POWERTECH (USA) INC.

Dewey-Burdock Project
Groundwater Discharge Plan
Custer and Fall River Counties, South Dakota

Prepared for:

South Dakota Department of Environment and Natural Resources
Ground Water Quality Program
523 E. Capitol Avenue
Pierre, SD 57501

Prepared by:

Powertech (USA), Inc.
P.O. Box 812
Edgemont, SD 57735

March 2012

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1.0 INTRODUCTION

Powertech (USA) Inc. (Powertech (USA)) submits this Groundwater Discharge Plan (GDP) and accompanying permit application to construct and operate two land application systems at the proposed Dewey-Burdock Project. The project will be located near Edgemont, South Dakota in Custer and Fall River Counties. The Dewey-Burdock Project is an in-situ recovery (ISR) uranium mine that will consist of a series of sequentially developed well fields, a satellite ion exchange (IX) facility at the Dewey portion of the project area and a central processing plant (CPP) and associated IX and process facilities at the Burdock portion of the project area to recover and process the final uranium product.

The uranium recovery process is primarily a closed loop in which groundwater is pumped from recovery wells, processed to remove uranium, and reinjected into injection wells. During uranium recovery and groundwater restoration, slightly more water will be pumped than is reinjected. This will create a cone of depression around the active well fields to control the movement of fluids. The excess water will be treated to remove radionuclides and disposed. In its application for a U.S. Nuclear Regulatory Commission (NRC) source and byproduct material license, Powertech (USA) proposes two alternatives for liquid waste disposal. The first and preferred alternative is treatment followed by injection in Class V wells completed in the Minnelusa or Deadwood Formations. Powertech (USA) is currently permitting the Class V disposal wells through the U.S. Environmental Protection Agency (EPA) Underground Injection Control (UIC) Program. In the event that the Class V UIC permit is not approved or insufficient disposal capacity is available, Powertech (USA) proposes to treat the liquid waste and dispose it in land application systems permitted under a Groundwater Discharge Plan through the South Dakota Department of Environment and Natural Resources (DENR).

The following GDP describes the proposed design and operation of the Dewey-Burdock land application systems. One system would be constructed near the Dewey satellite facility, and another would be constructed near the Burdock CPP. Both facilities have been designed to apply water at agronomic rates that prevent runoff and limit the potential for deep percolation beneath the land application areas. Hydrologic modeling presented in Section 5 demonstrates that groundwater is not expected to be impacted by the proposed land application systems. Nevertheless, Powertech (USA) proposes perimeter of operational pollution (POP) zones in the alluvial groundwater systems with perimeter compliance monitor wells to ensure protection of waters of the State of South Dakota. The proposed land application systems are separated from bedrock aquifers by some 25 to 500 feet of Graneros Group shales, which will eliminate any potential to impact bedrock aquifers.

2.0 PROJECT OVERVIEW

2.1 Owner/Operator Information

This GDP is submitted by Powertech (USA), which is the United States-based wholly owned subsidiary of Powertech Uranium Corp., a corporation registered in British Columbia. Powertech Uranium Corp. shares are publicly traded on the Toronto Stock Exchange (TSX) as PWE and the Frankfurt Stock Exchange as P8A. Powertech Uranium Corp. owns 100 percent of the shares of Powertech (USA). The corporate office of Powertech Uranium Corp. is located in Vancouver, British Columbia. Powertech (USA) is a United States-based corporation registered in the State of South Dakota.

The addresses and telephone numbers for the general office (Colorado) and the local office (South Dakota) of the applicant are listed as follows in accordance with ARSD 74:54:02:06 (1):

Name and address of discharger or person legally responsible for discharge:

Company:	Powertech (USA) Inc.
Signatory:	Richard Blubaugh
Title:	Vice President, Environmental Health & Safety
Address:	5575 DTC Parkway, Suite #140 Greenwood Village, CO 80111
Telephone:	(303) 790-7528

Local representative or contact person if different from above:

Name:	Mark Hollenbeck, P.E.
Title:	Project Manager
Address:	Powertech (USA) Inc. 310 2nd Avenue P.O. Box 812 Edgemont, SD 57735
Telephone:	(605) 662-8308

2.2 General Description of Operation

2.2.1 ISR Description

The ISR process involves the oxidation and solubilization of uranium from its reduced state using leaching fluid (lixiviant). The lixiviant consists of groundwater with an oxidant (in this case gaseous oxygen) added to oxidize the uranium to a soluble valence and a complexing agent (in this case gaseous carbon dioxide) to complex the uranium ion. Powertech (USA) will inject lixiviant through Class III injection wells permitted through the EPA UIC Program. Once solubilized, the uranium-bearing groundwater will be pumped using submersible pumps from well field production wells to the surface, where the uranium will be bonded onto ion exchange (IX) resins. After the uranium is removed, the groundwater will be fortified with additional oxygen and carbon dioxide and reinjected. When loaded with uranium, the IX resin will be moved to an IX elution (stripping) column where the uranium will be eluted (stripped) from the resin by a saltwater solution. The resulting barren (stripped) resin will then be recycled to recover additional uranium. The saltwater eluate solution will be pumped to a precipitation process where the uranium will be precipitated as a yellow solid uranium oxide. The precipitated uranium oxide will then be filtered, washed, dried and packaged in sealed containers for shipment for further processing.

Following uranium recovery in each well field, the groundwater in each well field will be restored in accordance with NRC license requirements. Specifically, Powertech (USA) will restore groundwater quality consistent with the groundwater protection standards contained in 10 CFR 40, Appendix A, Criterion 5(B)(5) on a parameter-by-parameter basis using best practicable technology. The method of aquifer restoration will depend on the liquid waste disposal option. In the deep disposal well option, the primary method of aquifer restoration will be reverse osmosis treatment with injection of permeate (nearly pure water) into the well fields. In the land application option, the water pumped from the well fields undergoing aquifer restoration will be treated and disposed in the land application systems and clean makeup water from the Madison Limestone or another suitable aquifer will be injected into the well fields.

Sources of liquid waste proposed for discharge in the land application systems include groundwater from the ore zone removed during aquifer restoration, affected groundwater generated during well development, and liquid process wastes, such as the production bleed, resin transfer water, and the brine generated from the elution and precipitation circuits. The production bleed is a relatively small amount (0.5 to 3 percent) of the production flow rate that is not reinjected during uranium recovery in order to maintain a cone of depression within each

well field and maintain hydraulic well field control. No domestic (septic) waste will be disposed in the land application systems.

In the land application option, the vast majority of liquid waste (typically greater than 90 percent) will result from aquifer restoration. Additional information regarding liquid waste water quality and flow rate is found in Section 5.

2.2.2 Land Application Description

Each land application system will consist of irrigation center pivots, associated pumps and piping, and catchment areas. Associated facilities include radium settling ponds and storage ponds. Liquid waste will be treated to remove radionuclides in lined radium settling ponds. Treated water will be temporarily stored in lined storage ponds and then seasonally applied to the land application areas through center pivots. Powertech (USA) anticipates that land application will typically occur during late March through October, but it could occur during other times of the year weather permitting. Adequate capacity in the storage ponds will provide storage during the months when land application will not be used (typically November through early March). Additional design information for each of the land application systems is presented in Section 5.

2.3 Project Location

The Dewey-Burdock Project is located approximately 13 miles north-northwest of Edgemont, South Dakota, in an area encompassing portions of Fall River and Custer counties. The proposed NRC license area, which is the same as the proposed DENR large scale mine (LSM) permit area, encompasses approximately 10,580 acres of mostly private land on either side of S. Dewey Road (County Road 6463). It includes portions of Sections 1-5, 10-12, and 14-15, Township 7 South, Range 1 East and Sections 20-21, and 27-35, Township 6 South, Range 1 East, Black Hills Meridian. Approximately 240 acres are under the control of the Bureau of Land Management (BLM) located in portions of Sections 3 and 10-12. Figure 2.3-1 shows the project location and NRC license/LSM permit boundary (herein referred to as the project boundary or project area).

The proposed GDP includes two land application areas, one at the Dewey site and one at the Burdock site. Figure 2.3-2 shows the proposed land application areas. The total irrigated area at each site at any given time is anticipated to be 315 acres, consisting of 50-acre, 25-acre, and 15-acre pivots. In addition, each site will contain 65 acres of center pivots on standby, which can be used during repairs and maintenance of other center pivots or used on a rotating basis. The legal

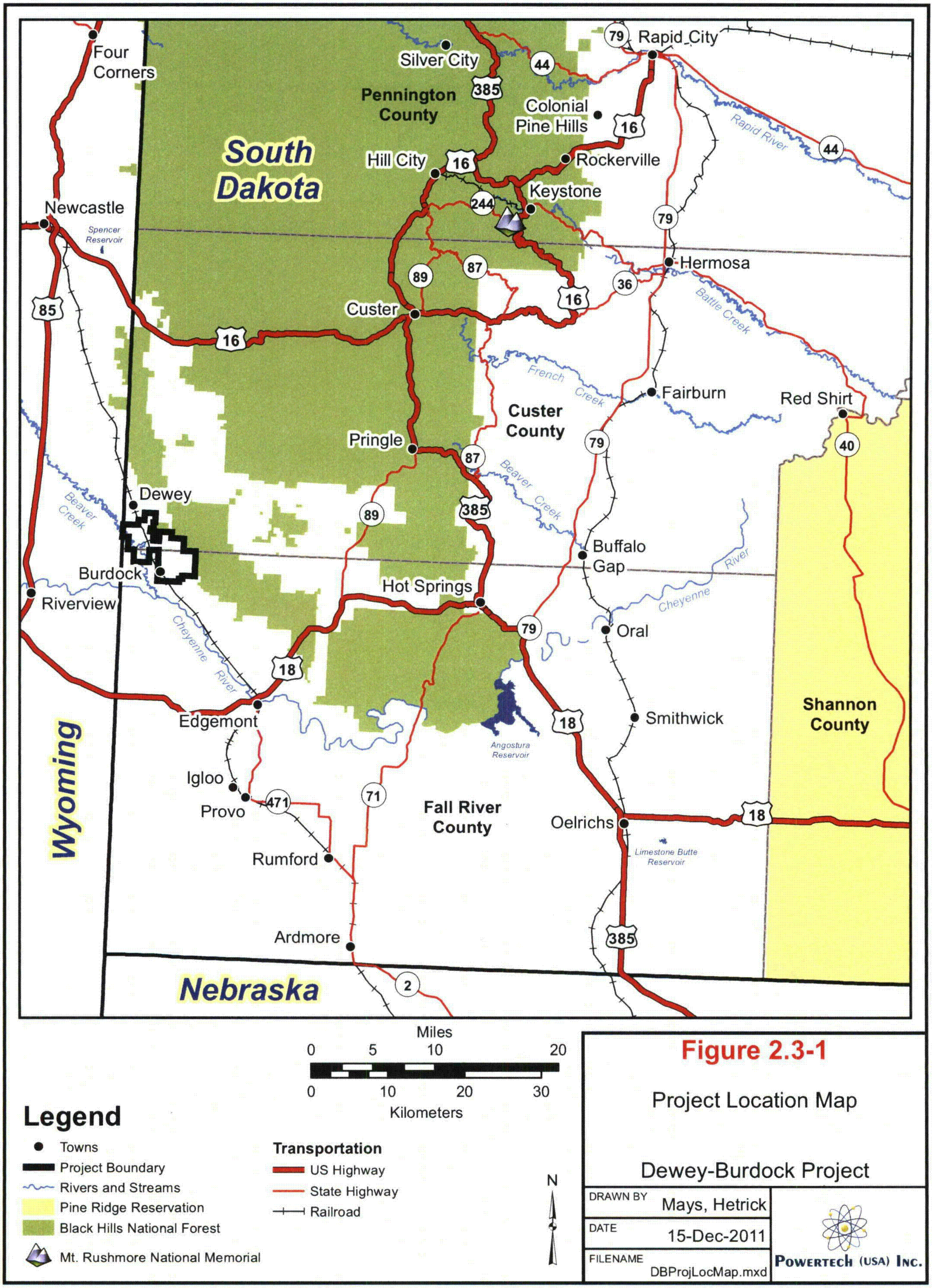
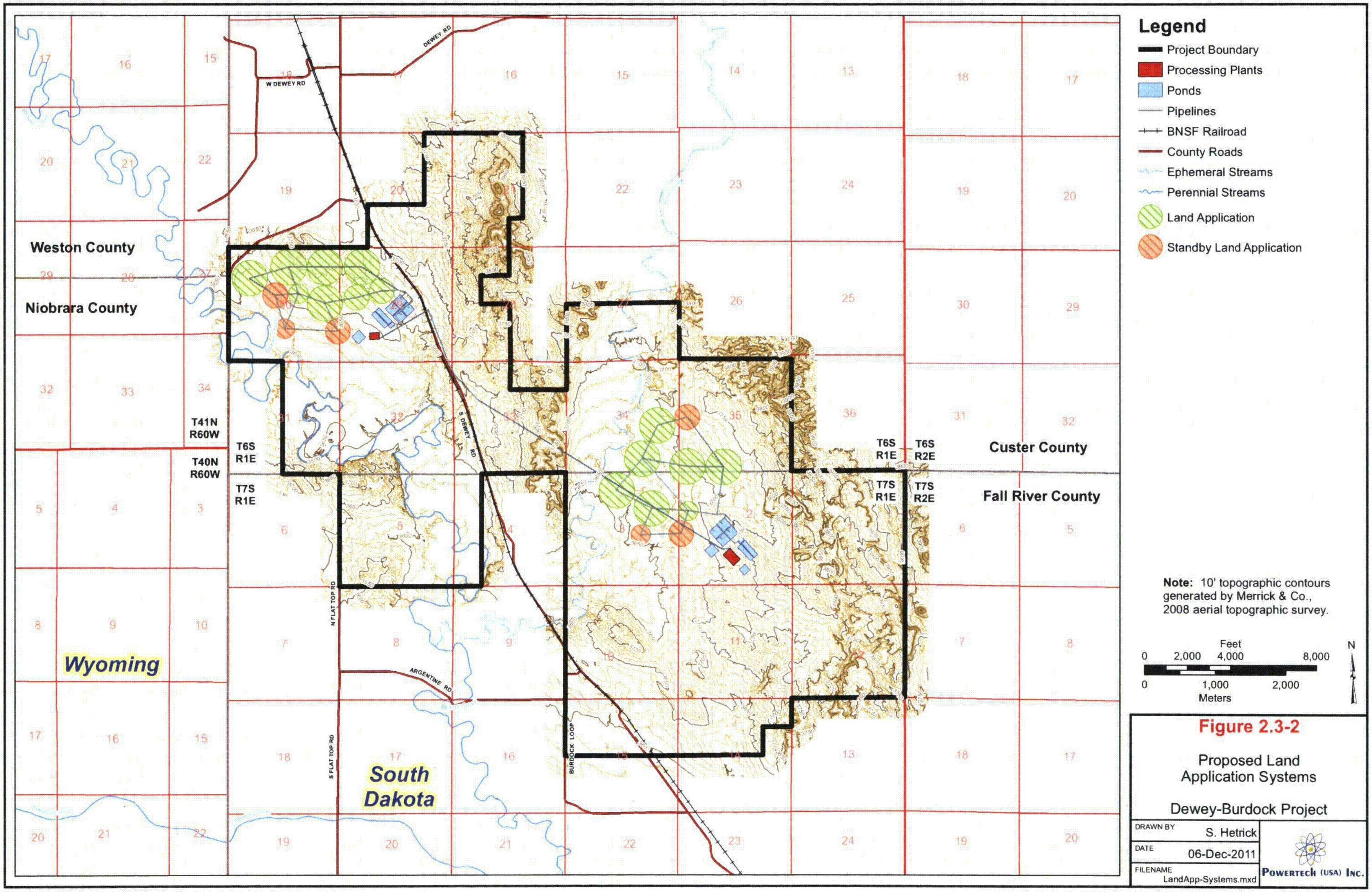


Figure 2.3-1

Project Location Map



Legend
Project Boundary
Processing Plants
Ponds
Pipelines
BNSF Railroad
County Roads
Ephemeral Streams
Perennial Streams
Land Application
Standby Land Application
Weston County
Niobrara County
Custer County
Fall River County
Wyoming
South Dakota
T41N R60W
T40N R60W
T6S R1E
T7S R1E
T6S R2E
T7S R2E
W DEWEY RD
DEWEY RD
S DEWEY RD
N FLAT TOP RD
S FLAT TOP RD
ARGENTINE RD
BURDOCK LOOP
Note: 10' topographic contours generated by Merrick & Co., 2008 aerial topographic survey.
Feet
0 2,000 4,000 8,000
0 1,000 2,000
Meters
N
Figure 2.3-2
Proposed Land Application Systems
Dewey-Burdock Project
DRAWN BY S. Hetrick
DATE 06-Dec-2011
FILENAME LandApp-Systems.mxd
POWERTECH (USA) INC.

description of the land application areas and associated POP zones, in accordance with ARSD 74:54:02:06 (2), includes portions of the following quarter-quarter sections:

- Dewey site:
  - Custer County, Township 6 South, Range 1 East
    - Section 29 - NW¼; SW¼ NE¼; NW¼ SE¼; SW¼
    - Section 30 - all except SW¼ SW¼
    - Section 31 - N½ NE¼
    - Section 32 - NW¼ NW¼
- Burdock site:
  - Custer County, Township 6 South, Range 1 East
    - Section 34 - SE¼; S½ NE¼; E½ SW¼; SW¼ SW¼
    - Section 35 - S½ NW¼; SW¼; SW¼ SE¼
  - Fall River County, Township 7 South, Range 1 East
    - Section 2 - NW¼; W½ SW¼; NE¼ SW¼; NW¼ NE¼
    - Section 3 - all except SW¼ SW¼

2.4 Project Schedule

Following the issuance of an NRC source and byproduct material license, DENR LSM permit, and other relevant permits, it is anticipated that construction of the initial Burdock well fields, CPP and ancillary facilities including storage ponds and land application systems will commence. The construction of the initial Dewey well fields and ancillary facilities will follow shortly thereafter. Startup of the Dewey and Burdock operations will commence upon completion of construction and will continue for approximately 7 to 20 years or more during which additional well fields will be completed along the roll fronts. The projected construction, operation, restoration and decommissioning schedule is provided in Figure 2.4-1.

Land application will occur during production and restoration, which are shown on Figure 2.4-1 to occur from approximately year 2 through early year 10 after licensing/permitting (approximately 9.25 years total). The application rates during initial production, concurrent production and restoration, and restoration without concurrent production are discussed in Section 5.6.

2.5 Project History

Uranium was first discovered in the Edgemont District in 1952 by professors from the South Dakota School of Mines and Technology. They mined about 500 pounds of ore and hauled it to

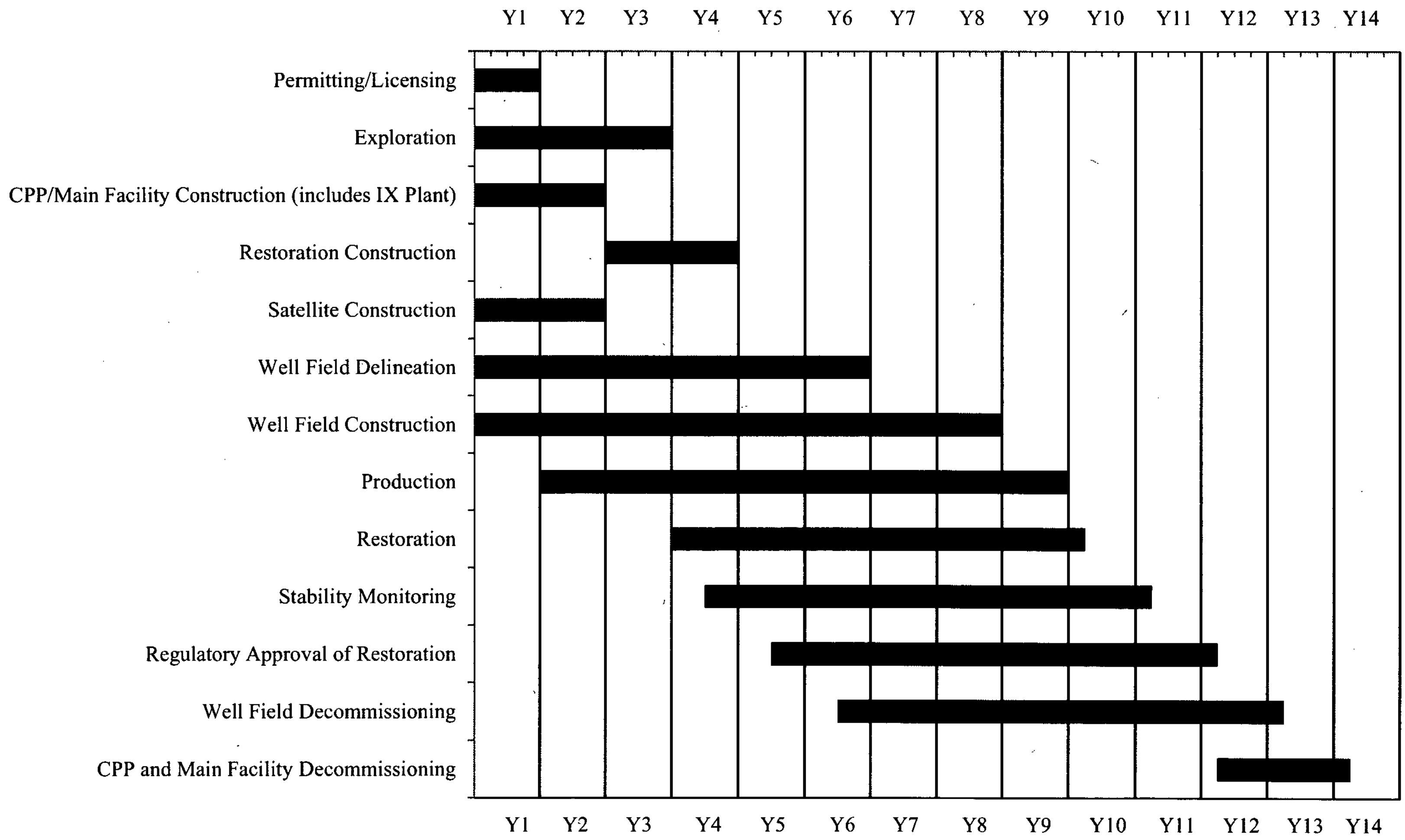


Figure 2.4-1: Projected Construction, Operation, Restoration and Decommissioning Schedule

Grand Junction, Colorado. The Atomic Energy Commission (AEC) announcement of a new district at Edgemont led to a boom of staking, mining, and dealing in the summer of 1952. By 1953 the AEC had built a buying station in Edgemont. In July 1956 a 250-ton-per-day mill began operating and soon expanded to 500 tons per day. In 1960 a vanadium circuit was added. Production from the Edgemont District (open pits in the Fall River Formation), some mines in the Powder River Basin and several mines in the northern Black Hills continued until 1972, when Susquehanna Western Inc. bought the Edgemont mill and took control of the mines in the Edgemont District. Until the late 1960's they were the only company active in the Edgemont District.

In 1967, Homestake Mining Company began exploration in the Dewey area. In 1974, Wyoming Mineral Corporation (WMC) acquired the Dewey properties from Homestake. In 1974, Tennessee Valley Authority (TVA) bought out the mill and mines from Susquehanna Western Inc. The mill was shut down, but exploration continued. Besides WMC and TVA, other companies exploring in the district were Union Carbide, Federal Resources, and Kerr McGee. TVA acquired the Dewey Project from WMC in 1978 and continued exploration until 1986. In total, over 4,000 exploration drill holes were completed on this project.

In 1981 TVA completed a mine feasibility study on the project deposits. A draft environmental statement (DES) was prepared by TVA to address the potential impacts of a proposed underground mine in the project area, but the NEPA process was never completed by TVA. In 1994 Energy Fuels Nuclear (EFN) acquired the mineral interests within the project area. Their intention was to extract the uranium by ISR. EFN did no additional exploration drilling on the project. In 2000 the leases were dropped.

In 2005, Powertech (USA) acquired control of the property, which currently consists of approximately 10,580 acres. Since spring 2007, Powertech (USA) has drilled approximately 115 exploration holes, including 20 monitor wells on the project. Both the historical and recent drill holes have been used to generate the geologic model and delineate the extent of the mineralized sands.

2.6 Statement of Procedural Completeness

This GDP has been prepared to meet the requirements of applicable Administrative Rules of South Dakota (ARSD) and South Dakota Codified Law (SDCL). Specifically, this GDP addresses the application requirements for groundwater discharge permits in ARSD 74:54:02:06 and other ARSD 74:54:01 and 74:54:02 requirements listed on the DENR permit application

form that accompanies the GDP. Table 2.6-1 lists the applicable ARSD and the section of the GDP that fulfills each requirement.

Table 2.6-1: Groundwater Discharge Permit Application Checklist

Regulation	Information Required	GDP Reference
ARSD 74:54:01:03	Classification of groundwater	Section 4.2.3
ARSD 74:54:01:04	Standards for groundwater of 10,000 mg/L TDS concentration or less	Section 6.1.1.4
ARSD 74:54:02:06 (1)	The name and address of the owner and operator of the project	Section 2.1
ARSD 74:54:02:06 (2)	The legal location of the facility by county, quarter, quarter, quarter, quarter, section, township, and range	Section 2.3
ARSD 74:54:02:06 (3)	The name of the project or facility and the type of operation, facility, or development, including the expected project life	Sections 2.2 and 2.4
ARSD 74:54:02:06 (4)	A plat map showing all wells, water bodies, drainages, natural or man-made structures, and water usage within a one-mile radius of the discharge. The plat map must show the location and depth of existing or proposed wells to be used for monitoring groundwater quality	Figures 3.5-1, 3.7-2, 3.7-3, 3.7-9, and 3.7-10; Tables 3.7-3, 3.7-4 and 4.1-3
ARSD 74:54:02:06 (5)	Geologic, hydrologic, and agricultural description of the area of review, including topography, soil types, aquifers, groundwater flow direction, aquifer material, and well logs. The hydrologic description must include a projected area of influence	Sections 3.1 through 3.7
ARSD 74:54:02:06 (6)	The type, source, and chemical, physical, radiological, and toxic characteristics of the effluent or leachate to be discharged; the average and maximum daily amount of effluent or leachate discharged (gpd), the discharge rate (gpm), and the expected concentrations of any contaminant (mg/L)	Sections 5.1, 5.2, 5.6 and 5.8
ARSD 74:54:02:06 (7)	Information which shows that the discharge can be controlled and will not migrate into or adversely affect the quality of any other waters of the state	Sections 5.7 and 8.0
ARSD 74:54:02:06 (8)	If applicable, the description of the POP, including the dimensions and hydrologic and geologic data used to determine the dimensions, the proposed compliance monitoring point, and justification of necessary economic or social development for the POP	Section 7.0
ARSD 74:54:02:06 (9)	Proposed monitoring plan	Section 6.0
ARSD 74:54:02:06 (9)(b)	Discussion of failure detection system	Section 6.3.3
ARSD 74:54:02:06 (10)	Plans and specifications relating to construction, modification, or operation of discharge systems	Section 5.0
ARSD 74:54:02:06 (11)	Description of the groundwater most likely to be affected by the discharge, including water quality information of the receiving groundwater prior to discharge, a description of the aquifer in which the groundwater occurs, the depth to the groundwater, the saturated thickness, flow direction, porosity, hydraulic conductivity, and flow system characteristics	Sections 3.7.2 and 4.2

Table 2.6-1: Groundwater Discharge Permit Application Checklist (cont'd)

Regulation	Information Required	GDP Reference
ARSD 74:54:02:06 (12)	Distance to the nearest well, the use and the water quality of that well, and a listing of all water wells in the area of review and the status of each	Section 3.7.2.3 and Appendices 4.2-A and 4.2-B
ARSD 74:54:02:06 (13)	A compliance sampling plan which includes provisions for sampling of effluent and for flow monitoring, to determine the volume and chemistry of the discharge onto or below the surface of the ground and a plan for sampling monitoring wells and appropriate nearby water wells which includes the parameters to be sampled for	Section 6.0
ARSD 74:54:02:06 (14)	A description of the flooding potential of the discharge site, including the 100-year flood plain, and any applicable flood protection measures	Sections 3.7.1.3 and 8.2
ARSD 74:54:02:06 (15)	A contingency plan for bringing the facility into compliance if permitted allowable limits are exceeded	Section 8.0
ARSD 74:54:02:06 (16)	Methods and procedures for inspections of the facility operations and for detecting failure of the system	Section 10.0
ARSD 74:54:02:11	Board issuance of water quality variance permit	Section 7.0
ARSD 74:54:02:17	Perimeter of operational pollution (POP)	Section 7.0
ARSD 74:54:02:18	Ambient water quality determination	Sections 4.1 and 4.2
ARSD 74:54:02:20	Periodic submission of monitoring reports to secretary	Section 11.0
ARSD 74:54:02:21	The operator of a groundwater discharge facility shall immediately notify the secretary of any mechanical or discharge system failures. The secretary shall require a written statement confirming the oral report within 30 days.	Section 11.0
ARSD 74:54:02:22	Correction of adverse effects required	Section 8.0
ARSD 74:54:02:25	Report of spills, leaks, and accidental releases to secretary	Section 11.0
ARSD 74:54:02:27	An accelerated schedule of monitoring is required upon determination of probable out-of-compliance status	Section 8.1.1

Note: This checklist includes sections of ARSD 75:54:01 and 74:54:02 from the GDP application.

3.0 ENVIRONMENTAL SETTING

3.1 Climate

The project 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 project 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 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 project area (listed in Table 3.1-1 and shown on Figure 3.1-12) 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, heating, and cooling degree days. The site that best represents the long-term precipitation and temperature of the project area is the Edgemont site, which is the closest in proximity and elevation to the Dewey-Burdock project 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).

Table 3.1-1: Meteorological Stations Included in Climatology Analysis

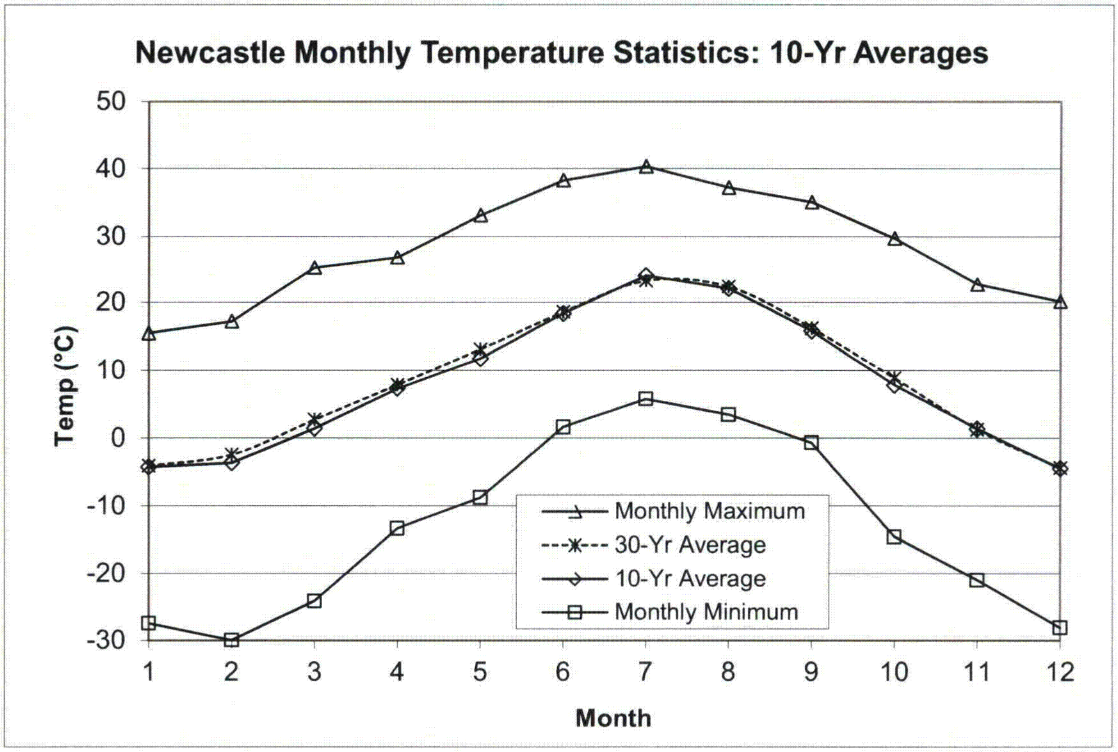
Name	Data Source	X (°W)	Y (°N)	Z (ft)	Years of Operation
Redbird	NCDC[a]	104.17	43.15	3,890	1948–2006
Oral	SDSU[b]	103.16	43.24	2,960	1971–2007
Oelrichs	NCDC	103.14	43.11	3,340	1948–2007
Newcastle	NCDC	104.14	43.51	4,380	1918–2006
Edgemont	NCDC	103.49	43.18	3,440	1948–2007
Custer	NCDC	103.36	43.46	5,330	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.

3.1.1 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 3.1.5.

The average daily temperature over the baseline monitoring year at Newcastle was 51.9°F, which is slightly warmer than the 10-year average (historic) daily temperature of 47.2°F. Figure 3.1-1 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.



