Table 3.5-12: Regional Baseline Impoundment Sampling

Site	Type/Name	Baseline Sampling				Downgradient of Proposed Facilities*
		3Q07	4Q07	1Q08	2Q08	
Sub01	Stock Pond	1	1	X	X	No
Sub02	Triangle Mine Pit	X	X	X	X	No
Sub03	Mine Dam	1	X	1	X	Yes
Sub04	Stock Pond	1	X	1	X	Yes
Sub05	Mine Dam	1	1	1	1	Yes
Sub06	Darrow Mine Pit Northwest	X	X	X	X	Yes
Sub07	Stock Dam	X	X	X	X	Yes
Sub08	Stock Pond	X	X	X	X	Yes
Sub09	Stock Pond	1	1	X	X	Yes
Sub10	Stock Pond		1	X	X	Yes
Sub11	Stock Pond	X	X	X	X	Yes
Sub20	Stock Pond					Yes
Sub21	Stock Pond					Yes
Sub22	Stock Pond					Yes
Sub23	Stock Pond					No
Sub24	Stock Pond			X		No
Sub25	Stock Pond					No
Sub26	Stock Pond					No
Sub27	Stock Pond					Yes
Sub28	Stock Pond					Yes
Sub29	Stock Pond					Yes
Sub30	Stock Pond					Yes
Sub31	Stock Pond					Yes
Sub32	Stock Pond					Yes
Sub33	Stock Pond					Yes
Sub34	Stock Pond					Yes
Sub35	Stock Pond					Yes
Sub36	Stock Pond					Yes
Sub37	Stock Pond					Yes
Sub38	Stock Pond					No
Sub39	Stock Pond					No
Sub40	Darrow Mine Pit Southeast					Yes
Sub41	Stock Pond					Yes
Sub42	Stock Pond					No
Sub43	Stock Pond					No
Sub44	Stock Pond					No
Sub45	Stock Pond					No
Sub46	Stock Pond					No
Sub47	Stock Pond					No
Sub48	Stock Pond					No
Sub49	Darrow Mine Pit					Yes
Sub50	Darrow Mine Pit					Yes
Sub51	Stock Pond					No
Sub52	Stock Pond					No
Sub53	Stock Pond					No
Sub54	Stock Pond					No

* Potentially subject to surface runoff from satellite facility, CPP, ponds, potential land application areas, pipelines, or potential well field areas.

Notes: X – Sample collected
1 – No sample collected due to impoundment being dry during quarterly visit

Table 3.5-13: Stream Water Quality

Constituent	Units	Beaver Creek	Pass Creek	Cheyenne River
Field Parameters				
Field Temperature	°C	-0.1 - 27.6	13.6 - 17.1	-0.1 - 27
Field pH	s.u.	7.5 - 8.9	8.1	7.4 - 8.4
Field Dissolved Oxygen	mg/L	6.5 - 13.7	9.5 - 10.3	3.7 - 13.1
Field Conductivity	umhos/cm	733 - 7,678	1,696 - 1,844	350 - 7,847
Field Turbidity	NTU	1.7 - 1,790	1,672 - 1,780	1 - 1,798
Microbiological				
Bacteria, Fecal Coliform	CFU/100 mL	<2 - 5,700	3,700 - 7,500	<2 - 3,500
Physical Properties				
Conductivity @ 25°C	umhos/cm	514 - 7,540	1,240 - 1,840	367 - 7,530
pH	s.u.	7.7 - 8.8	7.2 - 7.3	7.6 - 8.3
Sodium Adsorption Ratio (SAR)	unitless	1.9 - 13	<0.1	1.2 - 15
TDS @ 180 °C	mg/L	520 - 6,100	1,100 - 1,700	340 - 7,200
TSS @ 105 °C	mg/L	<5 - 4,600	140 - 3,700	<5 - 4,900
Common Elements and Ions				
Alkalinity, Total as $CaCO_3$	mg/L	78 - 220	50 - 62	80 - 352
Bicarbonate as HCO_3	mg/L	85 - 268	61 - 76	98 - 429
Carbonate as CO3	mg/L	<5	<5	<5
Calcium	mg/L	52 - 499	270 - 510	30 - 525
Chloride	mg/L	9 - 1,730	1.6 - 2.8	2 - 912
Fluoride	mg/L	<0.1 - 0.9	0.14 - 0.2	<0.1 - 0.7
Magnesium	mg/L	13 - 210	10.1 - 30.5	9 - 380
Nitrogen, Ammonia as N	mg/L	<0.1	0.1 - 0.2	<0.1 - 0.1
Nitrogen, Nitrate as N	mg/L	<0.1 - 0.6	0.56 - 0.77	<0.1 - 0.6
Potassium	mg/L	5 - 15	6 - 12.4	5 - 26
Sodium	mg/L	89 - 1,240	1.7 - 6.3	28 - 1,530
Sulfate	mg/L	286 - 2,670	645 - 1,400	86 - 4,520
Silica	mg/L	<1 - 15.5	1.7 - 16.5	2.6 - 14.1
Metals - Dissolved				
Aluminum	mg/L	<0.1	<0.1	<0.1
Arsenic	mg/L	<0.001 - 0.002	0.002	<0.001 - 0.001
Barium	mg/L	<0.1 - 0.1	<0.1 - 0.1	<0.1
Boron	mg/L	0.2 - 0.6	<0.1	<0.1 - 0.4
Cadmium	mg/L	<0.005	<0.005	<0.005
Chromium	mg/L	<0.01	<0.01 - 0.02	<0.05
Copper	mg/L	<0.01	<0.01	<0.01
Iron	mg/L	<0.03 - 0.18	<0.03 - 0.1	<0.03 - 0.15
Lead	mg/L	<0.001	<0.001	<0.001
Manganese	mg/L	<0.01 - 0.83	0.03 - 0.04	<0.01 - 3.01
Mercury	mg/L	<0.001	<0.001	<0.001
Molybdenum	mg/L	<0.1	<0.1	<0.1
Nickel	mg/L	<0.01 - 0.01	<0.01 - 0.03	<0.01 - 0.01
Selenium	mg/L	<0.001 - 0.004	<0.005	<0.0001 - 0.003

Table 3.5-13: Stream Water Quality (cont'd)

Constituent	Units	Beaver Creek	Pass Creek	Cheyenne River
Metals - Dissolved				
Silver	mg/L	<0.005	<0.005	<0.005
Thorium-232	mg/L	<0.005	<0.005	<0.005
Uranium	mg/L	0.002 - 0.027	0.0007 - 0.005	0.002 - 0.037
Vanadium	mg/L	<0.1	<0.1	<0.1
Zinc	mg/L	<0.01	<0.01	<0.01 - 0.02
Metals – Dissolved – Speciated				
Selenium-IV	mg/L	<0.001 - 0.002	<0.001	<0.001
Selenium-VI	mg/L	<0.001 - 0.004	<0.001	<0.001 - 0.002
Metals – Suspended				
Thorium-232	mg/L	<0.001 - 0.013	<0.001 - 0.002	<0.001 - 0.035
Uranium	mg/L	<0.0003 - 0.003	0.0004 - 0.0009	<0.0003 - 0.0067
Metals - Total				
Aluminum	mg/L	<0.1 - 99.3	58.7 - 85.9	<0.1 - 170
Arsenic	mg/L	<0.001 - 0.048	0.003 - 0.031	<0.001 - 0.029
Barium	mg/L	<0.1 - 1.1	0.2 - 0.8	<0.1 - 0.9
Boron	mg/L	<0.1 - 0.6	<0.1 - 0.3	<0.1 - 0.6
Cadmium	mg/L	<0.005	<0.005	<0.005
Chromium	mg/L	<0.05 - 0.19	<0.05 - 0.17	<0.05 - 0.19
Copper	mg/L	<0.01 - 0.11	<0.01 - 0.1	<0.01 - 0.1
Iron	mg/L	0.05 - 137	0.28 - 128	0.06 - 108
Lead	mg/L	<0.001 - 0.088	0.002 - 0.074	<0.001 - 0.118
Manganese	mg/L	0.05 - 1.82	0.12 - 2.55	0.1 - 2.94
Mercury	mg/L	<0.001	<0.001	<0.001
Molybdenum	mg/L	<0.1	<0.1	<0.1
Nickel	mg/L	<0.05 - 0.15	<0.05 - 0.15	<0.05 - 0.1
Selenium	mg/L	<0.001 - 0.004	<0.001 - 0.003	<0.001 - 0.003
Silver	mg/L	<0.005	<0.005	<0.005
Thorium-232	mg/L	<0.005 - 0.04	0.012 - 0.02	<0.005 - 0.046
Uranium	mg/L	0.003 - 0.026	0.0012 - 0.025	0.0043 - 0.0378
Vanadium	mg/L	<0.1 - 0.4	<0.1 - 0.1	<0.1 - 0.3
Zinc	mg/L	<0.01 - 0.54	0.02 - 0.34	<0.01 - 0.47
Metals – Total – Speciated				
Selenium-IV	mg/L	<0.001 - 0.001	<0.001	<0.001
Selenium-VI	mg/L	<0.001 - 0.004	<0.001	<0.001 - 0.003
Radionuclides - Dissolved				
Lead-210	pCi/L	<1 - 26	1.7 - 2.2	<1 - 6.6
Polonium-210	pCi/L	<1 - 3	0.2 - 0.7	<1 - 2.4
Radium-226	pCi/L	<0.2 - 2	0 - 0.1	<0.2 - 1.4
Thorium-230	pCi/L	<0.2 - 1.7	0	<0.2 - 0.3
Radionuclides – Suspended				
Lead-210	pCi/L	<1 - 15.3	-0.8 - 0.9	<1 - 22
Polonium-210	pCi/L	<1 - 3.7	0.3	<1 - 4.1
Radium-226	pCi/L	<0.2 - 3.1	-0.2 - 0.1	<0.2 - 4
Thorium-230	pCi/L	<0.2 - 3.4	0.2 - 0.5	<0.2 - 3.8

Table 3.5-13: Stream Water Quality (cont'd)

Constituent	Units	Beaver Creek	Pass Creek	Cheyenne River
Radionuclides - Total				
Gross Alpha	pCi/L	2.3 - 65.8	1.9 - 8.8	4 - 35.3
Gross Beta	pCi/L	<2 - 48.1	-7 - 15.1	<2 - 38
Gross Gamma	pCi/L	<20 - 1,310	0	<20 - 1,140
Lead-210	pCi/L	<1 - 35	0 - 3	<1 - 22
Polonium-210	pCi/L	<1 - 4.4	0.5 - 1	<1 - 4.6
Radium-226	pCi/L	<0.2 - 5.1	<0.2 - 0.7	<0.2 - 5.1
Thorium-230	pCi/L	<0.2 - 3.4	0.2 - 0.5	<0.2 - 3.8

Beaver Creek dissolved metals concentrations were typically low, with notable detections for boron, iron, manganese, and uranium. Total metal concentrations often were higher than dissolved concentrations, suggesting that some of the metals were associated with sediment or precipitates. Notable total metal detections included aluminum, arsenic, iron, lead, manganese, uranium and zinc.

Total radionuclide concentrations in Beaver Creek were relatively high in some samples. Maximum concentrations included 65.8 pCi/L gross alpha, 48.1 pCi/L gross beta, and 1,310 pCi/L gross gamma.

Pass Creek

Due to lack of precipitation-driven runoff, only four water quality samples were collected on Pass Creek, all of which were collected in July (2007 and 2008). Table 3.5-13 demonstrates less variability in Pass Creek water quality than Beaver Creek. This is attributed at least in part to the limited seasonal variation between samples. Field temperature ranged from about 13 to 17°C (55 to 63°F), field conductivity ranged from 1,696 to 1,844 µmhos/cm, and turbidity ranged from 1,672 to 1,780 NTU.

Pass Creek salinity (as TDS) ranged from 1,100 to 1,700 mg/L. Dissolved solids were almost entirely made up of calcium and sulfate. Magnesium, sodium and bicarbonate concentrations were much lower than calcium and sulfate, and sodium and chloride concentrations were very low (typically less than 5 mg/L). Dissolved metal concentrations were low or undetectable. Notable total metal detections included aluminum, arsenic, barium, iron, lead, manganese, nickel, uranium and zinc.

Total radionuclide concentrations in Pass Creek included gross alpha up to 8.8 pCi/L and gross beta up to 15.1 pCi/L.

Cheyenne River

Similar to Beaver Creek, the field water quality in Cheyenne River samples varied significantly seasonally, with temperature ranging from about 0 to 27°C (32 to 81°F), field conductivity ranging from 350 to 7,847 µmhos/cm and turbidity ranging from 1 to 1,798 NTU. Fecal coliform bacteria ranged from <2 to 3,500 CFU/100 mL. The fecal coliform bacteria concentration was less than 400 CFU/100 mL in 90% of samples (19 of 21). Dissolved Oxygen concentrations ranged from 3.7 to 13.1 mg/L.

Salinity (as TDS) in Cheyenne River samples ranged from 340 to 7,200 mg/L. Major ion chemistry was dominated primarily by sodium and sulfate, with increasing calcium concentrations from CHR01 to CHR05 (upstream to downstream). The average calcium concentration at CHR01, which is upstream from the confluence with Beaver Creek, was 270 mg/L. This increased to an average concentration of 463 mg/L downstream of the Beaver Creek confluence. Chloride concentrations similarly increased from an average of 129 mg/L at CHR01 to an average of 409 mg/L at CHR05. The maximum chloride concentration at CHR01 was 249 mg/L, while 3 of 12 (25%) of CHR05 samples yielded chloride measurements above 500 mg/L.

Dissolved metal concentrations typically were low or undetectable with notable detections of boron, iron, manganese and uranium. Total metal concentrations were typically higher than dissolved metal concentrations, with notable metal detections including arsenic, boron, iron, manganese, uranium, vanadium and zinc.

Total radionuclide concentrations in Cheyenne River samples ranged from non-detect to some relatively high concentrations, including maximum concentrations of 35.3 pCi/L gross alpha, 38 pCi/L gross beta, and 1,140 pCi/L gross gamma.

3.5.4.1.1 Comparison with Surface Water Standards

Tables 3.5-14 through 3.5-17 compare results and statistical summaries for samples collected at the Beaver Creek and Cheyenne River sites to DENR surface water quality standards in ARSD 74:51:01:48. Both the Cheyenne River and Beaver Creek stream segments near the permit area have beneficial uses for warmwater semipermanent fish life propagation water and limited contact recreation waters according to ARSD 74:51:03:08. Months without data indicate either a completely frozen stream or absence of water. Other surface water quality sites do not have enough data to justify running statistical analyses on measurements.

Analysis of Beaver Creek sampling results shows some exceedances of the ARSD 74:51:01:48 standard for total suspended solids (TSS), while other parameters all fell into the compliance range. TSS was higher than the monthly average standard of 90 mg/L in 6 of 22 measurements (27%), and higher than the 158 mg/L daily maximum standard in 4 of 22 measurements (18%). All other parameters were within the compliance range, including pH, dissolved oxygen, ammonia, and temperature. Krantz and Larson (2006) modeled temperatures in Beaver Creek and report from a temperature-sensitivity analysis that air temperature is the primary controlling factor for stream temperatures in Beaver Creek.

Table 3.5-14: BVC01 Comparison to DENR Standards

Date	BVC01 (Downstream of Permit Area)				
	Temperature (°F)	Field pH (s.u.)	Dissolved Oxygen (mg/L)	Total Ammonia Nitrogen as N (mg/L)	Total Suspended Solids (mg/L)
DENR Criteria[1]	≤ 90	≥ 6.5 - ≤ 9.0	≥ 5.0	pH Dependent Criteria	≤ 90 monthly avg. ≤ 158 daily max.
7/24/2007	NM	NM	NM	NM	27
8/20/2007	81.6	8.91	12.29	NM	51
9/26/2007	62.1	8.87	10.95	NM	31
10/17/2007	53.9	8.58	11.13	<0.1	<5
11/19/2007	38.4	8.20	12.20	<0.1	20
12/11/2007	31.9	7.94	11.21	<0.1	10
1/11/2008	31.9	7.67	10.07	<0.1	12
3/9/2008	32.3	8.24	13.57	<0.1	12
4/14/2008	60.9	8.15	9.20	<0.1	17
5/26/2008	55.1	7.95	6.86	<0.1	4,600
6/17/2008	74.9	8.13	10.39	<0.1	100
N	10	10	10	8	11
Mean	52.3	8.26	10.79	<0.1	443
Median	54.5	8.18	11.04	<0.1	24
Std. Dev.	18.2	0.41	1.85	<0.1	1,379
Min.	31.9	7.67	6.86	<0.1	<5
Max.	81.6	8.91	13.57	<0.1	4,600

Note: [1] ARSD 74:51:01:48 criteria for warmwater semipermanent fish life propagation waters.

Table 3.5-15: BVC04 Comparison to DENR Standards

Date	BVC04 (Upstream of Permit Area)				
	Temperature (°F)	Field pH (s.u.)	Dissolved Oxygen (mg/L)	Total Ammonia Nitrogen as N (mg/L)	Total Suspended Solids (mg/L)
DENR Criteria[1]	≤ 90	≥ 6.5 - ≤ 9.0	≥ 5.0	pH Dependent Criteria	≤ 90 monthly avg. ≤ 158 daily max.
7/24/2007	NM	NM	NM	NM	100
8/20/2007	81.0	8.82	12.31	NM	160
9/28/2007	51.4	7.60	6.85	NM	47
10/17/2007	50.1	8.46	10.45	<0.1	16
11/19/2007	41.2	8.18	12.39	<0.1	16
12/11/2007	31.9	7.86	11.01	<0.1	10
1/11/2008	31.8	7.74	11.37	<0.1	25
3/9/2008	31.9	8.12	13.74	<0.1	270
4/14/2008	62.5	8.27	12.21	<0.1	32
5/26/2008	55.5	8.09	6.54	<0.1	2,200
6/17/2008	77.3	7.52	9.55	<0.1	55
N	10	10	10	8	11
Mean	51.5	8.07	10.64	<0.1	266
Median	50.8	8.11	11.19	<0.1	47
Std. Dev.	18.1	0.40	2.38	<0.1	646
Min.	31.8	7.52	6.54	<0.1	10
Max.	81.0	8.82	13.74	<0.1	2,200

Note: [1] ARSD 74:51:01:48 criteria for warmwater semipermanent fish life propagation waters.

Table 3.5-16: CHR01 Comparison to DENR Standards

Date	CHR01 (Upstream of Permit Area)				
	Temperature (°F)	Field pH (s.u.)	Dissolved Oxygen (mg/L)	Total Ammonia Nitrogen as N (mg/L)	Total Suspended Solids (mg/L)
DENR Criteria[1]	≤ 90	≥ 6.5 - ≤ 9.0	≥ 5.0	pH Dependent Criteria	≤ 90 monthly avg. ≤ 158 daily max.
7/31/2007	NM	NM	NM	NM	54
9/5/2007	79.4	8.44	13.08	NM	54
9/26/2007	60.8	8.02	10.48	NM	35
10/17/2007	55.6	8.02	5.17	<0.1	12
11/19/2007	42.2	7.47	3.74	<0.1	8
3/9/2008	45.1	8.11	12.84	<0.1	400
4/16/2008	58.9	8.32	8.13	<0.1	8
5/26/2008	56.0	8.17	7.77	<0.1	4,400
6/17/2008	80.6	8.27	7.85	<0.1	110
7/31/2007	NM	NM	NM	NM	54
9/5/2007	79.4	8.44	13.08	NM	54
N	8	8	8	6	9
Mean	59.8	8.10	8.63	<0.1	565
Median	57.5	8.14	7.99	<0.1	54
Std. Dev.	14.0	0.29	3.35	<0.1	1,443
Min.	42.2	7.47	3.74	<0.1	8
Max.	80.6	8.44	13.08	<0.1	4,400

Note: [1] ARSD 74:51:01:48 criteria for warmwater semipermanent fish life propagation waters.

Table 3.5-17: CHR05 Comparison to DENR Standards

Date	CHR05 (Downstream of Permit Area)				
	Temperature (°F)	Field pH (s.u.)	Dissolved Oxygen (mg/L)	Total Ammonia Nitrogen as N (mg/L)	Total Suspended Solids (mg/L)
DENR Criteria[1]	≤ 90	≥ 6.5 - ≤ 9.0	≥ 5.0	pH Dependent Criteria	≤ 90 monthly avg. ≤ 158 daily max.
7/31/2007	NM	NM	NM	NM	14
9/5/2007	78.1	8.16	12.20	NM	6
9/26/2007	65.9	8.01		NM	23
10/17/2007	58.0	8.12	10.08	<0.1	8
11/19/2007	43.2	8.16	11.03	<0.1	16
12/11/2007	31.9	7.95	11.14	<0.1	7
1/11/2008	31.8	7.65	9.22	<0.1	<5
2/12/2008	32.4	7.42		<0.1	9
3/9/2008	32.0	8.24	12.92	<0.1	220
4/14/2008	53.8	8.10	9.92	<0.1	19
5/26/2008	55.9	8.19	7.69	<0.1	4,900
6/17/2008	74.1	8.24	7.63	<0.1	95
N	11	11	9	9	12
Mean	50.7	8.02	10.20	<0.1	443
Median	53.8	8.12	10.08	<0.1	16
Std. Dev.	17.5	0.26	1.83	<0.1	1,405
Min.	31.8	7.42	7.63	<0.1	<5
Max.	78.1	8.24	12.92	<0.1	4,900

Note: [1] ARSD 74:51:01:48 criteria for warmwater semipermanent fish life propagation waters.

Analysis of Cheyenne River sampling results shows similar exceedances for the TSS standard, with 6 of 21 samples (29%) exceeding the 90 mg/L monthly average standard and 4 of 21 (19%) exceeding the 158 mg/L daily maximum standard. In addition, 1 of 18 dissolved oxygen measurements (6%) was below the minimum standard of 5 mg/L. All other parameters were within the compliance range, including pH, ammonia, and temperature.

3.5.4.2 Impoundment Sampling Results

Table 3.5-18 compares the impoundment sampling results for several key water quality parameters. This table shows significant variability in impoundment water quality. Most of the variability is associated with the type of impoundment and its proximity to the historical open-pit mines in the permit area. A summary of water quality by type is presented below.

Triangle Mine Pit

The water quality in the Triangle Mine Pit (Sub02) is characterized by moderately high TDS (2,900 to 3,900 mg/L), slightly alkaline pH (7.8 to 8.1), and calcium-sulfate type water.

Darrow Mine Pit

The water quality in the Darrow Mine Pit Northwest (Sub06) is characterized by moderate to high TDS (4,500 to 8,600 mg/L), low pH (3.2 to 3.5), and magnesium-sulfate type water. The low pH suggests that surface drainage from previously disturbed mine pits may be influencing the water chemistry in the pit.

Impoundments Downgradient of Historical Mine Pits

The impoundments downgradient of historical mine pits or surface disturbance associated with historical mining include those identified in Table 3.5-18 as mine dams (Sub03 and Sub05) and some of the stock ponds or stock dams downgradient of historical mining operations (Sub04 and Sub07). The water quality in these impoundments is characterized by low to moderate TDS (180 to 1,700 mg/L), low pH (3.8 to 5.0), very low alkalinity, and calcium-sulfate or calcium/magnesium-sulfate major ion chemistry. Total radionuclide concentrations ranged from 3 to 19.9 pCi/L gross alpha, 13 to 51.3 pCi/L gross beta, 0 to 1,290 pCi/L gross gamma, and 0 to 4 pCi/L radium-226.

Other Impoundments

Other impoundments included stock reservoirs not located downgradient of historical mining activities (Sub01, Sub08, Sub09, Sub10, Sub11, and Sub24). The water quality in these

Table 3.5-18: Impoundment Water Quality Summary

Site	Type/Name	N	TDS (mg/L)	pH (s.u.)	Alkalinity (mg/L as $CaCO_3$)	TSS (mg/L)	Water Type
Sub01	Stock Pond	2	300 - 990	7.1 - 7.7	38 - 84	100 - 280	Na/Ca-SO_4 to Na/Ca-HCO_3
Sub02	Triangle Mine Pit	4	2,900 - 3,900	7.8 - 8.1	90 - 102	<5 - 10	Ca-SO_4
Sub03	Mine Dam	2	820 - 970	4.4 - 4.6	<5	6 - 26	Ca-SO_4
Sub04	Stock Pond	2	450 - 1,700	4.7 - 4.9	<5	<5 - 23	Ca-SO_4
Sub05	Mine Dam	0	Impoundment was dry during each sample event				
Sub06	Darrow Mine Pit Northwest	4	4,500 - 8,600	3.2 - 3.5	<5 - 82	5 - 14	Mg-SO_4
Sub07	Stock Dam	4	180 - 680	3.8 - 5.0	<5	<5 - 32	Ca/Mg-SO_4
Sub08	Stock Pond	4	1,300 - 3,400	7.5 - 9.4	102 - 246	<5 - 14	Na-SO_4
Sub09	Stock Pond	2	250 - 280	7.9 - 8.3	28 - 80	100 - 190	Ca/Mg-SO_4 to Ca/Mg-HCO_3
Sub10	Stock Pond	2	410 - 2,100	7.0 - 8.2	38 - 54	220 - 250	Ca/Mg/Na-SO_4
Sub11	Stock Pond	4	90 - 220	6.0 - 7.0	6 - 122	61 - 120	Ca/HCO_3 to Ca/SO_4
Sub24	Stock Pond	1	3,800	7.5	88	17	Na-SO_4

impoundments is characterized by low to moderately high TDS (90 to 3,400 mg/L), neutral to high pH (6.0 to 9.4), variable alkalinity (6 to 246 mg/L as $CaCO_3$), and variable major ion chemistry. Two of six impoundments (33%) were sodium dominant, three of six (50%) had incomplete cation dominance, and one of six (17%) was calcium dominant. Anion chemistry was approximately evenly divided between bicarbonate and sulfate. Total radionuclide concentrations ranged from <1 to 16.3 pCi/L gross alpha, 5.1 to 36.5 pCi/L gross beta, 0 to 1,100 pCi/L gross gamma, and <0.2 to 1.2 pCi/L radium-226.

3.6 Meteorology, Climatology and Air Quality

3.6.1 Meteorology and Climatology

The permit area is located in an area in southwestern South Dakota that can be characterized as a semiarid or steppe climate. It lies adjacent to the southwestern extension of the Black Hills. The area experiences abundant sunshine, low relative humidity, and sustained winds which lead to high evaporative demand. There are also large diurnal and annual variations in temperature.

Precipitation in the permit area is generally light or mild. Migratory storm systems that originate in the Pacific Ocean release a majority of their moisture over the Rocky or Cascade Mountains. Major precipitation events can occur when these systems regain moisture already present in the area or moisture adverted from the Gulf of Mexico. Localized summer convective storms, caused by the Black Hills, can produce heavy precipitation events.

To complete the site-specific analysis, a weather station was installed in coordination with the South Dakota State Climatology office and in accordance with NRC regulatory guidance at approximately the center of the permit area in July 2007. This site collects temperature, humidity, solar radiation, wind speed/direction, barometric pressure, and precipitation at 1-minute, 5-minute, and hourly time steps. The site-specific analysis presented herein was conducted over one year from July 18, 2007 to July 17, 2008. This corresponds to the required one-year monitoring period for the NRC license application.

Along with the site weather station, data compiled from several sites surrounding the permit area (listed in Table 3.6-1 and shown in Figure 3.6-12) were obtained from the High Plains Regional Climate Center (HPRCC), South Dakota State University (SDSU), and the Wyoming Refining Company (WRC) compliance site at Newcastle, Wyoming. These data were used to represent the long-term meteorological conditions of the project region. These sites were used to characterize regional trends of temperature, snowfall and precipitation along with growing,

Table 3.6-1: Meteorological Stations Included in Climatology Analysis

Name	Data Source	X (°W)	Y (°N)	Z (ft)	Years of Operation
Redbird	NCDC[a]	104.17	43.15	3,890	1948–2006
Oral	SDSU[b]	103.16	43.24	2,960	1971–2007
Oelrichs	NCDC	103.14	43.11	3,340	1948–2007
Newcastle	NCDC	104.14	43.51	4,380	1918–2006
Edgemont	NCDC	103.49	43.18	3,440	1948–2007
Custer	NCDC	103.36	43.46	5,330	1926–2007
Ardmore	NCDC	103.39	43.04	3,550	1948–2007
Angostura	NCDC	103.26	43.22	3,140	1948–2007
Jewel Cave	SDSU	103.49	43.43	5,298	2004–2008
Newcastle	IML[c]	104.21	43.85	4,333	2002–2011

Source: HPRCC, 2008; SDSU, 2008
(a) National Climatic Data Center.
(b) SDSU Climate Web site.
(c) IML Air Science, compliance monitoring results.

heating, and cooling degree days. The site that best represents the long-term precipitation and temperature of the permit area is the Edgemont site, which is the closest in proximity and elevation to the permit area. The Newcastle, Wyoming WRC compliance site was the only site with adequate representative data to characterize wind speed/direction.

Data were analyzed at each site by time of day, month, and season of the year. The seasons for this analysis are defined as: winter (December, January, February), spring (March, April, May), summer (June, July, August), and fall (September, October, November).

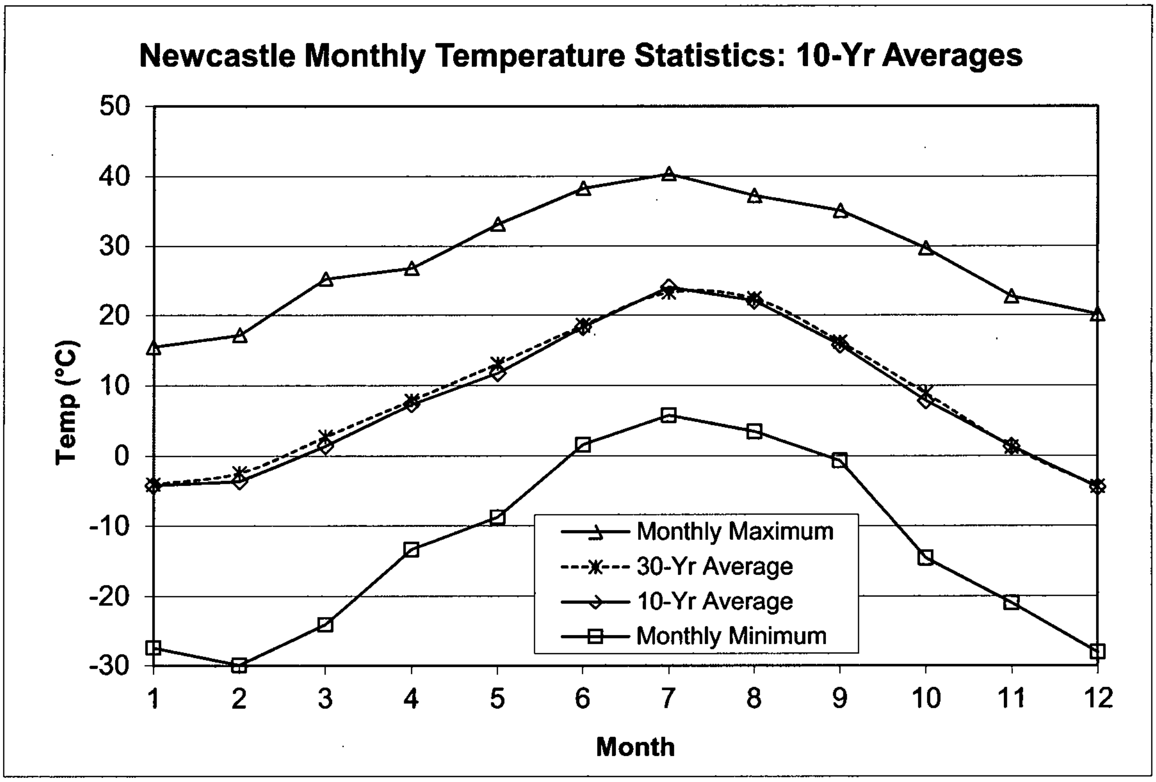
3.6.1.1 Regional Overview

Meteorological data from the WRC compliance site at Newcastle, Wyoming were assembled and analyzed to determine whether the baseline monitoring year's data (July 18, 2007 to July 17, 2008) were representative of longer-term (approximately 10-year) meteorological conditions in the area. The Newcastle site began monitoring on January 1, 2002, and meteorological data were available through August 31, 2011. The parameters analyzed were temperature, wind speed, wind direction, and standard deviation of wind direction. A comprehensive discussion of wind patterns at Newcastle is presented in Section 3.6.1.1.4 and Appendix 3.6-A.

The average daily temperature over the baseline monitoring year at Newcastle was 51.9°F, which is slightly warmer than the 10-year average (historical) daily temperature of 47.2°F. Figure 3.6-1 compares monthly temperature statistics for the two periods. It can be seen that both the average and extreme monthly temperatures for the baseline year are within a few degrees of the longer-term averages. The 10-year graph also includes 30-year average temperatures for Newcastle, obtained from the Western Regional Climate Center, demonstrating the 10-year average temperatures at the WRC site to be nearly identical to the 30-year average temperatures at the NWS Coop Site #486660 in Newcastle.

The average daily wind speed at Newcastle over the baseline monitoring year was 7.0 miles per hour (mph), very close to the 10-year historical average of 6.8 mph. Figure 3.6-2 compares the monthly average and maximum wind speeds for the short and long-term periods.

During the baseline monitoring year, Newcastle received 17.3 inches of precipitation, about 15% above the 100-year average annual precipitation of 15.1 inches. (Western Regional Climate Center, Coop Site #486660).



