary by Lifeform:					
		Perennial Grasses	**6.13**	**45.47**	**12.87**
		Annual Grasses	1.00	0.27	1.67
		Perennial Forbs	**0.53**	**0.33**	**0.20**
		Annual & Biennial Forbs	21.87	17.13	3.87
		Noxious / Aggressive Weeds	3.40	-	-
		Shrubs, Sub-shrubs, Cacti & Trees	**10.47**	**6.67**	**17.87**
Diversity (Number of Species with ≥1% Average Cover):					
		Number of Important Species =	**10.00**	**9.00**	**7.00**
Sample Adequacy Calculations:					
		Mean =	43.40	69.87	36.47
		Variance =	144.69	177.98	90.12
		n =	15.00	15.00	15.00
		n_{min} =	**13.90**	**6.60**	**12.26**

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

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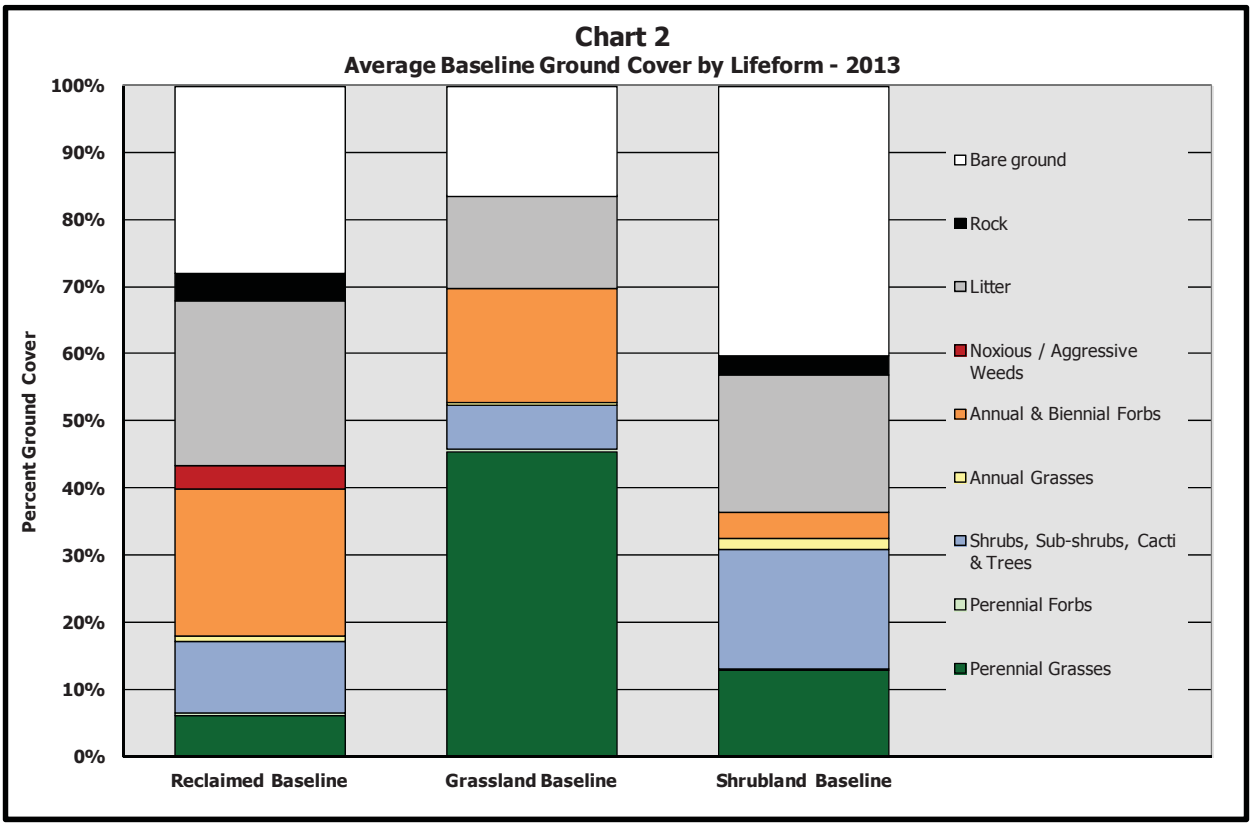

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Table 4 Church Rock Mill - Woody Plant Density - 2013

Baseline Summary - Woody Plant Density

Woody Plants per Acre

Life Form		Scientific name	*Area Sampled -->* Common Name	Reclaimed Baseline	Grassland Baseline	Shrubland Baseline
S		*Artemisia tridentata*	Big Sagebrush	8.1	40.5	1,230.2
S		*Atriplex canescens*	Fourwing Saltbush	121.4	8.1	-
S		*Ceratoides lanata*	Winterfat	18.9	13.5	-
S		*Chrysothamnus nauseosus*	Rubber Rabbitbrush	760.8	704.1	-
Su		*Opuntia polyacantha*	Plains Pricklypear	-	2.7	-
T	Nw	*Tamarix sp.*	Tamarisk	2.7	-	-
S		*Tetradymia glabrata*	Littleleaf Horsebrush	29.7	-	-
Life Form			**Shrub (S)**	**938.9**	**766.2**	**1,230.2**
			Succulent (Su)	**-**	**2.7**	**-**
			Tree (T)	**-**	**-**	**-**
			Noxious weed (Nw)	**2.7**	**-**	**-**
Total Woody Plants per Acre				**941.6**	**768.9**	**1,230.2**

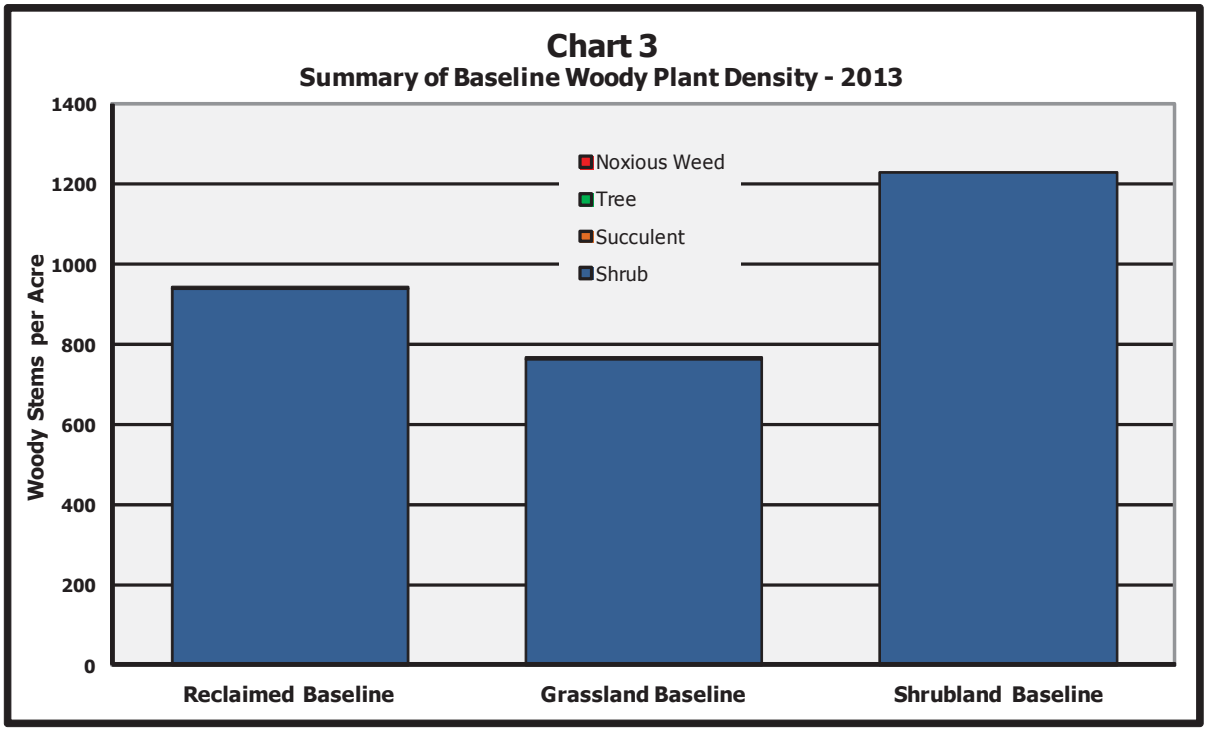

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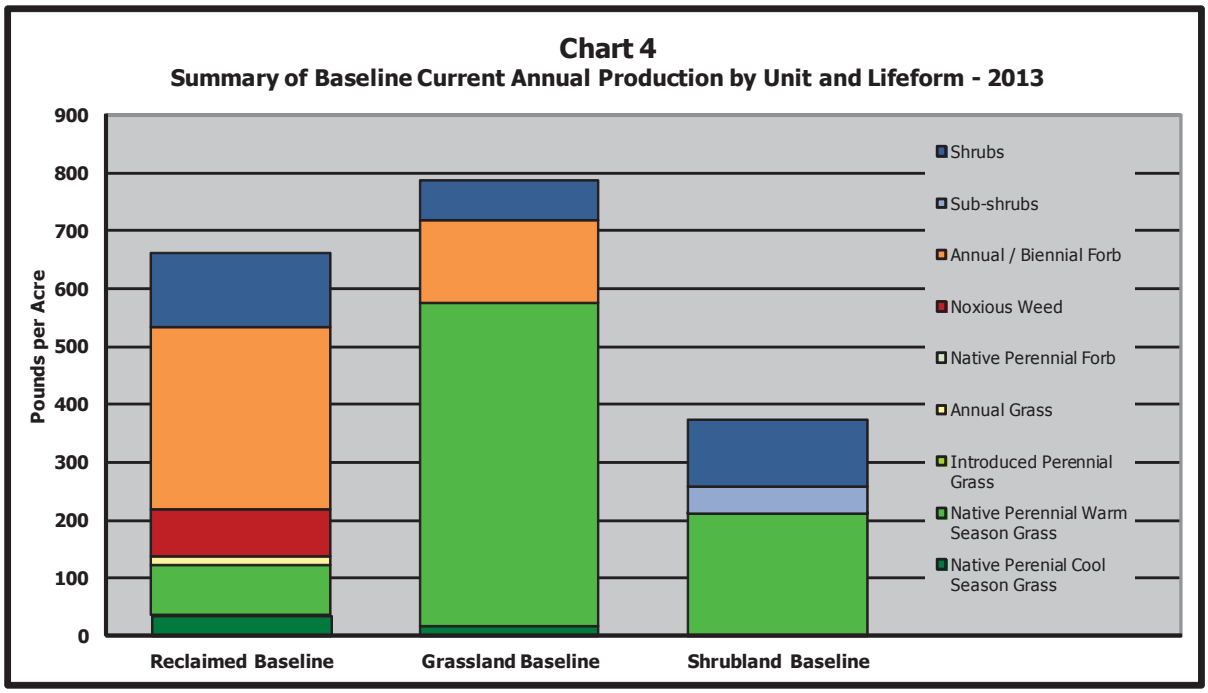
Table 5 Church Rock Mill - Vegetation Production - 2013

Baseline Summary - Production

lbs. per Acre

Area	Grasses				Forbs			Sub-shrubs	Shrubs	All Perennial	Total
	Perennial			Annual	Perennial	Annual & Biennial					
	Native		Intro-duced		Native	Noxious Weed	Native & Introduced				
	Cool-Season	Warm-Season									
Reclaimed Baseline	35.6	85.1	-	15.0	-	81.0	315.5	-	128.7	**249.3**	**660.8**
Grassland Baseline	15.8	558.1	-	-	-	-	143.3	-	68.4	**642.4**	**785.7**
Shrubland Baseline	-	210.7	-	0.2	-	-	0.5	46.0	115.3	**372.0**	**372.7**



3.4 Reclaimed Analog Area

Table 6 and Chart 5 indicate that total plant cover within the Reclaimed Analog at the time of the evaluation was 45.9% with an average perennial cover of 36.6%. Rock, litter, and bare ground exposure were 1.2%, 25.1%, and 27.9%, respectively. Shrubs, sub-shrubs, cacti and trees provided the majority of the floral cover (17.3%) followed by perennial grasses (14.0%), and then annual and biennial forbs (7.33%). Dominant taxa were fourwing saltbush, sand dropseed (*Sporobolus cryptandrus)* and Indian ricegrass (*Achnatherum hymenoides*) with 16.9%, 6.4%, and 5.7% cover, respectively. Review of Table 7 and Chart 6 reveals that woody plant density in this area averaged 2061.2 woody plants per acre, consisting entirely of shrubs. The dominant woody plants were fourwing saltbush with 1429.9 plants per acre, rubber rabbitbrush with 474.8 plants per acre, and big sagebrush with 156.5 plants per acre. Table 8 and Chart 7 exhibit the current annual production of the Reclaimed Analog with 647.7 pounds per acre of total production; of which, 605.6 pounds per acre was perennial production. Dominant life form categories in terms of production were native perennial grasses, shrubs, and native and introduced annual and biennial forbs, with an average of 419.4, 186.2, and 38.8 pounds per acre, respectively.

3.5 Grassland Analog Area

Table 6 and Chart 5 indicate that total plant cover in the Grassland Analog at the time of the evaluation was 35.1% with an average perennial cover of 31.7%. Rock, litter, and bare ground exposure were 6.7%, 25.3%, and 32.9%, respectively. Perennial grasses provided the majority of floral cover (25.7%), followed by shrubs, sub-shrubs, cacti and trees (6.1%), and annual and biennial forbs (3.4%). Dominant taxa were blue grama, broom snakeweed, Russian thistle, and rubber rabbitbrush with 24.5%, 4.4%, 2.9%, and 1.3%, respectively. Review of Table 7 and Chart 6 revealed woody plant density in the area averaged 122.6 stems per acre with an average 120.2 shrubs per acre and 2.3 trees per acre. The dominant woody plants were rubber rabbitbrush, fourwing saltbush, and winterfat with 64.2, 35.0, and 19.8 plants per acre, respectively. Table 8 and Chart 7 exhibit the current annual production of the Grassland Analog site with 351.8 pounds per acre of total production of which 346.4 pounds per acre was perennial production. Dominant life form categories in terms of production are native perennial grass, sub-shrubs, and shrubs with an average of 288.5, 50.8, and 6.5 pounds per acre, respectively.

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3.6 Shrubland Analog Area

Table 6 and Chart 5 indicate that total plant cover in the Shrubland Analog at the time of the evaluation was 24.8% with an average perennial cover of 23.0%. Rock, litter, and bare ground exposure were 1.3%, 26.5%, and 47.4%, respectively. Shrubs, sub-shrubs, cacti and trees provided the majority of floral cover (14.13%), followed by perennial grasses (8.87%), and annual and biennial forbs (1.80%). Dominant taxa were blue grama, big sagebrush, broom snakeweed, and lambsquarters (*Chenopodium album*) with 8.80%, 6.87%, 6.67%, and 1.20%, respectively. Review of Table 7 and Chart 6 revealed woody plant density in the area averaged 1049.5 stems per acre with an average of 1022.5 shrubs per acre and 27 trees per acre. The dominant woody plants were big sagebrush, two-needle Piñon (*Pinus edulis*), and winterfat with 990.1, 27.0, and 18.9 plants per acre, respectively. Table 8 and Chart 7 exhibit the current annual production of the Shrubland Analog with 225.3 pounds per acre of total production of which 223.6 pounds per acre was perennial production. Dominant life form categories in terms of production are sub-shrubs, native perennial grass, and shrubs with an average of 92.7, 73.7, and 57.2 pounds per acre, respectively.

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Table 6 Church Rock Mill - Vegetation Cover - 2013

Analog Areas - Average Cover Summary

		Area ——>	Reclaimed Analog Area	Grassland Analog Area	Shrubland Analog Area
Grasses					
P	*Achnatherum hymenoides*	Indian Ricegrass	**5.67**	0.07	-
P	*Agropyron smithii*	Western Wheatgrass	**1.47**	-	0.07
P	*Bouteloua curtipendula*	Sideoats Grama	-	0.67	-
P	*Bouteloua gracilis*	Blue Grama	-	**24.47**	**8.80**
P	*Elymus elymoides*	Squirreltail	0.47	0.07	-
P	*Hilaria jamesii*	Galleta	-	0.40	-
P	*Sporobolus cryptandrus*	Sand Dropseed	**6.40**	-	-
A		Unidentified Annual Grass	**3.80**	-	-
Forbs					
P	*Asclepias subverticillata*	Horsetail Milkweed	0.20	-	-
P	*Aster sp.*	Aster sp.	0.87	-	-
A	*Bassia scoparia*	Burningbush	0.13	-	-
A	*Chamaesyce serpyllifolia*	Thymeleaf Sandmat	**1.60**	0.13	-
A	*Chenopodium album*	Lambsquarters	-	0.27	**1.20**
A	*Helianthus sp.*	Helianthus sp.	0.27	-	-
A	*Portulaca oleracea*	Little Hogweed	0.27	0.13	-
A	*Salsola tragus*	Russian Thistle	**3.20**	**2.87**	0.60
P	*Symphyotrichum falcatum*	White Prairie Aster	**4.20**	-	-
Shrubs, Sub-shrubs, Cacti & Trees					
P	*Artemisia tridentata*	Big Sagebrush	-	-	**6.87**
P	*Atriplex canescens*	Fourwing Saltbush	**16.87**	0.20	0.07
P	*Ceratoides lanata*	Winterfat	-	0.13	0.13
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush	0.47	**1.27**	-
P	*Gutierrezia microcephala*	Threadleaf Snakeweed	-	0.07	0.40
P	*Gutierrezia sarothrae*	Broom Snakeweed	-	**4.40**	**6.67**
			Mean		
		Total Plant Cover	**45.87**	**35.13**	**24.80**
		Rock	1.20	6.73	1.33
		Litter	25.07	25.27	26.47
		Bare ground	27.87	32.87	47.40
		Total Non-Noxious Vegetative Cover	**45.87**	**35.13**	**24.80**
		Total Perennial Cover	**36.60**	**31.73**	**23.00**
Summary by Lifeform:					
		Perennial Grasses	**14.00**	**25.67**	**8.87**
		Annual Grasses	3.80	-	-
		Perennial Forbs	**5.27**	**-**	**-**
		Annual & Biennial Forbs	7.33	3.40	1.80
		Noxious / Aggressive Weeds	-	-	-
		Shrubs, Sub-shrubs, Cacti & Trees	**17.33**	**6.07**	**14.13**
Diversity (Number of Species with ≥1% Average Cover):					
		Number of Important Species =	**8**	**4**	**4**
Sample Adequacy Calculations:					
		Mean =	45.87	35.13	24.80
		Variance =	143.12	85.55	49.31
		n =	15.00	15.00	15.00
		n_{min} =	**12.31**	**12.54**	**14.51**

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

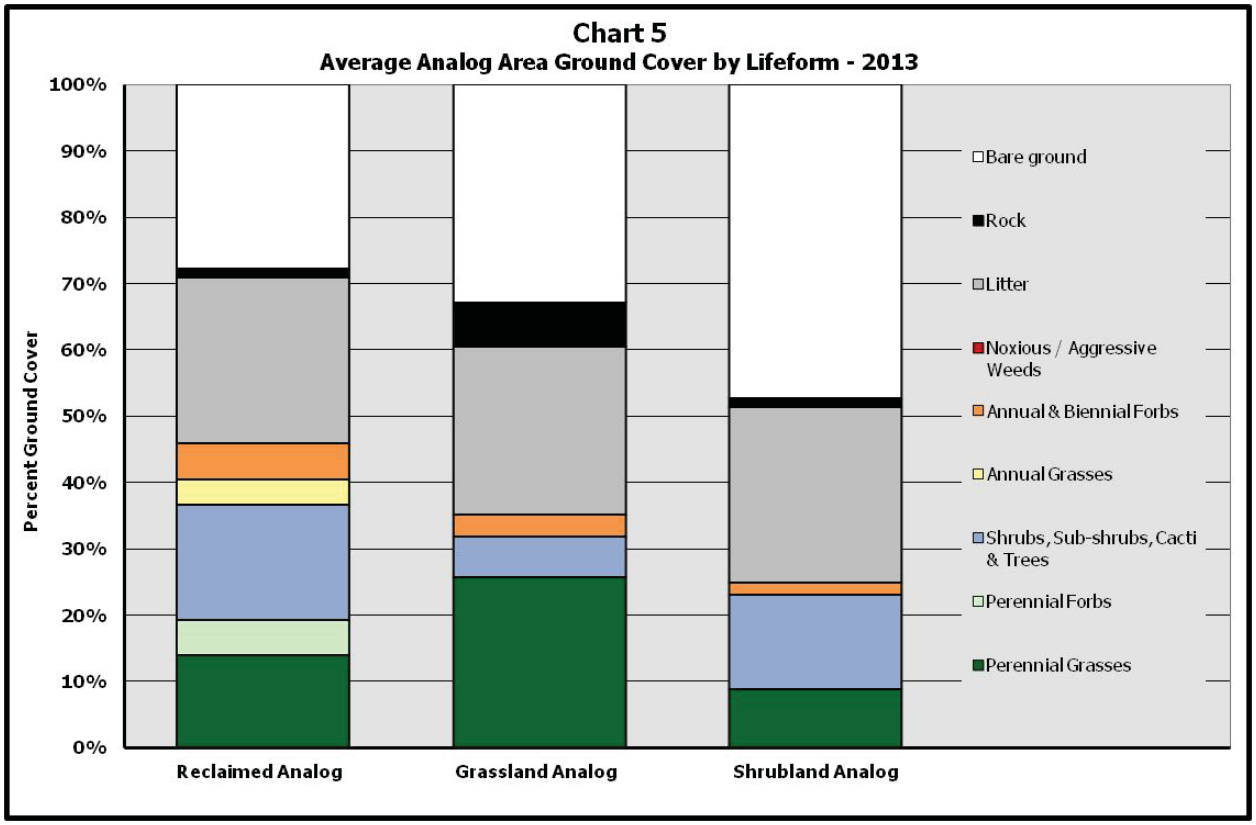
Chart 5
Average Analog Area Ground Cover by Lifeform - 2013
Percent Ground Cover
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Reclaimed Analog
Grassland Analog
Shrubland Analog
Bare ground
Rock
Litter
Noxious / Aggressive Weeds
Annual & Biennial Forbs
Annual Grasses
Shrubs, Sub-shrubs, Cacti & Trees
Perennial Forbs
Perennial Grasses

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Table 7 Church Rock Mill - Woody Plant Density - 2013

