Safety Evaluation Report (Revised) for the Dewey-Burdock Project Fall River and Custer Counties, South Dakota

Materials License No. SUA-1600

Docket No. 40-9075
Powertech (USA) Inc.

U.S. Nuclear Regulatory Commission

Office of Federal and State Materials and Environmental Management Programs

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

byproduct material	Tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by such solution extraction operations do not constitute "byproduct material" within this definition.
ac	acre
ACL	alternate concentration limit
Act	Atomic Energy Act of 1954, as amended
ADAMS	Agencywide Documents Access and Management System
ALARA	as low as is reasonably achievable
ALI	annual limit on intake
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
bgs	below ground surface
BLM	Bureau of Land Management
^{o}C	Celsius
CAB	Commission-approved background
CEDE	committed effective dose equivalent
CEO	chief executive officer
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGA	Compressed Gas Association
cm	centimeter
cms	cubic meters per second
cm/s	centimeters per second
CNSC	Canadian Nuclear Safety Commission
CO_2	carbon dioxide
COO	chief operating officer
cpm	counts per minute
CPP	central processing plant
DAC	derived air concentration
DDE	deep dose equivalent
DDW	deep disposal well
DHS	Department of Homeland Security
DOT	Department of Transportation
dpm	disintegrations per minute
EA	environmental assessment
EDE	Effective Dose Equivalent
Eh	oxidation-reduction potential

EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ER	environmental report
^{o}F	Fahrenheit
FEMA	Federal Emergency Management Agency
FR	*Federal Register*
ft	feet
ft msl	feet above mean sea level
ft/d	feet per day
ft^2/day	square feet per day
ft/s	feet per second
g	acceleration of gravity
gal	gallon
GDP	Groundwater Discharge Plan issued by SD DENR
GEIS	Generic Environmental Impact Statement
GIS	geographic information system
gpm	gallons per minute
GPS	Global Positioning System
GSA	General Services Administration
H_2SO_4	sulfuric acid
ha	hectares
HCl	hydrochloric acid
HDPE	high density polyethylene
HEC	Hydraulic Engineering Center
HEPA	high efficiency particulate air
HMS	Hydrologic Modeling System
HPT	health physics technician
IBC	International Building Code
IML	Inter-Mountain Laboratories, Inc.
in	inches
IX	ion exchange
ISR	in situ recovery
JFD	joint frequency distribution
kg	kilograms
km	kilometers
kph	kilometers per hour
LC	license condition
lb	pound
LDE	lens dose equivalent
LLD	lower limits of detection
Lpm	liters per minute

LSA	Low Specific Activity
m	meters
m^2/day	square meters per day
m^3	cubic meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mi	miles
MIT	Mechanical Integrity Test
MDC	minimum detectable concentration
MDA	minimum detectable activity
m msl	meters above mean sea level
mph	miles per hour
mrem	millirems
mv	millivolts
µCi/ml	microcurie per milliliter
NaI	sodium iodide
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC technical report designation (Nuclear Regulatory Commission)
NVLAP	National Voluntary Laboratory Accreditation Program (NVLAP)
NWS	National Weather Service
O_2	oxygen
OSL	Optically Stimulated Luminescence
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
P&A	plugging and abandoning
PBL	performance-based license (PBL)
pCi/L	picocurie per liter
pCi/m^2-s	picocurie per square meter-seconds
pCi/kg	picocurie per kilogram
PGA	peak ground acceleration
PIC	Pressurized Ion Chamber
POP	perimeter of operational pollution
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAI	Request for Additional Information
RAS	River Analysis System
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RO	reverse osmosis

RSO	Radiation Safety Officer
RWPs	radiation work permits
S_b	standard deviation of background count rate
SCS	Soil Conservation Service
SD DENR	South Dakota Department of Environment and Natural Resources
SDE	shallow-dose equivalent to the skin
SDGF&P	South Dakota Department of Game, Fish and Parks
SDGS	South Dakota Geological Survey
SEIS	supplemental environmental impact statement
SER	safety evaluation report
SERP	Safety and Environmental Review Panel
SOPs	standard operating procedures
SPAW	Soil-Plant-Atmosphere-Water
SRDT	solar radiation delta-T
SSLs	soil screening levels
standard review plan	NUREG-1569 - Standard Review Plan for In Situ Leach Uranium Extraction License Applications
TDS	Total Dissolved Solids
TEDE	Total Effective Dose Equivalent
TLD	thermoluminescent detector
tonnes	metric tons – 2,200 lb
TRG	target restoration goal
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
UCL	upper control limit
UIC	Underground Injection Control
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VP	vice president
WDEQ-LQD	Wyoming Department of Environmental Quality – Land Quality Division
WL	working levels
yd	yards
yd^3	cubic yards

INTRODUCTION

By letter dated February 25, 2009, Powertech (USA) Inc. (Powertech or the applicant) submitted a license application to the U.S. Nuclear Regulatory Commission (NRC) to construct and operate the Dewey-Burdock Project in Fall River and Custer Counties, South Dakota (Powertech, 2009b). The proposed project is a uranium in situ recovery (ISR) project. The application consisted of a technical report and an environmental report (Powertech, 2009c). In June 2009, the applicant withdrew the Dewey-Burdock Project application (Powertech, 2009a), and resubmitted a supplement to the original application on August 10, 2010 (Powertech, 2010a).

On October 2, 2009, the NRC staff notified the applicant of the staff's decision to accept the application for detailed technical and environmental review (NRC, 2009). After beginning its review, the staff requested additional information from the applicant. In response to the staff's requests (NRC, 2010), the applicant provided technical report revisions for NRC staff's technical review in correspondence dated June 28, 2011 (Powertech, 2011a) and supplemental technical responses to NRC staffs requests for information (RAIs).

This safety evaluation report (SER) documents the NRC staff's technical review of the applicant's revised technical report and supplements. Unless otherwise stated, this SER neither documents any review of the applicant's environmental report nor adopts any conclusions of the Supplemental Environmental Impact Statement that the Staff is preparing as part of its environmental review for the Dewey-Burdock Project.

The Atomic Energy Act of 1954, as amended, authorizes the NRC to issue licenses for the possession and use of source material and byproduct material. Source material licenses, which are required in order to conduct ISR operations, are subject to the safety requirements specified in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 40, "Domestic Licensing of Source Material." In determining whether to issue a license, the NRC staff must follow NRC regulatory requirements that are designed to protect public health and safety from radiological hazards. In accordance with 10 CFR 40.32, "General Requirements for Issuance of Specific Licenses," the NRC must make the following safety findings before it can issue an ISR license:

- The application is for a purpose authorized by the Atomic Energy Act;
- The applicant is qualified by reason of training and experience to use the source material for the purpose requested in such a manner as to protect health and minimize danger to life or property;
- The applicant's proposed equipment, facilities, and procedures are adequate to protect health and minimize danger to life or property; and
- The issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.

Safety Evaluation Report

This SER documents in the safety portion of the staff's review of the application included the application (Powertech, 2009c), a supplement to the application (Powertech, 2010a), technical report revisions (Powertech, 2011a), and supplemental technical responses to NRC staff's RAIs. This SER includes an analysis to determine the applicant's compliance with the requirements listed above, and with the applicable requirements and objectives set forth in 10 CFR Parts 20 (Standards for Protection Against Radiation) and 40 (Domestic Licensing of Source Material), and 10 CFR Part 40, Appendix A (Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for their Source Material Content). A Supplemental Environmental Impact Statement (SEIS) has been prepared in parallel with this SER to address the environmental impacts of the proposed action (NRC, 2013a).

The staff's safety review of the proposed Dewey-Burdock Project was performed using NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications," (NRC, 2003b)(standard review plan) and is an assessment of the applicant's proposed Dewey-Burdock Project. Regulations in 10 CFR Parts 20 and 40, and those in Appendix A to 10 CFR Part 40, contain the technical requirements for licensing an ISR facility. The staff organized this SER following the organization of NUREG-1569, except that sections addressing environmental aspects are not included in the SER as they are addressed in the SEIS (NRC, 2013a).

The staff's review of this application for the proposed Dewey-Burdock Project identified a number of facility-specific issues that require license conditions to ensure that the operation of the facility will be adequately protective of public health and safety. These specific conditions are found in SER Table 1-1, and the standard conditions applying to uranium recovery licenses generally and ISR licenses specifically are found in SER Appendix A.

The staff concludes that the findings described in this SER, including the necessary license conditions, support the issuance of a license authorizing the possession and use of source and byproduct material in connection with the proposed Dewey-Burdock Project. The staff supports the issuance of a license if the conditions identified in SER Appendix A are included in the license. The staff issued draft licenses to the applicant on July 31, 2012 (NRC, 2012), January 4, 2013 (NRC, 2013b), March 1, 2013 (NRC, 2013c), and March 19, 2013 (NRC, 2013d). By letter dated March 19, 2013, Powertech agreed to these license conditions (Powertech, 2013).

The NRC staff finds that the application for the Dewey-Burdock Project materials license complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's regulations. Based on its review, as documented in this SER, the staff concludes that the application meets the applicable requirements in 10 CFR Parts 20 and 40. More specifically, in accordance with 10 CFR 40.32(b)–(c), the staff finds that the applicant is qualified by reason of training and experience to use source material for its requested purpose, and that the applicant's proposed equipment and procedures for use at its Dewey-Burdock Project facility are adequate to protect public health and minimize danger to life or property. Therefore, in accordance with 10 CFR 40.32(d), the staff finds that issuance of a license to the applicant will not be inimical to the common defense and security or to the health and safety of the public.

Clarification on Required Environmental Sampling

The staff is defining two types of sampling programs that are required by the regulations in 10 CFR Part 40, Appendix A. First, Criterion 7 requires the collection of environmental baseline samples in starting at least one year prior to major onsite construction. This sampling program is designated as Criterion 7 baseline sampling in this SER and is discussed in SER Chapter 2. Second, Criterion 5B(5) specifies “Commission-approved background” as a primary groundwater protection standard. Therefore, sampling to determine Commission-approved background (CAB) is required, after license issuance, but prior to the start of principal activities at a site, or in a wellfield in the case of an ISR facility. CAB sampling is discussed in SER Chapter 5.

Clarification of Applicant’s Commitments

In various locations throughout the application, the applicant states specific commitments regarding its operations, some of which are reiterated in this SER. All commitments, whether or not they are repeated in this SER, are enforceable to the same extent as any regulation or license condition. This is the case because standard license condition 9.2 incorporates by reference all commitments made by the applicant in its application.

Table 1-1: List of Facility-Specific License Conditions

License Condition No.	License Condition
10.10	<u>Hydrologic Test Packages.</u> A. Prior to principal activities in a new wellfield, the licensee shall submit a hydrologic test package to the NRC at least 60 days prior to the planned start date of lixiviant injection. The hydrologic test package for B-WF-1 or D-WF-1, whichever is developed first, will be submitted for review and verification while the remaining hydrologic test packages will be submitted for NRC staff review except as described in paragraph B of this License Condition. In each hydrologic test data package, the licensee will document that all perimeter monitoring wells are screened in the appropriate horizon in order to provide timely detection of an excursion. Contents of a wellfield package shall include: • A description of the proposed wellfield (location, extent, etc.) • Map(s) showing the proposed production and injection well patterns and locations of all monitor wells • Geologic cross sections and cross section location maps • Isopach maps of the production zone sand and overlying and underlying confining units • Discussion of aquifer test procedures, including well completion reports

	• Discussion of the results and conclusions of aquifer tests, including raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and, when appropriate, directional transmissivity data and graphs • Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns • All raw analytical data for Commission-approved background water quality • Summary tables of analytical data showing computed Commission-approved background water quality • Descriptions of statistical methods for computing Commission-approved background water quality • Any other information pertinent to the proposed wellfield area tested will be included and discussed. B. The licensee will submit, for NRC review and approval, hydrologic test packages for wellfields B-WF-6, -7, and -8. No extraction will be permitted in these wellfields until the staff approves the hydrologic package. Hydrologic packages shall include all the information in paragraph A of this license condition and aquifer test results that address the partially unsaturated conditions of the Chilson Aquifer in these wellfields. These hydrologic packages will also contain a justification for well spacings in the monitoring well ring and overlying and underlying aquifers.
10.11	The licensee is prohibited from using the “glue and screw” method of joining well casings to construct any monitoring, injection, or production well.
10.12	If land application is utilized, the licensee will implement a pre operational and operational sampling plan, as discussed in Section 6.0 of the licensee’s Groundwater Discharge Plan submitted to and per the conditions in its Groundwater Discharge Plan permit issued by the South Dakota Department of Environment and Natural Resources, until principal activities at the land application areas cease.
10.13	The licensee shall conduct radiological characterization of airborne samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 for each restricted area air particulate sampling location at a frequency of once every 6 months for the first 2 years following issuance of the initial license, and annually thereafter to ensure compliance with 10 CFR 20.1204(g). The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required for compliance with 10 CFR 20.1204(g).
10.14	The licensee shall ensure radiation safety training is consistent with the current versions of Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure," Regulatory Guide 8.29, “Instruction Concerning Risks from Occupational Radiation Exposure," and Section 2.5 of Regulatory Guide 8.31, or NRC-approved equivalent guidance.
11.7	The licensee shall submit semi-annual reports that present the flow rates and volumes of liquid effluent discharged to Class V disposal wells and land application areas, influent flow rates into satellite and central processing plants, and bleed rates. The first report is due no later than 12 months after the start of operations,

	and shall account for all effluent discharges and inflows during the previous 12 months.
11.8	After the initial land use update discussed in LC 12.15, every 12 months thereafter the licensee shall submit a land use update report for NRC staff review, until groundwater restoration and decommissioning are completed and approved by the NRC.
12.7	At least 60 days prior to construction, the licensee will propose in writing, for NRC review and written verification, a monitoring well network for the Fall River Aquifer in the Burdock area for those wellfields in which the Chilson Aquifer is the extraction zone.
12.8	The licensee will continue to collect additional meteorological data on a continuous basis at a data recovery rate of 90 percent until the data collected is determined by the NRC staff to be representative of long-term conditions. Justification of the similarity or validity of the data will include analysis of the statistical data presented to illustrate confidence in the representativeness of the data. The data collected shall include, at a minimum, wind speed, wind direction, and an annual wind rose. The submittal shall include a summary of the stability classification.
12.9	The licensee shall submit preoperational surface water analytical data for the new surface water sampling locations to the NRC for review and written verification within 3 months of the initiation of operations. Surface water analytical data shall be of the same completeness (e.g. parameters, quality of analyses, and frequency) as the data provided in the licensee's June 2011 submittal (ADAMS Accession No. ML112071064).
12.10	Prior to commencement of operations, the licensee will collect four quarterly groundwater samples from each well within 2 km (1.25 mi) of the boundary of any wellfield, as measured from the perimeter monitoring well ring. This data shall be submitted to the NRC staff for review and written verification. Furthermore, all domestic, livestock, and crop irrigation wells within 2 km (1.25 mi) of the boundary of any wellfield, as measured from the perimeter monitoring well ring, will be included in the routine environmental sampling program provided that well owners consent to sampling and the condition of the wells renders them suitable for sampling.
12.11	No later than 30 days prior to construction, the licensee will provide additional statistical analysis of the soil sampling data and gamma measurements to establish sufficient statistical relationships. If such relationships are not sufficient for use at the site, additional procedures or data shall be submitted to the NRC staff for review and written verification.
12.12	No later than 30 days before the start of operations, the licensee shall provide the NRC staff, for review and verification, its procedures for documenting the wellfield inspections. These procedures shall include the personnel tasked with performing these inspections, items to be inspected, criteria for determining upset conditions, and the manner in which the inspections will be documented.
12.13	No later than 30 days prior to the preoperational inspection, the licensee shall provide to the NRC staff, for review and written verification, its procedures for preparing logs of the dryer and emissions control system performance in accordance with 10 CFR Part 40, Appendix A, Criterion 8. The procedure shall

	include the manner in which logs for inspection will be produced and maintained at the Dewey-Burdock Project. These procedures shall also specify specific job functions or categories of personnel responsible for responding to malfunctions of the dryer and emissions control system and the manner in which such responsible persons are notified of malfunctions.
12.14	No later than 90 days before the start of operations, the licensee shall provide, for the NRC Staff review and written verification, the qualifications and training required for RSO designees for reviewing and issuing radiation work permits.
12.15	No later than 30 days before the start of operations, the licensee shall submit a report for NRC staff review updating land use descriptions within the Dewey-Burdock Project and within 2 miles of the license boundary. This report shall identify actual land use changes, new structures and the purpose, and new water supply wells and the purpose.
12.16	At least 30 days prior to the preoperational inspection, the licensee shall provide a list of its instrumentation to be used during operations, including the manufacturer, model number or a description, and the range of sensitivity of the radiation survey meters for measuring beta radiation. The licensee shall also provide a plan for conducting beta surveys in process areas.
12.17	No later than 30 days before the preoperational inspection, the licensee shall submit to the NRC staff, for review and written verification, an acceptable method to ensure the soluble intake of uranium will be as low as reasonably achievable (ALARA).
12.18	The licensee shall submit to the NRC staff for review and written verification the procedures by which it will ensure that unmonitored employees will not exceed 10 percent of the dose limits in 10 CFR Part 20, Subpart C.
12.19	The licensee shall prepare a bioassay QA/QC procedure that is consistent with Regulatory Guide 8.22. This procedure shall be made available for NRC staff review and written verification during the preoperational inspection.
12.20	No later than 30 days before the preoperational inspection, the licensee shall develop a survey program for beta-gamma contamination for personnel exiting from restricted areas that will meets the requirements of 10 CFR Part 20, Subpart F.
12.21	The licensee shall provide, for NRC staff review and written verification, the surface contamination detection capability (scan MDC) for radiation survey meters used for contamination surveys to release equipment and materials for unrestricted use and for personnel contamination surveys. The detection capability in the scanning mode for the alpha and beta-gamma radiation expected shall be provided in terms of dpm per 100 cm^2.
12.22	No later than 30 days before the preoperational inspection, the licensee shall provide, to the NRC staff, for review and written verification, written procedures for its airborne effluent and environmental monitoring program that: A. Discuss how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for in, and verified by, surveys and/or monitoring.

	B. Evaluate the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302. C. Discuss and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2. D. Discuss how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire License Area from licensed operations will be accounted for, and verified by, surveys and/or monitoring.
12.23	Within 90 days of receipt of an NRC license, the licensee will submit to the NRC for review and approval a revised decommissioning, decontamination, and reclamation plan. The revised plan will include soil cleanup criteria for radionuclides other than radium based on the radium benchmark dose method, as well as procedures for monitoring beta-gamma contamination on equipment, structures, and material released for unrestricted use. The soil cleanup criteria, based on the radium benchmark dose methodology for U and other radionuclides, will demonstrate that residual radioactivity in soil meets the criteria in 10 CFR Part 40, Appendix A, Criterion 6(6). The revised plan will also include procedures for restoring stream channels to their original geomorphology.
12.24	At least 60 days prior to the preoperational inspection, the licensee will submit a completed Quality Assurance Project Plan (QAPP) to the NRC for review to verify that the QAPP will be consistent with Regulatory Guide 4.15 (as revised).
12.25	No later than 60 days prior to construction, the licensee shall submit to the NRC for review and verification, a pond detection monitoring plan that contains the number, locations, and screen depths of groundwater monitoring wells to be installed around the Burdock area and Dewey area ponds. The plan shall also include sampling frequency and sampling parameters. Monitoring wells installed to comply with the licensee's Groundwater Discharge Permit issued by the State of South Dakota may be incorporated into this monitoring network.

References

NRC (2003b). NUREG 1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Washington, DC. (ADAMS Accession No. ML031550302).

NRC (2009). Letter Regarding Results of Acceptance Review, Powertech (USA), Inc.'s Proposed Dewey-Burdock Facility, Fall River, and Custer Counties, South Dakota. (ADAMS Accession No. ML092610201).

NRC (2010). Request for Additional Information for Proposed Dewey-Burdock In Situ Recovery Facility. (ADAMS Accession No. ML101460286).

NRC (2012). Draft Materials License SUA-1600, Powertech (USA), Inc., Dewey-Burdock in Situ Recovery Facility, Fall River and Custer Counties, South Dakota, July 31, 2012 (ADAMS Accession No. ML12207A480).

NRC (2013a). NUREG-1910, Supplement 4 - Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities. (ADAMS Accession No. ML12312A039 and ML12312A040).

NRC (2013b). Second Draft Materials License SUA-1600, Powertech (USA), Inc., Dewey-Burdock in Situ Recovery Facility, Fall River and Custer Counties, South Dakota, January 4, 2013 (ADAMS Accession No. ML12355A655).

NRC (2013c). Third Draft Materials License SUA-1600, Powertech (USA), Inc., Dewey-Burdock in Situ Recovery Facility, Fall River and Custer Counties, South Dakota, March 1, 2013 (ADAMS Accession No. ML13052A777).

NRC (2013d). Email Containing Draft Materials License Conditions with the Addition of License Condition 12.25, March 19, 2013 (ADAMS Accession No. ML13078A056).

Powertech (2009a). Letter from Powertech (USA) Inc., Notification of Withdrawal of License Application and Plans to Resubmit with Additional Information and Analyses Referenced by NRC. June 19, 2009 (ADAMS Accession No. ML091890924).

Powertech (2009b). Letter Transmitting Application for New Materials License to U.S. NRC. February 25, 2009 (ADAMS Accession No. ML091030707).

Powertech (2009c). Powertech Dewey-Burdock Application. February 28, 2009 (ADAMS Accession No. ML091200014 - Package).

Powertech (2010a). Dewey-Burdock Project Supplement to Application for Uranium Recovery License Dated February 2009. August 10, 2010 (ADAMS Accession No. ML092870160 - Package).

Powertech (2011a). Revised Responses to the Request for Additional Information (RAI) for the Technical Report (TR); Powertech (USA) Inc.'s Proposed Dewey-Burdock Project. 08/01/2011 (ADAMS Accession No. ML112071064).

Powertech (2013). Letter from Powertech Consenting to the License Conditions in Draft Materials License SUA-1600. March 19, 2013 (ADAMS Accession No. ML13078A262).

1.0 PROPOSED ACTIVITIES

1.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the summary of the proposed activities at the Dewey-Burdock Project complies with 10 CFR Part 40.31, which describes the general requirements for issuance of a specific license.

1.2 ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40.31 using the acceptance criteria in Section 1.3 of the standard review plan, NUREG-1569 (NRC, 2003b).

1.3 STAFF REVIEW AND ANALYSIS

The applicant proposes to construct and operate an ISR facility at the Dewey-Burdock Project in Fall River and Custer counties, South Dakota, approximately 21 kilometers (km) (13 miles (mi)) northwest of the City of Edgemont, South Dakota (Powertech, 2009c). The Dewey-Burdock Project is comprised of approximately 4,282 hectares (ha) (10,580 acres (ac)), of which approximately 97 ha (240 ac) are on public lands administered by the Bureau of Land Management (BLM) (Powertech, 2009c). SER Figure 1-1 shows the location of the Dewey-Burdock Project.

Within the proposed license boundary, the Dewey-Burdock Project will consist of 14 wellfields, a satellite ion exchange (IX) plant in the Dewey area, and a full central processing plant (CPP) in the Burdock area (Powertech, 2011a). The applicant will process uranium to its final form, yellowcake, prior to shipment to a conversion facility. According to the applicant, the Dewey-Burdock project contains approximately 3.5 million kilograms (7.6 million pounds (lb)) of uranium at an average grade of 0.21percent. Ore is located within the Chilson Member of the Lakota Formation and Fall River Formation, both of which belong to the Inyan Kara Group geologic unit. Depth to the ore generally ranges from 61 to 152 meters (m) (200 to 500 feet (ft)). (Powertech, 2009c)

The applicant proposes to utilize ISR methods to extract uranium from underground ore bodies (Powertech, 2009c). The ISR process involves injecting a leaching solution through wells into underground ore bodies to dissolve the uranium. In the case of the Dewey-Burdock Project, the applicant specifies that the leaching solution will consist of native groundwater mixed with oxygen (O_2 gas) as an oxidant and carbon dioxide (CO_2) gas as a complexing agent. The oxidant will transform uranium in minerals from the insoluble to the soluble state; the complexing agent enhances uranium's solubility and mobility. (Powertech, 2009c)

The applicant will inject a leaching solution, called lixiviant, through a series of injection wells and collect the uranium-loaded (pregnant) lixiviant in a series of recovery wells (Powertech, 2009c). This solution will then be pumped to a processing plant where the uranium will be separated from the pregnant lixiviant by chemical adsorption of the uranium carbonate complexes onto ion exchange (IX) resin. The applicant will elute the resin, which is a chemical process that extracts the uranium from the resin by exchanging the uranium carbonate complex ions with ions in the eluant, such as chloride from a sodium chloride solution. Eluted resin is recycled, and the uranium in the eluant is purified, concentrated, and dried to produce "yellowcake," a yellow powder consisting of uranium oxides and peroxides. This will be the end-product of the proposed facility. Barren lixiviant will be refortified with oxygen and CO_2 and recirculated into the injection wells (Powertech, 2009c).

The applicant will design and construct wellfields using patterns of wells that consist of 4-, 5-, or 7-spot patterns. Each pattern will contain one central recovery well, and the injection wells will be distributed at equal distances from the recovery well at the vertices of a geometric shape (e.g., triangle, square, hexagon). Although the applicant has not proposed line-drive well patterns (injection and production wells oriented in a straight line), the staff notes that it is not approving the use of line-drive injection/production well patterns for this facility without the approval of a license amendment.

The applicant designed both the Dewey satellite plant and the Burdock central processing plant for a flow of 7,570 liters per minute (Lpm) (2,000 gallons per minute [gpm]) for a total of 15,140 Lpm (4,000 gpm). The applicant proposes to produce 454,545 kg (1 million lbs) per year of yellowcake (Powertech, 2009c). The latest information indicates that the applicant will construct 10 wellfields in the Burdock Area and 4 wellfields in the Dewey Area (Powertech, 2011a).

The applicant's ISR operations will generate byproduct material as defined in Section 11e.(2) of the Atomic Energy Act (AEA). Liquid byproduct material generated from the production and restoration operations at the Dewey-Burdock Project will be disposed primarily through Class V disposal wells and, to the extent necessary, a combination of ponds and land application (Powertech, 2009c). In the event the Class V disposal well option cannot be used, the applicant will rely solely on ponds and land application to dispose of liquid byproduct material. The applicant will be required to treat liquid byproduct material to remove radiological and chemical constituents prior to discharge to a Class V well or a land application area. Solid byproduct material, such as production equipment and piping, will be disposed of at a licensed mill tailings facility or other licensed facility not yet identified. (Powertech, 2011a)

Once extraction is completed in a wellfield, restoration will begin (Powertech, 2010a). The precise restoration method will depend upon the disposal method. If disposal wells are used, then restoration will consist of extracting groundwater, treating it with reverse osmosis (RO), then injecting the treated water into the production zone. If land application is used, then the applicant will extract groundwater, treat it with RO, then apply the treated water to certain land areas. Water will also be pumped from the Madison aquifer and injected into the production zone aquifers to stabilize the hydraulic head and promote restoration by groundwater sweep. (Powertech, 2010a)

The applicant presents a general schedule for the project. Operations will start at Burdock Wellfield 1, the CPP ancillary facilities, and disposal features (e.g. wells, ponds, irrigation pivots). Construction of Dewey Wellfield 1 and processing/disposal facilities will start after Burdock construction. After activating the first Dewey and Burdock wellfields, the remaining wellfields will be constructed during the maximum 20 years of operations. During operations, groundwater will be restored in spent wellfields, which is expected to require 2 years per wellfield. If groundwater restoration requires more time, alternate schedules will be requested. (Powertech, 2009c, 2011a)

A series of Federal, State, and local permits, license, and approvals are required prior to the possible start of operations, including:

- Water Rights Permit issued by the South Dakota Department of Environment and Natural Resources (SD DENR)
- Source Materials License issued by the NRC
- Plan of Operations approved by the BLM
- UIC permit for the Class III & Class V wells from the U.S. Environmental Protection Agency (EPA)
- Aquifer exemptions from the EPA
- USEPA National Emissions Standards for Hazardous Air Pollutants, 40 CFR Part 61, Subpart W

The applicant committed to having an approved financial assurance arrangement (surety instrument) in place prior to startup of operations. The financial assurance arrangement will be consistent with the requirements of 10 CFR Part 40, Appendix A, Criterion 9 and will include estimated costs for groundwater restoration, radiological decontamination, facility decommissioning, and surface reclamation of sites, structures, and equipment.

1.4 EVALUATION FINDINGS

The staff reviewed the applicant's information regarding its proposed activities at the Dewey-Burdock Project in accordance with the review procedures and acceptance criteria in Sections 1.2 and 1.3 of the standard review plan, respectively. The information contained in the application included: (1) the corporate entities involved, (2) the location of the facility, (3) land ownership, (4) ore-body locations, (5) the proposed recovery process, (6) operating plans and design throughput, (7) schedules for construction, startup, and duration of operations, (8) waste management and disposal plans, (9) groundwater quality restoration, decommissioning, and reclamation plans, and (10) financial assurance.

Based upon the review conducted by the staff as indicated above, the information provided in the application is consistent with the applicable acceptance criteria of standard review plan Section 1.3 and complies with the criteria in 10 CFR 40.31, which describes the information that must be included in an application for a specific license.

1.5 REFERENCES

NRC (2003b). NUREG 1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Washington, DC. (ADAMS Accession No. ML031550302).

Powertech (2009c). Powertech Dewey-Burdock Application. February 28, 2009 (ADAMS Accession No. ML091200014 - Package).

Powertech (2010a). Dewey-Burdock Project Supplement to Application for Uranium Recovery License Dated February 2009. August 10, 2010 (ADAMS Accession No. ML092870160 - Package).

Powertech (2011a). Revised Responses to the Request for Additional Information (RAI) for the Technical Report (TR); Powertech (USA) Inc.'s Proposed Dewey-Burdock Project. 08/01/2011 (ADAMS Accession No. ML112071064).

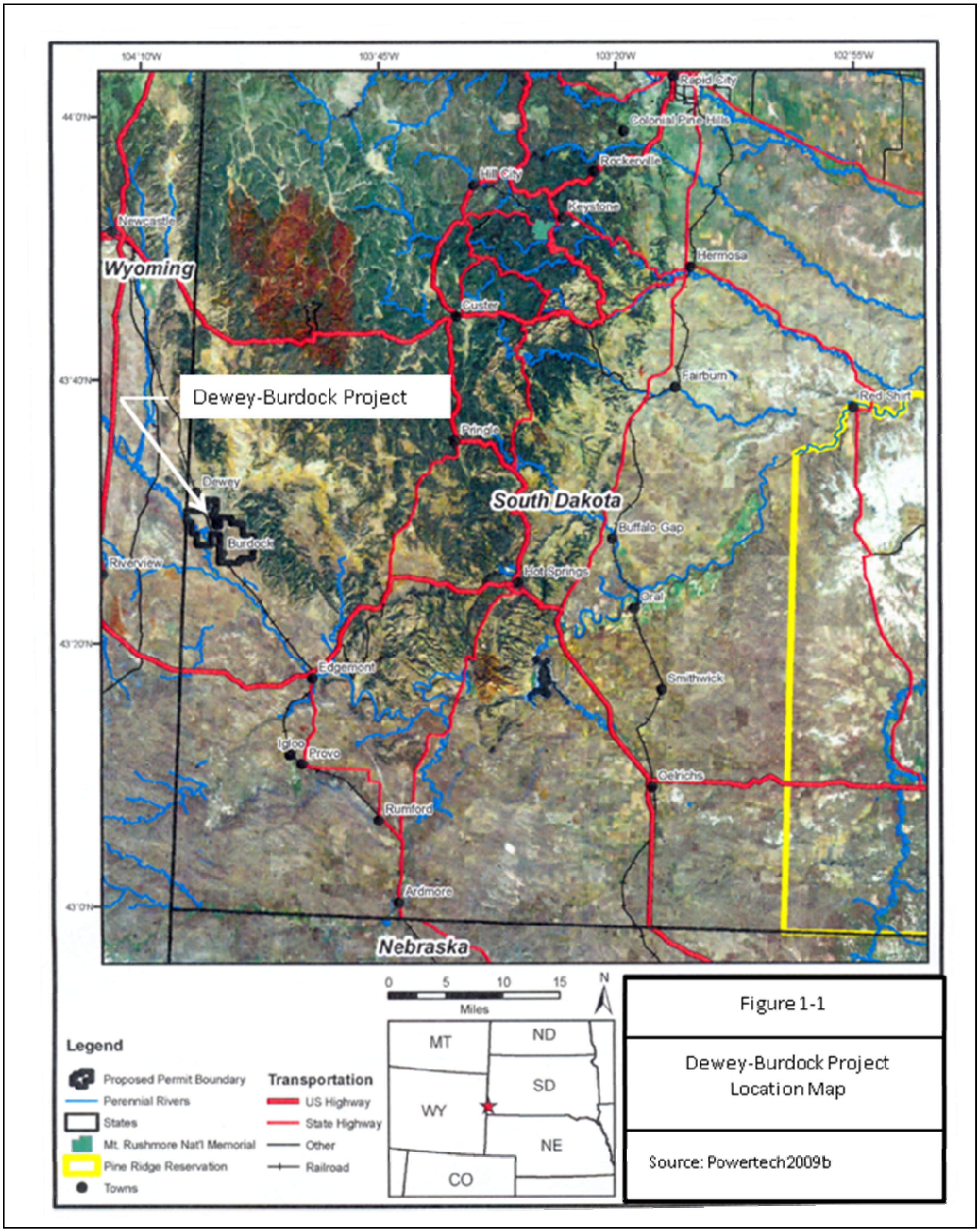


Figure 1-1: Dewey-Burdock Project Location Map

2.0 SITE CHARACTERIZATION

2.1 SITE LOCATION AND LAYOUT

2.1.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the descriptions of the Dewey-Burdock Project location and layout comply with the requirements of 10 CFR 40.31(g)(2).

2.1.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria in Section 2.1.3 of the standard review plan (NRC, 2003b).

2.1.3 STAFF REVIEW AND ANALYSIS

The proposed Dewey-Burdock Project is located 21 km (13 mi) north-northwest of Edgemont, South Dakota along the southwestern edge of the Black Hills National Forest. Other nearby towns include Hot Springs, South Dakota (40 km (25 mi) east); Newcastle, Wyoming (47 km (29 mi) northwest); and Custer, South Dakota (43 km (27 mi) northeast) ("Satellite Images of Dewey-Burdock Project and Vicinity,"). The project boundary encompasses approximately 4,282 ha (10,580 ac) of land on either side of County Road 6463 and includes portions of the following townships and ranges:

- Township 7 South, Range 1 East, Sections 1-5, 10-12, 14, and 15.
- Township 6 South, Range 1 East, Sections 20, 21, 27, 28, 29, and 30-35 (Powertech, 2009c).

Land within the project boundary is predominantly privately owned (97.5 percent) and the remaining 2.5 percent is managed by the BLM. Application Plates 1.5-1 and 1.5-2 show the mineral and land ownership for the Dewey-Burdock Project. (Powertech, 2009c)

Application Plate 3.1-3 (Powertech, 2010a) and application Figure 2.1-1 (Powertech, 2009c) contain maps showing site topography and the proposed license area. These maps show the potential location of facilities, initial wellfields, utilities, roads, potential land application sites, and restricted areas. The staff observed that the highest elevation of 1,189 meters above mean sea level (m msl) (3,900 ft msl) occurs along the southeastern edge of the site in the Burdock area. The lowest elevation of 1,067 m msl (3,500 ft msl) occurs along the southwest corner of the site in the Burdock area. Steepest slopes of approximately 92 percent occur along the eastern boundary of the site in the Burdock area, while the shallowest slopes of approximately 1.5percent occur in the Pass Creek and Beaver Creek stream valleys (Powertech, 2009c).

The staff also observed that one perennial stream, Beaver Creek, and one ephemeral stream, Pass Creek, traverse the proposed Dewey-Burdock Project (Powertech, 2011a). Pass Creek flows northeast to southwest through the Burdock area, and Beaver Creek flows northwest to southeast through the Dewey area. The confluence of both streams is approximately 0.81 km (0.5 mi) south of the Dewey area.

County Highway 6463 traverse the Dewey-Burdock Project. In addition, a rail line traverses the project area northwest to southeast, primarily through the Dewey area and the southwest corner of the Burdock area. (Powertech, 2011a)

Application Plates 3.1-2 and 3.1-3 show the various proposed facilities for both the land application disposal and deep well disposal options (Powertech, 2010a). According to the applicant, if land disposal is utilized a total of 21 circular, land application areas will be required, 10 at the Burdock area and 11 at the Dewey area. Associated with these areas are 17 ponds, 9 at the Burdock area and 8 at the Dewey area. For the deep disposal well option, no land application areas are required. Instead, the application proposes a total of two disposal wells, one at each area. Additionally, a total of 9 ponds would be utilized with the deep disposal well option, 5 at the Burdock area and 4 at the Dewey area. (Powertech, 2010a)

Application Table 2.2-3 presents a list of residences within 34 km (21 miles) of the proposed project centroid (Powertech, 2009c). According to this table, 16 residences are located within 34 km (21 miles) of the Dewey-Burdock Project. The nearest residence is 1.4 km (0.9 mi) south of the project centroid. (Powertech, 2009c)

The staff reviewed the applicant's description of the site location and layout and determined that the information provided is satisfactory. This determination is based on a comparison of the applicant's statements with the acceptance criteria presented in Section 2.1.3 of the standard review plan (NRC, 2003b). The staff, therefore, determined that the site location and layout descriptions are consistent with the acceptance criteria presented in Section 2.1.3 of the standard review plan and comply with 10 CFR 40.31(g)(2).

2.1.4 EVALUATION FINDINGS

The staff has reviewed the site location and layout of the Dewey-Burdock Project in accordance with the review procedures in standard review plan Section 2.1.2 and the acceptance criteria in standard review plan Section 2.1.3. The applicant has described the site location and layout with appropriately scaled and labeled maps showing the site layout, principal facilities and structures, boundaries, and topography. Based upon the review conducted by staff as indicated above, the information provided in the application is consistent with the applicable acceptance criteria of standard review plan Section 2.1.3 and complies with the requirements of 10 CFR 40.31(g)(2).

2.2 METEOROLOGY

2.2.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that its meteorology program—which is part of the site monitoring programs required by 10 CFR Part 40, Appendix A, Criterion 7—is sufficiently complete to allow for estimating doses to workers and members of the public.

2.2.2 Regulatory Acceptance Criteria

Staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria in Section 2.5.3 of the standard review plan (NRC, 2003b).

2.2.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the meteorological conditions and monitoring at the Dewey-Burdock Project. The aspects reviewed in the following sections include meteorological data acquisition, general site conditions, atmospheric dispersion, and meteorological data quality.

2.2.3.1 Meteorological Data Acquisition

In coordination with the South Dakota State Climatology Office the applicant installed a weather station at approximately the center of the Dewey-Burdock Project (Powertech, 2010a, 2011a). The applicant collected onsite meteorological data including temperature, humidity, solar radiation, wind speed/direction, barometric pressure, and precipitation at 1-minute, 5-minute, and hourly time intervals. Data were collected from July 2007 through July 2008 (Anna, L. O., 2010; Powertech, 2010a, 2011a).

To determine long-term representativeness of meteorological data at a site, Regulatory Guide 3.63 recommends comparing a concurrent period of meteorological data from a National Weather Service (NWS) station with the long-term meteorological data from that same NWS station (NRC, 1988a). The NWS station selected for this comparison should be in a similar geographical and topographical location and be reasonably close (preferably within 50 miles) to the site.

The applicant originally selected the Chadron, Nebraska, NWS station for this comparison (Powertech, 2009c). However, the applicant later determined that the Newcastle, Wyoming meteorological station operated by Inter-Mountain Laboratories, Inc (IML), in Sheridan, Wyoming, provides a better comparison to the Dewey-Burdock project area (Powertech, 2011a). The applicant made this determination (Powertech, 2011a) due to its proximity (within 48 km (30 mi)) and similar elevation, surrounding topography and proximity to the southwestern flank of the Black Hills (Powertech, 2011a).

Meteorological instruments at the Newcastle meteorological station are provided in application Table 2.5-1a-1 (Powertech, 2011a). The applicant states that all instruments were audited for accuracy on a semiannual basis. Representative audit reports performed by IML Air Science, spanning the baseline monitoring period for the Dewey-Burdock Project, are provided as application Appendix 2.5-D (Powertech, 2011a).

A review of meteorological station details provided by the applicant indicates that range, accuracy, and the threshold values for station requirement meet or exceed system accuracy, and instrumentation specifications listed in Regulatory Guide 3.63 (Powertech, 2012d). In addition, the Standard Operating Procedures for Meteorological Station Audit and Regulatory references provided by the applicant are consistent with system maintenance, servicing, and data recovery standards contained in Regulatory Guide 3.63 (Powertech, 2010a, 2011a, 2012d).

In Appendix 2.5E, and Addendum to Appendix 2.5D to the application, the applicant provided the statistical methodology developed by IML Air Sciences for assessing representativeness of wind data (Powertech, 2011a). The applicant used this methodology for quantitatively assessing the degree to which the distributions of wind speed class and wind direction frequencies from one year of monitoring at the site represent the long-term distributions at that same location (Powertech, 2011c).

Although, Regulatory Guide 3.63 recommends 30 years as an example of a long-term data set at an NWS station, the nearest NWS station is Chadron, Nebraska, which is over 101 km (62.5 mi) southeast of the proposed Dewey-Burdock Project (NRC, 1988a). The Newcastle, Wyoming, IML station is approximately half the distance from the Dewey-Burdock Project; however, this station collected only 9 years of data at the time the applicant submitted its application. Therefore, the applicant also performed statistical analysis on the four additional meteorological stations described above to demonstrate long-term representativeness of the wind data collected on site. These stations are the Antelope Coal Mine, Buckskin Coal Mine, Dry Fork Coal Mine, and Gillette Airport, which operated from 13 years to 20 years (Powertech, 2012a). IML also operates these stations and a review of the equipment and specifications indicates that these stations, along with the Newcastle station, meet the standards identified in Regulatory Guide 3.63 and are recognize by NRC staff as “Standard installations” per the standard review plan Section 2.5.3, acceptance criteria No. 1. Based on the corroborating data from these multiple meteorological stations, NRC staff has reasonable assurance that the wind data that was collected on site is representative of the long term meteorological conditions.

2.2.3.2 General Site Conditions

As the applicant states, the project is located in an area in southwestern South Dakota (Powertech, 2010a). According to the information provided by the applicant the area is considered semi-arid and is characterized by large diurnal and annual variations in temperature. The staff observed that the regional average temperature extremes range from -5 ^{o}C (23.0 ^{o}F) in the winter to 23 ^{o}C (73 ^{o}F) in the summer and average annual precipitation is 42 cm (16.5 in). During the summer the relative humidity here averages 60 percent while winter has the highest relative humidity that averages 69 percent. The staff finds precipitation in the area is generally light or mild. The average temperature by month from the Dewey-Burdock meteorological station is provided as a boxplot in application Figure 2.5-19 (Powertech, 2009c).

2.2.3.3 Atmospheric Dispersion

2.2.3.3.1 Discussion of Dispersion

Dispersion is the transport and diffusion of effluents that can result in dilution and deposition of a contaminant on the ground and in the breathing zone. Dispersion and deposition are dependent on wind speed, wind direction, atmospheric stability, and mixing height, as well as the type of terrain and height and density of structures near the release site. Mixing height is the vertical distance of a homogenous layer in the atmosphere between the Earth's surface and a temperature inversion.

Temperatures usually decrease with altitude. An inversion is created when the temperature increases with altitude. Turbulence generated within the mixing layer from interaction between the atmosphere and the Earth's surface or heating and cooling of the Earth's surface, further mixes air, and thus effluent. Mixing heights typically undergo large diurnal and seasonal variations that increase and decrease in depth proportionally with solar heat. Static stability occurs within the inversion layer, which impedes vertical and/or horizontal mixing and immobilizes the contaminant beneath the inversion. The stability class can vary from extremely unstable to extremely stable, and can be determined by temperature differences between two heights or the fluctuation of horizontal wind direction at a given height.

Joint frequency distribution (JFD) illustrates the frequency in which a joint frequency category occurs in a specified period. Each joint frequency category represents a range of wind speeds, directions, and stability conditions. The average morning and afternoon mixing heights and JFD are meteorological characteristics used as input parameters in atmospheric dispersion and transport computer codes, such as MILDOS-AREA, to calculate the concentration of a contaminant and the radiation dose commitments at a receptor point from the release site.

2.2.3.3.2 Applicant's Dispersion Data

From July 18, 2007, to July 17, 2008, the applicant collected temperature, humidity, solar radiation, wind speed/direction, barometric pressure, and precipitation data (Powertech, 2010a). The applicant reported that a majority of the winds (51 percent) originate from the southeast, and approximately 55 percent of all winds were slower than 7.4 kph (4.6 mph). December exhibits the slowest winds with 8 percent of the total winds being classified as calm and possessing an average wind speed of 4.5 kph (2.8 mph). In contrast, May exhibits the fastest winds with only 0.41 percent of calm winds and possessing an average wind speed of 11 kph (7 mph). (Powertech, 2010a)

The applicant states that delta temperature was not measured at the site, as required by the solar radiation delta-T (SRDT) method (Powertech, 2011a). Instead, an alternate sigma theta method was used to determine atmospheric stability classes and resulting joint frequency distributions. This method is turbulence-based, which uses the standard deviation of the horizontal wind direction (sigma theta) in combination with the scalar mean wind speed. Since sigma theta was not logged, it was necessary to derive this parameter from the hourly variation of 5-minute wind directions (Powertech, 2011a).

