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Annual Report

This Annual Report shows information the Division has for your mine. Submit the completed document and any additional information identified in the Appendices to the Division by the date specified in the cover letter. During a complete inspection an inspector will check and verify the information.

GENERAL INFORMATION

Company Name	Plateau Mining Corporation	Mine Name	Willow Creek Mine
Permit Number	C/007/0038	Permit expiration Date	April 24, 2016
Operator Name	Plateau Mining Corporation	Phone Number	+1 (435) 472-0475
Mailing Address	P.O. Box 30	Email	dware@alphanr.com
City	Helper		
State	UT	Zip Code	84526

DOGM File Location or Annual Report Location

Excess Spoil Piles	<input type="checkbox"/> Required <input checked="" type="checkbox"/> Not Required	
Refuse Piles	<input type="checkbox"/> Required <input checked="" type="checkbox"/> Not Required	
Impoundments	<input type="checkbox"/> Required <input checked="" type="checkbox"/> Not Required	
Other:		

OPERATOR COMMENTS

REVIEWER COMMENTS

Met Requirements Did Not meet Requirements

COMMITMENTS AND CONDITIONS

The Permittee is responsible for ensuring annual technical commitments in the Mining and Reclamation Plan and conditions accepted with the permit are completed throughout the year. The Division has identified these commitments below and has provided space for you to report what you have done during the past year for each commitment. If additional written response is required, it should be filed as an attachment to this report.

Title: CRANDALL CANYON SHAFT SETTLEMENT MONITORING

Objective: Perform Annual Shaft Settlement Surveys on Two Reclaimed Shafts in Crandall Canyon

Frequency: Annually, Beginning after the approval of phase II bond release until phase III bond release.

Status: Ongoing

Reports: Annual

Citation: MRP, Volume 17, Exhibit 24, Appendix 8

Operator Comments

Survey results attached as Addendum #1

Reviewer Comments Met Requirements Did Not Meet Requirements

REPORTING OF OTHER TECHNICAL DATA

Please list other technical data or information that was not included in the form above, but is required under the approved plan, which must be periodically submitted to the Division.

Please list attachments:

The "Revegetation Monitoring for Phase III Bond Release at the Willow Creek Mine Year 10: 2014" prepared by Mt. Nebo Scientific attached as Addendum #2.

Reviewer Comments

MAPS

Copies of mine maps, current and up-to-date, are to be provided to the Division as an attachment to this report in accordance with the requirements of R645-301-525.240. The map copies shall be made in accordance with 30 CFR 75.1200 as required by MSHA. Mine maps are not considered confidential.

Map Name	Map Number	Included		Confidential	
		Yes	No	Yes	No
<input type="text"/>	<input type="text"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Reviewer Comments Met Requirements Did Not Meet Requirements

PLATEAU MINING CORPORATION
CRANDALL CANYON RECLAMATION
ELEVATOR SHAFT SURVEY

10/15/2014

POINT NUMBER	2008 Survey			2009 Survey		2012 Survey		2013 Survey		2014 Survey	
	NORTHING (FEET)	EASTING (FEET)	ELEVATION (FEET)	ELEVATION (FEET)	ELEVATION DIFFERENCE						
BENCHMARK	517056.3	2164798.1	6783.2	6783.2	0.0	6783.2	2158014.9	6783.2	0.0	6783.2	0.0
Eastern Shaft Reclamation											
1	516995.5	2165011.0	6784.1	6782.7	1.4	6781.3	1.4	6781.2	0.1	6781.2	0.0
2	516991.9	2165017.9				6782.5		6782.5	0.0	6782.5	0.0
3	516981.1	2165024.6				6780.4		6780.4	0.1	6780.4	0.0
4	517008.3	2165033.6				6776.6		6776.6	0.1	6776.6	0.0
5	516979.8	2164986.4				6776.5		6776.6	0.0	6776.6	0.0
6	517019.4	2164994.1				6769.7		6769.6	0.1	6769.6	0.0
Western Shaft Reclamation											
7	516604.8	2164052.1				6819.7		6819.8	0.0	6819.8	0.0
8	516565.2	2164110.2				6826.3		6826.5	-0.2	6826.5	0.0
9	516570.5	2164089.1				6825.3		6825.3	0.0	6825.3	0.0
10	516568.1	2164060.0				6826.5		6826.6	0.0	6826.6	0.0
11	516565.1	2164044.1				6826.1		6826.2	-0.1	6826.2	0.0
12	516567.0	2164026.6				6824.0		6824.1	0.0	6824.1	0.0
13	516562.9	2164002.6				6822.3		6822.3	0.1	6822.3	0.0
14	516525.6	2164051.2				6827.9		6827.9	0.0	6827.9	0.0
15	516588.4	2164051.2				6821.9		6821.9	0.0	6821.9	0.0



WARE SURVEYING & ENGINEERING

G.P.S. & CONVENTIONAL SURVEYING - AUTOCAD MAPPING - CIVIL ENGINEERING

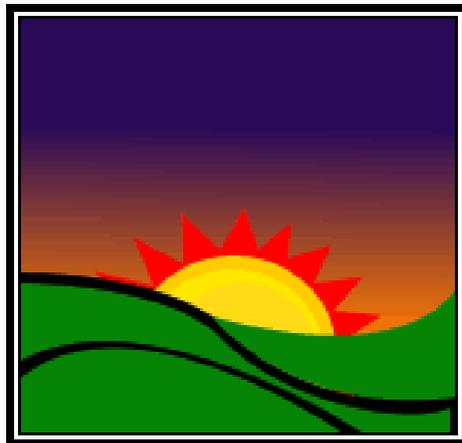
Phone: 435-820-4335

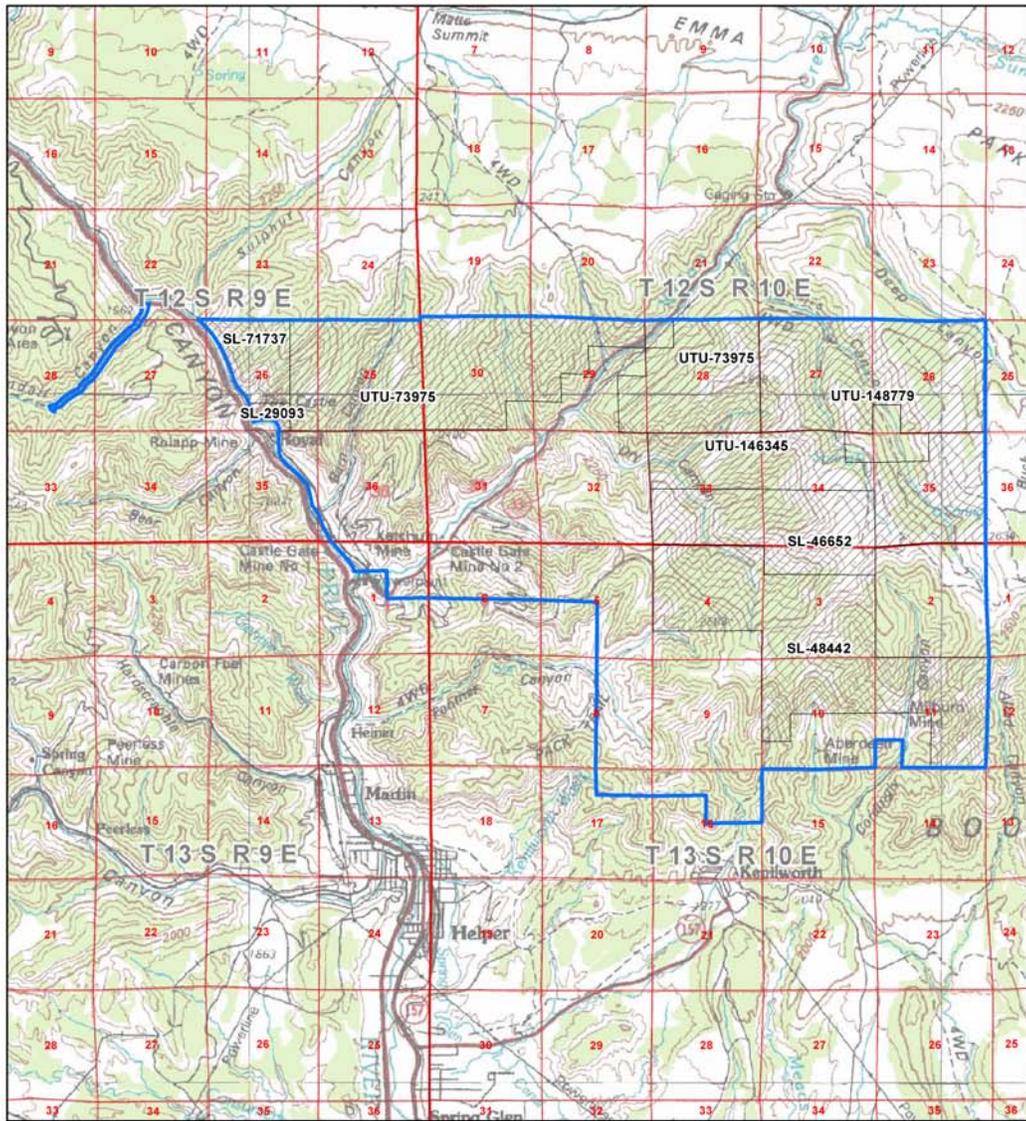
Email: waresurveying@emerytelcom.net



Revegetation Monitoring
for Phase III Bond Release
at the Willow Creek Mine
Year 10: 2014

for
Plateau Mining Corporation





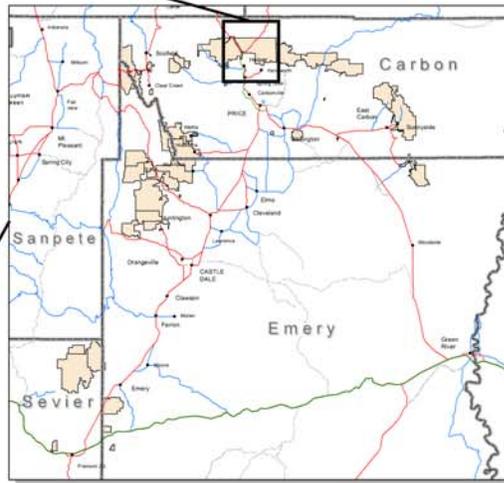
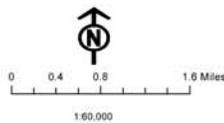
Willow Creek Mine

C0070038
Carbon County, Utah
January 2006

Township 12 South Range 9 & 10 East
Township 13 South Range 9 & 10 East

File: N:\gis\coal\coalareamaps\C0070038.pdf

- Permit Area
- Proposed Mine Plan Modification (if shown)
- Federal Lease Areas



Locator Map

Prepared by

MT. NEBO SCIENTIFIC, INC.
330 East 400 South, Suite 6
P.O. Box 337
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by

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for

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March 2015

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INTRODUCTION

The Study

The Willow Creek Mine, located in Price Canyon about 3.5 miles northwest of the town of Helper, Utah, ceased coal mining operations in 2000. Subsequently, reclamation began and by 2004, revegetation activities at the site were completed including areas called Gravel Canyon, Refuse Pile, Conveyor Corridor, Loadout, Riparian Bottoms and Crandall Canyon.

Following reclamation activities, mine sites are required to provide enough time to pass for acceptable plant establishment before applications can be made for bond release. This time-frame, called the *Responsibility Period*, prescribes at least 10 years before the mine owner can submit a request for *final* or *Phase III Bond Release* through the State of Utah, Division of Oil, Gas & Mining (DOGGM). It has been estimated that this period of time is long enough to determine whether or not adequate re-establishment of the plant communities has occurred on the reclaimed areas to the extent that they have become *diverse, effective, permanent and are capable of self-regeneration and plant succession*.