Analog Summary - Woody Plant Density

Woody Plants per Acre

Life Form	Scientific name	*Area Sampled -->* Common Name	Reclaimed Analog	Grassland Analog	Shrubland Analog
S	*Artemisia tridentata*	Big Sagebrush	156.5	1.2	990.1
S	*Atriplex canescens*	Fourwing Saltbush	1,429.9	35.0	13.5
S	*Ceratoides lanata*	Winterfat	-	19.8	18.9
S	*Chrysothamnus nauseosus*	Rubber Rabbitbrush	474.8	64.2	-
T	*Pinus edulis*	Two-needle Piñon	-	2.3	27.0
Life Form		**Shrub (S)**	**2,061.2**	**120.2**	**1,022.5**
		Succulent (Su)	**-**	**-**	**-**
		Tree (T)	**-**	**2.3**	**27.0**
		Noxious weed (Nw)	**-**	**-**	**-**
Total Woody Plants per Acre			**2,061.2**	**122.6**	**1,049.5**

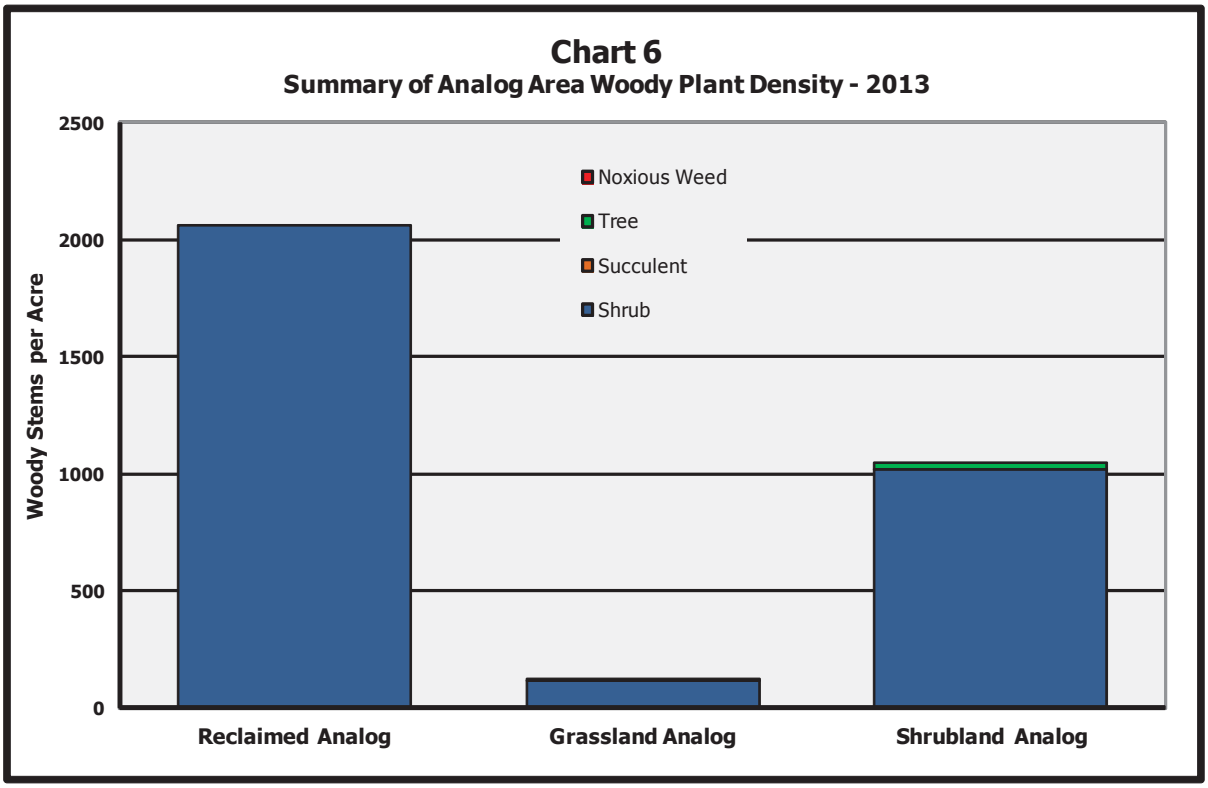

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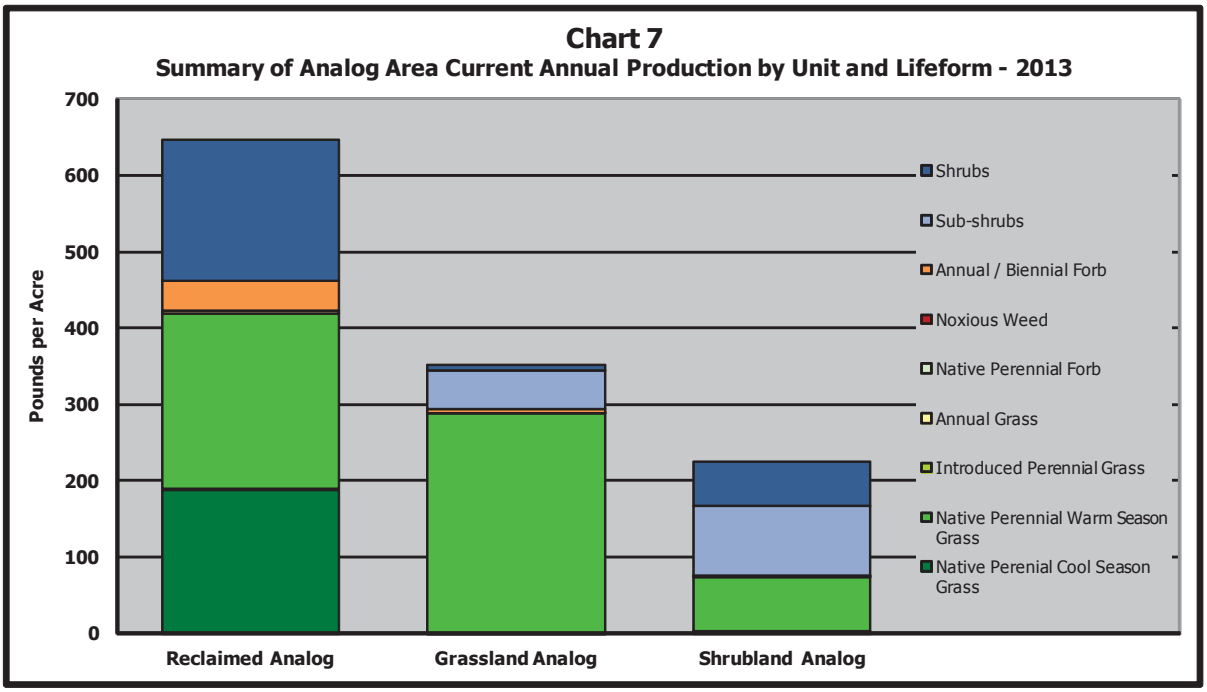
Table 8 Church Rock Mill - Vegetation Production - 2013

Analog Summary - Production

lbs. per Acre

Area	Grasses				Forbs			Sub-shrubs	Shrubs	All Perennial	Total
	Perennial			Annual	Perennial	Annual & Biennial					
	Native		Intro-duced		Native	Noxious Weed	Native & Introduced				
	Cool-Season	Warm-Season									
Reclaimed Analog	189.5	229.9	-	3.3	-	-	38.8	-	186.2	**605.6**	**647.7**
Grassland Analog	1.7	286.8	-	-	0.6	-	5.4	50.8	6.5	**346.4**	**351.8**
Shrubland Analog	3.9	69.8	-	0.4	-	-	1.3	92.7	57.2	**223.6**	**225.3**



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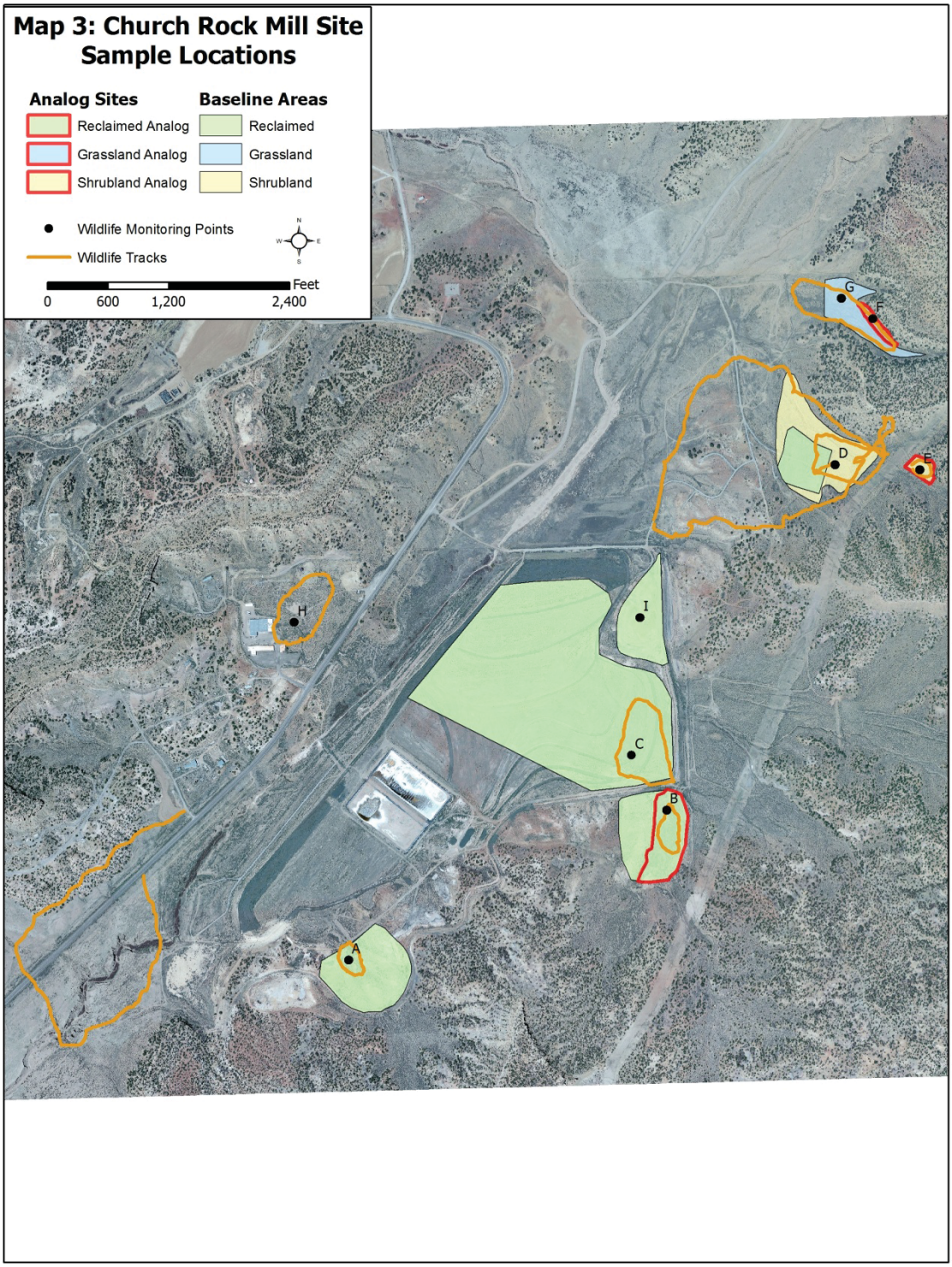

4.0 WILDLIFE RESULTS

Observed Habitats and General Wildlife Condition

As indicated in the methodology (Appendix B), several pedestrian transects were extended within the project disturbance footprint specifically for wildlife observations as well as several hundred feet of transect extended between the vegetation sample points. Weather was crisp and clear with no wind during the morning surveys. Over the course of these surveys, Cedar Creek observed only six habitats for indigenous fauna: piñon-juniper woodland (with an occasional Ponderosa pine); shallow canyons with peripheral rim rock ledges and boulder fields; sagebrush steppe; grassland; revegetated and ruderal shrubland; and disturbed bottomland. The rim rock occurs on the eastern and western flanks of the project area and varies from modest elevation rubble piles to vertical cliff faces of 20 to 30 feet in height. There were no areas of standing or seasonal water sources observed on site, except for the evaporation ponds on the tailings impoundment. As a result, water-dependent wildlife were not observed.

The first two of the aforementioned habitats correspond to the piñon-juniper ecotype. Three vegetation communities / wildlife habitats were sampled by Cedar Creek for the vegetation variables of ground cover, current annual production, and woody plant density. Disturbed bottomland was only evaluated for fauna. In general, these wildlife habitats were in varying stages of disclimactic or disturbed condition offering from poor to fair (at best) habitat requisites for indigenous wildlife. Because of past mine-related effects (e.g., tailings impoundment construction and operation), and subsequent reclamation, significant habitat fragmentation and degradation has been realized locally. Such fragmentation, in association with other anthropogenic land use-related effects (e.g., past heavy-grazing by domestic livestock) has reduced habitat quality and attendant local indigenous wildlife populations. The remnant areas of grassland and sagebrush steppe can be considered mid- to late-seral, and reflect modest wildlife habitat quality. The revegetated tailings area also reflects modest habitat quality given the number of birds observed in this area. The ruderal shrubland and disturbed bottomland communities reflect reduced habitat quality indicative of early seral communities.

With regard to the rim rock habitat type, multiple opportunities are offered for cliff nesting raptors as well as smaller avifauna, and the nearly ubiquitous boulder and cobble fields below the escarpments offer excellent escape cover for several species of small mammals and herpetofauna. However, no raptor nests were observed within surveyed areas most likely due to a reduced prey base (as indicated by the poor small mammal trapping results). In the rim rock areas and excepting the existing mine-related and livestock-related disturbances, Cedar Creek's observations indicated: 1) expected quality of habitats more distant from the project area, 2) the lack of more distant mining-related impacts, or 3) any continuing hazards to wildlife distant to the project area. The existing piñon-juniper woodland typical of these areas

was observed to generally be in fair condition in the understory given past moderate to heavy utilization by domestic livestock. However, signs of recovery were noted within the mill area given the advent of project fencing and past reclamation efforts. In contrast to the understory, the overstory was in relatively good condition and used by avian wildlife (i.e., the quantity of direct bird observations was in line with expectation).

As indicated above, observations identified a lack of continuing hazards to wildlife but included a variety of past land-use related effects to habitats that have suppressed indigenous populations, such as mule deer. The vast majority of land use perturbations were confined to the office facilities area and tailings disposal area. Furthermore, within the mill area, there were no observable continuing hazards to wildlife other than the conversion of natural habitats (that originally were of modest utility).

One observation of significant note is related to the paucity of mule deer signs evident on the various survey routes along the northern boundaries. Observations of mule deer hoof prints and especially pellet groups were less than expected for these habitats. This reduced population level can be explained by one of three possible causes. First, it is possible that a life requisite for mule deer is in short supply. This requisite cannot be escape cover, thermal cover, or forage as all of these are sufficiently abundant within the project vicinity. It is possible that water may be limiting as free-water sources were not readily observed in the area. A second possible cause is a natural population fluctuation (low point in the cycle) due to excessively cold winters, disease, or similar perturbation. The third possible cause for low populations is elevated predation, either by natural or man-related sources.

Another indicator of the quality (or lack thereof) of area habitats and their utilization can be inferred given a review of the limited number of direct sightings and/or observations of tracks, scat, nests, or burrows of indigenous wildlife. As indicated, this list based on professional experience is below expectation with fewer observations than anticipated. Relative density of observed taxa is as follows: U = Ubiquitous, VC = Very Common, C = Common, UC = Uncommon, R = Rare.

Direct Observations:

Mammals:	Cottontail (VC) Mexican Woodrat (UC) Piñon Mouse (C)	Rock Squirrel (R) Coyote (R) Deer Mouse (UC)	Gunnison's Prairie Dog (C) Cliff Chipmunk (UC)
Herpetofauna*:	Horned Lizard (UC)	Plateau Whiptail (UC)	Sagebrush Lizard (UC)

* From a previous Cedar Creek survey during summer (Cedar Creek Associates, Inc. 2010). Observations during late October would not normally occur.

Avifauna	Sage Sparrow (VC) Western Bluebird (C) Western Flycatcher (R) W. Meadowlark (UC)	Common Raven (C) W. Scrub Jay (R) Mtn. Bluebird (R) Downy Woodpecker (R)	Dark-eyed Junco (C) House Finch (R) Western Kingbird (UC)

Observation of Sign:

Mammals:	Mule Deer (UC) Badger (R) Pocket Gophers (R)	Cottontail (U) Mexican Woodrat (UC)	Coyote (UC) Gunnison's Prairie Dog (C)

A more specific accounting of terrestrial wildlife observations for each unique observation area visited during the late October fieldwork is provided on Table 9 below. All observations are qualified with an indication of relative abundance and/or density.

Table 9 - NECR - Wildlife Surveys - Fall 2013

Miscellaneous Wildlife Observations at Fixed Radius Circular Plots and Qualitative Observation Transects (Scat, Tracks, Direct Obs. etc.)

Surveys Occurred from 10/21/13 to 10/23/13

Sample Area (Plot No.)	Wildlife Observations
West Borrow Area (A)	Coyote Scat & Tracks (UC) / Cottontail Scat (VC) / Cottontail (2) / Mule Deer Tracks (UC)
East Borrow Area (B)	Coyote Scat (UC) / Cottontail Scat (VC) / Mule Deer Tracks & Pellets (UC)
Revegetated Tailings (C)	Cottontail Scat (VC) / Mule Deer Tracks & Pellets (C)
South Drainage Borrow Area (D)	Gunnison's Prairie Dogs in bottomland north of Tailings Facililty / Coyote (1) / Rock Squirrel (1) / Cottontails (2) / Cottontail Scat (VC) / Mule Deer Tracks & Pellets (C) / Badger (R)
Shrubland Analog Area (E)	Cottontail Scat (VC) / Mule Deer Tracks & Pellets (C)
Grassland Analog Area (F)	Cottontail Scat (VC) / Pocket Gophers (Burrows)-(R)
North Drainage Borrow Area (G)	Gunnison's Prarie Dogs (C) / Cottontail Scat (VC) / Mexican Woodrat (UC) / Cliff Chipmunk (UC)
Millsite Area (H)	Cottontail (1) & Cottontail Scat (VC)
Dilco Hill Area (I)	Cottontail Scat (VC)

U = Ubiquitous / VC = Very Common / C = Common / UC = Uncommon / R = Rare

Although raptors occur in the area, it is important to note that no direct observations occurred during site-specific surveys and no evidence of cliff nesting was observed within the rim rock immediately adjacent to the project area. Furthermore, there were no obvious nests observable within the piñons and junipers about the site with the exception of a few old magpie or raven nests that were in a state of disrepair.

Avian Observations at Nine Fixed-Radius Circular Plots

Table 10 and Chart 8 provide the avian observational data from the nine FRCPs recorded October 21 and 22, 2014. Surveys occurred within a 3-hour window each morning from about 07:30 am to 10:30 am. Survey conditions were ideal with calm winds, clear skies, and a crisp 25°F starting temperature. A total of only eleven different species were observed at the nine locations over the two days resulting in a total of 43 individual avian observations (37 birds within the FRCPs and 6 fly-overs). Three areas, (E, H, and I) yielded zero observations of birds within the FRCP over the two-day period, while two areas (C and G) yielded 16 and 13 total observations over the two-day period, respectively. The remaining four areas yielded total observations of 1, 2, or 3 birds over the survey period. The two sites with the most observations (C and G) were the revegetated tailings area and the native undisturbed area in the north portion of the project area, respectively. Given that the greatest number of species and the total number of individuals were noted for the revegetated tailings plot speaks well to past reclamation efforts.

The dominant taxon was the sage sparrow (now sagebrush sparrow) with 16 observations across 6 sites. Next in dominance was the dark-eyed junco (7 observations across 3 sites) and then western bluebird (4 observations at a single site). All three taxa are typically gregarious (individuals grouped in small flocks). Overall, the observed numbers are relatively low given expectation for area habitats. By comparison, surveys performed by Cedar Creek using identical procedures in similar habitats (approximately 170 miles to the east of Church Rock Mill Site in an area southwest of Santa Fe) typically yielded twice the diversity and twice the number of individuals. Therefore, the relative paucity of avian observations within the project area can be considered contributory to the classification of area habitats as being of reduced quality (poor to fair).

