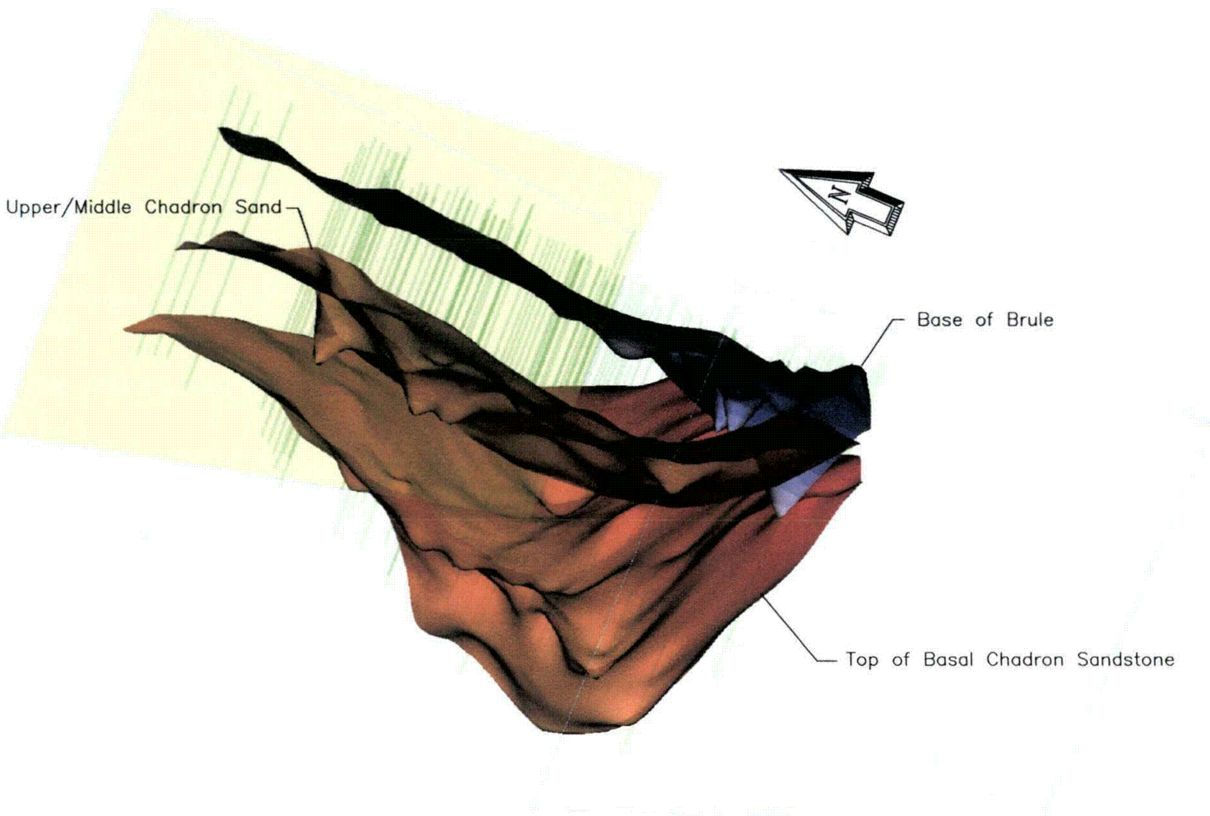


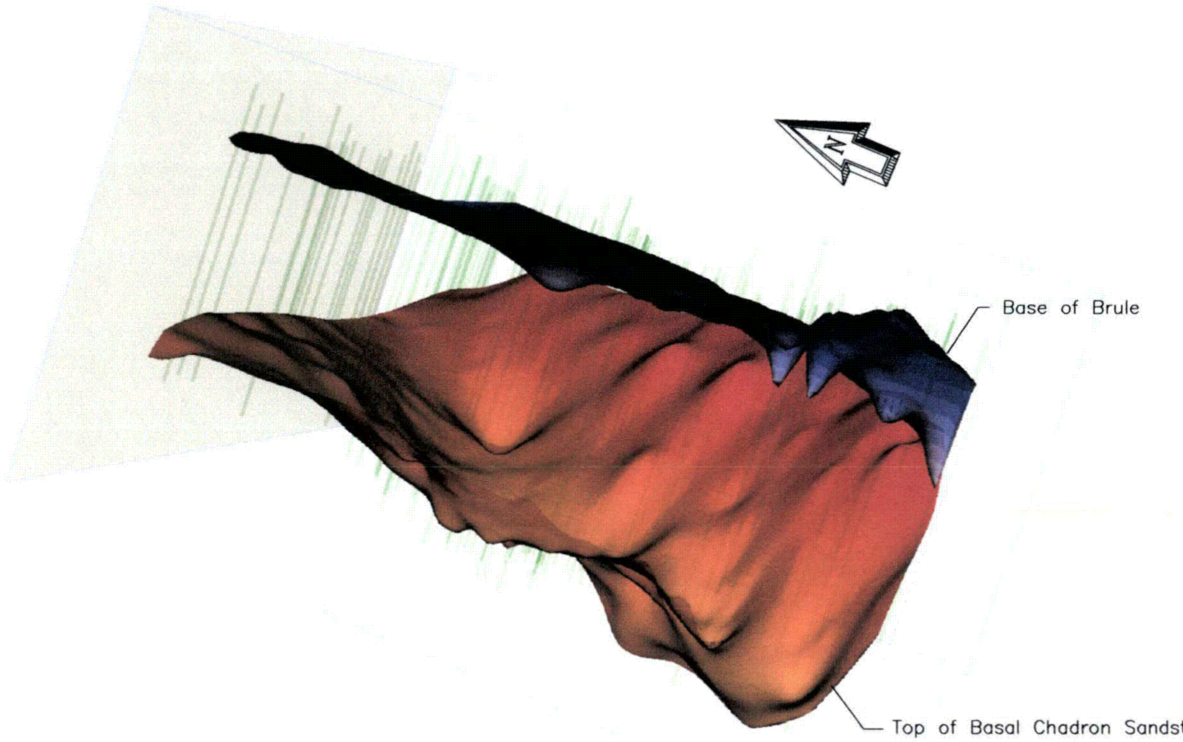
VERTICAL EXAGGERATION = 15x

CROW BUTTE RESOURCES, INC.

FIGURE 3.3-18
BASE OF BRULE, UPPER/MID CHADRON SAND
AND TOP OF BASAL CHADRON SANDSTONE
3-D VIEW LOOKING NORTHEAST

PROJECT: 223-37	DATE: MARCH 2007
DWG: Figure 2.6-18.dwg	BY: KRS CHECKED: HPD

Petrotek



VERTICAL EXAGGERATION = 15x

CROW BUTTE RESOURCES, INC.

FIGURE 3.3-19
BASE OF BRULE AND TOP OF
BASAL CHADRON SANDSTONE
3-D VIEW LOOKING NORTHEAST

PROJECT: 223-37	DATE: MARCH 2007	
DWG: Figure 2.6-19.dwg	BY: KRS	CHECKED: HPD

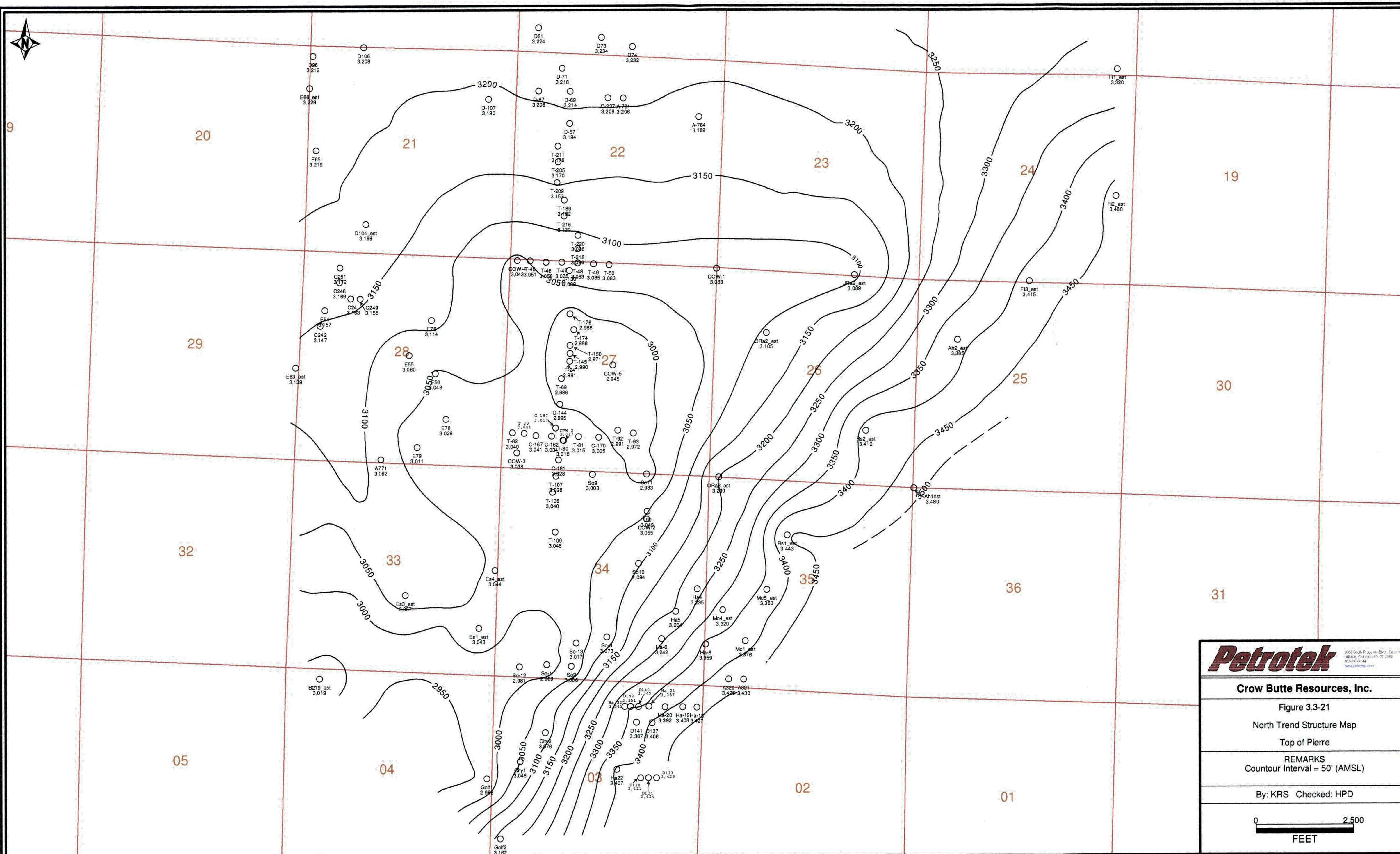
Petrotek

CROW BUTTE RESOURCES, INC.

FIGURE 3.3-20
TOP OF UPPER/MID CHADRON SAND
3-D VIEW LOOKING NORTHEAST

PROJECT: 223-37	DATE: MARCH 2007	
DWG: Figure 2.6-20.dwg	BY: KRS	CHECKED: HPD

Petrotek



Petrotek

Crow Butte Resources, Inc.

Figure 3.3-21

North Trend Structure Map

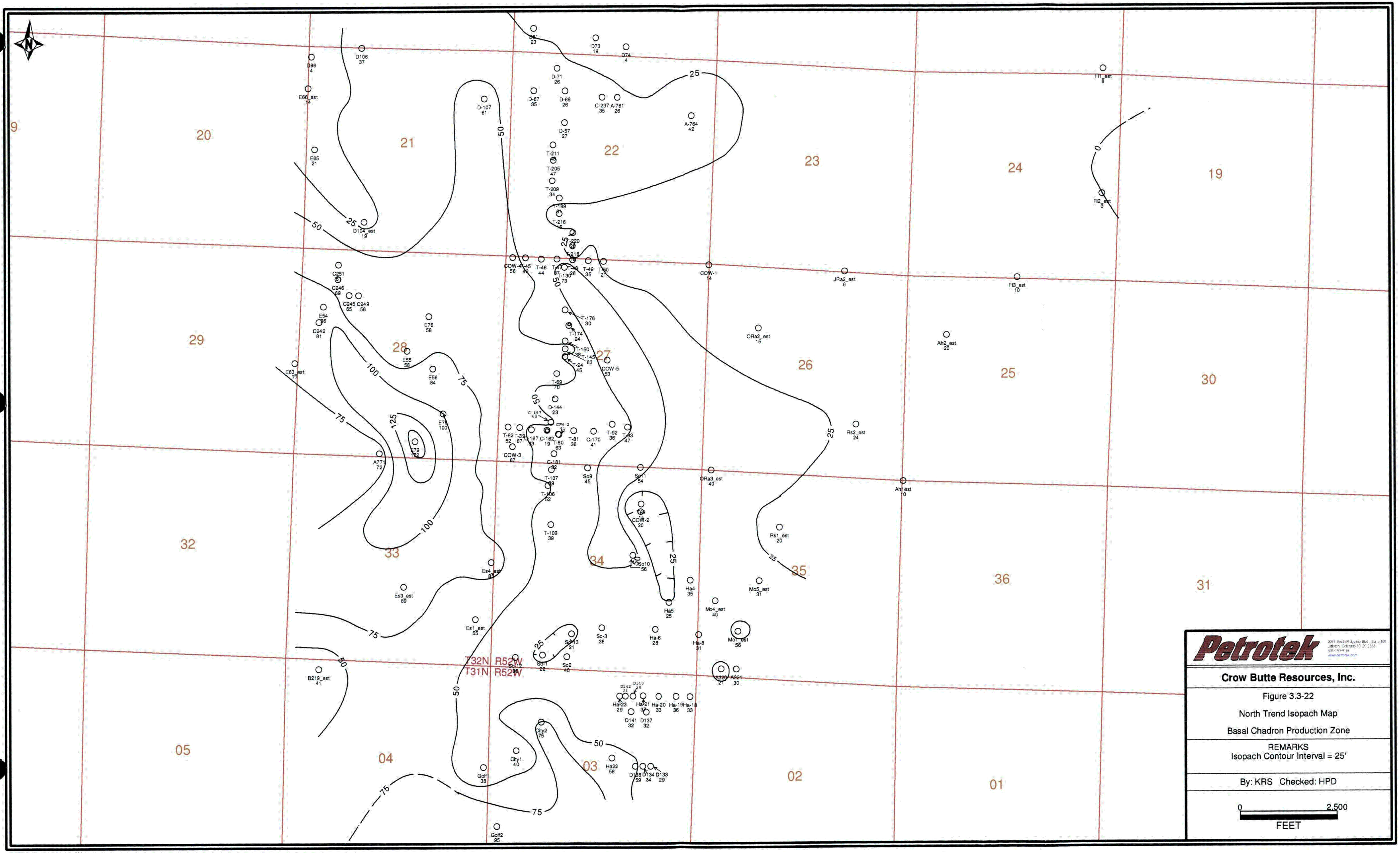
Top of Pierre

REMARKS
Countour Interval = 50' (AMSL)

By: KRS Checked: HPD

0 2,500
FEET

PETRA 3/14/2007 4:07:26 PM



Petrotek

Crow Butte Resources, Inc.

Figure 3.3-22

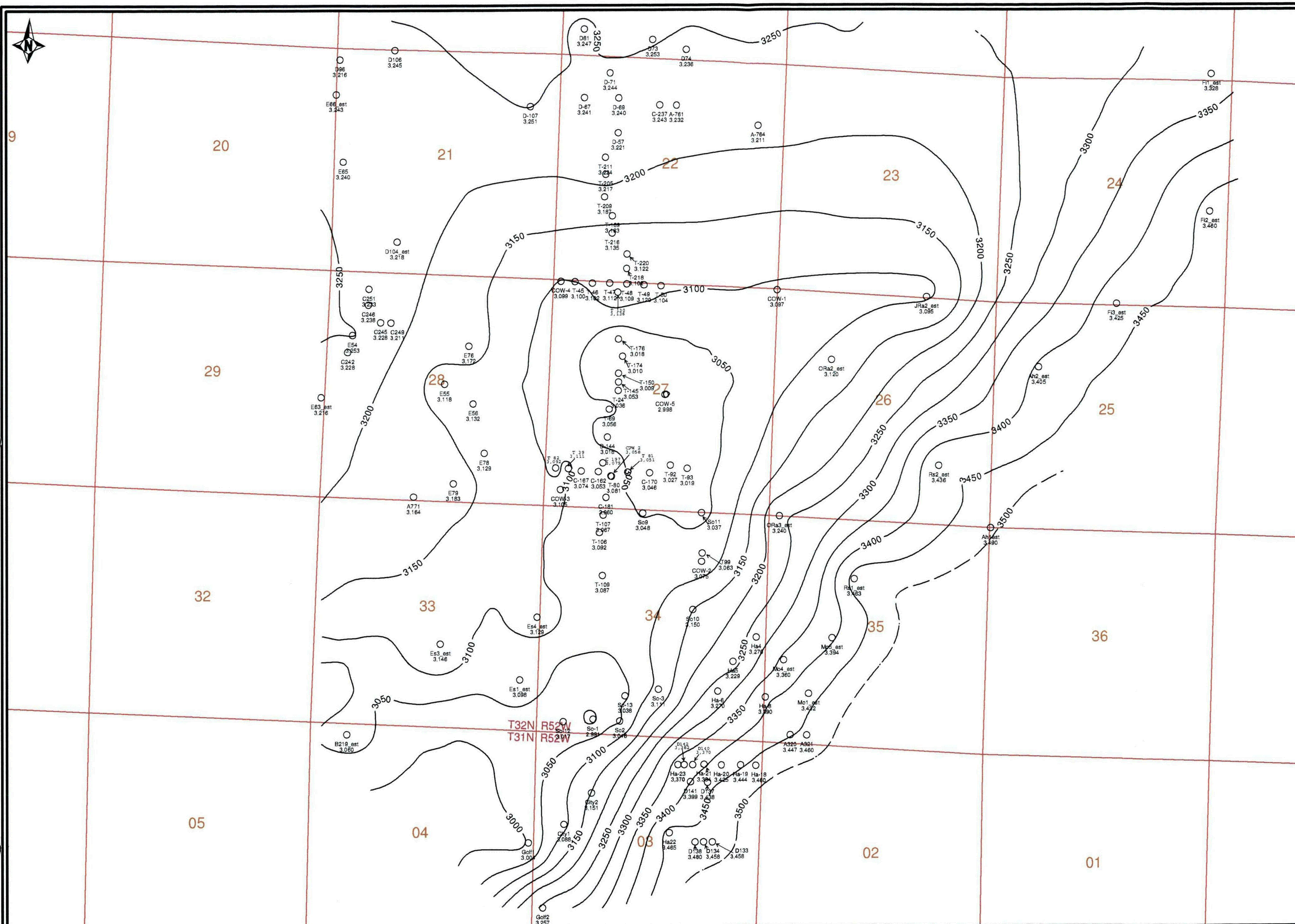
North Trend Isopach Map

Basal Chadron Production Zone

REMARKS
Isopach Contour Interval = 25'

By: KRS Checked: HPD

0 2,500 FEET



Petrotek

Crow Butte Resources, Inc.

Figure 3.3-23

North Trend Structure Map

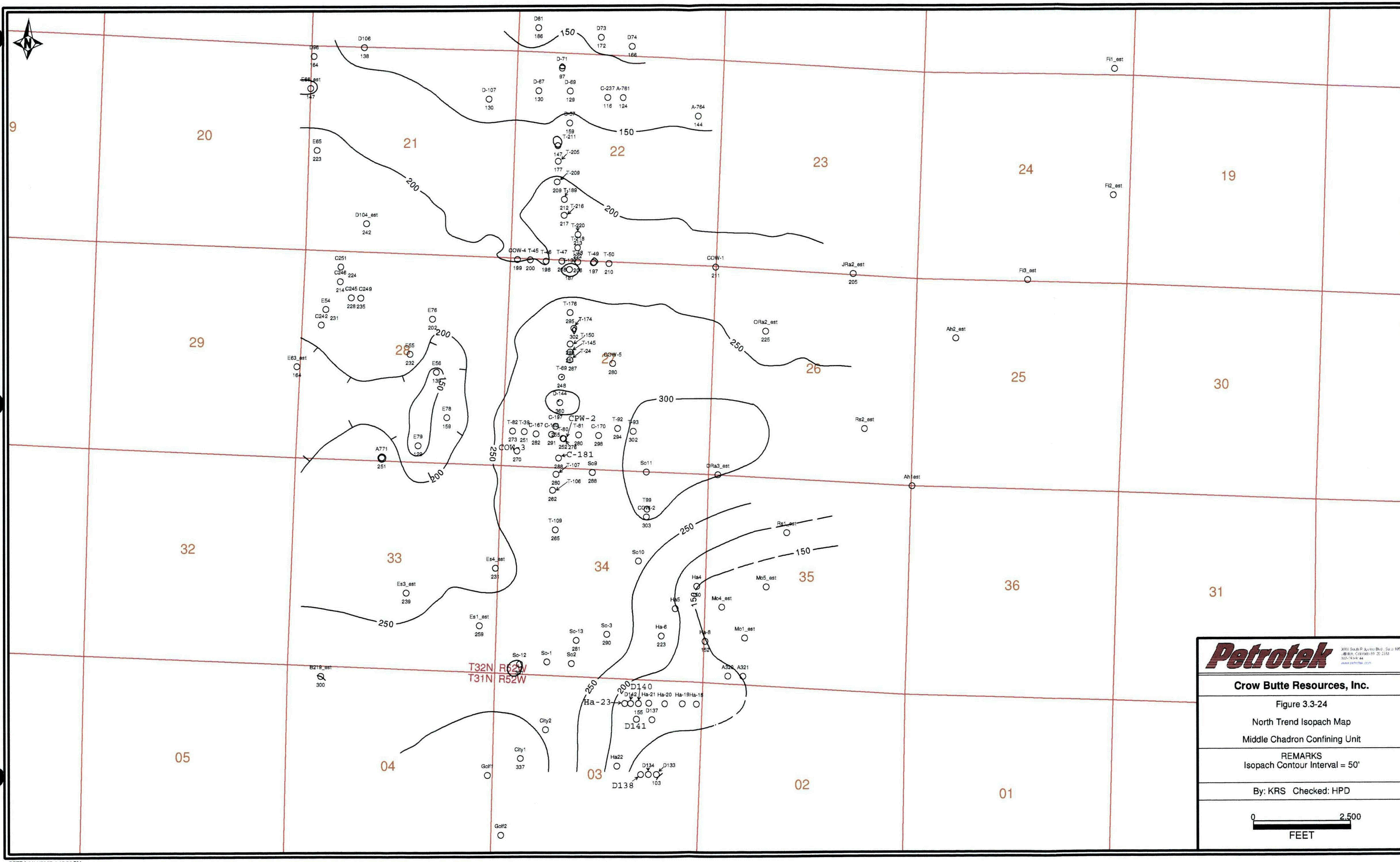
Top of Basal Chadron

REMARKS
Countour Interval = 50' (AMSL)

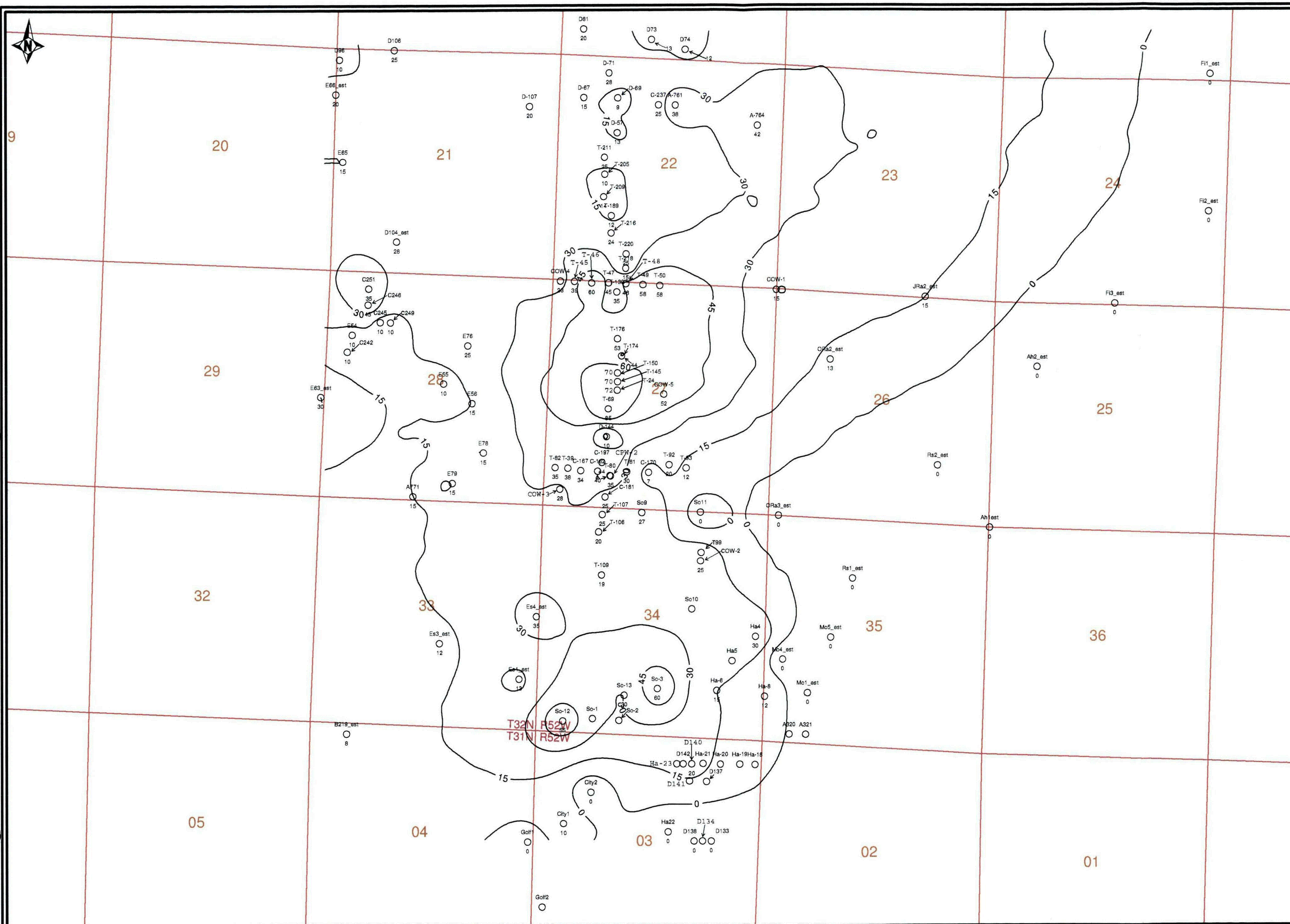
By: KRS Checked: HPD

0 2,500
FEET

PETRA 3/14/2007 4:22:57 PM



PETRA 3/14/2007 4:45:52 PM



Crow Butte Resources, Inc.

Figure 3.3-25

North Trend Isopach Map

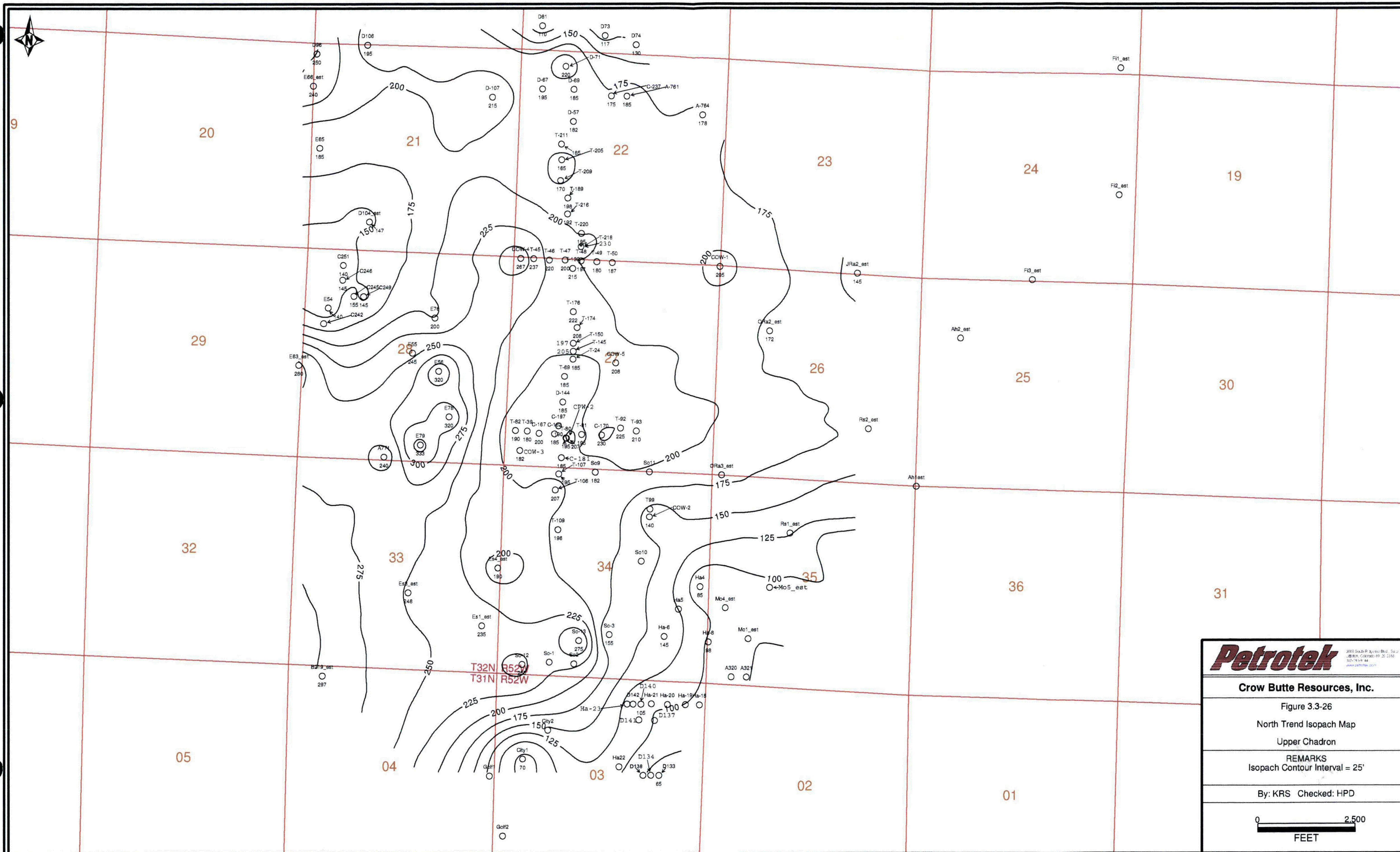
Upper/Mid Chadron Sandstone

REMARKS
Isopach Contour Interval = 15'

By: KRS Checked: HPD

0 2,500
FEET

PETRA 3/14/2007 5:16:58 PM



Crow Butte Resources, Inc.

Figure 3.3-26

North Trend Isopach Map

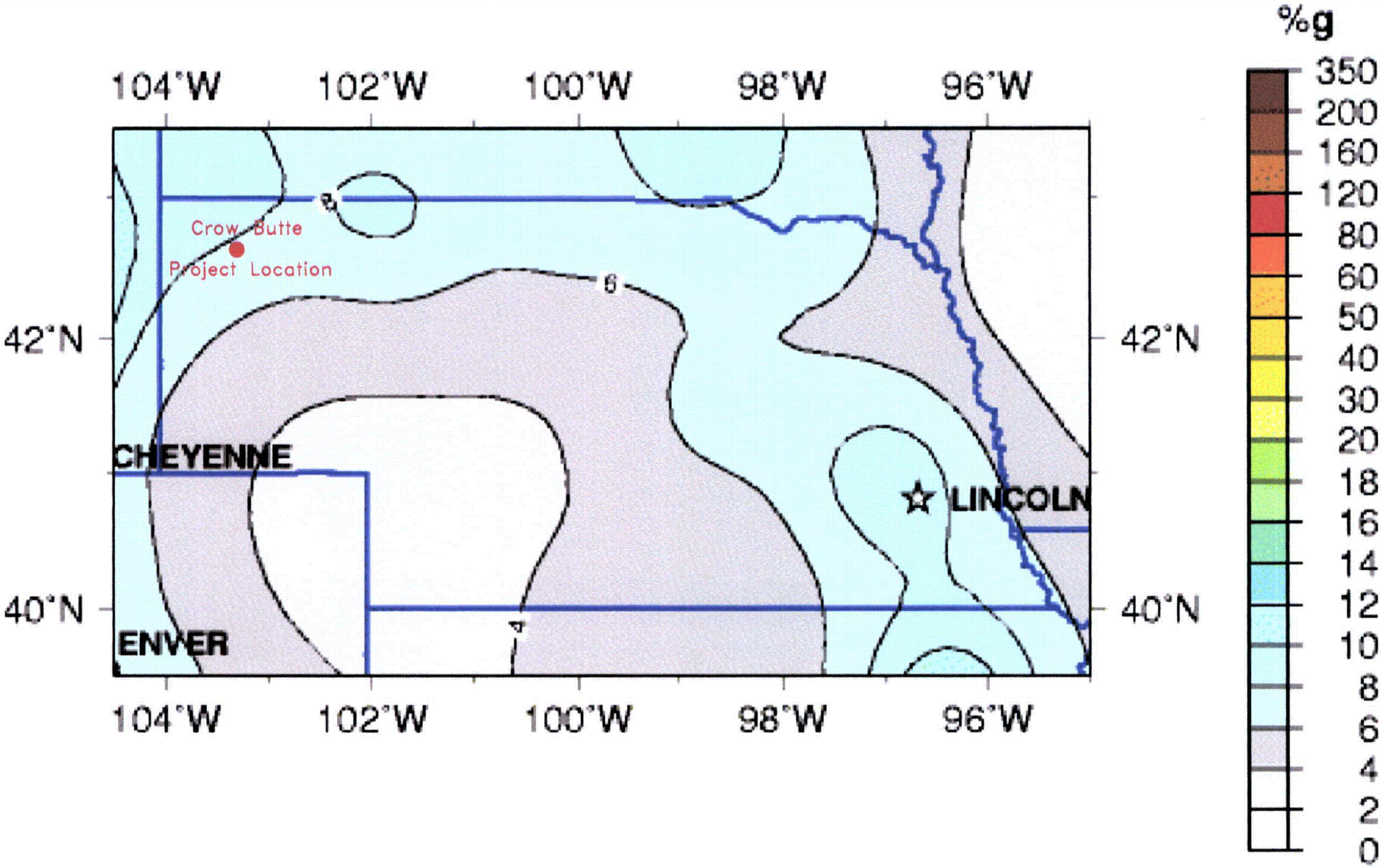
Upper Chadron

REMARKS
Isopach Contour Interval = 25'

By: KRS Checked: HPD

0 2,500
FEET

PETRA 3/14/2007 5:12:51 PM



LEGEND

Peak Acceleration (%g) with 2% Probabilty if Exceeedance in 50 Years
Site: NEHRP B–C boundary
National Seismic Hazard Mapping Project

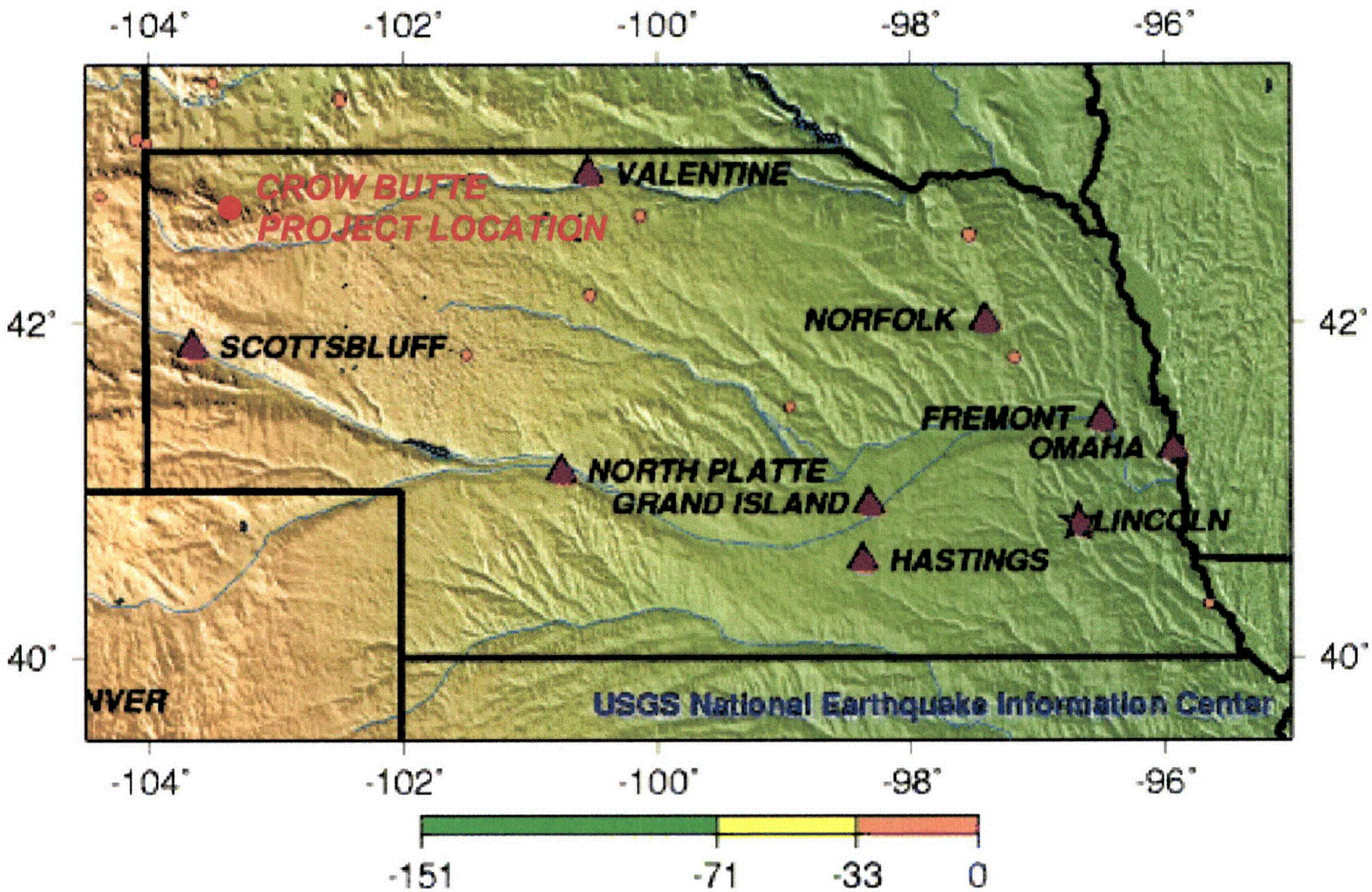
Source: USGS National Seismic Hazard Maps

CROW BUTTE RESOURCES, INC.

FIGURE 3.3-27
SEISMIC HAZARD MAP FOR NEBRASKA

PROJECT: 223–37	DATE: MARCH 2007	
NTLAAFig2.6–27.dwg	BY: KRS	CHECKED: HPD

Petrotek
10288 West Chatfield Ave., Ste 201
Littleton, Colorado 80127-4239
303-290-9414
www.petrotek.com



LEGEND

Purple Triangles towns; orange circles seismic events

Source: USGS National Earthquake Information Center

CROW BUTTE RESOURCES, INC.

FIGURE 3.3-28
SEISMICITY OF NEBRASKA 1990 – 2001

PROJECT: 223-37	DATE: MARCH 2007
NTLAAFig2.6-28.dwg	BY: KRS CHECKED: HPD

Petrotek

Source: NRCS, Soil Survey of Dawes County, Nebraska, 1977.

LEGEND

SrF MAP UNIT ID

MAP UNIT BOUNDARY

2000 0 1000 2000 3000 Feet

I:\CO001223\ACAD\1223 Figure 2.6-29.dwg

CROW BUTTE PROJECT

REGIONAL AREA BASE MAP

DAWES & SIOUX COUNTIES, NEBRASKA

FIGURE 3.3-29 NORTH TREND SOILS

Date:3/7/07 | Drawn:PBE | Fig.3.3-29

NEBRASKA

3.4 WATER RESOURCES

3.4.1 Water Use

The North Trend Expansion Area is drained by the White River, which flows to the northeast along the southern boundary of the proposed license area and through the 2.0-mile review area.

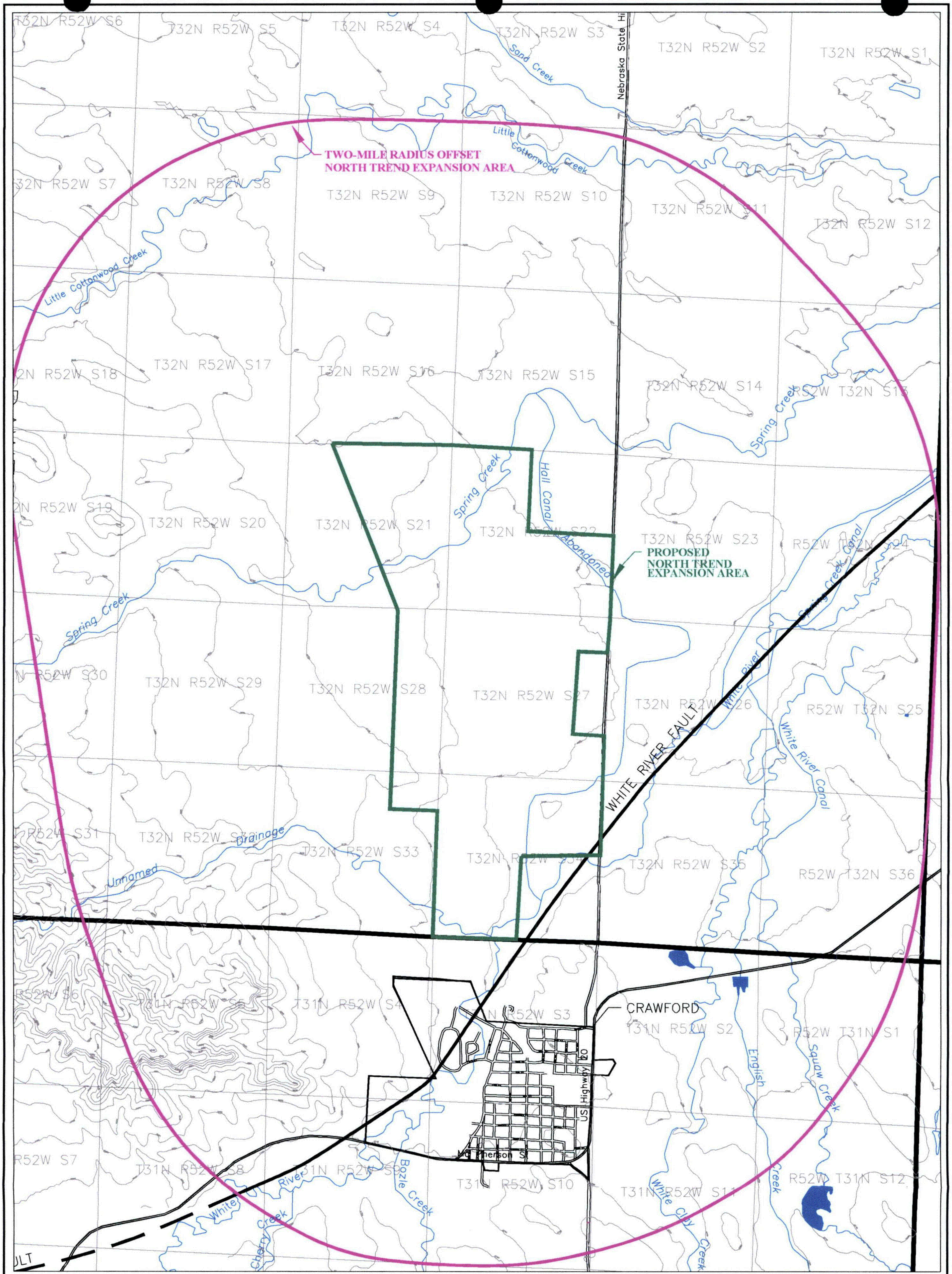
The White River is used to support agricultural production, wildlife habitat, and both warm and cold-water fish. For the period of record from 1931 to 1991, USGS data (USGS, 2004) indicate that the average monthly mean flow ranged from 6.3 to 122 cubic feet per second (cfs), with a mean value of 20.4 cfs. Based on data from the Nebraska Department of Natural Resources (Nebraska DNR, 2001), the flow of the White River in 2001 ranged from 8.5 to 69 cfs, with an annual mean of 20.0 cfs. Historical extremes related to flow in the White River are discussed in Section 2.7.

The Crawford National Fish Hatchery formerly was located in the Crawford City Park adjacent to the White River (Figure 3.4-1).

Spring Creek flows west to east through the northern portion of the North Trend Expansion Area (Figure 3.4-1). Little Cottonwood and Sand Creeks flow from west to east along the northern portion of the 2-mile review area where they join the White River. Squaw, English and White Clay Creeks flow to the White River in the southeastern portion of the 2.0-mile review area. On the south side of the review area, Dead Man's, Cherry, and Bozle Creeks flow northward to the White River.

To assess surface water quality in the project vicinity, data were retrieved from the EPA STORET database (http://www.epa.gov/storet/dbtop.html) for the White River at Crawford. Those data (11 sampling events during 1971 and 1972) indicate an average specific conductance of 330 μmhos. Data from the White River tributaries in the vicinity of North Trend were also retrieved from the STORET database. Those data include: Soldier Creek (west of Crawford); Squaw, White Clay and English Creeks (east of Crawford) and Deadman's Creek (south of Crawford). Specific conductance readings for these tributaries ranged from 360 to 507 μmhos.

No surface water impoundments are located within the North Trend Expansion Area. Several small impoundments are located on private ranches within the 2.0-mile review area, primarily along Squaw and White Clay Creeks (eastern portion of the review area) and Little Cottonwood Creek (northern portion of the review area). Surface water features are shown on Figure 3.4-1. Based on field inspections by CBR personnel, there is no irrigated farmland within the North Trend Expansion Area boundary.



LEGEND

N
W E

0 1500 3000 6000
SCALE IN FEET 1" = 3000'

CROW BUTTE RESOURCES, INC.

FIGURE 3.4-1
NORTH TREND SURFACE WATER FEATURES

PROJECT: 223-37	DATE: MARCH 2007	
DWG: CBRNT3CBase.dwg	BY: KRS	CHECKED: HPD

Petrotek
10288 West Chatfield Ave., Ste 201
Littleton, Colorado 80127-4239
303-290-9414
www.petrotek.com

The White River and associated tributaries indirectly supply some of the drinking water to the citizens of Crawford. The city system, which serves a population of 1,115 (Nebraska Department of Health & Human Services, 2004), is supplied by three infiltration galleries (located along the White River, Dead Man's Creek, and Soldier Creek) and two wells which produce "groundwater under the influence of surface water" (University of Nebraska Cooperative Extension HE Form 526). In 1981, average daily usage ranged from a low of 199 gallons per day per person (gpd) in February to a high of 508 gpd in July. The maximum recorded daily water usage in Crawford up to 1981 was nearly 1 million gallons. Based on the Crawford Municipal Water Conservation Plan (Spring 2003), the average per capita water use in 2002 (including residential and business customers; public facilities including parks etc.; and water lost to system leaks) was 323 gallons per day. Information regarding the City of Crawford water system is summarized in Table 3.4-1 (personal communication with CBR staff, February, 2007).

Table 3.4-1
Summary of City of Crawford Water System

Description	**Capacity**
Raw Water Storage Capacity	500,000 gallons
Treated Water Capacity West Tank East Tank	 1,000,000 gallons 750,000 gallons
Average Daily Use (2006)	419,181 gallons
Maximum Daily Use	1,000,000 gallons
Supply Wells South Well #1 (100 feet deep); Reg: G-93533 NW1/4 SW1/4 Sec. 15, T31N, R52W West Well #2 (100 feet deep); Reg: G-93532 NW1/4 SW1/4 Sec. 15, T31N, R52W	 104 gpm 54 gpm
Infiltration Gallery Pump #1; 27 feet; Reg: G-93551 SE1/4 SW1/4 Sec. 8 T31N R52W Pump #2; 27 feet; Reg: G-93551 SE1/4 SW1/4 Sec. 8 T31N R52W	 420 gpm 420 gpm
Dewatering Wells; 20 to 26 feet deep SE1/4 SW1/4 Sec. 8 T31N R52W Reg Nos: 93528, 93529, 93530	33 gpm (each)

In general, groundwater supplies in the vicinity of the North Trend Expansion Area are limited due to topography and shallow geology (University of Nebraska-Lincoln, 1986). Groundwater quality within the White River drainage generally is poor (Engberg and Spalding, 1978). Locally, groundwater is obtained at limited locations from shallow alluvial sediments. The primary groundwater supply is the Brule Formation, typically encountered at depths from 60 to 100 feet. The static water level for Brule wells in the North Trend Area ranges, based on topography, from 10 to 60 feet below ground surface.

Alternate supplies of stock water are provided by the underlying Basal Chadron Sandstone (400 to 900 feet). However, because of greater depth and inferior water quality, the Basal Chadron is not used for a domestic supply within the North Trend Expansion Area. In this regard, Gosselin et al. (1996) state that (1) "the sands near the bottom of the Chadron Formation yield sodium-sulphate water with high total dissolved solids", and (2) "near uranium deposits in the Crawford area, groundwater from the Chadron Formation is not suitable for domestic or livestock purposes because of high radium concentrations". Because of artesian pressure, most Chadron wells in the vicinity of North Trend either flow at the surface, or have water levels very close to surface elevation.

Based on National Groundwater Association website (www.ngwa.org), average water use for rural (domestic) wells in Nebraska is approximately 380 gallons per day (gpd). Assuming an average family size of four persons, this correlates well with data from USGS (National Handbook of Recommended Methods for Water Data Acquisition – Chapter 11) who suggest an average per capita use on the order of 97 gallons per day. As discussed previously, there are only two residences located within the proposed North Trend License Area. Using an average use of 380 gallons per day per residence, the total groundwater use within the Expansion Area likely is on the order of 760 gallons per day.

A summary of groundwater quality data collected from 1982 to 1987 to establish background conditions in the vicinity of the Crow Butte Project follows (Table 3.4-2). The data are presented for three hydrogeologic units: (1) the Chadron Sandstone (mining zone), the Brule Formation, which supplies the majority of groundwater in the project area, and (3) the Brule Alluvium. It is noted that supplies of Brule Alluvium are limited, and few wells produce from this interval, none of which are located in the North Trend Expansion Area.

Table 3.4-2
Summary of Groundwater Quality Data – Crow Butte Vicinity

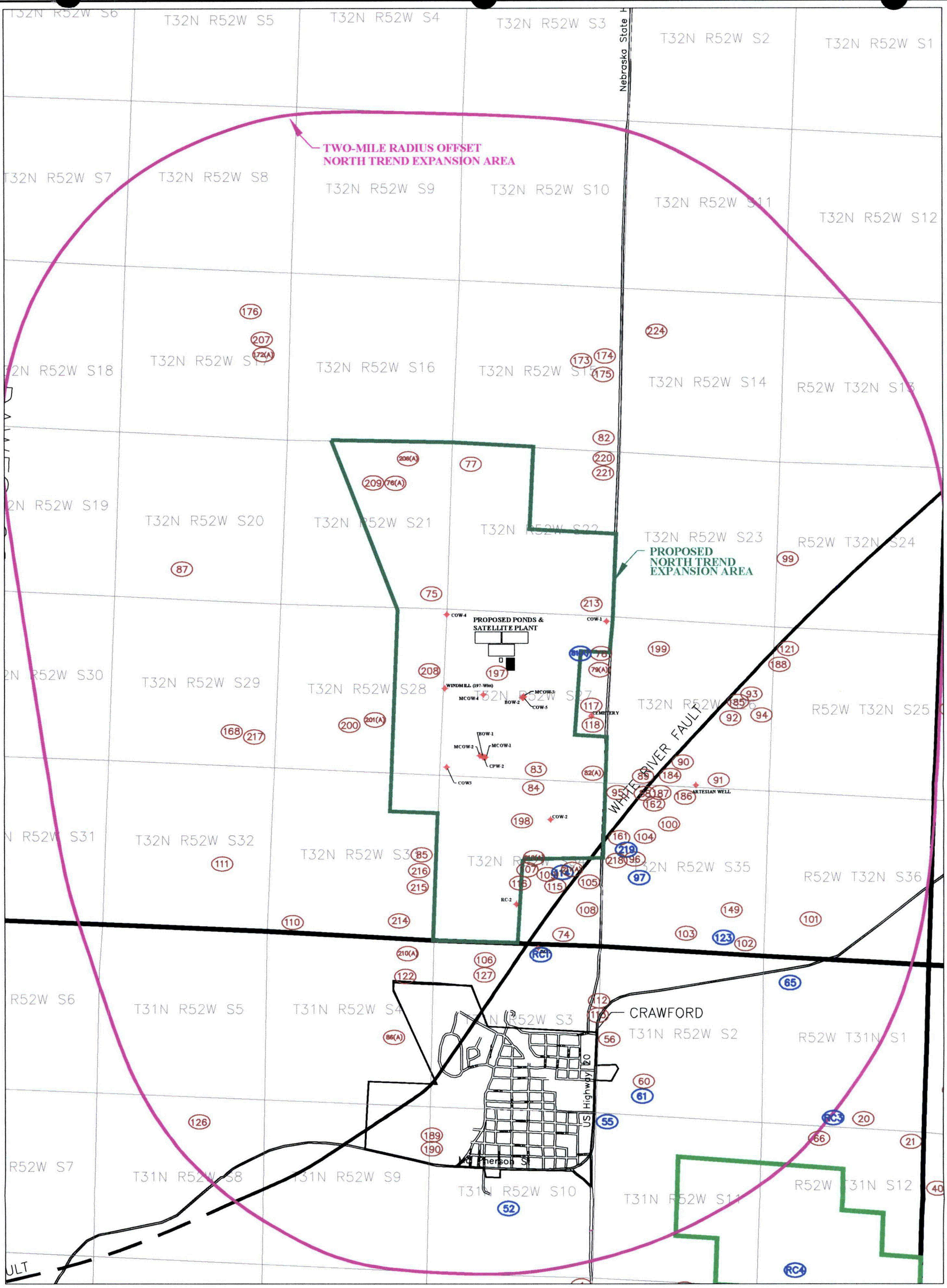
Constituent[1]	Brule Formation		Chadron Formation		Brule Alluvium	
	Range	Mean	Range	Mean	Range	Mean
Calcium	7.1 - 98	48	11 - 41	20	67 - 74	70.6
Magnesium	0.3 - 16	6.6	0.8 - 7.2	3.2	6.4 - 10	8.7
Sodium	12 - 340	104	340 - 540	411	34 - 41	36.5
Potassium	4.1 - 15.9	9.9	7.0 - 19.8	12.4	10.3 - 13	11.1
Bicarbonate	137 - 627	364	308 - 411	368	299 - 364	321
Sulfate	1 - 23	10	254 - 620	407	11 - 20	16.3
Chloride	1.6 - 192	48	134 - 250	176	5 - 10	6.7
Specific Conductance (µmhos)	246 - 1481	714	1500 - 2500	1932	507 - 614	548
PH (pH units)	6.80 - 8.50	7.80	7.60 - 8.70	8.20	7.10 - 8.40	7.70
Uranium (mg/l)	0.001 - 0.021	0.0064	<0.001 - 2.40	0.092	0.006 - 0.022	0.015
Radium-226 (pCi/l)	0.1 - 3.0	0.7	0.1 - 619	53	0.4 - 18.3	2.5

1) Concentrations in mg/l, unless otherwise noted.

A water well survey conducted by CBR in 1996 and updated in 2004 for the Expansion Area indicates that all of the groundwater pumped from active wells surveyed within a 2.0-mile radius of the proposed North Trend license area boundary is used either to water livestock or for domestic purposes. Figure 3.4-3 shows the location of all active and abandoned water wells in the North Trend license area and the 2.0-mile review area. Within the proposed License Area, all of the 14 active wells are completed in the Brule; there are no active wells completed in the Chadron in the License Area. Within the 2.0-mile review area, 41 of the wells are completed in the Brule Formation and 9 are completed in the Chadron Formation. With one exception (Well No. 61, located approximately 1.5 miles southeast of the Expansion Area boundary), the Chadron wells are all used exclusively for watering livestock. As discussed previously, the only domestic groundwater supply within the proposed license boundary is the Brule Formation.

Table 3.4-3 lists the active and abandoned groundwater wells in the Expansion Area and the 2.0-mile review area.

In summary, there is no domestic groundwater use of the Basal Chadron Sandstone within the North Trend Expansion Area. Two residences are supplied by wells completed in the Brule Formation. Based on population projections (see Section 3.10), future water use within the North Trend Expansion Area and the 2.0-mile review area likely will be a continuation of present use. It is unlikely that any irrigation development will occur within the license area due to the limited water supplies, topography, and climate. Irrigation within the review area is anticipated to be consistent with the past (e.g., limited irrigation in the immediate vicinity of the White River). It is anticipated that the City of Crawford municipal water supply will continue to be provided by the groundwater and infiltration galleries related to the White River and associated tributaries.



LEGEND

- (65) CHADRON WATER WELL
- (81(A)) ABANDONED CHADRON WATER WELL
- (83) BRULE WATER WELL
- (82(A)) ABANDONED BRULE WATER WELL

0 1500 3000 6000

SCALE IN FEET 1" = 3000'

N / W — E

CROW BUTTE RESOURCES, INC.

FIGURE 3.4-2

LOCATION OF ACTIVE AND ABANDONED WATER WELLS IN NORTH TREND EXPANSION AREA

PROJECT: 223-37	DATE: MARCH 2007	
DWG: CBRNT3CBase.dwg	BY: KRS	CHECKED: HPD

Petrotek

Table 3.4-3: Active and Abandond Water Wells in the North Trend Expansion Area and 2.0-Mile Review Area			
Well #	Estimated Depth	Formation	Well Use
52	420	Chadron	Agricultural
55	320	Chadron	Agricultural
56	200	Brule	Domestic
60	312	Chadron	Agricultural
61	280	Chadron	Domestic/Agricultural
65	260	Chadron	Agricultural
74	60	Brule	Agricultural
75	65	Brule	Agricultural
76	30	Brule	Abandoned
77	70	Brule	Domestic
78	98	Brule	Domestic
79	98	Brule	Abandoned
81	630	Chadron	Abandoned
82	120	Brule	Abandoned
83	50	Brule	Domestic
84	50	Brule	Agricultural
85	80	Brule	Domestic
86	300	Brule	Abandoned
87	50	Brule	Agricultural
88	60	Brule	Domestic
89	35	Brule	Agricultural
90	35	Brule	Agricultural
91	80	Brule	Domestic/Agricultural
92	167	Brule	Domestic
93	85	Brule	Domestic
94	52	Brule	Domestic
95	100	Brule	Domestic
96	86	Brule	Domestic
97	380	Chadron	Agricultural
99	50	Brule	Domestic
100	35	Brule	Agricultural
101	75	Brule	Domestic
102	100	Brule	Domestic
103	125	Brule	Agricultural
104	25	Brule	Domestic
105	70	Brule	Agricultural
106	100	Brule	Domestic
107	100	Brule	Domestic
108	75	Brule	Agricultural
109	55	Brule	Domestic
110	100	Brule	Domestic
111	90	Brule	Domestic
112	110	Brule	Domestic
113	110	Brule	Domestic
114	50	Brule	Agricultural
115	90	Brule	Domestic
116	35	Brule	Domestic
117	160	Brule	Agricultural
118	90	Brule	Agricultural
121	16	Brule	Agricultural
122	60	Brule	Agricultural
123	280	Chadron	Agricultural

Table 3.4-3: Active and Abandond Water Wells in the North Trend Expansion Area and 2.0-Mile Review Area

Well #	Estimated Depth	Formation	Well Use
126	290	Brule	Agricultural
127	105	Brule	Domestic
149	175	Brule	Agricultural
161	60	Brule	Domestic
162	*	Brule	Domestic
168	65	Brule	Agricultural
172	20	Brule	Abandoned
173	30	Brule	Agricultural
174	30	Brule	Agricultural
175	25	Brule	Dmstc / Agricltrl
176	70	Brule	Domestic
184	60	Brule	Domestic
185	70	Brule	Domestic
186	20	Brule	Domestic
187	78	Brule	Agricultural
188	95	Brule	Domestic
189	30	Brule	Agricultural
190	30	Brule	Agricultural
197	70	Brule	Agricultural
198	*	Brule	Agricultural
199	21	Brule	Agricultural
200	30	Brule	Agricultural
201	30	Brule	Abandoned
207	30	Brule	Agricultural
208	30	Brule	Agricultural
209	100	Brule	Agricultural
210	*	Brule	Abandoned
211	*	Brule	Abandoned
212	*	Brule	Abandoned
213	30	Brule	Agricultural
214	37	Brule	Agricultural
215	50	Brule	Agricultural
216	37	Brule	Agricultural
217	*	Brule	Agricultural
218	*	Brule	Agricultural
219	*	Chadron	Abandoned
220	35	Brule	Agricultural
221	35	Brule	Agricultural
224	*	Brule	Agricultural
RC1	350	Chadron	Agricultural
RC2	592	Chadron	No-Use
RC3	293	Chadron	No-Use

* No Reported Depth

3.4.2 Surface Waters

The North Trend Expansion Area lies within the watershed of Spring Creek and an unnamed creek which are small tributaries to the major regional water course, the White River.

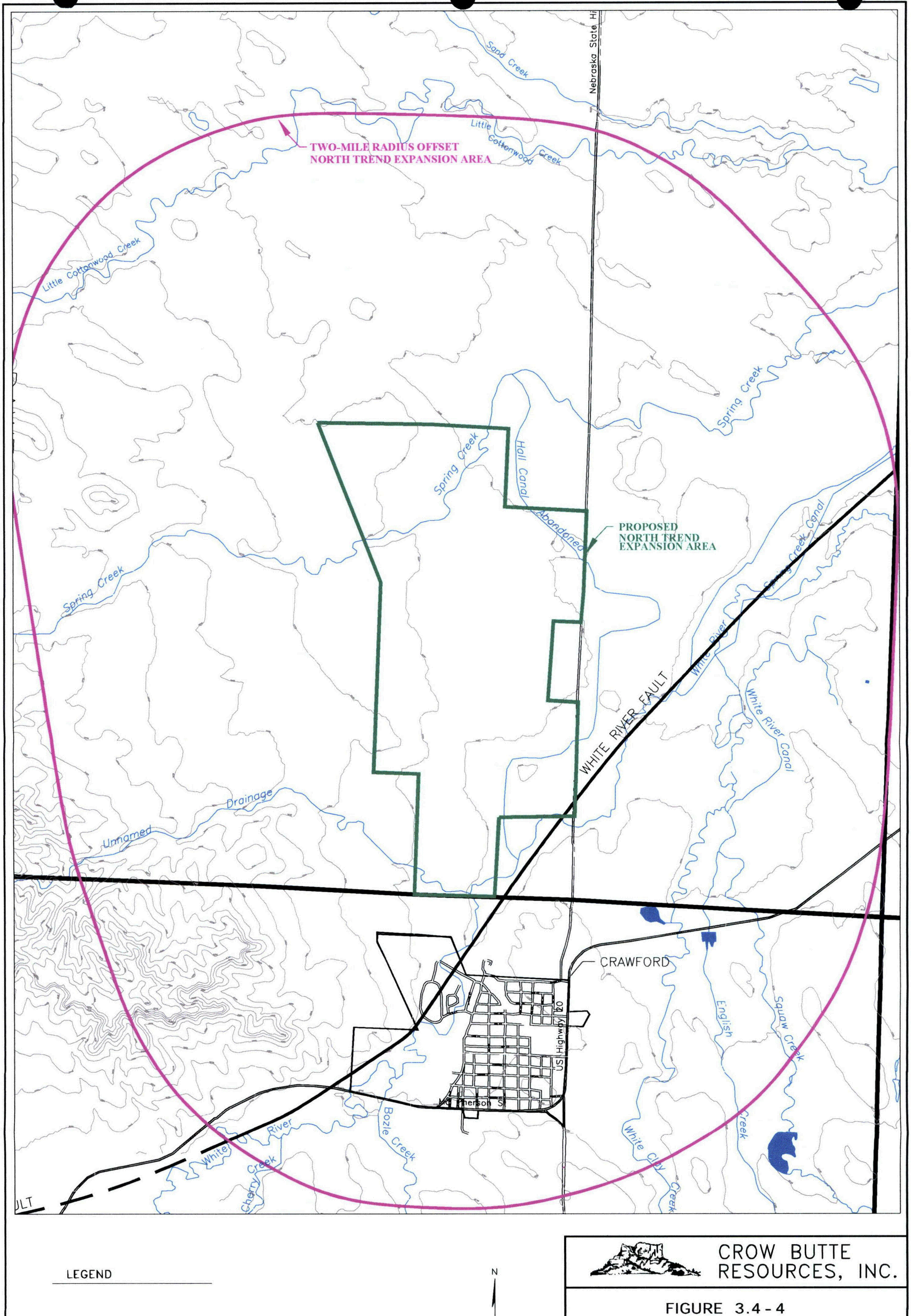
Based on available maps and site investigations conducted by CBR, no surface water impoundments, lakes or ponds have been identified within the North Trend Expansion Area. Permanent impoundments occur south-east of the North Trend Expansion Area, but these are south of the White River and hydraulically isolated from North Trend.

3.4.2.1 Location

The North Trend Expansion Area lies in Sections 21, 22, 27, 28, 33 and 34 of Township 32 North, Range 52 West within the drainage basin of the White River. The White River originates in Sioux County and flows northeasterly across Dawes County into South Dakota. Tributaries of the White River northeast of the Crawford area cross upland portions of the Pierre Shale, an impermeable formation. These streams are dry except for runoff flow, and include the ephemeral Spring Creek and an unnamed creek that occur within the boundaries of North Trend. The southern tributaries, across the White River and to the south – southeast of North Trend, originate in the Pine Ridge escarpment, and flow primarily over forest, range, and agricultural land. These streams are generally ephemeral except for source water from occasional springs.

Spring Creek and the unnamed creek within the North Trend Expansion Area are northern tributaries of the White River. The unnamed creek originates in Red Cloud Buttes southwest of the North Trend Expansion Area. Spring Creek originates in the hills of the Fort Robinson Wildlife Area, west of North Trend. From the headwaters, these ephemeral creeks flow eastward over range and agricultural land to the White River. Contributions to flow appear to be snowmelt and runoff, as well as springs. Figure 3.4-4 shows the location of all surface water features in the North Trend Expansion Area.

Spring Creek enters the proposed North Trend license boundary from the west in Section 21. The creek flow direction then changes to nearly due north. At the northern edge of the North Trend license boundary, a historic diversion canal (the Hall Canal) was constructed to direct flow from Spring Creek to the White River. Vestiges of this diversion canal can still be found in some locations. The unnamed creek crosses only the far southwestern edge of the North Trend Expansion Area (Section 34) before discharging to the White River. The White River crosses into the North Trend license boundary in the southern portion of Section 34.



CROW BUTTE RESOURCES, INC.

FIGURE 3.4-4

NORTH TREND SURFACE WATER FEATURES

PROJECT: 223-37	DATE: MARCH 2007	
DWG: CBRNT3CBase.dwg	BY: KRS	CHECKED: HPD

Petrotek
10288 West Chatfield Ave., Ste 201
Littleton, Colorado 80127-4239
303-290-9414
www.petrotek.com

3.4.2.2 Stream Flow

Table 3.4-3 shows the mean monthly discharge of the White River as compared to the mean monthly precipitation over several years (NOAA, 2006). These extended data show that a general correlation can be made between the direct precipitation and discharge. Higher flows are recorded in spring and early summer with lowest flow rates in late summer to early fall, reflecting seasonal changes related to precipitation. For the period of 1931 to 2004 the average normal annual mean discharge at the White River Station at Crawford was 20.3 cubic feet per second (cfs) with a standard deviation of 2.8 cfs. The maximum was 27 cfs and the minimum was 13 cfs.

Peak rainfall at Harrison and Scottsbluff, Nebraska occurs in May and June (NOAA, 1976 and 1980), and this precipitation pattern appears to be representative of the Crawford area. Table 3.4-4 provides mean monthly discharge information for the White River for 1992 through 1995, as well as data for 2004 and 2005. The recent data for the White River is comparable to the stream flow data shown in Table 3.4-3.

No flow measurements were attempted on Spring Creek or the unnamed creek due to the seasonal nature of flow in these features.

Table 3.4-3: Comparison of Mean Monthly Precipitation With Normal Mean Monthly Discharge of the White River at Crawford, Nebraska

Month	Mean Precipitation [1]		Mean Discharge [2]	
	inches	centimeters	Ft^3/sec	$Meters^3/sec$
January	0.61	1.55	21	0.59
February	0.76	1.93	23	0.65
March	1.74	4.42	27	0.76
April	2.65	6.73	25	0.71
May	3.11	7.9	27	0.76
June	2.42	6.15	22	0.62
July	2.77	7.04	16	0.45
August	1.21	3.07	13	0.37
September	1.38	3.51	14	0.4
October	1.66	4.22	17	0.48
November	0.82	2.08	19	0.54
December	0.79	2.01	20	0.57

1 - Climatology of the US No. 81, 1971-2000, NOAA, 25-Nebraska

2 - U.S. Department of the Interior, 1981, Period of Record 1931-2004.

Table 3.4-4: Normal Mean Monthly Discharge of the White River at Crawford, Nebraska, 1992 – 1995, part of 2003 and 2004

Month	1992 (Ft³/sec)	1993 (Ft³/sec)	1994 (Ft³/sec)	1995 (Ft³/sec)	2003 (Ft3/sec)	2004 (Ft3/sec)
January	21.4	20.7	21.4	20.3	no data	23
February	22.5	23.5	23	21.5	no data	24.8
March	22.3	31.2	23.3	19.7	no data	25.9
April	20	26.1	21.3	22.1	no data	22.7
May	18.8	19.7	19.6	27	no data	21.1
June	18.1	30.6	14	29.8	no data	17.1
July	15.6	25.3	12.3	18.5	no data	17.4
August	12.4	16.4	9.87	12.9	no data	11.3
September	12.4	17.8	11.1	13.6	no data	17.8
October	16	20.9	16.3	18.8	17.5	no data
November	18.8	21.2	17.9	19.8	22.6	no data
December	22.9	26.4	18.8	19.7	23.1	no data
Average	**18.4**	**23.3**	**17.4**	**20.3**	**21.6**	**20.1**

Note: data not available from 1995-2003 on USGS website

3.4.2.3 Surface Water Impoundments

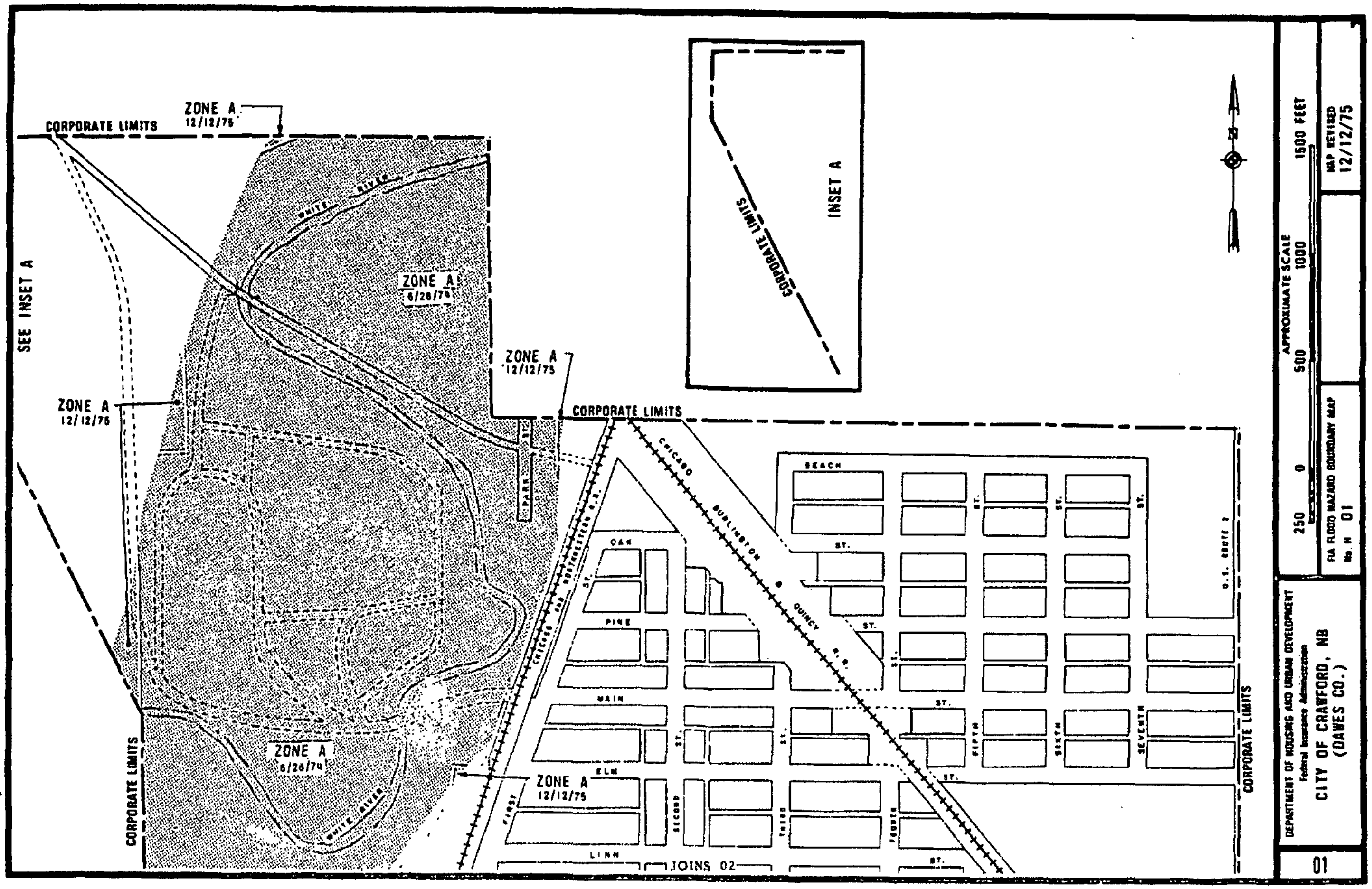
No private surface water impoundments have been identified at or within the North Trend Expansion Area. Similarly, no naturally occurring lakes or ponds have been identified within the boundary.

3.4.2.4 Assessment of Surface Water Features

As shown in Tables 3.4-3 and 3.4-4, the average monthly stream flow of the White River at the Crawford gauge station is about 20 cfs. The highest discharge and gauge height on record between 1920 and 2004 occurred on May 10, 1991. On that date, severe thunderstorms resulted in significant rainfall, the gauge height was 16.32 feet and the stream flow exceeded 13,300 cfs (State of Nebraska Department of Natural Resources, 2004). Several city facilities were damaged by floodwaters and hail, including the local golf course and fish hatchery, and the event was considered a "100 year" flood. The Rocky Mountain News (May 12, 1991) reported that mobile homes were swept away and the town's water system was knocked out of service. However, it is noted that, while there are certainly historical extremes, the average gauge height on the White River at Crawford is less than 5 feet, with an average annual stream flow of 20.2 cfs.

An assessment of the potential for flooding or erosion that could impact the in-situ mining processing facilities and surface impoundments has been performed based on data from the Federal Emergency Management Agency (FEMA; http://msc.fema.gov). FEMA has not mapped unincorporated Dawes County north of Crawford, Nebraska; however, FEMA maps are available for the City of Crawford, and an analogy can be drawn between the flooding potential in Crawford and that immediately north of Crawford adjacent to the proposed North Trend Expansion Area. As shown in Figure 3.4-5, FEMA has classified the portion of Crawford between the D M & E Railroad (immediately west of First Street) as Zone A (i.e., an area that could be impacted by a 100-year flood) (*Managing Floodplain Development in Approximate Zone A Areas; FEMA, April 1995*). The elevation of the White River in the Zone A classification ranges from 3,669 to 3,659 feet AMSL. The surface elevation of the railroad tracks ranges from 3,678 to 3,671 feet AMSL. These data suggest that significant flooding potential exists with a rise in the White River elevation of 9 to 12 feet above base flow conditions. This is consistent with the data from the 1991 100-year flood event, where the river elevation was approximately 11.3 feet above base gauge height (approximately 5 feet).

Figure 3.4-5: FEMA Zone A Flood Map,



The proposed North Trend surface facilities are to be located in the north-central portion of Section 27, approximately one mile northwest of White River, and approximately 70 feet topographically above the common river elevation. Proposed wellfields are planned for portions of Sections 21, 22, 27, 28, 33, and 34 T32N, R52W (Figure 3.4-4). With the exception of Section 34, the wellfields are projected to be at least 50 feet above the White River elevation.

The portion of the proposed North Trend Expansion Area where the greatest flooding potential related to the White River exists is the southeast part of Section 34 (Figure 3.4-3). The White River elevation in that area varies from 3,645 feet AMSL on the western portion of the southern permit boundary, to 3,622 feet AMSL to the northeast. Because of lower elevation and proximity to the White River, final wellfield layout in Section 34 may necessitate consideration of potential flood impacts (e.g., below a surface elevation of 3,657 feet on the west, and 3,634 feet to the northeast).

Based on these data, the North Trend surface facilities occur outside of the 100 year flood plain, and are not considered to be in a "flood prone" area. Therefore, consistent with NUREG-1623, erosion modeling was not considered necessary or performed.

The North Trend area does not include any major surface water features other than the White River. This feature is used to support agricultural production, wildlife habitat, and both warm- and cold-water fish. Upstream from the North Trend Expansion Area, the White River supplies drinking water for the City of Crawford (see Section 3.4.1 for additional discussion).

3.4.2.5 Water Quality

Water samples were collected from the single perennial surface water feature identified within the North Trend Expansion Area, the White River White River water quality data were assembled by EPA for various years from 1969-1994. These data, as well as groundwater quality sampling results, are presented in Section 3.4.4.

3.4.3 Groundwater

This section describes the regional and local groundwater hydrology including local and regional hydraulic gradient and hydrostratigraphy, hydraulic parameters, baseline water quality conditions, and local groundwater use including well locations related to the North Trend Expansion Area. The discussion is based on information from investigations performed within the North Trend Expansion Area, data presented in previous applications/reports for the Commercial Study Area (CSA) where In Situ Leach (ISL) mining is being conducted, and the geologic information presented in Section 3.1. In this regard, the hydrogeology of the North Trend area is expected to be similar in many

respects to that encountered in the CSA, recognizing that North Trend is on the north side of the White River while the CSA is on the south side of this river.

The hydrostratigraphic section of interest for North Trend includes the following (presented in descending order):

- Alluvium
- Brule Formation (including the first "aquifer" in the Brule sand/clay)
- Chadron Formation (Upper Confining Unit including the Upper Chadron confining layer, Middle/Upper Chadron sand [aquifer, where present], and Middle Chadron confining layer)
- Basal Chadron Sandstone (Mining Unit)
- Pierre Shale (Lower Confining Unit)

With regard to the Crow Butte Uranium Project and the North Trend Area in particular, two groundwater sources are of interest in the Crawford and Crow Butte area. These are the Brule sand and the Basal Chadron Sandstone. The Basal Chadron Sandstone contains the uranium mineralization in the CSA, and at North Trend.