The restored vegetation of the reclaimed lands must meet specific state and federal requirements. Consequently, beginning in Year 9 of the 10-year time-frame mentioned above, intensive sampling can be initiated for two consecutive years to determine whether or not the reclaimed site has met pre-determined revegetation success standards. The success standards can be prescribed using *reference areas*, or native, undisturbed plant communities chosen beforehand that approximate the mine site before it was disturbed by the mining activities. Using this approach, data are recorded and compared in the reference areas during the same sample period as the reclaimed areas. An alternate method for assigning success standards can be used by recording quantitative data beforehand, and using it as *baseline data* for comparisons with the disturbed areas once they are reclaimed

In 2013, the reclaimed sites were quantitatively sampled to provide vegetation data for year 9 following reclamation. A document was prepared and submitted to report the findings for that sample period. In 2014, the site was again sampled to provide results of the second of

two consecutive years of sampling required prior to submittal of an application for final bond release.

The scope of this report is to provide results from monitoring plant establishment, or to study revegetation success of the reclaimed sites in order to determine whether or not an application for reclamation bond release may soon be warranted. Even though a *separate* report was prepared that provided the 2013 sample results, some of that dataset has been included in this 2014 monitoring report for comparison purposes.

History of Onsite Vegetation Sampling

Vegetation data has been collected and compiled for the Willow Creek Mine since at least 1981. These datasets and methodologies can be challenging to follow, but this document attempts to clarify them. First, there have been ownership and operator changes at the mine site over that time period. Moreover, data collection methodologies have changed over time, and in most cases there are explanations for the changes. The Willow Creek Mining and Reclamation Plan (MRP) explains these changes (MRP Section 3.2.1.2). To begin, the primary vegetation dataset and report that was used for permitting was prepared for the Price River Coal Company. This document was called “*Vegetation Data Report of Price River Coal Company’s Mine Area*” (Mariah Associates 1981). In 1988, a modification of this document was used for permitting purposes for the Blackhawk Coal Company at the Willow Creek Mine. Later in 1989, the Castle Gate Coal Company used some of these same datasets for the Willow Creek area with subsequent permitting changes submitted in 1994. Finally, more vegetation work was conducted by the State of Utah, Division of Oil, Gas & Mining (DOGM), Abandoned Mine Reclamation (AMR) program in areas where some sites had been reclaimed. These sites had been disturbed prior to the Surface Mining Control and Reclamation Act of 1977 (SMRCA); the MRP refers to them as the “Reclaimed Areas” and there is no longer a reclamation bond associated with them.

Many changes have been made regarding the vegetation success standards since those early studies. Willow Creek’s MRP (Section 3.2.1.2) states that “*given the changes in regulatory requirements which have occurred since much of the data was originally collected*

and subsequent disturbance of many of the areas previously sampled at this location, the original data cannot be used directly to comply with current vegetation baseline requirements". For this and other plant nomenclature problems in the original dataset, the 1981 data were no longer sufficient to meet the state regulations. Accordingly, more vegetation sampling was conducted in 1994-1996 by K.A. Crofts to supplement the early vegetation data; these data can be found in an appendix in Willow Creek Mine's MRP called "Supplemental Tables of Vegetation Sampling Data: 1994-1996".

Sample Areas

The terminology used in the MRP for specific sample areas and the methodology criteria applied to sample them have been described below. The following information also drove the sample design and plans made to monitor the reclaimed areas by Mt. Nebo Scientific, Inc. in 2013 and 2014.

1. **Disturbed Areas** - This refers to those areas where the plant communities were disturbed pre-SMCRA and were later re-disturbed post-SMCRA by coal mining activities. Because of this, they are regulated differently and have different revegetation success standards for final reclamation from those areas that were not re-disturbed after the Act. Both types of areas at the Willow Creek Mine site, pre-SMCRA and post-SMCRA, have now been reclaimed under appropriate state and federal regulations. The reclaimed *Disturbed Areas* were sampled to provide the 'supplemental data' (1994-96) mentioned above and were again sampled in 2014 using the same methodologies for this report. The Disturbed Areas include the following sites:
 - a. Gravel Canyon
 - b. Refuse Pile
 - c. Conveyor Corridor
 - d. Loadout ²

"Baseline Data Methods" as per DOGMs *Vegetation Information Guidelines* (1992)¹ were employed to sample these areas. More detail about these methods has been provided in the METHODS section of this report.

¹ Vegetation Information Guidelines (Revised, February 1992). Utah Division of Oil, Gas and Mining, 1596 West North Temple, Suite 1210, Salt Lake City, Utah 84114-5801.

² There was some uncertainty where to place this small (<0.25 acre) reclaimed site for revegetation success comparisons.

2. **Reclaimed Areas** - These *Reclaimed Areas* were those areas that were disturbed pre-SMCRA and not re-disturbed by more current mining activities. These areas were later reclaimed by the AML program and are therefore not subject to the monitoring program required by Plateau Mining Corporation. Accordingly, these areas were not required to be sampled in 2013 and 2014.
3. **Riparian Bottoms** - This area was first sampled in 1994 to expand on the ‘supplemental data’ needed. They did not have the pre-SMCRA designation. Sample methods were different than those used for the *Disturbed Areas* above (more information about this will be described in the METHODS section of this report).
4. **Crandall Canyon** - Crandall Canyon, an area also associated with the Willow Creek Mine, is located on the west side of Price Canyon rather than the east side where the other reclaimed areas are located (see Willow Creek Mine Locator Map included at the beginning this report). Revegetation standards and sampling methods are yet again different than the above-mentioned areas. Again, more details about the methodologies employed will be provided later in this report.
5. **Reference Areas** - Based on the methods employed to monitor revegetation success and the standards that were pre-determined by representatives from the past mine operators and officials from DOGM, *Reference Areas* may or may not be used to determine adequate revegetation success at the Willow Creek Mine. Or in other words, Reference Areas are used as success standards for some of the reclaimed areas, whereas, they are not used in other areas.

Reference Areas are those sites that were chosen earlier to be sampled following final reclamation. Data from the Reference Areas and specific areas that have been reclaimed are to be compared statistically to determine whether or not successful revegetation has been achieved at the time of *final* or Phase III Bond Release. The “Reference Area Method” has been described in DOGMs *Vegetation Information Guidelines*¹.

The Reference Areas sampled in association with the Willow Creek Mine’s monitoring plan were:

- a. Mountain Brush (MB) Reference Area
- b. Crandall Canyon (SB) Reference Area

The above sample areas have been described in Willow Creek's MRP. Their locations can be found on several maps provided in that document.

METHODS

Methodologies used for vegetation sampling were consistent between years and performed in accordance with the aforementioned guidelines provided by DOGM. For reasons described above, and depending on the sample area, there has been an assortment of methods that have been employed to sample the vegetation at the Willow Creek Mine site. We have attempted to apply sampling methods that have appropriate scientific merit and comply with all state and federal regulations and guidelines, as well as remain consistent with previous sampling methods to make the earlier and current datasets comparable to each other. The vegetation sampling at the mine site for this report was conducted in August 2014.

Transect & Quadrat Placement

Random/regular placement of sample quadrats were designed as an attempt to provide unbiased accuracy of the data compiled. This was accomplished by establishing several transect lines along the entire length of each reclaimed area. At regular intervals along the transect lines, random numbers were generated and used to measure distances at right angles from the line to determine sample locations. Whether these random numbers were odd or even determined which side of transect line a given quadrat was placed. The random numbers selected were high enough to place quadrats to the lateral limits of each sample area and all areas in-between. This insured that the sample quadrats were placed randomly over the entire study area in an attempt to adequately address and represent each site as a whole.

Cover, Frequency & Composition

Depending on the sample area and the history of sampling it, cover estimates were made by using two different methods. In some areas ocular methods with meter square quadrats were used; other areas employed the point-intercept method using an inclined metal 10-point frame. Species composition and relative frequencies were also assessed from the cover data. Plant nomenclature follows "A Utah Flora" (Welsh et al. 2008)³.

Density

Similar to the reasons for employing different sample methods for cover, woody species density measurements also varied depending on the area. These methods were dictated by either community type, previous sampling history, or commitments about methods that were stated in the MRP. In some areas, woody plant numbers were measured using a distance method called the point-quarter technique. In this method, random points were placed on the sample sites and measured into four quarters. The distances to the nearest woody plant species were then recorded in each quarter. The average point-to-individual distance was equal to the square root of the mean area per individual. In other areas, densities were measured using 1.5 meter x 50.0 meter belt transects. Here, all woody plants were counted inside the belts; the counts were then summarized and converted into the number of individual woody plants per acre.

³ Welsh, S.L., N.D. Atwood, S. Goodrich and L.C. Higgins. 2008. A Utah flora. Print Services, Brigham Young University, Provo, UT. 1019 pp.

Biomass Production

Total annual biomass production was estimated by clipping, drying and weighing current annual growth in each sample quadrat. "Double sampling" methods were employed by placing four additional quadrats around the clipped quadrat, then estimating the production of them relative to the clipped plot. Herbaceous and woody species production were recorded separately, then combined to provide the total annual biomass production estimate.

Similarity & Diversity Indices

In specific areas only, and as specified in Willow Creek's Mining & Reclamation Plan (MRP), Sorensen's Similarity Index (SI) was calculated. The SI formula is shown below.

$$SI = \frac{2C}{A+B} \times 100$$

where,

SI = Similarity Index

A = Total number of species in community A

B = Total number of species in community B

C = Number of species common to both communities

Additionally, a diversity index has been employed to the reclaimed areas for comparisons to the reference areas. *MacArthur's Diversity Index* is an effective diversity measurement and is computed using the following equation:

$$1/\sum pi^2$$

where,

pi is the proportion of sum frequency contributed by the i th species in the sample area of concern.

The proportional contribution of each species is then squared and the values for all species in the sample areas are summed. This index integrates the number of species and the degree to which frequency of occurrence was equitably distributed among those species.

Sample Size & Adequacy

Sampling adequacy was calculated using formula given below.

$$nMIN = \frac{t^2 s^2}{(dx)^2}$$

where,

- nMIN = minimum adequate sample
- t = appropriate confidence t-value
- s = standard deviation
- x = sample mean
- d = desired change from mean

Confidence levels were calculated and reported for 80% and 90% (t) with the desired change from the mean (d) placed at 0.10. Sample sizes were, however, also based on the size of each study area, resulting in more samples taken in larger areas.

Photographs

Color photographs of the sample areas were taken at the time of sampling and a subset of them have been submitted in this report.

Success Standards

The sampling history above describes some of the reasons that certain methodologies were employed in specific sample areas at the Willow Creek Mine site. Often the methods to be

used to monitor a given parameter were dictated by the DOGM protocol that was chosen by representatives from the past mine operators and officials from that agency. Again, for some areas, the “**Reference Area**” protocol as described in DOGM’s *Vegetation Information Guidelines* was employed. In other areas, the “**Baseline Information**” protocol was employed (refer to History of Onsite Vegetation Sampling above for more discussion about this).

Summary of Sampling Methods

Below is a list of the protocols, sampling methods employed, and sample sizes for cover, woody species density and productivity of each sample site at the Willow Creek Mine site.

Summary of Vegetation Sample Areas, Protocols, Methods and Sample Sizes (2014)

SAMPLE AREA	PROTOCOL	COVER (sample size)	DENSITY (sample size)	PRODUCTIVITY (sample size)
Gravel Canyon	Baseline	Point-intercept (n=25)	Belt transects (n=10)	Clipped/Wt. (n=10)
Conveyor Corridor	Baseline	Point-intercept (n=50)	Belt transects (n=25)	Clipped/Wt. (n=25)
Refuse Pile	Baseline	Point-intercept (n=80)	Belt transects (n=30)	Clipped/Wt. (n=40)
Loadout	Baseline	Point-intercept (n=2)	Belt transects (n=1)	Clipped/Wt. (n=2)
Riparian Bottoms	Baseline	Ocular (n=30)	Point-quarter (n=30)	n/a
Crandall Canyon Reclaimed Sagebrush	Reference Area	Ocular (n=80)	Point-quarter (n=80)	Clipped/Wt. (n=40)
Crandall Canyon (East) Reclaimed Mtn. Brush	Reference Area	Ocular (n=10)	Point-quarter (n=10)	Clipped/Wt. (n=10)
Crandall Canyon (West) Reclaimed Mtn. Brush	Reference Area	Ocular (n=10)	Point-quarter (n=10)	Clipped/Wt. (n=10)
Mtn. Brush (MB) Reference Area	Reference Area	Ocular (n=40)	Point-quarter (n=40)	Clipped/Wt. (n=40)
Crandall Canyon (SB) Reference Area	Reference Area	Ocular (n=60)	Point-quarter (n=60)	Clipped/Wt. (n=60)

RESULTS

Gravel Canyon

In 2014, quantitative sampling of the vegetation at the reclaimed Gravel Canyon site showed the area to be dominated by bluebunch wheatgrass (*Elymus spicatus*), fourwing saltbush (*Atriplex canescens*), Gt. Basin wildrye (*Elymus cinereus*), big sagebrush (*Artemisia tridentata*) and Palmer penstemon (*Penstemon palmeri*). For a list of all plant species present in the sample quadrats along with their cover and frequency values, refer to Table 1. The total living cover of this reclaimed site was estimated at 57.20% (Table 2-A). Of that living cover, grasses comprised 57.11%, shrubs 25.23% and forbs 20.06% (Table 2-B).