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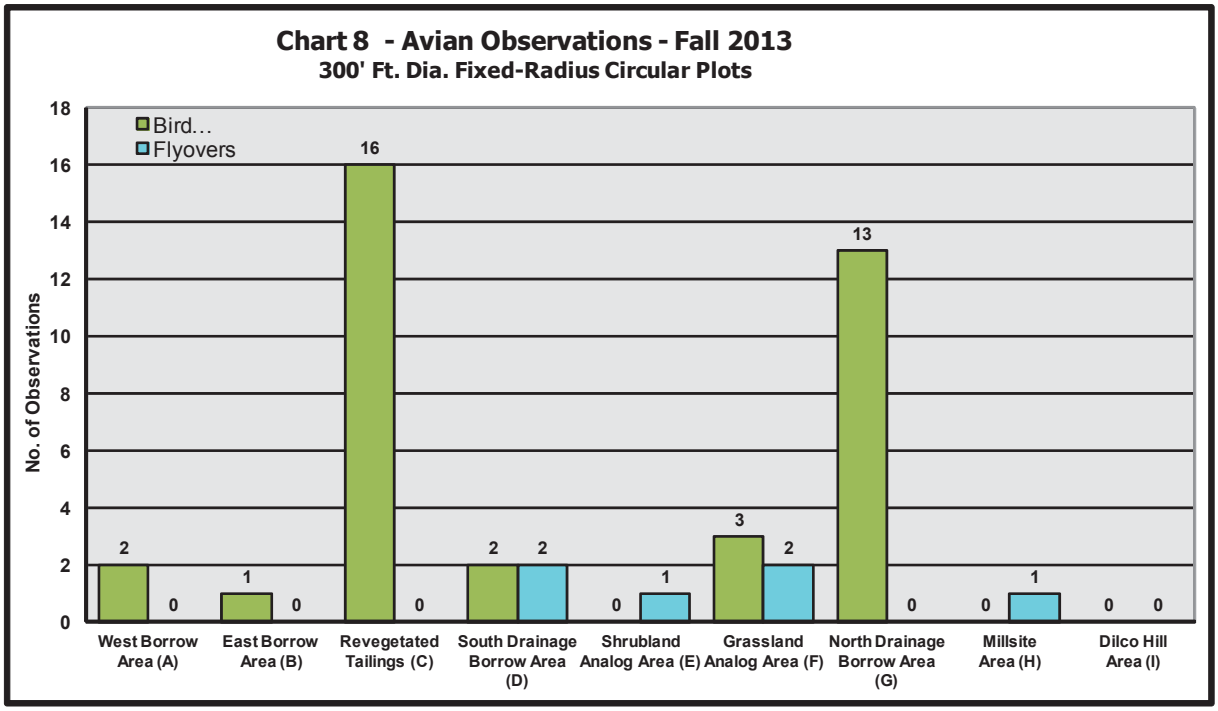
Table 10 - Avian Observations at Fixed-radius Circular Plots

Surveys Occurred on 10/21/13 and 10/22/13

Church Rock Mill - Wildlife Surveys - Fall 2013

DAY 1 - Clear, 25°F, No Wind DAY 2 - Clear, 25°F, No Wind

			OBSERVED BIRDS										FLYOVERS		
Sample Area (Plot No.)	Replicate	Time of Survey	Western Kingbird	Sage Sparrow	Dark-eyed Junco	Western Scrub Jay	House Finch	Western Flycatcher	Western Meadowlark	Mountain Bluebird	Western Bluebird	TOTAL	Downy Woodpecker	Common Raven	TOTAL
West Borrow Area (A)	1	0729-0739										2			0
	2	0730-0740		2											
East Borrow Area (B)	1	0749-0759										1			0
	2	0745-0755							1						
Revegetated Tailings (C)	1	0804-0814	3	4	2		1					16			0
	2	0802-0812		4					2						
South Drainage Borrow Area (D)	1	0838-0848				1						2		1	2
	2	0825-0835		1									1		
Shrubland Analog Area (E)	1	0852-0902										0		1	1
	2	0838-0848													
Grassland Analog Area (F)	1	0917-0927			2			1				3		1	2
	2	0900-0910												1	
North Drainage Borrow Area (G)	1	0939-0949		2							4	13			0
	2	0914-0924		3	3					1					
Millsite Area (H)	1	1010-1020										0		1	1
	2	0955-1005													
Dilco Hill Area (I)	1	1025-1035										0			0
	2	0935-0945													
			3	16	7	1	1	1	3	1	4	37	1	5	6



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5.0 CONCLUSIONS

Results from the vegetation and wildlife surveys indicate four main conclusions:

1. **No rare, threatened, or endangered species occur within any of the potential borrow sites.**
   Construction can proceed without concern for disturbing rare, threatened, or endangered flora or fauna. Vegetation and wildlife surveys yielded negative results for any species or suitable habitat tracked by the New Mexico Natural Heritage program.

2. **Noxious weeds, musk thistle and tamarix, were observed in the East Borrow.**
   If the East Borrow is selected for use in the repository cover, the noxious weeds should be managed via chemical control in the two years preceding construction. This will minimize or prevent the spread of noxious weeds as a result of construction.

3. **Analog sites are representative of the communities which may be disturbed during construction, therefore they can be used as logical targets for revegetation success criteria.**
   Since baseline and analog sites are comparable, the analog sites can be used as a reference for revegetation success criteria. This approach is common when designing revegetation procedures and determining appropriate success criteria.

4. **Results provide the basis for revegetation design.**
   Survey results indicate which species may prove successful during revegetation. These results, coupled with other project experience in the arid west, can be used to develop an effective and efficient revegetation plan.

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Appendix A

Vegetation Sampling Methodologies

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A.1 Introduction

Cedar Creek's vegetation sampling protocols involve an emphasis upon ground cover* primarily to maintain validity in future statistical comparisons, among other reasons. In brief, concentration on a single variable of plant ecology promotes improved comprehension and comparability over time and among treatment scenarios. Second, ground cover data, especially when determined using a very precise method such as the point-intercept procedure, provides some of the most important information regarding community variability that ecologists can evaluate. Such data facilitate the determination of true species composition, relative health (condition), and successional status of the sampled area. Furthermore, the same data can be utilized to develop the sister variables of frequency and species composition if desired. Third, strong inferences can be developed with other correlated variables such as production assuming species composition is a component of the analysis. Fourth, ground cover is a preferred variable for revegetation monitoring because cover data can be readily obtained in a statistically adequate and cost-effective manner (using the proper procedures), has broad application for evaluation (including erosion control modeling), precisely reflects species' dominance of a given area, and when collected using bias-free techniques such as the point-intercept procedure is one of the most repeatable variables among independent observers.

In addition to ground cover evaluations, Cedar Creek recommends evaluation of woody plant density and current annual vegetative production to facilitate a broader analysis. In this regard, it was determined most appropriate to document woody plant populations (for wildlife habitat considerations) by utilizing long quadrats or belts as detailed below. The most appropriate method for measuring current annual herbaceous production is use of long rectangular quadrats. Since sampling adequacy is not required (nor recommended) for woody plant density or vegetative production samples, one density belt and one production quadrat were co-located with each ground cover transect evaluated. Resulting data are then considered reasonable for the evaluation purposes intended.

A.2 Sample Site Selection / Location

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* To avoid confusion, the term "ground cover" is utilized to indicate the variable of non-overlapping foliar cover (the percent of the ground occupied by all above ground plant material) in addition to the ground surface covered by litter or rock. Non-overlapping means that only that cover which would be wetted by a light mist would be counted as opposed to that plant material which would not get wet due to overshadowing plant material. In this manner, total ground cover cannot exceed 100%. Other forms of "cover" would include: basal cover (the percent of the ground surface occupied by the living base of plants), crown or canopy cover (the percent of the ground occupied by the canopies of plants), or overlapping foliar cover (the percent of the ground occupied by all plant material allowing for overlapping vegetation - i.e., such cover can exceed 100%). Non-overlapping foliar cover is preferred because of its inherent repeatability among observers, resulting data are directly applicable to erosion control modeling efforts, and significant precedent has already been set in the mining industry. In contrast, the determination of the live portion of the base of a plant (as necessary for basal cover) becomes increasingly difficult and subjective given life forms such as certain bunch grasses and sod-formers.

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The primary field effort for vegetation calls for sampling potential soil borrows and control areas. The control areas were selected and established during floral evaluations in October 2013. The systematic procedure for determination of sample locations occurred in the following stepwise manner: First, a fixed point of reference was selected for the entire area to facilitate location of the systematic grid in the field. Second, a systematic grid of appropriate dimensions (i.e., 150′ X 150′) was selected by Cedar Creek to provide a minimum number of coordinate intersections within the target vegetative unit that could then be used for the initial set of sample sites. Third, a scaled representation of the grid was overlain on field maps extending parallel to major compass points to facilitate field location. Fourth, unbiased placement of this grid was controlled by selection of two random numbers between 0 and 150 (used as coordinates) that then controls the location of the grid. Fifth, utilizing a handheld compass and pacing techniques or a GPS, all 30 initial sample points were located in the field. If the initial 30 systematic samples had proven insufficient to provide an adequate ground cover sample, an "intergrid" would have been selected to provide additional systematically determined sample points.

A.3 Determination of Ground Cover

Ground cover at each sampling site was determined utilizing the point-intercept methodology (Bonham 1989) as illustrated on Figure 1. This methodology has been utilized for range studies for over eighty (80) years, however, Cedar Creek utilizes state-of-the-art instrumentation that it has pioneered to allow for rapid and accurate collection of data. Implementation of the technique for the sampling effort occurred as follows: First, a transect of 10 meters length was extended from the starting point of each sample site toward the direction of the next site to be sampled. Then, at each one-meter interval along the transect, a "laser point bar" was situated vertically above the ground surface, and a set of 10 readings recorded as to hits on vegetation (by species), litter, rock (>2mm), or bare soil. Hits were determined at each meter interval by activating a battery of 10 specialized lasers situated along the bar at 10 centimeter intervals and recording the variable intercepted by each of the narrow (0.02") focused beams (Figure 1). In this manner, a total of 100 intercepts per transect were recorded resulting in 1 percent cover per intercept. This methodology and instrumentation facilitates the collection of the most unbiased, repeatable, precise, and cost-effective ground cover data possible. Furthermore, the point-

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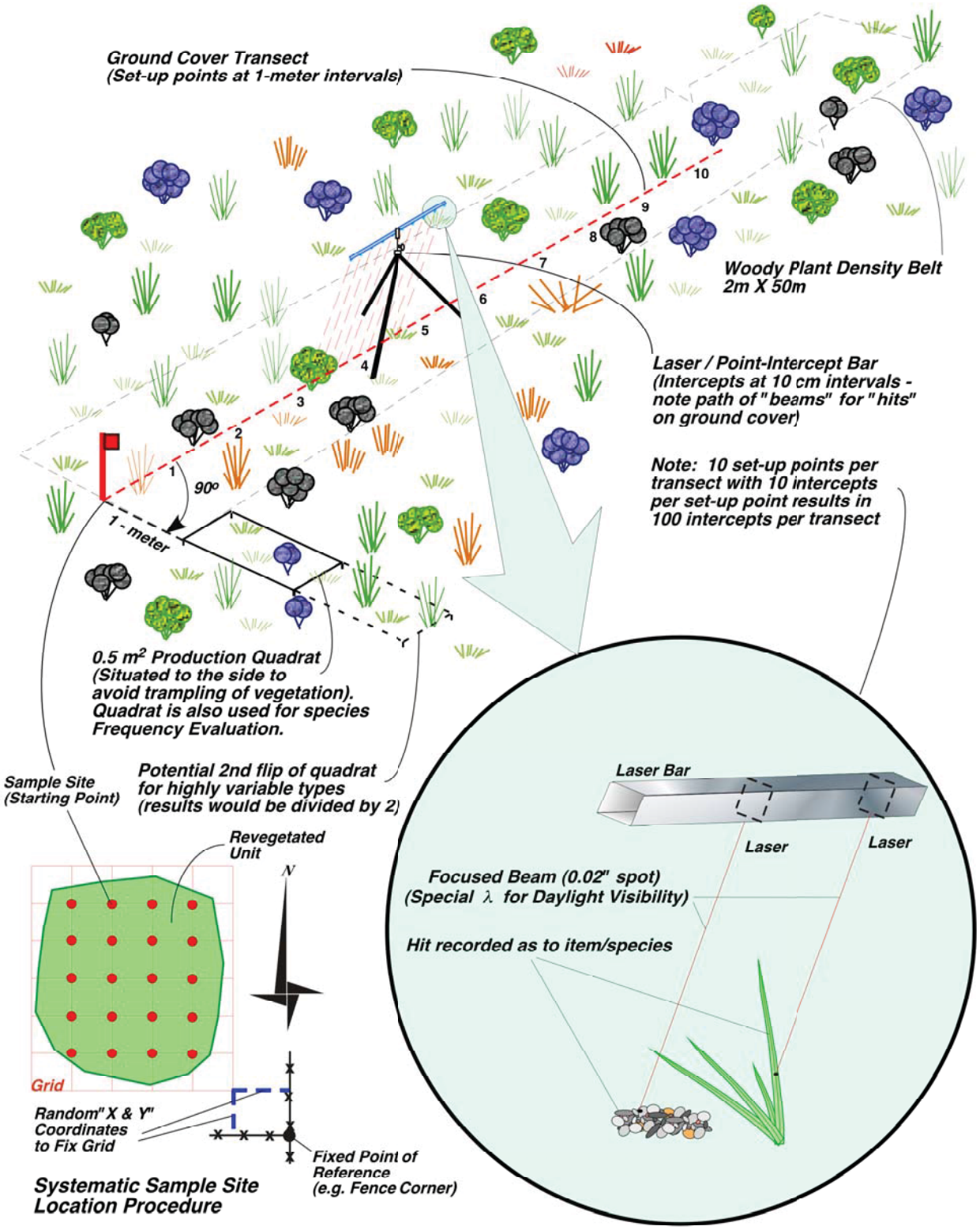

Figure - 1

Sampling Procedure at a Systematic Sample Site Location

intercept procedure has been widely accepted in the scientific community as the protocol of choice for vegetation monitoring and is also the protocol of choice within the mining industry in connection with bond release determinations.

A.4 Determination of Woody Plant Density

Woody plant density at each sampling site was determined using fixed length / width belt transects oriented parallel to, and co-located with, each ground cover transect. Each belt was 2 meters in width and extended from the beginning of the sample point for a distance of 50 meters (Figure 1). All shrubs, succulents, and trees rooted within the boundaries of these belts were counted and classified according to species (sub-shrubs were not counted). Entire plants rather than stems were counted to provide a more accurate representation of actual woody plant density.

One exception to this method was in the grassland control area, where a low woody plant population prompted a total count, where all plants within the boundary were recorded.

A.5 Determination of Vegetative Production

At each sample site, current annual production was collected from a $^1/_2$ m^2 quadrat frame at each sampling location. The quadrat was initially placed one meter and 90° to the right (clockwise) of the ground cover transect to avoid vegetation trampled by investigators during sample site location (Figure 1). From within each quadrat, all above ground current annual vegetation within the vertical boundaries of the frame was clipped and bagged separately by life form as follows:

Native Perennial Cool Season Grass
Native Perennial Warm Season Grass
Introduced Perennial Grass
Annual Grass
Sub-Shrub
Shrub
Native Perennial Forb
Native / Introduced Annual / Biennial Forb
Noxious Weed

All production samples were returned to the lab for drying and weighing. Drying occurred at 105° C until a stable weight was achieved (24 hours). Samples were then re-weighed to the nearest 0.1 gram.

A.6 Sample Adequacy Determination

Ground cover sampling was conducted to a minimum of 15 initial ground cover transects for the baseline and control areas. Production and woody plant density samples were co-located with each ground cover transect but were not subject to a determination of sampling adequacy. From these preliminary efforts for ground cover, a sample mean and standard deviation for total non-overlapping vegetation ground cover was calculated. These parameters were calculated in the field to insure collection of an adequate sample and once again by computer during final data analyses for each area.

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Sampling continued until an adequate ground cover sample, $\mathbf{n_{min}}$, was collected in accordance with the Cochran formula (below) for determining sample adequacy, whereby the population would be estimated to within 10% of the true mean (μ) with 90% confidence. Sampling to these limits facilitates a very strong estimate of target populations.

When the inequality ($\mathbf{n_{min}} \leq \mathbf{n}$) is true, sampling is considered adequate and $\mathbf{n_{min}}$ is determined as follows:

$$\mathbf{n_{min} = (t^2 s^2) / (0.1\ \bar{x})^2}$$

where: n = the number of actual samples collected (initial size = 15)

t = the value from the one-tailed t distribution for 90% confidence with n-1 degrees of freedom;

s^2 = the variance of the estimate as calculated from the initial samples;

$\bar{x}$ = the mean of the estimate as calculated from the initial samples.

If the initial 15 ground cover samples from each area did not provide a suitable estimate of the mean (i.e., the inequality was false), then additional samples would have been collected until the inequality ($\mathbf{n_{min}} \leq \mathbf{n}$) became true.

	n	n_{min}
Reclaimed Baseline	**15**	**13.90**
Grassland Baseline	**15**	**6.60**
Shrubland Baseline	**15**	**12.26**
Reclaimed Control Area	**15**	**12.31**
Grassland Control Area	**15**	**12.54**
Shrubland Contol Area	**15**	**14.51**

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A.7 Threatened, Endangered, and Rare Plant Species

A list of rare, threatened, and endangered plant and animal species that are known to occur within McKinley County and the grassland ecotype, which contains the study area, was developed from several sources including New Mexico Natural Heritage Program, New Mexico Rare Plant Website, and Navajo Nation EPA before baseline evaluation.

Prior to implementation of fieldwork, taxonomic descriptions and botanical drawings of these target species were compiled into a field guide. Actual fieldwork involved search patterns in all portions of appropriate habitat within the project area. Search procedures involved slow implementation of qualitative pedestrian transects and careful visual scanning of the ground surface for any of the target plant species. The compiled field guide was used to determine whether encountered plants were species of concern. A complete list of these species can be found in Appendix C.

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Appendix B

Wildlife Sampling Methodologies

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B.1 Introduction

It is most prudent for site-specific wildlife evaluations of small disturbance footprints to be limited to semi-quantitative and qualitative techniques of 1) small mammal trapping, 2) direct observation, 3) observation of sign, and 4) evaluation of habitat - owing to the modest size of disturbance footprints and the potential complication of livestock grazing. In this regard, efforts will be made by Cedar Creek biologists while on site, to document faunal resources during specifically implemented metrics that include trapping of small mammals within three specified habitats in the vicinity of the "repository"; fixed-radius avifauna observation stations; fixed-length sign observation transects; and variable-length general observational transects. All observations of wildlife, either directly or by sign, will be recorded in a manner to facilitate an indication of abundance and/or use of project area habitats.

Traplines, fixed-radius avifauna observation stations, and fixed-length sign observation transects will be established within three habitats near the repository and within the five alternate borrow sources and three analog sites, respectively. The site-specific "variable-length" observational transects will be extended radially from the central disturbance area for a length of between 100 and 200 meters to provide a better indication of: 1) wildlife use of the overall vicinity and habitats, 2) any remaining mine-related impacts, and 3) any continuing hazards to wildlife. Observational transects will only be implemented during the early morning or late evening hours to maximize opportunity for observing indigenous wildlife. A GPS will be utilized for spatial orientation and to facilitate documentation of any pertinent observations or transect alignments. Furthermore, project area habitats will be evaluated with regard to their capability to provide life requisites for anticipated indigenous wildlife, including sensitive or special status species.

B.2 Traplines

As indicated, small mammal traplines will be established within three habitats adjacent to the repository location to facilitate a determination of the existence, or lack thereof, of burrowing fauna. Each trapline will consist of a set of 25 Sherman live-traps baited with a mixture of rolled oats and peanut butter at 25- or 50-foot intervals (depending on the extent of targeted habitat). Sherman live-traps are 3" x 3" x 10" in size and will readily capture rodent taxa up to wood-rat or large ground squirrel sized animals. Traplines will be checked each morning and reset, and will remain in place for three consecutive nights. Captures will be identified each morning to species (to facilitate a determination of burrowing vs non-burrowing taxa) and the number of captures will be utilized to develop an estimate of species abundance.

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B.3 Fixed Radius Circular Plots

Fixed-radius avifauna observation stations will be established in the approximate center of each potential borrow source and analogue site. All observations of avifauna within 50 meters of the center point during a 10-minute observation period will be enumerated by species. Identification will occur either through direct visual or auditory observation. Observations will be utilized to develop estimates of relative abundance. Similarly, fixed-length observation transects will be established either in a circular or rectangular pattern across each potential borrow or analogue site. Length will be at least 100 meters, and where an area is sufficiently large, will be 200 meters. All observations of wildlife and/or their sign will be recorded.

B.4 Variable Length Observational Transects

Variable-length observational transects will be established centrally within the overall disturbance area and will extend outward in a radial pattern for a length of at least 200 meters. All wildlife observations (direct or sign) will be recorded as well as an indication of habitat. The total number of transects to be established will be dependent on habitats observed, however, at least four transects will be established.

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Appendix C

Field Guide to Sensitive Plant Species

Potentially Found in the Vicinity of Church Rock Mill Site

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Sensitive Plant Species Field Guide

A list of all rare and sensitive vascular plant species believed to occur within the Navajo Nation was acquired for the determination of potential species to be found in the vicinity of Church Rock Mill Site. A total of 63 species were included on the list with an additional nine species added that had been identified in the field as rare. The list of 63 was reduced to 23 potential species based on the incompatibility of habitat requirements with conditions that exist on the project area (see table below).

Scientific Name	Common Name	Global Status	Federal Status	NM State Status	Navajo Nation Status
Aliciella haydenii	San Juan Gilia	-	-	-	-
Artemisia pygmaea	Pigmy Sagebrush	G4	-	-	S1
Astragalus chuskanus	Chuska Milk-vetch	G3	SoC	SoC	S3
Astragalus cliffordii	Clifford's Milk-vetch	GNR	SoC	SoC	S1
Astragalus heilii	Heil"s Milk-vetch	G1	SoC	SoC	S4
Astragalus micromerius	Chaco Milk-vetch	G2	SoC	SoC	S2
Astragalus missouriens var. accumbens	Zuni Milk-vetch	G3	SoC	SoC	-
Astragalus naturitensis	Naturit Milk-Vetch	G2G3	SoC	SoC	S3
Astragalus oocalycis	Arboles Milk-vetch	G4	SoC	SoC	-
Erigeron acomanus	Acoma fleabane	G1G2	SoC	SoC	S3
Erigeron rhizomatus	Zuni Fleabane	G2	T	E	S2
Erigeron sivinskii	Sivinski's fleabane	G2	SoC	SoC	S4
Eriogonum lachnogynum var. sarahiae	Sarah's wild buckwheat	SNR	SoC	SoC	S4
Fritilaria atropurpurea	Spotted Fritillary	-	-	-	-
Mammillaria wrightii var. wrightii	Wright Fishhook Cactus	-	-	-	-
Muhlenbergia arsenei	Tough Muhly, Navajo Muhly	G5	SoC	SoC	-
Parthenium alpinum var. alpinum	Alpine Fever-few	G3	-	-	SNR
Phacelia splendens	Patch Phacelia	-	-	-	-
Phlox cluteana	Navajo Mountain Phlox	G2	SoC	SoC	-
Physaria navajoensis	Navajo Bladderpod	GNR	SoC	SoC	S3
Psorothamnus scoparius	Broom Pea	-	-	-	-
Puccinellia parishii	Parish's alkali grass	G2	SoC	E	S4
Senecio cliffordii	Clifford's Groundsel	GNR	SoC	SoC	-

All line drawings, photographs, and descriptions were acquired from the New Mexico Rare Plant website (http://nmrareplants.unm.edu/index.html maintained by the New Mexico Rare Plant Technical Council) unless cited otherwise. This guide was designed with the intention of being used in the field to identify potentially sensitive species.

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Aliciella haydenii (syn Gilia hayenii) (San Juan Gilia)

Habitat: Dry places, often on clay knolls or on shaley sandstone outcrops, from the sagebrush of saltbush plains up to the oak and ponderosa pine zones, often in the pinyon-juniper community (Cronquist et al, 1984).