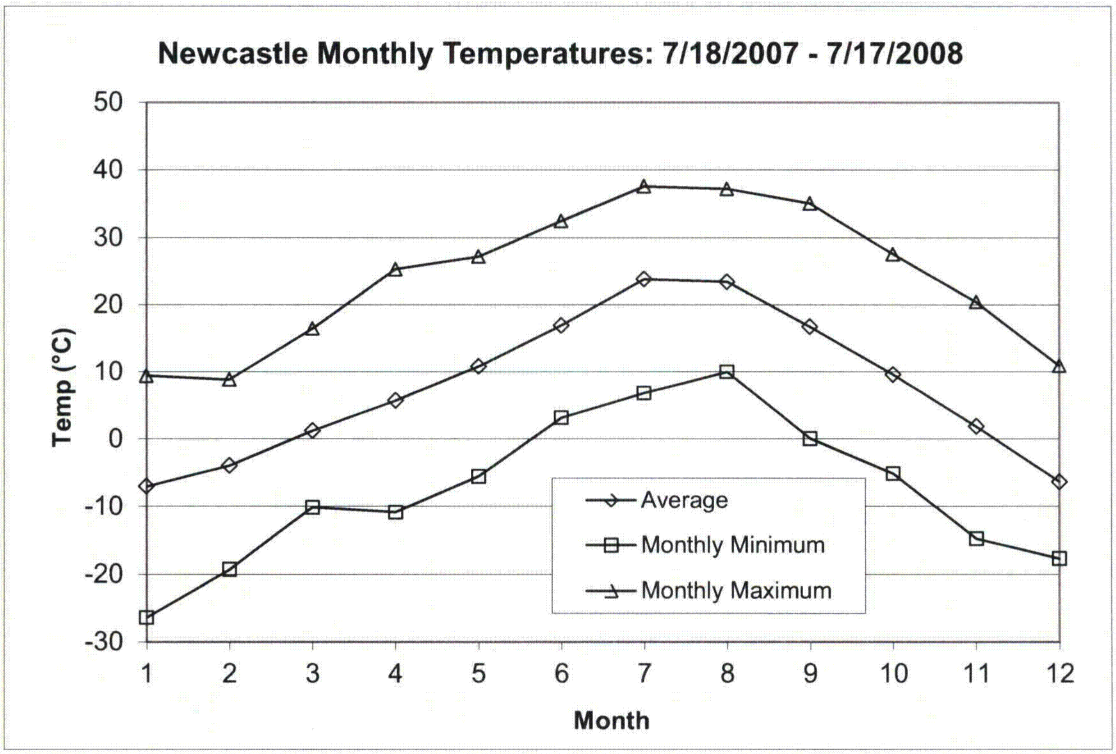


Figure 3.1-1: Short and Long-Term Temperatures at the Newcastle, Wyoming WRC Compliance Site

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 3.1-2 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).

3.1.1.1 Temperature

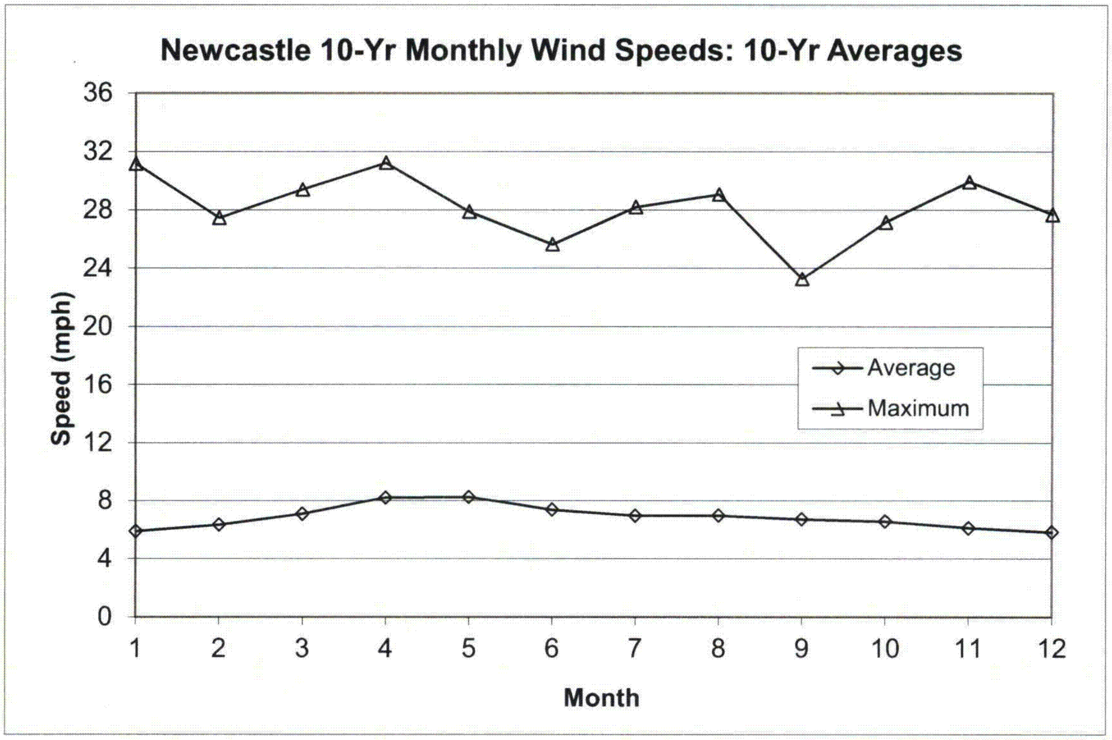
Long-term temperature statistics were also obtained from regional NWS sites. The annual average temperature in this region is 46.7°F. Figure 3.1-3 and Table 3.1-2 display the monthly, annual, and seasonal average temperatures. This region has its warmest days in the summer months with the hottest month being July (average temperature of 72.8°F). The coldest month of the year is January, with an average temperature of 23.0°F. During the months of April through October, when the proposed land application systems will operate, the average temperature is above freezing for all regional sites. 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 3.1-4 and 3.1-5 show the average maximum and minimum temperatures in the region. The average maximum temperature is 60.7°F annually, while the annual average minimum temperature is 32.7°F, as shown in Tables 3.1-3 and 3.1-4. Table 3.1-4 shows that the average minimum temperature for the Edgemont site is above freezing during April through October, when the proposed land application systems will operate. The highest average maximum temperatures in the region usually fall during the month of July (88.3°F). The lowest minimum temperatures can be found in January with a regional average of 10.4°F.

Figure 3.1-6 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.

3.1.1.2 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 3.1-7 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



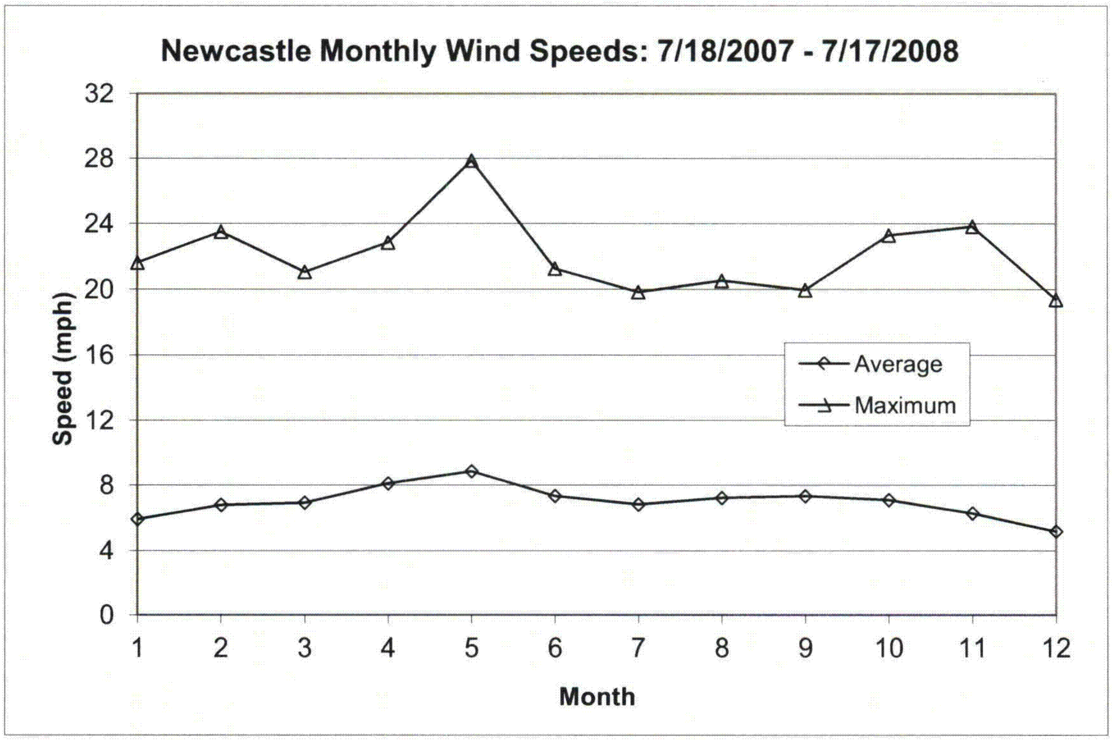


Figure 3.1-2: Short and Long-Term Wind Speeds at the Newcastle, Wyoming WRC Compliance Site

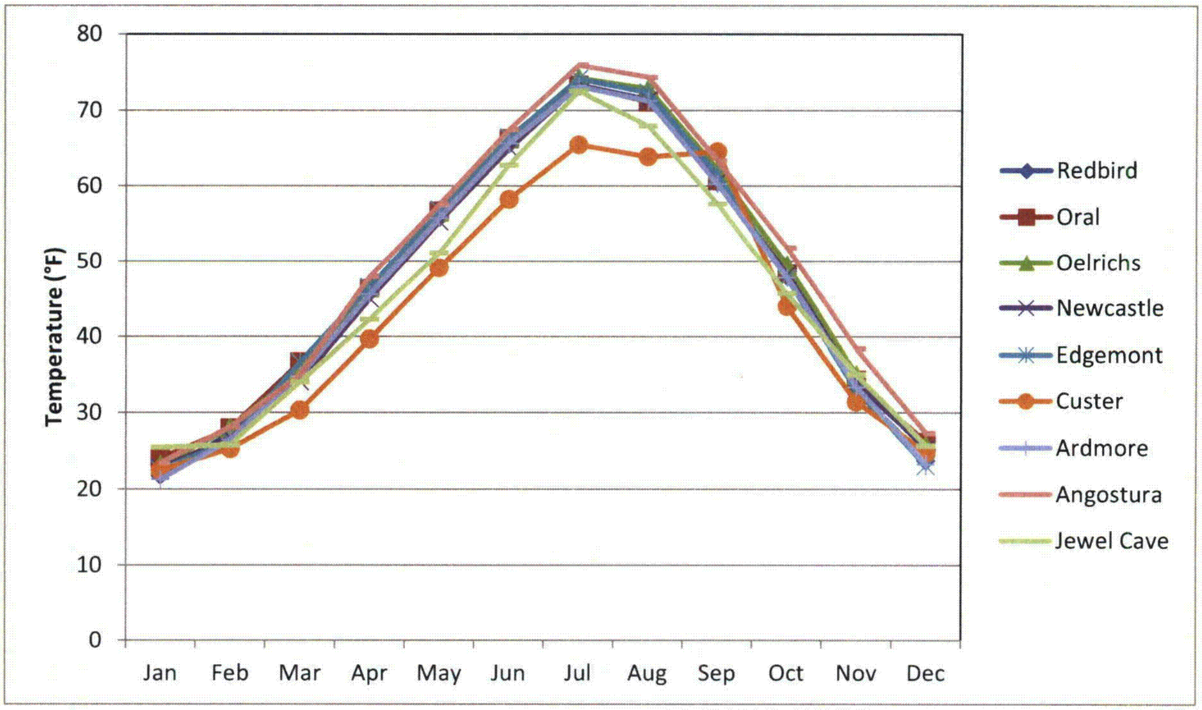


Figure 3.1-3: Average Monthly Temperatures for Regional Sites

Table 3.1-2: Average Monthly, Annual, and Seasonal 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

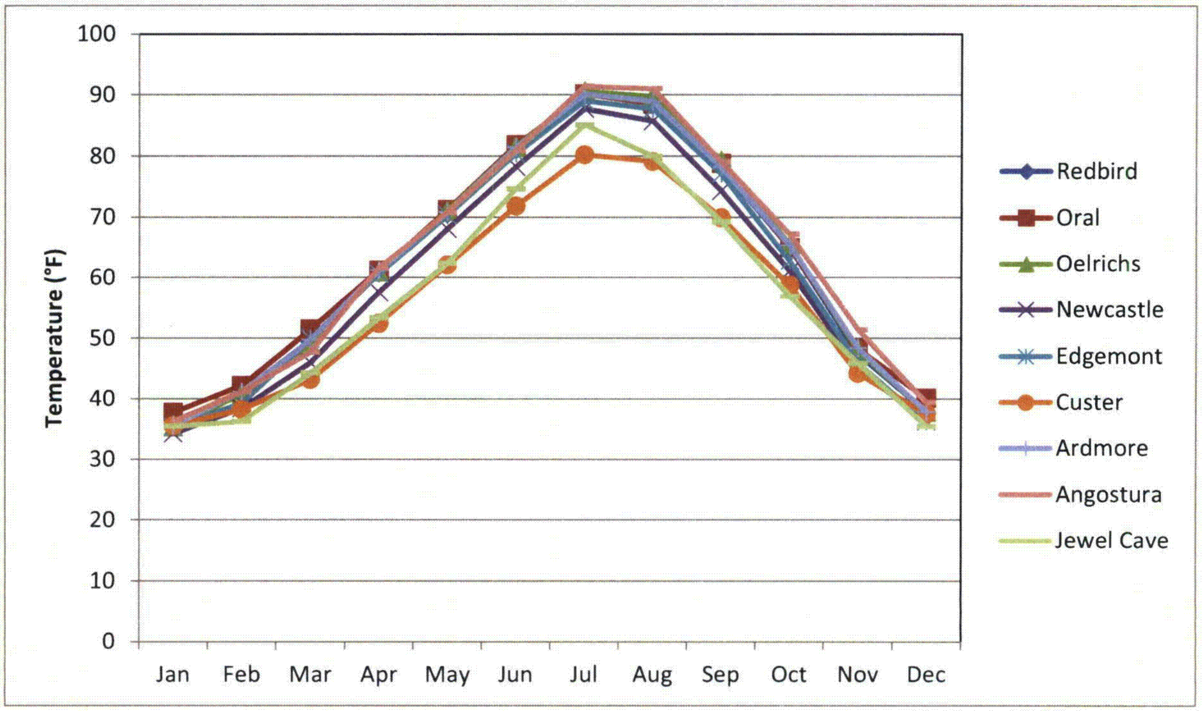


Figure 3.1-4: Average Monthly Maximum Temperatures for Regional Sites

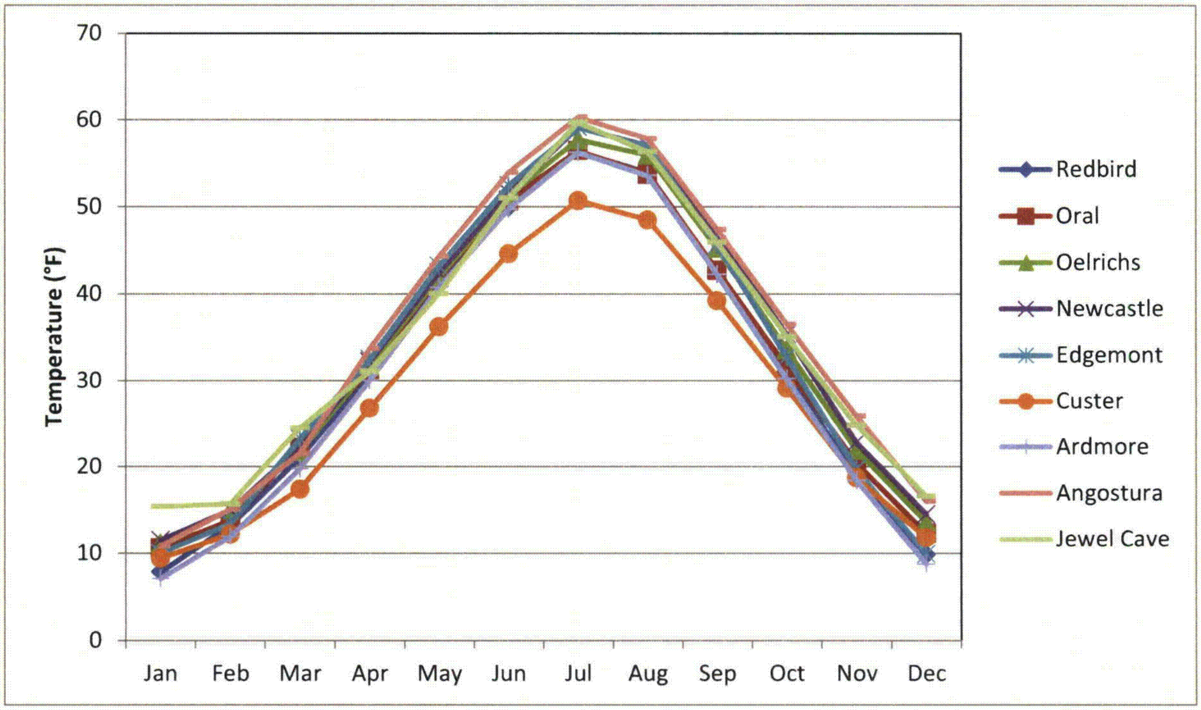


Figure 3.1-5: Average Monthly Minimum Temperatures for Regional Sites

Table 3.1-3: 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 3.1-4: 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: High Plains Regional Climate Center, 2008; South Dakota State University, 2008

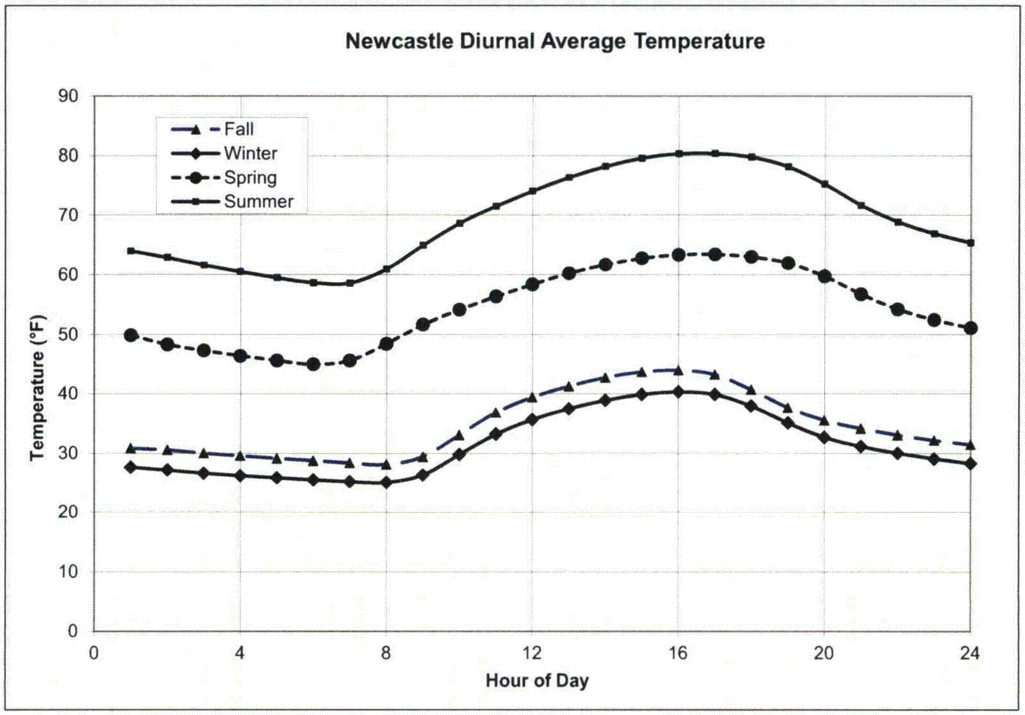


Figure 3.1-6: Newcastle, Wyoming, Seasonal Diurnal Temperature Variations

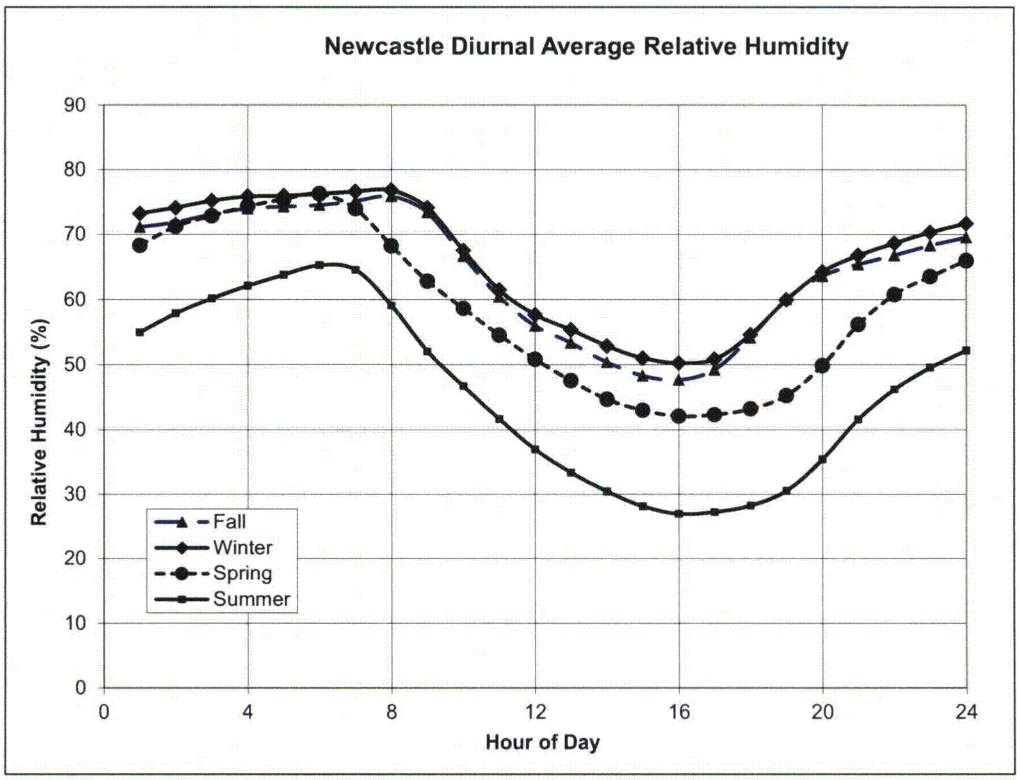


Figure 3.1-7: Newcastle, Wyoming, Seasonal Diurnal Relative Humidity Variations

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.

3.1.1.3 Precipitation

Figure 3.1-8 shows average monthly precipitation at the Newcastle NWS Coop site for the past 30 years. For comparison, Figure 3.1-9 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 3.1-10 and Table 3.1-5 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 annual accumulated 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 3.1-11, 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 3.1-12).

3.1.1.4 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 project 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. 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.

Figures 3.1-13 and 3.1-14 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

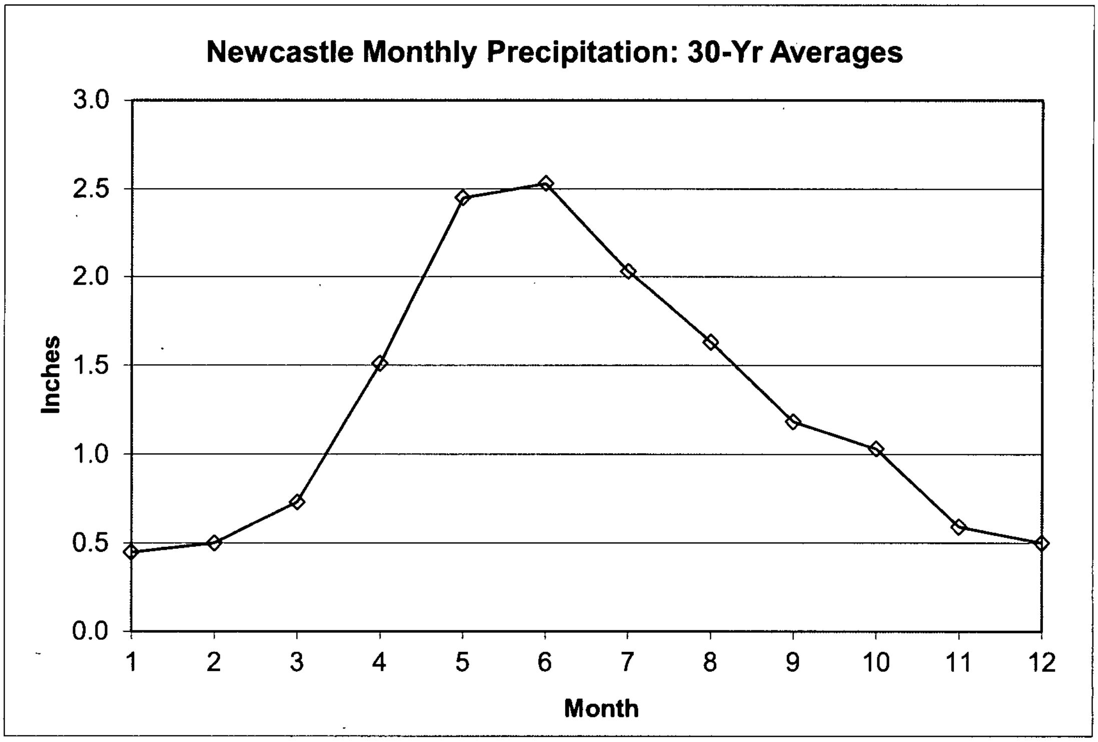


Figure 3.1-8: Average Monthly Precipitation for Newcastle, Wyoming

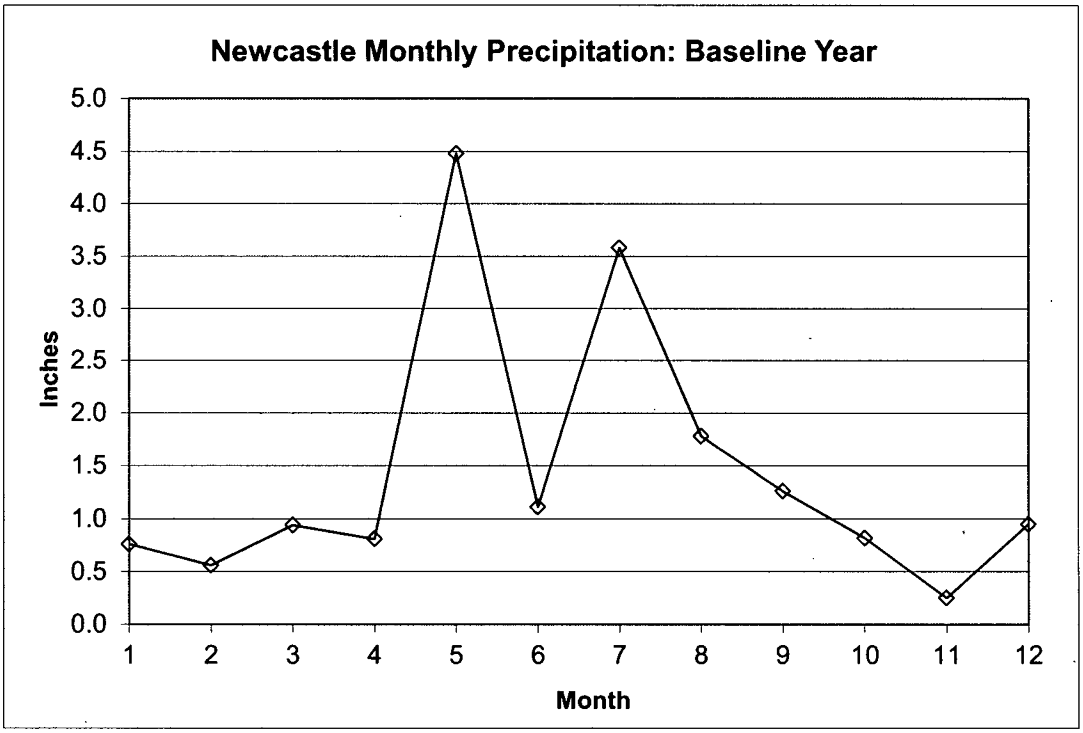


Figure 3.1-9: Baseline Year Monthly Precipitation for Newcastle, Wyoming

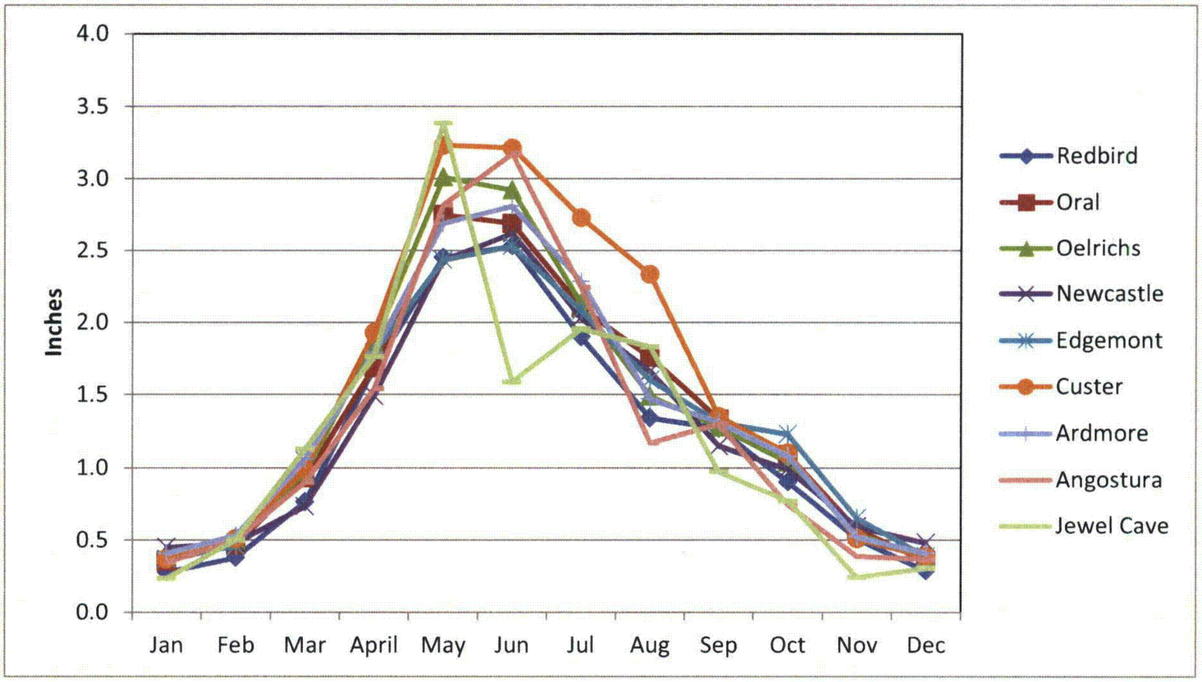


Figure 3.1-10: Average Monthly Precipitation for Regional Sites

Table 3.1-5: 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

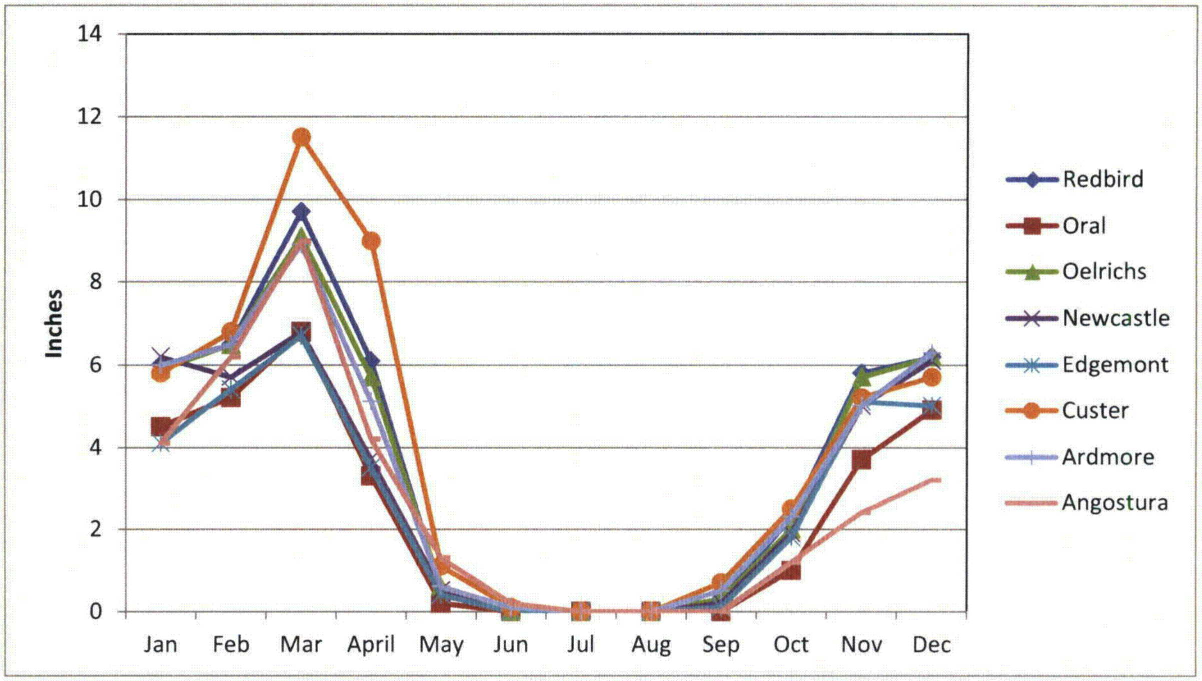


Figure 3.1-11: Average Monthly Snowfall at Regional Sites

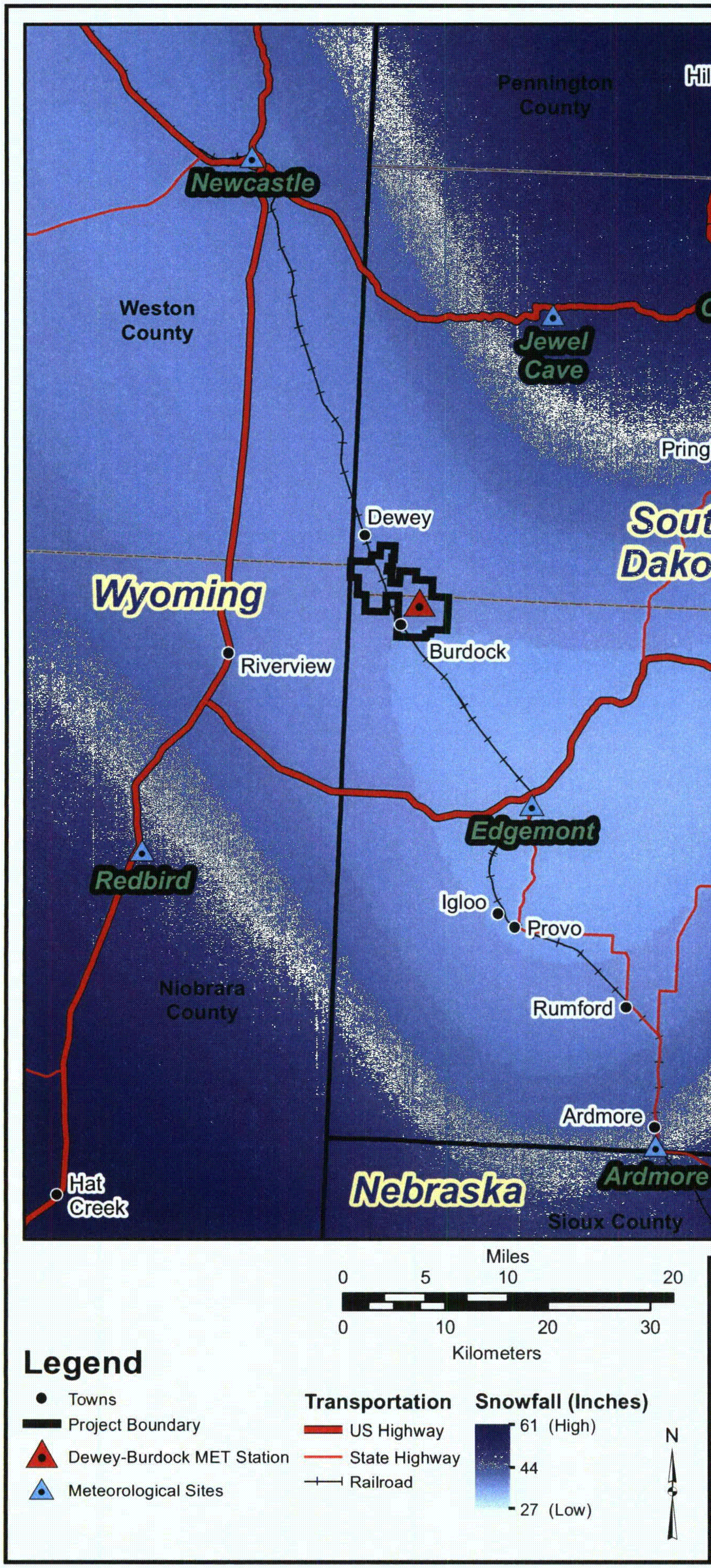


Figure 3.1-12

Annual Average Snowfall

Dewey-Burdock Project

DRAWN BY RESPEC, Hetrick
DATE 05-Dec-2011
FILENAME AnnualSnowfall.mxd

POWERTECH (USA) INC.

