3.10 Aquatic Resources

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

3.10.1 Methodology

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

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

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

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

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

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

3.10.2 Aquatic Survey Results

Amphibians and Aquatic Reptiles

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

Benthic Invertebrates

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

Fish

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

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

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

3.10.3 Species of State and Federal Interest

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

3.11 Cultural Resources

3.11.1 Methodology

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

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

3.11.2 Results and Discussion

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

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

The small number of Euro American sites documented was not unanticipated given the peripheral nature of the permit area in relation to the Black Hill proper. The disparity existing between the number of historic and prehistoric sites observed in the permit area is also not unexpected; however, the sheer volume of sites documented in the area is noteworthy. The land evaluated as part of the Level III cultural resources evaluation has an average site density of approximately one site per 8.1 acres. Even greater site densities were reported in 2000 during the investigation of immediately adjacent land parcels for the Dacotah Cement/BLM land exchange (Winham et al., 2001). This indicates that the permit area is not unique, in regard to the number of documented sites, and is typical of the periphery of the Black Hills.

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

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

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

3.11.3 Procedures to Avoid or Mitigate Potential Impacts

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

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

3.12 Noise

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

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

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

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

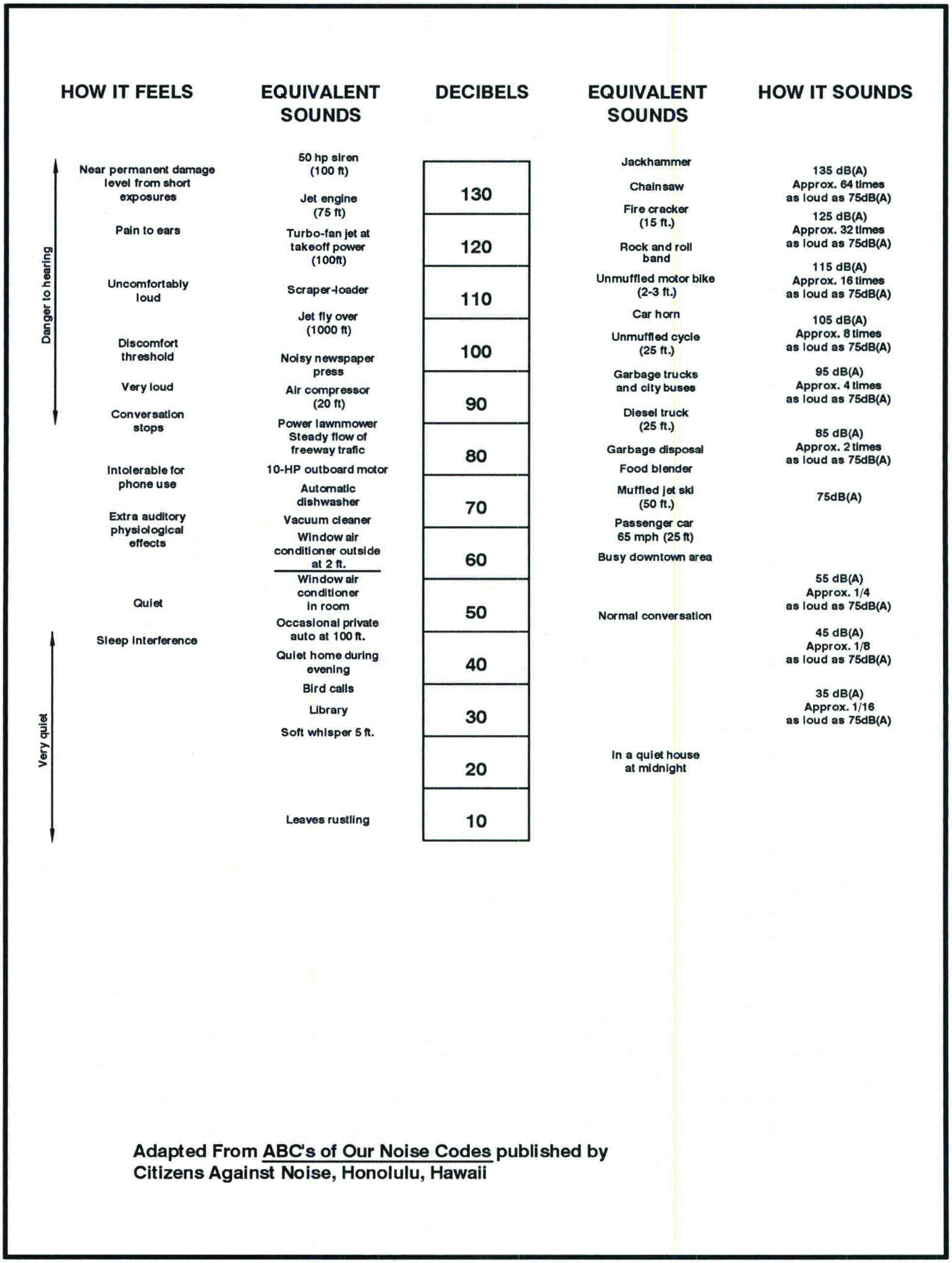


Figure 3.12-1: Relationship Between A-Scale Decibel Readings and Sounds of Daily Life

Table 3.12-1. Typical Vehicle Noise Levels

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

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

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

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

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

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

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

3.13 Visual Assessment

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

3.13.1 Methodology

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

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

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

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

3.13.2 Visual Resource Management Rating

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

Scenic Quality – Scenic quality is a measure of the visual appeal of a tract of land. In the visual resource inventory process, public lands are given an A, B, or C rating based on the apparent scenic quality, which is determined using seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. These key factors are rated according to form, line, color, texture, scale and space on a comparative scale from zero to five taking into consideration similar features within the same physiographic province. The results of the inventory and the associated rating for each key factor are summarized in Table 3.13-2 and Table 3.13-3.