Flowering/Fruiting Period: May to July (sometimes as late as Aug) (Cronquist et al, 1984)

Diagnostic Characteristics: Biennial, 1 – 5 dm tall from an often stout taproot, freely branched (sometimes even from the base) when well developed, the stem coarsely but rather sparsely stipulate-glandular throughout, varying to subglabrous; principal leaves forming a compact, persistent rosette at the base, mostly 1.5 – 6 cm long and 0.5 – 1.5 cm wide, coarsely few-toothed to more often pinnately lobed or cleft, with a broad undivided midstrip, crisp-puberulent above (varying to finely glandular), glabrous or nearly so, up to about 3 cm long, or the lower ones transitional to those of the rosette; flowers mostly crowded toward the tips of the branches, some of them virtually sessile, others on pedicels of varying length, up to about 1 cm long; calyx 2.5 – 4.5 mm long, stipitate-glandular, the lobes 1/3 – 1/2 as long as the tube; corolla anthocyanic, rose-purple to pink lavender (or the tube more maroon), but becoming more blue-purple in drying, narrowly funnel-form to salver-form, with spreading lobes, mostly 12-20 mm long overall, the tube and throat collectively 9 – 14 mm long (or smaller in the last-formed flowers); anthers 1 – 1.5 mm long, blue, borne on very short filaments at the sinuses; style elongate, commonly just reaching the orifice of the corolla; capsules 2.5 – 6 mm long; seeds (1) 2 – 4 per locule, 1.5 – 3 mm long, unchanged when wet (Cronquist et al, 1984).

No line drawing available

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Artemisia pygmaea (Pigmy Sagebrush)

Habitat: Pigmy sagebrush is found on barren knolls with soil derived from the Evacuation Creek member of the Green River formation. Pygmy sage occupies extremely dry sites, often with black sagebrush (*A. nova*). "It occurs in peculiar edaphic situations on Green River Shale, in clay soils forming the matrix in igneous gravels, on calcareous gravels, and on dolomitic outcrops and gravels, where it is often the dominant species in local areas. It is often a component of communities that support rare plant species." (Welsh et al, 1993).

Flowering/Fruiting Period: Not available

Diagnostic Characteristics: A small, woody sagebrush. Unlike many of the other sagebrushes, which have 3-toothed leaves, pygmy sagebrush has crowded stiff linear leaves that are green and glandular. It has a massive root system, much larger than the above-ground parts. The main branches seldom stand over 5 cm, while the narrow, erect inflorescence rises above them to 20 cm. The smallest of our woody sagebrushes, pygmy sage occupies some of the most harsh, dry sites in the state (Lyon, 2008).

No line drawing available

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Astragalus chuskanus (Chuska Milk-vetch)

Habitat: Degraded Chuska sandstone in openings in montane coniferous forest above 5,500 ft.

Flowering/Fruiting Period: Flowers late May through July.

Diagnostic Characteristics: Matted perennial herb; stems spreading on ground (humistrate), freely branching, densely leafy, to 4 dm long; herbage densely hairy with soft, fine, basifixed hairs; stipules connate; leaves silvery-gray, 1.5-4 cm long; leaflets 9-15, obovate or oblong-elliptic, 2.5-9 mm long, 1-3 mm wide; racemes shortly but loosely 4-10 flowered; flowers pea-like; calyx about 5.5 mm long; petals whitish, fading to ochroleucous, often blushed with lilac or dull purple; pods lying on the ground, twisted on the stalk and ascending, sessile, obliquely semi-ovoid, pilosulous, 6 mm long (excluding the persistent style base), 3 mm wide.

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Astragalus chuskanus

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Astragalus cliffordii (Clifford's Milk-vetch)

Habitat: Rim rock ledges of the Mesa Verde Group, in sagebrush and pinyon-juniper woodland; 6,800 ft.

Flowering/Fruiting Period: Flowers in June.

Diagnostic Characteristics: Caulescent perennial, 3.5-6.5 dm tall; basifixed pubescent; stems buried for 1-6 cm, erect-ascending, forming diffuse clumps; stipules 1.5-4.5 mm long, some connate-sheathing; leaves 3.5-6.5 cm long; leaflets 5-7 (occasionally 9), linear, acute, strigose, 8-28 mm long, 0.4-1 mm wide; peduncles 1.2-12 cm long, racemes loosely 5-19 flowered, ascending; flowers pea-like; calyx 1.8-3 mm long, the tube 1.2-1.8 mm long; petals pale, faintly suffused with purple, 4.3-6.1 mm long; pods declined, 9-12 mm long, the body elliptic to oblong, straight or slightly curved, sub-inflated, 9-9.8 mm long, 2.5-3 mm wide, compressed, glabrous, unilocular; ovules 4 or 5.

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Source: Dorothy Hoard, 2007

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Astragalus heilii (Heil's Milk-vetch)

Habitat: Rim rock ledges of the Mesa Verde Group, in pinyon-juniper woodland; 7,200 ft. *Astragalus heilii* is a very narrow endemic known only from the type location on the Navajo Nation near Borrego Pass. Additional field surveys are needed to determine its abundance and distribution.

Flowering/Fruiting Period: Flowers in May.

Diagnostic Characteristics: Low, subcaulescent perennial; basifixed pubescent; stems mostly 2-4 cm long, obscured by stipules and leaf bases; stipules 2-3 mm long, merely amplexicaul or the lowermost connate-sheathing; leaves 1-2.5 cm long; leaflets mostly 7-13, elliptic, obtuse, strigulose on both sides 2-3.5 mm long, 1-1.6 mm wide; peduncles 1-7 cm long, racemes with 2-4 (occasionally only 1) ascending flowers; flowers pea-like; calyx 2.3-3 mm long, the tube 0.9-1.7 mm long; petals whitish or tinged violet; pods spreading or pendulous, the body ellipsoid, sub-inflated, 9-9.8 mm long, 4.5-4.6 mm thick, slightly dorsiventrally compressed, thin-walled, red-mottled, unilocular; ovules 8-10.

Photograph by Steve O'Kane.
http://nmrareplants.unm.edu/rarelist_single_photo.php?SpeciesID=213

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Astragalus hallii

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Astragalus micromerius (Chaco Milk-vetch)

Habitat: Gypseous or limy sandstones in pinyon-juniper woodland or Great Basin desert scrub; 6,600-7,300 ft.

Flowering/Fruiting Period: Flowers July and August.

Diagnostic Characteristics: Perennial herb; stems 5-30 cm long, prostrate, silvery-hairy, bearing densely crowded small leaves; leaves 4-20 mm long, pinnately compound with 3-9 leaflets; flowers usually solitary or in pairs, pea-like, about 6 mm long, petals greenish-white with pale purple veins or tips; pods ovoid, 4-5 mm long, slightly longer than broad, unilocular, the tip forming a flattened beak.

Photograph by Ken Heil. http://nmrareplants.unm.edu/rarelist_single_photo.php?SpeciesID=28

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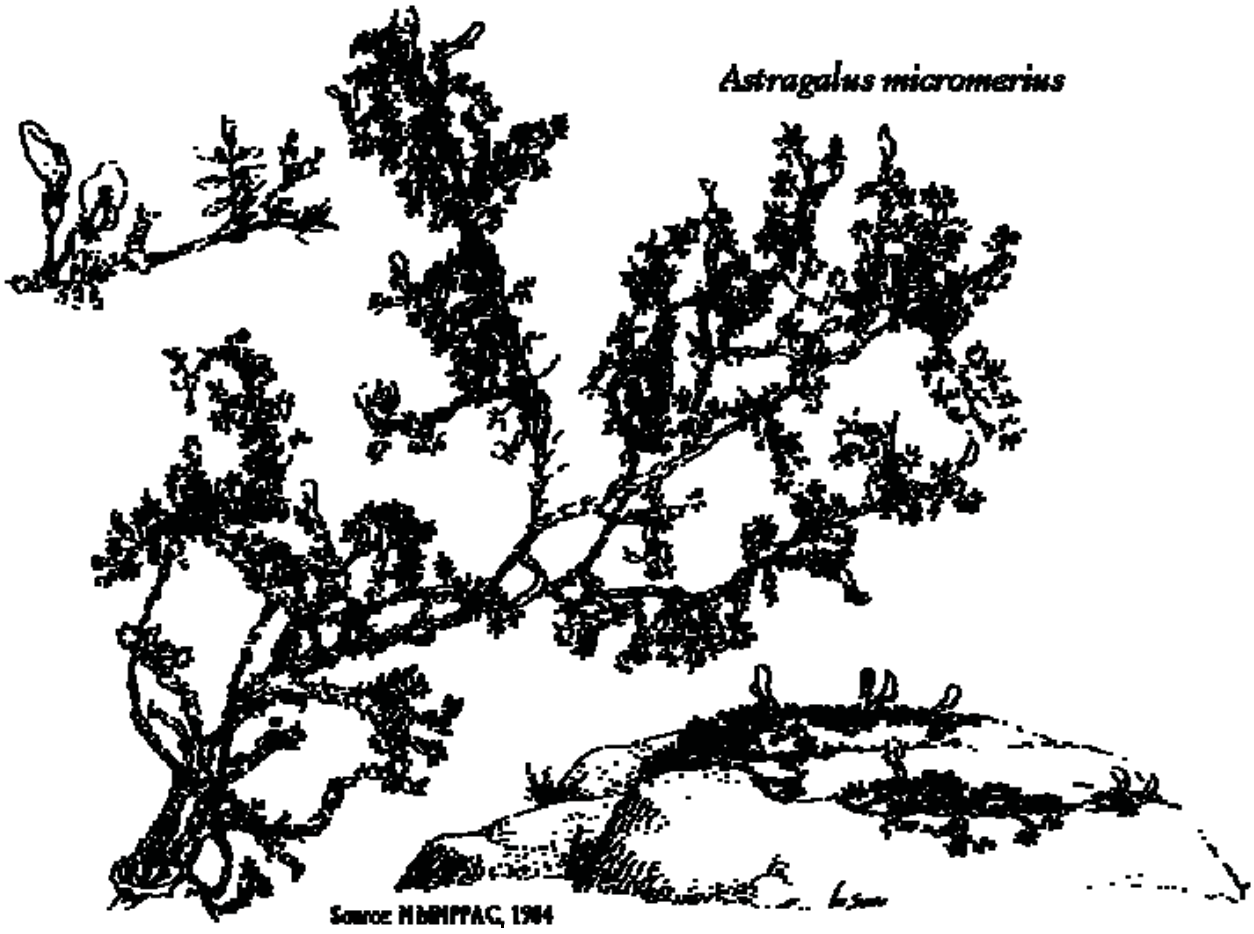

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Astragalus missouriensis var. accumbens

(Zuni Milk-vetch)

Habitat: Gravelly clay banks and knolls, in dry, alkaline soils derived from sandstone, in pinyon-juniper woodlands; 6,200-7,900 ft.

Flowering/Fruiting Period: Flowers as early as March, but typically May through June or as late as August.

Diagnostic Characteristics: Perennial; plants low, tufted, stemless or with short stem (0-4 (occasionally 6) cm long), stems prostrate; herbage usually silvery; foliage densely strigose with rather coarse straight and parallel, appressed, dolabriform hairs; stipules not connate; leaves 2-6.5 cm long; leaflets 7-15, obovate to oval, 2-8 (occasionally 11) mm long; flower stalks slender, wiry, often long-persistent, 3-6.5 cm long, prostrate in fruit; inflorescence (can be 3) 5-14-flowered, axis little elongating in fruit; calyx 4.5-5 mm long, with mixed black and white or sometimes all white hairs; flowers pea-like; petals ochroleucous with indistinct lilac veins, or banner and wings distally tinged with dull lilac, longest petals (wings) 7.5-9 mm long; banner abruptly recurved 90-100 degrees, 7-8.3 mm long; pod spreading or ascending, long-persistent, plumply ovoid or oblong-ellipsoid, straight, 9-18 mm long, 4-7(8) mm in diameter, rounded at base, abruptly contracted at tip into a stout cusp, exterior fleshy, green, smooth, strigulose, becoming leathery, brown or black, roughly netlike, either no septum or a rudimentary one up to 1.2 mm wide, dehiscing apically and ultimately through the length of the ventral (adaxial or upper) suture, the tips curling backward and gaping to release the seeds.

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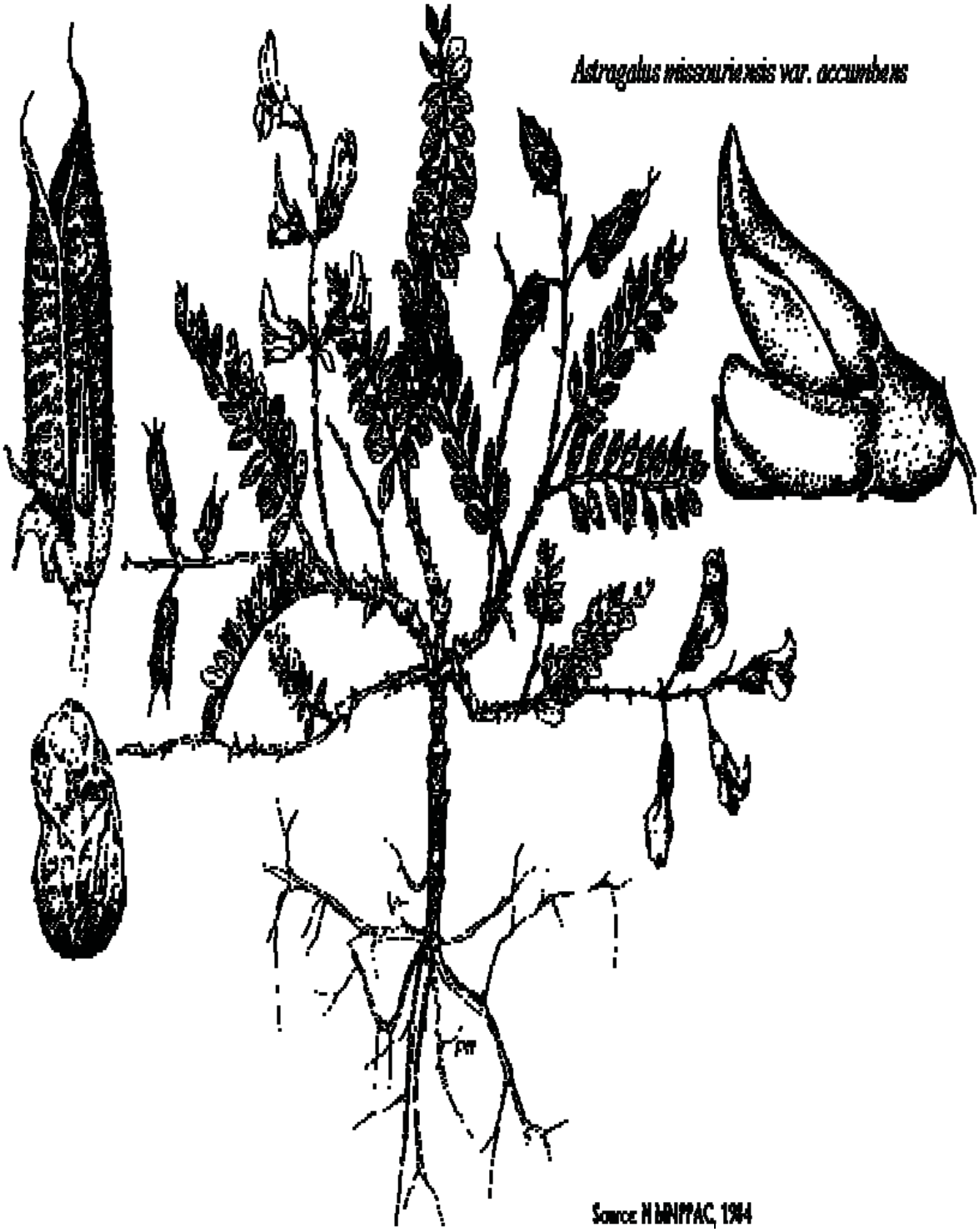

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Astragalus naturitensis (Naturita Milk-vetch)

Habitat: Sandstone ledges and rimrock along canyons in pinyon-juniper woodland; 5,400-6,200 ft.

Flowering/Fruiting Period: Flowers late April and May.

Diagnostic Characteristics: Low, subacaulescent perennial, about 10 cm tall; stems 2-6 cm long; leaves to 6 cm long; leaflets 9-15 , strigose with straight, overlapping hairs; flowers 1, pea-like, less than 14 mm long; petals bi-colored, banner white with lilac streaks, wings and keel-tips purple; pods leathery, strigose, curved.

Photograph by Daniela Roth.
http://nmrareplants.unm.edu/rarelist_single_photo.php?SpeciesID=30

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Source: NMNPEAC, 1984

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Astragalus oocalycis (Arboles Milk-vetch)

Habitat: Seleniferous clay soils (e.g. Mancos Formation) with sagebrush, pinyon-juniper woodland, and transitional areas between pinyon-juniper woodland and ponderosa pine forest; often on roadsides, road cuts, and in other disturbed areas; 5,600-7,200 ft. This species has a relatively limited distribution of approximately 65 km (40 mi) north/south by 80 km (50 mi) east/west, centered on Navajo Reservoir. Although this species has a restricted area of occurrence, populations may be locally abundant.

Flowering/Fruiting Period: Flowers May to July.

Diagnostic Characteristics: Perennial; stems erect or ascending, 20-40 cm long; herbage green to gray-green; leaves pinnately compound, 5-15 cm long; leaflets 19-27, 2-4 cm long, nearly glabrous above; flowers ochroleucus (yellow-white), in dense 35-60-flowered racemes; calyx densely hirsute with straight or spreading hairs, with age becoming papery and inflated, ovoid or subglobose, up to 14 mm long, 11 mm wide, contracted at the mouth; pods 6-7 mm long, declined, glabrous, grooved on lower side, becoming leathery as they mature.

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Source: EES Inc, 1995; Reams

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Erigeron acomanus (Acoma fleabane)

Habitat: Sandy slopes and benches beneath sandstone cliffs of the Entrada Sandstone Formation in pinyon-juniper woodland; 6,900-7,100 ft.

Flowering/Fruiting Period: Flowers in July.

Diagnostic Characteristics: Taprooted perennial, mat-forming, 10-70 cm in diameter; leaves mostly basal, spreading or ascending, 8-30 in rosettes at ends of caudex branches, oblanceolate to narrowly obovate or spatulate, 8-23 mm long, 2-7 mm wide, round or obtuse at the tip, moderately puberulent on both surfaces; flowering stems erect, 4.5-15 cm tall, bearing 4-10 reduced leaves; heads solitary, pendulous in bud, erect in flower and fruit; involucre 5 mm high; phyllaries 25-38, lanceolatate, 2.5-4 mm long, purplish on the margins; ray flowers 16-30, white, 4.5-9 mm long; disk corollas 2.5-3 mm long, yellowish; achenes somewhat flattened, lightly hirsute; pappus of fine barbellate bristles.

Photograph by Robert Sivinski.
http://nmrareplants.unm.edu/rarelist_single_photo.php?SpeciesID=73

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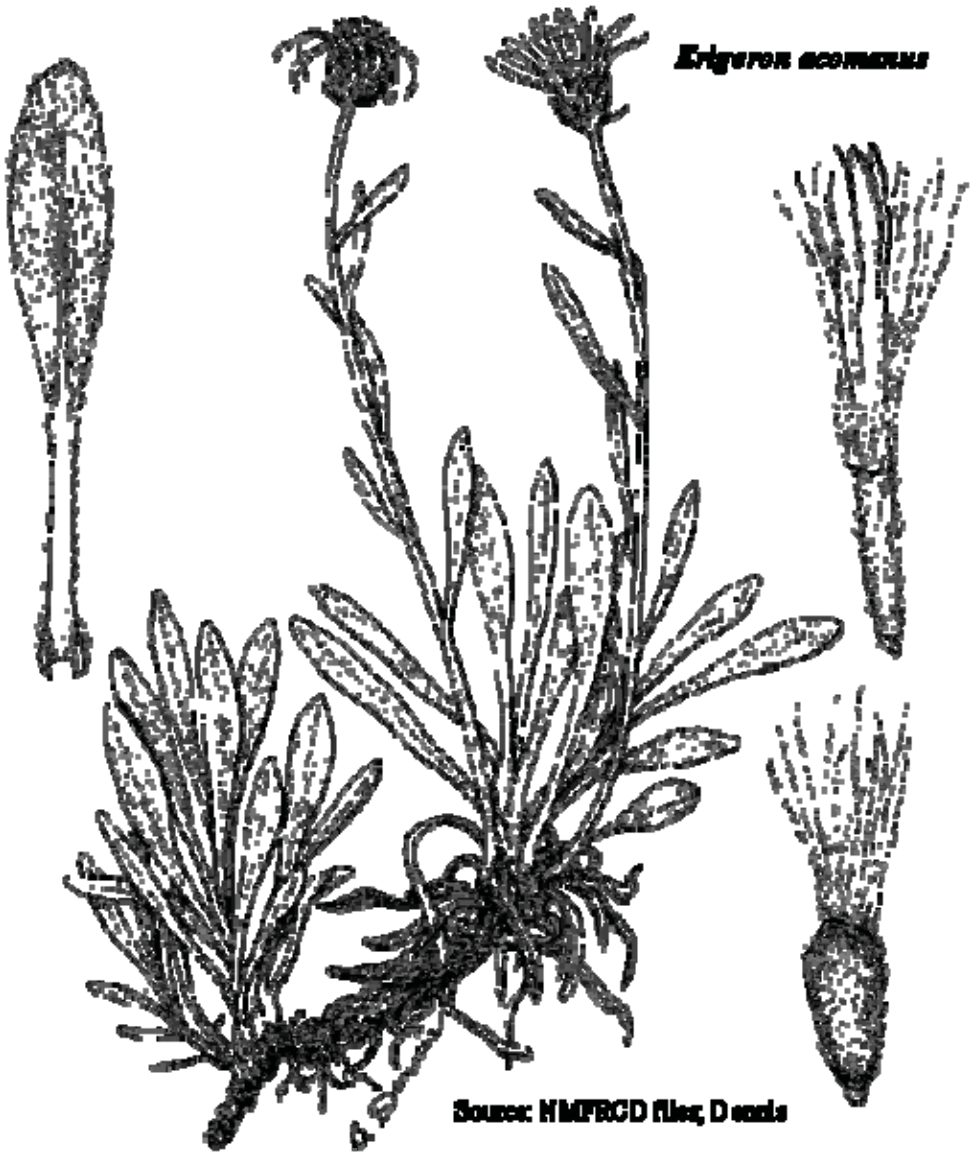

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Erigeron rhizomatus (Zuni Fleabane)

Habitat: Nearly barren detrital clay hillsides with soils derived from shales of the Chinle or Baca formations (often seleniferous); most often on north or east-facing slopes in open pinyon-juniper woodlands at 7,300-8,000 ft.