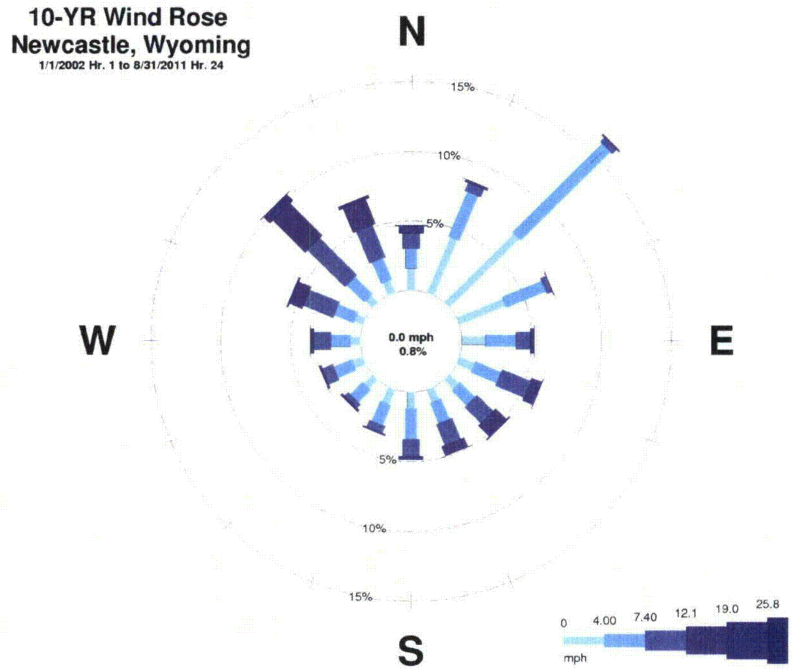


Figure 3.1-13: Newcastle 10-Year Wind Rose

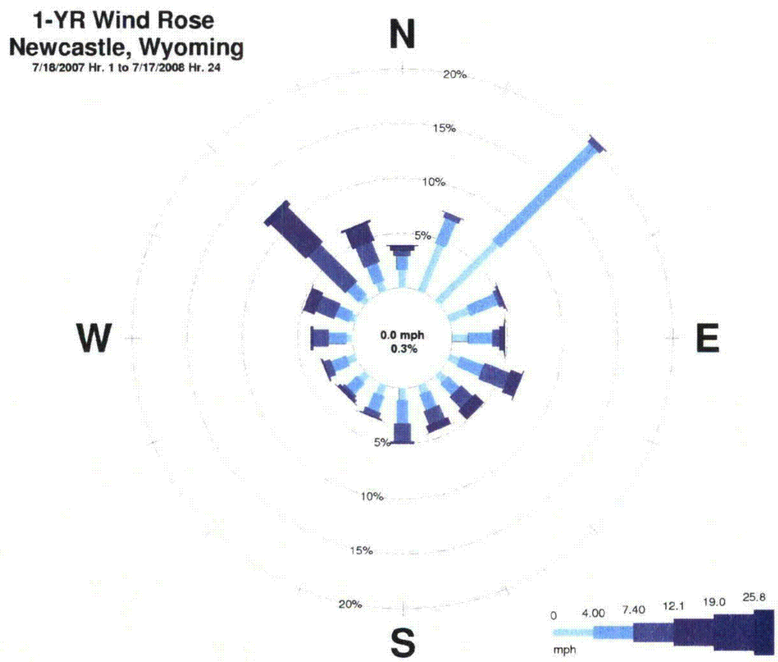


Figure 3.1-14: Newcastle 1-Year Wind Rose

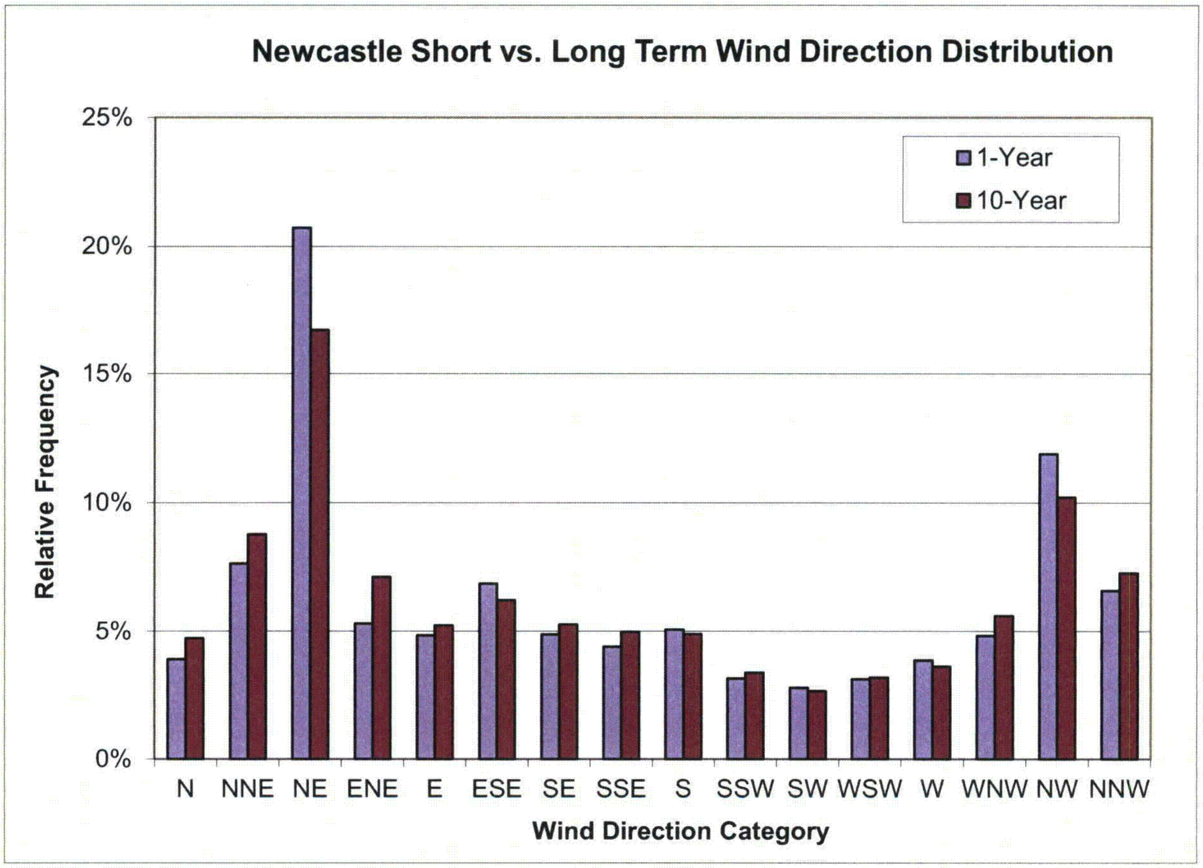


Figure 3.1-15: Newcastle Wind Direction Distributions

period. Figure 3.1-15 presents a graphical comparison of short and long-term wind direction distributions. Together these figures demonstrate qualitatively that the period from 7/18/2007 to 7/17/2008 is representative of the longer term.

3.1.1.5 Cooling, Heating and Growing Degree Days

The graphs shown in Figures 3.1-16, 3.1-17, and 3.1-18 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, which is likely caused by the higher relative elevations of these two sites.

Figure 3.1-19 presents these three measures for Newcastle on one 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.

3.1.1.6 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 Section 5.7.3, 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 where all these weather parameters were sampled, and was, therefore, the site used for the regional analysis. The data were available from May 8, 2003 to July 20, 2008. Figure 3.1-20 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. 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,

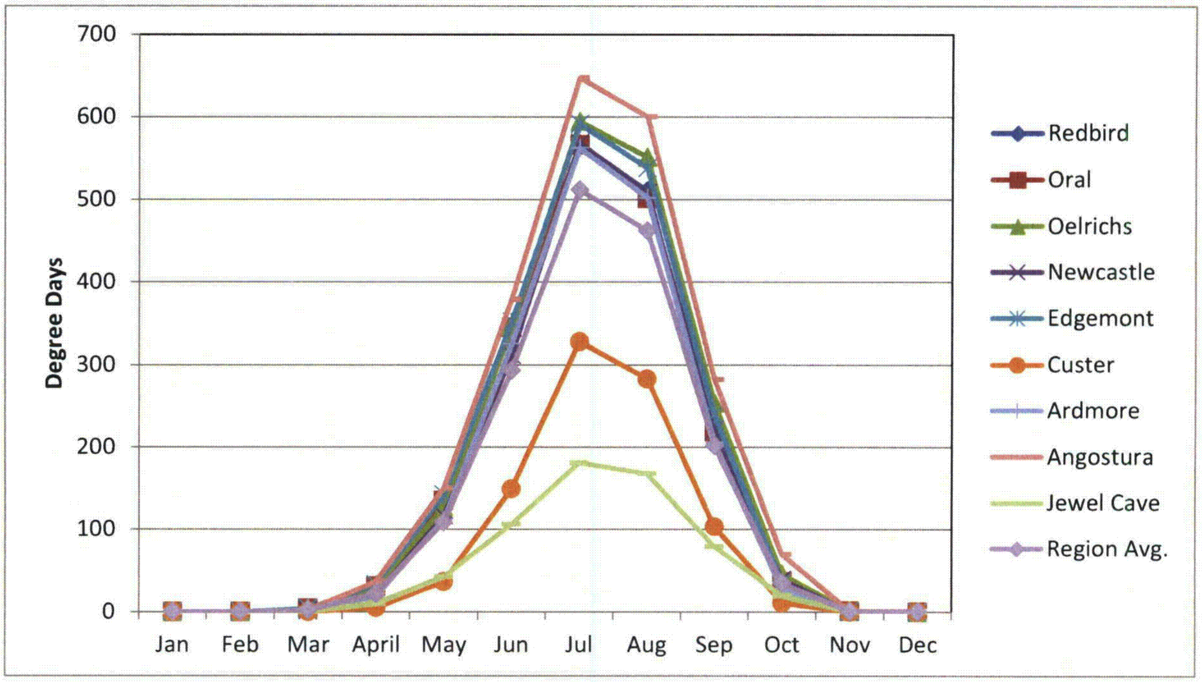


Figure 3.1-16: Growing Degree Days for Regional Sites

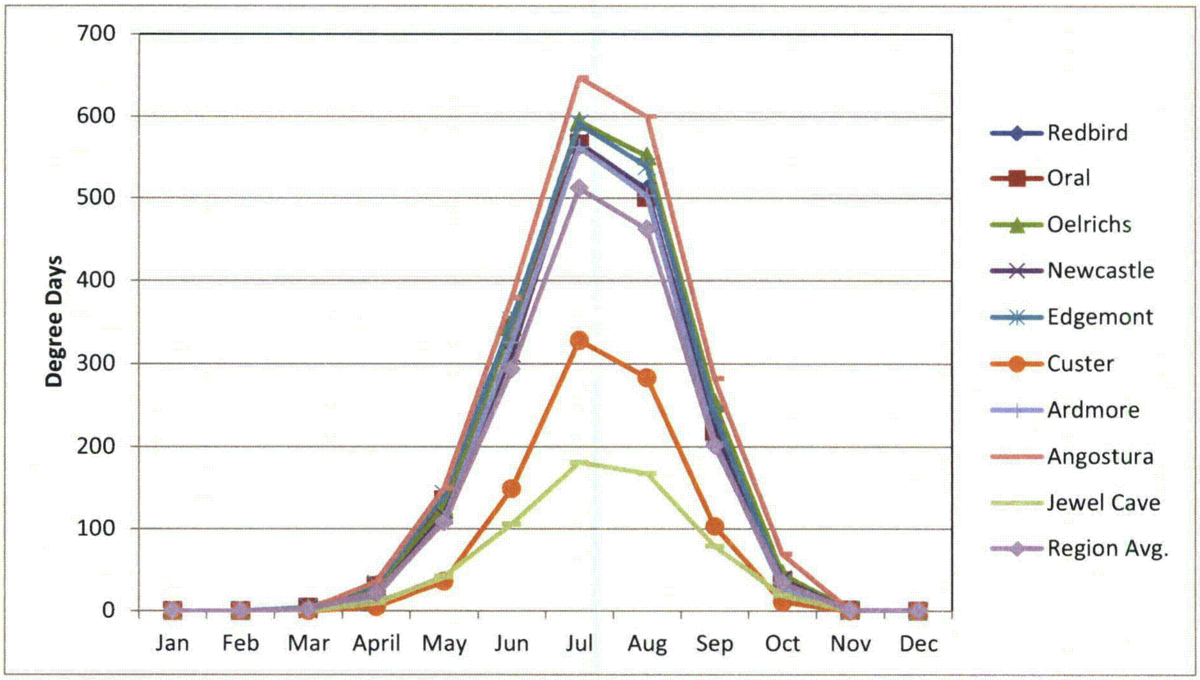


Figure 3.1-17: Cooling Degree Days for Regional Sites

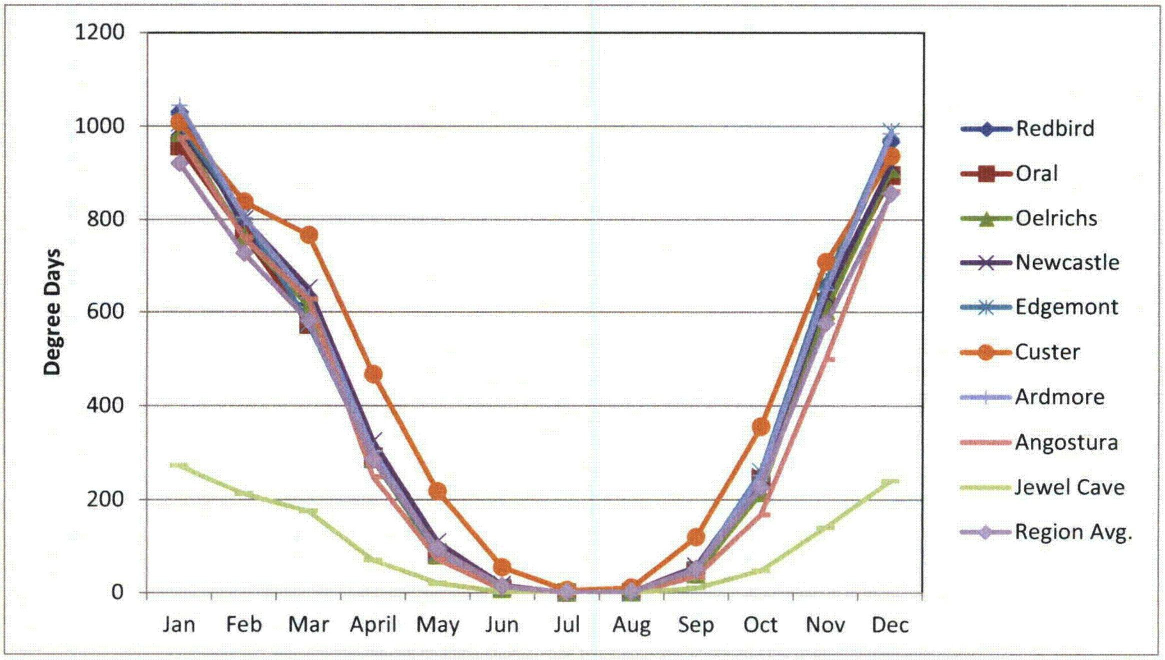
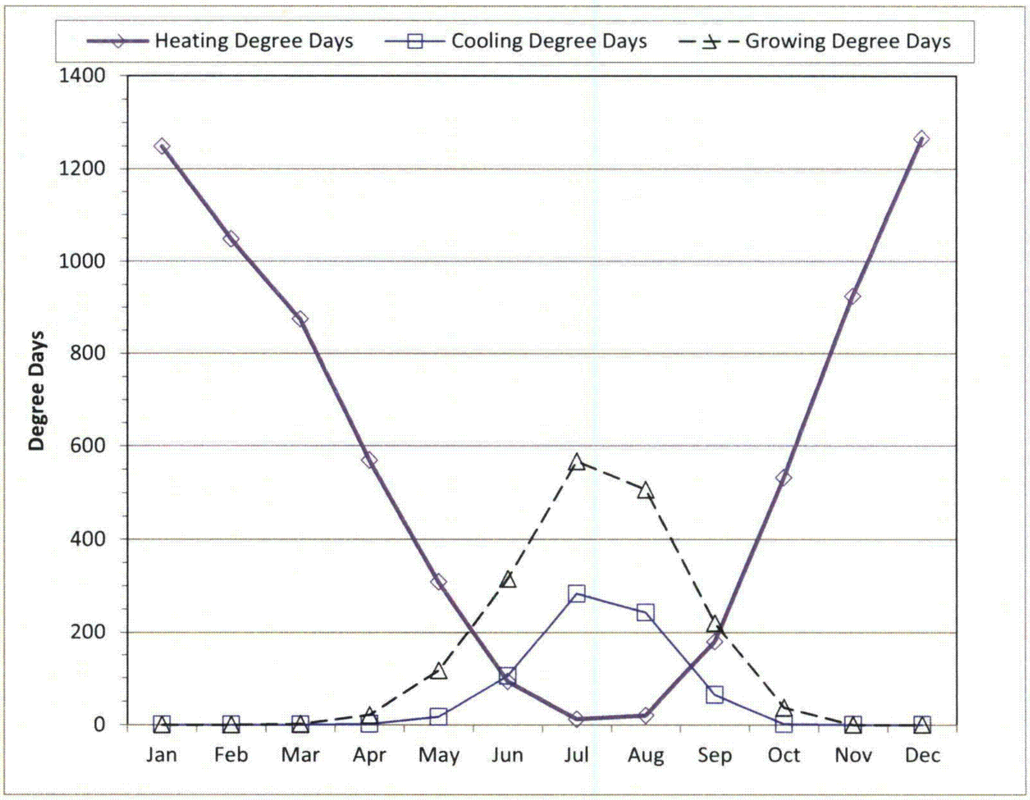


Figure 3.1-18: Heating Degree Days for Regional Sites



Source: WRCC, 2011

Figure 3.1-19: Degree Days for Newcastle NWS Site

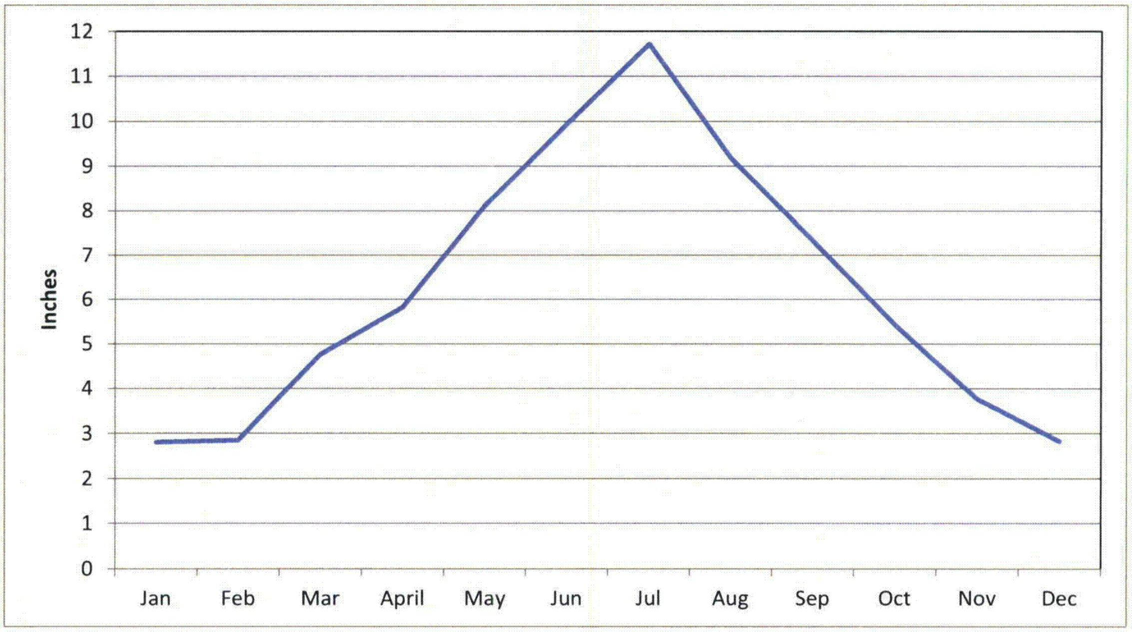


Figure 3.1-20: Average Monthly Accumulated Evapotranspiration for Oral, South Dakota

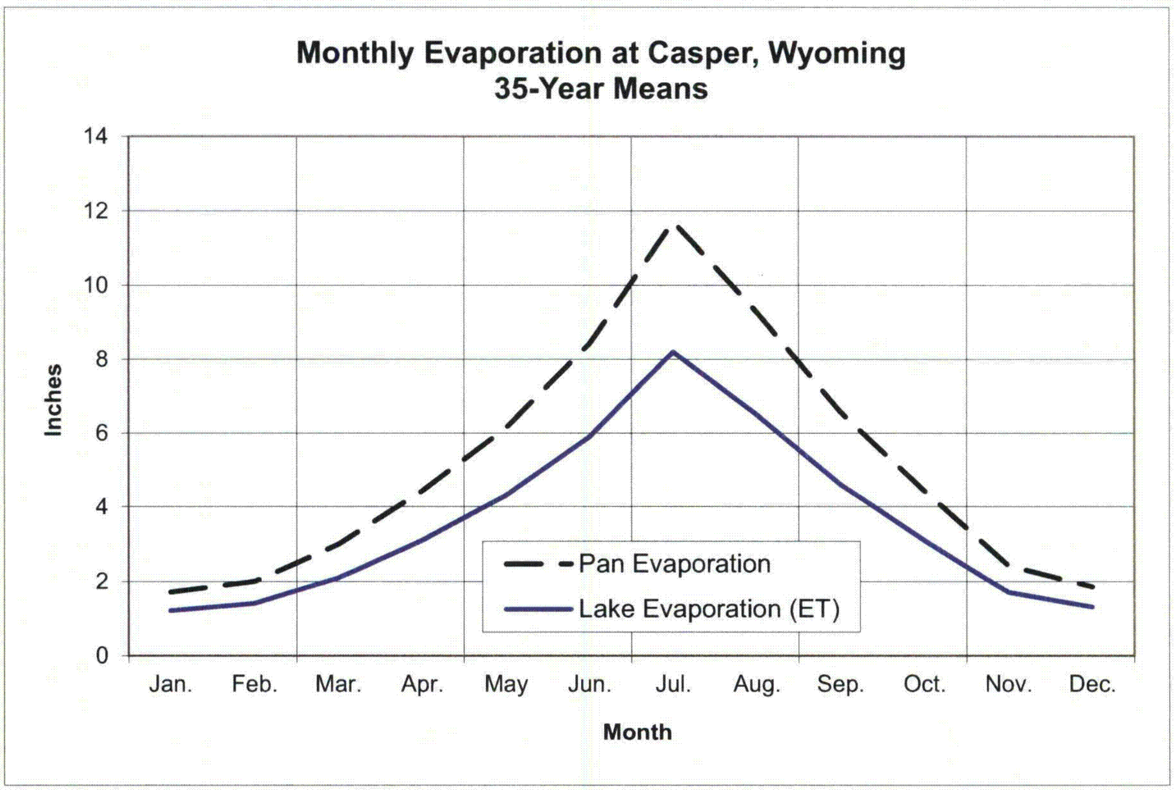


Figure 3.1-21: Average Monthly Evaporation for Casper, Wyoming

Wyoming (Figure 3.1-21). 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 3.1-21 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 3.1-20 and 3.1-21 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.

3.1.2 Site-Specific Analysis

The site-specific analysis was completed using data collected from a weather station installed in approximately the center of the proposed NRC license 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 3.1-6 lists the model number and specifications of the sensors that were installed.

3.1.2.1 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 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 3.1-22. July was the warmest month with a median temperature of 76°F with a first quartile value 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. The temperature was well above freezing for the months of April through October, during which the proposed land application systems will operate.

There were large variations in seasonal and diurnal temperature (Figure 3.1-23). 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,

Table 3.1-6: 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

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 3.1-24 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.