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

Table 3.13-1: BLM Visual Resource Inventory Classes

		Visual Sensitivity Levels						
		High			Medium			Low
Special Area		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	II	III	III* IV*	III	IV	IV	IV
	C		IV	IV	IV	IV	IV	IV
		f/m	b	s/s	f/m	b	s/s	s/s
		Distance Zones						

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

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

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

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

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

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

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

3.14 Baseline Radiologic Characteristics

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

4.0 SOCIOECONOMIC ASSESSMENT

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

5.0 MINE PLAN

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

5.1 General Mine Planning and Design

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

5.1.1 Overview of Operations

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

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

Table 5.0-1: Uranium ISR Permitting in South Dakota

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

Table 5.0-2: Regulatory Primacy

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

Notes:

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

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

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

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

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

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

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

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

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

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

5.1.2 Ore Body Geology

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

5.1.3 Chemistry of Uranium ISR

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

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

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

Dissolution: $UO_3 + 2\,HCO_3^- \rightarrow UO_2(CO_3)_2^{2-} + H_2O$
$UO_3 + CO_3^{2-} + 2HCO_3^- \rightarrow UO_2(CO_3)_3^{4-} + H_2O$

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

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

5.2 Schedule

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

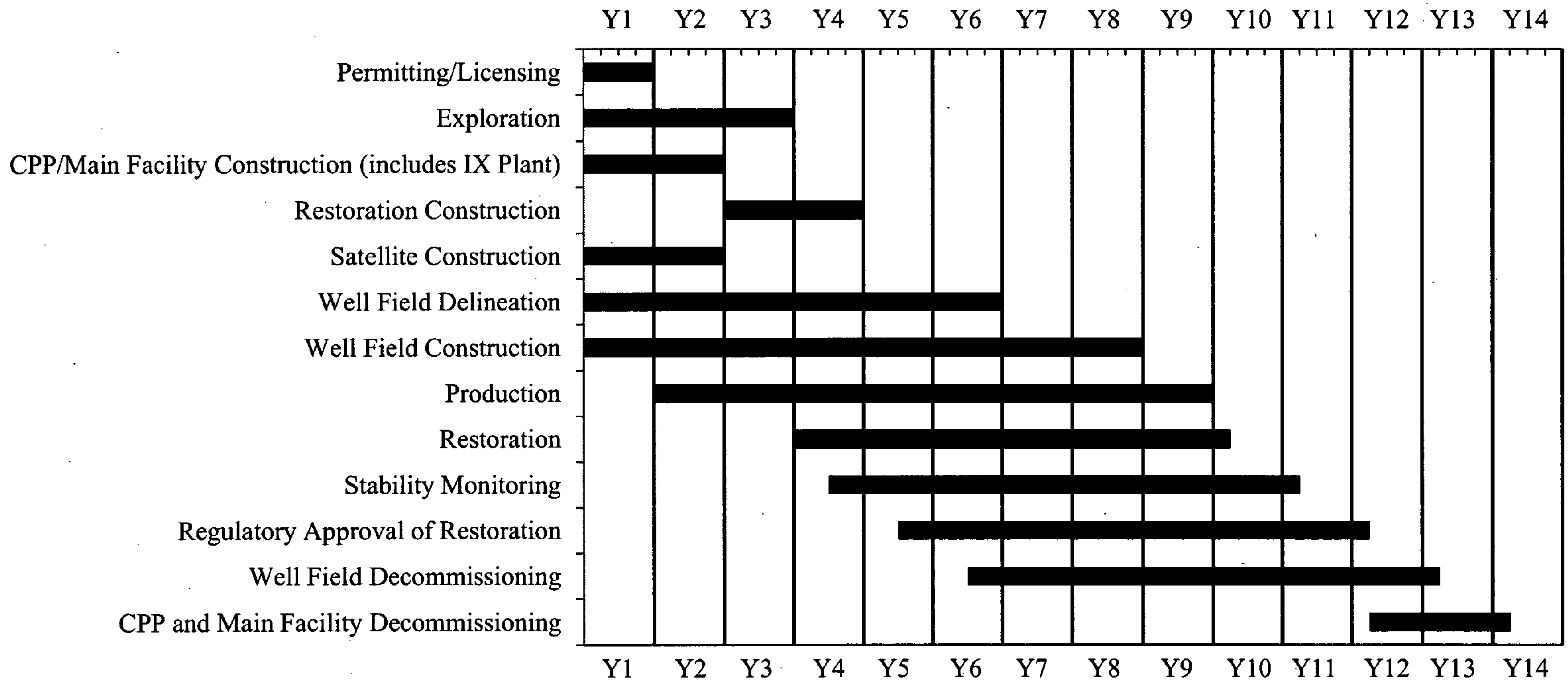


Figure 5.2-1: Projected Construction, Operation, Restoration and Decommissioning Schedule