Flowering/Fruiting Period: Flowers May and June.

Diagnostic Characteristics: Herbaceous perennial with creeping rhizomes; stems 2.5-4.5 dm tall, sparsely branching from near the base, growing in clumps to about 3 dm in diameter; leaves alternate, oblong, about 1.0 cm long, glabrous except for occasional ciliate hairs on the margins; flower heads solitary terminating the branches, 13-16 mm wide, involucral bracts in several series; ray flowers 25-45, white or tinged with blue-violet, 6-7 mm long and 1.3-1.5 mm wide; disk flowers yellow; achenes 5-6 nerved, nearly glabrous, pappus 25-35 fragile bristles with a few short outer setae.

Photograph by Robert Sivinski.
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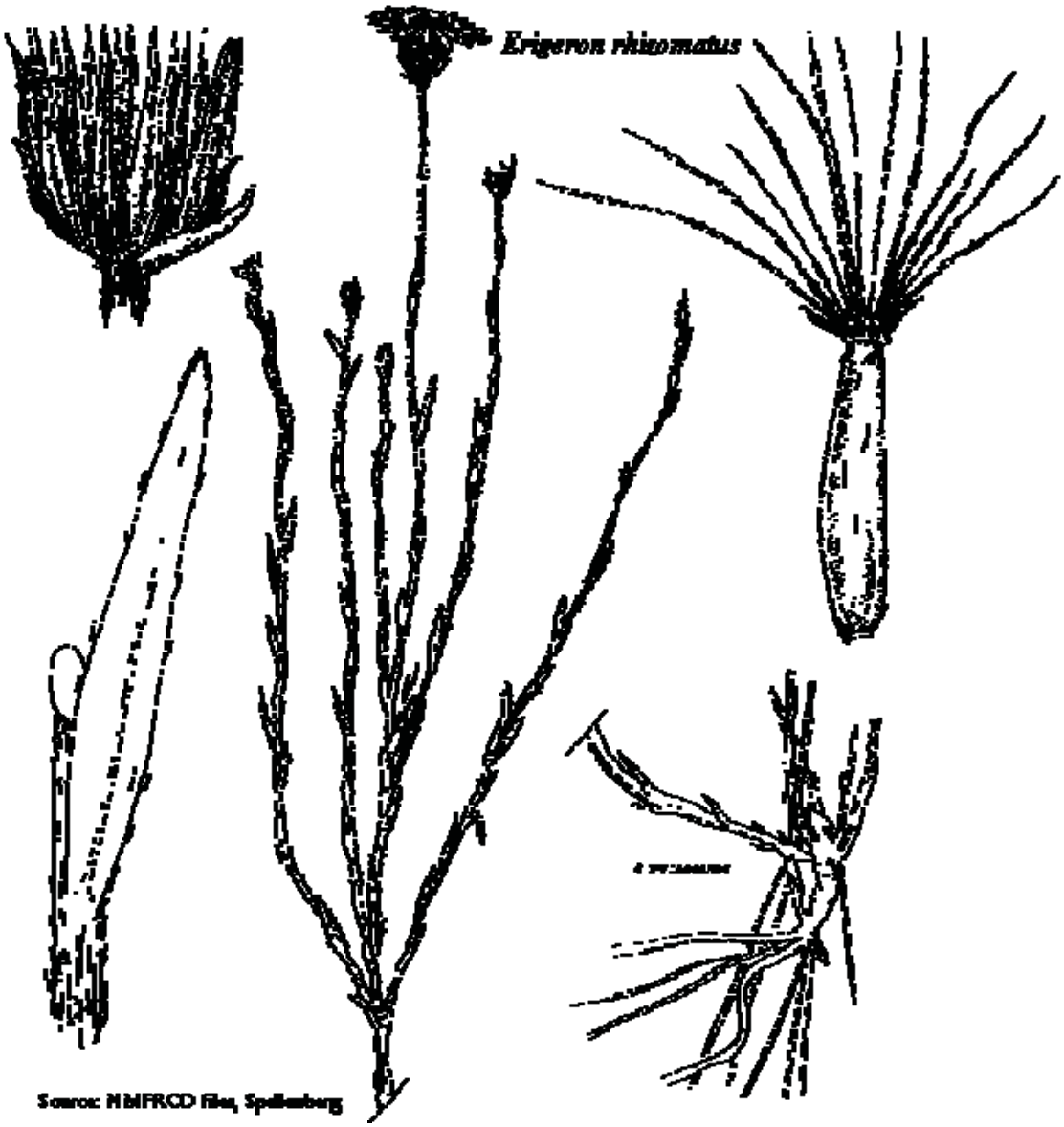

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Erigeron sivinskii (Sivinski's Fleabane)

Habitat: Chinle shale in pinyon-juniper woodland and Great Basin desert scrub; 6,100-7,400 ft.

Flowering/Fruiting Period: Flowers primarily in May and June.

Diagnostic Characteristics: Perennial herb arising from a thick taproot with numerous, short (1-3 cm), ascending-erect caudex branches, the upper portion of these with persistent old leaf bases; stems erect, 5-8 cm tall, unbranched, green, sparsely short-strigose with white, stiff, closely appressed trichomes, evenly distributed, even in length, 0.2-0.3 mm long; leaves green, similar in vestiture to the stems, arising in dense basal clusters from the caudex apices, erect to ascending, linear, 9-34 mm long, 0.5-0.8 mm wide, thickened, slightly flaring at the very base; stem leaves strictly ascending and continuing relatively unreduced in size half way to nearly all the way up the stems; heads solitary, terminal, involucre cup-shaped, 10-14 mm wide (pressed); phyllaries in 2-3 subequal series, 5-7 mm long, narrowly lanceolate with attenuate-filiform apices, minutely but prominently granular-glandular, the outer also sparsely pilose with a few crisped-spreading hairs arising centrally; ray florets 21-33, the corollas 7-10 mm long, 1.0-2.4 mm wide, white, drying pinkish, distinctly coiling from the apices with maturity; disk corollas 3.6-4.2 mm long, narrowly funnel-form, glabrate; style branches 0.5-0.6 mm long, the collecting appendages deltate to shallowly triangular, 0.1-0.2 mm long; achenes 2(-3) nerved, narrowly oblong, 2.8-3.1 mm long, the faces glabrous, the margins sparsely ciliate; pappus of 20-27 barbellate bristles.

Photograph by Robert Sivinski.
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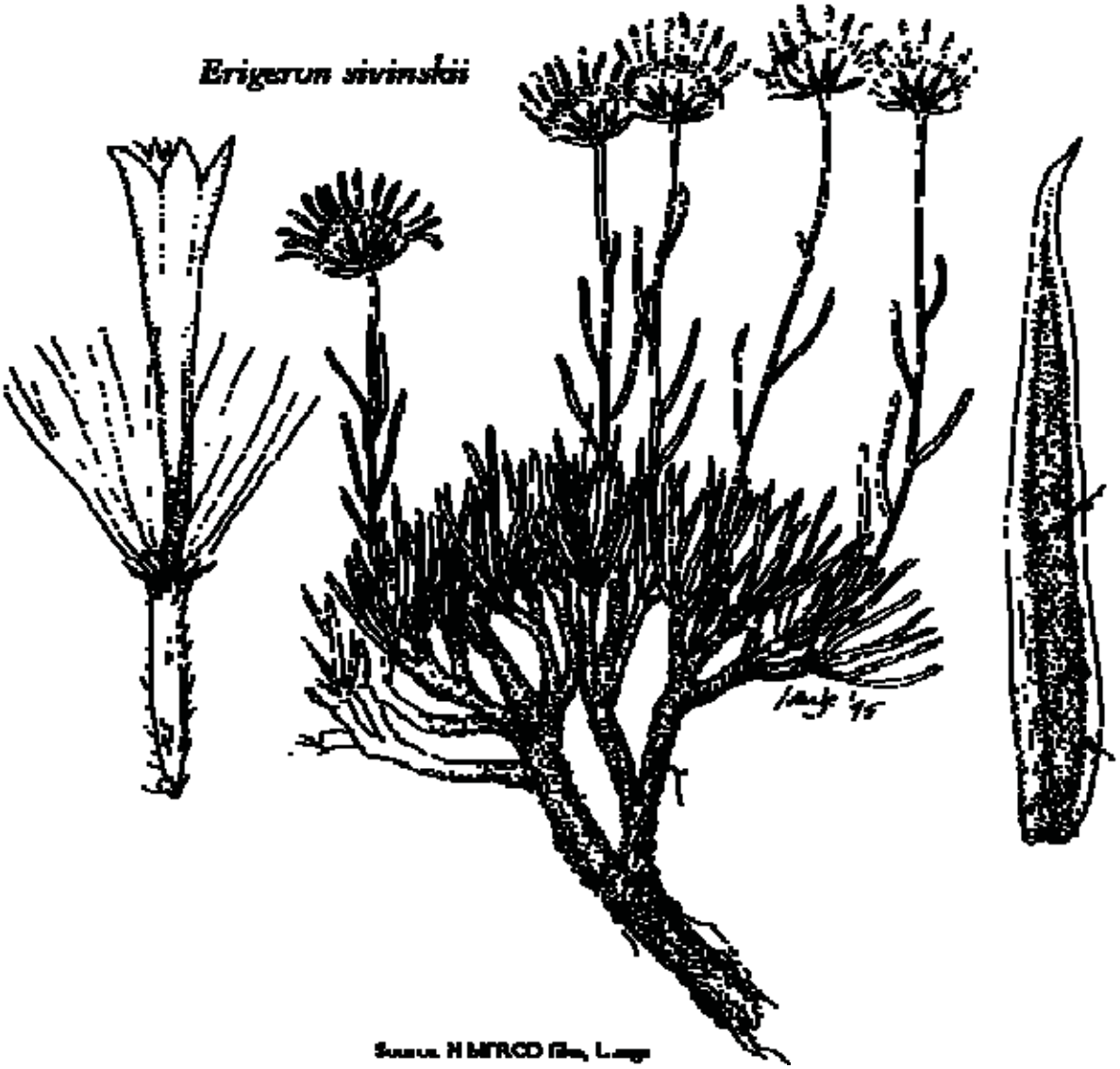

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Eriogonum lachnogynum var. sarahiae (Sarah's Wild Buckwheat)

Habitat: Open sandy limestone ridges and edges of mesas in pinyon-juniper woodland; about 5,900-7,540 ft.

Flowering/Fruiting Period: Flowers late May and June.

Diagnostic Characteristics: Perennial herb forming hemispheric mounds up to 3 dm across from an intricately branching caudex; leaves all basal, short-petiolate, the blade narrowly elliptic, 4-12 mm long, 1.5-4 mm wide, silky-tomentose below, green and strigose above, the margins revolute; inflorescence stems up to 40 or more per plant, 1.5-5.5 cm long, silky tomentose; inflorescences capitate; involucres 5-lobed, 3-5 mm high, 5-6.5 mm wide; flowers yellow, 2.5-4.5 mm long, 5-12 per involucre; petals villous pubescent on outer surface; ovaries and seeds villous.

Photograph by Robert Sivinski.
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Eriogonum lachnogynum var. sarahiae

Source: Dorothy Hoard, 2007

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Fritilaria atropurpurea (Spotted Fritillary)

Habitat: Grassy slopes and hills to coniferous montane forests in New Mexico. Open woodlands throughout most of the Intermountain Region, but infrequent and widely scattered (Cronquist et al, 1977).

Flowering/Fruiting Period: Flowers April to July (Cronquist et al, 1977).

Diagnostic Characteristics: Erect, slender perennial herbs 1 – 6 dm tall with leafy stems arising from tannish bulbs 1–1.5 (occasionally 2) cm long with a few, small, thin scales and few (if any) bulblets; leaves several, mostly 7 – 14, linear, (4) 6 – 10 (12) cm long, 2 – 4 (occasionally 7) mm wide, alternate or whorled and scattered on the upper half of the stem; flowers commonly 1 – 4, spreading or nodding, broadly campanulate, greenish-brown to chocolate brown with white or yellow spots or mottling, the tepals oblong to rhombic and tapering abruptly at the base, 10 – 20 mm long, 3 – 8 mm wide, the gland an indistinct brownish-yellow spot at the base; stamens 6 – 15 mm long, the filament slender, the anther 3 -4 mm long; styles connate only 1 – 2 mm, the branches 6 – 9 mm long, acutely angled (Cronquist et al, 1977).

No photo or line drawing available

Mammillaria wrightii var. wrightii (Wright Fishhook Cactus)

Habitat: Gravelly hills or sandy hills or plains, desert grassland to pinyon-juniper 3,000-7,000 ft (NMNPPAC, 1984).

Flowering/Fruiting Period: Flowers from May through August (NMNPPAC, 1984).

Diagnostic Characteristics: Stems solitary, to about 10 cm tall and 5 cm wide; spines 10-15 per cluster, the outer spines tan or gray, the central ones reddish brown and hooked, 10-13 mm long; flowers pink to purple or tinged with white or yellow, mostly 2.5–5 cm long and somewhat wider than long; fruit rounded to ovoid, rust red color (NMNPPAC, 1984).

No photo or line drawing available

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Muhlenbergia arsenei (Tough Muhli, Navajo Muhli)

Habitat: On limestone rock outcrops in pinyon-juniper woodland; 4,600-6,500 ft.

Flowering/Fruiting Period: Flowers August to September.

Diagnostic Characteristics: Loosely tufted perennial, the spreading base sometimes appearing rhizomatous; stems wiry, 1.0-4.5 dm tall, decumbent at base; leaf blade 1-5 cm long, less than 2 cm wide, inrolled; ligule 1-2 mm long; inflorescence 4-12 cm long, less than 3 cm wide, branches ascending to appressed; spikelets 3.5-5.0 mm long excluding the awn; glumes 2-3 mm long, tips acute to very short-awned; lemma short-soft hairy on the lower half, awn flexuous, 4-12 mm long.

Photograph by Kelly Allred. http://nmrareplants.unm.edu/rarelist_single_photo.php?SpeciesID=210

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Parthenium alpinum var. alpinum

(Alpine Fever-Few)

Habitat: Dry upland sites in sparse grasslands or shrublands, especially mountain-mahogany (Cerocarpus spp.) shrublands. Often on limestone; occasionally on shale. 4,900-7,200 ft elevation (NatureServe, 2009).

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Flowering/Fruiting Period: May

Diagnostic Characteristics: A perennial herb that forms a ground-hugging mat less than 4 cm in height. Flower heads are extremely inconspicuous: tiny, green, and mostly covered by the foliage (NatureServe, 2009).

No photo or line drawing available

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Phacelia splendens (Patch Scorpion-weed)

Habitat: Barren clay slopes in West central and Southwestern Colorado and extreme Northwest New Mexico (Cronquist et al, 1984).

Flowering/Fruiting Period: Unavailable

Diagnostic Characteristics: Seeds are conspicuously excavated on one or usually both sides of the prominent ventral ridge; plants annual to biennial; leaves strongly toothed to more often pinnately lobed or dissected; leaves less dissected, only the lower (or none) of the sinuses reaching the midrib; corolla-lobes entire or nearly so; seeds deeply excavated on both sides of the ventral ridge; filaments evidently exerted (to 2 mm or usually much more); flowers on short, stout pedicels up to about 1-1.5 mm long, or virtually sessile; leaves glaborous or nearly so, except sometimes along the petiole and the proximal part of the rachis.

No photo or line drawing available

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Phlox cluteana (Navajo Mountain Phlox)

Habitat: Light to heavy shade on sandy soils in ponderosa pine forest; 6,000-10,000 ft.

Flowering/Fruiting Period: Flowers June to July.

Diagnostic Characteristics: Perennial with slender, creeping rhizomes; stems mostly 8-10 cm long, sparsely to densely glandular pubescent; leaves evergreen, 1-4 cm long, entire, linear to narrowly lanceolate or elliptic, glabrous to ciliate or sometimes pubescent like the stems; inflorescence of short, terminal cymes; pedicels 3-15 mm long; flowers large and showy, light pink to purple; calyx 6-8 mm long; corolla tube 8-18 mm long, the lobes 8-10 mm long and nearly as wide, rounded at the apex; stamens included or slightly exserted.

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Source: Arizona Rare Plant Field Guide, 2001; M. Sharp

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Physaria navajoensis (Navajo Bladderpod)

Habitat: Mesa rims of Todilto limestone in sparse pinyon-juniper woodland; 7,200-7,600 ft.

Flowering/Fruiting Period: Flowers in May.

Diagnostic Characteristics: Perennial herb forming low, cushion-shaped clumps from an intricately branching, subterranean caudex; herbage silvery-gray, covered with a crust of flattened, stellate hairs; hairs usually with 5 main rays, each twice bifurcate into 20 tips, rays somewhat fused near the center by a thin, narrow webbing; stems crowded, buried among and not exceeding the leaves; leaves linear-oblanceolate, 3-8(occasionally up to 13) mm long, 0.7-1.4 mm wide; flowers and fruits in dense, few-flowered racemes, not or barely exceeding the leaves; pedicels straight to slightly sigmoid; sepals 4, yellow-green, 3.7-4.8 mm long; petals 4, deep yellow, spatulate, 5.2-6.5 mm long; fruits slightly inflated silicles, ovate, glabrous, reddish at maturity; styles 1.8-3 mm long in fruit; seeds suborbicular-ovoid, 1.5-2.4 mm long, 1.3-1.9 mm wide, strongly mucilaginous when wetted.

Photograph by Steve O'Kane.
http://nmrareplants.unm.edu/rarelist_single_photo.php?SpeciesID=112

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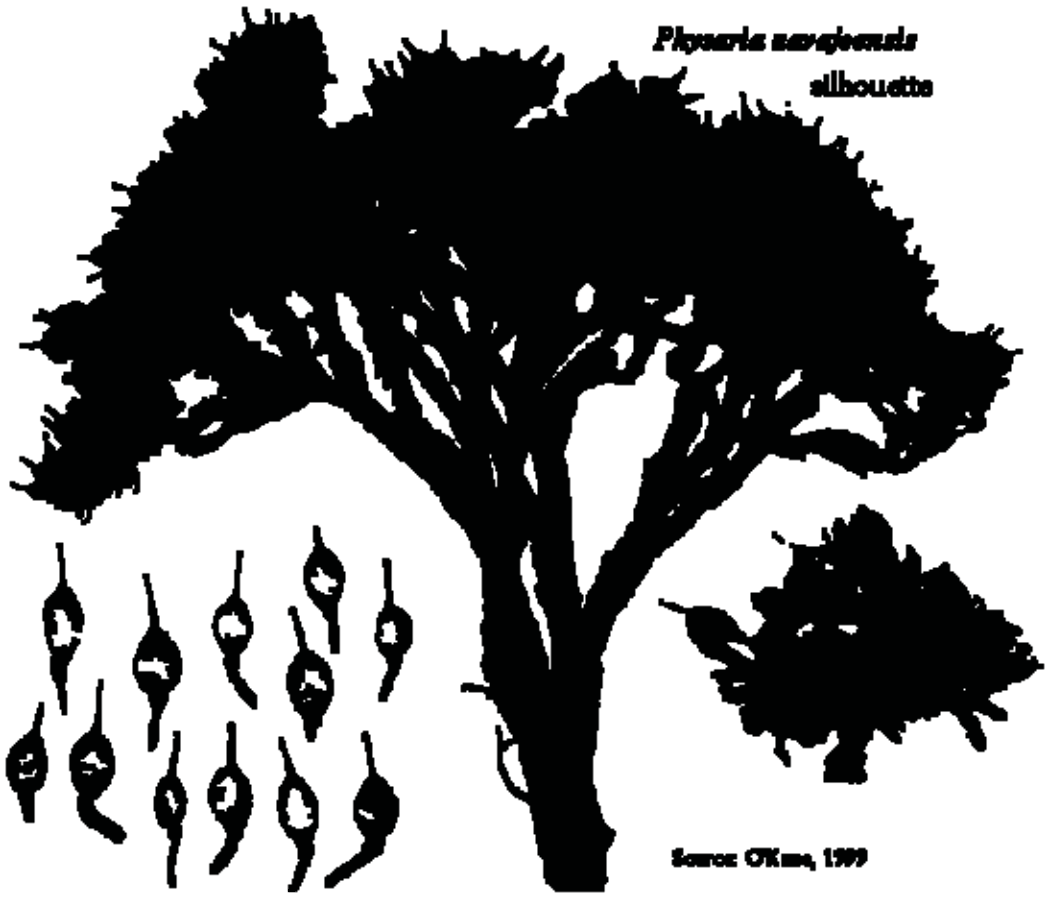

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Psorothamnus scoparius (Broom Pea)

Habitat: Open sunny areas in dunes and sandy arroyo bottoms (Cartron et al, 2008).

Flowering/Fruiting Period: Flowers June to September (Cartron et al, 2008).

Diagnostic Characteristics: Shrub to 3 ft tall; stems many branched, gray-green; herbage glandular dotted; leaves small, linear, 8-10 mm long; flowers small, clustered at the tips of stems, papilionaceous, fragrant, dark purple. It is a highly xerophytic shrub that is nearly leafless and covered in gray hairs (Cartron et al, 2008).

http://plants.usda.gov/gallery/standard/dasc7_1h.jpg

No line drawing available

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Puccinellia parishii (Parish's Alkali Grass)

Habitat: Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes at 2,600-7,200 ft range-wide. The species requires continuously damp soils during its late winter to spring growing period.

Flowering/Fruiting Period: Flowers May to June.

Diagnostic Characteristics: Dwarf annual with 1 to many stems; leaf blades about 1 mm broad, flat or involute, short; culms mostly 5-15 cm tall; panicle narrow, few-flowered, the branches erect-appressed; spikelets 4-6 mm long; glumes shorter than the first floret, broad, strongly nerved, scarious-margined; florets 4-6 per spikelet, disarticulating above the glumes; lemmas about 2 mm long, obtuse to truncate, scarious and somewhat erose at the tip, pubescent on the mid and lateral nerves nearly to the apex, and on the intermediate nerves about half way.

Photograph by Robert Sivinski.
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Senecio cliffordii (Clifford's Groundsel)

Habitat: Limy mudstones or sandy soils in pinyon-juniper woodland up to mixed conifer forest; 7,380-7,700 ft.