The total woody species density was estimated at 1,835 individuals per acre and was dominated by fourwing saltbush and big sagebrush (Table 3). Total annual biomass production of the site was estimated to be 1,632.33 pounds per acre, with 1,005.84 pounds coming from herbaceous and 626.49 pounds from woody plants (Table 4).

Conveyor Corridor

The reclaimed Conveyor Corridor was dominated by bluebunch wheatgrass, fourwing saltbush, big sagebrush and Western wheatgrass (*Elymus smithii*). For a list of the plant species present in the sample quadrats along with their cover and frequency values, refer to Table 5. The total living cover for this reclaimed site was estimated to be 61.80% (Table 6-A). The composition of the cover by lifeform was 57.82% grasses, 42.56% shrubs and 4.29% forbs (Table 6-B).

Table 7 shows the woody species density in this area consisted of 1,981 individuals per acre with the dominants for this parameter consisting of fourwing saltbush, rubber rabbitbrush (*Chrysothamnus nauseosus*) and big sagebrush. Productivity for the site was estimated at 1,779.10 pounds per acre with 1,226.28 pounds coming from woody plants and 552.82 pounds from herbaceous species (Table 8).

Refuse Pile

Quantitative sampling in the reclaimed Refuse Pile showed that the area was dominated by fourwing saltbush, bluebunch wheatgrass, thickspike wheatgrass (*Elymus lanceolatus*), Gt. Basin wildrye and Palmer penstemon. For a list of all plant species present in the sample quadrats and their cover and frequency values, refer to Table 9. The total living cover of this reclaimed site was estimated at 58.38% (Table 10-A). In that living cover, grasses comprised 57.00%, shrubs 26.13% and forbs 16.87% (Table 10-B).

The total woody species density was estimated at 1,826 individuals per acre and was dominated by fourwing saltbush, rubber rabbitbrush and big sagebrush (Table 11). Total annual biomass production of the site was estimated to be 1,479.88 pounds per acre, with 846.23 pounds coming from herbaceous species and 633.65 pounds from woody plants (Table 12).

Loadout

This was a very small area (less than ¼ acre), but because of its isolated location, it was sampled and reported separately. A very small portion of the reclaimed area is adjacent to the Price River, but the majority of it lies within an upland plant community.

The plant species present in the reclaimed Loadout consisted of thickspike wheatgrass, winterfat (*Ceratoides lanata*), bluestem wheatgrass and Gt. Basin wildrye (Table 13). The total living cover for this reclaimed site was estimated to be 65.00% (Table 14-A). The composition of the cover by lifeform was 71.43% grasses and 28.57% shrubs (Table 14-B).

Table 15 shows the woody species density in this area consisted of 1,835 individuals per acre and included winterfat, narrowleaf cottonwood (*Populus angustifolia*), rubber rabbitbrush and fourwing saltbush). Productivity for the site was estimated at 1,261.75 pounds per acre with 728.14 pounds coming from shrubs and 533.61 pounds from herbaceous species (Table 16).

Riparian Bottoms

The reclaimed Riparian Bottoms was greatly dominated by coyote willow (*Salix exigua*) in both the overstory and understory cover. For a list of the plant species present in the sample quadrats and their cover and frequency values, refer to Table 17.

The total living cover (overstory and understory cover combined) for this reclaimed site was estimated to be 66.50% (Table 18-A). The composition of the understory cover by lifeform was 85.70% shrubs, 11.16% grasses and 3.14% forbs (Table 18-B).

Table 19 shows the woody species density in this area consisted of 6,069 individuals per acre with the dominants here consisting of coyote willow, big sagebrush, Wood's rose (*Rosa woodsii*), rubber rabbitbrush and golden current (*Ribes aureum*). Production was not required as a revegetation success standard for the riparian zone.

Crandall Canyon Sagebrush Areas

Cover values by plant species for the Sagebrush Areas in Crandall Canyon are shown in Table 20. These results indicated that the area was dominated by big sagebrush and curl-leaf mountain-mahogany (*Cercocarpus ledifolius*). The total living cover of the reclaimed site was estimated at 61.06% (Table 21-A). In that living cover, shrubs comprised 51.48%, grasses 36.97% and forbs 11.55% (Table 21-B).

The total woody species density was estimated at 6,756 individuals per acre and was dominated by fourwing saltbush and curl-leaf mountain-mahogany (Table 22). Total annual biomass production of the site was estimated to be 1498.36 pounds per acre, with 850.13 pounds coming from woody and 648.24 pounds from herbaceous plants (Table 23).

Crandall Canyon Mtn. Brush Areas (East)

Two different relatively small areas were reclaimed as the Mountain Brush community type in Crandall Canyon. These areas were disjunct from each other therefore were sampled and recorded separately (the data were later lumped for the statistical comparisons).

Quantitative sampling the reclaimed Mountain Brush (East) site in Crandall Canyon revealed that the area was dominated by Gt. Basin wildrye (*Elymus cinereus*) and big sagebrush (Table 24). The total living cover of this reclaimed community was estimated at 63.50% (Table 25-A). Of the living cover, the composition was comprised of grasses at 58.61%, shrubs were 33.50% and forbs were 7.89% (Table 25-B).

The total woody species density was estimated at 1,230 individuals per acre and consisted of sagebrush, rubber rabbitbrush and narrowleaf cottonwood (Table 26). Total production of the site was estimated to be 1,715.42 pounds per acre, with 1,002.98 pounds coming from herbaceous and 712.44 pounds from woody plants (Table 27).

Crandall Canyon Mountain Brush Areas (West)

The other isolated reclaimed Mountain Brush site that was sampled in Crandall Canyon was located west of the first site. Quantitative sampling at this site showed that the area was dominated by big sagebrush, Gt. Basin wildrye, western wheatgrass and Pacific aster (*Aster chilensis*). For a list of all plant species present in the sample quadrats along with their cover and frequency values, refer to Table 28. The total living cover of this reclaimed site was estimated at 64.50% (Table 29-A). Of that living cover, grasses represented 44.89%, whereas forbs and shrubs were represented at 33.53% and 21.58%, respectively (Table 29-B).

The total woody species density was estimated at 3,601 individuals per acre and consisted of big sagebrush, curl-leaf mountain-mahogany and rubber rabbitbrush (Table 30). Total production of the site was estimated to be 1,326.72 pounds per acre, with 778.11 pounds coming from herbaceous and 548.61 pounds from woody plants (Table 31).

Crandall Canyon Mountain Brush (MB) Reference Area

When DOGM's Reference Area protocol was employed, the reclaimed areas were compared to these communities for standards of final revegetation success. The reference area to be compared to the reclaimed mountain brush communities in Crandall Canyon was called the Mountain Brush (MB) Reference Area. This reference area, however, was located near the old Conveyor Corridor at the Willow Creek Mine on the east side of Price Canyon rather than the west side where reclaimed Crandall Canyon sites are located.

Cover and frequency by plant species for this reference area is shown in Table 32. The 2014 sampling results in this area indicated that it was dominated by Salina wildrye by quite a wide margin, but followed by big sagebrush and Indian ricegrass (*Stipa hymenoides*). The tree and shrub species present in this community were Utah Juniper (*Juniperus osteosperma*) and Utah serviceberry (*Amelanchier utahensis*). The total living cover (including overstory and understory cover combined) of this reference area was estimated at 47.63% (Table 32-A). In living understory cover, grasses comprised 73.79%, shrubs 24.58% and forbs 1.63 (Table 32-B).

The total woody species density was estimated at 1,550 individuals per acre and was dominated by big sagebrush, Utah serviceberry, and Utah juniper (Table 34). Total production of the site was estimated to be 803.30 pounds per acre, with 450.20 pounds coming from herbaceous and 353.10 pounds from woody plant species (Table 35).

Crandall Canyon (SB) Reference Area

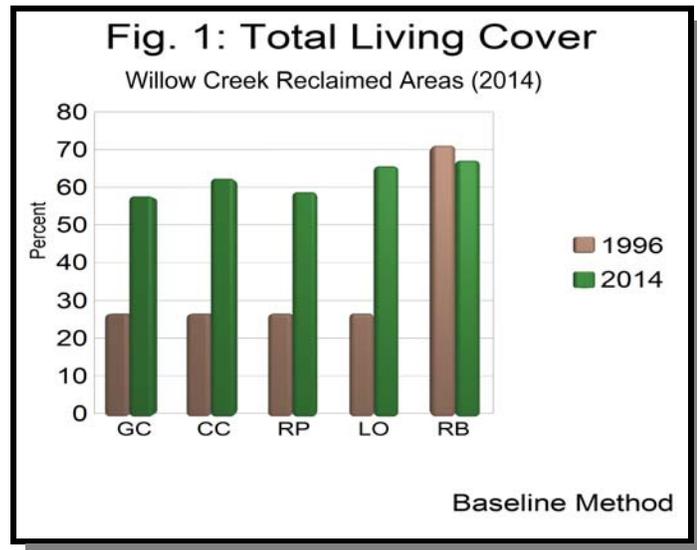
The reference area to be compared to the Reclaimed Sagebrush communities in Crandall Canyon was called the Crandall Canyon (SB) Reference Area. Like the above reference area, this area was located at the Willow Creek Mine on the east side of Price Canyon rather than the west side where the reclaimed sites of Crandall Canyon were located. The locations of the two reference areas, the Crandall Canyon Mountain Brush (MB) Reference Area and the Crandall Canyon (SB) Reference Area, are shown on maps in the Willow Creek Mine MRP, but a general locator map of the permit area (prepared by DOGM) shows the location of Crandall Canyon. This map was provided at the beginning of this report.

Cover and frequency by plant species for this reference area are shown in Table 36. In 2014, this reference area was dominated by Salina wildrye and big sagebrush by quite a wide margin. The total living cover of this reference area was estimated at 49.25% (Table 37-A). In that living cover, grasses comprised 57.47%, shrubs 40.48% and forbs 2.05% (Table 37-B).

The total woody species density was estimated at 1,160 individuals per acre and was dominated greatly by big sagebrush (Table 38). Total production of the site was estimated to be 952.39 pounds per acre, with 533.59 pounds coming from woody and 418.80 pounds from herbaceous plants (Table 39).

Comparisons Between Reclaimed Areas

Like the 2013 datasets provided in a report prepared for that year, the 2014 datasets were first summarized separately to show the similarities and differences between sample areas. This design enables the reviewer to observe the successes (or failures) of individual reclaimed areas. The following section provides graphical representations of the parameters for each reclaimed area and compares them to the success standards.