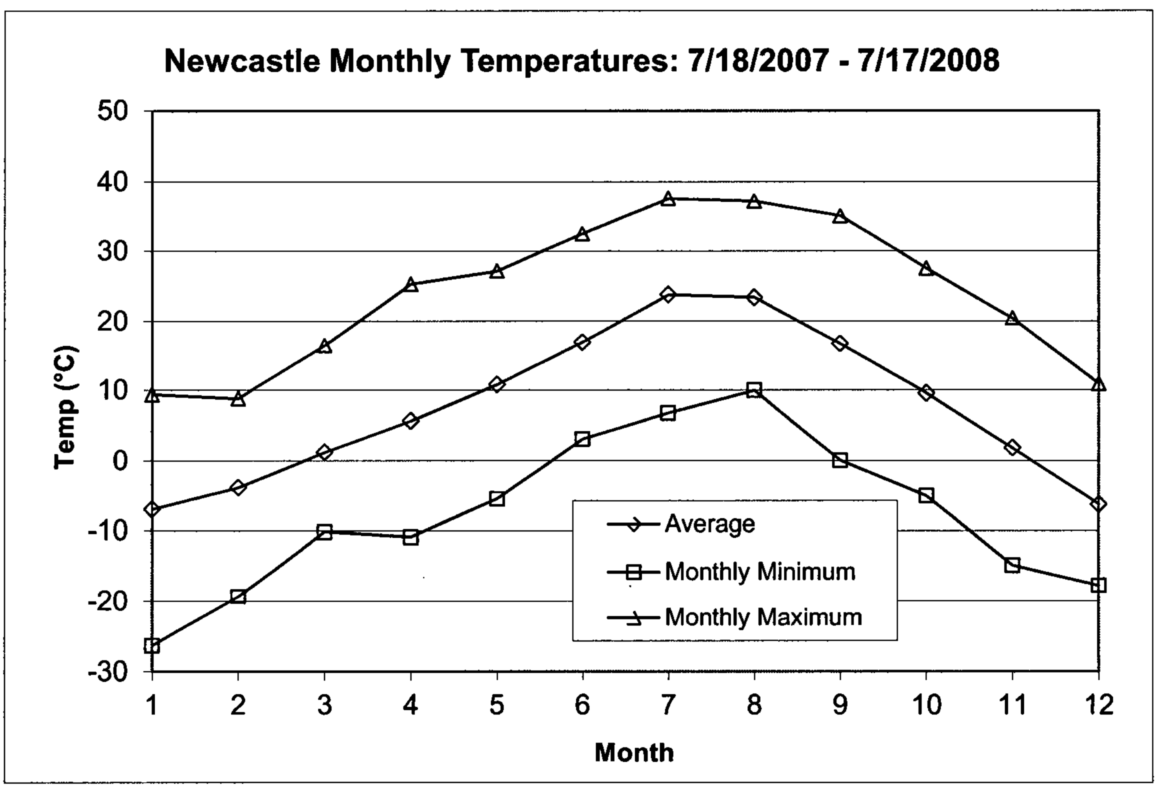
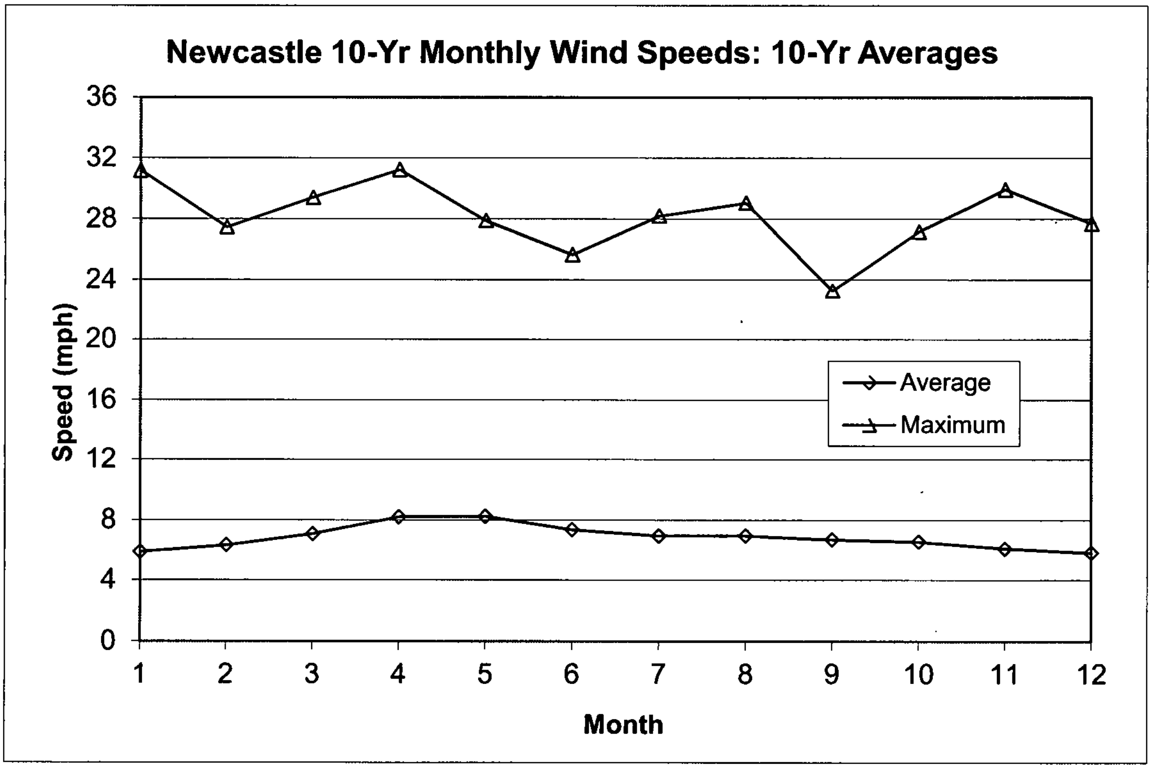


Figure 3.6-1: Short and Long-Term Temperatures at the Newcastle, Wyoming WRC Compliance Site



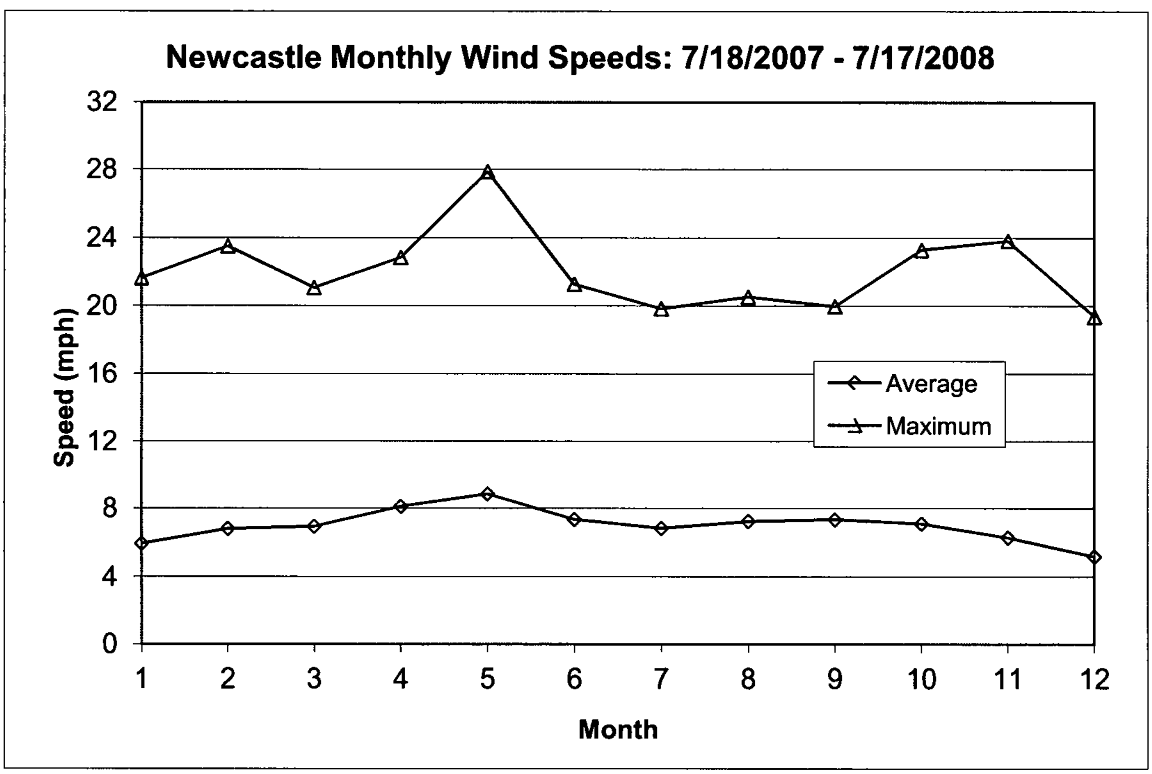


Figure 3.6-2: Short and Long-Term Wind Speeds at the Newcastle, Wyoming WRC Compliance Site

3.6.1.1.1 Temperature

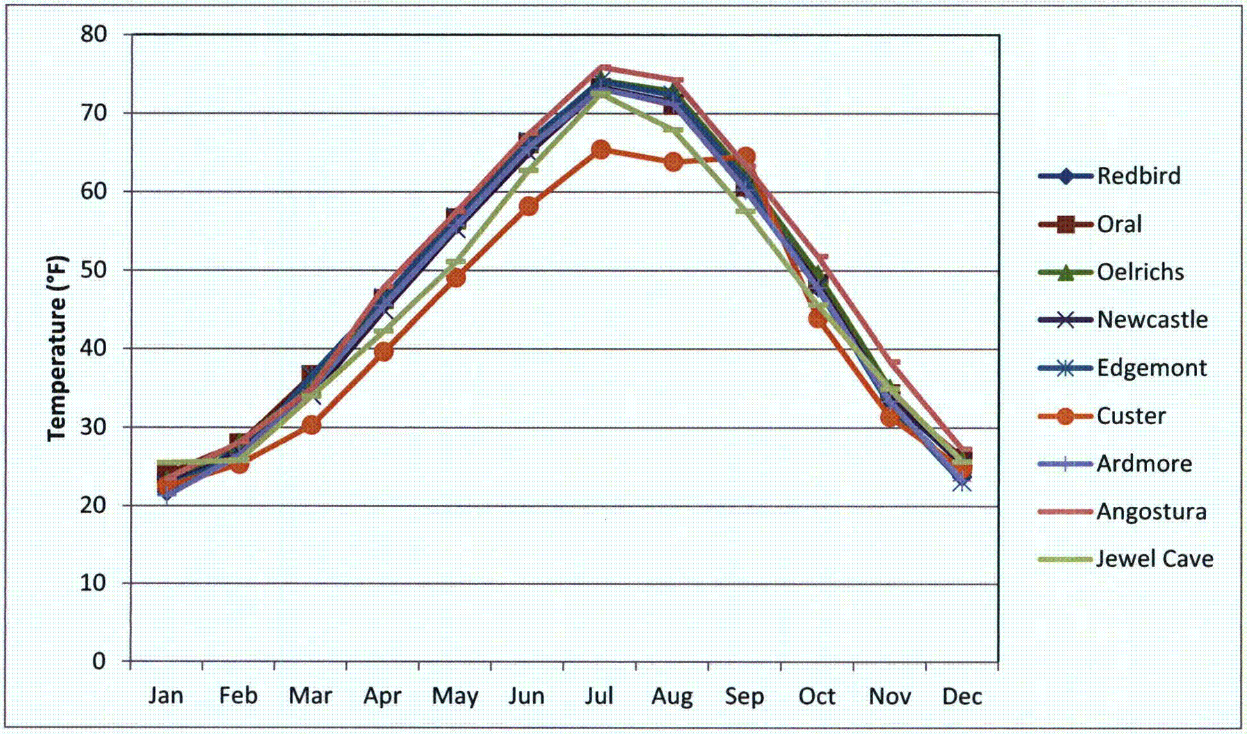
Long-term temperature statistics were also obtained from regional NWS sites. The annual average temperature in this region is 46.7°F. Figure 3.6-3 and Table 3.6-2 display the monthly, annual, and seasonal average temperatures. This region has some of its warmest days in the summer months with the hottest month being July (average temperature of 72.8°F). The coldest month of the year is January, with an average temperature of 23.0°F. The differences seen between sites can be attributed to elevation. Custer and Jewel Cave have the lowest average temperature primarily because these sites are nearly 1,000 feet higher in elevation than all other sites.

Figures 3.6-4 and 3.6-5 show the average monthly maximum and minimum temperatures in the region. The average monthly maximum temperature is 60.7°F, while the average monthly minimum temperature is 32.7°F, as shown in Tables 3.6-3 and 3.6-4. The highest average maximum monthly temperatures in the region usually fall during the month of July (88.3°F). The lowest average minimum monthly temperatures can be found in January, with a regional average of 10.4°F.

Figure 3.6-6 displays diurnal temperature variations by season for the Newcastle WRC site over the last 10 years. The figure shows large variations in average diurnal temperatures, especially during the summer months.

3.6.1.1.2 Relative Humidity

Relative humidity measures the ratio of moisture in the air to saturated moisture content at a certain temperature. This parameter was recorded for the Newcastle WRC site. Figure 3.6-7 displays the relationship of relative humidity to the season and time of day for this site. The figure shows that the summer has the lowest relative humidity, averaging 45.5 percent, while winter has the highest relative humidity, averaging 67.7 percent. Both seasonal and diurnal variations in relative humidity are largely attributed to air temperature. Since cooler air will hold less moisture, relative humidity tends to be higher during the winter and at night.



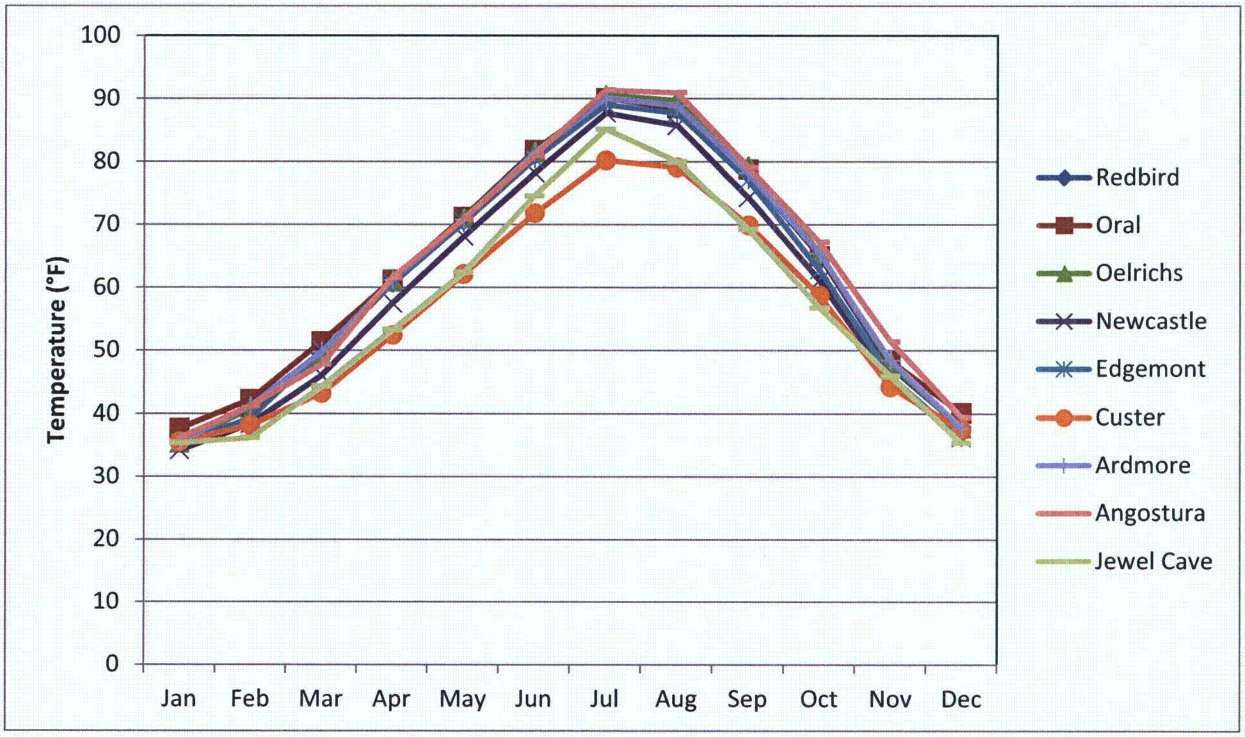
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-3: Average Monthly Temperatures for Regional Sites

Table 3.6-2: Average Monthly, Annual, and Seasonal Average Temperatures for Regional Sites

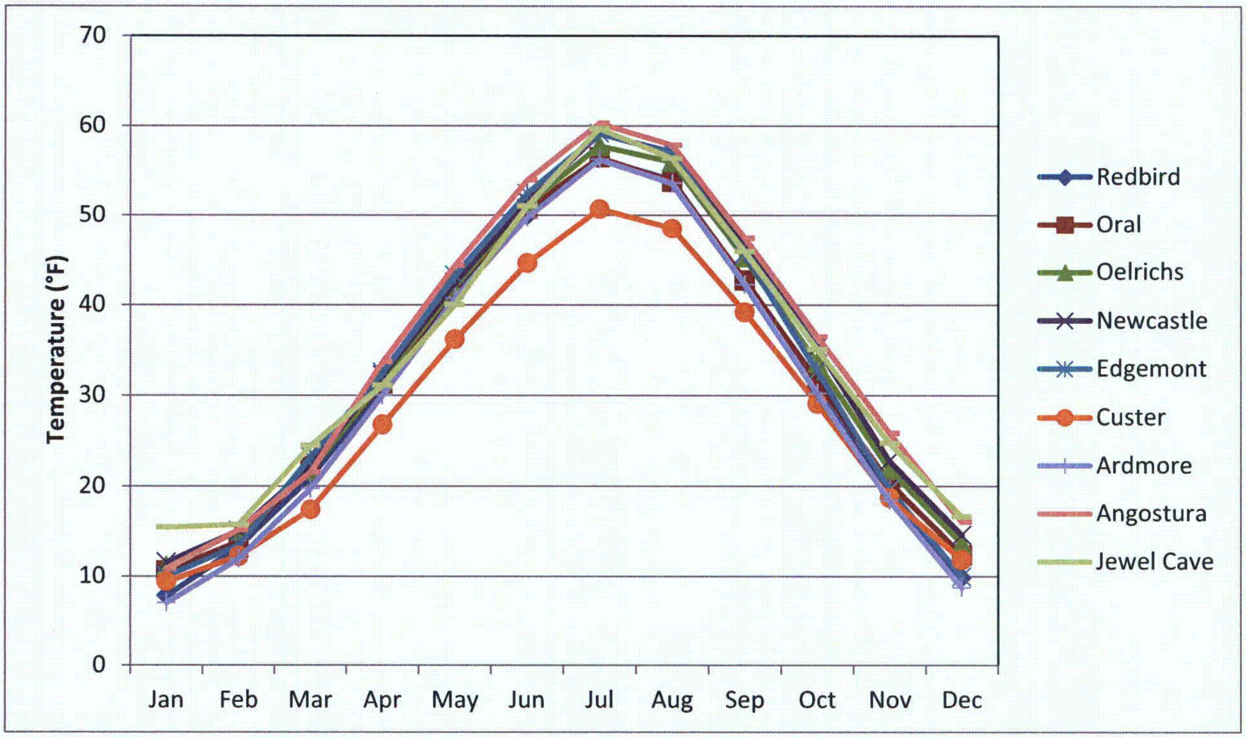
Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Fall
Redbird	21.8	27.3	35.1	45.8	55.8	65.5	73.3	71.4	60.4	47.9	33.1	23.8	46.8	24.3	45.6	70.1	47.2
Oral	24.1	27.9	36.6	46.3	56.6	66.2	73.2	71.1	60.7	48.3	34.3	26.1	47.6	26.1	46.5	70.2	47.8
Oelrichs	23.2	28.0	35.4	46.3	56.5	66.3	74.2	72.8	62.1	49.5	35.0	25.7	47.9	25.7	46.1	71.1	48.9
Newcastle	22.8	26.7	34.1	44.9	55.3	64.9	73.3	71.3	60.5	48.2	33.9	25.4	46.8	25.0	44.7	69.8	47.5
Edgemont	22.5	26.3	36.6	46.5	56.8	66.4	74.1	72.3	61.4	47.7	32.9	23.1	47.2	24.0	46.6	70.9	47.3
Custer	22.5	25.3	30.3	39.6	49.1	58.2	65.4	63.8	64.5	43.9	31.4	24.8	42.4	24.2	39.7	62.5	43.3
Ardmore	21.3	26.5	34.8	45.5	55.7	65.6	73.1	71.2	60.2	47.8	33.4	23.3	46.5	23.7	45.3	70.0	47.1
Angostura	23.5	28.1	34.9	47.9	57.5	67.4	75.9	74.3	63.3	51.8	38.4	27.3	49.2	26.3	46.8	72.5	51.2
Jewel Cave	25.5	25.8	34.0	42.2	51.1	62.7	72.5	67.9	57.6	45.6	35.0	25.7	45.5	25.7	42.4	67.7	46.1
Regional Average	23.0	26.9	34.6	45.0	54.9	64.8	72.8	70.7	61.2	47.9	34.2	25.0	46.7	25.0	44.9	69.4	47.4

Source: HPRCC, 2008; SDSU, 2008



Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-4: Average Monthly Maximum Temperatures for Regional Sites



Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-5: Average Monthly Minimum Temperatures for Regional Sites

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Table 3.6-3: Average Monthly, Annual, and Seasonal Maximum Temperatures for Regional Sites

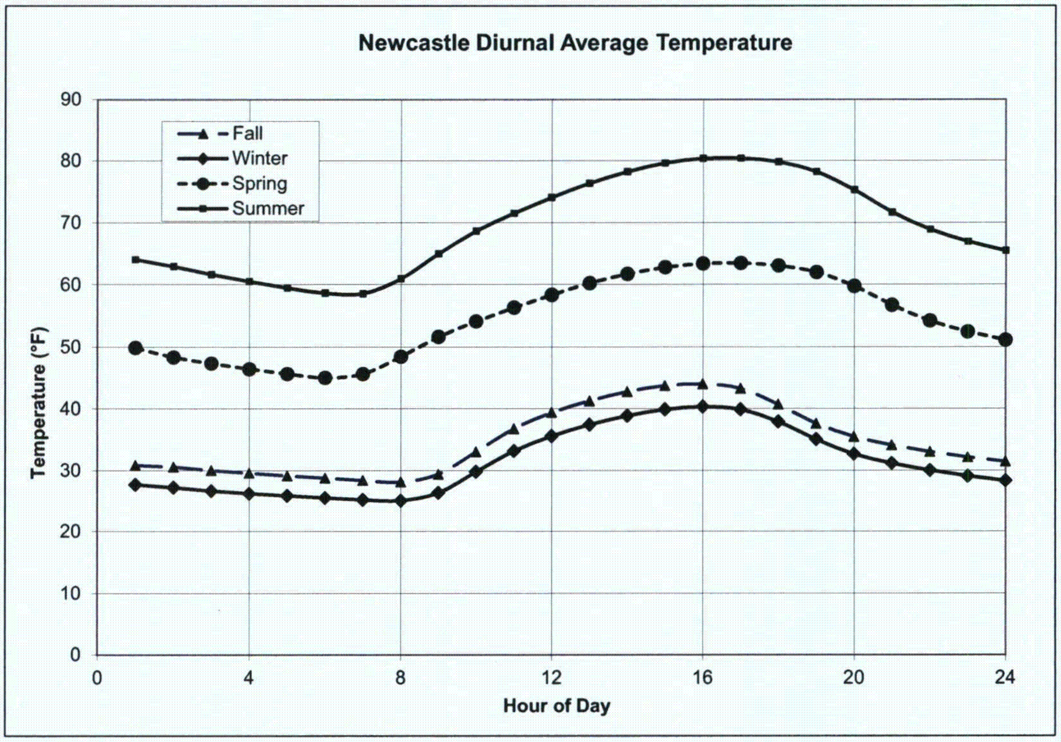
Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Fall
Redbird	35.8	41.3	49.3	60.7	70.6	81.1	90.2	88.9	78.2	65.0	47.4	37.9	62.2	38.3	60.2	86.7	63.5
Oral	37.7	42.2	51.4	61.2	71.2	81.8	90.1	88.5	78.8	65.0	48.3	40.1	63.0	40.0	61.3	86.8	64.0
Oelrichs	35.3	40.8	49.0	60.9	71.0	81.5	90.6	89.7	79.3	65.5	48.0	37.8	62.5	38.0	60.3	87.3	64.2
Newcastle	34.2	38.4	46.0	57.5	68.1	78.2	87.7	85.7	74.3	61.1	45.0	36.3	59.4	36.3	57.2	83.9	60.1
Edgemont	35.2	39.3	49.9	60.6	70.3	80.4	89.0	87.7	77.1	62.8	45.9	36.2	61.2	36.9	60.3	85.7	61.9
Custer	35.5	38.2	43.2	52.4	62.1	71.8	80.2	79.1	69.9	58.7	44.2	37.5	56.1	37.1	52.5	77.0	57.6
Ardmore	35.6	41.2	49.7	61.2	70.8	81.4	90.1	88.9	78.2	65.4	48.4	37.8	62.4	38.2	60.5	86.8	64.0
Angostura	36.2	41.2	47.7	61.6	70.8	80.9	91.4	91.0	79.1	67.2	51.4	39.4	63.2	38.9	60.0	87.8	65.9
Jewel Cave	35.4	36.2	44.3	53.3	62.4	74.6	85.1	80.0	69.2	56.8	45.9	35.4	56.5	35.6	53.3	79.9	57.3
Regional Average	35.7	39.9	47.8	58.8	68.6	79.1	88.3	86.6	76.0	63.1	47.2	37.6	60.7	37.7	58.4	84.7	62.1

Source: HPRCC, 2008; SDSU, 2008

Table 3.6-4: Average Monthly, Annual, and Seasonal Minimum Temperatures for Regional Sites

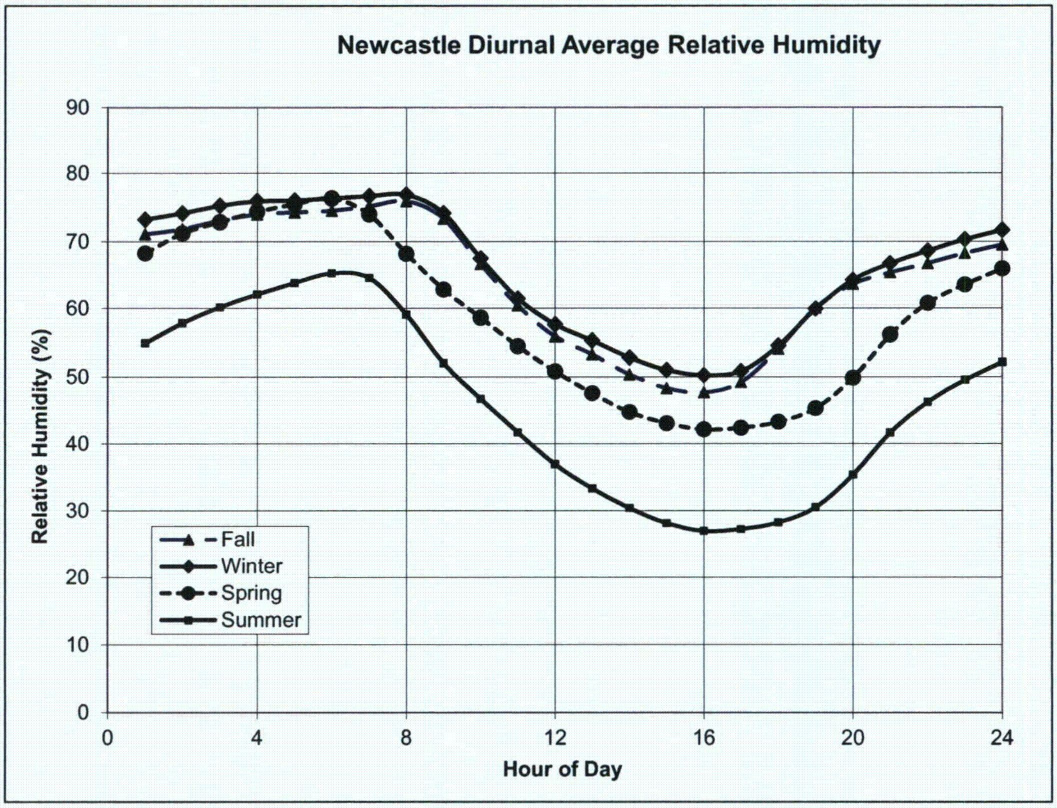
Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Fall
Redbird	7.8	13.2	21.0	30.8	41.1	49.9	56.3	53.9	42.6	30.9	18.8	9.8	31.4	10.3	31.0	53.4	30.8
Oral	10.6	13.8	22.2	31.3	41.9	50.7	56.4	53.7	42.7	31.6	20.4	12.3	32.3	12.2	31.8	53.6	31.6
Oelrichs	11.1	15.0	21.7	31.7	42.0	51.2	57.7	55.9	45.2	33.6	21.9	13.6	33.4	13.3	31.8	54.9	33.6
Newcastle	11.5	15.0	22.2	32.2	42.4	51.5	59.1	57.0	46.6	35.3	22.8	14.5	34.2	13.6	32.3	55.9	34.9
Edgemont	10.0	13.4	23.2	32.5	43.2	52.4	59.1	56.9	45.6	32.7	19.7	9.9	33.2	11.1	33.0	56.1	32.7
Custer	9.4	12.2	17.4	26.8	36.2	44.6	50.7	48.5	39.2	29.1	18.7	11.8	28.7	11.1	26.8	47.9	29.0
Ardmore	7.0	11.9	19.7	30.0	40.7	49.7	56.2	53.5	42.2	30.2	18.4	8.7	30.7	9.2	30.2	53.1	30.2
Angostura	10.8	15.1	21.5	33.7	44.3	53.9	60.3	57.8	47.4	36.5	25.9	16.0	35.3	14.0	33.2	57.3	36.6
Jewel Cave	15.4	15.7	24.5	31.1	40.0	51.0	59.7	56.3	45.9	35.1	24.8	16.6	34.7	15.9	31.9	55.7	35.3
Regional Average	10.4	13.9	21.5	31.1	41.3	50.5	57.3	54.8	44.2	32.8	21.3	12.6	32.7	12.3	31.3	54.2	32.7

Source: HPRCC, 2008; SDSU, 2008



Source: IML Air Science, 2011

Figure 3.6-6: Newcastle, Wyoming, Seasonal Diurnal Temperature Variations



Source: IML Air Science, 2011

Figure 3.6-7: Newcastle, Wyoming, Seasonal Diurnal Relative Humidity Variations

3.6.1.1.3 Precipitation

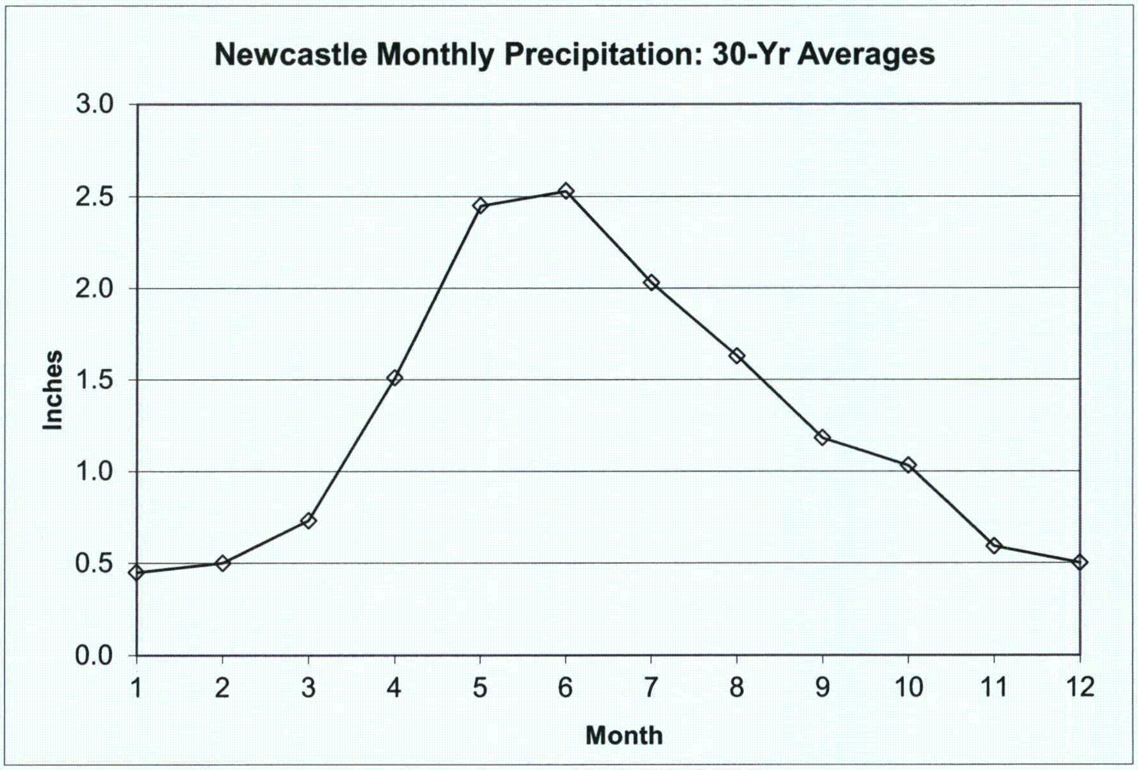
Figure 3.6-8 shows average monthly precipitation at the Newcastle NWS Coop site for the past 30 years. For comparison, Figure 3.6-9 shows monthly precipitation totals for the baseline monitoring year. It can be seen that unusually high precipitation was measured in the months of May and July of 2008.

Figure 3.6-10 and Table 3.6-5 show average monthly and seasonal precipitation amounts for all of the available meteorological monitoring sites in the area. This area can be very dry at times with a regional annual average precipitation of 16.5 inches. Most of the precipitation occurs during May, June, and July (48 percent of the annual). Typically, May is the wettest month of the year for this region with an average total of 2.8 inches. Winter receives roughly 8 percent of the total annual precipitation. January is the driest month of the year with an average accumulation of 0.36 inch of precipitation.

This region receives an average of 38 inches of snowfall each year. As shown in Figure 3.6-11, most snowfall occurs during the month of March with a regional average of 8.5 inches. Custer receives the most annual snowfall (48 inches). This can be attributed to the higher elevation and the influence of the surrounding Black Hills (Figure 3.6-12).

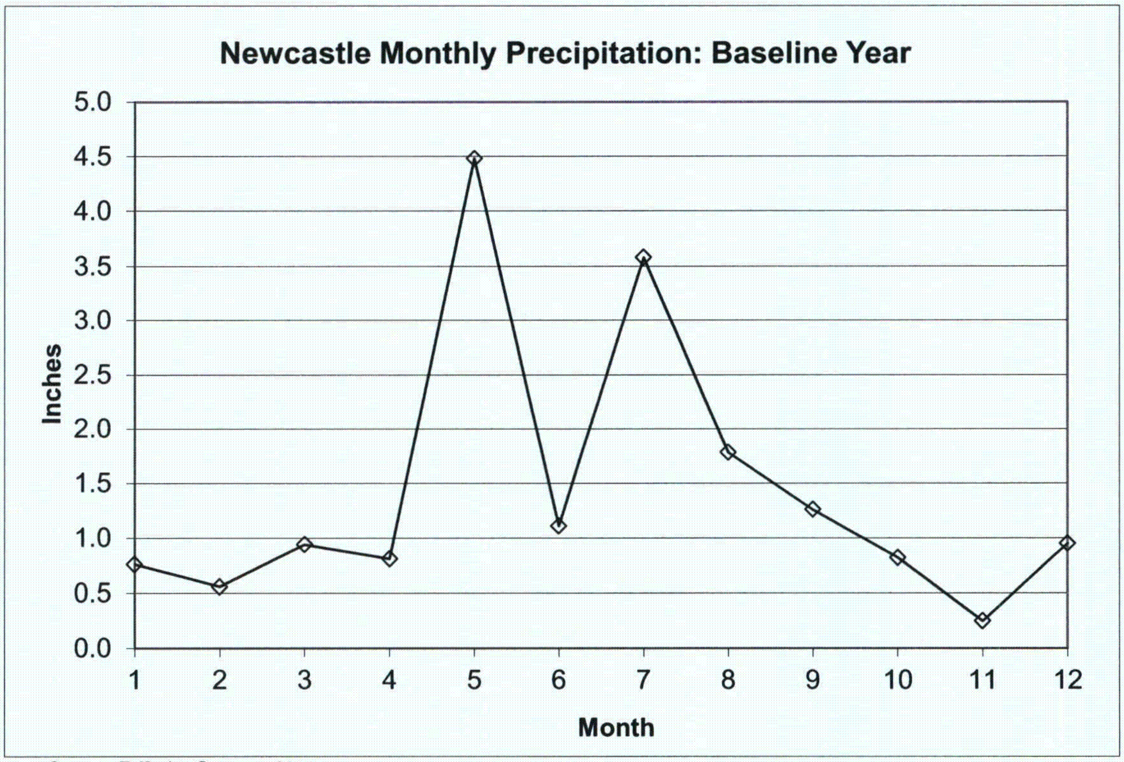
3.6.1.1.4 Wind Patterns

A meteorological station in Newcastle, Wyoming was used to evaluate long-term representativeness of the data collected at the site. The closest NWS station to the project site with hourly wind data is Chadron, Nebraska. Chadron was eliminated from consideration as it is more than 60 miles from the permit area and is lower in elevation. The wind patterns are substantially different, most likely due to the effect of the Black Hills on the Dewey-Burdock site. For demonstrating that baseline monitoring is representative of long-term conditions, particular emphasis is placed on wind speed, wind direction and atmospheric stability, as these parameters impact the modeling of potential radiological impacts from the Dewey-Burdock Project (MILDOS-AREA modeling) as well as air quality monitoring locations. While the Newcastle meteorological station is not strictly representative of the Dewey-Burdock site, it is sufficiently close in distance and geography to infer the regional relationship between the baseline monitoring period (7/18/2007 to 7/17/2008) and long-term conditions. The following describes how the baseline monitoring period is representative of long-term meteorological conditions in the region.