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

5.3 Description of Facilities

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

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

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

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

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

5.3.1 CPP Equipment and Chemical Storage Facilities

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

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

5.3.1.1 CPP Equipment

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

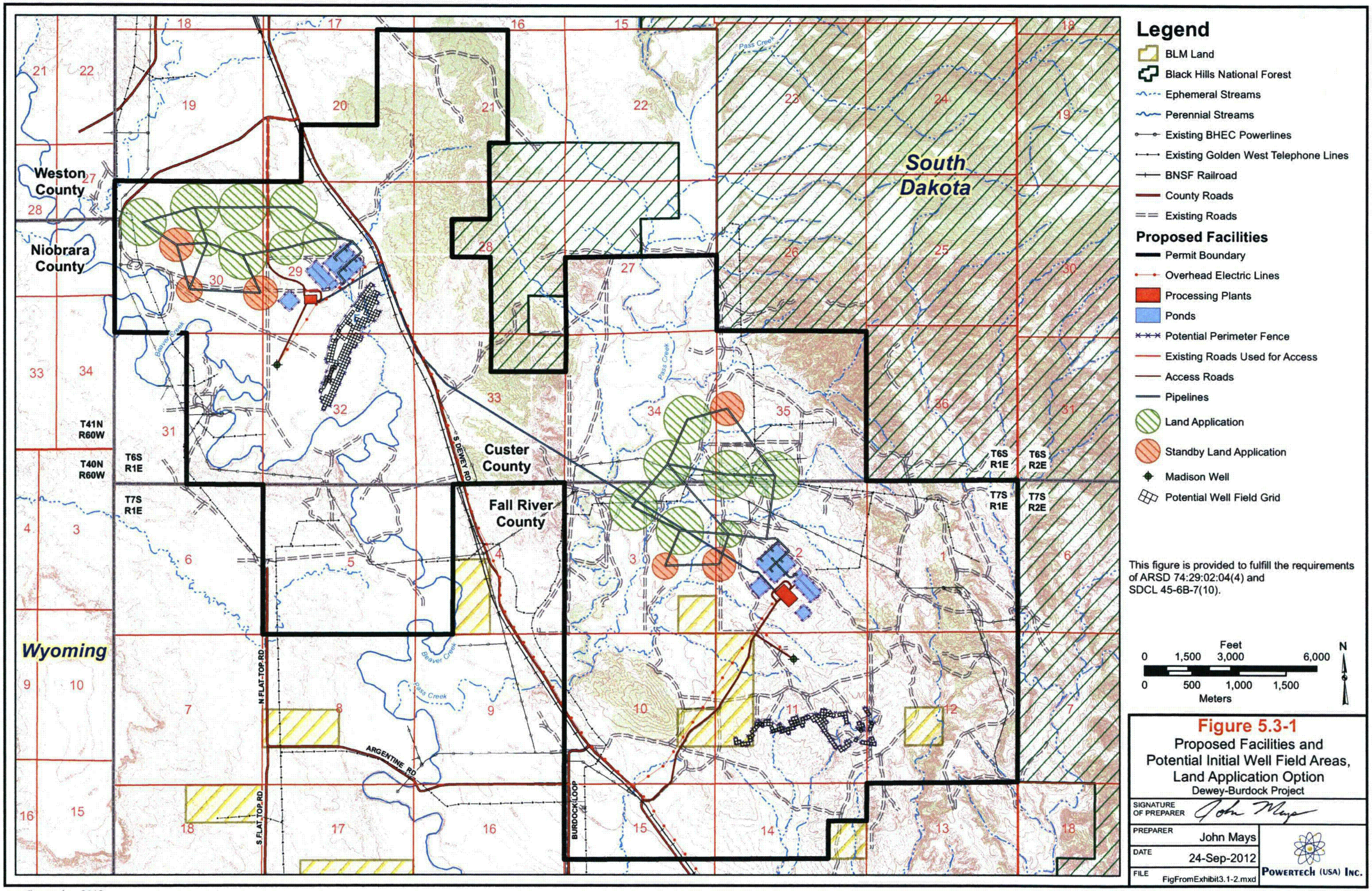
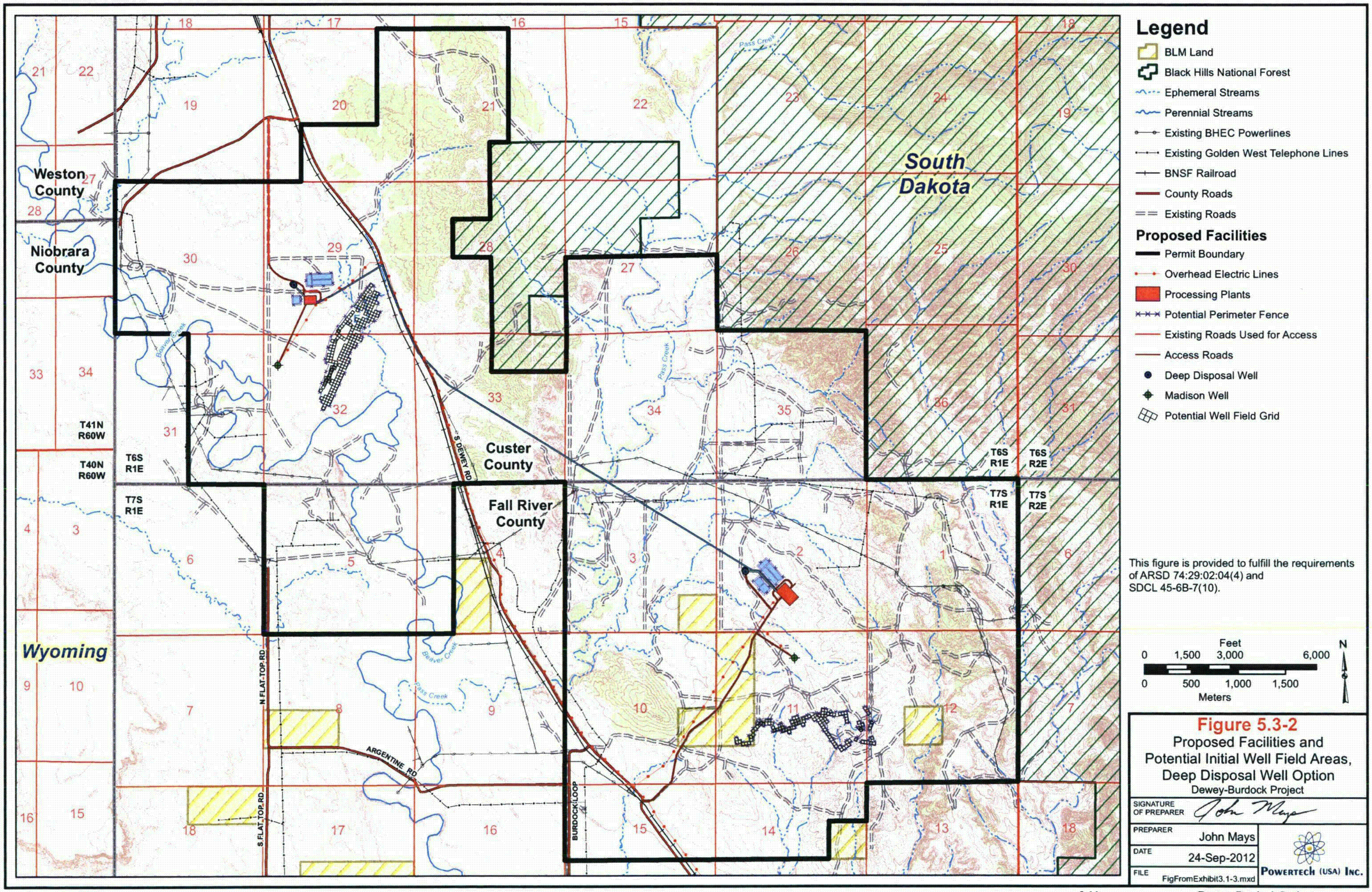