Flowering/Fruiting Period: Flowers April and early May.

Diagnostic Characteristics: Tufted perennial, 4-15 cm tall, forming clumps up to 2 dm across, covered with white, felty or woolly tomentum; basal leaves linear or linear-oblanceolate, 2-4 cm long, 1-3 mm wide, flat or with margins rolled inwards; stem leaves reduced to small scales; flower stems taller than basal leaves and terminated by one or three heads; flower heads about 10 mm long, involucral bracts in one or two series, green or becoming purplish at maturity; disk flowers yellow, ray flowers absent; achenes sparsely short-hairy along the longitudinal angles; pappus of white capillary bristles.

Photograph by Robert Sivinski.
http://nmrareplants.unm.edu/rarelist_single_photo.php?SpeciesID=217

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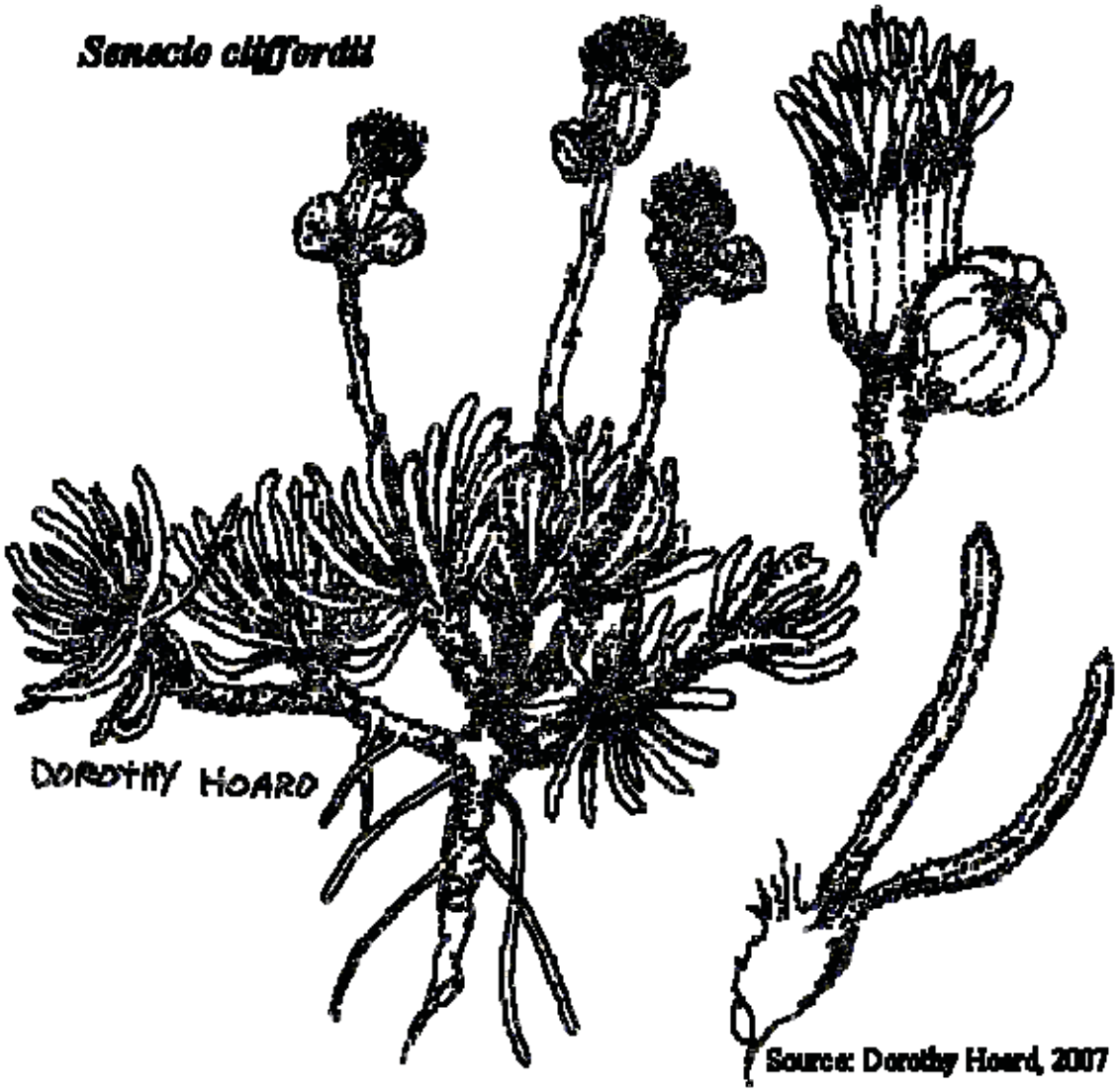

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Appendix D

Field Guide to Sensitive Mammal, Bird, and Reptile Species

Potentially Found on in the Vicinity of the Church Rock Mill Site

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Sensitive Mammal, Bird, and Reptile Species Field Guide

A list of all rare and sensitive animal species believed to occur within the Navajo Nation was acquired for the determination of potential species to be found in the vicinity of the Church Rock Mill Site. A total of 70 species were included on the list with an additional two species added that had been identified in the field and were not on the list. The list of 70 was reduced to 17 potential species based on the incompatibility of habitat requirements with conditions that exist on the project area. The additional two species that were identified in the field brings the list to 19 potential sensitive animal species that may be encountered during operations at Church Rock Mill Site (see table below).

Scientific Name	Common Name	Global Status	Federal Status	State Status	Navajo Nation
Mammals					
Puma concolor	Mountain lion	G5	-	S4	-
Sorex merriami	Merriam's Shrew	G5	Sensitive	S2	-
Birds					
Buteo swainsoni	Swainson's Hawk	G4	Sensitive	S4	G2
Callipepla squamata	Scaled Quail	G5	-	S5	-
Circus cyaneus	Northern Harrier	G5	-	S4	-
Geococcyx californianus	Greater Roadrunner	G5	-	S5	-
Haliaeetus leucocephalus	Bald Eagle	G4	T	T	G3
Hirundo rustica	Barn Swallow	G5	-	S5	-
Myadestes townsendi	Townsend's Solitaire	G5	-	S5	-
Progne subis	Purple Martin	G5	Sensitive	S4	-
Regulus satrapa	Golden-crowned Kinglet	G5	-	S4	-
Vireo vicinior	Gray Vireo	G5	Sensitive	S3	-
Reptiles					
Aspidoscelis tigris	Western Whiptail	G5	-	S3	-
Aspidoscelis inornatus	Little Striped Whiptail	G5	-	S5	-
Crotalus viridis abyssus	Grand Canyon Rattlesnake	G5	-	S5	-
Diadophis punctatus	Ringneck Snake	G5	-	S4	-
Eumeces multivirgatus	Many-lined Skink	G5	-	S5	-
Hypsiglena torquata	Night Snake	G5	-	S5	-
Sceloporus graciosus graciosus	Northern Sagebrush Lizard	G5	-	S4	-

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Description of Status Table Codes

Global

G3 Vulnerable - Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.
G4 Apparently Secure - Uncommon but not rare (although it may be rare in parts of its range, particularly on the periphery), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern. Typically more than 100 occurrences and more than 10,000 individuals.
G5 Secure - Common, widespread, and abundant (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences and more than 10,000 individuals.

Federal

T - A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Sensitive - A species that is likely to occur or have habitat on National Forest Service System lands and that has been identified by the Regional Forester as of concern for reduction in population viability as evidenced by: significant current or predicted downward trends in population numbers or density, or; significant current or predicted downward trends in habitat capability that would reduce the species' distribution.

State

S3 Vulnerable - Vulnerable in NM either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.
S4 Apparently Secure - Uncommon but not rare, and usually widespread in NM. Possible cause of long-term concern. Usually more than 100 occurrences and more than 10,000 individuals.
S5 Secure - Common, widespread, and abundant in NM. Essentially ineradicable under present conditions. Typically with considerably more than 100 occurrences and more than 10,000 individuals.

Navajo Nation

G2 - A species or subspecies whose prospects of survival or recruitment are in jeopardy.

G3 - A species or subspecies whose prospects of survival or recruitment are likely to be in jeopardy in the foreseeable future.

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MAMMALS

Puma concolor (Mountain lion)

Description: Mountain lions appear similar to a short-haired house cat, with a relatively small head, shortened face, small and rounded ears, elongated body, and long neck and tail. Males are about eight to as much as nine feet from the nose to the tip of its tail, and females, about 6 to 7 feet long. Both sexes range from 2 – 2 1/2 feet in height. Males usually weigh between 125 to 160 pounds and females between 80 to 100 pounds. Mountain lion have a variety of color from tawny to rufous to buff to bluish gray along the back and sides with a lighter colored belly, throat and inner legs and with a black-bracketed nose and a dark-tipped tail (Sharp, 1996).

Habitat: It tends to choose vegetated ridges, rocky cliffs and ledges, and other solid covers in inland areas found in the Southwest desert basin and mountain range country (Sharp, 1996).

Diet: Mountain lions often favor white tail and mule deer, but it will prey on any animal it can catch, including anything from elk, moose and bighorn sheep to rodents, reptiles and birds. Some even eat insects (Sharp, 1996).

Ecology: It is a solitary, nocturnal animal that is active throughout the year, although it may migrate up into the higher elevations in the summer and down into lower elevations in winter (Sharp, 1996).

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Sorex merriami (Merriam's Shrew)

Description: Merriam's shrew is brownish-gray or gray above with whitish undersides. Its tail is distinctly bi-colored. It is smaller than the dusky and masked shrew and it is very difficult to identify. Only close, microscopic examination of the teeth will allow experts to identify it with certainty. Its total length is 88 to 107 mm, tail length is 33 to 42 mm and it weighs 4 to 7 grams (Streubel, 2000).

Habitat: It is found at elevations of 650-9500 ft (200-2900 m), primarily in grasses in shrub steppe or pinyon-juniper habitat (recorded in spruce-aspen grove in New Mexico). It seems to prefer drier habitats than other shrews. (Streubel, 2000).

Diet: Feeds primarily on insects and other small invertebrates. Caterpillars are most common summer food item (Streubel, 2000).

Ecology: It is active throughout the year and it may utilize burrows and runways of other animals (Streubel, 2000).

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BIRDS

Buteo swainsoni (Swainson's Hawk)

Description: Swainson's hawk is a medium-sized bird with a stout body and broad wings. It has a white face with dark flight feathers that contrast with a pale inner wing, a dark chest band and a medium-long rounded tail that is light with multiple thin dark bands, one darker and broader near the tail tip. The juveniles have a similar underwing to the adults, but the underparts are streaked with large spotting on the breast (England et al, 1997).

Habitat: These hawks are locally uncommon in riparian woodland to fairly common in pinyon-juniper and adjacent riparian habitats (Schmitt, 1976).

Ecology: Swainson's hawk is a migratory species that breeds in North America and is mostly seen in McKinley County only during the summer months. It winters in South America. This species has had declining numbers throughout much of its range. It is susceptible to pesticides, especially on its wintering grounds. The use of pesticides in Argentina was responsible for the deaths of nearly 6,000 Swainson's Hawks in 1995 and 1996 (CLO, 2009a). Buteo swainsoni was listed under the Navajo Endangered Species List "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) (NESL, 1994). However,

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globally Buteo swainsoni was listed under the Natural Heritage Global Rank "G4" ("G4" = "Apparently Secure") (AGFD, 1995).

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Callipepla squamata (Scaled Quail)

Description: Scaled quail is medium-sized and pale gray overall. It has a bushy white chest and finely scaled pattern over neck, chest, and belly. The juveniles are similar to the adult, but start out without the scaling (Schemnitz, 1994). The cotton-top crest is often visible from some distance, and generally the grayish coloration of this species sets it apart from all other quail in the arid habitat where it occurs. Females may be distinguished from adult males by their less conspicuous crests and by the dark brown streaks on the sides of the face and throat (males have unstreaked pearly gray to white coloration in this area). The birds are usually reluctant to fly, preferring to run rather than remain hidden. The distinctive "pey-cos" location calls (stronger in males) often reveal the presence of scaled quail in the area (Johnsgard, 1975).

Habitat: The species seem to survive best where there is a combination of annual weeds, some shrubby or spiny ground cover, and available surface water. In the northern part of its natural range it is especially associated with sandy soils and sand sagebrush vegetation. A source of midday shade and loafing cover is important during summer, but it must not be so thick as to prevent escape by running (Johnsgard, 1975).

Ecology: Scaled quail are residents almost statewide and are considered rare to common. They are local in much of the central-western, extreme northwest and extreme central-northern areas. They exist casually at elevations above 7000 feet (Hubbard, 1978).

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Circus cyaneus (Northern Harrier)

Description: Northern harriers are medium-sized hawks with long, slender, rounded wings with a white rump and long tail. It flies low, with wings held up in a slight "V". It is one of the few raptors in which the sexes look quite different. The head, back, and upper chest of the male is light gray. The chest and belly are white with some rusty markings extending onto the flanks. Its underwings are white with black wingtips and a line of black on the rear of the wings. The tail is darkish gray above and whitish below with some barring. The back of the female is dark brown with many feathers edged with tawny. The female's face is streaked brown and whitish and outlined by a white facial disk. Its chest and belly are streaked dirty white and tan. The upper sides of the wings are brown and the lower sides are barred white and dark brown. The tail is brown with dark bars. The juveniles are similar to the adult female, but with rusty wash across mostly unstreaked underparts.

Habitat: Common winter resident in the Southwestern lowlands. It loves open country and glides low over grasslands close to water, over freshwater or saltwater marshes, or hovers over wet meadows (Davis, 1997).

Ecology: Typically perches on the ground rather than in trees. Nest is on the ground (Cartron et al, 2008).

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Geococcyx californianus
(Greater Roadrunner)

Description: Eyelids lashed; bill curved; feathers of crest and neck bristly, whole plumage coarse and harsh; tail long, graduated; wings very short; feet large and strong. Upperparts conspicuously streaked with brown and white, crest and foreparts of back glossed with steel-blue changing on lower back to lustrous bronzy green; upper tail coverts and middle tail feathers bronzy olive, glossed with purplish; outer tail feathers blue-black and green, tipped with white thumb marks; throat and belly whitish, chest streaked with black; iris yellow to orange, bare orbital space light blue anteriorly passing into bluish white beneath and behind the eye, the posterior portion deep orange or orange-red; bill horn color, legs and feet pale bluish (Bailey, 1928).

Habitat: The Greater Roadrunner can be found in cactus deserts or in dry, open country with various types of brush for cover (Davis, 1997).

Ecology: Rarely flies; typically is seen running rapidly and in zigzags with tail trailing on the ground (Carton et al, 2003). It's a common, permanent resident and is the state bird of New Mexico. It is demonstrably secure (G5) (BISON-M, 2009a).

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Haliaeetus leucocephalus (Bald Eagle)

http://www.nearfamous.com/Pages/BaldEagles.html

Description: Head, neck, and tail pure white, body blackish or dark brown with feathers of the leg not reaching the foot; iris usually pale yellow or whitish; bill, cere, legs, and feet corn yellow (Bailey, 1928). Juveniles are variably patterned with dark brown and white; takes five years to acquire full adult plumage. White not restricted to well defined areas, but appearing scattered throughout body, usually with brown mottling in same area. White in wings primarily in linings and not flight feathers. Bill and cere blackish gray. Eyes dark brown. Feet and lower legs yellow (CLO, 2009b).

Habitat: Bald eagles seem to prefer timbered areas along coasts, large lakes, and rivers, but they also occupy other areas (O'Gara, 1994). They exhibit casual use of Juniper Savannahs and Great Basin sage areas (BISON-M, 2009b).

Ecology: It is unlikely that the Bald Eagle would be present at this site, unless merely migrating through, given the heavy need for bodies of water for its prey, but due to the status of this bird (threatened) it is included in this survey.

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Hirundo rustica (Barn Swallow)

http://www.bison-m.org/booklet.aspx?id=041950

Description: Dark blue above; orange below with deeply forked tail (Rappole, 2000).

Habitat: Savanna, prairie, open areas near water (Rappole, 2000).

Ecology: It seldom nests away from human-made structures. Barn swallows often nest in colonies where they have access to various kinds of structures such as barns, bridges, culverts, outbuildings, or eaves of houses, to which they attach their nests (Davis, 1997).

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Myadestes townsendi (Townsend's Solitaire)

Description: Gray body; black, notched tail with white outer tail feathers; buff wing patches; white eyering (Rappole, 2000).

Habitat: Shrubby under story of montane coniferous forest; juniper, arid and semi-arid thorn forest in winter (Rappole, 2000). In summer, frequents mountainous coniferious forests around 3,000 feet below treeline; in winter, descends to canyons with open juniper forests on lower slopes (Alsop, 2001).

Ecology: As a breeder, the Townsend Solitaire is rather rare in New Mexico, and is confined during the summer to the higher parts of the mountains (Bailey, 1928).

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Progne subis (Purple Martin)

Description: The adult male is glossy blue-black both above and below. The head reflects violet coloration in full sunlight with the forked tail and wings showing dull black. It is the only dark-bellied swallow. The female is light bellied with a smoky-gray throat and breast, and often has a very light collar (Davis, 1997).

Habitat: It is found in open or semi-open country where it can find nesting sites in saguaro cacti or hallow trees (Davis, 1997). Nests in colonies, originally in trees, now often in specially constructed martin houses (Rappole, 2000).

Ecology: Uncommon to rare and local summer resident in the lowlands and foothills of Western New Mexico (Rappole, 2000).

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Regulus satrapa (Golden-Crowned Kinglet)

http://www.discoverlife.org/mp/20q?search=Regulus+satrapa

Description: Greenish above, whitish below; white wing bars, white eyering; male has orange crown bordered by yellow and black; female has yellow crown bordered in black (Rappole, 2000).

Habitat: Breeds in boreal zone mature spruce-fir and pine forest, especially red and douglas firs, sugar and ponderosa pines; a variety of woodland habitats in winter (Rappole, 2000).

Ecology: Seasonal migrant; vulnerable to habitat loss caused by logging, especially of mature coniferous forests (Alsop, 2001).

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Vireo vicinior (Gray Vireo)

Photo by Mark Watson http://www.bison-m.org/booklet.aspx?id=042200

Description: Gray above, whitish below with narrow white eyering and single, faint wingbar (Rappole, 2000).

Habitat: Desert thorn scrub, oak-pinyon-juniper woodlands (Rappole, 2000).

Ecology: The Gray Vireo is a threatened species in New Mexico (BISON-M, 2009c).

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REPTILES

Aspidoscelis tigris (Western Whiptail)

Description: 2 3/8 – 5 in. Back and sides with spots, bars, or network of dusky or black markings on background of gray, brown, yellowish, or tan. Light stripes may be present but often fade on lower back and base of tail. Ground color gray-brown, yellowish brown, yellowish, or olive. Tail becomes dark brown, dusky, or bluish toward tip. Usually cream-colored or yellowish below, with scattered spots of blackish, especially on chest and throat. In extreme darkening, the throat, chest, underside of front legs and belly are black; orange or pink on throat may be reduced to a few tan flecks. Rust-colored patches often present on sides of belly. Scales in front of gular fold only slightly enlarged and grading gradually into small granules of fold. Postantebrachials not enlarged. Supraorbital semicircles extend far forward. 68 – 114 dorsal granules. The young are spotted, marbled, or striped with black above; black fields alternating with narrow orange-yellow ones. Tails bright blue (Stebbins, 2003).

Habitat: Deserts and semiarid habitats, usually where plants are sparse and there are open areas for running. Ranges from deserts to montane pine forests (below sea level to around 7,000 ft) where it prefers warmer, drier areas. Avoids dense grassland and thick growth of shrubs. Ground may be firm soil, sandy, or rocky (Stebbins, 2003). This species is often associated with greasewood shrubs and pinyon-juniper woodlands (McCoy, 1965).

Breeding Period: One to two (perhaps 3) clutches usually with 1 – 4 (rarely 8) eggs, laid in April – Aug. Single clutches usually laid in cooler environments (Stebbins, 2003).

Ecology: The western whiptail appears to be limited to areas with 150 or more frost free days per year and requires sufficient soil moisture to prevent egg desiccation (McCoy, 1965).

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Aspidoscelis inornatus (Little Striped Whiptail)

http://www.jcmnaturalhistory.com/jcmTEIIDAE.html

Description: 2 – 3 2/5 in. 6 – 8 (usually 7) pale yellowish, gray, to whitish stripes; mid-dorsal stripe sometimes faint or absent. Dark field between stripes blackish, brown, or brownish green to gray, without light spots; dark field becomes lighter with age. Tail blue to purplish blue towards the tip. Usually bluish white to blue below (brightest in males). Postantebrachials and scales in front of gular fold only slightly enlarged or not at all. Supraorbital semicircles normal. 52 – 79 dorsal granules. Usually 3 enlarged, rounded scales in front of vent. The young are less blue below than adult. The male's chin and belly are more bluish than the female's. Both sexes have more vivid blue on the underside of tail than on remaining underparts (Stebbins, 2003).

Habitat: Chiefly a prairie grassland species, but ranges into grassy areas of shrubby desert, chaparral, the pinyon-juniper zone, and in the northwestern part of its range into open ponderosa pine forests. Frequents sandy or silty, sometimes gravelly ground of elevated plains or lowlands. Seldom found in rocky or very barren areas or in mesquite habitats occupied by Desert Grassland Whiptails. Elevation ranges generally from 1,000 – 5,500 ft, but have been found up to 7,000 ft (Stebbins, 2003).

Breeding Period: Clutch of 1 – 3 eggs, laid May – June, perhaps as late as August (Stebbins, 2003).

Ecology: Species in apparent decline in many areas, perhaps due to over-grazing and other human disturbances (Stebbins, 2003).

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Crotalus viridis abyssus

(Grand Canyon Rattlesnake)

Description: 16-64 inches. Size and color vary greatly. Brownish blotches down midline of back, generally edged with dark brown or black and often surrounded by light border; begin as oval, squarish, diamondlike, or hexagonal markings and tend to narrow into inconspicuous crossbands near tail. More than 2 internasal scales touch rostral scale. Scales keeled, in 25-27 rows (eNature, 2007a).

Habitat: Frequents a great variety of habitats, from shrub-covered coastal sand dunes to timberline and from prairies and desert-edge habitats of mesquite scrublands to pinyon-juniper woodland and montane forests. Rocky outcrops, talus slopes, rocky stream courses, and ledges are favorite haunts; in cooler areas (more northerly parts of its range and at higher elevations) it may den in mammal burrows, rock crevices, or caves, sometimes in large numbers (Stebbins, 2003).