As the applicant states, the combination of hourly wind speed, wind direction and stability class were used to generate Joint Frequency Distributions (JFDs) for an anticipated effluent release height of 10 m (33 ft) (Powertech, 2011a). JFDs are subsequently used in estimating doses to workers and the public through modeling using MILDOS-AREA model. In application Tables 2.5-3-1 through 2.5-3-5 the applicant provided the JFDs that are based on 10-m (33-ft) wind data (Powertech, 2011a).

The applicant states that the joint data recovery (wind speed and wind direction) for the baseline year was 87 percent, which is above the recommended minimum of 75 percent (NRC, 1988a). However, the individual wind data recovery was approximately 87 percent, which is below the recommended 90 percent for individual parameters. Therefore, a condition has been included in the license to address the need for additional wind data collection. This condition is discussed in SER Section 2.2.4.

For the Dewey-Burdock MILDOS-AREA modeling, the applicant used the default mixing height of 100 m (328 ft) (Powertech, 2011a). This default mixing height value according to the applicant is very conservative given that both morning and afternoon mixing heights, at Rapid City, South Dakota averaged much higher, 333 m (1,029 ft) and 1,547 m (5,074 ft), respectively. The applicant states that these values were computed from upper air and surface data at the Rapid City Airport, which is the closest site to the project area with upper air data. For comparison purposes the applicant provided average mixing heights of 1,110m, derived from the AERMOD calculations, based on hourly data obtained from the NWS stations in Rapid City (upper air), Custer, and the local Edgemont station (Powertech, 2011a).

The staff concurs that the mixing height of 100 m (328 ft) is conservative and accepts the use of this value. The staff reviewed the applicant's atmospheric dispersion calculations and determined that these calculations are appropriate and may be used in subsequent dose calculations.

The staff reviewed the applicant's atmospheric dispersion data, and determined that it is reasonably assured that it will collect the required meteorological data to properly calculate JFDs using in dose estimating. This reasonable assurance determination is based on the data presented in the license application supplemented by the information required by the license condition discussed in SER Section 2.2.4. The applicant also appropriately assuming a conservative mixing height for the Dewey-Burdock Project, and used appropriate methods for calculating atmospheric stability class.

2.2.3.4 Meteorological Data Quality

The applicant provided a description of the types and specifications including name, model number and the threshold values for the meteorological instrumentation in application Table 2.5-9-1 (Powertech, 2011a). The applicant states that the meteorological station was configured and installed by the South Dakota Office of Climatology. According to South Dakota State Climatologist, the automated weather station at Dewey-Burdock was installed at the request of the applicant and is part of the South Dakota Automated Weather Data Network (AWDN), currently in operation across the state (see application Appendix 2.5F). All instruments were factory-calibrated prior to installation. Data quality control during the baseline monitoring period was conducted by comparing hourly averages to nearby stations. Applicant states that during the baseline year, wind data recovery was 87 percent at the 10-meter level and 99.7 percent at the 3-meter level. Temperature data recovery was 97.5 percent, relative humidity data recovery was 100 percent, and solar radiation data recovery was 99.8 percent (Powertech, 2011a).

The staff finds the installation and calibration of the meteorological station acceptable. However, as previously stated, the wind data recovery provided is below the recommended 90 percent for individual parameters. Therefore, a license condition has been included stipulated the continued collection and reevaluation of wind data until the recommended recovery rate has been achieved.

2.2.4 Evaluation Findings

Staff reviewed the collected meteorological data and the description of meteorological conditions at the Dewey-Burdock Project in accordance with standard review plan Section 2.5.3 (NRC, 2003b). The applicant used data from on-site and nearby meteorological stations to represent conditions at the Dewey-Burdock Project. While the applicant prepared the necessary wind roses and JFD calculations, the wind recovery data was not consistent with Regulatory Guide 3.63. Therefore, the staff is including the following condition in the Dewey-Burdock license:

> The licensee will continue to collect additional meteorological data on a continuous basis at a data recovery rate of 90 percent until the data collected is determined by the NRC staff to be representative of long-term conditions. Justification of the similarity or validity of the data will include analysis of the statistical data presented to illustrate confidence in the representativeness of the data. The data collected shall include, at a minimum, wind speed, wind direction, and an annual wind rose. The submittal shall include a summary of the stability classification.

Based upon the review conducted by the staff as indicated above, the staff is reasonably assured that the necessary meteorological data will be collected at the Dewey-Burdock Project. This reasonable assurance determination is based on the acceptable information provided in the license application, as supplemented by the information required by the aforementioned license condition. Therefore, the staff determines that the information provided in the application as supplemented by information to be collected is consistent with the applicable acceptance criteria of standard review plan Section 2.5.3 (NRC, 2003a) and complies with the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.3 GEOLOGY AND SEISMOLOGY

2.3.1 Regulatory Requirements

The staff determines if the applicant has characterized the geology, soils, and seismology at the Dewey-Burdock Project sufficiently such that the applicant’s ability to maintain control over production fluids containing source and byproduct materials is adequately documented as required in 10 CFR 40.41(c).

2.3.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of the standard review plan (NRC, 2003b).

2.3.3 STAFF REVIEW AND ANALYSIS

2.3.3.1 Regional Geology

The applicant presents information on regional geology in application Section 2.6 (Powertech, 2009c). Application Figure 2.6-1, representing the regional geology, is an outdated map; therefore, the staff referred to more recent geologic information to describe some aspects of the regional geology. The proposed license area lies within the unglaciated Missouri Plateau Section of the Great Plains Physiographic province (USGS, 2011a). The Dewey-Burdock Project is located on the southwestern flank of the Black Hills uplift that formed the Black Hills during the Laramide Orogeny 60 to 65 million years ago (Timothy T. Bartos, L. L. H., and Kathy Muller Ogle, 2002). The staff also consulted the latest South Dakota geologic map produced by the South Dakota Geologic Survey (SDGS), which is reproduced as SER Figure 2.3-1 (James E. Martin, J. F. S., Mark D. Fahrenbach, Dennis Tomhave, and Layne D. Schulz, 2004). SER Figure 2.3-1 presents the surficial geology of the Black Hills area. The applicant also provided a stratigraphic column of the Black Hills area in application Figure 2.2-3 (Powertech, 2009c).

A review of the aforementioned information prepared by the applicant and confirmed by SDGS sources indicates that the regional geology consists of a deep Precambrian basement comprised of igneous and metamorphic rocks overlain by a thick sequence of alternating permeable and impermeable sedimentary layers. Permeable formations are either sandstone or limestone, of which the major formations are as follows (from shallowest to deepest):

- Alluvium
- Inyan Kara Group
- Unkpapa Sandstone
- Sundance Formation
- Minnekahta Limestone
- Minnelusa formation
- Madison Limestone
- Deadwood Formation

Low permeable units included (shallowest to deepest):

- Undifferentiated Pierre Shale to Skull Creek
- Undifferentiated Morrison Formation to Gypsum Spring Formation
- Spearfish Formation
- Opeche Shale

The total approximate thickness of the sediments overlying the igneous/metamorphic basement rock is 915 m (3,000 ft). SER Figures 2.3-2a and b presents a general geologic cross section of the Black Hills area near the Dewey-Burdock Project (Michael Strobel, G. J. J., J. Foster Sawyer, John R. Schleicher, and Mark D. Fahrenbach, 1999). A review of SER Figures 2.3-2a and b indicates that the sedimentary units dip to the southwest and that the aforementioned permeable units are separated by rocks of low permeability. The thinnest shale layer is the Opeche Shale at 7.6 m to 46 m (25 to 150 ft) thick, while the undifferentiated Pierre Shale/Skull Creek Shale sequence well exceeds 457 m (1,500 ft) (Michael Strobel, G. J. J., J. Foster Sawyer, John R. Schleicher, and Mark D. Fahrenbach, 1999).

Staff reviewed the regional geologic information supplied by the applicant and finds that the description presented by the applicant is consistent with published data for the regional geologic setting and supports its conceptual model of the subsurface. Based on this review, the staff concludes that the applicant has adequately described the regional geologic setting in accordance with the requirements of 10 CFR 40.41(c).

2.3.3.2 Site-Specific Geology

2.3.3.2.1 Geology and Stratigraphy

The applicant provided a description of the site geology based on site data and outside information. Application Figure 2.6-2 presents the Dewey-Burdock Project surficial geology, which is reproduced as SER Figure 2.3-3 (Powertech, 2009c). The applicant states that the Fall River Formation outcrops across the eastern part of the project and the Skull Creek Shale and Mowry Shale outcrop across the western part of the project (Powertech, 2009c). Alluvium is present along drainage areas, such as Beaver Creek and Pass Creek (Powertech, 2009c). The staff observes that the application does not discuss the presence of the Belle Fourche Shale, which outcrops on the surface of the Dewey area of the Dewey-Burdock Project. However, a published South Dakota geologic map clearly identifies the Belle Fourche Shale in the Dewey area of this project (James E. Martin, J. F. S., Mark D. Fahrenbach, Dennis Tomhave, and Layne D. Schulz, 2004).

The staff also observes that the applicant is inconsistent in its designation of the shales overlying the Fall River Formation. These shales are sometimes referred to as the Graneros Group (which includes multiple shale units), Mowry and Skull Creek Shales, or simply the Skull Creek Shale. For the purposes of this SER, the staff will refer to overlying shales in the Dewey-Burdock Project as the Graneros Group Shales. This designation is consistent with published general stratigraphic columns for the Black Hills area (Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002).

The applicant provided detailed information regarding the stratigraphy at the Dewey-Burdock Project (Powertech, 2010a). Application Figures 2.1-1 through 2.1-3 show geologic cross sections and the cross section locations at the Dewey-Burdock site that traverse northwest to southeast (Cross Section A-A’) and east to west (Cross Section B-B’). Geologic strata dip west and southwest at 2 to 6 degrees. Geologic units at the Dewey-Burdock Project consist of the following, from shallowest to deepest:

- Graneros Group (confining layers)
- Fall River Formation (extraction zone)
- Lakota Formation (extraction zone)
    - Fuson Shale (confining layer)
    - Chilson Member (extraction zone)
- Morrison Formation (confining layer)
- Sundance/Unkpapa (underlying aquifer)
- Spearfish Formation
- Goose Egg Formation
- Minnekahta Formation (regional aquifer)
- Opeche Shale
- Minnelusa Formation (regional aquifer)
- Leo Sandstone Member of the Minnelusa
- Madison Formation (regional aquifer)

In Application Exhibit 3.1-4, the applicant shows that uranium extraction in the Burdock area will occur primarily in the Chilson Member; extraction in the Dewey area will occur in the Fall River Formation and the Chilson Member (Powertech, 2011a). The applicant identifies the Leo Sandstone and Goose Egg Formation in its cross sections. These units are not discussed as distinct units in most USGS or SDGS maps and publications. However, the staff has identified certain publications discussing these units (Daniel G. Driscoll, 2002, Anna, 2010) Therefore, for the purposes of this SER, the staff finds acceptable the identification of distinct Leo Sandstone and Goose Egg Formation strata (Anna, L. O., 2010; Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002). Brief descriptions of the primary geologic units associated with this project are as follows.

Morrison Formation – Underlying Confining Layer

The Jurassic Age (205 to 138 million years ago) Morrison Formation is described as a floodplain deposit composed of calcareous, noncarbonaceous massive shale with numerous limestone lenses and a few thin fine-grained sandstones. This geologic unit constitutes the bottom confining layer for the Dewey-Burdock Project. The applicant reports that the Morrison Formation exhibits very low hydraulic vertical conductivities, ranging from 3.9E-9 cm/sec to 4.2E-8 cm/s (1.1E-5 ft/day to 1.2E-4 ft/day)(Powertech, 2009c).

Application Exhibit 2.6-2 is an isopach (thickness contour) map of the Morrison Formation (Powertech, 2011a). According to this exhibit, the Morrison Formation ranges from 18.3 to 48.8 m (60 to 160 ft) thick. The thinner portions of the Morrison Formation are on the north and east sides of the Dewey-Burdock Project, and its thickness increases toward the south and west. Application Exhibit 2.6-7 is a structural contour map of the top of the Morrison Formation. A review of this map indicates that no faults causing rock unit displacement occur within the Morrison Formation. Application Exhibit 2.3-4 is a site-wide cross section of the geologic units highlighting the Morrison Formation. A review of this cross section indicates that the Morrison Formation forms a thick confining unit underlying the Chilson Member of the Lakota Formation (Powertech, 2011a).

Inyan Kara Group – Extraction Zone

The Cretaceous Age (138 to 63 million years ago) Inyan Kara group consists of the Lakota Formation and the Fall River Formation (Powertech, 2009c). Sandstones within these two formations are hosts to all the uranium mineralization for the project. The Lakota Formation consists of two members, the lower Chilson Member and the upper Fuson Member (Powertech, 2009c).

The applicant states that the Chilson Member (commonly referred to as the Lakota Sandstone) is composed largely of fluvial deposits.(Powertech, 2009c). These deposits consist of sandstone, shale, and siltstone. The Chilson Member consists of two units; a basal carbonaceous black mudstone and an overlying unit of channel sandstones that are thick-bedded and nearly pure quartz. This unit also includes thin, discontinuous, carbonaceous mudstone beds (Schnabel, R. W., 1963). Analyses of core samples of these sandstones indicate these units exhibit high horizontal conductivity, ranging from 2.6 E-3 to 4.1 E-3 cm/s (7.4 to 11.6 ft/day). (Powertech, 2009c)

Application Exhibit 3.2-5 is an isopach map of the Chilson Member of the Lakota Formation showing the thickness of its channel sandstones and interbedded shales (Powertech, 2010a). Sandstone thicknesses vary from 27.4 to 73.2 m (90 to 240 ft). Staff finds that the Chilson Member was laterally continuous and sufficiently thick throughout the license area to support ISR operations.

The Fuson Member is the uppermost member of the Lakota Formation, and the shale-siltstone portion of the Fuson has been used to divide the Lakota Formation from the Fall River Formation (Powertech, 2009c). The applicant states that analyses of core samples of these lithologies demonstrate low vertical conductivity, ranging from 7.8E-9 to 2.2E-7 cm/s (2.2E-5 to 6.2E-4 ft/day). Application Exhibit 3.2-3 presents an isopach map of the Fuson Member (Powertech, 2009c). This exhibit shows the thickness of the shale siltstone unit ranging from 9.1 to 24.4 m (30 to 80 ft). The staff observed that the Fuson Member is laterally extensive throughout the project area, with the thinner areas generally along the eastern edge of the project and the thickest areas located along the southwest and northwest corners of the project (Powertech, 2009c).

The applicant indicated that the Fall River Formation is composed of carbonaceous interbedded siltstone and sandstone, channel sandstones, and a sequence of interbedded sandstone and shale (Powertech, 2009c). 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 applicant estimates the hydraulic conductivity of the Fall River Formation to be 7E-4 cm/s (2 ft/d) (Powertech, 2009c).

A review of application Exhibit 3.2-3 indicates that the Fall River Formation is 30.5 to 48.8 m (100 to 160 ft) thick with the thinnest portions occurring along the eastern boundary of the site toward the Black Hills uplift (Powertech, 2010a). Thickest portions of this formation occur in the middle of the Burdock area. The staff did not observe any areas where the Fall River Formation was absent. Along the northeastern portion of the Dewey-Burdock Project, this formation is exposed on the surface and erosion has taken place. Uranium mineralization in the Fall River

Formation occurs in the lower sandstone unit. NRC staff finds that the Fall River Formation was laterally continuous and sufficiently thick for ISR operations.

Graneros Group Shales

As previously stated, the applicant refers to the shales overlying the Fall River Formation by multiple names in multiple locations. For example, Figure 2.6-1 refers to the Belle Fourche and Mowry Shales (Powertech, 2009c), Figure 2.6-2 refers to Belle Fourche and Skull Creek Shales (Powertech, 2009c), Plate 315 refers to Skull Creek and Mowry Shales (Powertech, 2010a), and Exhibits 2.6-3 and 2.7-1 refer to the Graneros Group (Powertech, 2011a). However, for the purposes of this SER, the staff will use the term Graneros Group to represent the shales overlying the Fall River Formation.

At the Dewey-Burdock Project, the Graneros Group consists of the Skull Creek Shale, Mowry Shale, and the Belle Fourche Shale, which all together act as a confining unit that directly overlies the Fall River Formation (Powertech, 2011a). Graneros Group shales consists of dark-grey to black shale, organic material, and some silt sized quartz grains. Graneros Group shales may also include light gray marine shale with minor amounts of siltstone, fine grained sandstone, and a few thin beds of bentonite. Analyses of core samples demonstrate that the Skull Creek clays have extremely low vertical permeabilities, in the range of 6.8E-9 cm/s (2E-5 ft/day). A review of Plate 315 indicates that the Graneros Group is absent along the eastern part of the Dewey-Burdock Project in areas where the Fall River Formation is exposed (Powertech, 2010a). However, the thickness increases gradually to the west attaining thickness exceeding 152 m (500 ft)(Powertech, 2010a). Although the Newcastle Sandstone is present regionally between the Skull Creek and Mowry shales, it is absent at the Dewey-Burdock Project (Powertech, 2011a).

Terrace Deposits and Alluvium

The applicant described terrace deposit and alluvium present along the drainage paths, such as Beaver Creek and Pass Creek. These deposits 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. The recent deposits of alluvium consist of silt, clay, sand, and gravel.

2.3.3.2.2 Cross Section Analysis

The applicant provided cross sections representing both the Burdock and Dewey areas that depict the geologic strata, potentiometric surfaces, and ore locations. These cross sections are found in Exhibits 2.7-1a through 2.7-1j (Powertech, 2011a). A review of these cross sections indicates that those geologic units identified as confining layers (Graneros Group, Morrison Formation, and Fuson Shale) are thick and areally extensive throughout the Dewey-Burdock Project. The only exception is that the Graneros Group is absent along the eastern portion of the Burdock area in places where the Fall River Formation crops out (Powertech, 2011a).

The Fuson Shale ranges in thickness between 9.2 and 15.2 m (30 and 50 ft) and serves as a hydraulic boundary between the Fall River Formation and the Chilson Member (Powertech, 2011a). Along the eastern portion of the Burdock area, the Fuson Shale serves as the upper confining layer for proposed uranium extraction in the Chilson Member. Considering that the applicant intends to extract uranium from the Chilson Member in this portion of the Burdock area, the Fuson would serve to prevent the upward migration of production fluids into the Fall River Formation and the downward migration of Darrow Pit mine water into the Chilson Member. Despite its thickness, leakage may occur through unplugged boreholes. Further details regarding this issue are provided in SER Sections 2.3.3.5 and 2.4. (Powertech, 2011a)

The Morrison Formation is shown as a relatively thick bottom confining layer immediately below the Chilson Member (Powertech, 2011a). It is approximately 30.5 m (100 ft) thick and is a really extensive throughout the Dewey-Burdock Project. While many of the boreholes shown on the cross sections did not fully penetrate the Morrison Formation, a sufficient number of boreholes exist that can be used to justify the assumptions of thickness and its continuous nature. The applicant confirmed this on application Exhibit 2.6-3, which is a site-wide cross section focusing on the Morrison formation and underlying strata, the Unkpapa Sandstone and the Sundance Formation (Powertech, 2011a). This cross-section shows boring logs that penetrate the Morrison Formation and a few that penetrate the Unkpapa Sandstone. A review of this cross section also confirms that the Morrison is a really extensive and continuous throughout the Dewey-Burdock Project (Powertech, 2011a).

A review of the cross sections cited above indicated that no faults or major joints were identified on the Dewey-Burdock Project. Although the applicant identified the Dewey fault north of the Dewey-Burdock Project, no faults, geologic bed displacements, or joints were identified on any cross section or isopach map. A review of USGS information confirms that while faults and folds occur north and east of the site, no such structures are found onsite (Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002).

2.3.3.2.3 Geochemistry

The applicant describes the typical roll front geochemistry at the Dewey-Burdock Project, including the reduced, oxidized, and ore zones (Powertech, 2011a). The applicant states that roll fronts occur from depths of 30.5 to 244m (100 to 800 ft), and that the mineralized sandstones are typically fine to medium grained quartz sands. Scattered pyrite (iron sulfide) concretions are sometimes present. Average mineralization thickness is 1.4 m (4.6 ft), and the average grade is 0.21 percent (Powertech, 2011a).

The reduced zone occurs hydraulically downgradient of the roll front and contains grey sandstone, which is pyritic or carbonaceous (Powertech, 2011a). These sandstones may contain pyrite and marcasite, both of which are iron sulfide minerals, as well as carbonized wood fragments and humates (organic salt) (Powertech, 2011a). Humates and iron sulfide minerals are known to cause reducing environments that precipitate uranium. Trace amounts of copper, nickel, zinc, molybdenum, and selenium are found, as well as the minerals tourmaline, ilmenite, apatite, zircon, and garnet (Powertech, 2011a).

The oxidized zone occurs hydraulically upgradient of the roll front and contains iron oxides resulting in brown, pink, orange, or red staining in host sandstones (Powertech, 2011a). Reduced minerals such as pyrite have been oxidized to hematite (iron oxide) and goethite (iron or manganese oxides and hydroxides). Furthermore, organic matter normally found in the reduced zone is absent from the oxidized zone, and feldspar minerals have been transformed to clay minerals. Oxidized rocks in the Inyan Kara extend 24 km (15 mi) laterally and 6.4 to 8 km (4 to 5 mi) downgradient of the outcrop area. The oxidized nature of the groundwater in this area has liberated certain metals such as copper, nickel, zinc, molybdenum, and selenium—as well as uranium—and transported these metals downgradient toward the ore zone (Powertech, 2011a).

The ore zone occurs at the oxidation/reduction boundary where metals have precipitated due to rapid change in oxidation/reduction potential (Powertech, 2011a). Uranium precipitated to form uraninite (uranium, and possibly thorium, dioxide) and coffinite (uranium hydroxide), which also occur with montroseite (vanadium hydroxide) and pyrite. Selenium and molybdenum minerals are also found near the uranium deposits, as these metals precipitated when encountering the oxidation/reduction boundary (Powertech, 2011a).

Based on a review of the applicant's geochemistry information, the staff finds that the applicant adequately describes the ore zone geochemistry at the Dewey-Burdock Project. The applicant utilized mineralogical data obtained from site-specific samples (Powertech, 2011a). However, the staff has also corroborated the applicant's assessment of the ore zone mineralogy through published works (Garland B. Gott, D. E. W., and C. Gilbert Bowles,1974).

In Gott, 1974, the authors provided measurements of oxidation-reduction potential (ORP) that confirm a strong reducing environment. These measurements were made using specialized sampling equipment that prevents exposure of the groundwater to oxygen prior to collecting the measurement. Measurements indicate that ORP in the Dewey-Burdock project is a minimum of -116 millivolts (mv). Negative ORP measurements are characteristic of reducing environments.

The applicant has sufficiently described the geology, stratigraphy, and geochemistry of the rock units found regionally in the Black Hills area and at the site. The applicant used a combination of published data and site-specific borehole data to develop a conceptual geologic model of the proposed facility. During its review, the staff used published information to confirm the validity of the applicant's conceptual model. Based on the staff's review, the applicant's description of regional and site geology is consistent with Section 2.6.3 of the standard review plan and in compliance with 10 CFR 40.41(c).

2.3.3.3 Historic Borings, Mining, Breccia Pipes

2.3.3.3.1 Historic Borings

Application Section 2.6.4 presents information on historic exploration activities (Powertech, 2009c). According to the application, 4,000 exploration drill holes were completed at the Dewey-Burdock Project prior to the applicant's exploration activities. Since 2005, the applicant has drilled approximately 115 exploration holes at the project, including 20 monitoring wells. (Powertech, 2009c)

The applicant cannot attest to whether or not all historic borings were properly plugged and abandoned (Powertech, 2011a). However, it has made the following commitments to ensure that unplugged borings will not impact human health or the environment during operations. These commitments are as follows:

- The applicant will attempt to locate any unknown borings and wells in the vicinity of every potential wellfield using historical records.
- Pumping tests will be designed to detect and locate unplugged borings.
- Unplugged or improperly plugged borings will be plugged and abandoned using South Dakota standards (Powertech, 2011a).

The applicant states that little evidence of unplugged boreholes has been observed because borings tend to collapse or self-seal over time (Powertech, 2011a). This assertion is supported by infrared photography that identifies certain water features within and near the Dewey-Burdock Project. Figure TR RAI2.7-9-2 presents an infrared map of a portion of the Burdock area showing an alkali pond area, and Figure TR RAI 2.7-9-3 is a photograph of this same area. According to the applicant, unplugged borings appear to explain the presence of this pond area (Powertech, 2011a). Considering that no other pond areas or springs appear on the Dewey-Burdock Project, the applicant asserts that unplugged borings likely self-sealed and are likely no longer an issue (Powertech, 2011a).

The staff has reviewed the borehole information provided by the applicant and determined that it sufficiently describes the risks associated with unplugged borings. The staff concurs that, other than the alkali pond, no other evidence indicates that previously unplugged borings are current groundwater flow pathways. As discussed in SER Section 2.4, groundwater in the Fall River and Chilson Aquifers is under artesian conditions; therefore, groundwater would be expressing itself at the ground surface if unplugged borings were still conduits. The applicant has presented a satisfactory plan for identifying and addressing unplugged borings during operations to avoid potential cross contamination.

2.3.3.3.2 Breccia Pipes

The applicant investigated the potential for breccia pipes to occur at the Dewey-Burdock Project (Powertech, 2011a). Breccia pipes are collapse structures caused, in the Black Hills area, by dissolution of anhydrites and gypsum within the Minnelusa Formation. This dissolution forms cavities that cause overlying rock units to collapse. The applicant states that no such structures are present at the Dewey-Burdock Project. (Powertech, 2011a)

The staff reviewed information from the applicant and outside sources to assess the potential for breccia pipes to occur at the Dewey-Burdock Project. According to USGS Professional Paper 763, breccia pipes do not occur at the Dewey-Burdock Project (Garland B. Gott, D. E. W., and C. Gilbert Bowles, 1974). Furthermore, detailed isopach maps, structure maps, and cross sections provided by the applicant do not indicate the presence of collapse structures on the Dewey-Burdock Project (see SER Section 2.3.3.2). Considering these varying sources of information, the staff concurs with the applicant’s assessment that breccia pipes do not occur at the Dewey-Burdock Project.

2.3.3.3.3 Historic Mining

As depicted in Supplemental Exhibit 3.1-10 in the application, open-pit uranium mining previously occurred along the eastern portion of the Burdock area in Township 6S, Range 1E, Sections 34, and Township 7S, Range 1E, Sections 1 and 2 (Powertech, 2010a). Application Figure TR RAI P&R-2-2 also shows more detail of the mines and underground workings

(Powertech, 2011a). These historical mines consisted of 5 pits associated with the Darrow Mine and two pits associated with the Triangle Mine. One Darrow mine pit (Pit 6) was reclaimed (Powertech, 2011a).

Susquehanna-Western, Inc. (SWI) began developing the Triangle surface mine in 1960. The surface mine area was excavated to a depth of 36.6 m (120 ft) (Powertech, 2011a). After completing the surface mine, SWI excavated approximately 305 m (1,000 ft) of underground mine workings. Because these workings were updip, final excavations were shallower (approximately 21.3 m (70 ft) deep) (Powertech, 2011a).

Surface pits associated with the Darrow Mine were excavated to depths ranging from 15.2 to 27.4 m (50 to 90 ft) (Powertech, 2011a). The Darrow underground mine is located approximately 152 m (500 ft) northwest of Darrow Pit No. 2. Darrow underground workings consist of 366 m (1,200 ft) of workings accessed by declines. Underground mining occurred to a depth of approximately 21.3 m (70 ft). In addition to these workings, two adits (horizontal tunnels) were excavated into the walls within Darrow Pit No. 2 to access more uranium. Underground workings associated with the Freezeout Mine are located north of the Darrow workings and outside the Dewey-Burdock Project area; therefore, the staff will not discuss these mines further (Powertech, 2011a).

The Darrow mine pits accessed uranium ore in the Fall River Formation, which crops out in the area of the mines. In addition to the pits, underground mine workings were excavated by the miners to access uranium in the walls of one of the pits. Underground workings and the open pit were connected by an adit. All mining occurred in the Fall River sands, which overlie the Fuson Shale; the Fuson Shale is approximately 50 feet thick in the Triangle Mine area. According to cross section information (Application Exhibit 2.7-1f), the Fuson Shale is continuous across the the area of the Darrow mine pits and underground mine workings (Powertech, 2011a).

In its request for additional information, the staff requested that the applicant confirm its plans for uranium extraction in the area of the Darrow mine pits (NRC, 2010). The applicant states that it will not conduct any uranium recovery operations in the Fall River Formation in the area of the surface and underground mines. However, it will conduct such operations in the Chilson Member, which is separated from the Fall River Formation by the Fuson Shale (Powertech, 2011a).

The staff reviewed the information provided by the applicant regarding the location and history of surface and underground mining operations at the Dewey-Burdock Project. The applicant satisfactorily described mine features, mining horizons, and potential impacts on the proposed site operations. Based on the information provided by the applicant, the staff is reasonably assured that the proposed ISR operations at the Dewey-Burdock Project will not be affected by the presence of historic surface and underground mines. Therefore, the staff determines that the statements made in Section 2.3.3.3 are consistent with Section 2.6.3 of the standard review plan and 10 CFR 40.41(c).

2.3.3.4 Soils

The applicant performed detailed soil surveys to identify soil types, determine the depths to which topsoil should be salvaged, and identify those soils considered prime farmland (Powertech, 2009c). According to the applicant, Soils in the proposed Dewey-Burdock license area were described as typical for semiarid grasslands and shrublands in the Western United States. Application Plate 3.3-14 and application Table 2.6-1 provide a brief description of the soil types at the Dewey-Burdock Project and show soil unit acreage, soil unit disturbance area, and the percentage of total project area with each soil type. Application Table 2.6-1 states that a total of 3,221.6 ha (7,960.77 ac) of the Dewey-Burdock Project were characterized for soils, and of that total, 1,240.7 ha (3,065.74 ac) will be disturbed. (Powertech, 2009c)

To characterize the soil types, the applicant collected 33 soil samples for chemical analysis using the Wyoming Department of Environmental Quality – Land Quality Division (WDEQ-LQD), Guideline 1 procedures (Powertech, 2009c). According to the applicant, 1240.17 ha (3,065.74 ac) of soil contains salvageable topsoil while the remaining soil is unsuitable as topsoil (see application Tables 2.6-4 to 2.6-6). The applicant presents data regarding the erosion potential for each soil type found at the Dewey-Burdock Project (application Table 2.6-7). Based on the soil mapping unit descriptions, the hazard for wind and water erosion within the license area varies from negligible to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Considering the very fine and clayey texture of the surface horizons throughout the majority of the license area, the soils are more susceptible to erosion from water than wind. (Powertech, 2009c)

The applicant's assessment of prime farmland at the Dewey-Burdock project is as follows. Prime farmland, if irrigated, is found in Township 6S Range 1E, Sections 27, 30, 31, 32, 34, and 35 (Powertech, 2009c). Prime farmland, if irrigated, is found in T7S R1E: Sections 1, 3, 4, 5, 10, 12, 14, and 15. The following sections in T7S R1E contain farmland of statewide importance: Sections 2, 3, 4, 5, 10, 11, 12, 14, and 15. The following soil series have been listed as prime farmland, if irrigated: Alice, Ascalon, Barnum, Boneek, Haverson, Norka, Nunn, Satanta, and Tilford. The NRC staff finds that the soils in the proposed license area are adequately described. (Powertech, 2009c)

The staff reviewed the applicant's information regarding soils at the Dewey-Burdock Project. Based on this review, the staff finds that the applicant adequately described soil types by performing soil surveys, chemical and physical analyses, assessments of erosion, identification of prime farmland, and the depths of salvageable topsoil. This information is consistent with Section 2.6.3 of the standard review plan and also meets the requirements of 10 CFR 40.41(c).

2.3.3.5 Seismology

The applicant described the historical seismology for the area using data for the region and included the magnitude, date, and location of all known seismic events (Powertech, 2009c). No active faults with surface expression are known in regions where Dewey-Burdock is located, so no fault-specific analysis was possible (Powertech, 2009c).

Seismic hazards at the project site include low to moderate ground shaking associated with regional and local earthquake sources (Powertech, 2009c). Application Figures 2.6-4 through 2.6-6 include seismicity and peak ground acceleration (PGA) maps for the Dewey-Burdock Project, and Appendix 2.6-G is a summary of the USGS database results for historical earthquakes recorded within 100 and 200 km from the site since 1973. There are no capable faults (as defined in section III(g) of Appendix A of 10 CFR Part 100) known to be present within 100 km (62 mi) of the project site. The closest capable fault zone to the project is located nearly 345 kilometers (200 mi) west of the site in central Wyoming (Powertech, 2009c).

The applicant, therefore, concluded that the most significant seismic hazard is considered to be the randomly occurring, or 'floating', earthquake (Powertech, 2009c). According to the applicant, the maximum magnitude of such an earthquake is 6.1 (Richter scale). According to the U.S. Geological Survey's 2002 Seismic Hazard Mapping Program, PGA derived from the probabilistic maximum bedrock acceleration with a 10 percent exceedance in 50 years (475-year return period) is 0.03g (Figure 2.6-5) for the southwestern part of South Dakota. The probabilistic maximum bedrock acceleration with a 2 percent chance of exceedance in 50 years (2,475-year return period) is 0.09g (Figure 2.6-6). Both of these estimates are considered to reflect a relatively low ground motion hazard. (Powertech, 2009c)

Application Figure 2.6-4 of the Technical Report illustrates the location of seismic events in the region (Powertech, 2009c). This figure shows that four earthquakes occurred between 1872 and 2011 near the site. Two earthquakes were magnitude 2, one was magnitude 3, and one was magnitude 5 (Powertech, 2009c). The staff reviewed USGS data and determined the following regarding seismicity of the Dewey-Burdock Project area:

- Most recent earthquake occurred in 2004 north of Dewey, South Dakota – 2.8 magnitude (Richter scale).
- A cluster of six earthquakes occurred in the southern Custer State Park area – 4 magnitude (Richter scale).
- Two earthquakes occurred near Hot Springs, South Dakota – 2.3 and 2.8 magnitude (Richter scale).
- One earthquake occurred southeast of Edgemont, South Dakota – 2.8 magnitude (Richter scale). (USGS, 2011d)

Based on a review of the applicant's seismology assessment and the staff's individual analysis, the staff finds that the applicant adequately assessed the seismic risks to the Dewey-Burdock Project. The staff finds that the information provided is consistent with Section 2.6.3 of the standard review plan that recommends discussing historic seismisity and with 10 CFR 40.41(c) that requires licensees to restrict the uses of source and byproduct material to approved locations.

2.3.3.6 Former Black Hills Army Depot

The staff reviewed information regarding the former Black Hills Army Depot (BHAD) to determine whether or not proposed operations at the Dewey-Burdock Project could mobilize contamination from BHAD and subsequently harm public health and the environment. The staff reviewed portions of two documents:

- Final Work Plan for Black Hills Army Depot Remedial Investigation and Feasibility Study (U.S. Army Corps of Engineers (USACE), 2012).
- Final Archives Search Report, Preliminary Assessment of Ordnance Contamination at the former Black Hills Army Depot, South Dakota (USACE, 1992).

The former BHAD is located in Fall River County, South Dakota, approximately 30 miles southwest of Hot Springs, South Dakota, and approximately 14 miles south of the Dewey-Burdock Project (USACE, 2012). The BHAD was established in 1942 and remained in continuous operation until 1967. It consisted of approximately 8,537 ha (21,095 ac) and was used to store, maintain, demilitarize, and issue conventional and chemical munitions. Three areas are associated with chemical munitions and chemical agent disposal, BG-1, BG-2, and the Chemical Plant Area. (USACE, 2012)

Ammunition at the depot was stored in 802 igloo-type magazines, open storage sites between the igloos, 12 standard magazines, and miscellaneous outdoor storage areas (USACE, 2012). By 1964, the depot stored more than 227,300 tonnes (250,000 tons) of ammunition in the 802 igloos located throughout the facility. The facility also included 504 structures used for administrative, residential, and general operational purposes. Millions of tons of ordnance and bulk explosives passed through the depot during its existence. During the final years of operation, the majority of ordnance present at the BHAD was either shipped to other facilities or destroyed onsite. On June 30, 1967, the facility was permanently closed and transferred to the General Services Administration (GSA) (USACE, 2012).

Of particular interest to the staff was the geology of the former BHAD, the extent of known contamination, and the potential for the proposed operations to affect hydrogeologic conditions at the former BHAD. Regarding site geology, rock units beneath the former BHAD include Paleozoic and Mesozoic shale, limestone, and sandstone approximately 4,000 feet thick (USACE, 1992). These sedimentary rocks overly a Precambrian basement consisting of igneous and metamorphic rocks (USACE, 1992).

SER Figure 2.3-2 is a geologic cross section compiled from data north of the former BHAD (Strobel, 1999). Although this cross section does not traverse the former BHAD, it is reasonably representative of the geologic units at the depot. According to the cross section, surface geologic units consist of alluvium and a thick sequence of undifferentiated shale from the Pierre Shale to the Skull Creek Shale (Strobel, 1999). USACE reports that the geologic units are Pierre Shale, Niobrara Shale, and Carlile Shale each of which is exposed at different parts of the former depot (USACE, 1992). Underlying this shale sequence is the Inyan Kara Group sediments and the remaining stratigraphic column is similar that presented in SER Section 2.3.3.1.

The most likely mechanism by which the Dewey-Burdock Project could affect contaminant migration at the former BHAD is by changing the groundwater gradients of the Inyan Kara aquifers to redirect groundwater toward the Dewey-Burdock Project. However, the Inyan Kara aquifers must first be contaminated with constituents from the former depot in order for such a change in groundwater gradients to be of any consequence.

According to USACE, the Fall River aquifer is approximately 335 m (1,100 ft) deep at the former BHAD and is overlain by thick sequences of shales, as stated above (USACE, 1992). Any surface contamination would not penetrate such a thick shale sequence and contaminate the Fall River. Furthermore, the Fall River aquifer is artesian in this area (USACE, 1992). Therefore, if the overlying shales were perforated water would move upward toward the ground surface essentially preventing contamination from migrating downward into the aquifer.

In its work plan for a Remedial Investigation/Feasibility Study (RI/FS), USACE cites chlorinated solvents and fuel residues were discovered in shallow groundwater samples; however, no groundwater contamination was discovered in the burning ground areas (USACE, 2012). Also, groundwater is not being considered in the 2012 FI/FS work plan (USACE, 2012). Considering the isolated nature of the Inyan Kara aquifers and the lack of significant groundwater contamination at the site, the staff determines that proposed operations at the Dewey-Burdock Project will have no effect on site conditions at the former BHAD.

2.3.4 Evaluation Findings

The staff has completed its review of the site geologic information in accordance with review procedures in standard review plan Section 2.6.2 and acceptance criteria in standard review plan Section 2.6.3 (NRC, 2003b). The applicant has adequately described the geology and seismology by providing: (a) a description of the local and regional stratigraphy' (b) geologic, topographic, and isopach maps at acceptable scales showing surface and subsurface features and locations of all wells and site explorations used in defining stratigraphy; (c) a geologic and geochemical description of the mineralized zone and the geologic units adjacent to the mineralized zone; (d) a description of the local and regional geologic structure; (e) a discussion of the seismicity and seismic history of the region; (f) a generalized stratigraphic column that includes the thickness of rock units, a representation of rock units and a definition of mineralized horizon; and (g) a description and map of the soils.

Therefore, the information provided by the applicant is consistent with the acceptance criteria in standard review plan Section 2.6.3 and complies with the requirements of 10 CFR 40.41(c).

The staff notes the following specific commitments made by the applicant regarding the information addressed in this section:

- The applicant will attempt to locate any unknown borings and wells in the vicinity of every potential wellfield using historical records.
- Pumping tests will be designed to detect and locate unplugged borings.
- Unplugged or improperly plugged borings will be plugged and abandoned using South Dakota standards.