Figure 5.3-1
Proposed Facilities and Potential Initial Well Field Areas, Land Application Option
Dewey-Burdock Project



Legend
BLM Land
Black Hills National Forest
Ephemeral Streams
Perennial Streams
Existing BHEC Powerlines
Existing Golden West Telephone Lines
BNSF Railroad
County Roads
Existing Roads
Proposed Facilities
Permit Boundary
Overhead Electric Lines
Processing Plants
Potential Perimeter Fence
Existing Roads Used for Access
Access Roads
Deep Disposal Well
Madison Well
Potential Well Field Grid
South Dakota
Wyoming
Weston County
Niobrara County
Custer County
Fall River County
T41N R60W
T40N R60W
T6S R1E
T7S R1E
T6S R2E
T7S R2E
S DEWEY RD
N FLAT TOP RD
S FLAT TOP RD
ARGENTINE RD
BURDOCK LOOP
Beaver Creek
Pass Creek
This figure is provided to fulfill the requirements of ARSD 74:29:02:04(4) and SDCL 45-6B-7(10).
Feet
0 1,500 3,000 6,000
0 500 1,000 1,500
Meters
N
Figure 5.3-2
Proposed Facilities and Potential Initial Well Field Areas, Deep Disposal Well Option
Dewey-Burdock Project
SIGNATURE OF PREPARER
PREPARER John Mays
DATE 24-Sep-2012
FILE FigFromExhibit3.1-3.mxd
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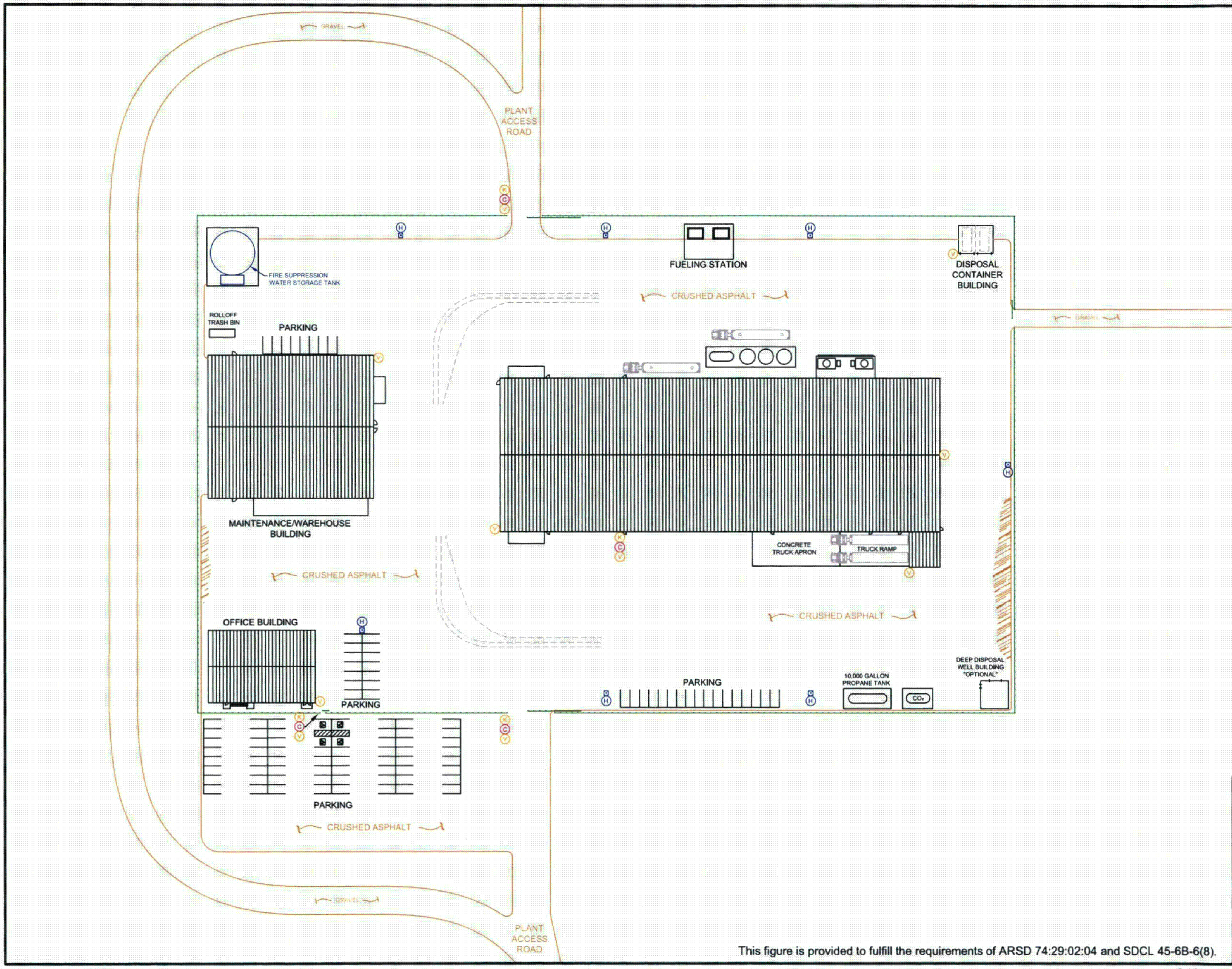