GC = Gravel Canyon; CC = Conveyor Corridor; RP = Refuse Pile; LO = Loadout; RB = Riparian Bottoms

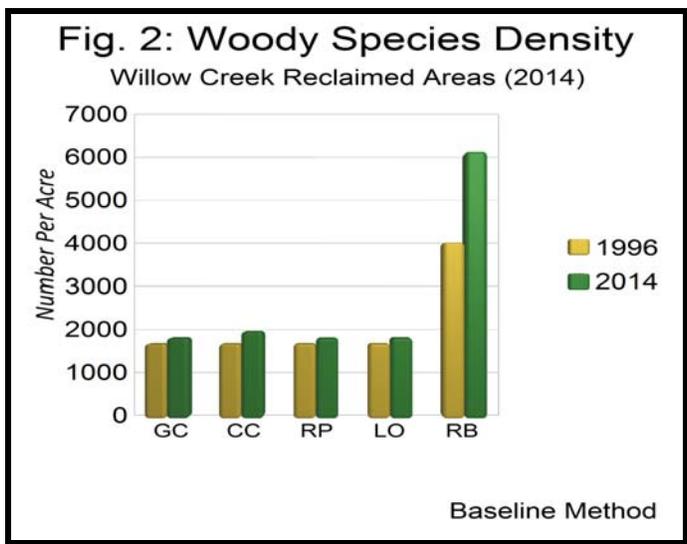
Willow Creek Mine Areas - The “Disturbed Areas” at the Willow Creek Mine site are comprised of reclaimed areas including: 1) Gravel Canyon, 2) Conveyor Corridor, 3) Refuse Pile and 4) Loadout. The reclaimed Riparian Bottoms have also been included in the Willow Creek monitoring regime. Because the protocol for revegetation success standards here

employed the *Baseline Method*,

comparisons were made between fixed success standards [or baseline datasets (1994-96)] and current datasets (2014).

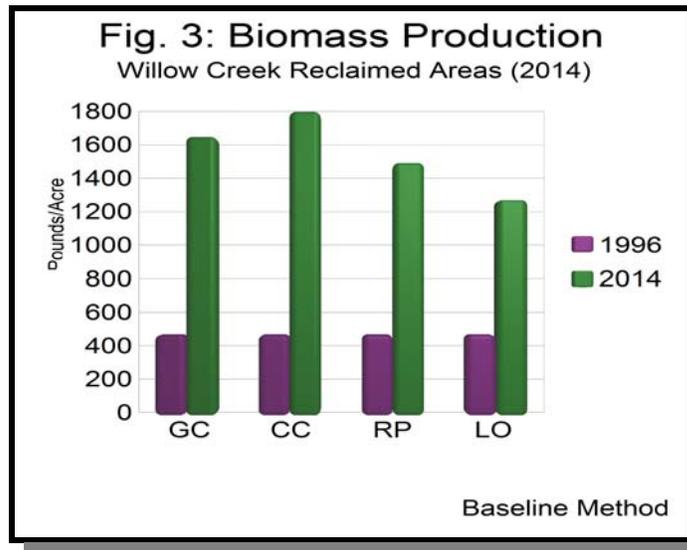
Fig. 1 illustrates that the total living cover values of the current dataset were almost all greater than that of the baseline data (only slightly lower in the Riparian Bottoms). The woody species density values of these same areas were also greater in the current dataset when compared to the baseline standards (Fig. 2).

Finally, total annual biomass production of the Disturbed



GC = Gravel Canyon; CC = Conveyor Corridor; RP = Refuse Pile; LO = Loadout; RB = Riparian Bottoms

Areas were also compared graphically (Fig. 3). The current productivity estimates greatly exceeded those shown in the baseline dataset.



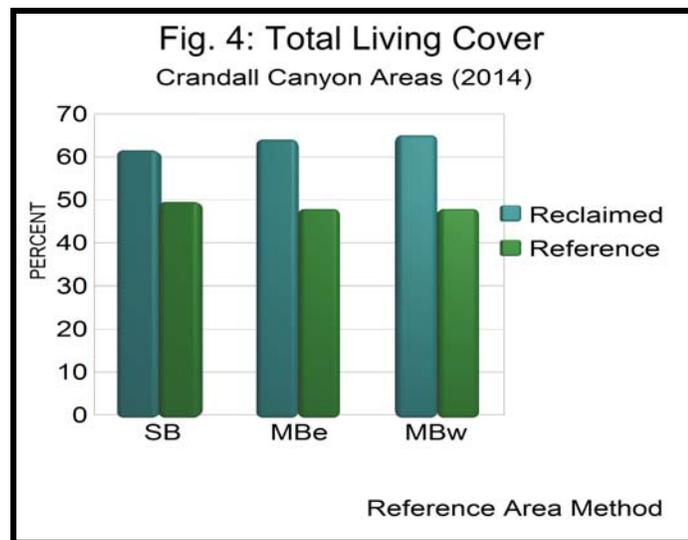
GC = Gravel Canyon; CC = Conveyor Corridor;
RP = Refuse Pile; LO = Loadout

Crandall Canyon Areas - The reclaimed areas in Crandall Canyon consist of: 1) Sagebrush Areas, 2) Mountain Brush Areas

(East), and 3) Mountain Brush Areas (West). The protocol to measure

revegetation success in these areas employed the *Reference Area* method. This method uses pre-determined reference areas, or undisturbed plant communities chosen to represent future revegetation success standards. Two reference areas were chosen to be compared with the reclaimed areas of Crandall Canyon including 1)

Mountain Brush (MB) Reference Area and 2) Crandall Canyon (SB) Reference Area. Graphic illustrations comparing the total living cover of the reclaimed areas in Crandall Canyon with their respective reference areas show that the reclaimed areas have exceeded their success standard (Fig. 4). In most cases,



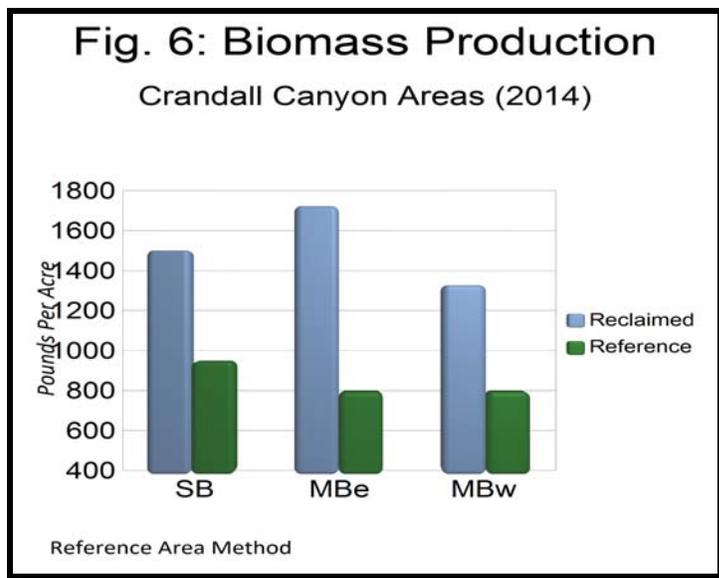
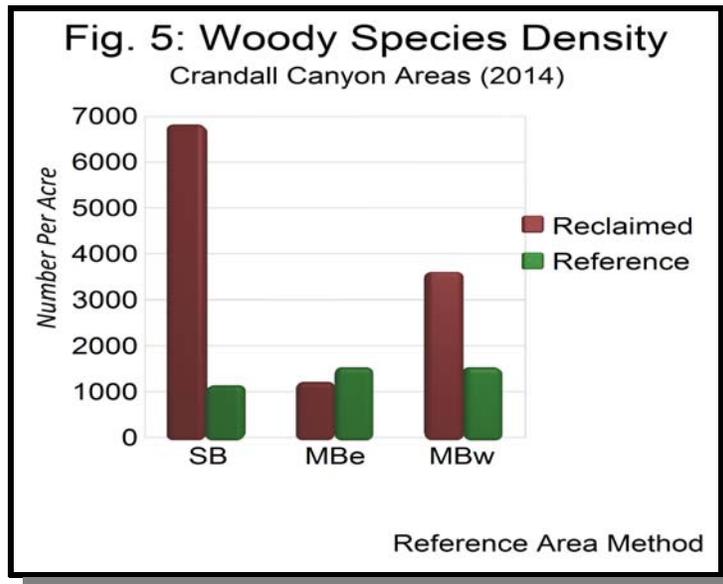
SB = Sagebrush; MBe = Mtn. Brush (east); MBw = Mtn. Brush (west)

woody species density values of the reclaimed sites in Crandall Canyon exceeded those of the reference area (Fig. 5).

Annual biomass production was again higher in the reclaimed areas when compared to the reference areas (Fig. 6).

As prescribed in the MRP, Sorenson's Similarity Index was applied to the Willow Creek reclaimed sites. Accordingly, the similarity between the reclaimed areas (2014 data) and the success standards (1994-96 data) was calculated. The

similarity value was measured at 31.11% – not a high value. This similarity value was close to what it was in the 2013 dataset, however, this index only takes into consideration the

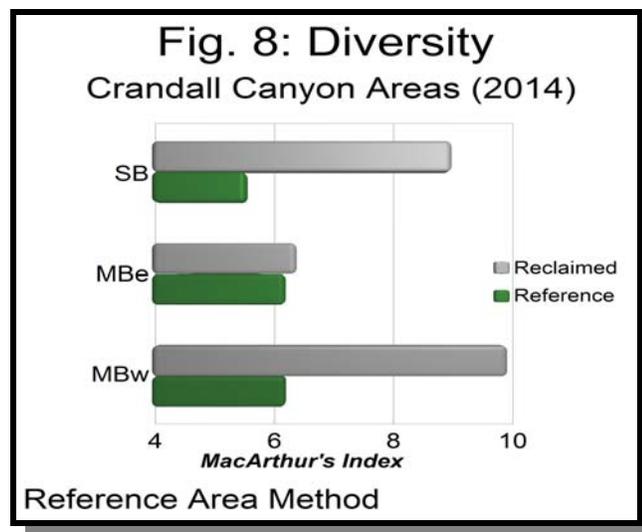
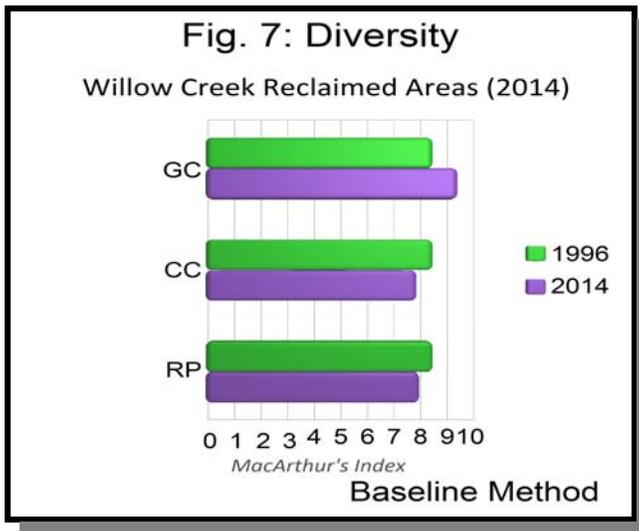


SB = Sagebrush; MBe = Mtn. Brush (east); MBw = Mtn. Brush (west)

MacArthur's Index was employed for total diversity comparisons.

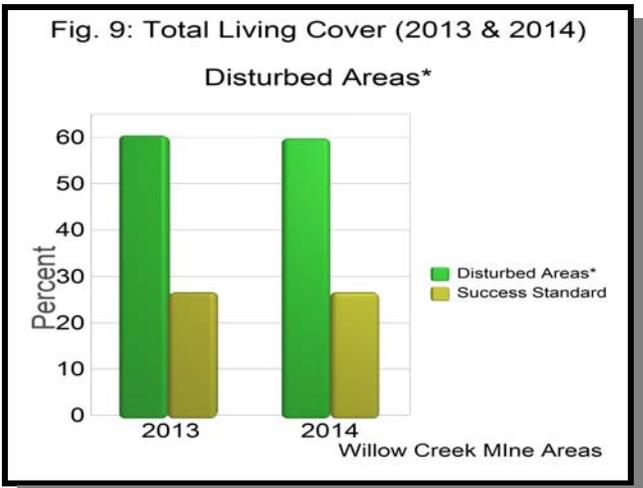
number of species the two datasets have in common. It does not consider whether or not the species present were “desirable” or compatible with the post-mining land use. In other words, the two datasets may have different plant species, but both may be appropriate for a successful revegetated plant community. That said, perhaps a more meaningful parameter to consider may be community diversity. Consequently,

For the Willow Creek sites, the 1994-96 and 2014 data were close (Fig. 7). In Crandall Canyon, all reclaimed areas were more diverse than their respective reference areas (Fig. 8).