3.4.3.1 Regional Groundwater Hydrology

A map prepared by Souders (2004) indicates that the water table configuration in the region trends north-northeast. No published regional water level maps are available for the Basal Chadron Sandstone or the local Brule sands. Souders (2004) states that aquifers within the White River Basin, which encompasses the northern half of Dawes County, are "nearly nonexistent". He indicates that a groundwater divide occurs to the south of the CSA along the Pine Ridge; groundwater north of this divide in the CSA and North Trend Expansion Area flows to the north, northwest and northeast, depending upon location with respect to the White River. The Brule, Chadron and Pierre Shale outcrop progressively northward from the Pine Ridge divide through the White River Basin, and Souder states that none of these formations "are considered major sources of groundwater".

Souder indicates that the Brule is a tight formation with a minimal hydraulic conductivity of less than 25 feet/day, although in a few areas there may be a significant saturated thickness, presumably where sandier intervals are present. The Chadron is described as consisting of claystones with extensive volcanic ash that is tight with low hydraulic conductivity comparable to the Brule, except where fractured, although the coarse Basal Chadron Sandstone is present at the bottom of the formation. The Pierre is described by Souders (2004) as a dark grey, bentonitic shale that is "very tight and is not considered to hold any extractable groundwater" except where fractured. Fractures may increase Brule and Chadron permeability in localized areas (Souders, 2004). It is noted that CBR

operations in the CSA to date do not support evidence of fracturing in the Pierre to a degree such that it would impact the designation of the Pierre as a lower confining unit below the Basal Chadron Sandstone.

Prior to mining in the CSA, water levels were measured in existing wells throughout the Crawford-Crow Butte area for the local Brule sand and the Basal Chadron Sandstone. Maps showing the potentiometric surfaces for these two aquifers are included as Figures 3.4-6 and 3.4-7. Based on these figures, the local direction of groundwater flow (e.g., in the vicinity of the CSA) in the Brule sand appears to be to the north-northwest.

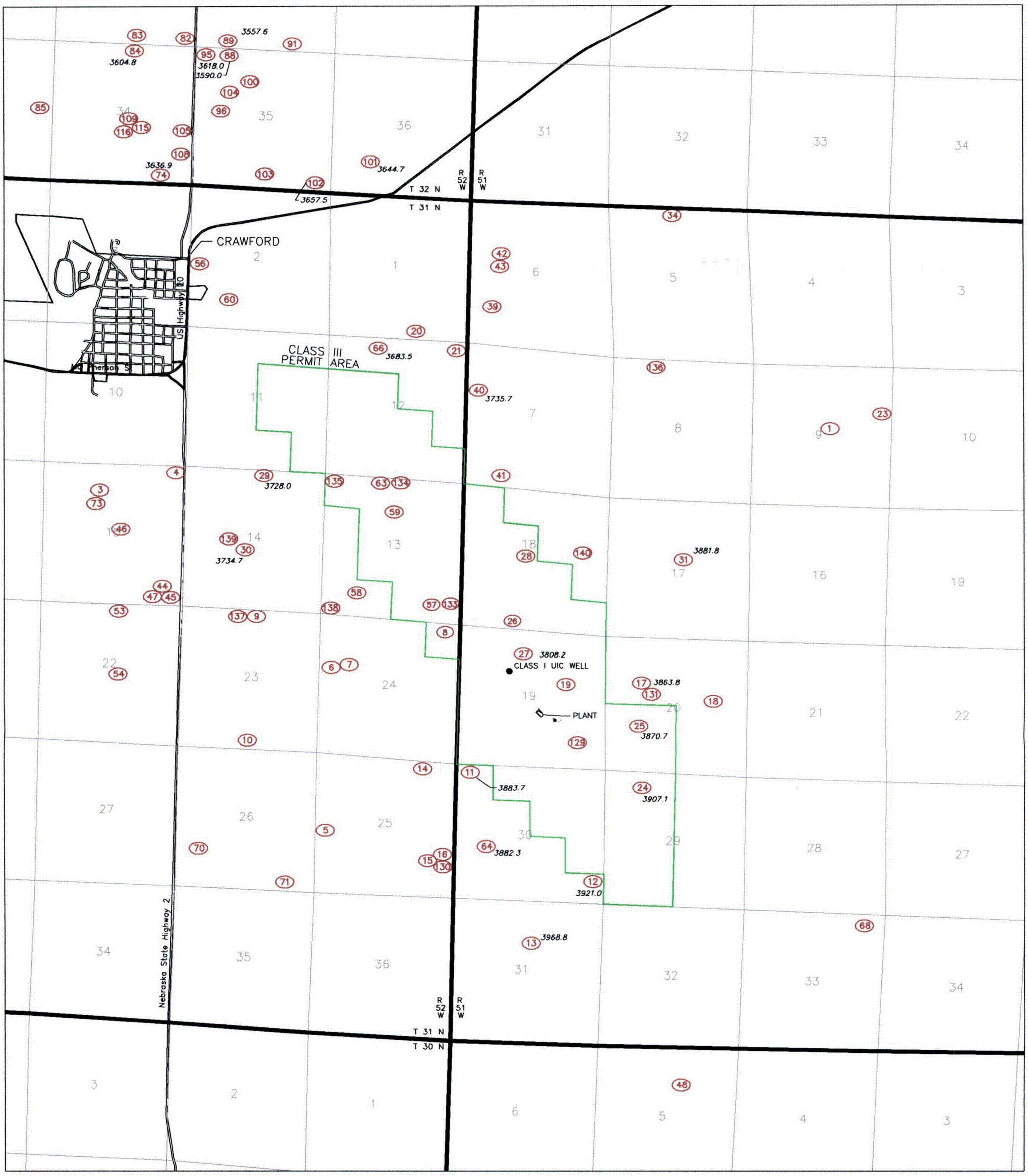
The Basal Chadron Sandstone is an artesian (confined) aquifer, and wells completed in it may flow to the surface near the White River. The direction of Chadron groundwater migration in the region is to the north-northwest in southern areas near the White River. Farther to the south, the potentiometric surface is almost flat.

Because these data presented in Figures 3.4-6 and 3.4-7 are over 10 years old and limited in extent, no potentiometric contours are presented. Further, because the regional flow in the Brule and Basal Chadron differ depending on location (e.g., south versus north of the White River), a regional potentiometric map with data from both the CSA and North Trend is not presented. Historical water level data for a one-year period from wells located in the CSA are included on Tables 3.4-5a (Brule wells) and 3.4-5b (Basal Chadron wells).

Regionally, the principal water bearing rocks below the Pierre Shale are the G Sand, J Sand, and the Dakota, Morrison and Sundance Formations. The Total Dissolved Solids (TDS) concentrations of the water below the Pierre Shale have been interpreted from deep oil and gas exploration logs. The Dakota Sandstone is at a depth of 2,972 to 3,020 feet in the Bunch No. 1 hole (Section 5, T31N, R52W). The minimum TDS of the water in the Dakota Sandstone, calculated from the spontaneous potential and sonic logs, is estimated to range from 14,000 to 26,000 mg/l (as NaCl). Based on samples collected during the installation and testing of the Crow Butte deep disposal well (DW #1, Section 19, T31N, R51W) located approximately six miles southeast of the North Trend area, TDS levels in the Morrison Formation (3,580 feet midpoint depth) and Sundance Formation (3,784 feet) are approximately 24,000 and 40,000 mg/l, respectively.

The Pierre is essentially impermeable which precludes its use as a water supply. A number of shallow wells are reported as having the Pierre Shale as the bedrock unit (Spalding, 1982) in Township 32 North, Range 51-52 West. These wells range in depth from 18 to 100 feet with an average depth of 44 feet, and were drilled in areas that have considerable alluvium atop the Pierre, including locations along Spring Creek and the White River between Crawford and Whitney Lake. These wells produce water from a few tens of feet of Quaternary Alluvium overlying the Pierre Shale, with the bottom few tens of feet in those wells providing storage. Spalding (1982) states that *"In very shallow*

wells (a few tens of feet) significant amounts of water utilized may be contained in the thin Quaternary sediments overlying the designated hydrogeologic unit. This situation is particularly true for those wells noted as completed in the Pierre Shale". In the geologic summary of the Spalding report, the groundwater potential of the Pierre Shale is discussed by Marvin Carlson (page 14), *"The oldest bedrock unit in the area, the Pierre Shale of Cretaceous Age, is not considered as a potential aquifer. It is, however, included in the discussion of completion horizons and hydrogeologic units. A few of the shallow wells produce from the Quaternary sediments immediately overlying the Pierre Shale".*



LEGEND

(129) 3968.8 Brule Formation Water Level Elevation (amsl)

0 0.5 1.0 2.0

SCALE IN FEET 1" = 1 MILE

N W E

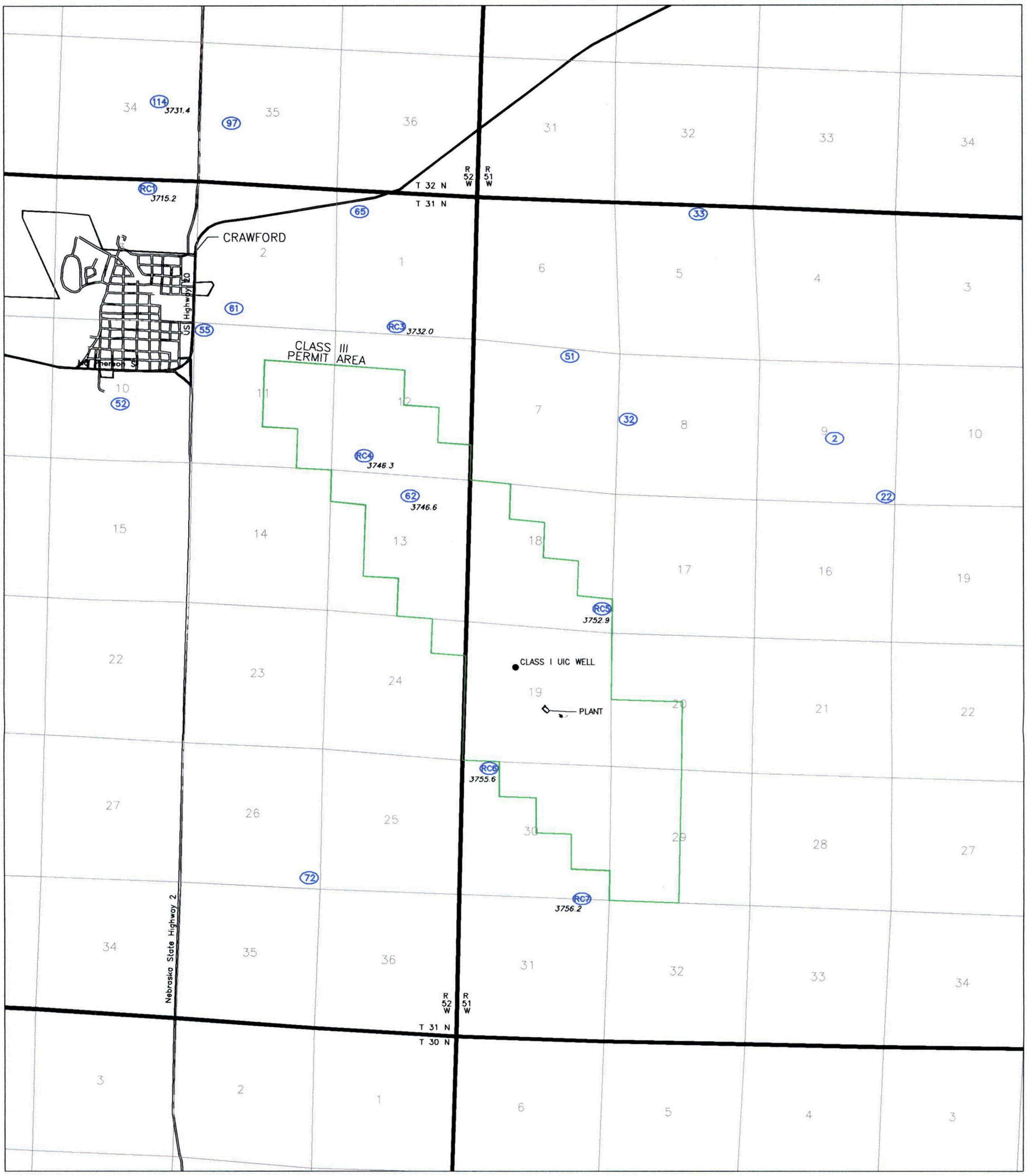
CROW BUTTE RESOURCES, INC.

FIGURE 3.4 - 6

REGIONAL WATER LEVEL MAP
BRULE SANDSTONE 1982–1983

PROJECT: 223–37	DATE: MARCH 2007	
NTAAFig2.7–2&3.dwg	BY: KRS	CHECKED: HPD

Petrotek



LEGEND

(129) Chadron Formation Water Level Elevation (amsl)
3968.8

0 0.5 1.0 2.0

SCALE IN FEET 1" = 1 MILE

N
W E

CROW BUTTE RESOURCES, INC.

FIGURE 3.4-7

REGIONAL WATER LEVEL MAP
BASAL CHADRON SANDSTONE 1982–1983

PROJECT: 223–37	DATE: MARCH 2007
NTAAFig2.7–2&3.dwg	BY: KRS CHECKED: HPD

Petrotek

Table 3.4-5a: Brule Water Levels (in feet above mean sea level)

Well	1982 Jan	Feb	Mar	April	May	June	July	August	Sept	Oct	Nov	Dec	1993 April	1993 July
11**	3831.7	3831.5	3831.8	3833	3833	3833.6	3833	3832.6	3831.5	3830.6	3830.3	3830.3	3843.5*	3837
12**	3928	3924	3923	3922.7	3923.7	3921.1	3922.1	3921.5	3922.2	3921.3	3903.3*	3918.7	3922.9	3920
13	3968.5	3968.7	3968.8	3969.4	3969.6	3969.2	3969.5	3968.9	3968.1	3967.5	3968.1	3968.4	3969	3970
17	3865	3863.5	3863.3	3862.6	3863.6	3864.8	3863.3	3862.8	3863.5	3863.8	3865.3	3864.6	3864.8	3862.8
24**	3902	3910.5	3909	3903	3910.9	3910.5	3910.5	3910	3904.7	3901.5	3895.7*	3910.1	3910.4	3911
25	3870	3870.8	3870	3871	3871	3871.3	3869.5	3870.9	3870.6	3870.5	3870.8	3870.9	3870.1	3871.6
31**	3883.1	3883.1	3883.2	3883.1	3883.3	3883	3882.6	3882.3	3882.6	3880	3882.3	3882.5	388.2	3872.3*
64	3882	3882.9	3882.6	3883.5	3883.6	3883.8	3881.4	3880.8	3881.5	3880	3880.4	3882	3884.3	3883.5

	1982 Sept	Oct	Nov	Dec	1983 Jan	Feb	March	April	May	June	July	August	Sept
RA-2	3737.1	3737	3738.5	3737.9	3739.2	3739.1	3739.7	3740.2	3740.9	3741	3739.9	3739.2	3738.1
RB-3	3962.6	3961.2	3963.5	3963.6	3963.8	3963.8	3963.3	3969.7*	3963.7	3963.7	3964.2	3964.1	3964.2
PM-6	------	3844.9	3844.9	------	3843.5*	3844.5	3844.9	3845.3	3845.5	3846	3845.9	3945.9	3845.7
PM-7	------	3845.7	3845.5	------	3845.9	3845.8	3845.7	3846.1	3846.3	3846.9	3846.7	3846.7	3846.6

Notes: * Suspect Data
** Well may have been pumped prior to water level reading.

Table 3.4-5b: Basal Chadron Water Levels (in feet above mean sea level)

Well	1982 Sept	Oct	Nov	Dec	1983 Jan	Feb	March	April	May	June	July	August	Sept
62	3748.4	3748	3747.2	3746.6	------	------	3746.1	3746.2	------	------	3746.1	3745.8	3745.4
RC-4	------	------	------	3746.7	------	------	------	3746.2	------	------	3746.2	3746.2	3746.3
RC-5	3753.6	3753.4	3753.4	3753.2	3753	3752.6	3752.7	3752.9	3752.8	3752.9	3752.7	3752.5	3752.4
RC-6	3755.2	3755.2	3755.7	3756.8	3757.5	3754.7	3754.9	3755.7	3755.6	3755.6	3755.4	3755.2	3754.7
RC-7	3755.2	3756.8	3756.3	3756.2	3756.4	3755.8	3756	3756.4	3756.5	3756.7	3756.2	3756.1	3755.9
PM-1	------	3754.5	3754.4	3754.1	3754.3	3754	3753.8	3754	3754.2	3754.1	3753.8	3753.5	3753.5
PM-4	------	3755.2	3755.2	3754.4	3754.4	3754.1	3754.2	3754.4	3754.8	3754.6	3754.3	3753.9	3754.6
PT-2	------	3747.1*	3747.1*	3754	3754.6	3754.3	3754.1	3754.3	3754.5	3754.7	3754.3	3753.9	3753.7
PT-7	------	3755.1	3755	3754.2	3754.2	3754	3754	3754.1	3754.8	3754.6	3754.3	3754.1	3753.9
PT-8	------	3755.5	3755.6	3754.6	3754.4	3754.4	3755.7	3754.4	3754.5	3754.6	3754.2	3753.8	3753.7
PT-9	------	3753.5	3753.5	3754.9	3754.6	3754.6	3754.6	3754.8	3854.8	3754.9	3754.5	3754.3	3754.1

Notes: * Suspect Data

3.4.3.2 North Trend Area Groundwater Hydrology

The hydrogeologic system within and surrounding the Crow Butte CSA is similar to that found regionally, including North Trend.

Alluvial deposits occur intermittently in ephemeral drainages, but are not considered to be a reliable water source. Over most of the North Trend Expansion Area, the Brule Formation outcrops, and is underlain by the Chadron Formation (including the Basal Chadron Sandstone) and the Pierre Shale. The occurrence and thickness of these geologic units within North Trend have been confirmed during exploratory drilling and logging activities. Based on these data, the relationship of the hydrostratigraphic units within North Trend is shown on a cross-section location map (Figure 3.4-8) and six cross-sections (Figures 3.4-9 through Figure 3.4-14). Appendix A presents data for the boreholes used in cross-section construction, and Table 3.4-6 summarizes information pertaining to these boreholes, including data from boreholes completed as wells.

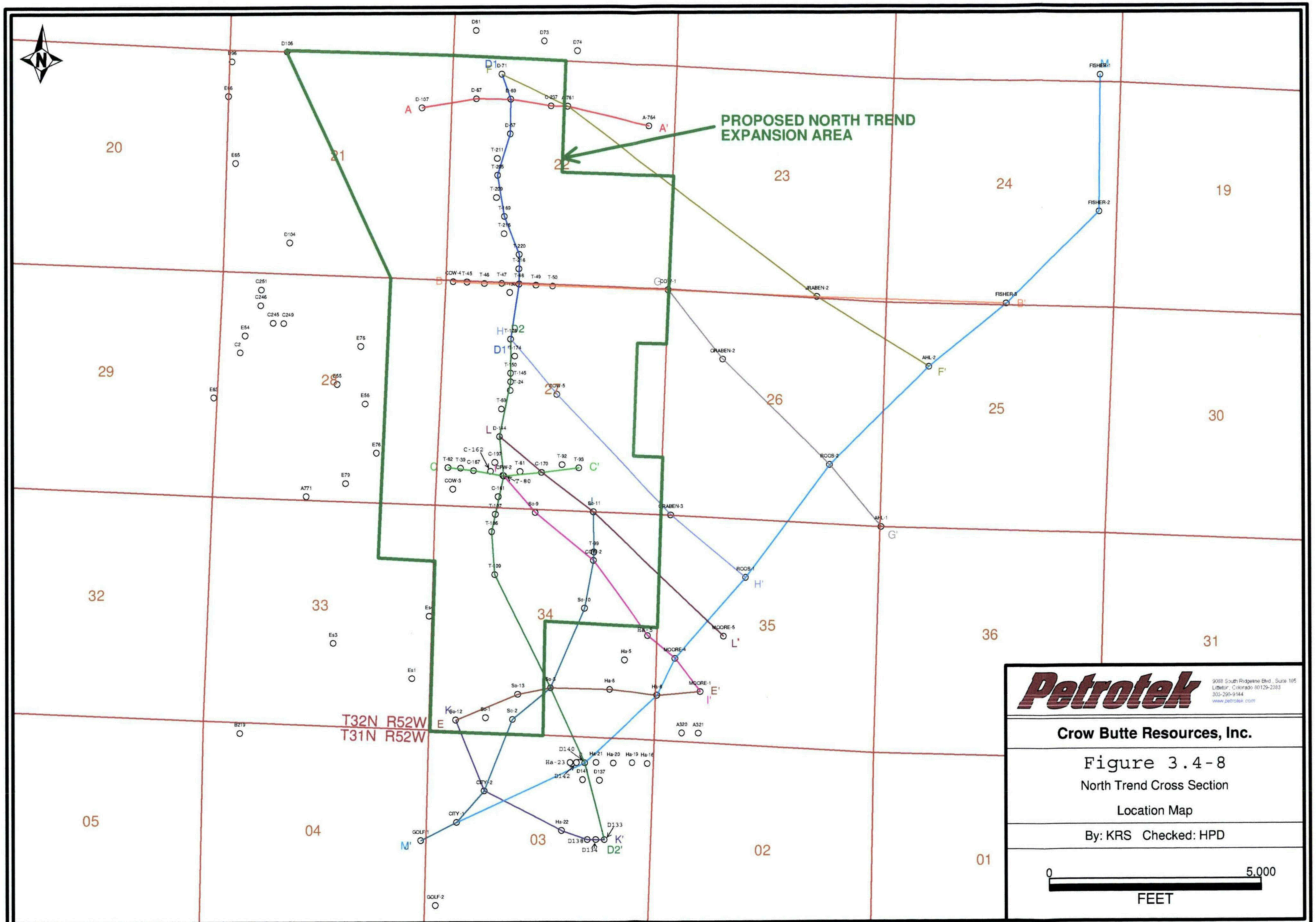
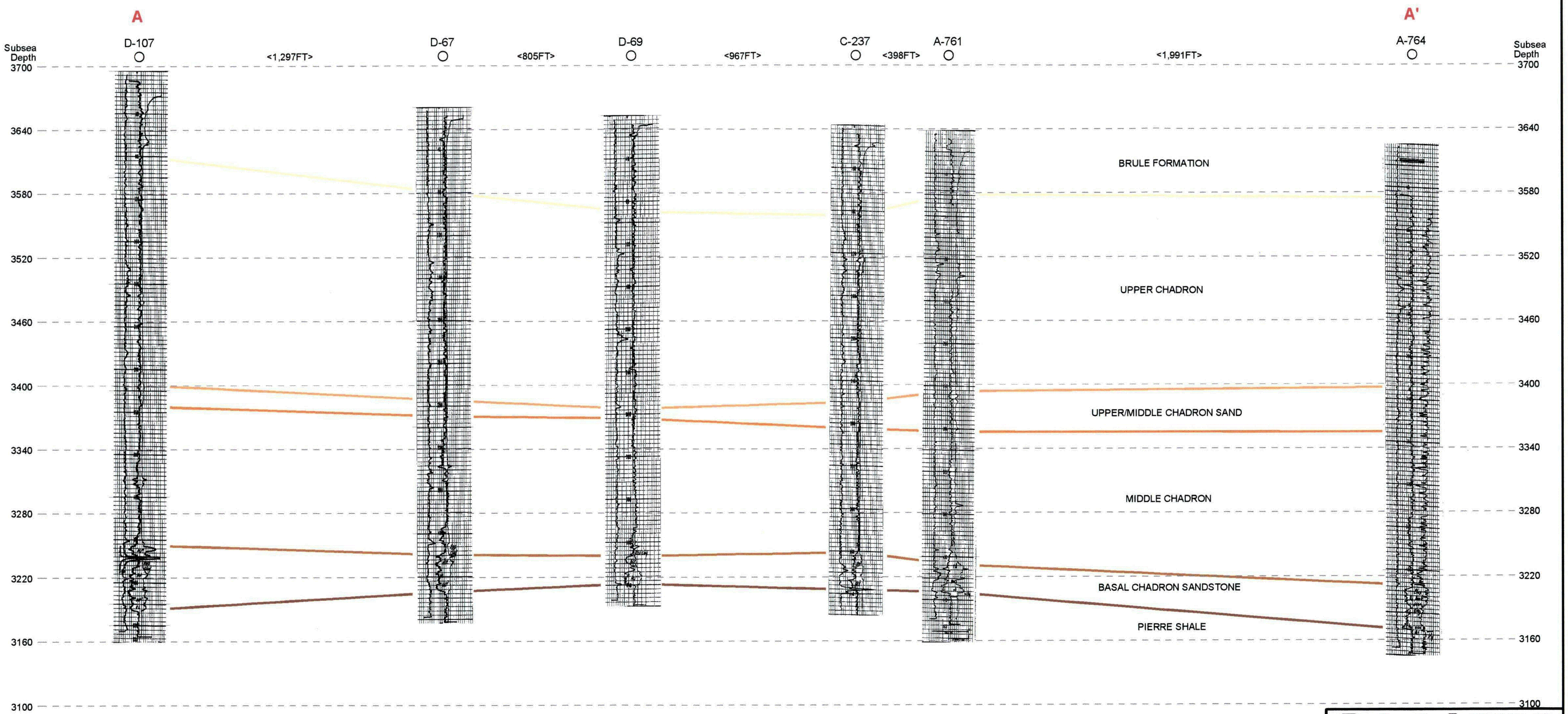


Figure 3.4-8
North Trend Cross Section
Location Map

PETRA 4/2/2007 3:01:20 PM



Petrotek

10288 West Chatfield Ave., Ste 201
Littleton, Colorado 80127-4239
303-290-9414
www.petrotek.com

CROW BUTTE RESOURCES, INC.

License Amendment Application

North Trend Structural

Cross Section: A - A'

TOPS AND MARKERS

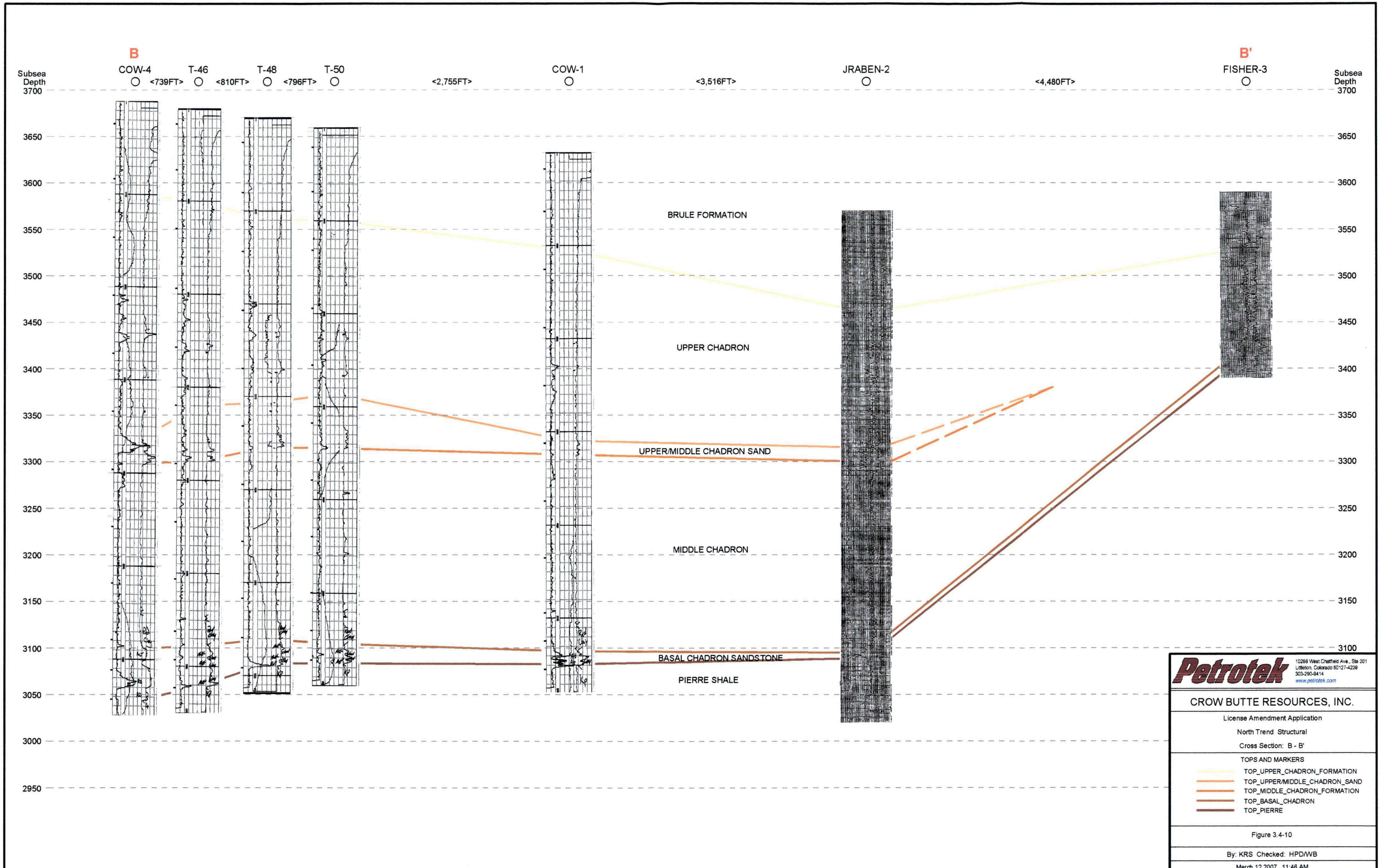
- TOP_UPPER_CHADRON_FORMATION
- TOP_UPPER/MIDDLE_CHADRON_SAND
- TOP_MIDDLE_CHADRON_FORMATION
- TOP_BASAL_CHADRON
- TOP_PIERRE

Figure 3.4-9

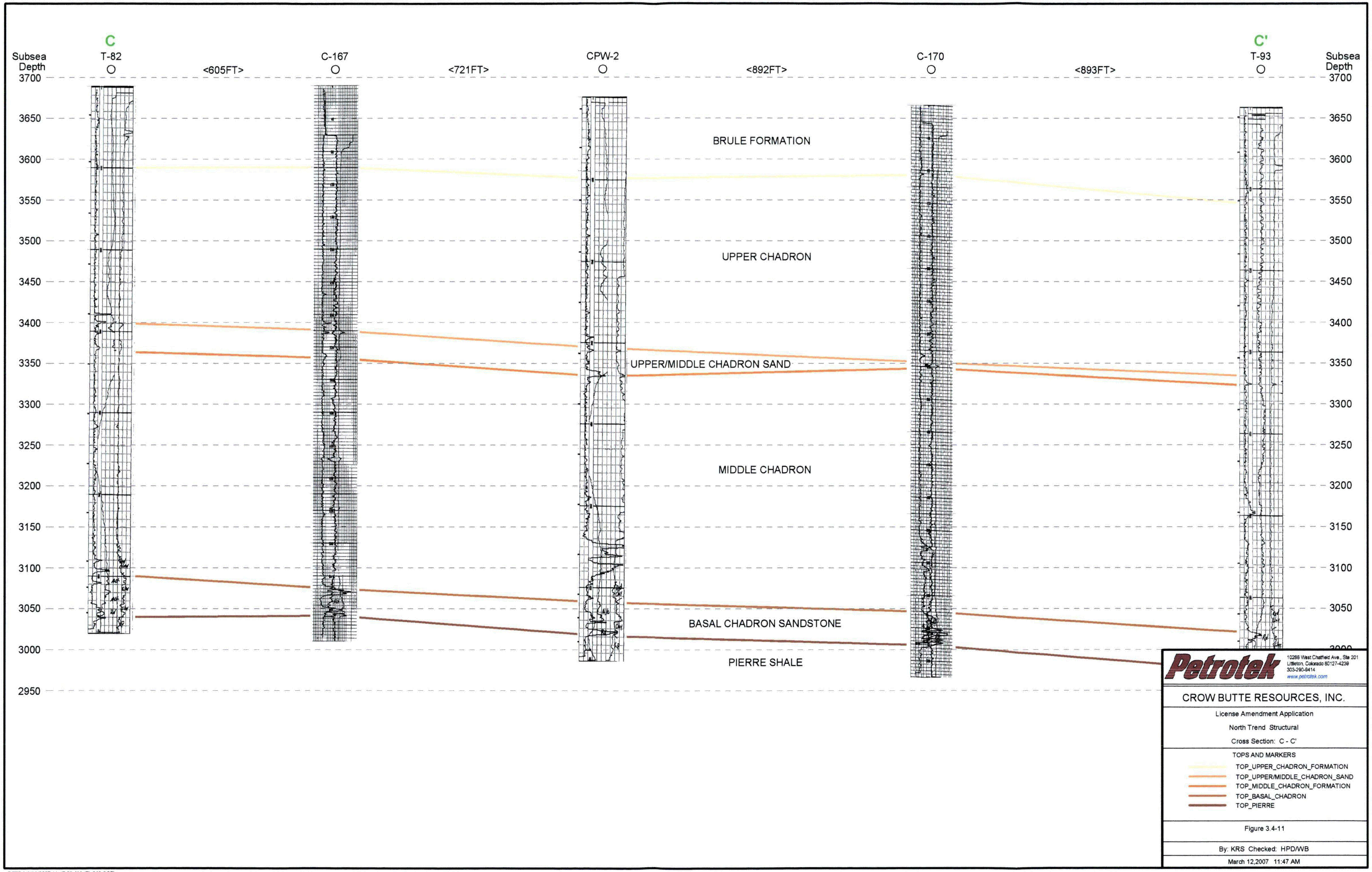
By: KRS Checked: HPD/WB

March 12,2007 11:45 AM

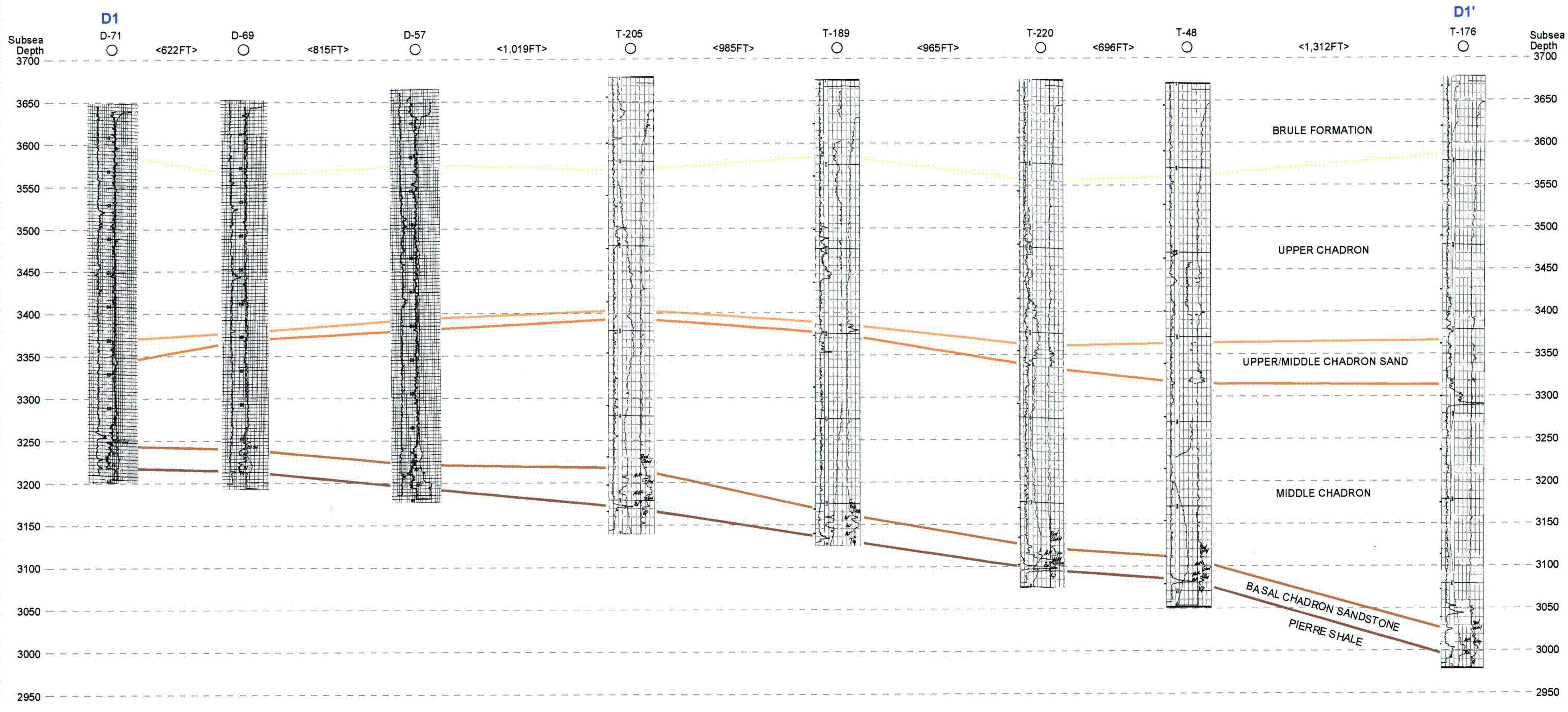
PETRA 3/12/2007 11:45:59 AM (Fig267.CSP)



PETRA 3/12/2007 11:46:45 AM (Fig268.CSP)



PETRA 3/12/2007 11:47:29 AM (Fig269.CSP)



Petrotek

CROW BUTTE RESOURCES, INC.

License Amendment Application

North Trend Structural

Cross Section: D1 - D1'

TOPS AND MARKERS

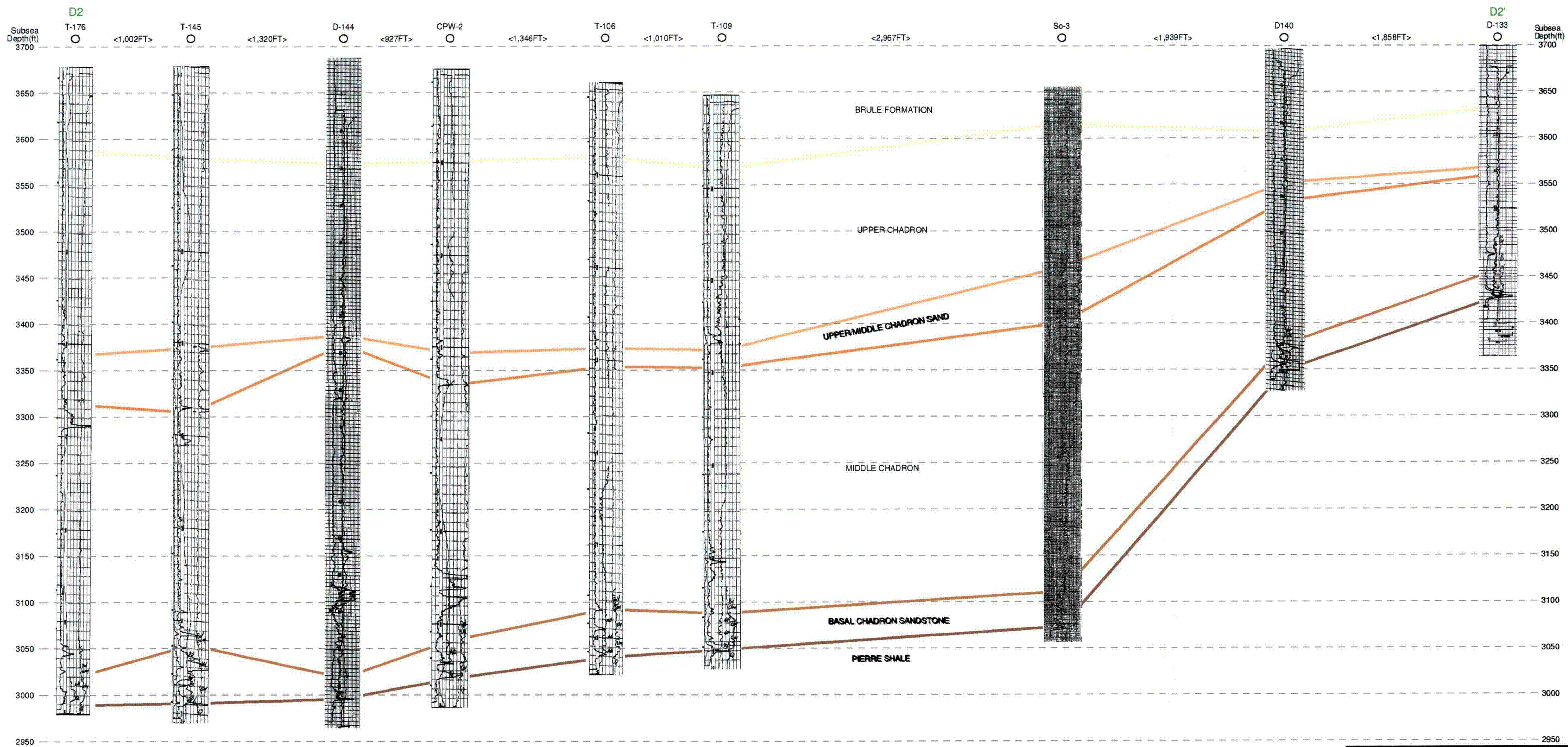
- TOP_UPPER_CHADRON_FORMATION
- TOP_UPPER/MIDDLE_CHADRON_SAND
- TOP_MIDDLE_CHADRON_FORMATION
- TOP_BASAL_CHADRON
- TOP_PIERRE

Figure 3.4-12

By: KRS Checked: HPD/WB

March 13,2007 4:38 PM

PETRA 3/13/2007 4:38:42 PM (Fig2610.CSP)



Petrotek

CROW BUTTE RESOURCES, INC.

License Amendment Application

North Trend Structural

Cross Section: D2 - D2'

TOPS AND MARKERS

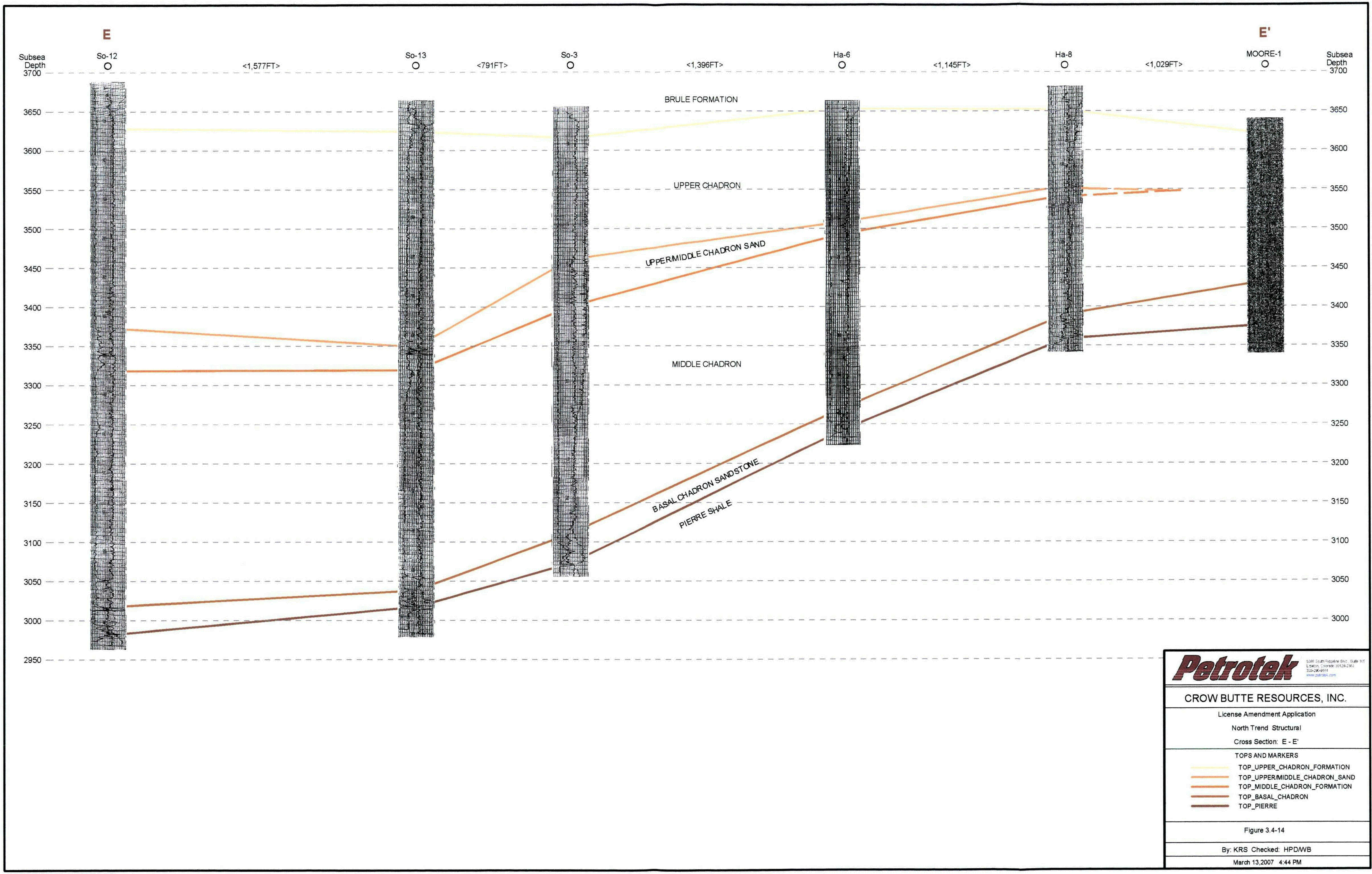
- TOP_UPPER_CHADRON_FORMATION
- TOP_UPPER/MIDDLE_CHADRON_SAND
- TOP_MIDDLE_CHADRON_FORMATION
- TOP_BASAL_CHADRON
- TOP_PIERRE

Figure 3.4-13

By: KRS Checked: HPD/WB

April 2,2007 3:47 PM

PETRA 4/2/2007 3:47:42 PM (Fig2611.CSP)



PETRA 3/13/2007 4:44:52 PM (Fig2612.CSP)

		Easting	Northing	TOC Elev	GL Elev	Casing Ht.	Bottom Brule	Top Mid Chadron	Bottom Mid Chadron	Top Basal Chadron
North	D-71	1,081,671.1	531,086.0		3,648.9		36	280	308	405
	D-69	1,081,875.6	530,498.7		3,652.8		36	275	284	413
	D-57	1,081,859.7	529,684.1		3,665.3		44	272	285	444
	T-211	1081556.19	529107.44		3666.47		47	270	295	442
	T-205	1081559.493	528710.35		3679.237		50	275	285	462
North - South Cross Section from the middle of Section 22 through Section 27 down to the middle of Section 34 T32N R 52W	T-209	1081533.912	528183.78		3679.773		60	270	284	493
	T-189	1081717.376	527738.07		3675.38		75	288	300	512
	T-216	1081713.165	527332.21		3677.565		75	302	326	543
	T-220	1082063.03	526836.69		3674.948		73	315	340	553
	T-218	1082053.79	526501.19		3668.89		56	330	345	567
	T-48	1082056.673	526140.59		3670.362		65	307	355	561
	T-130	1081840.767	525946.41		3672.661		42	315	350	537
	T-176	1081857.635	524844.05		3678.254		52	312	365	632
	T-174	1081955.57	524443.17		3674.022		47	318	362	664
	T-150	1081854.864	524041.97		3678.895		65	302	372	670
	T-145	1081854.596	523841.69		3679.205		65	305	375	626
	T-24	1081847.864	523637.10		3679.816		65	305	377	644
	T-69	1081636.60	523200.97		3683.6		55	295	380	628
	D-144	1,081,592.3	522,548.2		3,687.9		70	305	370	670
	CPW-2*	1081689	521626.3		3675.82		100	307	342	618
	C-197	1,081,482.3	521,942.6		3,688.2		72	310	354	609
	T-80	1081670.302	521633.07		3678.377		70	305	345	597
	C-181	1,081,557.1	521,134.6		3,657.6		67	285	310	598
	T-107	1081488.24	520720.51		3657.5		60	285	310	590
	T-106	1081399.095	520311.58		3660.693		70	287	307	569
	T-109	1081470.41	519304.14		3647.2		62	276	295	560

		Easting	Northing	TOC Elev	GL Elev	Casing Ht.	Bottom Brule	Top Mid Chadron	Bottom Mid Chadron	Top Basal Chadron
	So-3	1082777	516640.8		3655.7		40	195	255	545
	D140*	1083583	514877.6		3697		40	145	165	320
South	D133*	1084039	513075.9		3723.7		90	No data	No data	266

		Easting	Northing	TOC Elev	GL Elev	Casing Ht.	Bottom Brule	Top Mid Chadron	Bottom Mid Chadron	Top Basal Chadron
West	COW 2004-4	1080512.23	526200.97	3686.8	3686.0	0.8	70	367	390	589
	T-45	1080840.266	526195.72		3685.539		85	347	386	586
West to East Cross Section	T-46	1081246.405	526159.15		3680.201		85	320	380	578
along the North side	T-47	1081651.543	526159.50		3674.768		67	310	355	563
of Section 27 T32N R52W	T-48	1082056.673	526140.59		3670.362		65	307	355	561
	T-49	1082454.729	526113.09		3664.861		48	290	348	545
	T-50	1082851.45	526094.75		3659.473		55	287	345	555
	COW 2004-1	1085606.42	525988.48	3633.0	3631.9	1.1	50	310	325	536
	Jraben2	1089116	525824		3570		110	255	270	475
East	Fisher3*	1093593	525653		3590		60	No data	No data	165

		Easting	Northing	TOC Elev	GL Elev	Casing Ht.	Bottom Brule	Top Mid Chadron	Bottom Mid Chadron	Top Basal Chadron
West	T-82	1080377.726	521824.06		3689.506		67	290	325	598
	T-39	1080676.211	521810.14		3689.569		45	290	328	579
West to East Cross	C-167	1,080,978.5	521,749.8		3,690.3		77	300	334	616
Section	C-162	1,081,381.2	521,736.6		3,678.8		60	295	335	626
along the South side	CPW-2*	1081689	521626.3		3675.82		100	307	342	618
of Section 27 T32N R52W	T-80	1081670.302	521633.07		3678.377		70	305	345	597
	T-81	1082070	521724.86		3676.078		54	315	345	625
	C-170	1,082,577.2	521,706.8		3,666.0		37	315	322	620
	T-92	1083065.239	521885.55		3666.041		58	325	345	639

		Easting	Northing	TOC Elev	GL Elev	Casing Ht.	Bottom Brule	Top Mid Chadron	Bottom Mid Chadron	Top Basal Chadron	
East	T-93	1083464.293	521808.92		3663.462		77	330	342	644	
West	D-107	1,079,790.2	530,303.8		3,695.5		70	295	315	445	506
Cross Section West	D-67	1,081,070.9	530,511.1		3,661.0		40	275	290	420	455
to East	D-69	1,081,875.6	530,498.7		3,652.8		36	275	284	413	439
Section 22 T 32N	C-237	1,082,829.0	530,335.1		3,643.8		42	260	285	401	436
R 52W	A-761	1,083,226.9	530,324.6		3,638.5		42	245	283	407	433
East	A-764	1,085,160.0	529,850.0		3,625.0		45	228	270	414	456
West	So-12	1080544	515886.3		3688.3		60	315	370	671	707
Cross Section West	So-13	1082001	516487.9		3664.1		40	315	345	626	647
to East along South	So-3	1082777	516640.8		3655.7		40	195	255	545	583
Side Section 34	Ha-6	1084172	516599.5		3663.3		10	155	170	393	421
T32N R52W	Ha-8*	1085309	516460.9		3681.6		30	128	140	292	323
East	Mo-1*	1086335	516539		3640		20	No data	No data	208	264
Northwest	CPW2*	1081689	521626.3		3675.82		100	307	342	618	659
NW-SE Cross	So-9	1082421	520762.7		3648		103	285	312	600	645
Section through	COW2*	1083807.09	519628.76	3654.0	3652.1	1.9	50	250	275	578	598
Sections 27, 34, 25	Ha-4	1085092	517860.5		3620		85	170	200	350	385
T32N R52 W	Mo-4*	1085741	517327		3680		90	No data	No data	320	360
Southeast	Mo-1*	1086335	516539		3640		20	No data	No data	208	264
West	So-12*	1080544	515886.3		3688.3		60	315	370	671	707
West to East Cross	City-2	1081209	514220.4		3671.1		70	No data	No data	520	595
Section, Section 3	Ha-22	1083028	513291.4		3694.6		20	No data	No data	230	288

		Easting	Northing	TOC Elev	GL Elev	Casing Ht.	Bottom Brule	Top Mid Chadron	Bottom Mid Chadron	Top Basal Chadron	
T31N R52W	D-138	1083636	513072.8		3711.8		80	No data	No data	232	291
	D-133*	1084039	513075.9		3723.7		90	No data	No data	266	295
East											
Northeast	Fi1	1095856	531039		3570		80	No data	No data	242	250
	Fi2	1095815	527813		3560		15	No data	No data	100	100
	Fi3*	1093593	525653		3590		60	No data	No data	165	175
Northeast-Southwest Cross Section through Sections 24,25,36,3 T31 and 32N R52W	Ah2	1091762	524166		3600		40	No data	No data	195	215
	Rs2	1089402	521865		3590		30	No data	No data	154	178
	Rs1	1087407	519217		3615		40	No data	No data	152	172
	Mo4*	1085741	517327		3680		90	No data	No data	320	360
	Ha8*	1085309	516460.9		3681.6		30	128	140	292	323
	D140*	1083583	514877.6		3697		40	145	165	320	348
	City 1	1080560	513483.6		3679.8		175	245	255	592	632
Southwest	Golf 1	1079712	513055.5		3709.4		140	No data	No data	705	743
North Trend Pump Test Wells	COW 2004-1	1085606.42	525988.48	3633.0	3631.9	1.1	50	310	325	536	550
	COW 2004-2	1083807.09	519628.76	3654.0	3652.1	1.9	50	250	275	578	598
	COW 2004-3	1080497.45	521312.27	3684.5	3682.8	1.7	60	282	310	580	647
	COW 2004-4	1080512.23	526200.97	3686.8	3686.0	0.8	70	367	390	589	645
	COW 2004-5	1082950.491	523539.30	3671.04	3669.242	1.8	32	338	390	670	723

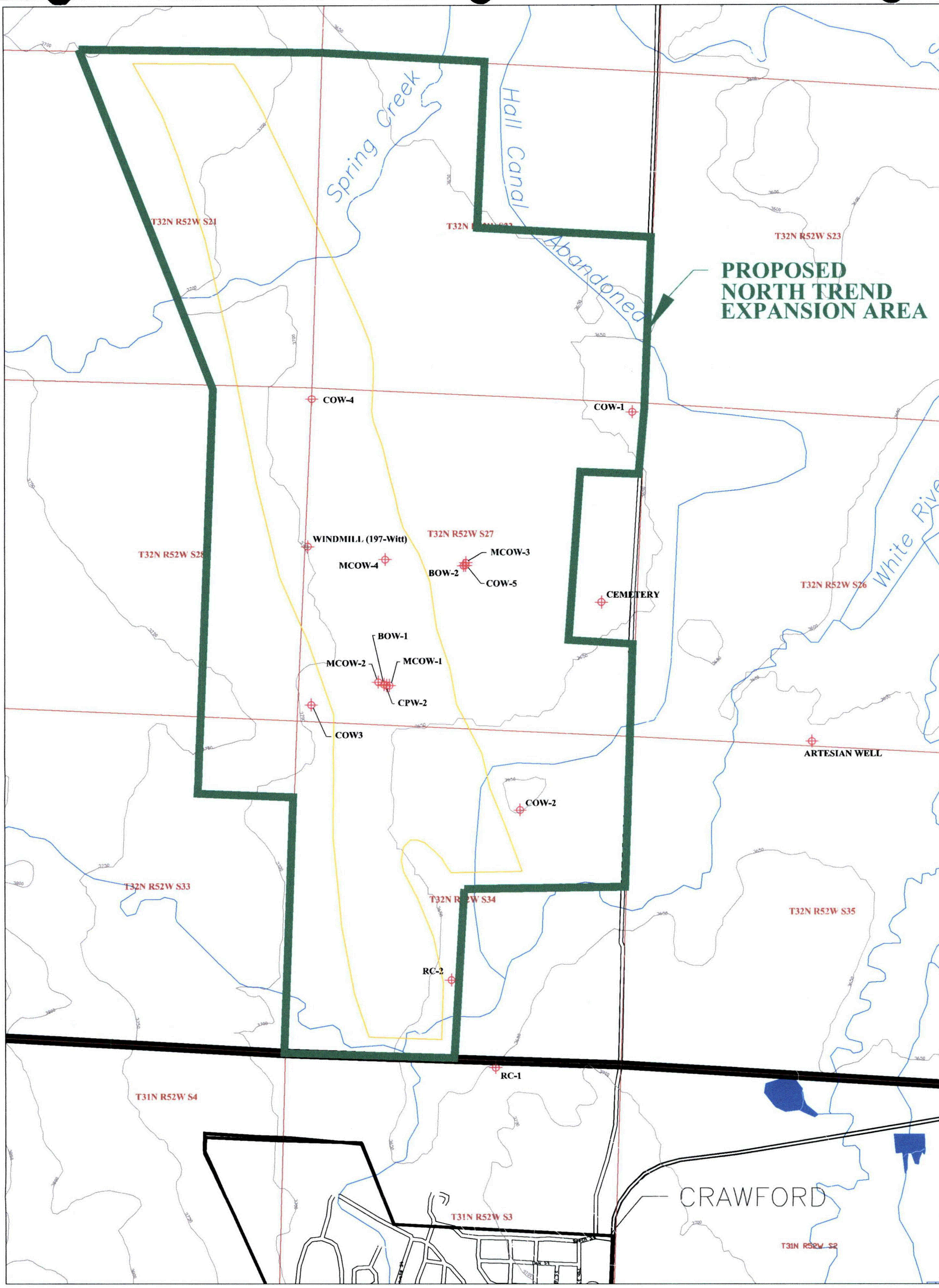
	Easting	Northing	TOC Elev	GL Elev	Casing Ht.	Bottom Brule	Top Mid Chadron	Bottom Mid Chadron	Top Basal Chadron	
CPW 2004-1	1081687.73	521629.85	3677.1	3675.3	1.8	37	307	342	618	658
CPW 2004-2	1081697.12	521622.58	3680.1	3678.6	1.5	37	307	342	618	659
BOW-2004	1081652.70	521638.30	3678.0	3676.4	1.6					

The Basal Chadron Sandstone, the aquifer which is host to the uranium mineralization, is bounded above and below by strata which form aquicludes. The term "aquiclude" is used to describe a strata capable of transmitting only minor amounts of fluid either vertically or horizontally. Typical values for vertical and horizontal permeability of "aquicludes" are in the range of 10^{-4} to 10^{-5} darcys (Todd, 1980), which is equivalent to a hydraulic conductivity of 10^{-7} to 10^{-8} cm/sec. The vertical hydraulic conductivities of the aquicludes calculated from pumping tests conducted in the CSA (discussed further in Section 3.4.3.3) are on the order of 10^{-11} cm/sec (Ferret Exploration of Nebraska, 1987). Laboratory analysis of cores from wells in the CSA indicates vertical hydraulic conductivities on the order of 10^{-10} to 10^{-11} cm/sec (Ferret Exploration of Nebraska, 1987).

The Upper/Middle Chadron sand occurs intermittently, and is underlain and overlain by hundreds of feet of low permeability Chadron clays. The unit was monitored during the North Trend Pump Test because, where present, it is possible that it could contain recoverable water. However, no domestic or livestock wells in the North Trend Expansion Area are completed in this interval, and it is unlikely that this zone would be considered an “overlying aquifer”. To be conservative, CBR chose to monitor a water level response in this interval. However, because of such limited production capacity in the Upper/Middle Chadron sand, the collection of representative groundwater samples could not be achieved. The wells did not produce sufficient water such that they could be adequately developed. Samples that were collected appeared to be impacted by drilling mud and cement.

In the upper part of the Brule Formation, sandstones and sandy siltstones are present which locally may be water bearing. However, these sandstones, siltstones, and clay stringers are difficult to correlate over any large distance, and are discontinuous lenses rather than laterally continuous strata. In the North Trend Area, private water wells are completed in this interval (see Section 3.4.1), and it is therefore the uppermost aquifer above the mined interval.

Figures 3.4-15 through 3.4-18 present the location of all groundwater wells in the North Trend Expansion Area, as well as potentiometric surfaces for the Brule, Basal Chadron Sandstone, and Middle Chadron sand, measured in February, 2007. As shown on these maps, local groundwater flow within the Basal Chadron is to the east, with a gradient of 0.0016 ft/ft (8.5 ft/mile). Based on only four data points, flow in the Brule is to the east/northeast at 0.005 ft/ft (26.4 ft/mile).



LEGEND

- North Trend Monitoring Well
- Ore Trend Outline

N
W E

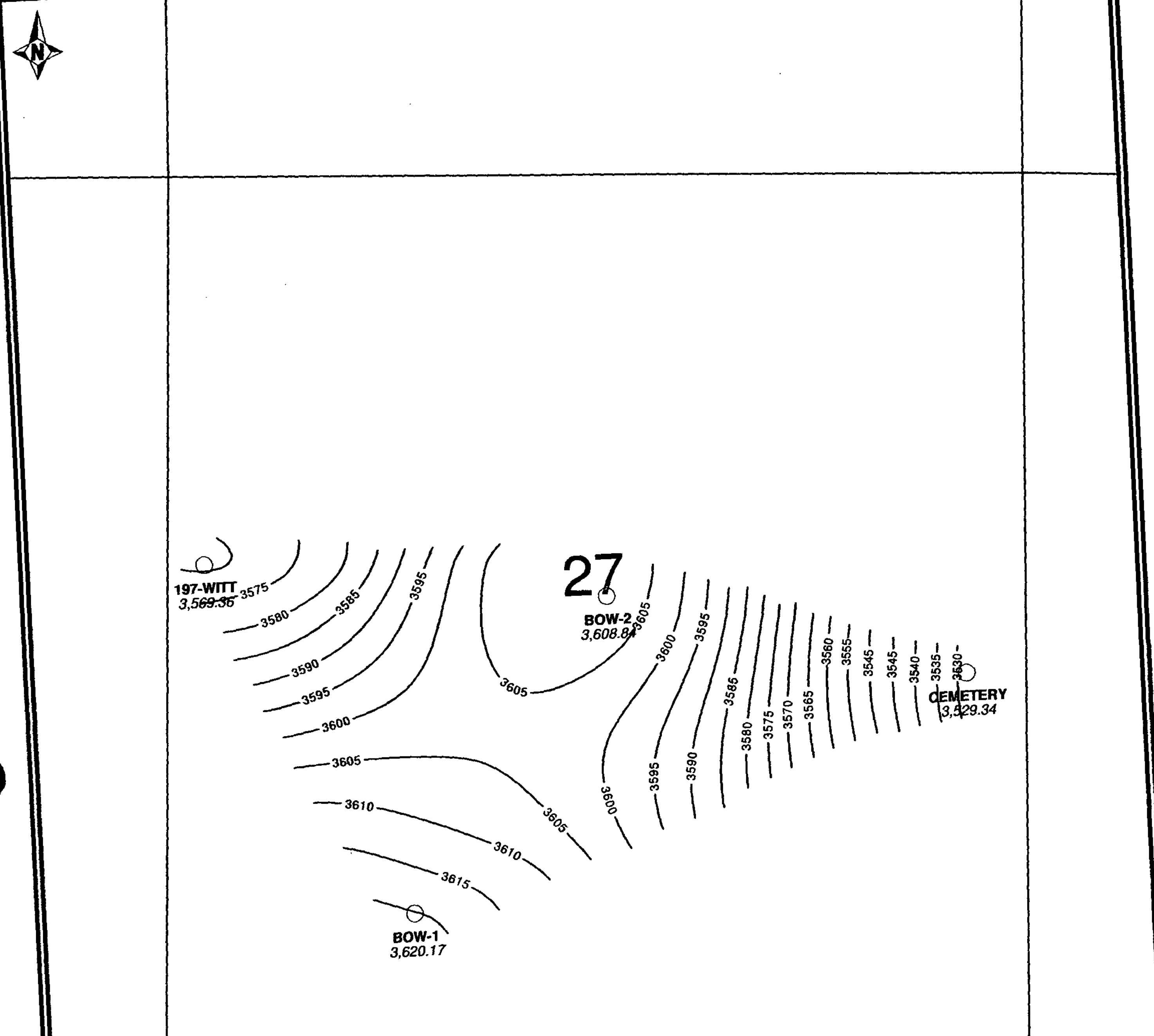
0 750 1500 3000
SCALE IN FEET 1" = 1500'

CROW BUTTE RESOURCES, INC.

FIGURE 3-4.15
NORTH TREND WELL LOCATION MAP

PROJECT: 223-37	DATE: MARCH 2007
DWG: CBRNT3CBase.dwg	BY: KRS CHECKED: HPD

Petrotek
10288 West Chatfield Ave., Ste 201
Littleton, Colorado 80127-4239
303-290-9414
www.petrotek.com



Petrotek
10288 West Chatfield Ave., Ste 201
Littleton, Colorado 80127-4239
303-290-9414
www.petrotek.com

Crow Butte Resources, Inc.

Figure 3.4-16

North Trend Area Local Water Level Map

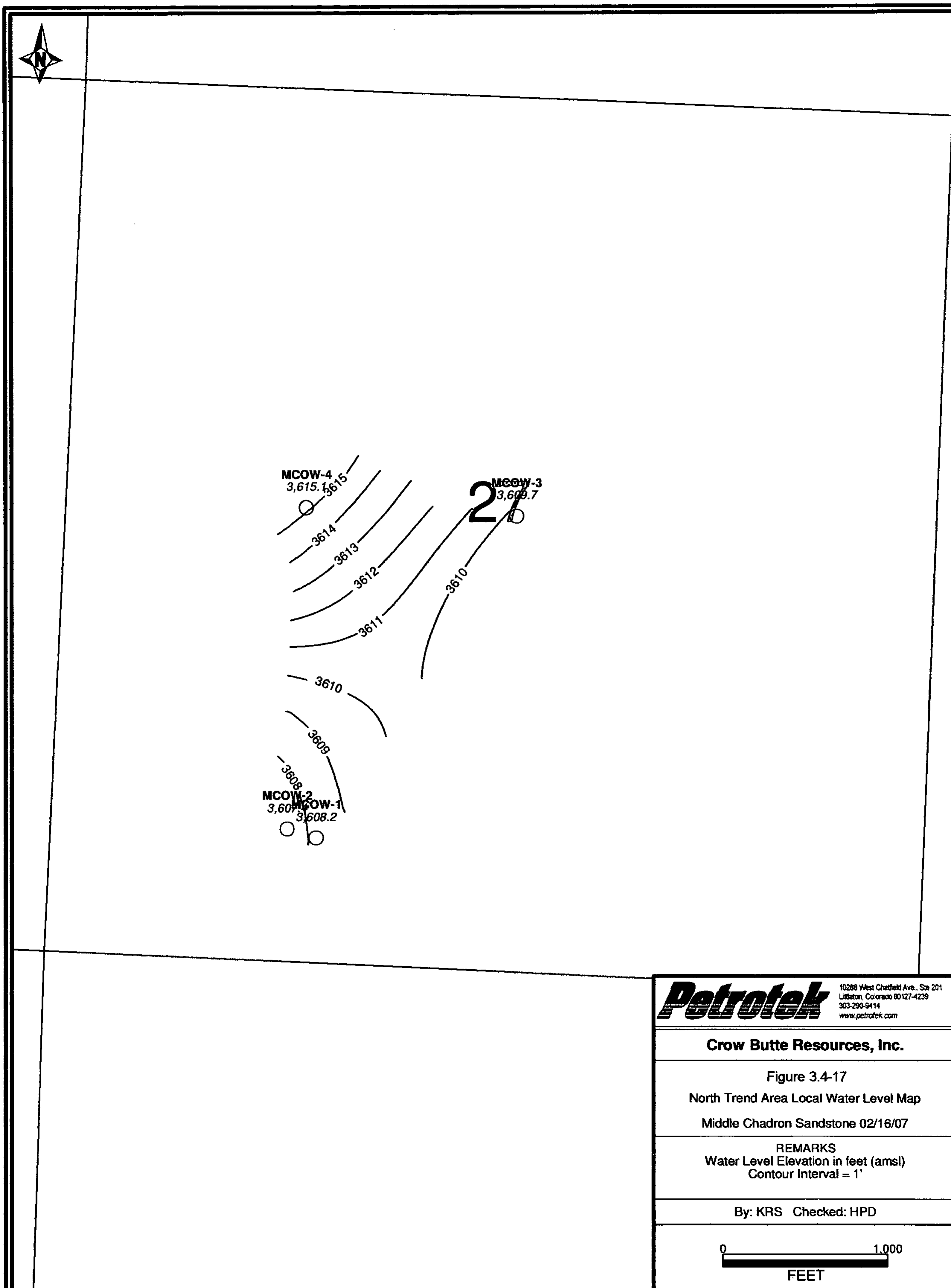
Brule Sandstone 02/07/07

REMARKS
Water Level Elevation in feet (amsl)
Contour Interval = 5'

By: KRS Checked: HPD

0 1,000
FEET

PETRA 3/14/2007 1:30:09 PM



Petrotek
10288 West Chatfield Ave., Ste 201
Littleton, Colorado 80127-4239
303-290-9414
www.petrotek.com

Crow Butte Resources, Inc.

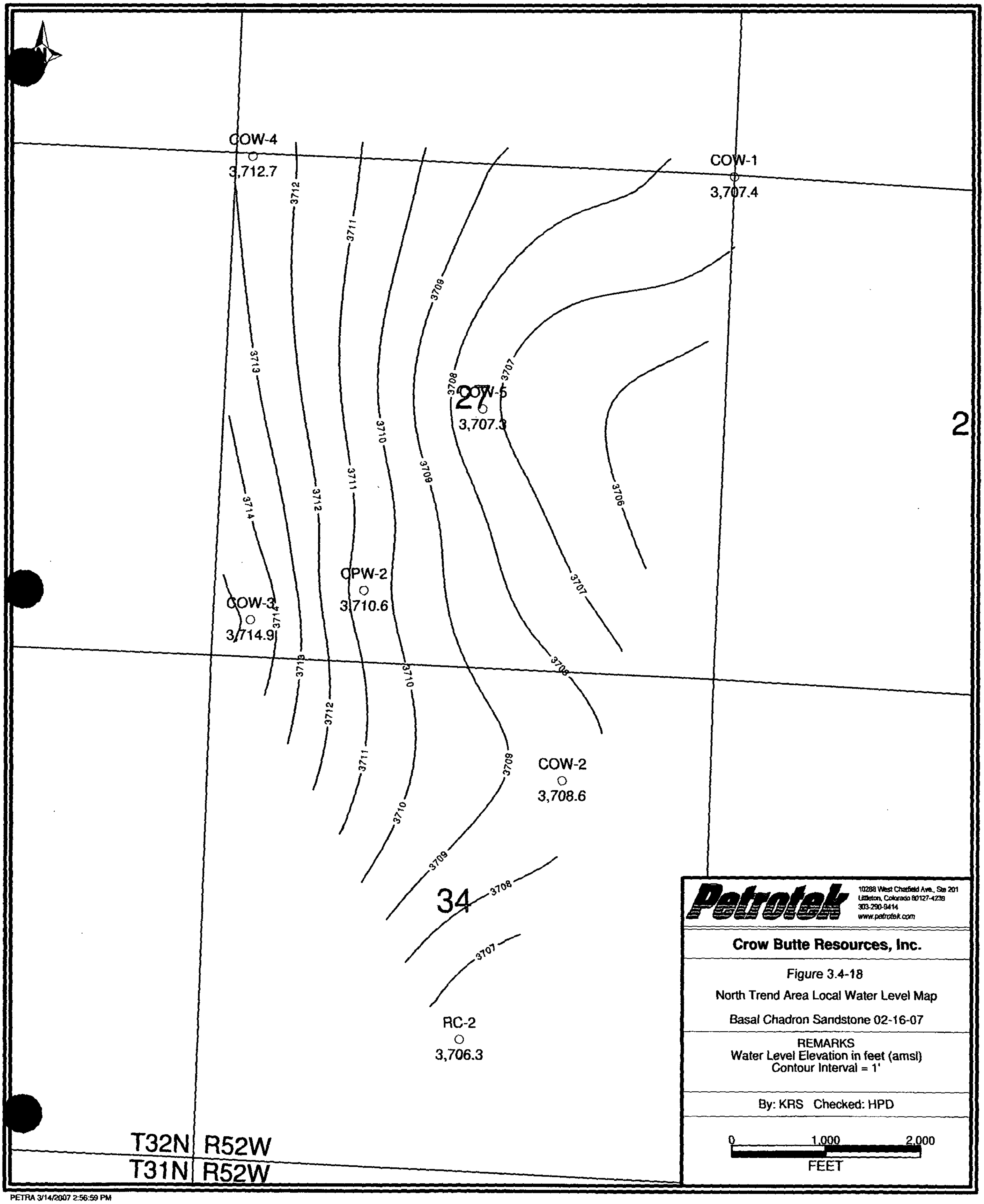
Figure 3.4-17

North Trend Area Local Water Level Map

Middle Chadron Sandstone 02/16/07

REMARKS
Water Level Elevation in feet (amsl)
Contour Interval = 1'

By: KRS Checked: HPD



Petrotek
10288 West Chatfield Ave., Ste 201
Littleton, Colorado 80127-4239
303-290-9414
www.petrotek.com

Crow Butte Resources, Inc.

Figure 3.4-18

North Trend Area Local Water Level Map

Basal Chadron Sandstone 02-16-07

REMARKS
Water Level Elevation in feet (amsl)
Contour Interval = 1'

By: KRS Checked: HPD

PETRA 3/14/2007 2:56:59 PM

Potentiometric levels in the overlying Upper/middle Chadron sand and Brule Formation are approximately 90 feet and 80 feet below that of the Basal Chadron (mined interval), respectively, indicating hydraulic isolation between the overlying units that were monitored and the Basal Chadron Sandstone.

Table 3.4-6 presents data for wells measured to construct the potentiometric maps; this data includes well locations as surveyed, well depths, and screened intervals. Water levels in each well were measured and recorded with In-Situ LevelTROLL transducer/dataloggers (Table 3.4-7).

Table 3.4-7: North Trend Pump Test Monitoring Information

Location ID	Monitoring Equipment	Serial Number	PSI
COW-5 (PW)	LevelTROLL	107167	100
COW-1	LevelTROLL	107145	30
COW-2	LevelTROLL	107156	30
COW-3	LevelTROLL	107139	30
COW-4	LevelTROLL	107140	30
CPW-2	LevelTROLL	107134	30
RC-2	LevelTROLL	107135	30
BOW-1	LevelTROLL	107058	30
BOW-2	LevelTROLL	107155	30
MCOW-1	LevelTROLL	107138	30
MCOW-2	LevelTROLL	107143	30
MCOW-3	LevelTROLL	107144	30
MCOW-4	LevelTROLL	107103	30

3.4.3.3 Aquifer Testing and Hydraulic Parameter Identification

Basal Chadron aquifer tests were conducted in the North Trend Expansion Area in 2004/2005 and 2006. Initial testing activities at North Trend commenced in 2004. However, the results from the 2004 tests were not definitive. For this reason, CBR conducted a longer test with additional monitoring wells in June and July 2006. A summary of testing and field operations for the 2004/2005 events are presented in Table 3.4-8, and a comparison of North Trend data obtained through testing versus data from the CSA is presented in Table 3.4-9.

Table 3.4-8: Summary of North Trend Pump Test Activities; 2004 and 2005

Start Date	Test/Field Operations	Purpose/Description	Result
8/9/2004	Test 1 (old #5)	Initial NT test to assess hydraulics and provide permitting data	Infiltration to Brule; possible hydraulic communication between Basal Chadron and Upper/Mid Chadron in MCOW1
8/23/2004	Test 2 (old #5a)	Duplicate Test 1	Confirmed responses observed in Test 1
9/28/2004	MITs and sampling	CPW-2, COW-3, MCOW-1, BOW-1	All wells pass MIT; samples could not be obtained from MCOW-1
12/8/04 to 12/22/04	Re-plugging	CPW-1	CWP-1 drilled out and re-plugged
	Install new monitoring wells	MCOW-2, COW-5	MCOW-2, COW-5 successfully installed
	Modify discharge line	Extend line 2500' to the east	Line extended along drain and across field
3/9/2005	Test 3	Assess confinement (MCOW-2); assess aquifer (COW-5)	Infiltration to Brule eliminated; drawdown in MCOW-1 during pumping
4/13/2005	Re-abandon exploration holes	Holes T80 & T85 re-abandoned	Holes located, re-drilled and re-plugged
5/2/2005	Test 4a	Evaluate whether meaningful data could be obtained by flowing CPW2	No meaningful data obtained; significant background trend in MCOW-1
5/10/2005	Test 4b	Pump CPW2; evaluate response in MCOW wells	Possible rain directly into wells; significant background trend in MCOW-1; generator ran out of fuel
5/24/2005	Test 4c	As above	No useful data; equipment problems
6/6/2005	Test 5a	As above; 2 cycles pumping and recovery	MCOW1 drawdown during both pumping periods; heavy rain - possible flow directly into wells
6/24/2005	Test 5b	Slug tests to test hypothesis that rain caused increase in water levels during Test 5a	Slug tests confirmed that water levels in BOW and MCOWs had been affected by rain.

Table 3.4-9: Comparison of 2004-2005 Testing Results to the Existing License Area

	Existing License Area Tests #1-#4 (mean)	Test #5 North Trend 2004-2005 (mean)
Transmissivity (ft^2/day)	363	103
Formation Thickness (feet)	39.0	19.8
Hyd. Cond. (ft/day)	9.3	5.2
Storativity	9.7E-05	7.1E-05

The June/July 2006 North Trend Pump Test was conducted in accordance with a Test Plan submitted by Crow Butte Resources, Inc. (CBR) to the Nebraska Department of Environmental Quality (NDEQ) in June 2006. In accordance with the Plan, CBR installed the necessary wells and performed a pump test to evaluate hydrogeologic conditions in the vicinity of the proposed North Trend Expansion Area. The pump test was designed to assess:

- The degree of hydrologic communication between the Basal Chadron Production Zone pumping well and the surrounding Production Zone monitor wells;
- The presence or absence of hydrologic boundaries within the Production Zone aquifer over the test area;
- The hydrologic characteristics of the Production Zone aquifer within the test area; and,
- The degree of hydrologic isolation between the Production Zone and the overlying aquifers.

The Production Zone in North Trend is the Basal Chadron Sandstone. The majority of the wells monitored during this test were completed in the Basal Chadron. The exact definition of the "overlying aquifer" at North Trend is somewhat difficult to determine. As such, to assess hydrogeologic isolation between the Production Zone and the overlying sands, overlying monitor wells were installed in both a Mid/Upper Chadron sand and a sandy clay within the base of the shallow Brule Formation. Because the production zone (Basal Chadron sand) is underlain by the Pierre Shale, no underlying monitoring wells were installed.

For the 2006 test, 13 wells (Table 3.4-10) were monitored using automated equipment. The test was conducted by pumping well COW-5 at 16.4 gpm for 357 hours (14.9 days). More than 110 feet of drawdown was achieved in the pumping well during testing. All of the Basal Chadron wells showed adequate drawdown (e.g., greater than 1.3 feet), which

confirms hydrologic communication within the Production Zone sand. Summary test results are presented in Tables 3.4-11 and 3.4-12.

