DAUB & ASSOCIATES, INC.

1985 ½ SOUTH BROADWAY
GRAND JUNCTION, CO 81507-9649
(970) 254-1224
FAX (970) 242-8438
email: gjdaub@daubandassociates.com
www.daubandassociates.com

NATURAL SODA

2010 Mine Plan
Volume 1, Section 3.0
General Site Conditions

Prepared for:

Natural Soda, Inc.

Piceance Creek Basin
Rio Blanco County, Colorado

Prepared by:

Daub & Associates, Inc.
Grand Junction, Colorado

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SECTION 3.0 GENERAL SITE CONDITIONS

3.1. Introduction

This section presents the general site conditions for the approximate 8,223 acre (BLM, 2001) sodium leases as described in Section 2.3 and illustrated in Figure 2-1. This section also presents more detailed information concerning cultural, paleontological, air quality, and soil studies which were conducted within an approximately 1,620 acre study area. This study area was within the lease boundaries and encompassed NSI's plant and proposed area of operations (herein referred to as the project area). The project area is expected to cumulatively accrue approximately 250 acres of disturbed area (assuming a 40-50 year mine life). As of 2008, the total disturbed acreage was 44.3 acres (BLM Annual Report, 2008).

3.2. Previous Mining Reclamation Activities

In the past there have been several exploration drilling programs on the lease and a Bulk Sampling Program involving a small-scale solution mining facility. In addition, Natural Soda, Inc. has constructed and is currently operating a commercial solution mine (shown on Figure 2-1) that has been in operation since 1991. This section briefly describes each of these activities and reclamation programs associated therewith.

3.2.1. Exploration Drilling

Several exploration development and monitoring well drilling programs have been constructed on the lease. These programs were intended to characterize the sodium resources on the leases and to characterize the ground water environment. The locations of drill holes associated with this activity, and other wells and boreholes in the area are presented in Figure 3-1. A detailed well location map of

the Natural Soda, Inc. lease area is in Figure 3-2. All drill pads associated with the older exploration drilling program have been successfully reclaimed.

3.2.2. Bulk Sampling Program

Permit applications to allow construction and operation of a 3 ton-per-day nahcolite bulk sampling facility were submitted on April 4, 1983. Approvals to begin construction were granted by the BLM on May 26, 1983. Shortly thereafter, the drilling of two production wells and one monitoring well was initiated. In early November of 1983, plant construction was completed and nahcolite bulk sampling by solution extraction began. The facility operated from early November 1983 until mid-February 1984, producing in excess of 165 tons of high purity sodium bicarbonate.

The Bulk Sampling Operation successfully demonstrated the effectiveness of solution mining in extracting deep bedded nahcolite resources. In addition, the results of monitoring and pressurization tests proved that solution mining of the Boies Bed could be conducted without impacting ground water present in the Dissolution Surface Aquifer. The program also provided insight into the design of an effective recrystallization flow sheet which was further refined into a future solution mining program.

Wells constructed on the bulk sampling site have been converted to monitoring wells and/or plugged and abandoned. The bulk sample site was recontoured and successfully revegetated.

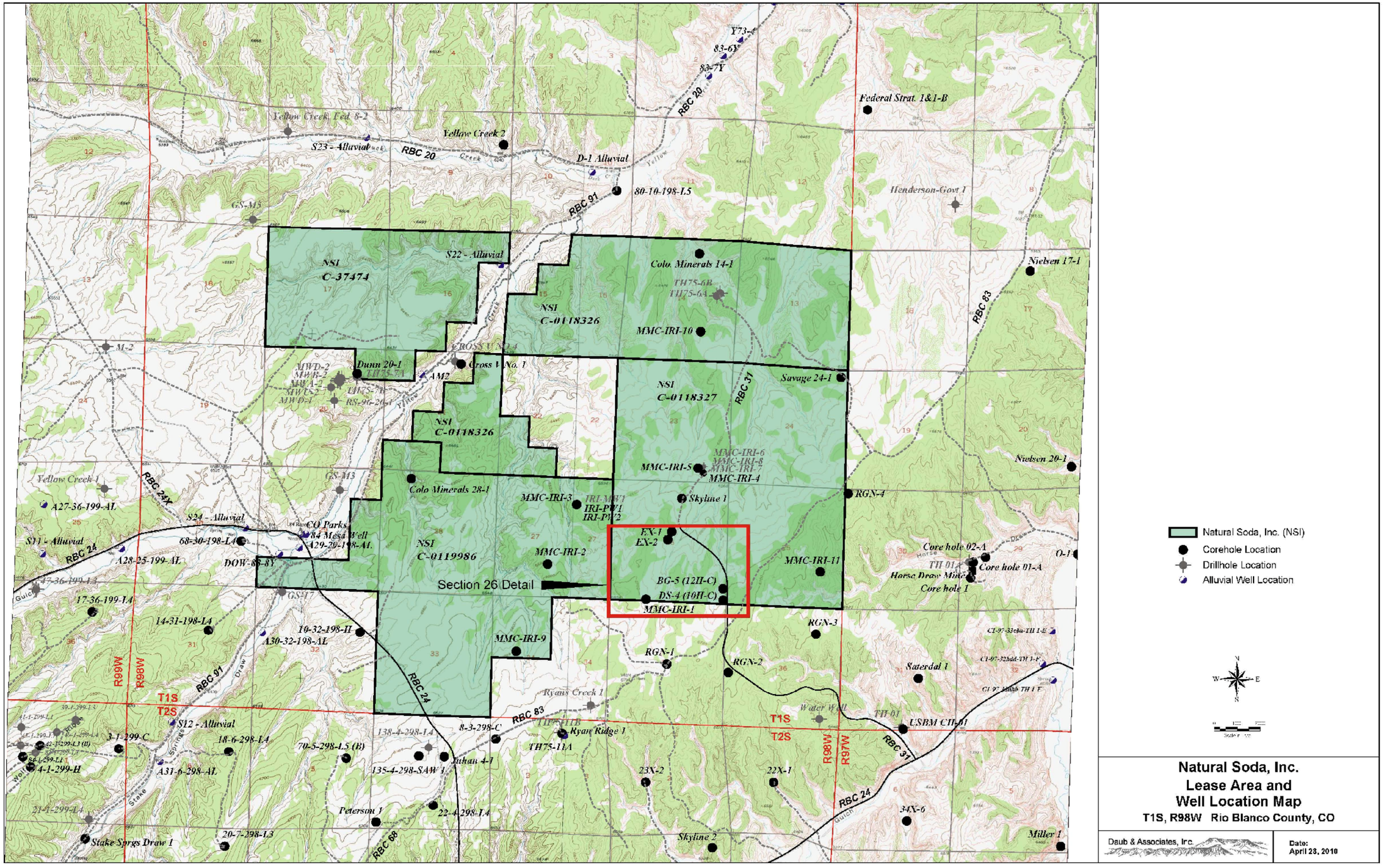

Figure 3-1. All Lease Areas and Well Location Map.

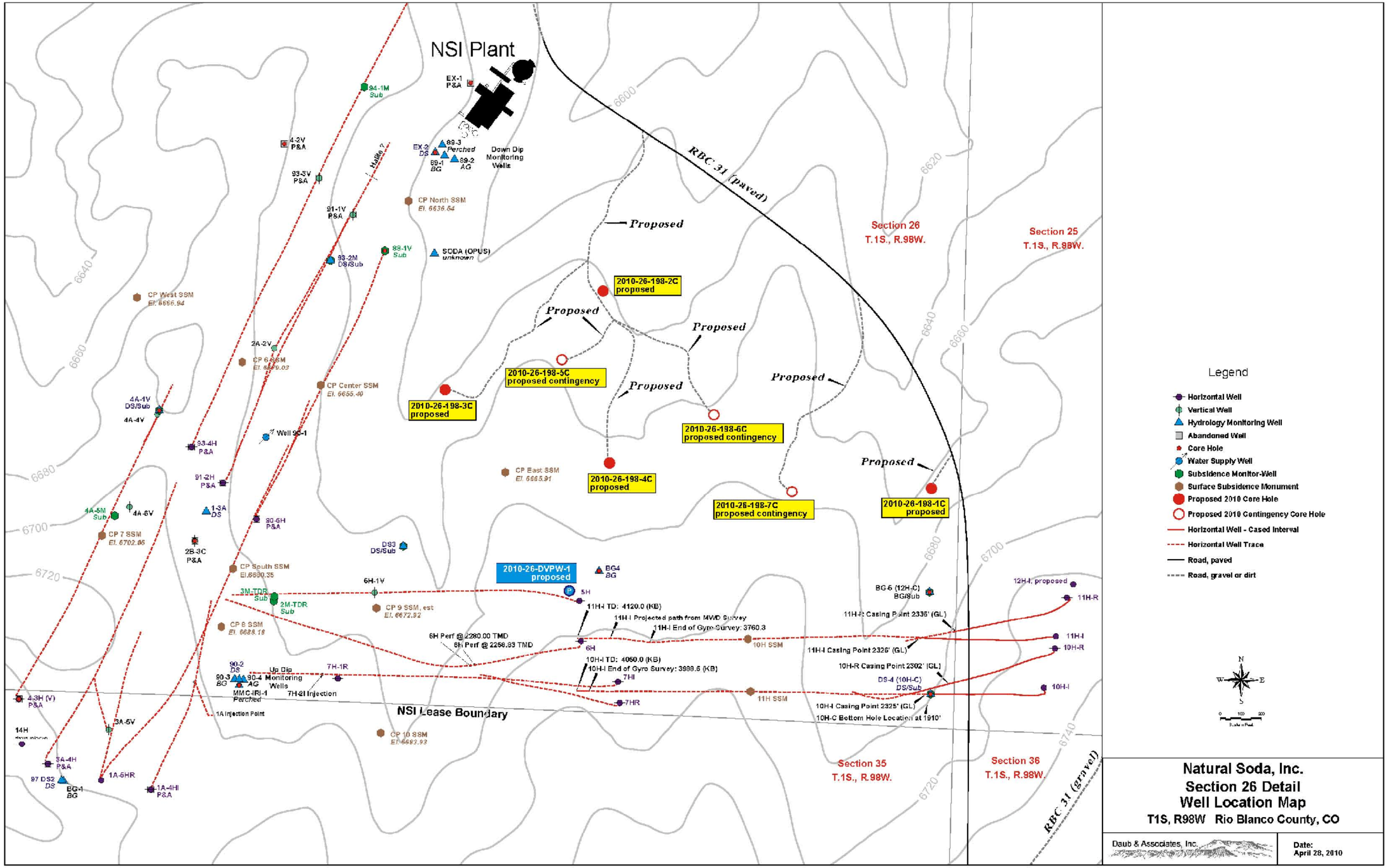

Figure 3-2. Natural Soda, Inc. Lease Area and Well Location Map.

3.2.3. Project Approval History

Permit applications to allow construction and operation of a 3 ton-per-hour TPH pilot solution mining facility were submitted on October 4, 1983 and approved February 9, 1984. On May 2, 1986 an EA for a 6 TPH pilot-scale operation was approved by the BLM. On November 20, 1987 the BLM approved NaTec's Mine Plan for a commercial-scale (125,000 TPY) nahcolite solution mine. Construction started in May of 1990 for the process facilities.

3.2.4. Commercial Operations

Prior to plant construction an Environmental Impact Statement (EIS) was assembled by the BLM in 1987. That EIS analyzed and defined potential environmental and socioeconomic effects of the mine plan's 30 year, 125,000 tons per year (TPY) operational plan. Also analyzed were a 50,000 TPY alternative, a 500,000 TPY alternative, and a no action (pilot project) alternative. Planned plant capacity for design purposes was 500,000 tons per year (TPY) of sodium bicarbonate (bicarb). The plant is to be constructed and expanded in phases or modules with each module representing a production increase of 125,000 TPY. Phase I (125,000 TPY production capacity) construction was completed in January, 1991. The anticipated completion of Phase 2 plant expansion is 2012, when production capacity is expected to be approximately 250,000 TPY. Subsequent to Phase 2 completion, production will continue to ramp up over the following years.

The mine is located near the depositional center of the Piceance Basin, which contains bedded and disseminated saline minerals and oil shale. NSI currently recovers nahcolite by in-situ solution mining of the Boies Bed, a deposit near the top of the Saline Zone and within tens of feet of the Dissolution Surface (DS), and bounded on the bottom by the top of the R-5 oil shale zone. Hot unsaturated (barren) brine dissolves the nahcolite as it circulates through the Boies Bed stratiform interval. The "pregnant" nahcolite solution is recovered from the cavity

and routed to the process plant via a surface pipeline. An electric submersible pump is used for fluid recovery, as applicable, to avoid influences on the overlying aquifers. Heat exchangers and crystallizers cool the pregnant solution causing the dissolved nahcolite to precipitate as sodium bicarbonate crystals. The bicarbonate crystals are de-watered, dried, classified, packaged and shipped to market. After crystallization of the pregnant solution, the remaining, now barren, brine is reheated and returned to the cavities forming a continuous, closed circuit process.

NSI established a mining panel concept with the initial development of the Boies Bed resource. Mine panels are approximately 500-800 feet wide and up to 3,000 feet in length (approximately 55 acres). Combinations of both vertical and directionally-drilled horizontal production and/or injection wells have been employed to recover saline minerals in the panels. In addition, currently unknown mining methods and technological advances may be identified and employed in the future. As of 2010, solution mining in Panel 1 has been suspended. Continued development of mine Panel 2 is planned (Figure 3-3). Combined recovery from Panels 1 and 2 between 2007 and 2012 is anticipated to be approximately 650,000 tons.

3.3. Cultural and Paleontological Resources

Cultural and paleontological resources investigations were conducted by Grand River Institute. The investigations consisted of archival reviews and intensive on-the-ground surveys consistent with BLM Class III standards. The first investigation was conducted for the Multi Minerals Corporation oil shale project (Grand River Institute 1980). Sixteen cultural sites, four features, and 27 isolated artifacts were recorded then, as well as one paleontological find. Three sites, one feature and six isolated artifacts were located during the second investigation (Grand River Institute 1984), which was conducted for this Mine Plan application. Five paleontological finds were also recorded during this investigation. Reports documenting the investigations have been submitted to the BLM Craig District and Meeker Area offices. Additional studies will be commissioned as directed by the BLM or other appropriate regulatory agency.

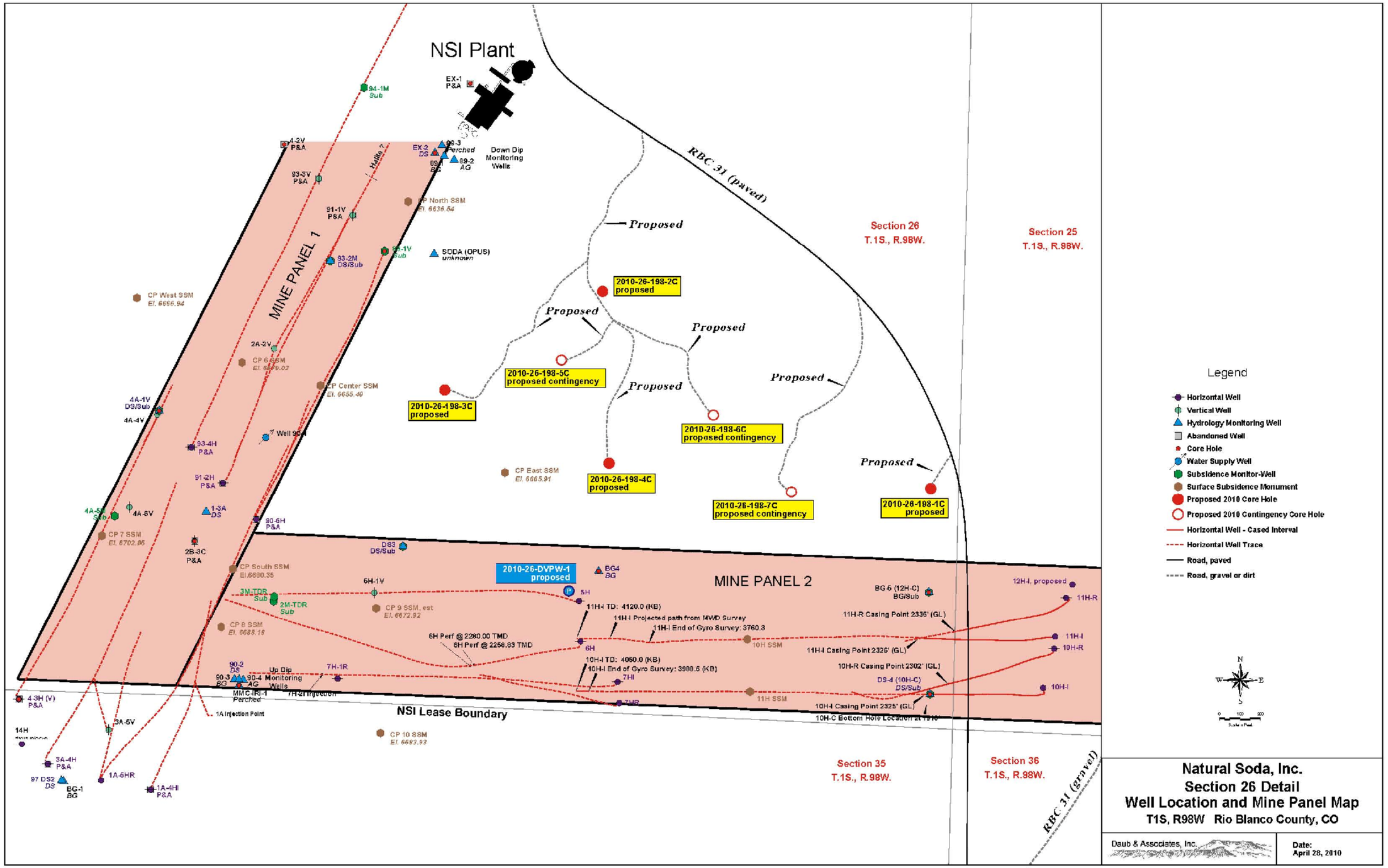

Figure 3-3. Natural Soda, Inc. Project Area showing mine panels 1 and 2.

3.3.1. Cultural Resources

Numerous cultural resource inventories have been conducted within NSI lease areas between 1980 and 2010. Five cultural sites, one feature, and 14 isolated artifacts were found in the project area. These sites are all associated with the Native American historic and prehistoric periods. One site, 5RB398, is considered to be of National Register of Historic Places (NRHP) quality. The remaining site, 5RB1880, is not considered to be NRHP quality; however, it may contain information useful for scientific interests. Additional cultural investigations will be undertaken, as required, prior to disturbance of any areas.

3.3.2. Paleontological Resources

The paleontological resources in the project area are limited to fossilized finds of two possible uintathere bone fragments, titanothere skull fragments and two turtle scutes (shell plate). They were all isolated finds having been eroded from other locations. No sources for the fossils were found during the field investigation. None of the finds are considered significant because they are badly weathered.

3.4. Scenic or Natural Attractions

The general area of the project is characterized by rolling to occasionally steep hills. The area has been rated by BLM (1983) as Class C for scenic quality. Class C areas have little variety or contrast in landform, vegetation, and color; are common and have low visual appeal.

Furthermore, the area is in BLM visual resource management Class III (BLM, 1994). Class III areas are areas of moderate scenic quality, and are considered of moderate visual value. Changes to the landscape should be moderate and should not be the main focus of the casual observer. In addition, landscape modifications

may attract attention and be dominant landscape features, but should reflect the basic visual elements (form, line, color, and texture) of the existing landscape.

There are no scenic or aesthetic sites near the project area. Impacts to the visual resources of the area are insignificant.

3.5. Existing and Proposed Post-Mining Land Use

The present land use on the lease tracts consists primarily of natural gas development, oil shale exploration, RD&D, livestock grazing, wildlife habitat, hunting, and nahcolite exploration and testing activities. The immediate surrounding land use (as well as the large majority of the Piceance Basin) is natural gas development, natural gas processing, livestock grazing, wildlife habitat, and hunting. Some coal and oil shale projects are located in and around the Piceance Basin. Many cattle ranches operate along the major perennial streams, including Piceance Creek, with much of the valley floor in hay meadows.

The proposed post-mining land use will be natural gas development and production, livestock grazing and wildlife habitat. The reclamation plan has been designed to provide a permanent vegetative cover that, in terms of productivity and quality, is at least equal to, or better than, the existing vegetative cover in surrounding areas. Details of the Reclamation Plan are provided in Section 8.0.

3.6. Climate and Air Quality

3.6.1. Regional Climatology

The Piceance Basin is generally characterized as being within a continental climate regime; however, the specific climate type for the region is not clearly defined. The Basin is positioned in the transition zone between two climate types (steppe and highlands) as defined by Koppen (1931).

The steppe climate, which is used most commonly to characterize the Basin, is defined by slight precipitation with vegetation restricted to sparse trees and short grasses. The arid nature of this climate type is strongly influenced by its location with respect to moisture sources. This type of climate is generally found in areas far removed from windward coasts (Critchfield 1974); in this case, the Pacific coast lies approximately 800 miles to the west. The aridity of the Piceance Basin region is further enhanced by major mountain barriers to the west.

Indicative of this continental climate type, mean monthly temperatures tend to have a large annual range. Summer temperatures, influenced predominantly by subsiding continental tropical air masses, are frequently above 80°F during the day. This is caused, in part, by the regional moisture deficiency, as heat normally used in the evaporation process is used for warming land surfaces and the overlaying air. This also results in a large diurnal temperature range, so that even on days of extremely high temperatures, nights are usually cool. During the winter, air masses affecting the region are again continental; however, they tend to be of polar origin. This results in extended periods of clear skies and low temperature, frequently below 0°F. During major outbreaks of polar air, severe freezing may occur with temperatures dropping to -40°F or lower.

There is no general rule covering precipitation for the steppe climate; however, large year to year variations are typical. Winter precipitation typically results from periodic cyclonic systems interspaced with periods of cold, clear weather. Summer rainfall, on the other hand, results typically from scattered thunderstorms which frequently occur after long dry periods. Depending on the amount of rainfall received from such storms and the length of the preceding dry period, significant damage may occur from flash flooding.

The Piceance Basin is also strongly influenced by the highlands climate type. Unlike the steppe climate, there is no distinct set of characteristics for the highlands climate. In the Piceance Basin, the primary action of the highlands climate is as a modifier to the steppe climate. The most significant modifications occur as a result

of increased insolation (proportional to altitude increase) and complex terrain. The combination of these factors results in large spatial variations in temperature, precipitation and airflow even over relatively short distances.