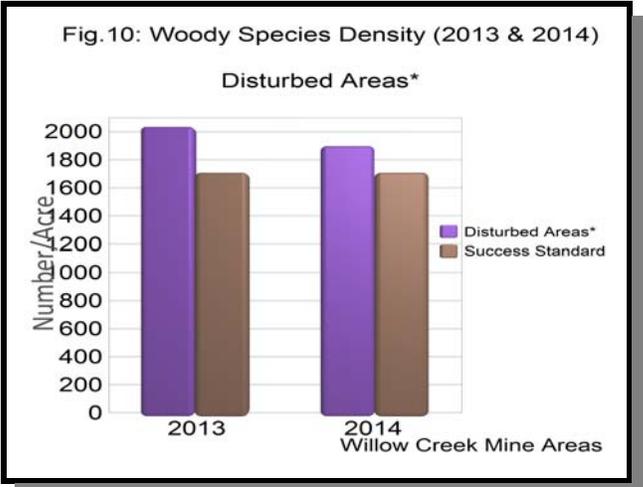


Comparisons Between Years

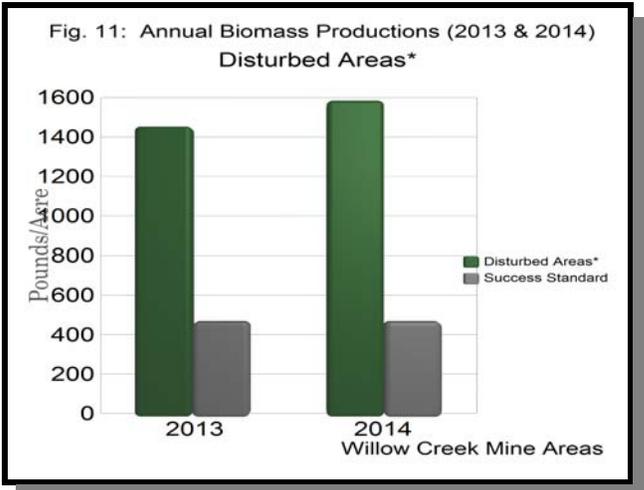
Although the scope of this report was to show the findings of the 2014 vegetation sampling for the second of the two consecutive sample years required for Phase III Bond Release (as mentioned, a report was previously submitted for the 2013 sample year), two-year comparisons of the primary parameters used for comparisons with the reference area has been shown graphically below (Figs 9-16).



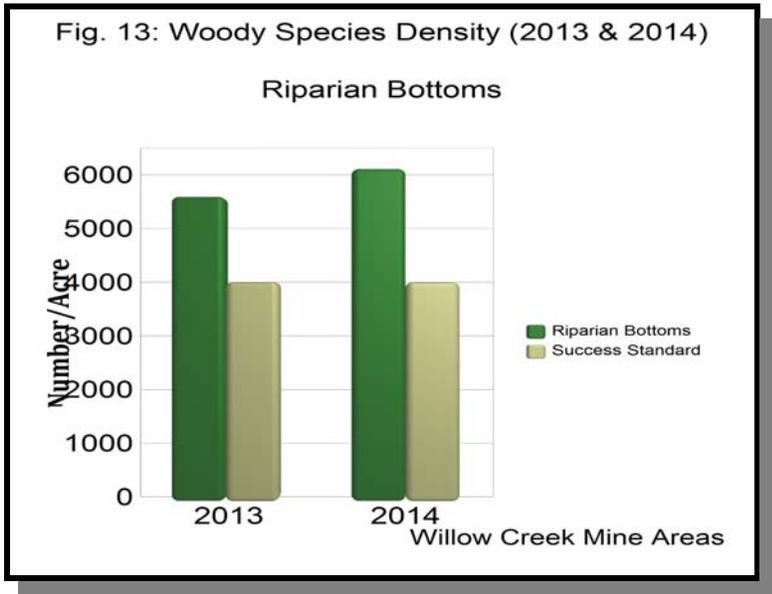
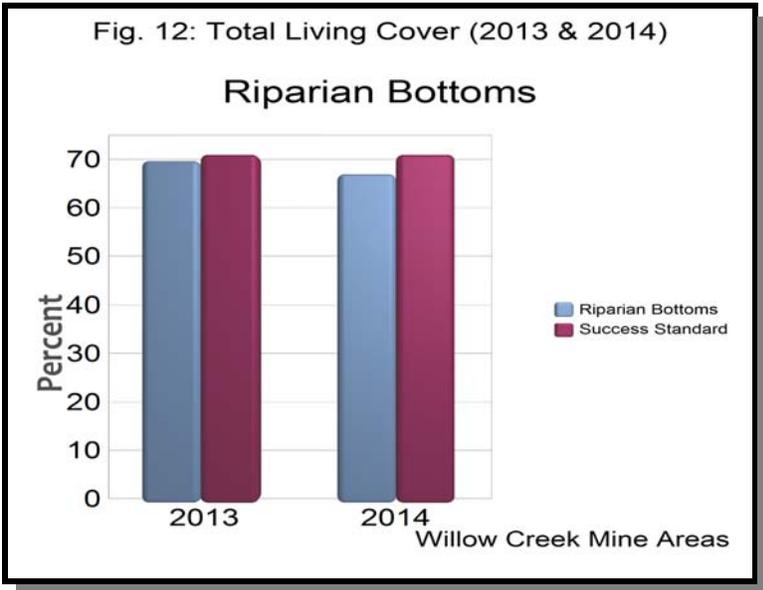
* Disturbed Areas: Gravel Canyon; Conveyor Corridor; Refuse Pile, Loadout

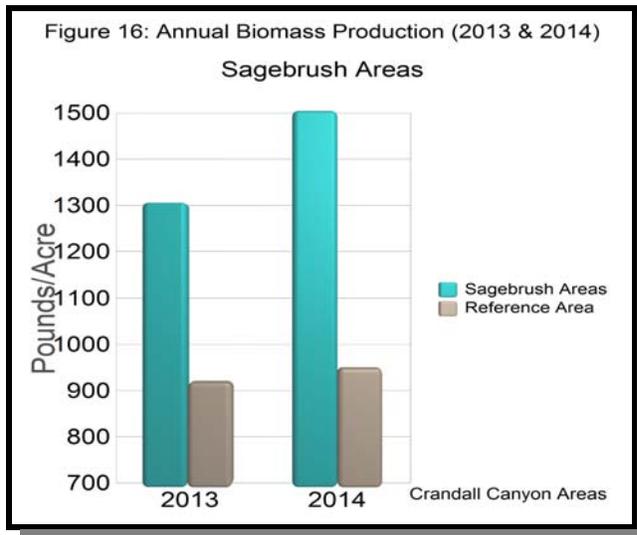
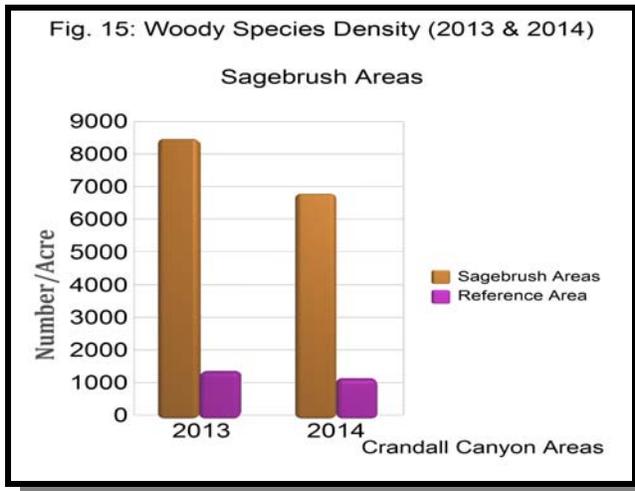
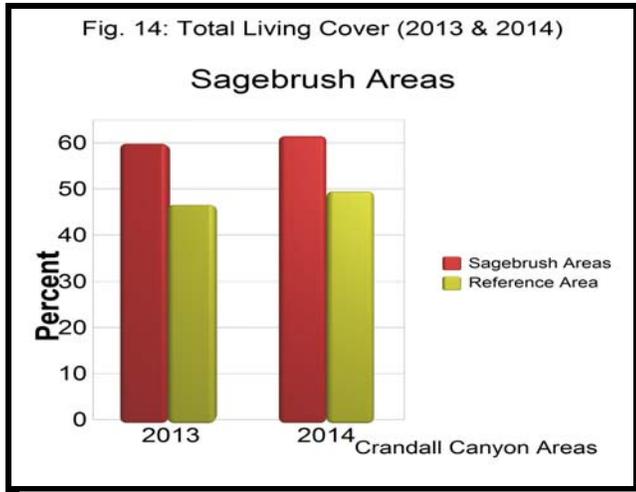


* Disturbed Areas: Gravel Canyon; Conveyor Corridor; Refuse Pile, Loadout



* Disturbed Areas: Gravel Canyon; Conveyor Corridor; Refuse Pile, Loadout





Statistical Comparisons

This section provides statistical comparisons of the fundamental parameters (those

suggested by state and federal regulations) with the revegetation success standards that are provided by reference areas or baseline datasets. The like-reclaimed areas that are to be compared with the success standards (whether from a fixed standard or a reference area standard) have been “lumped” together for the analyses. In other words, because some of the reclaimed areas of Willow Creek Mine site such as Gravel Canyon, Conveyor Corridor, Refuse Pile and Loadout areas have the same standards for revegetation success, and have been reclaimed to the same plant community, they have been lumped together for the statistical analyses. Results of the lumped data are shown on Tables 40-45.

Fig. 17: Statistical Analyses - Student’s t-tests comparing **total living cover** of the reclaimed areas and success standards (2014).

A. WILLOW CREEK MINE AREA

Disturbed Areas*: \bar{x} =59.36; s=9.82; n=157

Standard (1996): \bar{x} =26.72; s=6.68; n=25

t =16.0200; df =180; SL= p<0.01

nMIN

80%± 0.10 = 10 samples

90%± 0.10 = 16 samples

Riparian Bottoms: \bar{x} =66.50; s=5.94; n=30

Standard (1996): \bar{x} =70.43; s=14.41; n=21

t =1.3439 ; df =49; SL= NS

B. CRANDALL CANYON AREA

Sagebrush Areas: \bar{x} =61.06; s=9.70; n=80

Reference Area: \bar{x} =49.25; s=10.03; n=60

t =7.6658 ; df =138; SL= p<0.01

Mountain Brush Areas**: \bar{x} =64.00; s=8.75; n=20

Reference Area: \bar{x} =47.63; s=8.73; n=40

t =6.8419 ; df =58; SL= p<0.01

* Disturbed Areas = Reclaimed Gravel Canyon, Conveyor Corridor, Refuse Pile and Loadout (lumped)

** Mountain Brush Areas = Reclaimed Mountain Brush East & West (lumped)

\bar{x} = sample mean,

s = sample standard deviation,

n = sample size,

NS = non-significant,

t = Student's t-value,

df = degrees of freedom,

SL = significance level,

p = probability level

nMIN = sample adequacy

Willow Creek Mine Area - In

Willow Creek Mine area the total living cover value for the “Reclaimed Areas” (Gravel Canyon, Conveyor Corridor, Refuse Pile and Loadout) was significantly greater statistically than the revegetation success standards; the Riparian Bottom was not significantly different

(Fig. 17-A). Next, the woody species densities for those same areas were greater (Fig. 18-A). Lastly, total annual biomass production estimates shown on Fig. 19-A were significantly greater in the reclaimed sites when compared to the standards (production was not required for the Riparian Bottoms).

Crandall Canyon Area - In the Crandall Canyon area the total living cover of the reclaimed Sagebrush Areas was significantly greater than the reference area standard (Fig. 17-B). The same was true for the results in cover of the reclaimed Mountain Brush Areas (East & West). For woody species densities, the statistical analyses suggest that Sagebrush Areas had a greater density value (Fig. 18-B). Although the reclaimed Mountain Brush sites were somewhat higher than the reference area, the difference was not significant statistically (Fig. 18-B). Finally, total annual biomass production of all reclaimed sites in Crandall Canyon were significantly greater than the reference area (Fig. 19-B).