3.1.2.2 Wind Patterns

Wind speed and direction were measured in the field using Met-One 014A and 024A model sensors. 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 3.1-7, 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-southeasterly winds were prevalent in summer months. Figures 3.1-25 and 3.1-26 show the quarterly wind roses for the Dewey-Burdock project 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 3.1-27

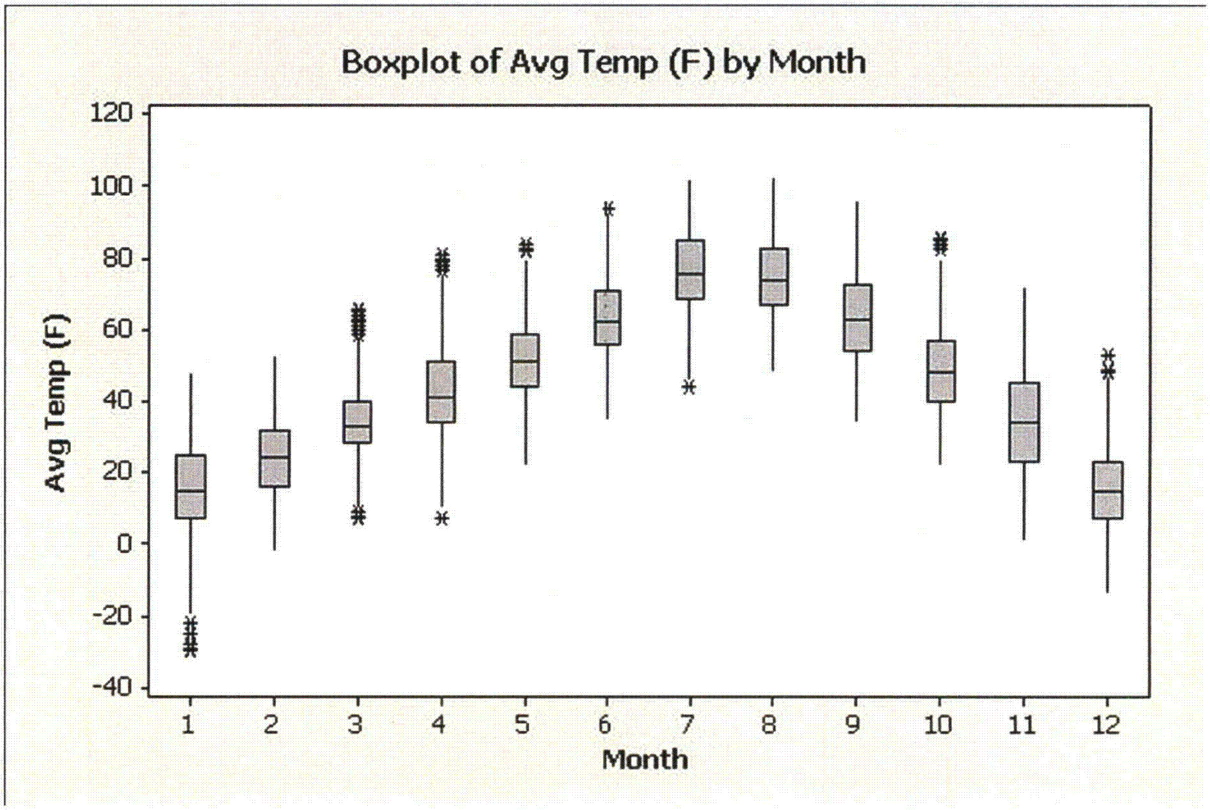


Figure 3.1-22: Average Temperature by Month from the Project Meteorological Site

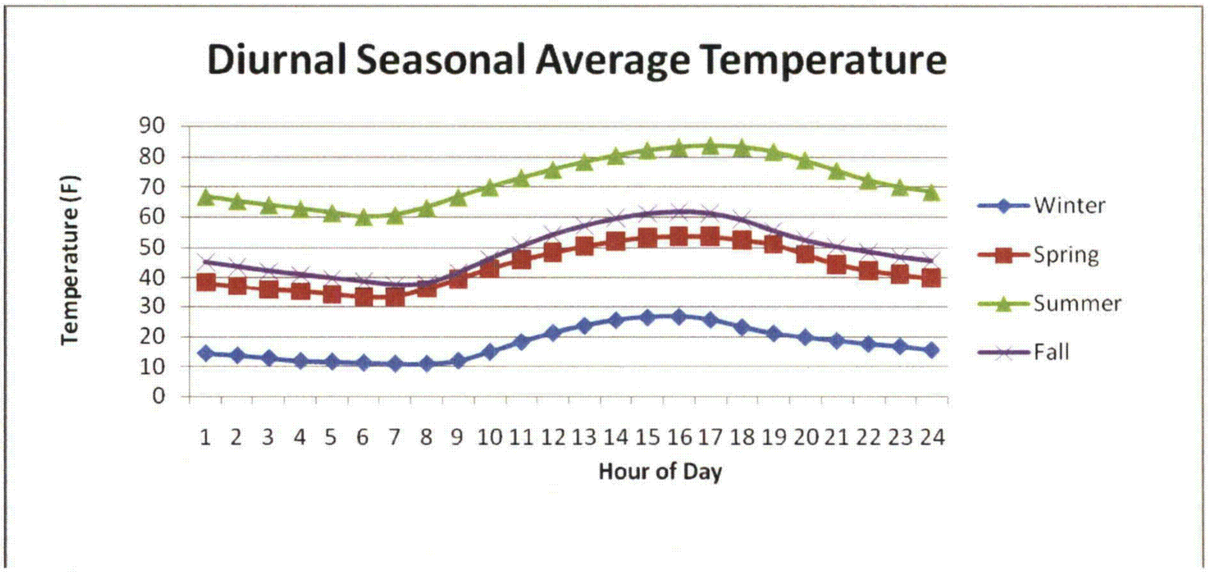


Figure 3.1-23: Diurnal Average Temperature for the Project Meteorological Site by Season

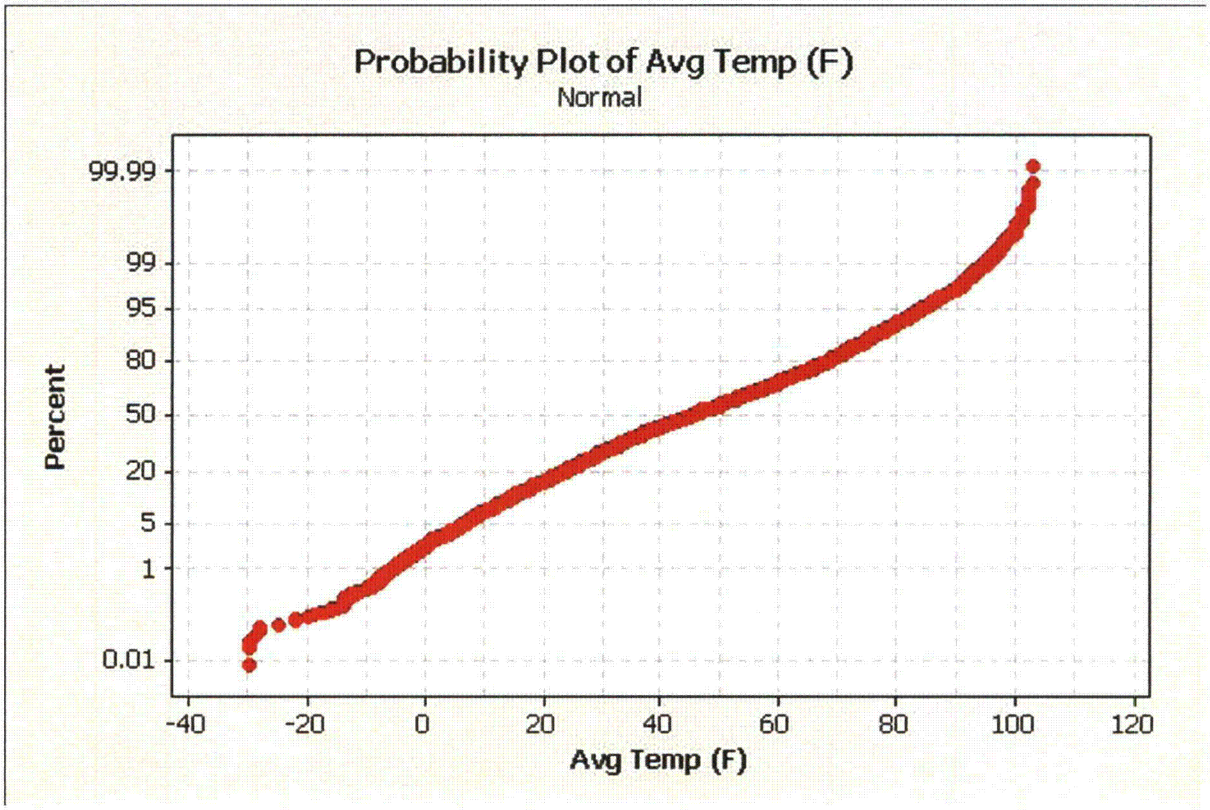
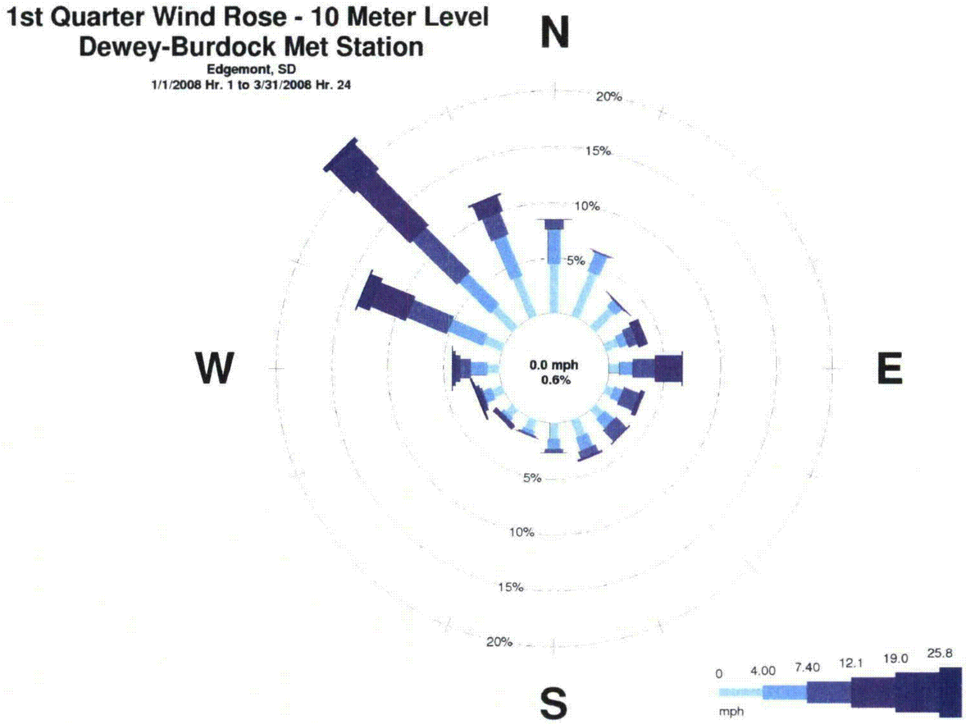


Figure 3.1-24: Probability Plot of Average Temperature from the Project Meteorological Site

Table 3.1-7: 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



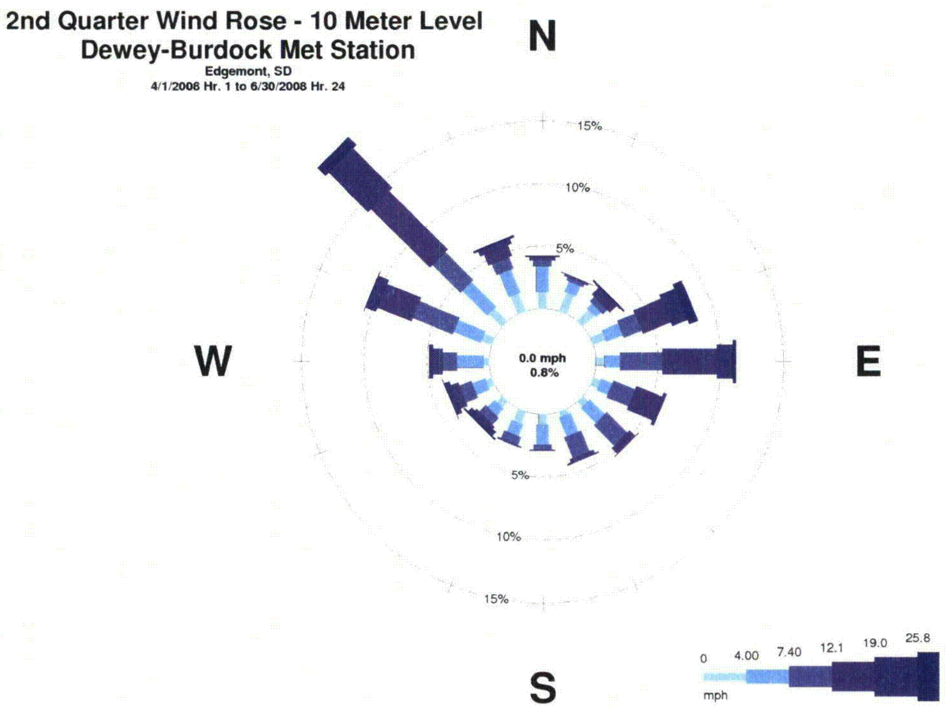
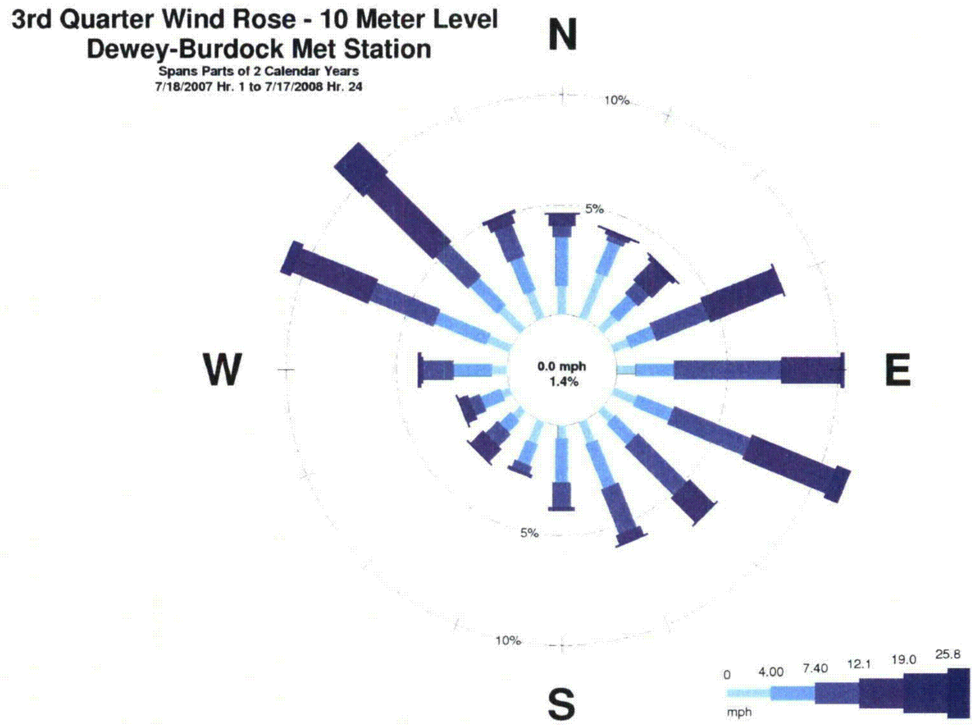


Figure 3.1-25: First and Second Quarter Wind Roses



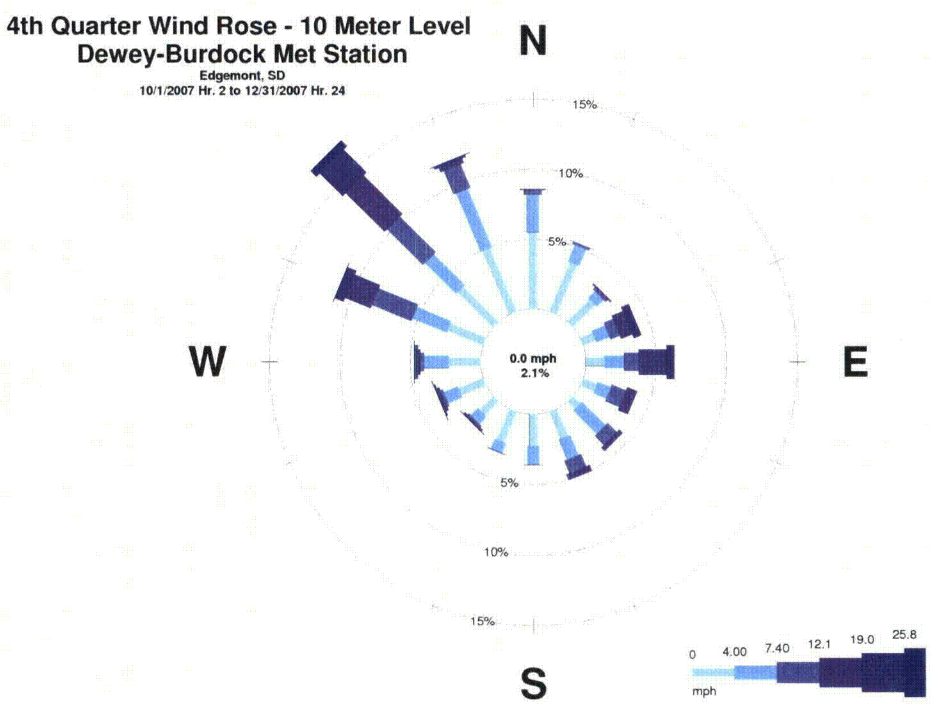


Figure 3.1-26: Third and Fourth Quarter Wind Roses

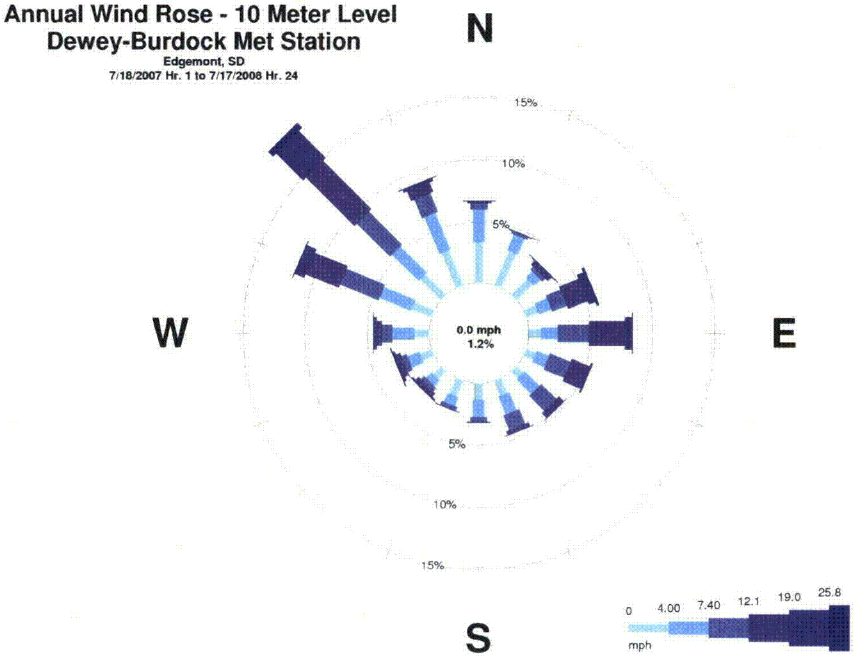


Figure 3.1-27: Annual Wind Rose

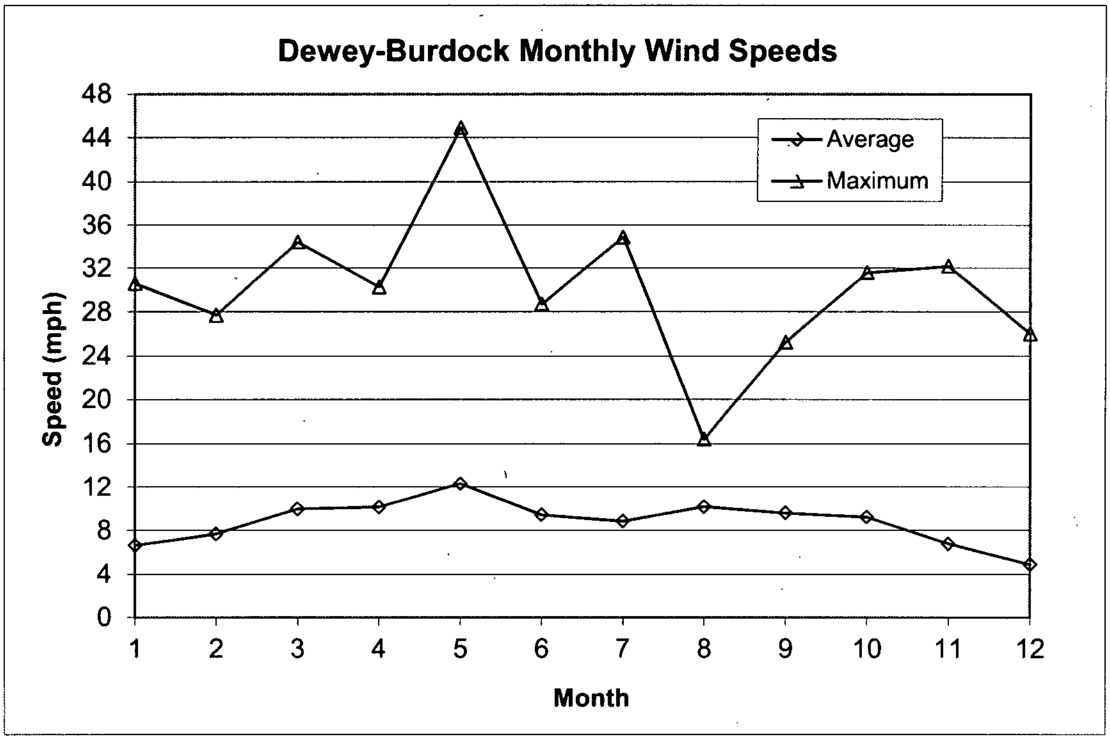


Figure 3.1-28: Dewey-Burdock Monthly Wind Speeds

shows the annual wind rose for the project site, with northwesterly and west-northwesterly winds dominating. Figure 3.1-28 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.

3.1.2.3 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 3.1-29). During the winter months, the diurnal relative humidity range was much less because of less intense and shorter duration solar radiation.

3.1.2.4 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 3.1-30 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.

3.1.2.5 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 3.1-31) 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.

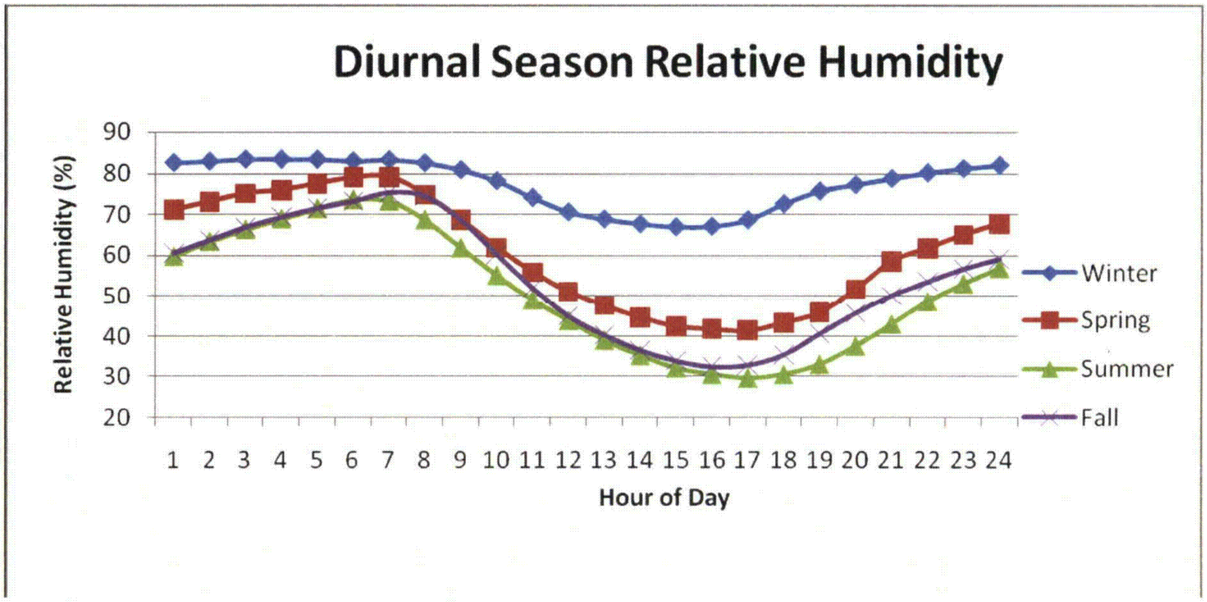


Figure 3.1-29: Diurnal Relative Humidity by Season from Project Meteorological Site

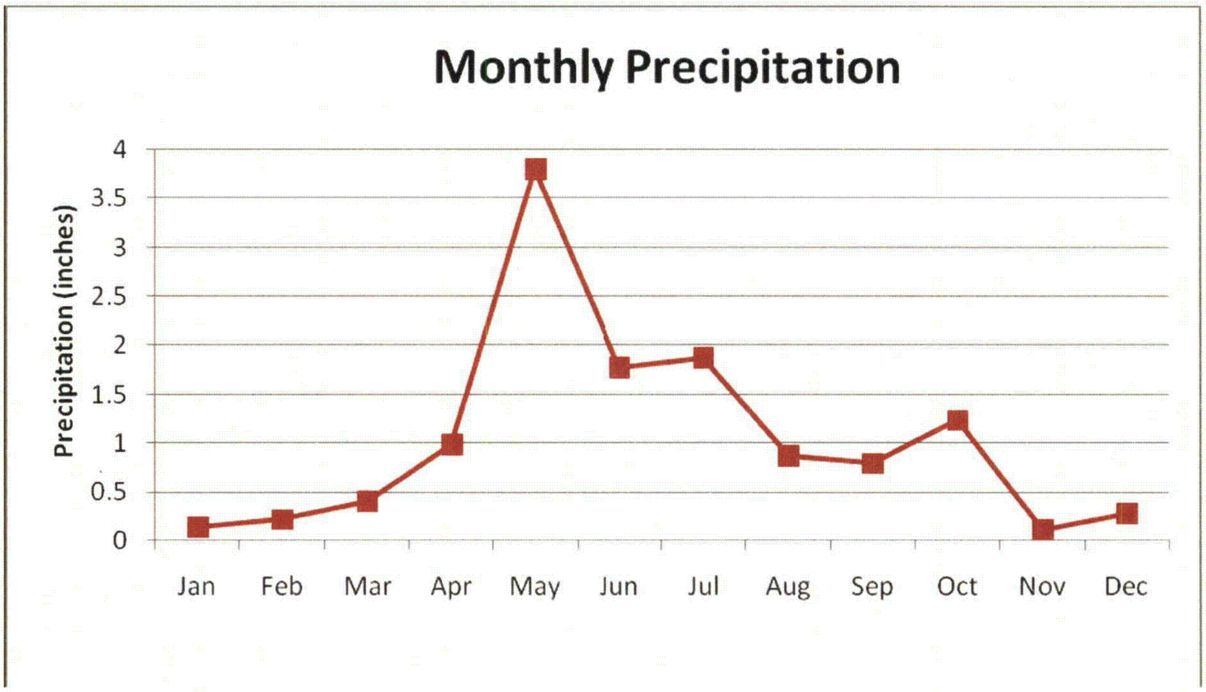


Figure 3.1-30: Monthly Precipitation from the Project Meteorological Site

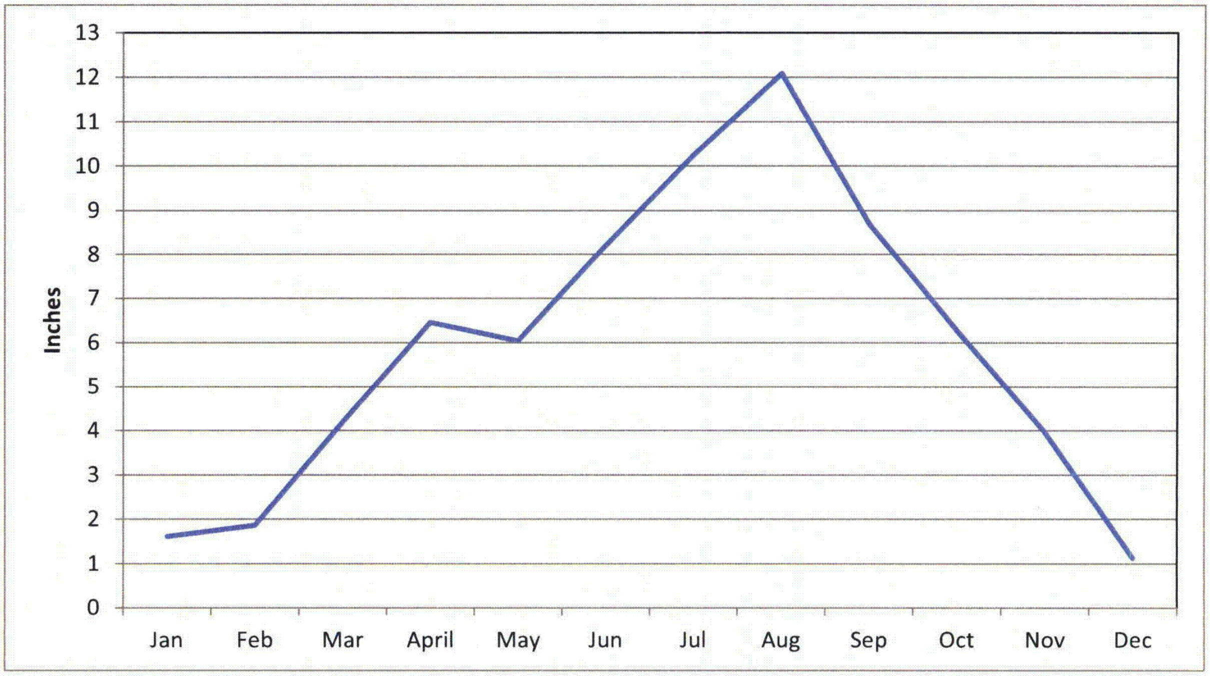


Figure 3.1-31: Estimated Evapotranspiration Calculated Using Weather Data Collected at the Project Meteorological Site

3.2 Soils

3.2.1 General Soil Description

Powertech (USA) conducted baseline soil sampling and mapping covering the proposed NRC license area/LSM permit area. Soils within the project area are typical for semi-arid grasslands and shrublands in the Western United States. Parent material included colluvium, residuum, and alluvium. Most soils are classified taxonomically as Aridic Argiustolls, Aridic Ustorthents, and Aridic Haplusterts.

3.2.2 Soil Survey Methodology

The soils in this portion of Custer and Fall River counties were studied and mapped to an Order 2 scale by the USDA, NRCS in 1982 and 1990. Information for Custer and Fall River counties is available electronically as well as hard copy. The NRCS has also centralized dissemination of typical soil series descriptions; general information is available on the Internet at http://www.nrcs.usda.gov.

BKS Environmental Associates, Inc. (BKS) of Gillette, WY performed the 2007 soil survey field work and compiled the resulting report. All soil analysis was handled by Energy Labs in Gillette, Wyoming.

Construction of the soil map was completed according to techniques and procedures of the National Cooperative Soil Survey. A total of 10,557 acres were included in the final soil mapping of the proposed NRC license area, in which 1,882 acres were located in the proposed POP zones.

Series were sampled and described by coring with a mechanical auger, i.e., truck-mounted Giddings. The physical and chemical nature of each horizon within the sampled profile was described and recorded in the field. Each hole augured for series and map unit verification was plotted on the soils map included with this report. Sampled soil material was placed in clean, labeled, polyethylene plastic bags and kept cool to limit chemical changes. Samples were kept out of direct sunlight and transported to Energy Labs for analysis. A total of 37 sites within and around the proposed NRC license boundary were sampled for analysis; all had corresponding soil profile descriptions written. Of these, eight sites were located within proposed POP zones.

3.2.3 Laboratory Analysis

Samples were individually placed into lined aluminum pans to air dry. Coarse fragments were measured with a 10 mesh screen prior to grinding; the entire sample was then hand ground to pass 10 mesh. An approximate 20 ounce subsample was obtained through splitting with a series of riffle splitters and subsequently analyzed. A second subsample was maintained in storage at Energy Labs. Approximately 10 percent of the samples are run for duplicate analysis. Actual laboratory analysis follows the methodology outlined in WDEQ-LQD Guideline 1 (August 1994 Revision). In general, samples were analyzed within 45 days of receipt of the samples at the laboratory. All analytical data are presented in Appendix 3.2-A.

3.2.4 Results and Discussion

Soil Survey - General

General topography of the area ranged from nearly level uplands to very steep hills, ridges and breaks of dissected shale plains. The soils in the project area were generally a clayey or very fine texture throughout with patches of sandy loam on upland areas and fine, clay textured soils occurring in or near drainages. The project area contained deep soils on level upland areas with shallow and very shallow soils located on hills, ridges and breaks. Plate 3.2-1 shows the soil map for the proposed NRC license area. Tables 3.2-1 and 3.2-2 provide the soil mapping unit designations and associated acreage within the Dewey and Burdock POP zones, respectively. Figure 3.2-1 provides the soils map at the Dewey land application area, and Figure 3.2-2 shows the soil map at the Burdock land application area.

The primary purpose of the 2007 fieldwork was to characterize the soils in terms of topsoil salvage depths and related physical and chemical properties. Refer to Appendix 3.2-A for soil mapping unit descriptions and soil series descriptions for those soils within the land application areas and associated POP zones.

Analyzed parameters are in Appendix 3.2-A. Laboratory soil texture analysis did not include percent fine sands. Field observations of fine sands within individual pedestals as well as sample site topographic position were used in conjunction with laboratory analytical results to determine series designation. Where applicable, field observation of fine sands is also included in the textures found in the soil series descriptions in Appendix 3.2-A. In several of the pedestal sampling locations, laboratory analysis yielded finer than expected textures (based upon field observations). Where textures are finer than typical for the series, it is noted in the Range of Characteristics (according to field observations, lab analysis) in the soil series descriptions.