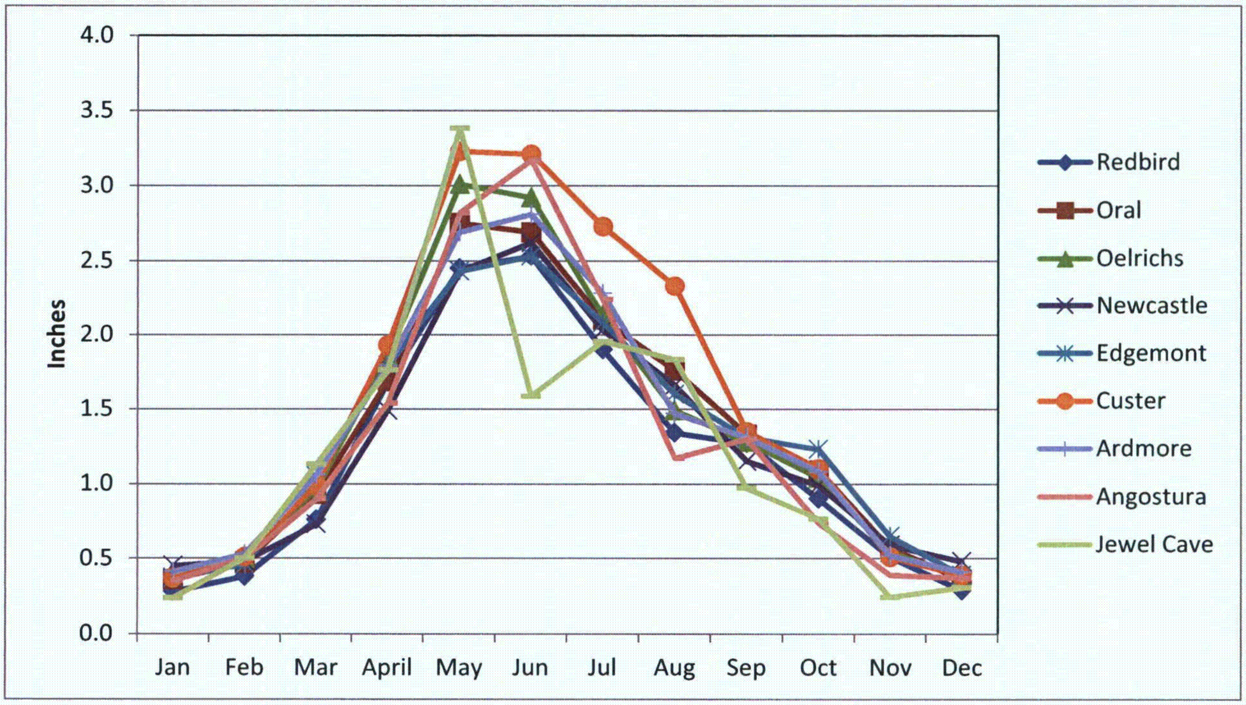
Source: IML Air Science, 2011

Figure 3.6-8: Average Monthly Precipitation for Newcastle, Wyoming



Source: IML Air Science, 2011

Figure 3.6-9: Baseline Year Monthly Precipitation for Newcastle, Wyoming



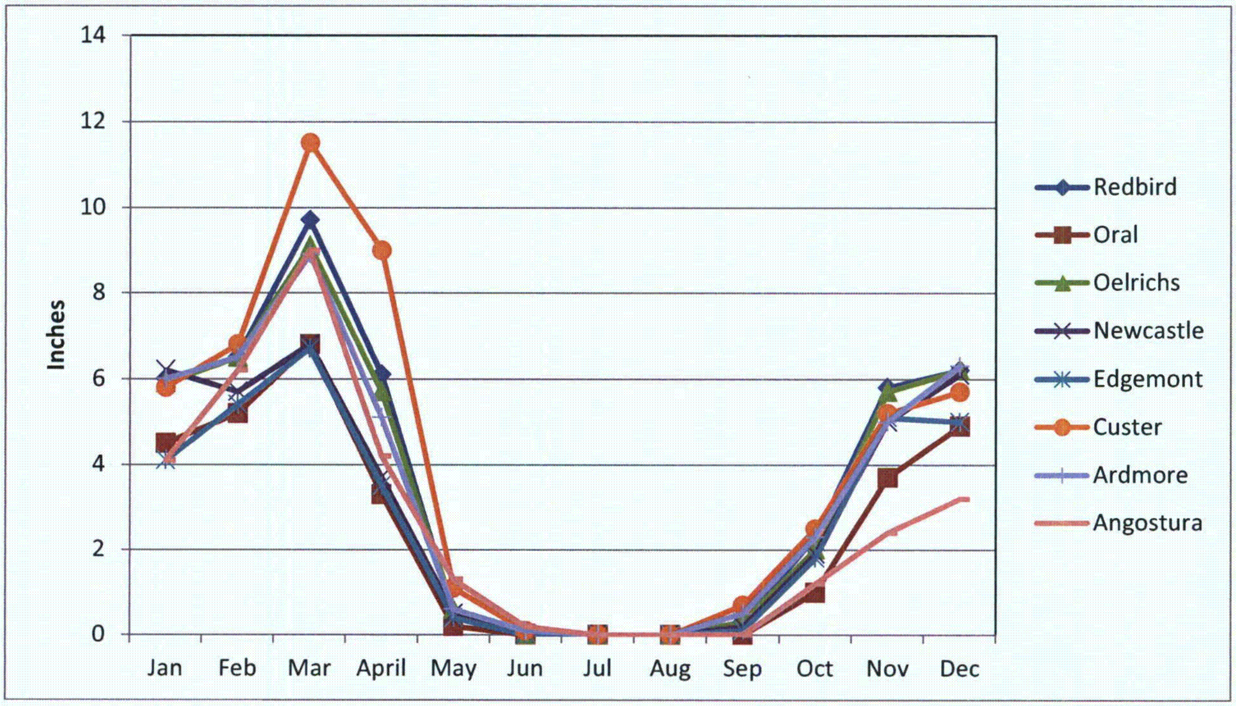
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-10: Average Monthly Precipitation for Regional Sites

Table 3.6-5: Average Seasonal and Annual Precipitation for Regional Sites

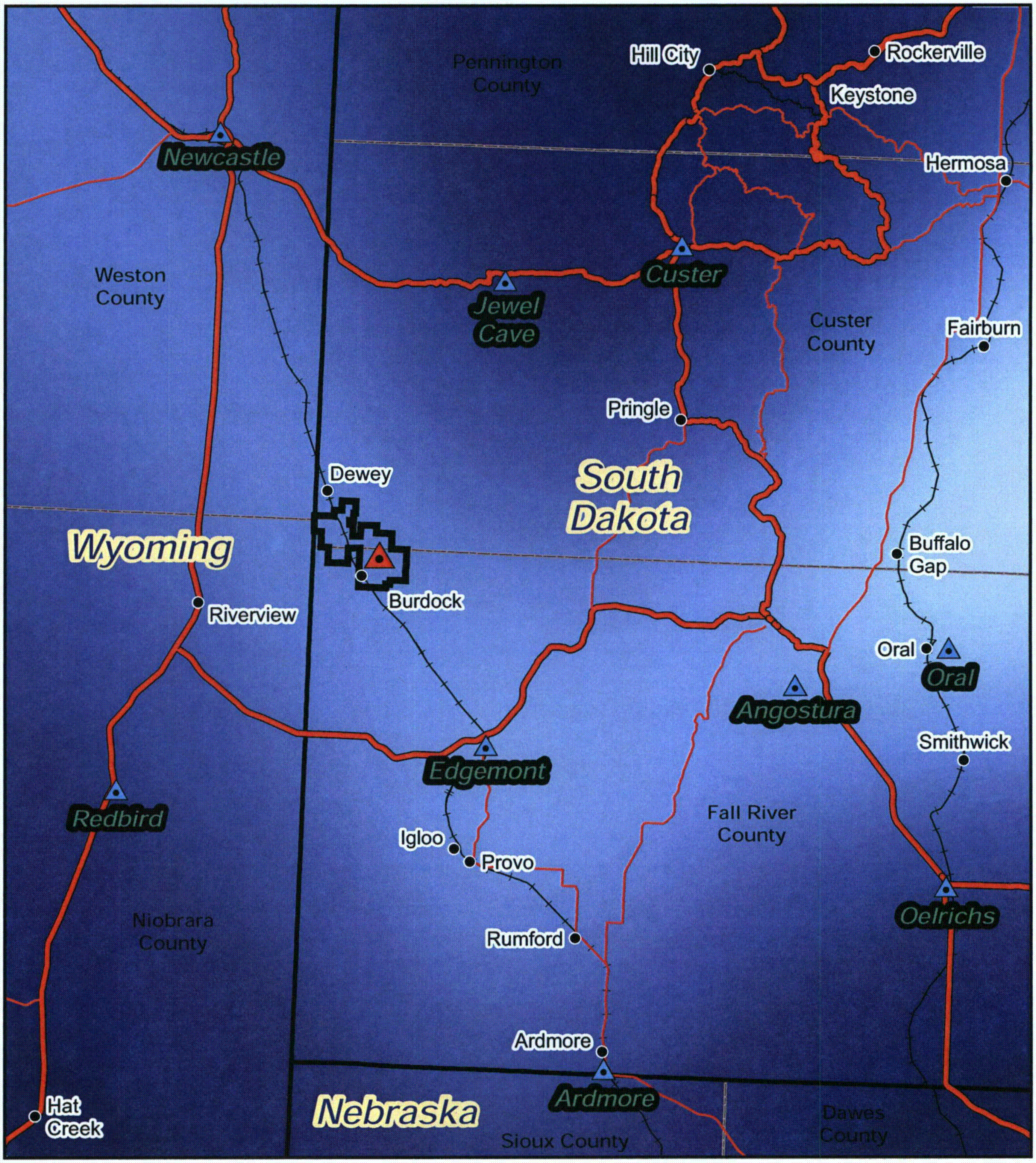
Name	Annual	Winter	Spring	Summer	Fall
Redbird	14.29	0.95	4.89	5.77	2.68
Oral	16.10	1.19	5.37	6.54	3.00
Oelrichs	16.50	1.28	5.83	6.54	2.85
Newcastle	15.11	1.41	4.65	6.32	2.73
Edgemont	15.87	1.22	5.26	6.20	3.19
Custer	18.66	1.27	6.15	8.28	2.96
Ardmore	16.35	1.34	5.54	6.56	2.91
Angostura	15.51	1.22	5.26	6.59	2.44
Jewel Cave	20.00	6.30	6.30	5.40	2.00
Region Average	16.49	1.80	5.47	6.47	2.75

Source: HPRCC, 2008; SDSU, 2008



Source: SDSU, 2008

Figure 3.6-11: Average Monthly Snowfall at Regional Sites



This figure is provided to fulfill the requirements of ARSD 74:29:02:11(1).

Miles: 0 5 10 20
Kilometers: 0 10 20 30

Legend

- Towns
- Permit Boundary
- Dewey-Burdock MET Station
- Meteorological Sites

Transportation
- US Highway
- State Highway
- Railroad

Snowfall (Inches)
- 61 (High)
- 44
- 27 (Low)

N

Figure 3.6-12

Average Annual Snowfall

Dewey-Burdock Project

SIGNATURE OF PREPARER	John Mays
PREPARER	John Mays
DATE	24-Sep-2012
FILE	AnnualSnowfall.mxd

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Figures 3.6-13 and 3.6-14 show wind roses at the Newcastle WRC site for the nearly 10 years of monitoring and for the one year corresponding to the Dewey-Burdock baseline monitoring period. Figure 3.6-15 presents a graphical representation of wind speed frequencies.

The long-term representativeness can be demonstrated quantitatively by isolating wind speed and wind direction variables to correlate short-term and long-term frequency distributions. IML Air Science has developed a statistical methodology for assessing the degree to which the distributions of wind speed class and wind direction frequencies from one year of monitoring at a particular location represent the long-term distributions at that same location.

For the joint frequency wind distribution used in the MILDOS-AREA model, wind speeds are divided into six classifications ranging from mild (0 – 3 mph) to strong (> 24 mph) as illustrated in Figure 3.6-15. Likewise, wind directions are divided into 16 categories corresponding to the compass directions illustrated in Figure 3.6-16.

The percent of the time that winds occur in each of the six wind speed categories can be calculated to produce a wind speed frequency distribution. The percent of the time that winds blow from each of the 16 directions can be calculated to produce a wind direction frequency distribution. For each parameter, the 1-year and 10-year distributions can then be compared. Linear regression analysis provides a useful tool to assess the degree of correlation between short and long-term distributions.

Figure 3.6-17 presents this correlation for the wind speed distributions at Newcastle. Each point represents one of the six wind speed classes. The x coordinate corresponds to the percent of the 1-year period during which the wind speed fell in a given class, while the y coordinate corresponds to the percent of the 10-year period during which the wind speed fell in that same class.

The regression line (red) in Figure 3.6-17 represents the least-squares fit to the six data points. The corresponding R^2 value of 99.3% implies very strong linear correlation. The linear slope of 0.98 further implies that short and long-term wind speed frequencies are substantially equivalent.

A similar analysis can be performed for wind direction frequencies. Figure 3.6-18 presents this correlation at Newcastle. Each point represents one of the 16 wind direction categories. The x coordinate corresponds to the percent of the 1-year period during which the wind blew from a given direction, while the y coordinate corresponds to the percent of the 10-year period during which the wind blew from that same direction.

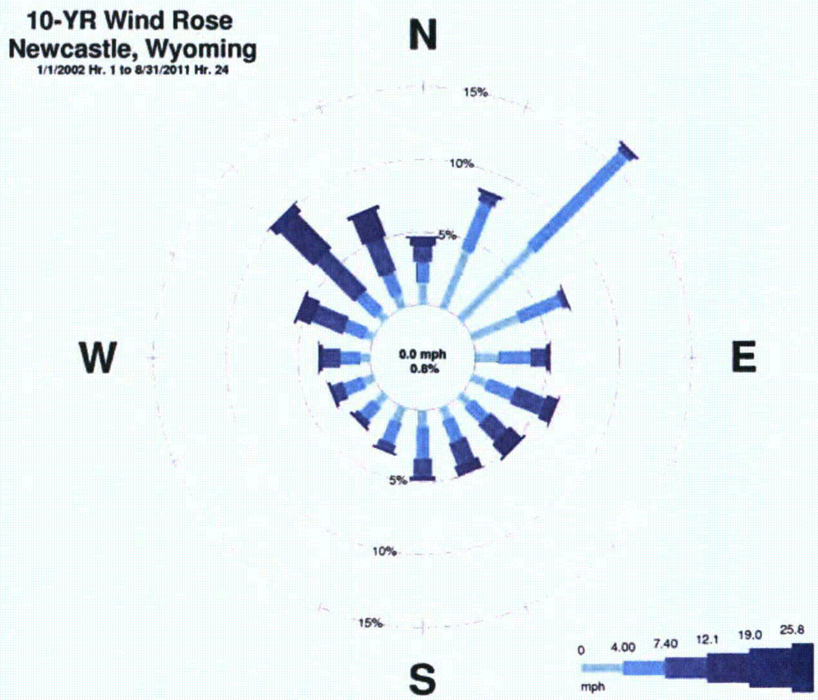


Figure 3.6-13: Newcastle 10-year Wind Rose

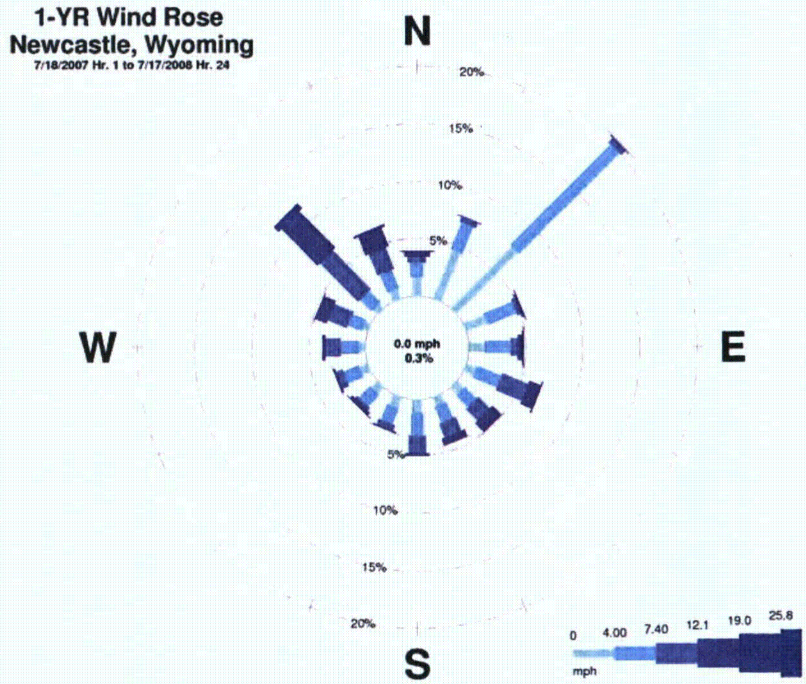
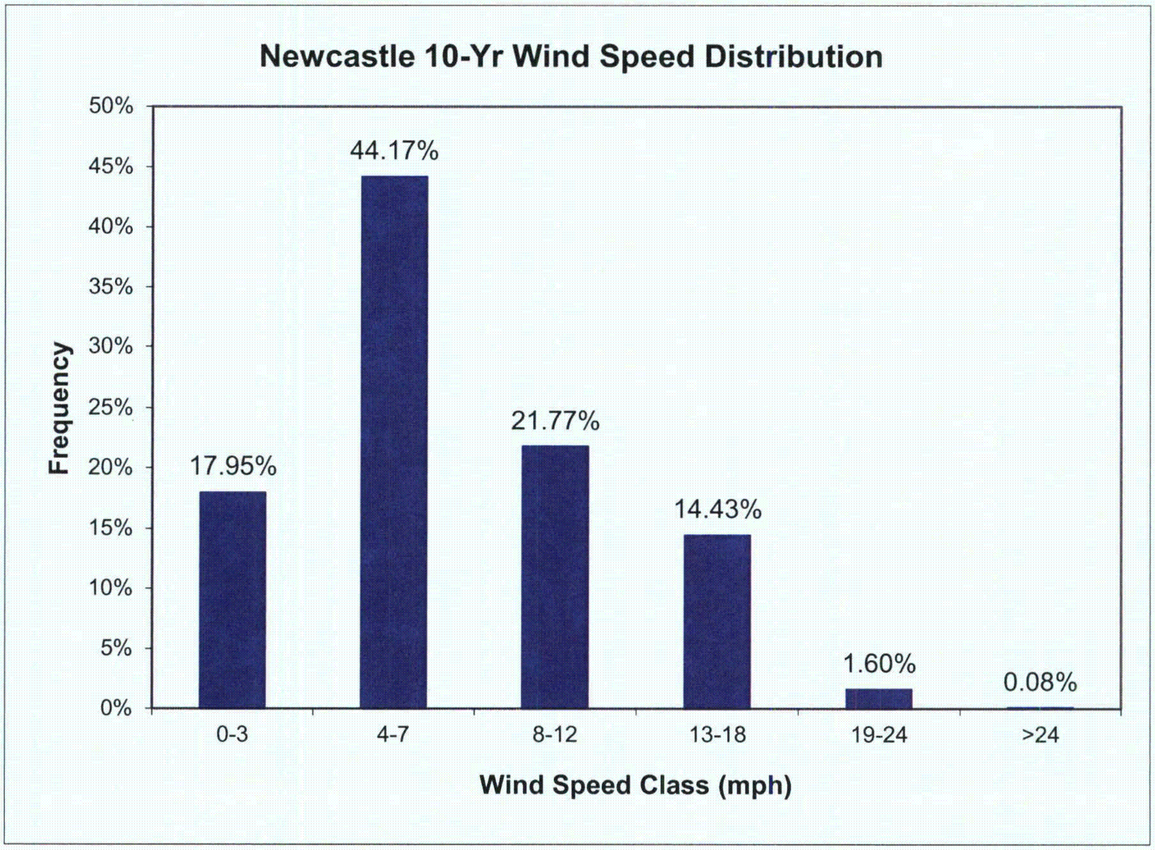


Figure 3.6-14: Newcastle 1-year Wind Rose



Source: IML Air Science, 2011

Figure 3.6-15: Wind Class Frequency Distribution for Newcastle, Wyoming from January 1, 2002 through August 31, 2011

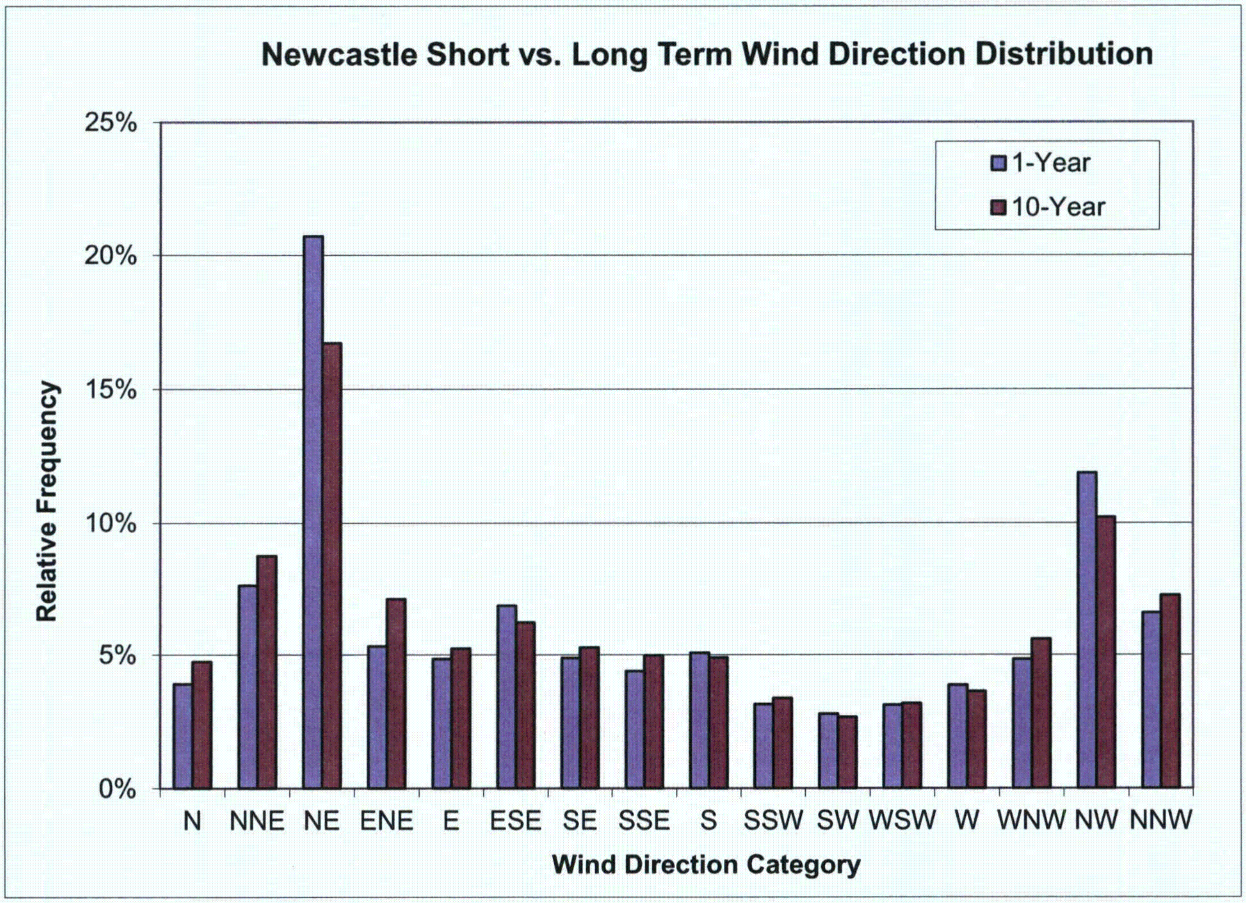


Figure 3.6-16: Newcastle Wind Direction Distributions

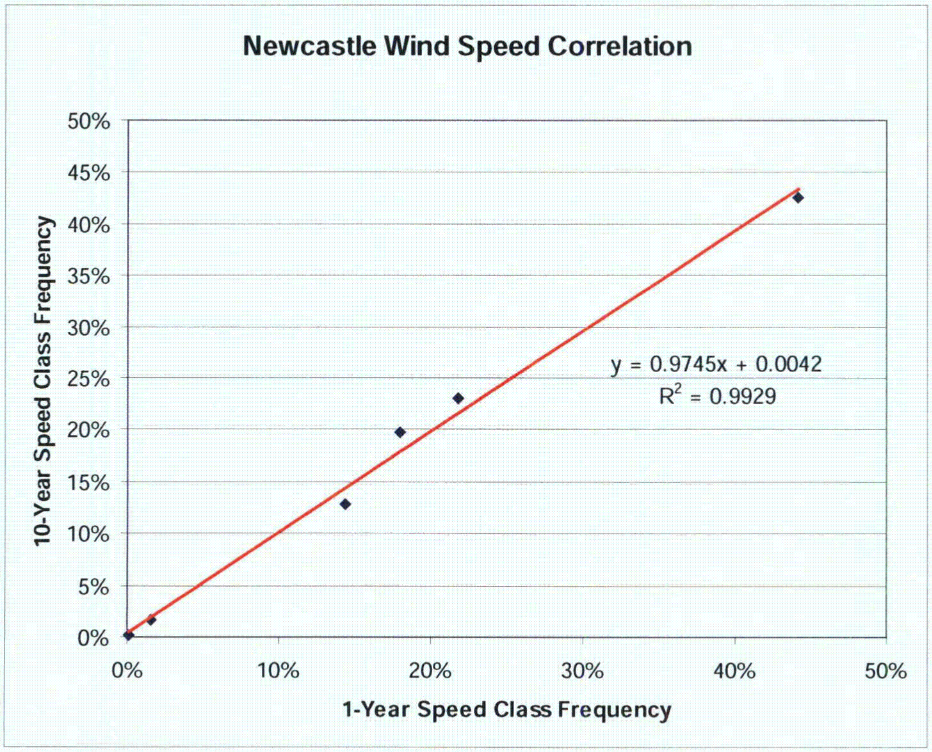


Figure 3.6-17: Newcastle Wind Speed Correlation

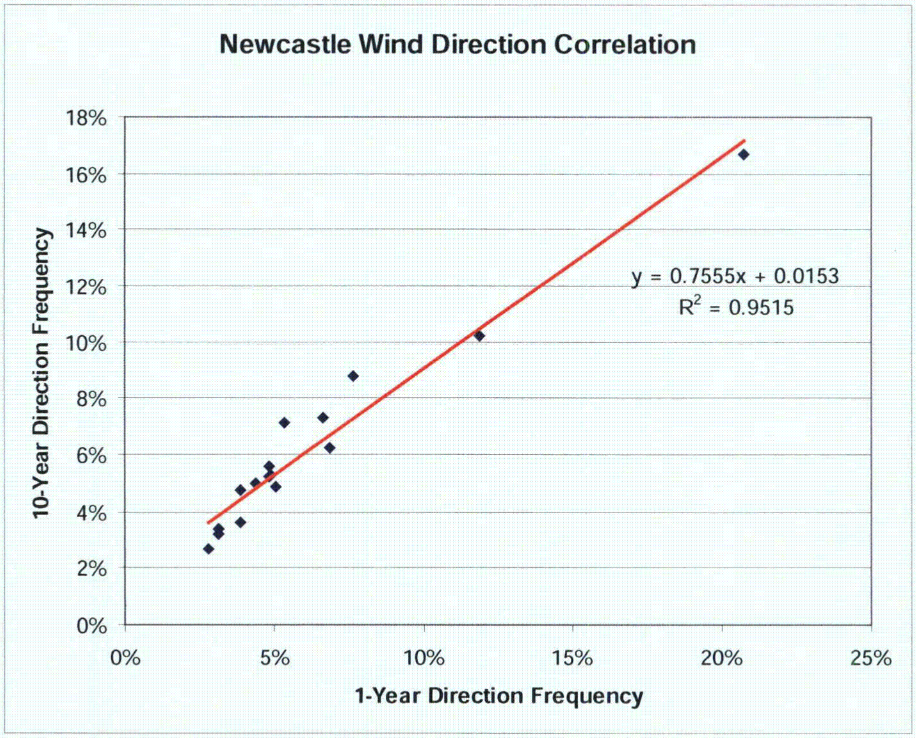


Figure 3.6-18: Newcastle Wind Direction Correlation

The regression line (red) in Figure 3.6-18 represents the least-squares fit to the 16 data points. The corresponding R^2 value of 95.2% implies very strong linear correlation. The linear slope of 0.76 further implies that short and long-term wind speed frequencies are similar.

Figures 3.6-17 and 3.6-18 offer conclusive evidence that the 2007-2008 baseline monitoring year adequately represents the last 10 years at Newcastle. Since the one-year wind data serve as reliable predictors of the long-term wind conditions at Newcastle, and since the Dewey-Burdock site experiences similar regional weather patterns, it is proposed here that the one-year baseline monitoring represents long-term meteorological conditions at the Dewey-Burdock site.

This same methodology can be used to determine whether or not Newcastle weather data are strictly representative of the Dewey-Burdock site. Figure 3.6-19 compares the wind direction distributions for the baseline monitoring year at the two sites. With an R^2 of 5.2%, Figure 3.6-19 indicates no correlation of wind direction frequencies between the two sites. Compared with the strong temporal correlation at the Newcastle site (short and long-term as demonstrated above), there appears to be very little spatial correlation between the two sites.

This result is heavily influenced by what appears to be an outlier. The NE sector constitutes 3.5% of the winds at the Dewey-Burdock site and 20.7% of the winds at Newcastle. This difference may stem from local topographic effects. Newcastle is situated in a "bowl" at the base of the Black Hills, and is subject to mild convection winds that tend to blow down the mountain from evening to early morning hours. This common phenomenon is related to differential air temperatures that cycle diurnally, with the cooler mountain air sinking to the adjoining valleys at night. Figure 3.6-20 shows the long-term wind rose for Newcastle for daytime hours only (9:00 a.m. to 5:00 p.m.). During these hours the NE component is substantially diminished relative to Figure 3.6-13, presumably due to the absence of down-slope convection breezes. It is reasonable to assume that the Dewey-Burdock site, situated several miles farther from the mountains than Newcastle, would not experience the same degree of diurnal convection breezes.

If the NE component is removed from each frequency distribution, a mild correlation between the two sites emerges. Figure 3.6-21 presents the same regression analysis as Figure 3.6-19, except with the NE outlier removed. While the much higher R^2 value of 60% still suggests no more than a weak correlation, it supports the premise that both sites are influenced by similar regional weather patterns. Hence, the conclusion that using the baseline year to represent long-term conditions is valid at either the Newcastle or the Dewey-Burdock site, but not between the two sites.

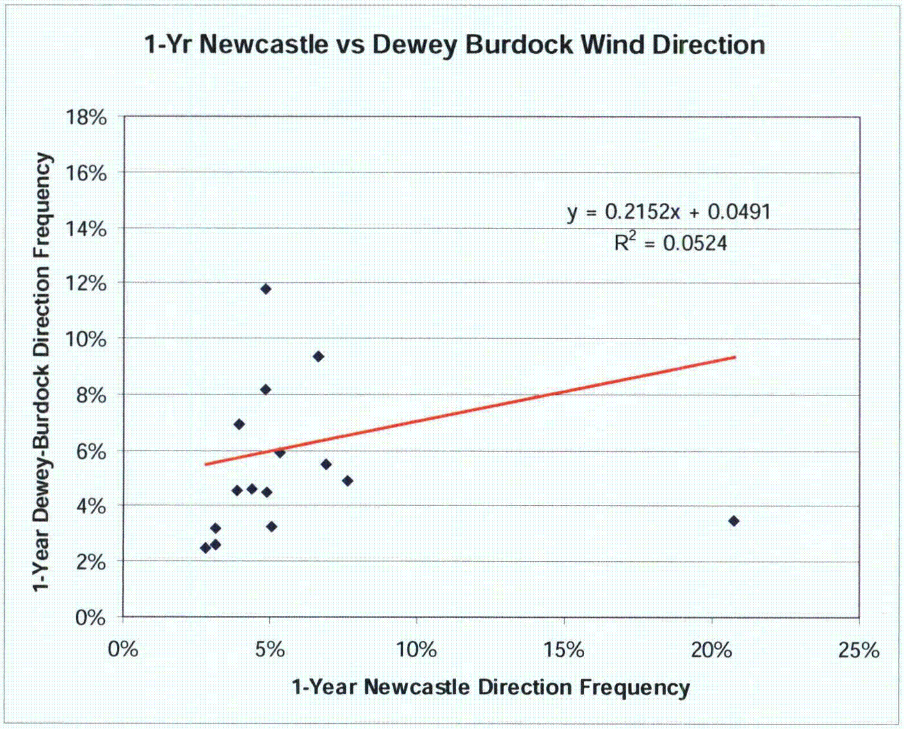


Figure 3.6-19: 1-year Newcastle vs. Dewey-Burdock Wind Direction

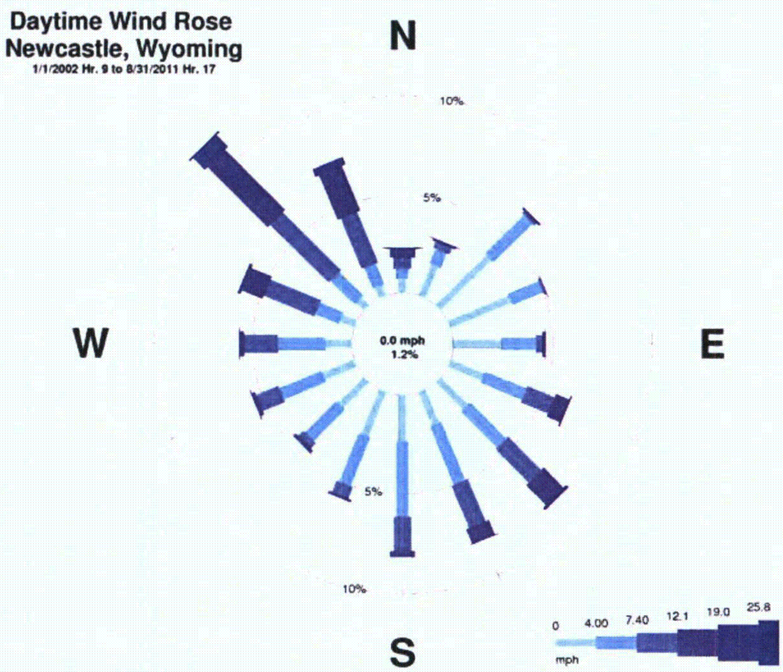


Figure 3.6-20: Newcastle Daytime Wind Rose

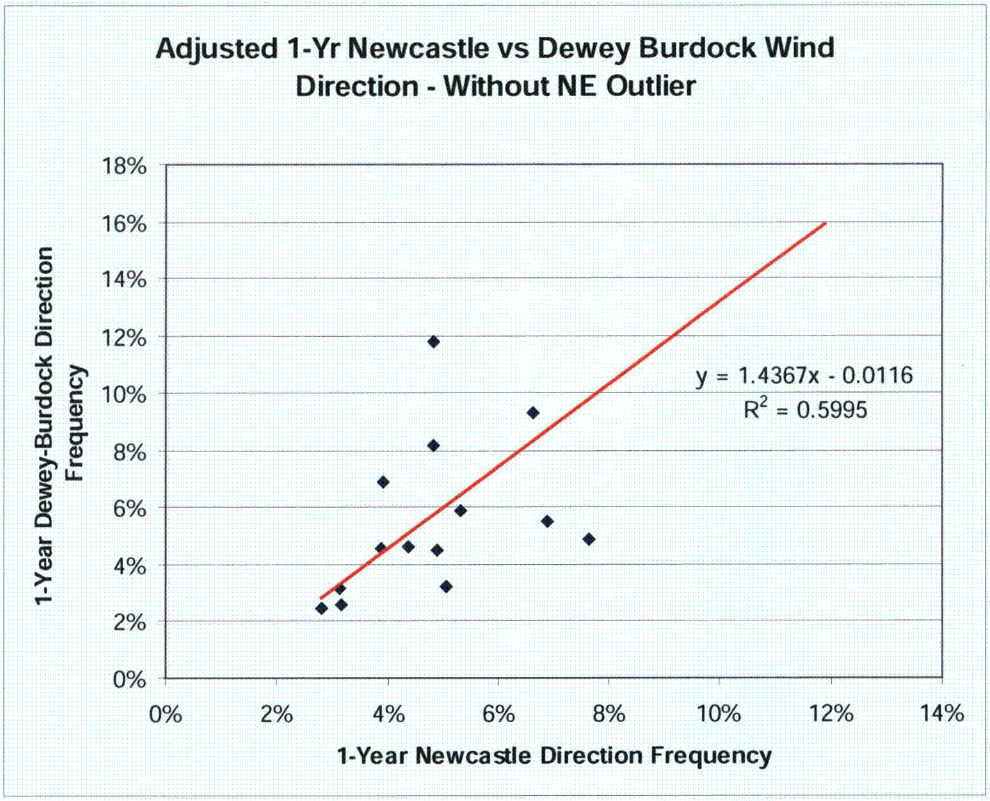


Figure 3.6-21: Adjusted 1-year Newcastle vs. Dewey-Burdock Wind Direction – Without NE Outlier

Figure 3.6-22 compares the baseline year wind roses from Newcastle, Dewey-Burdock, and Chadron. With the exception of the NE component discussed above, the Newcastle wind rose resembles that of Dewey-Burdock. On the other hand, the Chadron wind rose reflects an entirely different wind regime. The meteorological differences between Chadron and these other two sites may be attributed to the much greater distance from Chadron to the Black Hills, its lower elevation (3,280 ft), and the increased influence of Great Plains weather patterns.