7

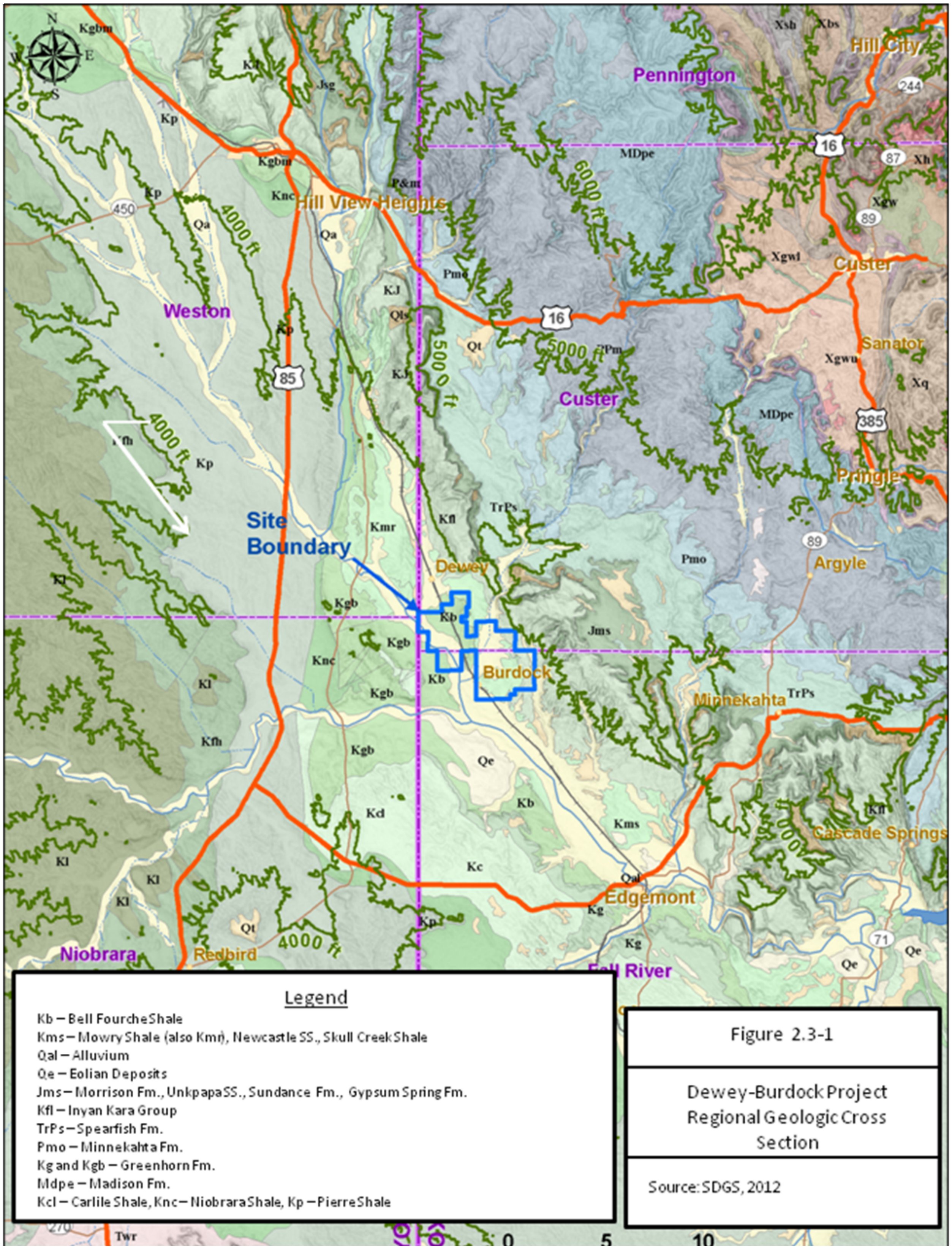
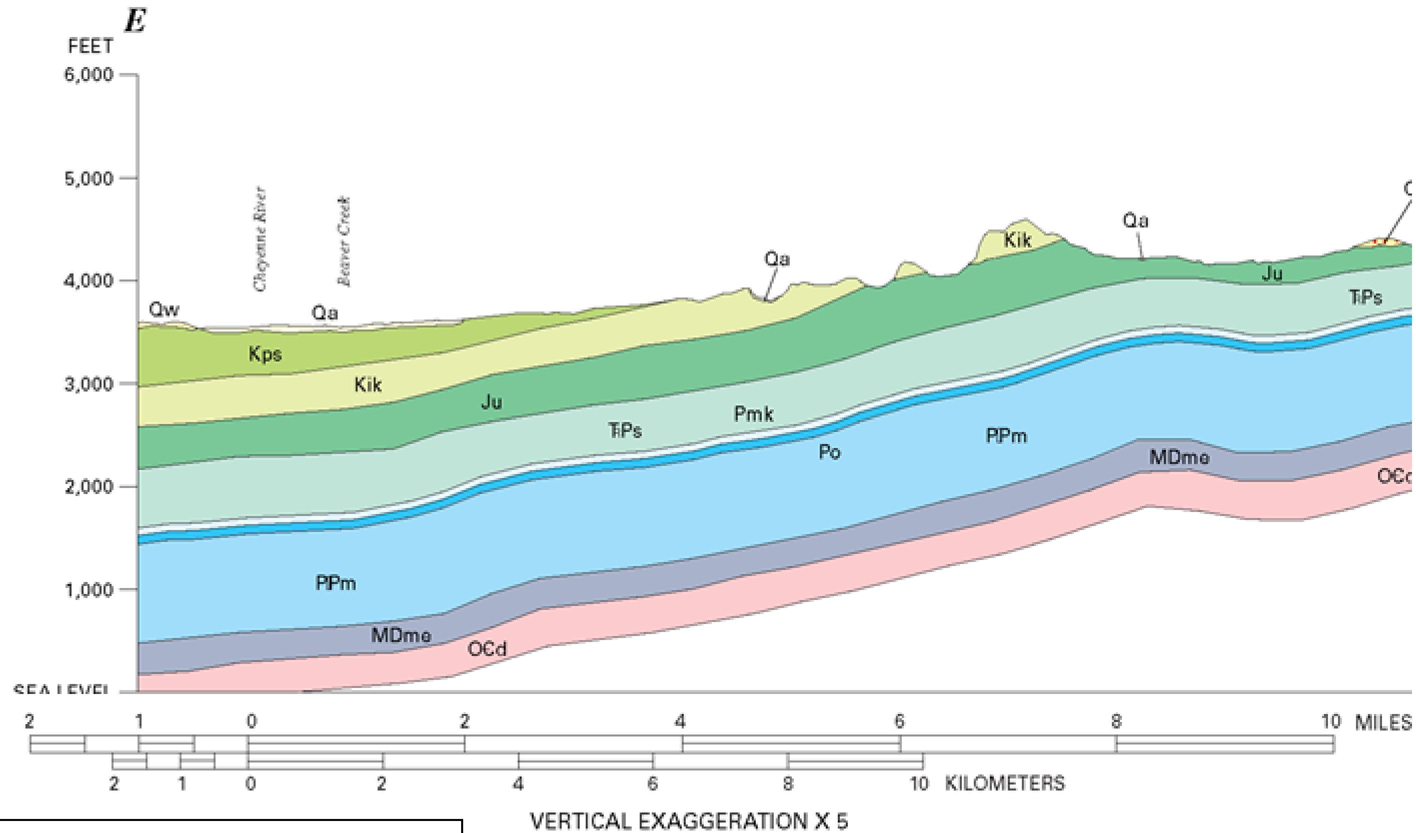


Figure 2.3-1

Dewey-Burdock Project Regional Geologic Cross Section

Source: SDGS, 2012

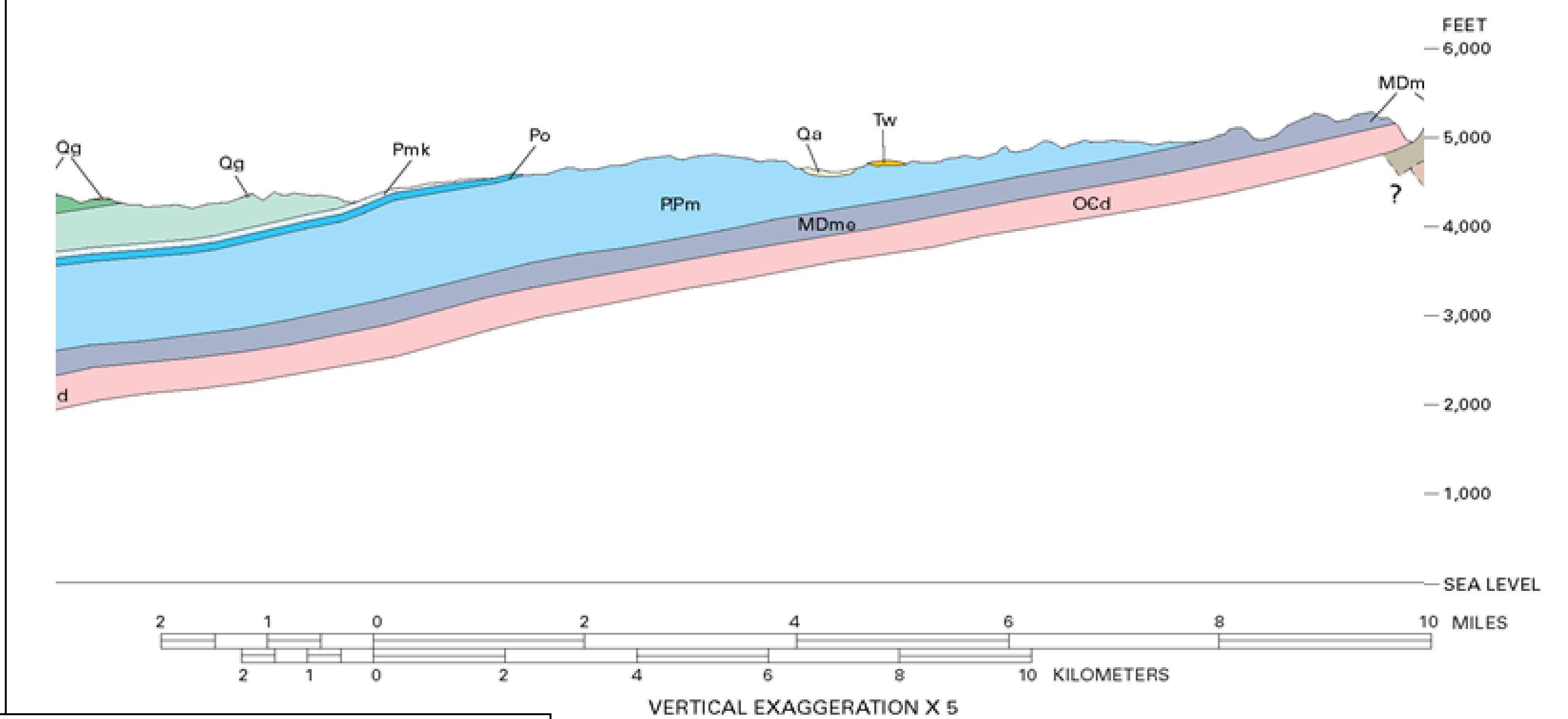
Figure 2.3-1: Dewey-Burdock Project Regional Geologic Map



Legend

Qa –	Alluvium
Qw –	Wind-Blown Deposits
Tw -	White River Group
Qg –	Gravel Deposits
Kps -	Pierre Shale to Skull Creek Shale, undifferentiated
Klk -	Inyan Kara Group
Ju -	Morrison Formation to Gypsum Spring Formation, undifferentiated
TrPs -	Spearfish Formation
Pmk -	Minnekahta Formation
Po -	Opeche Shale
PjPm -	Minnelusa Formation
Mdme -	Madison Limestone and Englewood Formation
Ocd -	Deadwood Formation

Figure 2.3-2a: Dewey-Burdock Project Regional Geologic Cross Section



Legend

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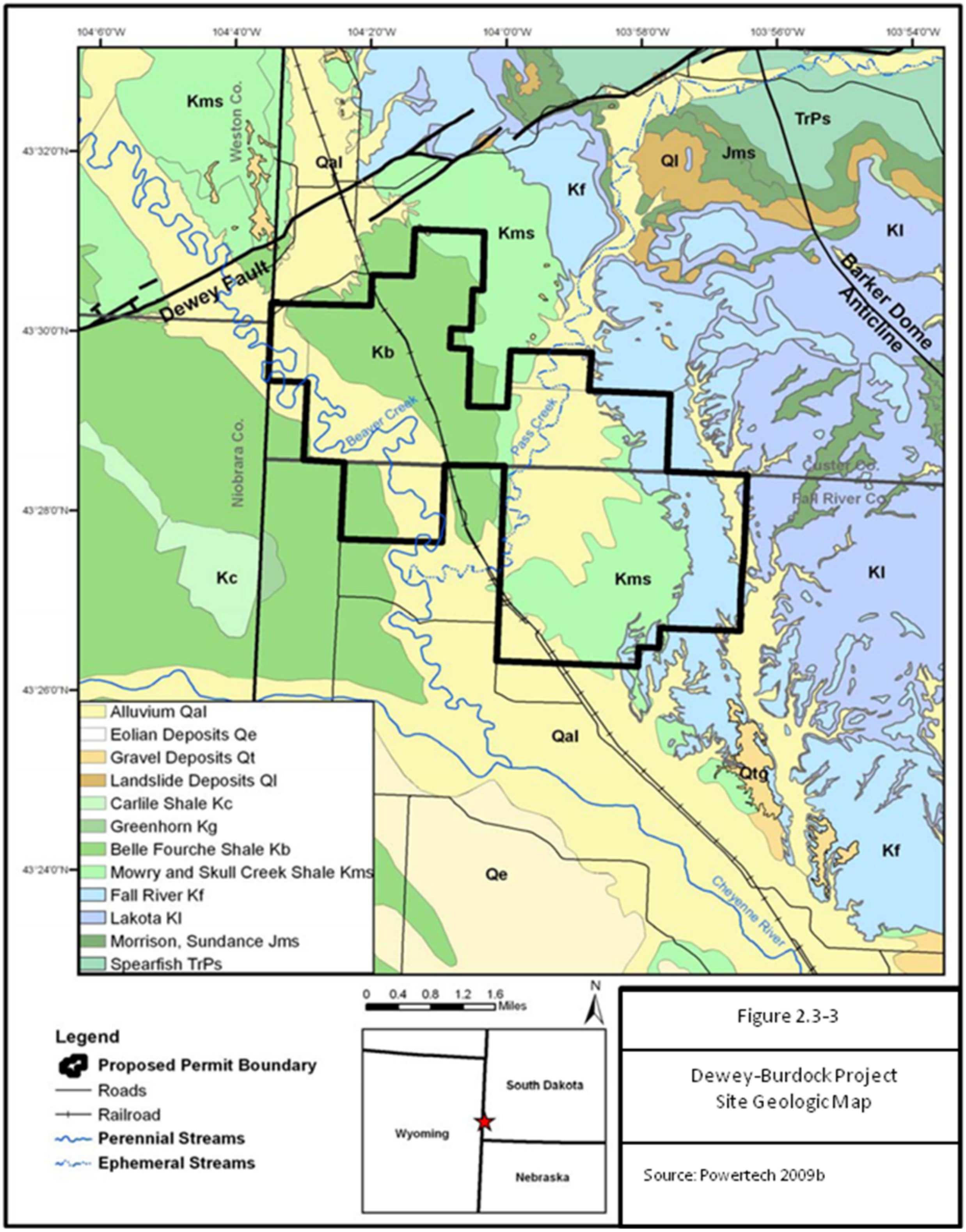
Kps -	Pierre Shale to Skull Creek Shale, undifferentiated
Klk -	Inyan Kara Group
Ju -	Morrison Formation to Gypsum Spring Formation, undifferentiated
TrPs -	Spearfish Formation
Pmk -	Minnekahta Formation
Po -	Opeche Shale
PjPm -	Minnelusa Formation
Mdme -	Madison Limestone and Englewood Formation
Ocd -	Deadwood Formation

Figure 2.3-2b: Dewey-Burdock Project Regional Geologic Cross Section

Figure 2.3-3: Dewey-Burdock Project Site Geologic Map



2.4 HYDROLOGY

2.4.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has characterized the surface and groundwater hydrology at the Dewey-Burdock Project sufficiently to document the applicant's ability to maintain control over production fluids containing source and byproduct materials, as required by 10 CFR 40.41(c).

2.4.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the standard review plan (NRC, 2003b).

2.4.3 STAFF REVIEW AND ANALYSIS

2.4.3.1 Surface Water

2.4.3.1.1 Drainage Basins

The Dewey-Burdock Project lies within both the Beaver Creek and Pass Creek drainage basins, of which Pass Creek is a sub-basin within the Beaver Creek basin (Powertech, 2009c). The Beaver Creek basin is part of the Cheyenne River watershed. Application Figure 2.7-1 shows the major stream systems near and within the Dewey-Burdock Project. Pass Creek, which is ephemeral, flows into Beaver Creek south of the site, and Beaver Creek subsequently flows into the Cheyenne River approximately 3.2 km (2 mi) south of the Burdock area (Powertech, 2009c).

The staff assessed stream flow beyond the Dewey-Burdock Project boundaries to determine regional flow patterns ("Satellite Images of Dewey-Burdock Project and Vicinity,"). The Cheyenne River flows into the Angostura Reservoir approximately 48 km (30 mi) southeast of the Dewey-Burdock Project, and its confluence with the Belle Fourche River is approximately 177 km (110 mi) northeast of the site. The Cheyenne River and Missouri River confluence occurs in Lake Oahe, 53 km (33 mi) northwest of Pierre, South Dakota. ("Satellite Images of Dewey-Burdock Project and Vicinity,")

The applicant described discharges for the Cheyenne River at Spencer, Wyoming (upstream of the project), and Edgemont, South Dakota (downstream of the project); both sites are USGS gauging stations (Powertech, 2009c). The staff reviewed the applicant's information and USGS data for these locations to determine the degree of consistency between the two data sets. According to USGS data, average monthly mean discharge is the lowest in January and December at 0.25 cubic m per second (cms) (9 cubic ft per second (cfs))(USGS, 2011c). Highest monthly mean discharges occur in May and June at 5.7 to 6.3 cms (200 to 224 cfs)(USGS, 2011c). A comparison of the USGS data with the applicant's data indicates that they are consistent.

According to the applicant, the Beaver Creek watershed occupies 3522 km^2 (1360 mi^2), excluding the Pass Creek sub-watershed, and extends from north of Upton, Wyoming, to south of Dewey, South Dakota (Powertech, 2009c). The applicant provided flow data along Beaver Creek at Newcastle, Wyoming, which is near the center of the watershed, data indicating that mean monthly flows are the lowest in November, December, and January 0.28 – 0.31 cms [(10-11 cfs)]. Monthly stream flows are highest in March [2.4 cms (84cfs)]. (Powertech, 2009c; USGS, 2011b)

The Pass Creek watershed is part of the larger Beaver Creek watershed and occupies 596 km^2 (230 mi^2) (Powertech, 2009c). Pass Creek is ephemeral, and no permanent gauging stations were installed in its channel (Powertech, 2009c). Therefore, the applicant modeled this and other ephemeral channels at the Dewey-Burdock Project to estimate flows and areas of inundation for a 100-year flood. Application Exhibit 2.7-M-1 shows all the drainage basins analyzed at the Dewey-Burdock Project. (Powertech, 2011a)

In addition to the surface water drainages, the Dewey-Burdock Project contains stock ponds within the license boundary, as shown on Exhibit 5.7-1 (Powertech, 2011a). According to Exhibit 5.7-1, 22 ponds are located within the Burdock area, including ponds associated with existing mine pits, while three ponds are located within the Dewey area. The applicant states that most of these surface impoundments are dry during most of the year and are primarily found along ephemeral streams and tributaries, particularly in the eastern section of the license area. The applicant states that two ponds in the eastern section of the license area are located within the primary facility zones. (Powertech, 2011a)

2.4.3.1.2 Surface Water Modeling

The applicant assessed the potential for flooding of its wellfields and facilities by first obtaining floodplain data. Application Exhibit 2.7-3 shows floodplain areas of Beaver Creek, Pass Creek, and tributaries of both creeks in relation to site facilities and wellfields (Powertech, 2011a). The applicant used two different methods for assessing flood inundation of Beaver and Pass creeks. For Beaver Creek, the applicant performed a log-Pearson III analysis of stream gauge data from a Newcastle, Wyoming, gauge on Beaver Creek (Powertech, 2009c). Results of this analysis are flows for certain return intervals (e.g. 100-year return interval).

For Pass Creek, the applicant modeled surface water flows and flood inundation using HEC-HMS (Hydrologic Modeling System) and HEC-RAS (River Analysis System) both developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC). The applicant used these systems because no long-term stream gauge is available for Pass Creek (USACE, 2010a). HEC-HMS is an industry standard for watershed analyses that provides various standard computations and algorithms to estimate flows from a watershed due to specific types of precipitation events. Basic input parameters for a watershed analysis are the Soil Conservation Service (SCS) Curve Number for surface water losses, SCS Unit Hydrograph for estimating runoff from precipitation events (transformation), initial abstraction (amount of precipitation required before runoff occurs), and lag time (time required for runoff to occur). Curve Number and SCS Unit Hydrograph methods are well established methods used in hydrologic modeling (McCuen, R. H., 1998). When performing the hydrologic analysis, the applicant estimated a 100-year return interval flow and an extreme flow condition based on a percentage of the probable maximum precipitation (Powertech, 2009c). Results of the hydrologic analysis using log-Pearson III and the hydrologic modeling analysis for Beaver Creek and Pass Creek, respectively, are as follows:

Table 2.4-1: Beaver Creek and Pass Creek Flow Estimates

Stream	Return Interval	Flow (cms/cfs)
Pass Creek	100-year	(159/5,620)
	Estimated PMF	(1,856/65,600)
	50% Estimated PMF	(928/32,800)
Beaver Creek	100-year	(213/7,503)*
	Estimated PMF	(533/18,833)*

Source: (Powertech, 2009c)
*Average of three values from three different computational methods

In addition to Pass Creek, the applicant performed hydrologic analyses on 15 tributaries of Pass Creek and Beaver Creek. Application Exhibits 2.7-M-1 through 2.7-M-3 show the reaches, hydraulic cross section locations, and 100-year inundation results of the flow and inundation modeling (Powertech, 2011a). Peak flows were based on the 100-year, 24-hour recurrence interval precipitation event for these 15 tributaries. Again, the applicant used HEC-HMS to estimate the peak flows, incorporating the same curve number and SCS Unit Hydrograph calculations used in the Pass Creek analysis. (Powertech, 2011a)

Results of this analysis are presented in Table 2.4-2 below:

Table 2.4-2: Tributary Peak Discharges

Watershed	Drainage Area (km^2/mi^2)	Peak Discharge (cms/cfs)
1	11.5/4.43	42.2/1,489.9
2	3.26/1.26	30.5/1,077.4
3	0.83/0.32	9.7/341.1
4	0.88/0.34	6.0/210.5
5	1.0/0.39	10.4/368.9
6	Closed Basin	
7	2.5/0.96	28.9/1,022.4
8	Closed Basin	
9	8.6/3.33	68.0/2,401.6
10	1.24/0.48	16.6/587.6
11	0.98/0.38	15.0/528.9
12	1.4/0.53	18.4/651.1
13	0.25/0.10	3.4/126.4
14	13.3/5.14	57.5/2,032.3
15	1.8/0.71	14.8/523.1
16	0.05/0.02	0.84/29.7
17	0.34/0.13	3.8/132.8

Source: (Powertech, 2011a)

After calculating the peak flows for Beaver Creek, Pass Creek, and all the aforementioned tributaries, the applicant calculated the resulting stream water levels and areas of flooding using HEC-RAS. HEC-RAS calculates water surface profiles using the energy equation for a series of cross sections in a stream reach. The necessary data include X and Y coordinates for each stream cross section, stream length, Manning's n roughness, and discharge (USACE, 2010b).

Actual cross section and stream length data was developed using geographic information system (GIS) data (Powertech, 2011a). Discharge data was obtained from HEC-HMS, and the applicant estimated the Manning's n for each channel using Cowan's method (Powertech, 2011a). The applicant used a Manning's n of 0.035 (Powertech, 2011a), which the staff finds acceptable based on published recommended values (McCuen, R. H., 1998). Final surface water modeling results included cross sections with water surface elevations and areas of inundation for a 100-year, 24-hour flood event. These data were compiled into a map of 100-year flood plains for Beaver Creek, Pass Creek, and 15 tributaries (see application Exhibit 2.7-M-2) (Powertech, 2011a).

After reviewing the applicant's flood data, the staff reviewed various Federal Emergency Management Agency (FEMA) floodplain maps and determined that the applicant's representation of the Pass Creek and Beaver Creek floodplains is acceptable (FEMA, 2012a, 2012b, 2012c, 2012d). The staff could not directly review the floodplains for the tributaries due to lack of actual water elevation data. However, the staff finds the Pass Creek model to be consistent with the aforementioned floodplain maps; therefore, floodplain calculations for the other tributaries are determined to be acceptable.

2.4.3.1.3 Surface Water Flow vs. Proposed Structures

A review of application Exhibit 2.7-3 indicates that some wellfields are transected by ephemeral tributaries with the 100- floodplains potentially leaving the channels (Powertech, 2011a). For example, several of the proposed production wells provided for Dewey Wellfield I and Burdock Wellfield I appear to be directly in the catchments. NRC also notes that the plant-to-plant pipeline and Burdock Wellfield V-to-plant pipeline appear to cross several ephemeral drainage channels, including Pass Creek. Furthermore, proposed evaporation ponds in the Dewey area and land application areas in the Burdock area either abut or cover ephemeral tributaries.

The applicant provided information regarding the manner in which spills will be contained to prevent migration to stream channels and the manner in which the applicant will protect wellfields and land application areas from flooding from stream channels (Powertech, 2011a). Protection methods will include locating most structures and equipment outside the 100-year flood boundary. Any facility that must be located within the 100-year flood boundary will be protected from damage by structures such as straw bales, collector ditches, engineered diversion structures and/or berms. Above-grade wellfield infrastructure will be located outside of the 100-year flood inundation boundary. However, if an individual well head is installed within the 100-year flood boundary, diversions or erosion control structures will be constructed to divert flow and protect the well head. Well heads will also be sealed to withstand brief periods of submergence. All pipelines, including the proposed plant-to-plant pipeline, will be buried below the frost line and therefore will not be affected by flooding. Pipeline valve stations will be located outside of the 100-year flood inundation boundary (Powertech, 2011a).

The staff reviewed the applicant's assessment of the surface water hydrology and flooding potential. Based on a review of the application and the staff's individual analysis, the staff determines that the applicant's description of surface water hydrology and flooding are consistent with Section 2.7.3 of the standard review plan and in compliance with 10 CFR 40.41(c). This determination is predicated upon fulfillment of the license conditions regarding protection of facilities from flooding, prevention of contamination of stream channels, and commitment to restore stream channels to the original morphology. These license conditions are discussed in SER Section 2.4.4, except for the condition regarding stream morphology, which is discussed in SER Section 6.2.4.

2.4.3.2 Regional Hydrogeology

In the southwestern Black Hills area, the hydrogeologic units consist of the following from youngest to oldest:

- surficial terrace/alluvial aquifers located adjacent to Beaver Creek, Pass Creek, Bennett Canyon drainage;
- the Graneros Group, a regional upper confining unit consisting of the Belle Fourche Shale, Mowry Shale, and Skull Creek Shale;
- the Inyan Kara aquifer, the extraction zone, consisting of the Fall River Formation and Lakota Formation, which contains the Fuson Shale and the Chilson Member;
- the Morrison Shale lower confining unit;
- underlying local water resource aquifers consisting of the Unkpapa Sandstone and the Sundance Formation; and
- the confining unit of the Spearfish Formation.

SER Section 2.3 provides more specific information regarding the hydrogeologic units that directly affect the proposed action (i.e., those units overlying and including the Morrison Formation). Information regarding the characteristics of those units underlying the Morrison Formation is presented below:

- Minnelusa Aquifer - Consists of interbedded siltstone, sandstone, anhydrite, and limestone. It ranges in thickness from 114 to 358 m (375 to 1,175 ft). Aquifer transmissivities range from 0.09 – 1,115 m^2/day (1 to 12,000 ft^2/day). The Minnelusa aquifer is confined above by the Opeche Shale and below by lower permeability layers at the base of the Minnelusa formation. This is one of the target aquifers to receive effluent from the applicant's proposed Class V injection wells.

- Madison Aquifer - Also known as the Pahasapa Limestone in the Black Hills area, the Madison Formation is an important aquifer because it is the source of municipal water in numerous communities, including Rapid City and Edgemont. It is mainly a dolomite unit, and its thickness ranges from 61 to 305 m (200 to 1,000 ft). Transmissivities range between 121 to 5,204 m^2/day (1,300 and 56,000 ft^2/day). Similar to the Inyan Kara and Minnelusa Formations, the Madison Formation is unconfined at its outcrop areas in the Black Hills and confined beyond the Black Hills. Low permeability layers within the overlying Minnelusa Formation act to confine the Madison; however, these confining layers may be absent or more highly conductive such that intercommunication between the Madison and Minnelusa occurs. The Madison may also be in connection with the underlying Deadwood aquifer where the Whitewood and Winnipeg confining units are absent.

- Deadwood Aquifer - Consists of basal conglomerates, sandstone, limestone, and mudstone, and its thickness ranges between absent and 152 m (500 ft). Transmissivities of the Deadwood range between 23 to 93 m^2/day (250 to 1,000 ft^2/day). The Deadwood aquifer is in contact with the overlying Madison aquifer except where the Whitewood and Winnipeg formations are present. It is confined below by Precambrian basement rock. This is the second target aquifer to receive effluent from the applicant's proposed Class V injection wells.

- Minor Aquifers - In addition to the major aquifers, minor aquifers around the Black Hills include the Minnekahta Limestone, Sundance/Unkpapa, Newcastle Sandstone, and alluvium. Where present and saturated, these units may yield small amounts of water. Locally, beds within the confining units may also contain aquifers (Driscoll et al., 2002). Typically, these minor aquifers are not heavily utilized because of more reliable sources in overlying or underlying aquifers. (Powertech, 2011a)

NRC staff concludes that this information is consistent with the general regional-scale hydrogeological descriptions provided by published information (Michael Strobel, G. J. J., J. Foster Sawyer, John R. Schleicher, and Mark D. Fahrenbach, 1999).

The applicant states that based on published sources, regional groundwater flow is radially away from the Black Hills (Powertech, 2009c). While the staff agrees with this statement for the area immediately surrounding the Black Hills, this statement overlooks the bigger picture. For example, groundwater flow in the major regional Paleozoic aquifers, such as the Deadwood, Madison, and Minnelusa Aquifers, is east-northeast from recharge areas in the Bighorn Mountains, Black Hills, and areas of central Montana (Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002). Groundwater in the western Black Hills area, on the other hand, will briefly flow in a westerly direction before being overtaken by regional groundwater flow patterns and flow northeasterly (Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002). An example of this is shown in Figure 70 in Driscoll 2002.

Regarding the Inyan Kara, regional groundwater flow is easterly and northeasterly from the Bighorn Mountains and areas in western Montana toward South Dakota and North Dakota. Similar to the Paleozoic aquifers, groundwater will flow west along the western side of the Black Hills in South Dakota before being overtaken by the regional groundwater flow direction, where groundwater will then flow northeasterly around the Black Hills toward central South Dakota (Lobmeyer, D. H., 1985). An example of such flow is shown in Driscoll's 2002 report on the Black Hills hydrology (Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002). Figure 70 of this report shows groundwater flow moving westward then eastward around the Black Hills (Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002). In addition to groundwater flow direction, hydraulic heads tend to be large to the point where artesian springs appear (Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002).

2.4.3.3 Site Hydrogeology

2.4.3.3.1 Aquifers and Confining Units

SER Section 2.3 presents geologic descriptions of the hydrologic units found at the Dewey-Burdock Project. A list of the hydrogeologic units is as follows from shallowest to deepest:

- Alluvial Aquifers - Locally saturated alluvial material along Pass Creek and Beaver Creek, and the Cheyenne River. Water level measurements in five alluvial piezometers indicate that the upper 3 to 4.6 m (10 to 15 ft) of the alluvium is unsaturated. The applicant indicated that the alluvial aquifers are typically unconfined.

- Graneros Group Confining Unit - Acts as the upper confining unit.

- Inyan Kara Aquifer - The proposed ore zones for uranium recovery are within the Inyan Kara aquifer, which is zero to over 500 feet below the ground surface within the license boundary. The Inyan Kara is subdivided into two sub-aquifers; the younger Fall River Formation and the older Lakota Formation. The Lakota Formation is subdivided into the younger Fuson Shale and the older Chilson Member. The application indicates that the Fall River Formation and the Chilson Member are water bearing units separated by the Fuson Shale, which is a confining unit that is locally leaky.

- Morrison Formation Confining Unit - The Morrison Shale is the underlying confining unit. As discussed in SER Section 2.3, the unit is approximately 100 feet thick and is laterally continuous throughout the site and its vicinity. Results of core sample geotechnical analyses from the upper Morrison indicate that the shale has a relatively low vertical permeability of about 2.0 E-8 cm/s (6.0 E-5 ft/day) in the Burdock License area (application Appendix 2.7-B) (Powertech, 2009c).

- Sundance and Unkpapa Aquifers - Overlying the Spearfish formation, the Sundance and Unkpapa aquifers are considered aquifers of minor importance within the Black Hills. These aquifers are a source of water within the license boundary. The Sundance Formation is composed primarily of shale and sandstone with an average thickness of 85 m (280 ft) near the project site. Where present, the Unkpapa is 15 to 24 m (50 to 80 ft) of well-sorted, fine-grained, eolian sandstone. For the purpose of this study, the Sundance and Unkpapa aquifers are considered one unit because there is no intervening confining unit separating the two.

- Spearfish Formation Confining Unit - In general, the Spearfish Formation is characterized by a thick sequence 76 to 137m (250 to 450 ft) of red shale and siltstone. Based on the few exploration holes that have penetrated the entire thickness of the formation in the Dewey-Burdock Project, the Spearfish is an average of 98 m (320 ft) thick. This thick sequence of shale serves as a hydrologic barrier or confining unit preventing nearly all vertical flow between the Paleozoic aquifers and the Jurassic/Cretaceous aquifers.

2.4.3.3.2 Groundwater Flow

Inyan Kara

The applicant provided piezometric surface maps for the Fall River and Chilson aquifers, which are both part of the Inyan Kara Group (Powertech, 2011a). Application Figures TR RAI 2.7-5-1 and TR RAI 2.7-5-2 both show groundwater flowing southwest away from the Black Hills uplift (Powertech, 2011a). As previously discussed, such a groundwater flow pattern is part of the regional pattern of radial groundwater flow away from the Black Hills uplift. The applicant's depiction of the groundwater flow direction is consistent with previous assessments of groundwater flow (Keene, J. R., 1973). At some location in Wyoming, flow within both of these aquifers will reach an inflection point, where groundwater will start flowing northeasterly with the overall regional groundwater gradient (Lobmeyer, D. H., 1985).

The applicant also provided piezometric data on cross sections found on Exhibits 2.7-1a through 2.7-1j (Powertech, 2011a). A review of these cross sections indicates the following:

- Along the eastern portion of the Burdock area, the Fall River Aquifer is partially to completely unsaturated. Also the upper Chilson Aquifer is partially saturated to completely saturated and confined. The lower and middle Chilson Aquifers are saturated and confined, including the lower Chilson ore zone.
- Along the eastern portion of the Burdock area, hydraulic heads of the Chilson Aquifer are either higher or lower than those of the Fall River Aquifer depending on the particular location of interest.
- Toward the central portion of the Burdock area, both the Fall River and Chilson Aquifers are saturated and confined. Furthermore, the hydraulic heads of the Chilson Aquifer exceed those of the Fall River Aquifer, indicating an upward vertical gradient.
- In the southern portion of the Burdock area, the Fall River Aquifer is heavily confined by over 100 feet of Graneros Shale. Both the Fall River and Chilson Aquifers exhibit the same piezometric surface, and in the southwest corner of the Burdock area both aquifers are flowing artesian (hydraulic head exceeds the ground surface elevation).
- In the area of the Darrow mine pit and underground mine workings, the lower Fall River Aquifer is unsaturated and separated from the mine pit by approximately 20 feet of shale. The Chilson Aquifer is saturated and confined with a piezometric surface approximately equal to that of the Fall River.
- In the Dewey Area, the Fall River Aquifer is heavily confined by approximately 500 ft of Graneros Shale. Piezometric surfaces for both the Chilson and the Fall River aquifers exceed surface elevations and are, therefore, artesian. Hydraulic heads in the Chilson Aquifer exceed those of the Fall River Aquifer. (Powertech, 2011a)

Application Figures TR RAI 2.7-9-5 and -6 present the areas of the Dewey-Burdock Project where the Fall River and Chilson aquifers are flowing artesian, respectively (Powertech, 2011a). A review of these figures corroborates information found on the cross sections. The central part of the Dewey area is under artesian conditions, as are wells in the western half of the Burdock area. However, the Chilson artesian area is slightly larger than the Fall River artesian zone in the Burdock area. (Powertech, 2011a)

In 1973, Keene reported that uncased and improperly abandoned boreholes were flowing in the artesian areas of the Dewey-Burdock Project (Keene, J. R., 1973). He surmised that reported head loss at the time of his report may have been partially caused by these uncased bore and improperly abandoned boreholes(Keene, J. R., 1973). However, as discussed in SER Section 2.3, the applicant provided infrared aerial photography demonstrating the signature of a leaking borehole. The applicant identified only one such location; no other such leaky borehole locations were identified.

Application Figures TR RAI 2.7-5-1 and TR RAI 2.7-5-2 show that groundwater flows generally to the southwest (Powertech, 2011a). NRC staff finds that the hydraulic gradient shown in these figures is approximately 0.011 to 0.003 for the Fall River and 0.006 for the Chilson Aquifer. These figures show that an upward hydraulic gradient exists between the Unkpapa Aquifer and the Lakota Aquifer, as demonstrated by Unkpapa hydraulic heads exceeding those in the Fall River and Lakota by 15 to 30.5 m (50 to 100 ft). (Powertech, 2009c)

Consequently, any artificial or natural discontinuity through the Morrison Formation (confining layer between the Unkpapa and Inyan Kara Aquifers) would cause water to flow up into the Inyan Kara from the Unkpapa. Therefore, the nature of the hydraulic head differential between these aquifers provides hydraulic containment for the ISR operations in the Inyan Kara Aquifer. The staff finds that applicant has demonstrated sufficient hydraulic containment between the production zone and the underlying aquifer, and monitoring in the underlying aquifer will not be necessary.

As stated above, the Chilson Aquifer is partially saturated in the eastern portion of the site. In this area, the Chilson Aquifer is divided into three permeable zones separated by two shale layers. Pumping tests in the Burdock area indicate that although vertical anisotropy exists in the Chilson Aquifer (see SER Section 2.4.3.4), the aquifer still acts like a single unit. Because unsaturated aquifers behave hydraulically differently from saturated aquifers, more detailed information is needed to assess the viability of the wellfields in the eastern portion of the Burdock area. Therefore, the staff is including a license condition that extraction in the eastern portion of the Burdock area cannot proceed until the staff has reviewed and approved the hydrologic package.

Alluvium

According to the applicant, alluvium is associated with stream channels or overbank areas, primarily of Beaver Creek and Pass Creek (Powertech, 2011a). Where saturated, alluvial aquifers are unconfined and are generally in direct connection surface water or stream channels. The applicant provided a potentiometric surface map of the alluvial aquifer system. A review of this map indicates that groundwater in the alluvium flows parallel to the stream channels in a southerly direction toward the Cheyenne River (Powertech, 2011a).

The applicant also assessed the potential for artesian groundwater to discharge into the alluvium from the Fall River or Chilson aquifers (Powertech, 2011a). As stated previously in SER Section 2.3.3.3, artesian discharge from the aforementioned aquifers exhibits a distinct signature at the land surface, as observed in the alkali lake area (Powertech, 2011a). The applicant's data indicates that no other such lakes, springs, or discharges are observed in the alluvium; therefore, the applicant concluded that no such discharge is occurring (Powertech, 2011a). The staff concurs with this conclusion that, in the absence of any contradicting information, artesian groundwater from the Inyan Kara aquifers is not discharging into the alluvium or adjacent stream channels.

Unkpapa Aquifer

The applicant provided measurements of water levels in wells completed in the Unkpapa aquifer (Powertech, 2011a). Application Figure 2.7-16 presents a piezometric surface map of the Unkpapa for the project site and surrounding region. This map is based on water level measurements taken by the applicant in 2008. Figures 2.7-16 shows that the groundwater flow direction is generally to the southwest. (Powertech, 2011a)

NRC staff finds that the groundwater gradient shown in Figure 2.7-16 is approximately 0.006 for the Unkpapa. As previously stated, an upward hydraulic gradient exists between the Unkpapa aquifer and the Lakota and Fall River aquifers. Therefore, groundwater cannot migrate down through the Morrison from the Lakota Aquifer to the Unkpapa Aquifer.

Additionally, staff notes that the broken free-flowing wells 635 and 696 are within the license boundary and downgradient of operations. Well 635 taps the Unkpapa and well 696 taps the Lakota, which is proposed for production. By a license condition discussed in SER Section 2.4.4, the staff will require these wells to be sealed and capped prior to ISR operations at the site.

2.4.3.4 Inyan Kara Aquifer Tests

NRC staff reviewed the aquifer pumping tests and associated analysis in Appendix 2.7-B of the Technical Report and Appendix A of the Technical Report Supplement (Powertech, 2009c, 2010a). Application Figure 1.1 (Appendix 2.7-B) shows the locations of the pumping tests reported by the applicant. Two of the tests were conducted by Tennessee Valley Authority (TVA) from 1979 through 1982 as part of a uranium mine development project near the towns of Edgemont and Dewey, South Dakota. The other two pumping tests were conducted by the applicant in 2008. The following discussions describe the pumping tests and results.

Burdock TVA Test

TVA conducted a pumping test in 1979 in what is now the Burdock area of the Dewey-Burdock Project (Powertech, 2010a). This test actually consisted of two pumping tests, first pumping in the Lakota Aquifer and second, pumping in the Fall River Aquifer. Fifteen monitoring wells were installed at various distances and within both aquifers, as well as in the Fuson Shale between the two aquifers. TVA concluded that the hydraulic conductivity of the Fuson Shale is 10^{-7} to 10^{-8} cm/s (10^{-3} to 10^{-4} ft/day), which is extremely low. TVA also concluded that the Fuson was leaky because drawdown in the Fuson Shale occurred after drawdown started in the Fall River. According to TVA, this could be indicative of natural or anthropogenic discontinuities (unsealed borings). TVA also installed a well in the underlying Sundance/Unkpapa Aquifer, and no response was identified. (Powertech, 2010a)

Dewey TVA Test

TVA conducted a pumping test in 1982 in what is now the Dewey area of the Dewey-Burdock Project (Powertech, 2010a). To conduct this test, TVA installed a pumping well in the Chilson aquifer and 11 observation wells in the Chilson Aquifer, Fall River Aquifer, and the Fuson Shale. One well was located in the Dewey Structural Zone area to test the effect of the Dewey Fault on groundwater flow patterns in the area. TVA concluded that the Fuson Shale was a leaky confining unit with an average vertical hydraulic conductivity of 7×10^{-8} cm/s (2×10^{-4} ft/day). Furthermore, the Dewey Fault acts as a flow barrier boundary, as opposed to a recharge boundary, based on the drawdown response of the well installed near it. (Powertech, 2010a)

Recent Pumping Tests

In 2008, the applicant conducted two pumping tests at both project areas to determine aquifer properties at the site (Powertech, 2009c). Application Appendix 2.7-B of the Technical report provides the aquifer testing methodology and the analysis of the results. In the Burdock area, the applicant installed a well network consisting of one pumping well in the Chilson Aquifer, four monitoring wells in the Chilson Aquifer, and one monitoring well in each of the Fall River and Sundance/Unkpapa Aquifers (see Figure 5.1 in Appendix 2.7-B). (Powertech, 2009c)

Testing occurred between May 21 and 24, 2008, by performing a 3-day constant rate test at 114 Lpm (30 gpm) (Powertech, 2009c). Results of the pumping test indicated that the entire Chilson Aquifer is in communication; however, the Chilson is anisotropic. The applicant's evidence for vertical anisotropy is a delayed response in an upper Chilson monitoring well, likely caused by interbedded shales. Regardless of the observed vertical anisotropy, pumping test data indicates that the entire Chilson acts as one interconnected aquifer (Powertech, 2009c).

This pumping test also confirmed that the overlying Fuson shale provides leakage to the Chilson, and the Fall River and Chilson Aquifers communicate through the Fuson (Powertech, 2009c). Drawdown in the Fall River monitoring well provides confirmation of such communication. Furthermore, hydraulic heads in both aquifers are equivalent, when the Chilson Aquifer should exhibit a higher head because its recharge zone is at a higher elevation in the Black Hills than that of the Fall River. This provides another indication that both aquifers communicate through the Fuson Shale. The applicant estimates the vertical hydraulic conductivity through the Fuson as 9.3 E-8 cm/sec (2.7E-4 ft/day); estimates are from laboratory analyses of rock core. Considering this very low conductivity, interconnectivity through the Fuson is likely through improperly plugged and abandoned boreholes (Powertech, 2009c).

The applicant also tested the confining capability of the lower confining unit, the Morrison Formation (Powertech, 2009c). Laboratory tests indicate that the vertical permeability of the Morrison Formation is 2.1E-8 cm/sec (6.5 E-5 ft/day). A review of the pumping test data indicates that the Sundance/Unkpapa is not hydraulically connected to the Chilson Aquifer. Considering the lack of hydraulic connection, and because the head in the Sundance/Unkpapa Aquifer is higher than that of the overlying aquifers, no groundwater monitoring will be required for the Sundance/Unkpapa (Powertech, 2009c).

To summarize, hydraulic properties calculated for the Chilson Aquifer are as follows: transmissivity – 14.7 m^2/day (158 ft^2/day), storativity – 1.12 E-4, horizontal hydraulic conductivity (from rock core) – 0.0026 cm/sec (7.3 ft/day), and vertical hydraulic conductivity (from rock core) – 0.001 cm/sec (3 ft/day). Average horizontal and vertical hydraulic conductivities for the Morrison Formation are 3.5 E-8 cm/sec (1E-4 ft/day) and 3E-9 cm/sec (1E-5 ft/day), respectively. Average horizontal and vertical hydraulic conductivities for the Fuson Shale are 3.5 E-8 cm/sec (1E-4 ft/day) and 3E-9 cm/sec (1E-5 ft/day), respectively. Graneros Shale samples were not collected at the Burdock Area; therefore, no hydraulic conductivity data can be reported.

In the Dewey area, the applicant installed a well network consisting of one pumping well in the Fall River Aquifer, four monitoring wells in the Fall River Aquifer, one existing stock well in the Fall River Aquifer, and one monitoring well in each of the Chilson and Sundance/Unkpapa Aquifers (see application Figure 4.1 in Appendix 2.7-B) (Powertech, 2009c). Testing occurred between May 12 and 18, 2008. First, the applicant performed a step test at 37.9, 75.7, 94.6, and 114 Lpm (10, 20, 25, and 30 gpm). Then, the applicant performed a 3-day constant rate test at 114 Lpm (30 gpm) (Powertech, 2009c).

Results of the pumping test indicated that the entire Fall River Aquifer is in communication. However, like the Chilson Aquifer, the Fall River Aquifer is anisotropic (Powertech, 2009c). The applicant's evidence for vertical anisotropy is a delayed response in an upper Fall River monitoring well, likely caused by interbedded shales. Regardless of the observed vertical anisotropy, pumping test data indicates that the entire Fall River Aquifer is one interconnected aquifer. (Powertech, 2009c)

This pumping test also confirmed that the underlying Fuson Shale does not leak, unlike the Fuson Shale in the Burdock area. Thus, the Fall River and Chilson Aquifers are hydraulically separated (Powertech, 2009c). As evidence, the applicant states that no drawdown was observed in the Chilson Aquifer monitoring well. Furthermore, hydraulic heads in the Chilson Aquifer are approximately 21 m (70 ft) higher than those of the Fall River. Such differences in head clearly demonstrate that hydraulic separation between both aquifers and a strong upward vertical hydraulic gradient exists. The pumping test also confirms that the Sundance/Unkpapa Aquifer is hydraulically isolated from the Fall River Aquifer (Powertech, 2009c).

Hydraulic properties calculated for the Fall River Aquifer are as follows: tranmissivity – 23 m^2/day (251 ft^2/day), storativity – 2.5E-5, horizontal hydraulic conductivity (from rock core) – 0.002 cm/sec (6.1 ft/day), and vertical hydraulic conductivity (from rock core) – 5E-4 cm/sec (1.4 ft/day). Average horizontal and vertical hydraulic conductivities for the Graneros Group Shale are 6E-8 cm/sec (1.7 E-4 ft/day) and 5E-9 cm/sec (1.5E-5 ft/day), respectively. Average horizontal and vertical hydraulic conductivities for the Fuson Shale are 6E-8 cm/sec (1.6E-4 ft/day) and 6E-9 cm/sec (1.8 E-5 ft/day), respectively. Morrison Formation samples were not collected at the Dewey Area; therefore, no hydraulic conductivity data can be reported.

2.4.3.5 Groundwater Use

The applicant identified four major water resource aquifers for the Black Hills area, which are from youngest to oldest 1) the Inyan Kara, 2) the Minnelusa, 3) the Madison, and 4) the Deadwood (Powertech, 2009c). In the Black Hills area, the last three aquifers are located more than 675 feet below the Inyan Kara aquifer (application Figure 2.2-3) (Powertech, 2009c). NRC staff finds that major regional resource aquifers in the Black Hills area also include the Minnekahta Limestone, which is regionally extensive and more than 525 feet beneath the Inyan Kara aquifer (Daniel G. Driscoll, J. M. C., Joyce E. Williamson, and Larry D. Putnam, 2002). However, the applicant refers to the Minnekahta as a minor aquifer. Staff notes this discrepancy; however, no safety issue is associated with this finding. Therefore, no action is required on the part of the applicant.

The applicant provided lists of wells within 2 km (1.2 mi) of the proposed Dewey-Burdock site. Exhibit 3.1-1 shows these well locations (Powertech, 2011a). Wells listed on application Table P&R-10-1 are categorized as follows: 19 domestic wells, 41 stock wells, and 47 monitoring wells. The distribution of these wells is presented in Table 2.4-3 (Powertech, 2011a).

Table 2.4-3: Summary of Well Types

Aquifer	Stock	Domestic	Monitor	Fuson[2]	Total
Chilson	13	9	20		42
Fall River	10	7	14	1	32
Inyan Kara[1]	1	2			3
Sundance			1		1
Unkpapa	2	1	2		5
Alluvial			7		7
Unknown	15		2		17
Total	41	19	46	1	107

Source: Table P&R-10-1, (Powertech, 2011a)
[1] Inyan Kara means that well is screened in both Fall River and Chilson Aquifers
[2] Assumes that this is a monitoring well in the Fuson Shale

The applicant also provided lists of wells that could not be found and wells that were abandoned. This information is presented in application Tables TR RAI P&R 10-2 and 10-3, respectively (Powertech, 2011a). According to application Exhibit 3.1-1 (Powertech, 2011a), the following wells are located within 0.25 mile of the proposed wellfields at the Dewey-Burdock Project (see Table 2.4-4):

Table 2.4-4: Wells Located within0.25 mile of Wellfields

Area	Well No.	Aquifer	Well Purpose
Dewey	38	Fall River	Stock
	49	Fall River	Stock
	681	Fall River	Monitor
	683	Fall River	Monitor
	685	Fall River	Monitor
	687	Fall River	Monitor
	689	Chilson	Monitor
	691	Fall River	Monitor
	693	Unkpapa	Monitor
Burdock	15	Chilson	Stock
	16	Chilson	Domestic
	17	Fall River	Stock
	61	Chilson	Stock
	618	Unknown	Stock
	637	Unknown	Monitor
	638	Fall River	Monitor
	662	Unknown	Monitor
	668	Inyan Kara	Stock
	676	Alluvial	Monitor
	680	Chilson	Monitor
	684	Chilson	Monitor
	686	Chilson	Monitor
	688	Fall River	Monitor
	690	Unkpapa	Monitor
	692	Chilson	Monitor
	703	Unkpapa	Domestic
	708	Alluvial	Monitor

Source: (Powertech, 2011a)

The applicant commits to removing all domestic wells within the Dewey-Burdock Project including wells 16 and 703 (both within proposed wellfields) and wells 13, 40, 42, 43, 704, and 4002 (all outside of proposed wellfields). The applicant also commits to removing all stock wells located within 0.4 km (0.25 mi) of a wellfield including wells 17, 38, 49, 61, 618, and 668, all of which are located in proposed wellfields.