The nearest overlying sand monitor well (MCOW-3; Upper/Middle Chadron Sand completion) was approximately 43 feet away from the pumping well used in the 2006 Test (see Figures 3.4-8 and 3.4-15); the nearest shallow aquifer monitor well (BOW-2; Brule completion) was located 32 feet from the pumping well. No significant water level changes due to the pump test were observed in the overlying or shallow monitor wells. Test results are summarized in Tables 3.4-11 and 3.4-12. The test results demonstrate:

- The Basal Chadron monitor wells are in communication with the Basal Chadron Production Zone throughout the North Trend test area;
- The Basal Chadron Sandstone has been adequately characterized with respect to hydrogeologic conditions within the majority of the proposed North Trend Expansion Area;
- Adequate confinement exists between the Basal Chadron sand Production Zone and the overlying Mid/Upper Chadron sand, and the overlying Brule Formation throughout the central portion of Section 27 of the proposed North Trend Expansion Area; and,
- While additional future testing will be necessary prior to mining in part of the proposed license area, the 2006 testing is sufficient to proceed with Class III permitting and NRC licensing for North Trend.

The North Trend Hydrologic Testing Report that provides a detailed description of the testing activities and results is attached to this application as Appendix B. Well completion reports are included with that document.

Table 3.4-10: Summary of 2006 North Trend Pump Test Well Information

Well ID	Distance to PW	North	East	Town-ship & Range	Sect	TOC Elev. (ft; AMSL)	Surface Elev. (ft; AMSL)	Casing Height (ft)	Hole Depth (ft; bgs)	Casing Depth (ft; bgs)	Top Screen (ft; bgs)	Bottom Screen (ft; bgs)	Screen Length (ft)	Screen Interval (feet)	Cas-ing O.D. (in.)	28 Jun 2006 Static Water Elev. (ft; AMSL)
Basal Chadron Pumping Well																
COW-5 (PW)	0.00	523,541.90	1,082,946.00	T32N R52W	27	3,669.05	3,667.65	1.40	740	708	653	708	55	22	4.5	3,704.85
Basal Chadron Observation Wells																
COW-1	3,614.28	525,991.00	1,085,604.00	T32N R52W	27	3,633.77	3,632.57	1.20	580	557	537	557	20	10	4.5	3,699.81
COW-2	4,001.38	519,632.50	1,083,799.00	T32N R52W	34	3,654.52	3,653.22	1.30	620	594	569	594	25	15	4.5	3,704.41
COW-3	3,315.00	521,315.40	1,080,490.00	T32N R52W	27	3,685.33	3,684.63	0.70	670	646	596	646	50	33	4.5	3,710.59
COW-4	3,609.34	526,204.30	1,080,509.00	T32N R52W	27	3,689.04	3,687.94	1.10	670	645	585	645	60	41	4.5	3,705.30
CPW-2	2,291.19	521,626.30	1,081,689.00	T32N R52W	27	3,676.92	3,675.82	1.10	710	685	615	685	70	35	4.5	3,705.99
RC-2	6,634.66	516,911.30	1,082,714.00	T32N R52W	34	3,651.22	3,648.42	2.80	630	630	572	630	58	25	4.5	3,703.93
Brule Observation Wells																
BOW-1	2,301.76	521,642.20	1,081,644.00	T32N R52W	27	3,677.39	3,675.49	1.90	65	65	45	65	20	5	4.5	3,620.68
BOW-2	31.78	523,534.20	1,082,915.00	T32N R52W	27	3,668.73	3,667.93	0.80	59	59	22	59	37	10	4.5	3,608.57
Middle Chadron Observation Wells																
MCOW -1	2,268.07	521,627.10	1,081,729.00	T32N R52W	27	3,676.80	3,675.50	1.30	380	350	305	350	45	5	4.5	3,607.29
MCOW -2	2,323.47	521,681.10	1,081,552.00	T32N R52W	27	3,678.82	3,677.52	1.30	370	360	315	360	45	7	4.5	3,606.83
MCOW -3	43.45	523,582.40	1,082,951.00	T32N R52W	27	3,668.85	3,667.65	1.20	390	391	325	391	66	17	4.5	3,606.14
MCOW -4	1,280.16	523,634.60	1,081,671.00	T32N R52W	27	3,681.66	3,679.86	1.80	371	371	290	371	81	19	4.5	3,608.27

Table 3.4-11: Summary of 2006 North Trend Pump Test Results

Well	Distance from Pumping Well (feet)	Analytical Results	Test #6 Analytical Method	
			Theis	Theis Recovery
COW-5 (PW)	0.00	Transmissivity (ft^2/day)	NA	*
		Hyd. Cond. (ft/day)	NA	*
		Storativity	NA	*
COW-1	3,614.28	Transmissivity (ft^2/day)	42.0	NA
		Hyd. Cond. (ft/day)	1.6	NA
		Storativity	2.30E-05	NA
COW-2	4,001.38	Transmissivity (ft^2/day)	74.8	NA
		Hyd. Cond. (ft/day)	2.9	NA
		Storativity	7.05E-05	NA
COW-3	3,315.00	Transmissivity (ft^2/day)	71.5	NA
		Hyd. Cond. (ft/day)	2.8	NA
		Storativity	8.40E-05	NA
COW-4	3,609.34	Transmissivity (ft^2/day)	51.7	NA
		Hyd. Cond. (ft/day)	2.0	NA
		Storativity	3.43E-05	NA
CPW-2	2,291.19	Transmissivity (ft^2/day)	60.7	NA
		Hyd. Cond. (ft/day)	2.3	NA
		Storativity	4.55E-05	NA
RC-2	6,634.66	Transmissivity (ft^2/day)	58.2	NA
		Hyd. Cond. (ft/day)	2.2	NA
		Storativity	6.18E-05	NA

NA - Data not analyzed; pumping data were sufficient for analysis.

* Unable to analyze recovery data due to lack of check valve on top of pump.

Table 3.4-12: Summary of 2006 North Trend Pump Test Results vs. Existing License Area

	Existing License Area Tests #1-#4 (mean)	Test #5 North Trend 2004 & 2005 (mean)	Test #6 North Trend 2006 (mean)
Transmissivity (ft^2/day)	363	103	60
Formation Thickness (feet)	39.0	19.8	26
Hyd. Cond. (ft/day)	9.3	5.2	2.3
Storativity	9.7E-05	7.1E-05	5.3E-05

Regional aquifer analysis data are also available. During the initial permitting and development activities within the CSA, two pumping tests were conducted in the central portion of the CSA to (1) assess the hydraulic characteristics of the Chadron Sandstone, and (2) demonstrate the confinement provided by the overlying and underlying aquicludes (the Brule-Chadron Formation and Pierre Shale, respectively). Those tests, referred to as Test #1 and Test #2, were performed in 1982 and 1987, respectively (Wyoming Fuel, 1983; Ferret Exploration of Nebraska, 1987). Test #3 was conducted in September, 1996 (Harlan & Associates, Inc., 1996).

The results from those tests indicate that the Chadron Sandstone is relatively homogeneous and isotropic (i.e., the hydraulic conductivity [permeability] is consistent with respect to direction and location) within the CSA. This is consistent with regional geologic information that suggests that the nature and characteristics of the Brule and Chadron Formations, and the Pierre Shale are consistent within the Crawford Basin. The depositional environment of these sections has been confirmed by exploratory drilling in the North Trend Expansion Area.

The CSA 1995 Application for Renewal of USNRC License SUA-1534 states that a porosity of 29% was assumed for the Basal Chadron Sandstone for a first aquifer test. The origin of this porosity estimate (i.e. core vs. well log) was not cited.

3.4.4 Surface Water and Groundwater Quality

Historical surface water quality data for the White River, assembled by EPA, are presented in Table 3.4-13a. Historical groundwater quality data from the CSA for the Brule Alluvium, Brule Formation, and Basal Chadron Formation are presented in Table 3.4-13b.

A monitoring program was conducted to establish baseline groundwater quality conditions in the North Trend Area. The program was conducted in 1996 and 1997, and includes samples from a Basal Chadron well (Well 81) and Brule well (Well 78) in the North Trend Expansion Area (Figure 3.4-15). The radiological results of baseline sampling for these wells are also discussed in section 6.1. Note that well 81 has since been abandoned.

Tables 3.4-14 and 3.4-15 summarize data obtained from these wells for four monitoring periods, obtained from October 1996 through June 1997 to assess seasonable variability in water quality. These data establish the groundwater conditions associated with the mineralized Basal Chadron sandstone and Brule in the North Trend area, at a location immediately outside and northeast of the proposed license area. The data indicate that the TDS for the Chadron ranges from 1790 to 1820 mg/l, while the TDS for the Brule ranges from 423 to 479 mg/l. Major ion content in groundwater is slightly higher in the Basal Chadron than the Brule, as would be expected by the TDS values. Alkalinity and conductivity are higher in the Chadron than Brule, but neither formation shows there to be measurable concentrations of most trace metals. Measurable uranium ranging in concentration from <0.0003 to 0.006 mg/l was detected in Chadron groundwater. These Chadron samples also showed radium-226 concentrations ranging from 10.3 to 14.7 pCi/l, which is above the NDEQ MCL of 5 pCi/l. Measurable uranium was also present in all four Brule samples with a maximum concentration of 0.016 mg/l. Radium-226 was present in the Brule samples with a maximum concentration of 0.5 pCi/l. While the concentrations of uranium and radium-226 in the Brule samples are below the NDEQ MCLs, they are elevated compared to concentrations typical for the area. CBR believes that integrity problems with the Chadron well casing may have had an impact on the water quality in the Brule well. The Chadron well has since been plugged and abandoned.

It is noted that gross alpha and beta analyses were not performed because uranium and radium were the anticipated compounds and were thus specifically included on the analyte list. Also, that the average values for all parameters presented on Tables 3.4-14 and 3.4-15 are almost identical to the individual sample values, and the sample value range for each parameter is relatively limited. Based on these data, there is little seasonable variability in water quality.

Table 3.4-13a: Historic White River Water Quality Data, 1968-1994*

PARAMETER	RESULTS										
	8/20/1968	5/6/1969	7/15/1969	5/24/1970	8/28/1970	8/5/1971	6/5/1972	10/2/1972	6/4/1973	9/23/1981	7/13/1994
NUMBER USED IN SAMPLE ACCOUNTING PROCEDURE	66	66	65	95	77	109	no data	no data	no data	1	1
TEMPERATURE, WATER (DEGREES CENTIGRADE)	21	18	28	18.5	21	19.5	22	12.5	17	no data	20
TEMPERATURE, AIR (DEGREES CENTIGRADE)	32	21	36	23	27	30	21	11.1	23	no data	no data
FLOW, STREAM, MEAN DAILY CFS	10	22	10	22	21	12	19	12	24	no data	no data
TURBIDITY, (JACKSON CANDLE UNITS)	41	62	10	45	337	5	36	4	4	no data	no data
SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)	400	390	355	353	305	340	340	340	400	330	700
OXYGEN, DISSOLVED MG/L	7.4	8.5	6.9	7.8	7	8	8.1	9.6	7.9	no data	6.9
OXYGEN, DISSOLVED, PERCENT OF SATURATION	82.2321	89.4889	87.3453	82.106	77.7793	85.1096	92.0463	88.8907	81 .4491	no data	75
PH (STANDARD UNITS)	7.7	8.2	8.2	7.9	7	8.5	8.4	8.5	7.6	no data	8.3
ALKALINITY, TOTAL (MG/L AS CACO3)	208	108	180	184	168	176	192	200	189	188	no data
RESIDUE, TOTAL FILTRABLE (DRIED AT 105C),MG/L	258	270	250	250	220	250	240	260	no data	288	no data
NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	0.1	0.1	1	0.1	0.6	0.1	0.2	0.1	no data	no data	no data
PHOSPHATE, TOTAL (MG/L AS PO4)	0.8	0.1	0.5	0.2	0.3	0.1	0.2	0.1	no data	no data	no data
HARDNESS, TOTAL (MG/L AS CACO3)	176	148	168	160	156	172	160	172	172	no data	159
CALCIUM, DISSOLVED (MG/L AS CA)	39	35	51	50	52	46	51	56	no data	no data	no data
MAGNESIUM, DISSOLVED (MG/L AS MG)	10	1	10	9	6	14	8	8	no data	no data	no data
SODIUM, DISSOLVED (MG/L AS NA)	36	24	43	24	22	16	15	15	no data	no data	no data
SODIUM ADSORPTION RATIO	0.4	0.9	1.5	0.8	0.8	0.5	0.5	0.5	no data	no data	no data
POTASSIUM, DISSOLVED (MG/L AS K)	6	8	13	8	9	9	10	9	no data	no data	no data
CHLORIDE,TOTAL IN WATER MG/L	12	18	4	1	2	4	1	2	7	5	no data
HARDNESS, CA MG CALCULATED (MG/L AS CACO3)	138.563	91.513	168.527	161.912	154.552	172.514	160.291	172.776	no data	174.528	159.437

* Summaries of data collected are presented. See http://www.epa.gov/storet/updates.html, EPA' STORET database, for full data sets

Table 3.4-13b: Water Quality Summary; Brule Formation and Basal Chadron Sandstone

CONSTITUENT[1)]	BRULE FORMATION		CHADRON FORMATION		BRULE ALLUVIUM	
	RANGE	MEAN	RANGE	MEAN	RANGE	MEAN
Calcium	7.1 - 98	48	11 - 41	20	67 - 74	70.6
Magnesium	0.3 - 16	6.6	0.8 - 7.2	3.2	6.4 - 10	8.7
Sodium	12 - 340	104	340 - 540	411	34 - 41	36.5
Potassium	4.1 - 15.9	9.9	7.0 - 19.8	12.4	10.3 - 13	11.1
Bicarbonate	137 - 627	364	308 - 411	368	299 - 364	321
Sulfate	1 - 23	10	254 - 620	407	11 - 20	16.3
Chloride	1.6 - 192	48	134 - 250	176	5 - 10	6.7
Specific Conductance (μmhos)	246 - 1481	714	1500 - 2500	1932	507 - 614	548
pH (pH units)	6.80 - 8.50	7.80	7.60 - 8.70	8.20	7.10 - 8.40	7.70
Uranium (mg/l)	0.001 - 0.021	0.0064	<0.001 - 2.40	0.092	0.006 - 0.022	0.015
Radium-226 (pCi/l)	0.1 - 3.0	0.7	0.1 - 619	53	0.4 - 18.3	2.5

[1)] Concentrations in mg/l, unless otherwise noted.

Table 3.4-14: Laboratory Analysis Report - Chadron Well W-81

	Units	Detection Limit	RESULTS 9/5/1996	12/13/1996	3/20/1997	6/26/1997	Average Value
Major Ions							
Calcium (Ca)	mg/L	1.0	29.4	28.9	29.1	30.9	29.6
Magnesium (Mg)	mg/L	1.0	5.4	5.33	5.2	5.2	5.3
Sodium (Na)	mg/L	1.0	555	568	561	582	567
Potassium (K)	mg/L	1.0	15.0	14.7	15.1	15.1	15.0
Carbonate (CO3)	mg/L	0.10	0	0	0	0	0
Bicarbonate (HCO3)	mg/L	0.10	399	404	398	401	401
Sulfate (SO4)	mg/L	1.0	740	744	743	720	737
Chloride (Cl)	mg/L	0.10	196	204	208	201	202
Ammonium (NH4) as N	mg/L	0.05	0.73	0.68	0.75	1	0.74
Nitrite (NO2) as N	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Nitrate (N03) as N	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Fluoride (F)	mg/L	0.10	1.24	1.21	1.22	1.24	1.23
Silica (S102)	mg/L	1.0	11.5	11.3	10.9	11.5	11.3
Non-Metals							
Total Dissolved Solids (TDS) @ 180°C	mg/L	1.0	1820	1810	1795	1790	1804
Conductivity	µmho/cm	1.0	2640	2750	2790	2710	2723
Alkalinity (CaCO3)	mg/L	1.0	327	331	326	329	328
pH	std. units	0.10	8.02	8.21	8	8.15	8.10
Trace Metals							
Aluminum (Al)	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Arsenic (As)	mg/L	0.001	< 0.001	< 0.001	0.002	< 0.001	<0.002
Barium (Ba)	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Boron (B)	mg/L	0.10	1.66	1.60	1.60	1.59	1.61
Cadmium (Cd)	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01
Chromium (Cr)	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Copper (Cu)	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01
Iron (Fe)	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Lead (Pb)	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Manganese (Mn)	mg/L	0.01	0.02	< 0.01	0.01	0.01	0.01

Table 3.4-14: Laboratory Analysis Report - Chadron Well W-81

RESULTS

	Units	Detection Limit	9/5/1996	12/13/1996	3/20/1997	6/26/1997	Average Value
Mercury (Hg)	mg/L	0.001	< 0.001	< 0.001	< 0.001	< 0.001	<0.001
Molybdenum (Mo)	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Nickel (Ni)	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Selenium (Se)	mg/L	0.001	< 0.001	0.175	< 0.001	< 0:001	<0.175
Vanadium (V)	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Zinc (Zn)	mg/L	0.01	0.02	0.01	0.02	< 0.01	<0.02
Radiometric							
Uranium (U nat)	mg/L	0.0003	< 0.0003	0.0060	<0.0003	0.0003	<0.0032
Radium 226 (Ra-226)	pCi/L	0.2	10.5	11.9	10.3	14.7	11.9
Radium Precision ±			0.4	0.6	0.6	1.3	
Quality Assurance Data		target range					
Anion	meq		27.55	27.94	27.93	27.31	27.68
Cation	meq		26.45	27.02	26.74	27.74	26.99
WYDEQ A/C Balance	%	-5 - +5	-2.04	-1.66	-2.18	0.77	-1.28
Calc TDS	mg/L		1754	1780	1773	1768	1769
TDS A/C Balance	dec. %	0.80 - 1.20	1.04	1.02	1.01	1.01	1.02

Table 3.4-15: Laboratory Analysis Report - Brule Well W-78

			RESULTS				
	Units	Detection Limit	10/11/1996	12/13/1996	3/20/1997	7/17/1997	Average Value
Major Ions							
Calcium (Ca)	mg/L	1.0	67.6	67.6	67.4	77.0	69.9
Magnesium (Mg)	mg/L	1.0	9.2	9.2	9.0	9.8	9.3
Sodium (Na)	mg/L	1.0	41.8	43.9	41.0	46.3	43.3
Potassium (K)	mg/L	1.0	16.6	16.7	16.1	16.9	16.6
Carbonate (CO3)	mg/L	0.10	0	0	0	0	0
Bicarbonate (HCO3)	mg/L	0.10	244	248	245	248	246
Sulfate (SO4)	mg/L	1.0	52.2	51.0	51.3	66.5	55.3
Chloride (Cl)	mg/L	0.10	26.9	27.0	27.2	31.9	28.3
Ammonium (NH4) as N	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Nitrite (NO2) as N	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Nitrate (N03) as N	mg/L	0.10	6.12	5.66	5.76	5.47	5.75
Fluoride (F)	mg/L	0.10	0.38	0.35	0.38	0.35	0.37
Silica (S102)	mg/L	1.0	68.0	68.0	64.9	68.0	67.2
Non-Metals							
Total Dissolved Solids (TDS) @ 180°C	mg/L	1.0	423	432	479	443	436
Conductivity	µmho/cm	1.0	622	618	650	624	606
Alkalinity (CaCO3)	mg/L	1.0	203	201	203	202	200
pH	std. units	0.1	8.22	7.91	7.90	7.98	7.89
Trace Metals							
Aluminum (Al)	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Arsenic (As)	mg/L	0.001	0.005	0.003	0.006	0.007	0.005
Barium (Ba)	mg/L	0.10	0.20	0.20	0.19	0.20	0.20
Boron (B)	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Cadmium (Cd)	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01
Chromium (Cr)	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Copper (Cu)	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01
Iron (Fe)	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Lead (Pb)	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Manganese (Mn)	mg/L	0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01
Mercury (Hg)	mg/L	0.001	< 0.001	< 0.001	< 0.001	< 0.001	<0.001

Table 3.4-15: Laboratory Analysis Report - Brule Well W-78

	Units	Detection Limit	RESULTS 10/11/1996	12/13/1996	3/20/1997	7/17/1997	Average Value
Molybdenum (Mo)	mg/L	0.10	< 0.10	< 0.10	_< 0.10	< 0.10	<0.10
Nickel (Ni)	mg/L	0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Selenium (Se)	mg/L	0.001	0.018	0.018	0.015	0.017	0.017
Vanadium (V)	mg/L	0.10	< 0.10	< 0.10	< 0.10	< 0.10	<0.10
Zinc (Zn)	mg/L	0.01	0.04	0.02	0.02	0.03	0.02
Radiometric							
Uranium (U nat)	mg/L	0.0003	0.0123	0.0069	0.014	0.016	0.0123
Radium 226 (Ra-226)	pCi/L	0.2	<0.2	0.5	0.3	<0.2	0.4
Radium Precision ±				0.1	0.2		
Quality Assurance Data		target range					
Anion	meq		6.30	6.31	6.29	6.75	6.41
Cation	meq		6.41	6.50	6.33	7.13	6.59
WYDEQ A/C Balance	%	-5 - +5	0.81	1.53	0.38	2.73	1.36
Calc TDS	mg/L		432	433	425	465	439
TDS A/C Balance	dec. %	0.80 - 1.20	1.01	0.98	1.02	1.03	1.01

Based on similar regional deposition, the North Trend Expansion Area ore body is expected to be similar mineralogically and geochemically to that of the CSA. The ore bodies in the two areas are within the same geologic unit (i.e. Basal Chadron sandstone) and have the same mineralization source (see Section 3.1). The sites are separated by only a few miles, and the cause of mineral deposition in the two areas appears to be similar (see Section 3.1). Neither site is anticipated to be affected by any recharge or other processes that would uniquely affect each area, so the groundwater characteristics of the CSA mineralized zone are presumed representative of that in the North Trend Expansion Area. Tables 3.4-16a through 3.4-16c are the Baseline and Restoration Values for Mine Units 1-3 in the CSA area (additional data for MU 1-9 are presented in Attachment 5.3[A]). The values in these tables are expected to be representative of the geochemical characteristics of the North Trend Expansion Area ore body. The North Trend Expansion Area ore body, the outline of which is presented on Figure 3.4-11, is considered a zone of distinct water quality characteristics primarily due to the presence of relatively concentrated uranium and radium in the zone when compared to the concentration of these parameters outside of the zone (e.g. Tables 3.4-14 vs. Tables 3.4-16a-c).

Table 3.4-16a: Baseline and Restoration Values for CSA Mine Unit 1

Baseline and Restoration Values for CSA Mine Unit 1	Groundwater Standard	MU-1 Baseline (Primary Standard)	MU-1 Standard Deviation	MU-1 NDEQ Restoration Value
Ammonium (mg/l)	10	<0.372		10
Arsenic (mg/l)	0.05	<0.00214		0.05
Barium (mg/l)	1	<0.1		1
Cadmium (mg/l)	0.01	<0.00644		0.005
Chloride (mg/l)	250	203.9	38	250
Copper (mg/l)	1	<0.017		1
Fluoride (mg/l)	4	0.686	0.04	4
Iron (mg/l)	0.3	<0.0441		0.3
Mercury (mg/l)	0.002	<0.001		0.002
Manganese (mg/l)	0.05	<0.011		0.05
Molybdenum (mg/l)	1	<0.0689		1
Nickel (mg/l)	0.15	<0.0340		0.15
Nitrate (mg/l)	10	<0.050		10
Lead (mg/l)	0.05	0.0315		0.05
Radium (pCi/L)	5	229.7	177.1	584
Selenium (mg/l)	0.01	<0.00323		0.05
Sodium (mg/l)	N/A	412	19.2	4120
Sulfate (mg/l)	250	356.2	9.4	375
Uranium (mg/l)	5	0.0922	0.089	5
Vanadium (mg/l)	0.2	<0.0663		0.2
Zinc (mg/l)	5	<0.036		5
pH (Std. Units)	6.5 - 8.5	8.46	0.2	6.5 – 8.5
Calcium (mg/l)	N/A	12.5	3.2	125
Total Carbonate (mg/l)	N/A	351	31.1	585
Potassium (mg/l)	N/A	12.5	1.5	125
Magnesium (mg/l)	N/A	3.2	0.8	32
TDS (mg/l)	N/A	1170.2	47.6	1170.2

Table 3.4-16b: Baseline and Restoration Values for CSA Mine Unit 2

Baseline and Restoration Values for CSA Mine Unit 2	Groundwater Standard	MU-2 Baseline (Primary Standard)	MU-2 Standard Deviation	MU-2 NDEQ Restoration Value
Ammonium (mg/l)	10	0.37	0.07	10
Arsenic (mg/l)	0.05	<0.001		0.05
Barium (mg/l)	1	<0.1		1
Cadmium (mg/l)	0.005	<0.007		0.005
Chloride (mg/l)	250	208.6	30.8	250
Copper (mg/l)	1	<0.013		1
Fluoride (mg/l)	4	0.67	0.04	4
Iron (mg/l)	0.3	<0.045		0.3
Mercury (mg/l)	0.002	<0.001		0.002
Manganese (mg/l)	0.05	<0.01		0.05
Molybdenum (mg/l)	1	<0.073		1
Nickel (mg/l)	0.15	<0.037		0.15
Nitrate (mg/l)	10	<0.039		10
Lead (mg/l)	0.05	<0.035		0.05
Radium (pCi/L)	5	234.5	411.8	1058
Selenium (mg/l)	0.05	<0.001		0.05
Sodium (mg/l)	N/A	410.8	18.2	4108
Sulfate (mg/l)	250	348.2	10.3	369
Uranium (mg/l)	5	0.046	0.037	5
Vanadium (mg/l)	0.2	<0.07		0.2
Zinc (mg/l)	5	<0.026		5
pH (Std. Units)	6.5 - 8.5	8.32	0.2	6.5 – 8.5
Calcium (mg/l)	N/A	13.4	2.4	134
Total Carbonate (mg/l)	N/A	366.9	13.3	585
Potassium (mg/l)	N/A	12.6	2.5	126
Magnesium (mg/l)	N/A	3.5	0.4	35
TDS (mg/l)	N/A	1170.4	41	1170.4

Table 3.4-16c: Baseline and Restoration Values for CSA Mine Unit 3

Baseline and Restoration Values for CSA Mine Unit 3	Groundwater Standard	MU-3 Baseline (Primary Standard)	MU-3 Standard Deviation	MU-3 NDEQ Restoration Value
Ammonium (mg/l)	10	<0.329		10
Arsenic (mg/l)	0.05	<0.001		0.05
Barium (mg/l)	1	<0.1		1
Cadmium (mg/l)	0.005	<0.01		0.005
Chloride (mg/l)	250	197.6	16.7	250
Copper (mg/l)	1	<0.0108		1
Fluoride (mg/l)	4	0.719	0.05	4
Iron (mg/l)	0.3	<0.05		0.3
Mercury (mg/l)	0.002	<0.001		0.002
Manganese (mg/l)	0.05	<0.01		0.05
Molybdenum (mg/l)	1	<0.1		1
Nickel (mg/l)	0.15	<0.05		0.15
Nitrate (mg/l)	10	<0.0728		10
Lead (mg/l)	0.05	<0.05		0.05
Radium (pCi/L)	5	165	222.5	611
Selenium (mg/l)	0.05	<0.00115		0.05
Sodium (mg/l)	N/A	428	27.6	4280
Sulfate (mg/l)	250	377	13.4	404
Uranium (mg/l)	5	0.115	0.158	5
Vanadium (mg/l)	0.2	<0.1		0.2
Zinc (mg/l)	5	<0.0131		5
pH (Std. Units)	6.5 - 8.5	8.37	0.3	6.5 – 8.5
Calcium (mg/l)	N/A	13.3	3.1	133
Total Carbonate (mg/l)	N/A	358.7	24.8	592
Potassium (mg/l)	N/A	13.9	4	139
Magnesium (mg/l)	N/A	3.5	0.9	35
TDS (mg/l)	N/A	1183	47.4	1183

Available groundwater data for both the Brule and Chadron do not indicate that there are any documented flow rate variations or recharge issues that would impact groundwater quality. There are no surface water ponds within the area, and only limited stream flow (see Section 3.4.1). The Brule, while considered an overlying aquifer, is not an extensive or exceptionally productive system. The available monitoring data (Table 3.4-5) do not indicate any seasonality or pumping effects by domestic wells within this zone. With respect to the Basal Chadron sandstone, there are no domestic wells completed within this interval in the immediate North Trend area, and there is no information to indicate that there are recharge or flow rate issues associated with the Basal Chadron sandstone that would affect groundwater quality.

During the course of mining the water quality is expected to change as outlined in Table 3.4-17 The chemicals used in the mining and recovery process will include sodium bicarbonate, an oxidizer such as oxygen, carbon dioxide, and chloride for elution. As a result, the greatest changes in water quality are expected to be in alkalinity, bicarbonate, chloride, sodium, conductivity, and TDS. Significant increases are also likely to occur in calcium concentrations as a result of ion exchange with clays. The oxidant will cause significant increases in uranium, vanadium, and radium and minor increases in trace metals such as copper, arsenic, molybdenum and selenium. The genesis of the ore body and the facies of the host rock at North Trend are similar to that of the CSA so it is probable the change in water quality at North Trend will be similar to that experienced at the CSA. Historic restoration activities at the CSA have demonstrated the ability to successfully restore groundwater to established restoration standards

As indicated in Section 3.4.1, Spring Creek and an unnamed creek are within the North Trend Expansion Area, and are northern tributaries of the White River. Both of the creeks are ephemeral and therefore could not be sampled on a seasonal basis for a period of one or more years. The White River is present to the south of the North Trend Expansion Area, and is perennial.

3.4.5 WATER USE INFORMATION

As discussed previously in Section 3.4.1, local water use is very limited. Isolated household wells are completed in the Brule Formation, and the city of Crawford uses two wells completed in the Brule outside the North Trend Expansion Area (see Figure 3.4-2). One well completed in the Basal Chadron is used for household purposes (Well No. 61; approximately 1.5 miles southeast of the Expansion Area boundary).

Table 3.4-17: Anticipated Changes in Water Quality During Mining

Average Ore Zone Water Quality			
Analyte	**Units**	**Pre-Mining (Well W-007)**	**Typical Water Quality During Mining at CSA**
Alkalinity, Total as CaCO3	mg/L	328	1,600
Carbonate as CO3	mg/L	0	<1.0
Bicarbonate as HCO3	mg/L	401	2,050
Calcium	mg/L	29.6	77
Chloride	mg/L	202	600
Fluoride	mg/L	1.23	0.6
Magnesium	mg/L	5.3	23
Ammonia as N	mg/L	0.74	<0.05
Nitrate+Nitrite as N	mg/L		0.46
Potassium	mg/L	15.0	35
Silica	mg/L	11.3	21
Sodium	mg/L	567	1,310
Sulfate	mg/L	737	900
Conductivity	umhos/cm	2,723	6,000
pH	s.u.	8.1	7.8
TDS	mg/L	1,804	4,080
Aluminum	mg/L	<0.10	<0.1
Arsenic	mg/L	<0.002	0.06
Barium	mg/L	<0.10	<0.1
Boron	mg/L	1.61	1.1
Cadmium	mg/L	<0.01	<0.005
Chromium	mg/L	<0.05	<0.05
Copper	mg/L	<0.01	0.04
Iron	mg/L	<0.05	<0.030
Lead	mg/L	<0.05	<0.05
Manganese	mg/L	0.01	0.05
Mercury	mg/L	<0.001	<0.001
Molybdenum	mg/L	<0.10	0.5
Nickel	mg/L	<0.05	<0.05
Selenium	mg/L	<0.175	0.07
Uranium	mg/L	<0.0032	44
Vanadium	mg/L	<0.10	2.5
Zinc	mg/L	<0.02	0.02
Radium 226	pCi/L	11.9	1,090

3.4.6 CONCEPTUAL MODELING OF SITE HYDROLOGY

Tables 2.6.1 and 2.6.2 present the regional and local stratigraphic columns within the North Trend area. As shown in these figures, the principal aquifers within the North Trend area are the Basal Chadron Sandstone, intermittent Upper/Middle Chadron sand, a sandy interval in the Brule Formation, and rarely, alluvial deposits. The Basal Chadron Sandstone is isolated from underlying sandstone intervals by more than 1,500 feet of thick Pierre Shale. Overlying confinement between the Basal Chadron and the Upper/Middle Chadron sand is provided by more than 200 feet of clay and shale in the Middle Chadron interval. Additional Overlying confinement above the Basal Chadron Sandstone is provided by more than 300 feet of clay and shale in the Brule Formation and the Upper Chadron.

Water level data presented in Figures 3.4-16, 3.4-17, and 3.4-18 show each saturated zone to have distinct elevations, with the Basal Chadron Sandstone water elevations approximately 80 to 90 feet higher than overlying units (Brule and Upper/Middle Chadron sand) indicating confined conditions within the Basal Chadron. Water level data indicate that the Brule is unconfined. Water level data support hydrologic isolation of the Basal Chadron Sandstone with respect to the other water-bearing intervals of interest in the North Trend Expansion Area. Ground water production rates within the Brule and Upper/Middle Chadron sands are low to exceptionally low.

The geochemical groundwater characteristics of the Brule and Chadron further indicate that the two zones are not naturally interconnected. For example, Table 3.4-13 shows that sulfate, sodium, and chloride concentrations as well as specific conductance significantly differ between the Brule and Basal Chadron Sandstone.

Groundwater information (Figure 3.4-16) indicates that groundwater within the Brule flows in a general east/northeastern direction in the North Trend Expansion Area with a gradient of about 0.005 ft/ft, toward the White River. This interval, in all likelihood, is dissected by the White River, which is either gaining from the Brule or losing to the Brule, depending upon the season. Alluvial deposits along the margins of the White River may offer limited groundwater storage depending on river levels. Recharge to the Brule likely occurs directly at or immediately north of North Trend, as geologic maps indicate this interval subcrops in the North Trend Expansion Area.

The Basal Chadron Sandstone outcrops approximately 10 miles north of the North Trend Expansion Area, where recharge occurs. Potentiometric maps (Figure 3.4-18) indicate groundwater flow within the Basal Chadron is predominantly to the east in the North Trend Expansion Area with a gradient of approximately 0.0016 ft/ft (8.5 ft/mile). This flow is roughly concurrent with the local dip on the top of the Basal Chadron sand. The Basal Chadron sand is over 500 feet below the base of the White River.

There is no identified hydraulic communication between the Basal Chadron and the White River. However, a distinct structural feature occurs in the general area of the White River (see Section 2.6.2), a monocline or fold within the Pierre, Chadron and Brule Formations, possibly caused by movement along a fault that is present at depth, but which terminates before transected these near surface formations. Along this feature, the orientation and dip of the Chadron changes from dipping to the southeast to the northwest.

Regional data regarding flow in the Basal Chadron are limited. Based on those data, the structural feature does not appear to dramatically impact flow in the Basal Chadron Sandstone. Additional investigations to be conducted during development of North Trend are expected to provide detailed information regarding the impact of this feature on regional and local flow in the Basal Chadron.

3.5 ECOLOGICAL RESOURCES

3.5.1 Introduction

This section describes the existing ecological resources within the North Trend Expansion Area. The analysis consisted of a review of documents, databases, and reports in conjunction with a reconnaissance biological field survey to determine the potential impacts, if any, to the habitats for special-status plant and wildlife species in the proposed Expansion Area. Agency coordination has included telephone and written correspondence among Greystone (now ARCADIS) biologists, U.S. Fish and Wildlife Service (USFWS), and Nebraska Game and Parks Commission (NGPC) management and staff. This coordination is ongoing. The purpose of these consultations and associated correspondence was to help identify biological issues and potential occurrences and distribution of special-status plants, wildlife, and their habitats.

3.5.2 Regional Setting

The project area occurs at the confluence of two Nebraska ecoregions – the Western High Plains and the Northwestern Great Plains (Chapman et al. 2001). The transition from Central Great Plains in the eastern part of the state to Western High Plains westward is primarily a factor of reduced effective precipitation. There is a general conformity in the composition of the plant cover, as many species are common to both ecoregions. Physiographically, this area comprises smooth to slightly irregular plains that support either cropland or grassland and grazing.

The Western High Plains ecoregion is characterized by a semi-arid to arid climate, with annual precipitation ranging from 13 to 20 inches. Higher and drier than the Central Great Plains to the east, much of the Western High Plains comprises a smooth to slightly irregular plain with a high percentage of dryland agriculture. Potential natural vegetation is dominated by drought-tolerant, short-grass prairie and large areas of mixed-grass prairie in the northwest portion of the state.

The Northwestern Great Plains ecoregion encompasses the Missouri Plateau section of the Great Plains. It is a semi-arid rolling plain of shale and sandstone punctuated by occasional buttes. Native grasslands persist in areas of steep or broken topography, but they have been largely replaced by spring wheat and alfalfa over most of this ecoregion. Agriculture exists on level to rolling hills and is generally limited by erratic precipitation patterns and limited opportunities for irrigation.

The Chadron State College herbarium contains 468 species from Dawes County (Wyoming Fuel Company [WFC] 1983). In addition, the Institute of Agriculture and Natural Resources

lists 603 native and 123 introduced species that occur in Dawes County. During the 1982 baseline study, more than 400 species of plants were collected (WFC 1983) (see Attachment 3.5-A).

3.5.2.1 Local Setting - North Trend Expansion Area

The proposed 2,110-acre Crow Butte North Trend Expansion Area is located in west-central Dawes County, Nebraska, just north of Crawford. The proposed North Trend Expansion Area is located within portions of Sections 21, 22, 27, 28, 33, and 34 of Township 32 North, Range 52 West. Figure 3.5-1 shows the general location of the current licensed area and the proposed North Trend Expansion Area.

3.5.3 Climate

The climate of the region is characterized by wide seasonal and day-to-day variations in temperature and precipitation. Dawes County is usually warm in the summer, with frequent spells of hot weather and occasional cool days interspersed, although sporadically, throughout the summer. These changes in weather can generate thunderstorms, which deliver a majority of the total annual precipitation. Annual average minimum and maximum temperatures are 34°F and 62°F, respectively, with a mean monthly average of 48°F (High Plains Regional Climate Center [HPRCC] 2004). Average total precipitation is 16.07-inches (HPRCC 2004). Precipitation occurs throughout the year, with yearly averages ranging from a low of 0.41 inches in December to a high of 2.96 inches in May (HPRCC 2004). Winter precipitation is typically relegated to storms with snow and the occasional blizzard. In this portion of Nebraska, the average annual seasonal snowfall is approximately 42 inches (HPRCC 2004).

3.5.4 Baseline Data

An ecological study was performed for a commercial CBR Uranium Project application in 1982 (Radioactive Source Materials License SUA-1534). Baseline flora and fauna data were collected to fulfill the objectives specified in USNRC Regulatory Guide 3.46, *Standard Format and Content of License Applications, Including Environmental Reports, For In Situ Uranium Solution Mining.* The 1982 baseline study focused on conducting intensive research within the principal study area, which included both the commercial study area and the five-mile adjacent area, and less intensive research within the 50-mile outer area. Additional baseline data was collected within the three areas in 1987, 1995, 1996, and 1997. During 2004, a field reconnaissance, agency contacts, and literature searches were conducted to obtain new baseline data for the North Trend Expansion Area.

3.5.5 Terrestrial Ecology

The information presented in this section summarizes the findings of the ecological baseline studies in 1982, 1987, 1995, 1996, and 1997 and field reconnaissance surveys conducted in 2004.

3.5.5.1 Methods

Reconnaissance-level investigations were used to describe the principal floral and faunal species of the area. General observations were used to generate a species list for the North Trend Expansion Area and to obtain information about faunal distribution.

3.5.5.2 Existing Disturbance

The agricultural value of the two ecoregions has tremendously impacted mixed-grass prairie grasslands and the resulting landscape has been substantially altered since settlement in the late 1800s. Economic incentives to convert natural landscapes to agriculture have been intensive and resulted in the loss of significant mixed-grass prairie grassland. Substantial areas of vegetation have been altered from their natural condition by past and current human activities. Agriculture, intensive grazing, haying, sand and gravel mining, road and railroad construction, and rural and urban development are the primary sources of surface disturbance to vegetation communities.

3.5.5.3 Vegetation and Land Cover Types

The vegetation/habitat classification system detailed in *Crow Butte Uranium Project Application and Supporting Environmental Report for NRC Research and Development Source Material License* (WFC 1983) was combined with pedestrian surveys to identify and map vegetation community types within the Project Area.

Six basic plant communities were identified in the project area: riverine deciduous forest, tree plantings, mixed-grass prairie, cultivated lands, and urban/development land. These broad categories often represent several vegetation community types that are generally defined by both species composition and relative abundance. The acres of occurrence and relative distribution of vegetation types within the project area are presented in Table 3.5-1.

TABLE 3.5-1 NORTH TREND HABITAT TYPES

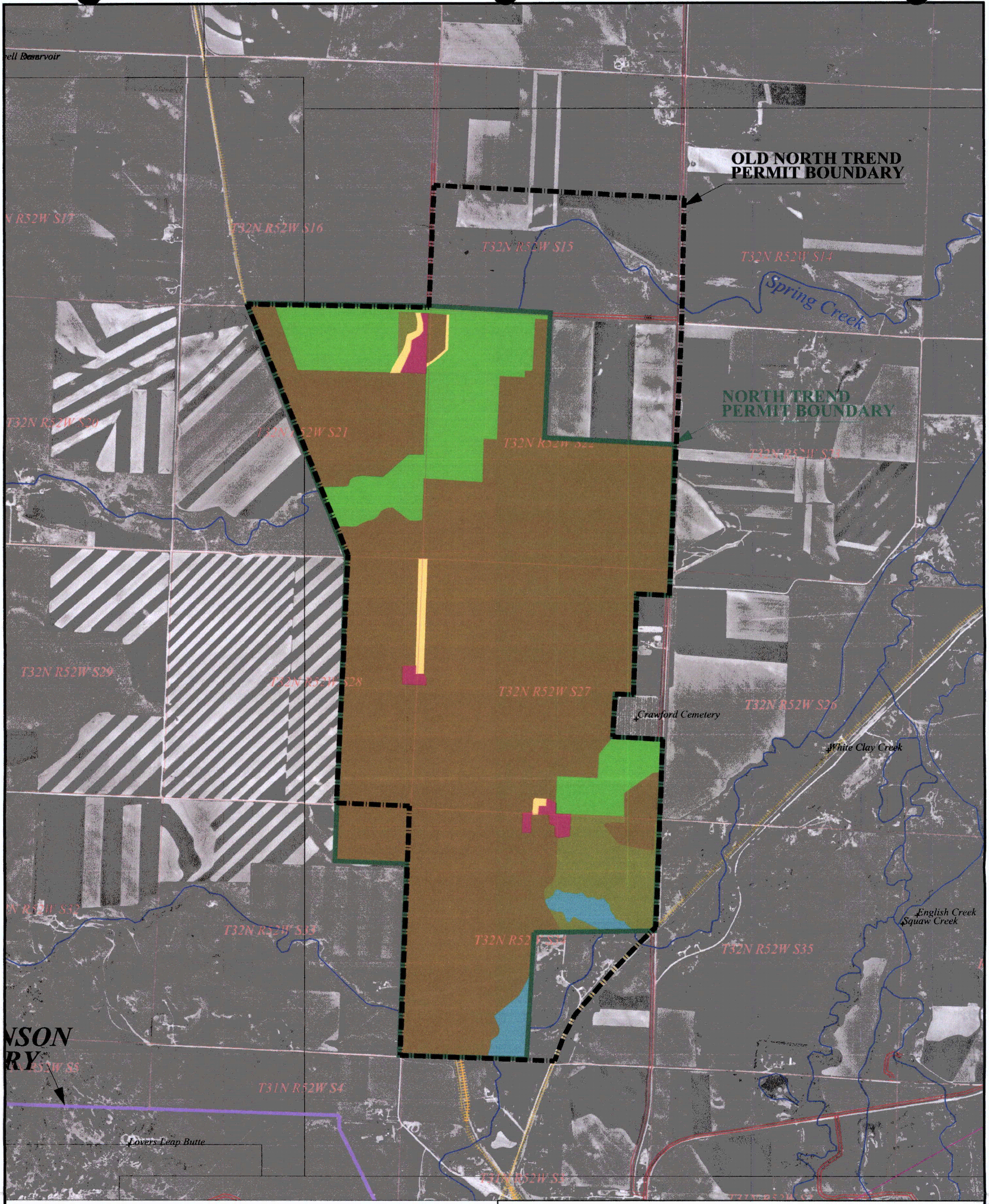
Habitat	Acreage
Riverine	3 acres
Deciduous Streambank Forest	83 acres
Tree Plantings	46 acres
Mixed-grass Prairie	532 acres
Range Rehabilitation	160 acres
Cultivated	1873 acres
Disturbed/Developed	53 acres

The habitats associated with the project area have been summarized into five general types and are briefly described below. The vegetative community types described below generally correlate with wildlife habitat types. Figure 3.5-1 details the distribution of the five principal plant communities within the project area.

Riverine Habitats (050 – 059)
Wetlands and their associated habitats are classified by several functions and values unique to each wetland complex. Wetlands perform many important hydrologic functions, such as floodwater storage and slowing stream flows, maintenance, streambank stabilization, nutrient removal and uptake, and groundwater recharge.

The Cowardin et al. (1979) classification method, the most widely recognized system, was used to classify wetlands within the project area.

Riverine (per Cowardin et al. (1979)):
Riverine: Non-tidal and tidal-freshwater wetlands within a channel. Vegetation, when present, is predominantly non-persistent emergent plants (non-persistent-emergent wetlands), or submersed and (or) floating plants (aquatic beds), or both.



LEGEND

- 050 RIVERINE
- 110 DECIDUOUS STREAMBANK FOREST
- 130 TREE PLANTINGS - ORCHARDS, SHELTERBELTS, WINDBRAKES
- 410 MIXED GRASS PRAIRIE
- 420 RANGE REHABILITATION - PERMANENT PASTURE
- 500 CULTIVATED
- 630 HUMAN BIOTOPES - BUILDINGS, TOWNS, FARMYARDS, ETC.

2000 0 1000 2000 3000 Feet

I:\CO001223\ACAD\1223 Figure 2.8-1 (new).dwg

CROW BUTTE PROJECT

REGIONAL AREA BASE MAP

DAWES & SIOUX COUNTIES, NEBRASKA

FIGURE 3.5-1 NORTH TREND HABITAT TYPES

N

NEBRASKA

Date:1-15-07	Drawn:PBE	Fig. 3.5-1

Riverine wetlands, defined by their close associations with perennial streams, occur along stream channels and are often associated with riparian areas. These areas are also supported by groundwater drainage associated with floodplains and by periodic flooding. Riverine wetlands are categorized by the nature of the adjacent stream (e.g., upper perennial or intermittent). Riverine wetlands can be further divided based on the dominant plant life form of the physiography and composition of the substrate (e.g., unconsolidated bottom unconsolidated shore, or streambed) and the seasonal water regime (e.g., permanently flooded, semi-permanently flooded, seasonally flooded, or temporarily flooded) (Cowardin et al. 1979).

Woodlands (100 – 160)
Woodlands are generally defined as vegetation communities that contain structure dominated by trees where canopy foliage covers 10 to 30 percent of the ground area (Butler et al. 1997).

Deciduous Streambank Forest – 110
The deciduous streambank forest occupies streamside sites adjacent to the White River. Eastern cottonwood (*Populus deltoides*) is the dominant upper canopy species within this vegetation community. Other species in the canopy include green ash (*Fraxinus pennslyvanica*), boxelder (*Acer negundo*), American elm (*Ulmus americana*), peachleaf willow (*Salix amygdaloides*), narrowleaf willow (*S. exigua*), shining willow (*S. lucida*), American plum (*Prunus americana*), and chokecherry (*P. virginiana*). Understory vegetation varies widely, depending primarily on the amount of grazing pressure.

Tree Plantings – 130
Tree plantings are hand- or mechanically-planted trees adapted to the soils of a site. Typically, they include a mixture of trees and shrubs that are planted in a multi-row approach, allowing at least 10 feet between rows. The mixture of vegetation provides food (e.g., fruits, nuts, acorns, seeds, foliage) and cover for wildlife.

Grasslands (410)
Grasslands are characterized by grasses and other erect herbs, usually without trees or shrubs (Butler et al. 1997).

Mixed-Grass Prairie – 410
The mixed-grass prairie vegetation community is dominated by cool- and warm-season midgrasses, short-grasses, and sedges. Short-grasses typically occur on the drier sites, such as on ridgetops and south-facing slopes, with blue grama (*Bouteloua gracilis*), hairy grama (*B. hirusuta*), little bluestem (*Schizachyrium scoparium*), and threadleaf sedge (*Carex filifolia)* as dominant species. On the more mesic sites, blue grama, green needlegrass (*Nassella viridula*), Indian grass (*Sorghastrum nutans*), needle and thread grass (*Hesperostipa comata*), and western wheatgrass (*Pascopyrum smithii*) occur as the dominant species. Characteristic

forbs include sand sagebrush (*Artemisia filifolia*), Nuttall's violet (*Viola nuttallii*), prickly-pear cactus (*Opuntia spp.*), and yucca (*Yucca glauca*).

Range Rehabilitation/Perm. Pasture – 420
Range rehabilitation areas are previously cultivated fields subjected to intensive grazing or seasonal haying. Species common to this type are smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), intermediate wheatgrass (*Thinopyrum intermedium*), tall wheatgrass (*Thinopyrum ponticum*), and crested wheatgrass (*Agropyron cristatum*). The quality and composition of the community type varies greatly, depending on the interval between the intensity of grazing and haying. In addition, the aspect varies from pure to sparse grass stands, to annual weed complex or bare ground.

Cultivated – 500
This type is composed of cultivated fields that are in summer fallow – crop rotation and alfalfa fields used for hay production. Primary crops include spring wheat, oats, and barley.

Disturbed/Urban/Developed Land – 630
This is defined as any man-made feature that includes farmsteads and associated buildings, gravel and dirt roads, and highways and associated rights-of-way. Urban or developed land includes areas of intensive use with much of the land covered by structures (e.g., houses and farm outbuildings). Included in this category are towns and cities; transportation infrastructure, including roads and railways; communication facilities; areas occupied by industrial and commercial complexes; and industrial infrastructure that may, in some instances, be isolated from the urban areas. Dominant species include smooth brome (*Bromus inermis*), cheatgrass (*Bromus tectorum*), white sweetclover (*Melilotus alba*), yellow sweetclover (*Melilotus officinalis*), and numerous mustard (*Brassicaceae* family) species. Cultivated agricultural crops include spring wheat (*Triticum spp.*), oats (*Avena spp.*), and alfalfa (*Medicago sativa*). The 1982 study (WFC 1983) estimated that 30 percent of species and more than 50 percent of plant cover consisted of exotics.

More than 400 species of plants were collected during the 1982 baseline study, (WFC 1983) (see Attachment 3.5-A).

3.5.5.4 Mammals

Thirty-six species of wild mammals were documented during the 1982 baseline study, and another 28 species, mostly bats, insectivores, and small rodents, were deemed likely to occur in the region (WFC 1983) (Attachment 3.5-B).

Big Game
Big game species that are expected to occur in suitable habitats throughout the project area include pronghorn antelope (*Antilocapra americana*), white-tailed deer (*Odocoileus virginianus*), and mule deer (*Odocoileus hemionus*). Elk (*Cervus elaphus*) and bighorn sheep (*Ovis canadensis*) may occur as transient species because of their known distribution in the Pine Ridge area (Nordeen 2004).

Pronghorn Antelope
Pronghorn typically inhabit grasslands and semi-desert shrublands of the western and southwestern United States. This species is most abundant in short- and mixed-grass habitats and is less abundant in more xeric habitats. Home ranges for pronghorn can vary between 400 and 5,600 acres, according to several factors including season, habitat quality, population characteristics, and local livestock occurrence. Typically, daily movement does not exceed 6 miles. Some pronghorn migrate seasonally between summer and winter habitats, but these migrations are often triggered by availability of succulent plants and not local weather conditions (Fitzgerald et al. 1994).

Nebraska is on the eastern fringe of the pronghorn's range, and there are large areas within the range boundary where pronghorns do not occur. The highest densities of pronghorn are in the northern and southern Panhandle, primarily in the short-grass prairies and badlands. According to Nordeen (2004), a large herd of approximately 60 to 100 antelope may use the area north of Crawford as winter range.

The Nebraska Game and Parks Commission (NGPC) allows pronghorn hunting in 11 units, and the project area is within the North Sioux unit. Antelope harvest information available from the NGPC (2004a) reveals that 310 firearm permits were issued in 2002, followed by a decrease to 264 permits issued in 2003. The population trend for the pronghorn inhabiting the region has seen an overall decline in herd numbers (Hams 2004). This trend is attributed to extreme drought that has limited forage availability along with low breeding success (Hams 2004).

Mule Deer
Mule deer occur throughout western North America from central Mexico to northern Canada. Typical habitats include shortgrass and mixed-grass prairies, sagebrush and other shrublands, coniferous forests, and forested and shrubby riparian areas. In Nebraska, mule deer occur in foothills, broken hill country, prairie grasslands, and shrublands. Browse is an important component of the mule deer's diet throughout the year, making up as much as 60 percent of total intake during autumn, while forbs and grasses typically make up the rest of their diet (Fitzgerald et al. 1994). This species tends to be more migratory than white-tailed deer, traveling from higher elevations in the summer to winter ranges that provide more food and cover. Fawn mortality is typically caused by predation or starvation. Adult mortality often occurs from hunting, winter starvation, and automobile collisions. Typical predators may

include coyotes, bobcats, golden eagles, mountain lions, bears, and domestic dogs (Fitzgerald et al. 1994).

Mule deer are distributed primarily along the foothills and escarpments, ranging outward into mixed-grass prairie and cultivated land. However, the distribution and abundance of mule deer varies by vegetation type in the project area. According to Nordeen (2004), approximately 100 to 200 mule deer and white-tailed deer may occupy a 1 to 2 square-mile area within the project area.

Because of concerns with harvest of buck deer, the NGPC conducted a study (based on aged sample projected by total kill) of adult bucks 2½ years or older during the 1987, 1992, and 1997 regular firearm hunting seasons (NGPC 2004b). Adult mule deer buck harvest in the Pine Ridge unit for 1987, 1992, and 1997 was 202, 446, and 385, respectively. According to Hams (2004), the mule deer population in the Nebraska panhandle is stable to increasing.

White-tailed Deer

White-tailed deer occur throughout North America from the southern United States to Hudson Bay in Canada. Across much of its range, this species inhabits forests, swamps, brushy areas, and nearby open fields. White-tailed deer are found throughout the state of Nebraska, typically concentrated in riparian woodlands, mixed shrubs riparian, and associated irrigated agricultural lands, and are generally absent from dry grasslands and coniferous forests (Clark and Stromberg 1987). Their diet is diverse, capitalizing on the most nutritious plant matter available at any time. In addition to native browse, grass, and forbs, this species would rely on agricultural crops, fruits, acorns, and other nuts. Mortality to white-tailed deer is typically related to hunting, winter starvation, collisions with automobiles, and predation. Predators may include coyotes, mountain lions, wolves, and, occasionally, bears, bobcats, and eagles (Fitzgerald et al. 1994).

In the project area, white-tailed deer are expected to be more widely distributed than mule deer. However, because of the high amount of cultivated land, white-tailed deer distributions may be primarily associated with riparian habitats along the White River and associated intermittent and ephemeral stream drainages. In addition, white-tailed deer may be absent from large expanses of mixed-grass prairie and shrub land habitats because of overlap of mule deer range in this part of the state.

Results of the white-tailed deer buck harvest for the Pine Ridge area were 186, 318, 363 and 1987, 1992, 1997, respectively. In addition, results of the overall deer (including both white-tailed and mule deer) harvest for the Pine Ridge unit in 2002 and 2003 season was 1,732 of 2,970 tags issued and 1,724 of 3,186 tags issued, respectively. According to the NGPC (2004c), the state's population of deer (including white-tailed and mule deer) is estimated between 300,000 and 350,000 animals.

Elk
Elk formerly ranged over much of central and western North America from the southern Canadian Provinces and Alaska south to the southern United States, and eastward into the deciduous forests. In Nebraska, this species occurs primarily in the northwestern region in a variety of habitats, including coniferous forests, meadows, short- and mixed-grass prairies, and sagebrush and other shrub lands. Similar to other members of the deer family, this species relies on a combination of browse, grasses, and forbs, depending on their availability throughout the seasons. Elk tend to be migratory, moving between summer and winter ranges. Typically, mortality is a result of predation on calves, hunting, and winter starvation. Predators may include coyotes, mountain lions, bobcats, bears, and golden eagles.

Elk ranges are concentrated in the Pine Ridge area and associated habitats in the Bordeaux and Hat Creek units. There are an estimated 200 to 250 elk in the state, with most of the herd concentrated in the Pine Ridge area (Nordeen 2004). Occasionally, elk may occur within the project area as transients primarily between the summer and winter range movements.

Bighorn Sheep
Prior to the 1900s, the Audubon bighorn sheep inhabited parts of western Nebraska including the Wildcat Hills, the Pine Ridge, along the North Platte River to eastern Lincoln County, and along the Niobrara River. It is thought that the Audubon bighorn probably became extinct in the early 1900s with its last stronghold being the South Dakota badlands.

In 1981, the Nebraska Game and Parks Commission began introducing bighorn sheep in the Pine Ridge area. A dozen bighorns were released into a 500-acre enclosure at Fort Robinson State Park near Crawford. In December 1988, 21 sheep were released from the pen and in January 1993, the remaining 23 sheep were released. Nebraska's bighorn sheep population is now estimated to be between 80 and 140 animals (Nordeen 2004). A few bighorn sheep are known to have ranged from the Fort Robinson area as far east as the Bordeaux Creek drainage southeast of Chadron, south near Belmont, west near the Gilbert-Baker Wildlife Management Area, and north into the Oglala grasslands (Nordeen 2004).

Carnivores
Low numbers of coyotes (*Canis latrans*), red fox (*Vulpes vulpes*), and long-tailed weasel (*Mustela frenata*) are expected to range freely and widely throughout the project area. Bobcat (*Lynx rufus*), badger (*Taxidea taxus*), and striped skunk (*Mephitis mephitis*) may also occur in the project area, but they are less common.

Small Mammals
The deer mouse (*Peromyscus maniculatus*), white-footed mouse (*Peromyscus leucopus*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), meadow jumping mouse (*Zapus hudsonius),* northern pocket gopher (*Thomomys talpoides*), and meadow vole (*Microtus pennsylvanicus*) are expected to occur in the highest abundances. The highest densities of these small mammals are expected to occur in the deciduous forest areas, whereas the lowest abundance of small mammals would most likely occur in the cultivated fields. According to results of the 1982 baseline study (WFC 1983), the greatest diversity of small mammals was detected in the mixed- and short-grass community, and the lowest diversity was observed in the non-wooded riparian and lower deciduous forest areas.

Muskrat (*Ondatra zibethicus*) may occur along watercourses, and beaver (*Castor canadensis*) may occur in the White River Basin. Porcupine (*Erethizon dorsatum*), fox squirrel (*Sciurus niger*), white-tailed jackrabbit (*Lepus townsendii*), black-tailed jackrabbit (*Lepus californicus*), and eastern cottontail (*Sylvilagus floridanus*) are also expected to occur throughout the project area.

3.5.5.5 Birds

The Nebraska Ornithologists' Union's (NOU) "Official" lists 434 birds (including two extinct species – passenger pigeon and Carolina parakeet) occurring in Nebraska (NOU 1997). Accordingly, Johnsgard (1979) lists 430 species, including 54 apparently "accidental" (vagrant) species, and nine extinct, extirpated, or probably extirpated species. In addition, Johnsgard (1979) lists 27 "hypothetical" species, and four unsuccessfully introduced species. Researchers documented 201 species during the 1982 baseline study (WFC 1983) (Attachment 3.5-C).

Of the NOU 434 birds sighted in Nebraska, approximately 200 species breed in the state. The largest single component is arboreal species adapted to living in trees, woodlands, and forests which make up approximately 45 percent of the state's total species, while aquatic and shoreline adapted species make up the second largest component or 32 percent of the state's total avifauna (Johnsgard 1979). Species primarily associated with grasslands comprise a still smaller breeding component, or approximately 10 percent of the state's total avifauna. Bird species associated with semi-desert scrub are the least numerous.

Common birds anticipated to occur within the cultivated fields include the American robin (*Turdus migratorius*), red-winged blackbird (*Agelaius phoeniceus*), mourning dove (*Zenaida macroura*), house wren (*Troglodytes aedon*), violet-green swallow, (*Tachycineta thalassina*), and horned lark (*Eremophila alpestris*). Birds associated with riparian and woodland habitats include pine siskin (*Carduelis pinus*), red crossbill (*Loxia curvirostra*), black-capped chickadee (*Poecile atricapillus*), rufous-sided towhee (*Pipilo erythrophthalmus*), yellow warbler (*Dendroica petechia*), and house wren (*Troglodytes aedon*).

Upland Game Birds
Wild turkey range now includes most major river drainages in the state and the Pine Ridge area. Populations of turkeys in the Pine Ridge and Niobrara River valley are primarily Merriam's turkey (*Meleagris gallopavo*). Fair numbers of turkeys may exist within the White River basin (Nordeen 2004), which is close to the project area. In addition, small, isolated populations may be found in suitable habitats outside of the White River basin.

Ring-necked pheasants (*Phasianus colchicus*) range from fairly abundant to common throughout the project area with preferred habitats occurring in shelterbelts, drainages, and edges of cultivated fields. However, regional pheasant populations are subject to extreme fluctuation primarily resulting from the availability of suitable cover and the severity of winter weather.

Sharp-tailed grouse (*Tympanuchus phasianellus*) are most commonly found in short- and mixed- prairie grassland areas interspersed with serviceberry (*Amelanchier spp.*), chokecherry (*Prunus virginiana*), and snowberry (*Symphoricarpos albus*). Shrubs and small trees play an important role in sharp-tailed grouse ecology, especially in winter when they provide both food and cover. Weed-grass types and cultivated crops (wheat and alfalfa) may be utilized in spring and summer. Sharptails may utilize agricultural fields, feed on waste grain, and associated insects. Within the project area, sharptails are expected to be distributed primarily in the north end of the Expansion Area where mixed-grass prairie is predominant.

Waterfowl
Waterfowl may occur throughout the region primarily during both the spring and fall migrations. However, because of the lack of wetlands and their associated habitats, the diversity and abundance is extremely low in the project area. Outside of the reaches of open water associated with the White River, impoundments and wetland habitats are absent from the project area. Researchers observed 24 species of waterfowl during the 1982 baseline surveys and mallard (*Anas platyrhnchos*) was the most commonly observed species (WFC 1983).

Raptors
Several raptor species are expected to occur in the project area, a reflection of the diversity in habitat types and the existence of many suitable nesting sites, such as tall trees. Golden eagles are permanent residents of the area, occurring in a variety of habitats. The most common permanent resident raptors occurring in the cultivated fields and mixed-grass prairies may include red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), northern harrier (*Circus cyaneus*), prairie falcon (*Falco mexicanus*), turkey vulture (*Cathartes aura*), and great horned owl (*Bubo virginianus*). In addition, rough-legged hawks (*Buteo lagopus*) are common winter residents of the Pine Ridge area (WFC 1983).

3.5.5.6 Reptiles and Amphibians

Of the 22 species of reptiles and amphibians recorded in Dawes and Sioux Counties (Ferraro 2004) (see Attachment 3.5-D), 13 were documented during the 1982 baseline investigation. Documented toads and frogs included Woodhouse's toad (*Bufo woodhousii*), great plains toad (*Bufo cognatus*), plains spadefoot (*Spea bombifrons*), western striped chorus frog (*Pseudacris triseriata*), northern leopard frog (*Rana pipiens*), and bullfrog (*Rana catesbeiana*). Two species of turtles observed were the snapping turtle (*Chelydra serpentina*) and painted turtle (*Chrysemys picta*). Snakes identified included the bullsnake (*Pituophis catenifer*), plains garter snake (*Thamnophis radix*), red-sided garter snake (*Thamnophis sirtalis*), and racer (*Coluber constrictor*).

3.5.6 Threatened, Endangered, or Candidate Species

Several species that could potentially occur within the project area are considered "threatened or endangered" because of their recognized rarity or vulnerability to various causes of habitat loss or population decline. These designated species receive specific protection defined in the federal Endangered Species Act of 1973, as amended, and the Nongame and Endangered Species Conservation Act (Neb. Rev. Stat. §37-430 et seq.). Other species have been designated as "candidate or sensitive" on the basis of adopted policies and expertise of state resource agencies or organizations with acknowledged expertise. A list of potentially occurring special-status species, along with specific occurrence records, was developed from an original list of target species based on records of the NGPC and the USFWS. Table 3.5-2 summarizes the known or potential occurrence of each species within the project area.

TABLE 3.5-2 FEDERAL AND STATE THREATENED, ENDANGERED, AND CANDIDATE SPECIES WITH THE POTENTIAL TO OCCUR WITHIN THE VICINITY OF THE NORTH TREND EXPANSION AREA

Species	Federal/State Listing Status	Habitat	Critical Habitat
Swift fox (Valpesvelox)	Endangered	Large tracts of short- and mid-grass prairie habitats.	None designated
Bald eagle (Haliaeetus leucocephalus)	February 14, 1978; Threatened (43 FR 6233) / None	Migrates spring and fall statewide, but primarily along the major river courses.	None designated.

Source: Anschutz 2004 and Godberson 2004.

Bald Eagle
The bald eagle (*Haliaeetus leucocephalus*) was listed as endangered on February 14, 1978, in all of the conterminous United States with the exception of Minnesota, Wisconsin, Michigan, Oregon, and Washington, where it was classified as threatened (USFWS 1978). On July 12, 1995, the USFWS reclassified the bald eagle from endangered to threatened throughout its range in the lower 48 states (USFWS 1995a). On July 6, 1999, the bald eagle was proposed for delisting (USFWS 1999).). Most recently, the decision to delist the bald eagle has been postponed until June 29, 2007.

Bald eagles occur throughout North America from Alaska to Newfoundland and from the southern tip of Florida to southern California. In Nebraska, this species builds large nests in the crown of large mature trees such as cottonwoods or pines. Fish and waterfowl are the primary sources of food where eagles occur along rivers and lakes. Big game and livestock carrion, as well as larger rodents (for example, prairie dogs) can also be important dietary components where these resources are available (Ehrlich et al. 1988).

This species is an uncommon breeding resident in Nebraska, using mixed coniferous and mature cottonwood riparian areas near large lakes or rivers as nesting habitat (NGPC 2004d). In recent years, bald eagles have attempted to nest every summer near large bodies of water, and in 1996, there were ten documented nests in Nebraska (NGPC 2004d). Data from the BBS Trend Analysis (Sauer et al. 2004) indicate a non-significant trend for populations of this species in Nebraska between 1966 and 2003. However, the trend for the United States, during the same period, is highly significant and positive.

Eagles are expected to winter in areas of suitable habitat within the region, especially in the Pine Ridge area. Feeding areas, diurnal perches, and night roosts are fundamental elements of bald eagle winter habitats. Although eagles can fly as far as 15 miles (24 kilometers) to and from these elements, they occur primarily where all three elements are available in comparatively close proximity (Swisher 1964). The availability of food is probably the single most important factor in the winter distribution and abundance of the eagle (Steenhof 1978).

In Nebraska, the diet of bald eagles is more varied than in other regions where fish are the primary food source. Nebraska grassland and shrub land habitats support a variety of suitable bald eagle prey species, including prairie dogs, lagomorphs, and big game and livestock carrion. They also prey on fish and waterfowl when available.

Swift Fox (State Endangered)
This species was petitioned for listing under the Endangered Species Act in 1992. The 90-day finding from U.S. Fish and Wildlife Service concluded that a species listing may be warranted range-wide. However, the 12- month finding issued in 1995 by the U.S. Fish and Wildlife Service resulted in a "warranted, but precluded decision," concluding that the

magnitude of threats to the species is low to moderate although the immediacy of threats remains imminent. Within Nebraska, the swift fox is listed as threatened under the Nongame and Endangered Species Conservation Act.

The swift fox (*Vulpes velox*) is found in short- and mid-grass prairie habitats. It appears to prefer flat to gently rolling terrain. Swift fox feed primarily on lagomorphs, but arthropods and birds are also included in their diets. They mate between late December and February. A mating pair can bear two to five pups late March to early May, and pups emerge from the den in June. Dens are generally located along slopes or ridges that offer good views of the surrounding area (Fitzgerald et al. 1994). In a study completed in southeastern Colorado, the home range size of an adult swift fox was approximately 9.4 square kilometers at night, and their day ranges are typically much smaller (Schauster et al. 2002).

The swift fox is found in native shortgrass in northwestern Nebraska. Unlike coyotes or red fox, the swift fox uses dens in the ground the entire year. Some characteristics of swift fox dens differentiate them from other dens. Swift fox den entrances measure about 8 inches in diameter, similar to the size of a badger den. However, swift fox usually have more than one entrance, whereas badgers and most other animals have only one. Swift fox tend to spread excavated soil over a larger area than most other animals, resulting in a less prominent mound near the burrow's entrance. Dens are located on relatively flat ground away from human activity. Where coyotes are abundant, predation by coyotes is a significant source of mortality for swift fox and den availability is an important aspect of swift fox survival (Schauster et al. 2002).

Numerous natural and anthropocentric factors influence swift fox populations. Natural factors include fluctuating prey availability, interspecific competition, disease, and landscape physiography. Anthropocentric factors include habitat loss from agricultural, industrial, and urban conversion; competing land uses on remaining habitat including hydrocarbon production, military training, and grazing; and pesticide use. Of these, prey availability and habitat loss appear to have the most profound effects on swift fox populations.

Sightings of swift fox have been documented in northwestern Nebraska since the late 1970's (Godberson 2004). Most of these sightings have occurred in and around Oglala National Grasslands primarily in large tracts of native prairie. Swift fox may occur within areas of suitable habitat, which in the project area are the rolling uplands between drainages and mixed-grass prairie habitats in Sections 15 and 21.

3.5.7 Aquatic Resources

Primary drainages within the project area include Spring Creek and the White River. These two surface waters are characterized by incised channels, small stream slopes, and relatively low basin elevations. Spring Creek is tributary to the White River, which is tributary to the Missouri River.

The project area is primarily contained within the White River basin. The White River originates on the Pine Ridge Escarpment in northwestern Nebraska. The river flows northeast into South Dakota, passing through boundaries of the Pine Ridge and Rosebud Sioux Indian reservations. It then turns east and empties into the Missouri River near Chamberlain, South Dakota. The entire drainage basin is approximately 10,200 square miles and 313 square miles within Dawes County. The White River is characterized as a larger basin with flat stream slopes that typically has high flows characterized by rapidly rising and gradually receding flows. The White River is primarily regulated by periods of snowmelt, direct precipitation, surface runoff, and ground water discharge from seeps and springs.

The White River has a shifting sand and silt substrate with few riffle areas and poorly-defined pools. Depths typically range from 0.5 to 2 m. Eroding streambanks are present along most sections. Stream width varies from about 3 to 5 m. Cover for fish is provided by deep water, log jams, and undercut tree roots. Some good riparian areas exist along the river, especially around Fort Robinson State Park. Other riparian areas are heavily grazed and typically lack understory vegetation. The White River is subject to fluctuating water levels and flooding. The White River drains portions of the project area.

Spring Creek originates in the Fort Robinson State Park, and travels through the plains and open high hills of Sioux and Dawes Counties. The stream is ephemeral, flowing primarily during spring runoff, generally following winters with above-average snowfall. Much of the upper watershed is forested, mainly because it is within the Fort Robinson State Park. In contrast, the middle and lower watershed consists of heavily grazed rangeland or cultivated small grain fields. Spring Creek is tributary to the White River. On-stream impoundments, where they exist, and pools created by washouts below culverts may provide the only suitable fish habitat. The watershed in this lower area is unstable and, as evidenced by high-water debris, is subjected to periodic high-volume surface flows.

In general, the aquatic habitats within the project area suffer from ongoing environmental stresses. Naturally occurring stresses include unstable substrates and banks, low flows, and periodic high-volume surface flows. Overgrazing on adjacent rangelands and riparian areas combined with farming practices along the stream courses further compound these problems.

Livestock grazing and watering add to impoverished stream conditions. These stresses are reflected in a fishery mostly consisting of non-game, tolerant species. Periodic stocking by

the NGPC has created some put-and-take sport fisheries in the area, but these are not self-sustaining because of environmental factors.

Aquatic Ecology

Aquatic ecology baseline data were collected in 1982 and 1996 to assess aquatic resources including fish and macroinvertebrates.

Fish

During the 1982 and 1996 baseline collections, fish were collected in various streams, including the White River, to document their occurrence. Fifteen species of fish were collected during the 1982 and 1996 collection periods (Attachment 3.5-E). Game fish collected in the White River included rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and white sucker (*Catostomus commersoni*). Minnow species collected in the White River include longnose dace (*Rhinichthys cataractae*), common shiner (*Luxilus cornutus*), fathead minnow (*Pimephales promelas*), and creek chub (*Semotilus atromaculatus*).

There is a regionally important put-and-take fishery in the White River within and around Fort Robinson State Park. However, fluctuating flows, periodic flooding, sand and silt substrates, and warm water temperatures are probably the most important factors limiting natural trout production in the White River, especially in areas of intense agriculture and grazing.

Macroinvertebrates

Macroinvertebrate density, diversity, and number of taxa for various streams including the White River were sampled in 1982 and 1996 (Attachment 3.5-F). Macroinvertebrate analyses of the samples indicate that, in general, most aquatic streams have stressed environments. More than 90 percent of the total abundance of all sampled areas were organisms considered tolerant. The most abundant groups of these tolerant species were: chironomidae - 34 percent, simulidae - 20 percent, oligochaeta - 19 percent, and ceratopogonidae - 15 percent. Exceptions occurred within the upper White River, where caddisflies and mayflies dominated the riffle habitat. These two taxa typically represent less-stressed environments than those of the above listed organisms.

Although densities of macroinvertebrates were high at most sampling stations, diversity values were low. Healthy streams usually have diversity values between 3.0 and 4.0, but many forms of stress reduce diversity by making the environment unsuitable for some species or by giving other species a competitive advantage. The White River did not have diversity values within this range, indicating relatively lower water quality and degraded stream habitats.

3.6 METEOROLOGY, CLIMATOLOGY, AND AIR QUALITY

3.6.1 Introduction

This section describes the meteorological conditions in the region surrounding the Crow Butte Project and the North Trend Expansion Area. The data presented in this section were used to determine the effect of the local climate on the development area. The joint frequency data can be used to assess the atmospheric dispersion characteristics present in the region.

Data sources for the meteorological conditions used for this report come from the High Plains Regional Climatic Center (HPRCC) for a site located in Chadron, Nebraska (HPRCC 2004) and from an on-site monitoring station near the Crow Butte facility. The period of record for the HPRCC data covers 56 years of observation between 1948 and 2003. The on-site monitoring data were collected between May 1982 and April 1984, and include temperature, precipitation, evaporation, wind speed, and wind direction. Data are also included from the National Weather Service Stations in Scottsbluff, Nebraska and Rapid City, South Dakota.

The North Trend Expansion Area is located in Dawes County (in the north central portion of the Nebraska panhandle), which shares its northern border with South Dakota. The weather patterns are typical of a semi-arid, continental climate. This climate is characterized by warm summers, cold winters, light precipitation, and frequent changes in the weather.

The Rocky Mountains, located to the west of the site, and the Black Hills, located to the north, effectively block moisture from these directions, while moisture from the south is directed eastward by a plateau south of the region. As a result of this topography, the project area is generally drier than the rest of the panhandle.

The HPRCC data were collected at the Chadron 1 NW site (latitude 42° 50' north, longitude 103° 01' west with a ground elevation of 1021 m [3350 ft] above mean sea level). The monitor is 1.4 km (0.9 miles) west northwest of Chadron, 37 km (23 miles) east northeast of Crawford, and 35 km (22 miles) east northeast of the proposed license area.

3.6.2 Temperature

Table 3.6-1 shows the mean daily maximum and minimum temperatures as well as the mean monthly temperatures. The months of November through March all have mean daily minimum temperatures below freezing, with January as the coldest month. December, January, and February all have monthly mean temperatures below freezing. The warmest months are July and August. The mean yearly temperature is 8.9°C (48.0°F).

The temperature extremes for the period of record are also given in Table 3.6-1, along with the year of occurrence. These data show that temperatures can exceed 100°F (38°C), and freezing or near-freezing temperatures can occur throughout the year.

Table 3.6-1 summarizes Mean Daily Maximum and Minimum and Mean Monthly Temperature Data for Chadron, Nebraska (From 1948 to 2003).

Table 3.6-2 lists the mean number of days per month with temperatures above or below selected values.

TABLE 3.6-1
MEAN DAILY MAXIMUM AND MINIMUM AND MEAN MONTHLY TEMPERATURE DATA FOR CHADRON, NEBRASKA

Month	Mean Daily Maximum	Mean Daily Minimum	Mean Monthly	Record High		Record Low	
	(°C)	(°C)	(°C)	(°C)	Year	(°C)	Year
Jan	2.0	-11.8	-4.9	21.1	1989	-33.9	1949
Feb	5.0	-9.2	-2.1	24.4	1982	-32.8	1982
Mar	8.9	-5.4	1.8	28.3	1967	-32.2	1989
Apr	15.1	0.2	7.7	33.9	1989	-23.9	1975
May	20.9	6.3	13.6	36.7	1969	-8.9	1954
June	27.1	11.6	19.3	41.7	1989	-3.3	1969
July	31.8	15.2	23.5	43.3	1954	3.3	1971
Aug	31.3	14.3	22.8	42.2	1980	2.2	1962
Sept	25.3	8.1	16.7	40.0	1978	-8.3	1984
Oct	18.2	1.3	9.7	34.4	1953	-21.7	1991
Nov	8.9	-5.4	1.8	27.2	1999	-27.8	1959
Dec	3.6	-10.1	-3.3	22.2	1980	-40.0	1989
Year	16.5	1.2	8.9	43.3	Jul-54	-40.0	Dec-89

Source: HPRCC

TABLE 3.6-2
TEMPERATURE OCCURRENCES FOR CHADRON, NEBRASKA
(FROM 1948 TO 2003)

Month	Mean Number of Days with Maximum Temperatures		Mean Number of Days with Minimum Temperatures	
	> 32.2°C	< 0°C	< 0°C	< -17.8°C
Jan	0.0	11.4	30.1	7.5
Feb	0.0	7.8	26.7	4.3
Mar	0.0	4.7	26.2	1.7
Apr	0.1	0.8	15.4	0.0
May	0.9	0.0	2.9	0.0
June	6.0	0.0	0.1	0.0
July	15.9	0.0	0.0	0.0
Aug	15.6	0.0	0.0	0.0
Sept	5.6	0.0	1.9	0.0
Oct	0.3	0.5	12.4	0.1
Nov	0.0	4.5	25.6	1.0
Dec	0.0	9.1	29.6	4.7
Year	44.3	38.7	170.8	19.3

Source: HPRCC

The average date of the last yearly 0°C (32°F) temperature is May 18 while the first fall freeze is expected on September 18. The average growing season is 120 to 130 days long (USDA 1981). These are average values, and the exact occurrence of freezing temperatures depends on exposure.

3.6.3 Precipitation

Precipitation in the region is generally light, with the heaviest occurrences in the spring and summer. Table 3.6-3 lists the monthly precipitation totals for the period of record. May has the heaviest precipitation, with good precipitation occurring through July. The driest months are November through February. The mean yearly precipitation is 40.79 cm (16.06 in). The maximum 24-hour precipitation events are also listed in Table 3.6-3.

The monthly mean and maximum snowfalls for the period of record are listed in Table 3.6-3. The mean annual snowfall is 107.44 cm (42.30 in). July and August are the only two months without a reported snowfall. The maximum mean monthly snowfall occurred in March.