Variations in local terrain cause significant differences in the effectiveness of insolation. For each change in slope with respect to incoming solar radiation, a different microclimate is established. This becomes an important factor in the assessment of local conditions within the Basin where a multitude of steep-sloped valleys are present. Temperature differences between sunlit and shaded areas become pronounced. This is most evident during the winter and spring as south facing slopes may be totally snow free while their north facing counter-parts maintain significant snowpack.

Differential heating effects can also be shown to have a dominant influence on the micro-scale wind fields in the complex terrain of the Basin. In the steep-walled valleys of the region, an intricate system of upslope and drainage flow is established, controlled almost entirely by the changes in surface heating. The result is that each location within the region has its own unique surface wind pattern.

The net effect of the mixture of these two climate types is that temperatures across the Basin vary most readily with elevation. Average summer temperatures range from a low of 45°F to 85°F, with maximums reaching 100°F. Contrastingly, average winter temperatures range between 5°F to 35°F with extremes of -40°F being recorded on occasion. Depending on local terrain and wind patterns, frost-free periods range between 60 and 150 days. Likewise, the growing season is highly variable. Data for the vicinity of Grand Junction show that the growing season runs about 190 days plus or minus 2 to 3 weeks depending on location. Precipitation is relatively uniform throughout the year with slightly more than half occurring during late spring through early fall. Total annual precipitation is highly variable and ranges between 8 and 24 inches. Winter snowpack ranges from 25 to 150 inches. Little data are available on regional evaporation rates; however, data collected in 1976 for the six month period running from May through October revealed total evaporation of

59.01 and 34.49 inches for Grand Junction and the nearby Federal Lease Tract C-a, respectively.

The wind fields of the Basin can be divided into two groups; upper level synoptic flow and low-level micro-scale. The synoptic flow, which is predominant throughout the year, is southwesterly, with an average annual speed of 13.18 mph, measured from 8,000 to 13,000 ft. Seasonally, speeds vary from a low of 4.59 mph during the summer to a high of 25.15 mph in winter near Tract C-a. Micro-scale patterns are more irregular and controlled by local terrain. These micro-scale winds have been shown to have a classic diurnal pattern. This pattern is composed of upslope winds, which usually occur on sunny days when air immediately above the ground is heated, and drainage flows which occur when surface heating is reduced.

Data on temperature and precipitation throughout the Basin and in surrounding areas are presented in Table 3-1. Extreme values are presented in Table 3-2.

Table 3-1. Average monthly temperatures and normal precipitation for northwestern Colorado.

TABLE 3-1

AVERAGE MONTHLY TEMPERATURES AND NORMAL PRECIPITATION FOR NORTHWESTERN COLORADO

	Temperature (°F)												
Station	J	F	M	A	M	J	J	A	S	0	N	D	ANI
Aspen	19.8	23.2	29.0	38.8	48.0	56.0	62.2	60.4	53.5	44.2	30.7	22.1	40
Cedaredge	27.3	32.9	40.2	47.4	56.2	66.4	71.8	70.1	61.8	50.3	37.3	28.8	49
Craig	16.9	21.8	30.5	41.9	51.5	59.5	66.6	64.9	56.0	45.1	31.5	21.3	42
Crested Butte	8.4	12.3	21.4	30.5	41.9	50.7	56.0	55.2	47.8	37.9	23.0	11.1	33
Eagle Airport	20.2	26.9	36.1	43.3	52.2	61.1	66.8	65.3	57.1	45.4	31.8	21.0	43
Fruita	24.5	32.2	41.9	49.1	59.1	68.6	74.8	72.9	63.6	51.3	37.8	27.8	50
Grand Junction WSO	26.1	34.1	43.4	50.9	60.5	71.1	76.8	74.7	65.4	52.7	38.1	28.2	51
Meeker	21.2	25.6	33.9	43.1	51.9	59.8	66.3	64.5	56.3	45.7	33.7	22.8	43
Palisade	28.3	36.1	45.1	52.9	62.2	72.6	78.5	76.4	67.5	55.4	40.8	30.7	53
Rifle	23.5	30.8	39.8	46.9	55.8	65.0	71.0	69.6	60.8	49.4	35.9	25.6	47

	Precipitation (inches)												
Station	J	F	M	A	M	J	J	A	S	0	N	D	ANI
Aspen	1.83	1.69	1.85	1.75	1.52	1.21	1.47	1.72	1.57	1.56	1.46	1.69	19.3
Cedaredge	1.19	0.88	1.34	0.97	1.22	0.59	0.91	1.19	1.10	1.65	1.24	0.97	13.2
Craig	1.14	0.88	1.03	0.96	1.04	1.03	0.77	0.74	0.90	1.32	1.23	1.35	12.3
Crested Butte	2.58	2.44	2.36	1.82	1.63	1.17	1.90	2.00	1.97	1.76	2.09	2.15	23.8
Eagle Airport	0.75	0.61	0.80	0.79	0.92	0.84	1.44	0.93	1.08	1.09	0.67	0.80	10.7
Fruita	0.65	0.57	0.96	0.77	1.04	0.51	0.77	0.73	0.78	1.01	0.74	0.65	9.1
Grand Junction WSO	0.60	0.50	1.00	0.86	0.98	0.41	0.66	0.84	0.91	1.00	0.71	0.52	8.9
Meeker	1.15	1.16	1.46	2.36	1.91	1.38	1.18	1.58	1.94	1.77	1.57	1.02	18.4
Palisade	0.58	0.56	1.14	1.12	1.21	0.70	0.76	0.80	1.05	1.27	0.94	0.59	10.7
Rifle	0.96	0.90	1.06	1.11	1.18	0.87	1.04	1.03	1.21	1.31	1.02	1.06	12.7

Source: Western Regional Climate Center, NCDC 1971-2000.

TABLE 3-2

EXTREME MONTHLY TEMPERATURES AND PRECIPITATION FOR NORTHWESTERN COLORADO

		Temperature (°F)												
Station		J	F	M	A	M	J	J	A	S	0	N	D	ANI
Aspen	Max	58	60	70	73	80	93	90	92	87	76	66	59	93
	Min	-33	-30	-14	-1	14	23	31	28	15	6	-19	-19	-33
Cedaredge	Max	60	66	73	82	93	103	97	96	93	84	70	62	103
	Min	-24	-22	-1	12	22	31	42	37	25	16	-9	-11	-24
Craig	Max	52	60	70	79	86	97	99	94	91	84	67	58	99
	Min	-45	-43	-21	7	14	25	30	28	18	0	-19	-31	-45
Crested Butte	Max	48	52	55	64	80	90	88	87	85	76	63	50	90
	Min	-43	-40	-25	-11	-1	22	23	25	10	-3	-26	-34	-43
Grand Junction	Max	60	64	81	85	94	103	105	103	96	88	71	64	105
	Min	-15	-8	6	11	26	35	48	43	30	18	5	-9	-15

	Precipitation (inches)											
Station	J	F	M	A	M	J	J	A	S	0	N	D
Aspen	4.40	3.04	5.34	3.45	3.32	3.77	2.30	4.38	5.80	4.53	2.93	4.75
Cedaredge	2.39	1.99	1.92	2.07	3.15	2.99	2.28	2.91	4.18	4.92	2.47	2.47
Craig	2.13	2.02	1.70	2.46	3.53	3.18	2.21	3.09	3.54	2.55	3.25	3.89
Crested Butte	11.09	4.35	5.13	3.95	3.93	3.78	3.66	3.64	5.15	4.89	4.06	12.60
Grand Junction	2.46	1.56	1.75	1.95	1.79	2.07	1.53	3.48	2.52	3.45	1.69	1.89

Table 3-2. Extreme monthly temperatures and precipitation for northwestern Colorado.

3.6.2. Regional Air Quality of the Piceance Basin

The Piceance Basin, a relatively undeveloped region, is typical of much of the western United States. Human activities have been limited to natural gas development, oil shale RD&D, recreational, agricultural and, in recent years, energy resource developments in most parts of the Basin. As a result of this low level of activity, the air quality of the Basin is characterized by ambient pollutant levels near or below the lower limit of detection of most monitoring systems. Exceptions to this general pattern occur most frequently for total suspended particulates (TSP), ozone (O_3), and carbon monoxide (CO) in the vicinity of local population centers, rather than in the surrounding rural areas. It should be noted, however, that at some remote sites, elevated levels of ozone have been encountered under certain meteorological conditions.

Comprehensive air quality data was collected in the Basin between 1975 and 1981. More recent air quality results are also displayed. The ambient levels of sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and the above-mentioned pollutants can be characterized as follows.

Sulfur Dioxide

The annual average for SO_2 ranges from 0.3 to 3.0 µg/m^3, while 24-hour averages run from a low of 50 to a high of 130 µg/m^3. These levels appear valid for both the remote sites as well as the more urban areas within the Basin. As can be seen from Table 3-3, these levels are well below both the federal and state air quality standards.

Table 3-3

COLORADO AND FEDERAL AIR QUALITY STANDARDS

	Ambient Standards (b)				PSD Increments(c)		
	NAAQS (1)		CAAQS (2)			Class I/	
Pollutant	Level	Averaging Time (a)	Level	Averaging Time (a)	Category I	Class II	Class III
Carbon Monoxide	10,000 µg/m3	8-hour	None		-	-	-
	40,000 µg/m3	1-hour			-	-	-
Lead	0.15 µg/m3	Rolling 3-Month Average	Same as Primary		-	-	-
Nitrogen Dioxide	100 µg/m3	Annual	Same as Primary		-	-	-
Particulate Matter (PM10)	150 µg/m3	24-hour	Same as Primary		-	-	-
	50 µg/m3	Annual	Same as Primary				
Particulate Matter (PM2.5)	15.0 µg/m3	Annual	Same as Primary		5 µg/m3 (d)	19 µg/m3	37 µg/m3
	65 µg/m3	24-hour	Same as Primary		10 µg/m3	37 µg/m3	75 µg/m3
Ozone	157 µg/m3	8-hour	Same as Primary		-	-	-
	235 µg/m3	1-hour	Same as Primary		-	-	-
Sulfur Dioxide	80 µg/m3	Annual	Same as Primary		2 µg/m3	20 µg/m3	40 µg/m3
	365 µg/m3	24-hour	Same as Primary		5 µg/m3	91 µg/m3	182 µg/m
	1,300 µg/m3	3-hour	700 µg/m3	3-hour	25 µg/m3	300	700 µg/m

(1) National Ambient Air Quality Standards

(2) Colorado Ambient Air Quality Standards

(a) Short-term standards (those other than Annual and Quarterly) are not to be exceeded more than once each year.

(b) Ambient standards are the absolute maximum levels allowed to protect either public health (primary) or welfare (secondary).

(c) Prevention of Significant Deterioration standards are the maximum incremental increase levels allowed above the baseline amounts of pollutants in regions of clean air.

(d) Total suspended particulate increments are not included in Colorado Category I standards.

Table 3-3. Colorado and Federal air quality standards.

Nitrogen Dioxide

Ambient levels of NO_2 in remote areas of the Basin range from 2.0 to 30.0 µg/m^3, while levels in the more developed regions run slightly higher, to 50.0 µg/m^3 on an annual average. This is still well below standards; however, it does reflect the effects of increased human activities.

Total Suspended Particulates

The annual average levels for TSP range from 10 to 40 µg/m^3 for remote sites and 80 to 130 µg/m^3 in urban areas. Twenty-four hour averages show the same pattern with remote sites reporting values in the 80 to 130 µg/m^3 range and urban areas with a higher range of 115 to 440 µg/m^3. The increased levels of TSP in the population centers result in part from a combination of the use of unpaved roads and much higher levels of vehicular traffic. When these values are compared to the standards presented in Table 3-3, it can be seen that violations do occur in the vicinity of population centers. This is especially true for Grand Junction, which has been designated a non-attainment area for TSP.

While violations of standards occur more often in urban areas, they can occur anywhere in the region. Remote areas experience this problem most frequently after major surface disturbances have removed vegetation, allowing winds to erode the soil surface.

Ozone

Ozone levels in the Basin have been found to be relatively high, with hourly averages ranging from 118 to160 µg/m^3. The specific causes for these elevated levels are as yet undefined, but may be the result of stratospheric injection, long-range transport from urban sources in the northwest or photochemical reaction of natural hydrocarbons.

Carbon Monoxide

One-hour average CO values in remote areas range from 1,000 to 5,400 µg/m^3, while urban areas have reported values over 18,000 µg/m^3. Although the one-hour average CO values in urban centers are less than half the standard, Grand Junction reported an eight-hour value of 9,660 µg/m^3 in 1981, nearly violating the eight-hour standard of 10,000 µg/m^3.

Air quality measurements made in remote and urban areas of the region from 1976 through 1981 are presented in Table 3-4. During this time the nearest stations to the project site collecting air quality data were located at Federal Lease Tract C-a. Data gathered during the course of monitoring at the tract are presented in Table 3-5. Although recent specific air quality monitoring is not conducted throughout most of the analysis area, air quality conditions are likely very good, as characterized by few air pollution emission sources (limited industrial facilities and few residential emissions, primarily from smaller communities and isolated ranches), good atmospheric dispersion conditions, as well as limited air pollutant transport into the project area, resulting in relatively low local air pollutant concentrations. More recent air quality data (2008) includes impacts from existing sources both inside and outside the project area and is presented in Table 3-6.

Table 3-4. Regional ambient air quality data (micrograms/cubic meter).

TABLE 3-4

REGIONAL AMBIENT AIR QUALITY DATA

(Micrograms/Cubic Meter)

Data Type (a)			1	2	3	2	3	2	3	2	3	2	3
Project Site		Period	TSP		CO		NO2		O3		SO2		Pb
Cathedral Bluffs	020	1979	16	63	217	2,300	0.5	88	52	192	0.6	13	-
		1980	10	-	78	1,700	0.7	27	59	122	2.0	21	-
		1981	14	69	100	1,800	1.0	17	65	161	3.2	16	-
	023	1979	16	81	218	3,600	1.6	38	76	246	0.3	49	-
		1980	11	-	92	3,800	0.8	51	75	154	1.1	21	-
		1981	14	86	25	1,800	2.1	45	77	155	1.8	31	-
Chevron Tract	A	1980-81	11	227	-	-	-	-	-	-	-	-	-
	E	1980-81	21	-	115	5,405	3.8	66	69	149	2.6	21	-
Naval Oil Shale Reserve		1980	-	-	-	-	-	-	-	-	-	118/69(b)	0.01
		1981	14	30	-	-	-	-	-	265	-	44/13	0.01
Superior Tract		1976-77	40	647	-	-	-	-	-	206	-	-	0.8
Grand Junction		1979	82	183	-	-	-	-	-	-	-	-	-
		1980	78	144	-	16,100	-	-	-	-	-	-	-
		1981	77	232	-	18,400	-	-	-	-	-	-	-

(a) 1 = Geometric mean.
2 = Maximum.
3 = Arithmetic mean.

(b) Average 3 hour max. concentration/24 hour max. concentration.

Table 3-5. Summary of air quality data between February 1975 and November 1980, Tract C-a.

TABLE 3-5

SUMMARY OF AIR QUALITY DATA COLLECTED BETWEEN
FEBRUARY 1975 AND NOVEMBER 1980. TRACT C-a

	2/75-1/77			12/77-11/78			12/78-11/79			12/79-11/80		
Parameter	Minimum (a)	Maximum (a)	Arithmetic Mean	Minimum (a)	Maximum (a)	Arithmetic Mean	Minimum (a)	Maximum (a)	Arithmetic Mean	Minimum (a)	Maximum (a)	Arithmetic Mean
Site 1												
03, ppm	0.000	0.068	0.034	0.017	0.088	0.057	0.018	0.080	0.049	0.013	0.077	0.046
CO, ppm	0.000	4.2	0.6	0.5	0.5	0.5	0.5	1.5	0.5	0.5	0.9	0.5
NO, ppm	0.000	0.237	0.008	0.005	0.016	0.006	0.005	0.048	0.005	0.005	0.061	0.005
NOx, ppm	0.000	0.234	0.009	0.005	0.023	0.006	0.005	0.048	0.005	0.005	0.062	0.005
H2S. ppm	0.000	0.05	0.01	0.01	0.04	0.01	0.01	0.01	0.01	0.002	0.012	0.003
S02, ppm	0.000	0.09	0.01	0.01	0.03	0 01	0.01	0.01	0 01	0.002	0.022	0 002
TSP, ug/m	1.000	211	9 (b)	1	59	14 (b)	1	303	11 (b)	2	61	13 (b)
Site 2												
TSP. ug/m	1	102	9 (b)	1	60	13 (b)	1	87	12 (b)	1	61	12 (b)
Site 3												
O3, ppm	0.000	0.089	0.031	0.004	0.072	0.038	0.005	0.076	0.038	0.003	0.070	0.035
CO, ppm	0.000	6.0	0.6	-	-	-	-	-	-	0.5	0.5	0.5
NO, ppm	0.000	0.159	0.006	-	-	-	-	-	-	0.005	0.024	0.005
Nox, ppm	0.000	0.154	0.006	-	-	-	-	-	-	0.005	0.021	0.005
H2S, ppm	0.000	0.03	0.01	0.01	0.55	0.01	0.01	0.14	0.01	0.002	0.060	0.004
S02, ppm	0.000	0.05	0.01	0.01	0.11	0.01	0.01	0.09	0.01	0.002	0.013	0.003
TSP, ug/m	1	281	15 (b)	1	160	26 (b)	3	192	21(b)	1	96	18 (b)

(a) Hourly average.
(b) Geometric Mean.
(c) 24-hour average.
Note: Values reported in ppm can be converted approximately to ug/m3 by multiplying by M/0.02404, where M is the molecular weight of the gas.

Table 3-6

Background Estimates of Air Pollution in the Piceance Basin

Pollutant	Background Estimates	Data Source
PM_{l0} Annual Arithmetic Mean	11 µg/m^3	American Soda, Piceance 2003 -2005.
PM_{10} 24 Hour Second Maximum	36 µg/m^3	
SO_2, Annual Mean	5.3 µg/m^3 (.002 ppm)	Unocal, 1983 -1984.
SO_2, 3 Hour Second Maximum	24.0 µg/m^3 (.009 ppm)	
SO_2, 24 Hour Second Maximum	13.3 µg/m^3 (.005 ppm)	
NO_2 Annual Mean	9.6 µg/m^3 (.005 ppm)	Encana, 2007
NO_2 1 Hour 98th Percentile	19.1 µg/m^3 (.010 ppm)	
CO 1 Hour Second Maximum	1,165 µg/m^3 (1 ppm)	American Soda, Piceance 2003 -2005.
CO 8 Hour Second Maximum	1,165 µg/m^3 (1 ppm)	
Ozone 1 Hour Second Maximum	160 µg/m^3 (.080 ppm)	Based on Rifle, 2008.
Ozone 8 Hour Fourth Maximum	132 µg/m^3 (.066 ppm)	
$PM_{2.5}$ Annual Mean	9 µg/m^3	Based on 650 South Avenue in Grand Junction.
$PM_{2.5}$ 98th Percentile	23 µg/m^3	
Lead Maximum Quarterly Mean	.009 µg/m^3	Based on Denver Municipal Animal Shelter, 2008.

Source: Colorado Department of Public Health and Environment

Table 3-6. Background estimates of air pollution in the Piceance Basin.

3.7. Toxic or Acid Wastes

3.7.1. Plant Wastes

The seven acre waste water evaporation pond is designed to contain treated plant water. This waste water currently consists of a concentration of salts from boiler blowdown, water treatment system blowdown, and cooling tower blowdown. Until 2002 plant injection brine was heated with glycol heaters, and at that time any glycol treated water was directed to the waste pond. The three acre process pond contains sodium bicarbonate contaminated precipitation runoff from the crystallization and product loadout areas, and any excess sodium bicarbonate brine from the processing area. The ponds are lined with double-layer impervious liners with leak monitoring/seepage collection systems to prevent ground water contamination. The wastes are periodically removed from the evaporation ponds and disposed of either in a depleted cavity or at an existing licensed disposal site.

3.8. Soils

3.8.1. Introduction

The baseline soils study for the Natural Soda, Inc. Sodium Minerals Project includes a soil survey, soil analyses, and report. The soil survey on the project area included an intensive survey (Order 2, SCS) of approximately 1,620 acres; a less intensive survey (Order 3, SCS) was made on the sodium lease tracts (8,223 acres). Soil samples were taken for analysis to determine soil suitability for topsoil material. Broad soil horizons were sampled for physical and chemical differences rather than by genetic horizons. This study was designed to meet the rules and regulations of the Colorado Division of Reclamation, Mining and Safety (CDRMS), and to supply data necessary to make an environmental assessment of the project for the Bureau of Land Management (BLM).

The project area is within a small topographic basin located about 40 miles northwest of Rifle, Colorado. This small basin is part of the larger northwest trending Piceance Basin. Landscape of this area is characterized by relatively flat hills, ridges, and shallow gulches or canyons. Drainages have a trellis-like pattern with parallel ridges and gulches that drain in a north and northwestern direction toward Yellow Creek. Elevations range from 6,200 feet at Yellow Creek to 5,700 feet at the southern edge of the project area. The canyon walls along Yellow Creek are about 160 feet high, while the ridge tops are only 60 to 80 feet above the surrounding terrain in the upper drainages.

3.8.2. Soil Survey Procedures

The Rio Blanco County Soil Surveys (SCS, 1982) was used for the Order 3 survey on the sodium lease area and was the primary source of soil information for the project area. In addition, an intensive Order 2 soil survey (SCS, NSH-undated) was conducted on the project area according to SCS guidelines. These data were supplemented by photo interpretation and laboratory analyses.

The soil survey and sampling were completed during August of 1984. The soils distribution on approximately 1,620 acres was mapped on aerial photographs at a scale of approximately 1:6,000 (Plate 3-1, see map pocket at end of section). A detail soil map around the NSI plant is illustrated in Figure 3-5. Soil patterns were studied in different landscapes, and the soil boundaries were predicted according to features such as physiographic position, vegetation, parent material, and soil morphology. Soil patterns described in the Rio Blanco Soil Survey and landscape features were used to establish the soils mapping unit boundaries. A number of soil profiles were evaluated to determine the nature and extent of soils in a mapping unit.

Soil characteristics were examined in hand-dug sample holes, road cuts, and gullies. The hand-dug holes were excavated to a depth of 32 inches. The lower substrata were examined by means of a 3-inch diameter hand auger to a minimum depth of 60

inches or to indurated bedrock, whichever occurred first. General soil descriptions were taken and compared to the established SCS soil series description.

Soils were mapped to the phase unit of classification; however, soil separation was based largely on use and management. New series or soil variants were not separated at a family level if the soils were managed in the same manner. However, the different soil characteristics are discussed in the general soil description.