Figure 5.3-3

General Site Plan
Central Processing Plant

Dewey-Burdock Project

SIGNATURE OF PREPARER	
PREPARER	John Mays
DATE	24-Sep-2012
FILE	CPP-SitePlan-New.dwg

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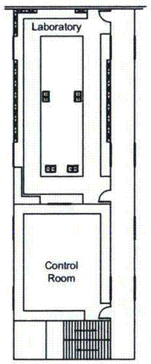
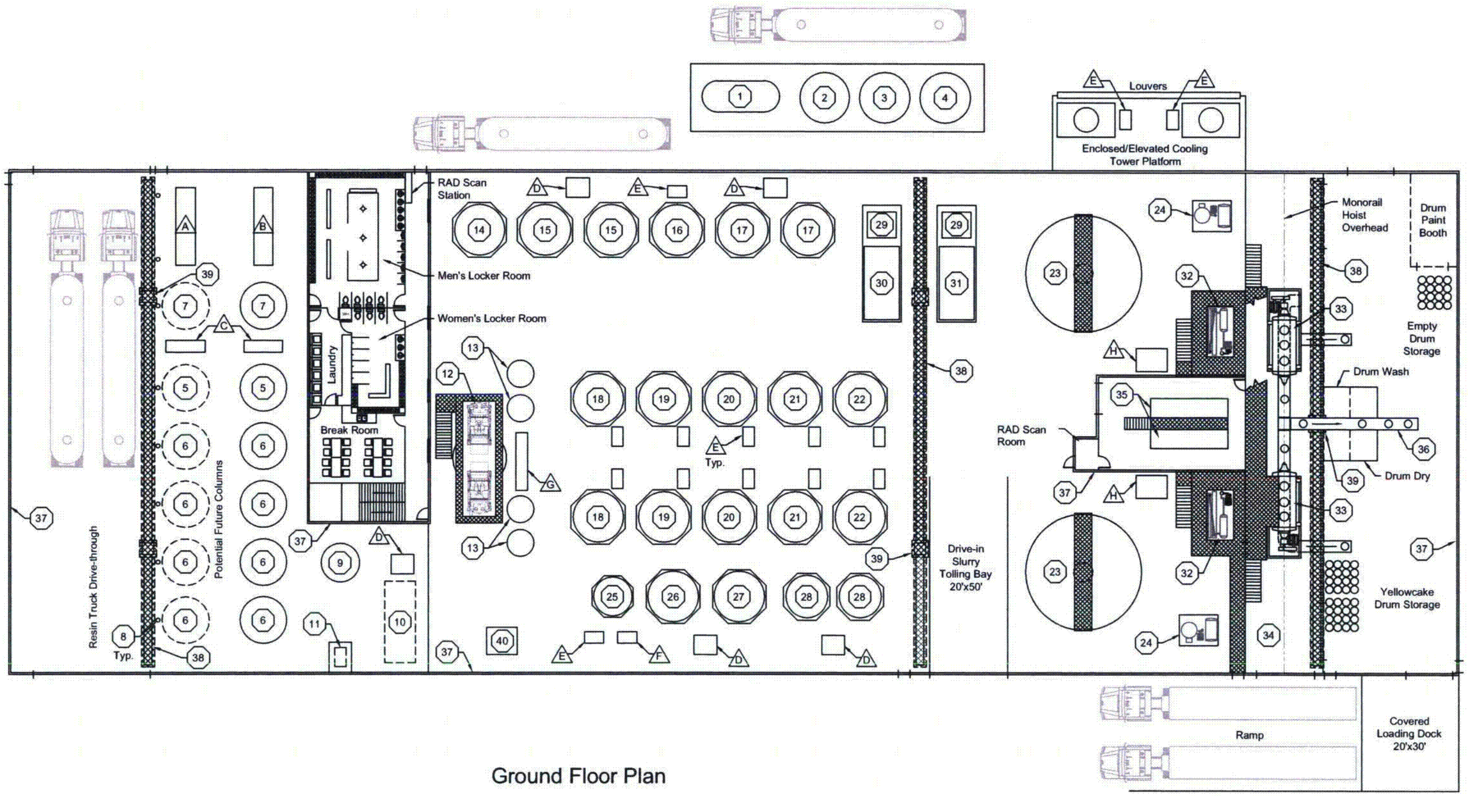