Precipitation data from the National Oceanic and Atmospheric Administration (NOAA) was also reviewed. The site in Scottsbluff, Nebraska is 98 km (60.9 mi) south of the license area and the site in Rapid City, South Dakota is 158 km (98.2 mi) north of the license area. These data indicate that precipitation in excess of 0.03 cm (.01 in) can be expected on an average of 91 and 96 days per year, respectively. These data are listed in Table 3.6-4.

Tornadoes are rare. In the USNRC, "Draft Generic Environmental Impact Statement on Uranium Milling", (USNRC 1979) the authors calculated a mean annual frequency of 0.6 for tornadoes in intensity Category I at Rapid City. The annual probability of occurrence at this location is 4.8 x 10^{-4}. A tornado in intensity Category I has a rotational speed of 134 meters per second (m/s) and a translational speed of 26 m/s.

TABLE 3.6-3
MEAN AND MAXIMUM PRECIPITATION DATA FOR CHADRON, NEBRASKA (FROM 1948 TO 2003)

Month	Water Equivalent		Snow Fall	
	Mean	Maximum 24-Hour	Mean	Maximum Monthly
	(cm)	(cm)	(cm)	(cm)
Jan	1.12	2.72	16.51	88.14
Feb	1.17	3.81	16.51	59.69
Mar	2.16	3.51	21.84	88.14
Apr	4.47	6.22	13.21	49.28
May	7.52	6.50	1.52	23.62
June	7.14	5.38	0.00	3.05
July	5.41	5.08	0.00	0.00
Aug	3.48	4.62	0.00	0.00
Sept	3.66	11.18	0.76	25.40
Oct	2.36	3.81	5.59	28.45
Nov	1.24	1.78	13.21	42.93
Dec	1.04	1.80	17.78	46.99
Year	40.79	11.18	107.44	196.85

Source: HPRCC

TABLE 3.6-4
PRECIPITATION EVENTS (1982 - 1990)

Month	Mean Number of Days with Precipitation	
	Scottsbluff, NE	Rapid City SD
January	5.4	5.4
February	5.4	6.2
March	7.3	9.2
April	9.2	8.0
May	12.0	10.8
June	9.2	11.3
July	8.6	8.3
August	8.2	8.6
September	8.0	8.3
October	5.3	6.6
November	6.6	6.2
December	6.2	6.8
Year	91.4	95.7
Period of Record (years)	9	9

Source: NOAA 1993

3.6.4 Humidity

Relative percent humidity at the Scottsbluff and Rapid City weather stations is given in Table 3.6-5. The humidity at 0500, 1100, 1700, and 2300 hours is listed. Both locations have about the same humidity during the night; but in the early morning, Scottsbluff is slightly more humid. By noon and throughout the afternoon, Scottsbluff becomes less humid than Rapid City. These data indicate that humidity differences are slight and the humidity at the license area can be expected to be similar to these locations.

TABLE 3.6-5
PERCENT RELATIVE HUMIDITY DATA (FROM 1982 - 1990)

Month	0500 Hours		1100 Hours		1700 Hours		2300 Hours	
	NE[a]	SD[b]	NE	SD	NE	SD	NE	SD
January	72.0	67.7	54.3	55.7	53.4	61.0	68.3	67.0
February	75.0	71.0	52.6	54.8	47.6	56.1	70.0	70.0
March	76.0	76.2	50.9	56.3	44.1	54.9	68.4	73.7
April	75.3	70.6	42.9	44.9	39.1	43.2	65.0	65.1
May	80.3	75.4	44.4	49.2	41.2	47.5	68.8	70.8
June	80.0	77.0	43.0	49.8	38.4	46.1	66.8	71.3
July	81.1	72.3	40.7	41.3	35.1	37.8	65.4	62.8
August	82.6	73.4	42.6	41.3	37.2	36.8	69.2	64.7
September	79.5	71.9	42.7	44.1	37.8	42.0	68.0	65.8
October	76.6	69.7	43.4	45.2	40.9	48.2	67.6	66.4
November	76.2	72.3	51.2	54.3	53.9	60.5	71.3	70.9
December	76.1	69.1	57.4	56.6	59.6	63.3	73.4	68.1
Year	77.6	72.2	47.2	49.5	44.0	49.8	68.5	68.1
Period of Record (years)	9	9	9	9	9	9	9	9

Source: NOAA 1993
a Scottsbluff, NE
b Rapid City, SD

3.6.5 Winds

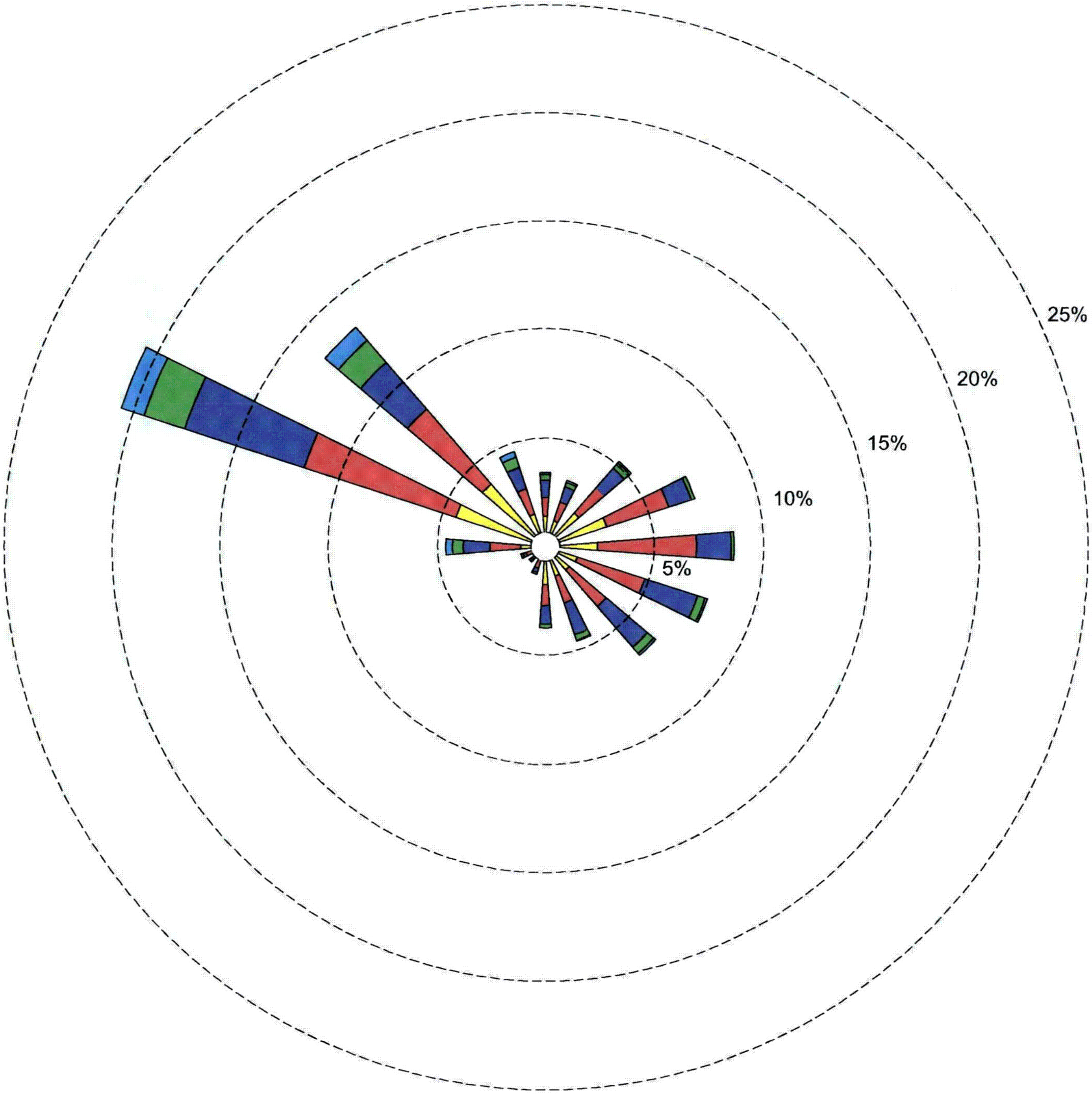
Figure 3.6-1 and Figure 3.6-2 are the wind roses for Scottsbluff, Nebraska and Rapid City, South Dakota, respectively. These figures show predominant wind patterns that are similar; however, the finer details are greatly influenced by the local topography. Rapid City has a predominant wind from the north-northwest while Scottsbluff has a slightly bimodal distribution with the predominant winds from the west-northwest and the east-southeast. The least prevalent wind direction at Scottsbluff and Rapid City is from the southwest.

As shown by the wind rose for the license area in Figure 3.6-3, the predominant air pollutant dispersion would be towards the north to northeast. The next most common directions would be towards the southwest to south-southwest.

Local terrain will have a significant influence on the wind patterns in a given area. Because of this, a meteorological station was installed on the current Crow Butte project site. This

station was capable of measuring wind speed, direction, and the standard deviation of the wind direction. Joint frequency data was compiled from this information. Figure 3.6-3 exhibits the wind rose that was identified for the site and Table 3.6-6 through Table 3.6-12 shows the frequency of winds by direction and speed for the six stability classes. Table 3.6-13 shows the annual relative joint frequency distribution. As shown on Figure 3.6-3, the predominant wind direction of the site is from a south-southwest direction approximately 45 percent of the time. Because of the differences among the site, Rapid City, and Scottsbluff, the two-year Crow Butte site wind record is considered the most representative.

Precipitation was also recorded at the station with a heated tipping bucket rain gauge. Evaporation was measured using a 48" evaporation pan and an evaporation gauge with analog output. The air temperature was also recorded using a precision linear thermistor and fan-aspirated radiation shield. All of the information was recorded on strip chart recorders. In addition, the information was run through a microprocessor and recorded on magnetic tape. The information from the tape was transferred to a computer and then verified by comparison from the strip charts and from visual observation records.



Source: Greystone

Wind Speed (Knots)

Blue	>21
Green	17-21
Dark blue	11-16
Red	7-10
Yellow	4-6
Black	1-3

Station: 24028 Scottsbluff, Nebraska

Avg. Wind Speed	9.69	knots
Percent Calm Winds	3.2	percent
Wind Direction	Blowing From	
Years	1984 - 1990	

1711-04 cb-wind-rose.dwg

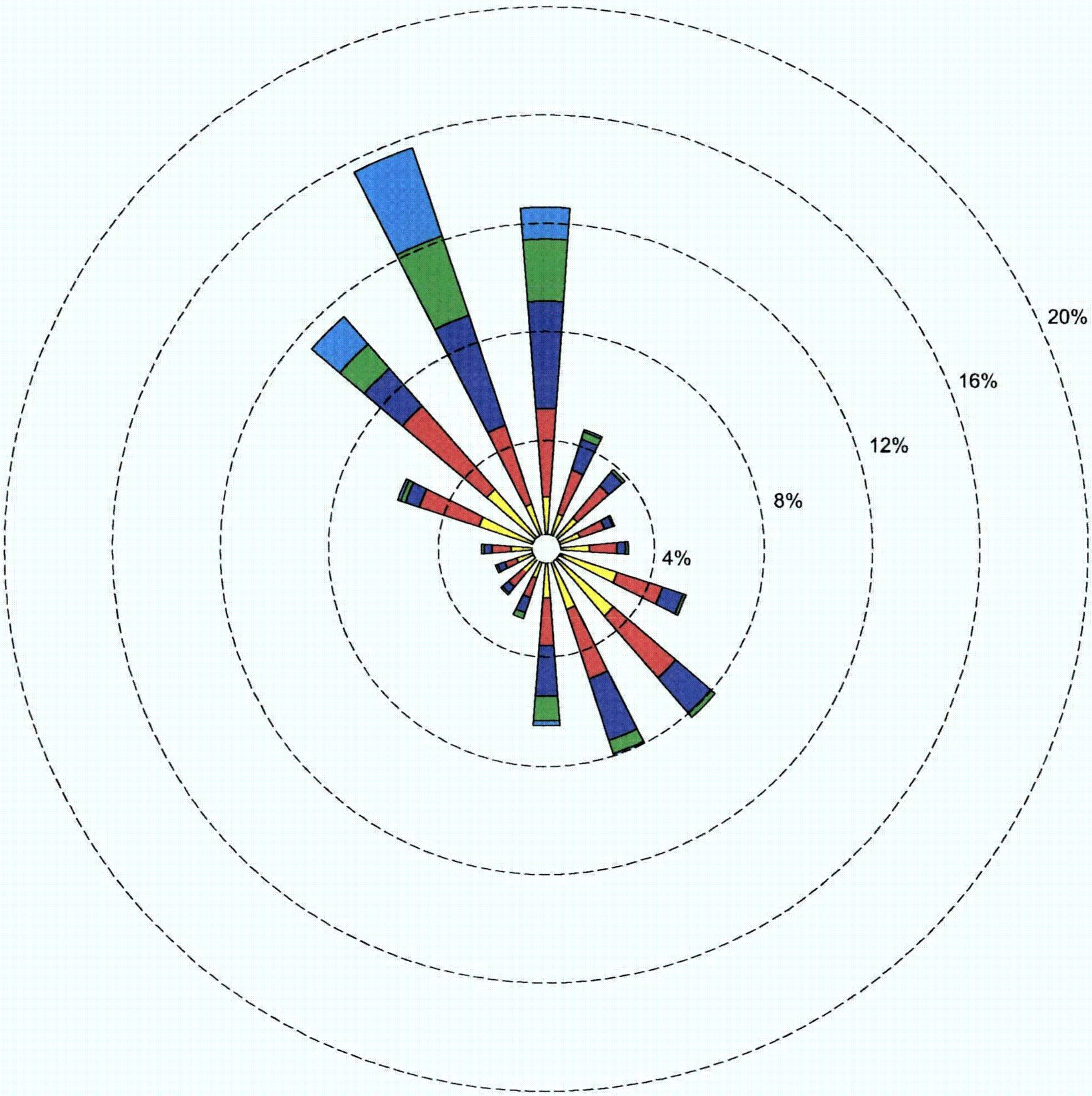
CROW BUTTE PROJECT

DAWES & SIOUX COUNTIES, NEBRASKA

FIGURE 3.6-1 SCOTTSBLUFF SURFACE WINDS

NEBRASKA

Date: 06/01/04 | Drawn: ETC | Fig. 3.6-1



Source: Greystone

Wind Speed (Knots)

>21	
17-21	
11-16	
7-10	
4-6	
1-3	

Station: 27090 Rapid City, South Dakota
Avg. Wind Speed 10.49 knots
Percent Calm Winds 2.88 percent
Wind Direction Blowing From
Years 1984 - 1990

1711-04 cb-wind-rose.dwg

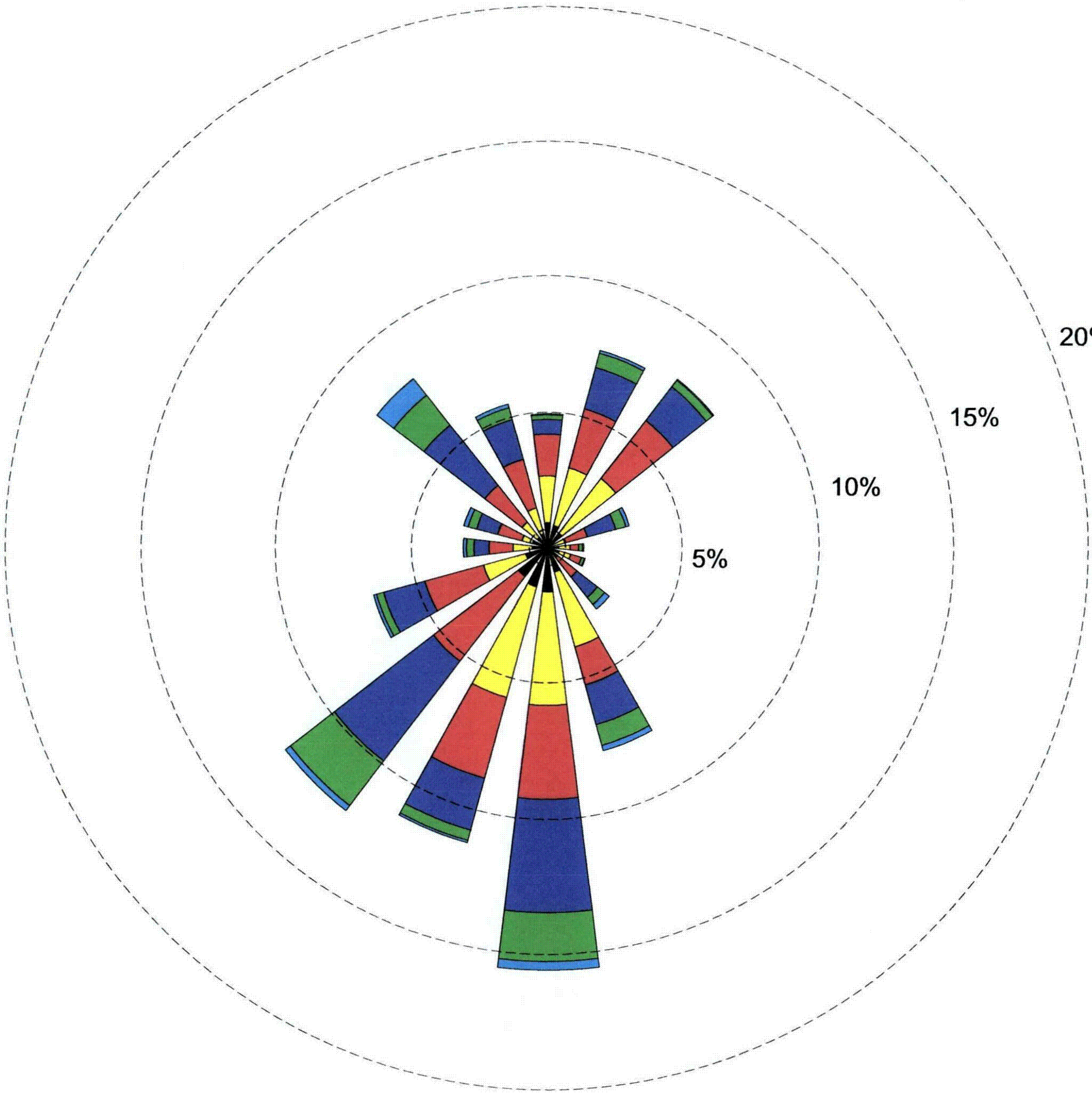
CROW BUTTE PROJECT

DAWES & SIOUX COUNTIES, NEBRASKA

FIGURE 3.6-2 RAPID CITY SURFACE WINDS

NEBRASKA

Date: 06/01/04 | Drawn: ETC | Fig. 3.6-2



Source: Greystone

Wind Speed (Knots)

- >21
- 17-21
- 11-16
- 7-10
- 4-6
- 1-3

Avg. Wind Speed	8.40	knots
Percent Calm Winds	0.3	percent
Wind Direction	Blowing From	
Years	May 1982 - April 1984	

1711-04 cb-wind-rose.dwg

CROW BUTTE PROJECT

DAWES & SIOUX COUNTIES, NEBRASKA

FIGURE 3.6-3
CROW BUTTE SURFACE WINDS

NEBRASKA

Date: ***06/01/04*** | *Drawn:* ***ETC*** | *Fig.* 3.6-3

TABLE 3.6-6
FREQUENCY OF WINDS BY DIRECTION AND SPEED
(STABILITY A)

Wind Direction	Speed Class Intervals (Knots)							
	1 - 3	3 - 6	6 - 10	10 – 16	16 - 21	>21	All	Mean Speed
N	0.98	8.63	2.62	0.11	0.00	0.00	12.34	4.90
NNE	2.61	8.74	2.95	0.11	0.00	0.00	14.31	4.60
NE	1.64	8.52	1.31	0.00	0.00	0.00	11.47	4.50
ENE	0.66	4.37	0.55	0.00	0.00	0.00	5.58	4.40
E	1.20	1.97	0.77	0.00	0.00	0.00	3.94	4.40
ESE	0.33	0.87	0.22	0.00	0.00	0.00	1.42	4.00
SE	0.98	1.75	1.64	0.00	0.00	0.00	4.37	5.10
SSE	0.44	2.61	1.64	0.11	0.00	0.00	4.70	5.30
S	0.98	3.72	1.53	0.00	0.00	0.00	6.23	5.00
SSW	0.55	1.97	2.08	0.22	0.00	0.00	4.82	6.00
SW	0.77	3.72	1.53	0.00	0.00	0.00	6.02	5.00
WSW	0.66	2.08	1.53	0.00	0.00	0.00	4.27	5.30
W	0.66	1.75	1.75	0.11	0.00	0.00	4.27	5.50
WNW	0.77	1.42	0.98	0.44	0.00	0.00	3.61	5.70
NW	0.66	2.30	1.53	0.11	0.00	0.00	4.60	5.50
NNW	1.53	3.93	1.86	0.44	0.00	0.00	7.76	5.30
ALL	15.32	58.25	24.49	1.65	0.00	0.00	99.71	5.00

Stability Class A
Data Recorded between May 1982 and April 1984
Crow Butte Uranium Project Site, Nebraska
Calm (less than one knot) = 0.3%
Period mean wind speed = 5.0 knots
Percent occurrence for A stability class = 5.6%

TABLE 3.6-7
FREQUENCY OF WINDS BY DIRECTION AND SPEED
(STABILITY B)

Wind Direction	Speed Class Intervals (Knots)							
	1 - 3	3 - 6	6 - 10	10 – 16	16 - 21	>21	All	Mean Speed
N	1.01	2.68	5.53	0.67	0.00	0.00	9.89	6.40
NNE	1.34	3.52	3.77	0.34	0.00	0.00	8.97	5.70
NE	0.92	5.28	5.45	0.50	0.00	0.00	12.15	6.00
ENE	0.84	1.76	2.85	0.25	0.00	0.00	5.70	6.00
E	0.17	0.84	0.75	0.08	0.00	0.00	1.84	6.00
ESE	0.59	0.59	1.09	0.00	0.00	0.00	2.27	5.80
SE	0.08	1.26	2.26	0.25	0.00	0.00	3.85	6.90
SSE	0.67	1.17	2.43	0.50	0.00	0.00	4.77	6.50
S	1.09	1.01	4.02	0.92	0.00	0.00	7.04	7.00
SSW	1.01	2.01	2.26	0.75	0.00	0.00	6.03	6.30
SW	0.92	3.19	2.61	0.59	0.00	0.00	7.21	6.10
WSW	0.59	2.01	2.60	0.84	0.08	0.00	6.12	6.90
W	0.42	1.34	2.35	0.42	0.08	0.00	4.61	7.20
WNW	0.67	1.09	2.10	0.34	0.00	0.00	4.20	6.60
NW	0.25	1.09	4.02	1.09	0.08	0.00	6.53	7.80
NNW	0.42	1.51	4.95	1.68	0.08	0.00	8.64	7.80
ALL	10.99	30.35	48.94	9.22	0.32	0.00	99.82	6.60

Stability Class B
Data Recorded between May 1982 and April 1984
Crow Butte Uranium Project Site, Nebraska
Calm (less than one knot) = 0.2%
Period mean wind speed = 6.5 knots
Percent occurrence for B stability class = 7.4%

TABLE 3.6-8
FREQUENCY OF WINDS BY DIRECTION AND SPEED
(STABILITY C)

Wind Direction	Speed Class Intervals (Knots)							
	1 - 3	3 - 6	6 - 10	10 – 16	16 - 21	>21	All	Mean Speed
N	0.74	1.54	2.68	0.74	0.00	0.00	5.70	6.70
NNE	0.63	2.62	2.90	0.85	0.00	0.00	7.00	6.60
NE	0.91	2.28	5.69	1.20	0.00	0.00	10.08	7.00
ENE	0.46	1.03	2.96	0.97	0.00	0.00	5.42	7.30
E	0.00	0.57	0.74	0.28	0.00	0.00	1.59	7.60
ESE	0.23	0.34	0.91	0.23	0.00	0.00	1.71	7.00
SE	0.17	0.68	1.82	0.74	0.00	0.00	3.41	7.70
SSE	0.46	0.74	2.22	1.48	0.00	0.00	4.90	8.00
S	0.97	1.65	5.30	2.28	0.00	0.00	10.20	7.70
SSW	1.14	3.02	3.93	0.97	0.00	0.00	9.06	6.60
SW	1.03	3.36	4.67	1.14	0.11	0.00	10.31	6.80
WSW	0.97	3.02	3.59	1.14	0.06	0.06	8.84	6.80
W	0.11	0.91	1.99	1.03	0.11	0.00	4.15	8.40
WNW	0.17	0.51	1.03	1.25	0.06	0.00	3.02	9.10
NW	0.40	0.74	3.70	2.22	0.06	0.00	7.12	8.70
NNW	0.40	1.42	3.42	2.11	0.00	0.00	7.35	8.20
ALL	8.79	24.43	47.55	18.63	0.40	0.06	99.86	7.40

Stability Class C
Data Recorded between May 1982 and April 1984
Crow Butte Uranium Project Site, Nebraska
Calm (less than one knot) = 0.2%
Period mean wind speed = 7.4 knots
Percent occurrence for C stability class = 10.8%

TABLE 3.6-9
FREQUENCY OF WINDS BY DIRECTION AND SPEED
(STABILITY D)

Wind Direction	Speed Class Intervals (Knots)							
	1 - 3	3 - 6	6 - 10	10 – 16	16 - 21	>21	All	Mean Speed
N	0.17	0.52	1.14	0.83	0.20	0.02	2.88	9.20
NNE	0.16	1.12	2.34	2.90	0.89	0.19	7.60	10.70
NE	0.13	1.53	2.65	2.72	0.46	0.08	7.47	9.80
ENE	0.04	0.47	0.79	0.50	0.06	0.00	1.86	8.30
E	0.02	0.06	0.28	0.22	0.04	0.00	0.62	9.50
ESE	0.01	0.25	0.35	0.13	0.00	0.00	0.74	7.40
SE	0.06	0.42	0.71	0.52	0.18	0.01	1.90	9.50
SSE	0.13	1.78	1.50	2.60	1.21	0.34	7.56	11.10
S	0.34	1.67	3.58	7.77	3.57	0.58	17.51	12.40
SSW	0.22	1.37	3.82	3.60	0.76	0.12	9.89	10.00
SW	0.17	2.11	5.80	3.80	0.29	0.02	12.19	8.80
WSW	0.17	0.61	2.28	2.74	0.54	0.16	6.50	10.70
W	0.10	0.20	0.64	1.03	0.47	0.19	2.63	12.60
WNW	0.05	0.17	0.91	1.39	0.66	0.28	3.46	13.20
NW	0.05	0.31	1.60	5.13	2.68	1.55	11.32	15.00
NNW	0.04	0.49	1.80	2.34	0.90	0.20	5.77	11.90
ALL	1.86	13.08	30.09	38.22	12.91	3.74	99.90	11.20

Stability Class D
Data Recorded between May 1982 and April 1984
Crow Butte Uranium Project Site, Nebraska
Calm (less than one knot) = 0.1%
Period mean wind speed = 11.2 knots
Percent occurrence for D stability class = 51.3%

TABLE 3.6-10
FREQUENCY OF WINDS BY DIRECTION AND SPEED
(STABILITY E)

Wind Direction	Speed Class Intervals (Knots)							
	1 - 3	3 - 6	6 - 10	10 – 16	16 - 21	>21	All	Mean Speed
N	0.85	2.92	0.65	0.04	0.00	0.00	4.46	4.60
NNE	0.97	2.80	1.82	0.00	0.00	0.00	5.59	5.20
NE	0.97	3.32	1.90	0.08	0.00	0.00	6.27	5.10
ENE	0.45	1.26	0.73	0.00	0.00	0.00	2.44	5.10
E	0.16	0.73	0.20	0.00	0.00	0.00	1.09	4.70
ESE	0.28	0.65	0.45	0.00	0.00	0.00	1.38	4.80
SE	0.49	1.82	0.85	0.12	0.00	0.00	3.28	5.10
SSE	1.70	7.62	1.05	0.08	0.00	0.00	10.45	4.40
S	2.23	11.06	4.34	0.16	0.00	0.00	17.79	5.00
SSW	2.11	10.53	2.80	0.04	0.00	0.00	15.48	4.70
SW	1.78	8.18	5.67	0.12	0.04	0.00	15.79	5.50
WSW	1.05	2.88	2.47	0.04	0.00	0.00	6.44	5.40
W	0.65	0.97	0.36	0.04	0.00	0.00	2.02	4.30
WNW	0.36	0.97	0.81	0.00	0.00	0.00	2.14	5.50
NW	0.45	1.18	0.85	0.20	0.00	0.00	2.68	5.70
NNW	0.61	1.34	0.49	0.00	0.00	0.00	2.44	4.50
ALL	15.11	58.23	25.44	0.92	0.04	0.00	99.74	5.00

Stability Class E
Data Recorded between May 1982 and April 1984
Crow Butte Uranium Project Site, Nebraska
Calm (less than one knot) = 0.2%
Period mean wind speed = 5.0 knots
Percent occurrence for E stability class = 15.2%

TABLE 3.6-11
FREQUENCY OF WINDS BY DIRECTION AND SPEED
(STABILITY F)

Wind Direction	Speed Class Intervals (Knots)							
	1 - 3	3 - 6	6 - 10	10 – 16	16 - 21	>21	All	Mean Speed
N	3.30	1.65	0.00	0.00	0.00	0.00	4.95	2.80
NNE	1.65	1.33	0.00	0.00	0.00	0.00	2.98	3.00
NE	0.95	1.40	0.00	0.00	0.00	0.00	2.35	3.10
ENE	1.40	0.76	0.00	0.00	0.00	0.00	2.16	2.80
E	1.27	0.44	0.00	0.00	0.00	0.00	1.71	2.80
ESE	1.78	1.02	0.00	0.00	0.00	0.00	2.80	2.60
SE	1.72	1.78	0.00	0.00	0.00	0.00	3.50	3.00
SSE	3.75	4.76	0.00	0.00	0.00	0.00	8.51	3.10
S	7.50	12.07	0.00	0.00	0.00	0.00	19.57	3.30
SSW	7.24	13.15	0.00	0.00	0.00	0.00	20.39	3.30
SW	6.48	8.01	0.00	0.00	0.00	0.00	14.49	3.20
WSW	2.73	2.60	0.00	0.00	0.00	0.00	5.33	3.00
W	1.78	1.46	0.00	0.00	0.00	0.00	3.24	2.90
WNW	0.83	0.95	0.00	0.00	0.00	0.00	1.78	3.00
NW	1.33	1.21	0.00	0.00	0.00	0.00	2.64	3.00
NNW	1.33	0.51	0.00	0.00	0.00	0.00	1.84	2.60
ALL	45.04	53.10	0.00	0.00	0.00	0.00	98.14	3.10

Stability Class F
Data Recorded between May 1982 and April 1984
Crow Butte Uranium Project Site, Nebraska
Calm (less than one knot) = 1.8%
Period mean wind speed = 3.1 knots
Percent occurrence for F stability class = 9.7%

TABLE 3.6-12
FREQUENCY OF WINDS BY DIRECTION AND SPEED
(ALL STABILITIES)

Wind Direction	Speed Class Intervals (Knots)							
	1 – 3	3 – 6	6 - 10	10 – 16	16 - 21	>21	All	Mean Speed
N	0.75	1.72	1.53	0.57	0.10	0.01	4.68	6.50
NNE	0.70	2.16	2.24	1.61	0.46	0.10	7.27	8.20
NE	0.57	2.64	2.69	1.57	0.23	0.04	7.64	7.70
ENE	0.37	0.99	1.08	0.38	0.03	0.00	2.85	6.50
E	0.24	0.42	0.35	0.15	0.02	0.00	1.18	6.20
ESE	0.31	0.46	0.44	0.09	0.00	0.00	1.30	5.50
SE	0.35	0.93	0.95	0.38	0.09	0.01	2.71	7.00
SSE	0.81	2.84	1.44	1.55	0.62	0.17	7.43	8.20
S	1.48	4.17	3.45	4.33	1.83	0.30	15.56	9.30
SSW	1.36	4.17	3.09	2.03	0.39	0.06	11.10	7.20
SW	1.21	3.91	4.62	2.13	0.17	0.01	12.05	7.10
WSW	0.70	1.60	2.21	1.60	0.29	0.09	6.49	8.20
W	0.40	0.69	0.87	0.68	0.26	0.10	3.00	8.90
WNW	0.27	0.54	0.91	0.90	0.35	0.14	3.11	10.20
NW	0.32	0.75	1.73	2.99	1.39	0.79	7.97	12.80
NNW	0.40	0.99	1.84	1.58	0.47	0.10	5.38	9.50
ALL	10.24	28.88	29.44	22.64	6.70	1.92	99.72	8.40

Stability Class All
Data Recorded between May 1982 and April 1984
Crow Butte Uranium Project Site, Nebraska
Calm (less than one knot) = 0.3%
Period mean wind speed = 8.4 knots
Percent occurrence for A stability class = 100.0%

Table 3.6-13 Joint Frequency Distribution

Stability Class A					
0.00056	0.00488	0.00148	0.00006	0.00000	0.00000
0.00142	0.00495	0.00167	0.00006	0.00000	0.00000
0.00093	0.00482	0.00074	0.00000	0.00000	0.00000
0.00037	0.00247	0.00031	0.00000	0.00000	0.00000
0.00068	0.00111	0.00043	0.00000	0.00000	0.00000
0.00019	0.00049	0.00012	0.00000	0.00000	0.00000
0.00056	0.00099	0.00093	0.00000	0.00000	0.00000
0.00025	0.00142	0.00093	0.00006	0.00000	0.00000
0.00056	0.00210	0.00087	0.00000	0.00000	0.00000
0.00031	0.00111	0.00117	0.00012	0.00000	0.00000
0.00043	0.00210	0.00087	0.00000	0.00000	0.00000
0.00037	0.00117	0.00087	0.00000	0.00000	0.00000
0.00037	0.00099	0.00099	0.00006	0.00000	0.00000
0.00043	0.00080	0.00056	0.00025	0.00000	0.00000
0.00037	0.00130	0.00087	0.00006	0.00000	0.00000
0.00087	0.00223	0.00105	0.00025	0.00000	0.00000
Stability Class B					
0.00074	0.00198	0.00408	0.00049	0.00000	0.00000
0.00099	0.00260	0.00278	0.00025	0.00000	0.00000
0.00068	0.00389	0.00402	0.00037	0.00000	0.00000
0.00062	0.00130	0.00210	0.00019	0.00000	0.00000
0.00012	0.00062	0.00056	0.00006	0.00000	0.00000
0.00043	0.00043	0.00080	0.00000	0.00000	0.00000
0.00006	0.00093	0.00167	0.00019	0.00000	0.00000
0.00049	0.00087	0.00179	0.00037	0.00000	0.00000
0.00080	0.00074	0.00297	0.00068	0.00000	0.00000

Table 3.6-13 Joint Frequency Distribution

0.00074	0.00148	0.00167	0.00056	0.00000	0.00000
0.00068	0.00235	0.00185	0.00043	0.00000	0.00000
0.00043	0.00148	0.00192	0.00062	0.00006	0.00000
0.00031	0.00099	0.00173	0.00031	0.00006	0.00000
0.00049	0.00080	0.00155	0.00025	0.00000	0.00000
0.00019	0.00080	0.00297	0.00080	0.00006	0.00000
0.00031	0.00111	0.00365	0.00124	0.00006	0.00000
Stability Class C					
0.00080	0.00167	0.00291	0.00080	0.00080	0.00000
0.00068	0.00284	0.00315	0.00093	0.00093	0.00000
0.00099	0.00247	0.00618	0.00130	0.00130	0.00000
0.00049	0.00111	0.00321	0.00105	0.00105	0.00000
0.00000	0.00062	0.00080	0.00031	0.00031	0.00000
0.00025	0.00037	0.00099	0.00025	0.00025	0.00000
0.00019	0.00074	0.00198	0.00080	0.00080	0.00000
0.00049	0.00080	0.00241	0.00161	0.00161	0.00000
0.00105	0.00179	0.00575	0.00080	0.00000	0.00000
0.00124	0.00328	0.00427	0.00093	0.00000	0.00000
0.00111	0.00365	0.00507	0.00130	0.00012	0.00000
0.00105	0.00328	0.00389	0.00105	0.00006	0.00006
0.00012	0.00099	0.00216	0.00031	0.00012	0.00000
0.00019	0.00056	0.00111	0.00025	0.00006	0.00000
0.00043	0.00080	0.00402	0.00080	0.00006	0.00000
0.00043	0.00155	0.00371	0.00161	0.00000	0.00000
Stability Class D					
0.00087	0.00266	0.00587	0.00427	0.00105	0.00012
0.0008	0.00575	0.01205	0.0149	0.00457	0.00099
0.00068	0.00785	0.01311	0.01397	0.00235	0.00043

Table 3.6-13 Joint Frequency Distribution

0.00019	0.00241	0.00408	0.0026	0.00031	0.00000
0.00012	0.00031	0.00142	0.00111	0.00019	0.00000
0.00006	0.0013	0.00179	0.00068	0.00000	0.00000
0.00031	0.00216	0.00365	0.00266	0.00093	0.00006
0.00068	0.00915	0.00773	0.01335	0.00624	0.00173
0.00173	0.00859	0.01842	0.04	0.01836	0.00297
0.00111	0.00705	0.01966	0.01854	0.00389	0.00062
0.00087	0.01088	0.02986	0.01953	0.00148	0.00012
0.00087	0.00315	0.01175	0.01409	0.00278	0.0008
0.00049	0.00105	0.00328	0.00532	0.00241	0.00099
0.00025	0.00087	0.0047	0.00717	0.0034	0.00142
0.00025	0.00161	0.00822	0.0264	0.01379	0.00797
0.00019	0.00253	0.00927	0.01205	0.00464	0.00105
Stability Class E					
0.00130	0.00445	0.00099	0.00006	0.00000	0.00000
0.00148	0.00427	0.00278	0.00000	0.00000	0.00000
0.00148	0.00507	0.00291	0.00012	0.00000	0.00000
0.00068	0.00192	0.00111	0.00000	0.00000	0.00000
0.00025	0.00111	0.00031	0.00000	0.00000	0.00000
0.00043	0.00099	0.00068	0.00000	0.00000	0.00000
0.00074	0.00278	0.00130	0.00019	0.00000	0.00000
0.00260	0.01162	0.00161	0.00012	0.00000	0.00000
0.00340	0.01688	0.00661	0.00025	0.00000	0.00000
0.00321	0.01607	0.00427	0.00006	0.00000	0.00000
0.00272	0.01249	0.00865	0.00019	0.00006	0.00000
0.00161	0.00439	0.00377	0.00006	0.00000	0.00000
0.00099	0.00148	0.00056	0.00006	0.00000	0.00000
0.00056	0.00148	0.00124	0.00000	0.00000	0.00000

Table 3.6-13 Joint Frequency Distribution

0.00068	0.00179	0.00130	0.00031	0.00000	0.00000
0.00093	0.00204	0.00074	0.00000	0.00000	0.00000
Stability Class F					
0.00321	0.00161	0.00000	0.00000	0.00000	0.00000
0.00161	0.00130	0.00000	0.00000	0.00000	0.00000
0.00093	0.00136	0.00000	0.00000	0.00000	0.00000
0.00136	0.00074	0.00000	0.00000	0.00000	0.00000
0.00124	0.00043	0.00000	0.00000	0.00000	0.00000
0.00173	0.00099	0.00000	0.00000	0.00000	0.00000
0.00167	0.00173	0.00000	0.00000	0.00000	0.00000
0.00365	0.00464	0.00000	0.00000	0.00000	0.00000
0.00729	0.01175	0.00000	0.00000	0.00000	0.00000
0.00705	0.01280	0.00000	0.00000	0.00000	0.00000
0.00631	0.00779	0.00000	0.00000	0.00000	0.00000
0.00266	0.00253	0.00000	0.00000	0.00000	0.00000
0.00173	0.00142	0.00000	0.00000	0.00000	0.00000
0.00080	0.00093	0.00000	0.00000	0.00000	0.00000
0.00130	0.00117	0.00000	0.00000	0.00000	0.00000
0.00130	0.00049	0.00000	0.00000	0.00000	0.00000

3.6.6 Air Quality

Although there are no ambient air quality monitoring data for non-radiological pollutants in the license area, PM_{10} concentrations have been measured in Rapid City, South Dakota and Badlands National Park in South Dakota. Both locations are geographically similar to the license area.

The Rapid City data were collected at the National Guard Camp Armory site about 2 mile west of the city. This are is classified as suburban. The Badlands data were collected in an area classified as rural. Because of the degree of urbanization, the air quality at the license area would probably fall somewhere between the air quality at these two locations. These data were obtained from the United States Environmental Protection Agency (USEPA) air quality monitoring database (USEPA 2007), and are presented in Table 3.6-14.

The National Ambient Air Quality Standards (NAAQS) for PM_{10} are 150 micrograms per cubic meter (24-hour average), and 50 micrograms per cubic meter (annual average). All counties within the 80 km radius or the project are in attainment of NAAQS.

TABLE 3.6-14
PM_{10} MONITORING SUMMARY
(MICROGRAMS PER CUBIC METER)

Year	Maximum 24-hr Average		Annual Average	
	Black Hills, SD	Rapid City, SD	Black Hills, SD	Rapid City, SD
1998	-	87.4	-	30.7
1999	-	116.9	-	28.2
2000	38.5	97.4	12.0	31.3
2001	47.9	81.5	12.6	34.6
2002	26.0	104.7	9.9	34.9
2003	74.4	91.8	16.3	36.2
2004	24.0	72.0	10.0	30.0
2005	40.0	94.00	9.0	27.0
2006	30.0	124.0	10.0	29.0

3.7 NOISE

Noise standards and sound measurement equipment have been designed to account for the sensitivity of human hearing to different frequencies. This varying sensitivity is accommodated by applying "A-Weighted" correction factors. This correction de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. The primary assumption is that the A-weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise. In general, a residential area at night is 40 dBA; a residential area during the day is 50 dBA; a rural area during the day is 40 dBA and a typical construction site is 80 dBA (EPA 1974). As a comparison, a normal conversation at 5 feet is 60 dBA (EPA 1974).

The nearest noise receptor (residence) to the Crow Butte North Trend Project (Project) is on State Highway (SH) 2/71 along the eastern project boundary. This residence is located approximately ½ mile from the satellite plant. The next closet residence is located along the southern project boundary at a distance of approximately 1.5 miles south of the satellite plant. The town of Crawford is located approximately 2.5 miles south of the satellite plant.

According to Sandy Seidel, Crawford City Clerk, the City of Crawford does not have a noise ordinance. A review of the City of Crawford Municipal Code revealed a noise ordinance related to industrial equipment. Section 2-103, Excessive Noise Control (Crawford 2007) reports that it is "unlawful to operate industrial equipment, heavy machinery, jack hammer and other industrial equipment emitting loud noise or to race automobile engines within the City between the hours of 8:00 P.M. and 7:00 A.M., in such a manner so as to disturb the .... peace .... unless such activity has been approved in advance by the City Council." Construction activities associated with the project would be conducted outside of the City of Crawford limits. The Dawes County Clerk's office did not know of a noise ordinance for Dawes County.

The project area is bounded on the west by the Burlington Northern Santa Fe (BNSF) rail line and on the east by Nebraska SH 2/71. Therefore, the existing ambient noise in the vicinity of the Project area is dominated by the traffic noise from SH 2/71 and trains on the BNSF rail line.

The State of Nebraska, Department of Roads, reports that the annual 24-hour average number of total vehicles to travel SH 2/71 along the eastern project boundary in 2004 was 265 (Nebraska 2007b). Thirty-five of these vehicles were reported to be heavy commercial vehicles. Table 3.7-1 (USDOT 1995) presents typical noise levels for automobiles at a distance of 15 meters (45 feet) at speeds ranging from 50 miles per hour (mph) to 70 mph.

Table 3.7-1
Typical Automobile Noise Levels

Speed (mph)	Noise Level at 45 ft (dBA)
50	62
55	64
60	65
65	66.5
70	68

Traffic noise is a combination of traffic density and vehicle speed. The speed limit along SH 2/71 near the project area is 60 miles per hour (Nebraska 2007a). The closest noise receptor (residence) to SH 2/71 is located adjacent to the road. Therefore, the existing noise level at that receptor due to existing traffic noise alone would be expected to be 65 dBA.

The precise noise levels from trains is a complex calculation that considers the train speed, the train length, the conditions of the wheels, and the condition of the track (Harris 1991). Noise from trains has been measured (Harris 1991) to range from 87 to 96 dBA at 100 feet from a track. The BSNF rail line runs through the town of Crawford. Assuming that a resident may live as close as 100 feet from the track, the existing noise for that receptor would be expected to be at least 87 dBA due to train noise alone.

The propagation of noise depends on many factors including atmospheric conditions, ground cover, and the presence of any natural or man-made barriers. As a general rule, noise decreases by approximately 6 dBA with every doubling of the distance from the source (Bell 1982). Therefore, noise levels at various distances can be predicted. The closest noise receptor, residence along SH 2/71, is located approximately 1.2 mile east of the BNSF. Using the doubling rule, the train noise at the residence would be 51 dBA, assuming a distance of 6400 feet. Because the effect of multiple noise sources is not a simple addition, but rather is a logarithmic addition, the existing noise levels at the closest receptor, based on noise from highway traffic and the BNSF, is likely to be 65 dBA or greater.

3.8 HISTORIC AND CULTURAL RESOURCES

Previous cultural resource investigations in the general area surrounding Crawford indicate that a variety of prehistoric and historic resources of potential significance exist in the vicinity. Resources include the Hudson-Meng prehistoric bison kill to the north of the area, several prehistoric camps and artifact scatters in the general areas, fur-trade period sites associated with the early history of Chadron, Fort Robinson to the west of Crawford, the Sidney-Deadwood Trail, the two historic railroads that cross where the town of Crawford emerged, and the town of Crawford itself. There has been extensive farming around Crawford, which may have disturbed many earlier sites, but has also created historic farming sites and features.

The proposed North Trend Expansion Area is on private lands north of the town of Crawford. An architectural and structural properties search was completed at the Nebraska State Historic Preservation Office and an archaeological site search was completed at the Archaeology Division of the Nebraska State Historical Society in July 2004. No previous cultural resources inventories have been documented for this area and the State Historic Preservation Office has no record of documented standing structures in the area. Two sites, one historic (25DW501) and one prehistoric (25DW73), in the general vicinity were identified in the archeological site search. The historic site is the ruins of the Hall Brothers Mill near the southeast edge of the Expansion Area along the White River. The prehistoric site is a reported Indian camp, also southeast of the Expansion Area. Information on the prehistoric site is scanty. Both of these sites were reported as being outside the assessment area. There are no reported National Register Properties or National Natural Landmarks in the vicinity of the project.

On April 30, 2004 letters identifying the nature and location of the proposed project were sent to the Nebraska Commission on Indian Affairs and the following 13 tribes: the Apache Tribe of Oklahoma; the Cheyenne River Sioux Tribe; the Cheyenne and Arapaho Tribes of Oklahoma; the Crow Creek Sioux Tribe; the Crow Nation; the Kiowa Tribe of Oklahoma; the Lower Brule Sioux Tribe; the Northern Arapaho Tribe; the Northern Cheyenne Tribe; the Oglala Sioux Tribe; the Pawnee Nation of Oklahoma; the Rosebud Sioux Tribe; and the Standing Rock Sioux Tribe. Follow up telephone calls were made in June to verify that the information had reached the appropriate persons in each tribe and to ask whether the tribes had any concerns about the project or were aware of any traditional concerns in the immediate vicinity of the project. Harvey Whitewoman of the Oglala Sioux called before the follow up calls were begun to ask what effect the proposed project might have on water quality. No other tribal concerns were identified.

The identification and assessment of cultural resources within the North Trend Expansion Area involved a single cultural resource inventory of a 1,190-acre area of anticipated development. This area was inventoried by Greystone (now ARCADIS) archaeologists from

August 16 through August 18, 2004 (Späth 2006). A 2,680 acre license area was defined, and a 1,190-acre archaeological review area was defined within that license boundary. (The size of the proposed license area has been reduced since 2004 to approximately 2,110 acres.) The archaeological review area was surveyed for the presence of cultural resources that may be impacted by the proposed mine development. Three historic sites and three isolated prehistoric artifacts were located and identified. The historic sites are the ruins of an abandoned farm complex (25DW296), an occupied farm complex (25DW297), and a refuse disposal area (25DW298). The individual artifacts are an early historic (1860s to 1870s)) metal trade point (25DW299), a chert core (25DW300), and a Plains Archaic chert point fragment (25DW301).

Appendix C to this ER contains a copy of the Cultural Resource Inventory Report and supporting correspondence including the Nebraska SHPO concurrence letter and the correspondence to the tribal authorities. Appendix B, Site Location Map and Appendix C, Site Forms from the Cultural Resource Inventory Report contain information that falls under the confidentiality requirement for archeological resources under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)). Additionally, disclosure of this information is protected under Nebraska State Statute Section 84-712.05 (13 and 14). Accordingly, disclosure is specifically exempted by statute as specified in 10 CFR §2.390(a)(3). Therefore, CBR requests that all portions of Appendices B and C remain "CONFIDENTIAL" for the purpose of Public Disclosure of this ER. Each page of the protected cultural resource information has been marked as follows:

Confidential Information Submitted under 10 CFR 2.390

The cover pages for each of these appendices have been marked with a more detailed statement, as follows:

Confidential Information Submitted under 10 CFR 2.390
Disclosure is Limited Under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)), and under the Nebraska Public Records Statutes (Neb. Rev. Stat. 84-712.05(13)).

All addenda are included in Volume II and must be kept confidential.

3.9 VISUAL/SCENIC RESOURCES

3.9.1 Introduction

The North Trend Expansion Area is on private land that is not managed to protect scenic quality by any public agency. However, it is located in scenic landscape of the Pine Ridge area of northwestern Nebraska and is visible from sensitive viewing areas. The existing landscape and the visual effect of the proposed facilities have been inventoried and assessed for the proposed project using the Bureau of Land Management (BLM) Visual Resource Management (VRM) system.

3.9.2 Methods

The VRM system is the basic tool used by the BLM to inventory and manage visual resources on public lands. The VRM inventory process involves rating the visual appeal of a tract of land, measuring public concern for scenic quality, and determining whether the tract of land is visible from travel routes or observation points.

The scenic quality inventory was based on methods provided in BLM Manual 8410 – *Visual Resource Inventory*. The key factors of landform, vegetation, water, color, influence of adjacent scenery, scarcity, and cultural modifications were evaluated according to the rating criteria, and provided with a score for each key factor. The criteria for each key factor ranged from high to moderate to low quality based on the variety of line, form, color, texture, and scale of the factor within the landscape. A score was associated with each rating criteria, with a higher score applied to greater complexity and variety for each factor in the landscape. The results of the inventory and the associated score for each key factor are summarized in Table 3.9-1. According to NUREG-1569, 2.4.3(7), if the visual resource evaluation rating is 19 or less, no further evaluation is required. The total score of the scenic quality inventory is 13; however, an analysis was prepared to reflect the growing concern some residents may have for the scenic resource, as Dawes County is expected to continue to develop tourism in the region.

TABLE 3.9-1
SCENIC QUALITY INVENTORY AND EVALUATION FOR THE NORTH TREND EXPANSION AREA

Key Factor	Rating Criteria	Score
Landform	Flat to rolling terrain with no interesting landscape features	1
Vegetation	Some variety of vegetation; cropland, range, riparian	3
Water	Water is present, but not evident as viewed from residences and roads	0
Color	Some variety in colors and contrasts with vegetation and soil.	3
Influence of adjacent scenery	Buttes of Fort Robinson State Park provide a scenic backdrop	5
Scarcity	Landscape is common for the region	1
Cultural modifications	Existing modifications are agricultural, and introduce no discordant elements.	0
Total Score		13

Visual Resource Management Classes

The elements used to determine the visual resource inventory class are the scenic quality, sensitivity levels, variety classes, and distance zones. Each of the elements used to identify the VRM Class is defined below:

Scenic Quality - Scenic quality is a measure of the visual appeal of a tract of land. In the visual resource inventory process, public lands are assigned an A, B, or C rating based on the apparent scenic quality, which is determined using seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. During the rating process, each of these factors is ranked comparatively against similar features within the physiographic province.

Sensitivity Level – A degree or measure of viewer interest in the scenic qualities of the landscape. Factors to consider include 1) type of users; 2) amount of use; 3) public interest; 4) adjacent land uses; and 5) special areas. Three levels of sensitivity have been defined:

- Sensitivity Level 1 – The highest sensitivity level, referring to areas seen from travel routes and use areas with moderate to high use.

- Sensitivity Level 2 – An average sensitivity level, referring to areas seen from travel routes and use areas with low to moderate use.

- Sensitivity Level 3 – The lowest sensitivity level, referring to areas seen from travel routes and use areas with low use.

Distance Zones – Areas of landscapes denoted by specified distances from the observer, particularly on roads, trails, concentrated-use areas, rivers, etc. The three categories are foreground-middleground, background, and seldom seen.

- Foreground-Middleground – The area visible from a travel route, use area, or other observer position to a distance of 3 to 5 miles. The outer boundary of this zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape and vegetation is apparent only in pattern or outline.

- Background - The viewing area of a distance zone that lies beyond the foreground and middleground. This area usually measures from a minimum of 3 to 5 miles to a maximum of about 15 miles from a travel route, use area, or other observer position. Atmospheric conditions in some areas may limit the maximum to about 8 miles or increase it beyond 15 miles.

- Seldom Seen – The area is screened from view by landforms, buildings, other landscape elements, or distance.

The visual resource inventory classes are used to develop visual resource management classes, which are generally assigned by the BLM through the resource management plan process. VRM objectives are developed to protect scenic public lands, especially those lands that receive the greatest amount of public viewing. The following VRM classes are objectives that outline the amount of disturbance an area can tolerate before it no longer meets the visual quality of that class.

- Class I Objective: To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.

- Class II Objective: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low.

- Class III Objective: To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate.

- Class IV Objective: To provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

The Scenic Quality, Sensitivity Level, and Distance Zone inventory levels are combined to assign the VRM Class to inventoried lands as shown in the following matrix:

Determining BLM Visual Resource Inventory Classes								
Visual Sensitivity		**High**			**Medium**			**Low**
Special Areas		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	II	III	III/IV	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
Distance Zones		f/m	b	ss	f/m	b	ss	ss

f/m = foreground-middleground
b = background
ss – seldom seen

3.9.3 Affected Environment

The Pine Ridge country that surrounds the North Trend Expansion Area features diverse and beautiful scenery that provides a setting for a variety of recreational activities as well as agricultural and other land uses. Rugged, white buttes rise up to 1,000 feet over stands of deep green Ponderosa pine. The buttes are surrounded by flat to rolling plains dissected by the White River and its various tributaries. Riparian vegetation along waterways includes a large variety of trees, shrubs, and grasses.

The North Trend Expansion Area is located on rolling plains with a backdrop of the spectacular buttes of Fort Robinson State Park, located west of the project area. The North Trend Expansion Area landscape is rural and agricultural in character, and is composed primarily of scenery that is common for the region. The landscape colors are dominated by tan, gold, and green vegetation; and the tan soils. Riparian vegetation along the White River and Spring Creek exhibits considerable variety in form, texture, and color. Dark to light green colors and a variety of forms and textures of the riparian vegetation provide pleasing contrasts to the flat, horizontal lines of the surrounding agricultural land in the project area.

Land use in the project area is dominated by crop production, primarily wheat. Grazing occurs on all lands not cultivated for crops, including riparian areas.

3.9.4 North Trend Visual Inventory

Most of the North Trend Expansion Area is characterized by the low, rolling plains and agricultural land uses that are typical of the Pine Ridge area in northwestern Nebraska. The scenic quality of the project area is common, or Class B. Class A landscapes consisting of the rugged buttes of the Fort Robinson State Park are visible to the west and southwest of the project area. The buttes provide a scenic backdrop to the project area that is visible to travelers on Nebraska State Highway (SH) 2/71, which forms the east boundary of the project area.

3.9.4.1 Sensitive Viewing Areas

There are sensitive viewing areas on SH 2/71 and in the Crawford Cemetery. The entire project area is within 5 miles of views from SH 2 and the cemetery, which places the area in the foreground – middleground distance zone. In general, residents and other users of the region are accustomed to viewing human modification in the rural landscape, but could be sensitive to increased levels of development.

The greatest number of viewers of the proposed facilities would be traveling on SH 2/71. The annual average daily traffic (AADT) on SH 2/71 north of Crawford for the year 2002 was 635 vehicles. Travelers on SH 2/71 include local traffic, vehicles traveling through the region, and visitors to local scenic, historic, and recreational attractions. The highway provides access to nearby Fort Robinson State Park, as well as other destination sites in the region (see discussion of local recreation in section 3.1.2). Some motorists exposed to the landscape would have a concern for scenic quality, and would be sensitive to modifications to the landscape.

Most of the project area is screened from views of motorists by the terrain. The rolling terrain consists of gentle ridges that trend in an east-west direction, which is approximately perpendicular to SH 2/71. The ridges block much of the interior of the project area from SH 2/71 north of the project area. In addition, the project area is at a higher elevation than the highway to the south, so that it is not visible to northbound travelers south of the highway until they reach the project area boundary. Most of the project area is in the seldom-seen distance zone of viewers on SH 2/71 to the north and south of the project area. However, a *short segment of highway located at the southbound lane on the downside of a high point of* elevation about 3,200 feet north of the Crawford Cemetery provides a panoramic view of the

interior project area. This highway segment has a large area of unimpeded views with the greatest potential for extended viewing times.

The Crawford Cemetery, which is located at the east-central boundary of the project area, provides views of the central interior of the project area to cemetery visitors. Unimpeded views of the project area span from the west boundary of the Crawford Cemetery, approximately midway between the north and south boundaries. The viewpoint provides a panoramic view of the project area that would be seen by visitors who are in the west side of the cemetery. Views from the central and eastern portions of the cemetery would be blocked to some degree by trees that are distributed throughout the cemetery.

The level of use at these viewing areas is low to moderate, or a Sensitivity Level 2. Viewers at isolated rural residences with views of the project area are few compared with viewers at other sensitive viewing areas, but these residents would generally have a strong level of concern for changes in the viewshed.

3.9.4.2 VRM Class

Based on the project area Class B scenic quality, the Sensitivity Level 2 as viewed from SH 2/71 and the Crawford Cemetery, and the location of the project area in the foreground-middleground distance zone as seen from the sensitive viewing areas, the North Trend Expansion Area has been assigned Class III for both the visual resource inventory and the VRM objective.

3.10 SOCIOECONOMIC

Information presented in this section concerns those demographic and social characteristics of the environs that may be affected by the proposed expansion of the Crow Butte Uranium Project to include operations in the North Trend Expansion Area. Data were obtained through the 1980, 1990, and 2000 U.S. Census of Population and various State of Nebraska government agencies.

3.10.1 Demography

3.10.1.1 Regional Population

The area within an 80-km (50-mile) radius of the project site includes portions of six counties in northwestern Nebraska, two counties in southwestern South Dakota, and two counties in eastern Wyoming. Because the 80-km radius extends only slightly into two very rural counties in Wyoming (with populations of less than 2,000 persons), the regional demography in Wyoming is not discussed in detail beyond that summarized in Table 3.10-1 through Table 3.10-3. Figure 3.10-1 depicts significant population centers within an 80 km radius of the proposed North Trend Expansion Area.

Historical and current population trends in the project area counties and communities are contained in Table 3.10-1. Between 1960 and 1980, Box Butte County exhibited the fastest rate of growth with more than a 17 percent population increase, largely occurring in the latter half of the 1970s. Box Butte County lost population between 1980 and 2000, with the greater population losses occurring during the 1990's.

All of the Nebraska counties comprising the project area experienced slight growth or actual population decline between 1960 and 1980 and population decline between 1980 and 1990. The state experienced its fastest growth since the 1920s during the years between 1990 and 2000. The total state population in 2000 was 1.7 million, which was an 8.4-percent increase over the 1990 population of 1.6 million. The Nebraska counties in the project area experienced little of the state's growth spurt. However, with the exception of Box Butte, the counties experienced a reversal of the downward trends of the 1980s. In general, population trends for the last decade show that population in urban areas is increasing, while population in rural areas is declining. Areas within 80 km of the project site that are defined as urban (all territory, population, and housing units in urbanized areas and in places of more than 2,500 persons outside of urbanized areas) by the U.S. Census 2000 are the cities of Chadron in Nebraska, and Hot Springs and Pine Ridge in South Dakota.

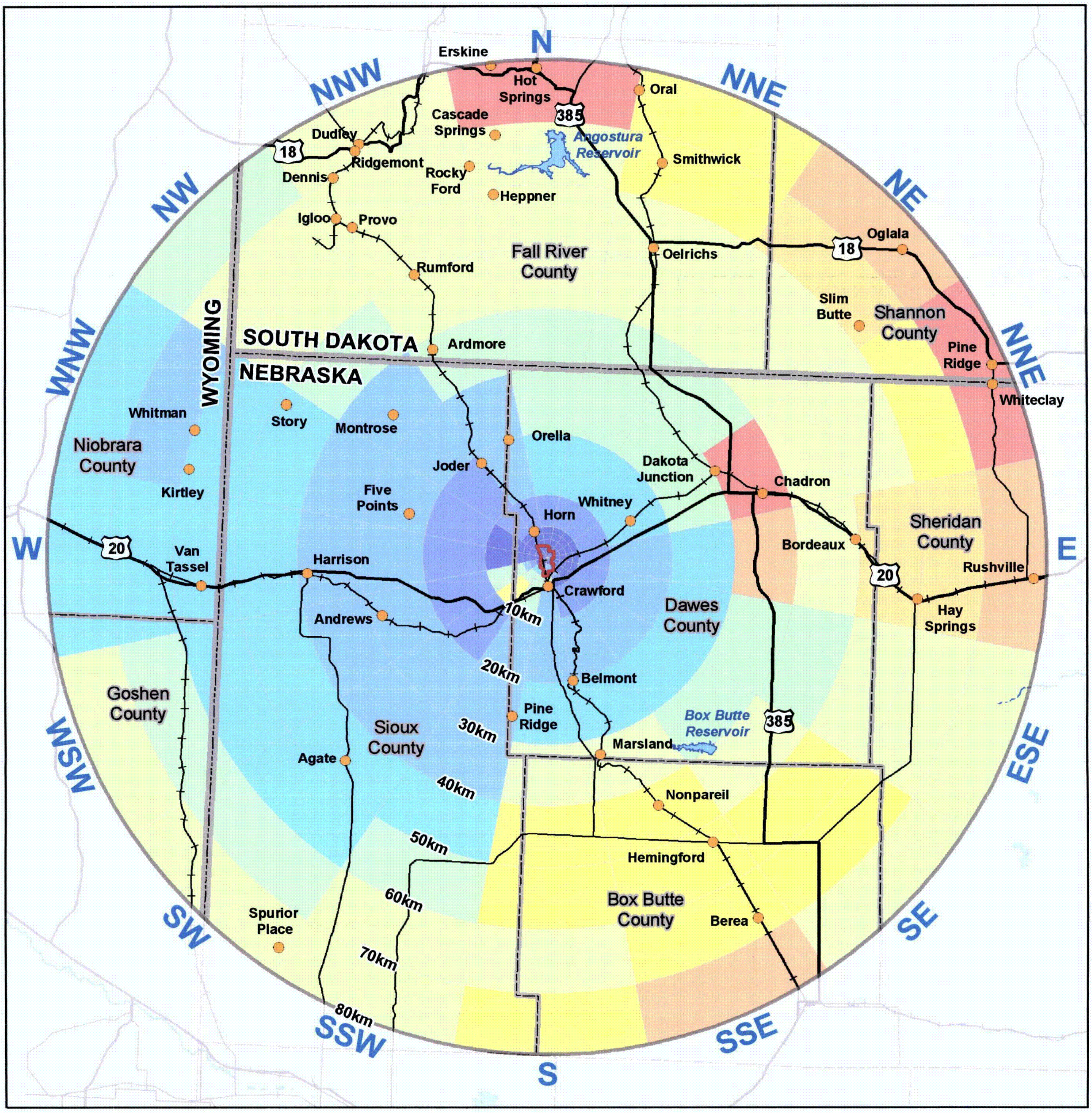
Dawes County grew slightly between 1990 and 2000, gaining 0.4 percent in population. Most of this growth occurred in the City of Chadron. The Dawes County communities of Chadron

and Crawford are the nearest communities to the project site. Chadron is located approximately 40-km (25 miles) northeast of the project site with a 2000 population of 5,634, an increase of 0.8 percent from 1990. The community of Crawford, within 10 km (2.0 miles) of the site, had a 2000 population of 1,107. Chadron experienced a small population gain between 1990 and 2000, while Crawford lost population.

Sioux County lost population at a slower rate in the years between 1980 and 1990 than in the previous decade. The slower decline of the county population occurred in part because the town of Harrison gained nearly 16 percent, which is a reversal of a trend that shows a decline in population since 1960. Between 1980 and 1985, the downward trend continued in Sioux and Morrill Counties, with Sheridan County exhibiting a slight turnaround. Between 1985 and 1990, the downward trend continued in the Nebraska counties, with the exception of Morrill County, which experienced an increase of 6.3 percent. However, this growth is a decrease from the 1980 population.

Sheridan County has experienced an overall decline of nearly 32 percent since 1960. Population has declined in the towns of Hay Springs and Rushville between 1980 and 2000, despite earlier gains in the 1980s. Scotts Bluff County experienced gradual population growth over the two-decade period between 1960 and 1980.

Scotts Bluff County, which is just south of the 80-km radius around the project site, was included within the 80-km radius of the original license area. The county experienced population gains between 1990 and 2000 primarily because the City of Scottsbluff, which is an urban area, showed a strong increase in population of 7.4 percent between 1990 and 2000.



Legend

Population

	0 - 4		98 - 179
	4 - 16		179 - 303
	16 - 33		303 - 679
	33 - 53		679 - 1701
	53 - 98		1701 - 5040

North Trend

N W E S

0 2.5 5 10 15 20 Miles

CROW BUTTE PROJECT

REGIONAL AREA BASE MAP

DAWES & SIOUX COUNTIES, NEBRASKA

FIGURE 3.10-1
SIGNIFICANT POPULATION CENTERS WITHIN 80 KILOMETERS

TABLE 3.10-1 HISTORICAL AND CURRENT POPULATION CHANGE FOR COUNTIES AND TOWNS WITHIN 80 KM OF THE NORTH TREND EXPANSION AREA SITE, 1960-2000

State County City	Population					Average Annual Percent Change			
	1960	1970	1980	1990	2000	1960/ 1970	1970/ 1980	1980/ 1990	1990/ 2000
NEBRASKA									
Dawes	9,536	9,761	9,609	9,021	9,060	2.4	-1.6	-6.1	0.4
Chadron	5,079	5,921	5,933	5,588	5,634	16.6	0.2	-5.8	0.8
Crawford	1,588	1,291	1,315	1,115	1,107	-18.7	1.9	-15.2	-0.7
Box Butte	11,688	10,094	13,696	13,130	12,158	-13.6	35.7	-4.1	-7.4
Alliance	7,845	6,862	9,869	9,765	8,959	-12.6	43.8	-1.1	-8.3
Hemingford	904	734	1,023	953	993	-18.8	39.4	-6.8	4.2
Sheridan	9,049	7,285	7,544	6,750	6,198	-19.5	3.6	-10.5	-8.2
Hay Springs	823	682	794	693	652	-17.1	16.4	-12.7	-5.9
Rushville	1,228	1,137	1,217	1,127	999	-7.4	7.0	-7.4	-11.4
Sioux	2,575	2,034	1,845	1,549	1,475	-21.0	-9.3	-16.0	-4.8
Harrison	448	377	361	241	279	-15.8	-4.2	-33.2	15.8
SOUTH DAKOTA									
Fall River	10,688	7,505	8,439	7,353	7,453	-29.8	12.4	-12.9	1.4
Hot Springs	4,943	4,434	4,742	4,325	4,129	-10.3	6.9	-8.8	-4.5
Oelrichs	132	94	124	138	145	-28.8	31.9	11.3	5.1
Ardmore	73	14	16	NA		-80.8	14.3		
Shannon	6,000	8,198	11,323	9,902	12,466	36.6	38.1	-12.6	25.9
Pine Ridge CDP	NA	NA	NA	422	1,229	NA	NA	NA	191.2
WYOMING	1,256	2,768	3,059	2,596	3,171	120.4	10.5	-15.1	22.1
Goshen	11,941	10,885	12,040	12,373	12,538	-8.8	10.6	2.8	1.3
Niobrara	3,750	2,924	2,924	2,499	2,407	-22.0	0.0	-14.5	-3.7
Lusk	1,890	1,495	1,650	1,504	1,447	-20.9	10.4	-8.8	-3.8

Note – CDP (Census Designated Place) is a statistical entity defined for each decennial census according to Census Bureau guidelines, comprising a densely-settled concentration of population that is not within an incorporated place, but is locally identified by a name.

Sources: U.S. Bureau of the Census, 1972a, 1972b, 1972c, 1979, 1981, 1986, 1990a, 1990b, 1990c, 2000

The two South Dakota counties in the 80-km study area include Fall River and Shannon. Fall River County experienced an overall population decline by more than 30 percent between 1960 and 2000; however, between 1990 and 2000, there was a small increase of 1.4 percent. The town of Ardmore lost more than 80 percent of its population between 1960 and 1980, and was disincorporated in 1984 (U.S. Census 1990e). Shannon County, on the other hand, grew by 25.9 percent between 1990 and 2000; more than double the 1960 population. Much of the growth occurred in the Pine Ridge and Oglala Census Designated Places (CDP), which are urban areas as defined by the U.S. Census, but are not incorporated municipalities. Most of Fall River County is included within 80 km of the project site; however, only the southwest portion of Shannon County is within 80 km of the project site.

The population declines in the counties within the 80-km radius reflect trends in the overall region, where declines have been attributed to the declines in the rural farming based economy and limited economic opportunities for youth. Persistent drought conditions have also contributed to the shrinking of the agriculture-based economy. Rural residents have been migrating to larger cities, depopulating the largely rural Great Plains states. Many of the people migrating out of the state are young adults and families, which results in fewer people of childbearing age, and therefore, fewer children. This trend also contributes to the increasing proportion of the elderly population in the state.

3.10.1.2 Population Characteristics

2000 population by age and sex for counties within 80 km of the Crow Butte project area is shown in Table 3.10-2. Overall, 67.7 percent of the population in the region is more than 20 years old. Fall River and Niobrara Counties reported the highest percentage of persons older than 18 with 75.0 percent. About 6.7 percent of the population was less than 5 years old in 2000. Shannon County reported the youngest population, with 10.9 percent less than 5 years old and slightly more than half (51.0 percent) at 18 years of age and under. Females slightly outnumbered males in most counties, with an overall population of 50.1 percent female to 49.9 percent male.

In 2000 slightly more than 75 percent of the ten-county population was classified as white. American Indians and persons of Hispanic origin comprised 21.2 percent and 4.3 percent, respectively, of the total population. Nearly 80 percent of the American Indians were Sioux living on the Pine Ridge Reservation in Shannon County, South Dakota.

3.10.1.3 Population Projections

The projected population for selected years by county within the 80-km radius of the proposed Crow Butte Project is shown in Table 3.10-3. The population is expected to decrease in the Nebraska Counties of Box Butte, Sheridan, and Sioux. These counties are

primarily rural, with agriculture-based economies. It is anticipated that the declining population trends of the last two decades will continue into the foreseeable future for these counties. The projected population for Dawes County is expected to increase at an annual rate of less than 1 percent over the next 20 years. This rate reflects recent increases in the population of Chadron that are expected to continue. In addition, Dawes County provides a scenic setting for a variety of outdoor recreation activities. The Pine Ridge region will probably increase in popularity with visitors and recreationists from outside of the region, as participation in outdoor recreational activities is expected to increase nationwide. An increase in visitor utilization of recreation facilities in Dawes County would revitalize the local economy, adding to the overall attractiveness of the region to potential residents.

3.10.1.4 Seasonal Population and Visitors

According to the Final Environmental Impact Statement for the Northern Great Plains Management Plans Revision (May 2001), the various state parks in northwest Nebraska, the Pine Ridge Ranger District and the Oglala National Grassland, are increasingly becoming regional tourist destinations.

Approximately 358,000 people visited Fort Robinson State Park in 2002. This number represents a 4.8-percent increase from 2001, but a decrease of 5.1 percent from the 1981 visitation of 377,000 people and a slight decrease of less than 1 percent from the 359,000 visitors in 1984 (Nebraska Department of Economic Development 2003). Visitor figures were up slightly for 2005, with a total of 361,230 visitors to the park (Nebraska Department of Economic Development 2007). Approximately 50 percent of the visitors in 2002 were from other states, which is an increase in the number of out-of-state visitors from 1981, as the majority of 1981 visitors were Nebraskan families. It is likely that the decline of visitors from Nebraska has resulted from the overall decline of population in rural counties within a few hours commuting distance of the park.

TABLE 3.10-2 POPULATION BY AGE AND SEX FOR COUNTIES WITHIN THE 80-KM RADIUS OF THE NORTH TREND EXPANSION AREA, 2000

State County	Age	Male	Female	Total	Total Percent Breakdown
Nebraska					
Box Butte	Under 5	436	361	797	6.6
	5 - 19	1,530	1,409	2,939	24.2
	20 - 34	935	963	1,898	15.6
	35 - 64	2,446	2,308	4,754	39.1
	65+	707	1,063	1,770	14.6
	Total	6,054	6,104	12,158	100.0
Dawes	Under 5	213	238	451	5.0
	5 - 19	1,143	1,043	2,186	24.1
	20 - 34	1,133	1,110	2,243	24.8
	35 - 64	1,400	1,438	2,838	31.3
	65+	540	802	1,342	14.8
	Total	4,429	4,631	9,060	100.0
Sheridan	Under 5	192	167	359	5.8
	5 - 19	716	660	1,376	22.2
	20 - 34	415	403	818	13.2
	35 - 64	1,132	1,170	2,302	37.1
	65+	580	763	1,343	21.7
	Total	3,035	3,163	6,198	100.0
Sioux	Under 5	43	36	79	5.4
	5 - 19	188	132	320	21.7
	20 - 34	98	95	193	13.1
	35 - 64	324	320	644	43.7
	65+	123	116	239	16.2
	Total	776	699	1,475	100.0

TABLE 3.10-2 POPULATION BY AGE AND SEX FOR COUNTIES WITHIN THE 80-KM RADIUS OF THE NORTH TREND EXPANSION AREA, 2000

State County	Age	Male	Female	Total	Total Percent Breakdown
South Dakota					
Fall River	Under 5	214	145	359	4.8
	5 - 19	847	661	1,508	20.2
	20 - 34	397	406	803	10.8
	35 - 64	1,596	1,513	3,109	41.7
	65+	846	828	1,674	22.6
	Total	3,900	3,553	7,453	100.0
Shannon	Under 5	676	684	1,360	10.9
	5 - 19	2,460	2,294	4,754	38.1
	20 - 34	1,205	1,297	2,502	20.1
	35 - 64	1,614	1,642	3,256	26.1
	65+	265	329	594	4.8
	Total	6,220	6,246	12,466	100.0
Wyoming					
Goshen	Under 5	378	349	727	5.8
	5 - 19	1,460	1,322	2,782	22.2
	20 - 34	1,001	946	1,947	15.5
	35 - 64	2,459	2,451	4,910	39.2
	65+	936	1,236	2,172	17.3
	Total	6,234	6,304	12,538	100.0
Niobrara	Under 5	60	55	115	4.8
	5 - 19	268	219	487	20.2
	20 - 34	134	180	314	13.0
	35 - 64	507	533	1,040	43.2
	65+	205	246	451	18.7
	Total	1,174	1,233	2,407	100.0

Source: U.S. Bureau of the Census 1981a, 1981b, 1981c, 1990a, 1990b, 1990c, 2000

TABLE 3.10-3 POPULATION PROJECTIONS FOR COUNTIES WITHIN AN 80-KM RADIUS OF THE CROW BUTTE PROJECT AREA, 2000-2020

County	Census 2000	Projected 2005	Projected 2010	Projected 2015	Projected 2020
Box Butte	12,158	11,759	11,387	11,048	10,662
Dawes	9,060	9,168	9,273	9,339	9,368
Sheridan	6,198	5,962	5,732	5,540	5,368
Sioux	1,475	1,424	1,364	1,294	1,215
Fall River	7,453	N/A	N/A	N/A	N/A
Shannon	12,466	N/A	N/A	N/A	N/A
Goshen	12,538	12,401	12,429	N/A	N/A
Niobrara	2,407	2,399	2,399	N/A	N/A

N/A not available
Sources: University of South Dakota, Bureau of Business Research 2004.
University of Nebraska-Lincoln, Bureau of Business Research 2004.
Wyoming Department of Administration and Information 2004.

There were 55,000 visitors to the Pine Ridge District of the Nebraska National Forest in 2001. Camping and motorized travel/viewing scenery are the two most popular recreation categories on the Pine Ridge Ranger District and the Oglala National Grassland.

The forest provides a wide range of other undeveloped backcountry recreation opportunities such as hunting, hiking, backpacking, fishing and wildlife observation. The district provides the greatest number of miles of mountain biking trails in the state. District trails also attract horseback riders and off-highway motorized vehicle use. The Pine Ridge is an important destination for deer hunting, and provides the most popular turkey hunting area in Nebraska.

One source of seasonal population in this region is Chadron State College, located approximately 35 km (21.6 miles) from the site. During the 2001 fall semester, enrollment was 2,804, an increase of 25 percent over the fall 1986 enrollment of 2,240 (Nebraska Department of Economic Development, 2002; Schmiedt 1987). In the 1994 fall semester, a total of 3,296 students were enrolled at the college (Taylor 1995).

3.10.1.5 Schools

Crawford is served by the Crawford Public School District. The Crawford High School and grade school are presently under capacity. Total enrollment in these two schools as of fall 2001 was 146 in the high school and 140 in the elementary school with maximum capacities of 545 and 185, respectively (National Center for Educational Statistics 2004; Crawford High School 1995; Crawford Elementary School 1995). Current enrollment numbers are 134 in the grade school and 134 in the high school (Crawford Public Schools 2007) and are comparable to annual enrollments since 1987 for both schools. The grade school currently has a student to teacher ratio of 13 to 1 and the high school has a ratio of 8 to 1. No historical high enrollment was given for the grade school. However, it was estimated in 1995 that the high school historical high enrollment was more than 200 pupils.

There is one rural school supporting grades one through eight within the Crawford district. The Belmont School is a two-room schoolhouse. Students living in the rural district attend Crawford High School. There were 6 pupils as of fall 2007 at the Belmont School from which Crawford High School draws, a decline from the 1995 enrollment of an estimated 100 pupils in seven rural school districts.

Families moving into the Crawford district as a result of the proposed North Trend Expansion Area operations would not stress the current school system because it is presently under capacity.

3.10.1.6 Sectorial Population

Existing population, as determined for the original analysis in the CBR commercial license application prepared in 1987 for the 80-km radius, was estimated for 16 compass sectors, by concentric circles of 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70 and 80 km from the site (a total of 208 sectors). Sectorial population for the application prepared in 2004 was updated with data from the 2000 U.S. Census. Subtotals by sector and compass points as well as the total population are shown in Table 3.10-4.

Population within the 80-km radius was estimated using the following techniques:

U.S. Census 2000 data were used to estimate the total population within an 80-km radius, measured from the center of the proposed North Trend Expansion Area site. The data were created by Geographic Data Technology, Inc., a division of ESRI, from Census 2000 boundary and demographic information for block groups within the United States.

ArcInfo Geographic Information System (GIS) was used to extract data from U.S. Census 2000 population estimates for 40 Census Tract Block Groups located wholly or partially

within the 80-km radius from the approximate center of the North Trend Expansion Area site. Urban areas within each county were generally assigned their own block group.