Other than the wells in the Unkpapa Aquifer, no wells are known to be screened in aquifers below the Inyan Kara aquifers. However, the applicant states that the town of Edgemont, South Dakota, utilizes water supply wells that tap the Madison Aquifer.

The applicant has committed to locating unknown boreholes or wells (See Table P&R 10-2). The applicant has also committed to plugging and abandoning historical wells and exploration holes, any holes it has drilled, and any wells that fail mechanical integrity tests (see SER

Section 3.0) (Powertech, 2011a). Plugging and abandonment procedures will be those specified by the State of South Dakota. As stated in SER Section 2.3, the applicant has determined that little evidence of leakage from old boreholes and wells exists except for the alkali lake that occurs in the southern portion of the Burdock area. Considering the absence of a surface signature and that artesian conditions exist at the site, the applicant determined than any unplugged borings have self-sealed by swelling, collapsing, or caving. During operations, pumping tests will be used to determine if leakage is occurring through unplugged or improperly plugged borings (Powertech, 2011a).

2.4.3.6 Groundwater Model

The applicant prepared a groundwater model to study the current hydrogeologic conditions at the Dewey-Burdock Project and to assess the effects of proposed operations on the groundwater flow regime at and around the site (Powertech, 2012a). To study hydrogeologic conditions, the applicant constructed a 4-layer numerical model using industry standard software and modeling/calibration techniques. The 4 layers in the model represent the Graneros Shale, Fall River Aquifer, Fuson Shale, and Chilson Aquifer, in this particular order. Geologic properties were obtained from borings, and hydraulic properties were obtained from pumping tests and laboratory core tests, as described in SER Section 2.3 and the preceding portions of SER Section 2.4 (Powertech, 2012a).

The base model domain encompasses 933 km^2 (360 mi^2) with domain dimensions of 49 km^2 (18.9 mi^2) on each side (Powertech, 2012a). The actual Dewey-Burdock Project is located in the northeast portion of the model domain. Boundary conditions were developed based on actual site conditions, with no-flow boundaries (model boundaries that transmit no groundwater or very little groundwater) being used to represent the Dewey Fault and the unsaturated outcrop areas of the Fall River and Chilson Aquifers along the eastern flank of the model domain. General head boundaries were used along the western and southern boundaries to represent groundwater flowing out of the model under existing natural groundwater gradients. Boundary segments in the northeast portion of the domain were also modeled as general head boundaries to account for recharge or groundwater flow originating from areas upgradient of the model domain (Powertech, 2012a).

The applicant first calibrated the model using a steady-state calibration accomplished by adjusting hydraulic conductivity, recharge, and hydraulic heads at the general head boundaries to synchronize actually well head measurements with modeled heads (Powertech, 2012a). A transient calibration was performed by simulating the two 2008 pumping tests and adjusting storativity values and hydraulic conductivity. The applicant completed its model development with a verification exercise and sensitivity analysis (Powertech, 2012a).

The staff reviewed model development and calibration and determined that the model was appropriately developed and sufficiently calibrated. Therefore, it is sufficient for use as a predictive tool. One significant conclusion resulting from the calibration is that the Fuson is not leaky through the rock matrix itself. The applicant drew this conclusion because it could not duplicate observed drawdown in the Fall River Aquifer as the Chilson Aquifer was pumped. Consequently, the applicant concludes that any leakage through the Fuson is caused by improperly completed wells or improperly abandoned boreholes. The staff will therefore include a license condition requiring that all boreholes and wells within 1000 feet of a wellfield be located, if possible, and properly plugged and abandoned. This license condition is presented in SER Section 2.4.4. SER Section 3.0 discusses the applicant's modeling efforts as they relate to operational aspects of the proposed Dewey-Burdock Project.

2.4.4 EVALUATION FINDINGS

The staff completed its review of the hydrologic site characterization information for the proposed Dewey-Burdock Project. The review included an evaluation using the review procedures in standard review plan Section 2.7.2 and the acceptance criteria outlined in standard review plan Section 2.7.3.

The applicant has acceptably described the surface water hydrology by providing the following:

- Locations of drainages in and around the license area.
- Peak flood estimates for appropriate recurrence intervals for all drainages.
- Flood potential analysis for the facilities.
- Descriptions of techniques to protect structures and equipment from flooding.

Based on a detailed review of the surface water hydrology at the Dewey-Burdock Project, the staff concludes that the information provided by the applicant is acceptable.

The applicant has acceptably described the groundwater hydrology by providing the following:

- A description of the regional hydrogeology.
- A description of the site-specific hydrogeology.
- A description of the overlying aquifer, extraction zone, and underlying aquifer hydrogeology using potentiometric surfaces maps with acceptable contour intervals based on an appropriate number of monitoring wells.
- Site-specific groundwater modeling to represent current hydrogeologic conditions at the site, and to assess the effects of breccia pipes and unplugged boreholes on the site-specific hydrogeology.
- Site-specific groundwater modeling to assess the effects of operations on well drawdown within and outside the Dewey-Burdock Project.

Based on a detailed review of the groundwater hydrology at the Dewey-Burdock Project, the staff concludes that the information provided by the applicant is acceptable, except for the following items, which will be addressed through the following license conditions.

To address uncertainties in the confining properties of the Fuson Shale in the Burdock area, the staff proposes the following license condition:

> At least 60 days prior to construction, the licensee will propose in writing, for NRC review and written verification, a monitoring well network for the Fall River Aquifer in the Burdock area for those wellfields in which the Chilson Aquifer is the extraction zone.

To address the uncertainty of the unsaturated conditions in the eastern portion of the Burdock area, the staff proposes the following license condition:

> The licensee will submit, for NRC review and approval, hydrologic packages for wellfields B-WF-6, -7, and -8. No extraction will be permitted in the aforementioned wellfields until the staff approves the hydrologic package. Hydrologic packages must include, at a minimum, pumping test results that address the partially unsaturated conditions of the Chilson Aquifer in these wellfields, as well as justification for well spacings in the monitoring well ring and overlying aquifer.

In addition, the applicant has made the following substantive commitments regarding groundwater protection:

- The applicant commits to removing all domestic wells within the Dewey-Burdock Project, including wells 16 and 703 (both within proposed wellfields) and wells 13, 40, 42, 43, 704, and 4002 (all outside of proposed wellfields). The applicant also commits to removing all stock wells located within 0.4 km (0.25 mi) of a wellfield, including wells 17, 38, 49, 61, 618, and 668, all of which are located in proposed wellfields.
- The applicant has committed to locating unknown boreholes or wells, and it has committed to plugging and abandoning historical wells and exploration holes, holes drilled by the applicant, and any wells that fail mechanical integrity tests.

Based upon the review conducted by the staff, and based on information provided by the applicant, the staff determines that the applicant’s description of surface water hydrology and hydrogeology is consistent with Section 2.7.3 of the standard review plan and complies with 10 CFR 40.31(c). This determination is predicated upon fulfillment of the aforementioned license conditions.

2.5 BACKGROUND SURFACE WATER AND GROUNDWATER QUALITY

2.5.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the characterization of surface and groundwater quality at the Dewey-Burdock Project has been performed to meet the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.5.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, Appendix A, Criterion 7, using the review procedures in Sections 2.7.2 and 2.9.2 and acceptance criteria in Sections 2.7.3 and 2.9.3 of the standard review plan (NRC, 2003b).

2.5.3 STAFF REVIEW AND ANALYSIS

2.5.3.1 Surface Water

According to Regulatory Guide 4.14, samples of surface water should be collected quarterly from each onsite water impoundment (such as a pond or lake) and any offsite water impoundment that may be subject to seepage from tailings, drainage from potentially contaminated areas, or drainage from a tailings impoundment failure (NRC, 1980). Samples should be collected at least monthly from streams, rivers, any other surface waters or drainage systems crossing the site boundary, and any offsite surface waters that may be subject to drainage from potentially contaminated areas or from a tailings impoundment failure. Any stream beds that are dry part of the year should be sampled when water is flowing. Samples should be collected at the site boundary or at a location immediately downstream of the area of potential influence. (NRC, 1980)

The applicant established 8 stream water quality sampling locations and 11 surface impoundment water quality sampling locations (SER Table 2.5-1)(Powertech, 2009c, 2011a). Most of the surface impoundment water quality sampling locations are located in the eastern portion of the proposed licensed area. Stream water sampling locations include upstream and downstream location in the Cheyenne River, Beaver Creek and Pass Creek, and selected locations in Bennett Canyon and an unnamed tributary. The surface impoundments not included in the water quality sampling program include mostly stock ponds (three of which are reported as under the influence of groundwater) and one mine pit. (Powertech, 2009c, 2011a).

The applicant reported that passive samplers were used to collect “ephemeral-flow events” in the Pass Creek, Bennett Canyon and the unnamed tributary sampling locations (Powertech, 2009c). Cheyenne River, Beaver Creek and Pass Creek sampling locations were visited monthly and sampled when water was present or not frozen. The parameters included in the applicant’s program are summarized in Table 2.5-2 (Powertech, 2009c).

Table 2.5-1 Preoperational Surface Water Quality Sampling Locations

Site ID	Coordinates (FT)		Use
	Easting	Northing	
Subimpoundments			
Sub01	998654	446816	stock pond
Sub02	1001071	443526	Triangle Mine Pit
Sub03	1005005	438448	mine dam
Sub04	1002542	437518	stock pond
Sub05	1004591	437191	mine dam
Sub06	1006665	437019	Darrow Mine pit
Sub07	1009312	434360	stock dam
Sub08	1004195	427057	stock pond
Sub09	1004640	427089	stock pond
Sub10	1005961	421367	stock pond
Sub11	1009659	432225	stock pond
Stream Sampling Locations			

Site ID	Coordinates (FT)		Use
	Easting	Northing	
BVC01	989871	428716	Beaver Creek downstream
BVC04	965366	460922	Beaver Creek upstream
CHR01	985098	423010	Cheyenne River upstream
CHR05	1015626	405925	Cheyenne River downstream
PSC01	996764	436205	Pass Creek downstream
PSC02	1002722	452563	Pass Creek upstream
BEN01	1015872	416196	Bennett Canyon
UNT01	1007565	422482	Unnamed Tributary

Source: (Powertech, 2009c)
Note: Coordinates are in South Dakota State Plane System

Table 2.5-2: Preoperational Surface Water Monitoring Parameters

Biological	**Dissolved Metals**	**Radionuclides (cont'd)**
Bacteria, Fecal Coliform	Aluminum	Gross Alpha – Total
	Arsenic	Gross Beta – Total
Major Anions	Barium	Gross Gamma - Total
Bicarbonate	Boron	
Carbonate	Cadmium	**Total Metals**
Sulfate	Chromium	Aluminum
Chloride	Copper	Arsenic
Fluoride	Iron	Barium
Nitrate as N	Lead	Boron
	Manganese	Cadmium
Major Cations	Mercury	Calcium
Ammonia as N	Molybdenum	Chromium
Sodium – Dissolved	Nickel	Chromium-III
Calcium – Dissolved	Selenium	Chromium-VI
Magnesium – Dissolved	Selenium-IV	Copper
Potassium – Dissolved	Selenium-VI	Iron
Silica – Dissolved	Silver	Lead
	Thorium-232	Magnesium
General Water Quality	Uranium	Manganese
Alkalinity – Total as $CaCO_3$	Vanadium	Mercury
Anion/Cation Balance	Zinc	Molybdenum
Conductivity		Nickel
pH	**Suspended Metals**	Potassium
Sodium Adsorption Ratio	Thorium 232	Selenium
Total Dissolved Solids (TDS)	Uranium	Selenium-IV
TDS Calculated		Selenium-VI
TDS Balance	**Radionuclides**	Silica
Solids - Suspended Sediment	Lead 210 – Dissolved	Silver
Total Suspended Solids (TSS)	Lead 210 – Suspended	Sodium
	Lead 210 – Total	Thorium-232
	Polonium 210 – Dissolved	Uranium
	Polonium 210 – Suspended	Vanadium
	Polonium 210 – Total	Zinc

	Radium 226 – Dissolved	
	Radium 226 – Suspended	
	Radium 226 – Total	
	Thorium 230 – Dissolved	
	Thorium 230 – Suspended	
	Thorium 230 – Total	

Source: (Powertech, 2009c)

A review of the analytical data indicates that the applicant collected surface samples at the frequencies recommended in Regulatory Guide 4.14 (see application Appendix 2.9-I) (Powertech, 2011a). A review of the analytical results indicates that certain surface water features were sampled less than 4 times. These features are Sub01 (stock pond), Sub03 (mine dam), Sub04 (stock pond), Sub05 (stock pond), Sub09 (stock pond), Sub10 (stock pond), Sub24 (stock pond), PSC01 (Pass Creek downstream), PSC02 (Pass Creek upstream), UNT01 (unnamed tributary). Because taking two samples from a location is generally insufficient for any statistical analysis or trend determination, the applicant will be required to collect additional samples at the aforementioned locations until four quarters of data are collected. This requirement is memorialized in a license condition discussed in SER Section 2.5.4.

The staff observes the following regarding constituent concentration, as presented in SER Table 2.5-3.

Table 2.5-3: Surface Water Constituent Observations

Sample No.	Location	Observations
Sub01	Stock Pond	U and Ra-226 concentrations below MCLs Gross alpha mean below MCLs, 1 sample above Toxic metals either ND or below MCLs
Sub02	Triangle Mine Pit	Impacted by mining operations Elevated TDS and conductivity Elevated uranium and gross alpha and beta Elevated calcium and magnesium Elevated sulfate
Sub03	Mine Dam	Elevated conductivity Slightly elevated TDS and calcium Elevated manganese Elevated Ra-226 and gross alpha, beta, and gamma pH is acidic
Sub04	Stock Pond	Elevated conductivity, sulfate, and calcium pH is acidic Elevated TDS, manganese Slightly elevated Ra-226
Sub06	Darrow Mine Pit	Impacted by mining operations Elevated conductivity, calcium, chloride Elevated sulfate and TDS Manganese, uranium, TDS, aluminum exceed MCLs or secondary MCLs

Sample No.	Location	Observations
		Elevated Zinc and gross alpha, beta, gamma pH is acidic
Sub07	Stock Dam	Elevated conductivity, calcium, sulfate, TDS pH is acidic Manganese exceeds MCL
Sub08	Stock Pond	Elevated conductivity, sulfate, TDS
Sub09	Stock Pond	U and Ra-226 concentrations below MCLs Gross alpha mean below MCLs, 1 sample above Toxic metals either ND or below MCLs
Sub10	Stock Pond	Elevated conductivity, sulfate, calcium Elevated sodium
Sub11	Stock Pond	Elevated thorium-230 and gross gamma (possibly caused by outlier)
Sub24	Stock Pond	Elevated conductivity, TDS Elevated sulfate, sodium, and calcium
BVC01	Beaver Creek – downstream	Elevated conductivity, sulfate, TDS Elevated, calcium, sodium, gross gamma Slightly elevated thorium-230
BVC04	Beaver Creek – upstream	Elevated conductivity, TDS, sulfate Elevated calcium, sodium, chloride Elevated lead-210, gross gamma
CHR01	Cheyenne River – upstream	Elevated conductivity, TDS, sulfate Elevated calcium, sodium, chloride Slightly elevated thorium-230, gross gamma, uranium
CHR02	Cheyenne River – downstream	Elevated conductivity, TDS, sulfate Elevated calcium, sodium, chloride Elevated lead-210, slightly elevated gross gamma
PSC01	Pass Creek – downstream	Elevated fecal coliform Elevated conductivity, TDS, sulfate
PSC02	Pass Creek – upstream	Elevated fecal coliform Elevated conductivity, TDS, sulfate
BEN01	Bennett Canyon	Dry – Automated sampler used, but no samples collected
UNT01	Unnamed Tributary	Slightly elevated gross gamma

Source: (Powertech, 2011a)

Proposed Changes to Baseline Surface Water Monitoring Program

The applicant states that it intends to modify its operational surface water monitoring program by relocating certain surface water sampling points and adding other sampling points. As such, the applicant commits to collecting 12 months of preoperational data at all new surface water sampling points to establish background constituent concentrations. The following is a list of the proposed changes:

- Both upstream and downstream surface water sampling locations in Beaver and Pass creeks will be relocated to the property boundaries.
- Total number of impoundments has been increased from 11 to 24.
- Total number of stream samples increased from 8 to 10.

The operational surface water monitoring network is discussed in greater detail in SER Section 5.7.9.

The applicant provided a sufficient number of data points to adequately characterize background surface water quality at the Dewey-Burdock Project. Although some ephemeral channels were not sampled for 4 quarters, the applicant sampled a sufficient number of streams and impoundments for the appropriate time periods to provide an adequate picture of surface water conditions within the Dewey-Burdock Project. The combination of existing data and commitments for additional data provides the staff a sufficient basis for determining that the applicant's description of background surface water quality is acceptable and consistent with Sections 2.7.3 and 2.9.3 of the standard review plan (NRC, 2003b). The staff therefore finds that the information provided by the applicant complies with 10 CFR 40, Appendix A, Criterion 7.

2.5.3.2 Groundwater

According to Regulatory Guide 4.14, groundwater samples should also be collected quarterly from each well within two kilometers of the proposed tailings area that is or could be used for drinking water, watering of livestock, or crop irrigation (NRC, 1980). The applicant reported that three preoperational groundwater quality sampling programs were conducted for the proposed project. The programs included:

- Sampling of 19 groundwater wells on a quarterly basis.
- Sampling another set of 12 wells monthly per South Dakota DENR requirements.
- Sampling another set of 9 wells once prior to the May 2008 pumping test.

SER Table 2.5-4 presents the monitoring network for these groundwater sampling programs. Sampling locations are presented in application Figures 2.7-9 to 2.7-10 (Powertech, 2009c). SER Table 2.5-5 presents the preoperational groundwater monitoring parameters.

Table 2.5-4: Preoperational Groundwater Quality Sampling Locations

Well ID	Aquifer	Description	Sampling Period
2	Lakota	Peterson domestic and stock	Quarterly
7	Fall River	Kennobie domestic	Quarterly
8	Fall River	Englebert domestic	Quarterly
13	Lakota	C. Spencer domestic	Quarterly
16	Lakota	Daniel domestic	Quarterly
18	Fall River	D. Anderson domestic	Quarterly
42	Lakota	L. Putnam domestic	Quarterly
619	Lakota	Daniel West – weather station stock	Quarterly
628	Inyan Kara	Abandoned windmill stock	Quarterly

Well ID	Aquifer	Description	Sampling Period
631	Fall River	Putnam big pump stock	Quarterly
635	Sundance	Sundance pond stock	Quarterly
650	Lakota	Daniel east stock	Quarterly
675	Alluvium	Marietta alluvial	Quarterly
676	Alluvium	Pass Creek Spencer alluvial	Quarterly
677	Alluvium	Putnam alluvial	Quarterly
678	Alluvium	Pass Creek alluvial	Quarterly
679	Alluvium	Pass Creek Doran alluvial	Quarterly
4002	Inyan Kara	Swimming Pool stock	Quarterly
7002	Lakota	Kennobie stock	Quarterly
615	Lakota	TVA No. 2	Monthly
622	Fall River	TVA No. 8	Monthly
680	Lakota	Burdock pump test	Monthly
681	Fall River	Dewey pump test	Monthly
688	Fall River	Burdock pump test west piezo	Monthly
689	Lakota	Dewey pump test north piezo	Monthly
694	Fall River	School House NW	Monthly
695	Fall River	Putnam east	Monthly
696	Lakota	School House SE	Monthly
697	Lakota	Putnam west	Monthly
698	Fall River	weather station	Monthly
3026	Lakota	Daniel new stock	Monthly

Source: (Powertech, 2009c)

Table 2.5-5: Preoperational Groundwater Monitoring Parameters

Major Ions	**Dissolved Metals (cont'd.)**	**Total Metals**
Alkalinity	Lead	Aluminum
Bicarbonate	Manganese	Arsenic
Carbonate	Mercury	Barium
Sulfate	Molybdenum	Boron
Chloride	Nickel	Cadmium
Fluoride	Selenium	Calcium
Nitrate as N	Silver	Chromium
Ammonia as N	Thorium-232	Chromium-III
Nitrite as N	Uranium	Chromium-VI
Sodium – Dissolved	Vanadium	Copper
Calcium – Dissolved	Zinc	Iron
Magnesium – Dissolved		Lead
Potassium – Dissolved	**Suspended Metals**	Magnesium
Silica – Dissolved	Uranium	Manganese
		Mercury
	Dissolved Metals Speciated	Molybdenum
Physical Properties	Selenium-IV	Nickel
Conductivity	Selenium-VI	Potassium
pH		Selenium

Sodium Adsorption Ratio	**Radionuclides**	Selenium-IV
Total Dissolved Solids (TDS)	Lead 210 – Dissolved	Selenium-VI
TDS Calculated	Lead 210 – Suspended	Silica
TDS Balance	Lead 210 – Total	Silver
Oxidation Reduction Potential	Polonium 210 – Dissolved	Sodium
	Polonium 210 – Suspended	Thorium-232
Dissolved Metals	Polonium 210 – Total	Uranium
Aluminum	Radium 226 – Dissolved	Vanadium
Arsenic	Radium 226 – Suspended	Zinc
Barium	Radium 226 – Total	
Boron	Thorium 230 – Dissolved	
Cadmium	Thorium 230 – Suspended	
Chromium	Thorium 230 - Total	
Copper	Radon-222	
Iron	Gross Alpha – Total	
	Gross Beta – Total	
	Gross Gamma - Total	

Source: (Powertech, 2009c)

NRC staff requires by license condition that the applicant sample all wells within 2 km (1.25 mi) of each wellfield. This approach meets the requirements of 10 CFR Part 40, Appendix A, Criterion 7 and is consistent with NRC Regulatory Guide 4.14 (NRC, 1980).. NRC Regulatory Guide 4.14 recommends that ground water samples “be collected quarterly from each well within two kilometers of the tailings area that is or could be used for drinking water, water for livestock, or crop irrigation.” The staff developed this guidance because conventional mill “tailings areas” have the potential to be a source of contamination to ground water.

The use of the two kilometer guideline was validated in NUREG/CR-6705, “Historical Case Analysis of Uranium Plume Attenuation.” (NRC, 2001) This report examined radiological plume dispersion from mill tailings disposal areas at Uranium Mill Tailings Remedial Action (UMTRA) sites in the United States. The report concluded the average radiological plume dispersion at UMTRA sites is less than 2 km for the 10–20 ppb uranium plume contour, which includes upgradient and downgradient dispersion. For this reason and other considerations discussed in the next paragraph, the NRC found that the 2 km radius provides adequate protection of water in wells for domestic uses, watering livestock, and crop irrigation. Moreover, NUREG/CR-6705 demonstrated that the dispersion of non-radiological contaminants mimics that of the radiological contaminants with a shorter dispersion range that occurs due to the production of relatively insoluble compounds.

The two kilometer guideline applied to licensed ISR facilities assumes each wellfield is a “temporary source area” of ground water contamination during production and restoration phases at an ISR facility. The temporary nature of groundwater disturbances at an ISR wellfield does not represent the same threat to groundwater as the continuing source of contamination at a mill tailings disposal area. Specifically, during the extraction and restoration phases at an ISR wellfield, the wellfield makes use of a bleed to create an inward gradient that prevents the movement of contamination outside the wellfield. Excursion monitoring wells surround, overlie and underlie the wellfield, in order to detect any movement of contamination and ensure corrective action is taken. The radius of 2 km (1.2 miles) from each proposed ISR wellfield has been shown to be sufficient based on historical and current monitoring data from NRC licensed sites. There are no reported instances of contamination of any monitored private wells within or beyond 2 km of an ISR wellfield at any sites historically or currently licensed by the NRC (NRC, 2009). Therefore, the staff includes license condition requiring the applicant to collect quarterly samples for all wells within 2 km (1.25 mi) of each wellfield boundary. This license condition is discussed in SER Section 2.5.4.

The applicant provided data on an individual well basis, but also summarized water quality data for each aquifer. SER Table 2.5-6 below summarizes the analytical results for the primary aquifers that are involved in this project.

Table 2.5-6: Summary of Aquifer Water Quality

Aquifer	Position	Observations
Alluvial	Surficial	Uranium exceeds drinking water standards Elevated TDS, max TDS close to undrinkable concentration Elevated sodium, sulfate, chloride, bicarbonate Uranium exceeds drinking water standard Radon exceeds proposed 300 pCi/l MCL; below proposed 4,000 pCi/l alternative MCL* Elevated gross gamma Neutral pH
Fall River	Ore Zone – Dewey Area Overlying Aquifer – Burdock Area	Neutral pH Uranium below MCLs Radon exceed aforementioned proposed MCLs Radium exceeds MCLs Elevated gross alpha, beta, and gamma Sulfate above MCLs Some areas of low dissolved oxygen
Chilson	Ore Zone in Dewey and Burdock areas	Neutral pH Uranium below MCLs Radon exceed aforementioned proposed MCLs Radium exceeds MCLs Elevated gross alpha, beta, and gamma Sulfate above MCLs Low dissolved oxygen.
Unkpapa	Underlying Aquifer	Basic pH Uranium below MCLs Radon below aforementioned proposed MCLs Radium below MCLs Elevated gross gamma Sulfate above MCLs

Source: (Powertech, 2011a)

Some noteworthy results include the radon concentrations detected in wells 42, 680 and 681. The applicant reports that the highest radon concentrations in these wells are 200,000, 359,000, and 462,000 pCi/l, respectively. Wells 680 and 681 are monitoring wells in proposed wellfields, while Well 42 is a domestic supply well south of the Dewey wellfields, but still within the Dewey-Burdock Project license boundary. Furthermore, each of these wells exhibits elevated radium-226 concentrations with mean concentrations of 97.2, 1,289, and 380 pCi/l, respectively.

Based on its review of the information discussed above, the staff is reasonably assured that the applicant will collect all the necessary groundwater data. This reasonable assurance determination is based on the fact that the applicant sampled the appropriate number of wells within the site boundary, as supplemented by the information required by the offsite well sampling license condition presented in SER Section 2.6.4. The information presented in the application, as supplemented by the additional required information, is consistent with Sections 2.7.3 and 2.9.3 of the standard review plan (NRC, 2003b) and with 10 CFR 40, Appendix A, Criterion 7.

2.5.4 Evaluation Findings

The NRC has completed its review of the preoperational surface water and groundwater quality environmental monitoring at the Dewey-Burdock ISR project. This review included an evaluation using review procedures in standard review plan Sections 2.7.2 and 2.9.2 and the acceptance criteria in standard review plan Sections 2.7.3 and 2.9.3. The applicant included descriptions of the sampling programs and parameters analyzed, as well as summaries of the data results. Based on the number of samples collected and parameters analyzed, the applicant has acquired sufficient preoperational background surface water and groundwater quality data to satisfy Criterion 7 of Appendix A in 10 CFR Part 40. The information presented by the applicant is also consistent with guidance in NUREG-1569.

At the same time, the applicant proposes to expand its operational surface water monitoring network and modify its preoperational monitoring locations to more closely follow Regulatory Guide 4.14. Preoperational monitoring data is required for each location to enable the applicant to assess baseline concentrations at surface sampling monitoring points. Therefore, the applicant has committed to collecting the necessary preoperational samples prior to ISR operations. Because the applicant has committed to preoperational sampling, the staff includes the following license condition regarding submittal of this data:

> The licensee shall submit preoperational surface water analytical data for the new surface water sampling locations to the NRC for review and written verification within 3 months of the initiation of operations. Surface water analytical data shall be of the same completeness (e.g. parameters, quality of analyses, and frequency) as the data provided in the licensee's June 2011 submittal (ADAMS Accession No. ML112071064).

To ensure the collection of ground water samples within 2 km of each wellfield, the staff adds the following condition to the Dewey-Burdock license:

> Prior to commencement of operations, the licensee will collect four quarterly groundwater samples from each well within 2 km (1.25 mi) of the boundary of any wellfield, as measured from the perimeter monitoring well ring. This data shall be submitted to the NRC staff for review and written verification. Furthermore, all domestic, livestock, and crop irrigation wells within 2 km (1.25 mi) of the boundary of any wellfield,

as measured from the perimeter monitoring well ring, will be included in the routine environmental sampling program provided that well owners consent to sampling, and the condition of the wells renders them suitable for sampling.

Based on the staff's review of the applicant's surface water and groundwater quality information, the staff finds that the applicant's information is consistent with the Sections 2.7.3 and 2.9.3 of the standard review plan and in compliance with 10 CFR 40.31(h). This determination is predicated on the fulfillment of the license conditions presented in this section.

2.6 BACKGROUND RADIOLOGICAL CHARACTERISTICS

2.6.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the background radiological characteristics or the preoperational environmental monitoring program is in compliance with 10 CFR Part 40, Appendix A, Criterion 7.

A preoperational monitoring program must be conducted at least one full year prior to any major site construction, and establishing background concentrations in environmental media is needed to determine operational and post operational compliance with the following regulations:

Criteria 6(6) of Appendix A to 10 CFR Part 40 requires that soil concentrations not exceed background concentrations by more than 5 pCi/g of radium-226, averaged over the first 15 cm below the surface.

Criterion 8 of Appendix A to 10 CFR Part 40 requires control of emissions to reduce population exposures to the maximum extent and avoid site contamination.

2.6.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with the 10 CFR Part 40, Appendix A, Criterion 7, using the acceptance criteria in standard review plan Section 2.9.3 (NRC, 2003b). The baseline radiological characterization is acceptable if:

- The sampling frequency, sampling methods, and sampling location and density are in accordance with preoperational monitoring guidance provided in Section 1.1 of Regulatory Guide 4.14 (NRC, 1980).
- The monitoring program includes air (particulate and radon), vegetation, food, fish, soil, sediment, direct radiation, and radon flux.
- Air monitoring stations are located in a manner consistent with the principal wind directions reviewed in Section 2.5 of NUREG-1569 (NRC, 2003b).
- Soil sampling is conducted at both a 5 cm (2 in) depth, as described in Regulatory Guide 4.14, Section 1.1.4 (NRC, 1980), and 15 cm [6 in] for background decommissioning data.

The staff discusses groundwater and surface water background radiological characteristics in SER Section 2.5 and is, therefore, not discussed here.

2.6.3 STAFF REVIEW AND ANALYSIS

2.6.3.1 Air (Particulate and Radon) Sampling

Regulatory Guide 4.14 (NRC, 1980) recommends preoperational air particulate and radon sampling at three locations at or near the site boundaries, one location at or near the nearest residence, and one control location remote from the site. Factors to consider in determining sampling locations include: (a) average meteorological conditions (wind speed, wind direction, atmospheric stability), (b) prevailing wind direction, (c) site boundaries nearest to mill, (d) direction of nearest occupiable structure, and (e) location of estimated maximum concentrations of radioactive materials.

A summary of the air particulate stations utilized by the applicant for Criterion 7 baseline sampling are presented in Table 2.6-1

Table 2.6-1: Original Air Particulate Monitoring Stations

Station No.	Location	Collection Dates	No. of Days Monitored	Parameters	Frequency
AMS-01	E portion of Burdock area	August 13, 2007 to August13, 2008	366	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites
AMS-02	W boundary of Burdock area	August 13, 2007 to August13, 2008	366	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites
AMS-03	W boundary of Dewey area	August 13, 2007 to August13, 2008	366	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites
AMS-04	1.5 mi NW of Dewey area	August 13, 2007 to August13, 2008	366	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites
AMS-05	1.4 mi S of Burdock area	August 13, 2007 to August13, 2008	366	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites
AMS-06	SW boundary	August 13, 2007 to August13, 2008	366	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites

AMS-07	3 mi S of Burdock area	August 13, 2007 to August13, 2008	366	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites
AMS-BKG	1.7 mi S of Dewey area	August 13, 2007 to August13, 2008	366	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites

Source: (Powertech, 2011a)

Initially, the applicant identified a total of eight air particulate sampling stations and 16 radon monitoring stations (eight at AMS and eight additional locations) in Figure TR RAI 2.9-1-1 of the application (Powertech, 2009c, 2011a). As stated in the application, these stations were used to collect preoperational data and will be used to collect data during operations (Powertech, 2011a). Subsequently, in their supplemental preconstruction and preoperational sampling plan the applicant proposed to collect air particulate samples continuously for one year from two locations at AMS-08 and AMS-09 in additions to the AMS-BKG (Powertech, 2012e) (see SER Table 2.6-2). The applicant states that these new sample results will supplement those collected earlier at AMS-01, AMS-02, AMS-03, and AMS-04.

Table 2.6-2: Proposed Additional Air Particulate Monitoring Stations and Samples

Station No.	Location	Proposed Collection Period	Parameters	Frequency
AMS-08	ESE	One year	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites of weekly filter change
AMS-09	NNW	One year	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites of weekly filter change
AMS-BKG	1.7 mi S of Dewey area	One year	natural uranium, radium-226, thorium-230, lead-210	Quarterly composites of weekly filter change
AMS-01	E portion of Burdock area	August 13 to October 2 and October 2 to January 4	natural uranium	Quarterly composites of weekly filter change
AMS-02	W boundary of Burdock area	August 13 to October 2 and October 2 to January 4	natural uranium	Quarterly composites of weekly filter change
AMS-03	W boundary of Dewey area	August 13 to October 2 and October 2 to January 4	natural uranium	Quarterly composites of weekly filter change
AMS-04	1.5 mi NW of Dewey area	August 13 to October 2 and October 2 to January 4	natural uranium	Quarterly composites of weekly filter change

Source: Application Figure 2.9-13 (Powertech, 2009c) and Application Figure 1 (Powertech, 2012e)

In Attachment B of the supplemental sampling plan, the applicant described criteria used to determine air particulate sampling locations and justifications that the preoperational air particulate sampling locations would be consistent with Regulatory Guide 4.14 and NUREG-1569 (Powertech, 2011a, Powertech, October 19, 2012). The applicant states that it used MILDOS–AREA to estimate radon and long-lived radionuclide concentrations (natural uranium, thorium-230, radium-226, and lead-210) in air at site boundary receptors in 16 directions around the Dewey satellite facility. T heses MILDOS-AREA results are summarized in Table 1 of the supplemental sampling plan (Powertech, 2012e). The applicant states that analyses will be performed to meet lower limits of detection (LLDs) and analytical reporting formats specified in RG 4.14. The applicant committed to provide the results to NRC at least 30 days prior to commencement of construction (Powertech, 2012e). However, the

NRC staff noted that these air monitoring locations are conditional to the final wind data. The applicant will also be required to perform new MILDOS–AREA modeling if needed, using updated meteorological data.

The air particulate sampling results are shown in SER Table 2.6-3.

Table 2.6-3: Air Particulate Results

Radionuclide	Concentrations (µCi/ml)		
	Low	High	Average
Natural Uranium	-3.00E-17	1.5E-14	1.4E-15
Thorium-230	-1.5E-18	5.60E-17	1.20E-17
Radium-226	-4.90E-17	5.30E-17	1.60E-18
Lead-210	6.0E-15	4.10E-14	1.5E-14

Radon monitoring data were collected quarterly from eight AMS and eight additional locations shown on Figures TR-RAI 2.9-1-1 (Powertech, 2011a). Radon samples were analyzed for Rn-222, and the results of the radon in air sampling are shown in application Table 2.9-11 (Powertech, 2009d). Results show that the radon concentrations measured at the 16 radon sampling locations ranged from 0.04 pCi/L to 0.4 pCi/L. Additionally, the applicant proposed to collect Radon-222 samples continuously during air particulate sampling at AMS-BKG, AMS-08 and AMS-09 using passive track etch film detectors which will be exchanged quarterly (Powertech, October 19, 2012).

Based on its review of the information as discussed above, the staff is reasonably assured that the applicant will collect all the necessary air particulate data consistent with the specifications in Regulatory Guide 4.14. This reasonable assurance determination is based on the air particulate data presented in the application, as supplemented by the information to be provided by the applicant as committed in the supplemental sampling plan (Powertech, 2012e). As previously stated, this data includes addition radon and air particulate analyses. Information presented herein, as supplement the by additional information, is consistent with Section 2.9.3 of the standard review plan and complies with 10 CFR 40, Appendix A, Criterion 7.

2.6.3.2 Radon Flux Monitoring

In application Section TR RAI 5.2-4 the applicant states that there will be no tailings piles within the Dewey-Burdock project area since no tailings are generated at ISR facilities and no on-site disposal is permitted at such facilities per 10 CFR Part 40, Appendix A, Criterion 2 (Powertech, 2011a). However, the applicant measured radon flux rates at nine locations coinciding with the nine soil samples collected from 0 to 100 cm (0 to 3.3 ft) below ground surface on three occasions in the Dewey- Burdock roll front areas. The locations are shown on Figure 2.9-8 (Powertech, 2009d). Flux measurements were conducted in September 2007, April 2008, and July 2008 and results are provided in application Table 2.9-14 (Powertech, 2009d). Results shows flux rates of 1.22, 0.74, and 1.5 picocuries per meter squared second (pCi/m^2-s) respectively for each of the time periods. Flux rates ranged between 0.68 and 1.77 pCi/m2-s in fall 2007, 0.28 and 1.33 pCi/m^2-s in spring 2008 and 0.48 and 2.38 pCi/m^2-s in summer 2008. Based on the information provided in the application, the radon flux monitoring is consistent with the guidance in Regulatory Guide 4.14 for the preoperational period. This data also complies with 10 CFR 40, Appendix A, Criterion 7. Therefore, the staff finds the discussion of radon flux measurement is acceptable.

2.6.3.3 Vegetation, Food, and Fish Sampling

Regulatory Guide 4.14 recommends collecting the following: (a) vegetation samples from three locations near the site in three different sectors having the highest predicted airborne radionuclide concentration due to milling operations; (b) three food sample locations that include crops, livestock, etc., within 3 km (2 mi) of the site; and (c) samples of fish in each body of water (NRC, 1980). SER Table 2.6-4 summarizes the applicant's vegetation and food sampling program, and SER Table 2.6-5 summarizes additional vegetation sampling committed to by the applicant.

Table 2.6-4: Vegetation, Food Sampling Summary

Station No.	Location	Type of Food Sample	Parameters
AMS-01	E portion of Burdock area	vegetation – grass	natural uranium, radium-226, thorium-230, lead-210
AMS-02	W boundary of Burdock area	vegetation – grass	natural uranium, radium-226, thorium-230, lead-210
AMS-03	W boundary of Dewey area	vegetation – grass	natural uranium, radium-226, thorium-230, lead-210
AMS-04	1.5 mi NW of Dewey area	vegetation – grass	natural uranium, radium-226, thorium-230, lead-210
AMS-05	1.4 mi S of Burdock area	vegetation – grass	natural uranium, radium-226, thorium-230, lead-210
AMS-06	SW boundary	vegetation – grass	natural uranium, radium-226, thorium-230, lead-210
AMS-07	3 mi S of Burdock area	vegetation – grass	natural uranium, radium-226, thorium-230, lead-210
AMS-BKG	1.7 mi S of Dewey area	vegetation – grass	natural uranium, radium-226, thorium-230, lead-210
DBAT-01(June, 2008)	N/A	cow meat	natural uranium, radium-226, thorium-230, lead-210, polonium-210
DBAT-02(June, 2008)	N/A	cow meat	natural uranium, radium-226, thorium-230, lead-210, polonium-210
DBAT-03 (June, 2008)	N/A	cow liver	natural uranium, radium-226, thorium-230, lead-210, polonium-210

Pork (April 2011)	N/A	Free ranging, locally grazed pig	natural uranium, radium-226, thorium-230, lead-210
Beef (April 2011)	N/A	Additional cow meat	natural uranium, radium-226, thorium-230, lead-210

Source: Application Figure 2.9-18 (Powertech, 2009c) and Table 2.9-19 (Powertech, 2011a)

Table 2.6-5: Proposed Additional Vegetation, Food Sampling

Station No.	Location	Type of Food Sample	Parameters
Beef	N/A	Additional cow meat (Prior to ISR operations)	natural uranium, radium-226, thorium-230, lead-210
Pork	N/A	Two additional pigs (Prior to ISR operations)	natural uranium, radium-226, thorium-230, lead-210

Source: Application Table 2.9-19 (Powertech, 2011a)

The applicant states that grasses were the only type of forage vegetation sampled during background radiological characterization (Powertech, 2011a). As recommended by Regulatory Guide 4.14, vegetation samples were collected from representative grazing areas in sectors near the air monitoring stations. Three sets of vegetation samples were collected in August 2007, April 2008, and July 2008 at each AMS at the locations shown on application Figure 2.9-8 and were analyzed for lead-210, polonium-210, radium-226, thorium-230, and natural uranium. Vegetation sampling results are reported in application Table 2.9-18 (Powertech, 2009c).

SER Table 2.6-6 presents a summary of the vegetation sampling results.

Table 2.6-6: Vegetation Sampling Results

Radionuclide	Minimum (pCi/g)	Maximum (pCi/kg)
Radium-226	0.02	0.09
Natural uranium	0.01	0.04
Thorium-230	0.01	0.03
Lead-210	0.6	1.7
Polonium-210	0.08	0.23

Source: (Powertech, 2009c)

In application Section TR RAI 2.9-12 the applicant states that vegetable gardens are present in the town of Dewey and at one location within the project area as shown on application Figure

TR RAI 2.9- 11-1 (Powertech, 2011a). Due to the large sample size (> 10 lbs) typically required to satisfy Regulatory Guide 4.14 suggested LLDs for vegetation and the relatively small size of the vegetable gardens, the applicant proposed to sample vegetable garden soil rather than the vegetables themselves and then apply plant-to-soil concentration factors to estimate the radionuclide concentrations in vegetables. To estimate radionuclide concentration in root and leafy vegetables and fruits based on soil radionuclide concentrations, the applicant proposed to use methods and parameters contained in NUREG/CR-5512 (NRC, 1992a). The NRC staff finds this method acceptable.

The vegetation sampling and analysis program is consistent with the guidance in Regulatory Guide 4.14 for the preoperational period and the staff finds it acceptable.

SER Table 2.6-4 summarizes the food samples analyzed by the applicant, which include three tissue samples, one liver and two meat samples from a locally grazing cow. Since then, the applicant has analyzed samples from another cow and committed to sample an additional cow prior to ISR operations, bringing the total number of samples to three (Powertech, 2011a). The applicant states that samples from one free ranging, locally grazing pig have been analyzed and committed to sampling two additional pigs prior to ISR operations. The results of the baseline radionuclide concentrations in local food are listed in application Table 2.9-19. The staff finds that the applicant's baseline livestock sampling is acceptable and is consistent with acceptance criterion (1) in standard review plan Section 2.9.

The applicant states that chickens are present within 3 km of the project area. But, the applicant does not propose to sample them as they are fed grains not originating from the project area and are not considered grazing animals (Powertech, 2011a). NRC staff concludes that the justification provided by the applicant for not collecting chicken samples is acceptable.

SER Table 2.6-7 summarizes the applicant's fish sampling program. Fish samples were collected from Beaver Creek and the Cheyenne River (Powertech, 2011a). No samples were collected from impoundments because, based on conversations with area landowners and the South Dakota Department of Game, Fish and Parks (SDGF&P), no fish are present in any impoundments within the project area or outside of the license boundary but immediately downstream from proposed activities (Powertech, 2011a). Lab results of fish samples analysis are included in Appendix 2.8-H, and are summarized in Table 2.8-30 of the application (Powertech, 2009d).

Table 2.6-7: Baseline Radiological Whole Fish Samples

Site	Species	No. of Fish	Parameters
Beaver Creek (01 April, 2008)	Green Sunfish	1	uranium, polonium-210, lead-210, thorium-210, radium-222
	Fathead Minnow	1	
	Plains Killifish	1	
	Longnosed Dace,	1	
Beaver Creek (04 April,	Plains Killifish	1	Uranium concentration, Uranium, polonium-210,
	River Carpsucker	1	
	Green Sunfish	1	

2008)			lead-210,
	Fathead Minnow	1	thorium-210, radium-222
	Channel Catfish	1	
	River Carpsucker	1	
Cheyenne River (05 April, 2008)	Green Sunfish	1	uranium concentrations and uranium radioactivity, polonium-210, lead-210, thorium-210, radium-222
	Shorthead Redhorse	1	
	Creek Chub	1	
	Plains Killifish	1	
Beaver Creek (01 July, 2008	Sand Shiner	1	uranium concentrations and uranium radioactivity, polonium-210, lead-210, thorium-210, radium-222
	Fathead Minnow	5	
	Plains Topminnow	5	
	Common Carp	1	
Beaver Creek (01 July, 2008)	Plains Killifish	5	uranium concentrations and uranium radioactivity, polonium-210, lead-210, thorium-210, radium-222
	Sand Shiner	5	
	Sand Shiner	5	
	Common Carp	1	
Beaver Creek (04 July, 2008)	Shorthead Redhorse	1	uranium concentrations and uranium radioactivity, polonium-210, lead-210, thorium-210, radium-222
	Fathead Minnow	5	
	Plains Killifish	5	
	Sand Shiner	5	
Cheyenne River (05 July, 2008	Fathead Minnow	5	uranium concentrations and uranium radioactivity, polonium-210, lead-210, thorium-210, radium-222
	Plains Killifish	4	
	Common Carp	1	
	Shorthead Redhorse	2	
	Channel Catfish	3	
	River Carpsucker	4	

Source: Application Table 2.8-23 (Powertech, 2011a)

The applicant states that many of the specimens collected in April 2008 contained no detectable uranium (Powertech, 2009c; 2011a). Channel catfish collected from the downstream Beaver Creek site (BVC04) was the only species collected in April that contained detectable uranium (0.05 mg/kg, and 3 X 10^{-5}µCi/kg) (Powertech, 2009c). Applicant states that it detected uranium in all of the fish collected in July 2008 mainly due to increased sample sizes (see application Table 2.8-30). The applicant states that uranium concentrations and uranium radioactivity were generally low and similar across sample sites when compared by species. As stated in the application, radioactivity from polonium-210, thorium-230, and radium-226 was detectable, but low in most samples. Applicant detected lead-210 only in one specimen (plains killifish) collected in April at the downstream Beaver Creek site (BVCO1). Lead-210 was not detected in any of the other samples (Powertech, 2009c).