3.6.1.1.5 Cooling, Heating and Growing Degree Days

The graphs shown in Figures 3.6-23, 3.6-24, and 3.6-25 summarize the growing degree, cooling degree, and heating degree days for the nine meteorological sites in the area. The data show a similar pattern for all three parameters throughout the sites with the exception of the Jewel Cave and Custer sites, the differences at which are likely caused by the higher relative elevation of these two sites.

Figure 3.6-26 presents these three measures for Newcastle on the same graph. All degree days calculations used a base temperature of 55°F. Heating and cooling degree days are included to show deviation of the average daily temperature from the chosen base temperature. The number of heating degree days is computed by taking the average of the high and low temperature occurring that day and subtracting it from the base temperature. The number of growing degree days and cooling degree days is computed in the opposite fashion where the base temperature is subtracted from the average of the high and low temperature for the day. Negative values are disregarded for both calculations.

3.6.1.1.6 Evapotranspiration

The American Society of Civil Engineers (ASCE) Standardized Reference Evapotranspiration Equation was used to calculate daily evapotranspiration (ET) using a tall reference crop coefficient. Note that these calculations were performed to estimate regional ET only; as described in Appendix 5.3-A and the GDP, hydrologic modeling of the land application systems conservatively assumed no crop (bare soil). The weather parameters needed to calculate ET using this method are daily maximum and minimum temperature, maximum and minimum relative humidity, total solar radiation, and average wind speed. The Oral site was the only one in the region with all these weather parameters being sampled and was, therefore, the site used for this analysis. The data were available from May 8, 2003, to July 20, 2008. Figure 3.6-27 displays a graph of the average accumulated ET for each month. Most ET occurs during the summer months of June, July, and August with an average monthly accumulation of 10.3 inches.

Powertech (USA) Inc.

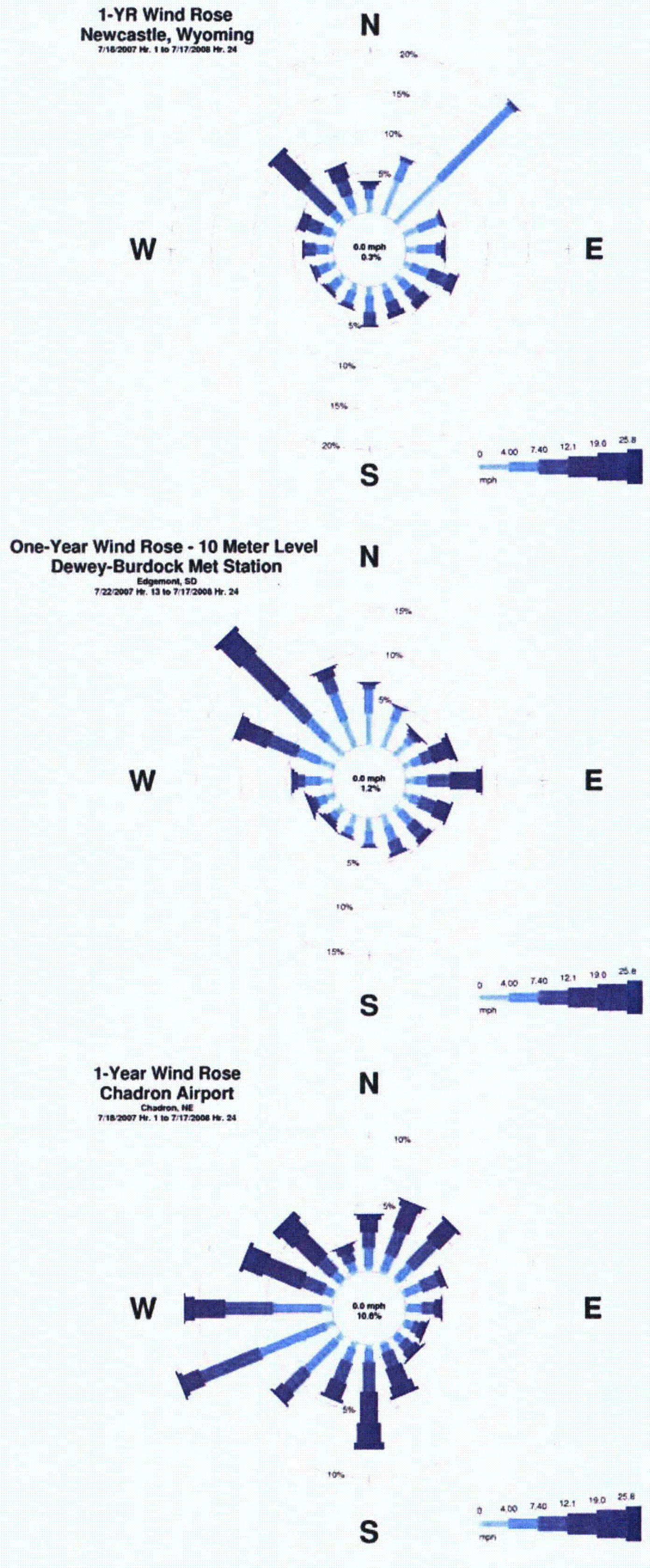
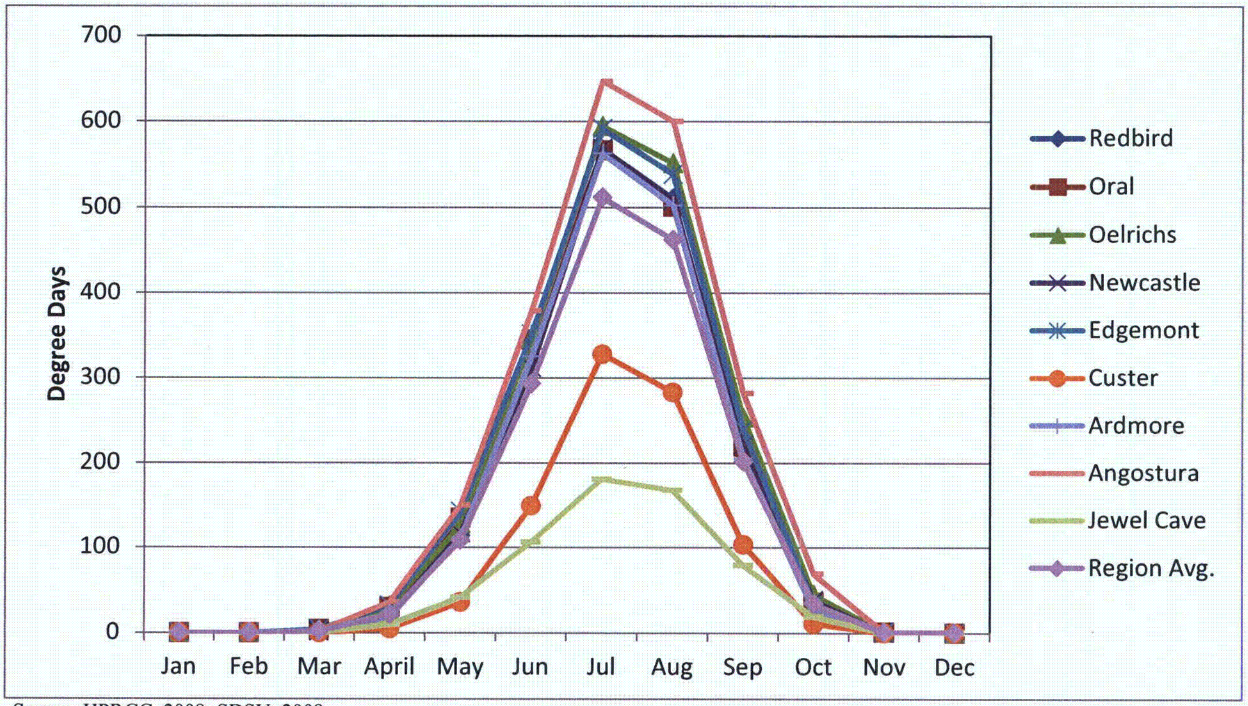
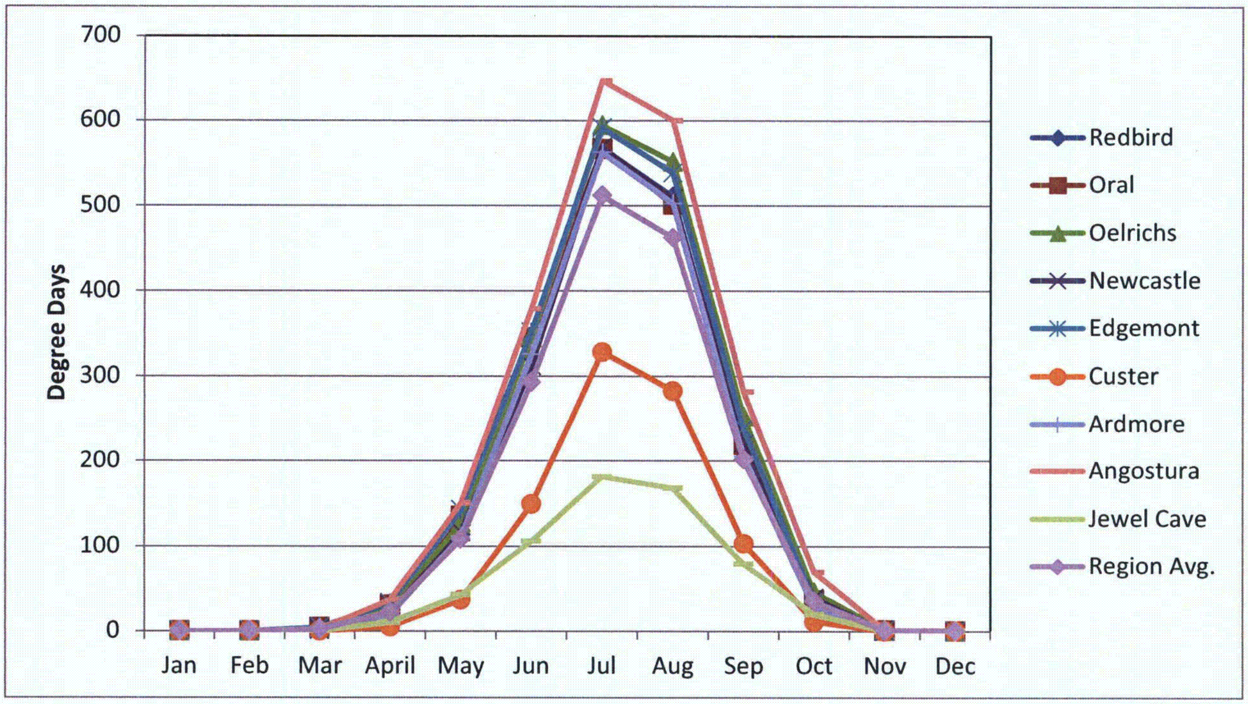


Figure 3.6-22: Comparative Wind Roses



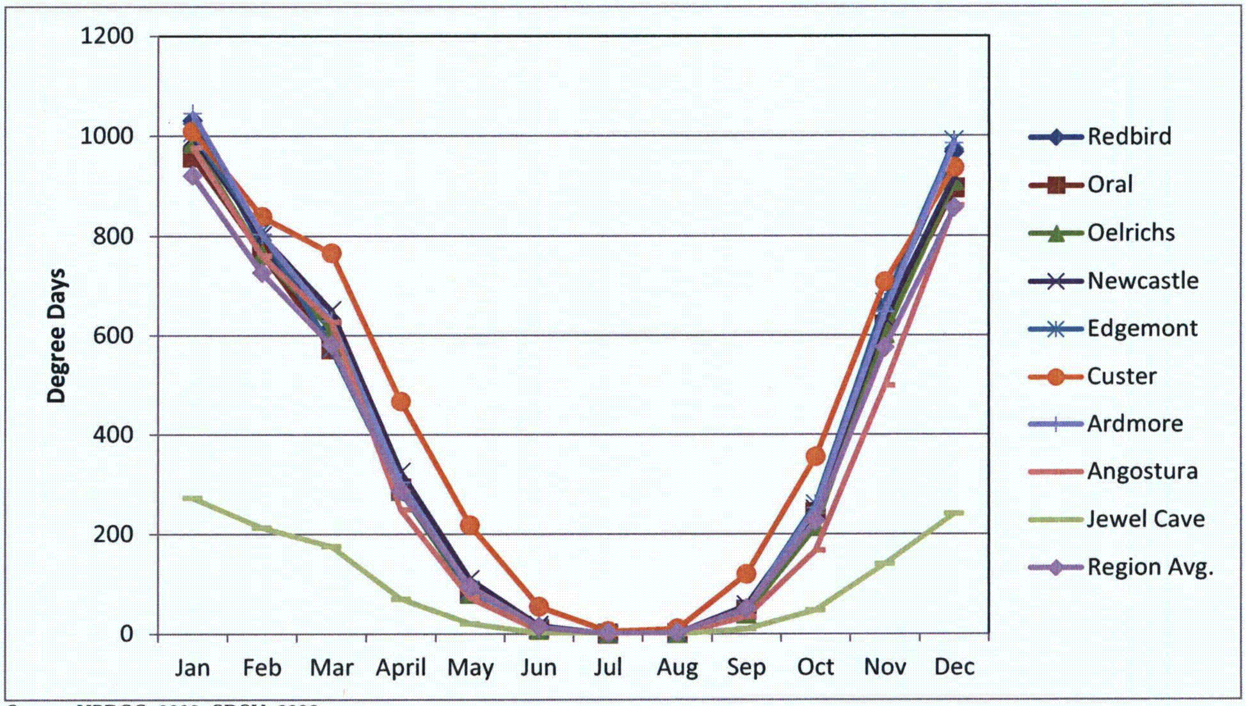
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-23: Growing Degree Days for Regional Sites



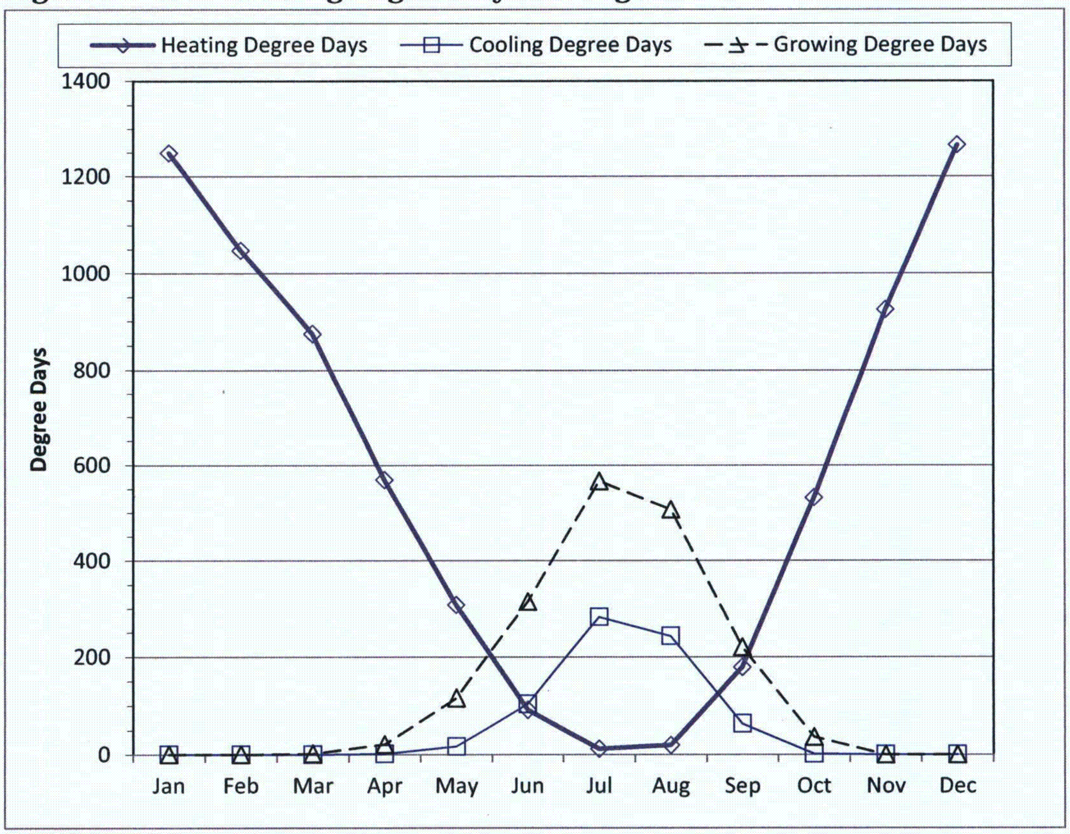
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-24: Cooling Degree Days for Regional Sites



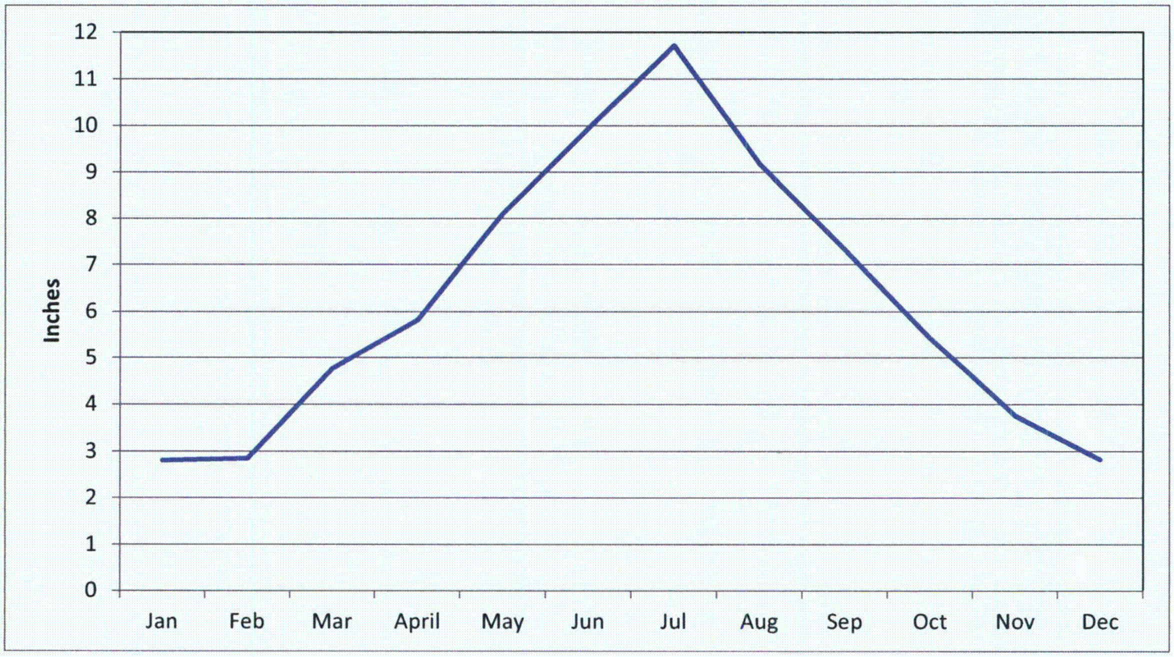
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-25: Heating Degree Days for Regional Sites



Source: WRCC, 2011

Figure 3.6-26: Degree Days for Newcastle NWS Site



Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-27: Average Monthly Accumulated Evapotranspiration for Oral, South Dakota

During the winter months, low ET (2.8 inches) occurs because of low temperatures and low solar radiation.

No ET data were available for the Newcastle site. The nearest relevant evaporation data in Wyoming were obtained from the Wyoming Water Research Center (WWRC) for Casper, Wyoming (Figure 3.6-28). Casper experiences solar radiation values similar to Newcastle. Higher winds and lower rainfall at Casper suggest that ET should be higher than at Newcastle.

The lake evaporation rates in Figure 3.6-28 are computed from pan evaporation measurements by applying a 0.70 multiplier, which is typical practice in this region. The WWRC source document states that "the potential evapotranspiration estimates are sometimes considered to be equivalent to lake evaporation." Therefore, the lake evaporation provides a surrogate measure of ET in Casper.

It will be noted by comparing Figures 3.6-27 and 3.6-28 that projected ET values are significantly higher at Oral, South Dakota than at Casper, Wyoming. This could be attributed to the use of a tall reference crop coefficient at the Oral, South Dakota site. Regardless, the Newcastle site is expected to more closely resemble Casper, Wyoming.

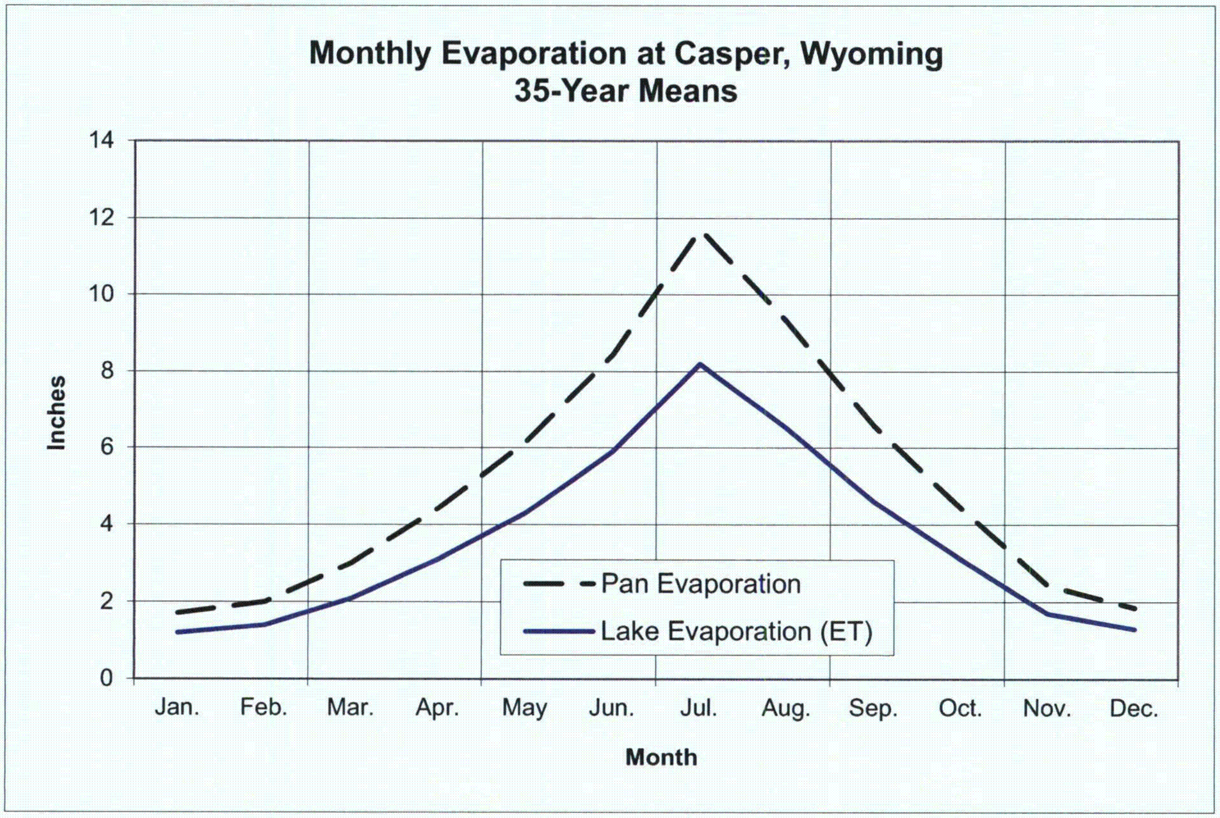
3.6.1.2 Site-Specific Analysis

The site-specific analysis was completed using data collected from a weather station installed in approximately the center of the proposed permit boundary. The station is located on a site that is representative of the area within the boundary. Twelve months of data from July 18, 2007 to July 17, 2008 are used for this analysis.

This site was installed in cooperation with the South Dakota State Climatology office according to the standards they use to install their Automatic Weather Data Network (AWDN) stations. The parameters being sampled at the site are air temperature, solar radiation, humidity, precipitation, and wind speed/direction at both 3- and 10-meter heights (9.8 and 32.8 feet). Table 3.6-6 lists the model number and specifications of the sensors that were installed. All results of the statistical analysis, completed using Minitab software version 14.0 for the parameters analyzed, are included in Appendix 3.6-B.

3.6.1.2.1 Temperature

The average hourly temperature over the year for the site was 45.5°F. A maximum temperature of 104°F was reached on both July 21, 2007 and August 13, 2007, while the minimum



Source: Wyoming Water Research Center, 1985

Figure 3.6-28: Average Monthly Evaporation for Casper, Wyoming

Table 3.6-6: Specifications for Weather Instruments Installed to Perform Site-Specific Analysis

Instrument	Model	Manufacturer	Accuracy/ Threshold	Operating Temperature	Required Standard
Precipitation	VR6101	Vaisala	0.01 inch	-40°C to 60°C	0.1 inch
Wind Direction	024A	Met-One	±5 degrees/1 mph	-50°C to 70°C	±5 degrees
Wind Speed	014A	Met-One	0.25 mph/1 mph (0.11 m/s)	-50°C to 70°C	1.0 mph (0.5 m/s)
Temperature and RH	HMP45C	Vaisala	Temp: ±2% for 10-90% RH: ±3% of 90-100% RH	-40°C to 60°C	Consistent with current state of the art
Solar Radiation	LI200X	Lt-Cor	Absolute error in natural daylight is ±5% max; ±3% typical	-40°C to 65°C	Consistent with current state of the art

temperature for the period of record was –28°F on January 22, 2008. A boxplot of the average temperature by month is shown in Figure 3.6-29. July was the warmest month with a median temperature of 76°F with a first quartile of 69°F and a third quartile value of 85°F. Conversely, December and January were the coolest months with a median temperature of 15°F.

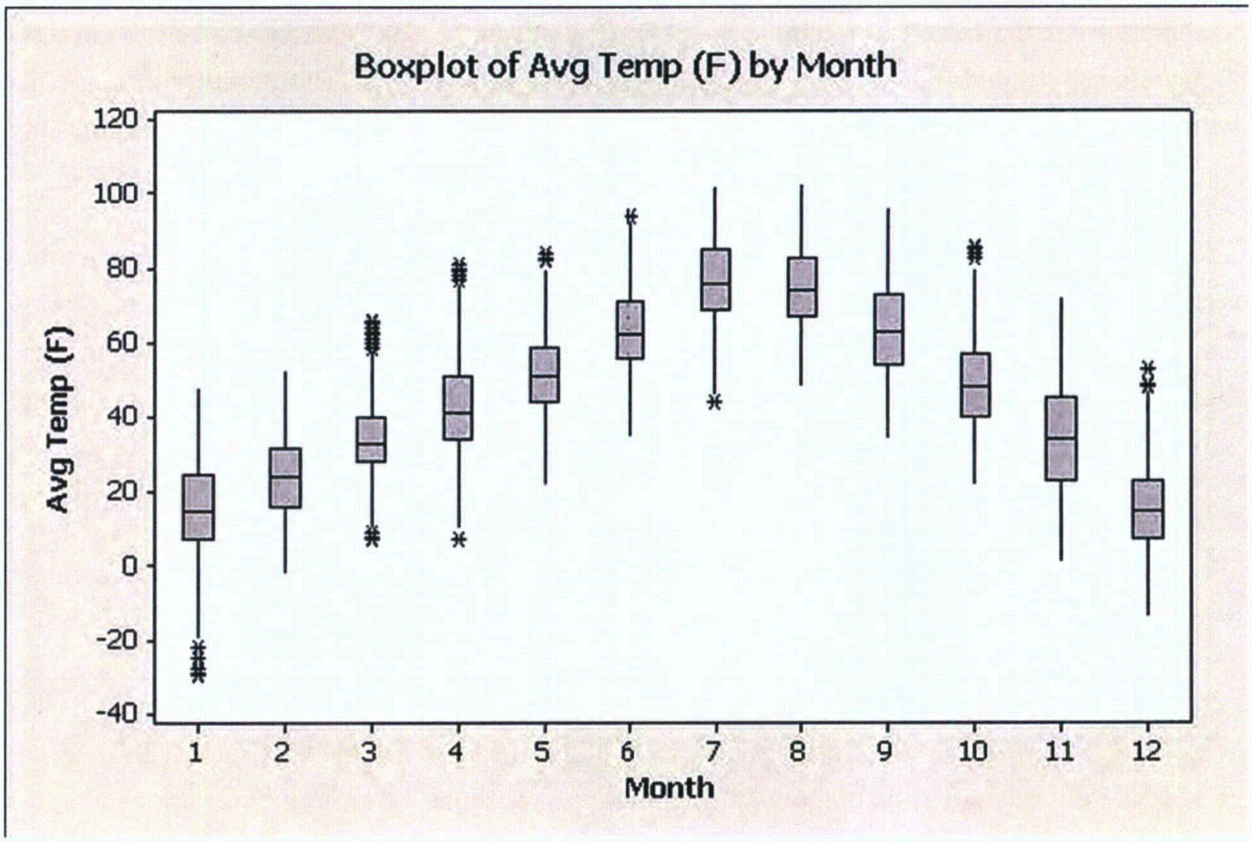
There were large variations in seasonal and diurnal temperature (Figure 3.6-30). In the summer season, average temperatures were from 60°F at 6 a.m. to 83.6°F at 5 p.m. In the winter season, temperatures averaged 11°F between 7 a.m. and 8 a.m. and rose to nearly 27°F at 4 p.m. The diurnal variations are the result of the lack of relative humidity in the atmosphere at the site, which causes the earth's surface to rapidly absorb and release the energy supplied by the sun.

Figure 3.6-31 shows a probability plot of average hourly temperature for the year. Temperatures above or below 46°F were expected at the site 50 percent of the time, and temperatures dipped below the freezing mark (32°F) 31 percent of the time.

3.6.1.2.2 Wind Patterns

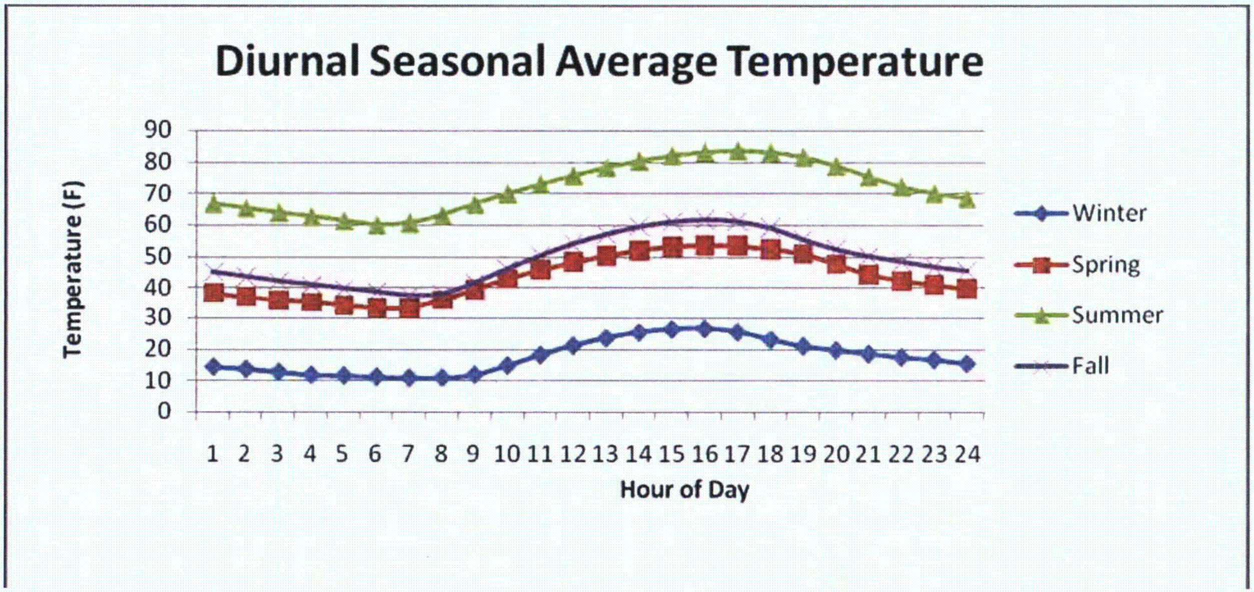
Wind speed and direction were measured in the field using Met-One 014A and 024A model sensors. Wind data analysis outputs are included in Appendix 3.6-C. The average wind speed over the period of record was approximately 9 mph, while calm winds occurred only 1.2 percent of the time.

As shown in Table 3.6-7, over a third of the winds (34 percent) come from the north-northwest, northwest and west-northwest. Approximately 24 percent of all winds were less than 3.5 mph. Northwesterly, west-northwesterly and north-northwesterly winds were prevalent in the winter months. Easterly, east-northeasterly and east-south easterly winds were prevalent in summer months. Figures 3.6-32 and 3.6-33 show the quarterly wind roses for the Dewey-Burdock permit area. The period from January through March was used for the 1st Quarter, April through June for 2nd Quarter, July through September for 3rd Quarter and October through December for 4th Quarter. The 3rd Quarter wind rose reflects hourly data from both 2007 and 2008. Figure 3.6-34 shows the annual wind rose for the project site, with northwesterly and west-northwesterly winds dominating. Figure 3.6-35 shows that December had the least amount of wind with an average wind speed of 5 mph. In contrast, May was the windiest month with an average wind speed of 12 mph.