To assign a population to each sector, a percentage area of each sector within one or more block groups was calculated for all of the block groups.

2000 U.S. Census of population estimates for cities and counties in Nebraska, South Dakota and Wyoming were used to determine total urban population.

TABLE 3.10-4 2000 POPULATION WITHIN AN 80-KM (50-MILE) RADIUS OF THE NORTH TREND EXPANSION AREA [A]

	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	Total
N	0	0	0	0	1	9	38	63	87	112	137	161	3,682	4,292
NNE	0	0	0	0	1	9	38	63	88	112	147	205	223	886
NE	0	0	0	0	1	9	38	63	88	109	116	624	679	1,728
ENE	0	0	0	0	1	9	37	58	5,039	113	132	224	3,139	8,754
E	0	0	0	0	1	9	29	48	1,007	113	587	435	1,207	3,436
ESE	0	0	0	0	1	7	29	48	69	91	117	131	107	601
SE	0	0	0	0	0	7	29	48	68	146	263	303	153	1,016
SSE	0	11	21	9	2	7	29	48	125	242	273	194	1,701	2,663
S	0	16	41	58	72	27	29	48	136	190	188	164	179	1,149
SSW	0	14	41	58	74	75	21	25	30	38	67	115	133	690
SW	0	4	39	58	74	291	13	21	29	38	46	70	112	794
WSW	0	0	6	33	60	75	13	21	29	38	53	83	98	509
W	0	0	0	0	1	3	13	21	29	38	33	39	49	226
WNW	0	0	0	0	1	4	13	21	29	38	38	32	37	212
NW	0	0	0	0	1	6	13	21	30	71	110	113	78	444
NNW	0	0	0	0	1	9	28	26	65	112	136	148	164	691
Total	0	46	148	214	293	560	409	645	6,950	1,601	2,443	3,041	11,741	28,092

Notes:

[a] Current population living between 10 and 80 km of the mine site were estimated using 2000 census data. Field reconnaissance was conducted in 2004 to verify data collected within 2.25 miles (3.6 km). See Section 3.10.1. for a detailed description of the methodology.

3.10.2 Local Socioeconomic Characteristics

3.10.2.1 Major Economic Sectors

In 2002, average annual unemployment rates in Dawes and Box Butte Counties decreased from the 1994 rates. Table 3.10-5 summarizes unemployment rates and employment in the Nebraska project area counties. Dawes and Box Butte Counties exhibited unemployment rates at 3.8 percent in Dawes County and 5.0 percent in Box Butte County. Unemployment rates for both counties increased between 1994 and 2002. In 1994, unemployment levels declined from February 1987 levels. These rates were a little higher than the statewide rate of 3.5 percent. Dawes County was close to the state unemployment rate, while the Box Butte rate was higher.

The major economic sectors in the project area have changed little in recent years, although individual sectors have shifted in their relative proportion in the overall economy. The area continues to depend on trades, government, and services. Economic activities in the Crawford area include farming, ranching, cattle feed lots, tourism, and retail sales.

Agriculture accounts for slightly more than 1 percent of the total employed labor force in Dawes County, while farm employment was 14 percent of total employment in Box Butte County. Government employment in Dawes County makes up 37 percent of total non-farm employment, followed by trade (16 percent), leisure and hospitality services (14 percent), and education and health services (9 percent). Construction and mining account for 5 percent. In Box Butte County, the largest four non-farm employment sectors are transportation (25 percent), government (22 percent), trade (16 percent), and manufacturing (9 percent).

Agriculture employment has a small share of total employment in both counties. However, agriculture provides the economic base for the counties, as other economic sectors support the agricultural industry. Events that affect agriculture are generally felt throughout rural economies. According to the Nebraska Department of Economic Development (2002), Farm employment in Nebraska is expected to decline by nearly 14,000 jobs (20 percent) between 2000 and 2045, while overall non-farm employment will increase by nearly 26 percent. The decrease in jobs in the agricultural sector could continue to fuel migration from rural counties to urban areas, resulting in overall declines in other sectors of the local economy as dollars spent from personal income and agricultural business expenditures move out of the counties.

Per capita personal income is the income that is received by persons from all sources, including wages and other income over the course of 1 year. In 2002, personal income in

Dawes County was $19,760, which was 68 percent of the state average of $29,182. The county ranks 84th out of 93 counties in the state (BEA 2004).

TABLE 3.10-5 ANNUAL AVERAGE LABOR FORCE AND EMPLOYMENT ECONOMIC SECTORS* FOR DAWES AND BOX BUTTE COUNTIES, 1994 AND 2002

	Dawes		Box Butte	
	1994	2002	1994	2002
Labor Force	4,490	4,663	6,156	5,670
Unemployment	149	175	235	282
Unemployment Rate	3.3	3.8	3.8	5.0
Employment	4,341	4,489	5,921	5,387
Farm Employment	564	550	763	760
Non-Farm Employment Total	3,479	3,903	5,446	5,241
Manufacturing	165	201	402	465
Construction and Mining	136	179	80	0
Transportation, Communication, and Utilities	N/A	N/A	1,909	1,288
Trade	952	N/A	1,106	825
Retail	824	636	840	539
Wholesale	128	N/A	265	286
Financial, Insurance, and Real Estate	77	117	215	205
Services	548	N/A	779	N/A
Information	N/A	0	N/A	110
Professional and Business Services	N/A	N/A	N/A	219
Education and Health Services	N/A	358	N/A	424
Leisure and Hospitality	N/A	533	N/A	372
Other Services	N/A	133	N/A	203
Government	1,384	1,450	955	1,130
Federal	144	161	65	67
State	721	719	67	62
Local	519	571	824	1,001

*: Industry employment estimates are based on the Standard Industry Classification System before 2001, and on the North American Industry Classification System after 2001.
N/A = not available

3.10.2.2 Housing

Between 1970 and 1980, total housing units increased by 17 percent in Dawes County from 3,388 to 3,965 units. By 2002, the growth of the preceding decades had slowed, and total housing units increased by 2.4 percent to 4,004 units from 3,909 units in 1990. Chadron, the largest community in Dawes County and within 40 km (25 miles) of the project site, experienced a 25 percent increase in housing stock between 1970 and 1980, and a 5 percent increase between 1990 and 2000. Crawford housing stock decreased by nearly 7 percent from 576 units in 1990. By 2000, there were 2,441 housing units in Chadron and 537 units in Crawford. Alliance, in Box Butte County (approximately 72 km [45 miles] from the project site) exhibited a 1 percent loss in total housing units between 1990 and 2000. In 2000, there were 4,062 housing units in Box Butte County (U.S. Department of Commerce, Bureau of the Census 1981a, 1990d, 2004).

In 2000, Dawes and Box Butte Counties had homeowner vacancy rates of 1.7 and 1.4 percent, respectively. A June 2004 listing of property for sale revealed two ranch properties near Crawford. Housing prices averaged $53,915 in 1999. According to the Dawes County Tax Assessor, no new houses are being built, as current housing needs are being met.

A local Crawford realtor indicated in 1999 that rental property in Crawford was scarce. The rental housing stock has not increased in 2000, as rental vacancy rates were 4.4 percent in Dawes County and 4.7 percent in Box Butte County (U.S. Department of Commerce 2004), compared with rental vacancy rates in 1990, which were 12.6 percent in Dawes County and 14.9 percent in Box Butte County (U.S. Department of Commerce 1990a).

High interest rates and tax rates were the major deterrents for potential homebuyers in the project area in the past. Current deterrents are economic uncertainty and unemployment. Recent interest rates on most home mortgages have ranged between 5 and 7 percent.

Population projections for Dawes County indicate an average annual growth rate of 10 percent between 2000 and 2020. Most of this growth is likely to occur in Chadron, as suggested by population growth between 1990 and 2000, rather than Crawford, which lost population. The majority of housing demand expected over the next two decades is most likely to occur in Chadron. However, housing stock in Crawford has decreased so that homeowner vacancy rates have also decreased. In the event that the various scenic and recreational amenities of the region stimulate the local tourist economy, it is likely that both population and housing stock would increase in Crawford.

The purchase of homes by Crow Butte employees provides the town of Crawford with ad valorem property taxes. The town of Crawford levies taxes at a dollar per hundred of

valuation. In 2001, the total levy was 0.43346, which would result in taxes on a $50,000 property of approximately $217 per year (Nebraska Department of Property Assessment and Taxation 2001).

3.10.3 Evaluation of Socioeconomic Impacts of the Current Operation

The preliminary evaluation of socioeconomic impacts of the commercial facility was completed in 1987 as reported in the original commercial license application. The preliminary evaluation was divided into two phases – construction and operation. The evaluation concluded that the construction phase would cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities. Impacts to community services such as roads, housing, schools, and energy costs would be minor or non-existent and temporary.

Since the inception of the operational phase, the overall effect of the current commercial facility operations on the local and regional economy has been beneficial. Purchases of goods and services by the mine and mine employees contribute directly to the economy. Local, state, and the federal governments benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, are also beneficial. These economic effects further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economy provided by the current operation would continue for the life of the mine, estimated to be an additional twelve years as of January 2007. However, the positive impacts from the current operation will begin to decline as reserves are depleted in the next five years.

The current mine operation has not resulted in any significant impact to the community infrastructure (including schools, roads, water and sewage facilities, law enforcement, medical facilities, and any other public facility) in the town of Crawford or in Dawes County. The mine employs a workforce of approximately 55 employees and 15 contractors. The majority of these employees are hired from the surrounding communities.

Monetary benefits accrue to the community from the presence of the Crow Butte Project. Against these monetary benefits are the monetary costs to the communities involved, such as those for new or expanded schools and other community services. While it is not possible to arrive at an exact numerical balance between these benefits and costs for any one community, or for the project, because of the ability of the community and possibly the project to alter the benefits and costs, this section summarizes the economic impact of the project to date.

3.10.3.1 Tax Revenues

The following table summarizes the recent tax revenues from the Crow Butte project.

	2006	**2005**	**2004**	**2003**
Property Taxes	627,000	351,000	144,000	65,000
Sales and Use Taxes	238,000	185,000	161,000	153,000
Severance Taxes	545,000	338,000	180,000	73,000
Total	**1,410,000**	**874,000**	**485,000**	**291,000**

3.10.3.2 Temporary and Permanent Jobs

3.10.3.2.1 Current Staffing Levels

CBR currently employs approximately 52 employees and 20 contractors on a full-time basis. Short-term contractors and part time employees are also used for specific projects and/or during the summer months and may add up to 10 percent to the total staffing. This level of employment is significant to the local economies. The private employment in Dawes County in 2006 was 2,189 out of a total labor force of 3,401. Based on these statistics, CBR currently provides approximately 2.3 percent of the private employment in Dawes County. In 2006, CBR's total payroll was over $2,543,000. Of the total Dawes County wage and salary payments of $76,006,000 in 2006, the CBR payroll represented about 3.4 percent.

Total CBR payroll for the past four years was:

2003: $2,102,000

2004: $2,213,000

2005: $2,382,000

2006: $2,543,000

The average annual wage for all workers in Dawes County was $22,350 for 2006. By way of comparison, the average wage for CBR was about $51,000. Entry-level workers for CBR earn a minimum of $15.53 per hour or $32,300 per year, not including bonus or benefits.

CBR actively pursues a policy of hiring and training local residents to fill all possible positions. Due to the technical skills required for some positions, a small percentage of the current mine staff (less than five percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal.

3.10.3.3 Impact on the Local Economy

In addition to providing a significant number of well-paid jobs in the local communities of Crawford, Harrison, and Chadron, Nebraska, CBR actively supports the local economies through purchasing procedures that emphasize obtaining all possible supplies and services that are available in the local area.

Total CBR payments made to Nebraska businesses for the past four years were:

2003:	$3,602,000
2004:	$3,597,000
2005:	$4,570,000
2006 (est):	$5,000,000

The vast majority of these purchases were made in Crawford and Dawes County.

3.10.3.4 Economic Impact Summary

As discussed in this section, the Crow Butte Project currently provides a significant economic impact to the local Dawes County economy. The current economic impact of operations is summarized in Table 3.10-5

Table 3.10-5
Current Economic Impact of Crow Butte Uranium Project

	Current Crow Butte Operation
Employment	
Full Time Employees	52
Full Time Contractor employees	20
Part Time Employees and Short Term Contractors	7
CBR Payroll, 2006	$2,543,000
Taxes	
Property Taxes	$627,000
Sales and Use Taxes	$238,000
Severance Taxes	$545,000
Total Taxes	$1,410,000
Local Purchases	
Local Purchases, 2006 (est.)	$5,000,000
Total Direct Economic Impacts	
	$8,953,000

3.11 PUBLIC AND OCCUPATIONAL HEALTH

3.11.1 Non-Radiological Impacts of the Current Operation

3.11.1.1 Chemical Impacts of the Current Operation

The current operation at the Crow Butte Central Plant involves the use of hazardous chemicals in the process in quantities that could present a hazard to workers and the environment. Specifically, CBR stores and uses hydrochloric acid, sodium hydroxide, hydrogen peroxide, liquid oxygen, and carbon dioxide. The design of facilities and the storage and handling of these chemicals at CBR is performed in accordance with accepted codes and standards as recommended in NUREG/CR-6733. CBR is also subject to the requirements of the Occupational Safety and Health Administration (OSHA) set forth in the Process Safety Management Standard contained in 29 CFR §1910.119. As a result of these requirements and the management and administrative controls implemented by CBR, there has never been a serious incident involving hazardous chemicals at the Crow Butte Uranium Project.

3.11.1.2 Potential Declines in Groundwater Quality

Excursions at the current operation represent a potential effect on the adjacent groundwater. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality in the exempted aquifer compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, and hydrofracturing of the ore zone or surrounding units.

To date, there have been several confirmed horizontal excursions in the Chadron sandstone in the current license area. These excursions were quickly detected and recovered through overproduction in the immediate vicinity of the excursion. In all but one case, the reported vertical excursions were actually due to natural seasonal fluctuations in Brule groundwater quality and very stringent upper control limits (UCLs). In no case did the excursions threaten the water quality of an underground source of drinking water (USDW) since the monitor wells are located well within the aquifer exemption area approved by the EPA and the NDEQ. Table 3.11-1 provides a summary of excursions reported for the current license area.

Table 3.11-1: Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM6-6	July 1, 1999	September 23, 1999	Excursion of mining solutions
PR-15	January 13, 2000	March 23, 2000	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM6-18	March 6, 2000	April 11, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
IJ-13	April 20, 2000		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM7-23	April 27, 2000	January 13, 2004	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-28	May 25, 2000	June 22, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-13	May 25, 2000	July 20, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-12	September 8, 2000	November 20, 2000	Surface leak
SM6-13	March 1, 2001	April 12, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
CM5-11	September 10, 2002	May 6, 2003	Excursion of mining solutions
CM6-7	April 4, 2002	April 25, 2002	Excursion of mining solutions
PR-8	December 23, 2003		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
CM5-19	May 2, 2005	July 26, 2005	Excursion of mining solutions
SM6-28	June 16, 2005	July 5, 2005	High water table due to heavy spring rains (unrelated to mining activities)
SM6-12	June 28, 2005	July 26, 2005	High water table due to heavy spring rains (unrelated to mining activities)
CM9-16	August 4, 2005	November 8, 2005	Excursion of mining solutions
CM8-21	January 18, 2006	April 7, 2006	Excursion of mining solutions
PR-15	September 26, 2006		See IJ-13 and PR-8

The long term impacts on groundwater quality should also be minimal, as restoration activities have been shown to be successful in returning the groundwater quality to background or class of use standards. Additionally, there is no mechanism in EPA or NDEQ regulations to "unexempt" an aquifer. Therefore, the groundwater in the immediate mining area will never be used as a USDW. The primary purpose for restoration is to ensure that postmining conditions do not affect adjacent USDWs.

3.11.1.3 Occupational Safety

CBR has an exemplary safety record at the Crow Butte Uranium Project. The company has been recognized on several occasions for this safety record including being named the recipient of the Governor's Safety Award and the Star Award, awarded by the Nebraska Safety Council. The Health and Safety Management System (HSMS) implemented at the project is designed to meet the OHSAS:18001 international HSMS standard.

3.11.2 Radiological Impacts of the Current Licensed Operation

CBR is currently licensed to operate the Crow Butte Uranium Project at a maximum production flow rate of 5000 gpm and a maximum annual production of 2,000,000 pounds U_3O_8. Since the project is an in-situ operation, the particulate emission sources normally associated with the ore crushing and grinding and tailings disposal at a conventional uranium mill are not present. A vacuum dryer is in use at the commercial operation. The vacuum dryer works on the principle that gases or particulates released into the system are collected in a liquid condenser and there is no release of particulates. The effluent collection efficiency for this dryer system is, therefore 100 percent. The only routine radioactive emission is radon-222 (radon) gas.

Radon is present in the ore body and is formed from the decay of radium-226. The radon dissolves in the lixiviant as it travels through the ore body to a production well, when the solution is brought to the surface, the radon is released.

In order to assess the radiological effect of radon on the environment, an estimate of the quantity released during the operation was made in the License Renewal Application submitted to NRC in 1995. Meteorological data and MILDOS-Area (June 1989) are used to predict the ground level air concentration at various points in the environment. The ingrowth of radon daughters is important and their concentration in the soil, vegetation and animals was calculated. Finally, the impact on man from these concentrations of radionuclides in the environment was determined.

Based on the MILDOS-Area results for the current operation, the anticipated effects were not significantly above naturally occurring background levels. This background radiation,

arising from cosmic and terrestrial sources, as well as naturally occurring radon, comprises the primary radiological impact to the environment in the region surrounding the project.

3.11.2.1 Exposures from water pathways

The solutions in the mining zone are controlled and adequately monitored to insure that migration does not occur. The overlying aquifers will also be monitored.

Three commercial evaporation ponds located approximately 2000 feet from the current plant building have been constructed for commercial operation. There are also two R&D evaporation ponds located approximately 1,000 feet from the plant building. The R&D evaporation ponds have a 34-mil Hypalon liner and a leak detection system. The commercial evaporation ponds are lined with double impermeable synthetic liners. The ponds, therefore, are not considered a source of liquid radioactive effluents. There is a leak detection system installed to provide a warning if the liner develops a leak.

The Crow Butte Plant is located on a curbed concrete pad to prevent any liquids from entering the environment. Solutions used to wash down equipment drain to a sump and are pumped to the ponds. The pad is of sufficient size to contain the contents of the largest tank in the event of its rupture.

Since there are no routine liquid discharges of process water from the Crow Butte Central Plant, there are no definable water related pathways.

3.11.2.2 Exposures from Air Pathways

The only source of radioactive emissions from the current operation is radon released into the atmosphere through the plant ventilation systems or from the wellfields. This radon release results in radiation exposure via the inhalation, ingestion, and external exposure pathways. The total effective dose equivalent (TEDE) to nearby residents in the region around the Crow Butte Project was estimated in the 1995 License Renewal Application by using the computer simulation, MILDOS-Area. The joint frequency data compiled from a site-specific meteorological station were used to define the atmospheric conditions in the project area.

Based on the site specific data and method of estimation of the source term, the emission rate of radon-222 from the Crow Butte Project was estimated at 5,937 Curies/yr for a flow of 5,000 gpm in the upflow ion exchange columns in the existing plant. In order to show compliance with the annual dose limit found in 10 CFR §20.1301, CBR demonstrated by calculation that the total effective dose equivalent (TEDE) to the individual most likely to receive the highest dose from the current licensed operation was less than 100 mrem per

year. The dose to the most effected resident was 23.2 mrem/yr (0.232 mSv/yr) or 23.2% of 100 mrem/yr dose constraint.

3.11.2.3 Exposure to Flora and Fauna

The exposure to flora and fauna was evaluated in the Environmental Report submitted in September of 1987 and the doses were found to be negligible.

3.12 WASTE MANAGEMENT

3.12.1 Gaseous and Airborne Particulates

The only radioactive airborne effluent at the current Crow Butte facility is radon-222 gas. Yellowcake processing and drying is carried out using a vacuum dryer with a wet condenser system, thus there are no airborne effluents from this system.

The radon-222 is contained in the pregnant lixiviant that comes from the wellfield into the plant. The majority of the radon-222 is released in the injection surge tanks and in the ion exchange columns. These vessels are covered and vented to the atmosphere. The vents from the individual vessels go into a manifold that is exhausted to atmosphere outside the plant building via an induced draft fan. Venting the radon-222 gas to atmosphere outside the plant minimizes employee exposure. Small amounts of radon-222 may be released via solution spills, filter changes, RO operation, and maintenance activities, but these are minimal releases on an infrequent basis. The exhaust system in the plant further reduces employee exposure. The air in the plant is sampled for radon daughters to assure that concentration levels of radon and radon daughters is maintained as low as reasonably achievable (ALARA).

The type of dryer utilized in the process facility is a vacuum dryer. With this dryer, the yellowcake is dried in a heating chamber that is maintained at negative pressure. Airflow in a vacuum dryer is minimal and is from the outside of the drying chamber into the chamber. Any particulate that may be released goes to a bag filter, with the moisture-laden air going to a closed loop condenser where the water condenses and entrains any remaining particulate. The water is periodically transferred to the yellowcake thickener. With a vacuum dryer, there is no release of particulate by way of a stack since there is no positive airflow. During packaging, the drum is sealed via a gasket to the dryer discharge. As the dryer is operating under vacuum, any leaks around this gasket result in air being drawn into the drum during the packaging of yellowcake, thus no contaminants are released. The air that may enter the discharge to the drum is also routed to the condenser system described above.

If the yellowcake emission control equipment fails to operate within specifications established in standard operating procedures, the drying and packaging room is immediately closed and declared an airborne radiation area. Heating operations are switched to cooldown, or packaging operations are temporarily suspended.

3.12.2 Liquid Waste

As a result of in-situ leach mining process, there are three sources of water that are collected on the site. These water sources include the following:

3.12.2.1 Water generated during well development

This water is recovered groundwater and has not been exposed to any mining process or chemicals. The water is discharged directly to one of the solar evaporation ponds and silt, fines and other natural suspended matter collected during well development is settled out. Well development water may also be treated with filtration and/or reverse osmosis and used as plant make-up water or disposed of in the deep disposal well.

3.12.2.2 Liquid process waste

The operation of the process plant results in two primary sources of liquid waste, an eluent bleed and a production bleed.

3.12.2.3 Aquifer restoration

Following mining operations, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan consists of four activities: 1) Groundwater Transfer, 2) Groundwater Sweep, 3) Groundwater Treatment, and 4) Wellfield Circulation. Only the groundwater sweep and groundwater treatment activities will generate wastewater.

During groundwater sweep, water is extracted from the mining zone without injection causing an influx of baseline quality water to sweep the affected mining area. The extracted water must be sent to the wastewater disposal system during this activity.

Groundwater treatment activities involve the use of process equipment to lower the ion concentration of the groundwater in the affected mining area. A reverse osmosis (RO) unit will be used to reduce the total dissolved solids of the groundwater. The RO unit produces clean water (permeate) and brine. The permeate is either injected into the formation, reused in the process, or disposed of in the waste disposal system. The brine is sent to the wastewater disposal system.

3.12.2.4 Domestic Liquid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the State of Nebraska. These systems are in common use throughout the United States and the effect of the system on the environment is known to be minimal when the systems are designed, maintained, and operated properly. CBR currently maintains a Class V UIC Permit issued by the NDEQ for operation of the septic system at the current license area.

3.12.2.5 Liquid Waste Disposal

Three methods of liquid waste disposal are permitted for use at the Crow Butte Central Plant:

- Deep disposal well injection;
- Evaporation via evaporation ponds; and
- Land application of treated wastewater.

Of these available disposal methods, the current operation relies on the evaporation ponds and the Class I deep disposal well for management of liquid wastes. CBR has not found it necessary to use the land application method at the current operation.

3.12.2.5.1 Deep Disposal Well

CBR operates a non-hazardous Class I injection well in the current license area for disposal of wastewater. The well is permitted under NDEQ regulations in Title 122 and operated under a Class I UIC Permit. CBR has operated the deep disposal well at the current license area for over ten years with excellent results and no serious compliance issues. CBR has found that permanent deep disposal is preferable to evaporation in evaporation ponds.

3.12.2.5.2 Evaporation Pond

Evaporation pond design, installation and operation criteria are those found in USNRC Regulatory Guide 3.11. CBR maintains three commercial and two R & D evaporation ponds in the current license area. The ponds are constructed with a primary and secondary liner system. An underdrain system consisting of perforated piping between the primary and secondary liners is installed to monitor for leaks. The underdrain slopes gradually to the ends of the ponds where they are connected to a surface monitor pipe.

Checking for an increase in measurable moisture inside the leak detection system and/or analyzing the water in the pipe can discover a leak in the pond liner.

The current pond inspection program is based on NRC recommendations in Regulatory Guide 3.11.1 and is approved in SUA-1534. Routine inspections are required as follows.

- Daily Inspections

  Daily inspections consist of checking the pond depth and visually inspecting the pond embankments for slumping, movement, or seepage. The pond depth measurements are checked against the freeboard requirements.

- Weekly Inspections

  Weekly inspections consist of checking the perimeter game-proof fence and restricted area signs, checking the pond inlet piping, making underdrain measurements, checking the pond enhanced evaporation system (if installed), visually inspecting the liner, and measuring the vertical depth of fluid in the pond underdrain standpipes. During periods of seismic activity, flooding, severe rainfall, or other event that could cause the pond to leak, underdrain measurements are taken daily and recorded.

- Monthly Inspections

  During monthly inspections, the waste piping from the plant building to the ponds is visually inspected for signs of seepage indicating a possible pipeline break. Diversion channels surrounding the ponds are examined for channel bank erosion, obstruction to flow, undesirable vegetation, or any other unusual conditions.

- Quarterly Inspections

  Quarterly inspections check for embankment settlement and for irregularities in alignment and variances from originally constructed slopes (i.e., sloughing, toe movement, surface cracking or erosion). Embankments are inspected for any evidence of seepage, erosion, and any changes to the upstream watershed areas that could affect runoff to the ponds. Emergency lines are inspected to ensure that the rope has not deteriorated and the ropes reach to the pond water level.

- Annual Inspection

Technical evaluations of the pond system are performed annually which address the hydraulic and hydrologic capacities of the ponds and ditches and the structural stability of the embankments. A survey of the pond embankments is done and the survey results documented and incorporated into the annual inspection report. The survey is reviewed for evidence of embankment settlement, irregularities in embankment alignment, and any changes in the originally constructed slopes. The technical evaluation is the result of an annual inspection and a review of the weekly, monthly, and quarterly inspection reports by a professional engineer registered in the State of Nebraska. Examination of the pond monitor well sampling data is also completed for signs of seepage in the embankments. The inspection report presents the results of the technical evaluation and the inspection data collected since the last report. The report is kept on file at the site for review by regulatory agencies.

3.12.3 Solid Waste

Any facility or process with the potential to generate industrial waste should practice good housekeeping. This activity generally consists of keeping facilities, equipment, and process areas clean and free of industrial waste or other debris. Good housekeeping includes promptly cleaning any spillage or process residues that are on floors or other areas that could be spread and collecting solid wastes in designated containers or area until proper disposal.

3.12.3.1 Non-contaminated Solid Waste

Non-contaminated solid waste is waste which is not contaminated with 11(e).2 byproduct material or which can be decontaminated and re-classified as non-contaminated waste. This type of waste may include trash, piping, valves, instrumentation, equipment and any other items which are not contaminated or which may be successfully decontaminated. Release of contaminated equipment and materials is discussed in further detail in Section 5 of the Technical Report.

CBR has recently estimated that the current licensed site produced approximately 1,055 cubic yards (yd^3) of non-contaminated solid waste per year. This estimate is based on the number of collection containers on site and the experience of the contract waste hauler. Non-contaminated solid waste is collected on the site in designated areas and disposed of in the nearest permitted sanitary landfill.

3.12.3.2 11(e).2 Byproduct Material

Solid 11(e).2 byproduct waste consists of solid waste contaminated with 11e.(2) byproduct material that cannot be decontaminated.

11(e).2 byproduct material generated at ISL facilities consists of filters, personal protective equipment (PPE), spent resin, piping, etc. CBR has recently estimated that the current licensed site produces approximately 60 to 90 cubic yards (yd^3) of 11(e).2 byproduct material waste per year. This estimate is based on the number of historical number of shipments to the licensed disposal facilities. These materials are stored on site until such time that a full shipment can be shipped to a licensed waste disposal site or licensed mill tailings facility. CBR currently maintains an agreement for waste disposal at a properly licensed facility as a License Condition for SUA-1534. CBR is required to notify NRC in writing within 7 days if the disposal agreement expires or is terminated and to submit a new agreement for NRC approval within 90 days of the expiration or termination.

If decontamination is possible, records of the surveys for residual surface contamination are made prior to releasing the material. Decontaminated materials have activity levels lower than those specified in NRC guidance. An area is maintained inside the restricted area boundary for storage of contaminated materials prior to their disposal.

3.12.3.3 Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms are disposed of in an approved septic system that meets the requirements of the State of Nebraska. Disposal of solid materials collected in septic systems must be performed by companies or individuals licensed by the State of Nebraska. NDEQ regulations for control of these systems are contained in Title 124.

3.12.3.4 Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). In the State of Nebraska, hazardous waste is governed by the regulations contained in Title 128. Based on waste determinations conducted by CBR as required in Title 128, CBR is a Conditionally Exempt Small Quantity Generator (CESQG). To date CBR only generates universal hazardous wastes such as used waste oil and batteries. CBR recently estimated that the current operation generates approximately 1,325 liters of waste oil per year. Waste oil is disposed by a licensed waste oil recycler. CBR has management procedures in place in

EHSMS Program Volume VI, *Environmental Manual* to control and manage these types of wastes.

4 ENVIRONMENTAL IMPACTS

4.1 LAND USE IMPACTS

4.1.1 Land Surface Impacts

The primary surface disturbances associated with solution mining are the sites containing the processing plants and associated facilities including satellite facilities and evaporation ponds. Surface disturbances also occur during the well drilling program, pipeline installation, and road construction. These more superficial disturbances, however, involve relatively small areas or have short-term impacts.

Construction of the North Trend Expansion Area will require disturbance of an estimated 1,310 acres for the satellite facility and associated wellfields. Of this total, approximately 30 acres will be associated with the satellite plant, deep disposal well, and evaporation ponds. Surface disturbances will include construction of access roads, plant site grading, construction of evaporation ponds, and contouring for control of surface runoff.

Due to the relatively minor nature of disturbances created by in-situ mining, there are only a few areas disturbed to the extent to which subsoil and geologic materials are removed, causing significant topographic changes that need backfilling and recontouring. Generally speaking, solar evaporation pond construction results in redistribution of sufficient amounts of subsurface materials, which requires replacement and contour blending during reclamation. The existing contours will only be interrupted in small, localized areas. Because approximate original contours will be achieved during final surface reclamation, no post-mining contour maps have been included in this application.

Changes in the surface configuration caused by construction and installation of operating facilities will be only temporary, during the operating period. These changes will be caused by topsoil removal and storage along with the relocation of subsoil materials used for construction purposes.

These surface impacts are unavoidable and will last for the duration of the project until final decommissioning. Mitigation measures for land surface impacts are discussed in Section 5.1.

4.1.2 Land Use Impacts

The principal land uses for the North Trend Expansion Area and the 2.25-mile review area is grazing livestock. Rangeland accounted for 55.7 percent of the land use in the

North Trend Expansion Area and the review area as discussed in Section 3.1. The secondary land use within this area is cropland, primarily for wheat, although a small proportion is used for alfalfa. Cropland accounted for 29.9 percent of the land use in the North Trend Expansion Area and the review area. Current land use was discussed in detail in Section 3.1.

An unavoidable impact of site preparation, construction, and operation will be the exclusion of cattle and crop production from the areas that are under development. The exclusion of agricultural activities from active mining areas is an unavoidable impact that will last for the duration of the project. For the 1,310-acre proposed wellfield areas, cropland accounts for 1,041.7 acres or 79.5 percent of the total area. Rangeland accounts for 267.9 acres or 20.5 percent of the total area. Figure 4.1-1 depicts the proposed wellfield areas and the current types of land use.

As a result of site preparation and construction, cattle production will be excluded from the areas that are under development. The total estimated area that will be impacted during the course of the project is the 267.9 acres associated with the satellite plant and wellfields. As discussed in Section 3.1, livestock and livestock products had a value of $28.81 per acre, indicating that livestock production on rangeland within the impacted wellfield area has a potential value of more than $7,770.

As a result of site preparation and construction, crop production will be excluded from the areas that are under development. The total estimated cropland area that will be impacted during the course of the project is the 1,041.7 acres associated with the satellite plant and wellfields. In 2001 Dawes County had 77,000 acres harvested for 123,800 tons of hay and 33,700 acres harvested for 1,198,700 bushels of winter wheat. These harvests resulted in yields of 1.6 tons of hay and 35.6 bushels of wheat per acre harvested. Based on these yields, the lost annual crop production in the North Trend Expansion Area would be up to 1,666 tons of hay and up to 37,085 bushels of wheat.

These impacts are considered temporary and reversible by returning the land to its former grazing use through post-mining surface reclamation. Mitigation measures for the loss of agricultural production over the course of the project are discussed in Section 5.1.

Figure 4.1-1: North Trend Wellfield Land Use

Adapt from TR Figure 7.2-1

4.2 TRANSPORTATION IMPACTS

4.2.1 Access Road Construction Impacts

As noted in Section 3.2, Nebraska Highway 2/71 and U.S. Highway 20 converge at Crawford. Nebraska Highway 2/71 lies along the east side of the North Trend Expansion Area. County roads that cross through the North Trend Expansion Area are Moody and Mill Roads. These roads provide access to residences and agriculture within the license area. The county roads are accessed from Highway 2/71.

The Burlington Northern Santa Fe (BNSF) Railroad runs in a northwesterly direction through the west side of the license area. The BNSF rail line along the western boundary is used for combining local "pusher" engines with southbound trains to assist them in climbing the Pine Ridge south of Crawford. This rail line accommodates a significant amount of rail traffic, primarily from the coal mines in northeastern Wyoming.

The DM&E Railroad runs in a northeasterly direction, and forms a portion of the southeast boundary of the license area. The junction of the two railroads is about 0.50 miles south of the license area.

The proposed project will have no impact on railroad operations in the area.

Access roads will need to be constructed from the existing transportation corridors to the North Trend satellite plant. Main access roads will be designed to allow safe access from public roads by employees, contractors, and delivery vehicles. The 2003 average daily traffic count on Nebraska Highway 2/71 at the east side of the North Trend expansion area was 360, so traffic associated with the operation of the proposed facility should not adversely impact existing traffic.

4.2.2 Transportation of Materials

Transportation of materials to and from the North Trend satellite plant is discussed in the following sections:

4.2.2.1 Shipments of construction materials, process chemicals, and fuel from suppliers to the site;

Shipments of construction materials, process chemicals, and fuel from suppliers will be received at the North Trend Satellite Plant. These shipments will generate additional noise in the area as discussed in Section 4.7. Since the site access roads will be surfaced

with gravel, the shipments will also generate additional dust. Air quality impacts and mitigation are discussed in Section 4.6.

Based on the current production schedule and material balance, it is estimated that approximately 150 bulk chemical and fuel deliveries per year will be made to the North Trend Satellite Plant. This averages about one truck per working day for delivery of fuel and chemicals throughout the operational life of the project. Types of deliveries include carbon dioxide, oxygen, soda ash, propane, and motor vehicle fuel.

Additionally, wellfield construction materials will be received periodically throughout the operational phase of the project. These shipments are expected to occur at a frequency of once per month.

4.2.2.2 Shipment of 11(e)2 by-product material from the site to a licensed disposal facility;

Low level radioactive waste or unusable equipment contaminated with 11(e)2 by-product material will be generated during operations and will be transported to a licensed disposal site. Because of the low volume of radioactive 11(e)2 by-product material generated, these shipments will be infrequent (averaging two per year if using roll off containers).

11(e)2 by-product material shipments will be handled as Low Specific Activity (LSA) material. All shipments will comply with all applicable DOT and USNRC regulations governing the transportation of this material.

4.2.2.3 Shipments of uranium-laden resin from the North Trend satellite plant to the central plant and return shipments of barren, eluted resin from the central plant back to the North Trend Satellite Plant;

Resin will be transported to and from the North Trend Satellite Plant in a 4,000 gallon capacity tanker trailer. It is currently anticipated that one load of uranium-laden resin will be transported to the Crow Butte central plant for elution and one load of barren eluted resin will be returned to the North Trend Satellite Plant on a daily basis. The transfer of resin between the two sites will occur on county and private roads. The planned transport route has been designed to avoid travel on U.S. Highway 20 and Nebraska State Highway 2/71. The planned transport route will cross these two highways.

Resin or eluate shipments will be treated similarly to 11(e)2 by-product material shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium laden and barren eluted resin. It is possible that the eluted resin may be clean enough to be transported as non-radioactive material, as defined by DOT regulations. Operating

experience will aid in the determination of the most practical and efficient way of dealing with the shipment of barren resin. Regardless, compliance with all applicable DOT and USNRC regulations will be the primary determining factor.

4.2.2.4 Impacts to Public Roads

The additional traffic generated by construction and operation of the proposed North Trend Expansion Area may result in degradation of public road surfaces. In particular, the additional traffic may adversely impact local gravel roads maintained by Dawes County. These impacts are expected to be minimal since the additional traffic is not significant in comparison with current traffic levels.

Mitigation measures for impacts to public roads are discussed in Section 5.2.

4.3 GEOLOGY AND SOILS IMPACTS

4.3.1 Geologic Impacts

Geological impacts are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the Basal Chadron Sandstone will be on the order of 1% or less, and the anticipated drawdown over the life of the project is expected to be on the order of 10% of the available head, or less. Further, once mining and restoration operations are completed and restoration approved, groundwater levels will return to near original conditions under a natural gradient.

If the White River structural feature is in fact a fault, changes in aquifer pressure potentially could impact activity related to the fault and the transmissive characteristics of the fault (e.g., resistance to flow). There are numerous documented cases where injection in the immediate vicinity of a fault has caused an increase in seismic activity. However, such response typically occurs when injection operations have increased the pressure in the aquifer by a significant amount (e.g., 40 to 200 percent pressure increase over initial conditions). The pressure in the Basal Chadron will be increased by localized scale by injection operations during mining and restoration operations, and will be more than offset by production within each wellfield pattern.

4.3.2 Soil Impacts

Construction of the facilities at the North Trend site will affect soils. Effects to soils would be significant on approximately 30 fenced acres of the 1,310 acres that will be disturbed by construction of the North Trend Satellite Plant and associated facilities. Much of the remaining 1,280 acres will be devoted to wellfield production where effects to soils would be much lower.

The severity of soil impacts would depend on the number of acres disturbed and the type of disturbance. Potential impacts include soil loss, sedimentation, compaction, salinity, loss of soil productivity, and soil contamination. Effects to soils at the North Trend site would result from the clearing of vegetation, excavating, leveling, stockpiling, compacting, and redistributing soils during construction and reclamation. Disturbance related to the construction and operation of the North Trend site would be long-term, lasting for the duration of the project.

Wind erosion is a concern at the North Trend site. Various soils meet the criteria for severe wind erosion hazard (USDA, 1977). These soils have one or more major constituents that are fine sand or sandy loam that can easily be picked up and spread by wind. Construction presents the greatest threat to soils with potential for wind erosion. Wind erosion will be controlled by removing vegetation only where it is necessary, avoiding clearing and grading on erosive areas, surfacing roads with gravel, and timely reclamation.

Water erosion is also a concern at the North Trend site. Various soils meet the criteria for severe water erosion hazard (USDA, 1977). These soils have low permeability and high K-factors, making them susceptible to water erosion. The K-factor is used to describe a soil's erodibility; it represents both susceptibility of soil to erosion and the rate of runoff. It is calculated from soil texture, organic matter, and soil structure. Construction and operation would increase soil loss through water erosion. Removal of vegetation for any activity exposes soils to increased erosion. Excavation could break down soil aggregates, increasing runoff and gully formation. Soil loss will be reduced substantially by avoiding highly erosive areas such as badlands and steep drainages. Locating roads in areas where cuts and fills would not be required, surfacing roads, installing drainage controls, and reseeding and installing water bars across reclaimed areas will also aid in reducing soil loss.

Sedimentation in streams and rivers at the North Trend site could result from soil loss. Sedimentation could alter water quality and the fluvial characteristics of drainages in the area. Installation of appropriate erosion control measures as required by CBR's Construction Stormwater NPDES authorization (see Section 4.4) and avoidance of erosive soils will aid in reducing sedimentation.

Activity on the site has the potential to compact soils. While soils sensitive to compaction, such as clay loams, do not exist on the site, the intense volume and degree of

activity at the North Trend site could damage soil properties and cause compaction. Compaction of the soils could decrease infiltration, promoting high runoff. If compaction occurs, reduced infiltration capacity could persist for over 50 years in some soils. Construction and traffic will be minimized where possible, and soils will be loosened for reseeding during reclamation to control the effects of soil compaction.

Any soil on the site can be saline depending on site-specific soil conditions, such as permeability, clay content, quality of nearby surface waters, plant species, and drainage characteristics. Saline soils are extremely susceptible to soil loss caused by development. Soil erosion in areas with high salt content would contribute to salinity in the White River Basin. Reclamation of saline soils can be difficult, and no method that works in all situations has yet been found.

Facility development would displace topsoil, which would adversely affect the structure and microbial activity of the soil. Loss of vegetation would expose soils and could result in a loss of organic matter in the soil. Excavation could cause mixing of soil layers and breakdown of the soil structure. Removal and stockpiling of soils for reclamation could result in mixing of soil profiles and loss of soil structure. Compaction of the soil could decrease pore space and cause a loss of soil structure as well. This would result in a reduction of natural soil productivity.

A number of erosion and productivity problems resulting from the North Trend site may cause a long-term declining trend in soil resources. Long-term impacts to soil productivity and stability would occur as a result of large-scale surface grading and leveling, until successful reclamation would be accomplished. Reduction in soil fertility levels and reduced productivity would affect diversity of reestablished vegetative communities. Moisture infiltration would be reduced, creating soil drought conditions. Vegetation would undergo physiological drought reactions.

Surface spillage of hazardous materials could occur at the North Trend site. If not remediated quickly, these materials have the potential to adversely impact soil resources. In order to minimize potential impacts from spills, a Spill Prevention, Control, and Countermeasure (SPCC) Plan will be implemented. The SPCC plan will include accidental discharge reporting procedures, spill response, and cleanup measures.

4.4 WATER RESOURCES IMPACTS

4.4.1 Surface Water Impacts of Construction

When stormwater drains off a construction site, it carries sediment and other pollutants that can harm lakes, streams and wetlands. The U.S. Environmental Protection Agency (EPA) estimates that 20 to 150 tons of soil per acre is lost every year to stormwater

runoff from construction sites. For this reason, stormwater runoff is controlled by National Pollutant Discharge Elimination System (NPDES) regulations.

Construction activities at the Crow Butte Project to date have had a minimal impact on the local hydrological system. CBR conducts construction activities under NDEQ permitting regulations for control of construction stormwater discharges contained in Title 119. CBR is required by NDEQ General Construction Stormwater NPDES Permit NER 100000 to implement procedures that control runoff and the deposition of sediment in surface water features during construction activities. These procedures are contained in EHSMS Volume VI, *Environmental Manual,* and require active engineering measures, such as berms, and administrative measures, such as work activity sequencing to control runoff and sedimentation of surface water features. CBR must annually submit a construction plan for the coming year and obtain authorization from the NDEQ under the general permit.

In addition to the administrative and engineering controls routinely implemented by CBR, it is expected that surface water impacts from initial site preparation and construction of the North Trend Satellite Plant and related facilities will be minimal since there are no nearby surface water features.

4.4.2 Surface Water Impacts of Operations

4.4.2.1 Surface Water Impacts from Sedimentation

Protection of surface water from stormwater runoff during on-going wellfield construction related to operations is regulated by the NDEQ as discussed in Section 4.4.1.

4.4.2.2 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as an evaporation pond leakage or failure or an uncontrolled release of process liquids due to a wellfield accident. Section 4.4.3.3 discusses the operation of the ponds and measures to prevent and control wellfield spills. An additional measure to protect surface water is that wellfield areas are installed with dikes or berms to prevent spilled process solutions from entering surface water features. Process buildings are constructed with secondary containment, and a regular program of inspections and preventive maintenance is in place. In addition to the administrative and engineering controls routinely implemented by CBR, it is expected that surface water impacts from potential accidents at the North Trend Satellite Plant and related facilities will be minimal since there are no nearby surface water features.

4.4.3 Groundwater Impacts of Operations

Potential impacts to water resources from mining and restoration activities include the following.

4.4.3.1 Groundwater Consumption

As discussed in Section 3.4, a regional pump test has been conducted to assess the hydraulic characteristics of the Basal Chadron Sandstone, and overlying confining units. Pump tests also will be performed for each mine unit to demonstrate hydraulic containment above the production zone, demonstrate communication between the production zone mining and exterior monitor wells, and to further evaluate the hydrologic properties of the Basal Chadron Sandstone.

A full and detailed analysis of the potential impacts of the mining operations at North Trend on surrounding water users will be provided in an Industrial Groundwater Use Permit application required by NDEQ. A similar permit application was submitted to NDEQ by Ferret Exploration of Nebraska (predecessor to Crow Butte Resources) in 1991, and that application provides a reasonable analogy between the current licensed area and North Trend. The application states that water levels in the City of Crawford (approximately three miles northwest of the mining area) could potentially be impacted by approximately 20 feet by consumptive withdrawal of water from the Basal Chadron Sandstone during mining and restoration operations (based on a 20-year operational period).

A similar order of magnitude impact (drawdown) likely exists for the North Trend operations. No impact to other users of groundwater is expected because: (1) there is no documented existing use of the Basal Chadron in the proposed North Trend expansion area; and, (2) the potentiometric head of the Basal Chadron Sandstone in the North Trend expansion area ranges from approximately 10 to more than 50 feet above ground surface.

Because the Basal Chadron Sandstone (production zone) is a deep confined aquifer, no surface water impacts are expected. As discussed in Sections 3.3 and 3.4, the outcrop of the Basal Chadron Sandstone is more than 10 miles north of the North Trend Expansion Area. As discussed in Section 3.4.1, there is no use of the Basal Chadron Sandstone in the North Trend Expansion Area; in this regard, the nearest use of the Basal Chadron is outside the proposed license boundary in the southeast quarter of Section 34 (livestock and lawn watering). The only Basal Chadron well within a 2-mile radius of the proposed license boundary that potentially could be used for drinking water purposes is Well No. 61 (Anders).

Further, the geologic and hydrologic data presented in Sections 3.3 and 3.4, respectively, demonstrate that (1) the occurrence of uranium mineralization is limited to the Basal Chadron Sandstone; and, (2) the Basal Chadron is isolated from underlying and overlying sands. Hence, the mining operations are expected to impact water quality only in the Basal Chadron Sandstone, and restoration operations will be conducted in the Basal Chadron following completion of mining.

Based on a bleed of 0.5% to 1.5%, which has been successfully applied in the current licensed area, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99%) of groundwater used in the mining process will be treated and re-injected (Figure 1-18). Potential impacts on groundwater quality due to consumptive use outside the license area are expected to be negligible.

Because of the uncertainty regarding the impact of the White River structural feature on groundwater flow in the Basal Chadron Sandstone, strict quantification of the mining impacts is difficult until more detailed information related to this feature isavailable.

To generally quantify the potential impact of drawdown due to mining and restoration operations, the following assumptions were used:

- Mining/restoration life: 20 years
- Average net consumptive use: 50 gpm
- Location of pumping centroid: Center of Section 27 (Mine Unit NT-1)
- Observation radius: 2-3 miles radially from centroid of pumping
- Formation transmissivity 60 ft^2/d
- Formation thickness 26 feet
- Formation hydraulic conductivity 2.3 ft/d
- Formation storativity 5.3×10^{-5}

The data were evaluated using a Theis semi-steady state analytical solution, which includes the following assumptions:

- The aquifer is confined and has apparent infinite extent;
- The aquifer is homogeneous and isotropic, and of uniform effective thickness over the area influenced by pumping;
- The piezometric surface is horizontal prior to pumping;
- The well is pumped at a constant rate;
- No recharge to the aquifer occurs;
- The pumping well is fully penetrating; and,
- Well diameter is small, so well storage is negligible.

Based on these assumptions and results from the North Trend Pump Test, drawdown after 20 years of operation at 2- and 3-mile radial distances from the centroid of pumping were estimated to be 65 and 55 feet, respectively. This amount of drawdown is approximately 10 percent of the available drawdown in the Basal Chadron Sandstone. It is noted that, because of lack of definitive data regarding the White River structural feature and variability of the Basal Chadron Sandstone at North Trend, some of the assumptions used in this calculation may not apply. In this regard, it is anticipated that a much more detailed quantitative analysis will be performed as part of the Industrial Groundwater Permit application, and that CBR will obtain data that will fully define the White River structure.

As discussed in Section 6 of this Environmental Report, an extensive water-sampling program will be conducted prior to, during and following mining operations at the North Trend facility to identify any potential impacts to water resources of the area.

Water level measurements will be routinely performed in the production zone and overlying aquifer. Sudden changes in water levels within the production zone may indicate that the wellfield flow system is out of balance. Flow rates would be adjusted to correct this situation. Increases in water levels in the overlying aquifer may be an indication of fluid migration from the production zone. Adjustments to well flow rates or complete shut down of individual wells may be required to correct this situation. Increases in water levels in the overlying aquifer may also be an indication of casing failure in a production, injection or monitor well. Isolation and shut down of individual wells can be used to determine the well causing the water level increases.

To ensure the leach solutions are contained within the designated area of the aquifer being mined, the production zone and overlying aquifer monitor wells will be sampled once every two weeks as discussed in Section 6.

These impacts are unavoidable aspects of solution mining. No mitigative measures have been identified.

4.4.3.2 Impacts on Groundwater Quality

Solution mining of a mineral deposit is accomplished by reversing the natural processes that deposited the uranium. The native formation waters in the ore zones in the Basal Chadron aquifer are not recommended for human consumption because of naturally high levels of dissolved radioactive materials (uranium and Ra-226). In addition to uranium, other metals will mobilize by the mining process. This process affects the mining zone, which must be exempted from Clean Water Act protections by the NDEQ and the EPA under the aquifer exemption provisions of the State and Federal UIC regulations.

Excursions represent a potential effect on the adjacent groundwater as a result of operations. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality in the exempted aquifer compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, and hydrofracturing of the ore zone or surrounding units.

To date, there have been several confirmed horizontal excursions in the Chadron sandstone in the current license area. These excursions were quickly detected and recovered through overproduction in the immediate vicinity of the excursion. In all but one case, the reported vertical excursions were actually due to natural seasonal fluctuations in Brule groundwater quality and very stringent upper control limits (UCLs). In no case did the excursions threaten the water quality of an underground source of drinking water since the monitor wells are located well within the aquifer exemption area approved by the EPA and the NDEQ. Table 4.4-1 provides a summary of excursions reported for the current license area.

Table 4.4-1: Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM6-6	July 1, 1999	September 23, 1999	Excursion of mining solutions
PR-15	January 13, 2000	March 23, 2000	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM6-18	March 6, 2000	April 11, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
IJ-13	April 20, 2000		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM7-23	April 27, 2000	January 13, 2004	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-28	May 25, 2000	June 22, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-13	May 25, 2000	July 20, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-12	September 8, 2000	November 20, 2000	Surface leak
SM6-13	March 1, 2001	April 12, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
CM5-11	September 10, 2002	May 6, 2003	Excursion of mining solutions
CM6-7	April 4, 2002	April 25, 2002	Excursion of mining solutions
PR-8	December 23, 2003		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
CM5-19	May 2, 2005	July 26, 2005	Excursion of mining solutions
SM6-28	June 16, 2005	July 5, 2005	High water table due to heavy spring rains (unrelated to mining activities)
SM6-12	June 28, 2005	July 26, 2005	High water table due to heavy spring rains (unrelated to mining activities)
CM9-16	August 4, 2005	November 8, 2005	Excursion of mining solutions
CM8-21	January 18, 2006	April 7, 2006	Excursion of mining solutions
PR-15	September 26, 2006		See IJ-13 and PR-8

Mitigative measures for impacts on groundwater quality are discussed in Section 5.3.

4.4.3.3 Potential Groundwater Impacts from Accidents

Groundwater quality could potentially be impacted during operations due to an accident such as evaporation pond leakage or failure, or an uncontrolled release of process liquids due to a wellfield accident. If there should be an uncontrolled pond leak or wellfield accident, potential contamination of the shallow aquifer (Brule), as well as surrounding soil, could occur. This could occur as a result of a slow leak or a catastrophic failure, a shallow excursion, an overflow due to excess production or restoration flow, or due to the addition of excessive rainwater or runoff.

To mitigate the likelihood of pond failure, all ponds at North Trend will be designed and built to NRC standards using impermeable synthetic liners. A leak detection system will also be installed, and all ponds will be inspected on a regular basis. In the event that a problem is detected, the contents of any given pond can be transferred to another pond while repairs are made. The proposed pond design and operation is discussed in greater detail in Sections 3.12 and 4.13.2.2.2.

Over the course of the current licensed operation, CBR has experienced several leaks associated with the inner pond liner on the commercial evaporation ponds. These small leaks are virtually unavoidable since the liners are exposed to the elements. In each case these leaks were quickly discovered during routine inspections, primarily due to a response in the underdrain system. Corrective actions included lowering the pond level and locating the leak to allow repairs. In none of these situations was the shallow groundwater affected since the outer pond liner functioned as designed and prevented a release of the pond contents. All pond leaks, causes, and corrective actions are reported to the NRC and the NDEQ.

With respect to potential overflow of a pond, current standard operating procedures require that pond levels be closely monitored as part of the daily inspection. Process flow to the ponds will be minimal in comparison to the pond capacity, thus it can easily be diverted to another pond if necessary. In addition, sufficient freeboard will be maintained on all ponds to allow for a significant addition of rainwater with no threat of overflow. Finally, the dikes and berms around the ponds will channel runoff away from the ponds.

Another potential cause of groundwater impacts from accidents could be releases as a result of a spill of injection or production solutions from a wellfield building or associated piping. In order to control these types of releases, all piping is either PVC, high density polyethylene with butt welded joints, or equivalent. All piping is leak tested prior to production flow and following repairs or maintenance.

4.5 ECOLOGICAL RESOURCES IMPACTS

4.5.1 Impact Significance Criteria

The following criteria were used to determine the significance of construction and operation of the proposed project on wildlife and vegetation resources within the project area. These criteria were developed based on professional judgment, involvement in other NEPA projects throughout the West, and state and federal regulations.

- Removal of vegetation such that following reclamation, the disturbed area(s) would not have adequate cover (density) and species composition (diversity) to support pre-existing land uses, including wildlife habitat;
- Unauthorized discharge of dredged or fill materials into, or excavation of, waters of the U.S., including special aquatic sites, wetlands, and other areas subject to the Section 404 of the Clean Water Act, Executive Order 11988-flood plains, and Executive Order 11990 - wetlands and riparian zones;
- Reclamation is not accomplished in compliance with Executive Order 13112 (Invasive Species);
- Introduction and establishment of noxious or other undesirable invasive, non-native plant species to the degree that such establishment results in listed invasive, non-native species occupying any undisturbed rangeland outside of established disturbance areas or hampers successful revegetation of desirable species in disturbed areas;
- Whether or not a substantial increase in direct mortality of wildlife caused by road kills, harassment, or other causes would occur;
- Incidental take of a special-status species to the extent that such impact would threaten the viability of the local population;
- Whether or not an officially-designated critical wildlife habitat was eliminated, sustained a permanent reduction in size, or was otherwise rendered unsuitable;
- Whether or not any effect, direct or indirect, results in a long-term decline in recruitment and/or survival of a wildlife population; and
- Construction disturbance during the breeding season or impacts to reproductive success which could result in the incidental loss of fertile eggs or nestlings, or otherwise lead to nest abandonment in accordance with regulations prescribed by the Migratory Bird Treaty Act.

4.5.2 Vegetation

As described in detail in Section 1, a total of 9 wellfields and the satellite processing facility will be constructed during the next 11 years with an expected mine life operation

of 15 years. Well placement within the project area is not known at this time; however, it was assumed that agricultural fields within Sections 21, 22, 27, 28, 33, and 34 (Township 32N, Range 52W) will be developed and contain a significant amount of project-related infrastructure. Production facilities are not anticipated to be constructed within the mixed-grass prairie vegetation community, which is primarily located in the north ½ of Section 21 (Township 32N, Range 52W).

Direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types) from soil disturbance and grading. Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; and changes in visual aesthetics.

Vegetation removal and soil handling associated with the construction and installation of wellfields, pipelines, access roads, and satellite facilities would affect vegetation resources both directly and indirectly. However, because most project-related infrastructure will be constructed within cultivated agricultural fields, vegetation impacts will be negligible. If the mixed-grass prairie vegetation community were to be developed, direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types). Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; reduction in livestock forage; and changes in visual aesthetics.

During the anticipated life of the project (15 to 18 years), an estimated 1,041.7 acres of cultivated agricultural fields would be affected by surface-disturbing production facilities. The likelihood of impact is greatest for the primary vegetation cover types of cultivated fields, which occupies 62 percent of the total impacted area. As stated above, clearing of mixed-grass prairie vegetation community types is not anticipated.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the project area. Non-native species invasion and establishment has become an increasingly important result of previous and current disturbance in western states. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with surrounding undisturbed vegetation. Currently, the project area is relatively free of noxious and other unwanted invasive, non-native species.

In general, the duration of effects on cultivated agricultural land and mixed-grass prairie vegetation are significantly different. Cropland areas can be readily returned to production through fertilizer treatments and compaction relief. However, disturbed native prairie tracts require reclamation treatments and natural succession to return to predisturbance conditions of diversity (both species and structural). Reestablishment of mixed-grass prairie to predisturbance conditions would be influenced by climate (growing season, temperature, and precipitation patterns) and edaphic (physical, chemical, and biological) conditions in the soil.

Previously planted agricultural fields would be recontoured to approximate precontours and ripped to depths of 12 to 18 inches to relieve compaction. If mixed-grass prairie tracts were disturbed by surface activities, these areas would be completely reclaimed. Reclamation of mixed-grass prairie would generally include: (1) completing cleanup of the disturbed areas (wellfields and access roads); (2) restoring the disturbed areas to the approximate ground contour that existed before construction; (3) replacing topsoil, if removed, over all disturbed areas; (4) ripping disturbed areas to a depth of 12 to 18 inches; and (5) seeding recontoured areas with a locally adapted, certified weed-free seed mixture.

4.5.3 Surface Waters and Wetlands

Surface disturbances associated with the proposed facilities would not affect either Spring Creek or the White River. In addition, no wetlands have been identified within the project area. Therefore, impacts to wetlands and surface waters are not anticipated.

4.5.4 Wildlife and Fisheries

The effects on wildlife would be associated with construction and operation of project facilities, which include displacement of some individuals of some wildlife species, loss of wildlife habitats, and an increase in the potential for collisions between wildlife and motor vehicles. Other potential effects include a rise in the potential for illegal kill, harassment, and disturbance of wildlife because of increased human presence primarily associated with increased vehicle traffic. The magnitude of impacts to wildlife resources would depend on a number of factors, including the time of year, type and duration of disturbance, and species of wildlife present.

4.5.5 Small Mammals and Birds

The direct disturbance of wildlife habitat in the project area likely would reduce the availability and effectiveness of habitat for a variety of common small mammals, birds, and their predators. The initial phases of surface disturbance and increased noise would

result in some direct mortality to small mammals and would displace some bird species from disturbed areas. In addition, a slight increase in mortality from increased vehicle use of roads in the project area would be expected.

The temporary disturbances that occur during the construction period would tend to favor generalist wildlife species such as ground squirrels and horned larks, and would have more impact on specialist species such as western meadowlarks, lark buntings, and grasshopper sparrows. Overall, the long-term disturbance of 1,310 acres would have a low effect on common wildlife species. Songbirds that may be affected by the reduction in cultivated fields would be horned larks, sage sparrows, sage thrashers, and vesper sparrows. Although there is no way to accurately quantify these changes, the impact is likely to be low in the short term and be reduced over time as reclaimed areas begin to provide suitable habitats.

Because of the high reproductive potential of these species, they would rapidly repopulate reclaimed areas as habitats become suitable. Birds are highly mobile and would disperse into surrounding areas and utilize suitable habitats to the extent that they are available. The primary small mammals found on the project area include, but are not limited to, eastern cottontail, deer mice, thirteen-lined ground squirrel, white-footed mouse, meadow jumping mouse, and northern pocket mouse. The initial phases of surface disturbance would result in some direct mortality and displacement of small mammals from construction sites. Quantifying these changes is not possible because population data are lacking. However, the impact is likely to be low, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area once reclamation efforts are initiated.

4.5.6 Big Game Mammals

The principal wildlife impacts likely to be associated within the project area include: (1) a direct loss of certain wildlife habitat; (2) the displacement of some wildlife species; (3) an increase in the potential for collisions between wildlife and motor vehicles; and, (4) an increase in the potential for the illegal kill and harassment of wildlife.

In general, direct removal of habitat used by big game mammals is expected to be minimal, as the project area is predominantly used for agricultural production. Because a substantial proportion of the project area is used for seasonal crop production, only a small proportion of the available wildlife habitat in the project area would be affected. The capacity of the project area to support big game populations should remain essentially unchanged from current conditions.

In addition to the direct removal of habitat because of the development of wells and associated satellite facilities, disturbances from drilling activities and traffic would affect

utilization of the habitat immediately adjacent to these areas; however, big game mammals are adaptable and may adjust to non-threatening, predictable human activity. It is envisioned that most big game mammal responses will consist of avoidance of areas proximal to the operational facilities, with most individuals carrying out normal activities of feeding and bedding within adjacent suitable habitats. In addition, the magnitude of displacement would decrease over time as: (1) the animals have more time to adjust to the operational circumstances; and, (2) the extent of the most intense activities such as drilling and road building diminishes and the wellfields are put into production. By the time the wellfields are under full production, construction will have ceased, and traffic and human activities in general would be greatly reduced. As a result, this impact would be minimal and it is unlikely that big game mammals would be significantly displaced under full field development. The level of big game mammal use of the project area is more likely to be determined by the quantity and quality of forage available.

The potential for vehicle collisions with big game mammals would increase as a result of increased vehicular traffic associated with the presence of construction crews and would continue (although at a reduced rate) throughout all phases of the wellfield operations. Development of new roads would allow greater access to more areas and may lead to an increased potential for poaching of big game animals; however, because of the proximity to Crawford and locations of farm residences in the project area, the incidence of vehicle collision impacts to big game mammals is anticipated to occur infrequently and no long-term adverse effects are expected.

Based on the foregoing, long-term adverse effects are not expected for any local big game mammal populations.

4.5.7 Upland Game Birds

The potential effects of the operation and maintenance of project facilities on upland game birds may include nest abandonment and reproductive failure caused by project-related disturbance and increased noise. Other potential effects involve increased public access and subsequent human disturbance that could result from new construction and production activities.

4.5.8 Sharp-tailed Grouse

No sharp-tailed grouse leks are known to occur within the project area. However, noise related to drilling and production activities may affect sharp-tailed grouse utilization of leks or reproductive success. Reduction of noise levels in areas near leks would minimize this potential impact. If leks are found, surface disturbance should be avoided within 0.25 miles of leks. If disturbance within the buffer areas is avoided, no impacts are expected.

Areas with large tracts of mixed-grass prairie would provide the best quality nesting habitat. To protect sharp-tailed grouse nesting habitats, construction should be limited within a 1-mile radius of an active lek between March 1 and June 30. Significant impacts to leks and subsequent reproductive success are not expected if these guidelines are implemented.

4.5.9 Raptors

Potential impacts to raptors within the project area include: (1) nest desertions or reproductive failure as a result of project activities and increased public access; (2) temporary reductions in prey populations; and, (3) mortality associated with roads.

The primary potential impact to raptors from project activities is disturbance during nesting that might result in reproductive failure. To minimize this potential, construction would not be allowed during the critical nesting season (Feb. 1 - July 31, depending on species) within 0.5 mile of an active nest of listed or sensitive raptor species, and 0.25 mile (depending on species or line of sight) of an active nest of other raptor species. The nature of the restrictions, exclusion dates, and the protection radii would vary, depending on activity status of nests, species involved, and natural topographic barriers, and line-of-sight distances should be developed in coordination within the Nebraska Game and Parks Commission (NGPC) or the U.S. Fish and Wildlife Service (USFWS).

Nests not used in 1 year, may potentially be used in subsequent years. Subsequent development within close proximity to these nests may preclude use of the nest in following years. Therefore, protection of nests that may potentially be used in the future may require limiting construction within 300 meters (depending on species or line of sight) to minimize impacts. If "take" of an inactive nest were unavoidable, development of artificial nesting structures would mitigate for the loss of the nest. In some instances, during the production phase when human activity is reduced, raptors may actually nest on artificial above-ground structures. Based on the foregoing, significant impacts to raptor nesting activities are not expected.

The development of proposed wellfield and satellite facilities would disturb an estimated 1,310 acres of potential habitat for several species of small mammals that serve as prey for raptors. This short-term impact would affect approximately 62 percent of the proposed license area, although this is not likely to limit raptor use within the project area. The small amount of short-term change in prey base populations created by construction is minimal in comparison to the overall status of the rodent and lagomorph populations. While prey populations on the project area would likely sustain some impact during the initial phase of the project, prey numbers would be expected to soon rebound to pre-disturbance levels following reclamation or active agricultural uses. Once reclaimed or in active agricultural uses, these areas would likely promote an increased

density and biomass of small mammals that is comparable to those of undisturbed areas. For these reasons, implementation of the project is not expected to produce any appreciable long-term negative changes to the raptor prey base within the project area.

The creation of new roads would increase public access to areas within the project area. As use of the project area increases, the potential for encounters between raptors and humans would increase and could result in increased disturbance to nests and foraging areas. Closure of roads located near active raptor nests to public vehicle use would offset this potential impact. Some raptor species feed on road-killed carrion on and along the roads, while others (owls) may attempt to capture small rodents and insects that are illuminated in headlights. These raptor behaviors put them in the path of oncoming vehicles where they are in danger of being struck and killed. The potential for such collisions can be reduced by requiring drivers to follow all posted speed limits.

4.5.10 Fish and Macroinvertebrates

Suitable habitat for fish and macroinvertebrates exists within portions of Spring Creek and the White River. However, the construction, operation, and maintenance of the project is not expected to affect either of these habitats.

4.5.11 Threatened and Endangered Species

4.5.11.1 Bald Eagle (Federal Threatened)

Nebraska's wintering bald eagle population is highly variable, ranging from 409 in 1984 to 1,292 in 1992, with an average of 714 bald eagles counted in Nebraska during the annual midwinter surveys between 1980 and 1993 (NGPC). Most of the wintering bald eagle population is found in close association with open water. However, bald eagles are known to occasionally occur in this region, primarily during the winter months (November through March). However, no bald eagle nests are known to occur within the project area. Moreover, no winter concentration areas or winter nighttime roosts have been documented within the project area (Fritz, 2004).

Based on our analysis of the effects of project implementation and the current and potential status of this species in northwestern Nebraska, we conclude that the proposed alternative will have no adverse effect on the bald eagle.

4.5.11.2 Swift Fox (State Endangered)

The swift fox is widely distributed throughout the Great Plains and there are small, disjunct populations in the western third of Nebraska and Kansas (USFWS, 1995). There is high-quality swift fox habitat present within the Oglala National Grassland immediately northwest of the project area. In addition, swift fox are closely linked with lagomorph populations, prairie dog colonies, ground squirrels, and other small mammals, which exist in varying densities and abundance throughout the project area.

Based on our analysis of the effects of project implementation, the current and potential status of this species in the project area, and more suitable habitats in the region, we conclude that the proposed project will have no adverse effect on the swift fox.

4.5.11.3 Reptiles, Amphibians, and Fish

No threatened or endangered reptiles, amphibians, or fish species have been recorded in the project area, and none are expected to occur.

4.5.12 Cumulative Impacts

Cumulative impacts to ecological resources are not anticipated, as no substantive impairment of ecological stability or diminishing of biological diversity is expected within the project area.

4.6 AIR QUALITY IMPACTS

Construction activities at the North Trend expansion area would cause minimal effects on local air quality. Effects to air quality would be increased suspended particulates from vehicular traffic on unpaved roads, in addition to existing fugitive dust caused by wind erosion, and diesel emissions from construction equipment. The application of water to unpaved roads would reduce the amount of fugitive dust to levels equal to or less than the existing condition. Diesel emissions from construction equipment are expected to be short term only, ceasing once the operational phase begins.

The primary new emission source of non-radiological pollutants will be tailpipe emissions of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), non-methane-ethane volatile organic compounds (VOC), and particulate matter with a diameter less than ten micrometers (PM_{10}) resulting from vehicle traffic within the North Trend expansion area. Approximately 6-8 vehicle trips per day (VTPD) are anticipated as part of regular operations. These vehicles are expected to be light duty pick-up style

trucks. Heavy equipment in the form of drill rigs, equipment haulers, or water trucks will be used as necessary and are anticipated to average less than one VTPD. These emissions are expected to be minor and should not affect the local ambient air quality.

Although there are no ambient air quality monitoring data for these non-radiological pollutants in the permit area, PM_{10} concentrations have been measured in Rapid City, South Dakota and Badlands National Park in South Dakota. Both locations are geographically similar to the permit area.

The Rapid City data were collected at the National Guard Camp Armory site about 2 miles west of the city. This area is classified as suburban. The Badlands data were collected in an area classified as rural. Because of the degree of urbanization, the air quality at the permit area would probably fall somewhere between the air quality at these two locations. These data were obtained from the United States Environmental Protection Agency (USEPA) air quality monitoring database (USEPA, 2007), and are presented in Table 4.6-1.

The National Ambient Air Quality Standards (NAAQS) for PM_{10} are 150 micrograms per cubic meter (24-hour average), and 50 micrograms per cubic meter (annual average). All counties within the 80-km radius of the project are in attainment of NAAQS.

TABLE 4.6-1
PM_{10} MONITORING SUMMARY
(MICROGRAMS PER CUBIC METER)

Year	Maximum 24-hr Average		Annual Average	
	Black Hills, SD	Rapid City, SD	Black Hills, SD	Rapid City, SD
1998	-	87.4	-	30.7
1999	-	116.9	-	28.2
2000	38.5	97.4	12.0	31.3
2001	47.9	81.5	12.6	34.6
2002	26.0	104.7	9.9	34.9
2003	74.4	91.8	16.3	36.2
2004	24.0	72.0	10.0	30.0
2005	40.0	94.00	9.0	27.0
2006	30.0	124.0	10.0	29.0

There will be an increase in the total suspended particulates (TSP) in the region as a result of the North Trend Expansion Area. This increase in TSP will be greatest during the site preparation phase of the satellite facility. Revegetation will be performed where possible to mitigate the problems associated with the resuspension of dust and dirt from disturbed areas. All areas disturbed during construction are revegetated with the exception of plant pad areas, roads, and areas covered by the pond liners. Of these, the only significant source of TSP is dust emissions from unpaved roads. The amount of dust can be estimated from the following equation taken from "Supplement No. 8 For Compilation of Air Pollutant Emission Factors" (USEPA, 1978).

$$E = (0.81s)\ \frac{S}{30}\ \frac{365 - w}{w}$$

Where:

E	=	emission factor, lb per vehicle-mile
s	=	silt content of road surface material, 40%
S	=	average vehicle speed
w	=	mean number of days with 0.01 inches or more of rainfall, 85

Using the values stated above, the emission factor is equal to 0.27 lb/vehicle-mile. The distance from the town of Crawford to the North Trend Satellite Plant is approximately 7.6 miles. Approximately 4 miles of this distance is on improved roads and 3.6 miles is on dirt or trail roads. CBR expects that most employees at the North Trend Satellite Plant will be from the town of Crawford. Assuming ten employees and a 7-day workweek, there would be 140 trips per week and the weekly mileage on dirt or trail roads would be 504 miles. Deliveries and other travel may require up to 50 trips per week, which would be an additional 360 miles per week on dirt or trail roads.

The distance from the satellite plant to the Crow Butte Central Plant is 8.1 miles of which 7.1 miles are on dirt or trail roads. Assuming a conservative 2 trips per day for resin transfer and an additional 10 trips per day for plant personnel traveling between the sites, the total mileage on dirt or trail roads will be approximately 1200 miles per week. This estimate is based on a 7-day workweek.

The total travel on dirt and trail roads for personnel, resin transfer, deliveries and incidental travel will be approximately 2,060 miles per week. With an emission factor of 0.27 lb. TSP per vehicle-mile there will be a total dust emission of approximately 14.5 tons per year as a result of increased traffic on dirt and trail roads.

Any increase in fugitive dust emissions resulting from operational activities within the North Trend Expansion Area would be minimal.

Mitigation measures for air quality impacts are discussed in Section 5.4.

Other operational activities may have impacts on surrounding air quality. The only atmospheric emission from the production and process facilities will be radon gas, which is discussed at length in Section 4.12.2.

4.7 NOISE IMPACTS

Noise sources during construction are expected to increase due to increased vehicle travel on SH 2/71. It is estimated that as many as 20 additional vehicles would travel along SH 2/71 each day as employees travel to and from Crawford for work. Additionally, heavy equipment used during construction may include bulldozers, scrapers, graders, front-end loaders, and cranes. Train usage would not increase as a result of construction.

Noise generated during the construction phase would result from vehicle travel and the operation of construction equipment. Table 4.7-1 presents typical noise levels for construction equipment at a distance of 15 meters (45 feet) (Crocker, 1982). These values assume the equipment is operating at full power.

Table 4.7-1
Typical Construction Noise Levels

Equipment Category	Noise Level at 45 ft (dBA)
Grader	85
Front-End Loader	84
Mobile Crane	83
Excavator	82
Backhoe	81
Bull Dozer	78

Using the doubling rule, noise impacts at a distance of 2880 feet, the approximate location of the closest receptor from construction equipment located at the satellite site, is calculated to be 49 dBA.

Increased vehicle travel during the construction phase of the project may result in a slight increase in noise impacts to residents. However, noise from construction would not be generated during nighttime hours and increases in noise levels would be intermittent and temporary. The resulting increase in vehicle noise from construction traffic (including movement of heavy equipment, which would be much less dense and slower than

highway traffic) would be barely perceptible over the existing ambient noise that is dominated by vehicle noise from SH 2/71 and the BSNF railroad. Noise from construction would be temporary and would briefly add to existing highway noise. Construction would be completed in a timely manner.

Noise sources during operation are expected to increase due to increased vehicle travel as increased numbers of employees traveling to and from Crawford for work and from resin transfer to the main plant. Train usage would not increase as a result of operation. Processing equipment at the satellite site would be minimal and is not expected to add to existing noise sources. Increases in noise levels due to operation are expected to be less than noise levels generated during construction. Therefore, it is expected that noise levels during operation would be barely perceptible over the existing ambient noise that is dominated by vehicle noise from SH 2/71 and the BSNF railroad.

4.8 HISTORIC AND CULTURAL RESOURCES IMPACTS

As discussed in Section 3.8, an archaeological review area was surveyed for the presence of cultural resources that may be impacted by the proposed mine development. Three historic sites and three isolated prehistoric artifacts were located and identified. The historic sites are the ruins of an abandoned farm complex (25DW296), an occupied farm complex (25DW297), and a refuse disposal area (25DW298). The individual artifacts are an early historic (1860's to 1870's) metal trade point (25DW299), a chert core (25DW300), and a Plains Archaic chert point fragment (25DW301). These resources are not likely to yield information important in prehistory or history and are considered not eligible for the National Register of Historic Places. Because these resources are considered not eligible, they are not historic properties. The proposed North Trend Expansion Area will have no effect on historic properties, and no further cultural resource work is recommended. The Nebraska State Historical Preservation Officer (SHPO) has concurred that the reported resources are not eligible for the National Register of Historic Places and that the proposed project will not affect archaeological, architectural, or historic context properties (Steinacher and Puschendorf, 2006).

Appendix C to this ER contains a copy of the Cultural Resource Inventory Report and supporting correspondence including the Nebraska SHPO concurrence letter and the correspondence to the tribal authorities. Appendix B, Site Location Map and Appendix C, Site Forms from the Cultural Resource Inventory Report contain information that falls under the confidentiality requirement for archeological resources under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)). Additionally, disclosure of this information is protected under Nebraska State Statute Section 84-712.05 (13 and 14). Accordingly, disclosure is specifically exempted by statute as specified in 10 CFR §2.390(a)(3). Therefore, CBR requests that all portions of Appendices B and C remain

"CONFIDENTIAL" for the purpose of Public Disclosure of this ER. Each page of the protected cultural resource information has been marked as follows:

Confidential Information Submitted Under 10 CFR 2.390

The cover pages for each of these appendices have been marked with a more detailed statement, as follows:

Confidential Information Submitted Under 10 CFR 2.390
Disclosure is Limited Under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)), and under the Nebraska Public Records Statutes (Neb. Rev. Stat. 84-712.05(13)).

All addenda are included in Volume II and must be kept confidential.

4.9 VISUAL/SCENIC RESOURCES IMPACTS

4.9.1 Environmental Consequences

The visible surface structures proposed for the North Trend Expansion Area include wellhead covers, wellhouses, electrical distribution lines, and one satellite processing plant. The project will use existing and new roads to access each wellhouse and the satellite plant.

Each wellhead cover would consist of a weatherproof structure placed over each well. Each structure would be approximately 3 feet high and 2 feet in diameter. Each well house consists of a small shed. The plant building would be approximately 100 feet by 130 feet in size. A permanent disturbance area around each wellhouse would be sized to provide an adequate vehicle turn-around. There would be an estimated 10 to 12 well houses on the new site.

Electric distribution lines would connect wellhouses to existing electric distribution lines. The distribution poles would be approximately 20 feet high. The poles would be wooden so that their natural color harmonizes with the landscape.

4.9.1.1 Short-term Effects

Temporary and short-term effects during the construction period to the visual character of the landscape at each well pad would result from wellhouse construction, well drilling, and associated construction of ancillary facilities, such as access roads and electric

distribution lines. Drilling and other construction activities would typically occur 8 to 12 hours per day during the regular workweek.

Following completion of facility installation, temporary disturbance areas would be reclaimed to pre-construction conditions. Only permanent disturbances associated with operations and maintenance of the facilities will remain following post-construction restoration.

4.9.1.2 Long-term Effects

Long-term effects for the project would result from the addition of structures to the landscape, such as the satellite plant, wellhouses, wellhead covers, and associated access roads and electric distribution lines. Effects from long-term activities would occur over the production life of the project.

Project development would alter the physical setting and visual quality of portions of the landscape, which would affect the overall landscape to some degree, as viewed from sensitive viewing areas. The proposed facilities would introduce new elements into the landscape and would alter the existing form, line, color, and texture, which characterize the existing landscape. The project would primarily affect croplands.

In foreground-middleground views, the satellite plant, wellhouses, and associated access road clearings would be the most obvious features of development. Clearings and access roads would be visible as light-tan exposed soils in geometrically-shaped areas with straight, linear edges that provide some textural and color contrasts with the surrounding cropland. The satellite plant, wellhouses, and wellhead covers would be painted to harmonize with the surrounding soil and vegetation cover. These facilities would be visible from SH 2/71 and the Crawford Cemetery, but would be subordinate to the rural landscape. Most of the occupied housing units are located near the south end of the project area, and would be screened from views of the facilities by riparian vegetation along the White River.