In addition to the food sources discussed above, the applicant identified game animals (pronghorn, wild turkey, etc.) but did not collect their samples as recommended in Regulatory Guide 4.14 (Powertech, 2011a). The applicant states that the migratory nature and relatively large home range of these game animals in relation to the size of the project area make it difficult to relate radionuclide concentrations to a particular site (Powertech, 2011a). NRC staff concludes that the applicant's justification for not collecting game animal samples is adequate.

According to the applicant, walk-in hunting areas (WIA) are permitted on privately owned lands and the rules related to the program prohibit firing a weapon within 91.5 m (100 yards (yd)) of a person or a structure (Powertech, 2011a). Prior to commencement of operations, the applicant will work with the BLM, the South Dakota Department of Game, Fish and Parks SDGF&P and private landowners to limit hunting within the project area to the extent practicable. The applicant will install temporary fencing, signage, gates and other means of restricting public access in areas of active ISR operations such as wellfields, processing plants and land application areas in order to protect the public, protect workers, prevent damage to facilities, and provide security (Powertech, 2011a).

Based on its review of the information discussed above, the staff is reasonably assured that the applicant will collect all the necessary vegetation, food, and fish data. This reasonable assurance determination is based on the data presented in the application, as supplemented by information that will be provided as committed to by the applicant in its supplemental sampling plan (Powertech, 2012e). Information presented herein, as supplemented by information as committed in its supplemental sampling plan, is consistent with Section 2.9.3 of the standard review plan (NRC, 2003b) and complies with 10 CFR 40, Appendix A, Criterion 7.

2.6.3.4 Direct Radiation

Regulatory Guide 4.14 recommends a total of 80 direct radiation measurements at 150 m (492ft) intervals up to a distance of 1500 m (4,920 ft) in eight directions from the center or 5 (or more) direct radiation measurements at the same locations used for the collection of particulate sample once prior to site construction (NRC, 1980). Instead of following the guidance recommendations, the applicant collected exposure rate measurements using thermoluminescent detectors (TLDs) and collected GPS-based gamma measurements.

Ambient exposure rates were measured for three periods using TLDs and analyzed by a third-party contractor (Powertech, 2011a). TLDs were deployed at each of the eight AMS locations. Duplicates were deployed at AMS-01 and the background location (AMS-BKG). The applicant did not monitor ambient exposure rate for the 29-day period between July 17 and August 15, 2008. (Powertech, 2011a). Ambient gamma dose rate monitoring results are listed in application Table 2.9-10 (Powertech, 2011a). The range of exposure rates for the rest of the locations were 91 to 123 millirems per year (mrem/yr). The applicant provided the TLD analytical reports in Appendix 2.9-C (Powertech, 2011a). The applicant will supplement its gamma exposure rate data by collecting measurements continuously for 1 year at the proposed air particulate sampling stations AMS-BKG, AMS-08 and AMS-09. Passive integrating devices (thermoluminescent dosimeters or an equivalent dosimeter) will be analyzed quarterly (Powertech, 2012e).

The applicant conducted GPS based gamma surveys using All Terrain Vehicles (ATVs) or by walking with the equipment in backpacks (Powertech, 2010a, 2011a). The applicant used unshielded Ludlum Model 44-10 2"x 2" sodium iodide (NaI) detectors coupled to Ludlum Model 2221 ratemeter/scalers (set in ratemeter mode) and a Trimble Pro XRS GPS Receiver with Trimble TSCe Datalogger. Simultaneous GPS and gamma exposure rate measurements were collected throughout the Permit Area using an onboard personal computer (Powertech, 2011a). The applicant states that it took 157,057 direct gamma measurements that greatly exceed the Regulatory Guide 4.14 recommended number (80) (NRC, 1980). In application Section TR RAI 2.9-38a, it is stated that all GPS based gamma survey data were gathered in fair weather under similar soil moisture conditions. (Powertech, 2011a)

In September 2007, the applicant performed initial GPS-based gamma surveys in the area of principal activities and surface mine area using 500-m (1,640 ft) and 100-m (328 ft) transect spacing, respectively (Powertech, 2009c, 2011a). Also in July 2008, gamma surveys at spacing of 100 m (328 ft) were conducted within the previously determined 500-m (1,640-ft) transects within the land application areas. Statistical tests were performed to confirm the data sets from 2007 and 2008 are not statistically different from one another and combining the data sets, concentrating on overlap areas considered free of anomalies. Results indicated that the two data sets were not statistically different from one another and no impact on the statistics was observed when summarizing the gamma count rate in and around the project area (Powertech, 2011a).

The applicant states that the 500-m (1,640-ft) transect spacing is based on the assumption that mineralized ore outcrops were not anticipated in areas where this transect spacing was used (Powertech, 2011a). Therefore, non-impacted areas were expected to be made up of large areas of different soil types or large fields having a unique history of fertilizer applications, if any. Characteristic sizes of these areas were expected to be large compared to 500 m (1,640 ft). Furthermore, on a regular basis, it evaluated whether the gamma count rates were consistent with the assumptions. Data anomalies were investigated and the transect spacing and areal extent of the survey were changed to bound the anomaly where ever appropriate. The applicant states that these daily evaluations of the data and changes to the survey density were made to correct for small departures from the conditions that were assumed while they were developing the plans (Powertech, 2011a).

The applicant analyzed the gamma data from the area of principal activities, surface mine area, and both land application areas (Dewey and Burdock) separately with a statistical software package (Powertech, 2011a). As stated in the application, the gamma data from the Main Permit Area were tested for a normal distribution. Results of the test as well as a histogram and statistical summary of the data are displayed in application Figure TR RAI 2.9-30a-1. According to the applicant the p-value demonstrated that the gamma data from the Main Permit Area are not normally distributed. (Powertech, 2011a).

The applicant states that ArcView GIS was used to map gamma survey data (Powertech, 2011a). Input parameters to ArcView GIS were gross gamma-ray count rates, in counts per minute (cpm), measured using matched sodium iodide detectors and recorded during the GPS-based survey. Results obtained from ArcView GIS were the predicted exposure rates, in µR/hr, calculated using the equation given in application(Powertech, 2010a, 2011a) TR Section 2.9.2.2.2. By using a minimum count rate cutoff of 5,500 cpm and the maximum observed gamma count rate of 460,485 cpm, the applicant calculated minimum and maximum exposure rates of 5.9 to 324 µR/hr. The applicant states that it did not use any interpolation or other method to predict gamma exposure rate spatially within the project. (Powertech, 2009c, 2011a).

Although direct radiation measurements were not collected in accordance with Regulatory Guide 4.14, the staff finds that the applicant followed site characterization methodology recommended in NUREG-1575, Revision 1, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000b). The staff determines that the applicant collected a sufficient number of gamma survey measurements to characterize the licensed area and thereby demonstrates compliance with establishing baseline direct radiation readings of the proposed licensed area as required by 10 CFR Part 40, Appendix A, Criterion 7.

2.6.3.5 Soil Sampling

Regulatory Guide 4.14 recommends collecting up to 40 surface soil samples at 300 m (984 ft) intervals to a distance of 1500 m (4,920 ft) in eight meteorological sectors, five or more surface soil samples at air particulate stations, and at least five subsurface soil samples in four meteorological sectors. Regulatory Guide 4.14 recommends that the soil samples be collected at 0 to 5 cm (0 to 2 in) (NRC, 1980). Standard review plan, Acceptance Criterion 2.9.3(2) recommends collecting soil samples at both a 5-cm (2-in) depth as described in Regulatory Guide 4.14 and 15-cm (6-in) for background decommissioning data. Regulatory Guide 4.14 also recommends collecting subsurface samples (to a depth of 1 m (3.3 ft)) at the center and at a distance of 750 m (2,460 ft) in each of the four compass directions.

The applicant states that it collected 80 samples at 0 to 15 cm (0 to 6 in) and supplemented the sampling with GPS-based gamma radiation surveys (Powertech, 2010a). A limited soil sampling was performed at 0 - 5 cm (0 to 2 in) depth interval at the AMS locations. In its application, the applicant requested a soil sampling program different from that specified in standard review plan. Specifically, the applicant did not propose taking soil samples at both a 5-cm and 15-cm depth as recommended by standard review plan, Acceptance Criteria 2.9.3(2). NRC staff evaluated the applicant’s rationale for its proposed soil sampling strategy in light of the Environmental Protection Agency’s (EPA) technical basis for its radium-226 soil cleanup standard in EPA’s Final EIS for inactive uranium processing site standards (EPA, 1982). EPA found no difference in health protection between averaging contaminations throughout the top 5 cm of soil versus the top 15 cm of soil. Consequently, the NRC staff finds the applicant’s proposed soil sampling strategy acceptable.

The applicant states that since the preoperational soil sampling strategy treated the entire project area as one “mill site”, it proposed to evaluate adequate number of samples for the entire project area, not sub-areas (Powertech, 2011a). However, the applicant acknowledged that there was a difference in sample density between the Dewey and Burdock portions of the project area and committed to collect 15 more surface soil samples in the Dewey area shown in application Figure TR RAI 2.9-40-2 prior to ISR operations (Powertech, 2011a). Applicant will also collect a surface soil sample at AMS-08 and AMS-09, the locations of which are shown in

Figure 1 (Powertech, October 19, 2012). This commitment by the applicant to collect the additional soils samples in the Dewey area is acceptable to the staff**.**

The applicant states that all soil samples were analyzed for radium-226, while 10 percent of the soil samples were also analyzed for natural uranium, thorium-230 and lead-210. All soil samples collected at the air particulate monitoring locations were analyzed for natural uranium, thorium-230, radium-226, and lead-210. The applicant states that at the area of principal activities and the surface mine area, subsurface radium-226 concentrations range from 0.7 to 5.6 pCi/g (see application Table 2.9-5) (Powertech, 2011a). The applicant states that the subsurface results in both land application areas are comparable to those observed in the 0 to 15 cm (0 to 6 in) surface samples and no apparent trend with depth were observed. (Powertech, 2010a, 2011a)

The applicant states that in conjunction with soil sampling and analysis and cross-reference to Pressurized Ion Chamber (PIC) measurements, the GPS-based gamma surveys were used to predict site-wide concentrations of gamma-emitting radionuclides and/or exposure rates (Powertech, 2009c). By using the equation in application Section 2.9.2.2.2, the applicant obtained the minimum and maximum predicted exposure rates of 5.9 to 324 μR/hr respectively (Powertech, 2011a). Application Figure 2.9-7 shows exposure rate estimates from points where gamma survey data were collected. The applicant states that although the radium-226 concentration data distributions within the area of principal activities and the surface mine area were similar, the gamma-ray count rate distributions were statistically different (Powertech, 2009c). The applicant states that with outliers removed, radium-226 concentration data from both the area of principal activities and the surface mine area fit a lognormal distribution (Powertech, 2009d). The geometric mean and geometric standard deviation of both data sets was 1.3 pCi/g which lie within the population range of 0.76 to 2.2 pCi/g. The applicant states that the range of radium-226 concentrations in the land application areas lies within the range of overall radium-226 concentrations, averaging 1.3 and 0.8 pCi/g in the Dewey and Burdock areas respectively (Powertech, 2011a).

The applicant states that linear regression modeling was used to provide a correlation between the concentration of radium-226 in soil and the gamma count rate (Powertech, 2011a). Application Table TR RAI 2.9-35c-1 provides the statistical analysis based on methods described in Section 6 of ASTM E178-08 and supports its decision to consider the sample results as outliers based on judgment and the outlier screening using box plots (Powertech, 2011a). The applicant further stated that consistent with ASTM E178-09, these observations were recognized as likely being from a different population than the other sample values and were not used in describing the central tendency of the data or other data analysis.

Instead of using the R^2 value the applicant directly compared model predictions to the data by examining the median and quartiles. The applicant concluded that the median and quartiles predicted by Equation 2 are very close to the median and quartiles of the data and are much closer than the median and quartiles of Equation 1 (Powertech, 2011a). However, the staff finds that the applicant has not provided sufficient justifications to validate the methodology used to exclude the outliers to establish the correlation between GPS based direct gamma measurement and the results obtained from soil samples. Also, the applicant is required to explain why the predicted median and quartiles using eqn.2 is not merely by coincidence. Therefore, the staff included a condition in the Dewey-Burdock license that addresses the need for additional statistical analysis of the soil sample data and gamma measurements. This condition is discussed in SER Section 2.6.4.

Although the applicant's assessment soil sampling program differed from the recommendations in Regulatory Guide 4.14, the staff determines that the number of soil samples and gamma measurements is acceptable. However, the staff determines that the statistical analysis is inadequate, and for that reason the aforementioned license condition requires additional analyses. The staff is reasonably assured that the soil sampling program information provided by the applicant, as supplemented by the license condition and by the additional surface soil samples that the applicant has committed to collect and analyze prior to major site construction, is consistent with the intent of Regulatory Guide 4.14 and meets the requirements of 10 CFR Part 40, Appendix A, Criterion 7.

2.6.3.6 Sediment Sampling

Regulatory Guide 4.14 recommends sediment sampling at two locations in each stream and one in each water impoundment (NRC, 1980). The applicant conducted baseline sediment sampling in June and August 2008 (Powertech, 2009c). Stream sediment samples were collected at the same locations as the surface water quality sampling locations (SER Table 2.5-1). Impoundment sediment samples were collected in the same impoundments at which surface water chemistry was sampled (SER Table 2.5-3).

In application Appendix 2.9-H, the applicant provided the analytical results of sediment sampling completed as part of the baseline monitoring program. A summary of radionuclide concentration in sediment samples is provided in Appendix 2.9-K (Powertech, 2010a). The applicant concluded that the radionuclide concentrations in sediments at Darrow Mine Pit and the Triangle Mine Pit are considerably higher than observed in US soil. Radionuclide concentrations within the rest of the license boundary are generally consistent with observed US soil concentrations (Powertech, 2010a).

The applicant states that supplemental sediment samples will be collected from each surface water impoundment and stream sampling location (Powertech, 2012e). Samples will be collected twice, once following spring runoff and once during late summer following an extended period of low flow. Several sediment samples will be collected by traversing each stream sampling location and compositing sediment into one sample for analysis. Samples will supplement those collected earlier at CHR01S, CHR05S, BEN01S, and UNT01S. Applicant states that analyses will be performed to meet LLDs and analytical reporting formats specified in RG 4.14. Applicant will provide the supplemental sediment sample results to NRC at least 30 days prior to operation. (Powertech, 2012e #91)

The applicant collected sediment samples from the same surface-water locations as described in Section 1.1.2 of Regulatory Guide 4.14 (NRC, 1980). As recommended by the regulatory guide, the applicant committed to collecting supplemental sediment samples in a traverse across the streambed and composited for analysis. Based on the information provided in the application, as supplemented by information committed to by the applicant, the staff is reasonably assured that the applicant will collect the necessary baseline sediment samples at the applicant's sediment sampling data is consistent with Regulatory Guide 4.14 and complies with 10 CFR Part 40, Appendix A, Criterion 7.

2.6.4 Evaluation Findings

Staff reviewed the background radiological characteristics of the Dewey-Burdock Project in accordance with Section 2.9.3 of the standard review plan. The staff's review of the information presented in this section indicates that the applicant has provided adequate justification for not conducting radon flux monitoring, analysis for dissolved radium-226 in surface water samples, and game, crop, and fish sampling during preoperational monitoring. The applicant has established background radiological characteristics by providing monitoring programs that include sampling frequency and methods, sampling locations, and types of analyses.

However, the staff determines that the applicant has not provided sufficient justifications to validate the methodology used to exclude the outliers to establish the correlation between the direct gamma measurements (i.e., measurements with various gamma probes) versus the results obtained from soil samples. Also, the applicant must explain the basis for its predicted median and quartile values using Equation 2. Therefore, the staff includes the following license condition in the Dewey-Burdock license that addresses the need for additional statistical analysis of the soil sample data and gamma measurements.

> No later than 30 days prior to construction, the licensee will provide additional statistical analysis of the soil sampling data and gamma measurements to establish sufficient statistical relationships. If such relationships are not sufficient for use at the site, additional procedures or data shall be submitted to the NRC staff for review and written verification.

Based upon the review conducted by the staff, the staff is reasonably assured that the information provided in the application, as supplemented by information that will be provided by the applicant as committed in its supplemental sampling plan, is consistent with the applicable acceptance criteria of standard review plan Section 2.9.3 and the requirements of 10 CFR 40, Appendix A, Criterion 7.

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3.0 DESCRIPTION OF PROPOSED FACILITY

3.1 IN SITU RECOVERY (ISR) PROCESS AND EQUIPMENT

3.1.1 REGULATORY REQUIREMENTS

The staff determines if the applicant demonstrated that the equipment and processes used in the wellfields during operations at the Dewey-Burdock Project meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.1.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using review procedures in Section 3.1.2 and acceptance criteria outlined in Section 3.1.3 of the standard review plan (NRC, 2003b).

3.1.3 STAFF REVIEW AND ANALYSIS

The following sections present the staff's review and analysis of various aspects of the ISR processes and equipment proposed for the Dewey-Burdock Project. Review areas addressed in this section include wellfield infrastructure, operations in the Fall River and Chilson aquifers, and the proposed schedule for operations. To evaluate the application of the ISR process at the Dewey-Burdock Project, NRC staff first reviewed the ore body characteristics and mine unit infrastructure, examining such features as well installation and completion, mechanical integrity testing, mine unit piping, header house design, water balances, and wastewater disposal capacity. The staff then reviewed the ISR mine unit operations to ensure that the applicant will be able to conduct its in-situ recovery operations in a safe manner.

3.1.3.1 Ore Body

Operations will be conducted in two distinct areas within the license area, the Dewey and the Burdock areas (Powertech, 2011a). Application Exhibit 3.1-4 presents the proposed wellfield layout of the Dewey-Burdock Project. The Dewey area will consist of four wellfields (D-WF1 through 4) and a satellite processing plant. The Burdock area will consist of ten wellfields (B-WF1 through 10) and will contain the central processing plant (CPP). Initially, the applicant proposes operating one wellfield at each of the Dewey or Burdock areas (Powertech, 2011a).

As described in SER Section 2.3, application Exhibits 2.7-1a through 2.7-1j, present geologic cross sections identifying the ore zone horizons, as well as the stratigraphy and groundwater elevations (Powertech, 2011a). A review of these cross sections and application Exhibit 3.1-4 discussed above indicates that the target ore zones in the Dewey area are the Lower Fall River zone, Upper Chilson zone, and the Middle/Lower Chilson zone. In the Burdock area, the target ore zones are, primarily, the Upper and Middle/Lower Chilson zones. One Burdock wellfield, B-WF10, will target the Lower Fall River zone. This particular wellfield is in the northwest portion of the Burdock area, and is geographically isolated from the other wellfields (Powertech, 2011a).

Application Exhibit 3.1-4 presents the wellfield layout in the Dewey and Burdock areas, respectively (Powertech, 2011a). A review of these figures indicates that the applicant organized the wellfields based upon the ore zone to be extracted. Therefore, certain wellfields will overlap because while these wellfields occupy the same geographical space, each wellfield will utilize a different ore zone. Examples of such overlap are as follows:

- B-WF3 (Upper Chilson Zone) overlaps B-WF1, 2, and 4 (Middle/Lower Chilson zones).
- B-WF5 (Upper Chilson zone) overlaps B-WF9 (Upper and Middle/Lower Chilson zones).
- D-WF3 (Lower Fall River zone) overlaps D-WF2 (Middle/Lower Chilson zone) and D-WF4 (Upper Chilson zone).
- D-WF2 (Middle/Lower Chilson zone) overlaps D-WF3 (Lower Fall River zone) and D-WF4 (Upper Chilson zone).
- D-WF4 (Upper Chilson zone) consists of three disconnected wellfields, which in the entirety overlap D-WF1 (Lower Fall River zone) D-WF2 (Middle/Lower Chilson zone), and D-WF3 (Lower Fall River zone) (Powertech, 2011a).

Because of the overlapping wellfields, the staff is including a license condition discussed in SER Section 3.1.4 that requires the applicant delineate the individual monitoring networks for each ore extraction zone and present these data in the wellfield-specific hydrologic package.

In the case of the Dewey-Burdock Project, the applicant proposes to use a lixiviant consisting of native groundwater enriched with gaseous oxygen and gaseous carbon dioxide (Powertech, 2009c). This lixiviant will be injected into a pattern wellfield to mobilize the uranium in the production zone; uranium enriched lixiviant (pregnant lixiviant) will be pumped from production zone aquifer to on-site treatment facilities at ground surface. On-site treatment consists of ion exchange units to remove the uranium from the lixiviant, and other equipment to concentrate, precipitate and dry the resulting yellowcake to produce the final product, which is a fine yellow-orange powder (Powertech, 2009c).

The staff has reviewed the applicant's description of the ore bodies and wellfields to be located in the ore bodies. The applicant identifies the ore-bearing strata and wellfield layout. However, due to the complex nature of the overlapping wellfields, the staff added a condition in the license requiring that additional information be provided in the wellfield hydrologic packages, which is discussed in SER Section 3.1.4. As stated above, this information will include locations on monitoring wells and logs showing screened intervals for each ore zone and horizon within each ore zone. The staff determines that the above information supplemented by the information provided in the license condition is consistent with Section 3.1.3 of the standard review plan and complies with 10 CFR 40.32(c) and 40.41(c).

3.1.3.2 Wellfield Infrastructure

Proposed wellfields will be comprised of contiguous, 5-spot well patterns, in which four injection wells are located at the corner of the pattern and the production well in the center. Well spacing for each pattern will range between 15 and 46 m (50 and 150 ft) (Powertech, 2009c). Application Exhibit 3.1-2 presents recovery patterns for the initial wellfields in the Dewey and Burdock areas (Powertech, 2011a). The geometry for a pattern may be modified based on site conditions (i.e., a triangular pattern rather than a square). All wells in the pattern will be constructed such that the well could be used for either injection or production if needed during restoration. (Powertech, 2009c, 2011a)

The applicant described the design, cementing, completion and development of the mine unit wells (Powertech, 2009c). Well materials will consist of thermoplastic such as polyvinyl chloride (PVC) with a nominal 10, 13, 15-cm (4, 5 or 6-inch) diameter and appropriate wall thickness for the design conditions. Well casings will be joined by fittings or using methods recommended by the casing manufacturers. The staff notes that a prior common practice of joining well casing was gluing casings to a coupling and then screwing the casings to the couplings (a.k.a. screw and glue). This method of joining casings is known to generate leaks as the wells age. Therefore, the staff will include a condition in the license that prohibits the screw and glue method of casing construction. This condition is presented in SER Section 3.1.4.

Well completion will be accomplished in the following manner:

- Annular spaces will be sealed with cement/bentonite grout.
- Well screen zones for the well will be completed by underreaming to a larger diameter below the casing to the total depth.
- Well screens will be inserted into the open hole and sealed at the casing with K-packers.
- Annular spaces between the well screen and aquifer will be backfilled with filter sand.
- Wells will be developed using air lifting, swabbing or other acceptable methods to ensure proper communication with the surrounding aquifer. (Powertech, 2009c)

Application Supplemental Exhibits 3.1-6 and 3.1-7 show initial wellfield details, including locations of wellfield patterns, locations of injection wells (“I” wells) and production wells (“P” wells), locations of monitoring wells (perimeter, overlying and underlying), and the distance to the aquifer exemption boundary (Powertech, 2010a). Both exhibits list the number of injection production wells for the first two wellfields. For the Dewey area, the first wellfield consists of 355 injection and 200 production wells. For the Burdock area, the first wellfield consists of 295 injection and 126 production wells (Powertech, 2010a).

A review of Supplemental Exhibits 3.1-6 and 3.1-7 shows that the applicant intends to tap multiple horizons in the various aquifers within each wellfield (Powertech, 2010a). However, each wellfield will be subdivided into mine units which will tap different horizons in a particular ore zone. Application Exhibit 3.1-6, for example, shows three horizons exist in the Lower Fall River aquifer, F11, F12, and F13. The applicant intends to establish specific mine units to tap each specific horizon. For example, Mine Units 1, 2, 3, 5, 7, 9, 10, 11, and 12 will be installed to tap the F13 horizon. The applicant does not provide specific information regarding the horizons that exist in the Fall River and Chilson extraction zones. However, pumping test information described in SER Section 2.4 states that each aquifer acts as one unit regardless of the vertical anisotropy that occurs. Furthermore, the applicant states that operational monitoring wells will be screened across entire ore zones, so these monitoring wells would intercept excursions originating from the various horizons. The staff determines the applicant adequately described its proposed wellfield layout. However, additional information and testing will be required by license condition. This license condition will stipulate that the staff will review the wellfield package for D-WF1 and provide written verification of the data and analyses, therein. SER Section 3.1.4 provides the proposed text of the condition. The license condition will specify the need for detailed geologic and hydrogeologic information, including the identification of the various horizons and the ability of the monitoring network to detect excursions from these horizons.

Wells will be fitted with the appropriate piping depending upon whether the well is an injection or production well (Powertech, 2009c). Each well will be connected to underground piping leading to a central header house. The wellhead connections will be constructed of stainless-steel material and located within an insulated wellhead cover. Based on the typical wellhead diagrams in the TR, the wellhead covers include an interior heating element. Underground piping will be constructed of a high density polyethylene (HDPE) material with heat-welded joints and buried approximately five (5) feet below ground surface. Piping will terminate within a header house (Powertech, 2009c).

A wellfield consists of several header houses connected to a selected group of injection/production wells (Powertech, 2009c). In the application, the applicant indicates that one header house will service up to 20 production wells and 80 injection wells. In the header house, the piping is ultimately connected to a central piping manifold leading to and from the Satellite or Central Processing plants. In application Section 4.2.3.1, the applicant indicated that the piping to the processing facilities will be constructed of PVC or HDPE material with butt-welded joints or equivalent. The piping will be subjected to pressuring testing before its initial use and be largely buried (Powertech, 2009c).

The staff has reviewed the applicant's description of the wellfield infrastructure. The applicant identifies the manner in which wellfields will be constructed, types of wellfield equipment, organization of wellfields and mine units, the ore-bearing strata and wellfield layout, and well construction details. However, due to the complex nature of mine unit development, the staff is including a license condition stating specific information required by the NRC staff. The staff determines that the above information supplemented by the information provided in the license condition is consistent with Section 3.1.3 of the standard review plan and complies with 10 CFR 40.32(c) and 40.41(c).

3.1.3.3 Mechanical Integrity Testing (MIT)

The applicant will perform mechanical integrity tests (MITs) on newly installed wells and also following any well repair (Powertech, 2009c). MITs will be repeated once every five years for active wells. MIT procedures begin by first isolating the casing above the top of the production zone to ground surface using a down hole packer and wellhead cap. Pressure inside the casing will then be increased to a specified initial pressure. The applicant specified that the initial pressures for a MIT will be the lesser of the following:

- 125 percent of the maximum operational pressures for a wellfield.
- 125 percent of the maximum operating pressure rating of the well casing.
- 90 percent of the formation fracture pressure.

A well passes an MIT test when 90 percent of any of the above initial pressures is maintained for ten minutes. If the well fails this requirement, it must be repaired and retested. If it cannot be repaired, the well will be plugged and abandoned. All MIT tests will be documented and the records will be maintained on site (Powertech, 2009c).

The staff has reviewed the applicant's description of these MIT methods and finds them acceptable. The applicant proposes appropriate MIT frequency and procedures. Requirements for MITs will be memorialized in a standard license condition found in SER Appendix A. The staff determines that the above information is consistent with Section 3.1.3 of the standard review plan and complies with 10 CFR 40.32(c) and 40.41(c).

3.1.3.4 Lixiviant

The applicant is proposing a lixiviant composed of natural groundwater fortified with gaseous oxygen and gaseous carbon dioxide (Powertech, 2009c). Oxygen will serve to alter the oxidation state of the ore zone allowing uranium to dissolve from the ore. Carbon dioxide will form uranyl carbonate complexes that will keep the uranium in solution as it is extracted from the wellfield.

Use of gaseous oxygen requires a sufficient hydraulic head in the ore zone to maintain pressures that will keep the oxygen in solution. If the hydraulic heads equal 30.5 m (100 ft), according to the staff's calculation, the concentration of oxygen cannot be greater than 119 mg/l. This actually assumes that water temperature is 25°C, which is warmer than the typical groundwater temperature. However, if the applicant injects lixiviant with higher concentrations of oxygen or if the aquifer hydraulic head is reduced, oxygen could evolve out of solution and decrease the conductivity of the ore zone in the area of the injection or production wells. Such circumstances are not a concern within most of the license area because of the large hydraulic heads and the confined nature of the extraction zone. However, as discussed in the following two paragraphs, oxygen evolution could be a concern along the eastern edge of the license area.

According to the applicant, operations in the eastern edge of the Burdock area will occur in the Chilson aquifer where hydraulic heads are approximately 30.5 m (100 ft) (Powertech, 2011a). Furthermore, although this Chilson ore zone is geologically confined, it is partially unsaturated. The applicant does not expect ISR operations to occur in areas with less than 15.2 m (50 ft) of hydraulic head. (Powertech, 2011a)

Unsaturated aquifers behave differently than saturated aquifers, and the potential for gas lock caused by oxygen evolution is increased because of the lower hydraulic heads in the unsaturated Chilson aquifer within the license boundary. Consequently, the applicant is required to demonstrate that ISR can be performed under unsaturated conditions and that its ability to detect and remediate excursions will not be impaired. The applicant has committed to preparing an additional delineation characterization report if partially saturated conditions are encountered. As part of its characterization, the applicant will install additional well installation, pumping tests, and groundwater sampling to determine if ISR is feasible in the unsaturated portions of the license boundary. The staff has determined that a license condition regarding operations in partially saturated zone of the Burdock area is necessary to ensure that no operations occur until issues regarding partially saturated conditions are resolved. This license condition is presented in SER Section 3.1.4.

The applicant provided a basic composition of the lixiviant to be used at the Dewey-Burdock Project in application Table 3.1-1 (Powertech, 2009c). A review of this table indicates that lixiviant constituents include substances injected into the lixiviant stream, substances added to the stream by processing (i.e., chloride) and those that potentially recirculate through the ore zone and plant (i.e. potassium). The staff understands that actual lixiviant composition will vary. Information concerning post-operational groundwater quality and effects on ore zones is presented in SER Section 6.0 rather than this section, although this information is discussed in standard review plan Section 3.1.3 (NRC, 2003b).

The staff has reviewed the applicant's description of its proposed lixiviant and finds it acceptable. The applicant proposes a standard alkaline lixiviant; however, the applicant did not describe the effects of lixiviant injection in unsaturated conditions. The requirement to provide this information is memorialized in a license condition described in SER Section 3.1.4. The staff is reasonably assured that the applicant will properly inject lixiviant. This reasonable assurance determination is based on the aforementioned information, and fulfillment of the proposed license condition. Therefore, the applicant's lixiviant description is consistent with Section 3.1.3 of the standard review plan and complies with 10 CFR 40.32(c) and 40.41(c).

3.1.3.5 Water Balance

The applicant states that process and wellfield designs are based on a nominal flow rate of 9,084 Lpm (2,400 gpm) for the Burdock area and 6,056 Lpm (1,600 gpm) for the Dewey area for a total of 15,140 Lpm (4,000 gpm) (Powertech, 2011a). Flow rates for individual production units (5-spot pattern) are between 76 and 114 Lpm (20 and 30 gpm). The applicant states that its bleed rate will range from 0.5 to 3 percent of the production rate, and that effluent systems will be designed for the 3 percent bleed. However, the most common long-term bleeds will be actually 0.5 – 1 percent with a maximum of 3 percent occurring in short durations (days to months) (Powertech, 2009c). The applicant also stated that its single-value typical bleed will be 0.875 percent (Powertech, 2011a). (Powertech, 2009c, 2011a)

Application Figure TR RAI P&R-14c-1 and Application Table TR RAI P&R-14c-1 present flow rates by aquifer, restoration method, and disposal method (Powertech, 2011a). Water balances are summarized in the following tables for the, Burdock and the Dewey areas.

Table 3.1-1: Burdock Area Water Balance

Operation Phase	Bleed Option	Disposal Option	A	B	C	D	E	F	G	H	I
Recovery	0.875%	Disposal Well	21	2400	2379	21	0	12	12	12	33
		Land Application	21	2400	2379	21	0	12	12	12	33
Restoration	without groundwater sweep	Disposal Well	2.5	250	175	75	73	0	73	0	75
		Land Application	2.5	250	0	250	248	0	248	0	250
	with groundwater sweep	Disposal Well	42	250	175	75	33	0	33	0	75
		Land Application	42	250	0	250	208	0	208	0	250

Source: (Powertech, 2011a). All measurements in gpm.

Legend:

A = Aquifer Bleed
B = Extraction Composite
C = Reinjection
D = Wellfield Bleed
E = Madison Make-up
F = Fresh Brine Make-up
G = Total Madison Withdrawal
H = Central Processing Plant Brine
I = Liquid Waste

Table 3.1-2: Dewey Area Water Balance

Operation Phase	Bleed Option	Disposal Option	A	B	C	E	I
Recovery	0.875%	Disposal Well	14	1600	1586	0	14
		Land Application	14	1600	1586	0	14
Restoration	without groundwater sweep	Disposal Well	2.5	250	175	73	75
		Land Application	2.5	250	0	248	250
	with Groundwater sweep	Disposal Well	42	250	175	33	75
		Land Application	42	250	0	208	250

Source: (Powertech, 2011a). All measurements in gpm.

According to information provided by the applicant, regardless of which liquid waste disposal option is selected (deep well disposal or land application), water will be withdrawn from the Madison Aquifer and injected into the wellfields to prevent excessive drawdown of the Chilson or Fall River Aquifers. The applicant states that it will obtain make-up water from the Inyan Kara, if it can create a source sufficiently distant from the Dewey-Burdock Project to prevent excessive drawdown. Excessive drawdown could impact water quantity of supply wells within or near the Dewey-Burdock Project (Powertech, 2009c).

Because a significant amount of make-up water could originate from the Madison Aquifer, local drawdown of this aquifer could be substantial. Although the effects of obtaining make-up water are beyond the scope of this SER, the staff reviewed water permits near the Dewey-Burdock Project to gauge potential hydraulic interferences in the Madison Aquifer. A review of South Dakota's water rights permits database indicates the following:

- The City of Custer draws all its water from Precambrian Crystalline rock.
- The City of Hot Springs draws all its drinking water from Quaternary alluvium. One Fall River Aquifer well provides water for geothermal purposes.
- The City of Edgemont has four permits for Madison Aquifer wells and one for an Inyan Kara well. Edgemont is permitted for 1,221 gpm from the Madison Aquifer and 90 gpm from the Inyan Kara Aquifer (SD DENR, 2012).

The staff constructed a simple 3-layer model to study the effects of a large withdrawal from the Madison Formation. The model included one well at the Dewey-Burdock Project operating at 500 gpm, and two wells in the City of Edgemont operating at 1,221 gpm to simulate Madison groundwater withdrawals. Water withdrawal rates in the City of Edgemont were obtained from water rights issued by the State of South Dakota and are publicly available on the SD DENR website (SD DENR, 2012). Results of the analysis indicate the Edgemont wells would produce a large cone of depression that encompasses the Dewey-Burdock Project, if these wells operated constantly (conservative assumption) (SER Figure 3.1-1). When the Dewey-Burdock well is operating full-time (conservative assumption), the Dewey–Burdock well superimposes its cone of depression onto the Edgemont wells (SER Figure 3.1-2). However, based on the staff's review of the steady-state potentiometric surface maps and Madison Aquifer drawdown the drawdown induced by constant pumping of the Dewey-Burdock well does not appear to affect the operation of the Edgemont wells. Therefore, the proposed maximum Madison withdrawals at the Dewey-Burdock project do not appear to affect water supplies in the City of Edgemont, South Dakota.

The staff has reviewed the applicant's water balance information and finds that it is acceptable. Water balance information addresses both the operations and restoration phases, individually, and in combination. The applicant also provides water balance information for each individual restoration and disposal method. The staff recognizes that a significant quantity of water will be required from the Madison Aquifer, if land application is utilized. However, the staff analyzed these withdrawals and the associated effects. Based on its review of the water balance information, the staff finds that it is consistent with Section 3.1.3 of the standard review plan and complies with 10 CFR 40.32(c) and 40.41(c).

3.1.3.6 Wellfield Operational Monitoring Network

The applicant proposes a wellfield monitoring network consisting of perimeter monitoring wells, overlying aquifer monitoring wells, and underlying aquifer monitoring wells (Powertech, 2009c). Regarding the perimeter monitoring network, wells will be installed approximately 122 m (400 ft) outside the wellfield and each well will be separated by approximately 122 m (400 ft) (Powertech, 2011a). Perimeter wells will be screened across an entire ore zone, either the Chilson or Fall River ore zones, but not both. Application Figures TR RAI 5.7.8-12-1 and 5.7.8-12-2 present the proposed monitoring network for the Burdock and Dewey areas, respectively (Powertech, 2011a).

A review of these figures indicates that the monitoring wells will be installed in appropriate hydrogeologic zones depending on the particular zone undergoing extraction. Wells will be screened across an entire zone, as each zone acts as a single hydrogeologic unit, based on the pumping test data discussed in SER Section 2.6. For these reasons, the proposed well construction will be sufficient to detect excursions and is consistent with Section 5.7.8.3 of the standard review plan (NRC, 2003b).

The applicant prepared a groundwater model to demonstrate that the perimeter monitoring wells are sufficiently spaced from the wellfield and between each well to detect excursions (Powertech, 2011a). Application Appendix 6.6-B presents model development, calibration, and the results of various upset conditions that can occur at an ISR. For this project, one simulation consisted of deactivating an extracting well in the southern part of a wellfield, thus, rendering the wellfield out of balance. This imbalance causes an excursion that migrates toward the perimeter wells. Particle tracking analysis indicates that one operating well is sufficient to detect an excursion. (Powertech, 2011a)

The applicant then modeled a scenario by which excursions can be recovered (Powertech, 2011a). This scenario involves over pumping two adjacent recovery wells and the deactivating injection wells, in order to optimize recovery times. The applicant demonstrated that within 1 hour, groundwater gradients would reverse and begin drawing back excursions to the wellfield. (Powertech, 2011a)

In addition to the monitoring well network, other wellfield monitoring mechanisms include pipeline monitoring and pond monitoring. According to the applicant, leak detection will be performed by daily visual inspection of all above-ground pipe, connections, and fittings by field personnel during their daily site visits (Powertech, 2009c). The applicant will also install automated control and data recording systems at the satellite facility and CPP that will provide centralized monitoring and control of the process variables, including, the flows and pressures of production, injection, and waste streams. These systems will include alarms and automatic shutoffs for the detection and control of a potential release or spill. The applicant does not discuss the manner in which wellfield inspections will be documented. Therefore, the staff is including a condition in the license to require documentation of wellfield inspections, which is discussed in SER Section 3.1.4.

For leak detection, pressure and flow sensors will be installed, on the main trunk lines that connect the CPP and satellite facility to the wellfields (Powertech, 2011a). In addition, flow rates of each production well and each injection well will be automatically measured, and measurements will be transmitted to both the CPP and satellite facility control systems. In the event that pressures or flows fluctuate outside of normal operating ranges, alarms will provide immediate warning to operators, which will allow for a timely response and appropriate corrective action (Powertech, 2011a).

Both external and internal shutdown controls will be installed at each header house, which are designed for the automatic and remote deactivation of each header house (Powertech, 2011a). In the event of a header house shutdown, an alarm will occur and the flows of all injection and production wells in that header house will be stopped automatically. The alarm will activate a blinking light on the outside of the header house and will cause an alarm signal to be sent to the CPP and satellite facility control rooms (Powertech, 2011a).

Each header house will also include a sump pump equipped with a water level sensor, so that if a leak occurs and the water level approaches the preset level, sensors will initiate an automatic shutdown of the header house (Powertech, 2011a). A pressure switch will be installed on the injection header to ensure that fluid pressures do not exceed the mechanical integrity test pressures of the injection wells served by that header house. If the injection pressure exceeds the maximum set value in the pressure switch, an automatic header house shutdown will occur. Downhole pressure transducers will be installed in all monitor wells for the measurement of potentiometric head. These instruments will alert operators to any significant change in the water levels within the monitor wells, which will provide an early detection of a potential lixiviant excursion. Operators, as necessary, will follow standard operating procedures to make adjustments to wellfield production and/or injection flow rates in order to avoid an excursion due to any unbalanced flow condition in a wellfield. (Powertech, 2011a)

Other Modeled Wellfield Operations

The applicant modeled other scenarios of wellfield operations including the flare factor for surety estimates and overall wellfield drawdown (Powertech, 2011a). Regarding flare factor, the applicant modeled a Dewey area wellfield by assigning and balancing flows for each injection and production well in the wellfield. Furthermore, the applicant assumed a bleed of 1 percent, which is the upper range of the "nominal" or typical bleed rates to be used for hydraulic control. According to the applicant, the calculated horizontal flare is 1.19. Vertical flare would essentially be the same or less because of the vertical anisotropy that occurs in the extraction zone at the Dewey-Burdock Project. Therefore, the total flare factor is 1.4 for both vertical and horizontal directions (Powertech, 2011a).

The staff determines that the estimated flare factor is acceptable. The applicant's modeling technique for estimating horizontal flare is acceptable, as it simulates actual production conditions. Furthermore, the modeling provides the applicant with insight into properly balancing the wellfield to avoid excursions. Assumptions regarding vertical anisotropy are valid, since pumping tests have detected vertical anisotropy through water level monitoring.

The staff has reviewed the applicant's plans for wellfield monitoring and has determined that these plans are acceptable. Monitoring well networks consist of appropriately spaced overlying and underlying monitoring wells, as well as perimeter monitoring wells. Perimeter monitoring wells are appropriately screened, and the applicant has demonstrated that the spacing is sufficient to detect excursions. Therefore, the staff determines that the information in this section is consistent with Section 3.1.3 of the standard review plan, and complies with 10 CFR 40.32(c) and 40.41(c).

3.1.3.7 Schedule

The applicant's schedule for the production, decommissioning, and restoration phases for all proposed wellfields indicates the applicant intends to extract uranium from each wellfield for 1 to 1.5 years and that groundwater restoration will require 0.25 to 0.5 years to complete (Powertech, 2009c). All activities are expected to be completed within 13 years after licensing. The staff notes that restoration typically requires years; therefore, the applicant's restoration schedule is very optimistic.

The period of operations and groundwater restoration phases affects the surety estimate. Therefore, a reasonable estimate of the duration of the phases is needed to properly calculate the surety. The staff determines that the groundwater restoration schedule is not reasonable given the period of time that has been needed to restore other wellfields at different licensed ISR facilities. For this reason, the staff is including a license condition requiring the applicant to propose a revised restoration schedule. The revised schedule will be used in the recalculation of the surety estimate. This license condition is discussed in SER Section 3.1.4.

3.1.4 EVALUATION FINDINGS

The staff reviewed and analyzed the ISR process and the equipment proposed for use at the Dewey-Burdock Project in accordance with review procedures in Section 3.1.2 and acceptance criteria in standard review plan Section 3.1.3. The applicant described and provided support for its evaluation of the ore body characteristics, wellfield infrastructure, equipment to be used onsite, mechanical integrity testing, and ISR operations. Based on an evaluation of these data, the staff finds the applicant satisfactorily documented that ore body characteristics at Dewey-Burdock exhibit the same characteristics present in ore bodies being safely extracted at operating NRC-licensed ISR facilities. The applicant made commitments to use specific materials in construction of the infrastructure and to conduct routine monitoring of surface and subsurface areas to detect potentially migrating production fluids. The staff finds these commitments adequately protect against unwanted vertical and horizontal migration of fluids. The staff also finds that the applicant's proposed ISR processes will meet the following safety criteria:

- Overall production rates are higher than injection rates to create and maintain a cone of depression.
- Plant source and byproduct material balances and flow rates are appropriate.

SER Section 4.0 discusses estimates of gaseous, liquid, and solid wastes and effluents. Therefore, this information is not discussed in SER Section 3.1, as suggested in the standard review plan (NRC, 2003b). Also, information regarding post-operation water quality is discussed in SER Section 6.0, rather than the SER Section 3.1, as recommended in the standard review plan (NRC, 2003b).

The staff's review of components for operations focused on potential safety risks and evaluated the applicant's proposal against current industry practice at existing NRC-licensed ISR facilities. The staff concludes the applicant specified acceptable instrumentation and monitoring programs designed to prevent, detect, and correct spills and/or excursions. In addition, the applicant provided acceptable operating plans, schedules, and timetables for wellfield operation and surface reclamation.