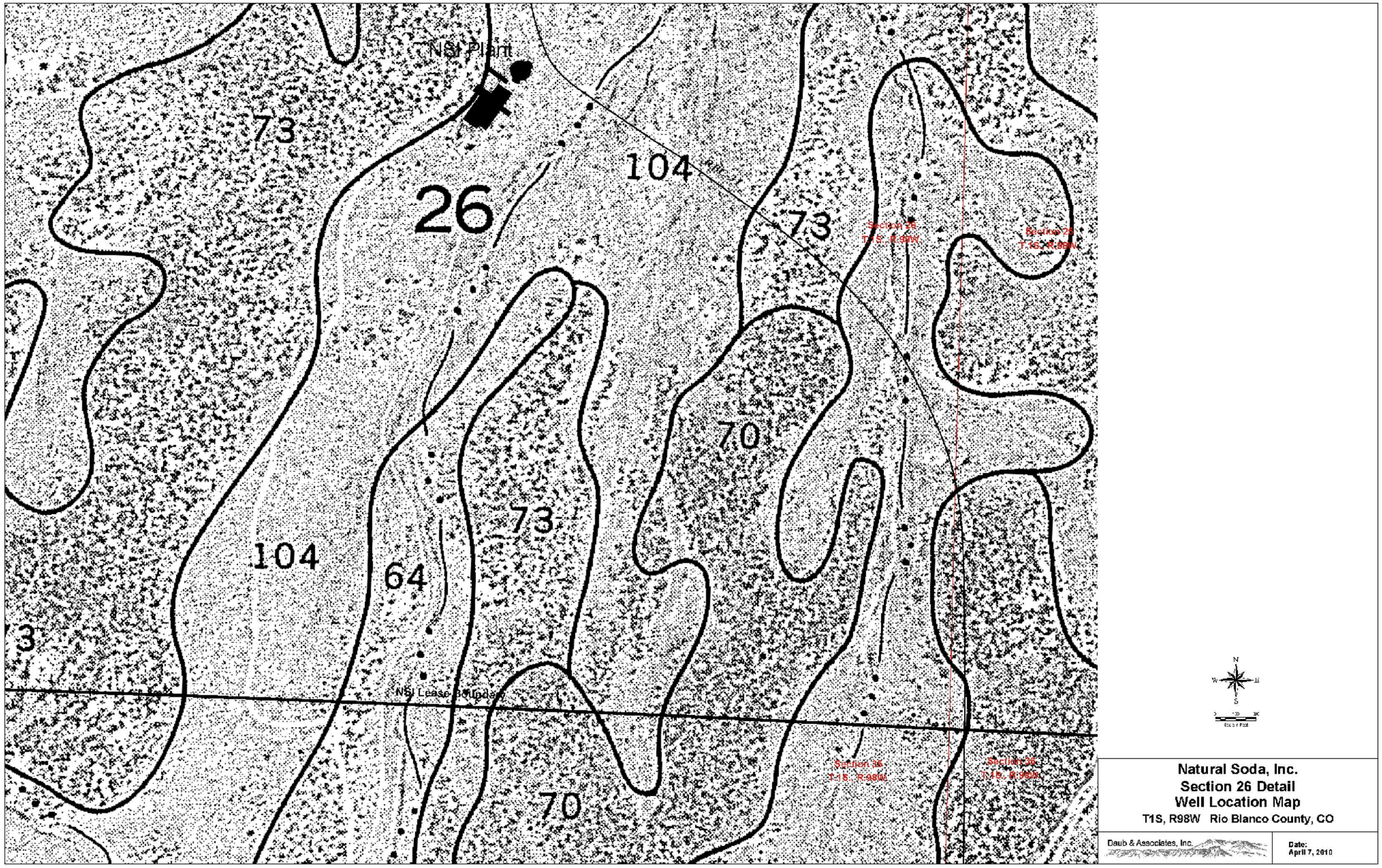

Figure 3-4. Detailed Soil Survey Map within Section 26.

3.8.3. Soil Sampling and Analysis

One profile for each soil series was sampled in the project area. Physical and chemical properties of the soils were also analyzed. These data were used to test field observations, confirm soil classification, evaluate topsoil suitability, and to make preliminary soil fertility assessments. Soils were analyzed for the parameters listed in Table 3-7 in accordance with the indicated laboratory procedures. Soils were tested for molybdenum, selenium, and boron whenever the vegetation, water tests, or soils indicated potential problems. Analytical results are listed in Table 3-8.

Soil profiles were sampled by horizons that indicated chemical and physical differences affecting management, rather than sampling by genetic horizons. The laboratory analyses were performed by Inter-Mountain Laboratories, Inc. located in Sheridan, Wyoming.

3.8.4. Soils of the Project and Lease Areas

Generally, the soils on the hills and ridges within the project area are shallow and have coarse textures. The side slopes below the ridges and broad upland slopes are moderately deep and have a medium texture. Deep soils with medium textures are typically located in drainages and fans. Slopes range from 3 to 15 percent in drainages and fans, to about 50 percent on the ridges and hills.

The nature of the soil and parent materials determine the kind and, to a considerable extent, the distribution of vegetation. This is largely because plant growth is heavily dependent on the chemical and physical characteristics of the soil. Other management factors such as fire, grazing, or other past land practices have altered the expected soil-plant relationship in some areas. Micro-relief and micro-climate factors influence plant-soil relationships as well. The project area exhibits a general soil-plant relationship as shown in Table 3-9.

TABLE 3-7

ANALYSES AND PROCEDURES FOR DETERMINING
SOIL SUITABILITY FOR TOPSOIL

Analysis	Reference Procedure
1. Preparation of soils for analysis	USDA Handbook 60 (1954), pp. 83-84; all analyses should be conducted on samples that have been passed through at least a 20-mesh sieve.
2. pH (determination on paste)	USDA Handbook 60, p. 102.
3. Conductivity mmhos/cm on saturation extract	USDA Handbook 60, pp. 88-89.
4. Saturation percentage	USDA Handbook 60, p. 84, methods 2 and 3a.
5. Calcium - in meq/1 on the extract	Preparation of extract, USDA Handbook 60, p. 84, methods 2 and 3a. Analysis of atomic absorption spectrophotometry (Perkin-Elmer Analytical Methods).
6. Magnesium - in meq/1	Same as for calcium.
7. Sodium - in meq/1	Same as for calcium.
8. SAR (Sodium Adsorption Ratio)	USDA Handbook 60, p. 26. $SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$ Where Na+, Ca2+, and Mg2+ are the concentrations of those ions found in 5, 6, and 7 above.
9. Boron (A) - Hot water extract reported	ASA Agronomy Monograph #9 (1965), part 2, method 75-4, pp. 1062 - 1063.
10. Particle size distribution (mechanical analysis) as % sand, % silt, % clay and very fine sand as well as the USDA textural classification.	ASA Agronomy Monograph #9, part 1, method 43-5, pp. 562-566. If EC is 4 mmhos/cm or more, include field texture determination.

Table 3-7. Analyses and procedures for determining soil suitability for topsoil.

TABLE 3-7 (Continued)
ANALYSES AND PROCEDURES FOR DETERMINING
SOIL SUITABILITY FOR TOPSOIL

Analysis	Reference Procedure
11. Selenium (ppm) (B)	Hot Water Extract - sum of water soluble selenate, selenite, and organic Selenium Extraction Procedure, ASA Agronomy Monograph #9, part 2, 80-3.2.2, p. 1122. Analysis of extract by sodium borohydride method. See Advances in Vapor Generation (1974), presented at Silver Anniversary, Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Cleveland, Ohio.
12. Molybdenum (ppm)	Acid Ammonium oxalate extraction. ASA Agronomy Monograph #9, part 2, pp. 1054-57. Analysis by thiocyanate procedure in this reference or by atomic absorption spectrophotometry.
13. Organic Matter (percent)	ASA Agronomy Monograph #9, part 2, method 90-3, pp. 1372-1376.

(A) If toxic levels of boron are suspected of being present.
(B) If primary selenium indicator plants are present.

Table 3-7. Analyses and procedures for determining soil suitability for topsoil (continued).

TABLE 3-8

TOPSOIL ANALYSIS

Sample ID	Depth Inches	pH	Cond. mmhos m @ 25°C	Saturation %	Soluble Cations			SAR (a)	OM% (b)	Molybdenum ppm (c)	Selenium ppm (d)	Boror ppm (
					Calcium meq/l	Magnesium meq/l	Sodium meq/l					
Pi-1	0-9	6.9	0.66	43.7	5.18	0.92	0.80	0.46	1.3			
Pi-2	9-24	7.7	0.43	39.6	1.21	0.46	4.05	4.43	0.6			
Pi-3	24-46	8.6	1.60	45.4	0.97	0.62	16.1	18.1	0.2	<0.05	<0.02	1.67
Re-4	0-9	7.2	0.47	53.8	3.44	0.63	1.29	0.90	2.0			
Ya-5	0-18	7.5	0.48	45.8	3.90	0.08	0.60	0.43	1.6			
Ya-6	18-34	7.7	0.79	36.9	7.00	1.05	4.01	2.00	1.0			
Ya-7	34-60	7.1	4.48	35.4	50.7	7.63	7.28	1.35	0.7			
Al-8	0-3	7.3	0.62	25.6	0.93	0.44	7.19	8.69	0.5	<0.05	<0.02	0.45
Al-9	3-11	8.0	1.82	59.5	1.77	0.81	18.4	16.2	0.8	<0.05	<0.02	0.86
Al-10	11-50	7.8	13.7	42.2	30.5	25.6	105	19.8	0.3	<0.05	0.08	1.95
Rn-11	0-10	7.4	0.48	42.2	4.79	0.34	1.06	0.66	0.8			

Table 3-8. Topsoil results of soils analyzed in the project area.

Table 3-8. Topsoil results of soils analyzed in the project area (continued).

TABLE 3-8 (continued)

Sample ID	CF% (e)	Very fine Sand %	Sand %	Silt %	Clay%	Texture	Reclamatio Suitability	Limitation
Pi-1	0.2	21.5	47.5	44.9	7.6	Loam	Good	None
Pi-2		17.7	33.8	53.1	13.1	Silt Loam	Good	None
Pi-3	1.3	14.9	30.2	54.9	14.9	Silt Loam	Unsuitable	High SAR
Re-4	9.3	15.8	66.5	31.3	2.2	Sandy Loam	Good	Shallow Dep
Ya-5	5.3	23.8	42.0	54.0	4.0	Silt Loam	Good	None
Ya-6	2.9	20.9	44.7	51.3	4.0	Silt Loam	Good	None
Ya-7	8.1	15.7	51.1	42.2	6.7	Sandy Loam	Fair	Some salts
Al-8		15.7	27.5	66.7	5.8	Silt Loam	Fair	Medium SA
Al-9		16.2	26.5	53.1	20.4	Silt Loam	Unsuitable	High SAR
Al-10		15.0	29.3	51.2	19.5	Silt Loam	Unsuitable	High SAR
Rn-11	25.4	12.0	72.9	24.9	2.2	Loamy Sand	Poor	Coarse fragme

(a) Sodium Adsorption Ratio.
(b) Organic matter.
(c) Ammonium Carbonate extractable.
(d) Hot-water Soluble.
(e) Coarse Fragments.

Analysis by: Inter-Mountain Laboratories

TABLE 3-9

GENERAL SOIL, VEGETATION AND TOPOGRAPHY RELATIONSHIP

Soils	Map Unit ID	Topography	Vegetation (a)
Barcus	6	Fans & Narrow Valleys	Western Wheatgrass, Basin Wildrye, Indian Ricegrass & Big Sagebrush
Forelle	33	Terraces & Uplands	Western Wheatgrass, Prairie Junegrass, Big Sagebrush, Rabbitbrush, & Needle-&-Threadgrass
Glendive	36	Alluvial Valley Floors	Basin Wildrye, Western Wheatgrass, Indian Ricegrass & Big Sagebrush
Havre	41	Flood Plains & Low Stream Terraces	Basin Wildrye, Western Wheatgrass, Streambank Wheatgrass, Bluegrass & Big Sagebrush
Piceance	64	Toe Slope & Upland Slopes	Bluebunch Wheatgrass, Western Wheatgrass, Big Sagebrush, Service-berry, Prairie Junegrass & Sand Lupine
Rentsac	73	Hills & Ridges	Pinyon & Utah Juniper with Understory Indian Ricegrass, Beardless Wheatgrass, Mountain Mahogany & Prairie Junegrass
Redcreek-Rentsac Complex	70	Hills & Ridges	Pinyon & Juniper with Understory Beardless Wheatgrass, Indian Rice-grass, Serviceberry, Mountain Mahogany, Sedges, & Big Sagebrush
Rentsac-Piceance Complex	75	Upland Slopes & Ridges	Potential Plant Community same for Rentsac (Rn) and Piceance (Pi) above
Yamac	104	Upland Drainage & Fans	Big Sagebrush, Western Wheatgrass, Stream Wheatgrass, Prairie Junegrass, Rabbi thrush & Winterfat
Rock Outcrop-Torrior-thents Complex	91	Ridges & Canyon-sides	Some Pinyon & Juniper, Indian Ricegrass, Beardless Wheatgrass, Prairie Junegrass, Rabbitbrush & Forbs

(a) Vegetation is defined as the potential plant community.

Table 3-9. General soil, vegetation and topography relationship.

TABLE 3-10

ACREAGES OF SOILS WITHIN THE SODIUM LEASE AND PROJECT AREAS

	Sodium Lease Tracts	Project Area
Barcus	35	0
Forelle	35	0
Glendive	167	0
Havre	87	0
Piceance	896	317
Rentsac	4,050	950
Redcreek-Rentsac Complex	501	45
Rentsac-Piceance Complex	105	160
Yamac	1.806	140
Rock Outcorp-Torriorthents Complex	678	8
Total Acres	8,360	1,620

Table 3-10. Acreages of soils within the sodium lease and project areas.

Generally, the vegetation in the drainages and fans of the project area is comprised of sagebrush, forbs, and mixed grasses. Stands of pinyon and juniper are located on the ridges and hills.

The soil series that occur within the sodium lease and project areas are discussed in the following sections. Table 3-10 indicates the soils and their corresponding acreages that occur in the areas.

3.8.4.1. Map Unit 6 -- Barcus Channery Loamy Sand, 2 to 8 Percent Slopes

This is a deep alluvial soil located on fans and in narrow valleys. The surface of this excessively drained soil is a pale brown, channery, loam sand, that is 6 inches thick. The upper part of the underlying material is a light yellowish-brown channery sand that is 10 inches thick. The lower part extends to a depth of 60 inches or more and is a stratified, light yellowish-brown and pale brown, very channery sand and very channery, loamy fine sand. The soil is calcareous throughout the profile. In some areas the surface layer is channery, fine sandy loam or channery sand.

The permeability of Barcus soil is rapid, and the available water capacity is low. Effective rooting depth is 60 inches or more. Runoff from this soil is slow and the corresponding water erosion hazard is moderate.

Due to its loamy sand texture, the Barcus soil has only 16 inches of fair topsoil material and 20 percent fine channery fragments. Below 16 inches, the soil has 50 percent channery fragments; consequently, the soil is rated as poor salvage material.

3.8.4.2. Map Unit 33 -- Forelle Loam, 3 to 8 Percent Slopes

This is a deep, well drained soil that is located on terraces and uplands. It is developing in calcareous eolian and alluvial materials that are derived from sedimentary rock. The 4-inch surface layer of this soil is a pale brown loam, and the upper 12 inches of the subsoil is a yellowish-brown, clay loam. The lower 5 inches of the subsoil is a light yellowish-brown loam that is overlying a very pale brown loam substratum that is 60 inches or more in depth.

Forelle soil is moderately permeable, but has a high available water holding capacity. The effective rooting depth is 60 inches or more, water runoff from this soil is medium, and the hazard of water erosion is moderate.

This is a good source of topsoil material. There is generally about 16 inches of good topsoil material. However, if the calcareous horizons below 16 inches have a pH above 8.8, the horizons will have a poor rating and will be of only limited use in revegetation.

3.8.4.3. Map Unit 36 -- Glendive Fine Sandy Loam, 2 to 4 Percent Slopes

This deep, well drained alluvial soil is found along drainage ways on the alluvial valley floors. The soil has a pale brown, fine sandy loam surface layer that is about 6 inches thick. The underlying material extends to a depth of 60 inches or more and is a very pale brown, stratified fine sandy loam that has thin lenses of loamy fine

sand to sandy clay loam. This soil is calcareous throughout. In some areas the surface layer is a channery, fine sandy loam.

Glendive soil has a moderate available water capacity and a moderately rapid permeability. The effective rooting depth is 60 inches or more. Runoff is slow, and the water erosion hazard is slight. This soil is subject to rare periods of flooding.

This deep soil is good topsoil material to a depth of 6 inches. Soil horizons below 6 inches, however, may be rated fair to poor because of the high pH. If this soil is to be used, any questionable horizons that have a pH greater than 8.8 should be avoided.

3.8.4.4. Map Unit 41 -- Havre Loam, 0 to 4 Percent Slopes

This is a deep, calcareous alluvial soil located on flood plains and along low stream terraces. This light brownish-gray loam soil has a surface layer 21 inches thick. The upper 19 inches of the underlying soil is a stratified, light gray loam and silty clay loam; the lower part extends to a depth of 60 inches or more and is stratified loam and sandy loam. In some areas the surface layer is clay loam or fine sandy loam.

Havre soil is moderately permeable, and the available water capacity is high. Vegetation roots effectively penetrate to a depth of 60 inches or more. Water runoff is medium, and the resulting erosion is slight. Small areas of this soil are subject to brief periods of flash flooding during late spring and summer.

Havre soil is good topsoil material to a depth of 21 inches. Below this depth the soil is calcareous and strongly alkaline; therefore, these lower horizons have a fair to poor rating. Soil materials with a pH of 8.8 and above are considered to be poor salvage material.

3.8.4.5. Map Unit 64 -- Piceance Loam, 5 to 15 Percent Slopes

This is a moderately deep to deep, well drained soil that is located on toe slopes and broad upland slopes. It is forming in eolian and colluvial materials derived from sandstone and siltstone. This soil has a brown loam surface layer that is 9 inches thick. The subsoil is a light yellowish-brown to brown silt loam. The substratum is a pale brown silt loam. Sandstone and siltstone are at a depth of 20 to 48 inches.

Piceance soil is moderately permeable, and the available water capacity is moderately low. The effective rooting depth is 20 to 48 inches. Runoff is slow to medium, and the hazard of water erosion is moderate to high.

The Piceance substratum may occasionally have a high pH, and may have a high accumulation of alkaline salts. Small areas of alkaline slick spots that are about 15 feet wide and 30 feet long may be scattered throughout this mapping unit.

The Piceance soil contains good salvage material to a depth of 24 inches; however, below this depth the soil is unsuitable due to the high sodium adsorption ratio (SAR).

3.8.4.6. Map Unit 70 -- Redcreek-Rentsac Complex, 5 to 30 Percent Slopes

These shallow soils are located on hills and ridges. This unit is comprised of 60 percent Redcreek sandy loam, 30 percent Rentsac channery loamy sand, and 10 percent other soils. The components of this unit are very intricately mixed, and consequently are not mapped separately.

The Redcreek is a shallow, well drained soil that is developing in residual and eolian material derived predominantly from sandstone. This soil has a brown, sandy loam surface layer that is 9 inches thick; it has a pale brown, channery sandy loam underlying material. Sandstone bedrock is found at a depth ranging from 10 to 20 inches.

The permeability of Redcreek soil is moderately rapid and the available water capacity is very low. The effective rooting depth is 10 to 20 inches. Water runoff is medium, and the water erosion hazard is moderate to high.

The shallow and well drained Rentsac soil in this unit is very much like the Rentsac channery loamy sand (Map Unit 73) described in Section 3.8.4.7.

Soils identified in this complex have only 9 to 10 inches of suitable topsoil material. The surface layer of Rentsac has a fair to poor rating; however, the Redcreek soil has a good rating.

3.8.4.7. Map Unit 73 -- Rentsac Channery Loam, 5 to 50 Percent Slopes

This shallow, well drained soil is found on hills and ridges. It is developing in residuum derived from calcareous sandstone or siltstone. The grayish-brown, channery loamy sand is about 10 inches thick; with underlying flaggy loam sand that is 3 inches thick. Sandstone or siltstone is located at a depth of 10 to 20 inches.

Rentsac soil permeability is moderately rapid, and the available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is rapid, and the water erosion hazard is moderate to very high.

The coarse fragments and shallow soil depth limits the use of this soil for topsoil material. Consequently, the surface horizon has only a fair to poor rating.

3.8.4.8. Map Unit 75 -- Rentsac-Piceance Complex, 2 to 30 Percent Slopes

This mapping unit is located on broad upland slopes and ridges. The unit is comprised of 60 percent Rentsac channery loamy sand, 30 percent Piceance loam, and 10 percent other soils. The Piceance soil is typically located on north-facing side slopes, and is generally found in areas that are more concave than where the Rentsac soil is found. The components of this unit are completely intermingled, and are not mapped separately.

The Rentsac soil found within this complex is nearly identical to the shallow, well drained Rentsac soil described previously in Section 3.8.4.7 (Map Unit 73).

The Piceance soil is a moderately deep to deep loam soil that was previously described in Section 3.8.4.5 (Map Unit 64); however, the alkaline slick spots are not as prevalent in this soils complex map unit.

The Rentsac-Piceance complex has 10 to 24 inches of topsoil material. Because these soils are so closely intermixed it will be difficult to salvage more than 10 inches of the surface layer for topsoil material.

3.8.4.9. Map Unit 91 -- Rock Outcrop-Torriorthents Complex, 15 to 90 Percent Slopes

This map unit is located in the extremely rough and eroded areas along ridge tops and canyon sides. The unit is comprised of 75 percent rock outcrop, 20 percent Torriorthents, and 5 percent other soils. Rock outcrop consists of barren escarpments, ridge caps, and sandstone points. Torriorthents are very shallow to moderately deep soils developing in weathered sandstone material. They are well to somewhat excessively drained.

This unit is comprised primarily of rock outcrop and weathered sandstone material, and there is only a limited amount of topsoil material available. Rock outcrops and shallow soils make this unit a very poor unit for soil salvage.

3.8.4.10. Map Unit 104 -- Yamac Silt Loam, 2 to 15 Percent Slopes

This deep, well drained soil is located on upland drainages and fans. It is developing in wind and water transported material. The surface layer is a brown silt loam that is 18 inches thick. The subsoil is a calcareous silt loam, and the substratum is a stratified sandy loam.

Yamac soil is moderately permeable and has a moderate to high available water capacity. The effective rooting depth is 60 inches or more. Water runoff is medium, and the water erosion hazard is slight to moderate. Most of these soils have some gullying.