The electric distribution line poles would be an estimated 20 feet tall, and would be located throughout the project area to connect wellhouses with existing lines. The distribution lines are similar in appearance to those typical of the rural landscape, but would occur at a higher density than on adjacent lands. The lines would be obvious to viewers at the sensitive viewing areas, but would not change the rural character of the existing landscape.

Wellhead covers would be difficult to discern in the landscape from any sensitive viewing area. The form and textural contrast would be very weak because the relatively low profile (3 feet high) and small size of the facilities would disappear into the

surrounding textures of soil and vegetation. Generally, color contrasts are most likely to be visible in foreground-middleground distance zone. However, the wellhead covers would be painted a tan color that would harmonize with the surrounding vegetation and soil colors. Therefore, contrast of line, form, texture, and color would be low. The facilities would not be noticeable to the casual observer. Wellhead covers would be visually subordinate to the landscape in foreground-middleground distance zone.

The objective of VRM Class III is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. The existing rural/agricultural landscape would be retained, but would be modified with a noticeable, but minor, industrial component. Line and textural contrasts of the well houses, the plant, and associated access roads and distribution lines would be visible from sensitive viewing areas; however, contrasts would be low to moderate. The VRM Class III objectives would be met by proposed long-term project facilities.

Mitigative measures for visual and scenic resource impacts are discussed in Section 5.5.

4.10 SOCIOECONOMIC IMPACTS

Monetary benefits accrue to the community from the presence of the Crow Butte Project. Against these monetary benefits are the monetary costs to the communities involved, such as those for new or expanded schools and other community services. While it is not possible to arrive at an exact numerical balance between these benefits and costs for any one community, or for the project, because of the ability of the community and possibly the project to alter the benefits and costs, this section summarizes the expected incremental economic impacts from operation of the proposed North Trend Satellite Facility.

4.10.1 Tax Revenues

Future tax revenues are dependent on uranium prices, which cannot be forecast with any accuracy; however, these taxes are also somewhat dependent on the number of pounds of uranium produced by CBR. To the extent that uranium prices remain at current levels (spot market of around $80 per pound U_3O_8 in mid-March 2007), the increased production from the satellite plants should contribute to higher tax revenues as well.

The present taxes are based on a relatively consistent production rate of 800,000 pounds per year. The additional production from the satellite plants should be about 600,000 pounds per year. This additional production will eventually be offset by declining production from the original plant; however, the incremental contribution to taxes would be on the order of $1.0 million to $1.2 million per year in combined taxes.

4.10.2 Temporary and Permanent Jobs

4.10.2.1 Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of future satellite plant(s) will provide approximately ten to fifteen temporary construction jobs for a period of up to one year for each satellite. It is likely that the majority of these jobs will be filled by skilled construction labor brought into the area by a construction contractor, although some positions could be filled by local hires. Permanent CBR employees will perform all other facility construction (e.g., wells and wellfields).

CBR actively pursues a policy of hiring and training local residents to fill all possible positions. Due to the technical skills required for some positions, a small percentage of the current mine staff (less than five percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of positions created by any future expansion will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. In 2006, total unemployment in Dawes County was 137 individuals, or 2.9 percent of the total work force of 4,799. CBR expects that any new positions will be filled from this pool of available labor.

CBR projects that the current staffing level will increase by ten to twelve full-time CBR employees for each active satellite plant. These new employees will be needed for satellite plant and wellfield operator and maintenance positions. Contractor employees (i.e., drilling rigs) may also increase by four to seven employees depending on the desired production rate. The majority if not all of these new positions will be filled with local hires.

These additional positions should increase payroll by about $40,000 per month, or $400,000 to $480,000 per year.

4.10.3 Impact on the Local Economy

As noted in Section 3.10, CBR actively supports the local economies through purchasing procedures that emphasize obtaining all possible supplies and services that are available in the local area. In 2006, these local purchases were estimated at $5,000,000. This level of business is expected to continue and should increase somewhat with the addition of expanded production from the satellite plant, although not in strict proportion to production. While there are some savings due to some fixed costs (central plant utilities

for instance), there are additional expenses that are expected to be higher (wellfield development for the satellites is expected to be more expensive). Therefore, it can be estimated that the overall effect on local purchases will be proportional to the number of pounds produced. In addition, mineral royalty payments accrue to local landowners. This should translate to additional purchases of $3.65 to $4.35 million per year.

4.10.4 Economic Impact Summary

As discussed in this section, approval of this license amendment request would have a positive impact on the local economy as summarized in Table 4.10-1.

Table 4.10-1
Projected Economic Impact from North Trend Expansion Area

	Estimated Economic Impact due to North Trend Expansion Area
Employment	
Full Time Employees	+ 10 to 12
Full Time Contractor employees	+ 4 to 7
Part Time Employees and Short Term Contractors	+ 10 to 15 (Satellite Construction)
CBR Payroll	+ $400,000 to $480,000
Taxes	
Property Taxes	-
Sales and Use Taxes	-
Severance Taxes	-
Total Taxes	+ $1,000,000 to $1,200,000
Local Purchases	
Local Purchases, 2006 (est.)	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts	
	+ $5,050,000 to $6,030,000

4.11 ENVIRONMENTAL JUSTICE

The 2000 Census provides population characteristics for census tracts, which contain block groups that are further divided into blocks. The blocks are the smallest census area that contains the race characteristics of the population in Dawes County. The review area contains all or a portion of 68 blocks within Census Tract 9506. Block groups are the smallest census area that contains poverty level information. There is no poverty data for

individual blocks within each block. There are three block groups that are located partially within the 2.25-mile review area; however, the block groups area includes most of the north portion of Dawes County.

The affected area selected for the Environmental Justice analysis includes the race characteristics of the population within the city of Crawford and the surrounding census tract blocks within the 2.25-mile review area. The population with an annual income below the poverty level was determined from block group characteristics.

According to the 2000 Census and summarized in Table 4.11-1, the combined population of the city of Crawford and the surrounding census blocks within the review area was 1,265. Minority populations accounted for a small percentage of the total population. The majority of minority populations resided within Crawford.

The state of Nebraska was selected to be the geographic area to compare the demographic data for the population in the affected blocks. This determination was based on the need for a larger geographic area encompassing affected area block groups in which equivalent quantitative resource information is provided. The population characteristics of the review area are compared with Nebraska population characteristics to determine whether there are concentrations of minority or low-income populations in the review area relative to the state.

The data in Table 4.11-1 shows that minority populations in the affected blocks account for considerably smaller proportion of the total review area population than the proportion of minority populations at the state level. No concentrations of minority populations were identified as residing near the proposed project facilities, as residents nearest to the North Trend Expansion Area are rural populations, while most of the minority population lives in Crawford. There would be no disproportionate impact to minority population from the construction and implementation of the North Trend Project.

With the exception of block group 3, the populations within the block groups have higher rates of people living below the poverty level than the state; however, lower income levels are characteristic of predominantly rural populations and small communities that serve as a local center of agricultural activity. No adverse environmental impacts would occur to the population within the review area from proposed project activities; therefore there would be no disproportionate adverse impact to populations living below the poverty level in these block groups.

Approval of the proposed North Trend Expansion Area may have a positive economic impact on the lower income and minority groups since the project will generate additional employment opportunities with compensation that compares favorably with other employment opportunities in the area.

TABLE 4.11-1
RACE AND POVERTY LEVEL CHARACTERISTICS OF THE POPULATION IN THE STATE OF NEBRASKA, DAWES COUNTY, AND THE 2.25-MILE REVIEW AREA

	Nebraska	Percent of Nebraska Pop.	Dawes County	Percent of Dawes County Pop.	Crawford City	Total Block Pop.	Crawford & Block Pop. (review area)	Percent of Crawford & Block Pop.	Block Group 1	Block Group 2	Block Group 3
Total Population	1,711,263	100.0%	9,060	100.00%	1,107	158	1,265	100.0%	1,111	1,137	890
White alone	1,533,261	89.6%	8,457	93.34%	1,037	151	1,188	93.9%	-	-	-
Black or African American	68,541	4.0%	73	0.81%	1	0	1	0.1%	-	-	-
American Indian and Alaska Native	14,896	0.9%	261	2.88%	38	6	44	3.5%	-	-	-
Asian alone	21,931	1.3%	28	0.31%	0	0	0	0.0%	-	-	-
Native Hawaiian and Other Pacific Islander	836	0.0%	5	0.06%	0	0	0	0.0%	-	-	-
Some other race	47,845	2.8%	93	1.03%	10	1	11	0.9%	-	-	-
Two or more races	23,953	1.4%	143	1.58%	21	0	21	1.7%	-	-	-
Hispanic or Latino	94,425	5.5%	220	2.43%	22	3	25	2.0%	-	-	-
Percent below poverty level:	9.4%	-	17.1%	-	14.4%	-	-	-	21.3%	14.0%	8.3%

Source: Census 2000.

4.12 PUBLIC AND OCCUPATIONAL HEALTH IMPACTS

4.12.1 Nonradiological Impacts

There are two effluents expected from the North Trend satellite. Neither effluent contains nonradiological contaminants that are released and could present a potential pathway to the public or environment.

A gaseous and airborne effluent will consist of air ventilated from the plant building ventilation system and vented from process vessels and tanks. This gaseous effluent will contain radon gas as discussed in Section 4.12.2. The gaseous and airborne effluent will not contain any non-radiological wastes.

The liquid effluent will be managed in the solar evaporation ponds and the deep disposal well. There is no discharge from the evaporation ponds. The deep disposal well will permanently dispose of liquid wastes and will be permitted under a Class I UIC Permit issued by the NDEQ. The current Class I UIC Permit for the deep disposal well located at the central plant implements injection limits and requires monthly monitoring for Resource Conservation and Recovery Act (RCRA) Metals to ensure that hazardous waste is not injected. Based on the monitoring for the current deep disposal well, there is no non-radiological impact expected due to the liquid effluents from the North Trend satellite facility.

4.12.2 Radiological Impacts

CBR is proposing to develop a satellite plant with a production flow of approximately 4500 gpm and an average restoration rate of 500 gpm. An assessment of the radiological effects of the North Trend satellite must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The North Trend satellite will have a production flow capacity of approximately 4,500 gpm and will use fixed bed downflow ion exchange columns to separate uranium from the pregnant production fluid. The satellite facility will also have a capacity to treat 500 gpm of restoration solution. The restoration process will use fixed bed downflow ion exchange columns to remove the uranium and reverse osmosis to remove the dissolved solids. Waste disposal at the satellite will be via a deep injection well and solar evaporation ponds to provide surge capacity. The North Trend satellite plant will not have any elution, precipitation, or yellowcake drying equipment. The loaded ion exchange resin will be transferred from the columns to a resin trailer for transport to the current Crow Butte central plant for regeneration and stripping. The eluted resin will be transported back to the North Trend Satellite Plant and reused in ion exchange columns.

The uranium-bearing eluent in the Crow Butte central plant is treated in the uranium precipitation circuit. The precipitated uranium is vacuum dried.

The only emission at the North Trend Satellite Plant will be radon-222 (radon) gas. Radon is present in the ore body and is formed from the decay of radium-226. Radon is dissolved in the lixiviant as it travels through the ore body to a production well, where the solution is brought to the surface. The concentration of radon in the production solution is calculated using methods found in NRC Regulatory Guide 3.59. The details of this calculation are found in Attachment 4.12.2(A).

MILDOS-Area was used to model radiological impacts on human and environmental receptors (e.g., air and soil) using site-specific radon release estimates, meteorological and population data, and other parameters.

In the following sections, the assumptions and methods used to arrive at an estimate of the potential radiological impacts of the North Trend Satellite Plant is discussed briefly. A detailed presentation of the source term and other MILDOS-Area parameters is included in Attachment 4.12.2(A). The anticipated effects are compared to the naturally occurring background levels. This background radiation, arising from cosmic and terrestrial sources, as well as naturally occurring radon gas, comprises the primary radiological impact to the environment in the region surrounding the proposed project.

4.12.2.1 Exposure Pathways

The proposed North Trend Satellite Plant is an in-situ uranium facility. The only source of planned radioactive emissions from the satellite is radon gas, which is dissolved in the leaching solution. Radon gas may be released as the solution is brought to the surface and processed in the satellite facility. Unplanned emissions from the site are possible as a result of accidents and engineered structure failure but are not addressed in the MILDOS-Area modeling. A human exposure pathway diagram addressing planned and unplanned radiological emissions is presented in Figure 4.12-1

The North Trend Satellite Plant will have pressurized downflow ion exchange columns capable of processing 4,500 gpm of production solution. The satellite facility will also have ion exchange and reverse osmosis equipment with a capacity of 500 gpm to process restoration solutions.

Within the pressurized columns, the radon will remain in solution and be returned to the formation. It will not be released to the atmosphere. There will be minor releases of radon gas during the air blowdown prior to resin transfer to the resin trailer. The air blowdown and the gas released from the vent during column filling will be vented into the exhaust

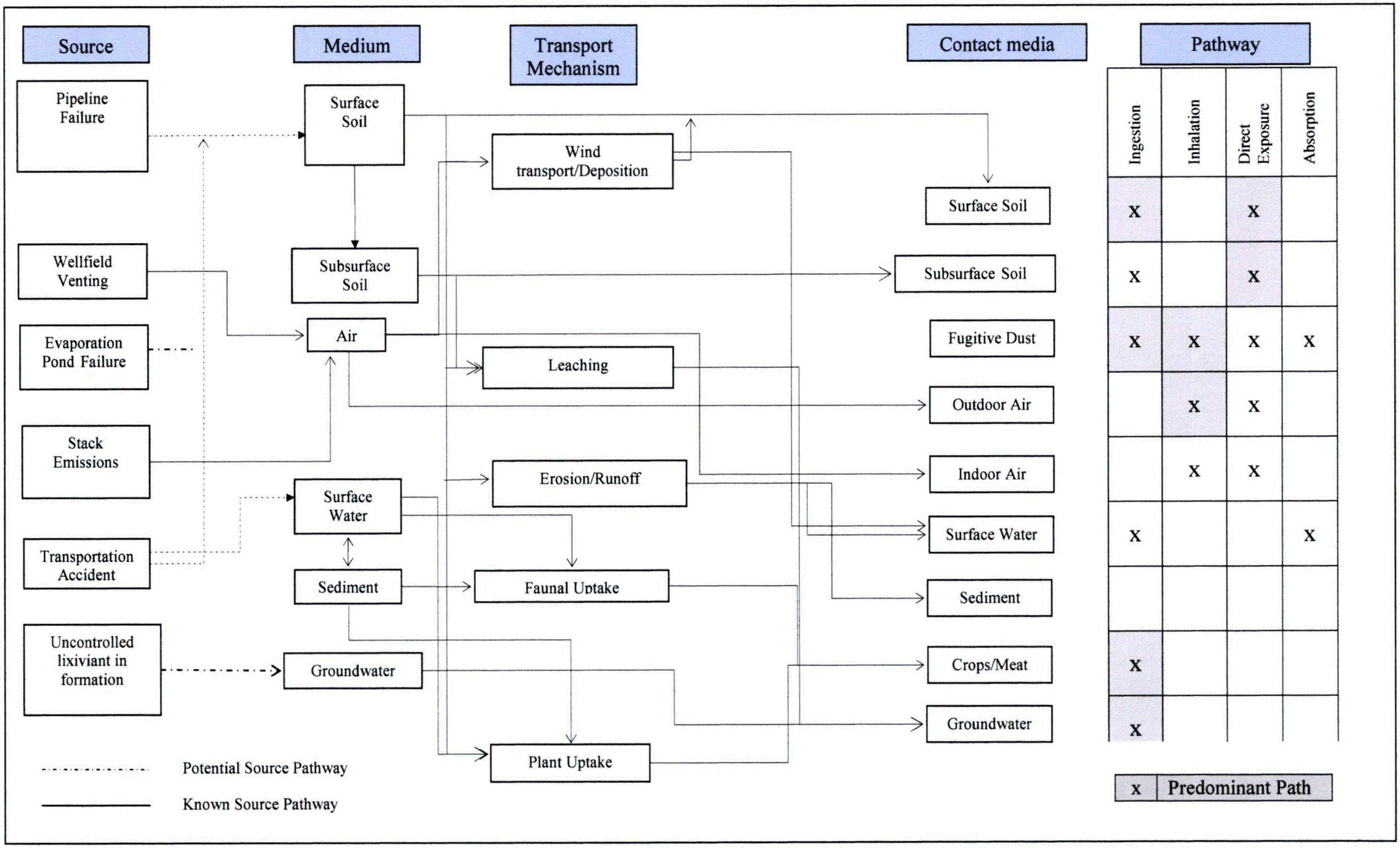
manifold and discharged via the main radon exhaust stack. It is estimated that less than 10 percent of the radon contained in the process solutions will be vented to atmosphere.

In the source term calculation, CBR estimates that 10 percent of the contained radon found in the 4,500-gpm flow processed by pressurized downflow IX columns will be released to the environment

After the IX resin is loaded it will be transferred to a resin trailer. The trailer will transfer the resin to the main process facility for additional processing. The stripped and regenerated resin will be transferred to the trailer and returned to the satellite plant and transferred into a process column. It is anticipated that two round trips will occur per day.

The injection wells will generally be closed and pressurized, but periodically vented. It is estimated that 25 percent of the radon will be released in the wellfield.

Figure 4.12-1 Human Exposure Pathways for Known and Potential Sources from the North Trend Expansion Area



Contact media	Ingestion	Inhalation	Direct Exposure	Absorption
Surface Soil	X		X	
Subsurface Soil	X		X	
Fugitive Dust	X	X	X	X
Outdoor Air		X	X	
Indoor Air		X	X	
Surface Water	X			X
Sediment				
Crops/Meat	X			
Groundwater	X			

Atmospheric emissions of radon will lend its presence to all quadrants of the area surrounding the North Trend Satellite Plant and the Crow Butte Project. Radon itself impacts human health or the environment marginally, because it is an inert noble gas. Radon has a relatively short half-life (3.8 days) and its decay products are short lived, alpha emitting, non-gaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. Figure 4.12-1 shows all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon were evaluated using MILDOS-Area.

4.12.3 Exposures from Water Pathways

The solutions in the zone to be mined will be controlled and adequately monitored to ensure that migration does not occur. The overlying aquifers will also be monitored.

The North Trend satellite will have evaporation ponds used to store waste solutions prior to deep disposal well injection. The ponds will be double-lined with impermeable synthetic liners. A leak detection system will be installed to provide a warning if the liner develops a leak. The ponds, therefore, are not considered a source of liquid radioactive effluents. The use of ponds to manage liquid waste is discussed in further detail in Section 4.13.

The primary method of waste disposal at the North Trend satellite will be by deep disposal well injection. The deep disposal well will be completed at an approximate depth of 3,500 to 4,000 ft, isolated from any underground source of drinking water by approximately 2,500 feet of shale (Pierre and Graneros Shales). The well will be constructed under a Class I Underground Injection Control (UIC) Permit issued by the NDEQ and will meet all requirements of the NDEQ UIC program. The use of a deep disposal well to manage liquid waste was discussed in further detail in Section 4.13.

The North Trend satellite processing facility will be located on a curbed concrete pad to prevent any liquids from entering the environment. Solutions used to wash down equipment will drain to a sump and be pumped to the ponds. The pad will be of sufficient size to contain the contents of the largest tank if it ruptures.

Since no routine liquid discharges of process water are expected from the North Trend satellite, there are no definable water-related pathways.

4.12.4 Exposures from Air Pathways

The only source of radionuclide emissions is radon released into the atmosphere through a vent system or from the wellfields. As shown in Figure 4.12-1, atmospheric releases of radon can result in radiation exposure via three pathways: inhalation, ingestion, and external exposure.

Based on the site-specific data and the method of estimation of the source term presented in Attachment 4.12.2(A), the modeled emission rate of radon from the North Trend satellite is 1662 Ci/yr, which includes releases from ion exchange, production and restoration activities. The complete results from MILDOS are contained in Appendix D.

The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the North Trend satellite and main processing site was also estimated using MILDOS-Area. Currently, CBR has a license amendment request pending to increase the annual plant throughput from 5,000 gpm, exclusive of restoration flow to 9,000 gpm exclusive of restoration flow. The license amendment was submitted on October 17, 2006 and the MILDOS-Area simulation included in this license amendment application reflects the requested flow increase. To show compliance with the annual dose limit found in 10 CFR § 20.1301, CBR has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the North Trend satellite operation is less than 100 mrem per year. The results of the MILDOS-Area simulation are presented in Table 4.12-1. The coordinates of all receptors are listed in Attachment 4.12.2(A) along with the source values and the locations of the sources. Receptor locations and appropriate identifiers are shown on Figure 4.12-2. Table 4.12-1 shows the estimated TEDE from operation of the main Crow Butte Project and the North Trend Satellite Plant.

No TEDE limits were exceeded. An evaluation of the TEDE follows:

1) The maximum TEDE is 31.7 mrem/yr.

2) Receptor #31 (NT-1) is the closest resident in the downwind direction for the North Trend Satellite Plant. The estimated TEDE at this location is 5.8 mrem/yr.

3) The effect of the North Trend Satellite operation on the nearby residents of the existing Crow Butte facility is less than 1 mrem/yr.

4) Since radon-222 is the only radionuclide emitted, public dose limits in 40 CFR 190 and the 10 mrem/yr constraint rule in 10 CFR §20.1101 are not applicable to the CBR facility.

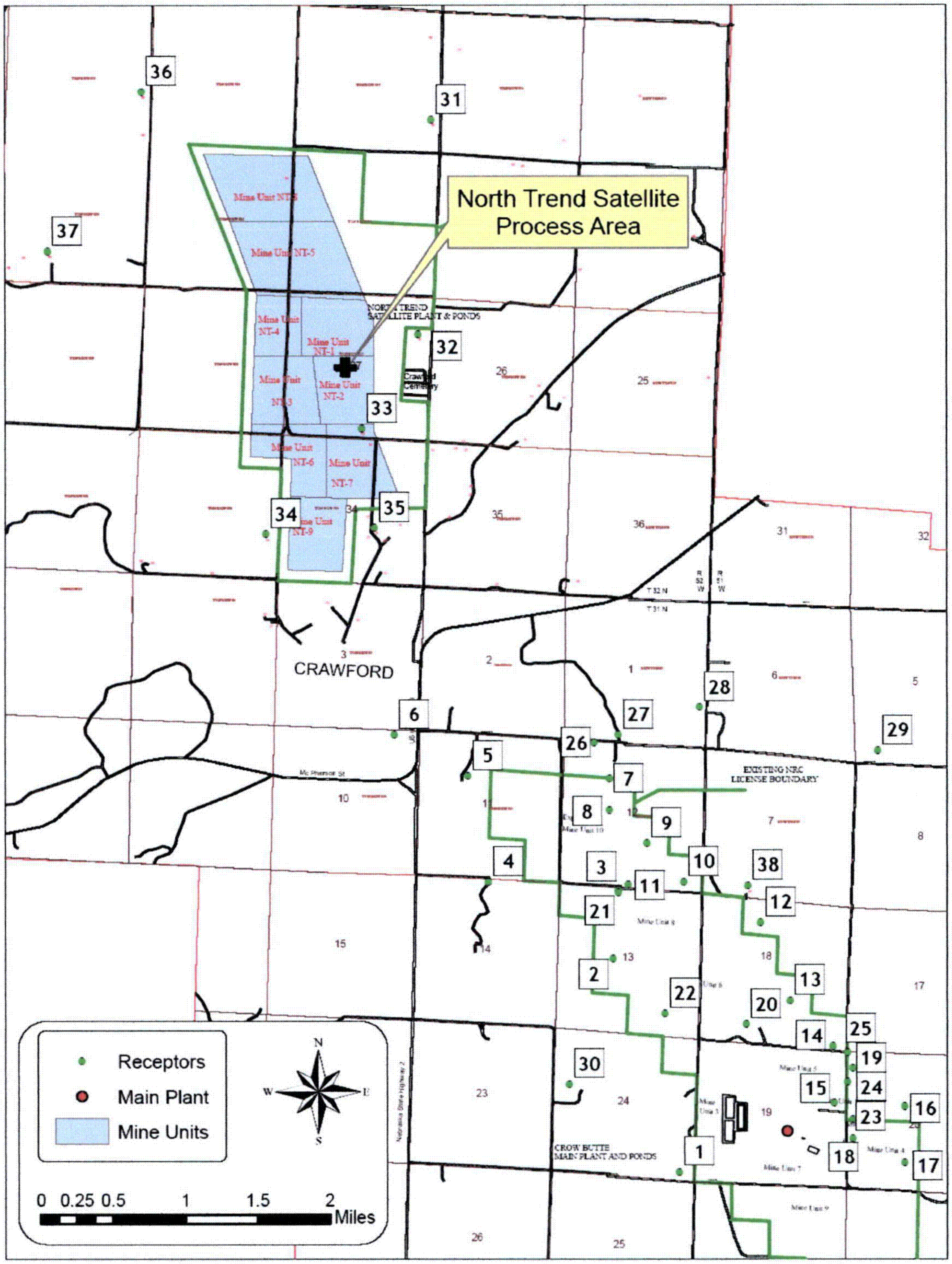


Figure 4.12-2 MILDOS Receptors for Main and Satellite Processing Facility

Table 4.12-1 Estimated Total Effective Dose Equivalent (TEDE) to Receptors Near the Crow Butte Uranium Processing Facility

Receptor #	Description	Distance from Main Plant (km)	TEDE* (mrem/y)
1	R1	1.29	6.64
2	R2	2.76	4.82
3	R3	3.30	6.14
4	R4	4.36	1.92
5	R5	5.35	1.98
6	Crawford	6.25	1.65
7	R7	4.43	4.87
8	R8	4.11	5.16
9	R9	3.59	8.12
10	R10	3.03	16.0
11	R11	3.29	7.34
12	R12	2.37	17.7
13	R13	1.49	28.1
14	R14	1.10	28.3
15	R15	0.62	31.7
16	R16	1.34	9.48
17	R17	1.35	6.06
18	Ehlers	0.73	15.5
19	Gibbons	1.03	24.9
20	Stetson	1.30	19.9
21	Knode	3.28	6.09
22	Brott	1.92	16.2
23	SP1	0.75	18.1
24	SP2	0.89	26.2
25	SP3	1.13	24.8
26	McDowell	4.87	4.24
27	Tagart	4.83	4.87
28	Franey	4.86	6.55
29	Bunch	4.39	7.54
30	Dyer	2.50	3.27
31	NT-1	12.01	5.84
32	NT-2	9.83	3.41
33	NT-3	9.19	3.09
34	NT-4	8.87	2.14
35	NT-5	8.18	2.42
36	NT-6	13.7	1.63
37	NT-7	12.86	1.04
38	NT-8	2.79	15.9

*No differences in TEDE between age classes were observed.

4.12.4.1 Population Dose

The annual population dose commitment to the population in the region within 80 km of the Crow Butte Project is also predicted by the MILDOS-Area code. The results are listed in Table 4.12-3, where the dose to the bronchial epithelium is expressed in person-rem. For comparison, the dose to the population within 80 km of the facility due to natural background radiation is included in the table. These figures are based on the 1980 population and average radiation doses reported for the Western Great Plains.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1-kilocurie release near Casper, Wyoming, during the year 1978. The results of these calculations are included in Table 4.12-3 and also combined with dose to the region within 80 km of the facility to arrive at the total radiological effects of one year of operation at the Crow Butte Project.

For comparison of the values listed in Table 4.12-3, the dose to the continental population as a result of natural background radiation has been estimated. This estimate is based on a North American population of 346 million and a dose to each person of 500 mrem/yr to the bronchial epithelium. The maximum radiological effect of the combined operation of the North Trend Satellite Plant and the Crow Butte Project would be to increase the dose to the bronchial epithelium of the continental population by 0.0023 percent.

4.12.5 Exposure to Flora and Fauna

The exposure to flora and fauna was evaluated in the environmental report submitted to NRC in September of 1987 and the doses were found to be negligible. The proposed satellite facility will have no measurable impact on dose to flora and fauna.

Table 4.12-3: Dose to the Population Bronchial Epithelium and Increased Continental Dose from One Year's Operation at the Crow Butte Facility

Criteria	Dose (person rem/yr)
Dose received by population within 80 km of the facility	171
Natural background by population within 80 km of the facility	24025
Dose received by population beyond 80 km of the facility	224
Total continental dose	394
Natural background for the continental population	$1.73 \times 10^{+8}$
Fraction increase in continental dose	2.27×10^{-6}

4.13 WASTE MANAGEMENT IMPACTS

This section describes the waste management impacts from the North Trend satellite facility. The effluents of concern at ISL operations include the release or potential release of radon gas (radon-222), radionuclides in liquid process streams, and dried yellowcake. Yellowcake processing and drying operations are conducted at the central plant. Loaded ion exchange resin from the North Trend satellite facility will be transported to the central plant for elution, precipitation, drying, and packaging.

The yellowcake drying facilities at the central plant are comprised of one vacuum dryer. The current license allows for the addition of a second dryer. By design, vacuum dryers do not discharge any uranium when operating. Effluent controls for yellowcake drying at the Crow Butte central plant have been reviewed by NRC and approved in the current license. The current waste streams and management programs were described in Section 3.12.

4.13.1 Gaseous and Airborne Particulates

The only radioactive airborne effluent at the North Trend satellite facility will be radon-222 gas. Radon-222 is found in the pregnant lixiviant that comes from the wellfield into the satellite facility for separation of uranium. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted to atmosphere outside the satellite building. Venting any released radon-222 gas to atmosphere outside the plant minimizes employee exposure. Small amounts of radon-222 may also be released via solution sampling and spills, filter changes, IX resin transfer, reverse osmosis (RO) system operation during groundwater restoration, and maintenance activities. These are minimal radon gas releases on an infrequent basis. The impacts from release of radon gas were discussed in Section 4.12.2.

Other emissions to the air are limited to exhaust and dust from limited vehicular traffic. These impacts were previously discussed in Section 4.6. There are no significant amounts of process chemicals that will be used at the satellite plant. There are no significant combustion related emissions from the process facility as commercial electrical power is available at the site.

4.13.2 Liquid Waste

4.13.2.1 Sources of Liquid Waste

As a result of in-situ leach mining, there are several sources of liquid waste. The potential wastewater sources that exist at the North Trend satellite facility will be similar to those

currently generated and managed at the central process plant. These sources of wastewater include the following:

4.13.2.1.1 Water Generated During Well Development

This water is recovered groundwater and has not been exposed to any mining process or chemicals; however, the water may contain elevated concentrations of naturally-occurring radioactive material if the development water is collected from the mineralized zone. The water will be discharged directly to the solar evaporation pond and silt, fines and other natural suspended matter collected during well development will settle out in the pond. Well development water may also be treated with filtration and/or reverse osmosis and used as plant make-up water or disposed of in the deep disposal well. The quantity of waste water generated by well development activities is estimated at approximately 2.5 million gallons per year based on the current operation.

4.13.2.1.2 Liquid Process Waste

The operation of the satellite facility results in one primary source of liquid waste, a production bleed as previously discussed. This bleed will be routed to either the deep disposal well or an evaporation pond. Process bleed is estimated at 0.5% to 1.5% of the process flow of 4,500 gpm. The impact of this process bleed was discussed in Section 4.4.3.

4.13.2.1.3 Aquifer Restoration Waste

Following mining operations at North Trend, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan consists of four activities:

1. Groundwater Transfer;
2. Groundwater Sweep;
3. Groundwater Treatment; and,
4. Wellfield Circulation.

Only the groundwater sweep and groundwater treatment activities will generate wastewater. During groundwater sweep, water is extracted from the mining zone without injection, causing an influx of baseline quality water to sweep the affected mining area. The extracted water must be sent to the wastewater disposal system during this activity. The impact of this restoration waste stream was discussed in Section 4.4.3.

4.13.2.2 Liquid Waste Disposal

Two methods of disposal are proposed for the North Trend satellite facility.

4.13.2.2.1 Deep Disposal Well

CBR has operated the deep disposal well at the current license area for over ten years with excellent results and no serious compliance issues. CBR expects that the liquid waste stream at the North Trend satellite facility will be chemically and radiologically similar to the waste disposed in the current deep disposal well.

CBR plans to install a deep disposal well at the North Trend satellite facility as the primary liquid waste disposal method. CBR has found that permanent deep disposal is preferable to evaporation in evaporation ponds. All compatible liquid wastes at the North Trend satellite facility will be disposed of in the planned deep disposal well. No adverse environmental impacts are expected from this type of disposal since the liquid waste is permanently isolated in an unusable geologic formation. At the time of preparation of this amendment request and ER, a permit application is under preparation for submittal to the NDEQ for a Class I UIC Permit for the North Trend satellite facility.

4.13.2.2.2 Evaporation Pond

Evaporation pond design, installation and operation criteria are those found in USNRC Regulatory Guide 3.11. The evaporation pond configuration at the North Trend facility will be similar to the existing ponds at the current CBR license area. The exact number and capacity of the ponds will depend upon the performance of the deep disposal well as far as waste water disposal rate.

Each pond will have the capability of being pumped to a water treatment plant before disposal. A variety of treatment options exist depending upon the specific chemical contaminants identified in the wastewater. In general, a combination of chemical precipitation and reverse osmosis is adequate to treat the water to a quality that falls well within NPDES criteria.

As noted in Section 3.12, CBR currently maintains three commercial and two R & D evaporation ponds in the current license area. There have been no adverse environmental impacts from the operation of these ponds. CBR does not expect any adverse impacts from operation of similar ponds at North Trend.

4.13.3 Solid Waste

Solid waste generated at the North Trend satellite site is expected to include spent resin, resin fines, empty reagent containers, miscellaneous pipe and fittings, and domestic trash. The solid waste will be segregated based on whether it is clean or has the potential for contamination with 11(e).2 byproduct materials.

4.13.3.1 Non-contaminated Solid Waste

Non-contaminated solid waste is waste which is not contaminated with 11(e).2 byproduct material or which can be decontaminated and re-classified as non-contaminated waste. This type of waste may include trash, piping, valves, instrumentation, equipment and any other items which are not contaminated or which may be successfully decontaminated. Release of contaminated equipment and materials is discussed in further detail in Section 5 of the License Amendment Application.

CBR estimates that the proposed North Trend satellite facility would produce approximately 700 yd^3 of non-contaminated solid waste per year. Non-contaminated solid waste will be collected on the site in designated areas and disposed of in the nearest permitted sanitary landfill.

4.13.3.2 11(e).2 Byproduct Material

Solid 11(e).2 byproduct waste consists of solid waste contaminated with 11e.(2) byproduct material that cannot be decontaminated.

11(e).2 byproduct material generated at ISL facilities consists of filters, personal protective equipment (PPE), spent resin, piping, etc. CBR estimates that the proposed North Trend satellite facility would produce approximately 60 yd^3 of 11(e).2 byproduct materials per year. These materials will be stored on site until such time that a full shipment can be shipped to a licensed waste disposal site or licensed mill tailings facility.

4.13.3.3 Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the State of Nebraska. Disposal of solid materials collected in septic systems must be performed by companies or individuals licensed by the State of Nebraska. NDEQ regulations for control of these systems are contained in Title 124.

4.13.3.4 Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Based on waste determinations, CBR is a Conditionally Exempt Small Quantity Generator (CESQG). To date CBR only generates universal hazardous wastes such as spent waste oil and batteries. CBR estimates that the proposed North Trend satellite facility would produce approximately 800 liters of waste oil per year. Waste oil is disposed of by a licensed waste oil recycler. CBR has management procedures in place in EHSMS Program Volume VI, *Environmental Manual,* to control and manage these types of wastes.

5 MITIGATION MEASURES

5.1 LAND USE IMPACT MITIGATION MEASURES

5.1.1 Land Surface Impact Mitigation Measures

The objective of reclamation is to return the affected land surface to conditions suitable for the uses for which they were suitable before mining. The methods to achieve this objective for the land surface are described in the following sections. These sections address the final decommissioning methods of disturbed lands including wellfields, plant areas, evaporation ponds, and diversion ditches that will be used on the Crow Butte and North Trend Expansion Area project sites. The sections discuss general procedures to be used during final decommissioning as well as the decommissioning of a particular phase or production unit area.

The current operations in the licensed area have shown that Crow Butte Resources (CBR) can successfully restore the land surface following mining operations. Short-term surface reclamation activities including contouring and revegetation have been performed routinely following initial mine unit construction. Additionally, CBR recently completed surface and subsurface reclamation of a significant portion of Mine Unit 1 following approval of groundwater restoration. These areas have been successfully recontoured and revegetation has been completed in accordance with Nebraska Department of Environmental Quality (NDEQ) requirements.

Decommissioning of wellfields and process facilities, once their usefulness has been completed in an area, will be scheduled after agency approval of groundwater restoration and stability. Decommissioning will be accomplished in accordance with an approved decommissioning plan and the most current applicable NDEQ and NRC rules and regulations, permit and license stipulations and amendments in effect at the time of the decommissioning activity.

The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed in Section 5.1.1.4.
- Determination of appropriate cleanup criteria for structures (Section 5.1.1.5) and soils (Section 5.1.1.6).
- Radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.

- Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation as discussed in Section 5.1.1.5.

- Decontamination of items to be released for unrestricted use to levels consistent with the requirements of NRC.

- Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility.

- Perform final site soil radiation surveys.

- Backfill and recontour all disturbed areas.

- Establish permanent revegetation on all disturbed areas.

The following sections describe in general terms the planned decommissioning activities and procedures for the Crow Butte facilities. These activities and procedures will apply to the North Trend Expansion Area facilities as well as the current facilities. CBR will, prior to final decommissioning of an area, submit to the NRC and NDEQ a detailed Decommissioning Plan for their review and approval at least 12 months before planned commencement of final decommissioning.

5.1.1.1 General Surface Reclamation Procedures

The principal objective of the surface reclamation plan is to return disturbed lands to production compatible with the post mining land use of equal or better quality than the premining condition. For the Crow Butte area, the reclaimed lands should be capable of supporting livestock grazing and providing stable habitat for native wildlife species. Soils, vegetation, wildlife and radiological baseline data will be used as guidelines for the design, completion and evaluation of surface reclamation. Final surface reclamation will blend affected areas with adjacent undisturbed lands so as to re-establish original slope and topography and present a natural appearance. Surface reclamation efforts will strive to limit soil erosion by wind and water, sedimentation and re-establish natural trough drainage patterns.

The following sections provide procedural techniques for surface reclamation of all disturbances contained in the Crow Butte Resources mine plan. Provided are reclamation procedures for the facility sites, wellfield production units, evaporation ponds, and access and haul roads. Reclamation techniques and procedures for the North Trend satellite facilities, ponds, and wellfields will follow these same concepts. Reclamation schedules for wellfield production units will be discussed separately because they are dependent upon the progress of mining and the successful

completion of groundwater restoration. Cost estimates for bonding calculations are discussed in Section 7 and include all activities that are anticipated to complete groundwater restoration, decontamination, decommissioning, and surface reclamation of wellfield and satellite plant facilities installed. These cost estimates are updated annually to cover work projected for the next year of mining activity.

5.1.1.1.1 Topsoil Handling and Replacement

In accordance with NDEQ requirements, topsoil is salvaged from building sites (including satellite buildings) and pond areas. Conventional rubber-tired, scraper-type earth moving equipment is typically used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations is determined by wellfield pattern emplacement and designated wellfield access roads within the wellfields, which are determined during final wellfield construction activities.

As described in Section 3.3, topsoil thickness varies within the North Trend Expansion Area. Topsoil thickness is usually greatest in and along drainages where material has been deposited and deep soils have developed. Therefore, topsoil stripping depths may vary in depth, depending on location and the type of structure being constructed. In cases where it is necessary to strip topsoil in relatively large areas, such as a major road or building site, field mapping and Soil Conservation Service Soil Surveys will be utilized to determine approximate topsoil depths.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles are generally located on the leeward side of hills to minimize wind erosion. Stockpiles are not located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles are seeded as soon as possible after construction with the permanent seed mix.

During mud pit excavation associated with well construction, exploration drilling and delineation drilling activities, topsoil is separated from subsoil with a backhoe. When use of the mud pit is complete, all subsoil is replaced and topsoil is applied. Mud pits generally remain open a short time. The success of revegetation efforts at the current site show that these procedures adequately protect topsoil and result in vigorous vegetation growth.

5.1.1.1.2 Contouring of Affected Areas

Restoration of the original land surface, which is consistent with the pre- and post-mining land use, the blending of affected areas with adjacent topography to approximate original contours, and the reestablishment of drainage patterns will be

accomplished by returning the earthen materials moved during construction to their approximate original locations.

Drainage channels that have been modified by the mine plan for operational purposes such as road crossings, will be re-established by removing fill materials and culverts, and reshaping to as close to pre-operational conditions as practical. Surface drainage of disturbed areas that have been located on terrain with varying degrees of slope will be accomplished by final grading and contouring appropriate to each location so as to allow for controlled surface run off and eliminate depressions where water could accumulate.

5.1.1.1.3 Revegetation Practices

Revegetation practices are conducted in accordance with NDEQ requirements. During mining operations the topsoil stockpiles and as much as practical of the disturbed wellfield and pond areas will be seeded with vegetation to minimize wind and water erosion. After placement of topsoil and contouring for final reclamation, an area will normally be seeded with a seed mixture developed in consultation with the Natural Resource Conservation Service as required by the NDEQ.

5.1.1.2 Process Facility Site Reclamation

Following removal of structures, as discussed in Section 5.1.1.5, subsoil and stockpiled topsoil will be replaced on the disturbances from which they were removed during construction, within practical limits. Areas to be backfilled will be scarified or ripped prior to backfilling to create an uneven surface for application of backfill. This will provide a more cohesive surface to eliminate slipping and slumping. The less suitable subsoil and unsuitable topsoil, if any, will be backfilled first so as to place them in the deepest part of the excavation to be covered with more suitable reclamation materials. Subsoils will be replaced using paddle wheel scrapers, bulldozers or other appropriate equipment to transfer the earth from stockpile locations or areas of use and to spread it evenly on the ripped disturbances. Grader blades may be used to even the spread of backfill materials. Topsoil replacement will commence as soon as practical after a given disturbed surface has been prepared. Topsoil will be picked up from storage locations by paddle wheel scrapers or other appropriate equipment and distributed evenly over the disturbed areas. The final grading of topsoil materials will be done so as to establish adequate drainage and the final prepared surface will be left in a roughened condition.

5.1.1.3 Evaporation Pond Decommissioning

5.1.1.3.1 Disposal of Pond Water

The volume of water remaining in the lined evaporation ponds after restoration, as well as its chemical and radiological characteristics, will be considered to determine the most practical disposal program. Disposal options for the pond liquid include evaporation, treatment and disposal, or transportation to another licensed facility or disposal site. The pond water from the later stages of groundwater restoration may be treatable to within discharge limits. If this can be accomplished, the water will be treated and discharged under an appropriate National Pollutant Discharge Elimination System (NPDES) permit. Evaporation of the remaining water may be enhanced by use of sprinkler systems, etc.

5.1.1.3.2 Pond Sludge and Sediments

Pond sludges and sediments will contain mining process chemicals and radionuclides. Wind blown sand grains and dust blown into the ponds during their active life also add to the bulk of sludges. This material will be contained within the pond bottom and kept in a dampened condition at all times, especially during handling and removal operation, to prevent the spread of airborne contamination and potential worker exposure through inhalation. Dust abatement techniques will be used as necessary. The sludge will be removed from the ponds and loaded into roll off containers, dump trucks, or drums and transported to a NRC-licensed disposal facility.

5.1.1.3.3 Disposal of Pond Liners and Leak Detection Systems

Pond liners will be kept washed down and intact as much as practical during sludge removal so as to confine sludges and sediments to the pond bottom. Pond liners will be cut into strips and transported to a NRC-licensed disposal facility or will be decontaminated for release to an unrestricted area. After removal of the pond liners, the pond leak detection system piping will be removed. Materials involved in the leak detection system will be surveyed and released for unrestricted use if not contaminated or transported to a NRC-licensed facility for disposal. The earthen material in the pond bottom and leak detection system trenches will be surveyed for soil contamination. Any contaminated soil in excess of the cleanup criteria discussed in Section 5.1.1.6 will be removed and disposed of at a NRC-licensed disposal facility.

Following the removal of all pond materials and the disposal of any contaminated soils, surface preparation will take place prior to reclamation.

5.1.1.3.4 On Site Burial

At the present time, on-site burial of contaminants is not anticipated; however, depending upon the availability of a NRC licensed disposal site at the time of decommissioning, on-site burial may become a potential alternative. Should this occur, pond locations would be considered initially as the on-site disposal locations for contaminated materials. Appropriate licensing with the regulatory agencies would be obtained prior to any on-site disposal of contaminated wastes.

5.1.1.4 Wellfield Decommissioning

Surface reclamation in the wellfield production units will vary in accordance with the development sequence and the mining/reclamation timetable. Final surface reclamation of each wellfield production unit will be completed after approval of groundwater restoration stability and the completion of well abandonment activities discussed below. Surface preparation will be accomplished as needed so as to blend any disturbed areas into the contour of the surrounding landscape.

Wellfield decommissioning will consist of the following steps:

- The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, wellhouses, electrical and control distribution systems, well boxes, and wellhead equipment. Wellhead equipment such as valves, meters or control fixtures will be salvaged.

- Removal of buried wellfield piping.

- Wells will be plugged and abandoned according to the procedures described below.

- The well field area may be recontoured, if necessary, and a final background gamma survey conducted over the entire wellfield area to identify any contaminated earthen materials requiring removal to disposal.

- Final revegetation of the wellfield areas will be conducted according to the revegetation plan.

- All piping, equipment, buildings, and wellhead equipment will be surveyed for contamination, prior to release, in accordance with the NRC guidelines for decommissioning.

It is estimated that a significant portion of the equipment will meet release limits, which will allow disposal at an unrestricted area landfill. Other materials that are contaminated will be acid washed or decontaminated with other methods until they are releasable. If the equipment cannot be decontaminated to meet release limits, it will be disposed of at a NRC-licensed disposal facility.

Wellfield decommissioning will be an independent ongoing operation throughout the mining sequence at the Crow Butte site and at the North Trend Expansion Area. Once a production unit has been mined out and groundwater restoration and stability have been accepted by the regulatory agencies, the wellfield will be scheduled for decommissioning and surface reclamation.

5.1.1.4.1 Well Plugging and Abandonment

All wells no longer useful to continue mining or restoration operations will be abandoned. These include all injection and production wells, monitor wells, and any other wells within the production unit used for the collection of hydrologic or water quality data or incidental monitoring purposes. The only known exception at this time may be a shallow well that could be transferred to the landowner for domestic or livestock use.

The objective of the Crow Butte well abandonment program is to seal and abandon all wells in such a manner as to assure the groundwater supply is protected and to eliminate any potential physical hazard.

The plugging method is approved by the NDEQ and is generally as follows:

- A mechanical plug may be placed above the screened interval.
- Thirty to fifty feet of coarse bentonite chips will be added to provide a grout seal.
- A plug gel or cement grout will be placed by tremie pipe from the chips to the top of the casing. The weight of the gel or grout plus the weight of the bentonite chips will be enough to exceed the local Chadron Formation pressure plus the maximum injection pressure allowed (100 psi).
- The tremie pipe will be removed (when possible) and the casing will be filled to the surface.
- An approved hole plug will be installed.

- The well casing will be cut off below ground level, capped with cement, and the surface disturbance will be smoothed and contoured.

- The hole will be backfilled and the area revegetated.

Records of abandoned wells will be tabulated and reported to the appropriate agencies after decommissioning. CBR must submit a notarized affidavit to the NDEQ detailing the significant data and the procedure used in connection with each well plugged. The Nebraska Department of Natural Resources (DNR) also requires filing a well abandonment notice for all registered wells.

5.1.1.4.2 Buried Trunklines, Pipes and Equipment

Buried process-related piping, such as injection and production lines, will be removed from the mine unit undergoing decommissioning. Salvageable lines will be held for use in ongoing mining operations. Lines that are not reusable may either be assumed to be contaminated and disposed of at a licensed disposal site or may be surveyed and, if suitable for release to an unrestricted area, may be sent to a sanitary landfill.

5.1.1.5 Removal and Disposal of Structures, Waste Materials, and Equipment

5.1.1.5.1 Preliminary Radiological Surveys and Contamination Control

Prior to process plant decommissioning, a preliminary radiological survey will be conducted to characterize the levels of contamination on structures and equipment and to identify any potential hazards. The survey will support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. In general, the contamination control program used during mining operations will be appropriate for use during decommissioning of structures.

Based on the results of the preliminary radiological surveys, gross decontamination techniques will be employed to remove loose contamination before decommissioning activities proceed. This gross decontamination will generally consist of washing all accessible surfaces with high-pressure water. In areas where contamination is not readily removed by high-pressure water, a decontamination solution (e.g., dilute acid) may be used.

5.1.1.5.2 Removal of Process Buildings and Equipment

The majority of the process equipment in the process building will be reusable, as well as the building itself. Alternatives for the disposition of the building and equipment are discussed in this section.

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., will be inventoried, listed, and designated for one of the following removal alternatives:

- Removal to a new location within the Crow Butte site for further use or storage;

- Removal to another licensed facility for either use or permanent disposal; or

- Decontamination to meet unrestricted use criteria for release, sale, or other non-restricted use by others.

It is most likely that process buildings will be decontaminated, dismantled and released for use at another location. If decontamination efforts were unsuccessful, the material would be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a licensed disposal site or properly licensed facility if contaminated.

Salvageable building materials, equipment, pipe, and other materials to be released for unrestricted use will be surveyed for alpha contamination in accordance with license conditions contained in SUA-1534 and NRC guidance.

The CBR release limits for alpha radiation are as follows:

- Removable of 1,000 dpm/100cm^2
- Average total of 5,000 dpm/100 cm^2 over an area no greater than one square meter
- Maximum total of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2

Monitoring for beta contamination is a current license requirement. This requirement has been eliminated in subsequent ANSI standards, including ANSI/HPS N13.12. In addition, CBR has routinely made these measurements but has never found them limiting.

Decontamination of surfaces will comply with CBR's ALARA policy to reduce surface contamination as far below the limits as practical.

Non-salvageable contaminated equipment, materials, and dismantled structural sections will be sent to an NRC-licensed facility for disposal. In most cases, the byproduct material will be shipped as Low Specific Activity (LSA-I) material, UN2912, pursuant to 49 CFR 173.427

If facilities or equipment are to be moved to a facility licensed for disposal of 11(e)2 byproduct material, the following procedures may be used:

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce interior contamination as necessary for safe handling.
- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be contaminated, the equipment will be washed down and decontaminated to permit safe handling.
- The equipment will be disassembled only to the degree necessary for transportation. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the plant building.
- Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in lined roll-off containers or covered dump trucks or drummed in barrels for delivery to the receiving facility.
- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.
- All other miscellaneous contaminated material will be transported to a licensed disposal facility.

If a piece of equipment or structure is to be released for unrestricted use, it will be appropriately surveyed before leaving the licensed area. Both interior and exterior surfaces will be surveyed to detect potential contamination. If the shape, size, or presence of inaccessible surfaces prevents an accurate and representative survey, the material will be assumed contaminated and properly disposed. Appropriate decontamination procedures will be used to clean any contaminated areas and the equipment resurveyed and documentation of the final survey retained to show that unrestricted use criteria were met prior to releasing the equipment or materials from the site. The current release criteria are based on NRC guidelines. The criteria to be used for release to unrestricted use will be the appropriate NRC guidelines at that time.

If a process building is left on site for unrestricted use by a landowner, the following basic decontamination procedures will be used. Actual corrective procedures will be determined by field requirements, as defined by radiological surveys.

- After the building has been emptied, the interior floors, ceiling and walls of the building and exterior surfaces at vent and stack locations will be checked for contamination. Any remaining removable contamination will be removed by washing. Areas where contamination was noted will be resurveyed to ensure removal of all contamination to appropriate levels.

- Process floor sump and drains will be washed out and decontaminated using water and, if necessary, acid solutions. If the appropriate decontamination levels cannot be achieved, it may be necessary to remove portions of the sump and floor to disposal.

- Excavations necessary to remove trunklines or drains will be surveyed for contaminated earthen material. Earthen material that is found to be contaminated will be removed to a licensed disposal facility prior to backfilling the excavated areas.

- The parking and storage areas around the building will be surveyed for surface contamination after all equipment has been removed.

- Decontamination of these areas will be conducted as necessary to meet the standards for unrestricted use.

5.1.1.5.3 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed of at a disposal site licensed by the NRC or an Agreement State to receive 11(e)2 byproduct material. CBR currently maintains agreements with two such facilities located in the states of Utah and Wyoming for disposal of 11(e)2 byproduct materials generated by mining operations. A contract for disposal at a minimum of one facility will be maintained current as required in SUA-1534.

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation (DOT) Hazardous Materials Regulations (49 CFR Part 173) and the NRC transportation regulations (10 CFR 71).

5.1.1.6 Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys

5.1.1.6.1 Cleanup Criteria

Surface soils will be cleaned up in accordance with the requirements of 10 CFR Part 40, Appendix A, including a consideration of ALARA (as low as reasonably achievable) goals and the chemical toxicity of uranium.

The proposed limits and ALARA goals for cleanup of soils are summarized in Table 5-1 and described below.

Table 5-1
Soil Cleanup Criteria and Goals

	Radium-226 (pCi/gm)		**Natural Uranium (pCi/gm)**	
Layer Depth	*Limit*	*Goal*	*Limit*	*Goal*
Surface (0-15 cm)	5	5	230	150
Subsurface (15 cm layers)	15	10	230	230

The existing radium-226 criterion in 10 CFR Part 40, Appendix A, was used to derive a dose criterion (Benchmark Approach) for the cleanup of byproduct materials. The Benchmark Dose was modeled using the RESRAD code (Version 6.22). The results show that a concentration of 537 pCi/g for natural uranium in the top 15 cm layer of soil for the resident farmer scenario is equivalent to the Benchmark Dose derived from a concentration of 5 pCi/g of radium-226.

ALARA considerations require that an effort be made to reduce contaminants to as low as reasonably achievable levels. The ALARA goals are normally based on a cost-benefit analysis. For the cleanup of gamma-emitting radionuclides, the cost of cleanup becomes excessively high as soil concentrations and/or gamma emission rates become indistinguishable from background.

Cleanup of uranium mill sites has demonstrated that conservatively-derived gamma action levels, along with appropriate field survey and sampling procedures, result in near background radium-226 concentrations for the site. In addition, the presence of a

mixture of radium-226 and uranium will tend to drive the cleanup to even lower radium-226 concentrations. It is therefore believed that no specific ALARA goal is required for surface radium-226.

CBR proposes an ALARA goal of limiting the natural uranium concentration in the top 15 cm soil layer to 150 pCi/g, averaged over 100 m^2. According to the RESRAD runs shown in Appendix E, the ratio of radium-226 dose rate per pCi/g to the uranium dose rate per pCi/g is 120. It is also shown by calculation that the ratio of radium-226 to uranium emission rates is 30. Therefore, if the action level for pure radium-226 results in cleanup of the site to less than 5 pCi/g, the action level should result in the cleanup of pure uranium to 30 times 5 or 150 pCi/g.

The uranium concentration should be limited to, at most, 230 pCi/g for all soil depths because of chemical toxicity concerns. Using the most conservative daily limit corresponding to the National Primary Drinking Water Standard, a soil limit of 230 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day.

CBR desires to reduce subsurface concentrations to a maximum of two-thirds of the proposed limit of 15 pCi/g radium-226. The subsurface uranium goal has not been reduced since it has not been demonstrated that these levels can be detected with readily available field instruments.

5.1.1.6.2 Excavation Control Monitoring

CBR will use 17,900 cpm as its gamma action level, as determined with a Ludlum Model 44-10/2221 NaI detection system or equivalent, held at 18 inches above ground surface. The gamma action level, defined as the gamma count rate corresponding to the soil cleanup criterion, will be used in the interpretation of the data. This action level will be used with caution, or until a new action level is developed.

Hand-held and GPS-based gamma surveys will be used to guide soil remediation efforts. Field personnel will monitor excavations with hand-held detection systems to guide the removal of contaminated material to the point where there is high probability that an area meets the cleanup criteria. Support will be provided by GPS-based gamma surveys periodically to more accurately assess the progress of excavation.

5.1.1.6.3 Surface Soil Cleanup Verification and Sampling Plan

Cleanup of surface soils will be restricted to a few areas where there are known spills and, potentially, small spills near well heads. Final GPS-based gamma surveys will be conducted in potentially contaminated areas, including 10 m buffer zones.

CBR will divide the area systematically into 100 m^2 grid blocks and sample all grid blocks containing gamma count rates exceeding the gamma action level. The samples will be five-point composites, and analyzed at an offsite laboratory for radium-226 and natural uranium.

CBR will sample the remaining grid blocks with average gamma count rates ranking in the top 10 percent.

If any grid blocks within the top 10 percent fail the cleanup criteria, CBR will sample the second 10 percent of grid blocks. This will continue until all grid blocks pass within a 10 percent grouping. To meet the cleanup criterion, each of the sampled grid blocks must satisfy the following inequality,

$$\sum \frac{C_i}{Cc} < 1$$

where C_i is the concentration of the constituent and C_c is the concentration of the constituent that is equivalent to the Benchmark Dose.

CBR will remediate the grid blocks failing this inequality or propose alternatives consistent with Appendix A of 10 CFR 40.

After all sampled grids have met the inequality, an EPA-recommended statistical test will be done to determine whether the mean of the equality defined above for all grid blocks is 1 or less at the 95 percent confidence level, using Equation 8-13 of draft NUREG/CR-5849. If the mean of the sample concentrations is less than the criterion but the data fail the statistical test, CBR will follow procedures similar to those recommended in Section 8.6 of draft NUREG/CR-5849.

5.1.1.6.4 Subsurface Soil Cleanup Verification and Sampling Plan

For subsurfaces, CBR will adopt different survey and sample protocols, depending on the type and size of excavation. CBR will rely more on sampling and radium-226 and

natural uranium analysis over surveying, to verify cleanup of subsurface excavations. The protocols are summarized in site procedures.

5.1.1.6.5 Temporary Ditches and Impoundments Cleanup Verification and Sampling Plan

CBR will adopt survey and sample protocols for temporary ditches and surface impoundments on a case-by-case basis. Ditches and impoundments can extend from the surface to the subsurface. For the purpose of decommissioning, the surfaces will be considered as part of adjacent soil surfaces. The subsurfaces will be surveyed and sampled systematically, based on their size and geometry. As with other subsurfaces, CBR will rely more on sampling and radium-226 and uranium analysis over surveying, to verify cleanup of ditches and impoundments. Surveying is applicable in larger impoundments; however, wherein the effects of geometry are not as pronounced, particularly in areas not influenced by adjacent walls.

5.1.1.6.6 Quality Assurance

Verification soil samples will be sent to a commercial laboratory for analysis of radium-226 and natural uranium. The criteria that CBR will use to select the commercial laboratory will follow the guidance published in the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP, NRC, 2001). The commercial laboratory will adhere to a well-defined quality assurance (QA) program that addresses the laboratory's organization and management, personal qualifications, physical facilities, equipment and instrumentation, reference materials, measurement traceability and calibration, analytical method validation, standard operating procedures (SOPs), sample receipt, handing, storage, records, and appropriate licenses.

The analytical work performed by the commercial laboratory will adhere to CBR-defined Data Quality Objectives (DQOs). Part of the DQO process is specific analytical sensitivities required by CBR. The minimum sensitivity required for each sample will be 0.5 pCi/g dry weight for each analyte, with an estimated overall error of $\pm$ 0.5 pCi/g.

CBR will expect the reporting equivalent of an EPA Contract Laboratory Program Level 3 data package from the commercial laboratory.

CBR will maintain a laboratory QA file that will include, at a minimum, the laboratory's Quality Assurance Manual (QAM) and audit reports.

5.1.2 Land Use Impact Mitigation Measures

Considering the relatively small size of the area impacted by construction and operation of the North Trend Expansion Area (1,310 acres), the exclusion of agricultural activities from this area over the course of the North Trend project should not have a significant impact on local agricultural production. Land owners of impacted areas will be compensated for lost production and income through surface lease and/or mineral royalty payments from CBR. These impacts are considered temporary and reversible by returning the land to its former grazing use through post-mining surface reclamation.

The operations in the current licensed area have shown that CBR can successfully restore the land surface following mining operations. Surface reclamation activities, including contouring and revegetation, have been performed routinely following initial mine unit construction. Additionally, CBR recently completed surface and subsurface reclamation of a significant portion of Mine Unit 1 following approval of groundwater restoration. These areas have been successfully recontoured and revegetation has been completed in accordance with NDEQ requirements.

5.2 TRANSPORTATION IMPACT MITIGATION MEASURES

The additional traffic generated by construction and operation of the proposed North Trend Expansion Area may result in the degradation of public road surfaces, particularly local gravel roads maintained by Dawes County. These impacts are expected to be minimal, since the additional traffic is not significant in comparison with current traffic levels. CBR contributes to the maintenance of these local roads through tax payments to Dawes County. In addition, CBR has voluntarily assisted Dawes County with materials to maintain county roads at the current operation. In the past, these materials have included gravel, road signs, and new culverts. CBR will continue to support Dawes County to mitigate impacts from company operations.

5.3 SOIL IMPACT MITIGATION MEASURES

Best Management Practices (BMPs) have been included in the project description, and will be followed for site preparation, to control erosion, minimize disturbance, and facilitate reclamation. The following mitigation measures will be valuable in reducing the effects to soil resources at the North Trend site. BMPs and mitigation measures relevant to soil resources are also discussed in the water quality and reclamation sections of this document.

5.3.1 Sediment Control

- Divert surface runoff from undisturbed area around the disturbed area.
- Retain sediment within the disturbed area.
- Surface drainage shall not be directed over the unprotected face of the fill.
- Operations and disturbance on slopes greater than 40 percent need special sediment controls and should be designed and implemented appropriately.
- Avoid continuous disturbance that provides continuous conduit for routing sediment to streams.
- Inspect and maintain all erosion control structures.
- Repair significant erosion features, clogged culverts, and other hydrological controls in a timely manner.
- If best management practices do not result in compliance with applicable standards, modify or improve such best management practices to meet the controlling standard of surface water quality.

5.3.2 Topsoil

- Topsoil to be removed should be removed prior to any development activity to prevent loss or contamination.
- When necessary to substitute for or supplement available topsoil, use overburden that is equally conducive to plant growth as topsoil.
- To the extent possible, directly haul (live handle) topsoil from site of salvage to concurrent reclamation sites.
- Avoid excessive compaction of topsoil and overburden used as plant growth medium by limiting the number of vehicle passes, and handling soil while saturated and scarifying compacted soils.
- Time topsoil redistribution so seeding, or other protective measures, can be readily applied to prevent compaction and erosion.

5.3.3 Roads

Construct and maintain roads to minimize soil erosion by:

- Restricting the length and grade of roadbeds;
- Surfacing roads with durable material;
- Creating cut and fill slopes that are stable;
- Revegetating the entire road prism, including cut and fill slopes; and,
- Creating and maintaining vegetative buffer strips, and constructing sediment barriers (e.g. straw bales, wire-backed silt fences, check dams) during the useful life of roads.

5.3.4 Regraded Material

- Design regraded material to control erosion using activities that may include slope reduction, terracing, silt fences, chemical binders, seeding, mulching etc;
- Divert all surface water above regraded material away from the area and into protected channels;
- Shape and compact regraded material to allow surface drainage and ensure long-term stability; and,
- Concurrently reclaim regarded material to minimize surface runoff.

Potential long-term effects include soil loss, sedimentation, compaction, salinity, loss of soil productivity, and soil contamination. Potential short-term effects include reduced soil productivity, erosion, compaction and soil contamination. Implementation of best management practices (BMPs), spill prevention control and countermeasures (SPCCs), and storm water pollution prevention plan (SWPPPs) will minimize effects to soils associated with the construction of the North Trend production facilities.

5.4 WATER RESOURCES IMPACT MITIGATION MEASURES

5.4.1 Groundwater Quality Impact Mitigation Measures

Impacts to groundwater quality in the mining zone are mitigated by groundwater restoration activities following completion of mining. The primary purpose of restoration is to ensure that affected water in the exempted aquifer cannot impact an adjacent underground source of drinking water (USDW). To accomplish this purpose, the goal of groundwater restoration is to return the affected ground water in the mining zone to conditions suitable for the uses for which they were suitable before mining. It should be noted that the methods used for groundwater restoration result in a consumptive use of the groundwater resources, particularly during the groundwater sweep phase. Water usage was discussed in Section 4.4.3.1.

The methods to achieve this objective for the affected groundwater are described in the following sections. Before discussing restoration methodologies, a discussion of the ore body genesis and chemical and physical interactions between the ore body and the lixiviant is provided.

5.4.1.1 Ore Body Genesis

The uranium deposit in the North Trend Expansion Area is similar to that found in the current license area. It is a rollfront deposit in a fluvial sandstone and is similar to those in the Wyoming basins such as the Gas Hills, Shirley Basin, and the Powder River Basin. The origin of the uranium in the deposit could lie within the host rock itself, either from the feldspar or volcanic ash content of the Chadron Sandstone. The source of the uranium could also be volcanic ash of the Chadron Formation which overlays the Chadron Sandstone. Regardless of the source of the uranium, it has precipitated in several long sinuous rollfronts. The individual rollfronts are developed within subunits of the Chadron Sandstone. The Chadron Sandstone is divided into local subunits by thin clay beds that confined the uranium-bearing waters to several distinct hydrological subunits of the sandstone. These clay beds are laterally continuous for hundreds of feet, but control the deposition of the uranium over greater distances, as other clay beds exert vertical control when the locally controlling beds pinch out. Precipitation of the uranium resulted when the oxidizing water containing the uranium entered reducing conditions. These reducing agents are likely hydrogen sulfide (H_2S) and, to a lesser degree, organic matter and pyrite.

Solution mining of the deposit is accomplished by reversing the natural processes that deposited the uranium. Oxidizing solution is injected into the mineralized portion of the Chadron Sandstone to oxidize the reduced uranium and to complex it with bicarbonates. Pumping from recovery wells draws the uranium-bearing solution through the mineralized portion of the sandstone. The presence of reducing agents will increase oxidant requirements over that necessary to only oxidize the uranium.

Since the deposition of the uranium was controlled between clay beds within the Chadron Sandstone, the mining solutions will be largely confined to this portion of the sandstone by selectively screening these intervals. This will limit the contamination, and thus the required restoration, of unmineralized portions of the sandstone.

5.4.1.2 Chemical and Physical Interactions of Lixiviant with the Ore Body

The following discussion is based on a range of lixiviant conditions from 0.5 to 3.0 grams per liter total carbonate and a pH from 6.5 to 9.0 standard units (S.U.). This represents the normal range of operating conditions for the North Trend Expansion Area in-situ mining operations.

5.4.1.2.1 Ion Exchange

The principal ion exchange reaction is the exchange of sodium from the lixiviant onto exchangeable sites on ore minerals with the release into solution of calcium, magnesium, and potassium. This reaction can be shown as follows:

$$Ca_{clay} + 2\ Na^{+}_{solution} = 2\ Na_{clay} + Ca^{++}_{solution}$$

Similar reactions can be written for magnesium and potassium. Due to higher solubility of their sulfate and carbonate compounds and their low concentrations in the Chadron Sandstone and the ore, magnesium and potassium in solution have no impact. The limited solubility of calcium carbonate ($CaCO_3$), and to a lesser degree, calcium sulfate, may lead to the potential for calcium precipitation.

Laboratory tests have indicated that the maximum calcium ion exchange capacity of the ore in a sodium lixiviant with a 3.0 g/L total carbonate strength is 1.21 milliequivalents of calcium per 100 grams of ore. This equates roughly to ½ pound of calcium or about 1.2 pounds of calcium carbonate per ton of ore that could potentially precipitate. Not all of this calcium, however, will be realized since laboratory testing is run in such a way as to indicate the maximum amount of calcium that can be exchanged. Somewhat less than this amount will be released and only a portion of that precipitated. There is no way to directly control the buildup of calcium in the lixiviant circuit. In practice, the lixiviant carbonate concentration and the lixiviant pH is controlled. The formation characteristics dictate an equilibrium calcium concentration in the lixiviant system and ion exchange and/or precipitation will occur until the equilibrium is satisfied. The production bleed represents a departure from this equilibrium and, as such, has some effect on the amount of calcium exchanged. If the bleed is kept generally small, on the order of 0.5 percent, the effect of the bleed on the ion exchange is small.

5.4.1.2.2 Precipitation

In the presence of carbonate ions and bicarbonate ions in the lixiviant system, calcium ions will precipitate, provided the limit of saturation has been reached. Calcium precipitation is a function of total carbonate, pH, and temperature. For example, at 15° C, a pH of 7.5 S.U., and 1 g/L carbonate in lixiviant, the equilibrium solubility of calcium is approximately 40 to 100 ppm. Some uncertainty is seen in these numbers due to the effect of ionic strength and supersaturation considerations; however, these figures illustrate the effect of carbonate concentration and pH on the equilibrium solubility of calcium.

The amount of calcium produced depends on the ion exchange that is taking place, while the precipitation of calcium is a function of the lixiviant chemistry, and the degree of supersaturation that is observed in the system. As a first approximation, the proportion of calcium precipitation occurring above ground and underground will occur in the ratio of the residence times. In other words, if the residence time is much longer underground than it is above ground, as is the case for most in-situ leach operations, including those projected for the North Trend Expansion Area, then more of the calcium will precipitate underground than above ground. The calcium precipitation is a function of turbulence in the solution, changes in dissolved carbon dioxide (CO_2) partial pressure or pH, and the presence of surface area. The most likely places for calcium to precipitate are underground where the ore provides abundant surface area for precipitation, at or near the injection or production wellbore where changes in pressure, turbulence and CO_2 partial pressure are all observed, and on the surface in the filters, in pipes, and in tanks. If all the calcium were to precipitate (based on 1.2 pounds of $CaCO_3$ per ton of ore) the precipitate would occupy about 0.15% of the void space in that ton of ore.

Calcium may be removed from the system in two ways:

- Filters will be routinely backwashed to the evaporation ponds and periodically acid cleaned, if necessary, to remove precipitated calcium carbonate from the filter housing or filter media; and,

- The solution bleed (approximately 0.5 to 1.0 percent) taken to create overproduction and a hydrologic sink in the mining area serves to eliminate some calcium from the system.

Should precipitation of calcium carbonate at or near the wellbore of the wellfield wells become a problem, these wells may be airlifted, surged, water jetted, or acidified to remove the precipitated calcium. Any water recovered from these wells containing dissolved calcium carbonate or particulate calcium carbonate is collected and placed into the waste disposal system. A liquid seal is maintained on any calcium carbonate in the evaporation ponds. Upon decommissioning, calcium carbonate from the plant equipment and pond residues will be disposed of in either a licensed tailings pond or a commercial disposal site.

The other possible precipitating species that has been identified is iron, which could precipitate as either the hydroxide or the carbonate, causing some fouling. Such fouling is usually evidenced by a reduction in the ion exchange capacity of the resin in the extraction circuit. Should this fouling become a serious problem, the resin can be washed and the wash solution disposed of in the waste disposal system. Due to the small amount of iron present in the Chadron Sandstone, iron precipitation has not been a problem in mining operations to date.

5.4.1.2.3 Hydrolysis

Hydrolysis reactions, which involve minerals and hydrogen or hydroxide ions, do not play an important role in the ore/lixiviant interaction. In the pH range of 6.5 to 9.0 S.U., the concentration of hydrogen and hydroxide ions is so small that these types of reactions do not occur to any great degree. The only potential impact would be a small increase in the dissolved silica content of the lixiviant system and a possible small increase in the cations associated with the siliceous minerals. The hydrolysis reaction does not have a significant effect on operations.

5.4.1.2.4 Oxidation

The oxidant consumers in the Chadron Sandstone are hydrogen sulfide in the groundwater, uranium, vanadium, iron pyrite, and other trace and heavy metals. The impacts of these oxidant consumers on the operation of the plant is a general increase in the oxidant consumption over that which would be required for uranium alone. The second effect is a release of iron and sulfate into solution from the oxidation of pyrite. A third effect is an increase in the levels of some trace metals such as arsenic, vanadium and selenium into solution. As mentioned previously, the iron solubilized will most likely be precipitated as the hydroxide or carbonate, depending on its oxidation state. Any vanadium that is oxidized along with the uranium will be solubilized by the lixiviant, recovered with the uranium, and could potentially contaminate the precipitated yellowcake product. Hydrogen peroxide precipitation of uranium is used to reduce the amount of vanadium precipitated in the product. Oxidation will also solubilize arsenic and selenium. The restoration program will return these substances to acceptable levels. A final potential oxidation reaction is the partial oxidation of sulfur species, increasing the concentrations of compounds such as polythionates, which can foul ion exchange resins. In in-situ operations with chemistries similar to the North Trend Expansion Area, these sulfur species are completely oxidized to sulfate, which poses no problems.

5.4.1.2.5 Organics

Organic materials are generally not present in the North Trend Expansion Area ore body at levels greater than 0.1 to 0.2 percent. Where present, organic materials effectively increase the oxidant consumption and reduce uranium leaching. On longer flow paths, organic material could potentially re-precipitate uranium should all of the oxidant be consumed and conditions become reducing. Another potential impact of mobilized organics could be the coloring and fouling of leach solutions. As the aquifer is maintained in the pH range of 6.5 to 9.0 S.U., mobilization of the organics and coloring of the leach solution is avoided.

5.4.1.3 Basis of Restoration Goals

The primary goal of the groundwater restoration program is to return groundwater affected by mining operations to pre-injection baseline values on a mine unit average, as determined by the baseline water quality sampling program. This sampling program is performed for each mine unit before mining operations commence. Should restoration efforts be unable to achieve baseline conditions after diligent application of the best practicable technology (BPT) available, CBR commits, in accordance with the Nebraska Environmental Quality Act and NDEQ regulations, to return the groundwater to the restoration values set by the NDEQ in the Class III UIC Permit. These secondary restoration values ensure that the groundwater is returned to a quality consistent with the use, or uses, for which the water was suitable prior to ISL mining. These secondary restoration values are approved by the NDEQ in the individual Notice of Intent (NOI) for each mine unit based on the permit requirements and the results of the baseline monitoring program.

5.4.1.3.1 Establishment of Baseline Water Quality

Before mining in each mine unit, the baseline groundwater quality is determined. The data are established in each mine unit by assigning and evaluating groundwater quality in "baseline restoration wells". A minimum of one baseline restoration well for each four acres is sampled to establish the mine unit baseline water quality. A minimum of three samples is collected from each well. The samples are collected at least 14 days apart. The samples are analyzed for the parameters listed in Table 5-2.

Attachment 5.3(A) contains the restoration tables for Mine Units 1 through 9 in the current commercial license area. These tables provide the baseline average and the range for all restoration parameters as well as the NDEQ restoration standard approved for that mine unit in the NOI.

5.4.1.3.2 Establishment of Restoration Goals

The baseline data are used to establish the restoration standards for each mine unit. As previously noted, the primary goal of restoration is to return the mine unit to preoperational water quality condition on a mine unit average. Since ISL operations alter the groundwater geochemistry, it is unlikely that restoration efforts will return the groundwater to the precise water quality that existed before operations.

Restoration goals are established by NDEQ to ensure that, if baseline water quality is not achievable after diligent application of best practicable technology (BPT), the groundwater is suitable for any use for which it was suitable before mining. NRC considers these NDEQ restoration goals as the secondary goals. The NDEQ restoration values are established for each mine unit and are approved with the Notice of Intent to Operate (NOI) submittals according to the following analysis:

- For parameters that have numerical groundwater standards established in Title 118, the restoration goal is based on the Title 118 maximum contaminant level (MCL).
- If the baseline concentration exceeds the applicable MCL, the standard is set as the mine unit baseline average plus two standard deviations.
- If there is no MCL for an element (e.g., vanadium), the restoration value is based on BPT.
- The restoration values for the major cations (Ca, Mg, K, Na) allow the concentrations of these cations to vary by as much as one order of magnitude as long as the total dissolved solids (TDS) restoration value is met. The total carbonate restoration criterion allows for the total carbonate to be less than 50 percent of the TDS. The TDS restoration value is set at the baseline mine unit average plus one standard deviation.

The current NDEQ restoration standards are listed in Table 5-2.

Table 5-2: NDEQ Groundwater Restoration Standards

Parameter	NDEQ Title 118 Groundwater Standard	NDEQ Restoration Standard[1]
Ammonium (mg/l)	Not Listed	10.0
Arsenic (mg/l)	0.010	0.010
Barium (mg/l)	2.0	2.0
Cadmium (mg/l)	0.005	0.005
Chloride (mg/l)	250	250
Copper (mg/l)	1.3	1.3
Fluoride (mg/l)	4.0	4.0
Iron (mg/l)	0.3	0.3
Mercury (mg/l)	0.002	0.002
Manganese (mg/l)	0.05	0.05
Molybdenum (mg/l)	(Reserved)	1.0
Nickel (mg/l)	(Reserved)	0.15
Nitrate (mg/l)	10.0	10.0
Lead (mg/l)	0.015	0.015
Radium (pCi/L)	5.0	5.0
Selenium (mg/l)	0.05	0.05
Sodium (mg/l)	N/A	Note 2
Sulfate (mg/l)	250	250
Uranium (mg/l)	0.030	0.030
Vanadium (mg/l)	(Reserved)	0.2
Zinc (mg/l)	5.0	5.0
pH (Std. Units)	6.5 - 8.5	6.5 – 8.5
Calcium (mg/l)	N/A	Note 2
Total Carbonate (mg/l)	N/A	Note 3
Potassium (mg/l)	N/A	Note 2
Magnesium (mg/l)	N/A	Note 2
TDS (mg/l)	N/A	Note 4

Notes:

1 NDEQ Restoration Standard based on groundwater standard (MCL) from Title 118. For parameters where the baseline concentration exceeds the applicable MCL, the standard is set as the mine unit baseline average plus two standard deviations.

2 One order of magnitude above baseline is used as the restoration value for some parameters due to the ability of some major ions to vary one order of magnitude depending on pH.

3 Total carbonate shall not exceed 50% of the total dissolved solids (TDS) value.

4 The restoration value for total dissolved solids (TDS) shall be the baseline mean plus one standard deviation.

Source: NDEQ Class III UIC Permit Number NE0122611

It is anticipated that the Class III UIC Permit issued for the North Trend Expansion Area will have similar requirements. Under the provisions of the performance-based license, the CBR Safety and Environmental Review Panel (SERP) reviews and approves the establishment of restoration standards using the review procedures discussed in Section 5 of the Technical Report. Table 5-2 lists the 27 parameters used at the Crow Butte Project to determine groundwater quality. The current MCLs from Title 118 are listed as well as the restoration standards from the Class III UIC Permit. The restoration value for each mine unit is based on the current Title 118 standard at the time the Notice of Intent is approved by the NDEQ.

5.4.1.4 Groundwater Restoration Methods

Restoration activities in the current license area have proven that the groundwater can be restored to the appropriate standards following commercial mining activities. As shown in Table 1-1, Mine Units 2 through 4 are currently undergoing restoration, with Mine Unit 2 undergoing extended stability monitoring following active restoration. Mine Unit 1 groundwater restoration has been approved by the NDEQ and the NRC. On February 12, 2003, the NRC issued the final approval of groundwater restoration in Mine Unit 1 at Crow Butte. This approval was the culmination of three years of agency reviews, including a license amendment to accept the NDEQ restoration standards as the approved secondary goals. Mine Unit 1 consisted of 40 patterns installed in 9.3 acres immediately adjacent to the central plant. Included within the boundaries of Mine Unit 1 were five wells that were originally mined beginning in 1986 as part of the research and development (R&D) pilot plant operation. Commercial mining activities began in 1991 and were completed in 1994. Mine Unit 1 was successfully restored to the approved primary or secondary restoration standards for all parameters.