The staff determined that the groundwater restoration schedule did not match the staff's experience with currently operating ISR facilities. For this reason, the staff will include an additional requirement to the standard License Condition 9.5:

> The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10CFR Part 40, Appendix A, Criterion 9, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination, which includes offsite disposal of radioactive solid process or evaporation pond residues, and ground-water restoration as warranted. The surety shall also include the costs associated with all soil and water sampling analyses necessary to confirm the accomplishment of decontamination.

Requirements for several aspects of the operations (in particular, lixiviant makeup, limitations on throughput capacity, groundwater monitoring and spill reporting), will be included in standard license conditions in the license (see SER Appendix A, which presents LC 10.1 for lixiviant makeup, LC10.2 for facility throughput and LC's 11.1 through 11.8 for monitoring and reporting requirements).

The applicant commits to modifying operations in the eastern portion of the Dewey-Burdock Project as follows:

> The applicant commits to preparing an additional delineation characterization report to include well installation, pumping tests, and groundwater monitoring data, if partially saturated conditions are encountered.

Because ISR operations in partially saturated conditions are different from operations in saturated conditions, the staff will include a condition in the license the addresses the hydrologic test packages in these areas. The license condition will ensure the applicant obtains the typical information required in a hydrologic test package, as well as, information specific to wellfields present at the Dewey-Burdock Project. The applicant will obtain data on wellfields that overlap other wellfields, that are overlapped by other wellfields, and that contain multiple horizons.

Hydrologic Test Packages

A. Prior to principal activities in a new wellfield, the licensee shall submit a hydrologic test package to the NRC at least 60 days prior to the planned start date of lixiviant injection. The hydrologic test package for B-WF-1 or D-WF-1, whichever is developed first, will be submitted for review and verification while the remaining hydrologic test packages will be submitted for NRC staff review except as described in paragraph B of this License Condition. In each hydrologic test data package, the licensee will document that all perimeter monitoring wells are screened in the appropriate horizon in order to provide timely detection of an excursion. Contents of a wellfield package shall include:

- A description of the proposed wellfield (location, extent, etc.).
- Map(s) showing the proposed production and injection well patterns and locations of all monitor wells.
- Geologic cross sections and cross section location maps.
- Isopach maps of the production zone sand and overlying and underlying confining units.
- Discussion of aquifer test procedures, including well completion reports.
- Discussion of the results and conclusions of aquifer tests, including raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and, when appropriate, directional transmissivity data and graphs.
- Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns.
- All raw analytical data for Commission-approved background water qualit.
- Summary tables of analytical data showing computed Commission-approved background water quality.
- Descriptions of statistical methods for computing Commission-approved background water quality.
- Any other information pertinent to the proposed wellfield area tested will be included and discussed.

B. The licensee will submit, for NRC review and approval, hydrologic test packages for wellfields B-WF-6, -7, and -8. No extraction will be permitted in these wellfields until the staff approves the hydrologic package. Hydrologic packages shall include all the

> information in paragraph A of this license condition and aquifer test results that address the partially unsaturated conditions of the Chilson Aquifer in these wellfields. These hydrologic packages will also contain a justification for well spacings in the monitoring well ring and overlying and underlying aquifers.

The applicant has not committed to documenting results of daily inspections for leaks during routine field surveys/activities. Therefore, the staff will include the following license condition to ensure daily inspections are conducted:

> No later than 30 days before the start of operations, the licensee shall provide the NRC staff, for review and verification, its procedures for documenting the wellfield inspections. These procedures shall include the personnel tasked with performing these inspections, items to be inspected, criteria for determining upset conditions, and the manner in which the inspections will be documented.

The applicant discussed well construction procedures in general terms; however, the staff is prohibiting the use of gluing and screwing methods for joining well casings by license condition. Because this joining method previously has been linked to chronic MIT failures, the staff prohibits this use to protect groundwater quality.

> The licensee is prohibited from using the “glue and screw” method of joining well casings to construct any monitoring, injection, or production well.

In addition, staff will include a standard license condition incorporating the applicant’s commitment to MIT procedures proposed in the application (see LC 10.5 in Appendix A).

The staff conducted a detailed review and evaluation on the proposed ISR process and equipment presented in the application and found they are acceptable. License conditions will impose additional inspections, data collection, and reporting requirements on the applicant and provide additional assurance. The staff finds sections reviewed are consistent with the acceptance criteria of standard review plan Section 3.1.3 and comply with 10 CFR 40.32(c), which requires the applicant’s proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property. The staff also finds the proposed operations comply with 10 CFR 40.41(c), which requires the applicant to confine source or byproduct material to the location and purposes authorized in the license. Staff finds that the proposed ISR operations are consistent with NRC-accepted practices and are consistent with operations employed safely at existing NRC-licensed facilities. Based on commitments in the application and the license conditions identified above, NRC staff concludes that the applicant will be able to operate the ISR process in a manner that is safe for workers and the public health and safety and the environment.

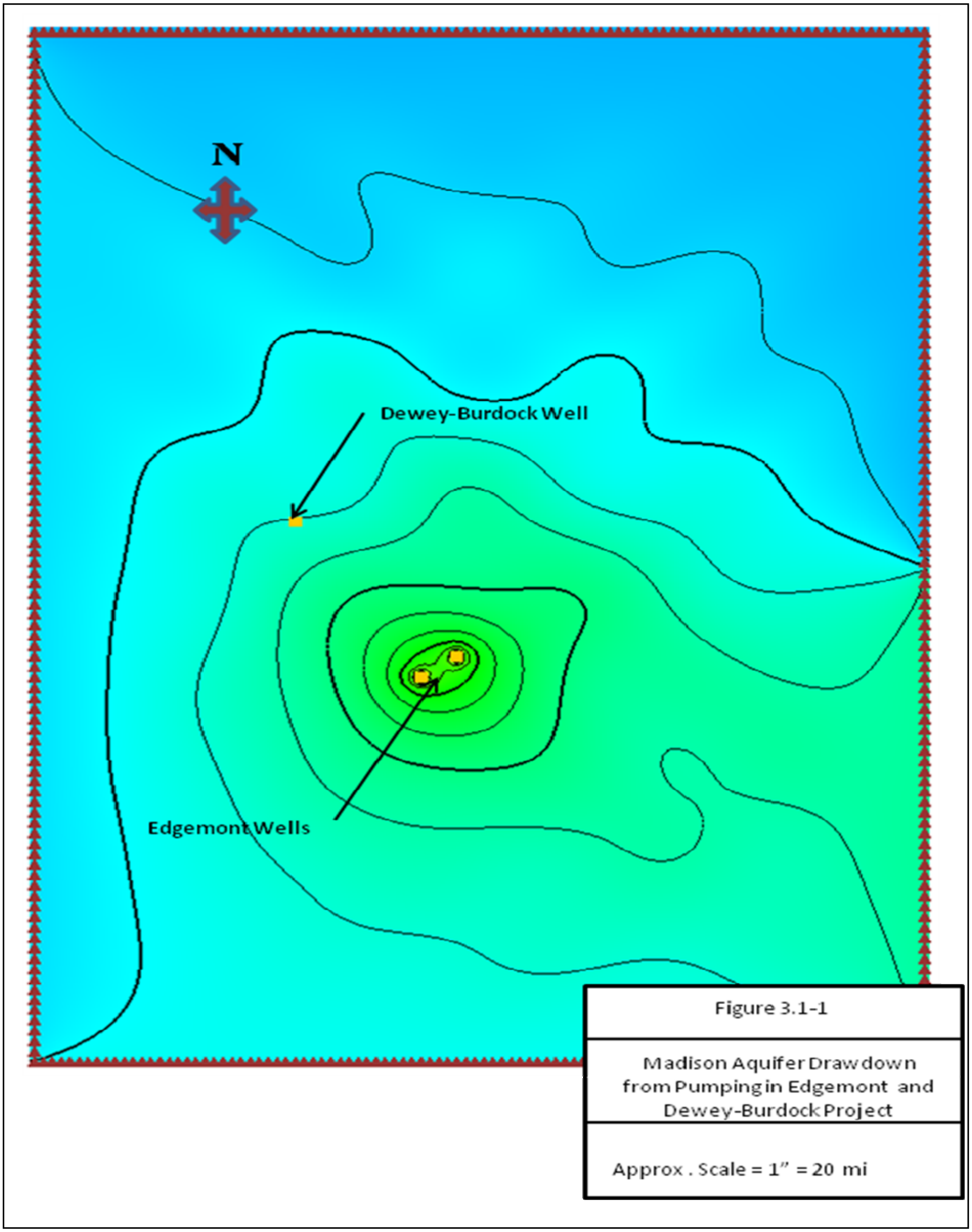

Figure 3.1-1: Madison Aquifer Drawdown – Edgemont Pumping

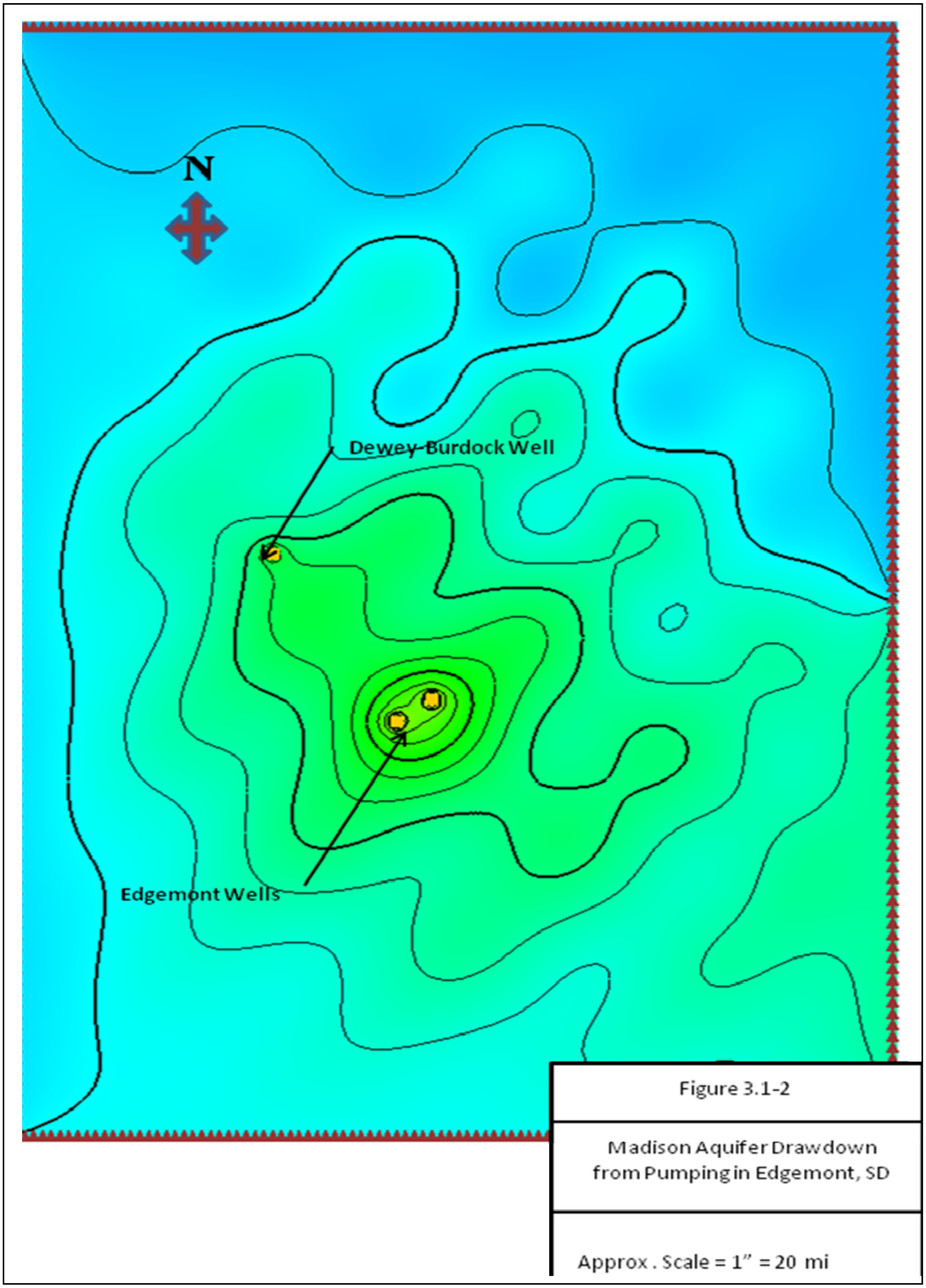

Figure 3.1-2: Madison Aquifer Drawdown – Edgement, Dewey-Burdock Pumping

3.2 PROCESSING PLANT, WELLFIELDS, AND CHEMICAL STORAGE FACILITIES

3.2.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the equipment and processes used during operations in the processing plant and other facilities at the Dewey-Burdock Project meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.2.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria in Section 3.2.3 of the standard review plan (NRC, 2003b).

3.2.3 STAFF REVIEW AND ANALYSIS

3.2.3.1 Processing Plant

The applicant states that the proposed action will make use of ISR production facilities at the Burdock central processing plant (CPP) and the Dewey ion exchange (IX) satellite sites (Powertech, 2009c). The IX process and wellfields are designed for a total flow of 15,140 Lpm (4,000 gpm) with an approximate flow rate of 9,084 Lpm (2,400 gpm) at the Burdock site and 6,056 Lpm (1,600 gpm) at the Dewey site. Total production from both sites is expected to be approximately 454,545 kg (1 million lb) of yellowcake per year. The CPP facilities will be housed in a building approximately 114 m (375 ft) long by 37 m (120 ft) wide, and will include the following systems: ion exchange, resin transfer, chemical addition, filtration, elution, precipitation and thickening, product drying and packaging, liquid waste removal, and drum storage. (Powertech, 2009c)

Equipment located in the plant will include IX and elution vessels, precipitation tanks, filter presses, storage tanks, and the associated piping, pumps, and valves required to be able to move the solutions throughout the plant (Powertech, 2009c). The CPP will also contain 2 vacuum dryers for drying yellowcake slurry into its final powder form. The CPP, an office building, a maintenance warehouse, and storage areas for chemicals and byproduct material will be located within the fenced area at the Burdock site. The Dewey IX satellite facility will be housed in a building located approximately 3 miles to the northwest of the CPP. IX facilities, resin loading and transfer areas, and chemical and temporary byproduct material storage areas will be located within the Dewey satellite fenced area. The applicant has provided drawings showing the layout of the major components within the plant in application Figures 3.2-4 and 3.2-5 in the application (Powertech, 2010b). (Powertech, 2009c).

In application Section 3.2, the applicant describes the proposed processes for uranium extraction and concentration (Powertech, 2009c). For uranium extraction, the applicant will add gaseous oxygen and gaseous carbon dioxide to the re-circulated groundwater from the ore zone aquifer to dissolve and mobilize the uranium. Once dissolved, the uranium bearing groundwater is pumped by submersible pumps in the wellfield production wells to the surface, where it is ionically bonded onto IX resins in the CPP or the satellite plant. After removal of uranium, the groundwater is re-circulated and re-injected via the wellfield injection wells. Once the IX resin is loaded with uranium, the loaded resin is moved to an IX elution (stripping) column where the uranium is stripped from the resin by a saltwater solution. The resulting barren resin is recycled to recover more uranium. Saltwater eluate solution is pumped to a precipitation tank where the uranium is precipitated as a solid uranium yellowcake. Precipitated yellowcake is filtered, washed, dried, and packaged into sealed containers for shipment to facilities for further processing. At the satellite facility, the uranium-rich resin is physically removed from the IX columns and transported via tanker truck to the CPP where uranium is stripped from the resin. Stripped resin is either returned to the satellite facility or disposed as byproduct material at a licensed disposal facility (Powertech, 2010b).

The staff notes that uranium yellowcake precipitated during the ISR process consists of uranium peroxides not uranium oxides as stated by the applicant. Drying yellowcake at approximately 232^{o}C (450^{o}F), as stated by the applicant, produces a yellowcake consisting of uranium oxides and peroxides. The presence of different uranium compounds produces yellowcake of varying solubility, which in turn affects dose and chemotoxicity of the yellowcake. In SER Section 5.0, the staff discusses the effects yellowcake solubility has on dose and toxicity.

The applicant states the primary exposure concerns at the facility are from radon-222 gas and yellowcake dust or particulates. The greatest radon emitting potential occurs at the IX vessels via the air/vacuum relief valves and the shaker screens where the loaded resin and resin transfer water are pumped onto an open screen (Powertech, 2009c). The staff review of processes capable of producing radon exposure is presented in SER Section 4.1. At both the satellite facility and the CPP, the air/vacuum relief valves on the IX columns will be piped together into a manifold vented above the rooflines of the buildings. Shaker screens will have a dedicated vent hood directly overhead connected to exhaust fans, which vent air through stacks in the roofs of the buildings. Building ventilation in the process equipment area uses an exhaust system that draws in fresh air and sweeps the plant air out to the atmosphere. In order to prevent radon accumulation in the CPP, all elution and precipitation tanks will be connected to a vent header that exhausts through a vent stack on the building roof. (Powertech, 2009c)

The applicant states that it will process uranium into yellowcake in two vacuum dryers located in the CPP (Powertech, 2009c). Vacuum dryers are designed to prevent the discharge of uranium during operation using air particulate controls, including a bag house, condenser, vacuum pump, and packaging hood. The bag house is an air and vapor filtration unit connected directly to each dryer. Particulates that pass through the bag filters are wetted and entrained in the moisture within the condensing unit. The vacuum pump is a rotary, water-sealed unit that provides a negative pressure on the entire system during the drying cycle. A sealed hood seated on the top of the drum captures particulates within the packaging system (Powertech, 2009c).

Byproduct material will be stored in roll off bins in a designated storage building at each of the Dewey and Burdock sites, prior to being transported to a licensed disposal facility (Powertech, 2009c). Roll off bins will be used for temporary storage of contaminated materials, including, contaminated used equipment parts, personal protective equipment, and waste from cleanup of spills or other housekeeping activities. Byproduct material wastes will be contained within designated, fully enclosed buildings provides for the control, monitoring and restricted access necessary to secure these materials (Powertech, 2009c).

The applicant's description and evaluation of the major components of the plant is consistent with acceptance criteria 1-4 in standard review plan Section 3.2.3. Detailed drawings showing the location and layout of the proposed ISR facilities provided additional data (NRC, 2003b). The staff observes that the processing plant design and proposed equipment are similar to those used safely in the ISR industry. For these reasons, the NRC has determined these features are acceptable for use in the proposed facility.

3.2.3.2 Chemical Storage Facilities

The ISR process requires chemical storage and feeding systems to store and distribute chemicals for use in various stages of the extraction, processing, and waste treatment processes. In application Section 3.2.8, the applicant states that chemicals to be used and stored onsite include sulfuric acid, sodium hydroxide, hydrogen peroxide, carbon dioxide, oxygen, sodium chloride, sodium carbonate, barium chloride, and propane (Powertech, 2009c). Each chemical storage and feeding system will be designed to safely store and accurately deliver process chemicals to the intended delivery points. (Powertech, 2010b). The applicant commits to designing each chemical storage and feeding system per the International Building Code, International Fire Code, OSHA regulations, RCRA regulations, and Homeland Security regulations (Powertech, 2009c). The applicant will utilize chemical engineering designs and implement chemical process safety standards to keep risks from chemical events at or lower than industry standards. To ensure the radiological risks are minimal, the applicant will implement applicable regulations:

- 40 CFR Part 68, Chemical Accident Prevention Provisions
- 29 CFR 1910.119, Occupational Safety and Health Administration Standards
- 40 CFR Part 355, Emergency Planning and Notification
- 40 CFR 302.4, Designation, Reportable Quantities, and Notification (Powertech, 2009c, 2011a).

Bulk hazardous chemicals that have the potential to impact radiological safety will be stored outside of buildings and will be segregated from areas where licensed materials are processed and stored (Powertech, 2009c). The applicant will develop strict standard operating procedures for receiving, storing, handling, and disposal of hazardous chemicals to ensure the safety of the public and workers.

Application Figures 3.2-4 and 3.2-5 identify the storage locations of all chemicals used in the process (Powertech, 2010b). Process safety controls will include the following: separate containment basins for chemicals stored outside the process buildings; vent headers and scrubbers exhausted through the building roof for tanks inside; level indicators in all tanks; and pressure indicators and flow meters for all pumps. Flow of chemicals will be indicated both locally and in the control room (Powertech, 2009c, 2011c).

Sodium chloride reacts vigorously with sulfuric acid (H_2SO_4). Therefore, the storage areas will be located in separate areas of the CPP to prevent the unintentional contact of these chemicals (see Application Figures 3.2-4 and 3.2-5)(Powertech, 2011a). Each tank also will be connected to a vent header vented through a stack on the roof and scrubbers will be used to prevent emission of particulates during truck unloading (Powertech, 2011a).

Sodium carbonate reacts vigorously with hydrochloric acid (HCl). Therefore, the storage areas will be located in separate areas of the CPP, to avoid unintentional contact of these chemicals (see application Figures 3.2-4 and 3.2-5) (Powertech, 2011a). Each tank will also be connected to a vent header that exhausts through a vent stack on the roof and scrubbers will be used to prevent particulate emissions during truck unloading. (Powertech, 2010b)

The acid, sodium hydroxide, and hydrogen peroxide storage and feeding system will include storage tanks and delivery pumps (Powertech, 2011a). Each 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, in addition to the precipitation expected in a 25-year, 24-hour storm event. This secondary containment basin will contain fluid for each tank individually to avoid hazardous reactions. Each tank will be vented to the atmosphere (Powertech, 2011a).

The oxygen storage facility will be located a safe distance from the CPP and other chemical storage areas (Powertech, 2010b). This storage facility design will meet industry standards set out in NFPA-50. Automatic shutoffs will be utilized in case of power failure. Ventilation equipment in each header house will prevent accumulation of oxygen. Appropriate industrial practices for handling compressed gases will implemented, including isolation the use of system barriers (Powertech, 2010b).

The barium chloride storage and feeding system will include a storage tank, agitator, and chemical metering pump (Powertech, 2010b). This system will be located in a metal building located adjacent to the wastewater pond. Safeguard systems will be designed to prevent the formation of mists and sprays from a piping system leak and the formation of dust to prevent airborne contamination (Powertech, 2010b).

The applicant identified and will implement the applicable Federal and State regulations for the proper handling of hazardous chemicals found in the acceptance criteria in standard review plan Section 3.2.3 (NRC, 2003b). Additionally, the process proposed by the applicant identified the chemicals to be used on site; the proper storage methods, and the potential impacts on radiological health and safety. The staff reviewed the chemicals, storage methods, and potential impacts on radiological health and safety and finds the applicant's proposal is consistent with the acceptance criteria in standard review plan Section 3.2.3 (NRC, 2003b). Therefore, the staff finds this information acceptable and in compliance with 10 CFR 40.32(c) and 40.41(c).

3.2.3.3 Wellfield Operations

The applicant developed a series of numerical simulations based on a calibrated groundwater flow model discussed in SER Section 2.4. The purpose of these simulations is to demonstrate how ore zone aquifers will behave during operations. Specific simulations developed by the applicant include:

- Demonstrations of the hydraulic effects that the proposed project will have on the Fall River and Chilson aquifers, including the sustainability of anticipated production and restoration flow rates.

- Comparison of hydraulic effects of variable bleed rates and production rates of the Fall River and Chilson aquifers.
- Assessment of the level of interference between wellfields that could occur with simultaneous production and restoration operations.
- Evaluation of potential hydraulic effects of the ISR operation on the open mine pit located on the eastern portion of the Dewey-Burdock Project.

The staff verified the applicant's model, the results of which are presented in a memo (NRC, 2013d) found in SER Appendix B. The staff concludes the model contained minor errors, but was satisfactory for use in predictions

Drawdown

The applicant modeled its operations from initial extraction through restoration to assess the drawdown impacts to groundwater from the Fall River and Chilson Aquifers located beyond the Dewey-Burdock Project license boundary (Powertech, 2012a). The applicant modeled 14 wellfields (10 in the Burdock area and 4 in the Dewey area), and the target production rate was 15,140 Lpm (4,000 gpm) at a 0.875-percent, bleed. In addition, multiple simulations were generated using the 0.875-percent production rates, variable bleed rates, and variable restoration rates. Restoration was modeled using extraction and reinjection minus a 1-percent bleed for one scenario and a second scenario assumed 1 pore volume of groundwater sweep (extraction and no reinjection) (Powertech, 2012a).

Application Tables 6-2 through 6-4 present various scenarios modeled by the applicant (Powertech, 2012a). Bleed rates ranged from 0.5 to 1 percent, flow rates ranged from 15,140-Lpm (4000-gpm) to 30,280 Lpm (8,000 gpm), and restoration methods varied from reinjection to no-reinjection for a portion of restoration. Flow rates varied depending on the year due to the number of wellfields in production and the number of wellfields in restoration. As operations continue, flow rates decrease as more wellfields move from production to restoration and restoration is completed (Powertech, 2012a).

Application Figures 6-3 through 6-23 present drawdowns of various time steps of the Burdock and Dewey areas, as operations cycle through production and restoration in all the wellfields (Powertech, 2012a). These figures are based on the proposed licensed flow rate of 15,140-Lpm (4000-gpm) and normal operating bleed of 0.875 percent. The applicant's models predict a maximum drawdown in the Fall River Aquifer of 2.1 m (7 ft) immediately outside the proposed license boundary in year 5 based on the combination of wellfields in production and restoration. Maximum drawdown in the Chilson Aquifer appears to occur in year 8 and is 2.4 m (8 ft) immediately outside the proposed license boundary. The most conservative scenario is a 30,280 Lpm (8,000 gpm) plant flow and a 1 percent bleed. Under these conditions, the maximum expected drawdown is 7.3 m (24 ft) within the wellfields and 3.7 m (12 ft) outside the license boundary (Powertech, 2012a).

The applicant also discusses the effects of ISR operations on water levels in the Triangle mine pits (Powertech, 2012a). According to application Figures 6-3 to 6-15, less than 1 (ft) of drawdown is expected to occur in the pit. Therefore, the applicant does not expect mine pit water to impact water quality or the operations at the Dewey-Burdock project.

Breccia Pipes

Using a groundwater model, the applicant investigated the effect of a potential breccia pipe within the Dewey-Burdock Project on operations. Breccia pipes occur in the Black Hills and are generally the result of dissolution of evaporite deposits in the Minnelusa Formation causing overlying rocks to collapse. Upward vertical gradients exist between the ore zone aquifers and those aquifers underlying the production zone. Therefore, any connection between them would allow water to flow upward into the production zone aquifers, not out of them.

The applicant used its calibrated model to evaluate the effect of a breccia pipe in the proposed project area. The model assumes an inflow of 200 gpm into the ore zone aquifers. Modeling results indicate that a clear groundwater mound forms in the potentiometric surface when breccia pipes are present and spread throughout an aquifer underlying the project area that would propagate throughout the Dewey-Burdock Project. The presence of a groundwater mound would be readily observable by the applicant. The applicant concludes that no breccia pipes exist within the license boundary because no groundwater mounds have been observed.

The staff reviewed the applicant's modeling efforts and determined that it adequately describes the effects of wellfield operations on groundwater hydrology and demonstrates that the applicant can control production fluids without affecting water supplies. The applicant demonstrated that facility operations will have a negligible effect on drawdown and potential of the Triangle mine pit to affect water quality is negligible. As was discussed in SER Section 3.1, the applicant will partially replenish water withdrawn from the Fall River and Chilson Aquifers with water from the Madison Aquifer, thereby preventing significant drawdown in the ore zone aquifers. The staff evaluates the effects the mine pit could have on the Fall River and Chilson Aquifers, in SER Section 2.4. The staff drafted a license condition requiring a monitoring program be in place to detect potential impacts from the mine pit on water quality.

The staff notes that it disagrees with manner in which the applicant modeled the breccia pipes. As previously stated, the applicant assumed that 200 gpm of water will flow from underlying aquifers into the Fall River and Chilson Aquifers. However, the staff's independent review of published reports indicates the opposite; water would flow out of the Chilson and Fall River Aquifers because the hydraulic heads in these aquifers are higher than those of underlying aquifers. This difference does not change the staff's determinations that breccia pipes are not located in the license area. The staff also finds that the applicant will be able to identify any hydrogeologic conditions indicative of breccia pipes during the installation and analysis of individual wellfields.

The staff reviewed information in the application identifying potential effects of facility operations on groundwater hydrology. The Staff determines that the proposed processes and equipment comply with the requirements of 10 CFR 40.32(c) and 40.41(c).

3.2.4 Evaluation Findings

The staff reviewed the proposed equipment to be used and materials to be processed in the recovery plant and chemical storage facilities at the Dewey-Burdock Project in accordance with the review procedures and the acceptance criteria in standard review plan Section 3.2.2 and

Section 3.2.3, respectively. The applicant described the equipment, facilities, and procedures that will be used to protect health and minimize danger to life or property.

Based upon the review conducted by the staff, as indicated in SER Section 3.2, the information provided in the application is consistent with the acceptance criteria of standard review plan Section 3.2.3 and complies with 10 CFR 40.32(c) and 10 CFR 40.41(c).

3.3 INSTRUMENTATION AND CONTROL

3.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated the instrumentation and controls proposed for the Dewey-Burdock Project meet the requirements of 10 CFR 40.32(c) and 40.41(c).

3.3.2 Regulatory Acceptance Criteria

Staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria in Section 3.3.3 of the standard review plan (NRC, 2003b).

3.3.3 Staff Review and Analysis

The applicant describes the instrumentation that will be used in the trunk lines, header houses, wellfields, and processing plant at the facility (Powertech, 2009c). The applicant indicates it will install automated control and data recording systems within the plants to supplement the oversight provided by the operators. Automated systems will include alarms and shutoffs to prevent overflow and overpressure situations and provide centralized monitoring of the process variables (Powertech, 2009c).

The applicant states that the control system at both the IX satellite facility and the CPP will include a programmable logic controller, personal-computer-based operating interface stations, and remote digital and analog input/output racks (Powertech, 2009c). Control systems will receive critical process data. Data to be gathered include header pressures and flow rates sent from header houses via radio signal, which will enable operators to configure flow paths for process streams by opening and closing valves. Operators also will be able to use the operator interface to: start and stop pumps and other equipment; monitor and control liquid levels, flow rates, pressures, and temperatures in process equipment; and monitor equipment process variables and trouble alarms. Control interlocks will be provided to prevent overfilling tanks during liquid transfers within buildings and in external storage tanks. Control interlocks also will be configured to prevent overpressure conditions in equipment and piping in the buildings and header houses, and in buried pipelines (Powertech, 2009c).

Field personnel will perform daily visual inspections of all above-ground pipes, connections, and fittings during daily site visits to detect possible leaks (Powertech, 2009c). Operating pressures of all injection wells, recovery wells, and associated buried piping systems will also be monitored during these visits. In addition, pressure and flow rates for each line would be monitored. If pressure/flow rates fluctuate outside of "normal" operating ranges, the affected line will be shut down. Header houses, pipelines, and deep disposal wells may pose the greatest risk for fluid spills of radioactive material. Consequently, these systems will have alarms to in place to detect high and low pressure, and flow alarms and automatically shut down operations when necessary. Backup generators will be installed to provide power in the event of a power failure to ensure instruments are operating and reporting on conditions in the CPP, SF, and wellfields (Powertech, 2010b) (Powertech, 2009c).

The applicant states that all IX vessels and elution columns will be equipped with pressure relief valves and air/vacuum release valves (Powertech, 2009c). Control interlocks with the well pumps, booster pumps, and inlet and outlet piping will prevent system pressure from exceeding the pressure ratings of system components. Tanks will be equipped with level indicators, and will be connected to vent headers and exhausted through the roof. All pumps will be equipped with pressure indicators and flow meters. Handheld radiation detection instruments and portable samplers will be used to monitor radiological conditions (gamma and beta surveys) in the central processing plant and satellite facility (see SER Section 5.7) (Powertech, 2009c).

The applicant states that the yellowcake drying and packaging system will operate automatically. Automatic shutdown systems to respond to malfunctions such as heating or vacuum system failures will be installed. Alarms will sound automatically if the emission control system does not perform within operational specifications (Powertech, 2010b). To ensure that the emission control system performs within specified operating conditions, instruments capable of continuous monitor will be installed. The use of a continuous monitoring system exceeds the requirement to conduct and document hourly checks specified in 10 CFR Part 40 Appendix A Criterion 8. This monitoring system will signal an audible alarm if the air pressure (i.e. vacuum level) falls below pre-determined levels. The operation of this system will be monitored routinely during dryer operations. The operator must perform and document additional visual inspections of the dryer differential pressure every four (4) hours. In addition, monitoring of air pressure differential gauges on other emission control equipment must be conducted and documented, at least once per shift during dryer operations (Powertech, 2010b).

10 CFR Criterion 8 specifically states that hourly logs must be produced and maintained on site. The applicant has committed to installing automatic monitoring and deactivation equipment for the drying, packaging, and emission controls systems. The staff recognizes, however, that applicant has not identified the procedure by which automated records will be generated into a log and maintained onsite. Furthermore, the applicant has not specified the manner in which plant operators actions will coordinate with the automated systems to ensure that system deactivation occurs when necessary. For these reasons, the staff conditioned the license to require the applicant to develop a procedure for creating and maintaining logs and for responding to automated system notifications. This license condition is found in SER Section 3.3.4.

The proposed instrumentation and control systems that will operate within the wellfields, wellfield houses, trunk lines, production circuit, and deep injection disposal wells have been acceptably described and evaluated by the applicant. The instrumentation proposed allows for continuous monitoring and control of systems, including, total inflow to the plant, total waste flow exiting the plant, tank levels, and the yellowcake dryer. Appropriate alarms and interlocks are part of the instrumentation systems.

The applicant has adequately described evaluated the instrumentation and control aspects of the facility that will be used to monitor the in-situ recovery process. The staff notes that the applicant proposed design and operation features that are consistent with general industry practices. The information provided on instrumentation and backup systems, dryer operational controls, and wellfield controls is consistent with standard review plan Section 3.3.3 acceptance criteria and complies with 10 CFR 40.32(c) and 40.41(c) (NRC, 2003a). Therefore, the proposed instrumentation and controls at the Dewey-Burdock Project are acceptable to NRC staff.

3.3.4 Evaluation Findings

The NRC staff completed its review of the proposed instrumentation and controls. This review included an evaluation using the review procedures in standard review plan Section 3.3.2 and the acceptance criteria in standard review plan Section 3.3.3. The instrumentation and control systems for the wellfields, wellfield houses, trunk lines, plant, and deep disposal wells were adequately described. As discussed in SER Section 3.3.3, the instrumentation will allow for continuous monitoring and control of systems, including flow rates for total inflow to the plant, total waste flow exiting the plant, and liquid levels. Appropriate alarms and interlocks are part of the instrumentation systems. Each control system is equipped with an acceptable alternative that shuts down the system in the event of an emergency or power failure.

The applicant did not provide procedures for producing and maintaining dryer and emissions control systems logs. Additionally, the applicant has not specified how operator actions will coordinate with the automated systems, to ensure shutdown of operations occurs during a malfunction. Therefore, the staff includes the following condition in the license:

> No later than 30 days prior to the preoperational inspection, the licensee shall provide to the NRC staff, for review and written verification, its procedures for preparing logs of the dryer and emissions control system performance in accordance with 10 CFR Part 40, Appendix A, Criterion 8. The procedure shall include the manner in which logs for inspection will be produced and maintained at the Dewey-Burdock Project. These procedures shall also specify specific job functions or categories of personnel responsible for responding to malfunctions of the dryer and emissions control system and the manner in which such responsible persons are notified of malfunctions.

Based on the information provided in the application and supplemented by the aforementioned license condition, and the detailed review conducted of the instrumentation and control for the Dewey-Burdock facility, the staff concludes that the proposed instrumentation is acceptable and is in compliance with 10 CFR 40.32(c) and 10 CFR 40.32(d)

3.4 REFERENCES

NRC (2003b). NUREG 1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Washington, DC. (ADAMS Accession No. ML031550302).

NRC (2013d). Staff Memorandum Regarding the Evaluation of the Powertech (USA) Inc., Groundwater Flow Model, February 19, 2013 (ADAMS Accession No. ML13046A280).

Powertech (2009c). Powertech Dewey-Burdock Application. February 28, 2009 (ADAMS Accession No. ML091200014 - Package).

Powertech (2010a). Dewey-Burdock Project Supplement to Application for Uranium Recovery License Dated February 2009. August 10, 2010 (ADAMS Accession No. ML092870160 - Package).

Powertech (2010b). Powertech (USA) Inc.'s Response to the NRC Staff's Requests for Additional Information Concerning the Dewey-Burdock Project, Custer and Fall River Counties, South Dakota. 12/23/2010 (ADAMS Accession No. ML110030730 - Package).

Powertech (2011a). Revised Responses to the Request for Additional Information (RAI) for the Technical Report (TR); Powertech (USA) Inc.'s Proposed Dewey-Burdock Project. 08/01/2011 (ADAMS Accession No. ML112071064).

Powertech (2012a). Numerical Modeling of Hydrogeologic Conditions, Dewey-Burdock Project, South Dakota. February 27, 2012 (ADAMS Accession No. ML120620195).

SD DENR. (2012). South Dakota Water Rights Permitting Database. April 11, 2012. Retrieved from http://denr.sd.gov/des/wr/dbwrsearch.aspx

4.0 EFFLUENT CONTROL SYSTEMS

4.1 GASEOUS AND AIRBORNE PARTICULATES

This section discusses the basic design and operation of the gaseous and airborne particulates effluent control systems for ISR facilities. Effluent control systems serve to (a) prevent and minimize the spread of gaseous and airborne particulate contamination to the atmosphere using emission controls, and (b) ensure compliance for radiation dose limits to the public.

4.1.1 REGULATORY REQUIREMENTS

For gaseous and airborne particulates generated at the Dewey-Burdock Project, the staff determines if the applicant has demonstrated compliance with 10 CFR Part 40, Appendix A, Criterion 8, which requires milling operations to be conducted so that all airborne effluent releases are reduced to levels ALARA. The applicant must also demonstrate that gaseous and airborne particulates comply with other relevant sections of 10 CFR Part 20 and 10 CFR Part 40.

4.1.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements in 10 CFR Parts 20 and 40 using the acceptance criteria in standard review plan Sections 4.1.3 and 5.7.1.3 that apply to effluent controls (NRC, 2003b). Effluent monitoring is addressed in SER Section 5.7.8, Effluent and Environmental Monitoring.

4.1.3 STAFF REVIEW AND ANALYSIS

4.1.3.1 General

In Section 4.1.2 of the application, it is stated that the primary radioactive airborne effluent at the Dewey-Burdock ISL Facility will be radon-222 and that it expects only minor, incidental releases of uranium during normal operations (Powertech, 2009c). Radon-222 gas will evolve at the locations where the lixiviant solution is initially exposed to atmospheric pressure and ambient temperatures. Airborne particulate emissions can occur during yellowcake drying, which will occur at relatively low temperatures [less than 400 °C (752 °F)] (Powertech, 2009c).

NRC staff notes that a dryer is not the only source of radioactive airborne particulates. Radon-222, a radioactive gas with a 3.8-day half-life, decays to several solid particles that tend to be electrically charged and can deposit on surfaces or attach to dust particles (Mohamed, A., et al., 2008). Radon progeny can build-up in buildings, such as the header houses, if the ventilation is not adequate to ensure complete air exchange. NUREG/CR-6733 also states that spills of radioactive liquids can be a source of air particulates and pose an inhalation hazard if the spills dry before they are cleaned (NRC, 1999a).

4.1.3.1.1 Ventilation Systems

In application Section 5.7.1.1, the applicant states that the process facility is designed such that the dryer and packaging operation are contained within a separate room, with its own HVAC system as well as a sealed hood system to prevent leakage of yellowcake solids during transfer from the dryer to the packaging drums (Powertech, 2009c). A dedicated air handler equipped with high efficiency particulate air (HEPA) filters will ventilate the dryer and packaging room and will provide an additional level of controlling particulate emissions. To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signals an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is routinely monitored during dryer operations. The operator will perform and document inspections of the differential pressure or vacuum every four (4) hours. Additionally, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations. The venting systems described above will be completely separate from the building heating, ventilating, and air conditioning (HVAC) system (Powertech, 2009c).

The applicant states that particulate capture will be provided by a sealed hood that fits on the top of the drum, which is vented through a sock filter to the condenser and the vacuum pump system when the yellowcake powder is being transferred (Powertech, 2009c). The vacuum dryer system will include instruments to operate automatically and to shut down for malfunctions such as heating or vacuum system failures. Alarms will be tripped if there is an indication that the emission control system is not performing within operational specifications. Applicant states that small amount of radon-222 may be encountered during a spill, filter changes, IX resin transfer operations and maintenance activities. Exhaust fans will be placed in key areas of the building to remove any radon that may be released inside the building (Powertech, 2009c).

At both the satellite plants and the CPP, the air/vacuum relief valves on the IX columns will be piped together into a manifold that will be vented above the roofline of the building (Powertech, 2009c). In addition, a flexible duct designed to attach to tanker trucks during loading and unloading of resin will be connected to this vent manifold. Pressure transmitters and pressure gauges on the inlet and outlet piping connected to each vessel will measure and indicate pressure both locally and in the control room. IX column and tanker truck vent systems will not use fans because vacuum relief requires an inflow of air. During favorable weather conditions, open doorways and convection vents in the roof will provide supplemental work area ventilation (Powertech, 2009c). The applicant states that the header houses will be equipped with fans to provide continuous ventilation in order to prevent buildup of oxygen (Powertech, 2011a).

In application Section TR RAI 4.1-3, the applicant has committed to conduct daily ventilation survey that is consistent with Regulatory Guide 8.30 (Powertech, 2011a). The survey will be performed by the radiation safety staff and will consist of operational checks of ventilation systems, to ensure they are operating effectively. The applicant further stated that whenever equipment or procedures in the CPP or the satellite facility are changed in a manner that affects ventilation, the radiation safety staff will conduct a ventilation rate survey using an anemometer or pitot tube to ensure that the ventilation system is operating effectively (Powertech, 2011a).

The staff finds that the description of the natural and engineered ventilation systems provided by the applicant, and discussed in more detail in SER Sections 4.1.3.2 and 4.1.3.3, is consistent with the guidance for ventilation and exhaust fans in Section 3.3 of Regulatory Guide 8.31 because the description follows the Regulatory Guide's recommendations for limiting airborne concentrations in buildings (NRC, 2002b). The staff also finds that the applicant located discharge stacks away from building ventilation intakes, as recommended in Regulatory Guide 8.31 (NRC, 2002b), to minimize exposures in accordance with 10 CFR 20.1101(b).

4.1.3.1.2 Control Systems for Airborne Effluents

In application Section TR RAI 4.1-4, the applicant states that radon effluent and worker exposure to radon decay products will be maintained at levels that are ALARA by implementing engineering controls such as building ventilation, and routine sampling and monitoring (Powertech, 2011a). The applicant states that the highest predicted Total Effective Dose Equivalent (TEDE) to a resident is estimated to be 2.21 mrem per year, which is in compliance with the requirements of 10 CFR 20.1302 (Powertech, 2011a).

To ensure effluents are ALARA, as described in Section 4.1.1, the applicant has committed to use sealed, pressurized, downflow IX vessels to limit routine radon-222 emissions from the CPP or Satellite Facility to resin transfer operations only (Powertech, 2011a). The radon emissions from the resin transfer operation will be exhausted using a dedicated ventilation system and released via a primary release point on or near the roof of the facility. According to the applicant the primary release point will be located away from building intakes to prevent introducing exhausted radon back into the facility. The applicant further stated (Powertech, 2011a) that normal HVAC system will also aid in reducing radon-222 and decay product concentrations within the facility. Potential release points as well as general air in the plant, will be routinely sampled for radon and decay products to assure concentration levels are maintained ALARA (Powertech, 2011a).

The staff finds the applicant's proposed effluent control systems is consistent with acceptance criteria (2) of standard review plan Section 4.1.3 and (4) of standard review plan Section 5.7.1.3 by describing (a) the airborne effluent control systems that are appropriate for the types of effluents generated and (b) performance specifications for the operation of the effluent controls that are consistent with those in Regulatory Guide 3.56, Section 1 (NRC, 1986b).

4.1.3.2 Airborne Uranium

The applicant states that potential radiological air particulate effluents, are generated primarily from dried uranium concentrate in the yellowcake drying and processing areas (Powertech, 2009c). The applicant states that the major source of uranium particulates will be from yellowcake processing and drying operations during normal operations. Yellowcake drying process will occur in vacuum dryer(s) and that, by design, vacuum dryers do not discharge any uranium when operating (Powertech, 2009c).

As stated in the application, gases generated during the drying cycle are filtered through a baghouse, which is located on the top of the dryer, to remove particles down to approximately 1 micron in size (Powertech, 2009c). Gases are then cooled and scrubbed in a surface condenser to further remove the smaller size fraction particulates and the water vapor during the drying process. Two rotary vacuum dryers will be located in a separate building attached to the CPP. This attached building will contain the dryers, the baghouses on the dryers, and a condenser scrubber and vacuum pump system for each dryer. The baghouse and vapor filtration unit will be mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house will be heated to prevent condensation and will be kept under negative pressure. A condenser will be located downstream of the bag house and will be water cooled. Uranium particulates that pass through the bag filters will be wetted and entrained in the condensing moisture within this unit (Powertech, 2009c).

In application Section TR RAI 4.1-2, the applicant states there are three discharge locations within the yellowcake drying and packaging system (Powertech, 2009c). These include: i) the yellowcake discharge valve located directly below the dryer, through which drums are filled with yellowcake, ii) the condensed water vapor that is removed from the condenser and recycled to the yellowcake thickener, and iii) very small amounts of air that are drawn through the vacuum pump and are exhausted into the dryer room of the CPP. The applicant states that the bag house filters and water condenser are designed to capture virtually all particles from the vapor stream leaving the dryer (Powertech, 2009c).