Table 3.2-1: Soil Mapping Unit Acreage within Proposed Dewey POP Zone

Map Symbol	Map Unit Description	Acreage	% Total Acreage
Ar	Arvada, 0 to 6 percent slopes	153.4	18.4
ArV	Arvada Variant Loam, 0 to 6 percent slope	3.6	0.4
Ar-SS	Arvada-Slickspots Complex, 0 to 6 percent slopes	80.5	9.7
Dg	Demar, 0 to 6 percent slopes	38.8	4.7
DA	Disturbed-Ag	0.2	0.0
GrA	Grummit, 0 to 6 percent slopes	47.9	5.8
GrB	Grummit, 6 to 15 percent slopes	16.2	2.0
GrB-RO	Grummit-Rock Outcrop Complex, 6 to 15 percent slopes	19.4	2.3
Ha	Haverson, 0 to 6 percent slopes	21.9	2.6
PeA	Pierre, 0 to 6 percent slopes	207.0	24.9
RO	Rock Outcrop	0.4	0.0
Sc-Ar	Satanta-Arvada Complex, 0 to 6 percent slopes	85.0	10.2
SS	Slickspots	131.6	15.8
ZnB	Zigweid, 6 to 15 percent slopes	17.2	2.1
ZnB-NF	Zigweid-Nihill Complex, 6 to 15 percent slopes	9.0	1.1
Total		**832.1**	**100.0**

Table 3.2-2: Soil Mapping Unit Acreage within Proposed Burdock POP Zone

Map Symbol	Map Unit Description	Acreage	% Total Acreage
Ar	Arvada, 0 to 6 percent slopes	47.3	4.5
Bc	Barnum, 0 to 6 percent slopes	176.5	16.8
Cy	Cushman, 6 to 15 percent slopes	73.2	7.0
DA	Disturbed-Ag	9.1	0.9
GrA	Grummit, 0 to 6 percent slopes	70.5	6.7
GrB	Grummit, 6 to 15 percent slopes	26.8	2.6
GrC	Grummit, 15 to 60 percent slopes	0.1	0.0
He	Hisle, 0 to 6 percent slopes	197.2	18.8
Ky	Kyle, 0 to 6 percent slopes	92.3	8.8
Lo	Lohmiller, 0 to 6 percent slopes	4.1	0.4
MP	Mine Pit	4.2	0.4
NuA	Nunn, 0 to 6 percent slopes	5.8	0.5
NuB	Nunn, 6 to 15 percent slopes	9.1	0.9
Pg	Penrose, 15 to 40 percent slopes	48.8	4.6
PeA	Pierre, 0 to 6 percent slopes	10.9	1.0
PeB	Pierre, 6 to 15 percent slopes	17.7	1.7
Sa	Samsil, 15 to 40 percent slopes	4.4	0.4
SS	Slickspots	51.3	4.9
Ta	Tillford, 0 to 6 percent slopes	196.9	18.8
W	Water	3.4	0.3
Total		**1,049.9**	**100.0**

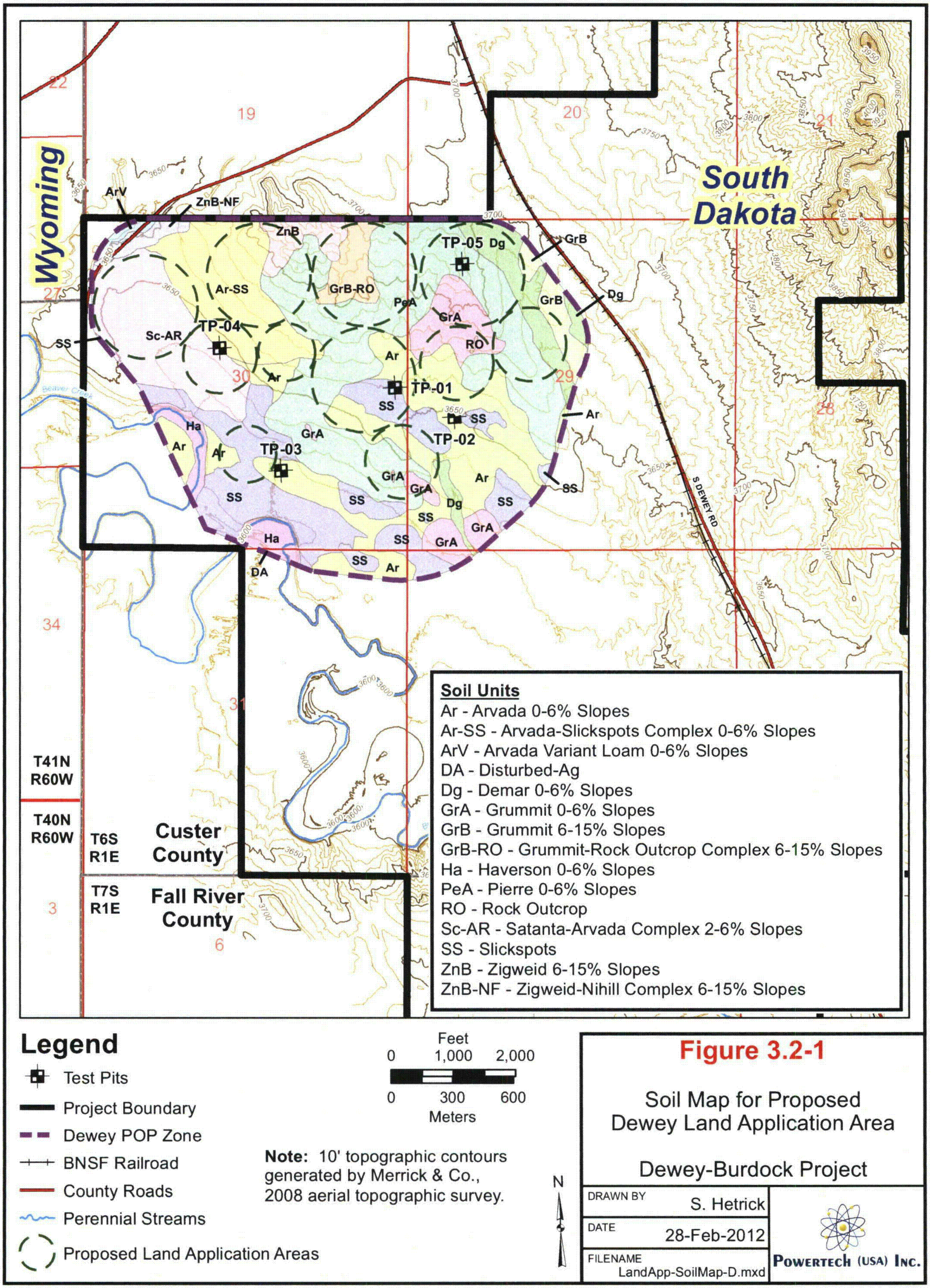


Figure 3.2-1

Soil Map for Proposed Dewey Land Application Area

Dewey-Burdock Project

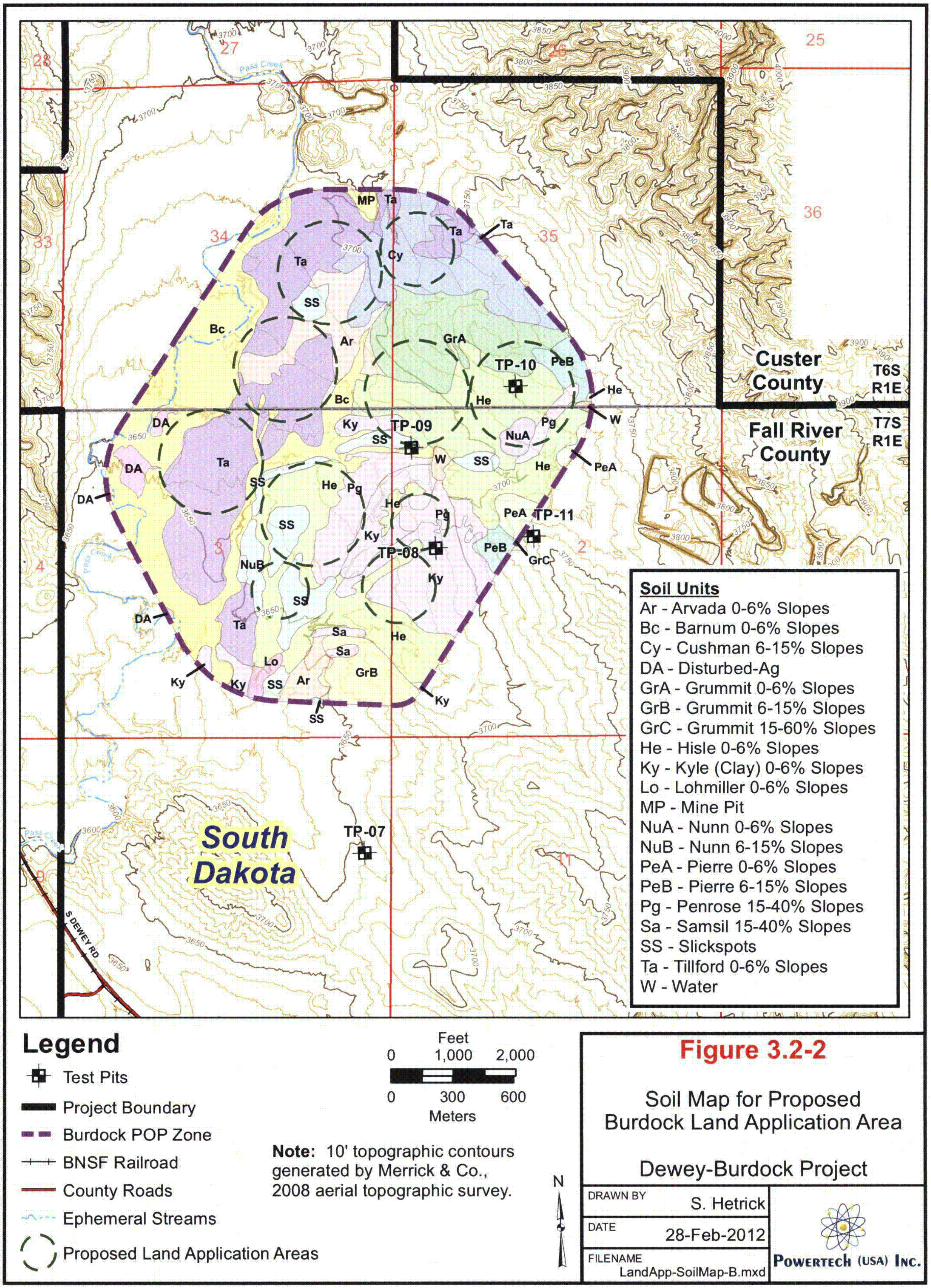


Figure 3.2-2

Soil Map for Proposed Burdock Land Application Area

3.2.5 Test Pits

To further characterize the soils at the land application sites, 11 test pits were excavated on July 11 and 12, 2008. Samples were collected at various depths and analyzed for particle size distribution, dry bulk density, permeability, and other geotechnical parameters. Test pits 1 through 5 were excavated at the Dewey land application area, and test pits 6 through 11 were excavated in and around the Burdock land application area. The test pit locations are shown on Figures 3.2-1 and 3.2-2. Table 3.2-3 shows the USDA soil texture and dry bulk density for the test pit samples. These parameters were used as input to the SPAW model as described in Section 5.7.

The particle size distributions for the NRCS soil mapping units were compared to the laboratory particle size distributions for the test pit soil samples. This comparison showed that the laboratory results for the test pit samples generally fell within the range of particle size distributions for the NRCS survey soil mapping units.

In addition to soil data from test pits, soil samples were obtained from auger holes located as shown on Plate 3.2-1. Soil samples were collected by BKS at various depths and analyzed for selected physical/chemical characteristics including saturated paste extracts for electrical conductivity (EC), pH, Ca, Mg, Na, Cl, SO_4, HCO_3, As, Ba, Cd, Cr, Pb, Hg, Se, and Ag. USDA percent sand, silt and clay, as well as organic matter, natural moisture content, and saturation moisture content also were determined. Table 3.2-4 summarizes average values at each site for EC, pH, organic matter, Ca, Mg, Na, sodium adsorption ratio (SAR), exchangeable sodium percentage (ESP), residual sodium carbonate (RSC), USDA soil texture, and as concentrations for the upper soil layer (0 to 11 inches below ground surface) and the deeper soil layer (approximately 50 inches below ground surface) for the auger samples. These are the parameters that are used to assess the success of crop growth using the treated land application water.

Analysis of Table 3.2-4 indicates that the existing soils to be irrigated at both the Dewey and Burdock sites are fine grained, comprised of primarily clay, clay loam, and silty clay textures. Particularly at Dewey, the sodicity of the soils, as reflected by SAR, could be a source of concern if these soils are irrigated. As described in Section 8.3, the land application water is expected to have a relatively low SAR, which will pose a low risk to soil infiltration rates. Should soil SAR increase and pose a risk to soil infiltration, Powertech (USA) will use amendments as necessary such as sulfur or gypsum. At both the Dewey and Burdock sites the physical/chemical constituents increase with soil depth and are typically high values below the top one foot of soil, as would be expected in these fine-grained soils of marine sediment parent material.

Table 3.2-3: Soil Test Pit Physical Properties

Sample No.	Depth (ft)	Gravel (% by wt)	Sand (% by wt)	Silt (% by wt)	Clay (% by wt)	Dry Bulk Density (lb/ft^3)	Permeability (cm/sec)
TP01-1	1	0.20	26.20	38.00	35.60	N/A	5.10E-05
TP01-3	3	0.10	25.70	27.20	47.00	101.20	
TP01-7	7	0.90	8.10	57.20	33.80	86.30	
TP02-1	1	0.00	19.90	40.70	39.40	94.50	
TP02-4	4	0.00	16.70	34.60	48.70	101.50	
TP02-7	7	0.20	26.70	34.80	38.30	92.50	
TP03-1	1	0.00	24.30	24.80	50.90	90.00	8.30E-05
TP03-7	7	0.00	2.40	25.10	72.50	104.60	
TP03-11	11	60.00	25.00	8.90	6.10		
TP04-1	1	2.20	47.80	18.20	31.80	98.10	
TP04-7	7	1.30	27.50	28.00	43.20	113.30	
TP05-1	1	1.50	24.00	31.60	42.90	97.00	
TP05-4	4	2.00	30.00	23.40	44.60	94.80	3.20E-05
TP05-8	8	0.80	22.10	57.60	19.50	106.30	
TP06-1	1	0.30	17.90	30.80	51.00	NA	
TP06-7	7	0.00	42.00	31.80	26.20	NA	
TP06-10	10	0.00	40.00	31.20	28.80	NA	
TP07-1	1	0.60	17.40	27.30	54.70	105.30	
TP07-5	5	0.1	22.1	25.9	51.9	103.90	
TP07-10	10	0.3	19.7	6.9	73.1	105.40	
TP08-2	2	0.1	11.9	35.7	52.3	95.20	5.70E-04
TP08-6	6	0.4	56.6	25.4	17.6	103.40	
TP09-1	1	0.3	15.2	39	45.5	94.90	
TP09-4	4	0.1	35.9	37.8	26.2	109.60	5.50E-06
TP10-1	1	1.8	21.1	34.8	42.3	99.10	
TP10-7	7	0.4	11.1	30.3	58.2	105.80	1.60E-07

Notes: NA = Results for these samples were not available.

Table 3.2-4: Summary of Dewey and Burdock Soil Physical/Chemical Characteristics in Land Application Areas

Area	Depth	EC	pH	Organic Matter	Ca	Mg	Na	SAR	ESP[6]	Texture	As
	(in)	(mS/cm)	(std. units)	(%)	(meq/L)	(meq/L)	(meq/L)	(unitless)	(unitless)	(unitless)	(mg/kg)
Dewey[1]	0 - 11	1.22	6.8	1.6	4.4	2.8	6.3	3.19	3.33	C-CL-SiCL	16.8
	≈50	5.40	6.8	0.5	16.9	27.0	33.0	7.39	8.79	SiC-CL-C-SL	13.1
Dewey[3]	84	--[5]	--[5]	1.3	100.4	50.2	78.6	10.90	12.91	C	--[5]
Burdock[2]	0 - 11	1.64	7.3	1.8	8.2	4.1	5.3	1.91	1.53	C-CL-SiC	9.6
	≈50	5.98	7.7	0.7	24.5	34.7	37.5	6.16	7.26	C-CL-SiC-L	9.4
Burdock[4]	84	--[5]	--[5]	1.1	100.6	84.9	28.3	4.80	5.50	CL	--[5]

(1) Average of auger cores. BKS Environmental Associates, Inc. (Oct. 7, 2008)
(2) Average of auger cores. BKS Environmental Associates, Inc. (Oct. 7, 2008)
(3) Average of 3 values from test pits. Knight Piésold and Co. (2008)
(4) Average of 2 values from test pits. Knight Piésold and Co. (2008)
(5) -- means no data available
(6) Calculated from average SAR

The two potential issues associated with long-term application of treated process water to the Dewey and Burdock sites are changes in the physical properties of the soils (lower hydraulic conductivity and crusting) and changes to the chemical properties of the soils (increased salts and trace metals). These potential changes will be closely monitored as described in Section 6.

3.3 Vegetation

3.3.1 Regional Setting

The project area is within the mixed grass eco-region of the Northern Great Plains (EPA, 1993), near the southwestern extension of the Black Hills. The elevation within the project area ranges from approximately 3,600 feet to 3,900 feet above mean sea level, with the highest elevations along the pine breaks that overlap its eastern boundary. Topography in the project area and surrounding lands is primarily gently rolling in the western quarter, with more varied terrain in the pine breaks and dissected hills that comprise the rest of the area.

The project area is comprised of five main vegetative communities, in descending order according to size: Big Sagebrush Shrubland, Greasewood Shrubland, Upland Grassland, Ponderosa Pine Woodland, and Cottonwood Gallery. Despite the overall ranking, Upland Grassland was present in the largest individual parcels. Interspersed among those primary habitats are smaller inclusions of Silver Sagebrush Shrubland, Agricultural Land, disturbed areas, creek channels, and numerous ephemeral draws.

Trees are present along the riparian corridors of both primary creeks and on the higher hilltops in the project area. The plains cottonwood (*Populus deltoides*) was the only tree present along the creek channels and was more prevalent in the Pass Creek corridor. Ponderosa pine (*Pinus ponderosa*) dominates the higher hilltops and breaks in the central and eastern portions of the project area, with Rocky Mountain juniper (*Juniperus scopulorum*) present as individual trees or small inclusions in some of the dry drainages.

3.3.2 Vegetation Survey Methodology

All vegetation sampling procedures were designed according to previous experience with similar projects and in collaboration with the South Dakota Department of Game, Fish and Parks (SDGF&P). Refer to Appendix 3.3-A for 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 NRC license boundary.

Mapping

Seven different plant communities were identified for the proposed NRC license 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 3.3-1).

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 NRC license 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 3.3-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 POP zones are contained in Appendix 3.3-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

This data was taken at the time of cover sampling to ensure adequate use of field time. Summarization of that data for the proposed POP zones can be found in Appendix 3.3-A.

Shrub density data was 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. Summarization of that data for the proposed POP zones can be found in Appendix 3.3-A.

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 3.3-A by vegetation community type for each of the five vegetation communities in the proposed POP zones. 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, 3rd Edition) 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.

3.3.3 Results

The NRC license acreage is 10,580 acres and 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 Tables 3.3-1 and 3.2-2 for acreage of each vegetation community within the land application sites and associated POP zones. Figures 3.3-1 and 3.3-2 provide the vegetation maps for Dewey and Burdock POP zones, respectively. Plate 3.3-1 provides the vegetation map for the Dewey-Burdock project area.

Table 3.3-1: Vegetation Mapping Unit Acreage within Proposed Dewey POP Zone

Map Unit	Acreage	% of Area
Sampled Vegetation Communities		
Greasewood Shrubland	645.2	77.5
Ponderosa Pine Woodland	2.2	0.2
Upland Grassland	157.7	19.0
Described Vegetation Communities		
Agricultural Land	20.5	2.5
Disturbed	4.2	0.5
Silver Sagebrush Shrubland	2.3	0.3
TOTAL	**832.1**	**100.0**

Table 3.3-2: Vegetation Mapping Unit Acreage within Proposed Burdock POP Zone

Map Unit	Permit area	% of Area
Sampled Vegetation Communities		
Big Sagebrush Shrubland	315.8	30.1
Greasewood Shrubland	426.8	40.7
Upland Grassland	162.8	15.5
Cottonwood Gallery	73.8	7.0
Described Vegetation Communities		
Existing Mine Permit	1.3	0.1
Silver Sagebrush Shrubland	66.9	6.4
Shale Outcrop	2.5	0.2
TOTAL	**1,049.9**	**100.0**

3.4 Livestock and Grazing Animals

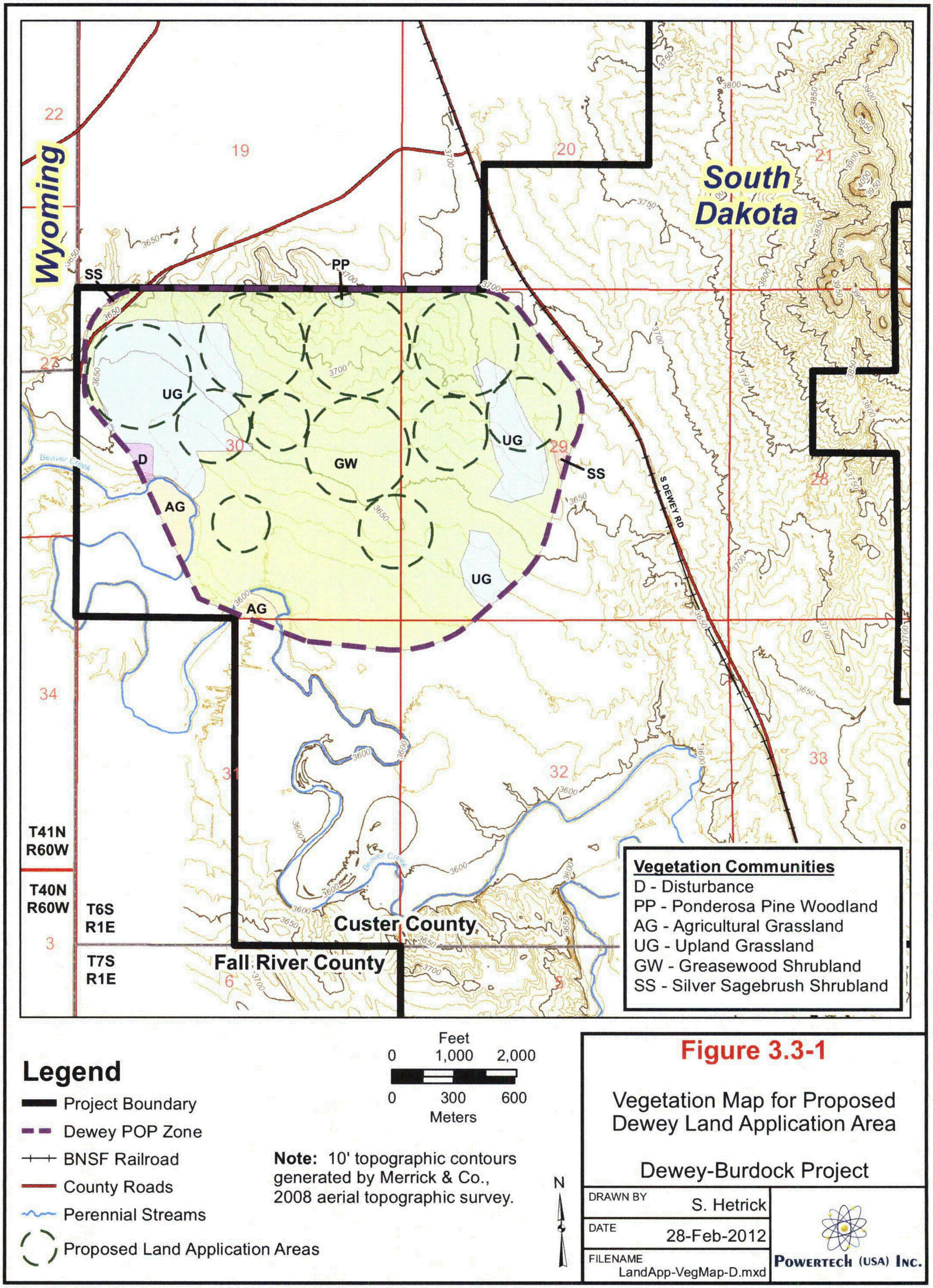
3.4.1 Regional Setting

This section provides a general discussion of the affected environment for vertebrate terrestrial wildlife. Background information for terrestrial fauna in the vicinity of the project was obtained from several sources, including records from SDGF&P, BLM, the U.S. Fish and Wildlife Service (USFWS), the U.S. Forest Service (USFS), and the TVA DES for similar operations overlapping the proposed NRC license area. Site-specific data for the project and surrounding perimeter were obtained from those same sources, with current data collected during regular site visits and targeted surveys conducted for the Dewey-Burdock Project.

3.4.2 Wildlife Survey Methodology

Wildlife sampling was conducted by ICF Jones & Stokes (formerly Thunderbird-Jones & Stokes) of Gillette, Wyoming from July 2007 through early August 2008.

Survey protocols and timing were developed collaboratively with SDGF&P to meet species-specific requirements. The survey area included the proposed NRC license area (project area) and one-mile perimeter for threatened and endangered (T&E) species, bald eagle winter roosts, all nesting raptors, upland game bird leks, and big game. Surveys conducted included other vertebrate species of concern tracked by the South Dakota Natural Heritage Program (SDNHP), as well as bats, small mammals, lagomorphs, prairie dog (*Cynomys* spp.) colonies, breeding birds, predators, and herptiles (reptiles and amphibians). In addition to these targeted


Wyoming
South Dakota
22
19
20
21
27
30
29
28
34
31
32
33
3
6
5
SS
PP
UG
D
AG
GW
UG
SS
UG
AG
S DEWEY RD
Beaver Creek
T41N R60W
T40N R60W
T6S R1E
T7S R1E
Custer County
Fall River County
Vegetation Communities
D - Disturbance
PP - Ponderosa Pine Woodland
AG - Agricultural Grassland
UG - Upland Grassland
GW - Greasewood Shrubland
SS - Silver Sagebrush Shrubland
Legend
Project Boundary
Dewey POP Zone
BNSF Railroad
County Roads
Perennial Streams
Proposed Land Application Areas
Feet
0 1,000 2,000
0 300 600
Meters
Note: 10' topographic contours generated by Merrick & Co., 2008 aerial topographic survey.
N
Figure 3.3-1
Vegetation Map for Proposed Dewey Land Application Area
Dewey-Burdock Project
DRAWN BY S. Hetrick
DATE 28-Feb-2012
FILENAME LandApp-VegMap-D.mxd
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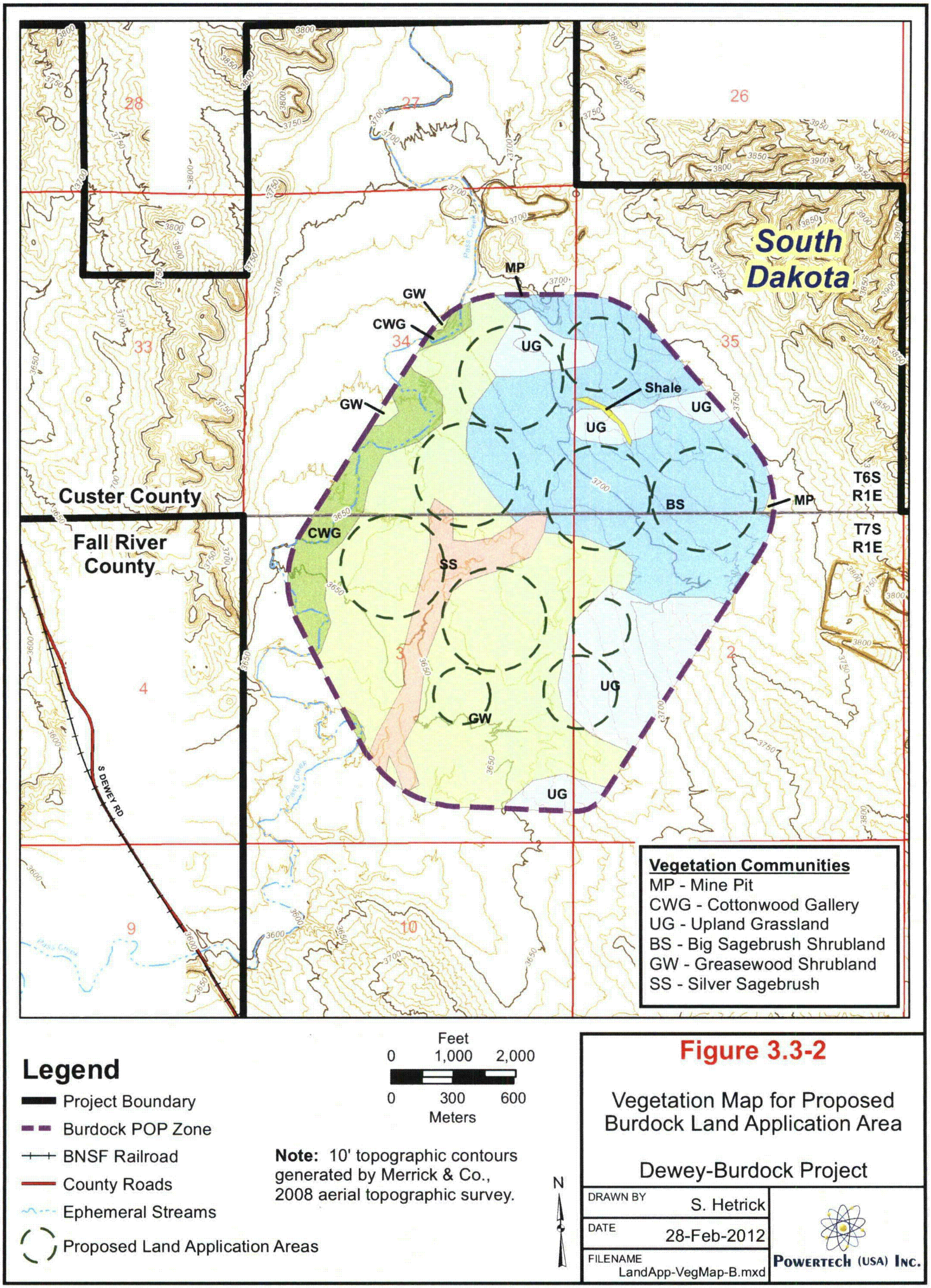

Figure 3.3-2

Vegetation Map for Proposed Burdock Land Application Area

Dewey-Burdock Project

DRAWN BY S. Hetrick
DATE 28-Feb-2012
FILENAME LandApp-VegMap-B.mxd

efforts, incidental observations of all vertebrate wildlife species were recorded during each site visit during the year-long baseline survey period. Surveys for black-footed ferrets (*Mustela nigripes*) were not required for the Dewey-Burdock Project due to a block clearance issued by the USFWS that includes the entire proposed NRC license area and vicinity. All surveys were conducted by qualified biologists using standard field equipment and appropriate field guides. Most observations were recorded from vantage points during pedestrian or vehicular surveys to avoid disturbing wildlife; exceptions included small mammal trapping. Raptor nests, prairie dog colonies, and other features or observation points of special interest were mapped in the field using a hand-held GPS receiver to record the Universal Transverse Mercator (UTM, NAD27) coordinates.

3.4.3 Wildlife Survey Results

The following survey results are limited to big game, upland game birds, small mammals, and other species that could potentially graze in the land application areas. The results of the complete wildlife survey, including T&E species, raptors and other birds, aquatic life, and herptiles will be presented in the DENR LSM permit application.

No crucial big game habitats or migration corridors are recognized by SDGF&P in the project area or surrounding one-mile perimeter. Crucial range is defined as any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain and reproduce itself at a certain level.

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. Elk (*Cervus elaphus*) and white-tailed deer (*O. 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 different times of the year.

The pronghorn is the most common big game species in the survey area, though no species is prevalent. The pronghorn is a browse species and sagebrush-obligate, using shrubs for both forage and cover (Fitzgerald et al., 1994). Pronghorn herds were most often observed in sagebrush stands just beyond the north-central boundary during winter 2007-2008. Conversely, herds were widely distributed throughout grassland habitats in the northwestern and southeastern portions of the survey area during spring, summer, and early fall 2008.

Mule deer use nearly all habitats, but prefer sagebrush-grassland, rough breaks, and riparian bottomland (Jones et al., 1983). Browse is an important component of the mule deer's diet

throughout the year, comprising as much as 60 percent of total intake during autumn, while forbs and grasses typically make up the rest of their diet (Fitzgerald et al., 1994). In the survey area, mule deer were observed as individuals or in small herds in ponderosa pine and cottonwood riparian habitats along Beaver and Pass Creeks, and in the pine breaks along the eastern edge of the boundary. They are considered year-round residents in the survey area.

By nature, elk are shy animals that are less accepting of human disturbance than pronghorn (Fitzgerald et al., 1994) or deer. Elk in the survey area share their range with pronghorn and domestic cattle from spring through fall. Because elk prefer grass to shrubs, the resident herd competes more directly with domestic cattle and wild horses than with pronghorn in the spring and summer months. A herd of six bull elk was observed in the survey area in ponderosa pine habitat on one occasion (June 2008) during the baseline survey period, but local residents report that elk are frequently seen in the pine stands, especially during fall and winter.

White-tailed deer are typically associated with forests, woodlands, and treed galleries along streams (Fitzgerald et al., 1994). Small numbers of white-tailed deer were observed in the survey area during the baseline survey period, predominantly in the cottonwood corridor along Pass Creek in the central portion of the project area. Most sightings of white-tailed deer were actually in the cottonwood corridor along the Cheyenne River, approximately 2-2.5 miles south of the project area. This species is considered an uncommon year-round resident in the survey area itself.

The wild turkey (*Meleagris gallopavo*) and mourning dove (*Zenaida macroura*) were the only upland game bird species observed in the project survey area during baseline inventories. Both species are relatively common and occur in a variety of woodland and open habitats in the project area.

A variety of small and medium-sized mammalian species have the potential to occur in the survey area, although not all were observed within the study area itself during the baseline wildlife surveys. These potential species include a variety of 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.), jackrabbits (*Lepus* spp.), and cottontails (*Sylvilagus* spp.) can also be found in the project 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. Jackrabbit sightings were uncommon and cottontail sightings were below normal, suggesting these species are currently in a local downward trend. Observations of small mammals occurred most often near Beaver and Pass Creeks, in the northwestern and central portions of the survey area, respectively.

One black-tailed prairie dog (*Cynomys ludovicianus*) colony is located in the northwestern corner of the project area, and two others are present in the southwestern portion of the one-mile perimeter. Local ranchers use shooting and other control methods to reduce and/or eradicate prairie dogs from private surface and surrounding private lands.

Other mammal species such as the striped skunk (*Mephitis mephitis*), porcupine (*Erethizon dorsatum*), and various weasels (*Mustela* spp.) inhabit sage-steppe communities, but no sightings or confirmed scat were recorded for these species during the surveys. Infrequent, incidental bat sightings (species unknown) occurred during nocturnal amphibian surveys and spotlighting efforts at targeted ponds during the baseline period. A northern river otter (*Lontra canadensis*) carcass was unexpectedly discovered at one of the fisheries sampling points along Beaver Creek in April 2008. The otter may have come up the creek during the flooding that occurred in early April, though the cause of death was not apparent. The carcass was gone by the July sampling period, presumably washed back downstream with the next flood event. Otters are tracked by the SDNHP.

Small mammal trapping was conducted during fall 2007 as part of the baseline survey requirements for the project. Trapping occurred in nine transects spread among six habitat types: Upland Grassland, Ponderosa Pine, Greasewood, Cottonwood Gallery, Clay Breaks, and Pine/Sage Edge. Grassland habitats occupy the largest parcels throughout the area, and held four transects; the remaining habitats held one transect each. Each transect included a combination of 20 live traps, 10 snap traps, and 5 pitfall traps. All traps were baited daily, with cotton balls placed in the live and pitfall traps for nesting material. Each transect was run for three consecutive days and nights (per SDGF&P). The deer mouse (*Peromyscus maniculatus*) dominated the captures, with only seven individuals of other species recorded (Table 3.4-1). Deer mice are known for their ubiquitous presence and generalized habitat use, and these survey results are similar to those from recent trapping efforts in northwest South Dakota.