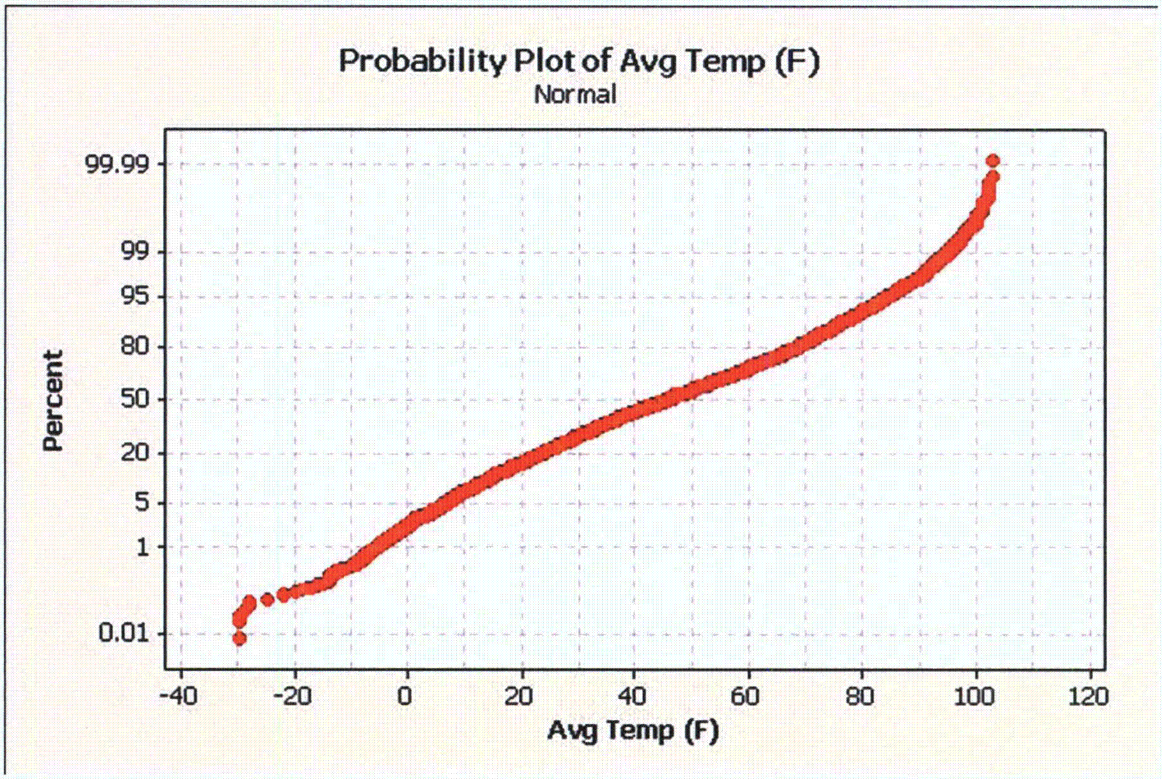
Source: SDSU, 2008

Figure 3.6-29: Average Temperature by Month from the Project Meteorological Site



Source: SDSU, 2008

Figure 3.6-30: Diurnal Average Temperature for the Project Meteorological Site by Season



Source: SDSU, 2008

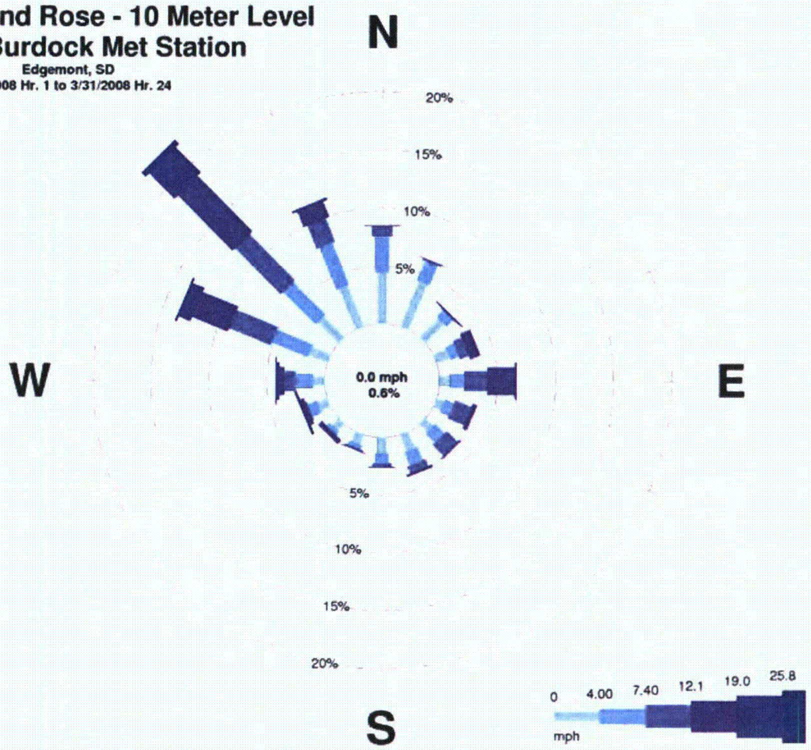
Figure 3.6-31: Probability Plot of Average Temperature from the Project Meteorological Site

Table 3.6-7: Normalized Frequency Distribution of Wind at the Project Meteorological Site

Frequency Distribution (Normalized)							
Wind Direction	Wind Speed Classification (mph)						
	1–3	4–7	8–12	13–18	19–24	≥ 24	Total
N	0.030713	0.024749	0.002587	0.001125	0.000337	0.000000	**0.059511**
NNE	0.027653	0.012374	0.001575	0.000450	0.000000	0.000112	**0.042165**
NE	0.016474	0.007087	0.004050	0.002025	0.000112	0.000337	**0.030086**
ENE	0.009649	0.011924	0.013612	0.011812	0.002025	0.001800	**0.050822**
E	0.009178	0.016424	0.028573	0.014174	0.001350	0.000562	**0.070262**
ESE	0.007531	0.014399	0.016312	0.008437	0.000787	0.000000	**0.047466**
SE	0.006825	0.015862	0.013837	0.002025	0.000225	0.000000	**0.038773**
SSE	0.011885	0.018224	0.008212	0.001237	0.000337	0.000000	**0.039896**
S	0.012120	0.013724	0.002025	0.000112	0.000000	0.000000	**0.027982**
SSW	0.012356	0.007087	0.002587	0.000337	0.000000	0.000000	**0.022368**
SW	0.008472	0.006750	0.002925	0.002137	0.000787	0.000112	**0.021184**
WSW	0.009414	0.010124	0.003600	0.002812	0.000900	0.000562	**0.027413**
W	0.009884	0.018449	0.006075	0.003262	0.001462	0.000112	**0.039245**
WNW	0.015650	0.031498	0.030486	0.018899	0.004162	0.000337	**0.101033**
NW	0.021299	0.035323	0.042298	0.042185	0.016762	0.002700	**0.160566**
NNW	0.028594	0.032623	0.012262	0.004837	0.001575	0.000337	**0.080229**
Subtotal	**0.237699**	**0.276621**	**0.191014**	**0.115868**	**0.030823**	**0.006975**	**0.859000**
Calms							**0.012200**
Missing/Incomplete							**0.128800**
Total							**1.000000**

Source: SDSU, 2008

1st Quarter Wind Rose - 10 Meter Level
Dewey-Burdock Met Station
Edgemont, SD
1/1/2008 Hr. 1 to 3/31/2008 Hr. 24



2nd Quarter Wind Rose - 10 Meter Level
Dewey-Burdock Met Station
Edgemont, SD
4/1/2008 Hr. 1 to 6/30/2008 Hr. 24

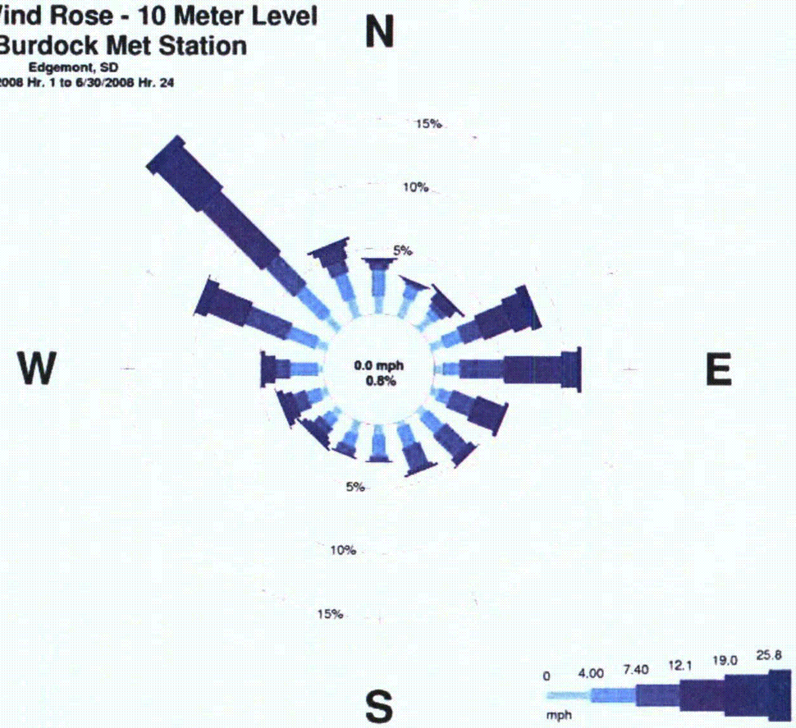
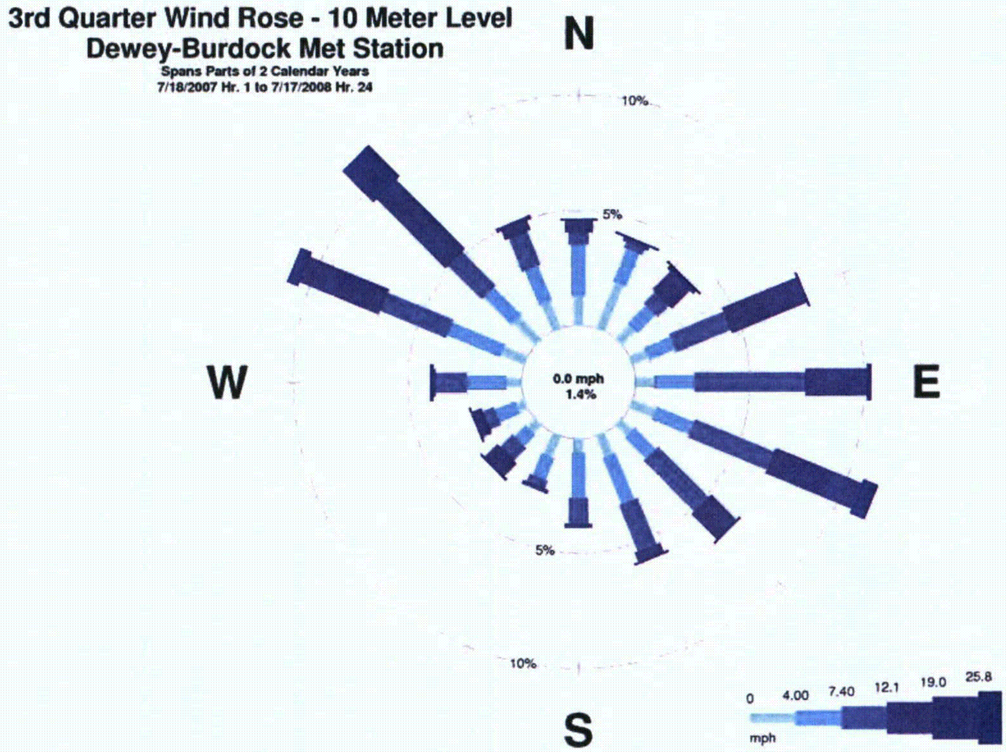


Figure 3.6-32: First and Second Quarter Wind Roses



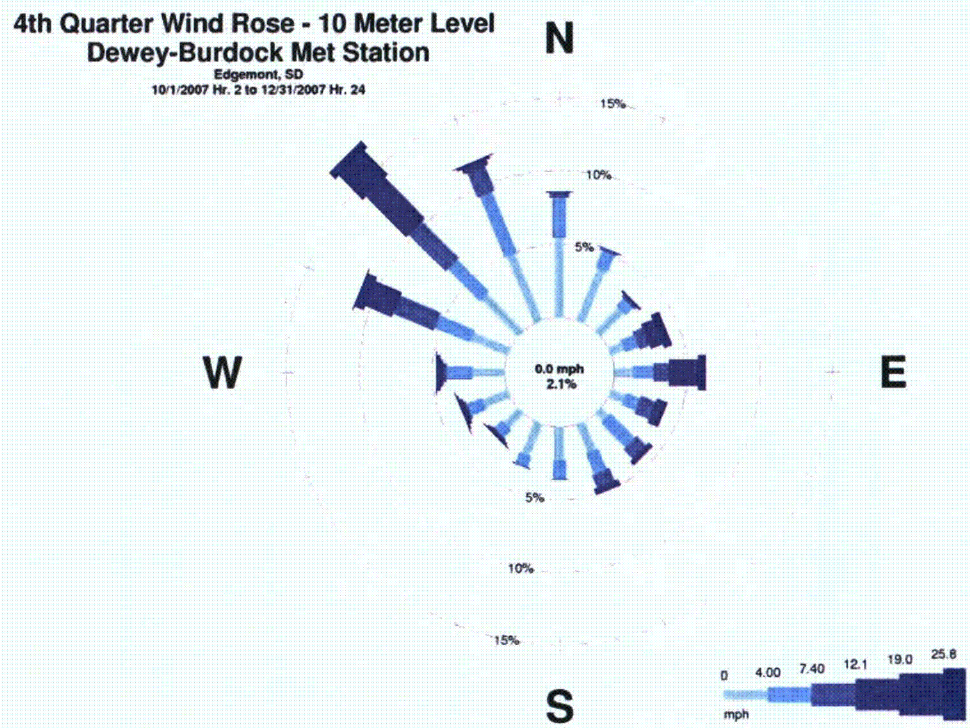


Figure 3.6-33: Third and Fourth Quarter Wind Roses

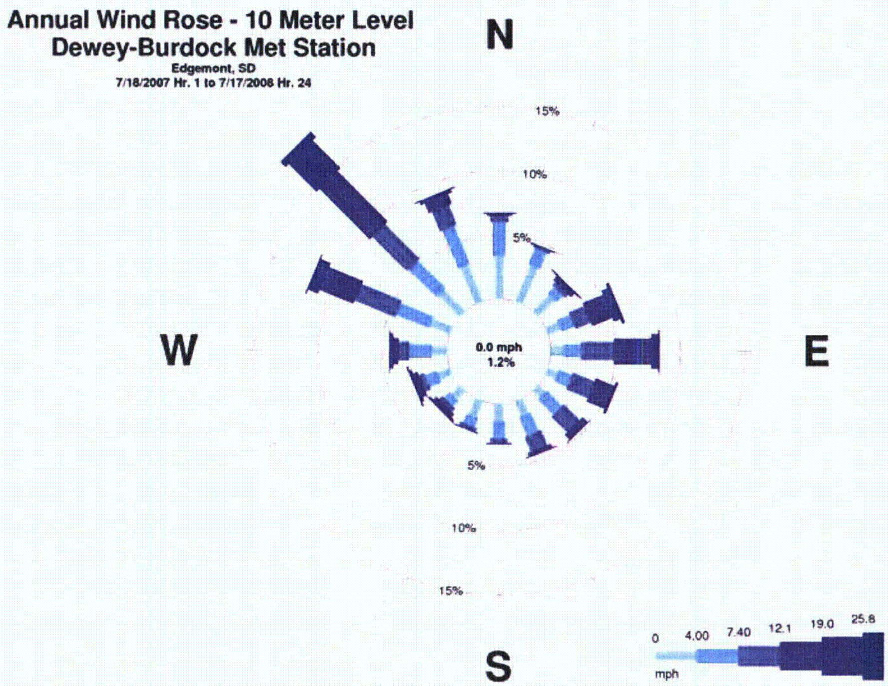


Figure 3.6-34: Annual Wind Rose

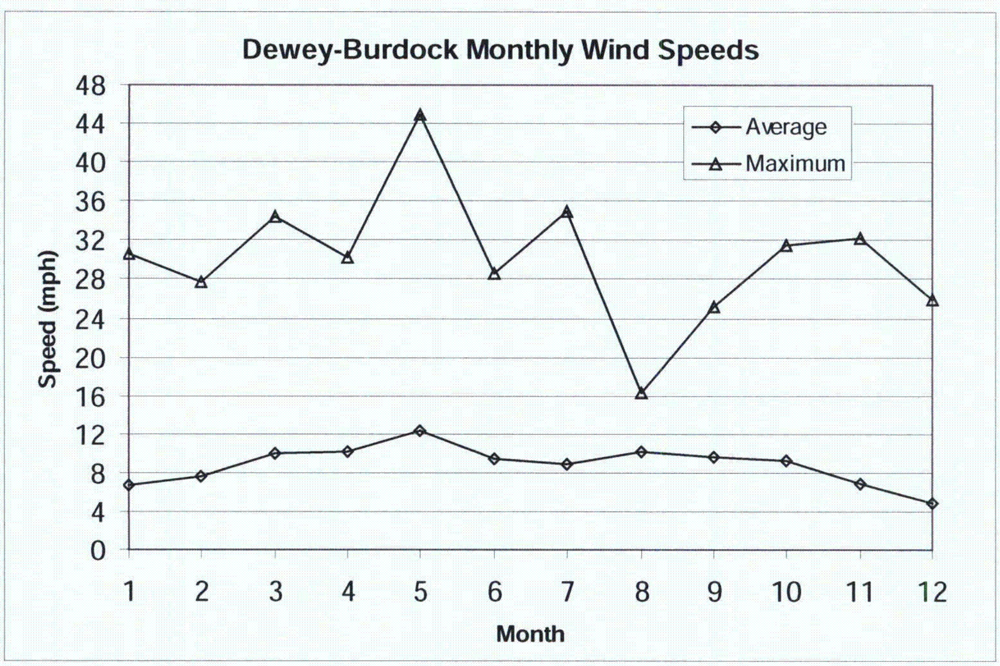


Figure 3.6-35: Dewey-Burdock Monthly Wind Speeds

3.6.1.2.3 Relative Humidity

As mentioned in previous sections, the relative humidity at the site is low. Mean values range from a low of 51 percent in the summer months to a high of 77 percent in the winter months. Relative humidity values varied greatly throughout the day, especially in the summer and spring months. On average, during the spring, summer, and fall months, relative humidity reached its maximum from 5 a.m. to 7 a.m. and then declined steadily until 4 p.m. to 5 p.m. when it began its evening ascent (Figure 3.6-36). During the winter months, the diurnal relative humidity range was much less because of less intense and shorter duration solar radiation.

3.6.1.2.4 Precipitation

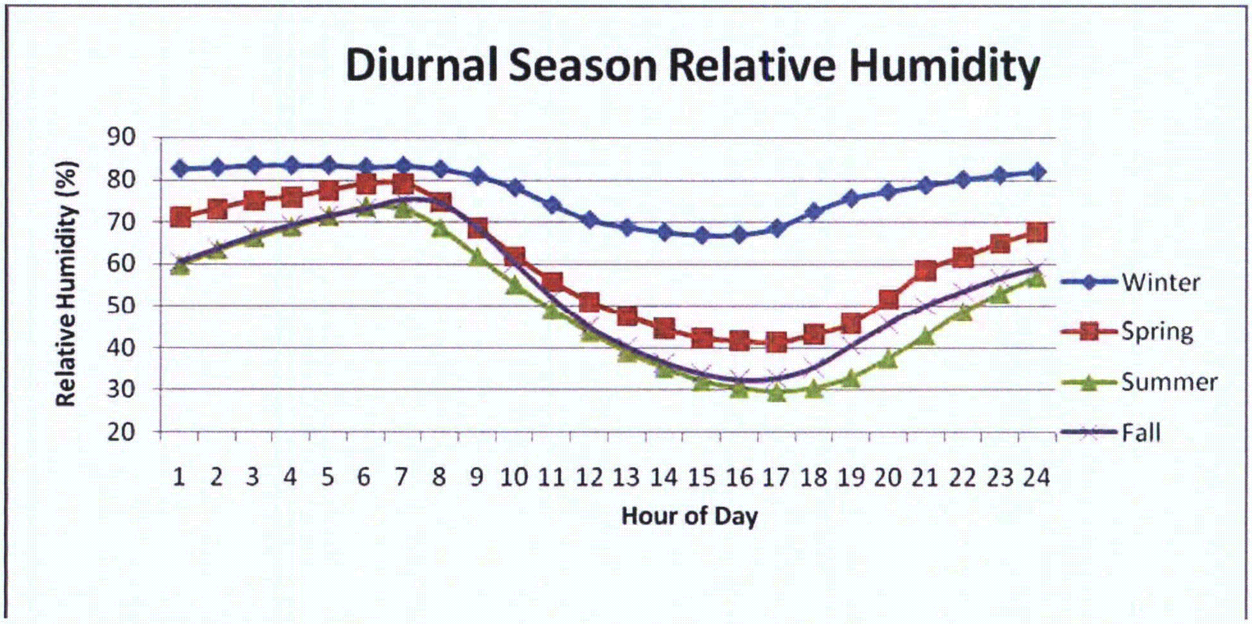
Data for this site were collected using a Vaisala VRG 101 all-weather precipitation gauge. The region received 12.42 inches of precipitation during the year of monitoring. Figure 3.6-37 displays the precipitation totals by month. The largest monthly precipitation total occurred in May (3.8 inches) and the least occurred in November (0.10 inch). The greatest daily precipitation total (1.29 inches) occurred on May 23, 2008. Also on May 23, 2008, the area received 0.71 inch of precipitation between the hours of 8 p.m. and 9 p.m., which was the most intense event of the sampled year.

3.6.1.2.5 Potential Evapotranspiration

The potential ET data were taken from July 18, 2007 to July 14, 2008. The ASCE Standardized Reference Evapotranspiration Equation for a tall reference crop was used to estimate daily ET. The weather parameters needed to estimate ET using this method are daily, maximum and minimum temperature, maximum and minimum relative humidity, total solar radiation, and average wind speed. Most ET occurs during the months of July, August, and September with an average monthly accumulation of 10.3 inches (Figure 3.6-38) because of the high temperatures and unstable weather. During the winter, low ET occurs because of low temperatures and low solar radiation. The average ET during the winter months is 1.5 inches.

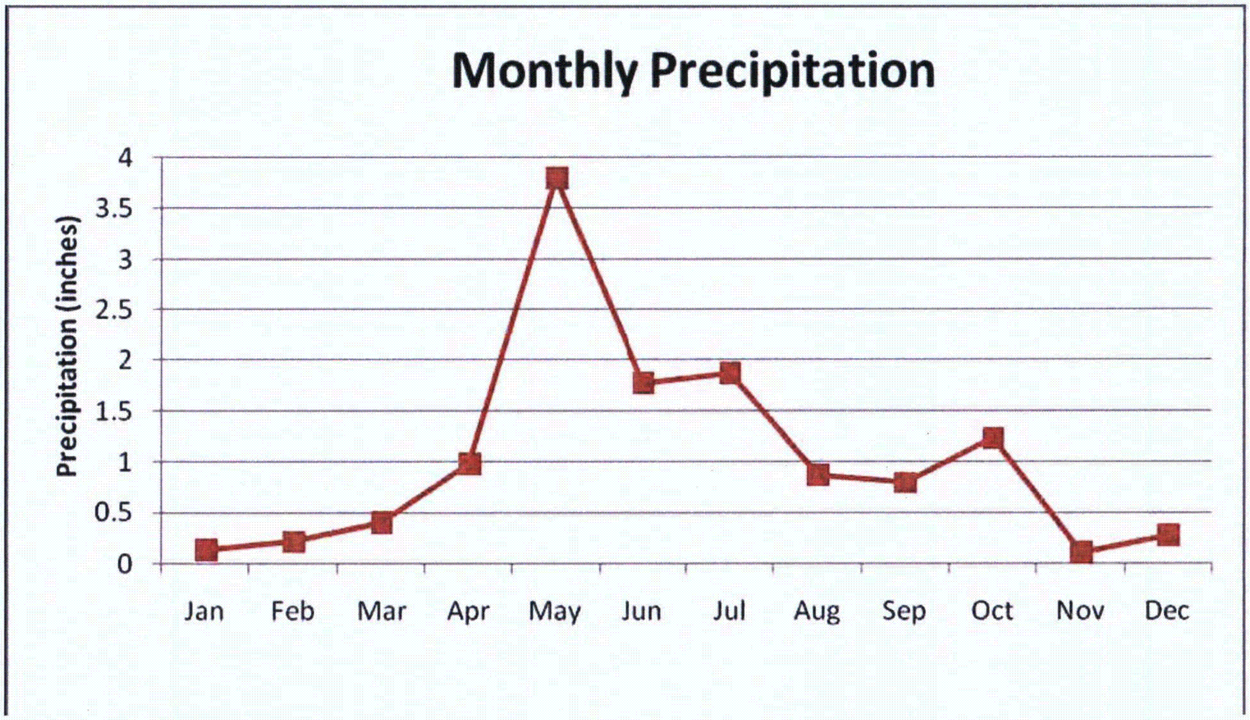
3.6.1.2.6 Upper Atmosphere Characterization

Mixing height is the height of the atmosphere above the ground that is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable. Higher mixing heights are associated with greater dispersion, all other parameters being the same. Stable periods have much lower mixing heights and accompanying lapse rates allowing for less temperature variation. Unstable air leads to more dispersion, which leads to lower predicted impacts on ambient air quality. The default mixing height used by MILDOS-AREA is



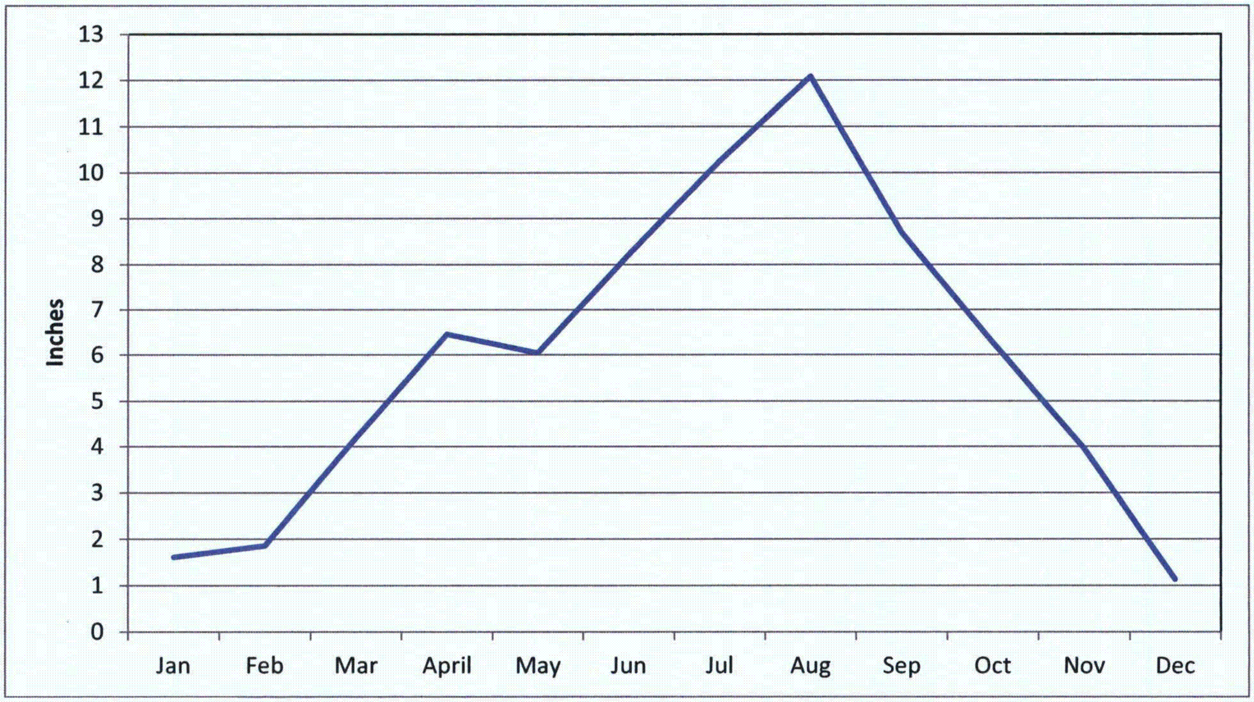
Source: SDSU, 2008

Figure 3.6-36: Diurnal Relative Humidity by Season from Project Meteorological Site



Source: SDSU, 2008

Figure 3.6-37: Monthly Precipitation from the Project Meteorological Site



Source: SDSU, 2008

Figure 3.6-38: Estimated Evapotranspiration Calculated Using Weather Data Collected at the Project Meteorological Site

100 meters, a very conservative value given that typical mixing heights exceed 1,000 meters. Table 3.6-8 provides the average mixing heights, computed from upper air and surface data, at the Rapid City Airport, which is the closest site to the permit area with upper air data.

For comparison purposes, average mixing heights were derived from the AERMOD calculations used for dispersion modeling, based on hourly data obtained from the NWS stations in Rapid City (upper air), Custer, and the local Edgemont station. The AERMOD calculation is based on a combination of mechanically and convectively driven boundary layer processes. The results of these calculations are provided on a quarterly basis in Table 3.6-9. The annual average mixing height is 1,110 meters, an order of magnitude higher than the default used for modeling potential radiological impacts.

3.6.2 Air Quality

Air particulate monitoring was conducted at the project for one year. Particulates were collected using high volume air samplers.

3.6.2.1 Methods

Eight Hi-Q Model HVP-4200AFC high volume air samplers were established within and surrounding the proposed permit area. The samplers operated continuously from August 2007 to August 2008 except for minor down time due to filter changes and short-term power outages. The locations of the air samplers are shown on Figure 3.6-39 and Plate 3.6-1.

The air particulate sampling locations were established in accordance with NRC regulatory guidance. The criteria used to establish air particulate sampling locations include the following factors:

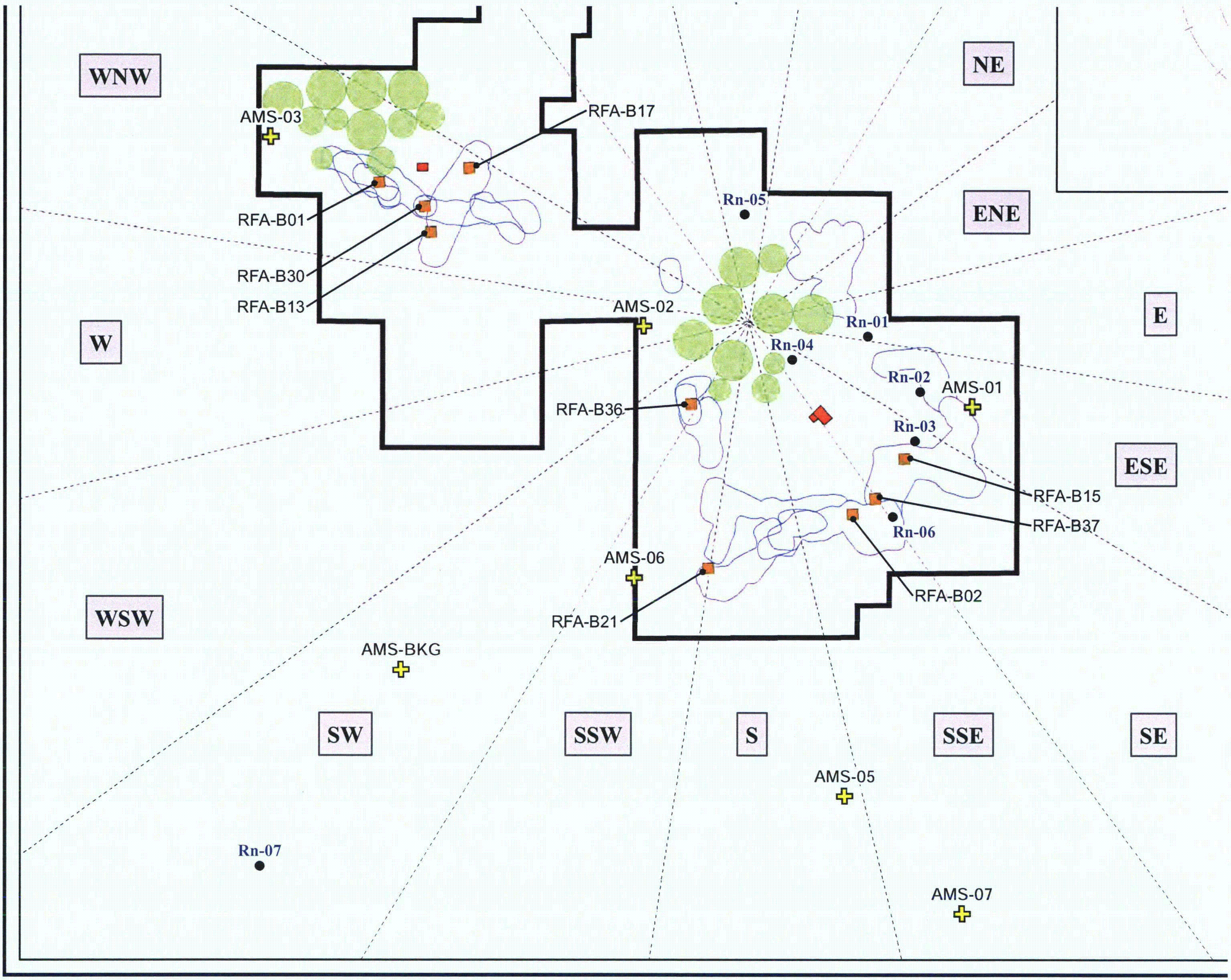
1) Average meteorological conditions such as wind speed, wind direction and atmospheric stability
2) Prevailing wind direction
3) Site boundaries nearest to proposed facility processing areas, land application areas, and well fields
4) Direction of nearest occupiable structure
5) Locations of estimated maximum concentrations of radioactive materials
6) Locations of existing features near or within the proposed permit boundary, but unrelated to proposed site activities, that may impact background radiological conditions (e.g., railroads and historical surface mines)
7) Location of nearest multiple resident area or town

Table 3.6-8: Rapid City Mixing Height Averages, 1984-1991

Averaging Period	Morning	Afternoon
Average Mixing Height (meters)	333	1,547

Table 3.6-9: Quarterly Mixing Height Averages

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Average Mixing Height (meters)	936	1,285	1,382	839



September 2012

Each high volume air sampler was equipped with an 8-in. by 10-in. 0.8 micron glass fiber filter paper. The air filters were collected approximately bi-weekly, prior to saturation, from each of the eight air samplers. Flow rate and total flow data were recorded at the same time. The samples were collected as follows:

- Period 1: August 13 to October 2, 2007
- Period 2: October 2, 2007 to January 4, 2008
- Period 3: January 4 to April 1, 2008
- Period 4: April 1 to July 9, 2008
- Period 5: July 9 to August 13, 2008

The air particulate samplers were equipped with air flow totalizers, which were recorded and reset during each filter change. Qualitative checks of air particulate sampler operation were also performed during each filter change. No anomalous flow volumes or conditions were observed.

The samples were composited and digested by the external independent analytical laboratory. The samples were analyzed for radium-226, thorium-230, natural uranium, and lead-210.

<u>*3.6.2.2 Sampling Results*</u>

In general and relative to one another (e.g., natural uranium to radium-226), the average concentrations of radionuclides were consistent at each location from period to period. The lowest average concentration was radium-226, followed by thorium-230, natural uranium, and lead-210. Average radium-226 concentrations were five orders of magnitude lower than lead-210 concentrations. The data are summarized in Table 3.6-10.

Site-wide, the data can be summarized as follows:

- Natural uranium concentrations ranged from $-8.1*10^{-18}$ to $1.5*10^{-14}$ µCi/ml and averaged $1.4*10^{-15}$ µCi/ml.
- Thorium-230 concentrations ranged from $-9.5*10^{-19}$ to $5.6*10^{-17}$ µCi/ml and averaged $1.2*10^{-17}$ µCi/ml.
- Radium-226 concentrations ranged from $-4.9*10^{-17}$ to $4.7*10^{-17}$ µCi/ml and averaged $1.7*10^{-18}$ µCi/ml.
- Lead-210 concentrations ranged from $7.0*10^{-18}$ to $4.3*10^{-17}$ µCi/ml and averaged $1.45*10^{-14}$ µCi/ml.