CBR's approved restoration plan consists of four steps:

- Groundwater transfer;
- Groundwater sweep;
- Groundwater treatment; and,
- Wellfield recirculation.

A reductant may be added at anytime during the restoration stage to lower the oxidation potential of the mining zone. A sulfide or sulfite compound will be added to the injection stream in concentrations sufficient to reduce the mobilized species.

The stabilization stage consists of monitoring the restoration wells for six months following successful completion of the restoration stage. Stabilization begins once restoration activities have returned the average concentration of restoration parameters to acceptable levels. Following the stabilization phase, CBR provides a restoration report to the appropriate regulatory agencies.

During mining and until restoration is complete, a hydrologic bleed will be maintained in each Mine Unit to prevent lateral migration of mining lixiviant. If a proper hydrologic bleed is not maintained, it is possible for water with chemistry similar to that in Table 2.7-15 column "Typical Water Quality During Mining at CSA" to begin migrating toward the monitor well ring. The mobile ions such as chloride and carbonate would be detected at the monitor well ring and adjustments would be made to reverse the trend. The maintenance of a hydrologic bleed and the close proximity of the monitor well ring, less than 300 feet from the mining patterns, will ensure there is negligible migration of mining fluid. Vertical migration of fluids is less of a concern than lateral migration due to the underlying and overlying aquitards. The ubiquitous Chadron Formation clays, which cap the Lower Chadron Formation ore body, have hydraulic conductivities on the order of 10-11 cm/sec as outlined in section 2.7.2.2 of this application. Likewise, the underlying Pierre Shale is over 1,200 feet thick and acts as a significant aquitard. The vastly different pieziometric heads between the Lower and Middle Chadron, as well as the results of the pumping test, support the conclusion that the Lower Chadron is vertically isolated.

5.4.1.4.1 Restoration Process

Restoration activities include four steps that are designed to optimize restoration equipment used in treating groundwater and to minimize the number of pore volumes circulated during the restoration stage. CBR will monitor the quality of selected wells during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary.

- Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mine unit commencing restoration and a mine unit commencing mining operations. Baseline quality water from the mine unit starting mining may be pumped and injected into the mine unit in restoration. The higher TDS water from the mine unit in restoration is recovered and injected into the mine unit commencing mining. The direct transfer of water will act to lower the TDS in the mine unit being restored by displacing water affected by the mining with baseline quality water.

The goal of the groundwater transfer step is to blend the water in the two mine units until they become similar in conductivity. The recovered water may be passed through ion exchange columns and filtration during this step if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens.

For the groundwater transfer step to occur, a newly constructed mine unit must be ready to commence mining. If a mine unit is not available to accept transferred water, groundwater sweep or other activity will be utilized as the first step of restoration. The advantage of using the groundwater transfer technique is that it reduces the amount of water that must ultimately be sent to the wastewater disposal system during restoration activities.

- Groundwater Sweep

During groundwater sweep, water is pumped without injection from the wellfield, causing an influx of baseline quality water from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline quality water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The affected water near the edge patterns of the wellfield is also drawn into the boundaries of the mine unit. The number of pore volumes transferred during groundwater sweep, if any, is dependent upon the presence of other active mine units along the mine unit boundary, the capacity of the wastewater disposal system, and the success of the groundwater transfer step in lowering TDS.

- Groundwater Treatment

Following the groundwater sweep step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. Ion exchange (IX), reverse osmosis (RO), and/or Electro Dialysis Reversal (EDR) treatment equipment is generally used during this stage, as shown on the generalized restoration flow sheet on Figure 5-1.

Water recovered from restoration that contains a significant amount of uranium is passed through the IX system. The IX columns exchange the majority of the contained soluble uranium for chloride or sulfate. Once the solubilized uranium is removed, a small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration of reductant injected into the formation is determined by the concentration and type of trace elements encountered. The goal of reductant addition is to reduce those minerals that are solubilized by carbonate complexes to prevent the buildup of dissolved solids, which would increase the time for restoration to be completed.

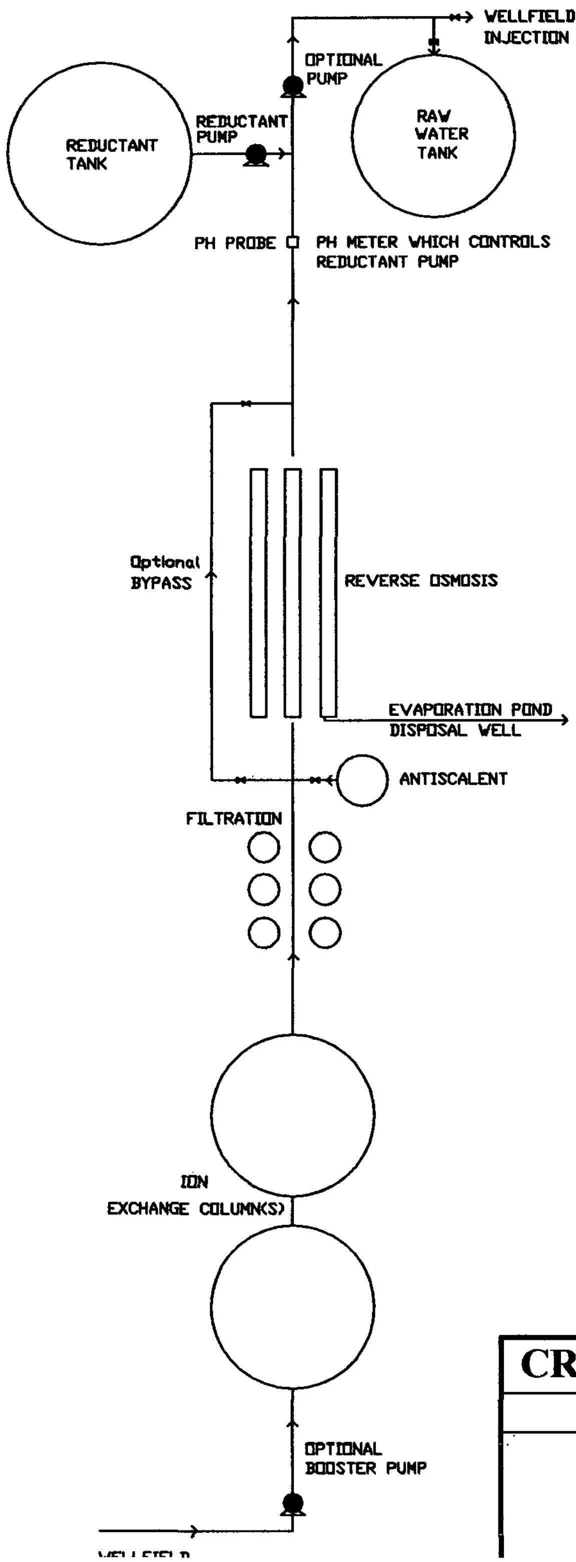
A portion of the restoration recovery water can be sent to the reverse osmosis (RO) unit. The use of a RO unit 1) reduces the total dissolved solids (TDS) in the contaminated groundwater; 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits; 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal; and, 4) enhances the exchange of ions from the formation due to the large difference in ion concentration.

Before the water can be processed by the RO, soluble uranium can be removed by the IX system. The RO unit contains membranes that pass about 60 to 75 percent of the water through, leaving 60 to 90 percent of the dissolved salts in the water that will not pass the membranes. Table 5-3 shows typical RO manufacturers' specification data for removal of ion constituents. The clean water, called "permeate", will be re-injected, sent to storage for use in the mining process, or sent to the wastewater disposal system. The 25 to 40 percent of water that is rejected, called "brine", contains the majority of dissolved salts that contaminate the groundwater and is sent for disposal in the waste system. Make-up water may be added to the wellfield injection stream to control the amount of "bleed" in the restoration areas.

The reductant (either biological or chemical) added to the injection stream during the groundwater treatment stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding a reductant, the Eh of the aquifer is lowered, thereby decreasing the solubility of these elements. Hydrogen sulfide (H_2S), sodium sulfide (Na_2S), or a similar compound will be added as a reductant. CBR typically uses sodium sulfide due to the chemical safety issues associated with proper handling

of hydrogen sulfide. A comprehensive safety plan regarding reductant use is implemented.

FIGURE 5-1
Restoration Process Flow Diagram



CROW BUTTE RESOURCES

DAWES COUNTY, NEBRASKA

Restoration Process Flow Diagram

The number of pore volumes treated and re-injected during the groundwater treatment stage will depend on the efficiency of the RO in removing total dissolved solids (TDS) and the reductant in lowering the uranium and trace element concentrations.

Table 5-3: Typical Reverse Osmosis Membrane Rejection

NAME	SYMBOL	PERCENT REJECTION
Cations		
Aluminum	Al^{+3}	99+
Ammonium	NH_4^{+1}	88-95
Cadmium	Cd^{+2}	96-98
Calcium	Ca^{+2}	96-98
Copper	Cu^{+2}	98-99
Hardness	Ca and Mg	96-98
Iron	Fe^{+2}	98-99
Magnesium	Mg^{+2}	96-98
Manganese	Mn^{+2}	98-99
Mercury	Hg^{+2}	96-98
Nickel	Ni^{+2}	98-99
Potassium	K^{+1}	94-96
Silver	Ag^{+1}	94-96
Sodium	Na^{+}	94-96
Strontium	Sr^{+2}	96-99
Zinc	Zn^{+2}	98-99
Anions		
Bicarbonate	HCO_3^{-1}	95-96
Borate	$B_4O_7^{-2}$	35-70
Bromide	Br^{-1}	94-96
Chloride	Cl^{-1}	94-95
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Ferrocyanide	$Fe(CN)_6^{-3}$	99+
Fluoride	F^{-1}	94-96
Nitrate	NO_3^{-1}	95
Phosphate	PO_4^{-3}	99+
Silicate	SiO_2^{-1}	80-95
Sulfate	SO_4^{-2}	99+
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+

Source: Osmonics, Inc.

- Wellfield Recirculation

At the completion of the groundwater treatment stage, wellfield recirculation may be initiated. In order to homogenize the aquifer, pumping from the production wells and re-injecting the recovered solution into injection wells may be performed to recirculate solutions.

The sequence of the activities will be determined by CBR based on operating experience and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by CBR.

Once the restoration activities are completed, CBR will sample the restoration wells and determine if the mining unit has achieved the restoration values, on a mine unit average basis. If so, CBR will notify the regulatory agencies that it is initiating the stabilization stage and will submit supporting documentation that the restoration parameters are at or below the restoration standards. If at the end of restoration activities the parameters are not at or below the approved values, CBR will either re-initiate certain steps of the restoration plan or submit documentation to the agencies that the best practical technology has been used in restoration. The documentation will include a justification for alternate parameter value(s), including available water quality data and a narrative of the restoration techniques used.

5.4.1.5 Stabilization Phase

Upon completion of restoration, a groundwater stabilization monitoring program will begin in which the restoration wells and any monitor wells on excursion status during mining operations will be sampled and analyzed for the restoration parameters listed in Table 5-2. The sampling frequency will be one sample per month for a period of 6 months, and if the 6 samples show that the restoration values for all wells are maintained during the stabilization period with no significant increasing trends, restoration shall be deemed complete.

5.4.1.6 Reporting

During the restoration process, CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be summarized and discussed in the Semiannual Radiological Effluent and Environmental Monitoring Report submitted to NRC. This information will also be included in the final report on restoration.

Upon completion of restoration activities and before stabilization, all designated restoration wells in the mine unit will be sampled for the constituents listed in Table

5-2. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NRC and the NDEQ, CBR will proceed with the stabilization phase of restoration.

During stabilization, all designated restoration wells will be sampled monthly for the constituents listed in Table 5-2. At the end of a six-month stabilization period, CBR will compile all water quality data obtained during restoration and stabilization and submit a final report to the regulatory agencies. If the analytical results continue to meet the appropriate standards for the mine unit and do not exhibit significant increasing trends, CBR would request the mine unit be declared restored. Following agency approval, wellfield reclamation and plugging and abandonment of wells will be performed as described in Section 5.1.1.

5.5 AIR QUALITY IMPACT MITIGATION MEASURES

Operational activities within the North Trend Expansion Area will cause a minimal increase in fugitive dust emissions. These emissions will be minimized on the mine property by strict enforcement of site speed limits. As discussed in Section 4.6, vehicle speed has a linear effect on the production of total suspended particulates (TSP). Speed limits at the current operation are 25 MPH or less. Similar controls will be implemented at the North Trend Expansion Area.

Dust emissions from county roads are expected to be a minimal incremental increase over those produced by current traffic levels. Implementation of dust mitigation measures (such as the application of water or dust control chemicals) to unpaved county roads are generally cost prohibitive. In the past, CBR has donated road surfacing materials to Dawes County for use on roads near residences that were adversely impacted by fugitive dust from CBR and public traffic.

5.6 VISUAL AND SCENIC RESOURCE IMPACT MITIGATION MEASURES

Mitigation measures are meant to minimize adverse contrasts of project facilities with the existing landscape. The measures should be applied to all facilities, even those that meet visual resource management (VRM) objectives. Mitigation would enable proposed project facilities to harmonize with the surrounding landscape to the extent feasible.

In addition to selecting paint colors that harmonize with the surrounding landscape, several other measures would minimize adverse effects of project facilities in the landscape.

- Using existing vegetation and topographic features to screen wells, facilities, and roads;
- Painting facilities with non-reflective paint that harmonizes with the surrounding landscape;
- Avoiding straight line-of-sight road construction;
- Aligning roads with the contours of the topography rather than cutting straight across contours to wellhouses, although this method of aligning the roads may result in a greater area of disturbance;
- Constructing clearings to appear as natural clearings by rounding corners and feathering the vegetation interface between the clearing and the surrounding grasses and shrubs (in those areas where the existing vegetation is dense, clearings should be irregular in shape); and,
- Removing construction debris immediately because it creates undesirable textural contrasts with the landscape.

In general, resource protection measures proposed for erosion control, road construction, rehabilitation and revegetation, and wildlife protection would mitigate effects to visual quality.

6 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 RADIOLOGICAL MONITORING

6.1.1 Background Radiological Characteristics

6.1.1.1 Introduction

This section discusses the environmental sampling program that CBR implemented to assess preoperational radiological background conditions in the vicinity of the North Trend Expansion Area. The results of this program, in comparison with the operational monitoring program that will be implemented during satellite operations, will be used to determine the effects on the environment, if any, of the proposed North Trend Expansion facilities.

Initial background radiological monitoring in the North Trend Expansion Area was performed over a period of one year beginning in July 1996 and lasting until June 1997. As part of this 1996 monitoring program, samples were collected and analyzed for the concentration of radionuclides in the pre-mining environment. The program was designed to meet the criteria outlined in USNRC Regulatory Guide 4.14 and was described in a preoperational environmental monitoring plan. The 1996 North Trend environmental monitoring program included sampling of air for radon, groundwater, soils, and vegetation and monitoring for direct gamma radiation. The 1996 monitoring program was designed to supplement the extensive environmental monitoring conducted by CBR in the project area since 1981. Coordination of the two programs allowed more comprehensive characterization and provides regional data.

In addition to the baseline data collected in 1996, CBR completed a supplementary monitoring program of the North Trend Expansion Area between July 2004 and June 2005. The purpose of this monitoring was to incorporate the guidance contained in NUREG-1569 and update and confirm the data collected in 1996. The 2004 North Trend environmental monitoring program included sampling of the air for radon and air particulates, groundwater, surface water, sediment, soils, and monitoring for direct gamma radiation.

The pre-mining North Trend data collected in 1996 and 2004 indicates that the existing background concentrations of the radionuclides of interest are in the range of baseline data previously collected by CBR for the current license area.

The results of the North Trend Expansion Area preoperational radiological monitoring are presented in this section. The results are organized by environmental media to allow ready comparison of monitoring data collected during both periods. A discussion of the scope of the monitoring program precedes the presentation of the data.

6.1.1.2 Baseline Air Monitoring

6.1.1.2.1 Selection of Air Monitoring Locations

USNRC Regulatory Guide 4.14 recommends that preoperational air monitoring should be conducted continuously at a minimum of three locations at or near the site boundary. Further, if there are residences or occupiable structures within 10 kilometers of the site, a continuous outdoor air sample should be collected at or near the structure with the highest predicted airborne radionuclide concentration. A continuous air sample should also be collected at a remote location that represents background conditions.

Five air monitoring locations were selected in 1996 as follows:

- One sample at the nearest affected residence to the projected location of the satellite plant (location NE-1);
- Four samples at the approximate 1996 North Trend Expansion license boundary locations (locations NE-2 through NE-5); and
- The background location recommended by Regulatory Guide 4.14. This location was identified as AM-6, which is used as the background control location for the current licensed operation. AM-6 is located on the eastern edge of the town of Crawford and is approximately one mile from the southern boundary of the North Trend Expansion Area.

CBR based the sample locations for the radon air monitoring program on the projected satellite plant location and license boundaries available in 1996. The sample locations for the radon air monitoring program were also based on the meteorological data available for the area. Data sources for the meteorological conditions are the Climatological Summary for Chadron, Nebraska and an on-site monitoring station which was located near the Crow Butte facility. The monitoring station on the Crow Butte site monitored temperature, precipitation, evaporation, wind speed and direction, and the standard deviation of the wind direction. The local meteorological station was operated from April 1982 through April 1984 during initial permitting for

the current licensed area. From this information joint frequency data was compiled. Further information on meteorological conditions is contained in Section 3.6.

Sample locations for the boundary and nearest resident samples were based upon the prevailing wind direction and the projected satellite plant location. As can be seen in the wind rose presented in Section 3.6 for the Crow Butte Project, the local wind direction is predominantly from south-southwest direction approximately 45 percent of the time. Winds can also be from the northeast. The boundary sample locations were determined based upon this data.

Figure 6-1 contains a map of the North Trend Expansion Area showing the 1996 monitoring locations. As noted, the air monitoring locations were designated as NE-1 (nearest residence); NE-2, NE-3, NE-4, and NE-5 (boundaries); and AM-6 (background control).

FIGURE 6-1

1996 - 1997 Preoperational Radiological Sampling Locations

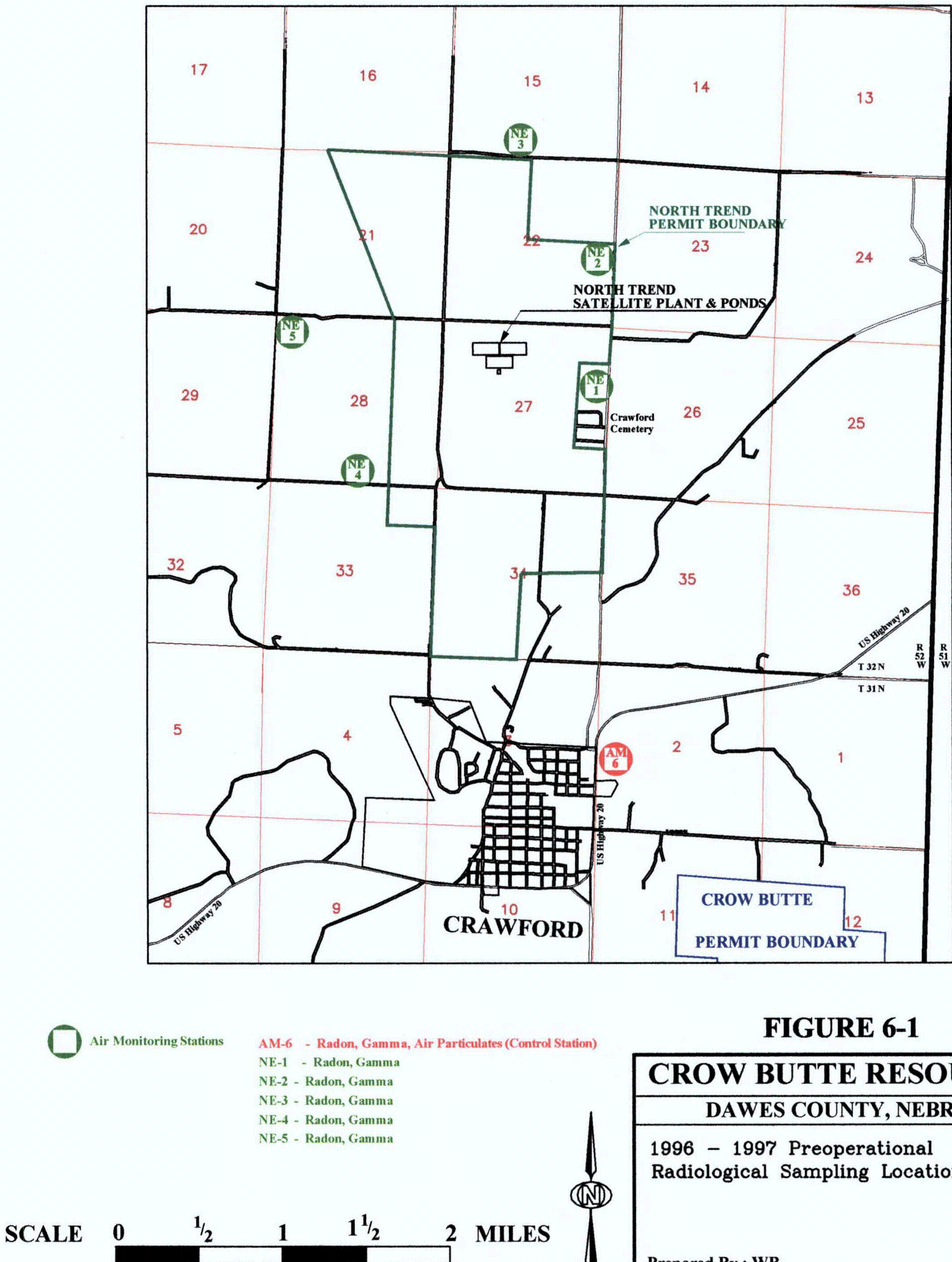


FIGURE 6-1

CROW BUTTE RESOURCES	
DAWES COUNTY, NEBRASKA	
1996 – 1997 Preoperational Radiological Sampling Locations	
Prepared By : WB	
Drawn By: WB	Date: 1/07

In general, the monitoring conducted in 2004 was an update of the 1996 monitoring. However, several changes were made to the air monitoring locations to more accurately provide boundary data based on the revised license boundaries, a revised satellite plant location, and to monitor additional nearby residences. Seven monitoring locations were used in the 2004 program. Following is a summary of the changes made to the air monitoring locations:

- NE-1 was located at the entrance to a nearby residence that was determined in 1996 to be the nearest affected residence for a potential satellite facility. This monitoring location was determined to be the most affected residence and was not changed for the 2004 monitoring. However, the location was redesignated AM-9 to be consistent with the air monitoring location designations used for the current license area (i.e., AM-1 through AM-8 are currently in use).

- NE-2 was moved approximately ½ mile north from the 1996 location to more accurately measure the north license boundary and to monitor conditions near a nearby residence. NE-2 was redesignated AM-10.

- NE-3 was determined to be unnecessary due to the location of AM-10 at the north boundary and was not monitored in 2004.

- NE-4 was moved approximately ½ mile east to a nearby residence that is in close proximity to the proposed satellite plant location. NE-4 was redesignated AM-12.

- NE-5 was redesignated AM-11 and was used to monitor the west license boundary.

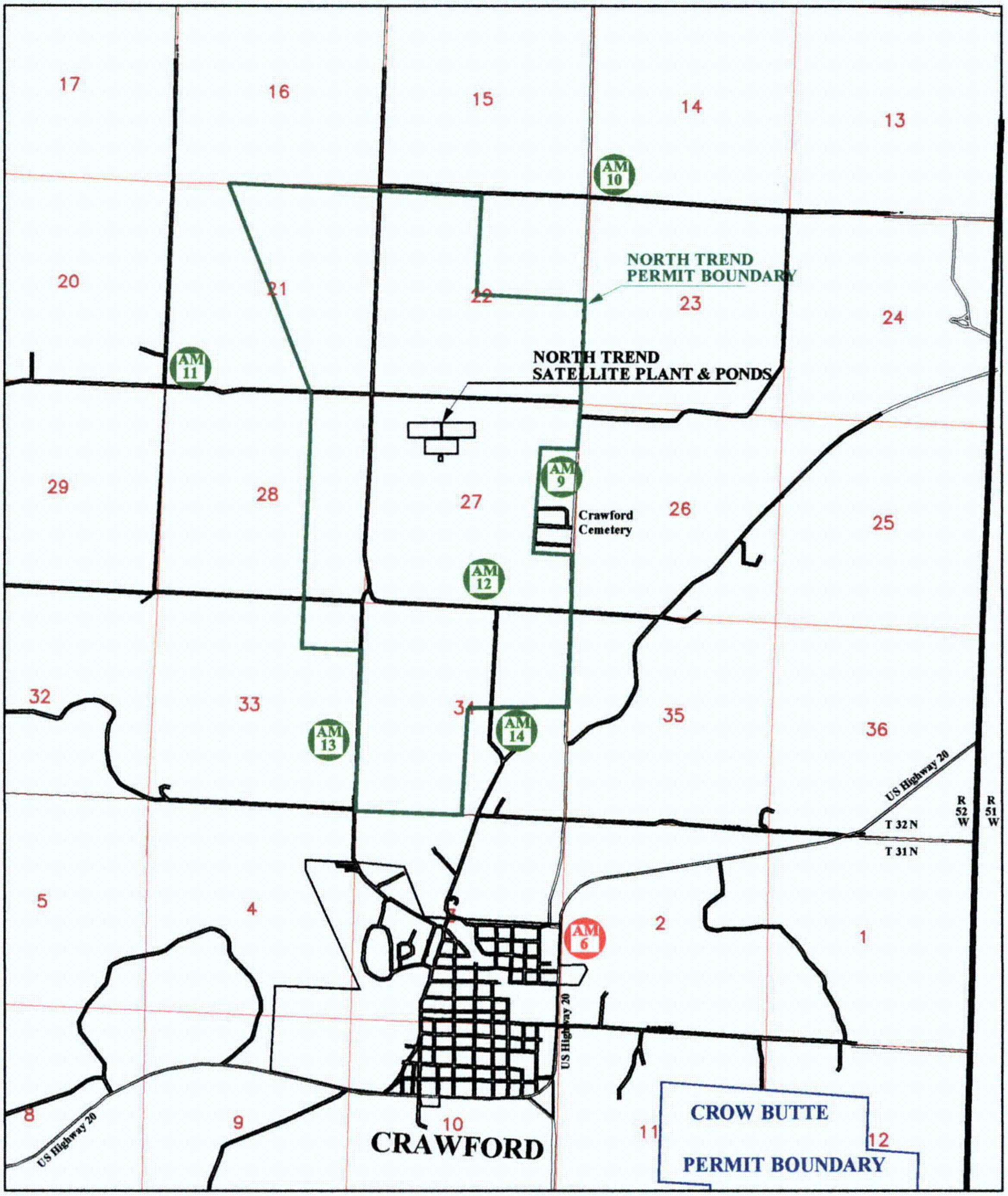
- New monitoring location AM-13 was established near the southwest corner of the proposed license boundary to monitor conditions near a residence and immediately north of the town of Crawford.

- New monitoring location AM-14 was established near the southeast corner of the proposed license boundary to monitor conditions near several residences and immediately north of the town of Crawford.

- The background location was again identified as AM-6, which is used as the background control location for the current licensed operation.

Figure 6-2 contains a map of the North Trend Expansion Area showing the 2004 monitoring locations.

FIGURE 6-2
2004 - 2005 Preoperational Radiological Sampling Locations



Air Monitoring Stations

- AM-6 - Radon, Gamma, Air Particulates (Control Station)
- AM-9 - Radon, Gamma
- AM-10 - Radon, Gamma, Air Particulates
- AM-11 - Radon, Gamma
- AM-12 - Radon, Gamma
- AM-13 - Radon, Gamma
- AM-14 - Radon, Gamma

SCALE 0 ½ 1 1½ 2 MILES

N

FIGURE 6-2

CROW BUTTE RESOURCES

DAWES COUNTY, NEBRASKA

2004 – 2005 Preoperational Radiological Sampling Locations

Prepared By : WB

Drawn By: WB

Date: 1/07

6.1.1.2.2 Radon Gas Monitoring Program

Air monitoring in 1996 involved radon gas sampling performed at quarterly intervals at air monitoring locations NE-1 through NE-5 and AM-6. Monitoring was performed using RadTrak® Type DRNF outdoor air radon detectors. RadTrak® cups contain a sensitized chip covered with a selectively permeable material allowing only the infiltration of radon. The sensitized chip records alpha disintegrations from radon daughters, allowing determination of average radon concentrations. The analysis of quarterly sampling has a sensitivity of 30 pCi/l-days.

Air monitoring in 2004 involved radon gas sampling performed at semiannual intervals using RadTrak® Type DRNF outdoor air radon detectors. The semiannual interval was chosen to ensure that monitoring results meet the lower limit of detection (LLD) requirement of 0.2 pCi/l (2×10^{-10} μCi/ml) from Regulatory Guide 4.14 and to be consistent with the semiannual intervals approved by NRC for the current operational monitoring.

Air monitoring for radon gas was performed for the North Trend Expansion Area during the third and fourth quarters of 1996 and the first and second quarters of 1997. A duplicate RadTrak® detector was installed at location NE-5 as a quality control measure and is denoted "NE-5 (D)" in the results.

The results of the 1996 radon sampling are presented in Table 6-1.This table gives the concentration of radon in air that were obtained at the air monitoring stations. The average values were consistent for all five monitoring stations with mean values ranging from 0.53×10^{-9} to 0.93×10^{-9} μCi/ml.

Table 6-1

Ambient Atmospheric Radon-222 Concentration North Trend Expansion Area (1996 – 1997)

Third Quarter 1996			
Location	**Date**	**Concentration µCi/ml x 10^{-9}**	**Error Estimate µCi/ml x 10^{-9}**
NE-1	7/2/96 - 10/1/96	0.6	0.13
NE-2	7/2/96 - 10/1/96	1.2	0.17
NE-3	7/2/96 - 10/1/96	0.7	0.12
NE-4	7/2/96 - 10/1/96	0.9	0.14
NE-5	7/2/96 - 10/1/96	0.9	0.11
NE-5 (D)	7/3/96 - 10/1/96	0.7	0.11
AM-6	7/1/96 – 10/1/96	0.8	0.09
Fourth Quarter 1996			
Location	**Date**	**Concentration µCi/ml x 10^{-9}**	**Error Estimate µCi/ml x 10^{-9}**
NE-1	10/1/96 - 1/2/97	0.6	0.15
NE-2	10/1/96 - 1/2/97	1.0	0.13
NE-3	10/1/96 - 1/2/97	0.7	0.13
NE-4	10/1/96 - 1/2/97	0.7	0.14
NE-5	10/1/96 - 1/2/97	1.0	0.13
NE-5 (D)	10/1/96 - 1/2/97	0.7	0.12
AM-6	10/1/96 - 1/2/97	0.8	0.10

Table 6-1 (continued)
Ambient Atmospheric Radon-222 Concentration
North Trend Expansion Area (1996 – 1997)

First Quarter 1997			
Location	**Date**	**Concentration** μ**Ci/ml x 10^{-9}**	**Error Estimate** μ**Ci/ml x 10^{-9}**
NE-1	1/2/97 - 4/1/97	0.8	0.14
NE-2	1/2/97 - 4/1/97	1.0	0.13
NE-3	1/2/97 - 4/1/97	0.5	n/a
NE-4	1/2/97 - 4/1/97	0.7	0.11
NE-5	1/2/97 - 4/1/97	0.5	0.09
NE-5 (D)	1/2/97 - 4/1/97	0.3	0.07
AM-6	1/2/97 - 4/1/97	0.3	0.05

Second Quarter 1997			
Location	**Date**	**Concentration** μ**Ci/ml x 10^{-9}**	**Error Estimate** μ**Ci/ml x 10^{-9}**
NE-1	4/1/97 - 7/1/97	0.7	0.15
NE-2	4/1/97 - 7/1/97	0.9	0.14
NE-3	4/1/97 - 7/1/97	0.8	0.12
NE-4	4/1/97 - 7/1/97	1.0	0.13
NE-5	4/1/97 - 7/1/97	1.0	0.13
NE-5 (D)	4/1/97 - 7/1/97	1.0	0.12
AM-6	4/1/97 - 7/1/97	0.7	0.09

Table 6-1 (continued)
Ambient Atmospheric Radon-222 Concentration
North Trend Expansion Area (1996 – 1997)

Mean 1996 – 1997 Radon Concentration		
Location	**Mean Concentration** $\mu Ci/ml \times 10^{-9}$	**Standard Deviation** $\mu Ci/ml \times 10^{-9}$
NE-1	0.675	0.09
NE-2	0.93	0.25
NE-3	0.60	0.20
NE-4	0.78	0.15
NE-5	0.65	0.19
NE-5 (D)	0.53	0.15
AM-6	0.65	0.24

The results of the 2004 radon sampling are presented in Table 6-2. This table gives the concentration of radon in air that were obtained at the seven air monitoring stations on a semiannual basis for the twelve month period beginning with the third quarter of 2004. Two duplicate RadTrak® detectors were installed at locations AM-10 and AM-13 as a quality control measure and are denoted as “AM-10 (D)” and “AM-13 (D)” in the results.

Table 6-2: Ambient Atmospheric Radon-222 Concentration North Trend Expansion Area (2004 – 2005)

Second Half 2004			
Location	**Date**	**Concentration (μCi/ml) x 10^{-9}**	**Error Estimate (μCi/ml) x 10^{-9}**
AM-6 (Bkgd)	7/1/04 - 1/3/05	0.2	0.04
AM-9 (NE-1)	7/1/04 - 1/3/05	0.6	0.06
AM-10	7/1/04 - 1/3/05	0.5	0.05
AM-10 (D)	7/1/04 - 1/3/05	0.6	0.06
AM-11 (NE-5)	7/1/04 - 1/3/05	0.5	0.05
AM-12	7/1/04 - 1/3/05	0.4	0.04
AM-13	7/1/04 - 1/3/05	0.5	0.05
AM-13 (D)	7/1/04 - 1/3/05	0.7	0.06
AM-14	7/1/04 - 1/3/05	Detector Cup Missing	N/A
First Half 2005			
Location	**Date**	**Concentration (μCi/ml) x 10^{-9}**	**Error Estimate (μCi/ml) x 10^{-9}**
AM-6 (Bkgd)	1/3/05 – 7/5/05	0.3	0.04
AM-9 (NE-1)	1/3/05 – 7/5/05	0.5	0.05
AM-10	1/3/05 – 7/5/05	0.6	0.06
AM-10 (D)	1/3/05 – 7/5/05	0.4	0.05
AM-11 (NE-5)	1/3/05 – 7/5/05	0.5	0.05
AM-12	1/3/05 – 7/5/05	0.5	0.05
AM-13	1/3/05 – 7/5/05	0.5	0.05
AM-13 (D)	1/3/05 – 7/5/05	0.6	0.06
AM-14	1/3/05 – 7/5/05	0.2	0.03

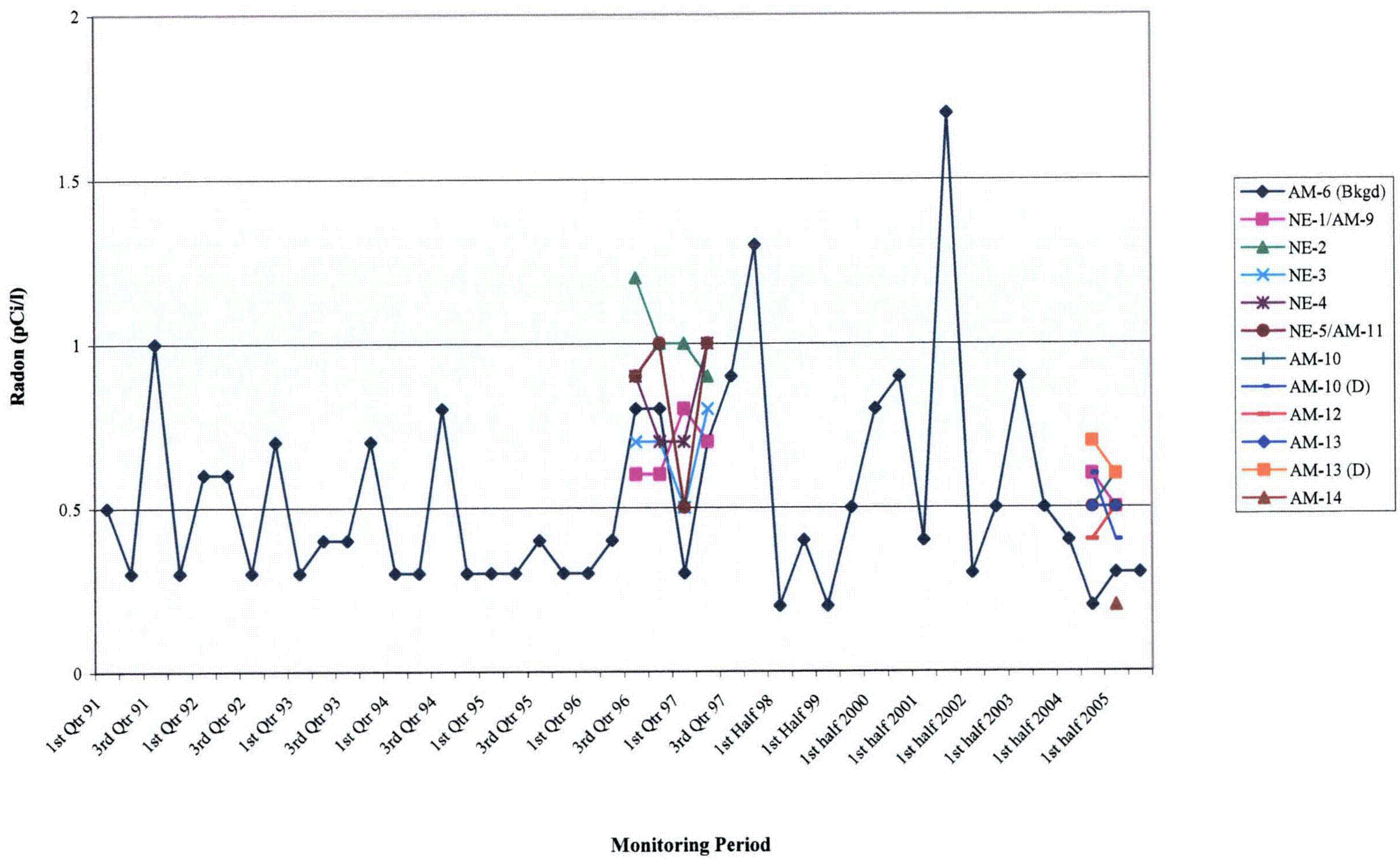
Mean 2004 – 2005 Radon Concentration	
Location	**Mean Concentration $\mu Ci/ml \times 10^{-9}$**
AM-6 (Bkgd)	0.25
AM-9 (NE-1)	0.55
AM-10	0.55
AM-10 (D)	0.50
AM-11 (NE-5)	0.50
AM-12	0.45
AM-13	0.50
AM-13 (D)	0.65
AM-14	0.2

The average values for the twelve month period were consistent for all seven monitoring stations with mean values ranging from 0.2×10^{-9} to 0.65×10^{-9} $\mu Ci/ml$. Note that the average for AM-14 (0.2×10^{-9} $\mu Ci/ml$) is based on a single monitoring result for the first half of 2005 since the detector for the second half of 2004 was missing at the end of the monitoring period.

Figure 6-3 is a plot of the results of radon monitoring from the North Trend air monitoring locations from the 1996 and 2004 baseline programs. The monitoring results for the background station AM-6 from January 1991 through June 2005 are also included for comparison.

The operational monitoring sites proposed for the North Trend satellite facility will be the same as those used to determine preoperational concentrations of radon in 2004. Operational monitoring of radon concentrations will continue as long as uranium recovery and restoration activities are in progress.

Figure 6-3
North Trend Baseline Environmental Radon Monitoring



6.1.1.2.3 Air Particulate Monitoring Program

For the 1996 baseline monitoring program, CBR determined that air particulate monitoring was not appropriate for the North Trend Expansion Area. Activities at North Trend will involve the operation of a satellite facility, which will not include drying, handling, or packaging of yellowcake. All drying and packaging operations will be performed at the current central plant facility. Therefore, there are no operations at the satellite plant that could cause a release of airborne particulate radionuclides and the 1996 monitoring program did not include air particulate monitoring.

For the 2004 monitoring period, CBR determined in discussions with USNRC staff that it would be useful to add a baseline preoperational air particulate monitoring station at the north end of the North Trend Expansion Area to provide additional regional background radiological information. This air monitoring station was designated as AM-10. Data from this station may be compared with air particulate data from AM-6, which is located south of the North Trend Expansion Area and has been monitored since 1982 as a background location for the current license area.

The airborne particulate samples were collected on the inlet filter of a regulated vacuum pump on a Type A/E 47 mm glass fiber filter paper. The low volume air samplers employed were the Eberline RAS-1 system that consists of a vacuum pump, an airflow regulator, a rotameter-type airflow indicator, and filter paper holder. The RAS-1 samplers were placed in protective enclosures that provided protection from the elements while allowing unimpeded sampling of the ambient air.

Clean filters were installed in the filter holder at the beginning of each sampling period. The pump flow rate was adjusted as necessary. The filter replacement schedule was determined based on the dust loading at a particular location. In general, samplers were run for one to two weeks without a significant reduction in the flow rate due to dust loading.

At the end of the calendar quarter, the composite filter samples for AM-6 and AM-10 were submitted to the contract laboratory for radiometric analysis using standard Chain of Custody Procedures. The filters were composited according to location. The composite samples were analyzed for the concentrations of natural uranium, radium-226, and lead-210. Thorium-230 was not selected for analysis as recommended in USNRC Regulatory Guide 4.14 based on the current NRC-approved Crow Butte operational air particulate monitoring program. Thorium-230 is not typically released through the *in-situ* leach mining process and is not a radionuclide of concern.

The flow rate on the RAS-1 pumps was calibrated at six-month intervals using accepted calibration methods in order to ensure the accuracy of the volume of air sampled. Records of sampler calibration are available on file at the Crow Butte Uranium Project.

As discussed with NRC staff in 2004, CBR does not propose to perform operational air particulate monitoring at AM-10 due to the absence of proposed operations that could be a source of airborne radioactive particulates. CBR will continue airborne particulate sampling at the air monitoring stations AM-1 through AM-8 for the current license area to monitor drying and packaging operations at the central process plant.

Air particulate monitoring for the North Trend Expansion Area was performed at locations AM-6 (background) and AM-10 (north boundary) during the third and fourth quarters of 2004 the first and second quarters of 2005. The results of the air particulate sampling are presented in Table 6-3. This table gives the concentrations of natural uranium, radium-226, and lead-210 in air that were obtained at the air monitoring stations.

Table 6-3

Airborne Particulate Concentrations
North Trend Expansion Area (2004 - 2005)

Location	Radionuclide	Date	Concentration µCi/ml	Error Estimate µCi/ml	LLD µCi/ml
Third Quarter 2004					
AM-6	Uranium	7/1/04 - 10/01/04	<1.00 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		1.21 E^{-16}	1.11 E^{-16}	1.00 E^{-16}
	Lead 210		1.93 E^{-14}	2.11E^{-15}	2.00 E^{-15}
AM-10	Uranium	7/1/04 – 10/1/04	<1.00 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.01 E^{-14}	1.93 E^{-15}	2.00 E^{-15}
Fourth Quarter 2004					
AM-6	Uranium	10/1/04 – 1/3/05	1.05 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.92 E^{-14}	1.07 E-15	2.00 E^{-15}
AM-10	Uranium	10/1/04 – 1/3/05	1.28 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.48 E^{-14}	9.65 E^{-16}	2.00 E^{-15}
First Quarter 2005					
AM-6	Uranium	1/3/05 – 4/1/05	1.05 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.84 E^{-14}	1.45 E^{-15}	2.00 E^{-15}
AM-10	Uranium	1/3/05 – 4/1/05	1.78 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.83 E^{-14}	1.38 E^{-15}	2.00 E^{-15}

Table 6-3 (continued)

Airborne Particulate Concentrations
North Trend Expansion Area (2004 - 2005)

Location	Radionuclide	Date	Concentration µCi/ml	Error Estimate µCi/ml	LLD µCi/ml
Second Quarter 2005					
AM-6	Uranium	4/1/05 – 7/5/05	1.24 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.08 E^{-14}	1.27 E^{-15}	2.00 E^{-15}
AM-10	Uranium	4/1/05 – 7/5/05	1.81 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.22 E^{-14}	1.29 E^{-15}	2.00 E^{-15}

6.1.1.2.4 Quality of Air Measurements

The accuracy of monitoring data is critical to ensure that the preoperational air monitoring program precisely reflects air quality. Regulatory Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclide	Recommended LLD µCi/ml	Actual LLD µCi/ml
Natural Uranium	1×10^{-16}	1×10^{-16}
Radium-226	1×10^{-16}	1×10^{-16}
Radon-222	2×10^{-10}	3×10^{-10} (1996 - 1997 data) 2×10^{-10} (2004 - 2005 data)
Lead-210	2×10^{-15}	2×10^{-15}

Note that Landauer does not provide the LLD on the analytical report. The LLD for Radtrak® detectors is a function of the exposure time and the area of the cup that is analyzed by Landauer.

6.1.1.3 Baseline Groundwater Monitoring

CBR conducted a water user survey in 1996 to identify and locate all private water supply wells within a 2-mile radius of the proposed North Trend license boundary. The water user survey determined the location, depth, casing size, depth to water, and flow rate of all wells within the area that were (or could be) used for domestic, agricultural, or livestock uses. Based on the data collected during the well user survey, CBR selected five representative wells in the North Trend Expansion Area for quarterly groundwater monitoring for selected radionuclides. The wells were chosen based on proximity to the proposed mining operation, use, and distribution throughout the expansion area.

The well locations are shown on Figure 6-1. This section will discuss the results of the radiometric analyses. Information on the selected wells including formation, depth, and usage is shown in Table 6-4.

Table 6-4: Private Wells Sampled Within the North Trend Expansion Area

Well Number	Formation	Estimated Depth (ft)	Use
W-77	Brule	61	Agricultural
W-78	Brule	98	Domestic
W-81	Chadron	630	Agricultural
W-83	Brule	50	Domestic
W-107	Brule	100	Domestic

CBR updated the water user survey for the current license area, the North Trend area, and the town of Crawford in 2004. CBR conducted groundwater sampling at the same five private wells in the third and fourth quarters of 2004 and the first and second quarters of 2005. The wells were sampled on a quarterly basis for natural uranium, thorium-230, radium-226, lead-210, and polonium-210. The wells were also sampled for uranium and radium-226 during the third quarter of 2005. In addition, a well installed in the Chadron Formation for hydrologic testing was sampled for water quality parameters as discussed in Section 3.4.

The 1996 sampling program began in the third quarter of 1996 with quarterly samples taken for one year. Additional monitoring was performed on a quarterly basis for one year beginning in the third quarter of 2004. The samples were collected at a discharge point close to the well and preserved following EPA Guidelines. The 1996 samples

were not filtered and the results represent the total concentration of the radionuclides. The 2004 samples were filtered and the results represent the dissolved concentration of the radionuclides. The primary analytical laboratory in 1996 and 2004 was Energy Laboratories in Casper, Wyoming. Some wells were also sampled for water quality parameters. The results of those analyses are discussed in section 3.4.

Table 6-5 contains the results of the analyses for radionuclides for all private wells sampled for the North Trend Expansion Area during 1996 – 1997 and 2004 - 2005. Results are for concentrations of natural uranium, thorium-230, radium-226, lead-210, and polonium-210 with the exception of the first quarter of 2005, when an error in the chain of custody resulted in no analysis for thorium-230, polonium-210, and lead-210.

Table 6-5
Private Well Monitoring
Third Quarter 1996

Location	Radionuclide	Date	Concentration µCi/ml x 10^{-9}	Error Estimate µCi/ml x 10^{-9}	LLD µCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	9/5/1996	8.8		0.2
	Th-230		10.8	1.0	0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
Brule Wells					
W-77	U-Nat	9/9/1996	31.1		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-78	U-Nat	9/5/1996	16.2		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		13.5	1.2	1.0
	Po-210		<1.0		1.0
W-83	U-Nat	9/9/1996	19.5		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-107	U-Nat	9/9/1996	10.8		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0

Table 6-5 (continued)
Private Well Monitoring
Fourth Quarter 1996

Location	Radionuclide	Date	Concentration μCi/ml x 10^{-9}	Error Estimate μCi/ml x 10^{-9}	LLD μCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	12/10/1996	<0.2		0.2
	Th-230		<0.2		0.2
	Ra-226		13.5	1.1	0.2
	Pb-210		12.9	4.5	1.0
	Po-210		3.3	0.7	1.0
Brule Wells					
W-77	U-Nat	12/10/1996	15.6		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-78	U-Nat	12/10/1996	7.45		0.2
	Th-230		<0.2		0.2
	Ra-226		0.4	0.2	0.2
	Pb-210		<1.0		1.0
	Po-210		1.4	0.4	1.0
W-83	U-Nat	12/10/1996	10.8		0.2
	Th-230		<0.2		0.2
	Ra-226		0.4	0.2	0.2
	Pb-210		2.5	1.2	1.0
	Po-210		<1.0		1.0
W-107	U-Nat	12/10/1996	8.12		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0

**Table 6-5 (continued)
Private Well Monitoring
First Quarter 1997**

Location	Radionuclide	Date	Concentration μCi/ml x 10^{-9}	Error Estimate μCi/ml x 10^{-9}	LLD μCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	3/11/1997	<0.2		0.2
	Th-230		<0.2		0.2
	Ra-226		10.9	1.0	0.2
	Pb-210		4.9	0.6	1.0
	Po-210		<1.0		1.0
Brule Wells					
W-77	U-Nat	3/11/1997	18.3		0.2
	Th-230		1.2	0.6	0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-78	U-Nat	3/11/1997	10.2		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-83	U-Nat	3/11/1997	14.9		0.2
	Th-230		1.0	0.5	0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-107	U-Nat	3/12/1997	6.09		0.2
	Th-230		<0.2		0.2
	Ra-226		0.5	0.1	0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0

Table 6-5 (continued)
Private Well Monitoring
Second Quarter 1997

Location	Radionuclide	Date	Concentration µCi/ml x 10^{-9}	Error Estimate µCi/ml x 10^{-9}	LLD µCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	6/16/1997	<0.2		0.2
	Th-230		<0.2		0.2
	Ra-226		12.7	1.1	0.2
	Pb-210		<1.0	1.2	1.2
	Po-210		12.4	1.2	1.0
Brule Wells					
W-77	U-Nat	6/16/1997	17.9		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		1.7	0.1	1.0
W-78	U-Nat	6/16/1997	10.7		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		2.0	0.1	1.0
W-83	U-Nat	6/16/1997	15.5		0.2
	Th-230		<0.2		0.2
	Ra-226		1.3	0.2	0.2
	Pb-210		<1.0		1.0
	Po-210		5.2	0.2	1.0
W-107	U-Nat	6/16/1997	8.9		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		8.6	0.3	1.0

Table 6-5 (continued)
Private Well Monitoring
Third Quarter 2004

Location	Radionuclide	Date	Concentration μCi/ml x 10^{-9}	Error Estimate μCi/ml x 10^{-9}	LLD μCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	7/30/2004	0.7		0.2
	Th-230		<0.2		0.2
	Ra-226		10.6	1.7	0.2
	Pb-210		<1.0		1.0
	Po-210		<2.7		2.7
Brule Wells					
W-77	U-Nat	7/30/2004	15		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<2.7		2.7
W-78	U-Nat	7/30/2004	9.6		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		1.4	0.8	1.0
	Po-210		<2.7		2.7
W-83	U-Nat	7/30/2004	16		0.2
	Th-230		<0.2		0.2
	Ra-226		0.8	0.7	0.2
	Pb-210		<1.0		1.0
	Po-210		<2.7		2.7
W-107	U-Nat	7/30/2004	8		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<2.7		2.7

Table 6-5 (continued)
Private Well Monitoring
Fourth Quarter 2004

Location	Radionuclide	Date	Concentration µCi/ml x 10^{-9}	Error Estimate µCi/ml x 10^{-9}	LLD µCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	11/17/2004	0.77		0.2
	Th-230		<0.2		0.2
	Ra-226		11.4	1.2	0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
Brule Wells					
W-77	U-Nat	11/17/2004	16		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-78	U-Nat	11/11/2004	9.3		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-83	U-Nat	11/17/2004	16		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-107	U-Nat	12/10/1996	8		0.2
	Th-230		<0.2		0.2
	Ra-226		0.7	0.4	0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0

Table 6-5 (continued)
Private Well Monitoring
First Quarter 2005

Location	Radionuclide	Date	Concentration µCi/ml x 10^{-9}	Error Estimate µCi/ml x 10^{-9}	LLD µCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	3/5/2005	0.7		0.2
	Ra-226		11.0	1.2	0.2
Brule Wells					
W-77	U-Nat	3/4/2005	20		0.2
	Ra-226		<0.2		0.2
W-78	U-Nat	3/4/2005	20		0.2
	Ra-226		<0.2		0.2
W-83	U-Nat	3/4/2005	20		0.2
	Ra-226		<0.2		0.2
W-107	U-Nat	3/4/2005	8		0.2
	Ra-226		<0.2		0.2

Note: Due to an error on the chain of custody, the groundwater samples for the first quarter 2005 were not analyzed for thorium-230, lead-210, and polonium-210.

Table 6-5 (continued)
Private Well Monitoring
Second Quarter 2005

Location	Radionuclide	Date	Concentration µCi/ml x 10^{-9}	Error Estimate µCi/ml x 10^{-9}	LLD µCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	5/27/2005	0.7		0.2
	Th-230		<0.2		0.2
	Ra-226		9.2	1.6	0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
Brule Wells					
W-77	U-Nat	5/27/2005	17		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-78	U-Nat	5/27/2005	12		0.2
	Th-230		<0.2		0.2
	Ra-226		0.6	0.6	0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-83	U-Nat	5/27/2005	18		0.2
	Th-230		<0.2		0.2
	Ra-226		0.6	0.6	0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-107	U-Nat	5/27/2005	8.7		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0

Table 6-5 (continued)
Private Well Monitoring
Third Quarter 2005

Location	Radionuclide	Date	Concentration µCi/ml x 10^{-9}	Error Estimate µCi/ml x 10^{-9}	LLD µCi/ml x 10^{-9}
Chadron Well					
W-81	U-Nat	9/16/2005	1.2		0.2
	Ra-226		10.2	1.2	0.2
Brule Wells					
W-77	U-Nat	9/16/2005	18		0.2
	Ra-226		<0.2		0.2
W-78	U-Nat	9/16/2005	12		0.2
	Ra-226		<0.2		0.2
W-83	U-Nat	9/16/2005	19		0.2
	Ra-226		0.2	0.4	0.2
W-107	U-Nat	9/16/2005	8.9		0.2
	Ra-226		<0.2		0.2

The results of the analyses indicate concentrations of the radionuclides are within the expected ranges for naturally occurring background in the area. The concentration of uranium in the wells completed in the Brule Formation within the North Trend Expansion Area ranged from <0.2 to 31.1 x 10^{-9} µCi/ml (<0.0003 to 0.05 mg/l). The concentration of radium-226 in these same wells ranged from <0.2 to 1.3 x 10^{-9} µCi/ml with the majority of the wells below the detection level.

One well within the North Trend Expansion Area (W-81) was completed in the Chadron Formation. This well was used by a local resident for irrigation purposes. The uranium results for well W-81 varied between <0.2 to 8.8 x10^{-9} µCi/ml. Radium-226 in this well was consistently above the detection level with a maximum concentration of 13.5 x 10^{-9} µCi/ml. Several other radionuclides were above detection levels on individual samples. These results are consistent with baseline sampling performed on Chadron wells in the current license area. Following the baseline collection period, the owner of well W-81 had the well plugged and abandoned due to well maintenance problems and does not intend to replace the well with another well in the Chadron Formation.

6.1.1.3.1 Quality of Groundwater Measurements

The accuracy of monitoring data is critical to ensure that the water monitoring program precisely reflects water quality.

In addition to recommending the use of approved analytical methods for water quality measurements (contained in 40 CFR 136), the USNRC also specifies analytical quality requirements in USNRC Regulatory Guide 4.14 for the following lower limits of detection (LLD) in water:

Radionuclide	**Recommended LLD µCi/ml**	**Actual LLD µCi/ml**
Natural Uranium	2 x 10^{-10}	2 x 10^{-10}
Thorium-230	2 x 10^{-10}	2 x 10^{-10}
Radium-226	2 x 10^{-10}	2 x 10^{-10}
Polonium-210	1 x 10^{-9}	1 x 10^{-9}
Lead-210	1 x 10^{-9}	1 x 10^{-9}

6.1.1.4 Baseline Surface Water Monitoring

The White River is located south of the North Trend Expansion Area. CBR has performed preoperational monitoring on the White River at locations W-1, W-2, and W-3 in connection with the current license area. Results for initial baseline sampling conducted during studies for the current license area were previously reported to NRC. The location of W-1 northeast of the North Trend Expansion Area is suitable for use as a downstream sample location.

Five sets of surface water samples were collected from W-1 and W-2 on a quarterly basis from the third quarter of 2004 through the third quarter of 2005. A summary of the results for the preoperational radiological surface water monitoring is given in Table 6-6. All samples were analyzed for the concentration of natural uranium, thorium-230, radium-226, lead-210 and polonium-210 with the exception of the first and third quarters of 2005, when an error in the chain of custody resulted in no analysis for thorium-230, polonium-210, and lead-210. The samples were filtered and the results of the analysis represent the dissolved concentrations. The primary analytical laboratory was Energy Laboratories in Casper, Wyoming.

Table 6-6
Surface Water Monitoring

Location	Radionuclide	Date	Concentration µCi/ml x 10^{-9}	Error Estimate µCi/ml x 10^{-9}	LLD µCi/ml x 10^{-9}
Third Quarter 2004					
W-1	U-Nat	7/30/2004	3.6		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-2	U-Nat	7/30/2004	4.2		0.2
	Th-230		<0.2		0.2
	Ra-226		1.0	0.7	0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
Fourth Quarter 2004					
W-1	U-Nat	11/11/2004	4.0		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-2	U-Nat	11/11/2004	4.3		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0

Table 6-6 (continued)
Surface Water Monitoring

Location	Radionuclide	Date	Concentration µCi/ml x 10^{-9}	Error Estimate µCi/ml x 10^{-9}	LLD µCi/ml x 10^{-9}
First Quarter 2005					
W-1	U-Nat	3/4/2005	5.0		0.2
	Ra-226		<0.2		0.2
W-2	U-Nat	3/4/2005	5.0		0.2
	Ra-226		<0.2		0.2
Second Quarter 2005					
W-1	U-Nat	5/27/2005	4.5		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
W-2	U-Nat	5/27/2005	4.7		0.2
	Th-230		<0.2		0.2
	Ra-226		<0.2		0.2
	Pb-210		<1.0		1.0
	Po-210		<1.0		1.0
Third Quarter 2005					
W-1	U-Nat	9/16/2005	4.6		0.2
	Ra-226		<0.2		0.2
W-2	U-Nat	9/16/2005	4.9		0.2
	Ra-226		<0.2		0.2

Note: Due to an error on the chain of custody, the groundwater samples for the first quarter 2005 were not analyzed for thorium-230, lead-210, and polonium-210.

6.1.1.4.1 Quality of Surface Water Measurements

The accuracy of monitoring data is critical to ensure that the water monitoring program precisely reflects water quality.

In addition to recommending the use of approved analytical methods for water quality measurements (contained in 40 CFR 136), the USNRC also specifies analytical quality requirements in USNRC Regulatory Guide 4.14 for the following lower limits of detection (LLD) in water:

Radionuclide	Recommended LLD µCi/ml	Actual LLD µCi/ml
Natural Uranium	2×10^{-10}	2×10^{-10}
Thorium-230	2×10^{-10}	2×10^{-10}
Radium-226	2×10^{-10}	2×10^{-10}
Polonium-210	1×10^{-9}	1×10^{-9}
Lead-210	1×10^{-9}	1×10^{-9}

6.1.1.5 Baseline Vegetation Monitoring

CBR conducted vegetation sampling in and near the current licensed area beginning in 1982 through 1998. Preoperational and operational vegetation sampling was conducted at the primary air monitoring stations (AM-1 through AM-8) during this period. In 1996, vegetation samples were obtained once during the grazing season from the five North Trend air monitoring locations (NE-1 through NE-5) and analyzed for natural uranium, thorium-230, radium-226, lead-210, and polonium-210.

As approved by NRC in the renewal of Source Materials License SUA-1534 in 1998, operational vegetation sampling was discontinued at the Crow Butte Uranium Project. This approval was based on the NRC recommendations in Regulatory Guide 4.14, which state that vegetation sampling should be conducted only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant pathway, defined as resulting in a dose in excess of five percent of the applicable protection standard. Based on this change to the Crow Butte license, preoperational baseline vegetation sampling was not repeated in 2004 – 2005 and operational vegetation monitoring is not planned for the North Trend site.

As part of the preoperational radiological monitoring program, vegetation samples were collected at the five monitoring stations (NE-1 through NE-5). These samples were collected during the third quarter of 1996 and analyzed for the concentrations of natural uranium, thorium-230, radium-226, lead-210 and polonium-210.

The results of the analyses are presented in Table 6-7. The vegetation sample at each monitoring station was a composite sample of the vegetation present in proportion to occurrence. Concentrations for natural uranium ranged from 2.8 E^{-6} to 5.5 E^{-6} μCi/kg. Concentrations for thorium-230 ranged from 1.6 E^{-5} to 3.2 E^{-5} μCi/kg. Concentrations for radium-226 ranged from 2.5 E^{-6} to 8.3 E^{-6} μCi/kg. Concentrations for lead-210 ranged from 2.0 E^{-5} to 1.2 E^{-4} μCi/kg. Concentrations for polonium-210 ranged from <3.5 E^{-7} to 1.5 E^{-5} μCi/kg. These results are similar to historical baseline vegetation monitoring performed in the project area by CBR.

6.1.1.5.1 Quality of Vegetation Measurements

The accuracy of monitoring data is critical to ensure that the vegetation monitoring program precisely reflects radionuclide concentrations. Regulatory Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclide	Recommended LLD μCi/kg (wet)	Actual LLD μCi/kg (wet)
Natural Uranium	2×10^{-7}	6.9×10^{-8}
Thorium-230	2×10^{-7}	6.9×10^{-8}
Radium-226	5×10^{-8}	6.9×10^{-8}
Polonium-210	1×10^{-6}	3.5×10^{-7}
Lead-210	1×10^{-6}	3.5×10^{-7}

Note that all recommended LLDs were met with the exception of radium-226. The actual LLD of 6.9×10^{-8} was slightly above the recommended LLD of 5×10^{-8}. The recommended LLD was not met due to inadequate sample size. However, all measured radium-226 values were well above the recommended LLD and the error estimate was at or near the 10% of the reported value recommended by NRC.

Table 6-7
Vegetation Monitoring

Location	Radionuclide	Date	Concentration µCi/kg	Error Estimate µCi/kg	LLD µCi/kg
NE-1	U-Nat	7/23/1996	2.8 E-06		6.9 E-08
	Th-230		1.7 E-05	1.0 E-05	6.9 E-08
	Ra-226		2.5 E-06	4.0 E-07	6.9 E-08
	Pb-210		2.0 E-05	2.2 E-06	3.5 E-07
	Po-210		<3.5 E-07		3.5 E-07
NE-2	U-Nat	7/23/1996	3.0 E-06		6.9 E-08
	Th-230		1.8 E-05	1.2 E-05	6.9 E-08
	Ra-226		3.2 E-06	4.6 E-07	6.9 E-08
	Pb-210		1.2 E-04	2.0 E-06	3.5 E-07
	Po-210		<3.5 E-07		3.5 E-07
NE-3	U-Nat	7/23/1996	3.8 E-06		6.9 E-08
	Th-230		1.6 E-05	7.0 E-06	6.9 E-08
	Ra-226		2.5 E-06	4.0 E-07	6.9 E-08
	Pb-210		3.2 E-05	2.5 E-06	3.5 E-07
	Po-210		<3.5 E-07		3.5 E-07
NE-4	U-Nat	7/23/1996	4.5 E-06		6.9 E-08
	Th-230		2.5 E-05	1.1 E-05	6.9 E-08
	Ra-226		5.5 E-06	5.6 E-07	6.9 E-08
	Pb-210		2.3 E-05	2.3 E-06	3.5 E-07
	Po-210		9.2 E-07	3.4 E-07	3.5 E-07
NE-5	U-Nat	7/23/1996	5.5 E-06		6.9 E-08
	Th-230		3.2 E-05	1.3 E-05	6.9 E-08
	Ra-226		8.3 E-06	6.9 E-08	6.9 E-08
	Pb-210		3.0 E-05	2.5 E-06	3.5 E-07
	Po-210		1.5 E-05	1.7 E-06	3.5 E-07

6.1.1.6 Baseline Soil Monitoring

In 1996, CBR collected soil samples once from each of the air monitoring locations (NE-1 through NE-5 and AM-6) and analyzed for natural uranium and radium-226. Soil samples were collected from the top 15 centimeters of soil.

In 2006, soil samples were also obtained from each of the air monitoring locations (AM-9 through AM-14) and analyzed for natural uranium, radium-226, and lead-210. Soil samples were collected from the top 5 and 15 centimeters of soil as required by NUREG-1569.

Vegetative roots, rocks and other debris were removed from the soil samples. The samples were sent to Energy Laboratories in Casper, Wyoming for analysis. The results of analysis of the soil samples are presented in Table 6-8.

In addition to the samples at the air monitoring locations, surface soil samples were obtained from the proposed plant and restricted area location to determine baseline concentrations of the radionuclides of interest.

In 2004, six soil samples (five-point composite samples) were collected from the proposed North Trend satellite processing area and analyzed for natural uranium and radium-226. The samples were collected by removing vegetation and compositing four grab samples spaced approximately 18 inches from a center point sample in each of four compass directions. The sample depth interval was 0-15 cm. Radium-226 soil concentrations ranged from 7.0 x 10^{-7} to 9.0 x 10^{-7} μCi/g with a mean concentration of 7.8 x 10^{-7} ± 7.5 x 10^{-8} μCi/g. Natural uranium soil concentrations ranged from 6.1 x 10^{-7} to 7.1 x 10^{-6} μCi/g with a mean concentration of 6.5 x 10^{-7} ± 4.5 x 10^{-8} μCi/g. Analytical results for these soil samples are presented in Table 6.9.

The general location of the proposed satellite facility in relation to the current Crow Butte facility and the locations of the six soil samples are shown on Figures 6-4 and 6-5 respectively. Figure 6-4 shows the sampled area is south of the currently proposed satellite area but soil characteristics in the general area should not change significantly and the sampled area remains representative of the general area. Once the final site for the satellite area is established, a gamma survey and possibly additional soil sampling of the area will be conducted.

Figure 6-4 General Area of Proposed North Trend Satellite Facility

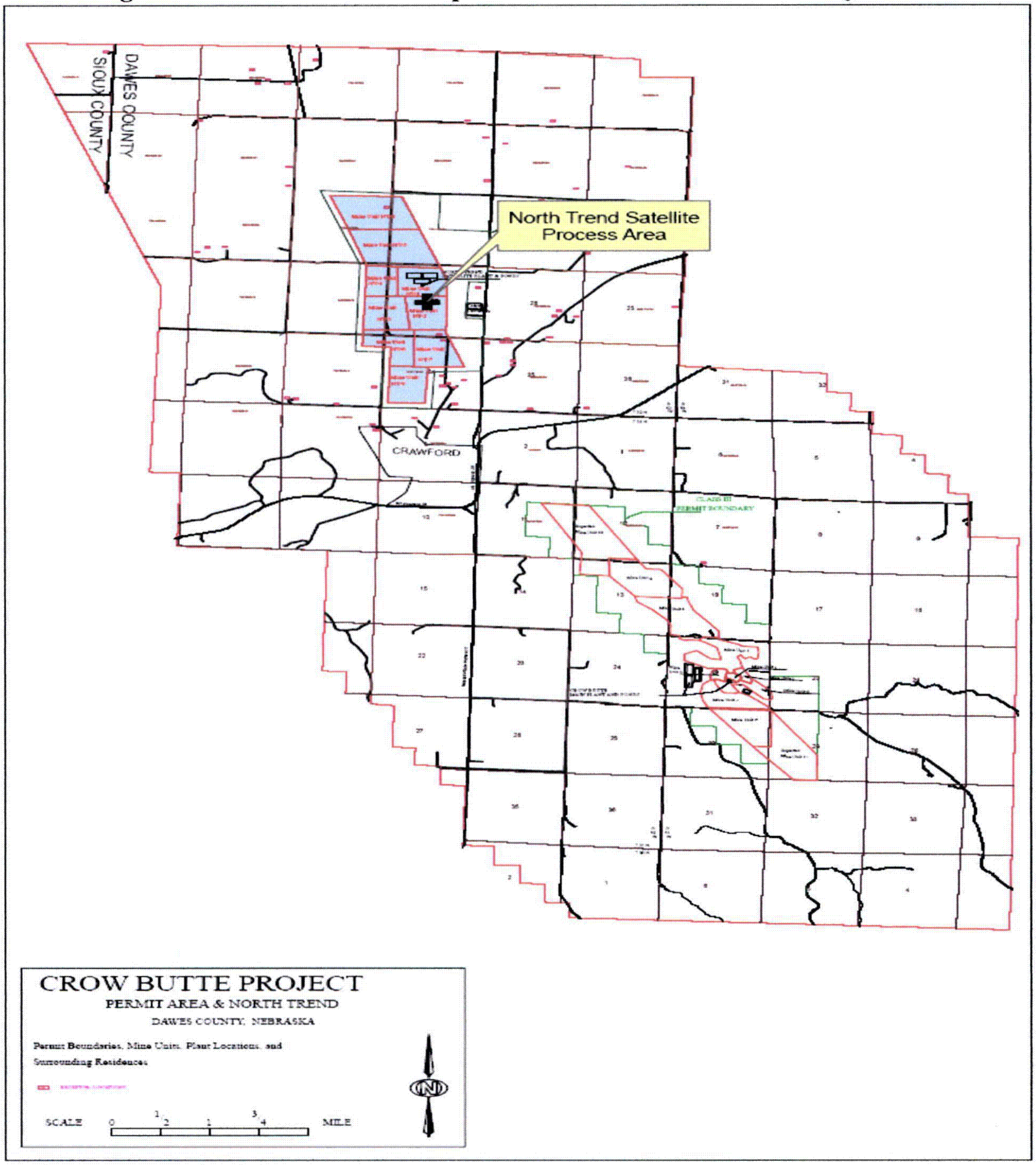
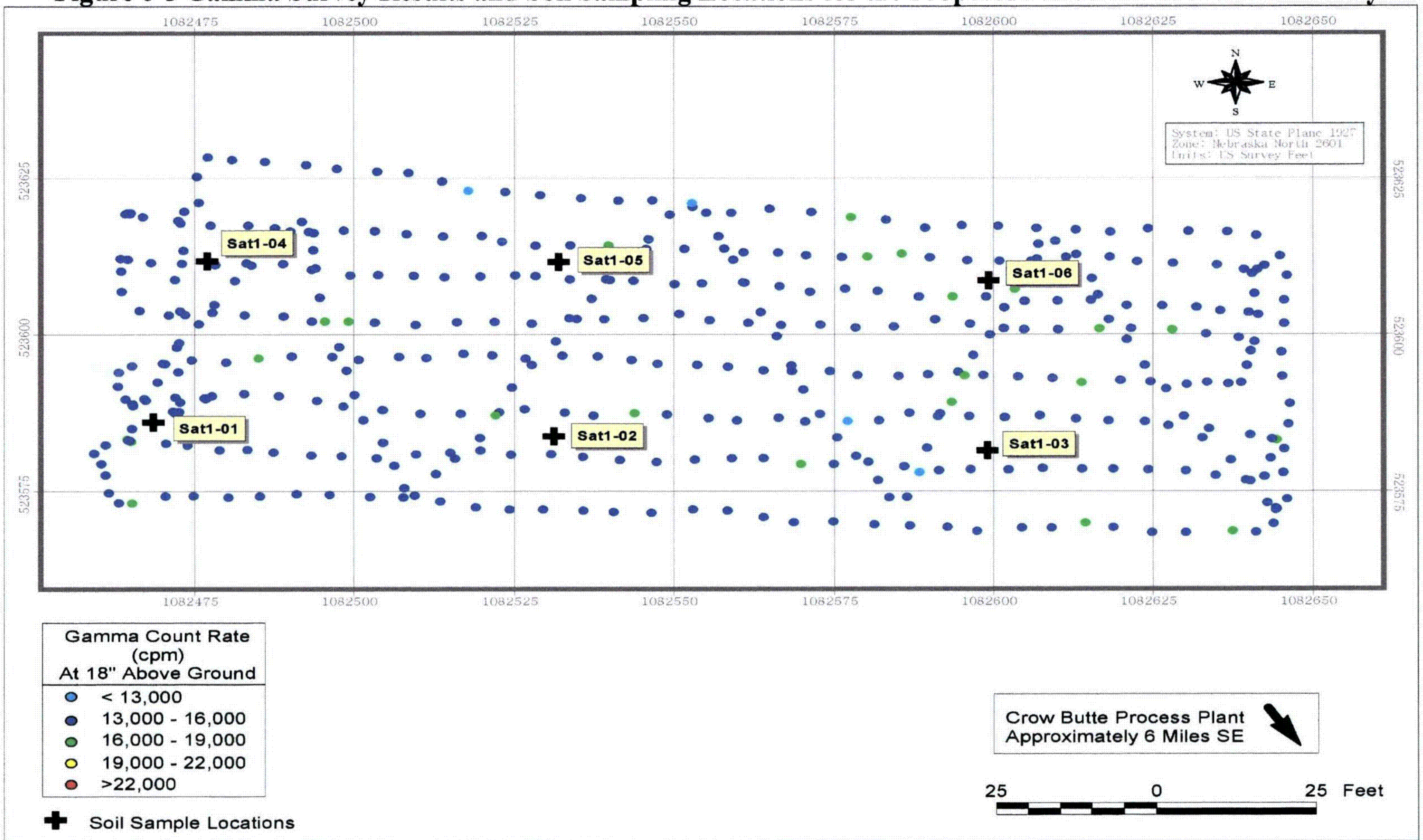


Figure 6-5 Gamma Survey Results and Soil Sampling Locations for the Proposed North Trend Satellite Facility



6.1.1.6.1 Quality of Soil Measurements

The accuracy of monitoring data is critical to ensure that the soil monitoring program precisely reflects radionuclide concentrations. Regulatory Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclide	Recommended LLD µCi/g	Actual LLD µCi/g
Natural Uranium	2×10^{-7}	2×10^{-8}
Radium-226	2×10^{-7}	2×10^{-8}

Table 6-8
Soil Sampling
Air Monitoring Locations

Location	Radionuclide	Date	Concentration µCi/g x 10^{-6}	Error Estimate µCi/g x 10^{-6}	LLD µCi/g x 10^{-6}
1996 Sample Results (15 centimeter sample depth)					
NE-1	U-Nat	7/24/1996	0.33		0.02
	Ra-226		1.05	0.17	0.02
NE-2	U-Nat	7/24/1996	0.51		0.02
	Ra-226		0.89	0.16	0.02
NE-3	U-Nat	7/24/1996	0.26		0.02
	Ra-226		0.41	0.11	0.02
NE-4	U-Nat	7/24/1996	0.32		0.02
	Ra-226		0.78	0.15	0.02
NE-5	U-Nat	7/24/1996	0.95		0.02
	Ra-226		1.01	0.16	0.02
AM-6	U-Nat	7/24/1996	0.33		0.02
	Ra-226		1.05	0.17	0.02

Table 6-8 (continued)
Soil Sampling
Air Monitoring Locations

Location	Radionuclide	Date	Concentration µCi/g x 10^{-6}	Error Estimate µCi/g x 10^{-6}	LLD µCi/g x 10^{-6}
2006 Sample Results (15 centimeter sample depth)					
AM-9	U-Nat	12/15/2006	0.45		0.2
	Ra-226		0.75	0.099	0.2
	Pb-210		0.75	0.19	0.2
AM-10	U-Nat	12/15/2006	0.38		0.2
	Ra-226		0.48	0.081	0.2
	Pb-210		0.58	0.18	0.2
AM-11 (NE-5)	U-Nat	12/15/2006	0.44		0.2
	Ra-226		0.58	0.088	0.1
	Pb-210		<0.2		0.2
AM-12	U-Nat	12/15/2006	0.53		0.2
	Ra-226		0.78	0.1	0.2
	Pb-210		0.74	0.18	0.2
AM-13	U-Nat	12/15/2006	0.32		0.2
	Ra-226		0.47	0.079	0.2
	Pb-210		<0.2		0.2
AM-14	U-Nat	12/15/2006	0.42		0.2
	Ra-226		0.47	0.081	0.2
	Pb-210		0.88	0.19	0.2

Table 6-8 (continued)
Soil Sampling
Air Monitoring Locations

Location	Radionuclide	Date	Concentration µCi/g x 10^{-6}	Error Estimate µCi/g x 10^{-6}	LLD µCi/g x 10^{-6}
2006 Sample Results (5 centimeter sample depth)					
AM-9	U-Nat	12/15/2006	0.47		0.2
	Ra-226		0.68	0.095	0.2
	Pb-210		1.2	0.21	0.2
AM-10	U-Nat	12/15/2006	0.4		0.2
	Ra-226		0.56	0.086	0.2
	Pb-210		0.84	0.19	0.2
AM-11 (NE-5)	U-Nat	12/15/2006	0.48		0.2
	Ra-226		0.61	0.091	0.2
	Pb-210		<0.2		0.2
AM-12	U-Nat	12/15/2006	0.51		0.2
	Ra-226		0.75	0.099	0.2
	Pb-210		0.61	0.18	0.2
AM-13	U-Nat	12/15/2006	0.34		0.2
	Ra-226		0.58	0.089	0.2
	Pb-210		<0.2		0.2
AM-14	U-Nat	12/15/2006	0.42		0.2
	Ra-226		0.41	0.076	0.2
	Pb-210		0.83	0.19	0.2

Table 6-9
Soil Sampling
Proposed Satellite Processing Area

Location	Radionuclide	Date	Concentration µCi/g x 10^{-6}	Error Estimate µCi/g x 10^{-6}	LLD µCi/g x 10^{-6}
2004 Sample Results (0-15 centimeter sample depth)					
Sat-1	U-Nat	5/05/2004	0.61		0.02
	Ra-226		0.9	0.1	0.02
Sat-2	U-Nat	5/05/2004	0.68		0.02
	Ra-226		0.8	0.1	0.02
Sat-3	U-Nat	5/05/2004	0.61		0.02
	Ra-226		0.7	0.1	0.02
Sat-4	U-Nat	5/05/2004	0.71		0.02
	Ra-226		0.9	0.1	0.02
Sat-5	U-Nat	5/05/2004	0.68		0.02
	Ra-226		0.8	0.1	0.02
Sat-6	U-Nat	5/05/2004	0.61		0.02
	Ra-226		0.7	0.1	0.02

6.1.1.7 Baseline Sediment Sampling

Sediments of lakes, reservoirs, and flowing bodies of surface water may become contaminated as a result of direct liquid discharges, wet surface deposition, or from runoffs associated with contaminated soils. Because of various chemically and physically binding interactions with radionuclides, sediments serve as integrating media that are important to environmental monitoring.