The applicant states that when the yellowcake is dried sufficiently, it will be discharged from the drying chamber through a bottom port into drums (Powertech, 2009c). The applicant states that particulate capture will be provided by a sealed hood that fits on the top of the drum, which is vented through a sock filter to the condenser and the vacuum pump system when the yellowcake powder is being transferred. The applicant states that in the event of system failure, the operator will perform and document checks of the differential pressure or vacuum every four (4) hours. During routine operations, the air pressure differential gauges for other emission control equipment will be observed and documented at least once per shift during dryer operations. Title 10, Part 40, Appendix A, Criterion 8, states that checks must be made and logged hourly of all parameters (e.g., differential pressures and scrubber water flow rates) that determine the efficiency of yellowcake stack emission control equipment operations. The staff cannot determine that the applicant has met this requirement. Therefore, the staff has included a condition in the license regarding commitments and procedures for hourly checks and documentation of all monitoring parameters for the drying and packaging systems. This condition is discussed in Section 4.1.4.

In application Section TR RAI Section 5.7.3-6, the applicant states that it will consider hydrogen peroxide precipitated yellowcake dried at < 400° C as a Class W compound for radiation protection purposes (Powertech, 2011a). The Class W designation will remain until either the solubility class specific to the Dewy-Burdock yellowcake has been analyzed or the specific process has been shown to be comparable to similar processes for which the solubility class of the product has been measured (Powertech, 2011a). A default solubility designation of Class W is acceptable to the staff because this designation is conservative regarding radiological doses when compared to solubility Class D.

The applicant states that the water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams and is recycled back to the process (Powertech, 2009c). This point of discharge will be routinely monitored via filter collection and radiochemical analysis for natural uranium, thorium 30, radium 226 and lead 210 to ensure radionuclide effluent releases are maintained ALARA. The water that is collected from the condenser will be recycled to the precipitation circuit, eluant makeup, or disposed with other process water. The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures (Powertech, 2009d).

If the vacuum dryer system alarms trip due to the emission control system, the operator will follow standard operating procedures to recover from the alarm condition, and the dryer will not be unloaded or reloaded until the emission control system is returned to normal service (Powertech, 2009c). To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signals an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is routinely monitored during dryer operations (Powertech, 2009c).

The staff finds that the applicant's design of the ventilation system and controls are sufficient to maintain airborne concentrations of natural uranium and its daughters in the workplace to less than 25 percent of the Derived Air Concentration (DAC) given in Table 1 of Appendix B to 10 CFR Part 20, as recommended in Regulatory Guide 8.31 (NRC, 2002b). Further, staff is reasonably assured that the applicant's operations will not result in exposures to members of the public above the dose limits established in 10 CFR 20.1301 (a) the distance of the facility from the public and (b) the engineering and administrative controls proposed will limit the public's exposure. This reasonable assurance determination is based on the fulfillment of the license condition regarding hourly monitoring and documenting the vacuum dryer functions discussed in SER Section 4.1.4.

The staff finds that the applicant's descriptions of: (a) emergency procedures in the event of equipment failures or spills, (b) the health and safety impacts of system failures, and (c) contingencies for such occurrences are consistent with acceptance criteria in standard review plan Sections 5.7.1.3 and 4.1.3 (NRC, 2003b). Therefore, the information presented by the applicant complies with 10 CFR Part 40, Appendix A, Criterion 8, and relevant sections of 10 CFR Part 20 and 10 CFR Part 40.

4.1.3.3 Radon

The applicant states that the primary radioactive airborne effluent, radon gas will evolve at certain locations in the CPP and/or satellite plants including the pressurized downflow IX columns into which the lixiviant is directed for loading of the uranium onto resin and the elevated shaker screens, which will receive the loaded resin prior to elution (Powertech, 2009c). Pressured downflow IX columns normally operate so that radon releases from the columns only occur during resin transfer operations. Dedicated local exhaust at the IX columns and shaker screens will be directed to a manifold that is exhausted to the atmosphere outside the building via an induced draft fan. Small amounts of radon-222 from secondary and/or infrequent releases will occur from the wellfield, solution spills, filter changes, byproduct impoundment areas, reverse osmosis (RO) system operation during groundwater restoration, and maintenance activities. The applicant states that radon releases associated with these secondary release points have been shown to be minor components of the overall facility radon-222 source term. The applicant committed to utilizing operational monitoring program similar to the preoperational monitoring program to measure radionuclide particulates and radon-222 that may result in the atmosphere outside the building and other specified locations within the Dewey-Burdock Project (Powertech, 2009c).

Radon emissions from the resin transfer operation will be exhausted using a dedicated ventilation system and released via a primary release point on or near the roof of the facility and away from building intakes (Powertech, 2011a). The applicant states that the general HVAC system in the plant will further reduce employee exposure by removing radon from plant air and will be exhausted through a separate stack. Redundant exhaust fans will direct collected gases to discharge piping that will exhaust fumes to the outside atmosphere. The applicant states that it will routinely sample potential release points as well as general air in the plant for radon and decay products to assure concentration levels are maintained ALARA. Using the results of monitoring obtained during initial plant operation, the applicant will adjust monitoring programs and upgrade ventilation and/or other effluent control equipment as necessary (Powertech, 2011a). The applicant will establish a facility action level of 25 percent of the Derived Air Concentration (DAC) for particulate radionuclides and 0.08 WL for radon-222 decay products. If an airborne radionuclide sample exceeds the action level for radioparticulates or radon-222, the RSO will investigate the cause for such exceedances and evaluate the performance of existing controls and implement new controls, as needed, to mitigate airborne radionuclide concentrations (Powertech, 2011a).

The staff finds that the applicant's design of the ventilation system and controls are sufficient to maintain airborne concentrations of radon and its progeny in the workplace to less than 25 percent of the DAC given in Table 1 of Appendix B to 10 CFR Part 20, as recommended in Regulatory Guide 8.31 (NRC, 2002b). According to the regulatory guide, the 25 percent figure is used to encourage the use of ventilation systems and controls to prevent the existence of airborne radioactivity areas, as defined in 10 CFR 20.1003, and (b) to comply with § 20.1701, which requires "the use, to the extent practical, process or other engineering controls (e.g., containment or ventilation) to control the concentration of radioactive material in air." The staff finds that the described operational monitoring and control systems for radon in the buildings is consistent with acceptance criteria (1) and (2) of standard review plan Section 4.1.3 and acceptance criterion (1) of standard review plan Section 5.7.1.3 and complies with the relevant parts of 10 CFR Part 20 and Part 40.

4.1.4 Evaluation Findings

The staff reviewed the proposed effluent control systems for gaseous and airborne releases of radioactive materials for the Dewey-Burdock Project in accordance with Sections 4.1.3 and 5.7.1.3 of the standard review plan (NRC, 2003b). The applicant described the release points and sources of both uranium and radon at the Dewey-Burdock Project. The applicant provided, in Sections 4.1.1 and 7.2 of the technical report, information on the radiological impact from normal and accidental releases, and stated that it will provide worker training and spill control procedures to deal with these accidental situations. The applicant has committed to meeting 10 CFR Part 20 occupational dose limits and public dose limits and to maintaining these doses ALARA.

The applicant did not specify that it would monitor vacuum dryer and emissions systems on an hourly basis and document such monitoring. Therefore, the staff is including a condition requiring this information, which is presented in SER Section 3.3.4.

Based upon the review conducted by the staff as described above, the information provided in the application, as supplemented by the information in the above license condition, is consistent with the acceptance criteria in standard review plan Sections 4.1.3 and 5.7.1.3, and meets the requirements of 10 CFR Parts 20 and 40.

4.2 LIQUIDS AND SOLIDS

4.2.1 REGULATORY REQUIREMENTS

For liquid effluents generated at the Dewey-Burdock Project, the staff determines if the applicant has demonstrated compliance with 10 CFR 20.1101, 10 CFR 20.1201, 10 CFR 20.1301, 20.2001, 20.2007, and 10 CFR Part 40, Appendix A. For solid byproduct material generated at the Dewey-Burdock Project, the staff determines if the applicant has demonstrated compliance with 10 CFR Part 40 Appendix A, Criterion 2.

4.2.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria in Section 4.2.3 of the standard review plan (NRC, 2003b). Additionally, the staff reviewed the application for compliance with the requirements of 10 CFR Part 20 using Section 6.1.3 in the standard review plan (NRC, 2003b).

4.2.3 STAFF REVIEW AND ANALYSIS

4.2.3.1 Liquids

4.2.3.1.1 Disposal Methods

Deep Disposal Wells

The applicant proposes two options for liquid waste disposal at the Dewey-Burdock Project (Powertech, 2011a). Liquid waste includes the production bleed, groundwater generated during aquifer restoration, process solutions (such as resin transfer water and brine generated from the elution and precipitation circuits), affected well development water, laboratory waste water, laundry water, and plant wash down water. The applicant provided the anticipated liquid byproduct material characteristics in application Table TR RAI P&R-14d-1 (Powertech, 2011a).

The applicant states that the preferred disposal option is underground injection of treated liquid waste in non-hazardous Class V deep disposal wells (DDWs) (Powertech, 2011a). In this disposal option liquid waste will be treated to satisfy EPA non-hazardous waste requirements and injected into the Minnelusa and/or Deadwood Formations in four to eight DDWs being permitted pursuant to the SDWA through the EPA Underground Injection Control (UIC) Program. The applicant indicates that the targeted injection interval in the Minnelusa Formation ranges from 492 to 774 m (1,615 to 2,540 ft) deep, and the targeted injection interval in the Deadwood Formation ranges from 944 to 1,076 m (3,095 to 3,530 ft) deep. (Powertech, 2011a) EPA issued a final rulemaking in December 1999 that revised the Class V UIC regulations. The revisions reclassified all wells that dispose of radioactive waste as Class I wells (40 CFR

144.6(a) and 146.5(a)). Since South Dakota law prohibits Class I DDWs, the applicant states that the liquid waste stream will be treated to remove radioactive constituents (Powertech, 2011a). It will then be disposed of in Class V DDWs or by a land application system if deep disposal is not available or insufficient. To meet the Class V UIC or land application requirements, the applicant proposes to treat the liquid waste to reduce radionuclide activities below the established limits for discharge of radionuclides to the environment, which are listed in 10 CFR Part 20, Appendix B, Table 2, Column 2. (Powertech, 2011a).

The applicant submitted a Class V UIC permit application to EPA Region 8 in March 2010 for authorization to install and operate four to eight DDWs within the project area. The number of wells required will depend on well capacity (Powertech, 2011a). The applicant has requested authorization to inject up to 1,136 Lpm (300 gpm) in a maximum of eight wells. Initially, four DDWs are proposed at the Dewey Satellite Facility and the Burdock CPP. Two disposal wells are proposed at each site, with one well targeting the Minnelusa Formation and one targeting the Deadwood Formation. Based on the anticipated porosity, thickness, lateral extent, and permeability of the receiving formations, the capacity of each Class V DDW is expected to range from 189 to 285 Lpm (50 to 75 gpm). (Powertech, 2011a)

The applicant states that, prior to Class V DDW disposal, liquid waste will be treated as necessary to comply with non-hazardous Class V UIC requirements (Powertech, 2011a). Treatment will typically include uranium removal and other dissolved species in IX columns followed by radium removal through co-precipitation with barium sulfate in radium settling ponds. Surface facilities near the Burdock CPP and Dewey Satellite Facility related to liquid waste disposal in the DDW option will include radium settling ponds, outlet and surge ponds, a Central Plant Pond located at the Burdock CPP, and surface facilities required for DDW operation such as pretreatment facilities, screen/filters, and high pressure pumps for DDWs. (Powertech, 2011a)

The applicant indicates it will provide updated information regarding its Class V application when appropriate milestones are reached (Powertech, 2011a). Class V injection of treated liquid waste is the preferred disposal option, and the applicant anticipates that all liquid waste will be disposed of using this option if sufficient capacity is available in DDWs. For its deep well disposal plans, the applicant indicates that it will be in compliance with the NRC regulations for the alternate disposal of byproduct material in 10 CFR 20.2001, as well as the dose limits in 10 CFR 20.1301. In order to meet the Class V UIC or land application requirements, the applicant proposes to treat the liquid waste to reduce radionuclide activities below the established limits for discharge of radionuclides to the environment, which are listed in 10 CFR Part 20, Appendix B, Table 2, Column 2. These limits are based on Annual Limits on Intake (ALI) of radionuclides for occupational exposure. (Powertech, 2011a)

Land Application

The alternate liquid waste disposal option is land application. This option involves treatment in lined settling ponds followed by seasonal application of treated liquid waste through center pivot sprinklers. Land application will be carried out under a Groundwater Discharge Plan (GDP) permit through the SD DENR (Powertech, 2012b). Depending on the availability and capacity of DDWs, the applicant may use land application in conjunction with DDWs or by itself (Powertech, 2011a).

The applicant states that the land application system will consist of irrigation center pivots, associated pumps and piping, radium settling ponds, and outlet and storage ponds (Powertech, 2011a). Two general land application areas are proposed for liquid waste disposal within the project area, one near the Dewey Satellite Facility and one near the Burdock CPP. Each land application area will have 127 ha (315 ac) of irrigated area and will have approximately 65 acres of center pivots on standby, which could be used during repairs and maintenance of other center pivots or used on a rotating basis. The total proposed land application area at the project would be 308 ha (760 ac), with only 255 ha (630 acres) needed for design flow rates. The center pivot irrigation systems will typically operate 24 hours per day during the growing season, which is approximately April through October. During winter months, when land application will not be used, the treated liquid waste stream will be temporarily stored in storage ponds, located near both the Dewey and Burdock processing facilities. The applicant estimated the disposal capacity for the land application system using the Soil-Plant-Atmosphere-Water (SPAW) model, which was developed by the U.S. Department of Agriculture (Powertech, 2011a).

The applicant indicates that the typical liquid waste flows using the land application option are 178 Lpm (47 gpm) during uranium recovery without concurrent restoration, 2,070 Lpm (547 gpm) during concurrent uranium recovery and aquifer restoration, and about 1,893 Lpm (500 gpm) during aquifer restoration only. The SPAW model results show that each land application area would be able to dispose of approximately 1,124 Lpm (297 gpm) from March 29 to May 10, about 2,472 Lpm (653 gpm) from May 11 to September 24, and approximately 1,124 Lpm (297 gpm) from September 25 to October 31. The applicant concludes that the combined capacity of both areas will be more than sufficient to dispose of the liquid waste stream during the spring, summer, and fall months, and adequate excess capacity will be present during those months to dispose of stored surplus liquid waste from the winter months (Powertech, 2011a).

Based on the staff's review of the applicant's information regarding liquid waste characteristics, plans for deep well disposal, and plans for land application, the staff is reasonably assured that the applicant will construct sufficient liquid waste disposal capacity to address the production and restoration needs at the Dewey-Burdock Project. The staff determines that the applicant's information is consistent with standard review plans Sections 6.1.3 and 4.2.3, because the applicant has adequately projected: (a) the liquid waste composition (which is consistent with the staff's experience at other ISR facilities); (b) the quantities of liquid waste to be produced (discussed in more detail in SER Section 3.0); and (c) adequately described the liquid waste disposal options and the conditions under which each option would be implemented. However, the applicant did not commit to providing effluent disposal information to the staff. Therefore, the staff will include a license condition, discussed in Section 4.2.4, that discusses the need for such information. Based on the staff's review of the applicant's information, as supplemented, by the information specified in the license condition, the staff determines that the applicant's discussion of the liquid waste disposal options complies with 10 CFR 20.1301, 20.2001, and 20.2007.

4.2.3.1.2 Pond Design

Pond Types

Ponds will be required for both of the wastewater disposal options proposed (Powertech, 2011a). Regardless of the option selected for wastewater disposal, wastewater will be treated with barium chloride and directed to radium settling ponds for the removal of the insoluble radium precipitate. In the case of the deep disposal well method of wastewater disposal, ponds will be both smaller and fewer in number than needed with the land application method. Other than radium removal ponds, an outlet pond, and a CPP pond, the waste disposal well option requires ponds only for surge and temporary storage of wastewater destined for injection into the disposal well. In the case of the land application method of wastewater disposal, several ponds will be required for seasonal storage of water during non-application periods (Powertech, 2011a).

The applicant provides information on the design of radium settling/evaporation ponds that may be used with either the deep well disposal or land application options for liquid waste (Powertech, 2010a). Using the deep well disposal option, the following ponds will be used for several purposes:

- 2, 207-m x 52-m (680-ft x 170-ft) radium settling ponds (one 15.9 acre-ft pond at each site) for taking radium out of operational and restoration waste streams;
- 2, outlet ponds (one 5.1 acre-ft pond at each site) to intercept treated water from the settling ponds and to store storm water;
- 2, surge ponds (one 8.4 acre-ft pond at each site) to hold treated water just before pumping to the disposal wells;
- 2, spare ponds (one 15.9 acre-ft pond at each site) for emergency containment in the event of any liner failure;
- 1, 15.9 acre-ft brine pond at the Burdock CPP (Powertech, 2011a).

Under the land application option, several types of ponds also will be needed:

- 2, radium settling ponds (one 39.4 acre-ft pond at each site) for taking radium out of operational and restoration waste streams.
- 2, outlet ponds (one 4.9 acre-ft pond at each site) to intercept treated water from the settling ponds and to store storm water.
- 8, 63.8 acre-ft storage ponds to store water during the non-irrigation season 4 at each site.
- 2, spare ponds (one 39.4 acre-ft pond at each site) for emergency containment should a pond with radium contaminated water fail.
- 2, spare storage ponds (one 63.8 acre-ft pond at each site) for emergency containment should any of the storage ponds fail or the land application system goes down.
- 1, 36.2 acre-ft brine pond at the Burdock CPP to temporarily store liquid waste originating from the CPP during uranium recovery and aquifer restoration operations until the CPP liquid waste can be blended with other sources of liquid waste and treated to meet discharge standards (Powertech, 2011a).

Pond Site Investigations

The staff review included an assessment of: (a) information related to the site of the storage ponds, including the soil conditions; (b) design and construction details of the storage ponds; and (c) operational inspection plans for the storage ponds.

The applicant performed a site investigation at the Dewey-Burdock sites in July 2008. Eleven test pits (5 at Dewey and 6 at Burdock) were excavated, ranging in depth from 1.8 to 4.0 m (6 to 13 ft) (Powertech, 2009c). The applicant determined that the soils underlying the sites consist primarily of lean clays, lean clays with sand, fat clays, and fat clays with sand. Bedrock, where encountered, consisted of claystone and shale. The applicant states that the results from the laboratory tests on samples obtained from the pits indicate the materials are suitable for the construction of the proposed ponds (Powertech, 2009c). Additional drilling activities at the site indicated the presence of a 61 m (200 ft) thick shale layer belonging to the Graneros Group beneath the pond locations. This shale layer does not contain water and isolates the ponds from the uppermost aquifer.

The primary and spare radium settling ponds and the CPP brine pond will be provided with liner systems composed of:

- an 80-mil high density polyethylene (HDPE) primary liner
- a 60-mil HDPE secondary liner
- a geonet drainage layer between the two HDPE liners
- a leak detection sump and access port system
- a 0.3-m (1-ft) thick clay layer below the secondary liner.

All other ponds (containing treated water awaiting disposal) will have a single 40-mil HDPE liner underlain by a 0.3-m (1-ft) thick clay layer. A minimum grade of 2 percent will be maintained across the bottom of the ponds to facilitate the drainage of any leaking water to the leak detection sump (Powertech, 2011a).

The applicant performed static and earthquake stability analyses on the embankment side slopes under normal operating conditions (no phreatic surface) and under conditions assuming leaking has allowed a phreatic surface to form (Powertech, 2010a). Soil strengths and densities for foundation and embankment materials were determined from test results on samples from test pits at both sites. The applicant's analysis was performed using the acceptable Bishop, Janbu, and Morgenstern-Price methods with the GeoStudio 2007 software package. Results of all conditions and methods of the analyses indicated that the minimum factor of safety for the analyses exceeds the 1.5 and 1.0 minimum values for static and pseudo-static analyses used in standard practice (Powertech, 2010a).

Elastic theory was used to obtain an estimate of embankment settlements using material properties obtained from the soil tests (Powertech, 2010a). Because of the low height of the embankments, settlement was determined to be insignificant and would occur during embankment construction (Powertech, 2010a).

The staff has reviewed the applicant's pond design information and determined that the designs are acceptable for the purposes stated in the application. The staff has reviewed test pit logs and the laboratory tests and concurs with the applicant's conclusions regarding suitability for construction. A review of the proposed liner system components indicates that the specifications for the radium settling ponds and CPP brine pond comply with the regulations in 10 CFR Part 40, Appendix A, requiring a synthetic liner have a leak detection system. The applicant has adequately described the materials that will be used to construct the liner and leak detection systems.

The staff notes that the other ponds have been designed to prevent migration of wastes to groundwater or surface water, which is consistent with standard review plan Section 4.2.3 (NRC, 2003b) and 10 CFR Part 40, Appendix A, Criterion 5A(3). When reviewing the design and location for the outlet and storage ponds, staff considered the nature and quantity of the wastes as well as the underlying geology. Staff observes that a thick aquitard layer is present between the liner system and the uppermost aquifer. This aquitard consists of shales belonging to the Graneros Group, which are approximately 61 m (200 ft) thick in the area of the ponds. The site investigations did not indicate the presence of groundwater in the vicinity of the ponds. However, the staff observed that the spare pond for the Burdock area is located within the alluvium, which is known to contain groundwater. Additionally, the pond systems have been designed to provide adequate storage volume for operational and restoration conditions, including maintaining a 0.9-m (3-ft) freeboard.

As part of its State of South Dakota Groundwater Discharge Permit for the land application system, the applicant will install a series of monitoring wells in the alluvium to monitor the land application system (Powertech, 2012b). SD DENR is also requiring, monitoring wells in the alluvium and downgradient of the ponds to determine if pond seepage is entering the perimeter of operational pollution (POP) for the land application area (SD DENR, 2013). As presented in application figure TR RAI 5.7.8-17, only one pond is located mostly in the alluvium; this is the spare pond for the Burdock area. Four land application surge ponds are located immediately adjacent to the alluvium (Powertech, 2011a). Because the alluvium forms a surficial aquifer (see SER Section 2.4.3.3.2), the staff is reinforcing SD DENR's requirement for monitoring wells west of the Burdock area ponds with a license condition discussed in SER Section 4.2.4.

The staff observes that the applicant has not proposed a groundwater monitoring network around the Burdock area and Dewey area ponds because the soils underlying the proposed pond locations are unsaturated and a thick layer of shale underlies those soils. However, the applicant has not clearly demonstrated that no groundwater exists in the shale layer below the proposed pond locations; therefore, the staff is adding a condition to the license stating that the applicant will submit a pond groundwater monitoring plan for the ponds. This condition is discussed in SER section 4.2.4.

The staff also observes that the applicant has demonstrated that the storage ponds will be stable under anticipated loading conditions. By demonstrating the stability of the storage ponds, the applicant has shown that this approach is consistent with standard review plan Section 4.2.3, which states the design of surface impoundments used in the management of byproduct material must meet or exceed the requirements in 10 CFR Part 40, Appendix A, Criterion 5A. The staff also finds the storage pond specifications to be consistent with Regulatory Guide 3.11, Section 2, which describes acceptable methods for slope stability and settlement analyses

(NRC, 2008). In particular, the staff finds the applicant has not presumed that the liner system will function without leakage in its demonstration of the structural integrity, as required by Criterion 5A(5) of Appendix A to 10 CFR Part 40. In addition, static stability analysis follows the recommendations in Section 2 of Regulatory Guide 3.11 (NRC, 2008).

4.2.3.1.3 Construction Considerations

The applicant provided a set of construction specifications and drawings that provide details of the construction aspects of the storage ponds (Powertech, 2011a). NRC staff reviewed the following items: (a) Specification section 4.0; Earthwork-General; (b) Specification section 5.0; Earthwork Preparation and Placement; (c) Specification section 7.0; Quality Assurance/Quality Control, (d) Drawings of site plans and pond sections for the Dewey and Burdock ponds under both the scenarios of land application and deep well disposal.

The staff notes that the applicant's construction specifications provide details regarding the manner in which the storage ponds will be constructed (Powertech, 2011a). The applicant will use excavated material to form the embankment, which will be placed in 20 cm (8 in) thick layers and will be compacted to at least 90-percent of the maximum dry density measured by ASTM D1557. The specifications call for moisture conditioning the soil as necessary to aid in achieving the desired density. For the geomembrane and leak detection system, the applicant has described the techniques that will be used to install these features. The staff reviewed the construction specifications and drawings, and notes that the applicant has provided information regarding storage pond construction. The staff notes that the applicant has construction specifications that clearly identify performance requirements during construction. (Powertech, 2011a)

The staff finds the drawings provide all necessary details, including conceptual-level location of the storage ponds, a cross section of the liner system, and details related to the liner and leak detection system. The staff finds that these specifications follow the construction guidance in Section 3 of NRC Regulatory Guide 3.11, are consistent with standard engineering practices in the geosynthetics industry, and are protective of public health (NRC, 2008). Therefore, construction information provided by the applicant complies with 10 CFR Part 40, Appendix A.

4.2.3.1.4 Operational Inspection

The applicant states that an inspection program based on Regulatory Guide 3.11 would be implemented for all ponds (Powertech, 2011a). A detailed checklist will be developed and followed to document the observations of each significant geotechnical, structural, and hydraulic feature, including control equipment. Trained personnel, who are knowledgeable of the pond construction and safety features, will conduct the inspections. Inspections will be documented and the reports retained on site for reference and inspection by regulatory authorities. Inspections will include but not be limited to the following:

- Daily inspections of the liner, liner slopes, and other earthwork features.
- Daily inspections of pond freeboard.
- Monthly inspection of leak detection systems or daily checks for water accumulation in leak detection systems.

- Quarterly inspections of embankment settlement and slope stability.
- Unscheduled inspections will be performed after occurrence of significant earthquakes, tornadoes, intense local rainfall, or other unusual events (Powertech, 2011a).

The applicant states that if these inspections reveal any damage or defects that could result in leakage, this information will be reported to the NRC within 24 hours, and appropriate repairs will be implemented as soon as possible (Powertech, 2011a). If significant water is found in the leak detection system, the water in the standpipes will be sampled immediately for indicator parameters to confirm that the water in the detection system is from the pond. Chloride and conductivity are proposed as the indicator parameters. If the analysis confirms a leak, a secondary sample will be collected and analyzed within 24 hours. Upon confirmation of a leak by the second analysis, the pond will be taken out of service until repairs can be completed. The leak will be reported to the NRC within 24 hours of the confirmation. A pond removed from service because of a confirmed leak will have its contents transferred to a spare pond. Regardless of the disposal option used at the project, the Dewey and Burdock areas will each have a spare pond of identical capacity, construction, and dimensions as the primary radium settling ponds. At the Burdock area, the spare pond may also serve as a spare for the Central Plant Pond. A spare storage pond will also be included at each area in the land application disposal option. (Powertech, 2011a)

4.2.3.1.5 System Failure

Liquid wastes also may occur due to accidental releases. Potential accidental sources of liquid pollution at the proposed facilities are spills from wellfields and pipelines, central plant and satellite facility operations, or deep well pump houses and wellheads. The only instance in which the wellfield features could contribute to pollution would be in the event of a release of injection or recovery solutions due to pipe or well failure. However, the applicant indicates that the piping will be leak checked first, the flows will be at a relatively low pressure and could be stopped quickly, wellfield header houses will be equipped with wet alarms for early detection of leaks, and piping from the wellfields will generally be buried, minimizing the possibility of an accident (Powertech, 2011a).

The applicant states that the CPP and satellite facilities will have the potential for spills or accidents resulting in the release of potential pollutants (Powertech, 2011a). Spills could result from a release of process chemicals from bulk storage tanks, piping failure, or a process storage tank failure. Outside chemical storage tanks will be contained within a curbed area that will accommodate 1.5 times the capacity of the largest tank. The design of the plant buildings will be such that any release of liquid waste will be contained within the structures. (Powertech, 2011a)

The CPP and the Satellite Facility buildings will be designed with concrete containment curbs around the building perimeters (Powertech, 2011a). The largest liquid-containing vessel in the CPP is the yellowcake thickener with a capacity of 141,940 L (37,500 gal). The applicant plans two of these vessels, having a combined capacity of 283,880 L (75,000 gal). A 15-cm (6-in) high containment curb around the entire perimeter of the CPP floor will contain 304,350 L (80,410 gal). This containment will be more than enough to contain the entire contents of both thickeners in the extremely unlikely event that both thickeners should fail simultaneously and spill their entire contents onto the floor of the CPP before any of the contents flowed into the sump. The sumps will provide additional temporary containment capacity such that the total containment capacity of curbs and sumps is above 200 percent of the largest liquid-containing tank or vessel in the CPP. Yellowcake thickeners will be separated by sufficient distance that collapse of the support footing for one thickener could not cause that thickener to fall into the second thickener. Standard operating procedures and employee training will be in place for emergency situations including spills in the CPP and Satellite Facility (Powertech, 2011a).

For the Satellite Facility, the largest liquid-containing vessel will be the utility water tank, with a volume of 60,560 L (16,000 gallons) (Powertech, 2011a). The Satellite Facility will include a 15-cm (6-in) high, containment curb around the perimeter wall of the building slab. The containment curb capacity will be at least 217,430 L (57,450 gal), or more than 350 percent of the volume of the utility water tank. Sumps will provide additional incremental containment capacity. Sump pumps will direct the spill to the radium, settling pond for treatment and disposal. Depending on the nature of the spilled fluid, the sump pumps may be used to pump the spilled fluid through the ion exchange system for removal of uranium and other dissolved constituents prior to disposal. (Powertech, 2011a)

The design of the deep well pump houses and wellheads will be such that any release of liquids will be contained within the building or in a bermed containment area surrounding the facilities (Powertech, 2011a). Liquid inside the pump house buildings will be contained and managed as appropriate**.** The automated control system on the Class V deep disposal wells will include control switches to alert the operator if certain operating conditions are encountered. A high injection pressure switch (set below the permitted maximum) and a low annulus differential pressure switch (set above the permitted minimum) will shut off injection pump power and will alert the operator so that the well can be fully isolated and secured. The alarm will sound in the central control room of the CPP and/or Satellite Facility. In the event that any of the license condition related set points are exceeded, injection operations will cease immediately until the problem is identified and corrected. An operator will manually restart the system when operating parameter compliance is verified. Lines leading to the deep well will be instrumented for leak detection and automatic deactivation (Powertech, 2011a).

4.2.3.1.6 Land Application Area Sampling

The applicant submitted a proposed Groundwater Discharge Plan to the SD DENR (Powertech, 2012b). This plan contains background sampling and operational monitoring requirements for the land application areas.

Operational land application monitoring will include the following:

- Groundwater monitoring – Alluvial monitoring wells will be installed downgradient at the perimeter of operational pollution (POP) and wells closer to the points of application. The applicant will also use existing wells for land application monitoring.
- Vadose zone monitoring – Suction lysimeters will be installed in each center pivot circle and catchment area.
- Surface water monitoring – The applicant will have 2 surface water sampling locations in each Beaver Creek and Pass Creek, as well as 4 impoundment sampling locations.
- Effluent monitoring – The applicant will measure effluent flow rates and water quality.

- Soil sampling – Prior to use, the applicant will collect 2 samples from each quadrant of each center pivot area for a total of 8 samples per pivot. During operations, the applicant will collect 2 samples from each pivot.
- Vegetation sampling.
- Livestock sampling.

SD DENR established compliance limits for the various media, consisting of the following:

- Groundwater - Compliance limits will be established on a well-by-well basis for each constituent in each compliance monitor well as the human health standards in Table 4.2-3 or ambient water quality, whichever is greater.
- Soil – Trigger limit for arsenic and selenium of baseline concentration plus two standard deviations. (Powertech, 2012b)

The staff has reviewed the applicant's information regarding the management of liquid byproduct material at the Dewey-Burdock Project. The staff determines that the applicant adequately described the proposed facilities for managing liquid byproduct material, has demonstrated that the proposed disposal capacity is sufficient for both production and restoration, and adequately described the inspection program, and procedures to address system failures. The applicant did not commit to providing a periodic report of effluent disposal information to the staff. Therefore, the staff is including a license condition addressing the need for effluent disposal data. Also, the staff is incorporating certain aspects of the Groundwater Discharge Plan prepared for the SD DENR in the Dewey-Burdock License. Based on the above information, the staff has reasonable assurance that the applicant will manage liquid byproduct material generated at the Dewey-Burdock Project in compliance with 10 CFR 20.1301, 20.2001, 20.2007, and 10 CFR Part 40, Appendix A. This reasonable assurance determination is based, in part, on compliance with the license conditions presented in SER Section 4.3.

4.2.3.2 Solids

Solid waste generated at the facility is expected normally to include spent resin, resin fines, miscellaneous pipe, pumps, and fittings, construction debris, and domestic trash, and can be categorized into uncontaminated solid waste, byproduct material, septic system solid waste, and hazardous waste (Powertech, 2009c). Uncontaminated/decontaminated waste will meet NRC activity requirements for release. Septic system waste will be handled in accordance with the South Dakota DENR Solid Waste Management rules and regulations. Hazardous waste is expected to be minimal and Dewey-Burdock will be classified as a Conditionally Exempt Small Quantity Generator. The applicant has committed to disposing of byproduct material (expected to average about 77 m^3 (100 yd^3) per year – primarily pond sludge) at a licensed site, and has indicated that a disposal agreement will be in place prior to the start of operations (Powertech, 2009c).

While the applicant commits to transporting solid byproduct material to a license disposal facility, the applicant has not finalized a disposal agreement. Therefore, the staff is including a condition in the license requiring the applicant to maintain a disposal agreement onsite. This is a standard license condition, and is presented in SER Appendix A.

The byproduct material will be stored on site inside the restricted area until such time as a shipment offsite can be made (Powertech, 2009c). Material will be stored in designated storage buildings, one at the CPP and one at the satellite facility. The buildings will include a concrete slab with a perimeter containment curb, and storage of material will be in enclosed, liquid-tight bins. Each building will accommodate two 15-m^3 (20-yd^3) bins, and thus the volume of byproduct material could accumulate to 31 m^3 (40 yd^3) at each location prior to transport offsite. The concrete slab will allow external decontamination of the roll off bins prior to transport. Containment of the byproduct wastes within a designated, enclosed building will allow proper control of the materials, monitoring, and restricted access (Powertech, 2009c).

In addition, surface and subsurface soil at the site occasionally may become contaminated by leaks and spills of process solutions (Powertech, 2009c). Although the specific concentration of radionuclides in these process solutions is expected to be low, the concentration of contamination in the soil may exceed regulatory limits if the solution is confined to a small area or if there are multiple spills in the same location. The applicant will require that the affected soil be surveyed for contamination and the area of the spill documented as required by the NRC. Spill response is addressed specifically in the applicant's Emergency Response Procedures. Final soil clean up and survey methods will be designed to meet current requirements of the NRC and will be described in the Decommissioning Plan required by the NRC license (Powertech, 2009c).

All site release information and survey results will be maintained as a component of the decommissioning records as required by 10 CFR §20.2103 (Powertech, 2009c). The NRC will be notified by telephone or email within 48 hours of discovery of a spill, pond leak, or excursion. A written report will be provided to the NRC within 30 days of discovery containing the information required by NRC license conditions (Powertech, 2009c).

4.2.4 EVALUATION FINDINGS

The staff reviewed the aspects of the solid and liquid effluents to be generated at the proposed Dewey-Burdock Project in accordance with the procedures in Section 4.2.2 and acceptance criteria in Section 4.2.3 of the standard review plan. The applicant has acceptably described the common liquid effluents generated at the facility. Appropriate control methods, i.e., deep well injection, land application, and surface storage ponds, have been identified. On-site evaporation system designs are prescribed in acceptable detail, including engineering plans and drawings. The applicant has shown that liquid waste disposal facilities are adequate to handle production and restoration efforts and has designed installation and operation of surface impoundments such that the impoundments can contain the entire contents of any other leaking or inoperative impoundment. Embankments used to construct surface-water impoundments comply with Regulatory Guide 3.11, and therefore meet the requirements of 10 CFR Part 40, Appendix A, Criterion 5(A)5. The applicant also presented acceptable plans and procedures that address mitigation and contingencies for all reasonably expected system failures.

Regarding solid byproduct material, the applicant presents acceptable descriptions of this material, expected quantities, storage methods, and disposal methods. However, the applicant has not provided an executed waste disposal contract. SER Appendix A contains a standard license condition regarding the need to maintain waste disposal contracts, and requirements for signing new contracts when necessary.

Because of the importance of maintaining sufficient disposal capacity, the staff is including the following reporting requirement in the license:

> The licensee shall submit semi-annual reports that present the flow rates and volumes of liquid effluent discharged to Class V disposal wells and land application areas, influent flow rates into satellite and central processing plants, and bleed rates. The first report is due no later than 12 months after the start of operations, and shall account for all effluent discharges and inflows during the previous 12 months.

The staff is also incorporating the operational sampling plan for the land application areas, contained in the applicant's SD DENR Groundwater Discharge Plan into this license by reference in the following license condition:

> If land application is utilized, the licensee will implement a pre operational and operational sampling plan, as discussed in Section 6.0 of the licensee's Groundwater Discharge Plan submitted to and per the conditions in its Groundwater Discharge Plan permit issued by the South Dakota Department of Environment and Natural Resources, until principal activities at the land application areas cease.

Furthermore, the staff is incorporating the following license condition regarding groundwater monitoring around the Burdock area and Dewey areas to serve as detection monitoring:

> No later than 60 days prior to construction, the licensee shall submit to the NRC for review and verification, a pond detection monitoring plan that contains the number, locations, and screen depths of groundwater monitoring wells to be installed around the Burdock area and Dewey area ponds. The plan shall also include sampling frequency and sampling parameters. Monitoring wells installed to comply with the licensee's Groundwater Discharge Permit issued by the State of South Dakota may be incorporated into this monitoring network.

Based on the information provided in the application and the detailed review conducted of the effluent control systems for liquids and solids for the Dewey-Burdock facility, the staff has concluded that the proposed effluent control systems for liquids and solids are acceptable and are in compliance with the following regulations:

- 10 CFR 20.1101, which requires that an acceptable radiation protection program that achieves ALARA goals are in place.
- 10 CFR 20.1201, which defines the allowable occupational dose limits for adults.
- 10 CFR 20.1301, which defines dose limits allowable for individual members of the public.

- 10 CFR 20.2007, which requires that disposal by injection in deep wells must also meet any other applicable federal, state, and local government regulations pertaining to deep well injection.
- 10 CFR Part 40, Appendix A, Criterion 2, which requires that Powertech provide an estimate of the amount of contaminated material that will be generated.
- 10 CFR Part 40, Appendix A, Criterion 5E, which requires measures to protect groundwater.
- 10 CFR Part 40, Appendix A, Criterion 5G(1), which requires that the chemical and radioactive characteristics of wastes be defined.

4.3 REFERENCES

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5.0 OPERATIONS

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

5.1.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed corporate organization and administrative procedures for the Dewey-Burdock Project are consistent with 10 CFR 20.1101, and 10 CFR 40.32(b) and (c), which require that the applicant be qualified through training and experience to use source materials.

5.1.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40 using the acceptance criteria presented in standard review plan Section 5.1.3 (NRC, 2003b).

5.1.3 STAFF REVIEW AND ANALYSIS

Powertech (USA) Inc. is the United States based wholly owned subsidiary of the Powertech Uranium Corp., a Corporation registered in British Columbia, Canada (Powertech, 2009c). For purposes of the Proposed Action, Powertech (USA) Inc. and not Powertech Uranium Corp. intends to serve as the licensee for the Dewey-Burdock Project. Powertech (USA) Inc. owns and will operate all of the company's uranium properties in the United States, including the Dewey-Burdock Project. (Powertech, 2009c)

The applicant's organizational structure flows vertically downward from its Board of Directors. The management portion of the applicant's corporate organization includes its Board of Directors, CEO/President, Chief Operating Officer (COO), Vice President (VP) for Exploration, VP for Engineering, VP for Environment, Health, and Safety, and the Facility Manager (Powertech, 2009c). Application Figures 5.1-1 and 5.1-2 present the organizational structure for the corporate management and facility management, respectively. The COO is empowered by the Board of Directors to have the responsibility and authority for the radiation safety and environmental compliance programs for all Powertech (USA) Inc.'s facilities. The VP of Environment, Health, and Safety reports directly to the COO. The VP is responsible for all radiation protection, health and safety, and environmental programs for Powertech. The VP is also responsible for ensuring these programs meet applicable regulatory requirements and industry best management practices (Powertech, 2009c).

The Facility Manager would also report directly to the COO and would be responsible for all uranium production activity at the Dewey-Burdock Project (Powertech, 2009c). The Facility Manager would be responsible for compliance with all applicable laws and regulations and corporate health, safety, and environmental programs. The Facility Manager is also authorized to terminate all activities that can threaten employees, members of the public, and the environment. This person would have the authority to assign facility resources to ensure corporate environmental, health, and safety goals and directives are met. The Facility Manager would act as necessary on recommendations made by the Radiation Safety Officer (RSO) to correct deficiencies identified in the radiation or environmental monitoring programs. (Powertech, 2009c)

All site operations, maintenance, construction, environmental health and safety, and support groups would report directly to the Facility Manager (Powertech, 2009c). The Senior Project Geologist, the Production Superintendent, the Construction Superintendent, and the Administrative Manager are the site department supervisors who would report directly to the Facility Manager. These people would be responsible for the direct supervision of site activities including construction, operation, and maintenance of the CPP, the satellite facility, and all wellfields (Powertech, 2009c).

The RSO would be responsible for the development, administration, and enforcement of all radiation safety and ALARA programs (Powertech, 2009c). This person would work with supervisory personnel to review and approve new equipment and changes in processes and procedures that may affect radiological safety and to ensure that established programs are maintained. The RSO would have the authority to enforce regulations and administrative policies that affect the radiation program and could raise issues concerning safety to the Facility Manager and the VP of Environment, Health, and Safety. This person would have no production-related responsibilities and, as such, would report directly to the VP of Environment, Health, and Safety. (Powertech, 2009c)

Per Regulatory Guide 8.31, the Facility Manager cannot unilaterally override a decision of the RSO to suspend, postpone, or modify an activity (NRC, 2002b). Compliance with Regulatory Guide 8.31 is a standard condition in ISR licenses, and in this case the condition on the applicant's license is reflected in SER Appendix A.

The applicant has requested a performance-based license (PBL) and has proposed the establishment of a Safety and Environmental Review Panel (SERP) (Powertech, 2009c). The purpose of the SERP would be to evaluate, discuss, approve, and record any changes to Standard Operating Procedures, the facilities, or tests and experiments involving safety and the environment. SERP composition, responsibilities, and review procedures are appropriately described in detail in the application. The SERP would consist of a minimum of three individuals. One member of the SERP would have expertise in management and would have the authority to implement managerial and financial changes (e.g., the Facility Manager); one member would have expertise in operations and would have the authority to make operational changes (e.g., the Production Superintendent); and one member would be the RSO. Others may be added to the SERP as appropriate, to address specific technical/scientific aspects of changes (Powertech, 2009c).

The SERP would be responsible for monitoring any proposed change in the facility or process, making changes in procedures, and conducting tests or experiments not contained in the approved NRC license application (Powertech, 2009c). As such, the SERP would be responsible for ensuring that any such changes result in no degradation in essential safety or environmental commitments. The applicant would keep records of the SERP evaluations. On an annual basis, the applicant would submit a report to the NRC that describes all changes, tests, or experiments made pursuant to the PBL, including a summary of the reason for each change and the SERP evaluation of each change (Powertech, 2009c). The particular requirements for SERP composition and authority are presented in a standard license condition found in SER Appendix A.

The applicant has provided an organization structure that defines management responsibilities and authority at each level. The applicant defines the responsibilities and procedures with respect to principal operations, radiation safety programs, environmental and groundwater monitoring programs, quality assurance programs, and routine/non-routine maintenance activities. Proposed integration among groups that support operation and maintenance of the facility is portrayed in the organizational management structure diagram. The applicant specifies acceptable requirements for a SERP with at least three individuals representing expertise in management/financial, operations/construction, and radiation safety matters. It has demonstrated that specific technical issues will be dealt with by the SERP, with support from other qualified staff members or consultants.

Based on the staff's review of the information provided in the application, the staff concludes that the proposed corporate organization and administrative procedures are consistent with the acceptance criteria presented in standard review plan Section 5.1.3 and comply with 10 CFR 20.1101, which defines radiation protection program requirements. In addition, the requirements of 10 CFR 40.32(b) and (c) are also met as they relate to the proposed corporate organization and SERP functions.

5.1.4 EVALUATION FINDINGS

The staff reviewed the corporate organization of the proposed Dewey-Burdock Project in accordance with standard review plan Section 5.1.3. The applicant described its corporate organization and defined management responsibilities and authority at each level. The staff finds the organizational management structure diagram portrays the proposed integration among groups that support operation and maintenance of the facility. The proposed management structure maintains sufficient independence for radiation safety personnel to raise safety issues to management. Therefore, the proposed management structure is acceptable to the staff. Based upon the review conducted by the staff as indicated above, the staff concludes that the proposed corporate organization and administrative procedures provided in the application are consistent with the acceptance criteria of standard review plan Section 5.1.3 and meet the requirements of 10 CFR 40.32(b) and (c), and 10 CFR 20.1101.

5.2 MANAGEMENT CONTROL PROGRAM

5.2.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed management control program for the Dewey-Burdock Project complies with requirements of 10 CFR 20, Subparts L and M, 10 CFR 40.60, 10 CFR 40.61, and 10 CFR Part 40, Appendix A, Criteria 8 and 8A.

5.2.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria outlined in Section 5.2.3 of the standard review plan (NRC, 2003b).