There are no clear patterns in the data, in terms of radionuclide concentrations, when evaluating them spatially or temporally. Natural uranium concentrations at each location were on the order

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Table 3.6-10: Summary of Radionuclide Concentrations in Air

Location	U-nat Concentration (µCi/ml)				Th-230 Concentration (µCi/ml)				Ra-226 Concentration (µCi/ml)				Pb-210 Concentration (µCi/ml)			
	Average	σ	Min	Max	Average	σ	Min	Max	Average	σ	Min	Max	Average	σ	Min	Max
AMS-01	1.4E-15	3.2E-15	-1.7E-17	7.1E-15	8.2E-18	6.4E-18	1.6E-18	1.7E-17	1.2E-17	3.0E-17	-3.1E-17	5.3E-17	2.3E-14	1.4E-17	9.1E-18	4.3E-17
AMS-02	1.4E-15	3.1E-15	-2.0E-17	7.0E-15	4.9E-18	6.5E-18	0.0E+00	1.6E-17	-1.4E-17	1.9E-17	-4.9E-17	-2.3E-18	1.3E-14	9.7E-18	7.0E-18	2.9E-17
AMS-03	1.0E-15	2.2E-15	-3.0E-17	5.0E-15	9.0E-18	7.2E-18	-1.5E-18	1.9E-17	-1.6E-18	9.3E-18	-1.4E-17	9.6E-18	1.1E-14	9.2E-18	8.9E-18	3.1E-17
AMS-04	1.0E-15	2.2E-15	-2.6E-17	5.0E-15	1.0E-17	9.8E-18	2.5E-18	2.7E-17	5.3E-18	2.7E-17	-2.8E-17	4.6E-17	1.3E-14	1.1E-17	8.3E-18	3.3E-17
AMS-05	1.2E-15	2.6E-15	0.0E+00	5.9E-15	2.4E-17	1.9E-17	4.7E-18	5.6E-17	9.6E-18	3.4E-17	-4.5E-17	4.7E-17	1.3E-14	1.0E-17	9.0E-18	3.4E-17
AMS-06	1.0E-15	2.3E-15	-1.4E-17	5.0E-15	9.9E-18	7.2E-18	1.5E-18	2.0E-17	-2.6E-18	2.3E-17	-3.9E-17	2.3E-17	1.4E-14	9.9E-18	7.4E-18	3.3E-17
AMS-07	3.1E-15	6.9E-15	-1.1E-17	1.5E-14	1.3E-17	5.7E-18	6.3E-18	2.0E-17	4.9E-18	1.7E-17	-1.3E-17	2.9E-17	1.6E-14	1.0E-17	7.5E-18	3.0E-17
AMS-BKG	1.1E-15	2.5E-15	-8.1E-18	5.7E-15	1.5E-17	1.4E-17	-7.8E-19	3.0E-17	-6.3E-19	1.1E-17	-1.7E-17	1.2E-17	1.3E-14	9.8E-18	8.0E-18	3.1E-17
Overall	1.4E-15		-3.0E-17	1.5E-14	1.2E-17		1.5E-18	5.6E-17	1.6E-18		-4.9E-17	5.3E-17	1.45E-14		7.0E-18	4.3E-17

of 10^{-17} μCi/ml over the course of monitoring. Thorium-230 concentrations fluctuated between the orders of 10^{-17} and 10^{-18} μCi/ml. Radium-226 concentrations fluctuated between the orders of 10^{-17} and 10^{-18} μCi/ml. Finally, lead-210 concentrations at each location were on the order of 10^{-15} μCi/ml over the course of monitoring.

3.6.2.3 Conclusions

With the exception of natural uranium, the values determined above are similar to U.S. background concentrations reported in the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report to the General Assembly, Sources and Effects of Ionizing Radiation, Annex B. The regional concentrations reported in this reference document are: uranium-238 ($2.4*10^{-17}$ to $1.4*10^{-16}$ μCi/ml), thorium-230 ($1.6*10^{-17}$ μCi/ml), radium-226 ($1.6*10^{-17}$ μCi/ml), and lead-210 ($2.7*10^{-15}$ to $2.7*10^{-14}$ μCi/ml).

3.7 Vegetation

A detailed vegetation study report is included in Appendix 3.7-A. The following information is provided as a summary of the information in the full report. Plate 3.7-1 was developed using the information presented in Appendix 3.7-A.

3.7.1 Methodology

All vegetation sampling procedures were designed according to previous experience with similar projects and in collaboration with SDGF&P. Refer to Appendix 3.7-A for the detailed vegetation study report, including the submitted methodology.

Vegetation sampling was conducted by BKS. Initial surveys were conducted during July 2007, with supplemental sampling performed to adjust to subsequent changes in the proposed permit boundary.

Mapping

Seven different plant communities were identified for the proposed permit area, i.e., Big Sagebrush Shrubland (BS), Greasewood Shrubland (GW), Ponderosa Pine Woodland (PP), Upland Grassland (UG), Cottonwood Gallery (CG), Silver Sagebrush Shrubland (SS), and Agricultural Land (AG), using 2001 color infrared (CIR) aerial photography, which was verified by field survey. The Agricultural Land was not sampled as it was actively being used for crop production. The Silver Sagebrush Shrubland will be described as an inclusion of the Greasewood Shrubland Community.

Transect Origin Selection

The transects were randomly located in the field within each sampled vegetation community. Each transect was at least 150 feet from the previous transect. Random numbers between 1 and 360 were generated to determine cover transect direction, and compasses were utilized to orient transects to the nearest 1/8 of 360 degrees in the field. Each sample site was marked with a hand-held Garmin global positioning system (GPS), and these points were later plotted on the final vegetation survey map (Plate 3.7-1).

Cover

A sample size of 37 50-meter point-intercept cover transects were sampled within the Ponderosa Pine Woodland and Greasewood Shrubland communities, while 27 samples were taken in the Big Sagebrush Shrubland, 26 samples in the Cottonwood Gallery and 30 samples in the Upland Grassland community for a total of 157 cover points in the proposed permit area.

In the vegetation communities, each 50-meter transect represented a single sample point. Percent cover measurements were taken from point-intercepts at 1-meter intervals along a 50-meter transect. Transects that exceeded the boundaries of the vegetation community being sampled were redirected back into its vegetation community at a 90 degree angle from the original transect direction at the point of intercept. In instances where a 90 degree angle of reflection did not place the transect within the sampled community, a 45 degree angle of reflection was used. Each point-intercept represents 2 percent towards cover measurements.

Percent cover measurements record "first-hit" point-intercepts by live foliar vegetation species, litter, rock, or bare ground. Multiple hits on vegetation were recorded, but used only for the purpose of constructing a plant species list for each plant community (Appendix 3.7-A).

Total Vegetation Cover

Vegetation cover data were recorded by species, using first hit data. All point intercepts of living vegetation and growth produced during the current growing season were counted toward total vegetation cover. Total vegetation cover measurements were expressed in absolute percentages for each sample point. Percent vegetation cover is the vertical projection of the general outline of plants to the ground surface. Cover summaries for each vegetation community within the proposed permit area are contained in Appendix 3.7-A.

Total Ground Cover

Total ground cover data was recorded by live vegetation, litter, or rock, minus bare ground. Litter includes all organic material that is dead including manure. Rock fragments were recorded when equal to or greater than two centimeters in size (i.e., sheet flow, minimum non-erodible particle size). Total ground cover measurements were expressed in absolute percentages for each sample point. Total ground cover equals the sum of cover values for percent vegetation, percent litter, and percent rock.

Shrub Density

These data were taken at the time of cover sampling to ensure adequate use of field time. Shrub density data were collected in conjunction with randomly selected cover transects, wherever possible. All shrubs, full, half, or sub, were counted within 50 centimeters on either side of the 50 meter cover transect (1 meter x 50 meter belt transect), yielding a 100 m^2 belt transect. Sample adequacy was not calculated for shrub density. The number of belt transects equaled the number of cover transects for a given vegetation type.

Tree Density

Data were collected at the time of cover sampling to ensure adequate use of field time. Tree density data were collected in the Ponderosa Pine Woodland vegetation community in conjunction with randomly selected cover transects, wherever possible. Tree density in this community was determined using the point-center quarter method. Trees within the Cottonwood Gallery or Riparian areas were directly counted on an aerial photograph. Within other vegetation communities, individual *Pinus ponderosa* (Ponderosa Pine) or other tree species found were directly counted for numbers. Sample adequacy was not calculated on the point-center quarter plots.

Species Composition

A list of plant species encountered during 2007 quantitative sampling is compiled in Appendix 3.7-A by vegetation community type for each of the vegetation communities. The species list includes plant species sampled in cover transects as well as plant species observed along the belt transect. Plant names in the Rocky Mountain Vascular Plants of Wyoming (Dorn, 2001) were utilized. Plant identification was confirmed by Robert Dorn, when necessary. Scientific nomenclature followed that in use at the Rocky Mountain Herbarium in Laramie, Wyoming, during 2007.

3.7.2 Vegetation Survey Results and Discussion

The permit area comprises five main vegetative communities: Big Sagebrush Shrubland, Greasewood Shrubland, Upland Grassland, Ponderosa Pine Woodland, and Cottonwood Gallery. Minor vegetation communities also include: Agricultural Land, Disturbed Areas, Existing Mine Pits, Silver Sagebrush Shrubland, Water, and Shale Outcrop. Refer to Table 3.7-1 for acreage of each vegetation community within the permit area. Plate 3.7-1 provides the vegetation map for Dewey-Burdock Project.

3.7.3 Species of State and Federal Interest

No threatened or endangered species were encountered within the permit area. The presence of the South Dakota-designated weed Canada thistle was present within the Cottonwood Gallery vegetation community. The presence of the Fall River County-designated weed field bindweed was present within the Greasewood Shrubland vegetation community.

3.8 Wetlands

A detailed wetland study report for the 2007 assessment is included in Appendix 3.8-A. Note that Section 3.8.3 describes updates in 2008 due to a change in the proposed permit area. The following information is provided as a summary of the information in the full report. Plate 3.8-1 was developed using the information presented in Appendix 3.8-A.

3.8.1 Methodology

BKS Environmental Associates, Inc. (BKS), of Gillette, Wyoming, completed the baseline wetland inventory fieldwork. The wetland surveys were conducted in accordance with the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region. All Waters of the U.S. (WoUS) and Other Waters of the U.S. (OWUS) were assessed during the surveys. The routine wetland delineation approach with onsite inspection was utilized, and the survey was conducted by pedestrian reconnaissance and review of existing maps of the permit area. Identification of potential wetlands was based on visual assessment of vegetation and hydrology indicators, as well as intrusive soil sampling to determine the presence of wetland criteria indicators. Wetland Determination Data Forms-Great Plains Region (DRAFT), were utilized for each observation point. Hydrology and soils were evaluated whenever a plant community type met hydrophytic vegetation parameters based on the Dominance Test and Prevalence Index (as defined by the Great Plains Regional Supplement), or whenever indicators suggested the potential presence of a seasonal wetland area under normal circumstances.

Table 3.7-1: Vegetation Mapping Unit Acreage within Proposed Permit Area

Map Unit	Acreage	% of Area
Sampled Vegetation Communities		
Big Sagebrush Shrubland	2,501.56	23.70
Greasewood Shrubland	2,190.45	20.75
Ponderosa Pine Woodland	2,183.76	20.69
Upland Grassland	2,187.56	20.72
Cottonwood Gallery	240.60	2.28
Described Vegetation Communities		
Agricultural Land	780.79	7.40
Disturbed	14.70	0.14
Existing Mine Pit	326.99	3.10
Silver Sagebrush Shrubland	119.49	1.13
Shale Outcrop	2.19	0.02
Water	8.94	0.08
TOTAL	**10,557.03**	**100.0**

Natural Resources Conservation Service (NRCS) soils mapping for Custer and Fall River counties, South Dakota (2007) and BKS soil mapping of the permit area were reviewed for general soils information.

Potential wetlands (WoUS) and OWUS were initially identified via review of area maps to include the following:

- 1977 USFWS National Wetland Inventory (NWI) mapping for the Dewey, Burdock and Twenty-one Quads
- Custer Quad Digital Elevation Model
- Burdock Quad Digital Elevation Model

Wetland indicator categories were identified for each dominant plant species noted through use of the National List of Vascular Plant Species that Occur in Wetlands, 1996 National Summary. Region 4 (North Plains) indicator categories were utilized for the permit area.

Field sample locations and resulting wetland boundaries were recorded with a hand-held Garmin GPS map 60Cx GPS unit in NAD 1983 UTM Zone 13.

3.8.2 Wetland Assessment Results and Discussion

The permit area generally occurs on uplands, with inclusions of two main drainages, Beaver Creek and Pass Creek, and several depressed areas. Beaver Creek and Pass Creek were evaluated using pedestrian reconnaissance, while the remaining small drainages were evaluated based on existing mapping. Wetlands were identified throughout the Beaver Creek drainage; however, Pass Creek only had wetlands present near an old open flowing well close to the project boundary. Wetlands were also identified in the majority of the old mine pits as well as depressed areas. The wetland classification along Beaver Creek was Riverine Lower Perennial Emergent (R2EM) WoUS, while that in Pass Creek and other small drainages was Palustrine Emergent (PEM) WoUS. The mine pits were primarily designated as Palustrine Unconsolidated Bottom (PUB) OWUS and depressions were typically PEM or PUB designations.

Beaver Creek had water present continuously in the drainage and wetland species near the banks. The upper banks were comprised mainly of *Artemisia tridentata* (big sagebrush), *Sarcobatus vermiculatus* (Greasewood), and *Elymus smithii* (Western wheatgrass). The wetland indicator status of these plants are UPL (upland), UPL, and FACU (facultative upland), respectively. The entire stretch of Beaver Creek within the permit area is designated as a R2EM wetland. Pass Creek was comprised of the Cottonwood Gallery vegetation community comprised mainly of

Bromus inermis (smooth brome), Western wheatgrass, and *Populus deltoides* (cottonwood trees). The wetland indicator statuses of these plants are UPL, FACU, and FAC (facultative), respectively.

There were several NWI 1977 previously mapped wetlands that were confirmed as non-wetland or not present during the 2007 field survey. The areas generally lacked hydrophytic vegetation, hydric soils, and hydrology. Most areas had geomorphic position but often lacked another secondary indicator. Datasheets were filled out to confirm no presence of these wetlands and can be found in Appendix 3.8-A.

There are seven historical open mine pits present within the permit area. Four of the mine pits were classified as non-wetland primarily due to lack of hydrophytic vegetation and/or hydrology presence. Two mine pits located in Section 1, T7S, R1E were classified as PUB wetlands. The only mine pit in Section 2 was classified as both a PEM and Open Water (OW). The PEM is located along the bank of the pit and OW throughout the rest of the pit. The mine pit in Section 34, T6S, R1E was classified as OW, and another small mine pit located at waypoint 92 in Section 1, T7S, R1E was classified as OW.

All the depressional areas identified as wetlands in 2007 were also previously identified during the 1977 NWI mapping. All of these wetlands are recommended to be non-jurisdictional based on the isolated nature of the wetlands. The wetlands were primarily classified as PEM, PEMC, PABJh, PUS, PUSA and PUB wetlands based primarily on the hydrology conditions of each waypoint.

Appendix 3.8-B includes a U.S. Army Corps of Engineers jurisdictional determination for some of the potential wetland sites within the permit area. Final determination of jurisdictional decision for all sites lies within the U.S. Army Corps of Engineers.

3.8.3 2008 Wetland Assessment Update

The following describes updates made in 2008 to the 2007 wetland assessment that occurred due to a change in the proposed permit area. The 2007 and 2008 boundaries are depicted in Appendix 3.8-A.

<u>Beaver Creek Update</u>

Beaver Creek is likely to have wetlands throughout the entire permit area as it is a major drainage and had a good flow of water when the surveys were conducted in 2007. The boundary change took out 1.956 acres of R2EM wetlands along Beaver Creek in the NW1/4 of Section 31, T6S, R1E. The boundary change also added 4.81 acres of R2EM wetlands along Beaver Creek in the SE1/4 of Section 31, T6S, R1E and E1/2 of Section 5 and SW1/4 of Section 4, T7S R1E. The total acreage addition to the wetlands along Beaver Creek was 2.86 acres of R2EM.

Small PEM and PUB isolated wetlands may be found southwest of the Beaver Creek drainage in Section 5, T7S, R1E; however, accessibility to the area was not present to confirm. There are two depressions that can be seen on the map and based on the 2007 surveys the likelihood of either of the depressions being classified as a wetland is rare.

Pass Creek Update

In 2007, Pass Creek had 0.503 acre of PEM wetlands surveyed along its stretch; however due to the recent boundary change there are now only 0.05 acre of wetlands present on Pass Creek. The boundary change moved the boundary east of W22, and now excludes the three wetland points of W20, W21, and W22. The wetlands present on Pass Creek are primarily due to an old open flowing well on the other side of the road outside the permit boundary.

In 2007, Pass Creek was surveyed from the southern permit boundary to the old mine pit and no wetlands were identified except near the spring. No surveys were conducted on Pass Creek in 2008 as the map indicated that the area is likely dry.

Old Mine Pits

There were no changes in 2008 to the acreages identified in 2007 of old mine pits wetland occurrences.

Depressional Areas and Ponded Areas Identified as Wetlands

No changes were made in 2008 to the acreages on the 2007 depressional areas and ponded areas identified as wetlands. As noted above there may be some isolated PUB or PEM depressional areas southwest of Beaver Creek, but accessibility to the area was not present during the 2008 surveys. However, it is unlikely that the areas indicated contain wetlands as the 2007 surveys proved that many of the potential wetlands indicated on the map and NWI no longer existed.

3.9 Wildlife

A detailed wildlife study report is included in Appendix 3.9-A. The following information is provided as a summary of the information in the full report. Plate 3.9-1 was developed using the information presented in Appendix 3.9-A.

3.9.1 Methodology

Wildlife sampling was conducted by ICF Jones & Stokes (formerly Thunderbird Wildlife Consulting) of Gillette, Wyoming. Appendix 3.9-B contains a letter from SDGF&P approving ICF Jones & Stokes as the wildlife consultant. Background information on terrestrial vertebrate wildlife species and aquatic vertebrates and invertebrates in the vicinity of the permit area was obtained from several sources, including records from SDGF&P, BLM, USFWS, U.S. Forest Service (USFS), and the original Draft Environmental Statement (DES) prepared by TVA in 1979. Previous site-specific data for the permit area and surrounding perimeter were obtained from those same sources.

Current baseline wildlife information was collected from July 2007 through early August 2008 to meet agency requirements for one year of baseline data, and to accommodate changes to the permit area boundary during that period. The survey area included the entire permit area and a perimeter offset 1 mile from the permit area boundary for threatened and endangered (T&E) species, bald eagle winter roosts, all nesting raptors, upland game bird leks, and big game. Survey protocols and timing were developed collaboratively with SDGF&P to meet species-specific requirements. Surveys and documentation of occurrence conducted only in the permit area included other vertebrate species of concern tracked by the South Dakota Natural Heritage Program (SDNHP), as well as bats, small mammals, lagomorphs, prairie dog colonies, breeding birds, predators, and herptiles.

All surveys were conducted by qualified biologists using standard field equipment and appropriate field guides. Most terrestrial data were collected from vantage points during pedestrian or vehicular surveys to avoid disturbing wildlife; exceptions included breeding bird surveys and small mammal trapping. Raptor nests, prairie dog colonies, and other features or points of special interest were mapped in the field using a hand-held GPS receiver. Species were identified with the aid of field guides and other literature including, but not limited to, Robbins et al. (1966), Burt and Grossenheider (1976), Jones et al. (1983), Clark and Stromberg (1987), Peterson (1990), South Dakota Ornithological Union (1991), Baxter and Stone (1995), Stokes and Stokes (1996), and Kiesow (2006).

3.9.2 Wildlife Survey Results

Appendix 3.8-A lists all species that could potentially reside in the vicinity of the permit area or pass through during migration. Species actually observed in or adjacent to the permit area are noted. The appendix includes various tables listing sightings of targeted wildlife species, including those tracked by SDNHP, recorded in the vicinity of the permit area from July 2007 through August 2008. Appendix 3.8-A also includes representative photographs of the permit area and wildlife species observed and resumes for the IFC Jones & Stokes staff who conducted the surveys and prepared the baseline report. Following is a brief summary of the wildlife survey results. Refer to Section 3.10 for aquatic resources survey results.

Habitat Mapping

A general description of the location, extent, and characteristics of each habitat is described in Appendix 3.8-A.

Big Game

Pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are the only two big game species that regularly occur in the survey area, and both are considered year-round residents. The pronghorn is the most common big game species in the survey area, though no species is prevalent. Elk (*Cervus elaphus*) and white-tailed deer (*Odocoileus virginianus*) are also present in the survey area, but only in small herds. The latter two species can also be seen in the survey area year-round, but may be more common during certain seasons.

Small Mammals

Four species of small mammals were captured in September 2007: the deer mouse (*Peromyscus maniculatus*), olive-backed pocket mouse (*Perognathus fasciatus*), western harvest mouse (*Reithrodontomys megalotis*), and northern grasshopper mouse (*Onychomys leucogaster*). The deer mouse was by far the most abundant small mammal captured during the baseline study, representing approximately 95 percent of the total, and was the only species trapped in all habitats. Each of the three other species captured accounted for less than 3 percent.

Lagomorphs

Two lagomorph species were observed within the survey area during spotlight surveys conducted in 2007: the white-tailed jackrabbit (*Lepus townsendii)* and cottontail (*Sylvilagus* spp.). Cottontail abundance was twice that of jackrabbits, though neither count was especially high. Results from lagomorph surveys conducted in northeast Wyoming annually since 1984, and periodic surveys in northwestern South Dakota in recent years, indicate that the regional lagomorph population recently experience a downward trend in its regular cyclic pattern. Although no data are available from the permit area prior to 2007, its proximity to other regional survey areas and the low counts recorded during the baseline survey period suggest the survey area lagomorph population was in a similar low cycle at that time. Declines in the Wyoming population have been attributed to Tularemia, a disease known to infect lagomorph populations once they reach a certain threshold. It is possible that a similar disease event occurred recently in western South Dakota.

Other Mammals

A variety of small and medium-sized mammalian species have the potential to occur in the survey area, although not all were observed in the permit area itself during the baseline wildlife surveys. These potential species include a variety of common predators and furbearers such as the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), bobcat (*Lynx rufus*), badger (*Taxidea taxus*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*). Numerous prey species, including rodents (e.g., mice, rats, voles, gophers, ground squirrels, chipmunks, prairie dogs, etc.), can also be found in the survey area. These species are cyclically common and widespread throughout the region, and are important food sources for raptors and other predators. Each of these prey species, with the exception of chipmunks and rats, were either directly observed during the field surveys, or were known to exist through burrow formation or scat. Observations of small mammals occurred most often near Beaver Creek and Pass Creek, in the northwestern and central portions of the survey area, respectively.

One black-tailed prairie dog colony overlaps the northwestern corner of the permit area, and two others are present in the southwestern portion of the one-mile perimeter. Portions of all three colonies were unoccupied during the baseline survey period. Local ranchers use shooting and other control methods to reduce and/or eradicate prairie dogs from private surface in the permit area and on surrounding lands. Other mammalian species such as the striped skunk (*Mephitis mephitis*), porcupine (*Erethizon dorsatum*), and various weasels (*Mustela* spp.) could inhabit the survey area, but no sightings or confirmed scat were recorded for those species during the baseline surveys. Infrequent, incidental bat sightings (species unknown) occurred during nocturnal amphibian surveys and spotlighting efforts conducted at targeted ponds in the permit area during the baseline period.

Game Birds

The wild turkey (*Meleagris gallopavo*) and mourning dove (*Zenaida Macroura*) were the only upland game bird species observed in the survey area during baseline inventories conducted from July 2007 to August 2008. Both species are relatively common and occur in a variety of woodland and open habitats in the permit area. No sage-grouse were observed during the entire year-long baseline survey period. Limited potential habitat for this species is present in the general survey area, but only in small stands of sage surrounded by less suitable grasslands and pine breaks. Although sage-grouse were historically recorded in the general vicinity (TVA DES, 1979), no leks have been documented by agency biologists within 6 miles of the permit area in recent years.

Raptors

Raptor species observed during the baseline wildlife surveys included the bald eagle, red-tailed hawk (*Buteo jamaicensis*), golden eagle, northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), turkey vulture (*Cathartes aura*), Cooper's hawk (*Accipiter cooperii*), rough-legged hawk (*Buteo lagopus*), merlin (*Falco columbarius*), great horned owl, and long-eared owl (*Asio otus*). Other raptor species also could occur in the survey area, particularly as seasonal migrants, but were not seen during the 2007 and 2008 inventories. The bald eagle, red-tailed hawk, American kestrel, and northern harrier were the most commonly seen raptor species in the area. Raptor sightings for those species were recorded with regularity during all four seasons throughout the baseline survey period, though some of those species may leave the area under harsh winter conditions. Five confirmed, intact (i.e., material present) raptor nests and one potential nest site were located in the permit area and two additional nest sites (one confirmed and one potential) were recorded in the one-mile survey perimeter.

Breeding Birds

Thirty-four species were identified within the breeding bird transects during spring 2008. Two additional unknown species were logged during the surveys, with two other species recorded only while flying over the transects; those observations were not included in data analyses. The western meadowlark (*Sturnella neglecta*) was the most common species, followed by the mourning dove. The dove was the only species recorded in all six habitat types. The long-billed curlew (*Numenius americanus*) was the only observed species that is tracked by the SDNHP. Defensive behavior recorded during the transect surveys indicated that up to three pairs may have nested near the south-central edge of the permit area.

Reptiles

Lizards (species unknown) were often observed sunning themselves on rocks and on sandy soil in the summer months during all except the early morning hours. These sightings were widespread throughout the survey area, with observations increasing as the summer progressed and the days got hotter. The shed remains of a snakeskin were found in the north central portion of the survey perimeter in early May 2007. The skin was at the base of a rock outcrop and looked as though it may have belonged to a bullsnake (*Pituophis cantenifer*).

3.9.3 Species of State and Federal Interest

The USFWS issued a block-clearance for ferrets throughout most of South Dakota in recent years, including the survey area in extreme southwestern Custer County and northwestern Custer County. No ferrets or evidence of their presence were observed during historical TVA surveys, or during the recent survey period.

The USFWS removed (delisted) the bald eagle from protection under the ESA in July 2007, and the ruling became effective that August. However, this species is still considered as a state-listed threatened species in South Dakota. In addition, bald eagles continue to be protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act, as well as any applicable state regulations. Bald eagles were repeatedly observed along Beaver Creek in the western portion of the permit area and perimeter during winter roost surveys conducted in late 2007 and early 2008.

Prior to initiating field surveys, biologists reviewed the list of rare, threatened, or endangered vertebrate species tracked by the SDNHP that could occur as permanent or seasonal residents on or within 1 mile of the permit area, based on each species' range and the habitats present in that area. Appendix 3.8-A includes a summary of vertebrate SDNHP species that were recorded in or within 1 mile of the permit area.

Seven vertebrate sensitive species or species of local concern other than the bald eagle were documented with the permit area during the baseline survey period: the long-billed curlew, great blue heron, golden eagle, Cooper's hawk, merlin, American white pelican, and long-eared owl. The long-eared owl and curlew are known or are suspected to have nested in the permit area, based on evidence (young present) or persistent defensive behavior, respectively. The remaining five species were observed perched in or flying over the permit area only once or twice each. These seven species of special interest are considered as secure populations within their respective overall ranges, though one or more could be less common in parts of a given range, especially in the periphery. Likewise, all seven are considered to be either rare and local throughout their statewide ranges, or locally abundant in restricted portions of those ranges. One other vertebrate species of concern was documented at least once in the one-mile perimeter: the Clark's nutcracker.

3.10 Aquatic Resources

The aquatic resources study was included as a portion of the complete wildlife study, included in Appendix 3.9-A. The following information is provided as a summary of the information in the full report.

3.10.1 Methodology

Because Beaver Creek is the only perennial stream in the permit area, and is the receiving water for drainage from the portions of the permit area identified for proposed ISR activities, it was the focus of aquatic habitat monitoring efforts conducted for this project. Some sampling was also conducted in the Cheyenne River downstream of the permit area to obtain additional site data. Baseline aquatics monitoring was conducted at sites that were previously established as water quality monitoring stations on Beaver Creek and the Cheyenne River. Using these sites allowed for comparisons with past and ongoing water quality records. One site on Beaver Creek was located upstream (BVC04) of the permit boundary and the other was downstream (BVC01). Fish sampling for species, abundance, and radiological testing was conducted at both Beaver Creek sites, and at one site on the Cheyenne River downstream of the Beaver Creek confluence (CHR05). Refer to Figure 3.5-12 and Plate 5.5-1 for the locations of these monitoring sites.

Habitat, invertebrate, and fish sampling was conducted during spring (April) and summer (July) conditions in 2008. This timing was selected to capture seasonal differences, including high and base flow conditions. However, the late spring and early summer of 2008 were unusually wet and, as a result, the flow during both seasonal events was similar.

The habitat description and invertebrate collection efforts followed the DENR protocol. Eleven cross-section transects were established at equidistant intervals from the downstream end of each sample site. The longitudinal distance of each survey reach was established as the distance equal to 30 average channel widths as determined by 10 preliminary width measurements.

Fish sampling was conducted according to SDGF&P guidelines by blocking and seining a 100-meter survey reach downstream of each sample site. Due to obstacles in the stream, it was not feasible to seine an entire reach in one sweep, so three separate sweeps were made at a given sample site and fish were collected on shore at three locations within each 100-meter reach. All fish captured were identified, counted, measured, and weighed. Individuals that were less than 100 millimeters in length were combined for a composite weight by species.

Numerous fish were collected for radiological testing during each of the spring and summer flow sampling events. The initial target at each sample site was six individual fish, preferably from six different species. Since many of the specimens collected in April 2008 contained no detectable uranium, up to five individuals of each of six species were collected in July 2008 (when available) and processed for radiology. Live fish were bagged, frozen, and kept frozen until they were analyzed by Energy Laboratories, Inc. for radionuclides that included uranium, thorium-230, radium-226, lead-210, and polonium-210. These radionuclides were selected in accordance with NRC regulatory guidance.

Benthic macro-invertebrates were sampled using DENR and EPA protocols. Samples were collected using a modified D-frame kick net, with sample sites located 1 meter downstream of each of the 11 cross-section transects at an assigned sampling point. Habitat conditions were also recorded at each sample site. Benthic samples were strained to cull the sample before sample preservation and packing. Samples were sorted, classified and counted in a private laboratory in Laramie, Wyoming.

3.10.2 Aquatic Survey Results

<u>Amphibians and Aquatic Reptiles</u>

Three aquatic or semi-aquatic amphibian species and one aquatic reptile were recorded during the 2007 and 2008 surveys conducted in the permit area: the boreal chorus frog (*Pseudacris triseriata*), Woodhouse's toad (*Bufo woodhousei*), great-plains toad (*B. cognatus*), and western painted turtle (*Chrysemys picta*). All four species were heard and/or seen in Beaver Creek as it flows through the western portion of the permit area or near stock reservoirs.

<u>Benthic Invertebrates</u>

The total number of invertebrates and the number of species were extremely low at both Beaver Creek sites. *Ephemeroptera* (mayflies) and *plecoptera* (stoneflies) were absent from both sites, indicating an impaired condition. Most taxa collected were moderately tolerant taxa. One individual of a sensitive taxa, *Lepidostoma*, and one individual of a highly tolerant taxa, *Culiciodes*, were collected at the downstream site (BVC01) in April. All other taxa collected are considered moderately tolerant.

<u>Fish</u>

A total of 12 fish species were collected from the three sampling locations. The fathead minnow (*Pimephales promelas*) was the most abundant species at both Beaver Creek sites during April and July 2008. The creek chub (*Semotilus atromaculatus*) was the most abundant species at the

Cheyenne River site in April, and the sand shiner (*Notropis stramineus*) was the most common fish caught there in July.

The only species that contained detectable levels of uranium in April was the channel catfish, but all of the fish collected in July contained uranium due, in large part, to increased sample sizes. Polonium-210, thorium-230 and radium-226 were detectable, but low in most samples. Lead-210 was only detected in one plains killifish (*Fundulus zebrinus*) collected in April at site BVC01.

3.10.3 Species of State and Federal Interest

The plains topminnow (*Fundulus sciadicus)* was the only aquatic species of concern documented in the survey area. It was captured during fisheries sampling efforts in the Cheyenne River in April 2008 and at the downstream sample site along Beaver Creek in July. Each of these sites is beyond the permit area. A northern river otter (*Lontra Canadensis)* carcass was discovered at the upstream fisheries sampling point (BVC04) on Beaver Creek in April 2008. The cause of death was not apparent, and the carcass was gone by the July 2008 sampling period. Otters are listed as a threatened species by the State of South Dakota, and are tracked by the SDNHP.

3.11 Cultural Resources

3.11.1 Methodology

A Level III Cultural Resources Evaluation was conducted in the permit area. Personnel from the Archeology Laboratory, Augustana College (Augustana), Sioux Falls, South Dakota, Conducted on-the-ground field investigations between April 17 and August 3, 2007.

Augustana documented 161 previously unrecorded archaeological sites and revisited 29 previously recorded sites during the current investigation. Expansion of site boundaries during the 2007 survey resulted in a number of previously recorded sites being combined into a single, larger site. Twenty-eight previously recorded sites were not relocated during the current investigation. Excepting a small foundation, the sites not relocated were previously documented as either prehistoric isolated finds or diffuse prehistoric artifact scatters.

3.11.2 Results and Discussion

The cultural resources evaluation is provided in Appendix 3.11-A. This appendix is being submitted as confidential information in accordance with SDCL 45-6B-19. The cover sheet for Appendix 3.11-A has been marked confidential. Following is a summary of the results of the cultural resources evaluation.

Approximately 87 percent of the total number of sites recorded are prehistoric. Historic sites comprise approximately 5 percent of total sites recorded, while multi-component (prehistoric/historic) sites comprise the remaining 8 percent.

The small number of Euro American sites documented was not unanticipated given the peripheral nature of the permit area in relation to the Black Hill proper. The disparity existing between the number of historic and prehistoric sites observed in the permit area is also not unexpected; however, the sheer volume of sites documented in the area is noteworthy. The land evaluated as part of the Level III cultural resources evaluation has an average site density of approximately one site per 48.8 acres. Even greater site densities were reported in 2000 during the investigation of immediately adjacent land parcels for the Dacotah Cement/BLM land exchange (Winham et al., 2001). This indicates that the permit area is not unique, in regard to the number of documented sites, and is typical of the periphery of the Black Hills.

The high density of sites observed in the permit area, specifically those of prehistoric affiliation, is both consistent with previous findings in the immediate vicinity (Winham et al., 2001) and strongly indicative of the intense degree to which this landscape was being exploited during prehistoric times. Data indicate a slight rise in the number of sites observed from earlier periods into the Middle Plains Archaic, and then a major increase into the Late Plains Archaic/Plains Woodland period before an equally significant drop-off into Late Prehistoric times. In general, this trend is largely consistent with the majority of available paleodemographic data from the region (Rom et al., 1996). Despite the high density of sites within the permit area, there is a lack of evidence indicative of extended or long-term settlement localities in the region. Though the reason behind this phenomenon remains unclear, the bulk of preliminary data from the current investigation appear to mirror this trend.