Second Floor Plan



Ground Floor Plan

Key Notes

1. CO_2
2. NaOH
3. H_2SO_4
4. H_2O_2
5. Reclamation IX Column 12'∅
6. Process IX Column 12'∅
7. Bleed IX Column 12'∅
8. Pipe Bollard Guard Post
9. Resin Transfer Water 10'∅
10. Resin Supersack Storage
11. Standby Generator in Sound Insulated Room
12. Shaker Screens with Shaker Overflow Collection Tank Below
13. Elution Column 7'∅
14. Reclamation Make-up Water 13'∅
15. NaCl 13'∅
16. Na_2CO_3 13'∅
17. Utility Water 13'∅
18. Fresh Eluant 13'∅
19. Lean Eluant 13'∅
20. Intermediate Eluant 13'∅
21. Rich Eluant 13'∅
22. Precipitation 13'∅
23. 30'∅ Thickener, 5'∅ Shear Tank Below
24. Hot Oil Boiler
25. Potable Water 10'∅
26. High TDS Wastewater Tank 13'∅
27. Low TDS Wastewater Tank 13'∅
28. Solids Removal Tank 11'∅
29. RO Pre-treatment
30. Recovery RO Unit
31. Restoration RO Unit
32. Elevated Condenser/Vacuum Pump Skid 7'x13'
33. Vacuum Dryer 8'x24'
34. Dryer Room 20'x130'
35. Filter Press and Transfer Pump 5'x20'
36. Drum Conveyor
37. 6" Curb Off All Walls, Typ.
38. 2'-0" Trench Drain, Typ.
39. 3'-0" Sump, Typ.
40. Barium Chloride Storage

Housekeeping Pads

- A: 5'x20' - PC Booster Pumps
- B: 5'x20' - IC Booster Pumps
- C: 3'x10' - Pump
- D: 6'x5' - Pump
- E: 3'x5' - Pump
- F: 3'x5' - Disinfectant
- G: 3'x15' - Pump
- H: 6'x8' - Pump

Feet: 0 15 30 60
Meters: 0 5 10 20

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

Figure 5.3-4

Central Processing Plant Detail

Dewey-Burdock Project

SIGNATURE OF PREPARER	John Mays
PREPARER	John Mays
DATE	18-Sep-2012
FILE	CPP-Floorplan.dwg