The Yamac soil is a good source of topsoil material. Although the surface horizon and the subsoil have a good rating, the substratum is rated only fair because of some salt accumulation. This soil can be salvaged to a depth of 60 inches or more.

3.8.5. Reclamation Characteristics

The Wyoming Department of Environmental Quality criteria were used to evaluate topsoil suitability (WDEQ 1981) (Table 3-11). Soils are appraised for use as topsoil material by horizon for each of the sampled soils (Table 3-8). The overall topsoil suitability rating for each horizon results from the most limiting criterion. For example, soil samples for the alkali slickspots (samples Al) indicate an unsuitable soil material with a high sodium adsorption ratio (SAR).

Because there appears to be adequate topsoil material in the project area, only the soils with good and fair ratings were used to calculate volumes of suitable material. High sodium concentrations and coarse fragments are the most restrictive features limiting the use of the project area soils. The lower 24 to 46-inch layer of the Piceance soil and the soils found in slickspot areas have a high SAR and are rated as unsuitable material. The channery coarse fragments in the Rentsac give this soil a poor rating. Soils with high pH and high salt content were analyzed for molybdenum, selenium, and boron. No chemical constituents were found in concentrations that could pose a potential hazard to plants or animals.

Within the project area, assuming a 40-50 year mine life, approximately 250 acres of soil will be disturbed. Approximately 440,000 cubic yards of suitable soil will be available for use in reclamation.

TABLE 3-11

TOPSOIL SUITABILITY CRITERIA

Parameter	Suitable			Unsuitable
	Good	Fai r	Poor	
pH	6.0 - 8.4	5.5 - 6.0 8.4 - 8.8	5.0 - 5.5 8.8 - 9.0	< 5.0 > 9.0
EC (Conductivity) mmhos/cm	0-4	4-8	8-16 > 8 may prove difficult to revegetate	> 16
Saturation Percentage	25-80		> 80 < 25	
Texture (a)	s1, 1, sil, scl, vfs1, fs1	ci, sic1,sc, ls, lfs	c, sic,s	
SAR	< 6	6-10	10 - 15 10 - 12 (b)	> 15 >12 (b)
Selenium		< 2.9 ppm		> 2.0 ppm
Boron		< 5.0 ppm		> 5.0 ppm
Calcium Carbonante	0-15%	15-30%	over 30%	
Coarse Frag 3-10 in. (%, Vol)	0 - 15	15 - 25	25 - 35	> 35
> 10 in.	0 - 3	3 - 7	7 - 10	> 10
Moist Consistency	vfr, fr	lo, fi	vfi, exfi	
Dry Consistency	lo, so	sh, h	vh	

(a) SCS. 1978. National Soils Handbook, Notice 24.
(b) For fine textured soils (Clay > 40%) (Gee et al., 1978).
Source: WDEQ (1981)

Table 3-11. Topsoil suitability criteria.

Long periods of stockpiling topsoil will cause some loss of microorganisms and consequently, a loss of organic matter and nitrogen. During topsoil removal, some subsurface materials will be mixed with topsoil and consequently will lower total soil fertility. Some mixing of alkali material with topsoil material will occur. All these soil conditions will be considered so the proper reclamation practices and mitigation techniques are used.

3.9. Vegetation

3.9.1. Introduction

The sodium leases are located in the Piceance Basin of northwest Colorado. The major vegetation types in the region include: pinyon-juniper, sagebrush, saltbrush, greasewood, agricultural, and barren types (BLM, 1980). Within the White River Field Office Area, pinyon-juniper and sagebrush vegetation types are co-dominant in the region comprising 33 and 31 percent, respectively. In the higher elevations (above 7,000 feet) conifer, mountain shrub, and broadleaf (aspen and willows) types are predominant. Additionally, riparian vegetation (cottonwoods and box elder) is found at lower elevations adjacent to perennial streams, throughout the region.

Vegetation in the region has been described by the BLM (1980, 1983, 1984, 1994), Tiedeman and Terwilliger (1978), and by Ward (1974). Specific studies near the lease area have been conducted for the C-a oil shale tract (Rio Blanco Oil Shale Project, 1977) and the Horse Draw Research Facility (VTN, 1980). Studies conducted on the sodium lease tracts include: the EIS for the C-18 oil shale tract (BLM, 1983); a biota study of Multi Minerals Corporation leases (LGL, 1981 and 1982), terrestrial biology studies for Industrial Resources, Inc's. pilot plant nahcolite solution mine plan (CDM, 1983), and studies by VTN for this mine plan application.

LGL (1981) delineated six vegetation types within an 18,770 acre study area encompassing the sodium lease tracts: Pinyon-Juniper Woodland, Chained Pinyon-Juniper. Big Sagebrush Shrubland, Greasewood-Sagebrush Bottomland, Bald (open shale outcrops) and Agricultural pasture. Studies by LGL (1982) and by COM (1983) identified and collected data on the two vegetation types which are located within the project area: Pinyon-Juniper Woodland and Big Sagebrush Shrubland. These studies contain information for the lease area on tree cover and density, and grass, shrub, and forb cover, diversity, and production. Additionally, a plant species collection was made by LGL; the specimens are stored in the Mesa College herbarium in Grand Junction.

3.9.2. Methods

The purpose of the current vegetation studies conducted in the project area was to: delineate and map the major vegetation types, measure the net annual plant productivity, and describe the plant species composition with respect to cover and occurrence within each major vegetation type. The studies were conducted on approximately 1,620 acres and included Sections 26, 27, and portions of Sections 33 and 34.

3.9.2.1. Vegetation Type Delineation and Mapping

Vegetation types which were identified in the project area by LGL (1981), CDM (1983), and VTN in this study include Big Sagebrush Shrubland and Pinyon-Juniper Woodland. These types were chosen in consideration of ecological conditions, reliability of aerial photographs, and field identification of types. These types are common in the Piceance Basin (Tiedeman and Terwilliger 1978).

The vegetation of the project area was then mapped on black and white aerial photos at a scale of 1:6000 (1 inch = 500 feet). All areas were classified into one of the two vegetation types. A general delineation of the vegetation types was developed by noting textural differences. In the field these differences were correlated to observable vegetation types based on two or more dominant plant species. Ecotones or areas that appeared to contain elements of both communities were resolved by examining the soil association map. All vegetation types were associated with specific soil series. This project area map was then used to locate random points for quantitative sampling in each vegetation type. Finally, the vegetation types were delineated onto topographic maps at a scale of 1:6000 (1 inch = 500 feet).

The vegetation map for the sodium lease tracts was derived from the map prepared by LGL (1981) for the Multi Minerals Corporation. The vegetation types were delineated onto topographic maps at a scale of 1:24000 (1 inch = 2,000 feet).

3.9.2.2. Randomized Sample Site Location

Locations for the 1984 quantitative samples were determined randomly in each of the two vegetation types. A grid was overlain on the aerial photo vegetation map, and Cartesian x and y axis coordinates were randomly selected from a random numbers table. The sample point was located on the map, and then in the field where again a random distance and direction were selected for the ultimate starting place for the transect (Chambers and Brown 1983). All randomly selected sample points were sampled until an adequate sample was reached. A total of 10 transects were sampled in the Big Sagebrush Shrubland, and 10 transects were sampled in the Pinyon-Juniper Woodland vegetation type.

3.9.2.3. Sample Types and Purposes

Quantitative sampling of the vegetation was undertaken to characterize canopy cover, annual browse species production, and shrub density. The following sections describe the methods that were employed.

Cover

The point-intercept method of sampling cover was used. This method has the advantage of minimizing the danger of observer bias. Points were observed at every meter along a transect 50 m in length. Points were observed using a scope with cross-hairs attached to a tripod; the scope was stationed perpendicular to the ground. The fifty point sample was used to calculate sample adequacy for each of the vegetation types. A total of ten transects were sampled in each type, although sample adequacy was reached with only 7.5 and 5.7 transects required for the Big Sagebrush Shrubland and the Pinyon-Juniper Woodland vegetation types, respectively.

Productivity

Annual forage production was estimated for important browse species using a clip sampling technique. One square meter was clipped at the 0 to 1 meter mark along the right side of each transect. All clipped samples were placed in paper bags and kept well aerated to prevent molding. After sampling was completed, the samples were oven dried at 100°C for 24 hours and immediately weighed to the nearest 0.1 gm on a triple beam balance. Since production data were obtained primarily to provide additional information concerning the important browse species for mule deer (BLM 1984b), an adequate sample for production was not obtained.

Shrub Density

Shrub density data were collected in each of the production plots that were sampled. Density was calculated based on the number of individuals observed in each square meter quadrant; the density for each species was based on the total area surveyed.

3.9.2.4. Sample Adequacy Calculations

To determine the number of transects required to adequately sample the vegetation on the project area, the formula presented in the Wyoming vegetation guidelines (1981) was utilized. This formula is:

$$n\min \geq \frac{2(sz)^2}{(d\bar{x})^2}$$

where ^{n}min = minimum number of transects required to adequately sample a vegetation type

s = sample standard deviation

z = (statistic) = 1.28 for shrublands

d = (desired change in the mean) = 0.1 (10%)

$\bar{x}$ = Sample mean of cover for each transect

Vegetation, litter, and rock cover estimates were included in the sample adequacy calculations.

3.9.2.5. Range Condition and Carrying Capacity

Two range sites occur within the project area--the Rolling Loam Range Site and the Rocky and Mountain Pinyon-Juniper. The Rolling Loam site corresponds to the Big Sagebrush Shrubland vegetation type, while the Pinyon-Juniper Woodland vegetation type corresponds to the Rocky and Mountain Pinyon-Juniper site identified by the SCS (1976) and BLM (1983). Range condition and carrying capacity were determined using information from the SCS (1982) and BLM (1983).

3.9.3. Results and Discussion

3.9.3.1. Vegetation Type Descriptions

The following vegetation type descriptions address species composition and abundance based on the results of the cover sampling.

The two vegetation types found on the project area, Big Sagebrush Shrubland type and Pinyon-Juniper Woodland type, are distributed as indicated in Figure 3-6 Vegetation types identified on the sodium lease tracts include the Agricultural pasture, Pinyon-Juniper, Chained Pinyon-Juniper, Greasewood-Sagebrush, Sagebrush and Bald vegetation types. The distribution of these types is found on Figure 3-6 while the number of acres of each vegetation type within these areas are indicated in Table 3-12.

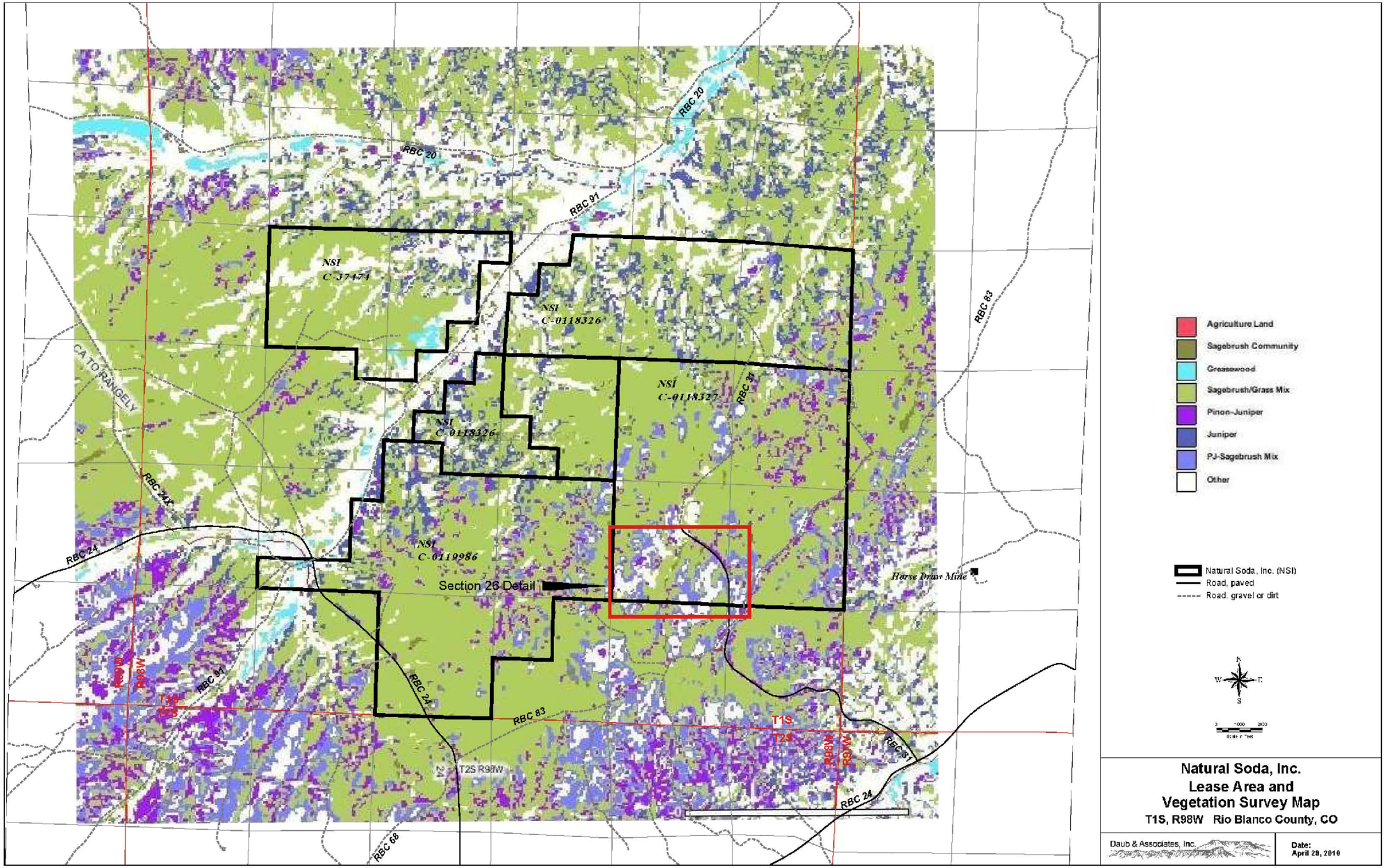

Figure 3-5. Vegetation Survey Map of the Lease Area.

TABLE 3-12

VEGETATION TYPE DISTRIBUTION

Vegetation Type	Sodium Lease Tracts (acres)	Project Area (acres)
Big Sagebrush Shrubland	4,632	859
Pinyon-Juniper Woodland	3,386	761
Chained Pinyon-Juniper	234	0
Greasewood Sagebrush	33	0
Agricultural Pasture	0	0
Bald	75	0
Total Acres	8,360	1,620

Table 3-12. Vegetation type distribution in the sodium lease and project areas.

The vegetation types that occur on the sodium lease and on the project areas are described in the following sections. Data for Big Sagebrush Shrubland and Pinyon-Juniper Woodland were from the 1984 study; remaining data for descriptions are from LGL (1981, 1982). Tables 3-13 and 3-14 include the quantitative sampling results from the cover transects within each vegetation type. Above ground biomass production, plant species composition and ground cover data were collected from nearby native rangelands on July 23 and 24, 2009 and are summarized in Table 3-19 (see Section 3.9.3.3).

TABLE 3-13

SAMPLED PERCENT COVER DATA FOR BIG SAGEBRUSH SHRUBLAND TRANSECTS,
SOLUTION MINING-NAHCOLITE PROJECT
RIO BLANCO COUNTY, COLORADO

Plant Species(a)	Transect Number										Mean (b
	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6	SB-7	SB-8	SB-9	SB-10	
Trees(c)											
Juniperus osteosperma						2					0.2
Pinus edulis											
Shrubs and Half Shrubs											
Artemisia tridentata	38	10	42	36	34	14	26	42	6	8	25.6
Ceratoides lanata				4							0.4
Chrysothamnus nauseosus									6		0.6
Chrysothamnus viscidiflorus							2	4	4		1.0
Eriogonum lonchophyllum									4		0.4
Gutierrezia sarothrae				2					4		0.6
Purshia tridentata											-
Sarcobatus vermiculatus		18				2					2.0
Tetradymia canescens									2		0.2
TOTAL SHRUB COVER	38	28	42	42	34	18	28	46	26	8	31
Forbs											
Antennaria rosea											-
Arenaria eastwoodiae											-
Astragalus convallarius										4	0.4
Astragalus spatulatus											-
Chaenactis douglasii									8		0.8
Comandra umbellata											-
Cryptantha serica						2					0.2
Euphorbia robusta									2		0.2
Gilia congesta											-
Haplopappus nuttallii											-
Hedysarum boreale							8		2		1.0
Hymenoxys acaulis											-
Lupinus argenteus									4		0.4
Phlox hoodii						6				8	1.4
Sphaeralcea coccinea						2			2		0.4
TOTAL FORB COVER	-	-	-	-	-	10	8	-	16	12	4.6

Table 3-13. Sampled percent cover data for Big Sagebrush Shrubland transects.

TABLE 3-13 (continued)

SAMPLED PERCENT COVER DATA FOR BIG SAGEBRUSH SHRUBLAND TRANSECTS,
SOLUTION MINING-NAHCOLITE PROJECT
RIO BLANCO COUNTY, COLORADO

Plant Species(a)	Transect Number										Mean (b
	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6	SB-7	SB-8	SB-9	SB-10	
Graminoids											
Agropyron dasystachyum							4				-
Agropyron smithii	2		2	18		2	2			10	3.6
Agropyron spicatum	8	16	10				2			2	3.8
Agropyron trachycaulum											-
Bouteloua gracilis						2					0.2
Bromus tectorum			20	8	16						4.4
Carex geyeri										2	0.2
Koeleria macrantha	8	10	2	2	4	10	18		2	4	6
Oryzopsis hymenoides	4				4	4			6		1.8
Poa secunda		6	4	2	4					4	2
Sitanion hystrix											-
Stripa comata		2	6	2	12	10	2			2	3.6
TOTAL GRAMINOID COVER	22	34	44	32	40	28	28	0	8	24	26
TOTAL VEGETATION COVER	60	62	86	74	74	56	64	46	50	44	61.6
Litter Cover	36	18	14	24	20	24	23	32	10	30	23.2
Soil Cover	2	20	-	-	6	20	12	6	26	22	11.4
Rock Cover	2	-	-	2	-	-	-	16	14	4	3.8

(a) Nomenclature fallows Harrington H.D. 1964. Manual of the Plants of Colorado.
(b) Mean is expressed as the sum of data for all transects divided by the total number of transects (10).
(c) Tree cover was only determined in the shrub layer, no canopy coverage was determined.

Table 3-13. Sampled percent cover data for Big Sagebrush Shrubland transects (continued).

TABLE 3-14
PERCENT COVER DATA FOR PINYON-JUNIPER WOODLAND TRANSECTS,
SOLUTION MINING-NAHCOLITE PROJECT
RIO BLANCO COUNTY, COLORADO

Plant Species(a)	Transect Number										Mean (b
	PJ-1	PJ-2	PJ-3	PJ-4	PJ-5	PJ-6	PJ-7	PJ-8	PJ-9	PJ-10	
Trees(c)											
Juniperus osteosperma					2	2	2				0.6
Pinus edulis					2				2		0.4
Shrubs and Half Shrubs											
Artemisia tridentata	18	6	6	2	2	8	6	10		2	6
Ceratoides lanata											-
Chrysothamnus nauseosus					2		2				0.4
Chrysothamnus viscidiflorus											-
Eriogonum lonchophyllum											-
Gutierrezia sarothrae	4										0.4
Purshia tridentata	4	4	10	2	4		18				4.2
Sarcobatus vermiculatus											-
Tetradymia canescens											-
TOTAL SHRUB COVER	26	10	16	4	12	10	28	10	2	2	12
Forbs											
Antennaria rosea						2					0.2
Arenaria eastwoodiae						2					0.2
Astragalus convallarius							2				0.2
Astragalus spatulatus										2	0.2
Chaenactis douglasii											-
Comandra umbellata						2					0.2
Cryptantha serica					2		2				0.4
Euphorbia robusta	2										0.2
Gilia congesta									2		0.2
Haplopappus nuttallii	2				2	2				4	1
Hedysarum boreale											-
Hymenoxys acaulis	2						2				0.4
Lupinus argenteus						4					0.4
Phlox hoodii			2	2		2					0.6
Sphaeralcea coccinea											-
TOTAL FORB COVER	6	-	2	2	4	14	6	-	2	6	4.2

Table 3-14. Percent cover data for Pinyon-Juniper Woodland transects.

TABLE 3-14 (continued)

PERCENT COVER DATA FOR PINYON-JUNIPER WOODLAND TRANSECTS,
SOLUTION MINING-NAHCOLITE PROJECT
RIO BLANCO COUNTY, COLORADO

Plant Species(a)	Transect Number										Mean (b
	PJ-1	PJ-2	PJ-3	PJ-4	PJ-5	PJ-6	PJ-7	PJ-8	PJ-9	PJ-10	
Graminoids											
Agropyron dasystachyum											-
Agropyron smithii											-
Agropyron spicatum											-
Agropyron trachycaulum	4				6	4	2	4	2	4	2.6
Bouteloua gracilis			2			2				2	0.6
Bromus tectorum											-
Carex geyeri	2	4					2				0.8
Koeleria macrantha				2	2					4	0.8
Oryzopsis hymenoides		2	6	6		2	2	2	8		2.8
Poa secunda		2						2	2		0.6
Sitanion hystrix		2					2			2	0.6
Stripa comata											-
TOTAL GRAMINOID COVER	6	10	8	8	8	8	10	10	12	12	9
TOTAL VEGETATION COVER	38	20	26	14	24	32	44	18	16	20	25.2
Litter Cover	12	32	34	32	12	26	28	62	26	34	29.8
Soil Cover	-	14	36	26	10	12	4	12	28	12	15.4
Rock Cover	2	34	4	28	54	30	24	8	30	34	29.6

(a) Nomenclature follows Harrington H.D. 1964. Manual of the Plants of Colorado.
(b) Mean is expressed as the sum of data for all transects divided by the total number of transects (10).
(c) Tree cover was only determined in the shrub layer, no canopy coverage was determined.

Table 3-14. Percent cover data for Pinyon-Juniper Woodland transects (continued).

Big Sagebrush Shrubland

The Big Sagebrush Shrubland type is a shrub dominated community found in drainages and gentle slopes usually on Yamac or Piceance fine sandy loams. The type is generally characterized by a shrub overstory of big sagebrush (Artemisia tridentata), ranging from 42 to 6 percent cover with an average of 25.6 percent cover (see Table 3-13). Lesser amounts of winterfat (Ceratoides lanata), rubber and Douglas rabbitbrush (Chrysothamnus nauseosus and c. viscidiflorus), and snakeweed (Guiterrezia sarothrae) are also found; these species never comprised more than six percent of the shrub cover. Total shrub cover ranged from 46 to 8 percent with an average of 31 percent.