Fig. 18: Statistical Analyses - Student's t-tests comparing **woody species density** of the reclaimed areas and success standards (2014).

A. WILLOW CREEK MINE AREA

Disturbed Areas*: \bar{x} =1886.06; s=391.85; n=61
Standard (1996): \bar{x} =1700.00; s=n/a; n=n/a
 t = n/a (fixed standard)

Riparian Bottoms: \bar{x} =6068.60; s=1799.80; n=30
Standard (1996): \bar{x} =4000.00; s=n/a; n=n/a
 t = n/a (fixed standard)

B. CRANDALL CANYON AREA

Sagebrush Areas: \bar{x} =6755.92; s=3410.40; n=80
Reference Area: \bar{x} =1160.08; s=488.00; n=60
 t =12.6022; df =138; SL= p<0.01

Mountain Brush Areas** : \bar{x} =1925.16; s=2636.72; n=20
Reference Area: \bar{x} =1549.77; s=457.34; n=40
 t =0.8815 ; df =58; SL= NS

* Disturbed Areas = Reclaimed Gravel Canyon, Conveyor Corridor, Refuse Pile and Loadout (lumped)

** Mountain Brush Areas = Reclaimed Mountain Brush East & West (lumped)

\bar{x} = sample mean,
 s = sample standard deviation,
 n = sample size,
 NS = non-significant,
 t = Student's t-value,
 df = degrees of freedom,
 SL = significance level,
 p = probability level

Fig. 19: Statistical Analyses - Student's t-tests comparing **annual biomass production** of the reclaimed areas and success standards (2014).

A. WILLOW CREEK MINE AREA

Disturbed Areas*: \bar{x} =1570.76; s=503.61; n=77

Standard (1996): \bar{x} =472; s=n/a; n=n/a

t = n/a; (fixed standard from baseline data)

Riparian Bottoms: \bar{x} =n/a; s=n/a; n=n/a

Standard (1996): \bar{x} =n/a; s=n/a; n=n/a

t = n/a (no production required)

B. CRANDALL CANYON AREA

Sagebrush Areas: \bar{x} =1498.36; s=372.05; n=40

Reference Area: \bar{x} =952.39; s=244.22; n=60

t =8.8668 df =98; SL= p<0.01

Mountain Brush Areas** : \bar{x} =1521.07; s=386.17; n=20

Reference Area: \bar{x} =803.30; s=192.79; n=40

t =9.6449 ; df =58; SL= p<0.01

* Disturbed Areas = Reclaimed Gravel Canyon, Conveyor Corridor, Refuse Pile and Loadout (lumped)
** Mountain Brush Areas = Reclaimed Mountain Brush East & West (lumped)
 \bar{x} = sample mean,
s = sample standard deviation,
n = sample size,
NS = non-significant,
t = Student's t-value,
df = degrees of freedom,
SL = significance level,
p = probability level

SUMMARY & CONCLUSIONS

Willow Creek Mine ceased coal mining operations in the year 2000. Subsequently, reclamation began and by 2004, revegetation activities at the site were completed. Following reclamation activities, mine sites must allow enough time to pass for acceptable plant establishment before applications can be made for *final* or *Phase III Bond Release* through the State of Utah, Division of Oil, Gas & Mining (DOG M). Consequently, beginning in year 9 of the 10-year *responsibility period*, intensive sampling can be initiated for two consecutive years to determine whether or not the reclaimed site has met pre-determined revegetation success standards. This sampling began in 2013 and was completed in 2014 for the Willow Creek Mine site. Although some data from the 2013 sampling were included in this report to facilitate comparisons between years, the complete datasets and results for that year were provided in an earlier report. This report provides the findings for the sampling conducted in 2014.

Reclaimed areas were sampled and reported separately at first. The *separated data* show the differences between each study site as well as comparisons with the reference areas. The summary tables also show additional information for individual sites including lifeform composition, frequency, species presence and diversity, as well as the more fundamental parameters such as total living cover, density and annual biomass productivity. For the fundamental parameters, analogous datasets were lumped to be compared statistically with their respective reference areas.

The parameters from quantitative sampling included: cover by species, total living cover, species composition, woody species density, annual biomass production, similarity and diversity. Although all these parameters can be compared, the primary parameters that were compared statistically with the revegetation success standards were: total living cover, woody species density and annual biomass productivity. The statistical analyses suggested *all reclaimed areas were equal to, or greater than the revegetation success standards*. Furthermore, diversity, plant species presence and composition all compared positively with the success standards.

In conclusion, the 2014 sampling results show that the restored plant communities at the Willow Creek Mine site have met or exceeded all final revegetation success standards. This conclusion, as well as consideration of 2013 findings, suggests that *final* or *Phase III Bond Release* at the Willow Creek Mine site may be warranted.

DATA SUMMARY TABLES

Table 1: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

n=25			
Gravel Canyon			
SHRUBS	Mean Percent	Standard Deviation	Percent Frequency
<i>Artemisia tridentata</i>	4.80	9.43	24.00
<i>Atriplex canescens</i>	7.60	15.04	24.00
<i>Chrysothamnus nauseosus</i>	2.00	6.93	8.00
FORBS			
<i>Achillea millefolium</i>	3.20	5.46	28.00
<i>Artemisia dracunculus</i>	0.40	1.96	4.00
<i>Aster chilensis</i>	1.20	5.88	4.00
<i>Linum lewisii</i>	1.20	3.25	12.00
<i>Penstemon palmeri</i>	4.80	6.40	40.00
GRASSES			
<i>Elymus cinereus</i>	6.80	8.35	48.00
<i>Elymus lanceolatus</i>	4.00	6.32	32.00
<i>Elymus smithii</i>	2.40	5.85	16.00
<i>Elymus spicatus</i>	18.80	14.78	76.00

Table 2: Willow Creek Mine Area. Total Cover and Composition (2014).

n=25*		
Gravel Canyon		
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	57.20	11.50
Litter	12.80	4.49
Bareground	14.80	7.55
Rock	15.20	7.55
B. % COMPOSITION		
Shrubs	25.23	27.36
Forbs	20.06	20.50
Grasses	57.11	24.75
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)		

**Table 3: Willow Creek Mine Area.
Woody Species Density (2014).**

n=10*	
SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	760.80
<i>Atriplex canescens</i>	836.34
<i>Ceratoides lanata</i>	10.79
<i>Chrysothamnus nauseosus</i>	161.87
<i>Ephedra viridis</i>	5.40
<i>Symphoricarpos oreophilus</i>	59.35
TOTAL	1834.56

* SAMPLE ADEQUACY (nMIN)
(calculated for the "lumped" dataset)

Table 4: Willow Creek Mine Area. Annual Production (2014).

n=10*		
LIFEFORM	Pounds/Acre	
	Mean	Std. Dev.
Herbaceous	1005.84	752.09
Woody	626.49	982.29
TOTAL	1632.33	519.83

* SAMPLE ADEQUACY (nMIN)
(calculated for the "lumped" dataset)

Table 5: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Reclaimed Conveyor Corridor			n=50
SHRUBS	Mean Percent	Standard Deviation	Percent Frequency
<i>Artemisia nova</i>	0.40	2.80	2.00
<i>Artemisia tridentata</i>	6.80	14.62	22.00
<i>Atriplex canescens</i>	10.20	15.03	38.00
<i>Bassia prostrata</i>	0.40	2.80	2.00
<i>Ceratoides lanata</i>	2.60	8.44	10.00
<i>Chrysothamnus nauseosus</i>	4.20	10.79	16.00
<i>Suaeda torreyana</i>	0.20	1.40	2.00
FORBS			
<i>Achillea millefolium</i>	1.20	3.82	10.00
<i>Halogeton glomeratus</i>	0.00	0.00	0.00
<i>Penstemon palmeri</i>	1.60	5.04	10.00
GRASSES			
<i>Bromus carinatus</i>	1.00	4.12	6.00
<i>Bromus tectorum</i>	0.80	3.37	6.00
<i>Elymus cinereus</i>	1.20	4.31	8.00
<i>Elymus lanceolatus</i>	5.00	7.81	32.00
<i>Elymus smithii</i>	5.80	10.22	28.00
<i>Elymus spicatus</i>	19.00	17.80	68.00
<i>Stipa hymenoides</i>	1.40	5.66	6.00

Table 6: Willow Creek Mine Area. Total Cover and Composition (2014).

Reclaimed Conveyor Corridor			n=50*
A. TOTAL COVER	Mean Percent	Standard Deviation	
Total Living Cover	61.80	7.92	
Litter	12.20	4.14	
Bareground	11.80	3.84	
Rock	14.20	6.35	
B. % COMPOSITION			
Shrubs	42.56	29.82	
Forbs	4.29	10.90	
Grasses	57.82	33.54	
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)			

**Table 7: Willow Creek Mine Area.
Woody Species Density (2014).**

Reclaimed Conveyor Corridor		n=25*
SPECIES	Individuals Per Acre	
<i>Artemisia tridentata</i>	418.71	
<i>Atriplex canescens</i>	807.21	
<i>Ceratoides lanata</i>	43.17	
<i>Suaeda torreyana</i>	10.79	
<i>Chrysothamnus nauseosus</i>	682.02	
<i>Ephedra viridis</i>	17.27	
<i>Symphoricarpos oreophilus</i>	2.16	
TOTAL	1981.32	
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)		

Table 8: Willow Creek Mine Area. Annual Production (2014).

Reclaimed Conveyor Corridor			n=25*
LIFEFORM	Pounds/Acre		
	Mean	Std. Dev.	
Herbaceous	552.82	697.75	
Woody	1226.28	1092.14	
TOTAL	1779.10	569.04	
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)			

Table 9: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Reclaimed Refuse Pile			
			n=80
SHRUBS	Mean Percent	Standard Deviation	Percent Frequency
<i>Atriplex canescens</i>	12.38	16.07	45.00
<i>Artemisia tridentata</i>	1.38	5.42	6.25
<i>Ceratoides lanata</i>	0.88	4.53	3.75
<i>Chrysothamnus nauseosus</i>	0.75	4.68	2.50
FORBS			
<i>Achillea millefolium</i>	1.38	4.68	10.00
<i>Linum lewisii</i>	0.75	3.80	3.75
<i>Penstemon palmeri</i>	7.00	10.42	38.75
GRASSES			
<i>Elymus cinereus</i>	7.13	12.77	27.50
<i>Elymus lanceolatus</i>	8.25	11.81	41.25
<i>Elymus salinus</i>	0.13	1.11	1.25
<i>Elymus smithii</i>	5.13	10.95	26.25
<i>Elymus spicatus</i>	9.88	14.70	40.00
<i>Stipa hymenoides</i>	3.25	8.77	15.00

Table 10: Willow Creek Mine Area. Total Cover and Composition (2014).

Reclaimed Refuse Pile		
		n=80*
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	58.38	10.06
Litter	11.00	3.39
Bareground	14.88	5.48
Rock	15.75	7.38
B. % COMPOSITION		
Shrubs	26.13	29.44
Forbs	16.87	23.59
Grasses	57.00	28.87
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)		

**Table 11: Willow Creek Mine Area.
Woody Species Density (2014).**

Reclaimed Refuse Pile		n=30*
SPECIES	Individuals Per Acre	
<i>Amelanchier utahensis</i>	5.40	
<i>Artemisia tridentata</i>	120.51	
<i>Atriplex canescens</i>	1302.18	
<i>Ceratoides lanata</i>	170.87	
<i>Chrysothamnus nauseosus</i>	196.05	
<i>Gutierrezia sarothrae</i>	5.40	
<i>Ephedra viridis</i>	10.79	
<i>Atriplex confertifolia</i>	3.60	
<i>Symphoricarpos oreophilus</i>	10.79	
TOTAL	1825.57	
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)		

Table 12: Willow Creek Mine Area. Annual Production (2014).