The landscape comprising the permit area is erosional in nature, leading to many sites being heavily deflated. The extend of the erosion processes is evidenced by the large number of sites recommended by Augustana as not eligible for listing on the National Register of Historic Places because of their location on deflated landforms. This equates to approximately half of the total number of identified sites in the permit area. Notable exceptions to these deflated localities include the valleys and terraces along Beaver and Pass Creeks, as well as many places within and adjacent to some of the more heavily wooded areas.

Nearly 200 hearths were identified within 24 separate sites areas during Augustana's investigation. These features varied considerably from one another in both size and form (and likely function in many cases) and ranged from fully intact to completely eroded. Previous research in the nearby area has demonstrated a similar pervasiveness of such features in the archaeological record (Buechler, 1999; Lippincott 1983; Reher, 1981; Sundstrom, 1999; Winham et al., 2001), and specifically in relation to Plains Archaic-period site assemblages (Rom et al., 1996). Radiocarbon data obtained from a number of these hearths produced dates ranging from approximately 3,150-1,175 before present (B.P.) (UGa-4080 and Uga-4081), with the majority of these samples dating to Middle and Late Plains Archaic times (Reher, 1981).

3.11.3 Procedures to Avoid or Mitigate Potential Impacts

Powertech (USA) will administer a historic and cultural resources inventory before engaging in any development activity not previously assessed by NRC or any cooperating agency. Any disturbances to be associated with such development will be addressed in compliance with the National Historic Preservation Act (NHPA), the Archeological Resources Protection Act, and their implementing regulations. Any disturbances also will be addressed in compliance with Powertech (USA)'s Memorandum of Agreement (MOA) with the South Dakota State Archeologist and any future MOAs developed by Powertech (USA) or NRC under the NHPA. Powertech (USA) executed the MOA with the South Dakota State Archeologist in September 2008. The MOA, which is provided as Appendix 3.11-B, establishes procedures to avoid or mitigate potential effects on archaeological and historic sites pursuant to SDCL 45-6D-14 and 45-6B.

Powertech (USA) will immediately cease any work resulting in the discovery of previously unknown cultural artifacts to ensure that no unapproved disturbance occurs. Powertech (USA) will notify appropriate authorities per any license conditions and will not go forward without appropriate approvals from NRC or other agencies as appropriate. Any such artifacts will be inventoried and evaluated, and no further disturbance will occur until authorization to proceed has been received. Powertech (USA) recognizes that the NHPA environment is not static, but rather is ongoing up to and through final NRC license termination and LSM permit termination.

3.12 Noise

This section describes the background noise sources within the permit area. Existing noise sources within the permit area include county and local road traffic, livestock operations, crop production, the BNSF railroad, and wind. As described in Section 3.1.2, the predominant land use within the permit area is agricultural production related to grazing (rangeland). Other land uses include hay production and recreation (primarily large game hunting). The nearest noise receptors are five residences within the permit area.

Due to the remoteness of the permit area, low population density of the surrounding area, and lack of noise generated from the primary land use of rangeland, existing noise levels are generally low. The majority of the existing ambient noise in the vicinity is generated from wind, the railroad, and traffic on county roads. Local residents use tractors, trailers, and pickup trucks when hauling livestock.

Noise standards and sound measurement equipment have been designed to account for the sensitivity of human hearing to different frequencies. The unit of measure used to represent sound pressure levels (decibels) using the A-weighted scale is a dBA (A-weighted decibel). It is a measure designed to simulate human hearing by placing less emphasis on lower frequency noise because the human ear does not perceive sounds at low frequency in the same manner as sounds at higher frequencies. Figure 3.12-1 and Tables 3.12-1 and 3.12-2 present noise levels associated with some commonly heard sounds. Table 3.12-1 presents typical noise levels from vehicles at a distance of 45 feet and speeds ranging from 50 to 75 mph. Assuming vehicles travel at 45 mph, the noise levels at 45 feet due to traffic generally should not exceed 79 dBA. The actual traffic noise levels at nearby residences would likely be much lower since residences are much more than 45 feet from county roads. The minimum distance between a residence and the primary county road in the permit area (S. Dewey Road is 3,700 feet). Noise levels from point sources decrease by about 6 dBA for each doubling of distance. Therefore, the maximum anticipated noise from a heavy truck traveling along the S. Dewey Road at a residence with the permit area is about 41 dBA.

The noise from the railroad is a result of the locomotive engine, wheel/rail interaction, and horn noise. Horn noise is a noise source at grade crossings where horns sounding are required by law for safety purposes. All these noises diminish with distance. The frequency of freight trains passing through the permit area on the BNSF railroad was reported by the local Edgemont Train Master to be 50 per day. The hourly rate is variable. The noise levels typically reported for a freight train traveling at approximately 50 mph on grade from a distance of 50 feet is approximately 80 dBA, with a range from about 55 to 90 dBA, depending on a number of factors, including condition and type of track, length of train, number of engines, condition of engines, speed, grade, etc. (Surface Transportation Board, CN-Control-EJ&E DEIS, Appendix L, 2008 and Surface Transportation Board, Alaska Railroad – Northern Rail Extension DEIS,

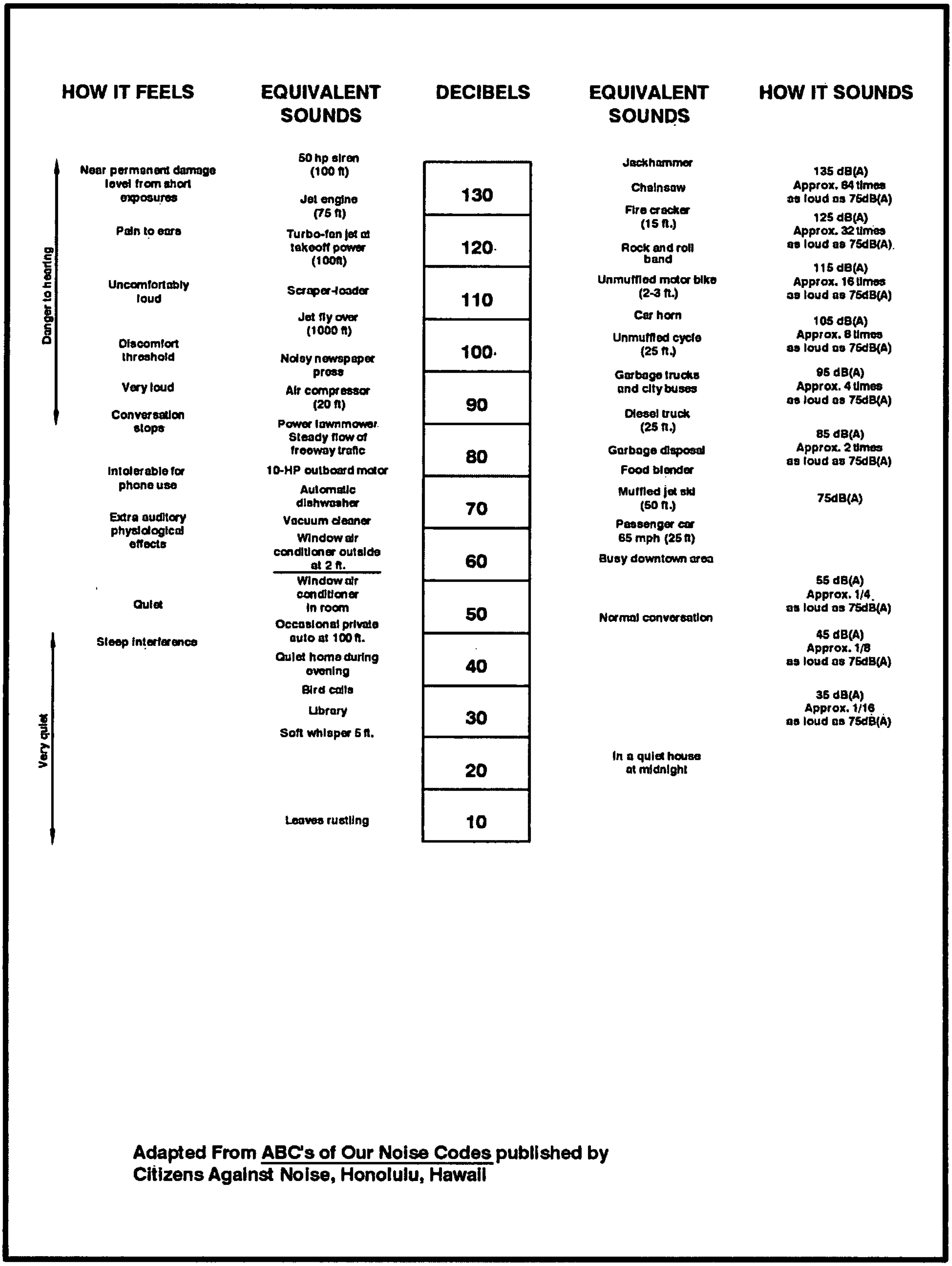


Figure 3.12-1: Relationship Between A-Scale Decibel Readings and Sounds of Daily Life

Table 3.12-1. Typical Vehicle Noise Levels

Speed (mph)	Noise Level at 45 ft (A-Weighted Decibels, dBA)		
	Automobiles	Medium Trucks	Heavy Trucks
45*	61	73	79
50	62	74	80
55	64	76	81
60	65	77	82
65	67	78	83
70	68	79	84

Notes: Automobiles: All vehicles with two axles and four wheels
Medium Trucks: All vehicles with two axles and six wheels
Heavy Trucks: All vehicles with three or more axles
*Noise levels for 45 mph were extrapolated
Source: DOT (1995)

Table 3.12-2: Comparative Examples of Noise Sources, Decibels and their Effects

Noise Source	Decibel Level	Decibel Effect
Jet take-off (at 25 meters)	150	Eardrum rupture
Aircraft carrier deck	140	
Military jet aircraft take-off from aircraft carrier with afterburner at 50 ft (130 dB).	130	
Thunderclap, chain saw. Oxygen torch (121 dB)	120	Painful, 32 times as loud as 70 dB.
Steel mill, suto horn at 1 meter. Turbo-fan aircraft at takeoff power at 200 ft (118 dB). Riveting machine (110 dB); live rock music (108 – 114 dB).	110	Average human pain threshold. 16 times as loud as 70 dB.
Jet take-off (at 305 meters), use of outboard motor, power lawn mower, motorcycle, farm tractor, jackhammer, garbage truck. Boeing 707 of DC-8 aircraft at one nautical mile (6080 ft) before landing (106 dB); jet flyover at 1000 feet (103 dB); Bell J-2A helicopter at 100 ft (100 dB).	100	8 times as loud as 70 dB. Serious damage possible in 8 hr exposure.
Boeing 737 or DC-9 aircraft at one nautical mile (6080 ft) before landing (97 dB); power mower (96 dB); motorcycle at 25 ft (90 dB). Newspaper press (97dB).	90	4 times as loud as 70 dB. Likely damage 8 hr exposure.
Garbage disposal, dishwasher, average factory, freight train (at 15 meters). Car wash at 20 ft (89 dB); propeller plane flyover at 1000 ft (88 dB); diesel truck 40 mph at 50 ft (84 dB); diesel train at 45 mph at 100 ft (83 dB). Food blender (88 dB); milling machine (85 dB); garbage disposal (80 dB).	80	2 times as loud as 70 dB. Possible damage in 8 hr exposure.
Passenger car at 65 mph at 25 ft (77 dB); freeway at 50 ft from pavement edge 10 a.m. (76 dB). Living room music (76 dB); radio or TV-audio, vacuum cleaner (70 dB).	70	Arbitrary base of comparison. Upper 70s are annoyingly loud to some people.
Conversation in restaurant, office, background music, air conditioning unit at 100 ft	60	Half as loud as 70 dB. Fairly quiet.
Quiet suburb, conversation at home. Large electrical transformers at 100 ft	50	One-fourth as loud as 70 dB.
Library, bird calls (44 dB); lowest limit of urban ambient sound	40	One-eighth as loud as 70 dB.
Quiet rural area	30	One-sixteenth as loud as 70 dB. Very quiet.
Whisper, rustling leaves	20	
Breathing	10	Barely audible

Table modified from http://www.wenet.net/~hpb/dblevels.html] on 2/2000.
SOURCES: Temple University Department of Civil/Environmental Engineering (www.temple.edu/departments/CETP/environ10.html), and Federal Agency Review of Selected Airport Noise Analysis Issues, Federal Interagency Committee on Noise (August 1992). Source of the information is attributed to Outdoor Noise and the Metropolitan Environment, M.C. Branch et al., Department of City Planning, City of Los Angeles, 1970.

Appendix J, 2008). A train's horn, dictated by the Federal Railroad Administration Train Horn Rule, is between 96 and 110 dBA for 15 to 20 seconds at railroad crossings.

Under the authority of the Noise Control Act of 1972, EPA identifies a 24-hour exposure level of 70 dBA as the level of environmental noise which will not cause any measureable hearing loss over a lifetime. A level of 55 dBA outdoors is identified as preventing activity interference and annoyance. People generally have a lower tolerance to noise at night when they are trying to sleep. Therefore 10 dBA is added to nighttime readings before an overall calculation of 24-hour equivalent sound level is made. Outdoor day-night sound levels in rural wilderness areas range from 20 dBA to 30 dBA (EPA, 1974). Given the moderately windy conditions in the permit area, the typical baseline noise levels are anticipated to range from 30 to 40 dBA, with higher levels present near the county road and BNSF railroad.

3.13 Visual Assessment

Visual and scenic resources consist of the visible natural (e.g., landforms and vegetation) and cultural components (e.g., roads and buildings) of the environment. Important visual resources can be landscapes that have unusual or intrinsic value, or areas with human or cultural influences that are valued for their visual or scenic setting. The BLM's Visual Resource Management (VRM) system is an attempt to assess and classify landscapes in order to properly manage their visual and scenic resources (BLM, 1984).

3.13.1 Methodology

In order to determine the VRM class of the landscape within the permit area and the surrounding 2-mile area, these areas were rated in accordance with BLM Manual 8400 – Visual Resource Management. The visual resource inventory classes are used to develop VRM classes. The following VRM classes are objectives that quantify the acceptable levels of disturbance for each class.

- Class I Objectives – To preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.
- Class II Objectives – To retain the existing character of the landscape. This level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

- Class III Objectives – To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
- Class IV Objectives – To provide management activities which require major modifications of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer's attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

According to the scenic quality inventory conducted in June 2008, which rated scenic quality, sensitivity level, and distance zones, the area was classified as a VRM Class IV. The objective of this class is to provide management for activities that might require major modifications of the existing character of the landscape. The level of change permitted for this class can be high. Table 3.13-1 was used to determine the visual resource inventory class.

3.13.2 Visual Resource Management Rating

In order to determine the scenic quality rating of the permit area and the surrounding 2-mile area, a visual resource inventory was conducted in accordance with the BLM Handbook H-8410-1, Visual Resource Inventory (BLM, 1986). A visual resource inventory was conducted for each of the Scenic Quality Rating Units (SQRU) – areas that demonstrated similar physiographic characteristics – in the area.

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 given 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. These key factors are rated according to form, line, color, texture, scale and space on a comparative scale from zero to five taking into consideration similar features within the same physiographic province. The results of the inventory and the associated rating for each key factor are summarized in Table 3.13-2 and Table 3.13-3.

Sensitivity Level – Sensitivity levels are a measure of the public's concern for scenic quality. Public lands are assigned high, medium, or low sensitivity levels by considering the following factors: type of users, amount of use, public interest, adjacent land use, and special areas.

Table 3.13-1: BLM Visual Resource Inventory Classes

<table>
<tr><td colspan="2" rowspan="2"></td><th colspan="7">Visual Sensitivity Levels</th></tr>
<tr><th colspan="3">High</th><th colspan="3">Medium</th><th>Low</th></tr>
<tr><td>Special Area</td><td></td><td>I</td><td>I</td><td>I</td><td>I</td><td>I</td><td>I</td><td>I</td></tr>
<tr><td rowspan="6">Scenic Quality</td><td>A</td><td>II</td><td>II</td><td>II</td><td>II</td><td>II</td><td>II</td><td>II</td></tr>
<tr><td rowspan="2">B</td><td rowspan="2">II</td><td rowspan="2">III</td><td>III*</td><td rowspan="2">III</td><td rowspan="2">IV</td><td rowspan="2">IV</td><td rowspan="2">IV</td></tr>
<tr><td>IV*</td></tr>
<tr><td>C</td><td></td><td>IV</td><td>IV</td><td>IV</td><td>IV</td><td>IV</td><td>IV</td></tr>
<tr><td></td><td>f/m</td><td>b</td><td>s/s</td><td>f/m</td><td>b</td><td>s/s</td><td>s/s</td></tr>
<tr><td></td><td colspan="7">Distance Zones</td></tr>
</table>

Source: BLM (1986)
* If adjacent area is Class III or lower, assign Class III, if higher assign Class IV
f/m = foreground–middleground
b = background
ss = seldom seen

Table 3.13-2: Scenic Quality Inventory and Evaluation of the SQRU 001 for the Permit Area

Key Factor	Rating Criteria	Score
Landform	Flat to rolling plains with weathered plateaus in the background	3
Vegetation	Vegetation is dominated by several variety of grasses and shrubs with some wildflowers and cottonwood trees	3
Water	Water is present but not visible from the road and view points	0
Color	Soil is light brown to brown and vegetation is tan to light green and dark green	3
Adjacent Scenery	The area borders the forested Black Hills Uplift	1
Scarcity	Landscape is common for the region	1
Cultural Modifications	Existing modifications consist of a gravel road and railway and grazing activities	0
Total Score		11

Table 3.13-3: Scenic Quality Inventory and Evaluation of the SQRU 002 for the Permit Area

Key Factor	Rating Criteria	Score
Landform	Flat to rolling plains with hills covered by evergreen forests	3
Vegetation	Vegetation is dominated by several variety of grasses and shrubs with some wildflowers and cottonwood trees and evergreen forest	3
Water	Water is present but not visible from the road and view points	0
Color	Soil is light brown to brown and vegetation is tan to light green and dark green	3
Adjacent Scenery	The area borders the forested Black Hills Uplift	1
Scarcity	Landscape of the Black Hills Uplift is uncommon with the physiographic province of the Great Plains	3
Cultural Modifications	Existing modifications consist of a gravel road and railway and grazing activities	0
Total Score		13

Distance Zones – Distance zones categorize areas according to their visibility from travel routes or observation points. The three categories are foreground-middleground, background and seldom seen.

- Foreground-Middleground Zone – The area that can be seen from each travel route from a distance of 3 to 5 miles where management activities might be viewed in detail. The outer boundary of this distance zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape.
- Background – The area that can be seen from each travel route up to a distance of 15 miles and that extend beyond the foreground-middleground zone.
- Seldom Seen – The areas that are not visible within the foreground-middleground and background zones or areas beyond the background zones.

3.14 Baseline Radiologic Characteristics

Appendix 3.14-A provides baseline radiological data for surface soils (0-5 and 0-15 cm), subsurface soils to a depth of 1 meter, vegetation, locally grazed cattle, direct radiation, radon-222 in air, and radon-222 flux rates representative of the project property. The work was performed by Environmental Restoration Group (ERG) between August 2007 and July 2008.

4.0 SOCIOECONOMIC ASSESSMENT

A socioeconomic assessment was prepared in 2008 using 2000 Census data, population and demographic estimates from 2006, and revenue estimates from 2007. The results of the assessment are included in Appendix 4.0-A.

5.0 MINE PLAN

The regulation of ISR uranium extraction falls under the jurisdiction of several State and Federal agencies. Table 5.0-1 provides an overview of the agencies and their regulatory authority, and Table 5.0-2 describes the jurisdictional primacy for various media or environmental issues. The mine plan describes all aspects of facility design, construction, operation, and monitoring to demonstrate that potential environmental impacts will be minimized. Abbreviated discussions are provided for areas not specifically regulated by DENR (e.g., radiological effluent control systems), while much greater detail is provided for areas for which DENR has primary or joint jurisdictional primacy, including pond design, access roads, diversions, and sediment control. The designs for these aspects have been advanced beyond what has been submitted in previous license or permit applications. Table 5.0-3 provides the proposed regulatory primacy for the mine plan, including facility design, construction, operation, and monitoring.

5.1 General Mine Planning and Design

The Dewey-Burdock Project will implement a phased approach, consisting of a series of sequentially delineated and developed well fields, a satellite ion exchange (IX) facility (Satellite Facility) at the Dewey portion of the permit area and a central processing plant (CPP) and associated facilities to recover and process the final uranium product. Following is a description of the ore body geology, chemistry of ISR uranium extraction, and operational overview.

5.1.1 Overview of Operations

The Dewey-Burdock Project will implement *in situ* recovery (ISR) methods for uranium extraction using a Satellite Facility and associated well fields within the Dewey portion of the permit area and a CPP and associated well fields within the Burdock portion of the permit area. The CPP will be used to produce the final uranium product (yellowcake or U_3O_8).

Uranium will be recovered by injecting lixiviant fortified with oxygen and carbon dioxide (barren lixiviant) into injection wells and recovering the resulting solution (pregnant lixiviant) from production wells. The uranium will be recovered from solution in ion exchange (IX) vessels in the Satellite Facility or CPP. The CPP will include elution, precipitation, drying and packaging systems to recover the yellowcake. If it is determined that vanadium will be recovered, modifications to the facilities will be made to accommodate vanadium recovery, drying and packaging. Prior to making any modifications to recover vanadium, Powertech (USA) will provide DENR with descriptions of the updated processes and facilities.

Table 5.0-1: Uranium ISR Permitting in South Dakota

Agency	Pertinent Area of Regulatory Authority	Statutory Authority
NRC	Public health and safety, environmental protection; primary focus is radiation protection in all media and safeguarding materials and facilities for national security	Atomic Energy Act of 1954, as amended (Regs in CFR Title 10)
EPA	Water quality (UIC & NPDES), air quality (NAAQS & NESHAPS)	Environmental Protection Act, Safe Drinking Water Act, Clean Air Act, Clean Water Act (Regs in CFR Title 40)
BLM	Federal land and resource management (MOU with NRC)	Federal Land Policy and Management Act of 1976 (Regs in CFR Title 43)
DENR	Promote and encourage development of mineral resources, prevent the waste and spoilage of the land, ensure the health and safety of the public, provide for usable and productive post-mining land use; water rights; groundwater discharge permits; air quality permitting; NPDES permitting; public water supply system permitting.	Mined Land Reclamation Act; SDCL 45-6B (Regs in ARSD Title 74, primarily 74:29, 74:02, 74:03, 74:27, 74:28, 74:36 & 74:54)
DOT	Transportation of radiological and nonradiological materials	Federal-Aid Road Act of 1916 and the Federal Highway Act of 1921 (Regs in CFR Title 49)
OSHA	Occupational safety and health (MOU with NRC)	Occupational Safety & Health Act of 1970 (Regs in CFR Title 29)
ACHP & SD SHPO	Cultural & historic resource protection	National Historic Preservation Act (NHPA) (Regs in CFR Title 36)

Table 5.0-2: Regulatory Primacy

Media or Environmental Issue (from ISR GEIS, NRC, 2009)	Regulatory Agency (in order of perceived jurisdictional primacy)
Land Use	NRC, DENR, BLM
Transportation	NRC, DOT
Geology	NRC, EPA, BLM, DENR
Water Resources	NRC, DENR, EPA, BLM
Ecology	NRC, DENR, BLM
Meteorology, Climatology & Air Quality	NRC, EPA, DENR, BLM
Noise	NRC, OSHA, DENR, BLM
Historic and Cultural Resources	NRC, BLM, SHPO, DENR
Visual Resources	NRC, BLM, DENR
Socioeconomics	NRC, DENR, BLM
Public and Occupational Health	NRC, OSHA, BLM, EPA, DENR
Waste Management	NRC, DENR, BLM
Decontamination, Decommissioning, Reclamation	NRC, DENR, EPA, BLM
Accidents	NRC, OHSA, BLM, DOT, DENR
Environmental Justice	NRC, BLM, EPA
Cumulative Impacts	NRC, BLM, DENR, EPA
Monitoring	NRC, DENR, BLM
Financial Assurance	NRC, DENR, EPA, BLM

Notes:

1) NRC is the lead federal agency and is primarily responsible for licensing the construction, operation and closure of the ISR project. NRC is the primary enforcement regulator.
2) BLM is a cooperating agency with NRC for the NEPA review and is responsible for the issuance of an approved "Plan of Operations."
3) EPA has permitting authority for the UIC Class V and Class III permits dealing with underground injection of liquid wastes and lixiviant for the recovery of uranium. EPA also is attempting to require air quality permit for radon releases from impoundments.
4) DENR - Chief Engineer is responsible for issuing water rights. DENR – Water Quality is responsible for approving the Groundwater Discharge Plan and NPDES permit for releases to surface water. DENR - Minerals and Mining is responsible for issuing a permit to mine.
5) Considering the implications of the 2011 South Dakota Legislature's Senate Bill 158 that tolled the regulations promulgated for ISR operations, DENR regulations may not be duplicative of either NRC's or EPA's regulations that apply to ISR operations. However, since the authority to mine in South Dakota still resides with DENR and the contents of an acceptable application are still listed in SDCL 45-6B, Powertech (USA) suggests that complying with the application content requirements is necessary and appropriate, considering the intent of SB 158.

Table 5.0-3: Anticipated Regulatory Primacy for Facility Design, Construction, Operation and Monitoring

Mine Plan Section	Description	Regulatory Agency (in order of perceived jurisdictional primacy)
5.3.1	CPP equipment and chemical storage facilities	NRC, OSHA
5.3.2	Satellite Facility equipment and chemical storage facilities	NRC, OSHA
5.3.3.1	Well field design	NRC
5.3.3.2	Well construction and integrity testing	NRC, DENR, EPA
5.3.3.3	Pump testing	NRC
5.3.3.4	Well field hydrogeologic data packages	NRC, EPA
5.3.3.5	Well field operation	NRC, EPA
5.3.3.6	Approach to well field development with respect to partially saturated conditions	NRC
5.3.3.6	Approach to well field development with respect to historical mine workings	NRC
5.3.3.6	Approach to well field development with respect to alluvium	NRC
5.3.4	Ponds	NRC, DENR
5.3.5	Instrumentation	NRC
5.3.6	Backup power	NRC
5.3.7	Topsoil handling	DENR, NRC, BLM
5.3.8	Roads	DENR, BLM
5.3.9	Water management and erosion control	DENR, NRC, BLM
5.4.1	Waste management - AEA-regulated waste	NRC
5.4.2	Waste management - non-AEA-regulated waste	DENR, EPA, NRC
5.5.1	Well field monitoring	NRC, EPA
5.5.2	Operational groundwater monitoring	NRC, DENR
5.5.3	Operational surface water monitoring	NRC, DENR
5.5.4	Land application effluent monitoring	DENR, NRC
5.5.5	Flow and pressure monitoring	NRC, EPA
5.5.6	Soil sampling	NRC, DENR
5.5.7	Vegetation sampling	NRC, DENR
5.5.8	Livestock and fish sampling	NRC, DENR
5.5.9	Air monitoring	NRC, DENR
5.6	Potential Impacts and Mitigation	NRC, DENR, BLM
5.7	Operations	NRC
5.7.2.6	Reporting	NRC, DENR, EPA

Aquifer restoration, or groundwater restoration, will be completed following uranium recovery in each well field. During aquifer restoration, the groundwater in the well field will be restored in accordance with NRC requirements. The primary goal of aquifer restoration will be to restore the groundwater to baseline (background) quality or an EPA-established maximum contaminant level (MCL), whichever is higher.

The vast majority of water withdrawn from the production wells will be reinjected as part of the ISR process, such that the net withdrawal rate will be only a small fraction of the gross pumping rate. A small portion of the production and restoration streams will not be reinjected in order to maintain an inward hydraulic gradient within each well field. This is referred to as the production or restoration bleed. The production and restoration bleed will be disposed using one of the two wastewater disposal options.

The preferred wastewater disposal option is underground injection of treated liquid waste in Class V deep disposal wells (DDWs). In this disposal option wastewater will be treated to meet EPA non-hazardous waste requirements and injected into the Minnelusa and/or Deadwood formations in four to eight DDWs being permitted pursuant to the Safe Drinking Water Act through the EPA UIC Program. It is anticipated that all wastewater resulting from ISR operations will be disposed using this option if sufficient capacity is available in DDWs.

The alternate wastewater disposal option is land application. This option involves treatment in lined radium settling ponds followed by seasonal application of treated wastewater through center pivot sprinklers. Land application would be carried out under a groundwater discharge plan (GDP), which is currently being permitted through DENR. Depending on the availability and capacity of DDWs, Powertech (USA) may use land application in conjunction with DDWs or by itself.

Solid wastes such as pond sludge; soils contaminated by spills or leaks; spills of loaded or spent IX resin; filter sand or other process media; and parts, equipment, debris (e.g., pipe fittings and hardware) and PPE that cannot be decontaminated for unrestricted release are considered AEA-regulated wastes and will be disposed at an NRC or NRC agreement state-licensed facility in accordance with NRC license requirements.

Monitoring systems will be implemented to minimize potential impacts to the environment and public health. These include extensive groundwater monitoring, including establishing a perimeter monitor well ring around each well field and monitoring overlying and underlying water-bearing intervals to identify any unintended movement of ISR solutions. It also includes instrumentation and control systems to rapidly detect any potential pipeline leaks or spills.

Section 6 describes the reclamation plan that will be implemented to restore groundwater, remove equipment, reclaim disturbed areas, and ensure that the permit area meets all postmining land uses following ISR activities.

5.1.2 Ore Body Geology

Uranium will be recovered from the Fall River Formation and Chilson Member of the Lakota Formation. Section 3.2 provides a detailed discussion on the regional geology, site geology, and ore mineralogy. The uranium mineralization targeted for ISR is found within fully saturated portions of the Fall River and Chilson, with overlying and underlying geologic confinement, making the project well suited for ISR uranium extraction. After LSM permit/NRC license issuance but prior to well field development, Powertech (USA) will conduct delineation drilling to fully characterize the geology of each well field (refer to Section 5.3.3.3).

5.1.3 Chemistry of Uranium ISR

The ISR process involves the oxidation and solubilization of uranium from its reduced state using a leaching solution (lixiviant). The lixiviant will consist of groundwater fortified with gaseous oxygen added to oxidize the solid-phase uranium to a soluble valence state and gaseous carbon dioxide added to form a complex with the soluble uranium ions so they remain in solution as they are transported through the ore body. As described in NRC guidance document NUREG-1569 (NRC, 2003), this lixiviant formulation will minimize potential groundwater quality impacts during uranium recovery and enable restoration goals to be achieved in a timely manner.

The chemistry of uranium oxidation and dissolution is described with the following equations:

Oxidation: $UO_2\text{ (solid)} + \frac{1}{2}O_2\text{ (in solution)} \rightarrow UO_3\text{ (at solid surface)}$

Dissolution: $UO_3 + 2\,HCO_3^- \rightarrow UO_2(CO_3)_2^{2-} + H_2O$

$UO_3 + CO_3^{2-} + 2HCO_3^- \rightarrow UO_2(CO_3)_3^{4-} + H_2O$

The principal uranyl carbonate ions formed as shown above are uranyl dicarbonate, $UO_2(CO_3)_2^{2-}$ [i.e., UDC], and uranyl tricarbonate, $UO_2(CO_3)_3^{4-}$ [i.e., UTC]. The relative abundance of each is a function of pH and total carbonate strength.

Once solubilized, the uranium-bearing groundwater will be pumped by submersible pumps in the production wells to the surface, where it will be ionically bonded onto IX resin. After the uranium is removed, the groundwater will be fortified with oxygen and carbon dioxide, recirculated and reinjected via the injection wells. When the IX resin is loaded with uranium, the loaded resin will be transferred to an elution (stripping) column, where the uranium will be eluted (stripped) from the resin using a saltwater solution. The resulting barren resin then will be recycled to recover more uranium. The saltwater eluate solution will be pumped to a precipitation process, where the uranium will be precipitated as a yellow, solid uranium oxide (yellowcake or U_3O_8). The precipitated uranium oxide then will be filtered, washed, dried and packaged in sealed containers for shipment for further processing to be used in the uranium fuel cycle. The chemistry of the IX process, elution, and precipitation is described in Section 5.3.1.1.

5.2 Schedule

Following the issuance of an NRC uranium recovery license, DENR LSM permit, and other relevant permits, it is anticipated that construction will commence on the first Burdock well field, CPP and ancillary facilities including storage ponds and land application pivots and/or deep disposal wells. It is anticipated that construction of the first Dewey well field and ancillary facilities will occur at the same time or follow shortly thereafter. Alternately, Powertech (USA) may develop either the Burdock or Dewey area well fields first, followed by the well fields in the other area. Uranium recovery operations within the permit area will continue for approximately 7 to 20 years during which additional well fields will be completed along the roll fronts at both the Dewey and Burdock portions of the permit area. Future exploration may occur within the permit area. Future exploration outside of the currently identified potential well field areas would be conducted under an exploration permit. With future exploration drilling, there is the potential of locating additional recoverable resources within the permit area, in which case Powertech (USA) would request an amendment to the LSM permit to accommodate additional potential well field areas. Following operation of each well field, aquifer restoration will restore groundwater quality. Following regulatory approval of successful aquifer restoration, each well field will be decommissioned, the procedures for which are described in Section 6. It is likely that the CPP will continue to operate for several years following decommissioning of the well fields. The CPP may continue to process uranium-loaded ion exchange resin from other ISR projects such as the nearby Powertech (USA) Aladdin and Dewey Terrace ISR projects planned in Wyoming, as well as possible tolling arrangements with other operators. The entire Dewey-Burdock Project then will be decommissioned and reclaimed in accordance with NRC, DENR, BLM and EPA

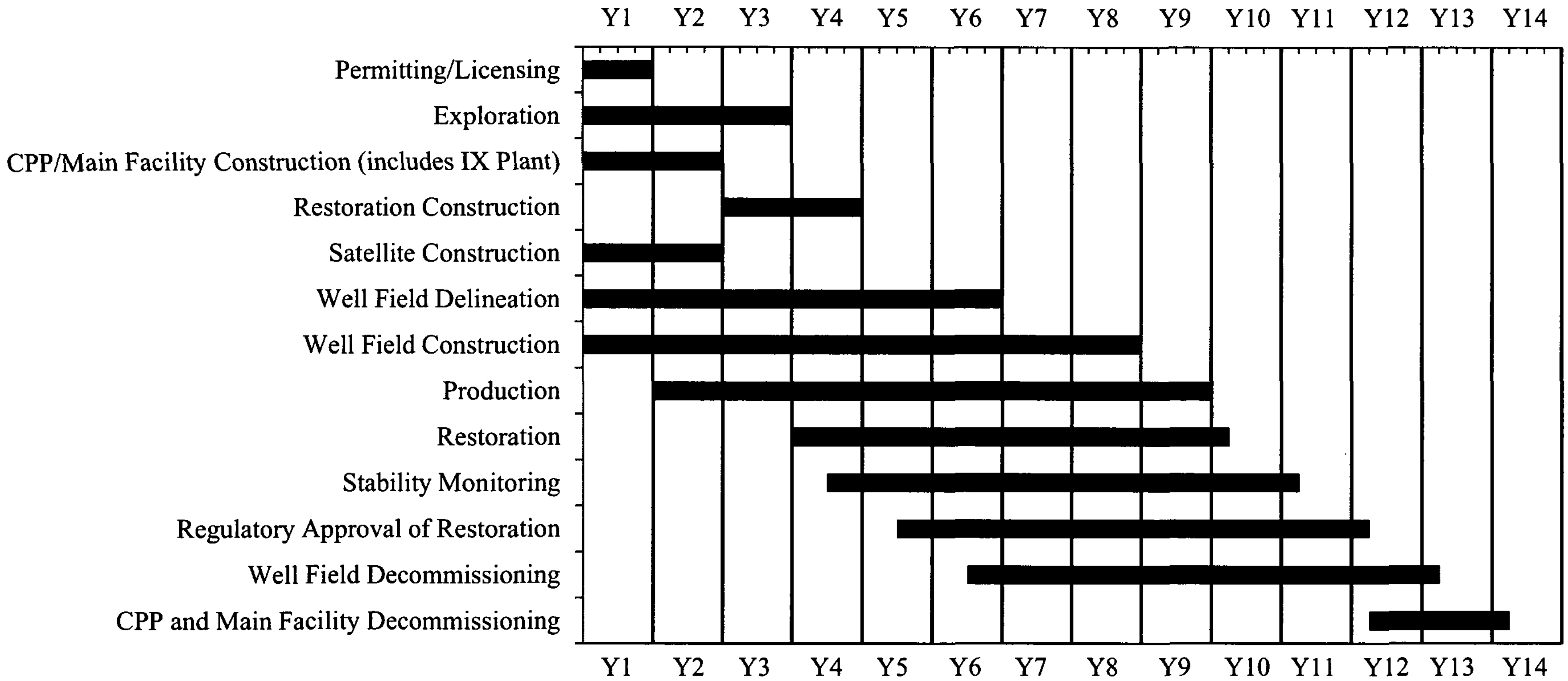


Figure 5.2-1: Projected Construction, Operation, Restoration and Decommissioning Schedule

requirements. The projected construction, operation, restoration and decommissioning schedule is provided in Figure 5.2-1.