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

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

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

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

5.3.1.1.1 Recovery

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

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

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

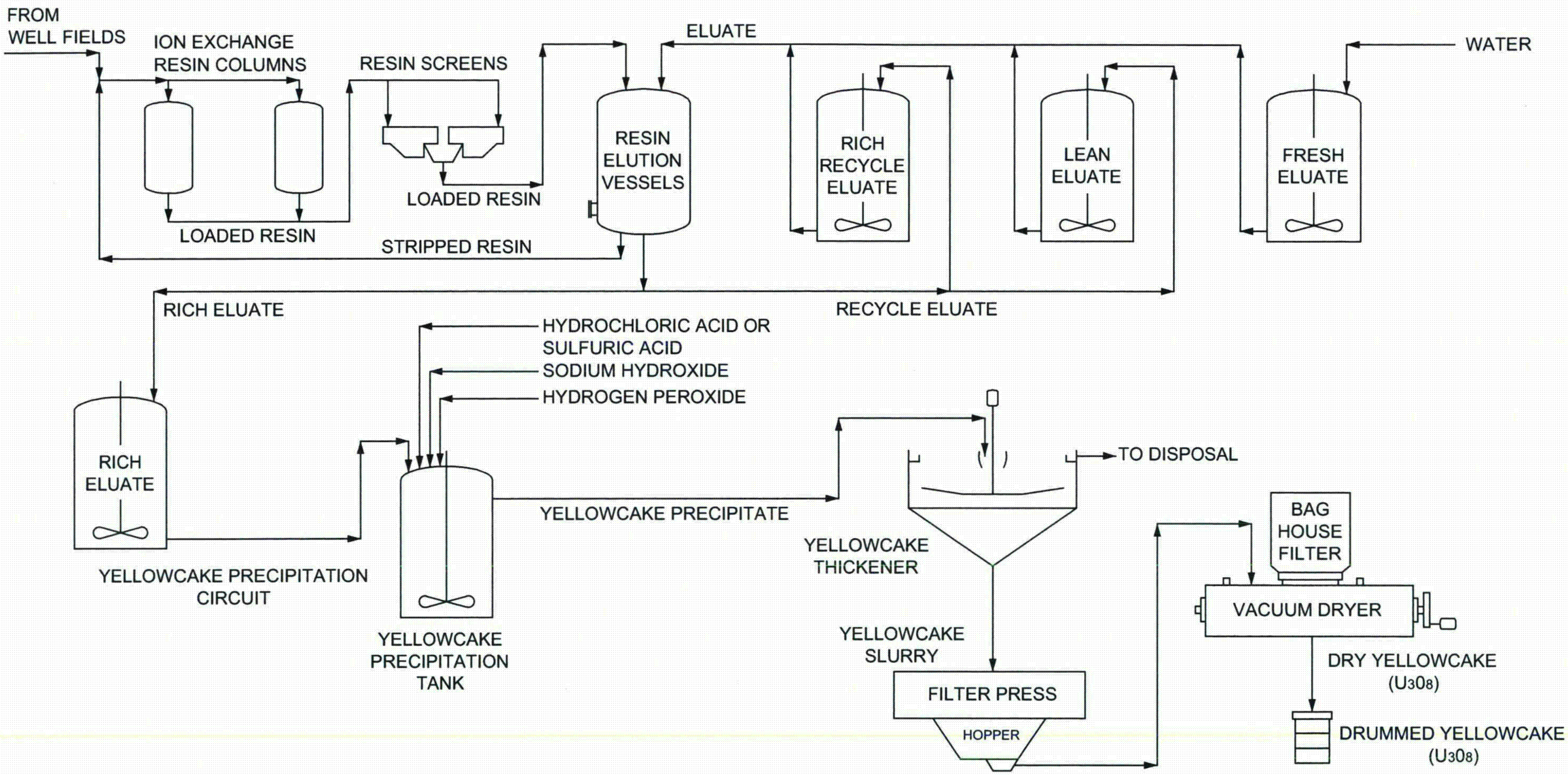

Figure 5.3-5

Process Flow Diagram

Dewey-Burdock Project

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

POWERTECH (USA) INC.

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

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

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

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

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

<u>5.3.1.1.2 Resin Transfer</u>

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

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

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

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

5.3.1.1.3 Elution

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

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

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

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

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

5.3.1.1.4 Precipitation

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

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

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

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

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

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

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

5.3.1.1.5 Drying and Packaging

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

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

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

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

5.3.1.1.6 Restoration

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

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

5.3.1.2 Chemical Storage and Feeding Systems

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

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

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

Each chemical storage and feeding system will be designed to safely store and accurately deliver process chemicals to the process delivery points. All chemical storage tanks will be clearly labeled to identify contents. Design criteria for chemical storage and feeding systems include applicable regulations of the International Building Code (IBC), National Fire Protection Association (NFPA), Compressed Gas Association (CGA), Occupational Safety and Health Administration (OSHA), Resource Conservation and Recovery Act (RCRA), and the Department of Homeland Security (DHS). Designing, constructing, and maintaining chemical storage facilities in accordance with applicable regulations will help ensure the safety of Powertech (USA) employees and members of the public, both with regard to the specific chemicals and with regard to the potential release of radioactive materials in the event of an accident.

Any negative impact to radiological safety from use of these chemicals would be due to accidents, improper use, or human error. Nevertheless, these chemicals would only indirectly cause a radiological hazard as they do not contain radiological materials themselves.

Figure 5.3-4 shows the storage locations of all chemicals used in the CPP. Oxygen will be stored as cryogenic liquid in tanks located in the well field areas. Oxygen storage tanks will be located near but at a safe distance from header houses as required by NFPA and OSHA standards.

At the CPP, the chemicals include sulfuric and/or hydrochloric acid, hydrogen peroxide, sodium hydroxide, sodium carbonate, and sodium chloride. Of these, only hydrogen peroxide presents a fire hazard if it comes in contact with combustible materials. Most of these chemicals are corrosive and reactive. Areas within the CPP and chemical storage areas will be provided with secondary containment consisting of concrete curbs around the floor perimeters. Curbs also will divide areas to prevent mixing of incompatible fluids in the event of a leak or spill. Concrete floors, secondary containment, and sumps in areas where corrosive fluids could be spilled will be coated with corrosion-resistant materials as recommended by the manufacturer. All slurry piping will use materials that are abrasion and corrosion resistant and solution piping will be appropriately corrosion resistant. Tanks holding process solutions will be constructed appropriate to the conditions as recommended by the manufacturers.

5.3.1.2.1 Sodium Chloride Storage

Sodium chloride will be used to make up fresh eluant and will be stored in tanks as a saturated solution (approximately 26 percent by weight) in equilibrium with a bed of crystals in each storage tank. Dry sodium chloride will be delivered by truck and will be blown into the storage tanks using air pressure.

5.3.1.2.2 Sodium Carbonate Storage

Sodium carbonate will be used to make up fresh eluant and will be stored in tanks as a saturated solution in equilibrium with a bed of crystals in the storage tank. Sodium carbonate solution must be kept above 140°F to prevent precipitation in the tank and piping. This will be accomplished by heating the water added to the tank, and continuously circulating liquid from the tank through a heat exchanger. An electric heater will be used to heat a thermal fluid to heat the exchanger. Dry sodium carbonate will be delivered by truck and will be blown into the storage tanks using air pressure.

5.3.1.2.3 Acid Storage and Feeding System

Sulfuric acid and/or hydrochloric acid will be used in the precipitation circuit of the CPP to break down the uranium carbonate complexes. The hazards associated with use and storage of acid include corrosiveness, toxicity to tissue, and reactivity with other chemicals at the project such as sodium carbonate and water. Acid storage tanks will be isolated from the above listed chemicals to reduce the risk of reactions. The acid storage and feeding system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a lined concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25-year, 24-hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems.