Reclaimed Refuse Pile			n=40*
LIFEFORM	Pounds/Acre		
	Mean	Std. Dev.	
Herbaceous	846.23	738.99	
Woody	633.65	803.90	
TOTAL	1479.88	346.32	
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)			

Table 13: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Reclaimed Loadout			n=2
SHRUBS	Mean Percent	Standard Deviation	Percent Frequency
<i>Ceratoides lanata</i>	20.00	20.00	50.00
FORBS			
GRASSES			
<i>Elymus cinereus</i>	5.00	5.00	50.00
<i>Elymus lanceolatus</i>	30.00	30.00	50.00
<i>Elymus spicatus</i>	10.00	10.00	50.00

Table 14: Willow Creek Mine Area. Total Cover and Composition (2014).

Reclaimed Loadout			n=2*
A. TOTAL COVER	Mean Percent	Standard Deviation	
Total Living Cover	65.00	5.00	
Litter	10.00	0.00	
Bareground	15.00	5.00	
Rock	10.00	0.00	
B. % COMPOSITION			
Shrubs	28.57	28.57	
Forbs	0.00	0.00	
Grasses	71.43	28.57	
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)			

**Table 15: Willow Creek Mine Area.
Woody Species Density (2014).**

Reclaimed Loadout		n=1*
SPECIES	Individuals Per Acre	
<i>Atriplex canescens</i>	215.83	
<i>Chrysothamnus nauseosus</i>	485.62	
<i>Ceratoides lanata</i>	593.53	
<i>Populus angustifolia</i>	539.58	
TOTAL	1834.56	
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)		

Table 16: Willow Creek Mine Area. Annual Production (2014).

Reclaimed Loadout			n=2*
LIFEFORM	Pounds/Acre		
	Mean	Std. Dev.	
Herbaceous			
Woody	533.61	533.61	
	728.14	728.14	
TOTAL	1261.75	194.53	
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)			

Table 17: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Reclaimed Riparian Bottoms			
			n=30
OVERSTORY	Mean Percent	Standard Deviation	Percent Frequency
<i>Salix exigua</i>	13.50	16.89	46.67
<i>Rosa woodsii</i>	5.33	14.66	13.33
<i>Populus augustifolia</i>	1.33	7.18	3.33
UNDERSTORY			
TREES/SHRUBS			
<i>Artemisia tridentata</i>	4.00	7.12	30.00
<i>Atriplex canescens</i>	2.50	11.01	6.67
<i>Chrysothamnus nauseosus</i>	4.33	11.74	16.67
<i>Ephedra viridis</i>	1.50	8.08	3.33
<i>Populus augustifolia</i>	1.00	5.39	3.33
<i>Ribes aureum</i>	4.67	11.61	16.67
<i>Rosa woodsii</i>	7.00	13.76	23.33
<i>Salix exigua</i>	13.17	17.39	46.67
FORBS			
<i>Linum lewisii</i>	0.67	3.59	3.33
<i>Penstemon palmeri</i>	1.33	4.46	10.00
GRASSES			
<i>Bromus tectorum</i>	0.83	4.49	3.33
<i>Elymus cinereus</i>	1.50	5.65	6.67
<i>Elymus lanceolatus</i>	2.00	6.53	10.00
<i>Elymus smithii</i>	0.67	3.59	3.33
<i>Elymus spicatus</i>	0.83	4.49	3.33
<i>Stipa hymenoides</i>	0.33	1.80	3.33

Table 18: Willow Creek Mine Area. Total Cover and Composition (2014).

Reclaimed Riparian Bottoms		
		n=30*
A. TOTAL COVER	Mean Percent	Standard Deviation
Overstory (O)	20.17	18.91
Understory (U)	46.33	16.78
Litter	27.13	23.04
Bareground	10.43	9.37
Rock	16.10	14.17
O + U	66.50	5.94
B. % COMPOSITION		
Shrubs	85.70	26.37
Forbs	3.14	8.66
Grasses	11.16	20.62
* SAMPLE ADEQUACY (nMIN) 80%± 0.10 = 1 sample 90%± 0.10 = 2 samples		

**Table 19: Willow Creek Mine Area.
Woody Species Density (2014).**

Reclaimed Riparian Bottoms	
SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	1163.15
<i>Atriplex canescens</i>	455.14
<i>Ephedra viridis</i>	101.14
<i>Populus angustifolia</i>	50.57
<i>Chrysothamnus nauseosus</i>	859.72
<i>Rosa woodsii</i>	910.29
<i>Ribes aureum</i>	455.14
<i>Salix exigua</i>	2073.44
TOTAL	6068.60
* SAMPLE ADEQUACY (nMIN) 80%± 0.10 = 14 samples 90%± 0.10 = 24 samples	

Table 20: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Reclaimed Sagebrush (Crandall Canyon)			
n=80			
TREES/SHRUBS	Mean Percent	Standard Deviation	Percent Frequency
<i>Artemisia tridentata</i>	17.13	14.57	77.50
<i>Cercocarpus ledifolius</i>	11.81	16.21	41.25
<i>Chrysothamnus nauseosus</i>	1.50	8.34	3.75
<i>Pinus ponderosa</i>	0.56	3.26	3.75
<i>Pseudotsuga menziesii</i>	0.63	3.20	5.00
FORBS			
<i>Artemisia ludoviciana</i>	0.19	1.24	2.50
<i>Aster chilensis</i>	1.19	4.42	8.75
<i>Linum lewisii</i>	1.38	3.53	16.25
<i>Mellilotus officinalis</i>	3.25	4.48	38.75
<i>Penstemon sp.</i>	0.44	2.26	3.75
GRASSES			
<i>Elymus cinereus</i>	7.13	12.77	33.75
<i>Elymus junceus</i>	0.94	4.41	6.25
<i>Elymus lanceolatus</i>	3.86	5.90	36.25
<i>Elymus smithii</i>	4.00	7.47	36.25
<i>Elymus spicatus</i>	3.56	8.11	21.25
<i>Poa secunda</i>	3.56	8.49	25.00

Table 21: Willow Creek Mine Area. Total Cover and Composition (2014).

Reclaimed Sagebrush (Crandall Canyon)		
n=80*		
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	61.06	9.70
Litter	11.19	4.28
Bareground	10.88	4.79
Rock	16.88	9.56
B. % COMPOSITION		
Shrubs	51.48	25.49
Forbs	11.55	15.13
Grasses	36.97	25.01
* SAMPLE ADEQUACY (nMIN) 80%± 0.10 = 4 samples 90%± 0.10 = 7 samples		

**Table 22: Willow Creek Mine Area.
Woody Species Density (2014).**

**Reclaimed Sagebrush
(Crandall Canyon)** n=80*

SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	4433.57
<i>Artemisia nova</i>	21.11
<i>Cercocarpus ledifolius</i>	1921.21
<i>Chrysothamnus nauseosus</i>	190.01
<i>Pinus ponderosa</i>	42.22
<i>Purshia tridentata</i>	21.11
<i>Pseudotsuga menziesii</i>	126.67
TOTAL	6755.92

* SAMPLE ADEQUACY (nMIN)
80%± 0.10 = 42 samples
90%± 0.10 = 69 samples

Table 23: Willow Creek Mine Area. Annual Production (2014).

**Reclaimed Sagebrush
(Crandall Canyon)** n=40*

LIFEFORM	Pounds/Acre	
	Mean	Std. Dev.
Herbaceous	648.24	716.41
Woody	850.13	852.84
TOTAL	1498.36	372.05

* SAMPLE size (n) = 40
* SAMPLE ADEQUACY (nMIN)
80%± 0.10 = 10 samples
90%± 0.10 = 17 samples

Table 24: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Reclaimed Mountain Brush - East (Crandall Canyon)			
			n=10
SHRUBS	Mean Percent	Standard Deviation	Percent Frequency
<i>Artemisia tridentata</i>	18.50	20.62	60.00
<i>Cercocarpus ledifolius</i>	1.50	4.50	10.00
FORBS			
<i>Linum lewisii</i>	1.50	3.20	20.00
<i>Melilotus officinalis</i>	0.50	1.50	10.00
<i>Penstemon sp</i>	2.00	3.32	30.00
GRASSES			
<i>Elymus cinereus</i>	29.00	26.25	80.00
<i>Elymus lanceolatus</i>	3.00	5.10	20.00
<i>Elymus smithii</i>	4.00	6.24	30.00
<i>Poa secunda</i>	3.50	7.76	20.00

Table 25: Willow Creek Mine Area. Total Cover and Composition (2014).

Reclaimed Mountain Brush - East (Crandall Canyon)		
		n=10*
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	63.50	10.74
Litter	11.00	4.36
Bareground	18.30	10.76
Rock	7.20	5.33
B. % COMPOSITION		
Shrubs	33.50	30.57
Forbs	7.89	13.23
Grasses	58.61	37.31
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)		

Table 26: Willow Creek Mine Area.

Woody Species Density (2014).

Reclaimed Mountain Brush - East (Crandall Canyon) n=10*

SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	1106.82
<i>Chrysothamnus nauseosus</i>	92.24
<i>Populus angustifolia</i>	30.75
TOTAL	1229.80

* SAMPLE ADEQUACY (nMIN)
(calculated for the "lumped" dataset)

Table 27: Willow Creek Mine Area. Annual Production (2014).

Reclaimed Mountain Brush - East (Crandall Canyon) n=10*

Pounds/Acre

LIFEFORM	Mean	Std. Dev.
Herbaceous	1002.98	1033.81
Woody	712.44	732.66
TOTAL	1715.42	420.02

* SAMPLE ADEQUACY (nMIN)
(calculated for the "lumped" dataset)

Table 28: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Reclaimed Mountain Brush - West (Crandall Canyon)			
			n=10
SHRUBS	Mean Percent	Standard Deviation	Percent Frequency
<i>Artemisia tridentata</i>	12.50	10.31	70.00
<i>Chrysothamnus nauseosus</i>	1.00	3.00	10.00
FORBS			
<i>Achillea millefolium</i>	2.00	4.00	20.00
<i>Artemisia ludoviciana</i>	1.00	2.00	20.00
<i>Aster chilensis</i>	8.00	12.69	40.00
<i>Linum lewisii</i>	2.00	3.32	30.00
<i>Melilotus officinalis</i>	7.22	4.16	80.00
<i>Penstemon sp.</i>	2.50	4.61	30.00
GRASSES			
<i>Elymus cinereus</i>	12.00	10.54	80.00
<i>Elymus lanceolatus</i>	5.50	6.50	50.00
<i>Elymus smithii</i>	8.00	11.87	50.00
<i>Poa secunda</i>	3.50	3.91	50.00

Table 29: Willow Creek Mine Area. Total Cover and Composition (2014).

Reclaimed Mountain Brush - West (Crandall Canyon)		
		n=10*
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	64.50	6.10
Litter	7.50	2.50
Bareground	10.00	4.47
Rock	18.00	5.10
B. % COMPOSITION		
Shrubs	21.58	17.38
Forbs	33.53	25.20
Grasses	44.89	23.30
* SAMPLE ADEQUACY (nMIN) (calculated for the "lumped" dataset)		

Table 30: Willow Creek Mine Area.

Woody Species Density (2014).

Reclaimed Mountain Brush - West (Crandall Canyon) n=10*

SPECIES	Individuals Per Acre
<i>Artemisia tridentata</i>	2700.93
<i>Cercocarpus ledifolius</i>	810.28
<i>Chrysothamnus nauseosus</i>	90.03
TOTAL	3601.24

* SAMPLE ADEQUACY (nMIN)
(calculated for the "lumped" dataset)

Table 31: Willow Creek Mine Area. Annual Production (2014).