Forbs were uncommon in the Big Sagebrush type, comprising 4.6 percent of the total cover. Common forbs included: northern sweetvetch (Hedysarum boreale); hood phlox (Phlox hoodii), scarlet globemallow (Sphaeralcea coccinea), narrow-leaved aster (Machaeranthera linearis), silvery lupine (Lupinus argenteus), and Wyoming painted-cup (Castilleja linariaefolia). In disturbed areas, weedy species such as pinnate tansy mustard (Descurinia pinnata), tumble mustard (Sisymbrium altissimum), Russian thistle (Salsola kali), and yellow sweetclover (Melilotus officinalis) are commonly found. Grasses are an important component of this type comprising 26 percent of the cover. Dominance varied between sample sites but generally prairie junegrass (Koeleria macrantha) is the most important species, with western and bluebunch wheatgrass (Agropyron smithii and A. spicatum), also being found. However, in some areas, possibly due to grazing related disturbance cheatgrass (Bromus tectorum) and needle-and-threadgrass were the dominant species. Also important were Sandberg bluegrass (Poa secunda) and Indian ricegrass (Oryzopsis hymenoides).

Saline soils are found in a few swales and other areas, which are dominated by black greasewood (Sarcobatus vermiculatus), big sagebrush, and scattered shadscale (Atriplex confertifolia) shrubs, comprising about 28 percent cover (Table 3-13; transect SB-2). Forbs were poorly represented, although grasses, especially

bluebunch wheatgrass and prairie junegrass were a dominant part, about 28 percent cover of this subtype.

Another inclusion or subtype was found on south-facing slopes and contains elements of both the Big Sagebrush and Pinyon-Juniper types (Table 3-13; transect SB-9). The shrub layer is more diverse with a lower dominance of big sagebrush and a greater amount of other shrubs including rubber and Douglas rabbitbrush, lance-leaved buckwheat (Eriogonum lonchophyllum), gray horsebrush (Tetradymia canescens) and Antelope bitterbrush (Purshia tridentata). Forbs included: Douglas dusty maiden (Chaenactis douglasii), stemless goldenweed (Hymenoxx acaulis), northern sweetvetch (Hedysarum boreale), silky cryptantha (Cryptantha sericea), and Nuttall's goldenweed (Haplopappus nuttallii). Grasses are not as common as in other sagebrush areas; 8 percent of the cover in transect SB-9 consisted of prairie junegrass and Indian ricegrass.

Pinyon-Juniper Woodland

The Pinyon-Juniper type is a tree dominated community with little understory. This type is generally found in shallow soils located on hills and side slopes. The soils on which this type most frequently occurs are the Rentsac, Rentsac-Piceance, and Torriorthents complex. Pinyon pine (Pinus edulis) and Utah juniper (Juniperus osteosperma) are the dominant species. Although no specific estimates of canopy cover were determined for these species, previous studies have estimated canopy coverage to be 26 percent (LGL, 1982) and 50 percent (CDM, 1983).

The shrub layer is typically sparse, comprising 12 percent of the vegetation cover (Table 3-14). Big sagebrush, Antelope bitterbrush, rubber rabbitbrush, and snakeweed are generally scattered throughout the understory. Localized areas of sandstone outcrops are vegetated by true mountain-mahogany (Cercocarpus montanus) and lance-leaved buckwheat.

Forbs found in the understory include: Nuttall's goldenweed, stemless hymenoxys, silky cryptantha, ballhead gilia (Gilia congesta), timber poisonvetch (Astragalus

convallarius), hood phlox, robust spurge (Euphorbia robusta), and cushion eriogonum (Eriogonum ovalfolium).

Grasses are not abundant in this type and comprise approximately 9 percent of the vegetative cover. Slender wheatgrass (Agropyron trachycaulum), Indian ricegrass, prairie junegrass, Sandberg bluegrass (Poa secunda), and bottlebrush squirreltail (Sitanion hystrix) were commonly encountered. Additionally, elk sedge and Douglas sedge (Carex geyerii and C. douglasii) were commonly found in this vegetation type.

Chained Pinyon-Juniper

The Chained Pinyon-Juniper type was created during BLM management activities in 1969 by knocking down many of the trees in the chaining site. The general appearance of the chained areas is that of a shrub-land with many fallen trees. Chaining, however, may be quite variable and leave a large number of standing trees. The Pinyon-Juniper trees in these areas have been re-established and new growth has taken hold. The LGL study showed that the chained areas had from 30-115 percent of the tree density found on non-chained pinyon-juniper woodlands (LGL 1981). Although, no cover data was collected for this type, the density data shows that the shrub layer is dominated by big sagebrush, Antelope bitterbrush, rubber rabbitbrush, grey horsebrush, and snakeweed.

Forb cover is low in this type area, comprising 1.4 to 3.4 percent of the vegetative cover. Nutall's goldenweed, dwarf rabbitbrush (Chrysothamnus depressus), hood phlox, narrow-leaved aster, plains prickly pear, ballhead gilia, cryptantha, and many flower twinpod were commonly found in the understory.

Graminoid cover was much higher--15 percent--than in the pinyon-juniper type. Common grasses included: Indian ricegrass, western wheatgrass, slender wheatgrass, bottlebrush squirreltail, blue gramma, Sandberg bluegrass, and needle-and-threadgrass.

Black Greasewood-Big Sagebrush

This vegetation type is found on deep, poorly drained, alluvial-alkaline soils (BLM 1980). This shrubland type is dominated by black greasewood and big sagebrush, with rubber and sticky rabbitbrush occurring infrequently (LGL 1981).

Forb cover was moderately important in this type ranging from 3 to 9 percent. Five-hook bassia (Bassia hyssopifolia), and wormseed goosefoot (Chenopodium ambrosioides) were the most common species located in this type.

The cover of the grass species varied greatly in the LGL samples from 0.1 to 13.3 percent. The important grass species included: western wheatgrass, crested wheatgrass (Agropyron desertorum), cheatgrass, bottlebrush squirreltail and Sandberg bluegrass (LGL 1981).

Bald

The Bald vegetation type is found on steep west and south facing slopes with sandstone outcrops, which are mostly devoid of vegetation. This type occurred on rock outcrop-Torriorthents complex soils which were infrequently found on the sodium lease tracts.

The shrub layer is composed of big sagebrush, rubber and sticky rabbit-brush, shadscale and true mountain-mahogany. Other less common shrubs include fringed sagebrush (Artemisia frigida), snakeweed, Antelope bitterbrush, and black greasewood.

Forbs are fairly common in this type consisting of 2 to 8 percent of the vegetative cover. These include hood phlox, Nuttall's goldenweed, buckwheat (Eriogonum spp), shrubby bedstraw (Galium multiflorum), silvery lupine, dwarf rabbitbrush, and Montana pepperteed.

Grass forms only a sparse understory in this type comprising 0.5 to 2.5 percent of the herbaceous cover. Slender wheatgrass, Indian ricegrass, western wheatgrass, and prairie junegrass were the only grass species commonly found (LGL 1981).

Agricultural Land

Within the sodium lease tracts, Agricultural lands or pasturelands are non-public, irrigated lands used primarily for grass and hay production (BLM 1980). This type was not studied by LGL (1981), as it accounted for less than one percent of the study areas.

3.9.3.2. Floral Composition

Total Species List

A list of plant species observed on the project area is presented in Table 3-15. Plant species lists from the LGL collections (Kelly 1982) and those from the C-a tracts (Rio Blanco Oil Shale Project, 1977) were used in the development of the species list. A total of 114 species in 27 different plant families have been identified in the project area.

TABLE 3-15

PLANT SPECIES INVENTORY, NATURAL SODA INC. SOLUTION MINING - NAHCOLITE PROJECT

RIO BLANCO COUNTY, COLORADO

Scientific Name(a)	Common Name(b)	Big Sagebrush Shrubland	Pinyon-Juniper Woodland
Trees			
CUPRESSACEAE	CYPRESS FAMILY		
Juniperus osteosperma	Utah Juniper	x	x
PINACEAE	PINE FAMILY		
Pinus edulis	Pinyon Pine	x	x
Shrubs and Half Shrubs			
ANACARDIACEAE	CASHEW FAMILY		
Rhus trilobata	Skunkbrush Sumac		x
ASTERACEAE	SUNFLOWER FAMILY		
Artemisia frigida	Fringed Sagebrush		x
Artemisia tridentata	Big Sagebrush	x	x
Chrysothamnus nauseosus	Rubber Rabbitbrush	x	x
Chrysothamnus viscidiflorus	Douglas Rabbitbrush	x	
Gutierrezia sarothrae	Snakeweed	x	x
Tetradymia canescens	Gray Horsebrush	x	
CHENOPODIACEAE	GOOSEFOOT FAMILY		
Atriplex confertifolia	Shadscale	x	
Ceratoides lanata	Winterfat	x	
Sarcobatus vermiculatus	Black Greasewood	x	
POLYGONACEAE	BUCKWHEAT FAMILY		
Eriogonum lonchophyllum	Lance-leaved Buckwheat	x	x
ROSACEAE	ROSE FAMILY		
Amelanchier utahensis	Utah Serviceberry		x
Cercocarpus montanus	True Mountain-mahogany		x
Purshia tridentata	Antelope Bitterbrush		x
Succulents			
CACTACEAE	CACTUS FAMILY		
Coryphantha vivipara	Lavendar Pincushion Cactus	x	
Opuntia polyacantha	Plains Pricklypear	x	x

Table 3-15. Plant species inventory for the Natural Soda, Inc. solution mining-nahcolite project

TABLE 3-15 (Continued)

PLANT SPECIES INVENTORY, NATURAL SODA INC. SOLUTION MINING - NAHCOLITE PROJECT

RIO BLANCO COUNTY, COLORADO

Scientific Name(a)	Common Name(b)	Big Sagebrush Shrubland	Pinyon-Juniper Woodland
Forbs			
AMARANTHACEAE	AMARANTH FAMILY		
Amaranthus graecizans	Tumbleweed Amaranth	x	
APIACEAE	CARROT FAMILY		
Cymopterus acaulis	Stemless Spring-parsley		x
Lomatium juniperinum	Juniper Lomatium		x
ASTERACEAE	SUNFLOWER FAMILY		
Ambrosia acanthicarpa	Annual Bursage	x	
Agroseris glauca	Pale Agroseris		x
Antennaria rosea	Rose Pussytoes		x
Artemisia dracunculus	Tarragon	x	
Artemisia ludoviciana	Louisiana Sagewort	x	
Chaenactis douglasii	Douglas Dustymaiden	x	x
Cirsium undulatum	Wavyleaf Thistle		x
Crepis occidentalis	Western Hawksbeard		x
Erigeron engelmannii	Engelmann-daisy	x	
Haplopappus acaulis	Stemless Goldenweed		x
Haplopappus nuttallii	Nuttall's Goldenweed	x	x
Hymenoxys acaulis	Stemless Hymenoxys		x
Lygodesmia juncea	Rush Skeletonweed	x	x
Machaeranthera linearis	Narrow-leaved Aster	x	
Senecio multilobatus	Lobeleaf Groundsel	x	x
Senecio spartioides	Broom Groundsel	x	x
Townsendia incana	Hoary Townsendia		x
Tragopogon dubius	Yellow Salsify	x	
ASCLEPIADACEAE	MILKWEED FAMILY		
Asclepias cryptoceras	Pallid Milkweed		x
BRASSICACEAE	MUSTARD FAMILY		
Alyssum desertorum	Desert Alyssum	x	
Arabis drummondii	Drummond Rockcress		x
Capsella bursa-pastoris	Shepherd's purse	x	
Chorispora tenella	Common Bluemustard	x	
Descurainia pinnata	Pinnate Tansymustard	x	
Lepidium montanum	Montana Pepperweed	x	
Lepidium perfoliatum	Clasping Pepperweed		x
Physaria floribunda	Manyflower Twinpod	x	x
Sisymbrium altissimum	Tumblemustard	x	
Berteroa incana	----------	x	

Table 3-15. Plant species inventory for the Natural Soda, Inc. solution mining-nahcolite project (continued).

TABLE 3-15 (Continued)

PLANT SPECIES INVENTORY, NATURAL SODA INC. SOLUTION MINING - NAHCOLITE PROJECT

RIO BLANCO COUNTY, COLORADO

Scientific Name(a)	Common Name(b)	Big Sagebrush Shrubland	Pinyon-Juniper Woodland
Forbs			
BORAGINACEAE	BORAGE FAMILY		
Cryptantha sericea	Silky Cryptantha	x	x
Lappula redowskii	Stickseed	x	
Lithospermum ruderale	Wayside Gromwell	x	
CARYOPHYLLACEAE	PINK FAMILY		
Arenaria eastwoodiae	Eastwood Sandwort	x	x
CHENOPODIACEAE	GOOSEFOOT FAMILY		
Astriplex rosea	Tumbling Orach	x	
Bassia hyssopifolia	Five-hook Bassia	x	
Chenopodium album	Lambs-quarter Goosefoot	x	
Chenopodium fremontii	Fremont Goosefoot		
Chenopodium leptophyllum	Slimleaf Goosefoot	x	
Kochia scoparia	Summer Cypress	x	
Salsola kali	Russian Thistle	x	
EUPHORBIACEAE	SPURGE FAMILY		
Euphorbia fendleri	Fendler Spurge	x	x
Euphorbia robusta	Robust Spurge	x	x
FABACEAE	PEA FAMILY		
Astragalus convallarius	Timber Poisonvetch	x	x
Astragalus kentrophyta	Kentrophyta Milkvetch		x
Astragalus purshii	Woolly-pod Milkvetch		x
Astragalus spatulatus	Tufted Milkvetch		x
Hedysarum boreale	Northern Sweetvetch	x	
Lupinus argenteus	Silvery Lupine	x	x
Trifolium gymnocarpon	Hollyleaf Clover	x	
Melilotus officinalis	Yellow Sweetclover	x	
LILIACEAE	LILY FAMILY		
Allium textile	Textile Onion		x
Calochortus nuttallii	Sego Lily		x
LINACEAE	FLAX FAMILY		
Linum lewisii	Lewis Flax	x	
LOASACEAE	BLAZING STAR FAMILY		
Mentzelia albicaulis	Whitestem Blazingstar	x	
MALVACEAE	MALLOW FAMILY		
Sphaeralcea coccinea	Scarlet Globe Mallow	x	x
NYCTAGINACEAE	FOUR-O'CLOCK FAMILY		
Abronia fragrans	Snowball Sand Verbena	x	

Table 3-15. Plant species inventory for the Natural Soda, Inc. solution mining-nahcolite project (continued).

TABLE 3-15 (Continued)

PLANT SPECIES INVENTORY, NATURAL SODA INC. SOLUTION MINING - NAHCOLITE PROJECT

RIO BLANCO COUNTY, COLORADO

Scientific Name(a)	Common Name(b)	Big Sagebrush Shrubland	Pinyon-Juniper Woodland
Forbs			
ONAGRACEAE	EVENING-PRIMROSE FAMILY		
Gayophytum ramosissimum	Branchy Ground Smoke	x	
Oenothera caespitosa	Tufted Evening Primrose	x	
POLEMONIACEAE	PHLOX FAMILY		
Gilia congesta	Ballhead Gilia	x	x
Ipomopsis aggregata	Skyrocket Gilia		x
Leptodactylon pungens	Granite Prickly Gilia		x
Phlox hoodii	Hood Phlox	x	x
POLYGONACEAE	BUCKWHEAT FAMILY		
Eriogonum alatum	Winged Buckwheat	x	
Eriogonum ovalifolium	Cushion Eriogonum		x
Eriogonum umbellatum	Sulfur Eriogonum		x
Polygonum sawatchense	Knotweed	x	
SANTALACEAE	SANDALWOOD FAMILY		
Comandra umbellata	Bastard Toadflax	x	x
SCROPHULARIACEAE	FIGWORT FAMILY		
Castilleja linariaefolia	Wyoming Paintedcup	x	x
Penstemon fremontii	Beard-tongue	x	x
Graminoids			
CYPERACEAE	SEDGE FAMILY		
Carex geyeri	Elk Sedge	x	x
Carex douglasii	Douglas Sedge		x
POACEAE	GRASS FAMILY		
Agropyron dasystachyum	Thickspike Wheatgrass	x	
Agropyron desertorum	Crested Wheatgrass	x	
Agropyron spicatum	Bluebunch Wheatgrass	x	x
Agropyron smithii	Western Wheatgrass	x	x
Agropyron trachycaulum	Slender Wheatgrass	x	x
Bouteloua gracilis	Blue Gramma	x	x
Bromus inermis	Smooth Brome	x	
Bromus tectorum	Cheatgrass	x	x
Elymus cinereus	Basin Wildrye	x	
Hordeum jubatum	Foxtail Barley	x	x
Koeleria macrantha	Prairie Junegrass	x	x
Oryzopsis hymenoides	Indian Ricegrass	x	x
Poa secunda	Sandberg Bluegrass	x	x
Stipa comata	Needle-and-Threadgrass	x	x
Sitanion hystrix	Bottlebrush Squirreltail	x	x

(a) Scientific terminology names generally follow Harrington, H.D. 1964. Manual of the Plants of Colorado

(b) Common names generally follow Dennis, E.C. 1980. Common Colorado Range Plants (Partial List).

Table 3-15. Plant species inventory for the Natural Soda, Inc. solution mining-nahcolite project (continued).

Noxious Weeds

The only weedy species listed (Wyoming, 1981) as being noxious or aggressive was blue mustard (Chorispora tenella), found along roadsides in the project area. However, several other weedy species are found in disturbed areas or along roadsides. These species include Russian thistle (Salsola kali), summer cypress (Kochia scoparia), tumble-mustard (Sisymbrium altissimum), tansy mustard (Descurania pinnata), and Bertoa incana. Additionally, cheatgrass is at times a dominant grass species, comprising from 0-20 percent of the grass cover in the Big Sagebrush type.

Selenium Indicator Species

No plant species known to be primary selenium indicator plants (Wyoming, 1981), e.g., prince's plume (Stanleya pinnata) were observed on the project site. However, some of the plant species observed in the Pinyon-Juniper type, especially woolly-pod milkvetch (Astragal us purshii) and stemless goldenweed (Haplopappus acaulis) are known to be tolerant of increased selenium levels.

3.9.3.3. Vegetation Monitoring Results

Above ground biomass production, plant species composition and ground cover data were collected from nearby native rangelands on July 23 and 24, 2009. The data were collected from within twenty 9.6 square foot quadrates at the peak of production for most native plant species. Quadrates were protected by enclosures to prevent vegetation removal by grazers and browsers. The enclosures are relocated each growing season to prevent multiple years of protection. Above ground vegetative biomass production was measured using a double sampling procedure of estimates adjusted by actual values from representative samples. Six of the twenty quadrates were estimated then clipped to obtain an actual weight correction factor to adjust estimated weights. Clipped samples were oven dried to obtain an air-dry weight correction factor for green weights. Ground cover values

were made from visual observations of cover type within each quadrate and reported as a percentage of total ground cover.

A summary of the data collected 2009 in comparison with data collected from previous years is presented in the tables that follow. Ground cover data are presented in Table 3-16, biomass production in Table 3-17 and species composition in Table 3-18. The data presented in these tables are summarized from the quantitative data collected in 2009 and presented at the end of this section. The scientific and common names of all the plant species encountered in the study are presented in the tables at the end of this section.

The ground cover data in Table 3-16 are summarized by class of vegetation and cover type from data presented in Table 3-19. The ground cover data in Table 3-19 are shown by plant species and cover type. The production data presented in Table 3-17 are summarized from the annual aboveground vegetation biomass production for each plant species as shown in Table 3-19. The species composition data presented in Table 3-18 are summarized by class of vegetation from the percent composition of each plant species encountered as determined by each species contribution to total biomass production as shown in Table 3-19.

Table 3-16
Ground Cover (%) for Native Rangeland (control), July 2009

	2004	2005	2006	2007	2008	2009	Change from 2008 to 2009
Perennial Grass	27.2	26.6	27.7	26.9	27.7	26.05	-5.90%
Perennial Forbs	10.1	12.6	6.1	5.6	6.65	6.55	-1.50%
Annual Grass	0.2	1.2	0.9	1.2	1.4	1	-28.60%
Weedy Forbs	1.1	3	0.8	0.6	0.75	0.25	-66.70%
Shrubs	13.9	14.8	14.9	18.7	19.8	19.7	-0.50%
Moss/Lichens	4.5	3.6	5.8	9.1	9.4	9.55	1.60%
Vegetative Litter	7.6	7.4	14.3	12.6	13.15	13.95	5.70%
Bare Ground	34	30.3	29.1	24.5	21.15	22.95	7.80%
Rock	1.4	0.5	0.4	0.8	0	0	0%
Total	100	100	100	100	100	100	

Table 3-16. Ground cover for native rangeland (control) in the project area from 2004-2009.

The ground cover values for perennial species have held relatively consistent over the last three years. Ground cover of native grasses in 2009 decreased about 6

percent from 2008. A 1.5 percent decrease in cover of native forbs occurred in 2009, but still remains consistent over the past three years. Native shrubs cover decreased by one-half a percent from 2008.

Table 3-17
Biomass Production (lbs/ac) from Native Rangeland, July 2009

	2004	2005	2006	2007	2008	2009	Change from 2008 to 2009
Perennial Grass	109.1	119	170.8	298. 1	335.66	325.18	-3.10%
Perennial Forbs	27.1	35	31.7	59.4	116.48	106.01	-9.00%
Annual Grass	2.1	16.7	5.9	10	12.31	15.53	20.70%
Weedy Forbs	1.2	9.3	3.4	6.8	4.85	6.52	25.60%
Shrubs	***	***	92.1	154	182.07	153.71	-15.60%
Total	***	***	303.9	528. 3	651.37	606.95	-6.80%

Table 3-17. Biomass production from native rangeland in the project area from 2004-2009.

Above ground biomass production for native grasses, forbs and shrubs declined in 2009 (Table 3-17). The 6.8 percent decline in total production in 2009 is most likely the result of less precipitation in the later half of the growing season. Native grass production has been consistent since 2007. Native forbs production declined in 2009 but remains substantially higher than values measured 2004 through 2007. Production of native shrubs declined 15.6 percent in 2009 from 2008 but remains consistent with 2007 production. Substantial increases in annual grass and weedy forbs occurred in 2009; however, the increase is only 3.6 percent of total production.