5.3 Description of Facilities

Following is a description of the proposed facilities, including CPP and Satellite Facility processing equipment, well fields, wastewater disposal systems, ponds, roads, diversion channels, and sediment control features. Figures 5.3-1 and 5.3-2 depict the general locations of proposed facilities and potential initial well fields in the land application and deep disposal well liquid waste disposal options, respectively. Plates 5.3-1 and 5.3-2 depict the proposed facilities in each disposal option in greater detail and present the proposed affected area boundary. These plates also provide the contour basis for mining in accordance with SDCL 45-6B(6)(8)(a). The only significant change in the premining contours depicted on these plates will be the construction of ponds and diversion channels, the locations of which are depicted on these plates. Following is a narrative description of the premining contours in accordance with ARSD 74:29:02:04(2).

The premining topography within the proposed permit area is described in Section 3.5.2.1. The elevation ranges from approximately 3,600 to 3,900 feet, and the average slope is approximately 6 percent. Within the proposed affected area, the elevation ranges from approximately 3,590 feet near D-WF1 along Beaver Creek to approximately 3,930 feet at a spoil pile associated with the historical Darrow Mine. The slope within the proposed affected area ranges from nearly flat along the Beaver Creek and Pass Creek floodplains to vertical slopes in portions of the historical surface pits. The average slope in the proposed affected area is approximately 5 percent.

Near the proposed CPP and associated ponds, the premining elevation ranges from approximately 3,690 to 3,780 feet. The slope ranges from approximately 1 to 12 percent and averages approximately 5 percent. In the vicinity of the Satellite Facility and associated ponds, the elevation ranges from approximately 3,630 to 3,680 feet. The slope ranges from approximately 0 to 6 percent and averages approximately 2 percent.

Refer to Section 5.4.1.1.2 for a description of the slopes within the proposed land application areas. Plates 3.2-23 through 3.2-27 depict cross sections through the proposed land application areas.

Cross Sections AA-AA' through HH-HH', provided on Plates 5.3-15 and 5.3-16, depict cross sections through the processing facilities and ponds. These cross sections depict the premining topography, postmining topography and the approximate finished ground topography during ISR operations. The postmining topography will approximate premining topography.

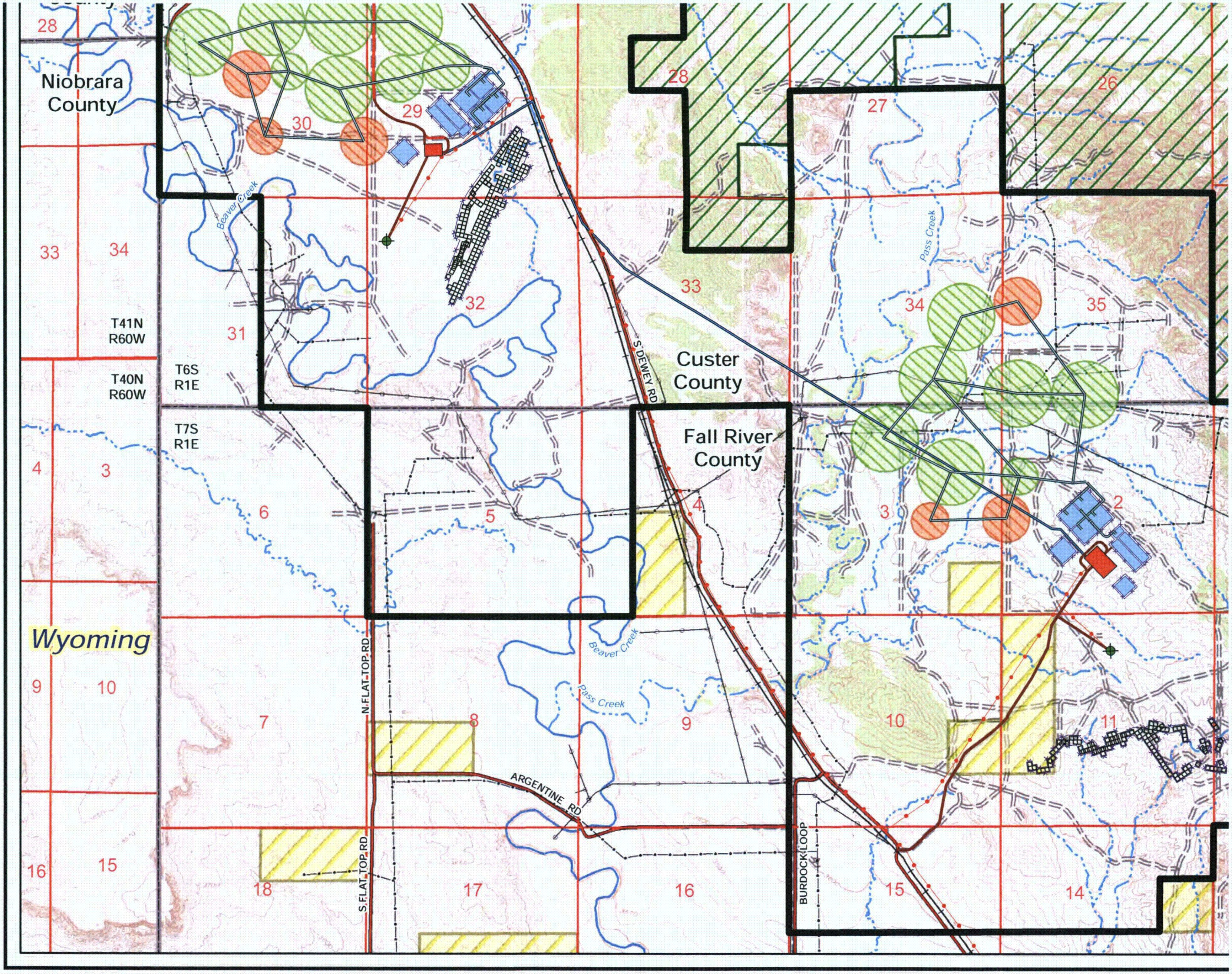
5.3.1 CPP Equipment and Chemical Storage Facilities

The CPP will be located in the Burdock portion of the permit area (Figures 5.3-1 and 5.3-2). Uranium recovery from the solution by IX, subsequent processing of the loaded IX resin to remove the uranium (elution), the precipitation of uranium, thickening of the uranium slurry, and the dewatering, drying, and packaging of solid uranium oxide (yellowcake) will be performed at the CPP.

The site for the CPP has been designed to provide security and ease of access for operating purposes. The site is designed with ample areas for access by resin transfer trucks as well as truck transports for chemical delivery and shipment of product and byproduct materials. Figure 5.3-3 shows the site layout of the CPP, including the placement of an office building, a maintenance shop and the CPP building. Traffic routes and truck turning radii are indicated on this figure. The processing equipment within the CPP is regulated by the NRC, and the chemical storage facilities are regulated by OSHA and NRC. The following discussion is provided for informational purposes in this permit application and is a summary of the discussion provided in the NRC license application.

5.3.1.1 CPP Equipment

The processing facilities will be housed in a pre-engineered metal building. The equipment layout within the CPP building is shown in Figure 5.3-4. The CPP will include the following systems:


Niobrara County
Custer County
Fall River County
Wyoming
T41N R60W
T40N R60W
T6S R1E
T7S R1E
Beaver Creek
Pass Creek
S DEWEY RD
N.FLAT TOP RD
S.FLAT TOP RD
ARGENTINE RD
BURDOCK LOOP
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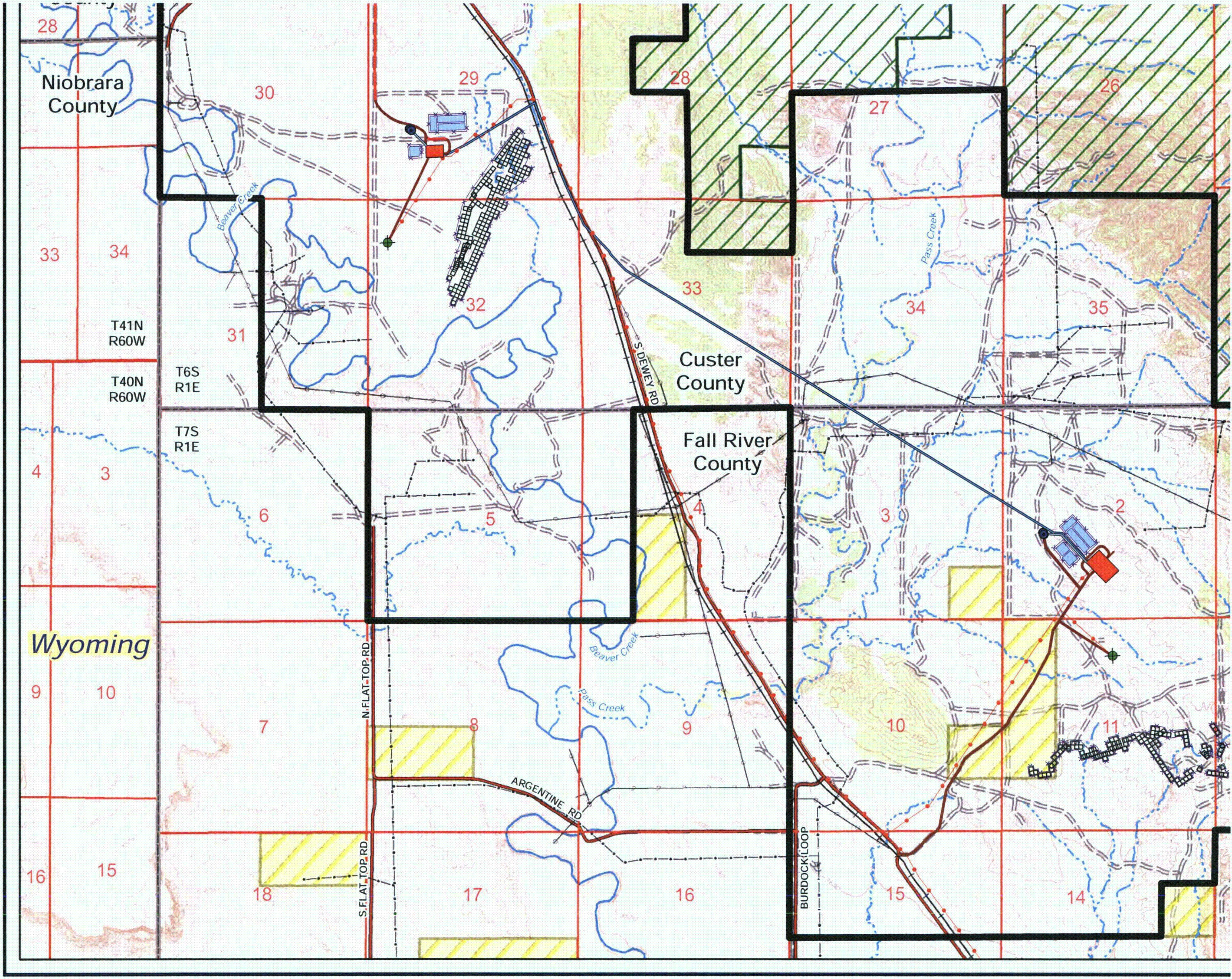

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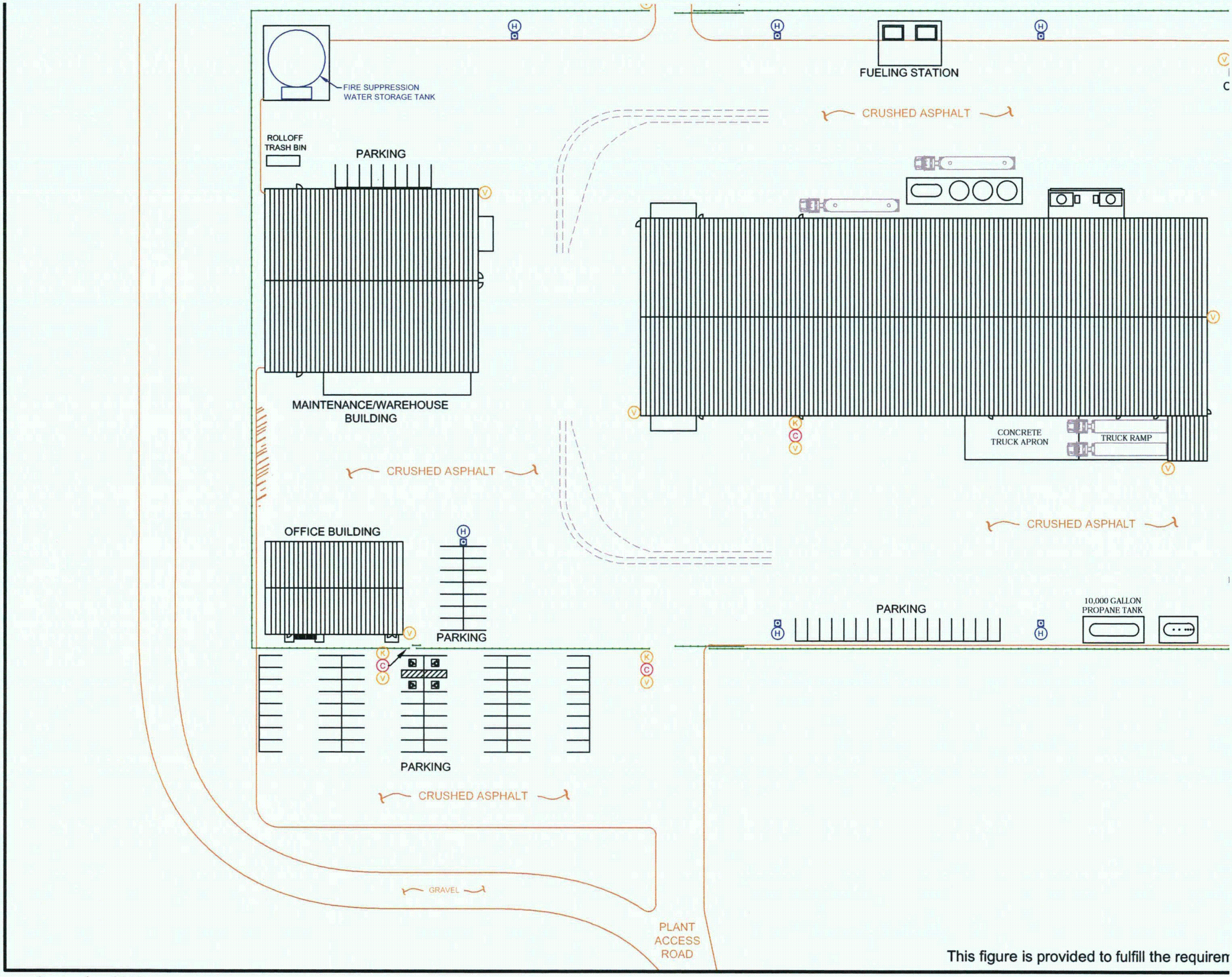
FIRE SUPPRESSION WATER STORAGE TANK
FUELING STATION
CRUSHED ASPHALT
ROLLOFF TRASH BIN
PARKING
MAINTENANCE/WAREHOUSE BUILDING
CRUSHED ASPHALT
CONCRETE TRUCK APRON
TRUCK RAMP
CRUSHED ASPHALT
OFFICE BUILDING
PARKING
PARKING
10,000 GALLON PROPANE TANK
PARKING
CRUSHED ASPHALT
GRAVEL
PLANT ACCESS ROAD
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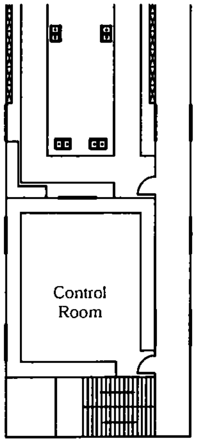
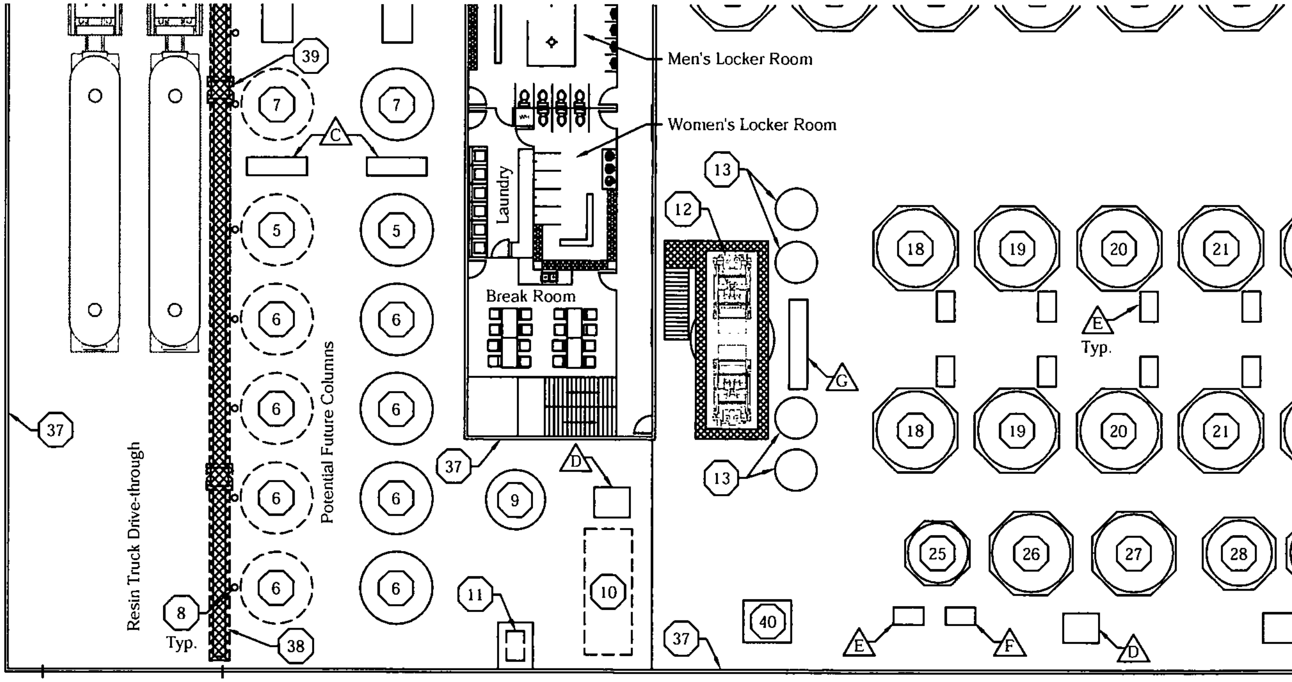


Second Floor Plan



Ground Floor Plan

Key Notes

1
2 NaOH
3
4
5
6
7
8 Pipe Bollard Guard Post
9
10 Resin Supersack Storage
11 Standby Generator in Sound Insulated Room
12 Shaker Screens with Shaker Overflow Collection Tank Below
13
14
15
16
17
18
19
20
21
22
23
24 Hot Oil Boiler
25
26
27
28
29 RO Pre-treatment
30 Recovery RO Unit
31 Restoration RO Unit
32 Elevated Condenser/Vacuum Pump Skid 7'x13'
33 Vacuum Dryer 8'x24'
34 Dryer Room 20'x130'
35 Filter Press and Transfer Pump 5'x20'
36 Drum Conveyor
37 6" Curb Off All Walls, Typ.
38 2'-0" Trench Drain, Typ.
39 3'-0" Sump, Typ.
40 Barium Chloride Storage

This figure is provided to fulfill the requiren

- Recovery – ion exchange (IX)
- Resin transfer
- Elution
- Precipitation
- Drying and packaging
- Restoration
- Chemical storage and feeding
- Utility water
- Wastewater
- Drum storage and decontamination area
- Byproduct storage

Based on preliminary design and site geotechnical evaluations, the project CPP will be located within Section 2, T7S, R1E. Chemical storage also will be located within this area. The plant location is shown on Figures 5.3-1 and 5.3-2.

The CPP will serve production from Dewey-Burdock ISR operations, and possibly resin from other potential Powertech (USA) satellite projects in the area. In addition, depending on market conditions and regional demand for yellowcake processing, the CPP may be used for tolling arrangements with other ISR operations licensed under a different operator.

The following subsections present a brief description of each recovery and processing system and the equipment components comprising each system. An overall process flow diagram is presented in Figure 5.3-5.

5.3.1.1.1 Recovery

Recovery of the uranium from the uranium bearing or pregnant lixiviant solution will be accomplished via an ion exchange process. The pregnant lixiviant from the well field will be pumped through IX vessels containing uranium-specific IX resin beads. As the lixiviant flows through the resin beds, the complexed uranium molecules attach themselves to the beads of resin, displacing chloride or bicarbonate ions as shown below:

$$2RCl + UO_2(CO_3)_2^{2-} \rightarrow R_2UO_2(CO_3)_2 + 2Cl^-$$

$$2RHCO_3 + UO_2(CO_3)_2^{2-} \rightarrow R_2UO_2(CO_3)_2 + 2HCO_3^-$$

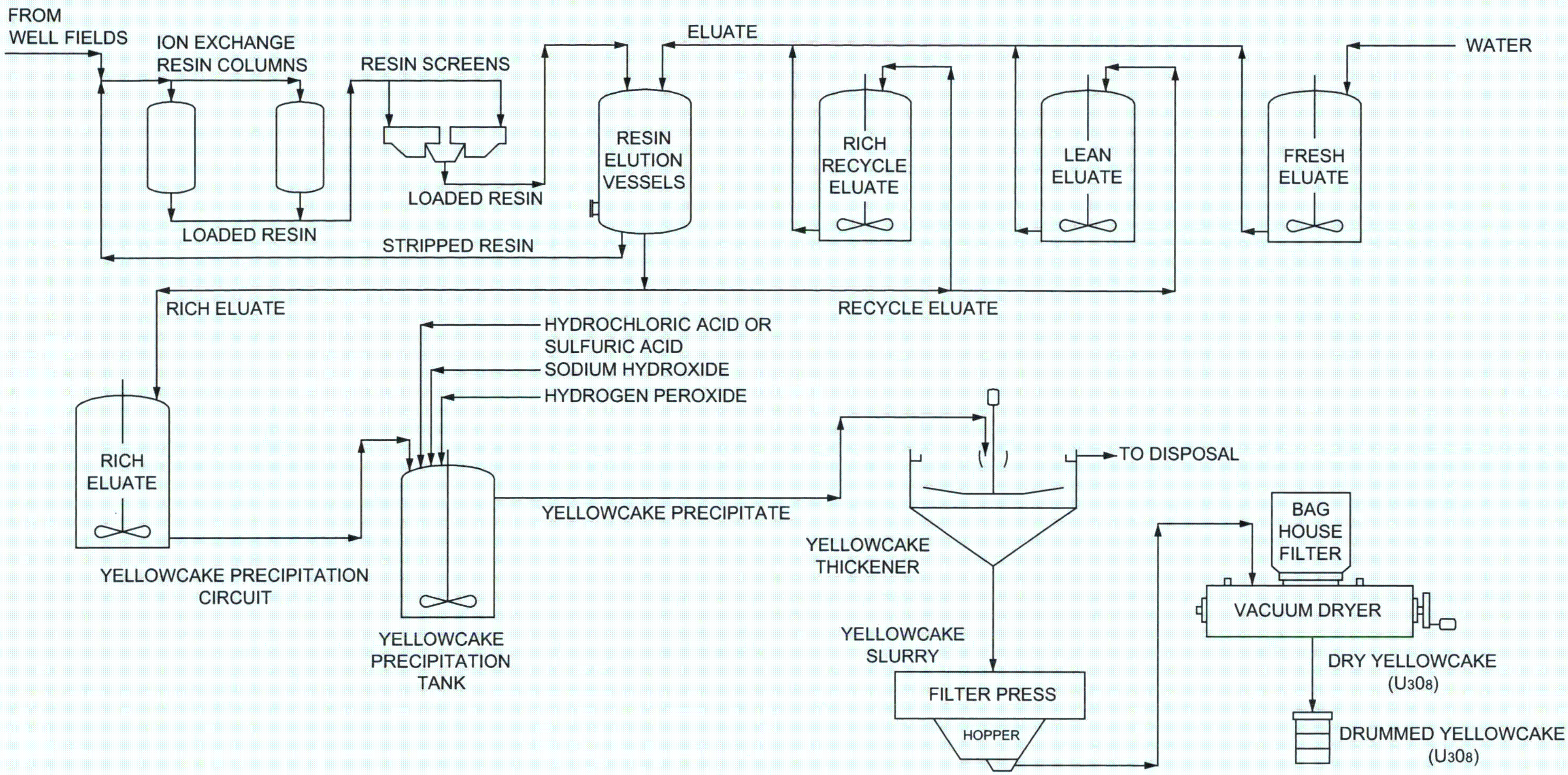


Figure 5.3-5

Process Flow Diagram

Dewey-Burdock Project

SIGNATURE OF PREPARER	John Mays
PREPARER	John Mays
DATE	16-Sep-2012
FILE	PFD.dwg

POWERTECH (USA) INC.

This figure is provided to fulfill the requirements of ARSD 74:29:02:04 and SDCL 45-6B-6(8).

Each resin bead has a finite number of sites where the uranium complex can attach. When most of the available sites in the resin bed are occupied by uranyl dicarbonate (UDC) or uranyl tricarbonate (UTC) ions, the resin will be considered to be "loaded" and will be ready for processing.

The IX vessels will be designed to operate in downflow mode, which will help ensure that radon-222 captured in the well field stays in solution and is not released. Each IX vessel will contain approximately 500 ft^3 of resin. The IX vessels will be arranged in multiples of two vessels in series. The lixiviant will be passed through the primary or lead vessel, where most of the resin loading will occur. The lixiviant will then pass through the secondary or lag vessel where the solution will be "polished" by removing any remaining dissolved uranium. When the lead vessel becomes loaded, it will be taken off line and flow of lixiviant will be routed to the secondary vessel, which will become the lead vessel. The resin in the off-line vessel will be removed and regenerated resin will be returned to the vessel. The resin that was removed will be transferred to the elution and regeneration process in the CPP.

After passing through the IX vessels, the barren lixiviant will be returned to the well field where oxygen and carbon dioxide will be added prior to reinjection. A sidestream referred to as the production bleed will be removed from the barren lixiviant and routed to the wastewater disposal system or the production bleed reverse osmosis (RO) system (if deep disposal wells are used). Refer to Section 5.4.1.1 for a discussion of the two options for liquid waste disposal.

The recovery equipment includes the recovery IX vessels, the production bleed RO system (deep disposal well option only), and the recovery and injection composite booster pumps.

5.3.1.1.2 Resin Transfer

Resin will be transferred out of IX vessels at the CPP to the elution circuit, where it will be regenerated by contacting it with concentrated salt solutions. The concentrated salt solution will displace the UDC and UTC and replace them with chloride or bicarbonate ions. The regenerated resin will be then transferred back to IX vessels.

At the CPP, resin transfer will be accomplished by pumping water into the top of the IX vessel with the bottom discharge valve open. This will force the resin to flow out of the vessel into the transfer pipe. The resin and water will be pumped via the transfer piping to one of two elevated shaker screens. The shaker screens will be inclined, vibrating screens which will separate transfer water, loaded resin, and waste into separate streams. The transfer water will pass through the screens and flow by gravity into a collection tank which feeds the resin transfer pumps. The loaded resin will drop into one of four elution columns to be regenerated. The oversized or undersized solid waste from the shaker screens will consist of broken resin beads, silt and sand from the wells, and scale removed from the resin, and will collect in a hopper to be periodically removed and drummed for disposal as 11e.(2) byproduct material.

Following elution of the resin, the transfer process will be reversed. Water will be pumped into the top of the elution column with the bottom discharge valve open. This will force the resin out of the column and into the resin transfer piping. The resin and water will be pumped back to the IX vessel.

Equipment associated with the resin transfer system includes two shaker screens, a shaker screen water tank, a resin transfer water tank, and a resin transfer pump.

5.3.1.1.3 Elution

The elution process will remove the UDC and UTC from the resin and restore the resin to its chloride form to allow it to be put back into service to remove uranium from pregnant lixiviant. This process is represented by the following equations (similar reactions for bicarbonate loading also will occur but are not shown):

$$R_2UO_2(CO_3)_2 + 2Cl^- \rightarrow 2RCl + UO_2(CO_3)_2^{2-}$$

$$R_4UO_2(CO_3)_3 + 4Cl^- \rightarrow 4RCl + UO_2(CO_3)_3^{4-}$$

Elution will be a four-stage process that will take place in an elution column and involve contacting the loaded resin with batches of eluant solution containing approximately 10 percent by weight sodium chloride and 2 percent by weight sodium carbonate. Each elution stage will strip the resin of additional uranium complex and further restore the exchange capacity of the resin. Following the final elution stage, more than 95 percent of the uranyl carbonate complexes will have been removed from the resin.

Elution system equipment will include four elution columns, eight elution tanks, and elution pumps.

5.3.1.1.4 Precipitation

The precipitation process will break the uranyl carbonate complexes, precipitate the uranium as uranium peroxide, and settle the precipitated solids from the eluant solution. The precipitation process will include a series of chemical addition steps, each causing a specific change in the rich eluate solution.

Prior to beginning the precipitation process, a pump will transfer the rich eluate from the rich eluate tank to the precipitation tank. The precipitation tank contents will be mixed via an agitator. The first stage of chemical addition will be to add sulfuric or hydrochloric acid to bring the pH down to a range of approximately 2-3 pH units. This change in pH will cause the uranyl carbonate complexes to break, liberating carbon dioxide, which will be vented from the tank, as illustrated in the following chemical reaction.

$$UO_2(CO_3)_3^{4-} + 6H^+ \rightarrow UO_2^{2+} + 3CO_2\uparrow + 3H_2O$$

Following completion of CO_2 evolution, sodium hydroxide will be added to raise the pH of the solution to between 4 and 5 pH units. When the pH has stabilized, hydrogen peroxide (H_2O_2) will be added to the solution to form insoluble uranium peroxide (UO_4) as shown below. Following addition of H_2O_2, the agitator speed will be slowed down to promote crystal growth.

$$UO_2^{2+} + H_2O_2 + 2H_2O \rightarrow UO_4 \bullet 2H_2O + 2H^+$$

After a precipitation period of up to 8 hours, sodium hydroxide will be added to raise the pH to approximately 7, and the contents of the precipitation tank will be pumped into the thickener.

Precipitation system equipment will include precipitation tanks, transfer pumps, a pressure filtration system (filter press), and thickeners.

5.3.1.1.5 Drying and Packaging

The uranium peroxide filter cake will be dried in a rotary vacuum dryer under low temperature (approximately 250°F). Angled paddles attached to a central shaft in the dryer will agitate the filter cake to promote even drying. The dryers will be heated with a thermal fluid that will be circulated through the dryer shell and the rotating central shaft. The thermal fluid will be heated by an electric heater with a pump for circulating the thermal fluid through the shell and central shaft of the dryer.

The vapor pulled from the dryer by the vacuum pump will be filtered through a baghouse filter located on the top of the dryer to remove particles down to approximately 1 micron in size. The vapor exiting the baghouse will be cooled using a condenser to remove water vapor and remaining small particles. Liquid ring vacuum pumps will provide the vacuum source. The water collected from the condenser will be pumped to the solids removal tank in the wastewater system.

Two rotary vacuum dryers, baghouses, and packaging equipment will be housed in a separate room in the CPP. The vacuum pump and condenser system for each dryer, and the thermal fluid heaters and pumps will be located in the main CPP area to provide access for operation and maintenance. The vacuum pumps will discharge to the dryer room. Air in the dryer and packaging room will be monitored routinely for airborne dust. A dedicated air handler equipped with HEPA filters will ventilate the dryer and packaging room and will provide an additional level of control for particulate emissions. NRC guidance in NUREG-1910 (NRC, 2009) describes how the system of treating gases emanating from the dryer chamber with bag house filters and water condenser is designed to capture virtually all particles from the vapor stream leaving the dryer. Furthermore, NUREG-1569 (NRC, 2003) states, "When a vacuum dryer is used for yellowcake, then dust emissions from drying may also be assumed to be negligible."

The major components of the system include the vacuum dryers, baghouses, vacuum pump and condenser systems, thermal fluid heaters, and the packaging system.

5.3.1.1.6 Restoration

The restoration system is designed to extract, store, and distribute makeup water for aquifer restoration of well fields. The restoration system may also incorporate an RO system to remove TDS from extracted water and return low TDS permeate to the restoration system. Reject from the RO system, if utilized, will be routed to a high TDS wastewater system.

Restoration system equipment will include a restoration water tank, a restoration makeup water pump, and a restoration RO system, if used.

5.3.1.2 Chemical Storage and Feeding Systems

The ISR process requires chemical storage and feeding systems to store and dose chemicals at various stages in the extraction, processing, and waste treatment processes. The chemicals to be utilized in uranium processing at the project are listed in Table 5.3-1. The potential for any of these chemicals to impact radiological safety is variable in likelihood and consequence. Chemicals that have the potential to impact radiological safety include hydrochloric acid, sulfuric acid, hydrogen peroxide, and sodium hydroxide. Oxygen, because of its ability to support combustion, also requires special handling. In all instances, process controls and preventative safety measures minimize the risk of increased radiological exposure or release.

Table 5.3-1: Process-related Chemicals and Quantities Stored On-site

Chemical Name	No. Tanks	Unit Storage Capacity	Units	Usage Rate ton/yr	Hazard Classification
Burdock CPP and Well Fields					
Sodium chloride (NaCl)	2	20,000	gal	2,250	Non-flammable
Sodium carbonate (Na_2CO_3) i.e., soda ash	1	20,000	gal	450	Non-flammable
Hydrochloric acid (HCl 32%) or sulfuric acid (H_2SO_4 93%)	1	7,000	gal	487	Toxic, reactive, corrosive
Sodium hydroxide (NaOH 50%)	1	7,000	gal	446	Toxic, reactive, corrosive
Hydrogen peroxide (H_2O_2 50%)	1	7,000	gal	177	Oxidizer, irritant, corrosive
Oxygen (O_2, liquid)	1	11,000	gal	979	Cryogenic, oxidizer
Carbon dioxide (CO_2)	1	6,000	gal	245	Asphyxiant, freezing hazard
Barium chloride ($BaCl_2$)	1	275	50-kg sacks	7	Toxic, non-flammable
Dewey Satellite Facility and Well Fields					
Oxygen (O_2, liquid)	1	11,000	gal	653	Cryogenic, oxidizer
Carbon dioxide	1	6,000	gal	163	Asphyxiant, freezing hazard
Barium chloride	1	138	50-kg sacks	7	Toxic, non-flammable