Breeding Period: Live bearing ranging from 1 – 25 (often 4-12) young, born Aug – Oct (Stebbins, 2003).

Ecology: They are widespread, common and are venomous and aggressive if disturbed (Carton et al, 2008).

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Diadophis punctatus (Ringneck Snake)

Description: 10-30 inches. A small slender snake, with a yellow, cream, or orange neck ring and bright yellow, orange, or red belly. Back gray, olive, brownish, or black; belly frequently marked with black spots. Neck ring may be interrupted, obscure, or occasionally absent. Loreal scale present. Scales smooth, in 15-17 rows. Anal plate divided (eNature, 2007b).

Habitat: Moist situations in varied habitat; forest, grassland, rocky wooded hillsides, chaparral, into upland desert along streams; sea level to ca. 7,000 ft (eNature, 2007b).

Breeding Period: Ringneck snakes mate in spring or fall. Clutches of 1-10 elongate white or yellowish eggs, 1 inch long, are laid June to July in communal nesting sites. Young hatch in about 8 weeks, at 4-6 inches; mature in 2-3 years. (eNature, 2007b).

Ecology: Some species have enlarged rear teeth and possibly toxic saliva, but are no threat to people. In other parts of the range 80 to 95 percent of individuals coil their tails to expose the bright red underside. This defense behavior is often reinforced by a discharge of musk. Adult males are less likely to tail-coil than juveniles and females (Fitch, 1975; Gehlbach, 1974; Smith, 1974).

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Eumeces multivirgatus (Many-lined Skink)

Description: 5-7 5/8 inches. Long-bodied, with many alternating light and dark stripes, including dorsolateral light stripe along 3rd scale row counting from middle of back. Back striping faded or absent in some populations. Tail tapers so gradually it appears swollen. Young have bright blue tail (eNature, 2007c).

Habitat: Little is known about the environmental requirements of this species but it is most often encountered in areas with rocks, under which they shelter (Hahn, 1968). Many-lined Skinks have been found in areas of rocks and small brush in open grassy plains, sand hills, and desert; mountainous wooded areas to 8,200 ft (eNature, 2007c).

Breeding Period: Lays clutch of 5 eggs, but there is uncertainty as to the timing (eNature, 2007c).

Ecology: They are active during the day, especially during the morning. They are seasonally active beginning in April extending through September, although May and June appear to the period of peak activity (Hahn, 1968).

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Hypsiglena torquata (Night Snake)

Description: 12-26 inches. Slender and cylindrical-bodied; beige, yellowish, or gray, patterned with numerous dark brown or gray blotches on back and side. Large blotch on each side of neck; a third spot may be present on nape or lateral blotches may be fused at midline. Eyes with vertical pupils. Dark bar behind eye; upper lip scales white. Belly cream or white, unpatterned. Scales smooth, in 19-21 rows. Anal plate divided (eNature, 2007d).

Habitat: A habitat generalist, the night snake is found in rocky areas of grassland, chaparral, desertscrub, woodland, moist mountain meadows, and thornscrub from sea level to 8,700 feet (ASDM, 2009).

Breeding Period: Habits poorly known. Clutches of 4-6 eggs, 7/8-1 ¼ inches long, have been deposited late April to early July. Incubation takes 7-8 weeks (eNature, 2007d).

Ecology: Seldom encountered during the day, this nocturnal snake is often seen crossing roads at night. The night snake preys upon lizards, small snakes, frogs, salamanders, and small mice, which it subdues with its mild venom; this venom poses no threat to humans. Young night snakes feed upon insects. If disturbed, the night snake raises its head and weaves, hisses, and flattens its neck in threat (ASDM, 2009).

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Sceloporus graciosus graciosus

(Common Sagebrush lizard)

Description: 5-6 3/16 inches. A spiny lizard. Granular scales do not overlap on rear of thigh. Grayish-green to brown; some darker spots and crossbars. Faint light dorsolateral stripes. Sides reddish-orange behind forelegs. Males have light-blue mottling (not patches) on throat and darker blue belly patches. Females have pinkish orange on sides and neck (eNature, 2007e).

Habitat: Primarily areas of sagebrush and gravelly soils or fine-sand dunes. Never far from shelter such as stony piles, crevices, animal burrows (eNature, 2007e). Sagebrush lizards range up from 5,000 - 8,500 ft (Douglas, 1966).

Breeding Period: Single clutch of 2-7 eggs is laid June to July, hatches July to August (eNature, 2007e).

Ecology: Diurnal. Primarily terrestrial, these lizards occasionally climb trees or bushes in pursuit of insect prey (eNature, 2007e). They retreat into burrows or rock crevices at high or low temperatures and the availability of shade is important. During winter, they must be deep enough to avoid freezing (Douglas, 1966). The average home range for males was 85.7 square meters and 49 square meters for females (Turner, 1974).

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Appendix E

Raw Data

Table E1 Church Rock Mill - Vegetation Cover - 2013

Reclaimed Baseline

Raw Data

Percent Ground Cover Based on Point-Intercept Sampling

			Transect No.——>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average Cover	Frequency
Grasses																				
P		*Achnatherum hymenoides*	Indian Ricegrass				8	9	3		6								**1.73**	**27**
P		*Agropyron smithii*	Western Wheatgrass	5	5							4							**0.93**	**20**
P		*Aristida purpurea*	Purple Three-awn					4											**0.27**	**7**
P		*Bouteloua curtipendula*	Sideoats Grama							8	13								**1.40**	**13**
P		*Bouteloua gracilis*	Blue Grama							11	8	1							**1.33**	**20**
P		*Elymus elymoides*	Squirreltail														3		**0.20**	**7**
P		*Hilaria jamesii*	Galleta								3								**0.20**	**7**
A		*Munroa squarrosa*	False Buffalograss	1	11	3													**1.00**	**20**
P		*Sporobolus cryptandrus*	Sand Dropseed			1													**0.07**	**7**
Forbs																				
A		*Amaranthus hybridus*	Slim Amaranth			8													**0.53**	**7**
P		*Aster sp.*	Aster sp.						3										**0.20**	**7**
A		*Bassia scoparia*	Burningbush									36	19	32	43	40	26		**13.07**	**40**
B	Nw	*Carduus nutans*	Musk Thistle															51	**3.40**	**7**
A		*Chamaesyce serpyllifolia*	Thymeleaf Sandmat	5	4	6												1	**1.07**	**27**
A		*Erodium cicutarium*	Redstem Stork's Bill	2	2														**0.27**	**13**
A		*Salsola tragus*	Russian Thistle				14	9				6	13	24	7	13	12		**6.53**	**53**
A		*Sisymbrium altissimum*	Tall Tumblemustard						6										**0.40**	**7**
P			Unidentified Perennial Forb			5													**0.33**	**7**
Shrubs, Sub-shrubs, Cacti & Trees																				
P		*Atriplex canescens*	Fourwing Saltbush	12			4						17					6	**2.60**	**27**
P		*Chrysothamnus nauseosus*	Rubber Rabbitbrush	11	33	14	6		39	6		5						2	**7.73**	**53**
P		*Gutierrezia sarothrae*	Broom Snakeweed								1								**0.07**	**7**
P		*Tetradymia glabrata*	Littleleaf Horsebrush								1								**0.07**	**7**
																			Mean	
			Total Plant Cover	**36**	**55**	**37**	**32**	**22**	**51**	**25**	**32**	**52**	**49**	**56**	**50**	**53**	**41**	**60**	**43.40**	
			Rock	0	16	27	6	12	0	0	0	0	0	0	0	0	1	0	**4.13**	
			Litter	31	25	26	32	9	26	26	23	18	20	18	25	31	35	24	**24.60**	
			Bare ground	33	4	10	30	57	23	49	45	30	31	26	25	16	23	16	**27.87**	
			Total Non-Noxious Vegetative Cover	**36**	**55**	**37**	**32**	**22**	**51**	**25**	**32**	**52**	**49**	**56**	**50**	**53**	**41**	**9**	**40.00**	
			Total Perennial Cover (noxious weeds excluded)	**28**	**38**	**20**	**18**	**13**	**45**	**25**	**32**	**10**	**17**	**0**	**0**	**0**	**3**	**8**	**17.13**	

Sample Adequacy Calculations	**Plant Cover Mean = 43.40** **t= 1.35** **n = 15** **Variance = 144.69** **n_{min} = 13.90**
Diversity	**Number of Species with ≥1% Average Cover = 10**

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

Table E2 Church Rock Mill - Vegetation Cover - 2013

Grassland Baseline

Raw Data

Percent Ground Cover Based on Point-Intercept Sampling

		Transect No.——>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average Cover	Frequency
Grasses																			
P	*Agropyron smithii*	Western Wheatgrass	3				5	6								2		**1.07**	**27**
P	*Bouteloua gracilis*	Blue Grama	29	27	51	45	67	22	32	58	74	37	37	40	27	61	59	**44.40**	**100**
A	*Munroa squarrosa*	False Buffalograss												4				**0.27**	**7**
Forbs																			
A	*Bassia scoparia*	Burningbush	10	2	4	3		3	1		3	1		2				**1.93**	**60**
A	*Chamaesyce serpyllifolia*	Thymeleaf Sandmat					1									1		**0.13**	**13**
A	*Erodium cicutarium*	Redstem Stork's Bill					4				14			18		1		**2.47**	**27**
P	*Phoradendron macrophyllum*	Colorado Desert Mistletoe													1		1	**0.13**	**13**
A	*Portulaca oleracea*	Little Hogweed	11	4	5	4	1	12				3		3	3			**3.07**	**60**
A	*Salsola tragus*	Russian Thistle	16	20	14	13	1	8	10	10		5	3		18	10	15	**9.53**	**87**
P	*Sphaeralcea coccinea*	Scarlet Globemallow								1								**0.07**	**7**
P		Unidentified Perennial Forb			1						1							**0.13**	**13**
Shrubs, Sub-shrubs, Cacti & Trees																			
P	*Artemisia tridentata*	Big Sagebrush					4	11								8		**1.53**	**20**
P	*Ceratoides lanata*	Winterfat							1									**0.07**	**7**
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush	5	5		4	1	9	13				4	7				**3.20**	**53**
P	*Gutierrezia microcephala*	Threadleaf Snakeweed			4		2		1		3	8	9			1		**1.87**	**47**
																		Mean	
		Total Plant Cover	**74**	**58**	**79**	**69**	**86**	**71**	**58**	**69**	**95**	**54**	**53**	**74**	**49**	**84**	**75**	**69.87**	
		Rock	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**0.07**	
		Litter	22	12	6	8	4	15	12	18	2	17	19	9	38	8	14	**13.60**	
		Bare ground	4	30	15	23	10	14	30	13	3	29	27	17	13	8	11	**16.47**	
		Total Non-Noxious Vegetative Cover	**74**	**58**	**79**	**69**	**86**	**71**	**58**	**69**	**95**	**54**	**53**	**74**	**49**	**84**	**75**	**69.87**	
		Total Perennial Cover (noxious weeds excluded)	**37**	**32**	**56**	**49**	**79**	**48**	**47**	**59**	**78**	**45**	**50**	**47**	**28**	**72**	**60**	**52.47**	

Sample Adequacy Calculations	**Plant Cover Mean = 69.87** **t= 1.35** **n = 15** **Variance = 177.98** **n_{min} = 6.60**
Diversity	**Number of Species with ≥1% Average Cover = 9**

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

Table E3 Church Rock Mill - Vegetation Cover - 2013

Shrubland Baseline

Raw Data

Percent Ground Cover Based on Point-Intercept Sampling

		Transect No.——>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average Cover	Frequency
Grasses																			
P	*Agropyron smithii*	Western Wheatgrass						3						1				**0.27**	**13**
P	*Bouteloua gracilis*	Blue Grama			27	20	17	11	27	11	17			23	21	9		**12.20**	**67**
P	*Elymus elymoides*	Squirreltail												1				**0.07**	**7**
A	*Munroa squarrosa*	False Buffalograss		1		2						22						**1.67**	**20**
P	*Sporobolus cryptandrus*	Sand Dropseed				1		1				3						**0.33**	**20**
Forbs																			
A	*Bassia scoparia*	Burningbush			2			11	1			14		2				**2.00**	**33**
A	*Chenopodium album*	Lambsquarters			4													**0.27**	**7**
P	*Eriogonum sp.*	Buckwheat sp.		1								2						**0.20**	**13**
A	*Portulaca oleracea*	Little Hogweed		3		2			3		1			3	3			**1.00**	**40**
A	*Salsola tragus*	Russian Thistle							8	1								**0.60**	**13**
Shrubs, Sub-shrubs, Cacti & Trees																			
P	*Artemisia tridentata*	Big Sagebrush	32	23	4	15	12	4	7	9	14	10	17	15	5	7	11	**12.33**	**100**
P	*Atriplex canescens*	Fourwing Saltbush										2						**0.13**	**7**
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush			2													**0.13**	**7**
P	*Gutierrezia microcephala*	Threadleaf Snakeweed	1	3							3		2	5		1		**1.00**	**40**
P	*Gutierrezia sarothrae*	Broom Snakeweed			1	9	5		3	6		1	6			12	21	**4.27**	**60**
																		Mean	
		Total Plant Cover	**33**	**31**	**40**	**49**	**34**	**30**	**49**	**27**	**35**	**54**	**25**	**50**	**29**	**29**	**32**	**36.47**	
		Rock	3	3	0	0	0	2	0	0	1	1	6	0	3	23	1	**2.87**	
		Litter	13	24	23	21	35	30	18	18	29	13	22	15	9	18	19	**20.47**	
		Bare ground	51	42	37	30	31	38	33	55	35	32	47	35	59	30	48	**40.20**	
		Total Non-Noxious Vegetative Cover	**33**	**31**	**40**	**49**	**34**	**30**	**49**	**27**	**35**	**54**	**25**	**50**	**29**	**29**	**32**	**36.47**	
		Total Perennial Cover (noxious weeds excluded)	**33**	**27**	**34**	**45**	**34**	**19**	**37**	**26**	**34**	**18**	**25**	**45**	**26**	**29**	**32**	**30.93**	

Sample Adequacy Calculations	**Plant Cover Mean = 36.47** **t= 1.35** **n = 15** **Variance = 90.12** **n_{min} = 12.26**
Diversity	**Number of Species with ≥1% Average Cover = 7**

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

Table E4 Church Rock Mill - Vegetation Cover - 2013

Reclaimed Analog Area

Raw Data

Percent Ground Cover Based on Point-Intercept Sampling

		Transect No.——>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average Cover	Frequency
Grasses																			
P	*Achnatherum hymenoides*	Indian Ricegrass			2	8		11	2					18	10	12	22	**5.67**	**53**
P	*Agropyron smithii*	Western Wheatgrass	1						1	11	9							**1.47**	**27**
P	*Elymus elymoides*	Squirreltail			5									2				**0.47**	**13**
P	*Sporobolus cryptandrus*	Sand Dropseed	25	3	3	13	5	11	1	3	3	6	4		12	7		**6.40**	**87**
A		Unidentified Annual Grass	4	11	8	2			1	4	2	5	9	1	9	1		**3.80**	**80**
Forbs																			
P	*Asclepias subverticillata*	Horsetail Milkweed										3						**0.20**	**7**
P	*Aster sp.*	Aster sp.	2	2	9													**0.87**	**20**
A	*Bassia scoparia*	Burningbush	2															**0.13**	**7**
A	*Chamaesyce serpyllifolia*	Thymeleaf Sandmat	2		6	5	6					1	3				1	**1.60**	**47**
A	*Helianthus sp.*	Helianthus sp.			2						2							**0.27**	**13**
A	*Portulaca oleracea*	Little Hogweed										2	2					**0.27**	**13**
A	*Salsola tragus*	Russian Thistle		5	3	4	5	4	4		4	5		8	5	1		**3.20**	**73**
P	*Symphyotrichum falcatum*	White Prairie Aster				13			6		2	10	8	2	8	7	7	**4.20**	**60**
Shrubs, Sub-shrubs, Cacti & Trees																			
P	*Atriplex canescens*	Fourwing Saltbush	33	46	1	5	15	11	31	31	26	1	33	9	4	7		**16.87**	**93**
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush														7		**0.47**	**7**
																		Mean	
		Total Plant Cover	**69**	**67**	**39**	**50**	**31**	**37**	**46**	**49**	**48**	**33**	**59**	**40**	**48**	**42**	**30**	**45.87**	
		Rock	0	0	0	0	0	0	4	0	2	0	0	2	0	0	10	**1.20**	
		Litter	21	9	30	22	25	24	26	34	44	40	29	12	30	22	8	**25.07**	
		Bare ground	10	24	31	28	44	39	24	17	6	27	12	46	22	36	52	**27.87**	
		Total Non-Noxious Vegetative Cover	**69**	**67**	**39**	**50**	**31**	**37**	**46**	**49**	**48**	**33**	**59**	**40**	**48**	**42**	**30**	**45.87**	
		Total Perennial Cover (noxious weeds excluded)	**61**	**51**	**20**	**39**	**20**	**33**	**41**	**45**	**40**	**20**	**45**	**31**	**34**	**40**	**29**	**36.60**	
Multiple Hits																		**Average Cover**	**Frequency**
Grasses																			
P	*Achnatherum hymenoides*	Indian Ricegrass				16	4	28	2					32	12	10	24	**8.53**	**53**
P	*Agropyron smithii*	Western Wheatgrass							2	10	20							**2.13**	**20**
P	*Elymus elymoides*	Squirreltail												2				**0.13**	**7**
P	*Sporobolus cryptandrus*	Sand Dropseed				14	10	19		5	15	10			11	2		**5.73**	**53**
A		Unknown Annual Grass				16	4		7	21	23	21	31		15	2		**9.33**	**60**
Forbs																			
A	*Amaranthus hybridus*	Slim Amaranth														2		**0.13**	**7**
P	*Asclepias subverticillata*	Horsetail Milkweed										2						**0.13**	**7**
P	*Aster sp.*	Aster spp.													3	2		**0.33**	**13**
A	*Salsola tragus*	Russian Thistle				2	6	3	3		3	1		4	11			**2.20**	**53**
P	*Symphyotrichum falcatum*	White Prairie Aster				10			1		2	2						**1.00**	**27**
Shrubs, Sub-shrubs, Cacti & Trees																			
P	*Atriplex canescens*	Fourwing Saltbush				14	18	32		44	25	4	57	12	2	9		**14.47**	**67**
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush														15		**1.00**	**7**
																		Mean	
		Overall Total Hits (LAI)	**69**	**67**	**39**	**122**	**73**	**119**	**61**	**129**	**136**	**73**	**147**	**90**	**102**	**84**	**54**	**91.00**	

Sample Adequacy Calculations	**Plant Cover Mean = 45.87**	**t= 1.35**	**n = 15**
	Variance = 143.12		**n_{min} = 12.31**
Diversity	**Number of Species with ≥1% Average Cover = 8**		

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

Table E5 Church Rock Mill - Vegetation Cover - 2013

Grassland Analog Area

Raw Data

Percent Ground Cover Based on Point-Intercept Sampling

		Transect No.——>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average Cover	Frequency
Grasses																			
P	*Achnatherum hymenoides*	Indian Ricegrass				1												**0.07**	**7**
P	*Bouteloua curtipendula*	Sideoats Grama													2	8		**0.67**	**13**
P	*Bouteloua gracilis*	Blue Grama	44	34	22	23	31	29	31	30	37	20	7	19	18	1	21	**24.47**	**100**
P	*Elymus elymoides*	Squirreltail										1						**0.07**	**7**
P	*Hilaria jamesii*	Galleta												4			2	**0.40**	**13**
Forbs																			
A	*Chamaesyce serpyllifolia*	Thymeleaf Sandmat												1		1		**0.13**	**13**
A	*Chenopodium album*	Lambsquarters	1							2	1							**0.27**	**20**
A	*Portulaca oleracea*	Little Hogweed	2															**0.13**	**7**
A	*Salsola tragus*	Russian Thistle	1				2	4	2	3	7	6	7	4	1	5	1	**2.87**	**80**
Shrubs, Sub-shrubs, Cacti & Trees																			
P	*Atriplex canescens*	Fourwing Saltbush											3					**0.20**	**7**
P	*Ceratoides lanata*	Winterfat			2													**0.13**	**7**
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush						3								4	12	**1.27**	**20**
P	*Gutierrezia microcephala*	Threadleaf Snakeweed												1				**0.07**	**7**
P	*Gutierrezia sarothrae*	Broom Snakeweed	1	4	5	12	3	11		7	3	6	3	4		4	3	**4.40**	**87**
																		Mean	
		Total Plant Cover	**49**	**38**	**29**	**36**	**36**	**47**	**33**	**42**	**48**	**33**	**20**	**33**	**21**	**23**	**39**	**35.13**	
		Rock	1	1	1	1	6	0	0	4	1	21	5	7	12	35	6	**6.73**	
		Litter	27	33	27	26	22	31	27	29	26	25	21	16	34	24	11	**25.27**	
		Bare ground	23	28	43	37	36	22	40	25	25	21	54	44	33	18	44	**32.87**	
		Total Non-Noxious Vegetative Cover	**49**	**38**	**29**	**36**	**36**	**47**	**33**	**42**	**48**	**33**	**20**	**33**	**21**	**23**	**39**	**35.13**	
		Total Perennial Cover (noxious weeds excluded)	**45**	**38**	**29**	**36**	**34**	**43**	**31**	**37**	**40**	**27**	**13**	**28**	**20**	**17**	**38**	**31.73**	

Multiple Hits

																		Average Cover	Frequency
Grasses																			
P	*Bouteloua curtipendula*	Sideoats Grama													2	17		**1.27**	**13**
P	*Bouteloua gracilis*	Blue Grama	20	30	11	28	26	28	19	19	29	12	9	14	6		6	**17.13**	**93**
P	*Elymus elymoides*	Squirreltail										1						**0.07**	**7**
P	*Hilaria jamesii*	Galleta												4				**0.27**	**7**
Forbs																			
A	*Chenopodium album*	Lambsquarters		1														**0.07**	**7**
A	*Salsola tragus*	Russian Thistle					2	2		7	23	5	8	3	2	1		**3.53**	**60**
Shrubs, Sub-shrubs, Cacti & Trees																			
P	*Atriplex canescens*	Fourwing Saltbush											2					**0.13**	**7**
P	*Chrysothamnus nauseosus*	Rubber Rabbitbrush						3								2	9	**0.93**	**20**
P	*Gutierrezia sarothrae*	Broom Snakeweed	7	1	10	14	5	11		8	8	7	2	6		5	3	**5.80**	**87**
																		Mean	
		Overall Total Hits (LAI)	**76**	**70**	**50**	**78**	**69**	**91**	**52**	**76**	**108**	**58**	**41**	**60**	**31**	**48**	**57**	**64.33**	