Table 3-18
Plant Species Composition (%) for Native Rangeland, July 2009

	2006	2007	2008	2009	Change from 2008 to 2009
Perennial Grass	56.9	56.4	51.35	53.58	4.20%
Perennial Forbs	10.5	10.9	17.81	17.46	-1.90%
Annual Grass	1.9	1.9	2.07	2.56	19.10%
Weedy Forbs	1.1	1.7	0.82	1.07	23.30%
Shrubs	29.6	29.1	27.95	25.33	-9.30%
Total	100	100	100	100	------

Table 3-18. Plant species composition for native rangeland in the project area from 2004-2009.

TABLE 3-19					
Native Rangeland Ground Cover, Biomass Production & Species Composition July 2009 (1)					
	Scientific Name	**Common Name**	**Percent Cover (2)**	**Production lbs/ac (3)**	**Species Composition (4)**
Grass					
AGSM	Agropyron smithii	Western Wheatgrass	4.10%	66.41	10.94%
AGSP	Agropyron spicata var. inermis	Beardless Bluebunch Wheatgrass	0.45%	2.08	34.00%
BRTE	Bromus tectorum	Cheatgrass (annual grass)	1.00%	15.53	2.56%
KOMA	Koeleria macrantha	Junegrass	2.75%	43.83	7.22%
ORHY	Oryopsis hymenoides	Indian Ricegrass	2.90%	21.23	3.50%
POSE	Poa secunda	Sandberg Bluegrass	1.45%	24.22	3.99%
SIHY	Sitanion hystrix	Squirreltail	0.20%	2.48	0.41%
STCO	Stipa comata	Needle & Thread Grass	14.20%	164.92	27.17%
		Total Grasses	**27.05%**	**340.7**	**56.13%**
Forbs					
ANMI	Antennaria microphylla	Rose Pussytoes	0.15%	2.6	0.43%
ASCO	Astragalus convallarius	Lesser-rushy Milkvetch	0.85%	11.9	1.96%
CANU	Calochortus nuttallii	Sego Lilly	0.05%	1.33	0.22%
CRFL	Cryptantha flava	Yellow Cryptanth	0.10%	2.4	0.40%
CROC	Crepis occidentalis	Hawksbeard	0.15%	1.64	0.27%
DESO	Descurainia sophia	Yellow Mustard (weedy forb)	0.05%	1.23	0.20%
EREA	Erigeron eatonii	Fleabane	0.50%	7.65	1.26%
GICO	Gilia congesta	Ballhead Gilia	0.20%	2.95	0.49%
HEBO	Hedysarum boreale	Utah Sweetvetch	0.75%	12.88	2.12%
LEDE	Lepidium densiflorum	Prairie Pepperweed (weedy forb)	0.20%	5.29	0.87%
LEER	Leucelene ericoides	Heath Aster	0.30%	5.52	0.91%
MAGR	Machaeranthera grindelioides	Discoid Tansyaster	0.35%	6.7	1.10%
OPPO	Opuntia polyacantha	Prickly-Pear Cactus	0.60%	7.83	1.29%
PHHO	Phlox hoodii	Longleaf Phlox	0.95%	15.92	2.62%
SPCO	Sphaeralcea coccinea	Scarlet Globemallow	1.25%	18.61	3.07%
TRGY	Trifolium gymnocarpon	Clover	0.35%	8.09	1.33%
		Total Forbs	**6.80%**	**112.53**	**18.54%**

Table 3-19. Native rangeland ground cover, biomass production, and species composition in the project area, July 2009.

TABLE 3-19 (Continued)					
Native Rangeland Ground Cover, Biomass Production & Species Composition July 2009 (1)					
	Scientific Name	**Common Name**	**Percent Cover (2)**	**Production lbs/ac (3)**	**Species Composition (4)**
Shrubs					
ARTR	Artemesia tridentata var. wyomingensis	Wyoming Big Sagebrush	17.15%	131.43	21.65%
CHDE	Chrysothamnus depressus	Longflower Rabbitbrush	0.70%	6.95	1.15%
CHVI	Chrysothamnus viscidiflorus	Low Rabbitbrush	0.35%	2.76	0.45%
EULA	Eurotia lanata	Winterfat	0.40%	3.65	0.60%
GUSA	Gutierrezia sarothrae	Broom Snakeweed	0.20%	3.1	0.51%
PIED	Pinus edulis	Pinyon Pine	0.90%	5.82	0.96%
		Total Shrubs	**19.70%**	**153.71**	**25.33%**
		Moss/Lichen	**9.55%**		
		Litter	**13.95%**		
		Bare Ground	**22.95%**		
		Rock	**0.00%**		
Total			**100.00%**	**606.95**	**100.00%**
(1) Data was collected July 2009 utilizing twenty 9.6 square foot quadrates.					
(2) Ground cover values were made from visual observations of cover type within each quadrate and reported as a percentage of total ground cover.					
(3) Production values were made using a double sampling procedure of estimates adjusted by actual values from representative samples to determine air-dry above ground biomass from the 20 quadrants, converted to pounds per acre using NRCS and BLM standard					
(4) Species composition values are based upon the percentage of total above ground biomass production for all species.					

Table 3-19. Native rangeland ground cover, biomass production, and species composition in the project area, July 2009 (continued).

Cover Estimates

The results of the shrub and herbaceous cover sampling are summarized in Table 3-20. While the results for each vegetative transect including litter, rock and soil cover estimates were presented in Tables 3-13 and 3-14. The average total cover ranges from approximately 61.6 percent for the Big Sagebrush Shrubland to 25.2 percent for the Pinyon-Juniper Woodland.

TABLE 3-20

COVER, PRODUCTIVITY AND DENSITY OF SAMPLED PLANT SPECIES,
NATURAL SODA SOLUTION MINING-NAHCOLITE PROJECT
RIO BLANCO COUNTY, COLORADO

Plant Species (a)	Big Sagebrush Shrubland			Pinyon-Juniper Woodland		
	Cover (b)	Prod. (c)	Density (d)	Cover (b)	Prod. (c)	Density (d)
Trees (e)						
Juniperus osteosperma	0.2			0.6		
Pinus edulis				0.4		
Shrubs and Half Shrubs						
Artemisia tridentata	25.6	187.4	12,000	6.0	19.8	2,000
Ceratoides lanata	0.4					
Chrysothamnus nauseosus	0.6			0.4	27.9	1,000
Chrysothamnus viscidiflorus	1.0					
Eriogonum lonchophyllum	0.4					
Gutierrezia sarothrae	0.6			0,4		
Purshia tridentata				4.2	21.8	2,000
Sarcobatus vermiculatus	2.0					
Tetradymia canescens	0.2					
TOTAL	31.0	187.4	12,000	12.0	69.5	5,000
Forbs						
Antennaria rosea				0.2		
Arenaria eastwoodiae				0.2		
Astragalus convallarius	0.4			0.2		
Astragalus spatulatus				0.2		
Chaenactis douglasii	0.8					
Comandra umbellata				0.2		
Cryptantha serica	0.2			0.4		
Euphorbia robusta	0.2			0.2		
Gilia congesta				0.2		
Haplopappus nuttallii				1.0		
Hedysarum boreale	1.0					
Hymenoxys acaulis				0.4		
Lupinus argenteus	0.4			0.4		
Phlox hoodii	1.4			0.6		
Sphaeralcea coccinea	0.2					
TOTAL	4.6			4.2		
Graminoids						
Agropyron dasystachyum	0.4			0.2		
Agropyron smithii	3.6					
Agropyron spicatum	3.8					
Agropyron trachycaulum				2.4		
Bouteloua gracilis	0.2			0.6		
Bromus tectorum	4.4					
Carex geyeri	0.2			0.8		
Koeleria macrantha	6.0			0.8		
Oryzopsis hymenoides	1.8			2.8		
Poa secunda	2.0			0.6		
Sitanion hystrix				0.6		
Stripa comata	3.6			0.2		
TOTAL	26.0			9.0		

(a) Nomenclature follows Harrington, H.D. 1964. Manual of the Plants of Colorado.
(b) Percent cover of plant species
(c) Estimated productivity for shrub species (kg/ha).
(d) Shrub density (stems/ha).
(e) Tree cover was only determined in the shrub layer, no canopy coverage was determined.

Table 3-20. Cover, productivity and density of sampled plant species on the Natural Soda, Inc. solution mining-nahcolite project lands.

Results of the 1984 vegetation study indicate higher cover estimates than those obtained in the studies by LGL (1982) and CDM (1983). The LGL and CDM studies estimated shrub and herbaceous cover to be 28.4 and 36 percent in the Big Sagebrush type and 5.7 and 5.5 percent for the Pinyon-Juniper type, respectively. This apparent discrepancy may be due to an artifact created by divergent sampling methodologies, or increased precipitation during the last several years.

Productivity Estimates

The productivity sampling data for browse species are summarized in Table 3-20. Within the Big Sagebrush Shrubland vegetation type, Big Sagebrush was estimated to have an average production rate of 187.4 kg/ha. This is comparable to other data collected within the study area which estimated between 54 to 189 kg/ha (LGL, 1981) and 160 kg/ha (CDM, 1983) in the big sagebrush type. Total production in the Pinyon-Juniper Woodland type was estimated at 70 kg/ha with rubber rabbit-brush, Antelope bitterbrush and big sagebrush being the shrub species sampled in this type (Table 3-13). This estimate is much higher than the previous studies by LGL (1981) and CDM (1983). LGL reported productivity estimates in the Pinyon-Juniper Woodland between 16 to 30 kg/ha, while CDM estimated 10 kg/ha. These apparent discrepancies are probably due to the higher precipitation the area has received in the last year.

Annual productivity (grasses and forbs) data were collected by LGL (1981) and reported by CDM (1983). LGL estimated productivity for the Sagebrush type grasses between 125 to 332 kg/ha, while CDM (1983) reported annual production, including forbs, at 283 kg/ha. Within the Pinyon-Juniper vegetation type, estimates by LGL ranged from 5 to 43 kg/ha for annual grass productivity and COM reported annual herbaceous productivity.

Density Estimates

Table 3-20 summarizes the density data obtained for each of the two vegetation types for the important browse species. In the Big Sagebrush Shrubland type, only one species, big sagebrush, was sampled which had an average shrub density of 12,000 stems/ha. Previous studies by LGL (1981) estimated between 11,176 to 2,097 stems/ha while CDM (1983) reported 9,916 stems/ha. Within the Pinyon-Juniper Woodland type, three species were sampled: big sagebrush, Antelope bitterbrush, and rubber rabbi thrush. These species had an average density of 5,000 stems/ha (Table 3-20). This is slightly higher than the estimates in previous studies which estimated between 443 to 3,095 stems/ha (LGL 1981) and 2,905 stems/ha (CDM 1983).

3.9.3.4. Correlation of Vegetation Types and Study Area Soils

Results of the vegetation-soil correlation show that the soils within the project area are closely related to the vegetation types. The Big Sagebrush Shrubland vegetation type occurs primarily on the Yamac and on the Piceance soils within the project area. The Pinyon-Juniper Woodland vegetation type occurs mostly on the Redcreek-Rentsac complex, the Rentsac, and on the Rentsac-Piceance complex soils in the study area. The plant-soils relationships for the plant communities that occur within the sodium lease areas were described in Table 3-9: General Soil, Vegetation and Topography Relationship.

3.9.3.5. Range and Woodland Site Descriptions and Carrying Capacity

Rolling Loam

The rolling loam range site is found on level to moderately steep areas in the southern Rocky Mountains from 5,500 to 7,000 feet elevation (SCS 1975). The annual precipitation ranges from 12-15 inches with 50 percent of that occurring in

the form of snowmelt. This range site is found on deep medium to moderately coarse textured soils, such as Piceance fine sandy loam.

The vegetation is characterized by open stands of big sagebrush and an abundant grass cover. Principal shrubs, other than big sagebrush, include grey horsebrush, rabbitbrush, and Utah serviceberry. Scarlet globemallow, lupines (Lupinus spp), buckwheats, yarrow (Achillea millefolicum), American vetch (Vicia americana) and balsamroot (Balsa-morrhiza sagittata) are the important forbs found in this range site. Important grasses such as western wheatgrass, beardless wheatgrass, bottlebrush squirreltail, bluegrasses, needlegrasses (Stipa spp), and Indian ricegrass are commonly found. Total annual production in this range site ranges from 897 to 1,121 kg/ha depending on the year, while optimum groundcover is about 30 percent.

The rolling loam site has a high value rating for cattle, sheep and horse grazing. It is also valuable habitat for deer, antelope, lagomorphs and upland game birds (SCS 1975).

Rocky and Mountain Pinyon-Juniper

This woodland site is found on moderately steep to steep hillsides with frequent sandstone outcrops (BLM, 1983). The overstory is dominated primarily by Utah juniper with scattered pinyon pine; the overstory canopy ranges from 40 to 80 percent cover. The scattered shrub layer consists primarily of big sagebrush, mountain mahogany, Antelope bitterbrush, and rabbitbrush. Important grasses include western wheatgrass, slender wheatgrass, Sandberg bluegrass and needle-and-threadgrass. The understory cover ranges from 10-15 percent, and average annual production ranges from 224 to 336 kg/ha.

Portions of the Pinyon-Juniper type have been subject to habitat manipulation by chaining. These areas are composed of big sagebrush, Antelope bitterbrush, rabbitbrush and small junipers and pinyon pine trees. Common grass species include western wheatgrass, needlegrass, Indian ricegrass, and crested wheatgrass. Annual production is estimated at 729 kg/ha.

The Rocky and Mountain Pinyon-Juniper woodland site constitutes important winter range for mule deer. However, these sites do not have high value rating for cattle, sheep, or horse grazing. These woodland range sites have some potential for forestry development. At the present time, some of the woodlands in the area are managed for occasional use of firewood and fencepost cutting.

Carrying Capacity

The sodium lease area is located within the Square S (No. 06027) grazing allotment, which is composed of approximately 64,050 acres of public land. Historically, 54% of the grazing allotment was in fair condition and 46% was in poor condition, and the initial animal unit month (AUM) allocation was 2,385 livestock (cattle), 3,952 deer, 42 elk and 1,680 wild horses (BLM, 1980). Currently (2010), the allotment contained 2,393 cattle with 3,520 AUMs (Hafkenschiel, personal communication).

3.10. Wildlife Information

3.10.1. Introduction

The Natural Soda, Inc. property is located within the Piceance Basin in northwest Colorado. Wildlife habitats within the Basin consist primarily of pinyon-juniper woodland, sagebrush, shrubland, and mixed mountain shrubland. Other habitat types which occur to a lesser extent include grassland, agricultural lands, riparian woodland, and cliffs or rimrock.

Approximately 365 species of wildlife have been identified or are expected to occur within the Piceance Basin. These animals occur either as permanent residents, temporary or seasonal residents, or on a migratory basis. Of these, 78 species are mammals, 255 species are birds, 15 species are fish, 12 are reptiles, and 5 species are amphibians. Wildlife species which occur on the sodium lease tracts or in the local vicinity of the project are discussed in this report.

3.10.2. Methods

From 1980 through 1982, the Multi Mineral Corporation (MMC) contracted Ecological Research Associates (LGL) to conduct biological baseline studies to satisfy the requirements of federal, state, and local mining and reclamation permits on the area covered by the sodium lease tracts. These studies included evaluation of the following wildlife populations: birds (songbirds, sage grouse, raptors), mule deer, feral horses, small mammals, mammalian carnivores, reptiles, and amphibians. These studies were conducted on approximately 18,000 acres which encompassed the 8,360-acres of the sodium lease tracts.

In addition, supplemental wildlife studies were conducted in 1984 by VTN to augment those earlier studies. These studies were conducted on approximately 1,600 acres within the project area, which encompasses the estimated 250 acres to be disturbed by the solution mine. Studies conducted in 1984 included a spring raptor survey and a spring sage grouse survey. The methods used and the results of the LGL and VTN studies are presented in this report.

3.10.2.1. Avifauna

<u>Songbirds</u>

Breeding bird surveys were conducted using the Emlen transect technique (Emlen, 1977). The Emlen technique involves the use of a transect or a series of transects to count birds detected within a belt-shaped transect. In the spring of 1981, 15 1 km long Emlen transects were established in each of the habitat types: four transects were established in sagebrush, four in pinyon-juniper, four in chained pinyon-juniper, and three in the greasewood-sage bottom (only 3 km of this type was available). The transects were surveyed (three replicates per transect) within 3 hours after sunrise each day during the spring of 1981 (O'Meara et al., 1981). Surveys were conducted on consecutive days, weather permitting. In addition to the Emlen surveys, opportunistic observations of songbirds were recorded.

The effective boundary line of the Emlen transect was calculated in order to determine at what distance from the transect center the detection of calling birds declined so as to warrant the exclusion of birds beyond that point in calculating population parameters. A 50 percent decrease in detections from that observed at the transect center served as the edge of the effective transect width. The effective transect width was found to be about 120 m wide (60 m on each side of the transect center).

Variations in weather apparently caused considerable variability in the number of birds observed during each survey replication. Consequently, the density and species diversity calculations were based on the largest number of birds (by species) detected among the three replications, rather than on the average number detected. This was based on the assumption that songbird populations are frequently underestimated, but never overestimated (LGL, 1981).

Raptors

In March of 1981, an aerial survey was conducted to locate raptor nests on bluffs and cliffs within the sodium lease tracts study area. All stick nests that were probably used by raptors were mapped, and those in good repair were later visited to verify use status. Raptor observations were conducted on an opportunistic basis during the remainder of 1981.

In June 1984, a pedestrian survey was conducted to determine the presence of raptor nests, or usage of the project area by raptor species. Approximately 4 man-days were devoted to this on-site survey. Additional opportunistic sightings were made during approximately 10 man-days in July.

Sage Grouse

Surveys for sage grouse leks were conducted in April of 1981 on the sodium lease area using ground and aerial methods. Ground surveys were conducted for approximately 5 man-days in sagebrush habitat, primarily during the early morning

hours when breeding birds are most active. An aerial survey was conducted during the early morning. Other opportunistic sightings of sage grouse were noted during the two year study.

In June 1984, a pedestrian survey was conducted to determine sage grouse usage on the project area. The survey was conducted at this time due to the fact that the spring of 1983 and 1984 were very wet years and that insects and succulent vegetation could be found on the site later into the summer months. Consequently, the potential for sage grouse to occur on the site, this late in the season was increased. During this survey, 4 man-days were devoted to observing for sage grouse, or sign of sage grouse leks. Additionally, approximately 10 additional man-days were spent in the field during July, when opportunistic observations were made.

3.10.2.2. Large Mammals

Mule Deer

In addition to a literature survey, on-site studies were conducted to evaluate the mule deer population on the lease area in 1980 and 1981 (LGL, 1981). These field studies included: 1) monthly aerial deer count and distribution surveys; 2) deer pellet group counts to determine the abundance and habitat preference; and 3) measurements of the distribution of deer pellet groups in relation to browse plants to determine plant species preference.

Monthly aerial surveys were conducted between August of 1980 and June of 1981. Surveys were conducted in fixed-wing aircraft at about 150 m elevation between sunrise and 2 hours after sunrise. Deer groups were counted and their locations plotted on a topographic map.

Deer pellet groups were counted along belt transects which were 2 m by 1000 m long. Pellet group transect locations followed that of the Emlen bird transects. Each transect was subdivided into 10 equal segments to allow for among-segment

treatment of the data. Deer preferences among habitats were assumed to be proportional to relative pellet-group densities. Average deer densities for winter months were computed from pellet-group data using the assumptions that (1) deer occupied the study area in appreciable numbers for about 6 months (180 days); (2) each deer defecated about 13 times per day; and (3) negligible number of pellet groups were missed from transects prior to counts or missed by observers (LGL 1981).

A method was developed to measure the "actual" versus the "expected" proximity of plant species to pellet groups in order to test for preferred browse species (LGL, 1981). From the center of each current year's pellet group, the browse species (tree or shrub) that had the nearest reachable foliage (<1.5 m above ground) to that point in each of four quadrants surrounding the plant was recorded. The same notations were made at each of 50 systematically-selected points (20 m apart) along each pellet transect in order to obtain an "expected" distribution of browse around the sample points. By statistically comparing the actual with the expected ratios of plant species (chi-square analysis), the distribution of deer pellets could indicate preferred browse species (LGL, 1981).

Feral Horses

Feral horse populations were evaluated during the course of mule deer surveys for the sodium lease tracts conducted from 1980-1981. The numbers and the locations of feral horses observed during the monthly aerial mule deer survey were plotted on a topographic map of the area in an effort to determine the seasonal population densities and any apparent habitat preferences. During other times, feral horse sign such as horse droppings and hoof prints were noted.

Carnivores

Mammalian carnivore studies were conducted in conjunction with the 1980-1981 study of the sodium lease tracts. Methods for determining the relative abundance of

carnivore populations included scent post stations and counting tracks (in fresh snow) which crossed roads. Additional general information was obtained by opportunistic observations, lagomorph studies, and interviews with local trappers.

Scent posts were established according to the methods established by Linhart and Knowlton (1975). Fifty scent post stations were established every 0.5 km along most of the unpaved roads in the sodium lease tracts area. These posts were examined for three days in September 1980. A track-count survey route was also established along 33.3 km of roads in the lease. Because of the infrequent snowfall during the 1980-1981 winter, tracks were counted only four times from January to March.

3.10.2.3. Small Mammals

Data were collected on both rodents and rabbits during the studies conducted on the sodium lease tracts between 1980 and 1981.

Rodents

Studies were conducted on small mammal populations during the 1980-1981 studies. The purpose of these studies was to determine species composition within each habitat type, the relative abundance and densities of each species, and habitat associations. The population data were derived from 10 - 2.2 ha (100 trap) live trapping grids in six habitats. The habitat types that were sampled included sagebrush, pinyon-juniper, greasewood-sage bottom, wash (found within the greasewood-sage bottom), and bald types. Traps were set for three days each month from August 1980 through July 1981; data were analyzed for approximately 4,200 captures. The following parameters were evaluated: density (minimum number alive per hectare), number captured per grid, survival and recruitment rates, biomass (standing crop and amount lost to predation), various reproductive parameters, habitat associations by general habitat type and by micro-habitat (multivariate analyses).

Rabbits and Hares

The purpose of this study was to determine the species composition within each habitat type, the relative densities and abundance of each rabbit or hare species, and the habitat associations of each species. Rabbits were sampled by driving a survey route in the sodium lease area for 3 evenings per month from August 1980 through July 1981. The route was 45 km long and passed through all habitat types.

3.10.2.4. Reptiles and Amphibians

The objectives for the 1980-1981 study were to identify the common species of reptiles and amphibians that occur on the sodium lease area. The purpose was also to determine the habitat affinity of the species, and to determine their relative abundances by vegetation type. The methods of observation included: opportunistic observation, examination of 1.3 km of 2 m wide transects. These transects were in 10 0-13 km segments on 8 grids, and 4 0.33 km segments on 2 grids. In addition, 60 pitfall traps were observed during May, June, and July 1981 in the pinyon-juniper, sagebrush, and the chained pinyon-juniper habitat types.