Table 3.4-1: Small Mammal Abundance during Trapping within the Project Area in September 2007

Species	Total
Deer mouse (*Peromyscus maniculatus*)	152
Olive-backed pocket mouse (*Perognathus fasciatus*)	3
Western harvest mouse (*Reithrodontomys megalotis*)	3
Northern grasshopper mouse (*Onychomys leucogaster*)	1
Total	**159**

Lagomorph (hares and rabbits) surveys are also a common component of baseline wildlife inventories. Spotlight lagomorph counts were conducted on two consecutive nights in fall 2007. Cottontail abundance was twice that of jackrabbits, though neither count was especially high (Table 3.4-2). Results from lagomorph surveys conducted in northeast Wyoming annually since 1984 indicate that the regional lagomorph population is experiencing a downward trend in its regular cyclic pattern. Although no data are available from the project area prior to 2007, its proximity to the annual survey area in Wyoming suggests that the population trend is similar in southwestern South Dakota.

Table 3.4-2: Total Lagomorphs Observed during Spotlight Surveys and Abundance Indices within the Project Area in September 2007

Parameter	Species		
	White-tailed jackrabbit	**Cottontail**	**Total**
Lagomorph Count[1]	**12**	**28**	**40**
Lagomorphs/Survey Mile[2]	**1.5**	**3.4**	**4.9**

1 Number given is highest count per species from two survey nights.
2 Survey route totaled 8.2 miles.

3.4.4 Livestock

As described in Section 3.5, lands within the project area are currently used for livestock grazing. Most land serves as grazing land for cattle that are consumed locally and sold as food. There are also a small number of horses grazed within the project area. Both cattle and horses have potential to graze within the proposed land application areas. A small number of pigs are grazed

south of the project area, but no pigs currently graze within the project area or within the proposed land application areas.

3.5 Land Use

The predominant land use within the project area is agricultural production related to grazing (rangeland). Most of the land serves as grazing land for cattle and a few horses. Approximately 390 acres of land are irrigated for hay production along Beaver Creek. Historically, some of the land within the project area was used for mining.

There are five residences within the proposed NRC license boundary, including seasonal residences. There are two residences located within ¼ mile of the land application areas, but no residences are located within the proposed POP zones. Residences and drinking water wells are depicted on Figure 3.5-1 in relation to the proposed land application areas. The drinking water well number 43 near the Burdock area is associated with a former residence that is no longer inhabitable. Well 43 will be removed from private use and converted to a monitor well prior to operation of the Dewey-Burdock Project.

Recreational use in and around the project area is limited primarily to large game hunting. Within the project area, hunting is currently open to the public on approximately 5,700 acres. Approximately 240 acres are public lands managed by BLM. In addition, SDGF&P leases around 3,000 acres annually of privately owned land that is designated as walk-in hunting areas. Prior to commencement of operations, Powertech (USA) will work with BLM, SDGF&P and private landowners to limit hunting within the project area to the extent practicable. Temporary fencing, signage, gates and other means of restricting public access will be installed in areas of active ISR operations such as well fields, processing plants and land application areas in order to protect the public, protect workers, prevent damage to facilities, and provide security.

Within the eastern portion of the project area are historical surface and underground mine workings associated with shallow, underground uranium mines and open pits. All of the underground workings are associated with open-pit remnants that are clearly visible in the project area. There are no underground mines within the project area that are not associated with, adjacent to, or extensions of the open pits. These types of underground workings were common at historical surface mines and were considered to be extensions of the open pit mining operations. Based on historical TVA maps, an interview with a former underground mine worker, and an interview with the former Susquehanna-Western geologist who directed the

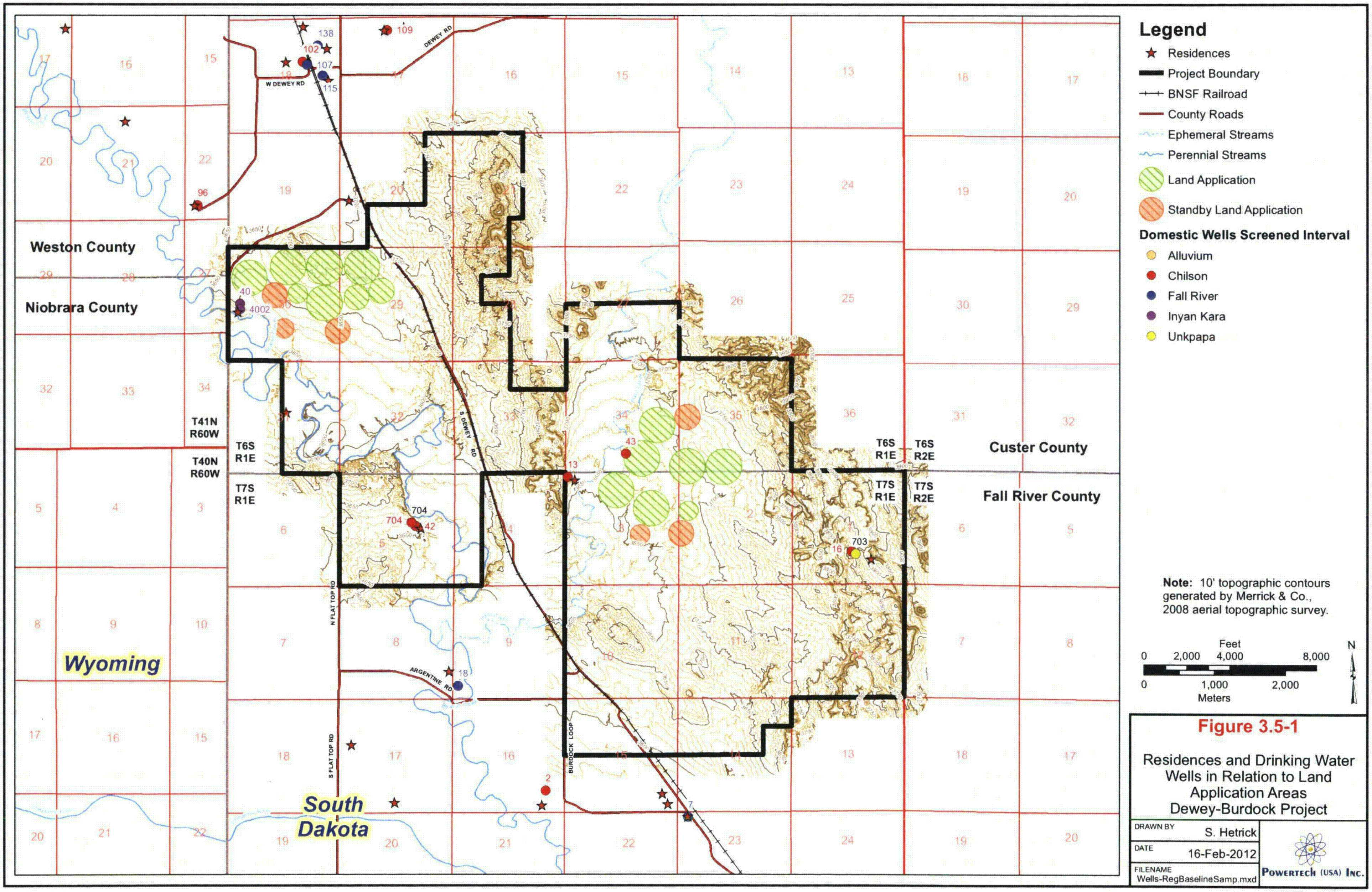

Figure 3.5-1

Residences and Drinking Water Wells in Relation to Land Application Areas Dewey-Burdock Project

DRAWN BY	S. Hetrick
DATE	16-Feb-2012
FILENAME	Wells-RegBaselineSamp.mxd

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delineation drilling for one of the primary surface mines, there are no underground mine workings within the proposed POP zones.

3.6 Geology

3.6.1 Regional Setting

The project area is located in the Great Plains Physiographic province on the southwestern flank of the Black Hills uplift in southwestern South Dakota. To the west of the project area is the Powder River Basin of Wyoming. The regional geologic map is shown in Figure 3.6-1.

3.6.1.1 Regional Structure

The dominant structural feature in this region is the Black Hills Uplift. This uplift is of Laramide age (65 million years ago) and is an elongate northwest trending dome about 125 miles long and 60 miles wide. Igneous and metamorphic Precambrian-age rock are exposed in the core of the uplift and are surrounded by outward-dipping Paleozoic and Mesozoic rocks that form cuestas and hogbacks around the core of the uplift. Folds constitute the major structural features in the Black Hills. In early Cretaceous time minor deformation along concealed northeast trending structures of Precambrian age affected the courses of the northwest flowing streams and their tributaries, thereby influencing the location of the fluvial sandstone deposits of the Inyan Kara Group.

3.6.1.2 Regional Stratigraphy

The oldest rocks in the region are Precambrian metamorphic rocks and granites. These form the core of the Black Hills Uplift and are exposed at the surface of this structural feature. Away from the center of the Black Hills uplift up to 2000-3000 feet of Paleozoic sediments overlie the crystalline rocks. This sedimentary sequence contains several regional aquifers, including the Deadwood Formation of Cambrian age, the Mississippian Madison Limestone and the Pennsylvanian/Permian-age Minnelusa Formation.

Mesozoic sediments include the Triassic age Spearfish Formation and the Sundance Formation, Unkpapa Sandstone, and Morrison Formation of Jurassic age. The Sundance Formation is a minor aquifer in the southern Black Hills region. A thick sequence of Cretaceous age sediments completes the Mesozoic section.

The Early Cretaceous sediments of the Inyan Kara Group consist of the Lakota Formation and the Fall River Formation. The Inyan Kara Group is a transitional unit, exhibiting a change from

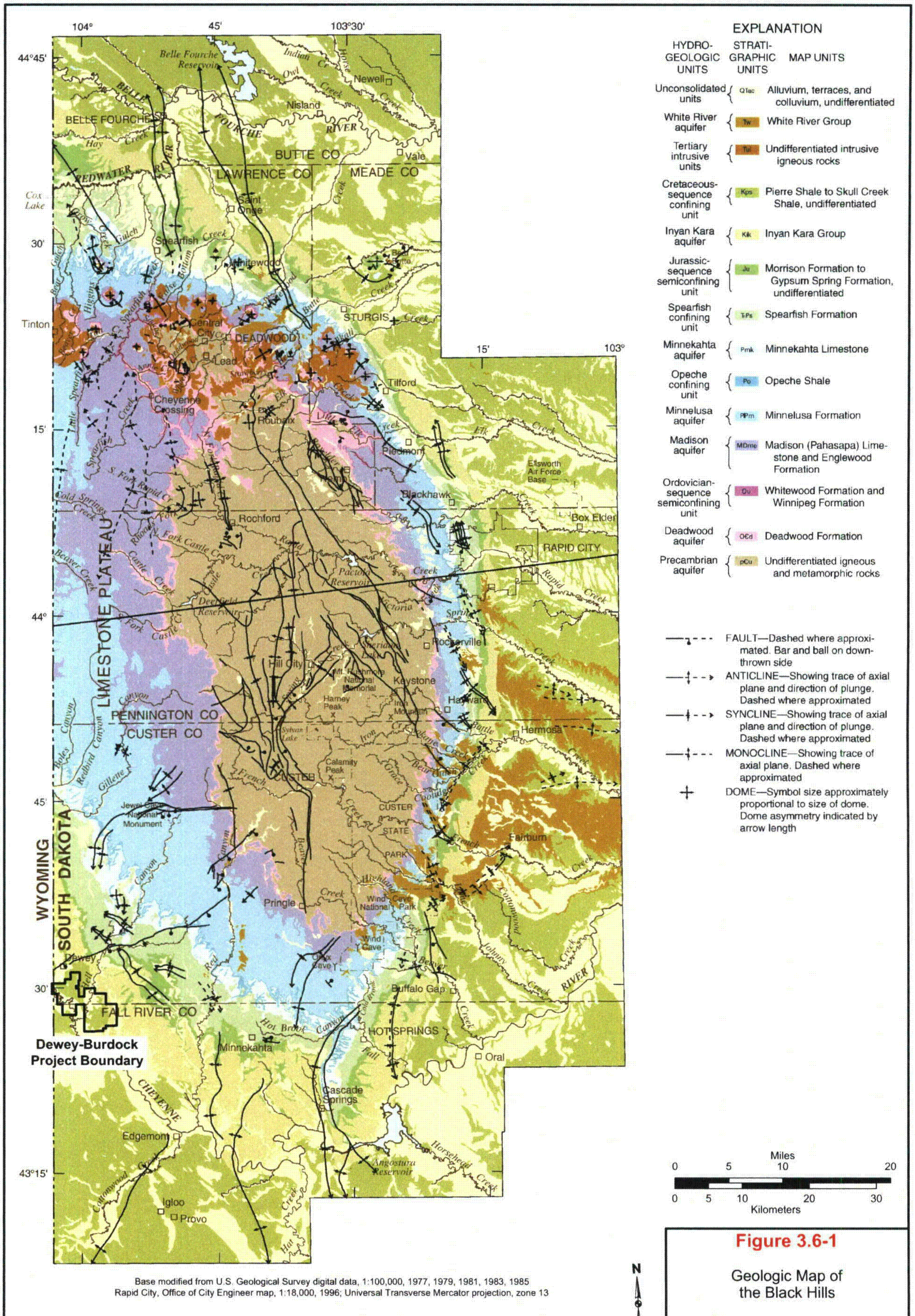

Figure 3.6-1

Geologic Map of the Black Hills

Dewey-Burdock Project

DRAWN BY Bonner, Hetrick

DATE 05-Dec-2011

FILENAME BlackHillsGeoMap.dwg

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Source: Ground-Water Resources in the Black Hills Area, South Dakota. Water-Resources Investigations Report 03-4049, by J. M. Carter, D. G. Driscoll and J. F. Sawyer, Rapid City, South Dakota, 2003, p. 5.

terrestrial to marine deposition. The basal Lakota Formation (Chilson Member) is a fluvial sequence, which grades upward into marginal marine sediments as the Cretaceous Seaway inundated a stable land surface. Basal units of the Lakota Formation scour into clays of the underlying Morrison Formation and display the depositional nature of a large braided stream system, crossing a broad, flat coastal plain and flowing toward the northwest. Younger fluvial sand units of the Lakota become progressively thinner and less continuous and are separated by thin deposits of overbank and flood plain silts and clays. At the top of the Lakota is the Fuson Member. The Fuson consists of shale with minor beds of fine grained sandstone and siltstone. The Fuson separates the underlying Lakota Formation from the overlying Fall River Formation. The Fall River consists of thick, widespread fluvial sands in the lower portion, grading to thinner, less continuous, marginal sands in the upper part. The Cretaceous Lakota and Fall River Formations are the hosts of the roll front uranium mineralization in the Black Hills region.

Following deposition of the Fall River, this region was covered by the North American Cretaceous Seaway, which resulted in the accumulation of vast thicknesses of marine sediments (from 3000-5000 feet thick). These marine sediments are represented by the Skull Creek Shale, Newcastle Sandstone, Mowry Shale, Belle Fourche Shale, Greenhorn Formation, Carlile Shale, Niobrara Formation and Pierre Shale. In Late Cretaceous time, the modern Rocky Mountain Uplift began, forcing the retreat of the Cretaceous seaway.

Unconformably overlying the Cretaceous sediments in the Black Hills region is the Tertiary-age (Oligocene) tuffaceous White River Formation. This thick, tuffaceous sequence was the result of volcanic eruptions to the west and was rich in volcanic fragments. The White River sediments have primarily been removed by erosion and can be found only as erosional remnants. This unit is thought to be the source of the uranium deposits found in the Black Hills region and the Powder River Basin of Wyoming.

The most recent sediments in the region are Quaternary-age deposits consisting of local material derived as a result of post-Laramide-uplift erosion. Recent deposits include alluvium and floodplain terrace deposits.

Figure 3.6-2 shows a stratigraphic column of the Black Hills.

3.6.2 Site Geology

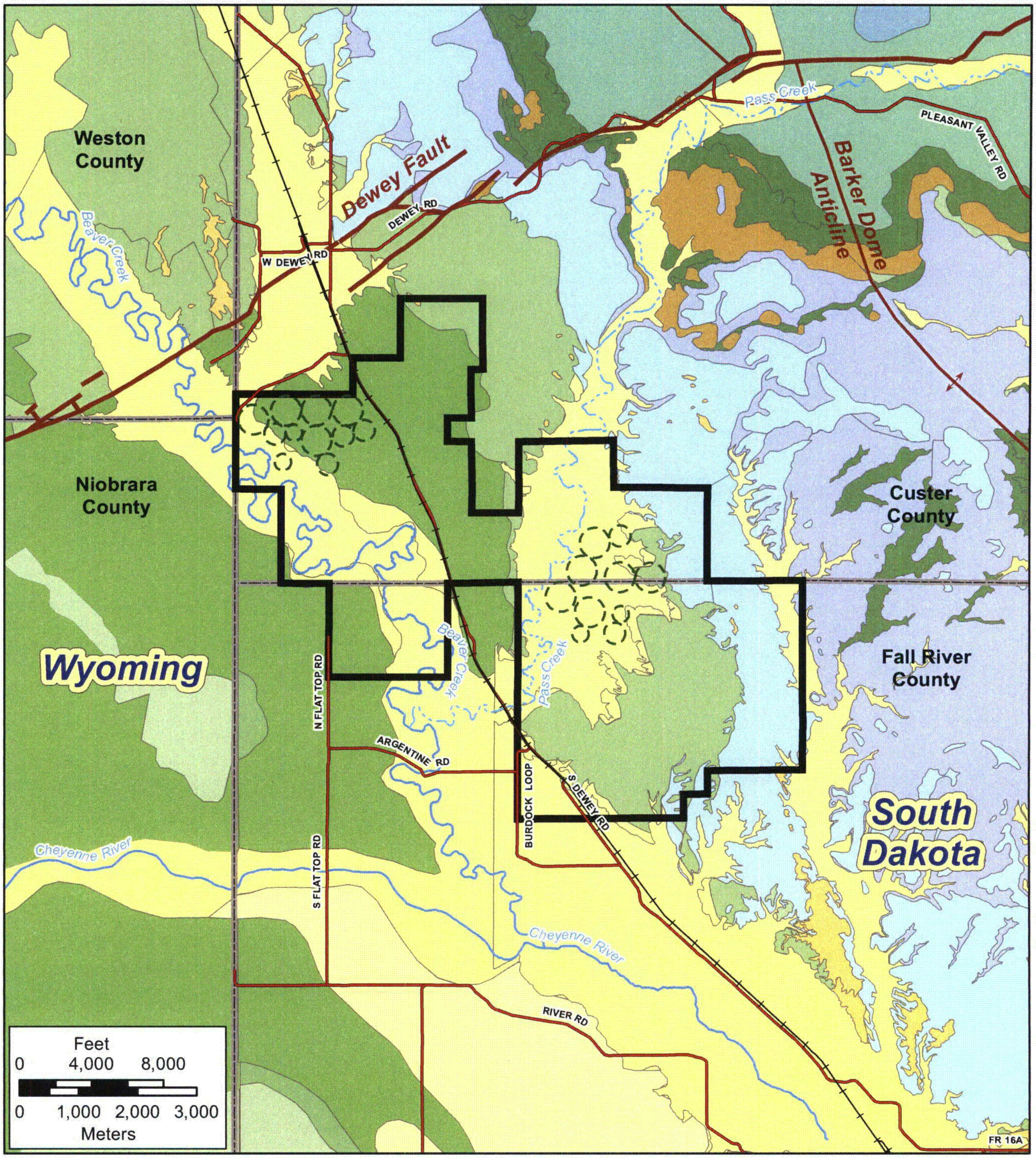
The site surface geology is shown in Figure 3.6-3. The Fall River Formation crops out across the eastern part of the project area and the Skull Creek Shale, Mowry Shale, and Belle Fourche Shale

ERATHEM	SYSTEM	ABBREVIATION FOR STRATIGRAPHIC INTERVAL	STRATIGRAPHIC UNIT	THICKNESS IN FEET	DESCRIPTION
CENOZOIC	QUATERNARY & TERTIARY (?)	QTac	UNDIFFERENTIATED ALLUVIUM AND COLLUVIUM	0-50	Sand, gravel, boulder, and clay.
CENOZOIC	QUATERNARY & TERTIARY (?)	Tw	WHITE RIVER GROUP	0-300	Light colored clays with sandstone channel fillings and local limestone lenses.
CENOZOIC	TERTIARY	Tui	INTRUSIVE IGNEOUS ROCKS	--	Includes rhyolite, latite, trachyte, and phonolite.
MESOZOIC	CRETACEOUS	Kps	PIERRE SHALE	1,200-2,700	Principal horizon of limestone lenses giving teepee buttes. Dark-gray shale containing scattered concretions. Widely scattered limestone masses, giving small teepee buttes. Black fissile shale with concretions.
MESOZOIC	CRETACEOUS	Kps	NIOBRARA FORMATION	[1]80-300	Impure chalk and calcareous shale.
MESOZOIC	CRETACEOUS	Kps	CARLILE SHALE: Turner Sandy Member; Wall Creek Member	[1]350-750	Light-gray shale with numerous large concretions and sandy layers. Dark-gray shale
MESOZOIC	CRETACEOUS	Kps	GREENHORN FORMATION	225-380	Impure slabby limestone. Weathers buff. Dark-gray calcareous shale, with thin Orman Lake limestone at base.
MESOZOIC	CRETACEOUS	Kps	GRANEROS GROUP: BELLE FOURCHE SHALE	150-850	Gray shale with scattered limestone concretions. Clay spur bentonite at base.
MESOZOIC	CRETACEOUS	Kps	GRANEROS GROUP: MOWRY SHALE	125-230	Light-gray siliceous shale. Fish scales and thin layers of bentonite.
MESOZOIC	CRETACEOUS	Kps	GRANEROS GROUP: MUDDY SANDSTONE / NEWCASTLE SANDSTONE	0-150	Brown to light-yellow and white sandstone.
MESOZOIC	CRETACEOUS	Kps	GRANEROS GROUP: SKULL CREEK SHALE	150-270	Dark-gray to black siliceous shale.
MESOZOIC	CRETACEOUS	Kik	INYAN KARA GROUP: FALL RIVER FORMATION	10-200	Massive to thin-bedded, brown to reddish-brown sandstone.
MESOZOIC	CRETACEOUS	Kik	INYAN KARA GROUP: LAKOTA FM: Fuson Shale Minnewaste Limestone Chilson Member	10-190 0-25 25-485	Yellow, brown, and reddish brown massive to thinly bedded sandstone, pebble conglomerate, siltstone, and claystone. Local fine-grained limestone and coal.
MESOZOIC	JURASSIC	Ju	MORRISON FORMATION	0-220	Green to maroon shale. Thin sandstone.
MESOZOIC	JURASSIC	Ju	UNKPAPA SS	0-225	Massive fine-grained sandstone.
MESOZOIC	JURASSIC	Ju	SUNDANCE FORMATION: Redwater Member; Lak Member; Hulett Member; Stockade Beaver Mem.; Canyon Spr Member	250-450	Greenish-gray shale, thin limestone lenses. Glauconitic sandstone; red sandstone near middle.
MESOZOIC	JURASSIC	Ju	GYPSUM SPRING FORMATION	0-45	Red siltstone, gypsum, and limestone.
MESOZOIC	TRIASSIC	TRPs	SPEARFISH FORMATION: Goose Egg Equivalent	375-800	Red silty shale, soft red sandstone and siltstone with gypsum and thin limestone layers. Gypsum locally near the base.
PALEOZOIC	PERMIAN	Pmk	MINNEKAHTA LIMESTONE	[1]25-65	Thin to medium-bedded, fine-grained, purplish gray laminated limestone.
PALEOZOIC	PERMIAN	Po	OPECHE SHALE	[1]25-150	Red shale and sandstone.
PALEOZOIC	PERMIAN / PENNSYLVANIAN	PIPm	MINNELUSA FORMATION	[1]375-1,175	Yellow to red cross-bedded sandstone, limestone, and anhydrite locally at top. Interbedded sandstone, limestone, dolomite, shale, and anhydrite. Red shale with interbedded limestone and sandstone at base.
PALEOZOIC	MISSISSIPPIAN	MDme	MADISON (PAHASAPA) LIMESTONE	[1]<200-1,000	Massive light-colored limestone. Dolomite in part. Cavernous in upper part.
PALEOZOIC	DEVONIAN	MDme	ENGLEWOOD FORMATION	30-60	Pink to buff limestone. Shale locally at base.
PALEOZOIC	ORDOVICIAN	Ou	WHITEWOOD (RED RIVER) FORMATION	[1]0-235	Buff dolomite and limestone.
PALEOZOIC	ORDOVICIAN	Ou	WINNIPEG FORMATION	[1]0-150	Green shale with siltstone.
PALEOZOIC	CAMBRIAN	OЄd	DEADWOOD FORMATION	[1]0-500	Massive to thin-bedded buff to purple sandstone. Greenish glauconitic shale flaggy dolomite and flat-pebble limestone conglomerate. Sandstone, with conglomerate locally at the base.
PRECAMBRIAN		pЄu	UNDIFFERENTIATED IGNEOUS AND METAMORPHIC ROCKS		Schist, slate, quartzite, and arkosic grit. Intruded by diorite, metamorphosed to amphibolite, and by granite and pegmatite.

[1]Modified based on drill-hole data

Source: Driscoll et al. (2002)

Figure 3.6-2: Stratigraphic Column of the Black Hills



- Alluvium
- Gravel Deposits
- Landslide Deposits
- Carlile Shale
- Greenhorn
- Belle Fourche Shale
- Mowry and Skull Creek Shale
- Fall River
- Lakota
- Morrison, Sundance
- Spearfish

Legend

- Project Boundary
- County Roads
- BNSF Railroad
- Ephemeral Streams
- Perennial Streams
- Fault
- Anticline
- Proposed Land Application Areas

N

Figure 3.6-3

Site Surface Geology

Dewey-Burdock Project

DRAWN BY	RESPEC, Hetrick
DATE	28-Feb-2012
FILENAME	SurfaceGeology.mxd

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(collectively referred to as the Graneros Group) crop out across the western part of the project area. The formations dip west and southwest at 2 to 6 degrees.

3.6.2.1 Site Structure

The structure across the project area is simple and shows sediments dipping gently 2 to 6 degrees to the southwest. This is illustrated by a structure contour map on the top of the Fall River Formation (Plate 3.6-1). Isopach maps are also provided for the Fall River Formation (Plate 3.6-2), Graneros Group (Plate 3.6-3) and alluvium (Plate 3.6-4).

The Dewey Fault, a northeast to southwest trending fault zone, is present approximately one mile north of the project area. The Dewey Fault is a steeply dipping to vertical normal fault with the north side uplifted approximately 500 feet by a combination of displacement and drag. The USGS considers an area 7 miles southeast of the project as the Long Mountain Structural Zone. This northeast–southwest trend contains several small, shallow surface faults in the Inyan Kara. No faults show up along this trend on subsurface structure maps of the underlying Madison Limestone, Minnelusa Formation or the Deadwood Formation. Despite the presence of faulting north and south of the site, there are no identified faults within the Dewy-Burdock project area.

3.6.2.2 Site Stratigraphy

The geologic units of primary interest to the GDP are the Quaternary alluvium and Cretaceous Graneros Group. These units are described below along with a description of the Fall River Formation, which contains the uppermost bedrock aquifer encountered beneath the land application areas.

Geologic cross sections through the proposed land application areas are provided as Plate 3.6-5 through Plate 3.6-9. The Dewey area cross sections (A-A' and B-B') show the presence of the Beaver Creek alluvium under a portion of the proposed land application area. This is underlain by 500 to 550 feet of Graneros Group shales, below which is the Fall River Formation. The Fall River Formation contains the uppermost bedrock aquifer beneath the land application areas.

The Burdock area cross sections (C-C' through E-E') show the presence of the Pass Creek alluvium and Graneros Group in relation to the proposed land application area. The thickness of the Graneros ranges from about 25 to 250 feet thick beneath the land application area. Below the Graneros Group is the Fall River Formation. Plate 3.6-3 shows the Graneros Group thickness in relation to all proposed land application areas.

Fall River Formation

The Fall River Formation is composed of carbonaceous interbedded siltstone and sandstone, channel sandstones, and a sequence of interbedded sandstone and shale. The lower part of the Fall River Formation consists of dark carbonaceous siltstone interbedded with thin laminations of fine-grained sandstone. Channels were cut into this interbedded sequence by northwest flowing rivers, and fluvial sandstones were deposited. These channel sandstones occur across various parts of the project and generally contain the uranium deposits. Overlying the channel sandstones is another sequence of alternating sandstone and shales. The sandstones are cross-bedded to massive, fine to medium-grained, and well-sorted.

The Fall River Formation has a range of thickness of 120 to 160 feet. The thickening of the formation indicates the presence of channel sandstones. East of the proposed land application areas along the northeastern portion of the project area, this formation is exposed on the surface and erosion has taken place.

Graneros Group

The Cretaceous Graneros Group consists of several geologic units, including the Skull Creek Shale, Newcastle Sandstone (where present), Mowry Shale, and Belle Fourche Shale, which act as a single confining unit overlying the Fall River Formation. When present the Newcastle Sandstone is stratigraphically located between the Skull Creek Shale and the Mowry Shale. There is no Newcastle Sandstone on the surface or in the subsurface within the project area based on the results of extensive exploration drilling. In the project area, the thickness of the Graneros Group ranges from zero at the outcrop of the Fall River Formation (east of the land application areas) to more than 500 feet (Plate 3.6-3). Following is a description of the geologic units that make up the Graneros Group within the project area.

Skull Creek Shale - The Skull Creek Shale directly overlies the Fall River Formation and consists of dark-gray to black shale, organic material, and some silt sized quartz grains. The Skull Creek Shale has a thickness of approximately 200 feet and is part of the Graneros Group. Analyses of core samples demonstrate that the Skull Creek clays have extremely low vertical permeabilities, in the range of 6.8×10^{-9} cm/sec (0.007 millidarcies). The Skull Creek Shale is eroded from the eastern parts of the project area but is present everywhere under the land application areas.

Mowry Shale - At the project area the Skull Creek Shale is directly overlain by the Mowry shale, also considered to be part of the Graneros Group. The Mowry Shale consists of light gray

marine shale with minor amounts of siltstone, fine grained sandstone, and a few thin beds of bentonite. Dark-gray to purple and black iron and manganese concretionary zones are common within the shale. When present the Newcastle Sandstone is stratigraphically located between the Skull Creek Shale and the Mowry Shale. Drilling has encountered no Newcastle Sandstone on the surface or in the subsurface within the Dewey-Burdock project area.

Belle Fourche Shale - The uppermost unit of the Graneros Group is the Belle Fourche Shale. This 300-foot unit consists of thin-bedded gray to black soft shale, containing black-reddish brown ironstone concretions, which are particularly abundant in the basal 20-30 feet. There is also bentonite production from the lower part of the Belle Fourche Shale.

Terrace Deposits - Along the sides of drainages are relatively flat terrace deposits representing floodplains and former levels of streams. The terraces are primarily overbank deposits of clay and silt with gravel beds. Gravel deposits consist of boulders and pebbles of chert, sandstone, and limestone.

Alluvium - The most recent sedimentary units are the Quaternary age alluvium deposits, which are present in the major drainages and their tributaries. The alluvium consists of silt, clay, sand and gravel. An isopach of the alluvium is presented as Plate 3.6-3. Cross sections of the Pass Creek alluvium are presented on Figure 3.6-4.

Powertech (USA) completed an alluvial geotechnical drilling program in May 2011 to further characterize the alluvium within the project area. Nineteen borings were drilled into the alluvium along Beaver Creek and Pass Creek, many of which were dry. Alluvial drilling logs indicating water levels (where present) are provided in Appendix 3.6-A. The alluvium in the Pass Creek drainage is up to 50 feet thick; in the Beaver Creek drainage, the alluvium is up to 30 feet thick. Only the bottom 0 to 15 feet of the alluvium typically contains gravel, and this is typically a mixture of silt, clay and sand with scattered gravel. The top of the alluvium contains a mixture of silt, clay and sand and may be better described as colluvium.