Sediments in the White River were sampled as part of the North Trend Expansion Area preoperational baseline monitoring program. Sediment samples were collected at the same locations as surface water samples. Sediment samples were obtained at locations W-1 and W-2 during the fourth quarter of 2004 and the fourth quarter of 2006. These sediments were analyzed for the concentration of natural uranium, radium-226, and lead-210. Analysis of thorium-230 in sediments was discontinued by CBR in 1998 with the

concurrence of NRC staff. The results from the analysis of the sediment samples are listed in Table 6-10.

Historical sediment sampling by CBR in connection with the current license area began in May 1982 and has continued on an annual basis. Results from sediment sampling for the North Trend Expansion Area are comparable with the results of the historical sampling.

6.1.1.7.1 Quality of Sediment Measurements

The accuracy of monitoring data is critical to ensure that the sediment monitoring program precisely reflects radionuclide concentrations. Regulatory Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclide	Recommended LLD µCi/g	Actual LLD µCi/g
Natural Uranium	2×10^{-7}	2×10^{-8} (1996 samples) 1×10^{-8} (2004 samples) 2×10^{-7} (2006 samples)
Thorium-230	2×10^{-7}	2×10^{-8}
Radium-226	2×10^{-7}	2×10^{-8} (1996 samples) 2×10^{-7} (2004 and 2006 samples)
Lead-210	2×10^{-7}	1×10^{-7} (1996 samples) 1×10^{-6} (2004 samples) 2×10^{-7} (2006 samples)

Table 6-10
Sediment Sampling Results

Location	Radionuclide	Date	Concentration µCi/g x 10^{-6}	Error Estimate µCi/g x 10^{-6}	LLD µCi/g x 10^{-6}
2004 Sample Results					
W-1	U-Nat	11/11/2004	0.04		0.01
	Ra-226		0.3	0.06	0.2
	Pb-210		<1.0		1.0
W-2	U-Nat	11/11/2004	0.04		0.01
	Ra-226		0.3	0.06	0.2
	Pb-210		<1.0		1.0
2006 Sample Results					
W-1	U-Nat	12/15/2006	0.46		0.2
	Ra-226		0.35	0.069	0.2
	Pb-210		<0.2		0.2
W-2	U-Nat	12/15/2006	0.56		0.2
	Ra-226		0.57	0.086	0.2
	Pb-210		<0.2		0.2

6.1.1.8 Baseline Direct Radiation Monitoring

The preoperational baseline radiation monitoring program included routine monitoring of direct radiation levels at the air monitoring stations. The preoperational direct gamma radiation program was designed to meet the guidance provided in NRC Regulatory Guide 4.14. NRC guidance recommends a combination of direct gamma radiation measurements and exposure measurements made with integrating devices (i.e., thermoluminescent detectors or TLDs) during preoperational monitoring. Direct measurements are made in areas where process facilities will be located during site characterization.

6.1.1.8.1 Integrated Radiation Monitoring Results

As part of the preoperational monitoring program for the North Trend Expansion Area, the gamma radiation in the environment around the area was measured. CBR conducted direct radiation monitoring at the five North Trend air monitoring locations (NE-1 through NE-5) during the 1996 monitoring program. However, the control badge was stored in an area with high background radiation during this time and the results from the 1996 monitoring are not comparable with the more recent monitoring.

CBR conducted direct gamma radiation monitoring at the revised air monitoring locations (AM-9 though AM-14) in 2004. Monitoring was conducted by placing environmental thermoluminescent dosimeters (TLDs) provided by Thermo Nutech on a quarterly basis at the monitoring locations. Lithium fluoride chips were used and housed in rugged containers to provide protection from the weather. The containers or monitors were placed at the predetermined monitoring locations approximately one meter above ground level. They were exchanged with new monitors on a quarterly basis and the exposed monitors were returned to the vendor for processing. These devices provide an integrated exposure for the period between annealing and processing. The results were reported in mrem per week.

Table 6-11 summarizes the environmental direct gamma monitoring results from the North Trend Expansion Area.

The average background gamma level in the Western Great Plains has been reported to be 0.014 mR/hr, which corresponds well to the results obtained with the TLD gamma monitors.

Table 6-11
Environmental Thermoluminescent Detector Results

Location	Dates	Gamma Exposure Rate (mrem/qtr)	Standard Deviation (mrem/qtr)	95% Confidence Interval (mrem/qtr)
2004 - 2005				
AM-9	7/1/2004 – 10/1/2004	9	1.3	1.6
	10/1/2004 – 1/1/2005	1	1.3	1.6
	1/1/2005 – 4/1/2005	6	2.1	2.6
	4/1/2005 – 7/1/2005	8	3.2	3.9
AM-10	7/1/2004 – 10/1/2004	12	.9	1.1
	10/1/2004 – 1/1/2005	4	3.0	3.7
	1/1/2005 – 4/1/2005	7	1.8	2.2
	4/1/2005 – 7/1/2005	3	3.5	4.4
AM-11 (NE-5)	7/1/2004 – 10/1/2004	12	.9	1.1
	10/1/2004 – 1/1/2005	3	1.3	1.7
	1/1/2005 – 4/1/2005	7	1.2	1.5
	4/1/2005 – 7/1/2005	0	4.6	5.7
AM-12	7/1/2004 – 10/1/2004	6	.9	1.1
	10/1/2004 – 1/1/2005	0	2.9	3.5
	1/1/2005 – 4/1/2005	5	1.1	1.4
	4/1/2005 – 7/1/2005	2	2.7	3.3
AM-13	7/1/2004 – 10/1/2004	11	1.3	1.6
	10/1/2004 – 1/1/2005	3	1.3	1.6
	1/1/2005 – 4/1/2005	6	1.5	1.9
	4/1/2005 – 7/1/2005	5	1.9	2.3
AM-14	7/1/2004 – 10/1/2004	9	1.2	1.5
	10/1/2004 – 1/1/2005	0	1.1	1.4
	1/1/2005 – 4/1/2005	8	0.8	1.0
	4/1/2005 – 7/1/2005	6	3.3	4.1
AM-6 (Bkgd)	7/1/2004 – 10/1/2004	10	1.3	1.6
	10/1/2004 – 1/1/2005	9	1.2	1.5
	1/1/2005 – 4/1/2005	8	2.1	2.6
	4/1/2005 – 7/1/2005	15	9.7	12.1

6.1.1.8.2 Direct Gamma Radiation Measurement Results

In addition to the environmental gamma monitors, NRC recommends that the background gamma radiation in the area of the facility be measured with a scintillometer. NRC recommends preoperational gamma radiation measurements at 150-meter intervals in each of eight compass directions out to a distance of 1,500 meters from the center of the "milling" area.

Direct gamma radiation measurements were conducted at the proposed satellite processing area in May 2004. A rectangular area approximately 190 feet long by 70 feet wide (0.3 acres) was surveyed using a Ludlum Model 44-10 2-inch by 2-inch NaI detector coupled to a Ludlum Model 2221 ratemeter/scaler and a Trimble ProXRS GPS survey unit. The detector was carried approximately 18 inches above the ground surface. Survey personnel walked the area at a rate of approximately 2.5 feet per second with a transect spacing of approximately 10 feet. The survey system automatically logged individual gamma count rates with a corresponding coordinate every two seconds. A total of 422 measurements were collected and are presented in Figure 6-4. In addition, exposure rate measurement were collected at each satellite processing area soil sample location described in Section 6.1.1.6 using a Ludlum Model 19 μR meter. Summary data for the gamma direct gamma radiation measurements are presented in Table 6-12.

Table 6-12
Gamma Survey Results for Proposed Satellite Processing Area

Location	Dates	Gamma Exposure Rate (μR/hr)*	Standard Deviation (μR/hr)	95% Confidence Interval (μR/hr)
2004				
SAT-1	5/05/2004	19	NA	NA
SAT-2	5/05/2004	17	NA	NA
SAT-3	5/05/2004	17	NA	NA
SAT-4	5/05/2004	17	NA	NA
SAT-5	5/05/2004	18	NA	NA
SAT-6	5/05/2004	17	NA	NA
Satellite Processing Area	5/05/2004	15.1	0.9	1.76

*Gross count rate data was converted to estimated exposure rates using the correlation information in Section 6.3 of the Wellfield Decommissioning Plan for Crow Butte Uranium Project, June 2004.

Table 6-13

**1996-1997 Radiological Preoperational Monitoring Program
North Trend Expansion Area**

Type of Sample	Number	Sample Collection			Sample Analysis	
		Location	Method	Frequency	Frequency	Type of Analysis
Air Monitoring						
Radon Gas	One	Nearest residence (NE-1)	Continuous using RadTrak® Type DRNF	Quarterly	Quarterly	Rn-222
	Four	Site boundary (NE-2 – NE-5)	Continuous using RadTrak® Type DRNF	Quarterly	Quarterly	Rn-222
	One	Control (Background) location (AM-6)	Continuous using RadTrak® Type DRNF	Quarterly	Quarterly	Rn-222

Table 6-13

1996-1997 Radiological Preoperational Monitoring Program North Trend Expansion Area

Type of Sample	Number	Sample Collection			Sample Analysis	
		Location	Method	Frequency	Frequency	Type of Analysis
Water Monitoring						
Groundwater	One from representative water supply wells	Representative wells within 1 km of license area boundary	Grab	Quarterly for one year	Quarterly	Natural Uranium, Th-230, Ra-226, Pb-210, Po-210
Vegetation Monitoring						
Vegetation	One each	Air monitoring stations (NE-1 – NE-5)	Composite of dominant vegetation present	Once during grazing season	Each sample	Natural Uranium, Th-230, Ra-226, Pb-210, Po-210
Soil Monitoring						
Surface Soil	One each	Air monitoring stations (NE-1 – NE-5)	Grab	Once	Each sample	Natural Uranium, Ra-226
Direct Radiation Monitoring						
Continuous	One each	Air monitoring stations (NE-1 – NE-5, AM-6)	Dosimeter	Continuous	Quarterly	Gamma exposure using a continuous integrating device

Table 6-14
2004-2005 Radiological Preoperational Monitoring Program
North Trend Expansion Area

Type of Sample	Number	Sample Collection			Sample Analysis	
		Location	Method	Frequency	Frequency	Type of Analysis
Air Monitoring						
Air Particulate	Two	Control background location and north of expansion area (AM-6 and AM-10)	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Pb-210
Radon	One	Nearest residence (AM-9)	Continuous using RadTrak® Type DRNF	Quarterly	Quarterly	Rn-222
	Five	Site boundary (AM-10 – AM-14)	Continuous using RadTrak® Type DRNF	Quarterly	Quarterly	Rn-222
	One	Control (Background) location (AM-6)	Continuous using RadTrak® Type DRNF	Quarterly	Quarterly	Rn-222

Table 6-14
2004-2005 Radiological Preoperational Monitoring Program
North Trend Expansion Area

Type of Sample	Number	Sample Collection			Sample Analysis	
		Location	Method	Frequency	Frequency	Type of Analysis
Water Monitoring						
Groundwater	One from representative water supply wells	Representative wells within 1 km of license area boundary	Grab	Quarterly	Quarterly	Natural Uranium, Th-230, Ra-226, Pb-210, Po-210
Surface water	Two from surface water that could be impacted by satellite plant	Surface water features within the license area or off site that could be affected by mining operations consisting of one sample upstream and one sample downstream of site boundary (W-1 and W-2)	Grab	Quarterly	Each sample	Natural Uranium, Th-230, Ra-226, Pb-210, Po-210
Sediment Monitoring						
Sediment	One	One from each surface water monitoring location (W-1 and W-2)	Grab	Twice	Each sample	Natural Uranium, Ra-226, Pb-210

Table 6-14
2004-2005 Radiological Preoperational Monitoring Program
North Trend Expansion Area

Type of Sample	Number	Sample Collection			Sample Analysis	
		Location	Method	Frequency	Frequency	Type of Analysis
Soil Monitoring						
Surface	One each	Air Monitoring stations (AM-6, AM-9 through AM-14)	5 cm composite	Once	Each sample	Natural Uranium, Ra-226, Pb-210
Surface	One each	Air Monitoring stations (AM-6, AM-9 through AM-14)	15 cm composite	Once	Each sample	Natural Uranium, Ra-226, Pb-210
Surface	Six each	Proposed Satellite Plant locations	Grab	Once	Each sample	Natural Uranium, Ra-226
Direct Radiation Monitoring						
Continuous	One each	Air Monitoring stations (AM-6, AM-9 through AM-14)	Dosimeter	Continuous	Quarterly	Gamma exposure using a continuous integrating device
Survey	422 measurements	Proposed Satellite Plant locations	Grab	Once	Once	Gamma exposure using Sodium Iodide scintillometer

6.1.2 Operational Radiological Monitoring Program

6.1.2.1 Airborne Effluent and Environmental Monitoring Programs

6.1.2.1.1 Radon

The radon gas effluent released to the environment will be monitored at the same air monitoring locations (AM-9 through AM-14) that were used for baseline determination of radon concentrations as described in Section 6.1.1.2. Sampling locations are shown on Figure 6-6. Monitoring will be performed using Track-Etch radon cups. The cups will be exchanged on a semiannual basis in order to achieve the required lower limit of detection (LLD). EHSMS Program Volume IV, *Health Physics Manual,* currently provides the instructions for environmental radon gas monitoring. In addition to the manufacturer's Quality Assurance program, CBR will expose one duplicate radon Track Etch cup per monitoring period.

In addition to the environmental monitoring, release of radon from process operations will be estimated and reported in the semi-annual reports required by 10 CFR § 40.65 and License SUA-1534 License Condition Number 12.1.

6.1.2.1.2 Surface Soil

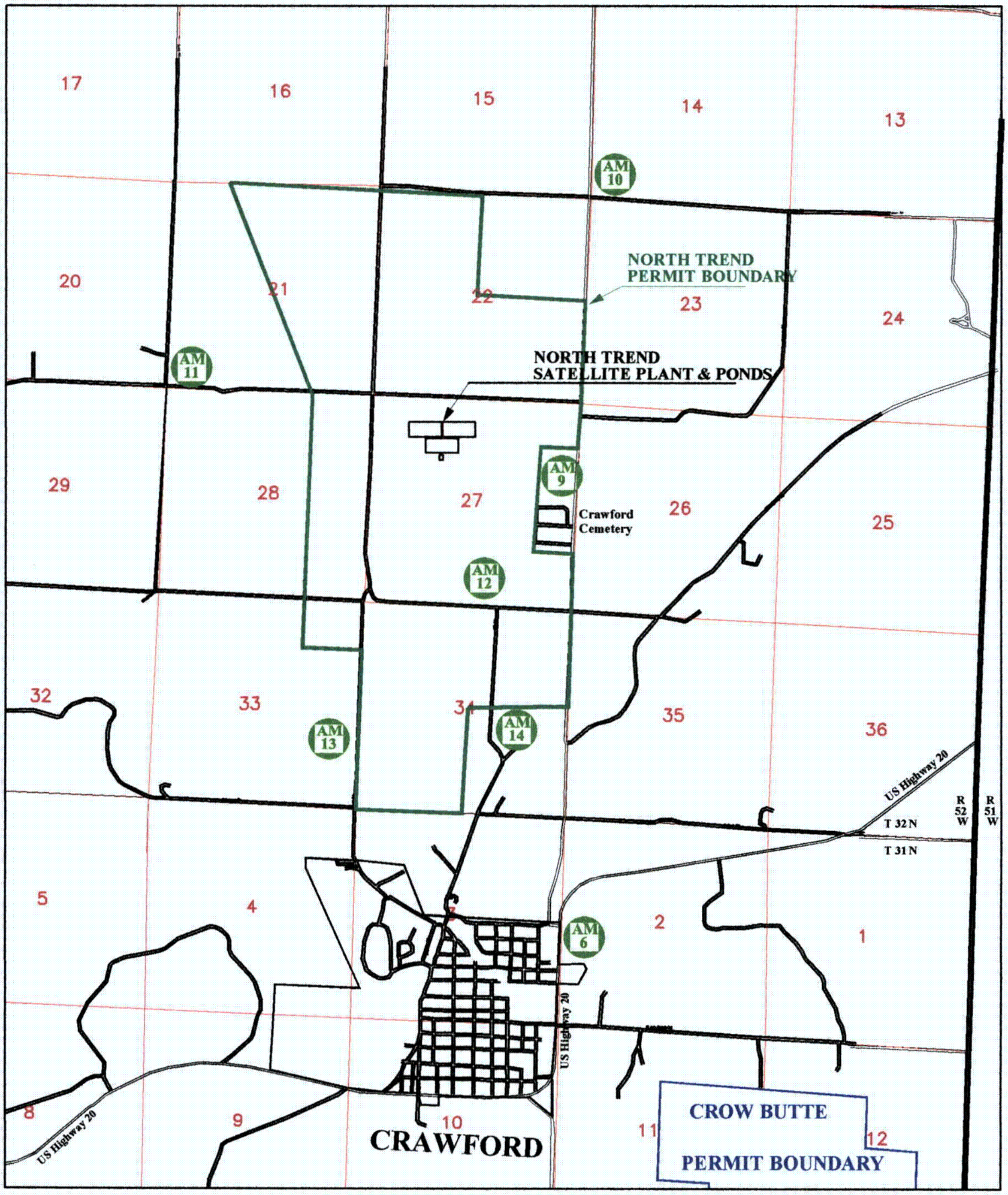
Surface soil has been sampled as described in Section 6.1.1.6. Surface soil samples will be taken at the monitoring locations (AM-9 through AM-14) following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Surface soil will also be sampled at the plant location as described in Section 6.1.1.6. Post operational surface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

6.1.2.1.3 Subsurface Soil

Subsurface soil will be sampled at the plant location as described in Section 6.1.1.6. Post operational subsurface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

FIGURE 6-6
PROPOSED AIR MONITORING LOCATIONS



AM 13 Air Monitoring Stations

AM-6 - Radon, Gamma, Air Particulates
AM-9 - Radon, Gamma
AM-10 - Radon, Gamma, Air Particulates
AM-11 - Radon, Gamma
AM-12 - Radon, Gamma
AM-13 - Radon, Gamma
AM-14 - Radon, Gamma

SCALE 0 1/2 1 1 1/2 2 MILES

N

FIGURE 6-6

CROW BUTTE RESOURCES

DAWES COUNTY, NEBRASKA

Proposed Air Monitoring Stations
& Permit Boundary

Prepared By : WB

Drawn By: WB

Date: 1/07

6.1.2.1.4 Vegetation

Preoperational vegetation samples from the North Trend Expansion Area were collected in 1996-1997 at the air monitoring locations as described in Section 6.1.1.5.

CBR does not perform operational vegetation sampling at the environmental monitoring stations for the current production area and does not propose to perform operational vegetation sampling for the North Trend Expansion Area. In accordance with the provisions of USNRC Regulatory Guide 4.14, Footnote (o) to Table 2 requires that "*vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway...*" defined as a pathway which would expose an individual to a dose in excess of 5% of the applicable radiation protection standard. This pathway was evaluated by MILDOS-Area and is discussed further in Section 4.12.

6.1.2.1.5 Direct Radiation

Environmental gamma radiation levels will be monitored continuously at the air monitoring stations (AM-9 through AM-14). Gamma radiation will be monitored through the use of environmental dosimeters obtained from a NVLAP certified vendor. Dosimeters will be exchanged on a quarterly basis.

6.1.2.1.6 Sediment

Upstream and downstream sediment samples from the White River will be collected annually. Samples will be analyzed for natural uranium, radium-226, and lead-210.

6.1.2.2 Groundwater/Surface Water Monitoring Program

6.1.2.2.1 Program Description

During operations at the North Trend satellite plant, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. CBR's operational water monitoring program includes the evaluation of groundwater on a regional basis, groundwater within the permit or licensed area and surface water on a regional and site specific basis.

6.1.2.2.2 Groundwater Radiological Monitoring

All private wells within one kilometer of the wellfield area boundary are sampled on a quarterly basis with the landowner's consent. CBR will perform similar private well monitoring around the North Trend Expansion Area. Groundwater samples are taken in accordance with the instructions contained in EHSMS Program Volume VI, *Environmental Manual.* Samples are analyzed for natural uranium and radium-226.

6.1.2.2.3 Surface Water Monitoring

Pre-operational surface water quality monitoring was performed as discussed in Section 6.1.1.4. The proposed license area does not contain surface water features. However, the proximity of the White River to the southern boundary of the license area required CBR to collect upstream and downstream samples. Surface water samples are taken in accordance with the instructions contained in EHSMS Program Volume VI, *Environmental Manual.* Upstream and downstream samples from all locations will be obtained quarterly. Surface water samples are analyzed for the parameters given in Section 6.1.1.4, Table 6-6. Surface monitoring results are submitted in the semi-annual environmental and effluent reports submitted to NRC.

6.1.2.3 Radiological Monitoring Quality Assurance Program

A quality assurance program is in place at Crow Butte Uranium Project for all relevant operational monitoring and analytical procedures. The objective of the program is to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program provides assurance to both regulatory agencies and the public that the monitoring results are valid.

The QA program addresses the following:

- Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports is provided.
- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program.
- Written procedures for QA activities. These procedures include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting.

- Quality control (QC) in the laboratory. Procedures cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs. Outside laboratory QA/QC programs are included.

- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.

The EHSMS Program developed by CBR is a critical step to ensuring that quality assurance objectives are met. Current procedures exist for a variety of areas, including but not limited to:

1. Environmental monitoring procedures.

2. Testing procedures.

3. Exposure procedures.

4. Equipment operation and maintenance procedures.

5. Employee health and safety procedures.

6. Incident response procedures.

6.2 PHYSIOCHEMICAL MONITORING

6.2.1 Groundwater Monitoring

The groundwater excursion monitoring program is designed to detect excursions of lixiviant into the ore zone aquifer outside of the wellfield being leached and into the overlying or adjacent water bearing strata. The Pierre Shale below the ore zone is over 1200 feet thick and contains no water bearing strata. Therefore, it is not necessary to monitor any water bearing strata below the ore zone.

6.2.1.1 Monitor Well Baseline Water Quality

After delineation of the production unit boundaries, monitor wells are installed no further than 300 feet from the wellfield boundary and no further than 400 feet apart. After completion, wells are washed out and developed (by air flushing or pumping) until water

quality in terms of pH and specific conductivity appears stable and consistent with the anticipated quality of the area. After development, wells are sampled to obtain baseline water quality. For baseline sampling, wells are purged before sample collection to ensure that representative water is obtained. All monitor wells including ore zone and overlying monitor wells are sampled three times at least fourteen (14) days apart. Samples are analyzed for chloride, conductivity, and total alkalinity as specified in License Condition 10.4. Results from the samples are averaged arithmetically to obtain an average baseline value as well as a maximum value for determination of upper control limits for excursion detection. Well development and sampling activities are performed in accordance with the instructions contained in EHSMS Program Volume VI, *Environmental Manual.*

6.2.1.2 Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, upper control limits (UCLs) are set for chemical constituents which would be indicative of a migration of lixiviant from the wellfield. The constituents chosen for indicators of lixiviant migration and for which UCLs are set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during mining. Water levels are obtained and recorded prior to each well sampling. However, water levels are not used as an excursion indicator. Upper control limits are set at 20% above the maximum baseline concentration for the excursion indicator. For excursion indicators with a baseline average below 50 mg/l, the UCL may be determined by adding 5 standard deviations or 15 mg/l to the baseline average for the indicator.

Operational monitoring consists of sampling the monitor wells on a biweekly basis and analyzing the samples for the excursion indicators chloride, conductivity, and total alkalinity. License SUA-1534 Condition 11.2 currently requires that monitor wells be sampled no more than 14 days apart except in the event of certain situations. These situations include inclement weather, mechanical failure, holiday scheduling, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment. In these situations, CBR documents the cause and the duration of any delays. In no event is sampling delayed for more than five days.

6.2.1.2.1 Excursion Verification and Corrective Action

During routine sampling, if two of the three UCL values are exceeded in a monitor well, or if one UCL value is exceeded by 20 percent, the well is resampled within 48 hours and analyzed for the excursion indicators. If the second sample does not exceed the UCLs, a third sample is taken within 48 hours. If neither the second or third sample results exceeded the UCLs, the first sample is considered in error.

If the second or third sample verifies an exceedance, the well in question is placed on excursion status. Upon verification of the excursion, the USNRC Project Manager is notified by telephone or email within 48 hours and notified in writing within thirty (30) days.

If an excursion is verified, the following methods of corrective action are instituted (not necessarily in the order given) dependent upon the circumstances:

- A preliminary investigation is completed to determine the probable cause.
- Production and/or injection rates in the vicinity of the monitor well are adjusted as necessary to increase the net over recovery, thus forming a hydraulic gradient toward the production zone.
- Individual wells are pumped to enhance recovery of mining solutions.

Injection into the wellfield area adjacent to the monitor well may be suspended. Recovery operations continue thus increasing the overall bleed rate and the recovery of wellfield solutions.

In addition to the above corrective actions, sampling frequency of the monitor well on excursion status is increased to weekly. An excursion is considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion for three consecutive one-week samples.

6.2.1.3 Evaporation Pond Leak Detection Monitoring

The evaporation pond will be lined and equipped with a leak detection system. During operations, the leak detection standpipes will be checked for evidence of leakage. Visual inspection of the pond embankments, fences and liners and the measurement of pond freeboard will also be performed during normal operations. The current CBR Pond Inspection Program will be adapted for the North Trend Satellite Plant and will meet the

guidance contained in USNRC Regulatory Guide 3.11 and USNRC Regulatory Guide 3.11.1.

A minimum freeboard of 5 feet is allowed for the current commercial ponds during normal operations. Anytime six (6) inches or more of fluid is detected in a leak detection system standpipe, it will be analyzed for specific conductivity. Should the analyses indicate that the liner is leaking (by comparison to chemical analyses of pond water), the following actions will be taken:

- The USNRC will be notified by telephone or email within 48 hours of leak verification;
- The level of the leaking pond will be lowered by transferring its contents into an adjacent pond. While lowering the water level in the pond, inspections of the liner will be made to determine the cause and location of the leakage. The area of investigation first centers around the pond area specific for the particular standpipe which contains fluid;
- Once the source of the leakage is found, the liner will be repaired and water will be reintroduced to the pond; and,
- A written report will be submitted to the USNRC within 30 days of leak verification. The report will include analytical data and describe the cause of the leakage, corrective actions taken and the results of those actions.

6.3 ECOLOGICAL MONITORING

CBR does not perform any ecological monitoring at the current licensed operation. Based on the discussion concerning ecological impacts in Section 4.5, CBR does not propose to perform any ecological monitoring for the North Trend Expansion Area.

7 COST-BENEFIT ANALYSIS

7.1 GENERAL

The general need for production of uranium is assumed in the operation of nuclear power reactors. In reactor licensing evaluations, the benefits of the energy produced are weighed against environmental costs, including a prorated share of the environmental costs of the uranium fuel cycle. The incremental impacts of typical mining and milling operation required for the fuel cycle are justified in terms of the benefits of energy generation to the society in general. However, the specific site-related benefits and costs of an individual fuel-cycle facility such as the Crow Butte Project and the proposed North Trend Expansion Area must be reasonable as compared to that typical operation.

7.2 ECONOMIC IMPACTS

Monetary benefits accrue to the community from the presence of the Crow Butte Project, such as local expenditures of operating funds and the federal, state and local taxes paid by the project. Against these monetary benefits are the monetary costs to the communities involved, such as those for new or expanded schools and other community services. While it is not possible to arrive at an exact numerical balance between these benefits and costs for any one community, or for the project, because of the ability of the community and possibly the project to alter the benefits and costs, this section summarizes the economic impact of the project to date and projects the incremental impacts from operation of the proposed North Trend satellite facility.

7.2.1 Tax Revenues

The following table summarizes the tax revenues from the Crow Butte Project.

	2006	2005	2004	2003
Property Taxes	627,000	351,000	144,000	65,000
Sales and Use Taxes	238,000	185,000	161,000	153,000
Severance Taxes	545,000	338,000	180,000	73,000
Total	**1,410,000**	**874,000**	**485,000**	**291,000**

Future tax revenues are dependent on uranium prices which cannot be forecast with any accuracy; however, these taxes are also somewhat dependent on the number of pounds of

uranium produced by CBR. To the extent that uranium prices remain at current levels (spot market of around \$80 per pound U_3O_8 in mid-March 2007), the increased production from the satellite plants should contribute to higher tax revenues as well.

The present taxes are based on a relatively consistent production rate of 800,000 pounds per year. The additional production from the satellite plant should be about 600,000 pounds per year. This additional production will eventually be offset by declining production from the original plant; however, the incremental contribution to taxes would be on the order of \$1.0 million to \$1.2 million per year in combined taxes.

7.2.2 Temporary and Permanent Jobs

7.2.2.1 Current Staffing Levels

CBR currently employs approximately 52 employees and 20 contractors on a full-time basis. Short-term contractors and part-time employees are also used for specific projects and/or during the summer months and may add up to 10 percent to the total staffing. This level of employment is significant to the local economies. The private employment in Dawes County in 2006 was 2,189 out of a total labor force of 3,401. Based on these statistics, CBR currently provides approximately 2.3 percent of the private employment in Dawes County. In 2006, CBR's total payroll was over \$2,543,000. Of the total Dawes County wage and salary payments of \$76,006,000 in 2006, the CBR payroll represented about 3.4 percent.

Total CBR payroll for the past four years was:

2003:	\$2,102,000
2004:	\$2,213,000
2005:	\$2,382,000
2006:	\$2,543,000

The average annual wage for all workers in Dawes County was \$22,350 for 2006. By way of comparison, the average wage for CBR was about \$51,000. Entry-level workers for CBR earn a minimum of \$15.53 per hour or \$32,300 per year, not including bonus or benefits.

7.2.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of future satellite plant(s) will provide approximately ten to fifteen temporary construction jobs for a period of up to one year for each satellite. It is likely that the majority of these jobs will be filled by skilled construction labor brought into the area by a construction contractor, although some positions could be filled by local hires. Permanent CBR employees will perform all other facility construction (e.g., wells and wellfields).

CBR actively pursues a policy of hiring and training local residents to fill all possible positions. Due to the technical skills required for some positions, a small percentage of the current mine staff (less than five percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of positions required at the current facility and those that will be created by any future expansion will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. In 2006, total unemployment in Dawes County was 137 individuals, or 2.9 percent of the total work force of 4,799. CBR expects that any new positions will be filled from this pool of available labor.

CBR projects that the current staffing level will increase by ten to twelve full-time CBR employees for each active satellite plant. These new employees will be needed for satellite plant and wellfield operator and maintenance positions. Contractor employees (i.e., drilling rigs) may also increase by four to seven employees depending on the desired production rate. The majority, if not all, of these new positions will be filled with local hires.

These additional positions should increase payroll by about $40,000 per month, or $400,000 to $480,000 per year.

7.2.3 Impact on the Local Economy

In addition to providing a significant number of well-paid jobs in the local communities of Crawford, Harrison, and Chadron, Nebraska, CBR actively supports the local economies through purchasing procedures that emphasize obtaining all possible supplies and services that are available in the local area.

Total CBR payments made to Nebraska businesses for the past four years were:

2003:	$3,602,000
2004:	$3,597,000
2005:	$4,570,000

2006 (est.): $5,000,000

The vast majority of these purchases were made in Crawford and Dawes County.

This level of business is expected to continue and should increase somewhat with the addition of expanded production from the satellite plant, although not in strict proportion to production. While there are some savings due to some fixed costs (central plant utilities for instance), there are additional expenses that are expected to be higher (well-field development for the satellites is expected to be more expensive). Therefore, it can be assumed that the overall effect on local purchases will be proportional to the number of pounds produced. In addition, mineral royalty payments accrue to local landowners. This should translate to additional purchases of $3.65 to $4.35 million per year.

7.2.4 Economic Impact Summary

As discussed in this section, the Crow Butte Project currently provides a significant economic impact to the local Dawes County economy. Approval of this license amendment request would have a positive impact on the local economy, as summarized in Table 7.6-1.

Table 7-1
Current Economic Impact of Crow Butte Uranium Project and Projected Impact from North Trend Expansion Area

	Current Crow Butte Operation	Estimated Economic Impact due to North Trend Expansion Area
Employment		
Full Time Employees	52	+ 10 to 12
Full Time Contractor Employees	20	+ 4 to 7
Part Time Employees and Short Term Contractors	7	+ 10 to 15 (Satellite Construction)
CBR Payroll, 2006	$2,543,000	+ $400,000 to $480,000
Taxes		
Property Taxes	$627,000	-
Sales and Use Taxes	$238,000	-
Severance Taxes	$545,000	-
Total Taxes	$1,410,000	+ $1,000,000 to $1,200,000
Local Purchases		
Local Purchases, 2006	$5,000,000	+ $3,650,000 to $4,350,000

(est.)		
Total Direct Economic Impacts		
	$8,953,000	**+ $5,050,000 to $6,030,000**

7.2.5 Estimated Value of North Trend Resource

CBR is currently continuing to develop the reserve estimates for the North Trend Expansion Area. Based on the current recoverable resource estimate of 2,000,000 pounds U3O8 and the current market price of uranium ($80 per pound at mid-March 2007), the total estimated value of the energy resources at North Trend is $160,000,000. This value will fluctuate as the market price and realized price varies.

7.2.6 Short-Term External Costs

7.2.6.1 Housing Impacts

The available housing resources should be adequate to support the short-term needs during facility construction. According to the Nebraska Department of Economic Development, in 2000 a total of 492 housing units were vacant in Dawes County out of a total housing base of 4,004 units. Of the vacant units, 176 were available for rent. In addition to this availability of rental housing units, there are two small motels in Crawford that generally have vacancies and routinely provide units for itinerant workers such as railroad crews.

7.2.6.2 Noise and Congestion

CBR projects an increase in the noise and congestion in the immediate area of the North Trend satellite plant during initial construction of the facility. This will include heavy truck and equipment traffic and access to the jobsite by construction workers. These impacts will be most noticeable to residents in the immediate vicinity of the facility and will be temporary in nature. The increase in noise should be considered in light of the project location, which is bounded on the west by the Burlington Northern Santa Fe rail line and on the east by Nebraska State Highway 2/71. The rail line along the western boundary is used for combining local "pusher" engines with south bound trains to assist them in climbing the Pine Ridge south of Crawford. As a result, there is a significant amount of noise generated by this activity, including trains parked for extended periods. Dust from construction activities will be controlled using standard dust suppression techniques used in the construction industry.

7.2.6.3 Local Services

As previously noted, CBR actively recruits and trains local residents for positions at the mine. CBR expects that the majority of permanent positions at the new North Trend satellite facility will be filled with local hires. As a result of using the local workforce, the impact on local services should be minimal. In many cases these services (e.g., schools) are underutilized due to population trends in the area.

7.2.7 Long-Term External Costs

7.2.7.1 Housing and Services

Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of long-term positions that will be created by the expansion to the proposed North Trend area will be filled with individuals from the local workforce and that there will be no significant impact on services and resources, such as housing, schools, hospitals, recreational facilities, or other public facilities. In 2006, total unemployment in Dawes County was 137 individuals, or 2.9 percent of the total work force of 4,799. CBR expects that the new positions at the North Trend satellite facility will be filled from this pool of available labor.

7.2.7.2 Noise and Congestion

CBR projects a minor increase in the long-term noise and congestion in the immediate area of the North Trend satellite plant. Most of this will consist of increased traffic from employees commuting to and from the work site and performing work in the wellfields. Some increase in heavy truck traffic will occur due to deliveries of process chemicals, such as oxygen, and the shipment of ion exchange resin from the North Trend satellite plant to the central processing facility. Delivery and ion exchange shipments should average two per day. These impacts will be most noticeable to residents in the immediate vicinity of the facility. As noted in Section 7.2.6.2, there is significant existing noise in the immediate area generated by the adjacent rail line and highway.

In the area around Crawford, the increased traffic will be unnoticeable due to the presence of U.S. Highway 20 and Nebraska Highway 2/71, which are both significant transport routes. The annual average 24-hour total and heavy vehicle count for U.S. Highway 20 at the eastern approach to Crawford for 2004 was 1,795 and 235, respectively. The limited additional traffic related to the North Trend Expansion Area operation will not significantly affect these main routes.

7.2.7.3 Aesthetic Impacts

The visible surface structures proposed for the North Trend Expansion Area include wellhead covers, wellhouses, electrical distribution lines, and one satellite processing plant. The project will use existing and new roads to access each wellhouse and the satellite plant. Project development would alter the physical setting and visual quality of portions of the landscape, which would affect the overall landscape to some degree, as viewed from sensitive viewing areas. The proposed facilities would introduce new elements into the landscape and would alter the existing form, line, color, and texture, which characterize the existing landscape. The project would primarily affect croplands.

In foreground-middleground views, the satellite plant, wellhouses, and associated access road clearings would be the most obvious features of development. Clearings and access roads would be visible as light-tan exposed soils in geometrically-shaped areas with straight, linear edges that provide some textural and color contrasts with the surrounding cropland. The satellite plant, wellhouses, and wellhead covers would be painted to harmonize with the surrounding soil and vegetation cover. These facilities would be visible from Nebraska State Highway 2/71 and the Crawford Cemetery, but would be subordinate to the rural landscape. Most of the occupied housing units are located near the south end of the project area, and would be screened from views of the facilities by riparian vegetation along the White River.

The electric distribution line poles would be an estimated 20 feet tall, and would be located throughout the project area to connect wellhouses with existing lines. The distribution lines are similar in appearance to those typical of the rural landscape, but would occur at a higher density than on adjacent lands. The lines would be obvious to viewers at the viewing areas, but would not change the rural character of the existing landscape.

Wellhead covers would be difficult to discern in the landscape from any sensitive viewing area. The form and textural contrast would be very weak because the relatively low profile (3 feet high) and small size of the facilities would disappear into the surrounding textures of soil and vegetation. Generally, color contrasts are most likely to be visible in foreground-middleground distance zone; however, the wellhead covers would be painted a tan color that would harmonize with the surrounding vegetation and soil colors. Therefore, contrast of line, form, texture, and color would be low. The facilities would not be noticeable to the casual observer. Wellhead covers would be visually subordinate to the landscape in foreground-middleground distance zone.

7.2.7.4 Land Access Restrictions

Property owners of land located within the immediate wellfield and plant boundaries will lose access and free use of these areas during mining and reclamation. The areas impacted are all used for agricultural purposes and the owners will lose the ability to use the areas for production purposes. Offsetting these land use restrictions are the surface lease and mineral royalty payments to the landowners.

7.2.8 Most Affected Population

The expected impacts from the proposed North Trend satellite plant can be characterized as an incremental increase in the impacts from operation of the current facility. For the most part, the impact from operation of the current Crow Butte Uranium Project has been positive for Crawford and the surrounding communities. CBR has provided much-needed well compensated employment opportunities for the local population. Additionally, the policy of purchasing goods and services locally to the extent possible has had a positive economic impact on an area facing economic challenges. Tax expenditures and particularly the recent increases in local property taxes paid due to the increase in the price of uranium, have had a significant economic impact on local government-provided services.

Offsetting these positive impacts to the local population are increases in noise, congestion, and aesthetic impacts for residents in and adjacent to the proposed North Trend satellite facility. Most residents located in the proposed license area are land owners that have mineral and/or surface leases with CBR and will benefit economically from the presence of the facility.

7.2.9 Plant Decommissioning Costs

Approval of the proposed North Trend satellite facility will result in CBR incurring additional decommissioning liabilities for the installed facilities. The actual estimated decommissioning costs will be included in the annual surety update required by SUA-1534 submitted to the NDEQ and the NRC for approval prior to construction activities.

7.3 THE BENEFIT COST SUMMARY

The benefit-cost summary for a fuel-cycle facility such as the Crow Butte Project involves comparing the societal benefit of a constant U_3O_8 supply (ultimately providing energy) against possible local environmental costs for which there is no directly related compensation. For this project, there are basically three of these potentially uncompensated environmental costs:

- Groundwater impact;
- Radiological impact; and,
- Disturbance of the land.

The groundwater impact is considered to be temporary in nature, as restoration activities will restore the groundwater to a pre-mining quality. The successful restoration of groundwater during the research and development (R&D) project and the commercial restoration of Mine Unit 1 have demonstrated that the restoration process can meet this criterion successfully.

The radiological impacts of the current and proposed project are small, with all radioactive wastes being transported and disposed of off-site. Radiological impacts to air and water are also minimal. Extensive on-going environmental monitoring of air, water, and vegetation has shown no appreciable impact to the environment from the Crow Butte Project.

The disturbance of the land for an in-situ leach (ISL) facility is quite small, especially when compared with conventional surface mining techniques. All of the disturbed land will be reclaimed after the project is decommissioned and will become available for previous uses.

7.4 SUMMARY

In considering the energy value of the U_3O_8 produced to U.S energy needs, the economic benefit to the local communities, the minimal radiological impacts, minimal disturbance of land, and mitigable nature of all other impacts, it is believed that the overall benefit-cost balance for the proposed North Trend Expansion Area is favorable, and that issuing an amendment to SUA-1534 is the appropriate regulatory action.

8 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

This Environmental Report (ER) has characterized the existing baseline environment of the North Trend Expansion Area and the surrounding area in Section 3. The potential environmental impacts (adverse and positive) of the proposed action were discussed in detail in Section 4. In this impact analysis, Crow Butte Resources (CBR) identified unavoidable impacts of the proposed action. Alternatives for mitigation were discussed in Section 5.

This section summarizes the environmental impacts that cannot be avoided. Where available, means of mitigation is summarized.

Table 8-1 summarizes the unavoidable environmental impacts of the proposed construction, operation, and decommissioning of the North Trend Expansion Area. Each impact is quantified (where possible). All impacts are short-term, i.e., the predicted impact will exist during the construction, operation, and decommissioning of the North Trend Expansion Area. No significant long-term impacts that would extend beyond the duration of the project have been identified. For each impact, mitigative measures are summarized.

Table 8-1: Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
Production		
Production of U3O8 (lbs./yr.)	600,000	None
Use of Natural Resources		
Temporary Land Surface Impacts (acres)	Significant land surface impacts to 30 acre satellite plant site; minimal disturbance to remaining 1,280 acres of wellfield; impacted for the duration of the project.	Sediment and topsoil management during construction and operation; Surface reclamation following operational activities to return surface to pre-operational condition.
Temporary Land Use Impacts	Restriction of agricultural use of proposed 1,310 acre site; impacted for the duration of the project.	Surface reclamation following operational activities to return surface to pre-operational use.
Lost cattle production ($/yr.)	$7,770	Compensation to landowners through surface leases and/or mineral royalties.
Lost wheat production (Bu.)	Up to 37,085	Compensation to landowners through surface leases and/or mineral royalties.
Lost hay production (tons/yr.)	Up to 1,666	Compensation to landowners through surface leases and/or mineral royalties.
Groundwater consumption in Basal Chadron Formation (net gpm)	50	None
Groundwater quality impacts	Temporary impacts to groundwater quality in the Basal Chadron mining zone.	Proven groundwater restoration following mining to return Chadron groundwater quality to baseline or pre-operational water uses.
Visual and scenic impacts	Noticeable minor industrial component in existing agricultural/rural landscape; VRM Class III objectives met.	Use of harmonizing colors; use of existing vegetation and topography; avoidance of straight line site roads to follow topography; removal of construction debris.

Table 8-1: Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
Emissions		
Dust emissions (tons/yr.)	14.5	Dust control measures implemented where appropriate.
Radon emissions (Curies/yr.)	1662	None
Radiological Impacts		
Additional maximum predicted dose (mrem/yr.)	2.8	None
Socioeconomic Impacts		
Employment		
Additional full time employment	10 to 12	None
Additional contractor employment	4 to 7	None
Part time and contractor employment (during satellite construction)	10 to 15	None
Additional CBR payroll ($/yr.)	$400,000 to $480,000	None
Taxes Paid ($/yr.)	$1,000,000 to $1,200,000	None
Local purchases	$3,650,000 to $4,350,000	None
Waste Management Impacts		
Wastewater (gpm)	50	None
Solid waste produced (yd^3/yr.)	700	None
11(e)2 byproduct waste produced (yd^3/yr.)	60	None

9 LIST OF REFERENCES

9.1 REFERENCES FOR SECTION 1, INTRODUCTION OF THE ENVIRONMENTAL REPORT

Ferret Exploration of Nebraska, *Application and Supporting Environmental Report For USNRC Commercial Source Material License*, September 1987.

Energy Information Administration, *Summary Production Statistics of the U.S. Uranium Industry*, www.eia.doe.gov/cneaf/nuclear/dupr/dupr.html, accessed February 22, 2007.

Energy Information Administration, *2005 Uranium Market Annual Report*, www.eia.doe.gov/cneaf/nuclear/umar/umar.html, accessed February 22, 2007.

National Fire Protection Association, NFPA-50, *Standard for Bulk Oxygen Systems at Consumer Sites*, (NFPA, 1996).

Compressed Gas Association, CGA G-4.1, *Cleaning Equipment for Oxygen Service*, (CGA, 2000).

Compressed Gas Association, CGA G-4.4, *Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems*, (CGA, 1993).

9.2 REFERENCES FOR SECTION 2, ALTERNATIVES

Energy Information Administration, *Summary Production Statistics of the U.S. Uranium Industry*, www.eia.doe.gov/cneaf/nuclear/dupr/dupr.html, accessed February 22, 2007.

Energy Information Administration, *2005 Uranium Market Annual Report*, www.eia.doe.gov/cneaf/nuclear/umar/umar.html, accessed February 22, 2007.

U.S. Nuclear Regulatory Commission, *Draft Environmental Statement Related to the Operation of the Teton Project*, NUREG-0925, June 1982. Para. 2.3.5.

Crow Butte Resources, Inc., *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, December 1995.

USNRC, *Environmental Assessment for Renewal of Source Material License SUA-1534*, February 1998.

Argonne National Laboratory, *MILDOS-Area: An Enhanced Version of MILDOS For Large-Area Sources*, June 1989.

9.3 REFERENCES FOR SECTION 3, DESCRIPTION OF THE AFFECTED ENVIRONMENT

9.3.1 References for Land Use

DeLorme Maps. 1996. Nebraska Atlas and Gazetteer. Yarmouth, Maine.

Ferret Exploration of Nebraska, *Application and Supporting Environmental Report For USNRC Commercial Source Material License*, September 1987.

Nebraska Game and Parks Commission. 2007. Nebraska Game and Parks Interactive Map. http://mapserver.ngpc.state.ne.us/website/gpc_land/viewer.htm. Accessed 1/25/07.

Nebraska Public Power Corporation. 2005. Economic Importance of and Economic Impacts Associated with Livestock Production in Dawes County. Prepared by Donis N. Petersan, Ph.D., CEcD Economist. Economic Development Department, Nebraska Public Power District. [Web Page]

U.S.D.A. Natural Resources Conservation Service (NRCS). 2007. National Cooperative Soil Survey Web Soil Survey, http://websoilsurvey.nrcs.usda.gov/app/. Accessed 1/25/07.

U.S. Nuclear Regulatory Commission (USNRC). 2007. Locations of Fuel Cycle Facilities, http://www.nrc.gov/info-finder/materials/fuel-cycle. Accessed 1/25/07.

National Agricultural Statistics Service (NASS). 2004a. Quick Stats Nebraska County Data – Crops, http://www.nass.usda.gov/QuickStats/Create_County_Indv.jsp. Accessed on 6/15/04.

National Agricultural Statistics Service (NASS). 2004b. Quick Stats Nebraska County Data – Livestock, http://www.nass.usda.gov/QuickStats/Create_County_Indv.jsp. Accessed on 6/15/04.

Nebraska Department of Roads. 2003. 2003 – 2004 Nebraska Highway Systems Map. Lincoln, Nebraska.

U.S. Census. 2004. Census 2000 Summary File 1 (SF 1) 100-Percent Data, Detailed Tables, http://factfinder.census.gov/servlet/DTGeoSearchByListServlet?ds_name=DEC_2000_SF1_U&_lang=en&_ts=188137217426. Accessed 6/15/04.

9.3.2 References for Geology and Soils

Burchett, R.R., 1990, *Earthquakes in Nebraska:* University of Nebraska-Lincoln, Educational Circular No. 4a, 20 pp.

Burchett, R.R., 1986, *Geologic Bedrock Map of Nebraska*: Nebraska Geological Survey.

Chaney, B., *Earthquakes*, Chadron Record, June 24, 1982, p.1.

Collings, S.P. and Knode, R.H., 1984, *Geology and Discovery of the Crow Butte Uranium Deposit, Dawes County, Nebraska*: Practical Hydromet '83; 7th Annual Symposium on Uranium and Precious Metals, American Institute of Metallurgical Engineers, pp.5-14.

Crow Butte Resources, Inc., *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, December 1995.

DeGraw, H.M., 1969, *Subsurface Relations of the Cretaceous and Tertiary in Western Nebraska*: University of Nebraska, MS Thesis, 137 pp.

Docekal, J., 1970, *Earthquakes of the Stable Interior with Emphasis on the Mid-Continent*: University of Nebraska, PhD Thesis.

Ferret Exploration Company of Nebraska, Inc., Application and Supporting Environmental Report for USNRC Commercial Source Material License; September, 1987.

Hansley, P.L., S.P. Collings, I.K. Brownfield, and G.L. Skipp, *Mineralogy of Uranium Ore from the Crow Butte Uranium Deposit, Oligocene Chadron Formation, Northwestern Nebraska*, USGS Open File Report 89-225, 1989.

NRCS 1977. USDA, NRCS, in cooperation with University of Nebraska Conservation and Survey Division, Soil Survey of Dawes County Nebraska, Issued February 1977.

Rothe, G.H., 1981, *Earthquakes in Nebraska through 1979*: Earthquake Notes, V.52, No. 2, pp.59-65.

Rothe, G.H., Lui, C.V., and Steeples, D.W., 1981, *Recent Seismicity on the Chadron-Cambridge Arch, South-Central Nebraska*: Earthquake Notes, V.52, No. 1, p.61.

Schultz, C.B. and Stout, T.M., 1938, *Preliminary Remarks on the Oligocene of Nebraska (Abs)*: Geological Society American Bulletin, V.49, p.1921.

Seeland, D., 1985, *Oligocene Paleogeography of the Northern Great Plains and Adjacent Mountains*, in Flores, R.M. and Kaplan, S.S., eds., Cenozoic Paleogeography of the West-Central United States: Rocky Mountain Section, SEPM, pp.187-206.

Singler, C.R. and Pichard, M.D., 1979, *Petrography of the White River Group (Oligocene) in Northwest Nebraska and Adjacent Wyoming*: Contributions to Geology, University of Wyoming, V.18, pp.51-67.

Singler, C.R., and Picard, M.D., 1980, *Stratigraphic Review of Oligocene Beds in Northern Great Plains*: Earth Science Bul., WGA,. V.13, No.1, pp.1-18.

Souders, V.L., 1981, Geology and Groundwater Supplies of Southern Dawes and Northern Sheridan Counties, Nebraska: Conservation and Survey Division, University of Nebraska open-file report.

Spalding, Roy, 1982, *Baseline Hydrogeochemical Investigation in a Part of Northwest Nebraska*, prepared for the Nebraska Dept. of Environmental Control by the Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

Swinehart, J.B., Souders, V.L., DeGraw, H.M. and Diffendal, R.F. Jr., 1985, *Cenozoic Paleography of Western Nebraska*, in Flores, R.M. and Kaplan, S.S., eds., Cenzoic Paleogeography of the West-Central United States: Rocky Mountain Section, SEPM, pp.187-206.

U.S. Nuclear Regulatory Commission, Regulatory Guide 3.46, Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solutions Mining.

United States Department of Agriculture (USDA), National Resource Conservation Service (NRCS), 2006. Soil Survey Geographic (SSURGO) database for Dawes County, Nebraska. Located at: http://SoilDataMart.nrcs.usda.gov. Published: November 21, 2006.

Witzel, F.L., 1974, *Guidebook and Road Logs for the Geology of Dawes and Northern Counties, Nebraska*: MS Thesis, 97 pp.

Wyoming Fuel Company, 1983, *Crow Butte Project, Dawes County, Nebraska, Application and Supporting Environmental Report for State of Nebraska*, submitted to Nebraska Dept. of Environmental Control.

Internet references:

http://earthwuate.usgs.gov/regional/states/nebraska/seismicity.php
http://folkworm.ceri.memphis.edu/recenteqs/
http://www.neded.org
http://tonto.eia.doe.gove/FTPROOT/coal/05842005.pdf

9.3.3 References for Water Resources

R.A. Engberg and R.F Spalding, 1978; *Groundwater Quality Atlas of Nebraska*; prepared by USGS and the University of Nebraska-Lincoln, Conservation and Survey Division, Resource Atlas No. 4.

Gosselin, D. C., Headrick, J., Chen, X-H., Summerside, S. E., 1996; *Regional Analysis of Rural Domestic Well-water Quality -- Hat Creek-White River Drainage Basin*; from *Domestic Water-well Quality in Rural Nebraska*, Nebraska Department of Health.

Environmental Protection Agency, Handbook for Sampling and Sample Preservation of Water and Wastewater; September, 1982.

EPA, 2004; STORET Website, http://www.epa.gov/storet/

Federal Emergency Management Agency, Managing Floodplain Development in Approximately Zone A Areas; April, 1995.

Ferret Exploration Company of Nebraska, Inc., Application and Supporting Environmental Report for USNRC Commercial Source Material License, September, 1987.

Ferris, J.G., Knowles, R.H., Brown, R.H., and Stallman, R.W., Theory of Aquifer tests; U.S.G.S. Water Supply Paper, 1962; 1536-E., p. 171.

Harlan & Associates, Inc., October 15, 1996, Ground-water Pumping Test #3: Report prepared for Crow Butte Resources, Inc. and submitted to the Nebraska Department of Environmental Quality.

National Groundwater Association, 2004; Association Website, http://www.ngwa.org/pdf/states/ne.pdf.

National Oceanic and Atmospheric Administration, Annual Climatological Summary for Chadron, Nebraska; EDS-NNC; Ashville, North Carolina; 1981.

_____, Climate of Harrison, Nebraska, Climatography of the United States, 1976; No. 20.

_____, Local Climatological Data, Annual Summary with Comparative Data, 1980; Scottsbluff, Nebraska.

Nebraska Department of Health & Human Services Website; Safe Drinking Water Information System. http://www3.hhs.state.ne.us/Sdwis_State/JSP/WaterSystemDetail.jsp?tinwsys_is_number=712799&tinwsys_st_code=NE&wsnumber=NE3104505

Nebraska Department of Natural Resources, 2001; Discharge Records of Streams, Canals, Pumps and Storage Reservoirs, Hydrographic Report.

Souders, V.L. and Freethey, G.W., Water-Table Configuration, Fall 1971, Alliance Quadrangle, Nebraska and Eastern Part of Torrington Quadrangle, Wyoming and Nebraska; University of Nebraska, Institute of Agricultural and Natural Resources, Conservation and Survey Division; Lincoln, Nebraska; U.S. Geological Survey; 1975.

Souders, V.L, 2004, Report on Hydrologically Connected Ground Water and Surface Water in the Upper Niobrara-White Natural Resource District, Nebraska Department of Natural Resources; October, 2004.

Spalding, Roy, Baseline Hydrogeochemical Investigation in a Part of Northwest Nebraska, University of Nebraska, Institute of Agricultural and Natural Resources, Conservation and Survey Division; Lincoln, Nebraska; Nebraska Department of Environmental Control; 1982.

State of Nebraska Department of Natural Resources, Discharge Records of Streams, Canals, Pumps and Storage in Reservoirs; 2004.

Struempler, A.W., Trace Metals in Rain and Snow During 1973 at Chadron, Nebraska, Atmospheric Environment, 1976; v.10, 33-37pp.

Struempler, A.W., Interrelationships of Selected Physical Properties and Chemical Constituents of Ground Water in Northwest Nebraska, Trans. Nebr. Acad. Soc.; 1979; v.VII, 41-44pp.

Todd, David Keith, Ground Water Hydrology, John Wiley & Sons, New York; 1980.

University of Nebraska-Lincoln, undated; University of Nebraska Cooperative Extension HE Form 526.

http://216.239.57.104/search?q=cache:ndrpVibkk6wJ:communityprograms.unl.edu/html/pdf/HEF526.pdf+University+of+Nebraska+Cooperative+Extension+HE+Form+526&hl=en&ie=UTF-8

University of Nebraska-Lincoln, Conservation and Survey Division, 1986; *The Groundwater Atlas of Nebraska*, Resource Atlas No. 4.

USGS, undated, National Handbook of Recommended Methods for Water Data Acquisition – Chapter 11, http://water.usgs.gov/pubs/chapter11/.

USGS, 2004; National Water Information System Website http://nwis.waterdata.usgs.gov/ne/nwis/monthly/?site_no=06444000&agency_cd=USGS.

Wyoming Fuel Company, Application and Supporting Environmental Report for Research and Development Source Material License, February 11, 1983.

Website References:

http://www.epa.gov/storet/updates.html
http://msc.fema.gov

9.3.4 References for Ecological Resources

Anschutz, S. 2004. Personal Communication [May 27 letter to R. Henning, Greystone Environmental Consultants, Inc., Greenwood Village, Colorado. RE: Threatened and Endangered Species Request]. Nebraska Field Supervisor, U.S. Dept. of Interior, Fish and Wildlife Service, Grand Island, NE. 4 pages.

Butler, L.D., J.B. Cropper, R.H. Johnson, A.J. Norman, P.L. Shaver. 1997. National Range and Pasture Handbook. Natural Resources Conservation Service's Grazing Lands Technology Institute. Fort Worth, Texas. 472 pp.

Hams, K. 2004. Personal Communication [July 15 telephone conversation with R. Henning, Greystone Environmental Consultants, Inc., Greenwood Village, Colorado. RE: Big Game Mammals in Sioux and Dawes Counties]. Big Game Biologist, Nebraska Game and Parks Commission, Lincoln, NE. 1 page.

Chapman, S.S., J.M. Omernik, J.A. Freeouf, D.G. Huggins, J.R. McCauley, C.C. Freeman, G. Steinauer, R.T. Angelo, and R.L. Schlepp. 2001. Ecoregions of Nebraska and Kansas [Web Page]. Website located at ftp://ftp.epa.gov/wed/ecoregions/ks_ne/ksne_front.pdf Accessed July 13, 2004.

Clark, T.W., and M.R. Stromberg. 1987. Mammals in Wyoming. University of Kansas Museum of Natural History Press. Lawrence, KS. 320 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States [Web Page]. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/classwet/classwet.htm (Version 04DEC98). Accessed: July 15, 2004.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The Birder's Handbook: A Field Guide to the Natural History of North American Birds. Simon and Schuster, New York. 785 pp.

Ferraro, D. 2004. Personal Communication [July 9 e-mail to R. Henning, Greystone Environmental Consultants, Inc. RE: Amphibian and Reptile Distribution in Sioux and Dawes County]. Herpetologist, University of Nebraska, Lincoln, NE. 1 page.

Ferret Exploration of Nebraska. 1987. Application and Supporting Environmental Report for USNRC Commercial Source Material License. September 1987.

Fitzgerald J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History, Denver, Colorado.

Godberson, J. 2004. Personal Communication [July 9 telephone conversation with R. Henning, Greystone Environmental Consultants, Inc., Greenwood Village, Colorado. RE: Threatened and Endangered Species]. Environmental Analyst Supervisor, Nebraska Game and Parks Commission, Lincoln, NE. 1 page.

High Plains Regional Climate Center (HPRCC). 2004. Western U.S. Climate Historical Summaries [Web Page]. Website located at http://hprcc.unl.edu/cgi-bin/cli_perl_lib/cliMAIN.pl?ne1575 accessed July 13, 2004.

Johnsgard, P.A. 1979. The Birds of Nebraska and Adjacent Plains States [Web Page]. Located at http://rip.physics.unk.edu/NOU/Johnsgard/ Accessed: July 15, 2004.

Nebraska Ornithologists' Union Records Committee. 1997. The official list of the birds of Nebraska [Web Page]. Located at http://rip.physics.unk.edu/NOU/Official/ Accessed July 23, 2004.

Nebraska Game and Parks Commission. 2004a. Big game hunting guide 2002 - 2003 antelope harvest information [Web Page]. Located at http://www.ngpc.state.ne.us/hunting/guides/biggame/BGantharvest.asp Accessed July 22, 2004.

Nebraska Game and Parks Commission. 2004c. Big game hunting guide 2001 - 2002 Deer Harvest Information - Buck Harvest Summary [Web Page]. Website located at http://www.ngpc.state.ne.us/hunting/guides/biggame/buckharvest.asp Accessed July 27, 2004.

Nebraska Game and Parks Commission. 2004c. Big game hunting guide - white-tailed and mule deer [Web Page]. Website located at http://www.ngpc.state.ne.us/hunting/guides/biggame/BGdeer.asp Accessed July 22, 2004.

Nordeen, T. 2004. Personal Communication [July 15 telephone conversation with R. Henning, Greystone Environmental Consultants, Inc., Greenwood Village, Colorado. RE: Upland and Big Game Distributions near Crawford, NE.]. Biologist, Nebraska Game and Parks Commission, Alliance, NE.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results and Analysis 1966 - 2003. Version 2002.1, U.S. Geological Survey Patuxent Wildlife Research Center, Laurel, MD. Located at http://www.mbr-pwrc.usgs.gov/bbs/bbs2001.html Accessed July 17, 2004.

Schauster E. R., E. M. Gese, and A. M. Kitchen. 2002. Population ecology of swift foxes (*Vulpes velox*) in southeastern Colorado. Canadian Journal of Zoology 80:307-319.

Steenhof, K. 1978. Management of wintering bald eagles. U.S. Fish and Wildlife Service, Biological Services Program, FWS/OBS-78/79.

Swisher, J.F. 1964. A roosting of the bald eagle in northern Utah. Wilson Bulletin 76(2): 186 – 187.

U.S. Department of Interior, Fish and Wildlife Service. 1978. Final Special Rule, 17.41(a) Determination of Certain Bald Eagle Populations as Endangered or Threatened. February 14, 1978. Federal Register 43 6230 – 6233.

U.S. Department of Interior, Fish and Wildlife Service. 1995a. Final Rule to Reclassify the Bald Eagle from Endangered to Threatened in All of the Lower 48 States. July 12, 1995. Federal Register 60(133): 36000–36010.

U.S. Department of Interior, Fish and Wildlife Service. 1995b. Endangered and Threatened Wildlife and Plants; 12-Month Finding for a Petition to List the Swift Fox as Endangered. Federal Register Vol. 60, No. 116. 31663-31666.

Wyoming Fuel Company. 1983. Application and Supporting Environmental Report for Research and Development Source Material License; February 1983.

9.3.5 References for Meteorological

United States Department of Agriculture (USDA). 1981. *Draft Environmental Impact Statement. Nebraska National Forest, Land, and Resource Management Plan.* USDA 02-07-81-07. USDA Forest Service, Chadron, NE.

United States Nuclear Regulatory Commission (USNRC), 1979. *Draft Generic Environmental Impact Statement on Uranium Milling* NUREG – 0511. Washington, D.C.

HPRC Center 2004, Historical Data Summaries. [Web page] located at http://hprcc.unl.edu/cgi-bin/cli_perl_lib/cliMAIN.pl?ne1575 Accessed May 24, 2004.

NOAA. 1993. Solar and Meteorological Surface Observation Network 1961 – 1990, Version 1.0. September.

USEPA. 2007. AirData: Access to Air Pollution Data. [Web page] located at http://www.epa.gov/air/data/index.html Accessed: March 2, 2007.

9.3.6 References for Noise

Bell, Lewis H. 1982. *Industrial Noise Control, Fundamentals and Applications*, Marcel Dekker, Inc., New York, New York.

City of Crawford Nebraska (Crawford). 2007. Ordinances, [Web page]. Located at http://www.crawfordnebraska.net/depts/ordinances.html. Accessed: March 7, 2007.

Harris, Cyril M. 1991. *Handbook of Acoustical Measurements and Noise Control.* McGraw-Hill, New York, New York.

State of Nebraska, Department of Roads (Nebraska). 2007a. NDOR Map Library, Miscellaneous Categories. *Current Nebraska Speed Limit Maps*. [Web page].

Located at http://www.nebraskatransportation.org/maps/#traffvol. Accessed: March 7, 2007.

State of Nebraska, Department of Roads (Nebraska). 2007b. NDOR Map Library, Traffic Volume Maps and Info. *2004 NE Highway Traffic Flow Map.* [Web page]. Located at http://www.nebraskatransportation.org/maps/#traffvol. Accessed: March 7, 2007.

U.S. Department of Transportation (USDOT), Federal Highway Administration, Office of Environment and Planning, Noise and Air Quality Branch, 1995. *Highway Traffic Noise Analysis and Abatement Policy and Guidance*, June.

9.3.7 References for Historic and Cultural Resources

Späth, Dr. Carl. 2006. *Crow Butte Resources North Trend Expansion Area Class III Cultural Resource Inventory, Dawes County, Nebraska*, February 2006.

Steinacher, Terry, and L. Robert Puschendorf. 2006. *Crow Butte Resources North Trend Expansion, Dawes Co., NE, H.P. #0603-040-01.* Letter to Dr. Carl Spath from the Nebraska State Historical Society, 21 March 2006.

9.3.8 References for Visual and Scenic Resource

U.S.D.I., Bureau of Land Management (BLM). 1986. *Visual Resource Contrast Rating.* BLM Manual Handbook 8431-1.

U.S.D.I., Bureau of Land Management (BLM). 1986. *Visual Resource Inventory.* BLM Manual Handbook 8410-1.

Nebraska Department of Roads, 2003. *2002 NE Highway Traffic Flow Map.* [web page] located at: http://www.nebraskatransportation.org/maps/#traffvol Accessed: 6/15/04.

9.3.9 References for Socioeconomic

Bureau of Economic Analysis (BEA). 2004. 2002 Personal Income for Dawes County, Nebraska.

Budler, M. 1987. Nebraska Department of Labor. Personal communication.

Crawford Elementary School. 1995. Clerk's Office. Personal communication.

Crawford High School. 1995. Clerk's Office. Personal communication.

Crawford Public Schools. 2007. Clerk's Office. Personal communication.

Datson, B. 1982. Chadron State College. Office of Development and Planning. Personal communication.

Dawes County. 1987. Clerk's Office. Personal communication.

Mathis, G. 1982. Dawes County Commissioner. Personal communication.

Lemmon, L. 1982. Personal communication.

Lemmon, L. 1987. Personal communication.

National Center for Education Statistics. 2004. Public Schools, Crawford, NE, located at www.nces.ed.gov.

Nebraska Agricultural Statistics Service. 2001. Nebraska Agricultural Statistics 2000-2001, August.

Nebraska Department of Economic Development. 1986. Nebraska Profile - Crawford.

Nebraska Department of Economic Development. 2002. Nebraska Data Book located at www.info.neded.org/databook/php

Nebraska Department of Economic Development. 2003. Attendance at Selected Nebraska Attractions, 2001-2002. Tourism Division.

Nebraska Department of Economic Development. 2007. Tourism Statistics, located at www.visitnebraska.org/pressroom/facts/stats.htm, accessed March 6, 2007.

Nebraska Department of Labor, Division of Employment, Research and Statistics. 1981a. Annual Planning Report, 1982.

Nebraska Department of Labor, Division of Employment, Research and Statistics. 1981b. Nebraska Non-Farm Employment, 1974-1979.

Nebraska Department of Labor, Division of Employment, Research and Statistics. 1981c. Nebraska Work Trends.

Nebraska Department of Labor. 1987. Labor Trends.

Nebraska Department of Labor. 1987. Labor Market Information.

Nebraska Department of Labor. 1995. Labor Market Information.

Nebraska Department of Labor. 2003. Labor Market Information.

Nebraska Department of Roads. 2003. 2002 NE Highway Traffic Flow Map. [web page] located at: http://www.nebraskatransportation.org/maps/#traffvol. Accessed: 6/15/04.

Nebraska Department of Property Assessment and Taxation. 2001. 2001 Annual Report. Located at www.pat.nol.org/reports/pdf/2001AR.PDF Accessed on 7/14/2004.

Nebraska Game and Parks Commission. 1982. Discover Nebraska Travel Guide, Nebraskaland Magazine.

Nebraska Public Power District. 1986. Industrial Facts - Crawford, Nebraska.

Nebraska Public Power District. 1991. Industrial Facts - Crawford, Nebraska.

Petersen, R. 1987. Crawford Realtor. Personal communication.

Plooster, L. 1995. Office Manager, Fort Robinson State Park. Personal communication.

Schmiedt, J. 1987. Chadron State College, Dean of Students. Personal communication.

Suchor, R. 1995. Broker/Owner, Suchor Realty. Crawford, Nebraska. Personal communication.

Taylor, A. 1995. Chadron State College, Institutional Research. Personal communication.

U.S. Department of Commerce, Bureau of Census. 1972a. 1970 Census of Population. Nebraska.

U.S. Department of Commerce, Bureau of Census. 1972b. Census of Populations, South Dakota.

U.S. Department of Commerce, Bureau of Census. 1972c. Census of Population, Wyoming.

U.S. Department of Commerce, Bureau of Census. 1978a. Current Population Reports, Estimates of the Population of Counties and Metropolitan Areas 1975, Series P-25, No. 739.

U.S. Department of Commerce, Bureau of Census. 1979. Estimates of the Population of the Counties and Incorporated Places, Series P-25, Nos. 840, 854, 863.

U.S. Department of Commerce, Bureau of Census. 1981. 1980 Census of Population and Housing, Advance Report, Nebraska, 680-V.

U.S. Department of Commerce, Bureau of Census. 1982. Census Retrieval and Information Service, 1980 Census, Tape STFIA.

U.S. Department of Commerce, Bureau of Census. 1980. Quadrangle maps including Dead Man's Creek, Belmont, Coffee Mill Butte SW, chimney Butte, Crow Butte, and Crawford, Nebraska.

U.S. Department of Commerce, Bureau of Census. 1990a. 1990 Census of Population and Housing, Summary of Population and Housing Characteristics, Nebraska.

U.S. Department of Commerce, Bureau of Census. 1990b. Summary of Population and Housing Characteristics, South Dakota.

U.S. Department of Commerce, Bureau of Census. 1990c. Summary of Population and Housing Characteristics, Wyoming.

U.S. Department of Commerce, Bureau of Census. 1990d. Population and Housing Unit Counts, Nebraska.

U.S. Department of Commerce, Bureau of Census. 1990e. Population and Housing Unit Counts, South Dakota.

U.S. Census Bureau. 2001. 1990 and 2000 Census Data on Population and Housing, Colorado Economic and Demographic Information System. Racial and Ethnic Composition, and Average Household Size. Link to U.S. Census Bureau, American Fact Finder. [Web Page] located at: http://factfinder.census.gov/servlet/DTTable?_ts=35204832296. Accessed: May 2001.

U.S. Census Bureau. 2003. 1990 Census of Population and Housing; Population and Housing Unit Counts, South Dakota. [web page] located at: http://www.census.gov/prod/cen1990/cph2/cph-2-43.pdf

Nebraska Geological Survey. 1974. Inventory of Mining Operations in Nebraska, 1981 Nebraska Mineral Operations Review, 1980.

University of Nebraska, Bureau of Business Research. 2004. Population Projections of Nebraska, 2000-2020.

University of South Dakota, Bureau of Business Research. 2004. Projections of South Dakota Population: 2000-2020.

Wyoming Department of Administration and Information, Economic Analysis Division. 2004. Wyoming Population Estimates and Forecasts from 1991 to 2010.

9.3.10 References for Public and Occupational Health

Crow Butte Resources, Inc., *Application for Renewal of USNRC Radioactive Source Materials License SUA-1534*, December 1995.

US Department of Labor, Bureau of Labor Statistics, as of March 5, 2007.

9.3.11 References for Waste Management

U. S. Nuclear Regulatory Commission, Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002).

Nebraska Department of Environmental Quality, Title 119, *Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System* (May 2005).

Nebraska Department of Environmental Quality, Title 122, *Rules and Regulations for Underground Injection and Mineral Production Wells* (April 2002).

U. S. Nuclear Regulatory Commission, Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills* (Revision 2, December 1977).

U. S. Nuclear Regulatory Commission, Regulatory Guide 3.11.1, *Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings* (Revision 1, October 1980).

U. S. Nuclear Regulatory Commission, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source or Special Nuclear Material* (May 1987).

Nebraska Department of Environmental Quality, Title 124, *Rules and Regulations for the Design, Operation, and Maintenance of On-site Wastewater Treatment Systems* (May 2005).

Nebraska Department of Environmental Quality, Title 128, *Nebraska Hazardous Waste Regulations* (January 2007).

9.4 REFERENCES FOR SECTION 4, ENVIRONMENTAL IMPACTS

9.4.1 References for Water Resource Impacts

Nebraska Department of Environmental Quality, *Title 119 – Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System*, May 16, 2005.

9.4.2 References for Ecological Resources Impacts

Fritz, M. 2004. Personal Communication [August 6 telephone conversation with R. Henning. Greystone Environmental Consultants, Inc. Greenwood Village, CO]. RE: Raptor species including Bald Eagle. Raptor Biologist, Nebraska Game and Parks Commission. Lincoln, NE. 1 Page.

Nebraska Game and Parks Commission. 2004d. Bird of Nebraska: an interactive guide, http://www.ngpc.state.ne.us/wildlife/guides/birds/showbird.asp?BirdID='98' Accessed July 27, 2004.

U.S. Department of Interior, Fish and Wildlife Service. 1999. Proposed rule to remove the bald eagle in the lower 48 states from the list of endangered and threatened wildlife. Federal Register Vol. 64, No. 128 36454 – 36464.

9.4.3 References for Air Quality Impacts

USEPA. 2007. AirData: Access to Air Pollution Data. [Web page] located at http://www.epa.gov/air/data/index.html Accessed: March 2, 2007.

U.S. Environmental Protection Agency, USEPA—1978, *Supplement No. 8 for Compilation of Air Pollutant Emission Factors Third Edition (Including Supplements, 1-7),* Research Triangle Park, North Carolina, May 1978.

9.4.4 References for Noise Impacts

Crocker, M.J., Kessler, F.M. 1982. *Noise and Noise Control*, Volume II. CRC Press, Inc., Chemic Rubber Company, Cleveland, OH.

9.4.5 References for Historical and Cultural Resources Impacts

Steinacher, Terry, and L. Robert Puschendorf. 2006. *Crow Butte Resources North Trend Expansion, Dawes Co., NE, H.P. #0603-040-01*. Letter to Dr. Carl Spath from the Nebraska State Historical Society, 21 March 2006.

9.4.6 References for Public and Occupational Health Impacts

U.S. Nuclear Regulatory Commission, Regulatory Guide 3.59, *Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations*, March 1987.

Argonne National Laboratory, *MILDOS-Area: An Enhanced Version of MILDOS For Large-Area Sources,* June 1989.

Ferret Exploration of Nebraska, *Application and Supporting Environmental Report For USNRC Commercial Source Material License*, September 1987.

Center for Nuclear Waste Regulatory Analysis, *A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees*, NUREG/CR-6733, September 2001.

9.4.7 References for Waste Management Impacts

U. S. Nuclear Regulatory Commission, Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002).

Nebraska Department of Environmental Quality, Title 119, *Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System, (*May 2005).

U. S. Nuclear Regulatory Commission, Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills* (Revision 2, December 1977).

U. S. Nuclear Regulatory Commission, Regulatory Guide 3.11.1, *Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings* (Revision 1, October 1980).

U. S. Nuclear Regulatory Commission, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source or Special Nuclear Material* (May 1987).

Nebraska Department of Environmental Quality, Title 124, *Rules and Regulations for the Design, Operation, and Maintenance of On-site Wastewater Treatment Systems,* (May 2005).

Nebraska Department of Environmental Quality, Title 128, *Nebraska Hazardous Waste Regulations,* (January 2007).

9.5 REFERENCES FOR SECTION 5, MITIGATION MEASURES

9.5.1 References for Land Use Impact Mitigation Measures

American National Standards Institute, ANSI/HPS N13.12, *Surface and Volume Radioactivity Standards for Clearance*, 1999.

Nuclear Regulatory Commission, NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Termination, Draft Report for Comment*, June 1992.

9.5.2 References for Water Resources Impact Mitigation Measures

Nebraska Department of Environmental Quality, *Title 118 – Ground Water Quality Standards and Use Classification,* March 27, 2006.

9.6 REFERENCES FOR SECTION 6, ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

9.6.1 References for Radiological Monitoring

USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills* (1980).

Resource Technologies Group, Inc., *Preoperational Environmental Monitoring Plan For Mining Expansion*, Crow Butte Mine, Dawes County, Nebraska (1996).

USNRC, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications*, NUREG-1569, November 2002.

Ferret Exploration Company of Nebraska, Inc., *Application and Supporting Environmental Report for USNRC for Commercial Source Material License*, 1987.

USNRC, *Environmental Assessment for Renewal of Source Material License SUA-1534*, February 1998.

USNRC, *Description of the United States Uranium Resource Areas and Supplement to the Generic Environmental Impact Statement on Uranium Milling*, NUREG-0597, June 1979.

9.6.2 References for Physiochemical Monitoring

U. S. Nuclear Regulatory Commission, Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills* (Revision 2, December 1977).

U. S. Nuclear Regulatory Commission, Regulatory Guide 3.11.1, *Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings* (Revision 1, October 1980).

9.7 REFERENCES FOR SECTION 7, COST BENEFIT ANALYSIS

US Department of Labor, Bureau of Labor Statistics, as of March 5, 2007.

Nebraska Department of Economic Development, *Nebraska Databook*, December 2006; http://info.neded.org/stathand/isect10.htm.

Nebraska Department of Roads, *Traffic Flow Map of the State Highways, State of Nebraska*, http://www.dor.state.ne.us/maps/Statewide%20Traffic%20Flow%20Maps/2004%20Statewide%20Traffic%20Flow%20Map.pdf.

10 LIST OF PREPARERS

The following individuals and organizations were involved in the preparation of the Technical Report and this Environmental Report supporting the amendment request for Source Materials License SUA-1534 to allow development of the North Trend Expansion Area:

Crow Butte Resources, Inc.
PO Box 169
Crawford, Nebraska 69339

Jim Stokey, Ph.D.	Mine Manager
Dennis Kersteins	Consulting Engineer
Larry Teahon	Manager, Health Safety & Environmental Affairs
John Cash	Superintendent, Operations
Wade Beins	Senior Geologist
Rhonda Grantham	Supervisor of Radiation Safety & Regulatory Affairs / RSO
Jay Douthit	Wellfield Operator II

Petrotek Engineering Corporation
10288 West Chatfield Avenue, Suite #201
Littleton, Colorado 80127

Hal Demuth	Principal, Hydrogeologist & Engineer
Connie Walker	Hydrogeologist
Errol Lawrence	Hydrogeologist
Ken Cooper	Principal, Engineer
Ken Schlieper	Hydrologist & Graphics Specialist

ARCADIS US Inc.
630 Plaza Drive, Suite 100
Highlands Ranch, Colorado 80129

Brandon Evans	Project Manager/Engineer
Mike Kolin	Project Manager/Engineer
Jerry Koblitz	Quality Control Officer
Lisa Welch	Senior Scientist
Elaine Porter	Staff Scientist – Biologist
Ryan Henning	Senior Scientist – Biologist
Carl Spaath, Ph.D.	Archeologist
Gordon Frisbie	Air Quality Specialist
Susan Riggs	Air Quality Specialist
Mike Holle	GIS Specialist
Mike McDermott	AutoCAD Specialist
Jamie Jagla	AutoCAD Specialist
Chris Russo	GIS Specialist
Deb Ballheim	Editor
Audrey Hanbury	Word Processing

Environmental Restoration Group
8809 Washington NE
Albuquerque, New Mexico 87113

Kenneth R. Baker, Ph.D.	Principal - Sr. Health Physicist
Chuck Farr	Engineer
Mike Schierman	Sr. Health Physicist
Neil Wrubel	Sr. Environmental Scientist

Griffin Consulting, Inc.
P.O. Box 344
Crawford, Nebraska 69339

Michael Griffin	Licensing Consultant