Reclaimed Mountain Brush - West (Crandall Canyon)

n=10*

LIFEFORM	Pounds/Acre	
	Mean	Std. Dev.
Herbaceous	778.11	667.53
Woody	548.61	674.13
TOTAL	1326.72	215.17

* SAMPLE ADEQUACY (nMIN)
(calculated for the "lumped" dataset)

Table 32: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Mountain Brush Reference Area				n=40
OVERSTORY				
<i>Amelanchier utahensis</i>	0.13	0.78	2.50	
<i>Pinus edulis</i>	0.50	3.12	2.50	
UNDERSTORY				
TREES/SHRUBS				
<i>Amelanchier utahensis</i>	2.13	6.31	12.50	
<i>Artemisia nova</i>	0.63	3.90	2.50	
<i>Artemisia tridentata</i>	7.75	11.34	37.50	
<i>Atriplex canescens</i>	1.00	4.36	5.00	
<i>Ephedra viridis</i>	0.25	1.56	2.50	
<i>Juniperus osteosperma</i>	0.50	3.12	2.50	
FORBS				
<i>Machaeranthera canescens</i>	0.63	2.29	7.50	
GRASSES				
<i>Bromus tectorum</i>	1.00	4.36	5.00	
<i>Elymus salinus</i>	27.50	15.17	45.00	
<i>Poa secunda</i>	0.25	1.56	2.50	
<i>Stipa comata</i>	0.38	2.34	2.50	
<i>Stipa hymenoides</i>	5.00	8.37	30.00	

Table 33: Willow Creek Mine Area. Total Cover and Composition (2014).

Mountain Brush Reference Area			n=40*
A. TOTAL COVER	Mean Percent	Standard Deviation	
Overstory (O)	0.63	3.20	
Understory (U)	47.00	9.14	
Litter	10.88	4.01	
Bareground	14.50	4.44	
Rock	27.63	10.25	
O + U	47.63	8.73	
B. % COMPOSITION			
Shrubs	24.58	25.27	
Forbs	1.63	5.93	
Grasses	73.79	24.37	
* SAMPLE ADEQUACY (nMIN)			
80%± 0.10 = 6 samples			
90%± 0.10 = 10 samples			

Table 34: Willow Creek Mine Area.

Woody Species Density (2014).

Mountain Brush Reference Area		n=40*
SPECIES	Individuals Per Acre	
<i>Amelanchier utahensis</i>	203.41	
<i>Artemisia nova</i>	29.06	
<i>Artemisia tridentata</i>	1026.72	
<i>Atriplex canescens</i>	87.17	
<i>Atriplex confertifolia</i>	9.69	
<i>Rhus aromatica</i>	9.69	
<i>Ephedra viridis</i>	38.74	
<i>Juniperus osteosperma</i>	106.55	
<i>Opuntia polyacantha</i>	9.69	
<i>Pinus edulis</i>	29.06	
TOTAL	1549.77	

* SAMPLE ADEQUACY (nMIN)
 80%± 0.10 = 14 samples
 90%± 0.10 = 24 samples

Table 35: Willow Creek Mine Area. Annual Production (2014).

Mountain Brush Reference Area

n=40*

LIFEFORM	Pounds/Acre	
	Mean	Std. Dev.
Herbaceous	450.20	399.07
Woody	353.10	442.40
TOTAL	803.30	192.79

* SAMPLE size (n) = 40
 * SAMPLE ADEQUACY (nMIN)
 80%± 0.10 = 9 samples
 90%± 0.10 = 16 samples

Table 36: Willow Creek Mine Area. Living Cover and Frequency by Plant Species (2014).

Crandall Canyon (SB) Reference Area			
			n=60
SHRUBS	Mean Percent	Standard Deviation	Percent Frequency
<i>Artemisia tridentata</i>	17.92	18.63	53.33
<i>Atriplex canescens</i>	1.50	7.26	5.00
<i>Chrysothamnus nauseosus</i>	0.33	2.56	1.67
<i>Gutierrezia sarothrae</i>	0.17	1.28	1.67
<i>Opuntia polyacantha</i>	0.25	1.42	3.33
FORBS			
<i>Artemisia ludoviciana</i>	0.95	2.40	15.00
GRASSES			
<i>Bromus tectorum</i>	4.00	6.11	35.00
<i>Elymus salinus</i>	18.17	16.98	66.67
<i>Hilaria jamesii</i>	0.17	1.28	1.67
<i>Stipa comata</i>	5.80	10.12	36.67

Table 37: Willow Creek Mine Area. Total Cover and Composition (2014).

Crandall Canyon (SB) Reference Area		
		n=60*
A. TOTAL COVER	Mean Percent	Standard Deviation
Total Living Cover	49.25	10.03
Litter	9.83	2.88
Bareground	10.67	4.96
Rock	30.25	10.39
B. % COMPOSITION		
Shrubs	40.48	36.83
Forbs	2.05	5.32
Grasses	57.47	36.01
* SAMPLE ADEQUACY (nMIN) 80%± 0.10 = 7 samples 90%± 0.10 = 11 samples		

**Table 38: Willow Creek Mine Area.
Woody Species Density (2014).**

Crandall Canyon (SB) Reference Area		n=60*
SPECIES	Individuals Per Acre	
<i>Amelanchier utahensis</i>	9.67	
<i>Artemisia tridentata</i>	1019.90	
<i>Atriplex canescens</i>	43.50	
<i>Chrysothamnus nauseosus</i>	14.50	
<i>Ephedra viridis</i>	4.83	
<i>Echinocereus triglochidiatus</i>	4.83	
<i>Gutierrezia sarothrae</i>	4.83	
<i>Opuntia polyacantha</i>	24.17	
<i>Rhus aromatica</i>	9.67	
<i>Yucca harrimaniae</i>	24.17	
TOTAL	1160.08	
* SAMPLE ADEQUACY (nMIN)		
80%± 0.10 = 29 samples		
90%± 0.10 = 40 samples		

Table 39: Willow Creek Mine Area. Annual Production (2014).

Crandall Canyon (SB) Reference Area			n=60*
LIFEFORM	Pounds/Acre		
	Mean	Std. Dev.	
Herbaceous	418.80	434.32	
Woody	533.59	563.86	
TOTAL	952.39	244.22	
* SAMPLE size (n) =			
* SAMPLE ADEQUACY (nMIN)			
80%± 0.10 = 11 samples			
90%± 0.10 = 18 samples			

Table 40: Willow Creek Mine Area. Lumped Data for Total Cover (2014).

Reclaimed Areas (Gravel Canyon, Conveyor Corridor, Refuse Pile, Loadout)	Mean Percent	Standard Deviation
TOTAL LIVING COVER	59.36	9.82

SAMPLE size (n) = 157
 SAMPLE ADEQUACY (nMIN)
 80%± 0.10 = 4 samples
 90%± 0.10 = 7 samples

Table 41: Willow Creek Mine Area. Lumped Data for Total Woody Species Density (2014).

Reclaimed Areas (Gravel Canyon, Conveyor Corridor, Refuse Pile, Loadout)	Mean	Standard Deviation
Number of Individuals Per Acre		
TOTAL	1886.06	391.85

SAMPLE size (n) = 61
 SAMPLE ADEQUACY (nMIN)
 80%± 0.10 = 7 samples
 90%± 0.10 = 12 samples

Table 42: Willow Creek Mine Area. Lumped Data for Total Annual Biomass Production (2014).

Reclaimed Areas (Gravel Canyon, Conveyor Corridor, Refuse Pile, Loadout)	Mean	Standard Deviation
Pounds/Acre		
TOTAL	1570.76	503.61

SAMPLE size (n) = 77
 SAMPLE ADEQUACY (nMIN)
 80%± 0.10 = 17 samples
 90%± 0.10 = 28 samples

Table 43: Willow Creek Mine Area. Lumped Data for Total Cover (2014).

Reclaimed Areas in Crandall Canyon (Mountain Brush - East, West)		
	Mean Percent	Standard Deviation
TOTAL LIVING COVER	64.00	8.75

SAMPLE size (n) = 20
 SAMPLE ADEQUACY (nMIN)
 80%± 0.10 = 3 samples
 90%± 0.10 = 5 samples

Table 44: Willow Creek Mine Area. Lumped Data for Total Woody Species Density (2014).

Reclaimed Areas in Crandall Canyon (Mountain Brush - East, West)		
Number of Individuals Per Acre	Mean	Standard Deviation
TOTAL	1925.16	2636.72

SAMPLE size (n) = 20
 SAMPLE ADEQUACY (nMIN)
 80%± 0.10 = 307 samples
 90%± 0.10 = 508 samples

Table 45: Willow Creek Mine Area. Lumped Data for Total Annual Biomass Production (2014).

Reclaimed Areas in Crandall Canyon (Mountain Brush - East, West)		
Pounds/Acre	Mean	Standard Deviation
TOTAL	1521.07	386.17

SAMPLE size (n) = 20
 SAMPLE ADEQUACY (nMIN)
 80%± 0.10 = 11 samples
 90%± 0.10 = 17 samples

COLOR PHOTOGRAPHS
OF THE SAMPLE AREAS

Willow Creek Mine Area

Reclaimed Gravel Canyon



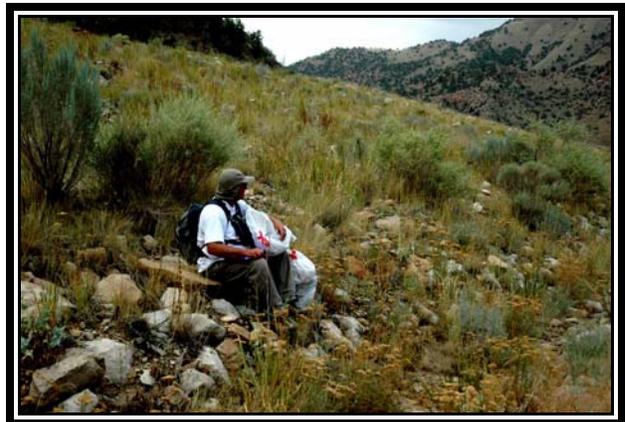
Reclaimed Conveyor Corridor





Reclaimed Refuse Pile





Reclaimed Loadout



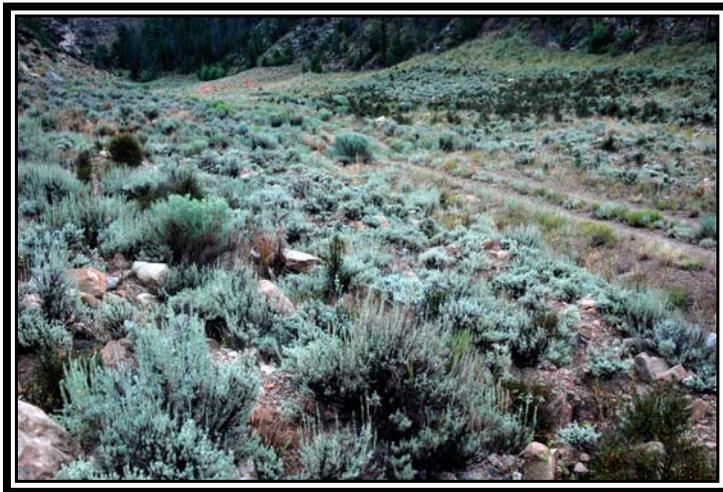
Reclaimed Riparian Bottoms



Crandall Canyon Area

Reclaimed Sagebrush





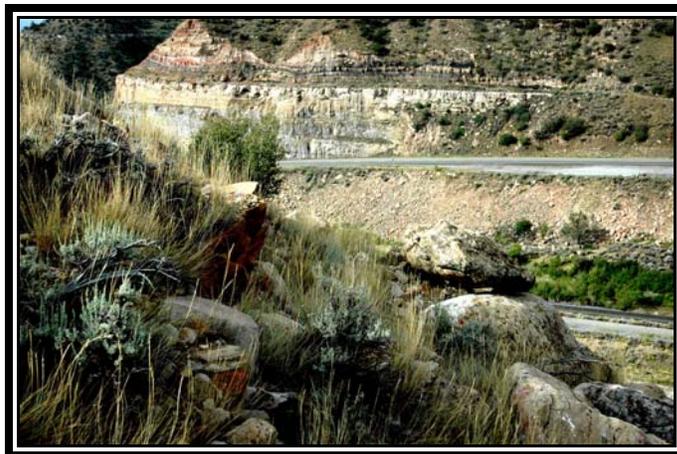
Reclaimed Mountain Brush (East)



Reclaimed Mountain Brush (West)



Mountain Brush Reference Area



Crandall Canyon Reference Area