3.10.3. Results of Wildlife Studies

Baseline wildlife and vegetation studies performed in the vicinity of the project area indicate that pinyon-juniper woodland and sagebrush shrubland were the predominant habitat types (LGL 1981). Ephemeral streams are the only water bodies near the project area, hence no major stream or pond aquatic habitats occur. A variety of mammals, birds, reptiles, and amphibians are expected to occur in the vicinity of the project area (Table 3-21). Some of the species (e.g.. waterfowl and shorebirds) listed in this table will most likely be found near permanent water sources such as Piceance and Yellow Creeks, and will occur in these areas only on a temporary basis. Additional information concerning the results of the 1980-1981 wildlife study is contained in the 1981 LGL report.

TABLE 3-21

WILDLIFE SPECIES (BY ORDER) OTHER THAN BATS,
EXPECTED TO OCCUR IN HABITATS IN THE VICINITY
OF THE NATURAL SODA SOLUTION MINING - NAHCOLITE PROJECT AREA

Common Name	Scientific Name
MAMMALS	
Insectivores	Insectivora
Masked Shrew	Sorex cinereus
Merriam's Shrew	Sorex merriami
Lagomorphs	Lagomorpha
Nuttall's Cottontail	Sylvilagus nuttallii
Desert Cottontail	Sylvilagus audubonii
Black-tailed Jackrabbit	Lepus californicus
White-tailed Jackrabbit	Lepus townsendii
Rodents	Rodentia
Least Chipmunk	Eutamias minimus
Colorado Chipmunk	Eutamias quadrivittatus
Golden-mantled Ground Squirrel	Spermophilus lateralis
13-lined Ground Squirrel	Spermophilus tridecemlineatus
Northern Pocket Gopher	Thomomys talpoides
Apache Pocket Mouse	Perognathus apache
Deer Mouse	Peromyscus maniculatus
Pinyon Mouse	Peromyscus truei
Bushy-tailed Woodrat	Neotoma cinerea
Montane Vole	Microtus montanus
Sagebrush Vole	Lagurus curtatus
Porcupine	Erethizon dorsatum
Carnivores	Carnivora
Coyote	Canis latrans
Gray Fox	Urocyon cinereoargenteus
Long-tailed Weasel	Mustela frenata
Spotted Skunk	Spi1ogale putorius
Striped Skunk	Mephitis mephitis
Badger	Taxidea taxus
Bobcat	Felis rufus
Mountain Lion	Felis concolor
Perissodactyls	Perissodactyla
Wild Horse	Equus caballus
Artiodactyls	Artiodactyla
Elk	Cervus elaphus
Mule Deer	Odocoileus hemionus
Domestic Cattle	Bos taurus

Table 3-21. Wildlife species (by order) other than bats, expected to occur in habitats in the vicinity of the Natural Soda, Inc. solution mining – nahcolite project.

TABLE 3-21 (Continued)

WILDLIFE SPECIES (BY ORDER) OTHER THAN BATS,
EXPECTED TO OCCUR IN HABITATS IN THE VICINITY
OF THE NATURAL SODA SOLUTION MINING - NAHCOLITE PROJECT AREA

Common Name	Scientific Name
BIRDS	
Waterfowl	Anseriformes
Mallard	Anas platyrhynchos
Gadwal1	Anas strepera
Green-winged Teal	Anas crecca
Blue-winged Teal	Anas discors
Cinnamon Teal	Anas cyanoptera
Vultures, Hawks, Falcons	Falconiformes
Turkey Vulture	Cathartes aura
Sharp-shinned Hawk	Accipiter striatus
Northern Goshawk	Accipiter gentilis
Cooper's Hawk	Accipiter cooperii
Red-tailed Hawk	Buteo jamaicensis
Rough-legged Hawk	Buteo lagopus
Bald Eagle	Haliaeetus leucocephalus
Golden Eagle	Aquila chrysaetos
Northern Harrier	Circus cyaneus
Prairie Falcon	Falco mexicanus
American Kestrel	Falco sparverius
Gallinaceous Birds	Galliformes
Sage Grouse	Centrocercus urophasianus
Shorebirds	Charadriiformes
Virginia Rail	Rallus limicola
Sora	Porzana carolina
American Coot	Fulica americana
Killdeer	Charadrius vociferus
Common Snipe	Capella gallinago
Spotted Sandpiper	Actitis macularia
Solitary Sandpiper	Tringa solitaria
American Avocet	Recurvirostra americana
Pigeons and Doves	Columbiformes
Mourning Dove	Zenaida macroura
Owls	Strigiformes
Eastern Screech-Owl	Otus asio
Great Horned Owl	Bubo virginianus
Northern Saw-whet Owl	Aegolius acadicus
Northern Pygmy-Owl	Glaucidium gnoma
Long-eared Owl	Asio otus
Short-eared Owl	Asio flammeus
Goatsuckers	Calprimulgiformes
Common Poorwill	Phalaenoptilus nuttallii
Common Nighthawk	Chordeiles minor

Table 3-21. Wildlife species (by order) other than bats, expected to occur in habitats in the vicinity of the Natural Soda, Inc. solution mining – nahcolite project (continued).

TABLE 3-21 (Continued)

WILDLIFE SPECIES (BY ORDER) OTHER THAN BATS,
EXPECTED TO OCCUR IN HABITATS IN THE VICINITY
OF THE NATURAL SODA SOLUTION MINING - NAHCOLITE PROJECT AREA

Common Name	Scientific Name
BIRDS	
Swifts and Hummingbirds	Apadiformes
White-throated Swift	Aeronautes saxatalis
Broad-tailed Hummingbird	Selasphorus platycercus
Woodpeckers	Piciformes
Northern Flicker	Colaptes auratus
Perching Birds	Passeriformes
Say's Phoebe	Sayornis saya
Gray Flycatcher	Empidonax wrightii
Western Wood-pewee	Contopus sordidulus
Horned Lark	Eremorphila alpestris
Violet-green Swallow	Tachycineta thalassina
Tree Swallow	Tachycineta_ bicolor
Northern Rough-winged Swallow	Stelgidopteryx serripennis
Barn Swallow	Hirundo rustica
Cliff Swallow	Hirundo pyrrhonota
Scrub Jay	Aphelocoma coerulescens
Black-billed Magpie	Pica pica
Common Raven	Corvus corax
Pinyon Jay	Gymnorhinus cyanocephalus
Clark's Nutcracker	Nucifraga columbiana
Mountain Chickadee	Parus gambeli
Plain Titmouse	Parus inornatus
Bushtit	Psaltriparus minimus
White-breasted Nuthatch	Sitta carolinensis
Red-breasted Nuthatch	Sitta canadensis
House Wren	Troglodytes aedon
Rock Wren	Salpinctes obsoletus
Sage Thrasher	Oreoscoptes montanus
American Robin	Turdus migratorius
Hermit Thrush	Catharus guttatus
Mountain Bluebird	Sialia currocoides
Blue-gray Gnatcatcher	Polioptial caerulea
Ruby-crowned Kinglet	Regulus calendula
Water Pipit	Anthus spinoletta
Gray Vireo	Vireo vicinior
Solitary Vireo	Vireo solitarius
Virginia's Warbler	Vermivora virginiae
Yellow Warbler	Dendroica petechia
Yellow-rumped Warbler	Dendroica coronata
Black-throated Gray Warbler	Dendroica nigrescens
Yellow-breasted Chat	Icteria virens
Western Meadowlark	Sturnella neglecta
Red-winged Blackbird	Agelaius phoeniceus

Table 3-21. Wildlife species (by order) other than bats, expected to occur in habitats in the vicinity of the Natural Soda, Inc. solution mining – nahcolite project (continued).

TABLE 3-21 (Continued)

WILDLIFE SPECIES (BY ORDER) OTHER THAN BATS,
EXPECTED TO OCCUR IN HABITATS IN THE VICINITY
OF THE NATURAL SODA SOLUTION MINING - NAHCOLITE PROJECT AREA

Common Name	Scientific Name
BIRDS	
Perching Birds	Passeriformes
Brewer's Blackbird	Euphagus cyanocephalus
Brown-headed Cowbird	Molothrus ater
House Finch	Carpodacus mexicanus
Red Crossbill	Loxia curvirostra
Green-tailed Towhee	Pipilo chlorurus
Rufous-sided Towhee	Pipilo erythrophthalmus
Grasshopper Sparrow	Ammodramus savannarum
Vesper Sparrow	Pooecetes gramineus
Lark Sparrow	Chondestes grammacus
Sage Sparrow	Amphispiza belli
Dark-eyed Junco	Junco hyemalis
Chipping Sparrow	Spizella passerina
Brewer's Sparrow	Spizella breweri
White-crowned Sparrow	Zonotrichia leucophrys
Song Sparrow	Melospiza melodia
REPTILES	
Eastern Fence Lizard	Sceloporus undulatus
Sagebrush Lizard	Sceloporus graciosus
Tree Lizard	Urosaurus ornatus
Short-horned Lizard	Phrynosoma ornatus
Western Terrestrial Garter Snake	Thamnophis elegans
AMPHIBIANS	
Great Basin Spadefoot	Scaphiopus intermontanus
Chorus Frog	Pseudacris triseriata

Source: LGL Ecological Research Assoc. (1981).

Table 3-21. Wildlife species (by order) other than bats, expected to occur in habitats in the vicinity of the Natural Soda, Inc. solution mining – nahcolite project (continued).

3.10.3.1. Avifauna

Bird surveys conducted in the Piceance Basin Region show that raptor, gamebird, and songbird species exist. The Colorado Field Ornithologist Latilong study lists a total of 278 bird species which could potentially occur in the study area (Kingery and Graul, 1978). Cringan (1973) reported 258 species of birds which could potentially occur in the Piceance Basin. A study conducted on the Rio Blanco Oil Shale properties showed that 139 avian species were observed during a 2-year period (Rio

Blanco Oil Shale Project, 1977). The BLM (1980) found during an environmental baseline study conducted on the White River Resource Area that 186 bird species are known to occur in that area, including 21 raptor species, 27 species of gamebirds, and 138 songbird species. Lists of these species and their status are available in the documents cited. It should be noted that many of these species are not present on the sodium lease area since they are associated with habitats which do not exist on the study area. In addition, a number of species may be migrants or extra limital strays that occur only rarely in the region.

Songbirds

The songbird species in the study area are typical of those found in the Piceance Basin. Results of the LGL study (1981) showed that 66 species of songbirds were encountered on the sodium lease area; 24 species were encountered during the Emlen breeding bird surveys. This difference arises because 1) the Emlen surveys were conducted only during the breeding season; and 2) some breeding male birds do not sing on their territories and are missed by the Emlen survey.

Of the 24 species encountered during the Emlen survey, 17 species were encountered in pinyon-juniper habitats, 9 in greasewood-sage bottoms, 8 in sagebrush, and 6 in chained pinyon-juniper. Eight of the 24 species occurred in more than one habitat. The most common species encountered in the study area was the Brewer's sparrow. Its density was higher in three habitat types (greasewood-sage bottom, sagebrush, and chained pinyon-juniper) than the density of any other species in any habitat. Other common species included the black-throated gray warbler, solitary vireo, mountain chickadee, and chipping sparrow in the pinyon-juniper habitats; green-tailed towhee, vesper sparrow, and meadowlark in sagebrush habitats; and green-tailed towhee, blue-gray gnatcatcher, and sage thrasher in greasewood-sage bottom.

Songbird density was highest in the greasewood-sage bottom habitats (about 8 birds/ha). The density of songbirds in other habitats was considerably lower: pinyon-

juniper, chained pinyon-juniper, and sagebrush had about 3.5, 3.3, and 2.6 birds/ha, respectively. Total songbird population in the study areas was estimated to be about 23,643 individuals.

Species diversity--estimated using the Shannon-Wiener index (Pielou 1966)--was highest in the pinyon-juniper habitat type -- H' = 1.93. There was little difference indicated among the other habitat types: chained pinyon-juniper, H' = 1.33; sagebrush, H' = 1.41; and grease-wood-sage bottom, H' = 1.24.

Songbird species frequently prefer certain types of habitats; this is usually based on the vegetation height and density (Odum, 1945; Bond, 1957; Hilden, 1965; Balda, 1975; Buttery and Shields, 1975; Peterson, 1975). The most frequently used classification consists of grassland, shrubland, and tree cover. The habitat preference of common species of songbirds (based on density estimates) in this study is listed in Table 3-22.

TABLE 3-22

HABITAT PREFERENCE OF COMMON SPECIES OF SONGBIRDS

Species	Habitat
Black-throated Gray Warbler	Pinyon-Juniper
Solitary Vireo	Pinyon-Juniper
Mountain Chickadee	Pi nyon-Juniper
Chipping Sparrow	Pinyon-Juniper
White-breasted Nuthatch	Pinyon-Juniper
Plain Titmouse	Pinyon-Juniper
Brown-headed Cowbird	Pinyon-Juniper
House Finch	Pinyon-Juniper
Brewer's Sparrow	Greasewood-Sage Bottom
Blue-gray Gnatcatcher	Greasewood-Sage Bottom
Sage Thrasher	Greasewood-Sage Bottom
Green-tailed Towhee	Chained Pinyon-Juniper
Vesper Sparrow	Chained Pinyon-Juniper
Western Meadowlark	Sagebrush

Table 3-22. Habitat preference of common species of songbirds.

Pianka (1973) described the niche breadth index (B) which indicates a species' flexibility of habitat occupation. Species which occur in a larger variety of habitats are characterized by a higher B value. From the data gathered in the Emlen study,

the green-tailed towhee (B =2.36), the vesper sparrow (B = 2.21), and the Brewer's sparrow (B = 2.12) are the most flexible species in their ability to live in various habitat types in the study area. Each of these species occurred in three or four habitat types. However, 16 of the 24 species were not encountered in more than one habitat (B = 1.00). This indicates that either most songbird species that occur on the study area strongly prefer one habitat, or that the density of birds was too low to indicate actual habitat preference.

Raptors

The project area is inhabited throughout the year by a variety of raptors. Common breeders include: American kestrel, golden eagle, red-tailed hawk, Cooper's hawk and long-eared owl (BLM 1984a). The sharp-shinned hawk and goshawk are relatively rare breeding residents. The rough-legged hawk and bald eagle forage in open vegetative types throughout Piceance Basin during the winter months (BLM, 1984a).

Generally, local breeding raptors construct or return to traditional nest sites in mid-February to early April to lay their eggs sometime in March or April. Nest occupation continues until chicks are fledged which, depending on when nesting activities began, occurs from early June to mid-August (BLM, 1984a).

Information obtained during the 1980-1981 surveys indicated that the lease area also was not used heavily during these years. Approximately 20 cliff nests were found in various stages of decay in the sodium lease area or within a mile of this area. At that time, two of the nests appeared to have been used recently by large raptors. None of these nests were located within a mile of the project area. The two nests are located: 1) on Ryan Gulch Road about 1.25 miles from its junction with Piceance Creek Road; and 2) on Piceance Creek Road about 1.25 miles north of its junction with Horse Draw. The nest on Ryan Gulch Road was judged to have been used by red-tailed hawks (LGL, 1981). The nest along Piceance Creek Road was probably used by golden eagles in the spring of 1980 (LGL, 1981).

A raptor survey conducted in the spring of 1984 indicated that the project area was not a high use area for raptor species. During the survey, one great horned owl was observed in a mesic drainage along the western boundary of Section 27. No nest was found and no sign was observed, indicating that this was not a frequented roosting site. The only nest that was observed was a large raptor nest located in a pinyon tree along a gulch at the northern boundary of Section 27. The nest did not appear to have been used in several years.

In 2006, inventories of raptor transects were performed from May to July. Previously spotted owl nests and red-tailed hawk nests were not rebuilt, or in use in 2006. No new nests were spotted within the survey area.

From 2007 to 2009, inventories of raptor transects were performed from May to July. No new nests were spotted within the survey area.

Although raptor species frequently use nearby areas for nesting and other seasonal use, the project area does not appear to contain habitat which is subject to frequent use by any raptor species. Several raptor species do, however, use the project area and sodium lease area occasionally. The most common raptor species which has been observed within the sodium lease area or in nearby habitats are American kestrel which are common along Ryan Gulch and Piceance Creek Roads. Cooper's hawks have been occasionally observed in the pinyon-juniper woodlands during the summer; goshawks and sharp-shinned hawks were likewise observed in the pinyon-juniper habitat (LGL, 1981). Common winter inhabitants include golden eagles, red-tailed hawks, marsh hawks, and rough-legged hawks. Bald eagles have been sighted soaring above the sodium lease area during the winter, primarily along Piceance Creek. Long-eared owls, great horned owls, and possibly pigmy owls were also observed in the sodium lease area. Birds that may nest in the area in some years include the red-tailed hawk and great-horned owls. Because large raptors commonly return to a site after a year or two, these birds may nest on the sodium lease tracts during some years and not in others.

Sage Grouse

Sage grouse is an important gamebird in northwestern Colorado. Although sage grouse may winter sporadically on portions of the sodium lease area, no leks are known to occur within the project area or the sodium lease area (LGL, 1981; ECI, 1976; BLM and CDOW, 1977). A known historic lek was located near the oil shale Tract C-a airstrip. This lek has reportedly been abandoned (LGL, 1981).

Sage grouse do not appear to be a frequent or common inhabitant within the project area. Neither sage grouse nor sage grouse sign were observed in the project area during the June 1984 spring sage grouse survey. During the approximately ten man-day visit to the project area in July 1984, no sage grouse or sage grouse sign were observed. Furthermore, few sage grouse sightings were made during the 1980-1981 study (LGL, 1981). In April, one male grouse flushed and flew across the sagebrush flat on 84 Mesa, 1.75 miles NNE of the junction of Yellow Creek and Stake Springs Draw. Some sage grouse sign was found on the sagebrush flat 1.25 miles SE of the junction of Yellow Creek and Stake Springs Draw. One grouse was flushed near this site in midwinter during the course of other work (LGL, 1981). This area is reportedly near a sage grouse winter concentration area (BLM and CDOW, 1977).

In February of 1984, a number of sage grouse--up to 35 birds—were observed for a period of about one week, near Ryan Gulch Road in the vicinity of the access road (Clark, 1984). Thus, it is possible that some sage grouse winter on the southwestern portion of the sodium lease area between Yellow Creek and Ryan Gulch. However, because only one grouse and little grouse sign were seen during the 1980-81 surveys, its importance as winter habitat is probably minimal (LGL, 1981). Furthermore, Morris (1984), Lockhart (1984), and Hollowed (1984) have noted that the project area is not a sage grouse concentration area, but that sage grouse probably use this area occasionally during migration or infrequently as a wintering area.

3.10.3.2. Large Mammals

Mule Deer

The Piceance Basin supports one of the largest migratory mule deer herds in North America, and it winters the nation's largest herd. Numerous studies have also indicated that mule deer are the most abundant large mammal in the Piceance Basin and the Colorado River Valley (C-b Shale Oil Project, 1976; Rio Blanco Oil Shale Project, 1977; LGL, 1981; BLM, 1980). The deer population has fluctuated dramatically in the Basin since the 1950's, primarily due to the severe winters, condition of the winter range, and habitat destruction (BLM, 1984b). Although the deer herd was on the increase in recent years since the massive die-off during the 1978-1979 winter, the winter kill during the 1983-1984 winter may be significant (Morris, 1984). However, recovery normally progresses rapidly to mean population figures of about 24,000 animals (BLM, 1994).

Game Management Unit 22, which circumscribes the Basin, is consistently among the top deer harvest areas in Colorado. In 1978 it accounted for 10 percent of the state's entire deer harvest. The post-hunt deer count in the Piceance Basin for 1983 was 27,398 + 5,187; for 1982 the count was 16,605 + 4,017; and the 1981 deer count was about 21,014 + 6,118. The Colorado Division of Wildlife's (CDOW) goal for this Game Management Unit is about 40,000 animals (Morris, 1984).

Observations of mule deer indicate that they utilize a variety of cover and habitat types. During the summer, they tend to occupy higher elevations and mountain shrub, aspen, and Douglas-fir vegetation types provide the primary summer range. However, during the winter months, mule deer concentrate in lower elevation habitats such as sagebrush, pinyon-juniper, riparian, and agricultural habitat types located below 7,400 feet elevation. The sodium lease tracts are used by deer exclusively during the winter. Results of the 1980-1981 deer survey indicate that mule deer use the lease area from September to May, with the heaviest use occurring in March and April (LGL, 1981). Generally, occupation of the sodium

lease tracts begins in September and deer densities increase through January as snow accumulations at higher elevations force descent to late winter ranges. Deer remain in the lease area through April and essentially vacate the vicinity by late May. In addition, fall and spring migrations in September-October and April-May involve concentrated deer movement across the lease area (Figure 3-7).

Approximately 70 percent of the winter range encompassed by the lease tracts is considered severe winter range (Figure 3-7). These specifically defined winter ranges are key to herd sustenance during winters of unusually severe and prolonged inclement weather (large snow depth, very low temperature) when adjacent winter range resources are unavailable or inaccessible.

Deer make differential use of winter ranges by season and vegetative type. Deer populations are not static during the winter months; they tend to follow snowmelt in search of favorable habitat. During particularly cold weather and during February and March the deer are less mobile and tend to remain in one area, although they occupy areas of favorable habitat. During the winter months deer use chained pinyon-juniper and pinyon-juniper woodlands where preferred shrub forage is most available. Beginning in late February, deer make increasingly heavy use of hay meadows and sagebrush bottoms as succulent herbaceous vegetation begins growth. Deer use of these winter ranges varies considerably year-to-year depending upon herd size and winter weather conditions.

Pellet group counts and aerial surveys were conducted on the sodium lease area during the winter of 1981. Winter deer densities in the chained pinyon-juniper habitat were calculated to be 67 deer/square mile, 26 deer/square mile in pinyon-juniper woodland, and 13 deer/square mile in sagebrush (LGL, 1981). It should be noted that in 1980 and 1981 the Piceance deer herd was at one of its lowest recorded population levels, and the winter conditions were unusually mild. Higher deer density would be expected in the lease area winter ranges during more severe winters and with deer populations at higher levels. In 1978-79, Colorado Division of Wildlife estimated overall population densities for local winter ranges to be 54 deer/square mile and for the severe winter range, 80 deer/square mile.