Sample Adequacy Calculations	**Plant Cover Mean = 35.13** **t= 1.35** **n = 15** **Variance = 85.55** **n_{min} = 12.54**
Diversity	**Number of Species with ≥1% Average Cover = 4**

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

Table E6 Church Rock Mill - Vegetation Cover - 2013

Shrubland Analog Area

Raw Data

Percent Ground Cover Based on Point-Intercept Sampling

		Transect No.——>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average Cover	Frequency
Grasses																			
P	*Agropyron smithii*	Western Wheatgrass	1															**0.07**	**7**
P	*Bouteloua gracilis*	Blue Grama	14	14	6	10	15	3	6	7	4	13	1	10	6	10	13	**8.80**	**100**
Forbs																			
A	*Chenopodium album*	Lambsquarters	3							1	3	2		5		2	2	**1.20**	**47**
A	*Salsola tragus*	Russian Thistle										3	3			2	1	**0.60**	**27**
Shrubs, Sub-shrubs, Cacti & Trees																			
P	*Artemisia tridentata*	Big Sagebrush	7	7	2	14	16	8	3	8	10	3	4	2	8	6	5	**6.87**	**100**
P	*Atriplex canescens*	Fourwing Saltbush	1															**0.07**	**7**
P	*Ceratoides lanata*	Winterfat									1					1		**0.13**	**13**
P	*Gutierrezia microcephala*	Threadleaf Snakeweed												4			2	**0.40**	**13**
P	*Gutierrezia sarothrae*	Broom Snakeweed	3	5	7	7	6	4	12	9	7	5	2	5	16	5	7	**6.67**	**100**
																		Mean	
		Total Plant Cover	**29**	**26**	**15**	**31**	**37**	**15**	**21**	**25**	**25**	**26**	**10**	**26**	**30**	**26**	**30**	**24.80**	
		Rock	0	6	1	2	0	3	4	0	1	0	1	0	0	0	2	**1.33**	
		Litter	25	34	25	28	27	35	28	27	14	42	30	23	14	26	19	**26.47**	
		Bare ground	46	34	59	39	36	47	47	48	60	32	59	51	56	48	49	**47.40**	
		Total Non-Noxious Vegetative Cover	**29**	**26**	**15**	**31**	**37**	**15**	**21**	**25**	**25**	**26**	**10**	**26**	**30**	**26**	**30**	**24.80**	
		Total Perennial Cover (noxious weeds excluded)	**26**	**26**	**15**	**31**	**37**	**15**	**21**	**24**	**22**	**21**	**7**	**21**	**30**	**22**	**27**	**23.00**	

Multiple Hits

																		Average Cover	Frequency
Grasses																			
P	*Bouteloua gracilis*	Blue Grama	12	23	5	8	10	3	2	6	4	10		6		4	7	**6.67**	**87**
Forbs																			
A	*Chenopodium album*	Lambsquarters	4								2					3		**0.60**	**20**
A	*Salsola tragus*	Russian Thistle										6	3		1	10		**1.33**	**27**
Shrubs, Sub-shrubs, Cacti & Trees																			
P	*Artemisia tridentata*	Big Sagebrush	13	11	1	26	7	9	5	15	18	3	7	5	4	8	7	**9.27**	**100**
P	*Atriplex canescens*	Fourwing Saltbush	3															**0.20**	**7**
P	*Ceratoides lanata*	Winterfat									1					2		**0.20**	**13**
P	*Gutierrezia microcephala*	Threadleaf Snakeweed												1			8	**0.60**	**13**
P	*Gutierrezia sarothrae*	Broom Snakeweed	4	4	7	11	2	10	21	9	10	9	4	4	14	12	8	**8.60**	**100**
																		Mean	
		Overall Total Hits (LAI)	**65**	**64**	**28**	**76**	**56**	**37**	**49**	**55**	**60**	**54**	**24**	**42**	**49**	**65**	**60**	**52.27**	

Sample Adequacy Calculations	**Plant Cover Mean = 24.80** **t= 1.35** **n = 15** **Variance = 49.31** **n_{min} = 14.51**
Diversity	**Number of Species with ≥1% Average Cover = 4**

P=Perennial A=Annual B=Biennial Nw=Noxious Weed

Table E7 Church Rock Mill Site - Vegetation Production - 2013

Reclaimed Baseline

Raw Data

Oven Dry Weight (grams per 1/2 square meter)

Sample No.	Grasses				Forbs			Sub-shrubs	Shrubs	TOTAL PERENNIAL		TOTAL	
	Perennial			Annual	Perennial	Annual & Biennial							
	Native		Intro-duced		Native	Noxious Weed	Native & Introduced						
	Cool-Season	Warm-Season								g./0.5m²	lbs./ac.	g./0.5m²	lbs./ac.
1	6.6	0.3					0.6		8.4	15.3	**273.0**	15.9	**283.7**
2	0.5	17.7		0.2			0.2		2.7	20.9	**372.9**	21.3	**380.1**
3	0.2	15.1		0.1			1.2			15.3	**273.0**	16.6	**296.2**
4									15.3	15.3	**273.0**	15.3	**273.0**
5	4.9			0.5			18.5		20.6	25.5	**455.0**	44.5	**794.0**
6				11.8					34.4	34.4	**613.8**	46.2	**824.4**
7	0.4	24.3					0.2			24.7	**440.7**	24.9	**444.3**
8		14.1								14.1	**251.6**	14.1	**251.6**
9	17.3						42.6			17.3	**308.7**	59.9	**1068.8**
10							58.9			0.0	**0.0**	58.9	**1051.0**
11							45.2		10.3	10.3	**183.8**	55.5	**990.3**
12							52.5			0.0	**0.0**	52.5	**936.8**
13							28.4			0.0	**0.0**	28.4	**506.8**
14							16.9		16.5	16.5	**294.4**	33.4	**596.0**
15						68.1				0.0	**0.0**	68.1	**1215.1**
Average	**2.0**	**4.8**	**0.0**	**0.8**	**0.0**	**4.5**	**17.7**	**0.0**	**7.2**	**14.0**	**249.3**	**37.0**	**660.8**

Table E8 Church Rock Mill Site - Vegetation Production - 2013

Grassland Baseline

Raw Data

Oven Dry Weight (grams per 1/2 square meter)

Sample No.	Grasses				Forbs			Sub-shrubs	Shrubs	TOTAL PERENNIAL		TOTAL	
	Perennial			Annual	Perennial	Annual & Biennial							
	Native		Intro-duced		Native	Noxious Weed	Native & Introduced						
	Cool-Season	Warm-Season								g./0.5m²	lbs./ac.	g./0.5m²	lbs./ac.
1		42.1					1.0			42.1	**751.2**	43.1	**769.1**
2		16.6					31.1			16.6	**296.2**	47.7	**851.1**
3		35.2					15.2			35.2	**628.1**	50.4	**899.3**
4		28.1								28.1	**501.4**	28.1	**501.4**
5		27.3							49.3	76.6	**1366.8**	76.6	**1366.8**
6	13.3	35.1								48.4	**863.6**	48.4	**863.6**
7		6.4					22.1			6.4	**114.2**	28.5	**508.5**
8		51.0								51.0	**910.0**	51.0	**910.0**
9		27.8					2.4		4.4	32.2	**574.6**	34.6	**617.4**
10		9.3							3.8	13.1	**233.7**	13.1	**233.7**
11		24.3								24.3	**433.6**	24.3	**433.6**
12		25.1					10.2			25.1	**447.9**	35.3	**629.9**
13		14.1					38.5			14.1	**251.6**	52.6	**938.6**
14		79.1								79.1	**1411.4**	79.1	**1411.4**
15		47.7								47.7	**851.1**	47.7	**851.1**
Average	**0.9**	**31.3**	**0.0**	**0.0**	**0.0**	**0.0**	**8.0**	**0.0**	**3.8**	**36.0**	**642.4**	**44.0**	**785.7**

Table E9 Church Rock Mill Site - Vegetation Production - 2013

Shrubland Baseline

Raw Data

Oven Dry Weight (grams per 1/2 square meter)

Sample No.	Grasses				Forbs			Sub-shrubs	Shrubs	TOTAL PERENNIAL		TOTAL	
	Perennial			Annual	Perennial	Annual & Biennial							
	Native		Intro-duced		Native	Noxious Weed	Native & Introduced						
	Cool-Season	Warm-Season								g./0.5m²	lbs./ac.	g./0.5m²	lbs./ac.
1									16.6	16.6	**296.2**	16.6	**296.2**
2		10.3		0.2					2.4	12.7	**226.6**	12.9	**230.2**
3		31.9					0.1			31.9	**569.2**	32.0	**571.0**
4		7.0						5.6	8.7	21.3	**380.1**	21.3	**380.1**
5		8.0							11.4	19.4	**346.2**	19.4	**346.2**
6		5.5						4.7	12.0	22.2	**396.1**	22.2	**396.1**
7		25.7							6.6	32.3	**576.3**	32.3	**576.3**
8		27.0					0.2			27.0	**481.8**	27.2	**485.3**
9		1.2						14.6		15.8	**281.9**	15.8	**281.9**
10		2.3							10.7	13.0	**232.0**	13.0	**232.0**
11		19.3							10.1	29.4	**524.6**	29.4	**524.6**
12								2.7	7.6	10.3	**183.8**	10.3	**183.8**
13		24.2					0.1			24.2	**431.8**	24.3	**433.6**
14		14.7						0.7	10.8	26.2	**467.5**	26.2	**467.5**
15								10.4		10.4	**185.6**	10.4	**185.6**
Average	**0.0**	**11.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.6**	**6.5**	**20.8**	**372.0**	**20.9**	**372.7**

Table E10 Church Rock Mill Site- Vegetation Production - 2013

Reclaimed Analog Area

Raw Data

Oven Dry Weight (grams per 1/2 square meter)

Sample No.	Grasses				Forbs			Sub-shrubs	Shrubs	TOTAL PERENNIAL		TOTAL	
	Perennial			Annual	Perennial	Annual & Biennial							
	Native		Intro-duced		Native	Noxious Weed	Native & Introduced						
	Cool-Season	Warm-Season								g./0.5m²	lbs./ac.	g./0.5m²	lbs./ac.
1	16.9	0.3					6.5		12.2	29.4	**524.6**	35.9	**640.6**
2	47.4						8.2			47.4	**845.8**	55.6	**992.1**
3							5.5		20.5	20.5	**365.8**	26.0	**463.9**
4		27.0					0.9		4.5	31.5	**562.1**	32.4	**578.1**
5									19.7	19.7	**351.5**	19.7	**351.5**
6		42.0					0.6			42.0	**749.4**	42.6	**760.1**
7	31.6	0.3					1.5			31.9	**569.2**	33.4	**596.0**
8		0.1		2.0			0.3		18.0	18.1	**323.0**	20.4	**364.0**
9		63.7					0.4			63.7	**1136.6**	64.1	**1143.8**
10	20.0	13.2					0.5		12.9	46.1	**822.6**	46.6	**831.5**
11	25.9						0.8			25.9	**462.1**	26.7	**476.4**
12	5.5						0.5		37.2	42.7	**761.9**	43.2	**770.8**
13	0.4	46.7					1.0			47.1	**840.4**	48.1	**858.3**
14	11.6						0.4		15.8	27.4	**488.9**	27.8	**496.0**
15				0.8			5.5		15.7	15.7	**280.1**	22.0	**392.6**
Average	**10.6**	**12.9**	**0.0**	**0.2**	**0.0**	**0.0**	**2.2**	**0.0**	**10.4**	**33.9**	**605.6**	**36.3**	**647.7**

Table E11 Church Rock Mill Site - Vegetation Production - 2013

Grassland Analog Area

Raw Data

Oven Dry Weight (grams per 1/2 square meter)

Sample No.	Grasses				Forbs			Sub-shrubs	Shrubs	TOTAL PERENNIAL		TOTAL	
	Perennial			Annual	Perennial	Annual & Biennial							
	Native		Intro-duced		Native	Noxious Weed	Native & Introduced						
	Cool-Season	Warm-Season								g./0.5m²	lbs./ac.	g./0.5m²	lbs./ac.
1		20.0						4.2		24.2	**431.8**	24.2	**431.8**
2	0.4	20.1						0.9		21.4	**381.9**	21.4	**381.9**
3	0.4	18.3						8.6		27.3	**487.1**	27.3	**487.1**
4		13.5			0.3					13.8	**246.2**	13.8	**246.2**
5		14.9					0.1		4.9	19.8	**353.3**	19.9	**355.1**
6		18.2								18.2	**324.8**	18.2	**324.8**
7		9.7						2.5		12.2	**217.7**	12.2	**217.7**
8		24.4						7.2		31.6	**563.9**	31.6	**563.9**
9		21.4					1.2	0.9	0.6	22.9	**408.6**	24.1	**430.0**
10		8.2					0.5	6.1		14.3	**255.2**	14.8	**264.1**
11		17.5						0.3		17.8	**317.6**	17.8	**317.6**
12		19.3					1.8			19.3	**344.4**	21.1	**376.5**
13		19.8					0.5			19.8	**353.3**	20.3	**362.2**
14		9.9					0.4	7.2		17.1	**305.1**	17.5	**312.3**
15	0.6	5.9			0.2			4.8		11.5	**205.2**	11.5	**205.2**
Average	**0.1**	**16.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**2.8**	**0.4**	**19.4**	**346.4**	**19.7**	**351.8**

Table E12 Church Rock Mill Site - Vegetation Production - 2013

Shrubland Analog Area

Raw Data

Oven Dry Weight (grams per 1/2 square meter)

Sample No.	Grasses				Forbs			Sub-shrubs	Shrubs	TOTAL PERENNIAL		TOTAL	
	Perennial			Annual	Perennial	Annual & Biennial							
	Native		Intro-duced		Native	Noxious Weed	Native & Introduced						
	Cool-Season	Warm-Season								g./0.5m²	lbs./ac.	g./0.5m²	lbs./ac.
1		2.2					0.3	7.1		9.3	**165.9**	9.6	**171.3**
2		2.9						6.6		9.5	**169.5**	9.5	**169.5**
3		16.5					0.2			16.5	**294.4**	16.7	**298.0**
4		5.0						11.5		16.5	**294.4**	16.5	**294.4**
5		3.3						3.8		7.1	**126.7**	7.1	**126.7**
6	1.5								13.6	15.1	**269.4**	15.1	**269.4**
7	1.8			0.3				4.2	12.1	18.1	**323.0**	18.4	**328.3**
8		12.2					0.3		5.7	17.9	**319.4**	18.2	**324.8**
9		4.9							8.6	13.5	**240.9**	13.5	**240.9**
10								4.8	3.8	8.6	**153.5**	8.6	**153.5**
11							0.3	12.2	4.1	16.3	**290.8**	16.6	**296.2**
12								10.5	0.2	10.7	**190.9**	10.7	**190.9**
13		2.6						3.0		5.6	**99.9**	5.6	**99.9**
14		2.0						5.4		7.4	**132.0**	7.4	**132.0**
15		7.1						8.8		15.9	**283.7**	15.9	**283.7**
Average	**0.2**	**3.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**5.2**	**3.2**	**12.5**	**223.6**	**12.6**	**225.3**

Table E13 Church Rock Mill - Woody Plant Density - 2013

Reclaimed Baseline

Raw Data

Sampling Method: 2m x 50m Belt Transects

Life Form	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Count	Per Acre	Stems per Acre by Lifeform
S	*Artemisia tridentata*						2		1								**3**	**8.1**	**Shrub (S) = 938.9**
S	*Atriplex canescens*	4	1	2		1	1	1	3			1	8	8	9	6	**45**	**121.4**	**Succulent (Su) = 0.0**
S	*Ceratoides lanata*			7													**7**	**18.9**	**Tree (T) = 0.0**
S	*Chrysothamnus nauseosus*	15	17	9	58	48	47		9	15	15	11	14	14	7	3	**282**	**760.8**	**Noxious Weed (NW) = 2.7**
T	Nw *Tamarix sp.*														1		**1**	**2.7**	
S	*Tetradymia glabrata*							4	7								**11**	**29.7**	
	Total	**19**	**18**	**18**	**58**	**49**	**50**	**5**	**20**	**15**	**15**	**12**	**22**	**22**	**17**	**9**	**349**	**941.6**	

Sample Adequancy Calculation		
	t = 1.345	**mean = 23.27**
	var. = 250.8	**n_{min} = 83.8**

Table E14 Church Rock Mill - Woody Plant Density - 2013

Grassland Baseline

Raw Data

Sampling Method: 2m x 50m Belt Transects

Life Form	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Count	Per Acre	Stems per Acre by Lifeform
S	*Artemisia tridentata*	6	1			6	1	1									**15**	**40.5**	**Shrub (S) = 766.2**
S	*Atriplex canescens*	1					2										**3**	**8.1**	**Succulent (Su) = 2.7**
S	*Ceratoides lanata*		1				1					1	2				**5**	**13.5**	**Tree (T) = 0.0**
S	*Chrysothamnus nauseosus*	29	31	14	20	19	39	9	11	4	4	1	23	28	16	13	**261**	**704.1**	**Noxious Weed (Nw) = 0.0**
Su	*Opuntia polyacantha*								1								**1**	**2.7**	
	Total	**36**	**33**	**14**	**20**	**25**	**43**	**10**	**12**	**4**	**4**	**2**	**25**	**28**	**16**	**13**	**285**	**768.9**	

Sample Adequancy Calculation		
	t = 1.345	**mean = 19.00**
	var. = 153.9	**n_{min} = 77.1**

Table E15 Church Rock Mill - Woody Plant Density - 2013

Shrubland Baseline

Raw Data

Sampling Method: 2m x 50m Belt Transects

Life Form	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Count	Per Acre	Stems per Acre by Lifeform
S	*Artemisia tridentata*	37	38	25	44	30	26	23	29	29	32	39	25	26	32	21	**456**	**1,230.2**	**Shrub (S) = 1,230.2**
																			Succulent (Su) = 0.0
																			Tree (T) = 0.0
																			Noxious Weed (Nw) = 0.0
	Total	**37**	**38**	**25**	**44**	**30**	**26**	**23**	**29**	**29**	**32**	**39**	**25**	**26**	**32**	**21**	**456**	**1,230.2**	

Sample Adequancy Calculation		
	t = 1.345	**mean = 30.40**
	var. = 43.5	**n_{min} = 8.5**

Table E16 Church Rock Mill - Woody Plant Density - 2013

Reclaimed Analog Area

Raw Data

Sampling Method: 2m x 50m Belt Transects

Life Form	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Count	Per Acre	Stems per Acre by Lifeform
S	*Artemisia tridentata*	2	0	0	19	6	1	3	2	1	0	15	0	7	0	2	**58**	**156.5**	**Shrub (S) = 2,061.2**
S	*Atriplex canescens*	41	11	3	1	38	26	11	44	66	18	43	106	60	20	42	**530**	**1,429.9**	**Succulent (Su) = 0.0**
S	*Chrysothamnus nauseosus*	8	31	10	25	15	19	23	0	1	15	14	0	1	8	6	**176**	**474.8**	**Tree (T) = 0.0**
																			Noxious Weed (Nw) = 0.0
	Total	**51**	**42**	**13**	**45**	**59**	**46**	**37**	**46**	**68**	**33**	**72**	**106**	**68**	**28**	**50**	**764**	**2,061.2**	

Sample Adequancy Calculation		
	t = 1.345	**mean = 50.93**
	var. = 483.5	**n_{min} = 33.7**

Table E17 Church Rock Mill - Woody Plant Density - 2013

Grassland Analog Area

Raw Data

Sampling Method: Total Count

Life Form	Species	Total Count	Per Acre	Stems per Acre by Lifeform
S	*Artemisia tridentata*	1	1.2	Shrub (S) = ###
S	*Atriplex canescens*	30	35.0	Succulent (Su) = 0.0
S	*Ceratoides lanata*	17	19.8	Tree (T) = 2.3
S	*Chrysothamnus nauseosus*	55	64.2	Noxious Weed (Nw) = 0.0
T	*Pinus edulis*	2	2.3	
	Total	**105**	**122.6**	

Sample Adequancy Calculation		
	t = N/A	mean = 3.03
	var. = N/A	n_{min} = N/A

Table E18 Church Rock Mill - Woody Plant Density - 2013

Shrubland Analog Area

Raw Data

Sampling Method: 2m x 50m Belt Transects

Life Form	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Count	Per Acre	Stems per Acre by Lifeform
S	*Artemisia tridentata*	20	22	13	16	14	15	36	28	41	30	27	30	28	26	21	**367**	**990.1**	**Shrub (S) = 1,022.5**
S	*Atriplex canescens*	1						1		2	1						**5**	**13.5**	**Succulent (Su) = 0.0**
S	*Ceratoides lanata*			1	2	1			2					1			**7**	**18.9**	**Tree (T) = 27.0**
T	*Pinus edulis*	2	1						2	2		1			1	1	**10**	**27.0**	**Noxious Weed (Nw) = 0.0**
	Total	**23**	**23**	**14**	**18**	**15**	**15**	**37**	**32**	**45**	**31**	**28**	**30**	**29**	**27**	**22**	**389**	**1,049.5**	

Sample Adequancy Calculation		
	t = 1.345	**mean = 25.93**
	var. = 75.5	**n_{min} = 20.3**

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Appendix F

Photos

Plate 1 – Reclaimed Baseline – Dilco Hill – 2013

Plate 2 – Reclaimed Baseline – South Drainage Disturbance – 2013

Plate 3 – Reclaimed Baseline – Tailings Facility – 2013

Plate 4 – Reclaimed Baseline – West Borrow – 2013

Plate 5 –Grassland Baseline – North Drainage Borrow – 2013

Plate 6 – Shrubland Baseline – South Drainage Borrow – 2013

Plate 7 – Reclaimed Analog Area – 2013

Plate 8 – Grassland Analog Area – 2013

Plate 7 – Shrubland Analog Area – 2013