5.3.1.2.4 Sodium Hydroxide Storage and Feeding System

The sodium hydroxide system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25-year, 24-hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems. The sodium hydroxide feed pump will be located inside the building, directly adjacent to the storage tank. Sodium hydroxide will be purchased as aqueous caustic soda, and will be pumped directly into the storage tank from the supplier's tanker trucks.

5.3.1.2.5 Hydrogen Peroxide Storage and Feeding System

The hydrogen peroxide system will include a storage tank and delivery pump. The storage tank will be located outside of the CPP building in a concrete secondary containment basin designed to contain 110 percent of tank volume plus a 25-year, 24-hour storm event. This secondary containment basin will be separate from the containment basins for other chemical systems. Hydrogen peroxide is a strong oxidizer, can be very reactive and is easily decomposable. Its hazardous decomposition products include oxygen, heat, and steam.

The hydrogen peroxide feed pump will be located inside the building, directly adjacent to the storage tank.

5.3.1.2.6 Oxygen Storage and Feeding System

Liquid oxygen will be present within the well fields. The primary hazard associated with oxygen is fire since it is a strong oxidizer in the presence of combustible materials. To reduce the risk of an accident that could potentially affect other processes or storage facilities and radiological safety, oxygen will be stored near the well fields, so that in the event of an accidental release the gas would disperse and not cause a fire hazard to project equipment or infrastructure. Where above-ground oxygen storage or conveyance facilities exist, barriers will be used to prevent impacts from mobile equipment. Oxygen conveyance pipelines will be surveyed and marked with tracer wire to make them locatable by field personnel during excavation activities. A fire within a header house, where the oxygen is metered into separate injection lines, could damage equipment and instrumentation within the header house but would be unlikely to result in a spill of injection or recovery fluids. If a spill of lixiviant were to occur, well field personnel will have been trained in emergency procedures for responding to well field spills containing radiological materials. Oxygen will be stored in storage vessels designed, fabricated, tested, and inspected in accordance with the ASME Boiler and Pressure Vessel Code. Oxygen storage vessels will be equipped with safety relief devices and will be located at least 25 feet from buildings or as required by applicable NFPA and OSHA standards. Oxygen will be delivered and stored as a cryogenic liquid and then conveyed to the injection point (either upstream of the injection manifold within the header house or at each well head) as a gas through piping made from appropriate materials. Oxygen storage and delivery systems will be designed and fabricated in accordance with NFPA 55 and OSHA standards for the installation of bulk oxygen systems on industrial premises (29 CFR § 1910.104). To reduce the risk of an accident which could potentially affect other processes or storage facilities and radiological safety, oxygen will be stored a sufficient distance from other infrastructure and storage areas. Facilities used to store oxygen will conform to standards detailed in NFPA 55. Typically, oxygen storage and dispensing systems will be leased from the bulk oxygen vendor. Conveyance systems for oxygen will be clean of oil and grease because these substances will burn violently if ignited in the presence of oxygen. The proper pressure relief devices, component isolation and barriers also will be employed. Cleaning of equipment used for delivering and storing oxygen will be done in accordance with CGA G4.1. The design and installation of the oxygen piping system will be done according to the requirements of CGA G4.4. Powertech (USA) will develop procedures that implement emergency response instructions for a spill or fire involving oxygen systems.

5.3.1.2.7 Carbon Dioxide Storage and Feeding System

The carbon dioxide storage and feeding system will be used to dissolve carbon dioxide into the pregnant lixiviant to improve recovery of uranium in the IX vessel. This system will be a vendor supplied packaged system including cryogenic tank, vaporizer, pressure gauges, and pressure relief devices.

5.3.1.2.8 Barium Chloride Storage and Feeding System

The barium chloride storage and feeding system includes a storage tank, agitator, and chemical metering pump. This system will be designed to dissolve solid barium chloride in water to make up the solution for feeding into the low TDS wastewater for radium precipitation. Barium chloride will be stored as palletized sacks.

5.3.1.2.9 Byproduct Storage

Prior to transportation to a licensed disposal facility, 11e.(2) byproduct material will be stored in designated storage buildings (also referred to as "byproduct storage buildings"), one located at the CPP site and one located at the Satellite Facility site. These buildings will consist of a concrete slab with a containment curb surrounding the perimeter. Storage of byproduct material will be within "roll-off" containers (bins) which are both liquid tight and fully enclosed. As each storage building will accommodate two 20 cubic yard bins, the volume of byproduct material could accumulate to 30 to 40 cubic yards at each of the two storage locations prior to transport. There will be two bays in each storage building, each accessed by an overhead roll-up door and allowing exchange of containers necessary for transport to a licensed 11e.(2) disposal site. The concrete slabs will be designed to allow external decontamination of the roll-off bins prior to transport.

The byproduct storage buildings will allow for control of byproduct materials and specific segregation of these wastes from other non-11e.(2) wastes. Typically these wastes are expected to consist of contaminated used equipment parts, personal protective equipment, and wastes from cleanup of spills or other housekeeping activities. Other waste not in contact with the uranium production process will be disposed of in regular dumpsters situated at a separate location.

Containment of these byproduct wastes within a designated, fully enclosed building will allow for proper control of the materials, monitoring, and necessary restricted access. These measures will ensure best possible control of 11e.(2) solid and liquid wastes to minimize any potential exposures or contamination.