3.7 Hydrology

3.7.1 Surface Water

3.7.1.1 Regional Surface Water Hydrology

The project area is on the southwest flank of the Black Hills. The area includes two physiographic divisions that are characterized as the Black Hills and the Great Plains Divisions. The Black Hills Division generally consists of steep formations of metamorphosed and intensely

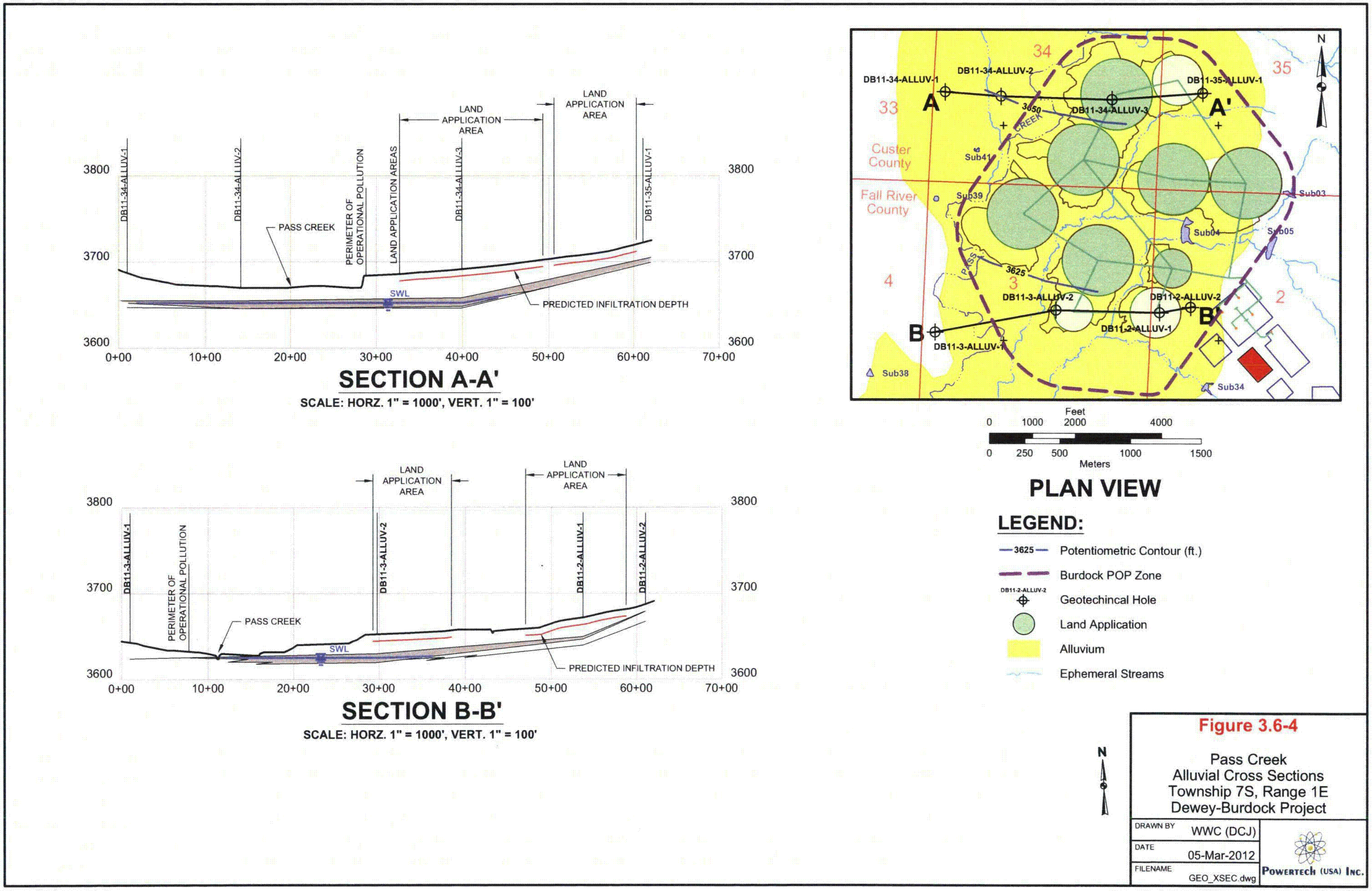


Figure 3.6-4

Pass Creek
Alluvial Cross Sections
Township 7S, Range 1E
Dewey-Burdock Project

compacted sedimentary rocks, which form a perimeter around an intrusion of Precambrian igneous and crystalline rocks. The sedimentary layers contain aquifer formations that typically have enough permeability to allow for the transportation and storage of water. Aquifers are usually separated by aquitard layers that restrict the vertical transport of water from one aquifer to the next. The aquifers generally receive most of their recharge from stream losses and infiltration along the outcrops which occur on the flanks of the Black Hills Uplift. The infiltration rates can vary greatly due to variations in slope and soil and can have a significant impact on the base flows of natural streams (Driscoll et al., 2002).

The Great Plains physiographic division is characterized by relatively flat, rolling hills which are divided by low-sloping streams. The streams generally have well-developed natural drainage areas that primarily flow from northwest to southeast in this vicinity toward the east-flowing Cheyenne River.

Precipitation incorporates both rainfall and snow which can differ greatly based on elevation and time of year. According to historical data, the upper elevations of the Black Hills can receive up to 24 inches of precipitation annually, while most of the lower plains receive significantly less (Driscoll et al., 2002).

3.7.1.2 Site Surface Water Hydrology

The project area lies primarily within the Beaver Creek Basin and is drained by both Beaver Creek and Pass Creek. The Pass Creek watershed is a sub-basin within the Beaver Creek basin, but the two watersheds were characterized as separate basins. The Beaver Creek system flows through the northwestern section of the project area from the northwest to the southeast. The Pass Creek system flows south through the central portion of the project area and joins Beaver Creek southwest of the project area. Three miles south of this confluence, Beaver Creek converges with the Cheyenne River (Figure 3.7-1), which eventually flows into the Missouri River. The Beaver Creek Basin drainage area is 1,360 mi^2, excluding the Pass Creek subbasin. It extends from a few miles northwest of Upton, WY to about 8 miles southeast of Dewey, SD and lies within Weston, Niobrara and Crook counties in Wyoming and Pennington, Custer and Fall River counties in South Dakota. Beaver Creek is a perennial stream with ephemeral tributaries. The Pass Creek watershed, characterized as a subbasin of the larger Beaver Creek basin, comprises most of the east-southeast portion of the Beaver Creek basin and is almost fully contained in South Dakota. The Pass Creek drainage area is 230 mi^2 and is located in Custer, Fall River, and Pennington counties in South Dakota and a very small portion of Weston County

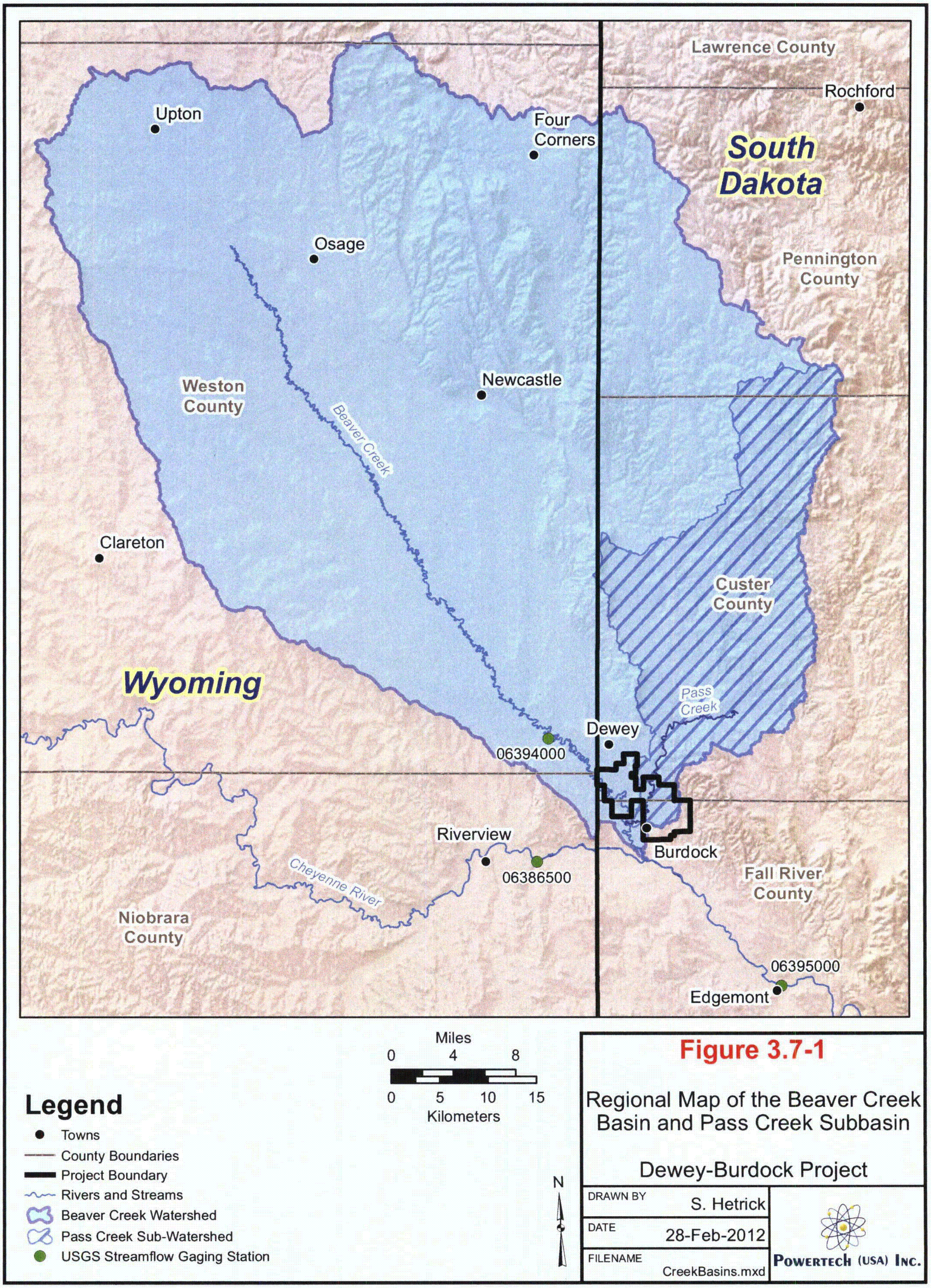


Figure 3.7-1

Regional Map of the Beaver Creek Basin and Pass Creek Subbasin

Dewey-Burdock Project

DRAWN BY S. Hetrick

DATE 28-Feb-2012

FILENAME CreekBasins.mxd

POWERTECH (USA) INC.

in Wyoming. Pass Creek is dry except for brief periods of runoff following major storms and snowmelt.

Several small impoundments exist within 1 mile of the proposed POP zones as shown on Figures 3.7-2 and 3.7-3. An inventory of impoundments within 1 mile of the proposed POP zones is provided in the surface water quality discussion in Section 4.1. These include stock dams and historical mine pits. Many of the impoundments only contain water temporarily following precipitation events or snowmelt. No springs have been identified within 1 mile of the proposed POP zones.

3.7.1.3 Flood Analysis

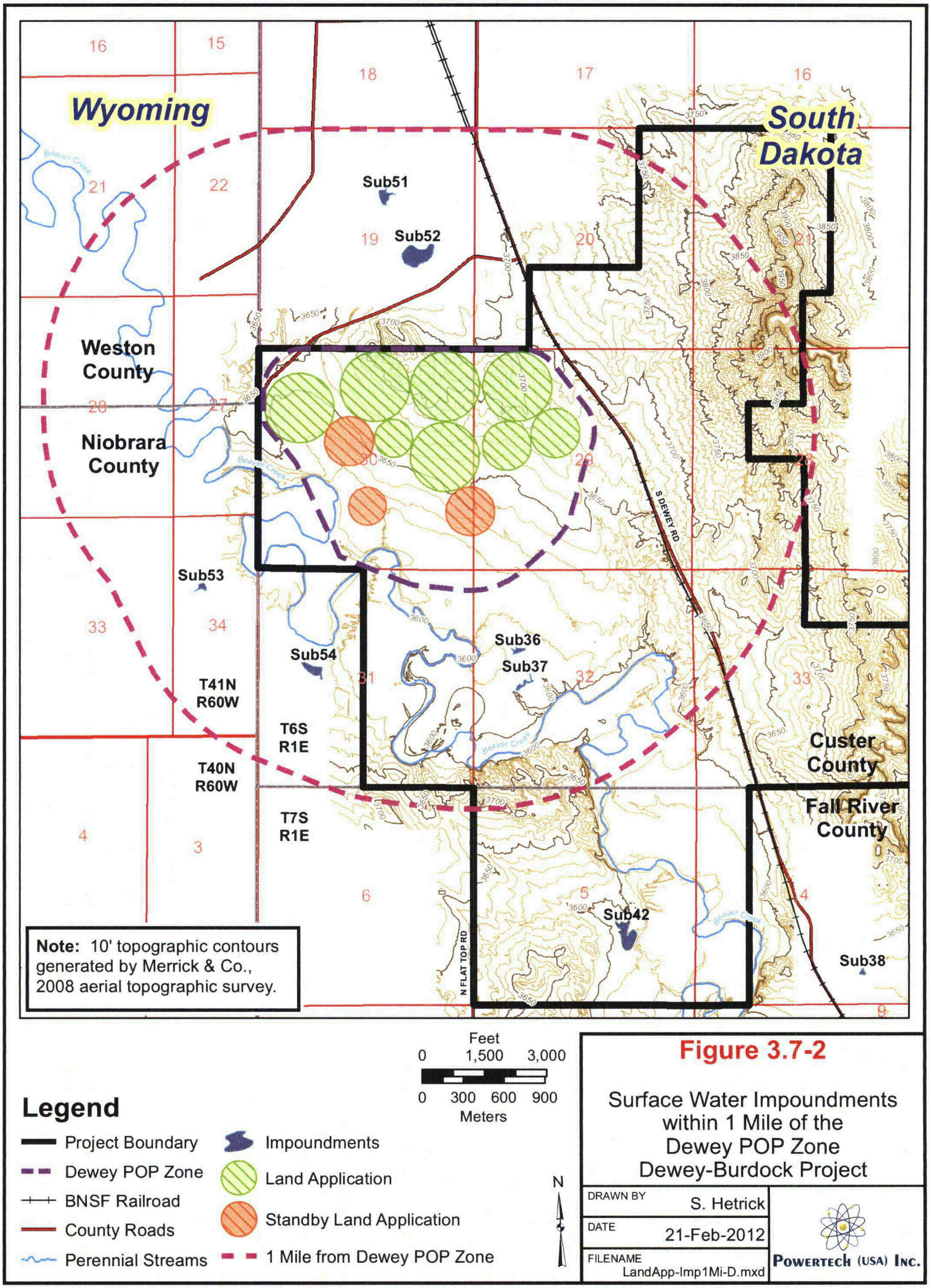
Powertech (USA) has evaluated flood inundation boundaries and will construct facilities outside of these boundaries to avoid potential impacts to facilities from flooding and potential impacts to Beaver Creek and Pass Creek in the event of any potential spills or leaks. Additional information is found in Section 8.2.

The potential for flood or erosion damage was evaluated by developing a design flood using statistical methods and a computer model for watershed hydrology. Peak discharge of the design flood was then transformed to a water level using a computer model for stream hydraulics. This approach provides a floodplain map that shows the maximum area inundated by the design flood, as well as detailed information on the depth and velocity of flood water at points of interest in the study area. The 100-year event was used for the design flood, since it represents an appropriate level of risk for the evaluation of flood potential near the facilities.

Hydrologic Analysis – Beaver Creek

USGS gage number 06394000 is located on Beaver Creek near Newcastle, WY (Figure 3.7-1). Statistical methods were used to estimate the design flows. Three software programs were used: National Flood Frequency (NFF) Program 3.2 (Ries and Crouse, 2002), PKFQWin 5.0 (Flynn et al., 2006), and a Matlab Flood Frequency Analysis program (Rao and Hamed, 2000).

The NFF program uses sub-watershed areas, geographical information, and precipitation averages to estimate flood events based on regional regression analyses. The PKFQWin and Matlab programs use the 55 years of historical peak flow at gage 06394000 to estimate flood events. The NFF and PKFQWin methods compute estimated floods ranging from 2- to 500-year frequencies.


Wyoming
South Dakota
Weston County
Niobrara County
Custer County
Fall River County
Sub51
Sub52
Sub53
Sub54
Sub36
Sub37
Sub42
Sub38
T41N R60W
T40N R60W
T6S R1E
T7S R1E
S DEWEY RD
N FLAT TOP RD
Beaver Creek
Note: 10' topographic contours generated by Merrick & Co., 2008 aerial topographic survey.
Feet
0 1,500 3,000
0 300 600 900
Meters
N
Legend
Project Boundary
Dewey POP Zone
BNSF Railroad
County Roads
Perennial Streams
Impoundments
Land Application
Standby Land Application
1 Mile from Dewey POP Zone
Figure 3.7-2
Surface Water Impoundments within 1 Mile of the Dewey POP Zone Dewey-Burdock Project
DRAWN BY S. Hetrick
DATE 21-Feb-2012
FILENAME LandApp-Imp1Mi-D.mxd
POWERTECH (USA) INC.

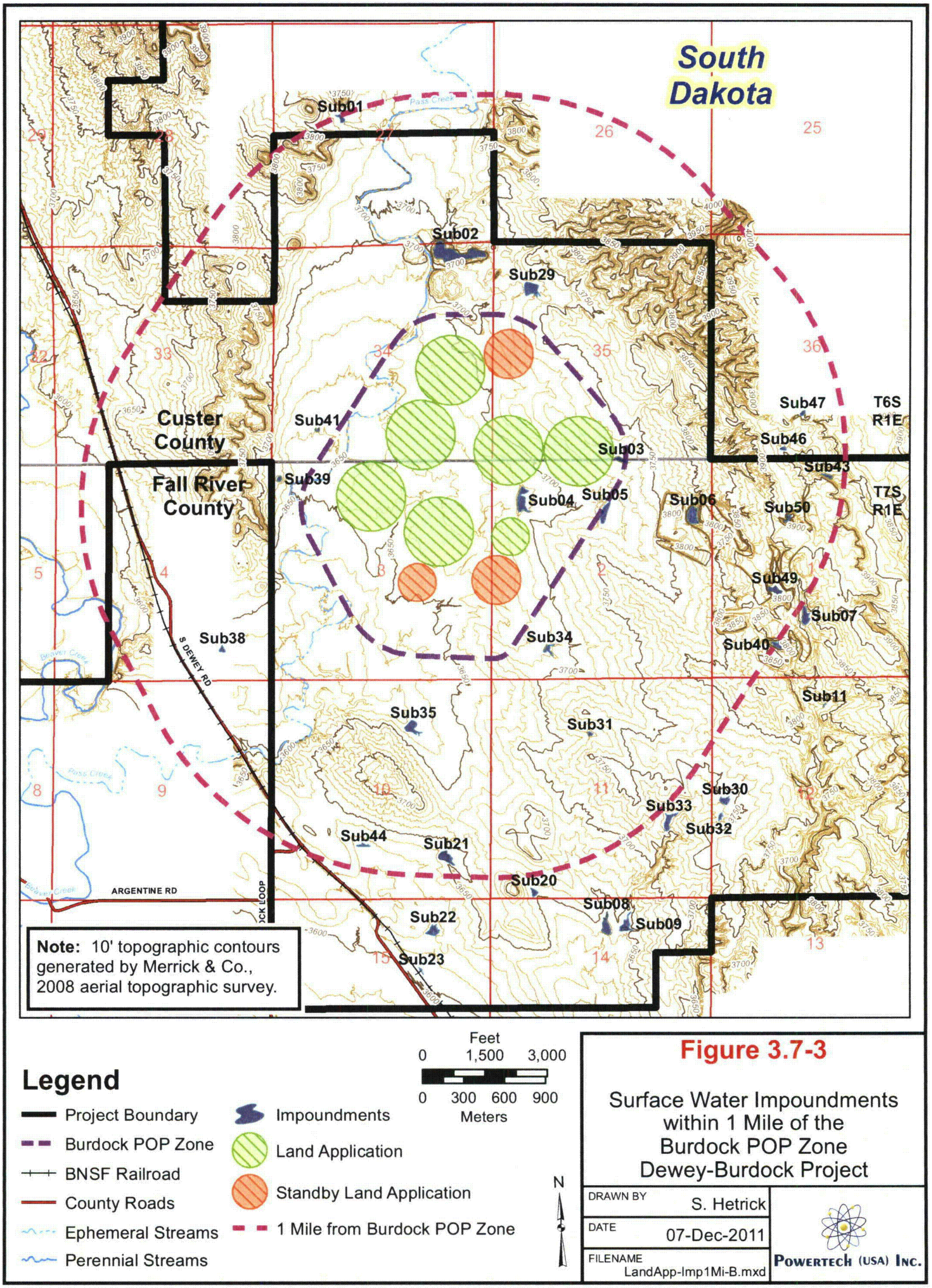


Figure 3.7-3

Surface Water Impoundments within 1 Mile of the Burdock POP Zone Dewey-Burdock Project

DRAWN BY	S. Hetrick
DATE	07-Dec-2011
FILENAME	LandApp-Imp1Mi-B.mxd

POWERTECH (USA) INC.

The flood estimates for Beaver Creek are summarized in Table 3.7-1. The flow value selected for the floodplain analysis of Beaver Creek was 7,990 cfs, representing the 100-year flood. This value was chosen because it represents the most conservative design flow estimate.

Table 3.7-1: Summary of Flood Estimates for Beaver Creek

Recurrence Interval (years)	PKFQWin Estimate (cfs)	NFF Estimate (cfs)	Matlab Estimate (cfs)
100	7,990	7,950	6,570

Hydrologic Analysis – Pass Creek

There are no gage sites along Pass Creek or its tributaries (Hell Canyon, West Hell Canyon, Sourdough Draw, and Tepee Canyon) to provide measured flow data. To obtain design flow values for the stream channel of Pass Creek, a rainfall runoff model was used to generate stream flows with a range of exceedance probabilities. The 100-year event was used as the primary condition for evaluating the risk of flooding and erosion in the Pass Creek area.

The Hydrologic Modeling System (HEC-HMS) is designed to simulate the precipitation-runoff processes of dendritic watershed systems. HEC-HMS was used to estimate the 100-year flood event for Pass Creek using a HEC-GeoHMS basin model created from a high resolution digital elevation model (DEM) in ArcGIS.

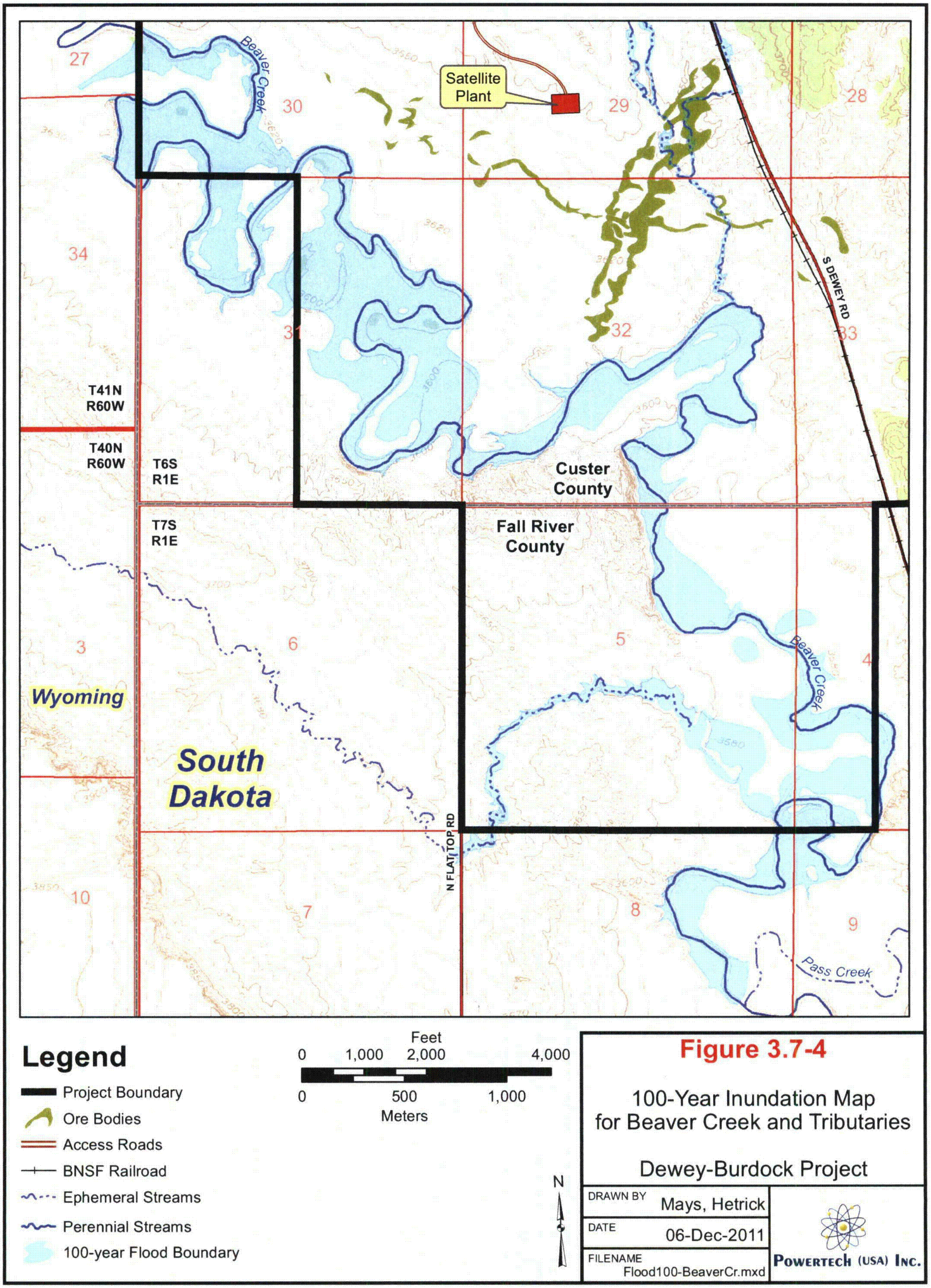
The output result from the HEC-HMS model of the Pass Creek watershed is shown in Table 3.7-2. The estimated 100-year peak discharge rate is 5,620 cfs.

Table 3.7-2: Discharge Results for the Single Basin Model of the Pass Creek Watershed

Recurrence Interval (years)	Peak Discharge (cfs)
100	5,620

Hydrologic Analysis – Beaver Creek and Pass Creek Tributaries

HEC-HMS models were used to calculate peak discharges for various storm events for minor drainages within the project area, and HEC-RAS models were used to predict the 100-year flood inundation boundary for the channels within the project area. The flood inundation boundaries on Beaver Creek and tributaries are depicted on Figure 3.7-4, and the flood inundation boundaries on Pass Creek and tributaries are depicted on Figure 3.7-5.


Satellite
Plant
Beaver Creek
27
30
29
28
34
31
32
33
S DEWEY RD
T41N
R60W
T40N
R60W
T6S
R1E
T7S
R1E
Custer
County
Fall River
County
3
6
5
4
Wyoming
South
Dakota
N FLAT TOP RD
10
7
8
9
Pass Creek
Legend
Project Boundary
Ore Bodies
Access Roads
BNSF Railroad
Ephemeral Streams
Perennial Streams
100-year Flood Boundary
Feet
0
1,000
2,000
4,000
0
500
1,000
Meters
N
Figure 3.7-4
100-Year Inundation Map
for Beaver Creek and Tributaries
Dewey-Burdock Project
DRAWN BY
Mays, Hetrick
DATE
06-Dec-2011
FILENAME
Flood100-BeaverCr.mxd
POWERTECH (USA) INC.

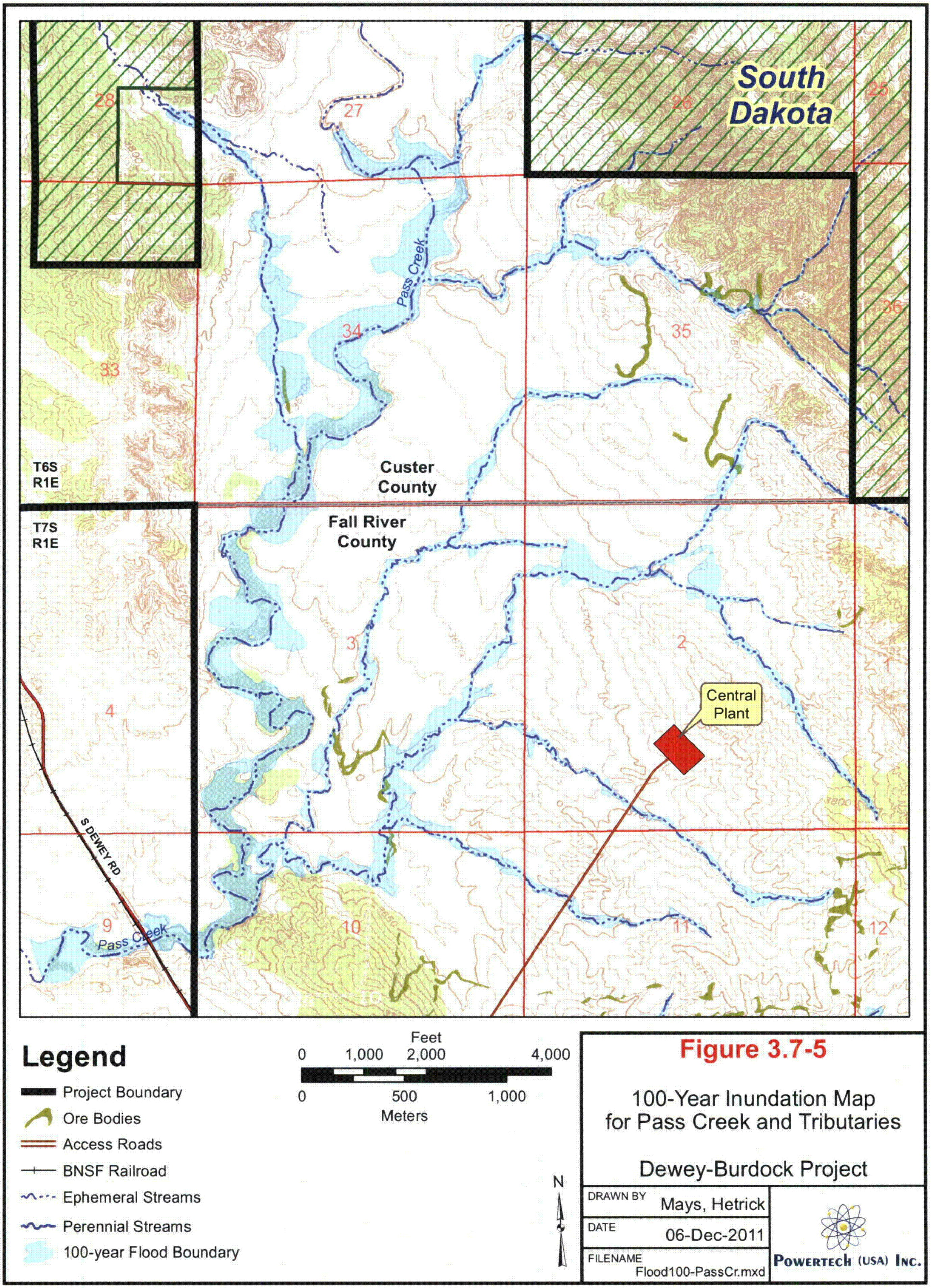


Figure 3.7-5

100-Year Inundation Map for Pass Creek and Tributaries

Dewey-Burdock Project

3.7.2 Groundwater

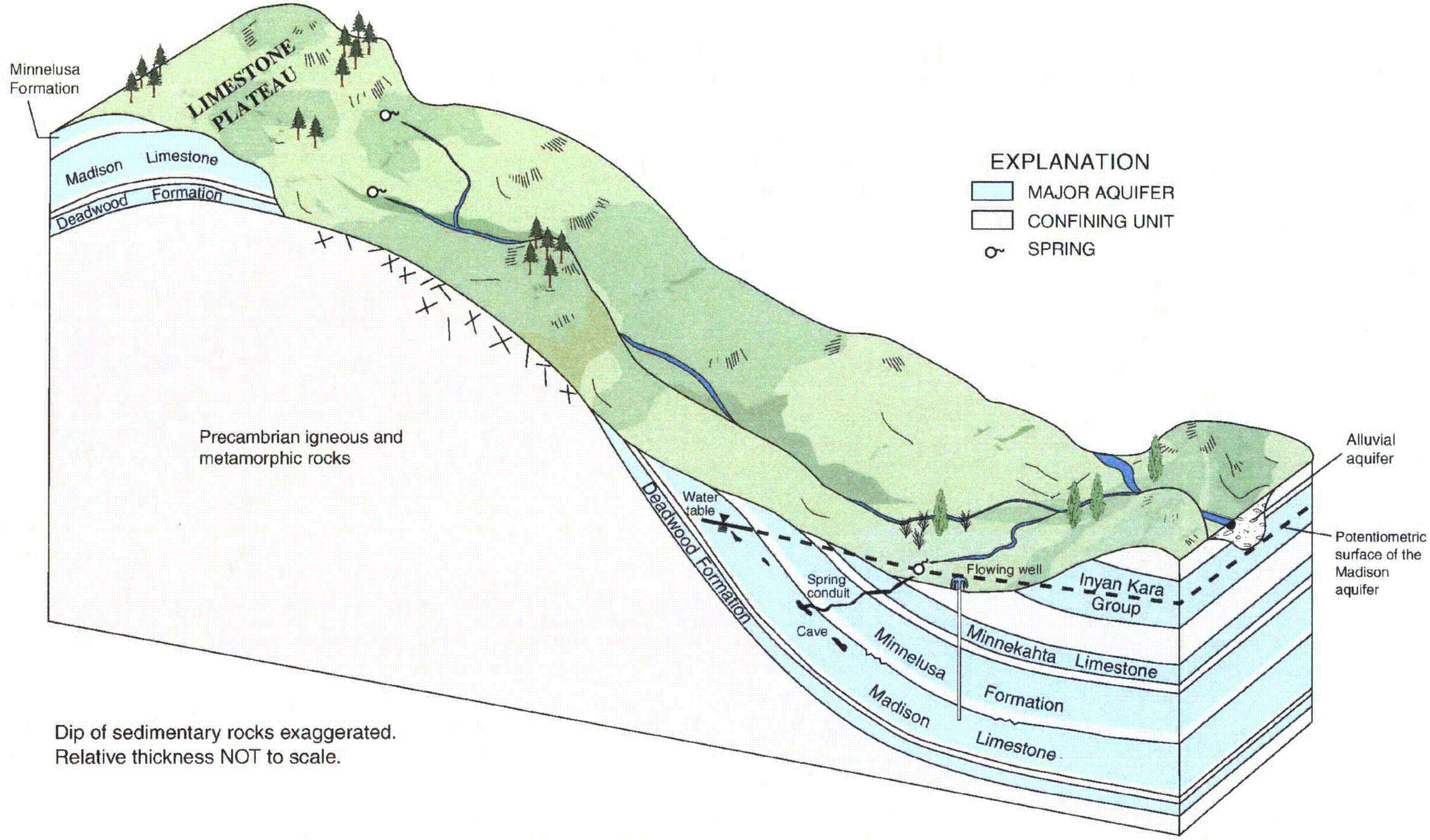
3.7.2.1 Regional Groundwater Hydrology

The Black Hills Uplift is the principal recharge area for the regional bedrock aquifer systems in southwestern South Dakota and northeastern Wyoming. The stratigraphy of the Black Hills area is summarized on Figure 3.6-2. Regionally, four principal aquifers are utilized as major sources of water supply. These are the Inyan Kara Group, Minnelusa Formation, Madison Limestone, and Deadwood Formation. In addition to these four major aquifers, other units including the Precambrian, Minnekahta Limestone, Sundance Formation, and Unkpapa Sandstone are utilized locally as sources of water supply at or near the outcrop areas in the central portion of the Black Hills. Within the Dewey-Burdock project area, none of the deeper regional aquifers below the Sundance is used as a water supply, mainly because of the availability of shallower sources and the poor water quality in the deeper aquifers. There are no water supply wells within 2 km of the project area completed in aquifers below the Sundance Formation. The closest municipal wells are the Edgemont Madison wells, which are approximately 15 miles to the south-southeast.