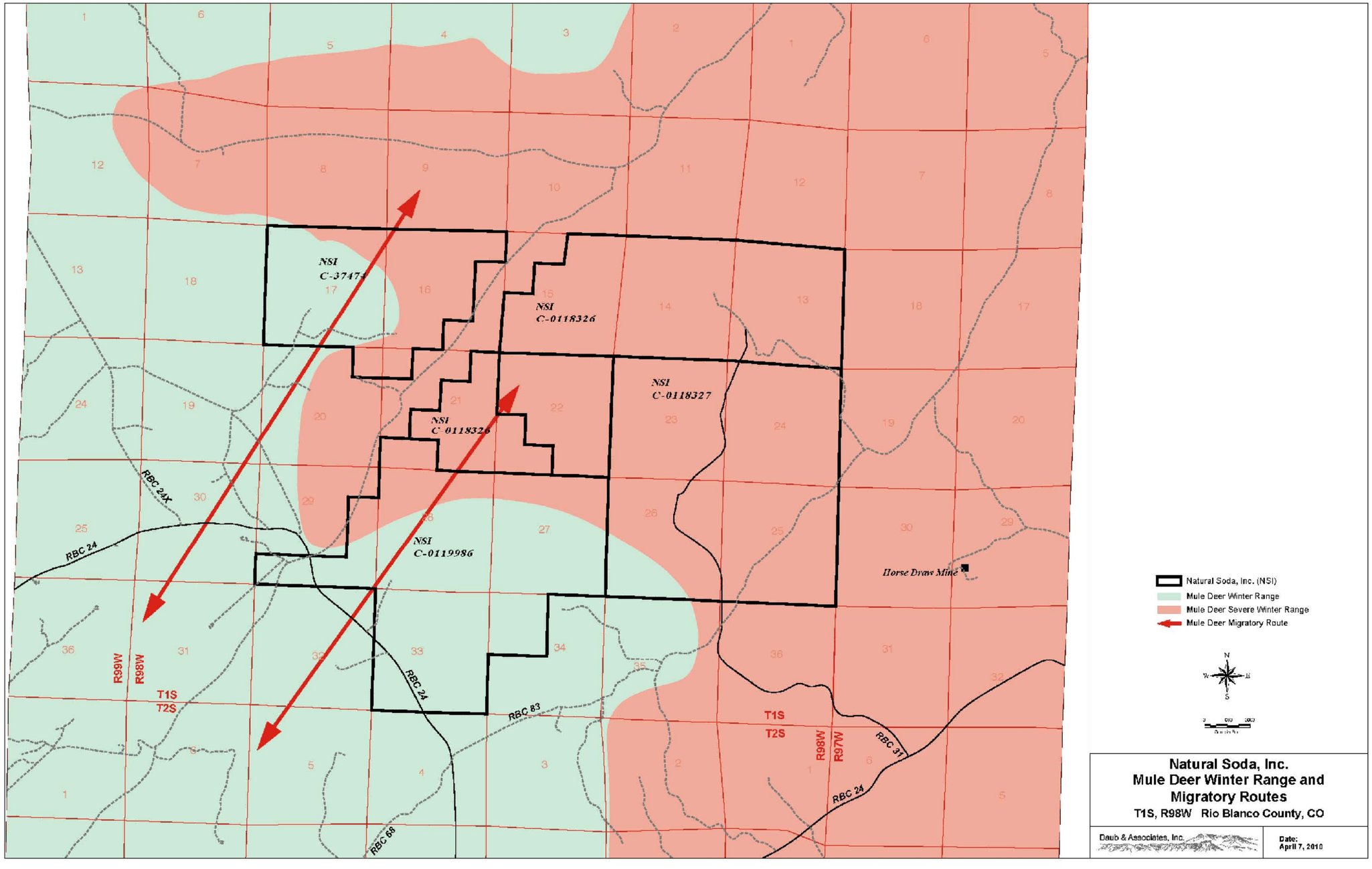

Figure 3-6. Mule Deer Winter Range and Migratory Routes.

The results of the browse species preference test indicates that deer prefer antelope bitterbrush on the lease area during the fall and the early winter months before the snow cover becomes too great (LGL, 1981). After this time, the deer seem to prefer (in order of preference) sagebrush, pinyon, and juniper, all of which become the predominant browse species.

Feral Horses

Wild horses have been reported in the Piceance Basin since the 1880's when the first settlers arrived in the Meeker area (BLM, 1984b). In the northwestern portion of the Basin – within the White River Resource Planning Area – three Wild Horse Units, including the Piceance-East Douglas HMA, West Douglas HA, and the North Piceance HA, encompasses about 597,942 acres of both private and BLM land (BLM, 1994). The Piceance Basin feral horse herd was initially estimated in 1975 to be about 143 head. The 1983 population was estimated to be about 274 head. The 1994 population estimate of 516 was extrapolated from an aerial census done in March 1993 with a 20 percent adjustment for annual population recruitment. The population of the Piceance-East Douglas herd, prior to the spring 2005 foal crop, was estimated to have decreased from 319 in 1994 to 290 (BLM, 2005). These horses are distributed among the three wild horse units that occur in ten livestock allotments within the planning area (BLM, 1994).

Several factors influence feral horse migration within their range in the Piceance Basin. First, fences greatly influence the movement of these horses between allotments; they generally move between allotments that are incompletely fenced. Horse migration has been observed over the Cathedral Bluffs, thereby allowing the possibility of breeding between the Douglas Creek herd and the Piceance Basin herd. Second, seasonal factors influence the migration of the horses on their range. During the winter months, the horses concentrate on windswept and south facing slopes where the forage is more readily available. During the summer months,

horses must concentrate near water sources. The most important water sources in the Piceance Basin area are Yellow Creek, Stake Springs, Box Elder Creek, Corral Gulch, Duck Creek, and Spring Creek. These water sources are important because they are perennial sources of water; during the summer season many of the intermittent sources dry up. There are an additional 19 developed springs and 37 reservoirs within the White River Planning Area (BLM, 1984b).

Wild horses must compete with livestock, as well as with the elk and large mule deer herds for forage. Increased energy development in the Piceance Basin resulting from the oil and gas and the oil shale industries have forced the horses to increase their range. Consequently, they are currently found in areas outside of their recognized range as delineated by the Wild and Free-Roaming Horse and Burro Act of 1971 (BLM, 1984b).

Although several of the important sources of water are near the project area, few horses have been observed on the lease area. During the monthly aerial surveys conducted from August 1980 through July 1981, eight sightings of horses or horse groups were made. The horse groups ranged in size from one to seven animals, with most of the groups consisting of 3-4 horses. Most of the horses were observed in the large area of sagebrush habitat about 2-3 km east of the confluence of Yellow Creek and Stake Springs. Observations of the horses during the 1980-1982 study indicated that the horses preferred the open habitat areas (sagebrush and chained pinyon-juniper) over wooded or dense sagebrush habitats (pinyon-juniper or greasewood-sagebrush). This is probably due to the fact that better quality forage exists in the sagebrush and chained pinyon-juniper habitat types.

Carnivores

Results of the study conducted on the sodium lease from 1980-1981 indicated that six species of mammalian carnivores inhabit the area. These species include coyote, gray fox, long-tailed weasel, badger, striped skunk, and bobcat. Of these, the coyote appears to have the highest population.

Six additional species have been reported to occur in the vicinity: raccoon, ringtail, red fox, ermine, black bear, and mountain lion (BLM, 1984b). These species may not be present on the sodium lease tracts because of a lack of suitable habitat, or they may be present in such low numbers that they were not detected (LGL, 1981). Recent information obtained for the Basin suggests that these species are present in such low numbers that ordinary detection methods are not adequate. BLM (1984b) reported that mountain lions are distributed throughout the entire Basin and prefer areas of dense mountain shrub, or pinyon-juniper cover on rocky, rugged terrain. A current population of only 15 animals is estimated for the entire Basin and that population is currently exhibiting a downward trend. BLM (1984b) also reported that black bear habitat of adequate quality is scarce in the Piceance Basin. One sighting of a black bear was made along Yellow Creek in 1981 (Clark, 1984). It is estimated that the population is currently stable, though no current population estimates are available.

3.10.3.3. Small Mammals

Rodents

During the study conducted on the sodium lease area, 36,000 trap nights were expended and data were collected on approximately 10,000 individuals (LGL, 1981). Eleven species of rodents were captured, with deer mice and least chipmunks comprising 92 percent of the total capture. Other species observed on the site include the golden-mantled ground squirrel, Apache pocket mouse, Colorado chipmunk, sagebrush vole, montane vole, desert woodrat, bushy-tailed woodrat, pinyon mouse, and the northern pocket gopher. Also captured were a juvenile cottontail rabbit and five long-tailed weasels.

The three most abundant species captured were deer mice (69 percent), least chipmunks (23 percent), and golden-mantled ground squirrels (5 percent). These species occurred on all trapping grids, while most of the other species occurred on less than half of the grids. Deer mice was the only species that was captured during

every month of the year. Other species were captured less frequently for several probable reasons: 1) because they hibernate during the colder portions of the year; 2) they occurred in lower densities, and 3) were less trappable than the other three species.

The total number of individuals for all species of rodents captured was the highest in the greasewood-sage bottom habitat type and lowest on the sagebrush habitat type. However, the total number of individuals was inversely related to both the total number of species of rodents and the rodent species diversity. Grids with high numbers of species of rodents and high rodent species diversities had smaller total numbers of individuals than did those with few species and low species diversities.

Rabbits and Hares

Rabbit and hare species encountered on the site during the 1980-1982 study included Nuttall's cottontail, desert cottontail, black-tailed jackrabbit, and the white-tailed jackrabbit. During this period, a total of 37 individuals were observed. Cottontails were the most commonly observed species on the site--81 percent of the total observations. Information obtained for the Piceance Basin region likewise indicates that cottontails are also the primary small game mammal in the Basin. Cottontails inhabit all vegetation types, with the highest populations occurring in the greasewood-sagebrush draws (BLM, 1984b). White-tailed and black tailed jackrabbits were less frequently observed and accounted for 16 and 3 percent of the observations, respectively (LGL, 1981).

3.10.3.4. Reptiles and Amphibians

During the 1980 and 1981 studies, one species of frog, three species of lizard, and two species of snake were observed in the sodium lease area. Species observed included the chorus frog, short-horned lizard, sagebrush lizard, eastern fence lizard, gopher snake, and the western terrestrial garter snake. In terms of habitat affinity, the chorus frogs were heard in the vicinity of Yellow Creek in the wet area. The

short-horned lizard and sagebrush lizards were observed in all habitat types except in the greasewood-sagebrush bottom habitats. The western terrestrial garter snake was observed in the bald habitat.

3.10.4. Threatened or Endangered Species

Six federally listed wildlife species of special concern are found within the Piceance Basin region: the bald eagle, peregrine falcon, whooping crane, black-footed ferret, Colorado River squawfish, and the humpback chub. In addition to the federally listed species, several Colorado State listed endangered species may be found in the region: the greater sandhill crane and the Colorado River cutthroat trout. Bald eagles are the only known threatened or endangered species which occasionally use the sodium lease area. No critical habitat has been identified for federally listed species in the Basin (BLM, 1984). Furthermore, no essential habitats for threatened and endangered species are known to occur in the project area (CDM, 1983b).

3.10.5. Seasonal Use

Wildlife species require special habitat features before any given area will be utilized by a species. Seasonal use by wildlife species of special concern needs to be seriously considered during project development and operation. The most important habitat feature within the arid west is the distribution and availability of water. Table 3-19 illustrates the species of special concern identified by BLM and the important habitat features for these species (BLM, 1984b).

Seasonal use of the project area by wildlife species of special concern is limited primarily to mule deer. Mule deer use the sodium lease and project area exclusively during the winter and these areas are considered to be important winter habitat. Other species of special concern which occasionally use the project area include raptor species. Red-tailed hawks, Cooper's hawks, long-eared owl, and possibly sharp-shinned and goshawks may nest in the pinyon-juniper woodlands habitat type within the project area. The area may be occasionally used by mountain lions in

conjunction with mule deer use during the winter months. Elk may migrate across the project area during some years. However, CDOW states that the area is not an important migratory route, and is not an area that is used frequently by elk (Morris, 1984). Individual sage grouse may use nearby areas as wintering grounds during some years. But neither the project area nor any of the nearby area is considered to be important to sage grouse (Morris, 1984). As noted in Section 3.10.4, Threatened and Endangered Species, bald eagles may occasionally use the sodium lease area (BLM, 1984a). The project area however, is neither an important wintering area, nor a high use area for bald eagles. It is, therefore, unlikely that bald eagles will be affected by project development. It is unlikely that the other wildlife species of special concern discussed in Table 3-23 will be impacted by development of the project. Additional details concerning seasonal use of the project area by wildlife species is discussed in the sections presented for each species.

TABLE 3-23

IMPORTANT HABITAT FEATURES

Species	Habitat Features
Mule Deer	Severe Winter Range Winter Concentration Areas
Elk	Summer Range
Mountain Lion	Winter Concentration Areas
Sage Grouse	Winter Range Brood Habitat Strutting Grounds (leks) Nesting Habitat (less than 2 mi from lek)
Raptors	Nesting Habitat (includes nest sites and feeding areas)
Colorado River Squawfish	White River
Humpback Chub	White River
Bald Eagles	Wintering Areas Concentration Areas
Colorado River Cutthroat Trout	Trappers Creek

Source: BLM 1984b

Table 3-23. Important habitat features for various species of animal found in the project area.

3.10.6. General Effects on Wildlife

3.10.6.1. Construction Phase

During construction of the mine plant, approximately 155 acres of vegetation was removed. Consequently, some small mammals and big game animals, such as mule deer, were disturbed during the construction. In addition to some initial habitat loss, the increased human activity in the project area had a minor impact upon the wildlife. Some individuals and very few species were displaced due to this activity, while most wild life have become accustomed to the project activity and operations. Appearances of deer, elk, and other small mammals are often seen in the vicinity of the plant and well field.

3.10.6.2. Operating Phase

Although minor habitat loss has occurred in an initial displacement or loss of animals from the area, most of the animals have returned to the project area during the operating period. It has been shown on several mines in the Rocky Mountain region that some species, namely mule deer, are attracted to the mine areas for several reasons. First, hunting is often not allowed within the mining area. Second, since livestock grazing is limited or prohibited in the mine areas, forage often increases. The cumulative effect results in a safe habitat with increased forage, and an increased deer population.

Throughout the life of the project, wildlife will be affected by the project development and by the increased human population. The increased noise, hunting pressure, human activity, and road kill will affect wildlife populations. Due to the limited scale of the project operations, the overall impact of the project will not significantly alter the animal populations or distribution, and has not affect the economic value of hunting in the area.

The following discussion outlines the minor impacts to major groups of wildlife species affected by the development of the project.

Mule Deer

The establishment of the well field and plant facilities, including roads, buildings, processing facilities, and topsoil storage areas, necessitated the removal of some wintering habitat and feeding areas. Approximately 100 acres of the well field will infringe on mule deer severe winter range, of which about 50 acres has been disturbed.

The number and extent of developments in the Piceance Basin area will influence the ultimate impact on wildlife. Severe climatic conditions (e.g., low temperatures and deep snows) when added to the impact of habitat alteration and/or reduction, will affect the animals by increasing their concentration in the major use areas. However, construction of the well field has resulted in smaller areas of disturbance located within large contiguous areas of one habitat type. In addition, reclamation has resulted in increased deer populations in the area.

Increased vehicular traffic to and from the project area will increase the probability of deer loss.

Black Bear and Mountain Lion

Black bear and mountain lions have not been observed near the project area. Furthermore, these species generally avoid human contact if possible, and will not be directly affected by the development of the project. They may be, however, indirectly affected by the loss of habitat and range.

Small Mammals and Rodents

Rodents have been killed either by heavy equipment operations or indirectly by loss of habitat. Total numbers lost in any one year would depend on the density of

individual species in each of the areas that have been developed. Other small mammals such as rabbits have adapted to the NSI operations. Predator species, including raptors, that are dependent upon these rodents as a food source, are common in the area and do not appear to have been adversely affected.

Raptors

Although raptor species have been sighted in the vicinity of the project area, impacts upon these species are likely to be insignificant since the total area impacted by mining operations is insignificant. Furthermore, increased rodent populations after reclamation may enhance raptor use of the area.

Sage Grouse

The sodium lease area consists of low quality habitat for the sage grouse species, and no sage grouse have been observed within the project area. Development of the project has not affected sage grouse or their habitat.

Songbirds

Species in this group would be affected by some limited loss of nesting sites and food sources during operations. The impacts have been very minimal. Because the well field configuration has resulted in small areas of disturbance within large, contiguous areas of habitat, habitat diversity has increased. The total number of birds initially affected was low, and indeed, because additional habitat has been created due to patchy habitat configuration of the well field, songbird populations have likely increased.

Amphibians and Reptiles

Impact on these species is expected to be low because of the few species observed during the study.

Threatened and Endangered Species

Results of the wildlife studies indicate that, except for occasional use by bald eagles (Section 3.10.4) no threatened or endangered species occur at the site. No critical or essential habitats for threatened or endangered species are found within the boundaries of the project area.

3.10.7. Mitigation

The rules and regulations promulgated by the Colorado Division of Reclamation, Mining and Safety (CDRMS) in August 2006 provide reclamation performance standards for all mining operations. The Regular Mining and Reclamation Permit--administered by the CDRMS--requires that a complete reclamation plan be submitted with the permit application. The reclamation plan must include a description of how the plan will be implemented as it applies to each requirement of Rule 6--the reclamation performance standards. The reclamation performance standards require the operator to discuss how the project will protect wildlife on the mine site, processing site, and along access roads to the mine site. Special consideration must be given to critical periods in the life cycle of those species requiring consideration. For example, critical wintering areas, calving grounds, migration routes, raptor nests, etc., must be taken into account. If wildlife habitat management is a part of the reclamation plan, reclamation must be directed toward encouraging wildlife diversity, and rehabilitating or improving wildlife habitat.

In addition to the CDRMS rules and regulations, the U.S. Fish and Wildlife regulations--CFR, Title 50, Part 13, require protection of all threatened or endangered wildlife species.

Section 8.0 (Reclamation Plan) of this mine plan addresses the reclamation and mitigation issues surrounding reseeding, regrading, and topsoil. Mitigation for flora and fauna is ongoing throughout the life of the mine plant. Specific measures taken can be found below in Section 3.10.7.2 Mitigation Measures by Species.

3.10.7.1. General Measures

Environmental impact mitigation measures are most appropriately described in terms of the types or groups of animals which are being protected; explicit control measures by animal group are discussed in Section 3.10.7.2. Generally however, the types of mitigation measures will consist of the following; (1) avoidance and minimization of damage; (2) human activities control; and (3) monitoring of selected species.

During all phases of future and current construction and operation, the operator will avoid disturbing any area unnecessarily, and will attempt to minimize damages to the environment as a result of project development. Examples of such avoidance and minimization of damage could include the following:

1. Restriction of traffic to existing roads to minimize possible habitat destruction.

2. Prompt reclamation of disturbed areas using plant species which will serve to meet reclamation requirements and facilitate wildlife habitat restoration. Vegetation ultimately governs the type and extent of wildlife utilization in reclaimed areas.

3. Fences will be constructed so as not to impede wildlife migration.

4. State and federal rules and regulations, as well as permit requirements and stipulations, will be followed to prevent and minimize damage to wildlife species.

Human activities will be monitored and controlled throughout any future construction and operation of the project. Human activities could be controlled in several ways to reduce wildlife impacts in the project area. Such control measures will include the following:

1. Restricting hunting on the property will increase human safety and reduce wildlife harassment and impacts.

2. Vehicular traffic on the property will be restricted to established roads; speed controls will be established to reduce wildlife road kill.

3. Workers will be educated about potential wildlife impacts, permit requirements to protect wildlife, and necessary control measures to minimize wildlife impacts.

3.10.7.2. Mitigation Measures by Species

Mule Deer

Mitigation of impact on these species will require effective and rapid restoration of disturbed areas. Disturbed areas will be restored by reseeding with grasses, forbs, and shrubs as described in the Reclamation Plan (Section 8.0).

Human activity in all areas will be controlled to reduce adverse impacts (harassment, poaching, road kills, etc.) on the deer. All travel will be restricted to existing roads to minimize possible habitat destruction. Speed controls will be established in the vicinity of the project area to reduce road kill. Carpooling among project employees will be encouraged to reduce the potential for road kills of wildlife.

Any fences surrounding the project area will be built so that they do not impede wildlife migration, but will prevent livestock from entering the project area. Where consumption of contaminated water would be detrimental to animals, a fence will be built to prevent access by wildlife and livestock.

In the 17-year history of the project, impacts on severe winter range (in the well field), occurred at a rate of approximately 3.5 acres per year during years 3 through 10 and years 15 through 17. During all other years, construction and operation of the project has taken place on winter range. All impacts in the foreseeable future are anticipated to be on winter range, as mine plant expansion is taking place to the west. A total of about 250 acres will be disturbed by the project, assuming a 40-50 year mine life. Of this, approximately 50 acres is anticipated to be in severe winter range, and approximately 200 acres will be in winter range areas.

Because construction of the well field resulted in a habitat configuration characterized by small areas of disturbance (3.5 acres per year) within larger areas of single habitat types, the total habitat diversity has increased within the project area. This increased habitat diversity has resulted in higher deer populations upon completion of reclamation.

Raptors

Impacts on raptors could be mitigated in several ways:

1. Prior to removal, trees will be individually examined for evidence of raptor nesting. This is especially important during the spring nesting period.

2. All power lines could be constructed in accordance with standards established in the USDA REA Bulletin 61-10. This would help reduce raptor loss by electrocution.

3. Rapid reclamation of disturbed areas could result in an influx of rodents that will provide an increased food source.

4. Increased food source after reclamation and increased habitat created within the well field is likely to increase nesting and hunting areas.

Small Mammals

The reclamation practices described for mule deer has also benefit these species. Rodents respond to the increase in food availability from young forage plants; small carnivores and raptor species have benefited from the increased rodent population.

Songbirds

Rapid reclamation and revegetation -- which will provide food and cover for these species -- has proved to be the best mitigation measure for these species. The

more successful the reclamation program, the more rapidly these species will reestablish.

Amphibians and Reptiles

Disturbed areas should be reclaimed as soon as possible to minimize the impact of lost habitat.

3.10.8. Monitoring Plan

It is stated in the rules and regulations promulgated by the CDRMS that if wildlife habitat management is a part of the reclamation plan, reclamation must be directed toward encouraging wildlife diversity, and rehabilitating or improving wildlife habitat. The reclamation standards require the operator to discuss how wildlife will be protected during all phases of the project. This information is contained in Section 3.10.7. In order to ensure that these requirements are fulfilled, monitoring of selected wildlife species will be required throughout the life of the project. The wildlife species selected for monitoring will be based upon discussions with the CDOW and special permit stipulations as discussed in the preceding sections. The monitoring sampling techniques will be based upon the species selected and the most appropriate method for that species.

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