Regional groundwater flow within the principal Black Hills aquifers is generally radially outward from the central Black Hills highlands toward the plains. All of the principal aquifers are hydraulically unconfined (partially saturated) near their outcrops in the central highlands and become confined by the overlying strata with distance away from the central highlands. Except near the outcrops, the potentiometric surface elevations in all principal aquifers are above the formation tops; the degree of this artesian condition increases with distance from the central Black Hills highlands. Locally, the potentiometric surface of the aquifers may be above land surface.

The primary source of recharge to the principal Black Hills aquifers is infiltration from precipitation and surface runoff at the outcrop areas. Other sources of recharge to individual units can occur from leakage between aquifers. Most interconnection between aquifers appears to be associated with the thinning or absence of confining units between aquifers. Some investigators have suggested that solutioning and subsequent collapse (i.e., karsting) of the overlying strata may provide a pathway for upward groundwater movement (Gott et al., 1974). This is reported to occur some 6 miles northeast of the project area, but no evidence of karsting has been observed in the project area.

Refer to Figure 3.7-6, which provides an overview of the hydrologic setting and general hydrogeologic flow within the Black Hills.



Source: Ground-Water Resources in the Black Hills Area, South Dakota. Water-Resources Investigations Report 03-4049, by J. M. Carter, D. G. Driscoll and J. F. Sawyer, Rapid City, South Dakota, 2003, p. 7.

Figure 3.7-6
Diagram Showing a Simplified View of the Hydrogeologic Setting of the Black Hills Area

Dewey-Burdock Project

DRAWN BY Mays, Hetrick		POWERTECH (USA) INC.
DATE 06-Dec-2011		
FILENAME Driscoll_L.dwg		

3.7.2.2 Site Groundwater Hydrology

The main aquifers to be utilized during uranium recovery and aquifer restoration in the Dewey-Burdock Project (the Fall River Formation and Chilson Member of the Lakota Formation) are recharged locally and are isolated from the deep regional flow system in the Paleozoic formations that typically characterize regional groundwater flow and are the focus of numerous USGS research studies.

3.7.2.2.1 Site Hydrostratigraphic Units

In the Dewey-Burdock project area, the sedimentary rocks dip gently to the southwest at 2 to 6 degrees. As the land surface is generally flatter than the dip of the underlying bedrock strata, younger strata outcrop at the ground surface sequentially from east to west. The structure is illustrated by the structural contour map on top of the Fall River (Plate 3.6-1). Based on the logs for 3,900 exploration holes, no major faults or other structural features have been identified within the Dewey-Burdock project area.

Following is a description of the site hydrostratigraphic units of importance to the GDP. The discussion includes, from deepest to shallowest, the Fall River Formation, Graneros Group, and alluvium. The Fall River is confined below from the Chilson Member of the Lakota Formation by the Fuson Shale, which has been mapped by Powertech (USA) and consists of 20 to 80 feet of low-permeability shales and clays.

Fall River Formation

The Fall River Formation, along with the Chilson Member of the Lakota Formation, are the principal sources of water in the vicinity of the project area for domestic, livestock, and agricultural uses. These same formations are the host rocks for uranium mineralization within the project area.

The Fall River Formation is composed of carbonaceous interbedded siltstone and sandstone, channel sandstones, and a sequence of interbedded sandstone and shale. The Fall River ranges from about 120 to 160 feet thick.

The Fall River is confined above by the Graneros Group, a thick sequence of dark shales that varies in thickness from zero, where the Fall River Formation outcrops near the eastern edge of the project area, to more than 500 feet in the northwestern portion of the project area. Because of its thickness and low permeability, the Graneros Group precludes vertical migration of water between the Fall River Formation, overlying alluvial aquifers, and the ground surface.

Graneros Group Confining Unit

The Cretaceous Graneros Group consists of several geologic units, including the Skull Creek Shale, Newcastle Sandstone (where present), Mowry Shale, and Belle Fourche Shale, which act as a single confining unit overlying the Inyan Kara. Extensive exploration drilling has shown that the Newcastle Sandstone is not present within the project area. The Graneros Group shales have a thickness of zero at the Fall River Formation outcrop to more than 500 feet (Plate 3.6-3). Analyses of core samples of the Graneros Group clays (Skull Creek Formation) indicate low vertical permeability on the order of 6.8×10^{-9} cm/sec (0.007 millidarcies). This formation is present beneath all the land application areas proposed in this application.

Terrace Deposits and Quaternary Alluvium

The most recent sedimentary units within the Dewey-Burdock project area are the Quaternary alluvial deposits present along the major drainages and their tributaries. The alluvium varies from 0 to 50 feet thick and consists of an unconsolidated mixture of silt, clay, sand and gravel.

An isopach map depicting the thickness of the alluvium in the Beaver Creek and Pass Creek drainages is shown on Plate 3.6-4.

3.7.2.2.2 Groundwater Occurrence and Flow

Based on the regional and site-specific hydrogeological characterization, groundwater occurrence and flow in the Dewey-Burdock project area can be subdivided into three main components, or flow regimes. These include the deep regional flow system, a shallow perched groundwater flow system, and an intermediate groundwater flow system that includes the Fall River Formation.

There are multiple deep regional groundwater flow systems within the Paleozoic section. These regional flow systems are associated with the permeable strata within the Deadwood Formation, Madison Limestone, and Minnelusa Formation. These deep regional flow systems and associated aquifers are isolated by low permeability layers, or confining beds, from the shallower formations that could potentially be impacted by the Dewey-Burdock Project, including the Fall River Formation, Chilson Member of the Lakota Formation, and alluvium.

An intermediate groundwater flow system exists within the Fall River Formation. This intermediate flow system has its origin in the areas within the eastern portion of the project area and immediately to the east and north of the project area where the Fall River Formation crops out at the land surface. The Fall River flow system is recharged directly by precipitation that

falls on the land surface and by infiltration of surface runoff, primarily in the Pass Creek and Bennett Canyon drainages north and east of the project area, respectively.

Within the project area, the Fall River dips gently to the southwest at 2 to 6 degrees away from its outcrop areas. As a result, groundwater flow generally occurs from the northeast to the southwest toward the Powder River Basin.

A potentiometric contour map for the Fall River Formation is shown on Figure 3.7-7. This map is based on representative water level measurements taken over a 5-day period from April 25 through April 29, 2011. The potentiometric contour map for the Fall River Formation shows a relatively uniform hydraulic gradient across the project area, with the potentiometric levels decreasing to the southwest.

A shallow, perched groundwater system exists within some of the alluvium associated with Beaver Creek, Pass Creek, and Bennett Canyon on the eastern edge of the project area. These alluvial systems are perched above the top of the Graneros Group on the portions of the project area where land application of water is proposed. Groundwater flow within the alluvium is controlled by the configuration of the drainage channel on the top of bedrock and in most situations is generally parallel to surface drainage patterns. In the case of Bennett Canyon, the alluvium directly overlies the Chilson Member of the Lakota Formation. As such, the alluvial groundwater is a potential source of recharge to the underlying Chilson. The closest land application area, Burdock, is over 4,000 feet west of Bennett Canyon and will have no influence on Bennett Canyon alluvium or the Chilson Member.

A potentiometric surface contour map for the Pass Creek and Beaver Creek alluvium is shown on Figure 3.7-8. An isopach map for the alluvium is shown on Plate 3.6-4. The potentiometric surfaces within the alluvium show typical down-valley gradients paralleling the surface topography. Note that most alluvial drill holes in the Beaver Creek alluvium did not encounter water due to the clay-rich alluvial material and lack of gravel. The potentiometric contour shown in the Beaver Creek alluvium is inferred from a single data point.

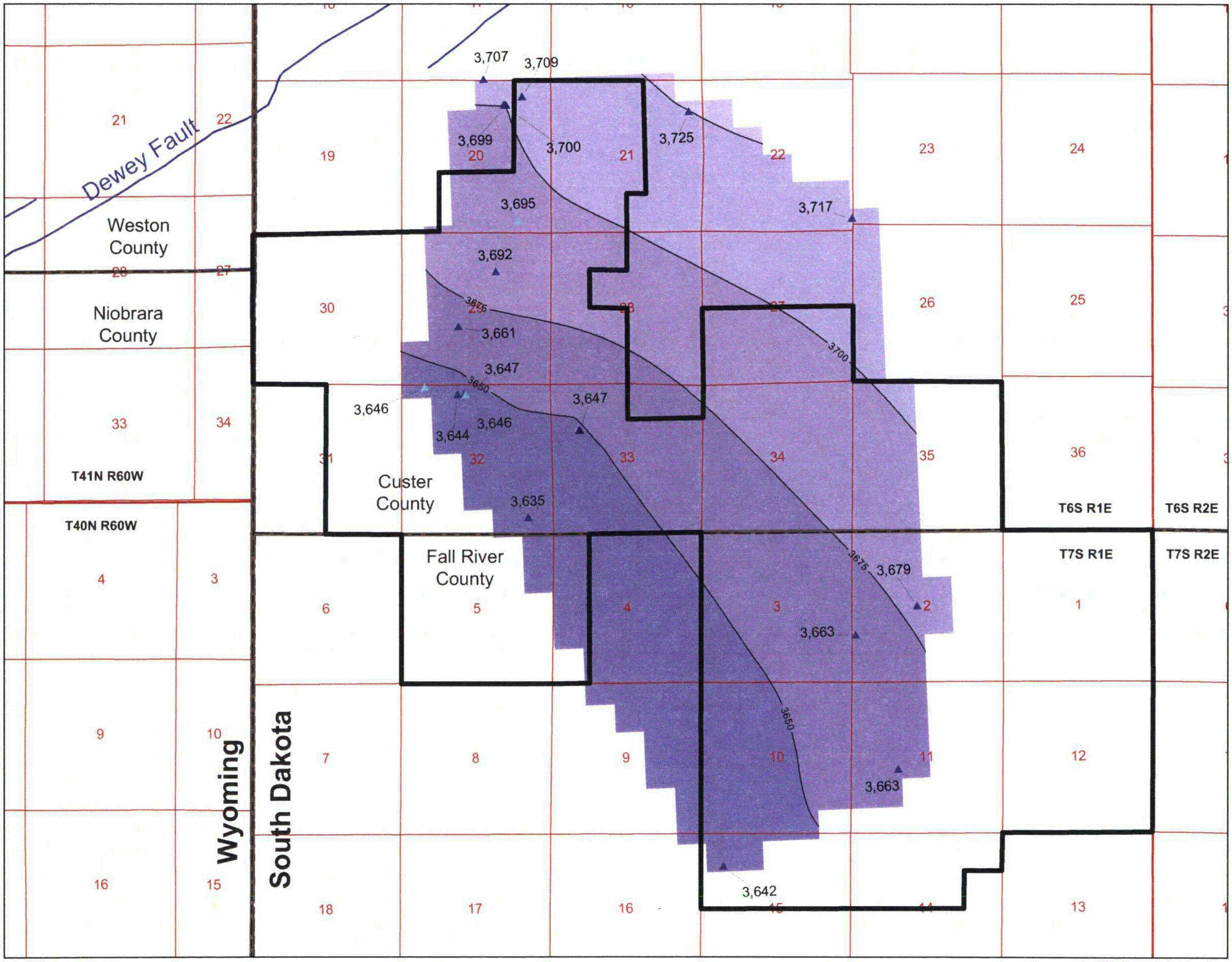


Figure 3.7-7

Potentiometric Contour Map, Fall River Formation

Dewey-Burdock Project

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DATE	1-Nov-2011
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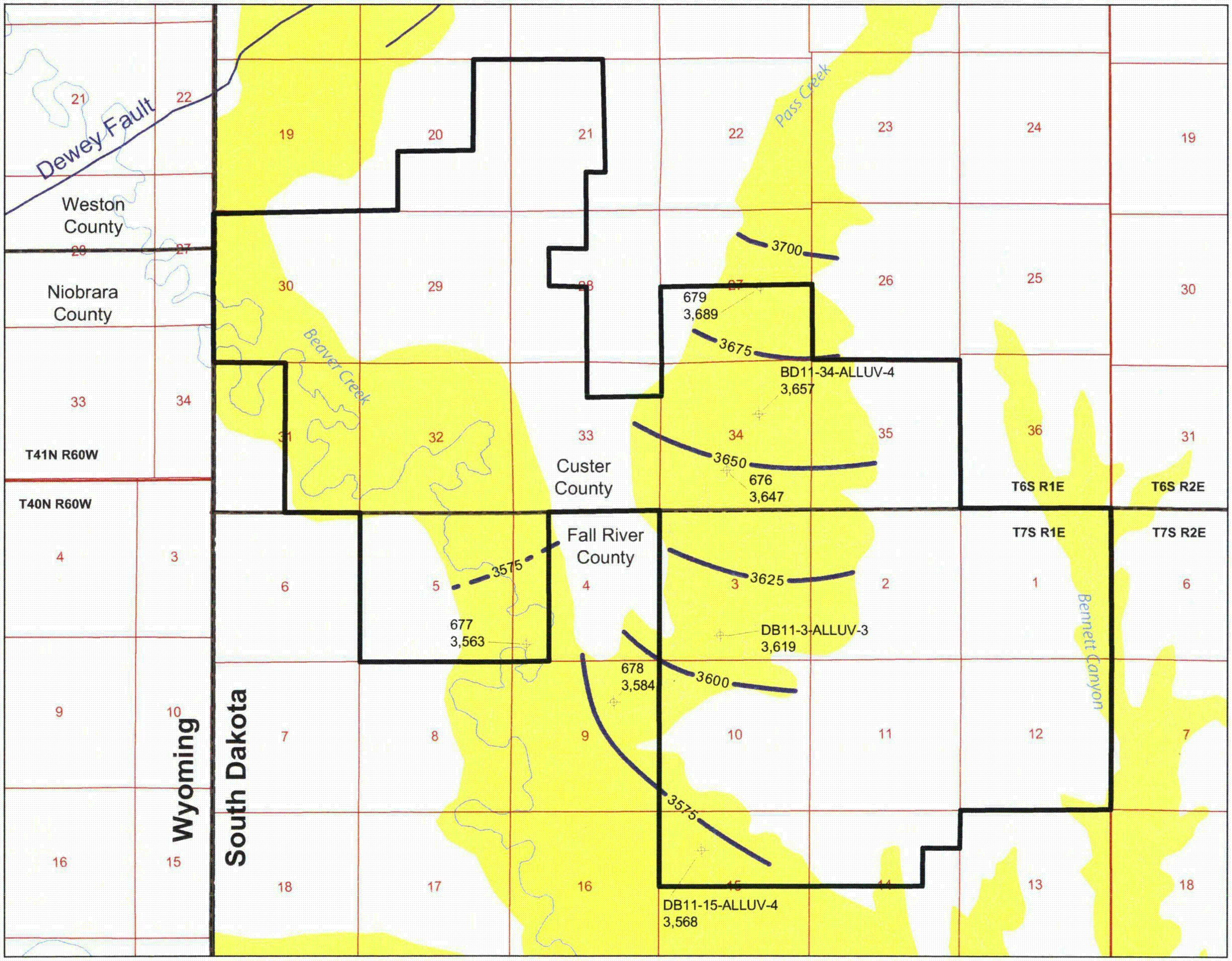

Figure 3.7-8
Potentiometric Contour Map, Pass Creek and Beaver Creek Alluvium Dewey-Burdock Project

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DATE 1-Nov-2011
FILENAME 2011_DB_Fig_2.7-21.ai
POWERTECH (USA) INC.

3.7.2.3 Existing Wells

Historical records and field investigations of the project area and surrounding area were used to develop an inventory of existing wells. An initial investigation of the wells was completed in 2007, and additional surveys were conducted in 2011 to evaluate the use and condition of the wells. The well inventory included existing wells, wells with historical records that are currently not present at the surface, and wells with historical records that have been visually confirmed as plugged and abandoned. The following sections describe the well inventories for the areas within 1 mile of the proposed Dewey and Burdock POP zones.

Proposed wells include monitor wells and ISR injection and production wells. Monitor wells associated with the GDP are described in Section 6.1. Additional monitor wells and injection/production wells will be constructed within the project area as part of the ISR operations.

3.7.2.3.1 Dewey Area

Table 3.7-3 and Figure 3.7-9 present the well inventory within 1 mile of the proposed Dewey POP zone, which includes 26 existing wells. No wells with historical records that are currently not present or confirmed abandoned have been identified within 1 mile of the Dewey POP zone. Of the 26 existing wells, 3 are currently used for domestic use, 7 for stock watering, and 16 for monitor wells.

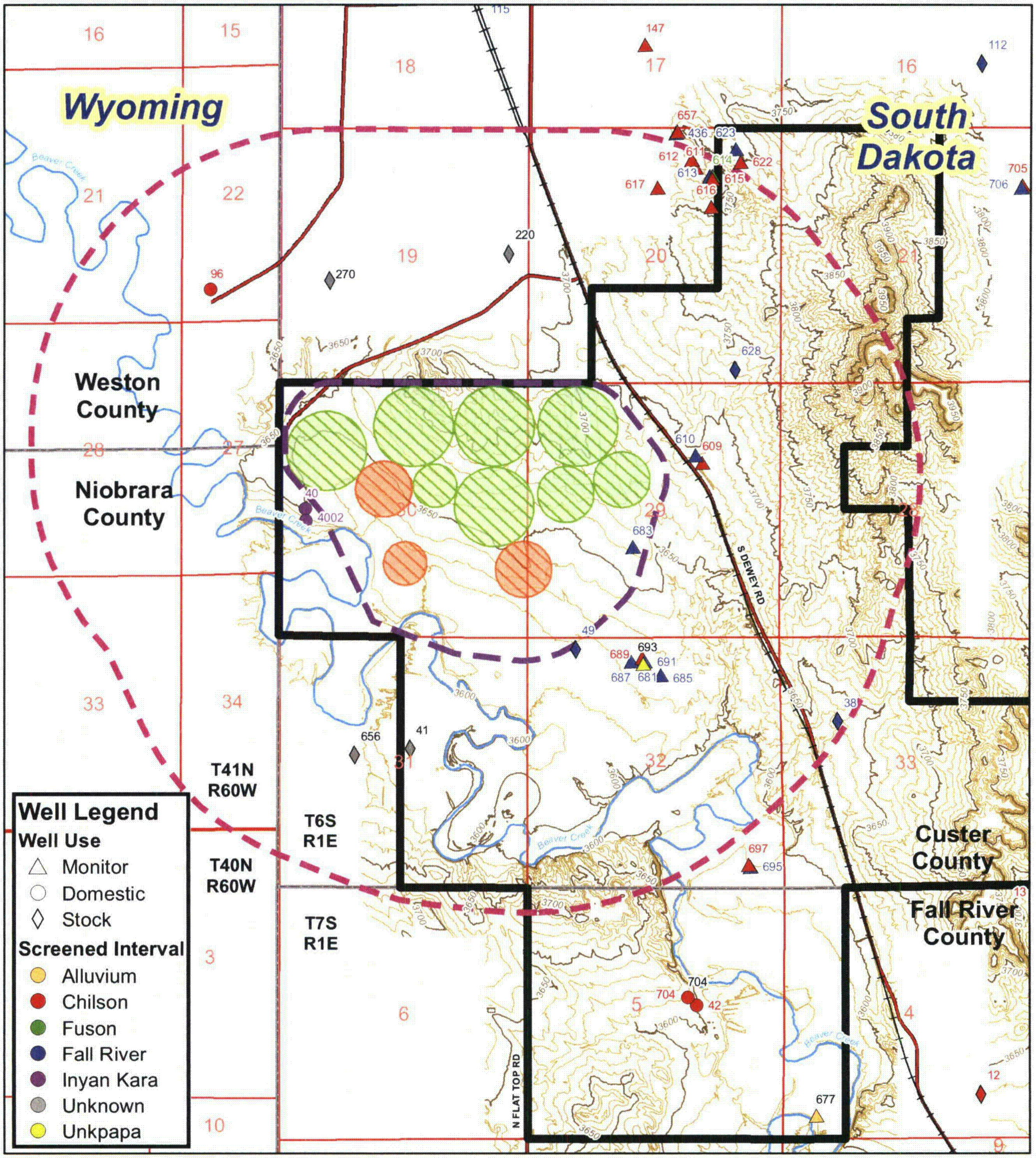
All existing domestic wells within the project area will be removed from private use prior to ISR operations, including wells 40 and 4002. Lease agreements for the entire project area currently allow Powertech (USA) to remove and replace the water supply wells as needed. Depending on the well construction, location and screen depth, Powertech (USA) may continue to use the former domestic wells for monitoring or plug and abandon the wells. The remaining domestic well within 1 mile of the proposed Dewey POP zone, well 96, is outside of the project area and will not be impacted by the proposed ISR operations.

Table 3.7-3: Wells within 1 Mile of Proposed Dewey POP Zone

Hydro ID	Township	Range	Section	1/4 - 1/4 Location	Coordinates East[1]	Coordinates North[1]	Screened Location[2]	Well Use
Existing Wells								
38	6S	1E	33	SWNW	1,024,328	442,289	Fall River	Stock
40	6S	1E	30	SWNW	1,013,415	447,182	Inyan Kara	Domestic
41	6S	1E	31	SWNE	1,015,385	442,081	Unknown	Stock
49	6S	1E	32	NWNW	1,018,932	444,022	Fall River	Stock
96	41N	60W	22	SWSW	1,011,630	451,853	Chilson	Domestic
220	6S	1E	19	SENE	1,017,872	452,334	Unknown	Stock
270	6S	1E	19	NWSW	1,014,108	451,942	Unknown	Stock
609	6S	1E	29	SWNE	1,021,735	447,808	Chilson	Monitor
610	6S	1E	29	SWNE	1,021,599	447,969	Fall River	Monitor
611	6S	1E	20	NWNE	1,021,835	453,954	Chilson	Monitor
612	6S	1E	20	NWNE	1,021,755	454,128	Chilson	Monitor
613	6S	1E	20	NWNE	1,022,125	453,775	Fall River	Monitor
614	6S	1E	20	NWNE	1,022,185	453,769	Fuson	Monitor
615	6S	1E	20	NWNE	1,022,172	453,708	Chilson	Monitor
616	6S	1E	20	SWNE	1,022,132	453,134	Chilson	Monitor
617	6S	1E	20	NENW	1,021,026	453,582	Chilson	Monitor
628	6S	1E	20	SESE	1,022,496	449,718	Fall River	Stock
656	6S	1E	31	SENW	1,014,230	442,000	Unknown	Stock
681	6S	1E	32	NENW	1,020,330	443,725	Fall River	Monitor
683	6S	1E	29	NESW	1,020,212	446,104	Fall River	Monitor
685	6S	1E	32	NWNE	1,020,690	443,409	Fall River	Monitor
687	6S	1E	32	NENW	1,020,081	443,724	Fall River	Monitor
689	6S	1E	32	NENW	1,020,316	443,789	Chilson	Monitor
691	6S	1E	32	NENW	1,020,364	443,698	Fall River	Monitor
693	6S	1E	32	NENW	1,020,327	443,661	Unkpapa	Monitor
4002	6S	1E	30	NWSW	1,013,414	446,931	Inyan Kara	Domestic

[1] Coordinate system is NAD 27 South Dakota State Plane South

[2] Inyan Kara indicates that screened interval includes both Chilson and Fall River



Note: 10' topographic contours generated by Merrick & Co., 2008 aerial topographic survey.

Feet: 0, 1,500, 3,000
Meters: 0, 300, 600, 900

Legend

- Project Boundary
- Dewey POP Zone
- BNSF Railroad
- County Roads
- Perennial Streams
- Land Application
- Standby Land Application
- 1 Mile from Dewey POP Zone

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Figure 3.7-9

Existing Wells within 1 Mile of the Proposed Dewey POP Zone

Dewey-Burdock Project

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3.7.2.3.2 Burdock Area

Table 3.7-4 and Figure 3.7-10 present the well inventory within 1 mile of the proposed Burdock POP zone, which includes 25 existing wells and 7 wells with historical records that have been confirmed as plugged and abandoned. No wells with historical records that are currently not present have been identified within 1 mile of the Burdock POP zone. Of the 25 existing wells, 2 are currently used for domestic use, 8 for stock watering, and 15 for monitor wells.

All existing domestic wells within the project area will be removed from private use prior to ISR operations, including wells 13 and 43. As described in Section 3.5, well 43 is associated with a former residence that is no longer inhabitable.

Depending on the well construction, location and screen depth, Powertech (USA) may continue to use the former domestic wells for monitoring or plug and abandon the wells.

Seven wells are identified as abandoned in Table 3.7-4. Each well was visually inspected, and it has been determined that cement was placed within the well bore.

Table 3.7-4: Wells within 1 Mile of Proposed Burdock POP Zone

Hydro ID	Township	Range	Section	1/4 - 1/4 Location	Coordinates East[1]	Coordinates North[1]	Screened Location[2]	Well Use
Existing Wells								
12	7S	1E	4	SESE	1,026,978	434,378	Chilson	Stock
13	7S	1E	3	NWNW	1,028,360	438,470	Chilson	Domestic
14	7S	1E	2	NWSW	1,033,704	434,723	Fall River	Stock
15	7S	1E	2	NENW	1,035,304	438,317	Chilson	Stock
43[3]	6S	1E	34	SWSE	1,031,123	439,436	Chilson	Domestic
51	7S	1E	9	SENE	1,027,411	431,487	Chilson	Stock
61	7S	1E	11	NWSE	1,036,832	429,987	Chilson	Stock
618	7S	1E	2	SENE	1,038,074	435,906	Unknown	Stock
619	7S	1E	2	SENW	1,034,866	436,729	Chilson	Stock
620	6S	1E	35	NWNW	1,033,951	443,209	Chilson	Stock
638	7S	1E	2	NENE	1,038,269	437,976	Fall River	Monitor
662	7S	1E	11	SESW	1,035,381	428,928	Unknown	Monitor
676	6S	1E	34	SESW	1,030,846	439,891	Alluvial	Monitor
678	7S	1E	9	SWNE	1,026,522	431,925	Alluvial	Monitor
679	6S	1E	27	NWSE	1,032,294	446,245	Alluvial	Monitor
680	7S	1E	11	NESW	1,035,078	429,969	Chilson	Monitor
682	7S	1E	11	SENW	1,035,139	431,257	Chilson	Monitor
684	7S	1E	11	NESW	1,035,191	429,744	Chilson	Monitor
686	7S	1E	11	NESW	1,034,970	429,749	Chilson	Monitor
688	7S	1E	11	NESW	1,035,027	429,974	Fall River	Monitor
690	7S	1E	11	NESW	1,035,114	429,970	Unkpapa	Monitor
692	7S	1E	11	NESW	1,035,075	430,014	Chilson	Monitor
698	7S	1E	2	NESW	1,035,909	435,651	Fall River	Monitor
707	6S	1E	34	SWNE	1,031,935	441,809	Alluvial	Monitor
708	7S	1E	3	SESW	1,030,254	434,094	Alluvial	Monitor
Abandoned Wells								
606	7S	1E	11	SWSW	1,033,713	428,609	Chilson	None
636	7S	1E	11	NESW	1,034,774	429,982	Unknown	None
652	7S	1E	2	NWSE	1,036,360	434,742	Inyan Kara	None
654	6S	1E	34	NWNE	1,032,372	443,410	Inyan Kara	None
655	6S	1E	34	NENE	1,033,454	443,307	Inyan Kara	None
665	7S	1E	11	SWSW	1,033,153	428,901	Fall River	None
666	7S	1E	11	SWSW	1,033,128	428,870	Chilson	None

1 Coordinate system is NAD 27 South Dakota State Plane South
2 Inyan Kara indicates screened interval includes both Chilson and Fall River
3 Former residence is uninhabitable

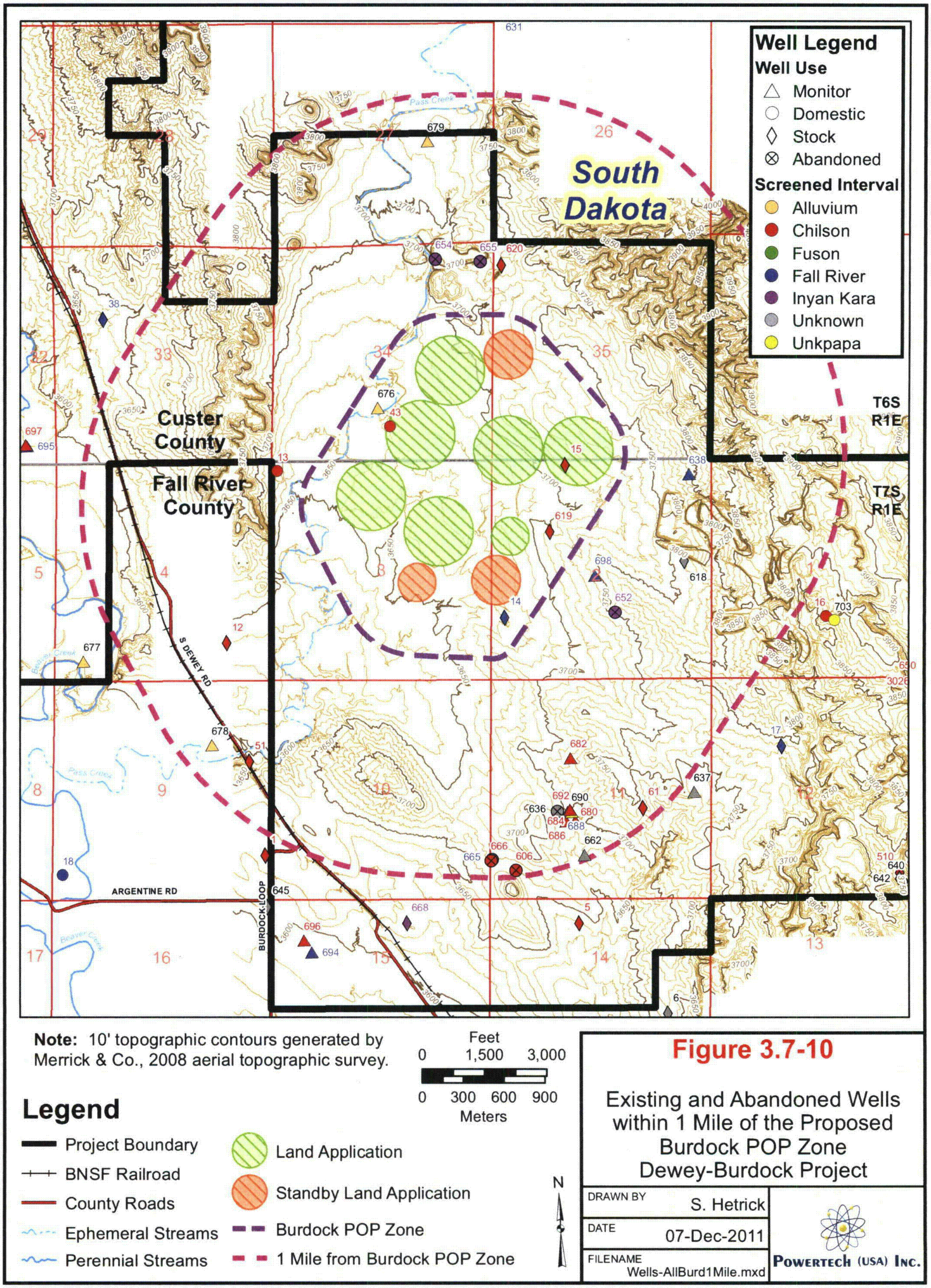

Figure 3.7-10

Existing and Abandoned Wells within 1 Mile of the Proposed Burdock POP Zone Dewey-Burdock Project

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