5.2.3 STAFF REVIEW AND ANALYSIS

The applicant will develop written Standard Operating Procedures (SOPs) for all routine activities involving handling, processing, or storing radioactive materials at the Dewey-Burdock Project, and for health physics monitoring, sampling, analysis, and instrument calibration (Powertech, 2009c). The RSO will review and approve all procedures involving radiation safety, and perform an annual review of the operating procedures. These annual reviews will be documented in a review report. Radiation Work Permits (RWPs) would be issued for activities of a non-routine nature with potential for significant exposure to radioactive materials and for which no operating procedure exists. These RWPs would be reviewed and approved by the RSO or, in the absence of the RSO, the RSO designee (Powertech, 2009c). Because the applicant has not yet provided the training program and qualifications for the RSO designee, the staff is including a license condition regarding RSO-designee training. This condition is discussed in SER Section 5.2.4 (Powertech, 2009c).

The applicant will develop instructions for maintenance, control, and retention of records that will be consistent with 10 CFR Part 20 Subpart L, and with 10 CFR Part 40.61 (Powertech, 2009c). The following records will be maintained on site and made available for NRC inspection until license termination:

- Records of any byproduct material disposal (land application/deep well).
- Records of measurements and calculations to evaluate the release of radioactive effluents to the environment.
- Records of inspections of waste retention systems.
- As-built drawings and photographs.
- Records of occupational monitoring.
- Information pertinent to decommissioning and reclamation (spills, excursions, contamination events, facility stoppages, and unusual occurrences).
- Information related to radiological characterization of the facilities.

In addition, records of surveys and calibrations would be maintained for at least 3 years, and records of the periodic RSO inspections and reviews of radiation protection activities would be maintained for at least 5 years. The RSO would be responsible for ensuring that all required records are maintained and controlled. (Powertech, 2009c)

Per 10 CFR 20, Subpart M, 10 CFR 40.60, and consistent with Regulatory Guide 10.1 (NRC, 1981), the applicant will prepare the following reports (Powertech, 2011a):

- Reports of theft or loss of licensed material (10 CFR 20.2201).
- Notification of incidents (10 CFR 20.2202).

- Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the constraints or limits (10 CFR 20.2203).
- Reports of planned special exposures (10 CFR 20.2204).
- Reports to individuals of exceeding dose limits (10 CFR 20.2205).
- Reporting requirements under 10 CFR 40.60.
- Reporting requirements under 10 CFR 40.64.
- Effluent monitoring reporting requirements (10 CFR 40.65).
- Requirements for advance notice of export shipments of natural uranium (10 CFR 40.66).

Specific incident reporting requirements under 10 CFR 40.60 include notifying the NRC within 24 hours of any of the following events:

- An unplanned contamination event that involves a quantity of licensed material greater than 5 times the lowest annual limit on intake or requires restricted access to the contaminated area, by workers or the public, for more than 24 hours.

- Equipment necessary for control of radioactive material or radiation fails and there is no adequate redundancy/substitute.

- An event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body.

- An unplanned fire or explosion affecting the integrity of either a container of licensed material containing a quantity greater than 5 times the lowest annual limit on intake or the licensed material itself.

The applicant will prepare written operating procedures describing reporting requirements after license issuance but prior to ISR operations. (Powertech, 2011a) The applicant will prepare these procedures consistent with 10 CFR Part 20, Subpart M: 10 CFR Part 40.60, and the appropriate recommendations listed in Regulatory Guide 10.1, (Powertech, 2011a).

In addition to the reporting requirement commitments stated above, the applicant will provide the following reports to the staff:

- Email or telephone notification within 48 hours of any spills, pond leaks, or excursions (Powertech, 2009c).
- A written report within 30 days of the occurrence of any of the above reportable events to include: conditions leading up to the event, corrective actions taken, and the results of those actions (Powertech, 2009c).
- Semi-annual report presenting effluent and environmental monitoring data (Powertech, 2009c).
- Annual submittal containing the SERP Report, the ALARA Audit Report, and a summary of radiation program monitoring data and corrective actions resulting from SERP actions, inspections, or reportable events (Powertech, 2009c).
- Annual land-use survey report documenting changes within 3.3 km (2 mi) of license boundary (Powertech, 2011a).

The applicant will also be required to maintain a log of all spills occurring at the site whether or not these spills are reportable to the NRC staff per 10 CFR 40.60. This log will contain at a minimum, date and time of spill, material spilled, amount of the material spilled, cause of spill, spill remediation efforts, spill location (by geographic coordinates), and size of the spill area. Any spill that the applicant must report to any other state or federal agency will be reported to the NRC staff, and all records regarding spills and releases must be maintained onsite until license termination. These reporting requirements will be included in a license condition that is discussed in Section 5.2.4.

The applicant performed a Class III Cultural Resources Survey for the entire area within the proposed license boundary (Powertech, 2009b). The survey documented many archaeological sites. The staff reviewed the archeological survey materials, documented its initial impact assessment to archeological sites found within the site, and proposed mitigation measures for affected sites in its Final SEIS published in January 29, 2014 (ADAMS Accession Numbers ML14024A477and ML14024A478). The staff consulted with interested Indian Tribes on the identification of properties of cultural and religious significance to the Tribes located at the Dewey-Burdock site. Tribal cultural surveys and tribal properties located are described in the tribal survey report. (ADAMS Accession Number ML13343A142). The staff published its determination on the eligibility of cultural resources for listing on the National Register of Historic Places and its determination of effects. (ADAMS Accession Number ML13343A155 and ADAMS Accession Number ML13354B948.

A Programmatic Agreement executed on April 7, 2014, after consultation with consulting parties and Tribes, defines the procedures for identifying, evaluating and protecting historic properties at the site during construction, operations, and decommissioning (ADAMS Accession Number 14066A344; see also SER Appendix A, License Condition 9.8). The applicant states avoidance of archeological sites and tribal properties is its primary goal. Where avoidance is not possible, additional mitigation measures will be employed after consultation with consulting parties and Tribes.

A standard license condition requires the licensee to develop a plan to identify and evaluate historic properties before engaging in any development activity not previously assessed by the staff (see SER Appendix A, License Condition 9.8). In addition, the license condition states the licensee shall comply with the terms and conditions included in the Programmatic Agreement developed to protect cultural resources within the Dewey-Burdock project boundary, in compliance with the National Historic Preservation Act, the Archeological Resources Protection Act, and their implementing regulations.

Regarding posting requirements per 10 CFR 1902(e), the NRC is granting an exemption of these posting requirements for areas within the facility. This exemption is subject to the provision that all entrances to the facility are conspicuously posted with the words, "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL." This exemption is memorialized in a standard license condition found in SER Appendix A.

Based on the review of the information provided in the application, the staff is reasonably assured that the applicant's management control program will sufficiently maintain safe operations at the proposed facility. This reasonable assurance determination is based on information from the application, as supplemented by the standard and site-specific license conditions discussed above. With the fulfillment of the aforementioned license conditions, the staff finds the applicant's description of the management control program is consistent with the acceptance criteria in standard review plan Section 5.2.3 (NRC, 2003b) and complies with 10 CFR Part 40, Appendix A, Criterion 8 and 8A, 10 CFR 20.1101, 10 CFR Part 20, Subparts L and M, 10 CFR 40.60, and 10 CFR 40.61. A facility specific license condition is discussed in SER Section 5.2.4. Information regarding the SERP that is discussed in the aforementioned standard review plan section is discussed in SER Section 5.1.

5.2.4 EVALUATION FINDINGS

The staff reviewed the management control program of the proposed Dewey-Burdock Project in accordance with standard review plan Section 5.2.3. The applicant has proposed acceptable recordkeeping, retention, and reporting programs to ensure that the applicant is able to track and control source and byproduct materials that are processed, produced, or stored at the Dewey-Burdock Project. The applicant has demonstrated an acceptable program to maintain records on spills, likely contamination events, and unusual occurrences for use in calculating surety amounts and to ensure acceptable decommissioning. The applicant will maintain the necessary records in a manner that is consistent with Section 5.2.3 of the standard review plan (NRC, 2003b). The applicant will make reports to the NRC staff, as required by regulations. The staff's determination is based on the information provided in the application, as supplemented by the license conditions discussed below.

The staff notes that spills, excursions, and other contamination events at ISR facilities may not be captured by Part 20 and Part 40 reporting requirements, but such events nonetheless need to be tracked to adequately ensure that the health and safety requirements of 10 CFR 40.32(c) will be met. Therefore, the staff is adding the following language to standard license condition 11.6 to ensure that the applicant reports and documents these activities during operation of the facility (See SER Appendix A):

> Until license termination, the licensee shall maintain documentation on unplanned releases of source or byproduct materials (including process solutions) and process chemicals. Documented information shall include, but not be limited to, the date, spill volume, total activity of each radionuclide released, radiological survey results, soil sample results (if taken), corrective actions, results of postremediation surveys (if taken), a map showing the spill location and the impacted area, and an evaluation of NRC reporting criteria.
>
> The licensee shall have written procedures for evaluating the consequences of the spill or incident/event against 10 CFR Part 20, Subpart M, "Reports," and 10 CFR 40.60 reporting criteria. If the criteria are met, then the licensee shall report to the NRC Operations Center as required.
>
> If the licensee is required to report any production area excursions and spills of source material, byproduct material, or process chemicals that may have an impact on the environment, or any other incidents/events, to any State or other Federal agencies, a report shall be made to the NRC Headquarters Project Manager (PM) by telephone or electronic mail (e-mail) within 24 hours. In accordance with LC 9.3, this notification shall

> be followed, within 30 days of the notification, by submittal of a written report to NRC Headquarters, detailing the conditions leading to the spill or incident/event, corrective actions taken, and results achieved.

Regarding the RSO designee, the staff is requiring the following information by license condition:

> No later than 90 days before the start of operations, the licensee shall provide, for the NRC Staff review and written verification, the qualifications and training required for RSO designees for reviewing and issuing radiation work permits.

Because land use is an important aspect of determining doses to members of the public and addressing overall public safety, the following conditions are added to the license:

> No later than 30 days before the start of operations, the licensee shall submit a report for NRC staff review updating land use descriptions within the Dewey-Burdock Project and within 2 miles of the license boundary. This report shall identify actual land use changes, new structures and the purpose, and new water supply wells and the purpose.
>
> After the initial land use update discussed in LC 12.15, every 12 months thereafter, the licensee shall submit a land use update report for NRC staff review, until groundwater restoration and decommissioning are completed and approved by the NRC.

Based on the information provided in the application and the information required by the license condition above, the staff concludes that the proposed management control program is consistent with the acceptance criteria in Section 5.2.3 of the standard review plan and complies with 10 CFR 20, Subparts L and M, 10 CFR 40.60, 10 CFR 40.61, and 10 CFR Part 40, Appendix A, Criteria 8 and 8A.

5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAM

5.3.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed management audit and inspection program for the Dewey-Burdock Project meets the requirements of 10 CFR 40.32(b) and (c).

5.3.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria outlined in Section 5.3.3 of the standard review plan (NRC, 2003b).

5.3.3 STAFF REVIEW AND ANALYSIS

The Dewey-Burdock RSO, or an RSO designee, will conduct a daily visual inspection of all work and storage areas in the facility to determine if SOPs are being followed properly and good radiation practices are being implemented (Powertech, 2009c). Once a week, the RSO and

Facility Manager will perform an inspection of all facility areas. The purpose of these inspections would be to examine the general radiation control practices and observe any required changes in procedures and equipment. Procedural deviations or other issues potentially causing facility compliance, health and safety, or environmental impacts would be recorded in an inspection logbook or equivalent tracking system along with the date of the inspection and the signature of the inspector. These entries would be kept on file for at least a year (Powertech, 2009c).

The staff notes that the applicant neither provided the qualifications and training program for the RSO designee to perform daily visual inspections nor the duration of the use of such designees. Because inspections are a function of the RSO consistent with Regulatory Guide 8.31 and compliance with this guide is incorporated into a standard license condition, the staff must review the qualifications of all RSO-appointed designees to ensure that radiation safety is maintained (NRC, 2002b). Therefore, the staff is not approving the use of designees for daily inspections until such time that the staff has reviewed and approved the qualifications and training for such individuals. SER Section 5.2.4 discusses the requirement for designee qualifications, and approvals for designees may be sought per standard license condition 9.7 (see SER Appendix A).

At least monthly, the RSO will review the results of daily and weekly inspections, including a review of all monitoring and exposure data for the month (Powertech, 2009c). The RSO will then write a report summarizing the significant worker protection activities for the month. The report would summarize the most recent personnel exposure data, bioassays, and time-weighted calculations for the month along with the pertinent radiation survey records for the month. Additionally, the monthly reports would discuss any trends or deviations from the radiation protection and ALARA program, including an evaluation of the adequacy of the implementation of license conditions regarding radiation protection and ALARA. The reports also would provide a description of unresolved issues and the proposed corrective measures. Monthly summary reports would be submitted to the Facility Manager and made available to the Senior Project Geologist, Construction Superintendent, Production Superintendent, and Administrative/HR Manager (Powertech, 2009c).

The ALARA and radiation protection program would undergo audits annually to provide assurance that all radiation health protection procedures and license condition requirements are being implemented properly (Powertech, 2009c). Audits would be performed by a team consisting of people who are knowledgeable about the radiation protection program at the facility. One team member would be experienced in the operational aspects of radiation protection practices specific to uranium recovery facilities. The RSO would not be a member of the audit team but would be available to support the team and provide needed information.

A written report of the audit will be sent to the Vice President of Environment, Health, and Safety, as well as to the Facility Manager. Reports will summarize employee exposure records (external and internal); bioassay results; inspection log entries; reports of daily, weekly, and monthly inspections; documented training program activities; radiation safety meeting reports; radiological survey and sampling data; reports on overexposure of workers submitted to the NRC; and operating procedures that were reviewed during this time period. Also, the reports will include trend evaluations of personnel exposures; assessments of whether equipment for exposure control is being properly used, maintained, and inspected; and recommendations on ways to further reduce personnel exposures (Powertech, 2009c).

The applicant's management and audit program will be designed to provide quality assurance based upon reviews and evaluations of the effectiveness of radiation protection provided for workers and members of the public (Powertech, 2011a). The applicant will use the report required under 10 CFR 40.65 to specify the quantity of each principal radionuclide released to unrestricted areas during the previous six months of operation. The stated goal of the applicant's radiation protection program is to ensure that doses to workers and the members of the public are ALARA, consistent with 10 CFR 20.1101 (Powertech, 2011a).

The following inspections and audits will ensure the ALARA goal is met (Powertech, 2011a):

- Accident reports and corrective action plans.
- Effluent monitoring programs and air emissions restriction plan.
- Emergency plans.
- Radiation exposure records and monitoring program.
- Security of licensed materials on site.
- Retention system program and reports.
- Transportation of licensed material.
- Environmental monitoring program.
- Inspection and documentation of equipment operation to ensure the equipment is operating consistently near peak efficiency; this includes drying and packaging operations.
- Other institutional controls that will be utilized to prevent and minimize the potential for exposure to members of the public, including the remoteness of the project area and restrictions on land and groundwater use (Powertech, 2011a).

The applicant also discusses a series of engineering controls to keep occupational and public exposures ALARA (Powertech, 2011a):

- Constraint on Radioactive Effluents to Air: Serves to restrict air emissions of radioactive material to the environment, excluding radon-222 and decay products.
- Effluent Control and Monitoring - Serves to establish the control and monitoring system utilized for the facility and ensure monitoring locations are optimized for the intended function.
- Waste Storage Program – Serves to develop and implement a waste storage system that will ensure that the design and installation is conducted in such a manner as to assure any dose that may result is ALARA.

Based on the information provided in the application and the review conducted of the management audit and inspection program for the Dewey-Burdock facility, the staff concludes that the proposed programs are consistent with standard review plan Section 5.3.3 and in compliance with 10 CFR 20.1702, which requires the use of process or other engineering measures to control the concentrations of radioactive material in the air. The proposed programs are also consistent with 10 CFR 20.1101, which contains requirements for maintaining radiation exposure limits ALARA. However, due to a lack of information regarding RSO designees, use of such personnel is not approved at this time. In addition, the requirements of 10 CFR 40.32(b), (c), and (d) are met as they relate to the acceptability of management audits to ensure protection of health and minimize danger to life and property.

5.3.4 EVALUATION FINDINGS

The staff reviewed the management audit and inspection program of the proposed Dewey-Burdock Project in accordance with standard review plan Section 5.3.3. The applicant described the various aspects of daily and weekly inspections that its staff will perform within the facilities and at the storage ponds. The applicant described the personnel that will perform these inspections and is proposing an alternative to the guidance in Regulatory Guide 8.3 pertaining to the RSO designee. However, because the applicant has not provided the qualifications and training for the RSO designee, the staff is not approving the use of RSO designees for daily inspections until such time that the staff reviews and provides written verification of the qualifications and training requirements for such individuals. SER Section 5.2.4 contains a license condition regarding the submission of designee qualifications, and a standard license condition regarding the approval of designee qualifications is contained in standard license condition 9.7.

Based on its review of the applicant's management audit and inspection program, the staff is reasonably assured that the applicant will develop and maintain an audit and inspection program that is consistent with standard review plan Section 5.3.4 and Regulatory Guide 8.31 and complies with 10 CFR 40.32(b) and (c). This reasonable assurance determination is based on the information provided in the application, as supplemented by information required by license conditions discussed above.

5.4 QUALIFICATIONS OF RADIATION SAFETY PERSONNEL

5.4.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the qualifications of the personnel conducting the radiation safety program satisfy 10 CFR 20.1101, which defines the radiation protection program requirements, and 10 CFR 40.32(b), which provides requirements for applicant qualifications.

5.4.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria outlined in Section 5.4.3 of the standard review plan (NRC, 2003b). Regulatory Guide 8.31 also provides recommendations for technical qualifications of radiation safety staff (NRC, 2002b).

5.4.3 STAFF REVIEW AND ANALYSIS

5.4.3.1 Radiation Safety Officer (RSO)

The applicant identified the minimum qualifications for the RSO to include a bachelor's degree in a physical science, industrial hygiene, or engineering from an accredited college or university, or an equivalent combination of training and relevant experience in uranium mill/solution mining radiation protection (Powertech, 2009c). Other minimum qualifications for the RSO identified by the applicant include a minimum of one year of work experience relevant to uranium mill/solution operations in applied health physics, radiation protection, industrial hygiene or similar work, and at least four weeks of specialized training in health physics applicable to uranium recovery operations. An RSO must also possess a thorough knowledge of the proper application and use of all health physics equipment used in operations, the procedures for radiological sampling and monitoring, and methods used to calculate personnel exposures to uranium and its progeny. The RSO must also have a thorough understanding of the uranium recovery process, along with the equipment used, and an understanding of how hazards are generated and controlled during the process. The applicant states that two years of relevant experience is generally considered equivalent to one year of academic study, which is consistent with Regulatory Guide 8.31 (Powertech, 2009c).

Based on the information provided by the applicant, the staff has determined that the RSO qualifications are consistent with Regulatory Guide 8.31 and the acceptance criterion in standard review plan Section 5.4.3. Therefore, the information the applicant has submitted regarding RSO qualifications complies with 10 CFR 40.32(b).

5.4.3.2 Health Physics Technician (HPT)

The applicant identified the minimum qualifications for the Health Physics Technician(s) (HPT) as one of the following combinations of education, training, and experience. One set of qualifications would include an associate's degree or two or more years of study in the physical sciences, engineering, or a health related field; at least a total of four weeks of generalized training in radiation protection applicable to uranium recovery facilities, of which up to two weeks may be on-the-job training; and one year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene or industrial safety measures to be applied in a uranium mill/solution operation.

The applicant states that a high school diploma, a total of three months of specialized training in radiation health protection relevant to uranium recovery facilities (of which up to one month may be on-the-job training), and two years of relevant work experience in applied radiation protection would be an alternative set of qualifications for an HPT. The NRC staff has determined that the HPT qualifications identified by the applicant are consistent with the training and experience recommended in Regulatory Guide 8.31, Section 2.4, as well as the acceptance criterion in standard review plan Section 5.4.3. Therefore, the information provided by the applicant meets the requirements of 10 CFR 40.32(b).

5.4.3.3 Designee

The staff observed that Regulatory Guide 8.31 suggests that a daily inspection be conducted by the RSO or designated HPT (NRC, 2002b). The staff did not find a description of minimum qualifications provided by the applicant for the designee to perform daily inspections or other activities as stated in Sections 5.3.1, 5.2.1, 5.2.2, and 6.5 of the application, in the absence of the RSO and HPT (Powertech, 2010a). Therefore, the staff could not determine whether the training and experience of its proposed designee will meet the requirements of an RSO or HPT as suggested by Regulatory Guide 8.31. Therefore, the NRC staff does not approve the use of a designee as mentioned in the application (Powertech, 2009d), and any future use of the designee for any of the health physics activity is contingent upon the NRC's review and verification of the designee's training requirements, as discussed in SER Sections 5.2.4 and 5.3.4.

5.4.4 EVALUATION FINDINGS

The staff reviewed the qualification requirements of the personnel conducting the radiation safety program at the proposed Dewey-Burdock Project in accordance with standard review plan Section 5.4.3. The applicant described qualifications of the RSO and HPT that are consistent with Regulatory Guide 8.31 (NRC, 2002b).

Standard license condition 9.7, described in SER Section 5.3.4, will require that health physics activities, including daily inspections, be conducted in accordance with Regulatory Guide 8.31, unless the applicant has submitted a modified training program for the designee to the NRC staff for review and written verification. Based upon the information provided by the applicant, the staff is reasonably assured that the applicant will develop and maintain a safety personnel training program consistent with the applicable acceptance criteria of standard review plan Section 5.4.3 and the requirements of 10 CFR 20.1101 and 10 CFR 40.32(b). This reasonable assurance determination is based upon information provided in the application and additional information stipulated in standard and facility specific license conditions discussed in SER Section 5.2.4.

5.5 RADIATION SAFETY TRAINING

5.5.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed radiation safety training program for the Dewey-Burdock Project complies with 10 CFR 19.12, which provides requirements for instructions to workers; 10 CFR 20.1101, which defines radiation protection program requirements; and 10 CFR 40.32(b), as it relates to applicant qualifications through training.

5.5.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 19, 20, and 40, using the acceptance criteria outlined in Section 5.5.3 of the standard review plan (NRC, 2003b). Also, Regulatory Guides 8.13 (NRC, 1999b), 8.29 (NRC, 1996), and 8.31 (NRC, 2002b) provide guidance on (1) protecting the fetus, (2) a basis for training employees on the risks from radiation exposure in the work place, and (3) the fundamentals of protection against exposure to uranium and its progeny, respectively.

5.5.3 STAFF REVIEW AND ANALYSIS

5.5.3.1 New Workers and Supervisors

The applicant states that it will administer its training program in accordance with Regulatory Guide 8.29 (NRC, 1996) and Regulatory Guide 8.31 (NRC, 2002b) (Powertech, 2010a). Training will include information from Regulatory Guide 8.13 regarding prenatal exposures

(NRC, 1999b; Powertech, 2009c). The applicant states that all new workers, including supervisors “subject to occupational radiation dose limits” (i.e. radiation workers), will be given instruction by means of a documented training class that addresses the risks of radiation exposure and fundamentals of protection against exposure to uranium and its progeny. Training topics will include fundamentals of health protection, personal hygiene, facility provided protection, health protection measurements, radiation protection regulations, and emergency/contingency plans. According to the applicant, each worker will be given a written or oral test with questions directly related to the training topics. Any worker who fails the test (less than 70 percent correct) will be retested after receiving additional training (Powertech, 2010a). The applicant states that each radiation worker and supervisor will be provided annual refresher training. It is also stated that the RSO will receive a minimum of 40 hours of documented refresher training in health physics at least once every two years (Powertech, 2010a).

The staff finds the applicant’s plan for training new workers and supervisors is consistent with the recommendations in Section 2.5 of Regulatory Guide 8.31, and is, therefore, in compliance with 10 CFR 19.12, 10 CFR 20.1101, and 10 CFR 40.32(b).

5.5.3.2 Visitors and Contractors

The applicant states that all visitors who enter process areas and have not received training described in application Section 5.5.1 will be escorted by someone trained and knowledgeable about the hazards at the facility (Powertech, 2010a). At a minimum, visitors will be instructed specifically on what they should do to avoid possible hazards (radiological and nonradiological) in the areas of the facility they will be visiting. Contractors working at the facility will be appropriately trained regarding site safety. Contractors working on heavily contaminated equipment or within the process area shall receive the same training and radiation safety instruction normally required of all radiation workers. On the other hand, only job-specific radiation safety instruction is necessary for contract workers who have previously received full training on prior work assignments at the facility or have documentation of recent and relevant radiation safety training elsewhere (Powertech, 2010a).

The staff finds the applicant’s plan for training visitors and contractors consistent with the recommendations in Section 2.5 of Regulatory Guide 8.31.

5.5.3.3 Prenatal Exposure Training

The applicant states that it will ensure that the radiation dose to an embryo/fetus during the entire pregnancy of a declared pregnant worker does not present a health threat and is maintained ALARA (Powertech, 2011a). To ensure this, the applicant has committed to take the following steps (Powertech 2009c):

1) Advise all female workers of child-bearing age at the time of employment that if they are pregnant or become pregnant during their employment, they can voluntarily declare their pregnancy to the applicant to limit radiation exposure to their unborn child. The applicant will provide copies of this policy to all female employees.
2) The applicant encourages pregnant women to declare their pregnancy in order to protect the embryo/fetus.

3) In addition to providing instructions in accordance with 10 CFR 19.12, provide to all female employees the information specified by NRC Regulatory Guide 8.13, including information on biological risks to the embryo/fetus exposed to radiation, the dose limit for the embryo/fetus, and suggestions for reducing radiation exposure.
4) Limit the exposure to the unborn child from occupational exposure of the expectant mother to 500 millirems for the entire pregnancy, if the pregnancy has been declared by the mother.
5) Avoid assigning job duties that could result in substantial variations in the rate of exposure (Powertech, 2011a).

Regulatory Guides 8.13, 8.29, 8.31, and 8.13 provide methods acceptable to the NRC staff for implementing the regulatory requirements in 10 CFR 19.12, 10 CFR 19.13, 10 CFR 19.15, 10 CFR 19.16, 10 CFR Part 20, Subpart C and 10 CFR 20.1208. The staff finds that the radiation safety training program proposed by the applicant is complete except for the following items:

- Acknowledgement in writing by each trainee that the training has been received and understood, as recommended in Regulatory Guides 8.29 (NRC, 1996a) and 8.31 (NRC, 2002b).
- Information concerning potential biological effects resulting from exposure to radiation that is commensurate with the radiological risks present in the workplace, provided to workers as recommended in Regulatory Guide 8.29.

The staff is reasonably assured that the applicant's proposed radiation safety training program will be sufficient to ensure compliance with 10 CFR Parts 19 and 20, contingent upon the fulfillment of the license condition in SER Section 5.5.4, which will require the applicant to administer a training program consistent with Regulatory Guides 8.13, 8.29, and Section 2.5 of Regulatory Guide 8.31, or an NRC-approved equivalent.

5.5.4 Evaluation Findings

The staff reviewed the radiation safety training aspects of the proposed Dewey-Burdock Project. Based on its review of the radiation safety training program, the staff is reasonably assured that the applicant's program will be consistent with standard review plan Section 5.5.3 and will comply with 10 CFR 19.12, Part 20, Subpart C, and 10 CFR 40.32(b). This reasonable assurance determination is based on the information provided in the application, as supplemented by fulfillment of the following license condition:

> The licensee shall ensure radiation safety training is consistent with the current versions of Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure," Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," and Section 2.5 of Regulatory Guide 8.31, or NRC-approved equivalent guidance.

5.6 SECURITY

5.6.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed security measures for the Dewey-Burdock Project meet the requirements of 10 CFR 20, Subpart I.

5.6.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria outlined in Section 5.6.3 of the standard review plan (NRC, 2003b).

5.6.3 STAFF REVIEW AND ANALYSIS

As required in 10 CFR 20, Subpart I, the applicant will secure (from unauthorized removal or access) licensed materials stored in controlled or unrestricted areas by using passive and administrative controls (Powertech, 2009c). All areas where licensed material is stored (e.g. wellfields, CPP, Satellite Facility) would be fenced. All gates accessing areas where licensed material is stored would be posted and locked when facility personnel are not immediately available to prevent unauthorized access to or removal of licensed materials. Facility fences, gates, and postings would be inspected daily as part of the inspection programs. Staff would be on duty at the facility 24 hours a day, 7 days a week, and visitors to the facility would enter through an access point at the main plant entrance where they would sign in and receive required training. In addition, the applicant would control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and is not in storage, such as licensed material being transported from the Satellite Facility to the CPP (Powertech, 2009c).

The security measures proposed for the Dewey-Burdock Project demonstrate that the applicant would have acceptable active and passive constraints on entry to the licensed and restricted areas. The applicant has identified acceptable passive controls, for example, fencing, locked gates, and warning signage for site control, and active security systems and procedures for buildings.

Based on the information provided in the application and the detailed review conducted of the security measures for the Dewey-Burdock facility, the staff concludes that the security measures are acceptable and are in compliance with 10 CFR Part 20, Subpart I, which provides requirements for the security of stored material and control of material not in storage.

5.6.4 EVALUATION FINDINGS

The applicant has described the security measures that will be used for stored material and the control measures it will use for material not in storage. The security measures at the Dewey-Burdock Project, as discussed above, demonstrate that the applicant has acceptable active and passive constraints on entry to the licensed and restricted areas. The applicant has identified acceptable passive controls—for example, fencing, locked gates, and warning signage—for site control, and it has committed to providing active security systems for buildings.

Based on the information provided in the application and the detailed review conducted of the security measures for the Dewey-Burdock Project, the staff concludes that the security measures are acceptable and in compliance with 10 CFR Part 20, Subpart I, which provides requirements for the security of stored material and control of material not in storage.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

This section discusses radiation safety controls and monitoring techniques used to ensure the applicant maintains radiation exposures and releases of radioactive materials in effluents to unrestricted areas ALARA.

5.7.1 STANDARDS

5.7.1.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed radiation safety controls and monitoring for the Dewey-Burdock Project meet the requirements of 10 CFR Part 20 and 10 CFR Part 40, Appendix A, Criteria 7 and 8. The NRC's regulation at 10 CFR 20.1101 requires the applicant to utilize procedures and engineering controls based upon sound radiation protection principles to achieve ALARA doses to workers and the public. Further, 10 CFR 20.1101 requires a licensee to develop, document, and implement a radiation safety program to ensure compliance with the following regulations:

- 10 CFR Part 20, Subparts –
  - C: Occupational Dose Limits, 10 CFR 20.1201-20.1208;
  - D: Radiation Dose Limits for Individual Members of the Public, 10 CFR 20.1301 and 20.1302;
  - F: Surveys and Monitoring, 10 CFR 20.1501 and 20.1502;
  - H: Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas, 10 CFR 20.1701-20.1705;
  - I: Storage and Control of Licensed Material, 10 CFR 20.1801 and 20.1802;
  - J: Precautionary Procedures, 10 CFR 20.1901-20.1906
  - L: Records, 10 CFR 20.2101-20.2110; and
  - M: Reports, 10 CFR 20.2201-20.2206
- 10 CFR Part 20, Appendices
  - A: Assigned Protection Factors for Respirators; and
  - B: Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupations Exposure; Effluent Concentrations; Concentrations for Release to Sewerage.

The following requirements must also be addressed by the licensee:

- 10 CFR 20.1101(c) requires an annual review of the program content and implementation to ensure compliance.

- 10 CFR 20.1301(e) requires compliance with the EPA's environmental radiation standards in 40 CFR Part 190.

- 40 CFR Part 190 mandates that the maximum annual dose equivalent cannot exceed 25 millirems (mrem) to the whole body and 25 (mrem) to any organ of any member of the public as the result of exposures to radiation and to planned discharges of radioactive materials, excluding radon and its progeny, to the general environment from uranium milling operations.

In addition to 10 CFR Part 20, regulations in 10 CFR Part 40, Appendix A, require the following:

- Criterion 7 requires that an operational monitoring program be conducted throughout the construction and operating phases of the mill: (1) to measure or evaluate compliance with applicable standards and regulations; (2) to evaluate performance of control systems and procedures; (3) to evaluate environmental impacts of operation; and (4) to detect potential long-term effects.
- Criterion 8 requires that all airborne effluent releases are reduced to ALARA.

5.7.1.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20, 10 CFR Part 40, and 40 CFR Part 190 using the acceptance criteria in the standard review plan (NRC, 2003b) and the guidance provided in the following:

- Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Mining," June 1982.
- Regulatory Guide 3.51, "Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations," March 1982.
- Regulatory Guide 3.56, "General Guidance for Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills," May 1986.
- Regulatory Guide 3.59, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations," March 1987.
- Regulatory Guide 3.63, "Onsite Meteorological Measurement Program for Uranium Recovery Facilities—Data Acquisition and Reporting," March 1988.
- Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills," April 1980.

- Regulatory Guide 4.15, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)—Effluent Streams and the Environment,” July 2007.
- Regulatory Guide 8.7, “Instructions for Recording and Reporting Occupational Radiation Exposure Data,” Revision 2, November 2005.
- Regulatory Guide 8.9, “Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program,” Revision 1, July 1993.
- Regulatory Guide 8.10, “Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable,” Revision 1-R, May 1977.
- Regulatory Guide 8.13, “Instruction Concerning Prenatal Radiation Exposure,” Revision 3, June 1999.
- Regulatory Guide 8.15, “Acceptable Programs for Respiratory Protection,” Revision 1, October 1999.
- Regulatory Guide 8.22, “Bioassay at Uranium Mills,” Revision 1, August 1988.
- Regulatory Guide 8.25, “Air Sampling in the Workplace,” Revision 1, June 1992.
- Regulatory Guide 8.29, “Instruction Concerning Risks from Occupational Radiation Exposure,” Revision 1, February 1996.
- Regulatory Guide 8.30, “Health Physics Surveys in Uranium Recovery Facilities,” Revision 1, May 2002.
- Regulatory Guide 8.31, “Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable,” Revision 1, May 2002.
- Regulatory Guide 8.34, “Monitoring Criteria and Methods To Calculate Occupational Radiation Doses,” July 1992.
- Regulatory Guide 8.36, “Radiation Dose to the Embryo/Fetus,” July 1992.
- Regulatory Guide 8.37, “ALARA Levels for Effluents from Materials Facilities,” July 1993.
- NUREG-1575, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” Revision 1, 2000.
- Branch Technical Position, “Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material,” Division of Fuel Cycle, Medical, Academic, and Commercial Use Safety, Washington, DC April 1993.

5.7.2 EFFLUENT CONTROL TECHNIQUES

The staff addresses the review and acceptance criteria in standard review plan Section 5.7.1, which pertains to effluent control techniques, in other sections of this SER. The staff’s review of the applicant’s proposed effluent control techniques and monitoring may be found in SER Sections 4.1 and 5.7.8, respectively.

5.7.3 External Radiation Exposure Monitoring Program

5.7.3.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed external radiation exposure monitoring program for the Dewey-Burdock Project meets the requirements of 10 CFR Part 20, Subparts B, C, F, J, L, and M, and 10 CFR 40.61.

5.7.3.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40 using the acceptance criteria in standard review plan Section 5.7.2.3 (NRC, 2003b). Regulatory Guides 4.14 (NRC, 1980), 8.7 (NRC, 2005), 8.10 (NRC, 1977), 8.30 (NRC, 2002a) , 8.31 (NRC, 2002a), and 8.34 (NRC, 1992a) provide guidance on how compliance with these regulations can be demonstrated.

5.7.3.3 Staff Review and Analysis

The following sections present the staff's review and analysis of various aspects of the external radiation exposure monitoring program for the Dewey-Burdock Project. Review areas addressed in this section include radiation surveys, personnel monitoring, records, and reporting.

5.7.3.3.1 Surveys

In application section 5.7.2, the applicant states that its external radiation monitoring program will be consistent with the recommendations of NRC Regulatory Guide 8.30 (Powertech, 2009c). It will perform external radiation measurements continuously at fixed locations, in addition to employee monitoring and period work area surveys. Shortly after the facility becomes operational, the applicant will collect at least 20 gamma radiation measurements to characterize the radiation levels. Locations of these measurements are depicted on figures 5.7-2 through 5.7-5 (Powertech, 2009c).

Based on these measurements, areas where a person may receive a dose of 5 mrem in 1 hour at 30 cm (1 ft) from a radiation source or radiation-emitting surface will be posted as a "Radiation Area" as required in 10 CFR 20.1902(a) (Powertech, 2009c). For areas with radiation levels less than those defined for a radiation area, follow-up measurements will be performed semiannually to evaluate potential impacts of changing process conditions on facility radiation levels. Areas posted as "radiation areas" will be investigated to determine the source of radiation and will be surveyed for gamma radiation quarterly, as described in Regulatory Guide 8.30. Areas posted as "radiation areas" will be investigated to determine the source of radiation and will be surveyed for gamma radiation quarterly using TLDs or equivalent devices, as described in Regulatory Guide 8.30. Methods to reduce radiation levels using engineering controls, process adjustments, or maintenance practices will be evaluated once the source of radiation is determined Powertech, 2009c).

The staff determines that the applicant's commitment to conduct gamma surveys and maintain exposures ALARA is consistent with those recommendations in Regulatory Guides 8.10 (NRC,

1977) and 8.31 (NRC, 2002b), and with acceptance criterion (7) in standard review plan Section 5.7.2.3, which recommends keeping radiation doses ALARA by following these two regulatory guides. The applicant included a drawing that depicted the facility layout and the locations of monitors for external radiation, as recommended in Regulatory Guide 4.14, Sections 1.1.5 and 2.1.6 (NRC, 1980). This is consistent with acceptance criteria in standard review plan Section 5.7.2.3.

The staff notes that the types of survey instruments required depend on the exposures and doses expected. The applicant states that occupational exposures are expected to range from background up to 1000 μR per hour and there may be rare occasions where the gamma dose rate may approach 5 mrem per hour (Powertech,2009c, 2011a). In TR RAI 5.7-2-1-1 of the application (see SER Table 5.7-1), the applicant provided the operating specifications, including radiation type, measurement range (except lower range for beta radiation), and sensitivity of the survey instrumentation that it plans to use. The applicant will use a Ludlum 19 or equivalent meter for most gamma surveys. For gamma dose rates larger than 5 mrem/hr, the applicant will use a Ludlum model 44-38 or equivalent type of detector coupled with an appropriate rate meter (Powertech, 2011a). Ludlum model 44-38 has a measurement range up to 50 mR/hr. According to the applicant, both instruments will be onsite and available for use by properly trained staff during operations. The applicant states that the instrumentation will be calibrated according to the manufacturer's instructions or at least once a year (Powertech, 2009c). Operational checks on the instruments will be performed before each daily use and the instruments will be operated according to manufacturer's recommendations (Powertech, 2009c.

The staff finds the applicant’s description of gamma survey instrument calibration and use is consistent with the recommendations in Section 8 in Regulatory Guide 8.30 (NRC, 2002a). The applicant’s commitments are also consistent with acceptance criterion (3) of standard review plan Section 5.7.2.3 by: (a) identifying the monitoring equipment by type; (b) describing the use of the monitoring equipment to protect health and safety; and (c) describing the calibration methods, frequency, and sensitivity. Therefore, the applicant’s commitments are in compliance with 10 CFR 20.1501(b) and 20.2103(a).

Regulatory Guide 8.30 recommends that, in addition to gamma surveys, beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake be performed to ensure that extremity and skin exposures are not unduly high (NRC, 2002a). Beta surveys should be used to determine the need for protective clothing for these operations. While the applicant identified a type of beta detecting instrument, it is not clear to NRC staff that the applicant intends to perform beta surveys in and around the process area. In addition, the NRC staff did not find the LLD on the beta radiation survey instrumentation, and, therefore, it was unable to determine whether the monitoring equipment has a lower limit of detection that is sufficiently sensitive. Therefore, a license condition as described in SER Section 5.7.3.4 will be included in the Dewey-Burdock Project license.

The applicant states that beta doses will be determined either by utilizing Figures 1 and 2 from Regulatory Guide 8.30 or by using the information acquired during beta radiation surveys (Powertech, 2209c). Average beta radiation fluence rates (number of particles crossing a unit sphere per unit time) can be estimated, assuming all net counts are beta radiation from the yellowcake. The applicant will estimate the beta radiation dose to the skin of workers using the following information:

- Estimated average particle fluence rates.
- Time spent on each operation by each worker.
- The average energy of beta radiation emitted from yellowcake (Powertech, 2009c).

The staff is reasonably assured that the applicant's plans to conduct beta exposure monitoring will be consistent with the acceptance criteria in standard review plan Section 5.7.2.3 and with the recommendations to conduct surveys and re-evaluate the radiation safety program to minimize exposures in Regulatory Guides 8.10, 8.30, and 8.31. This reasonable assurance determination is based on the fulfillment of the license condition presented in SER Section 5.7.3.4 regarding the need for beta surveys. Based on the information presented above and the additional data requested in the aforementioned license condition, the applicant's radiation monitoring program is in compliance with 10 CFR 20.1101 and 20.1501(a)(2)(i).

5.7.3.3.2 Personnel Monitoring

Consistent with 10 CFR 20.1201(a), the applicant has committed to utilize Optically Stimulated Luminescence (OSL) dosimeters exchanged quarterly for assessing the external dose for individuals who may potentially exceed 10 percent of the annual occupational limit (Powertech, 2011a). The applicant may monitor other workers for occupational exposures during the first year of operations, or any other period deemed necessary, to ensure that all workers are receiving less than 10 percent of the 5 rem annual limit. Initially, the applicant will include 83 personnel in the external radiation monitoring program (Powertech, 2011a).

The applicant states that individuals working in and around the areas with gamma exposure rate measurements above 0.25 mR/hr will wear personal dosimeters (Powertech, 2011a). The applicant will conduct an evaluation regarding the cause of the exposure and steps will be taken to keep exposure rates ALARA. Any area exhibiting gamma exposure rate measurements in excess of 5 mR/hr will be designated as a "Radiation Area." An evaluation regarding the cause of such exposure rates will be conducted and steps will be taken to reduce the exposure rate. In addition, once typical operational gamma dose rate levels have been established, the applicant has committed to establishing additional administrative action levels as deemed appropriate by the RSO and as reviewed by the SERP. The applicant committed to implementing the following action levels for dosimeter results:

1) Measured individual worker external whole body deep radiation doses above 125 mrem per calendar quarter or 500 mrem per calendar year will result in investigations as to the cause of the dosimeter result, and steps will be taken to keep radiation doses ALARA.
2) Measured individual worker shallow-doses (skin) above 1,250 mrem per calendar quarter or 5,000 mrem per calendar year will result in investigations as to cause and procedures to mitigate.
3) Measured individual worker external whole body radiation deep doses above 312 mrem per calendar quarter or 1,250 mrem per calendar year will result in work restrictions for the affected workers until an investigation has determined that cumulative internal and external effective dose equivalent (EDE) for the year are unlikely to exceed 5 rem, and that the doses are ALARA. (Powertech, 2011a)

The applicant states that the applicable adult worker radiation dose limits are 5 rem deep-dose equivalent (DDE), 15 rems lens dose equivalent (LDE), 50 rems shallow-dose equivalent to the skin (SDE), and 50 rems shallow-dose equivalent to any extremity (Powertech, 2009c). Applicable limits for minors working at the facility are 10 percent of the adult limits. Applicable limits for declared pregnant workers are the same as adult workers, with the exception of the DDE, which is 10 percent of the adult limit for the period of gestation (Powertech, 2009c).

The applicant states that it may issue multiple dosimeters to employees that have the potential to receive two or more of the doses listed above (Powertech, 2009c). Dosimeters will have a sensitivity of 1 mrem and will be issued by a company currently holding personal dosimeter accreditation by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). Dosimeters will be exchanged monthly for workers with declared pregnancies and quarterly for all other radiation workers. In Section 5.7.2.2 of the Technical Report the applicant states that any external dose received by monitored personnel above 10 percent of the dose limits will be reported on NRC Form 5 or in a format which contains all the information listed on NRC Form 5 (Powertech, 2009c).

The staff finds that the applicant's personnel monitoring program is consistent with Regulatory Guides 8.7 and 8.34 and, thus, consistent with acceptance criteria (2), (5), and (10) in standard review plan Section 5.7.2.3. Therefore, the staff finds the applicant's personnel monitoring program for employees, contractors, and visitors to comply with 10 CFR 19.13 and 10 CFR Part 20, Subparts C, D, F, and L.

5.7.3.3.3 Records and Reporting

The applicant addressed records and reporting in Sections 5.2.5 and 5.2.6 of the approved application (Powertech, 2009c). The applicant committed to permanently maintaining records of its occupational monitoring, both onsite and at an offsite location, until license termination. Additionally, records of surveys and calibrations will be maintained for at least 3 years. Any external dose received by monitored personnel above 10 percent of the dose limits will be reported on NRC Form 5 or in a format which contains all the information listed on NRC Form 5 (Powertech, 2009c).

The staff finds that the applicant's records and reporting for the personnel-monitoring program are consistent with Regulatory Guide 8.7 and, thus, consistent with the acceptance criteria in standard review plan Section 5.7.2.3 and in compliance with 10 CFR Part 20, Subparts C, L, and M, and 10 CFR 40.61.

5.7.3.4 Evaluation Findings

The staff reviewed the radiation safety controls and monitoring aspects of the proposed Dewey-Burdock Project in accordance with standard review plan Section 5.7.2.3. The applicant has provided drawings that depict the facility layout and the location of external radiation monitors. The applicant has identified radiation instrumentation that it will use to conduct gamma radiation surveys and described the frequency of these surveys. The applicant has committed to conducting beta dose rate surveys in accordance with Regulatory Guide 8.30 when needed. The applicant has committed to providing dosimetry to all individuals who may potentially exceed 10 percent of the annual occupational limit and to measuring the DDE and shallow-dose equivalent, if applicable.

The staff has determined that the applicant's commitments regarding gamma exposure rate measurements and assessments are acceptable. Regarding beta exposures, the applicant has not stated whether it would conduct beta surveys in process areas; however, it did provide procedures for calculated beta doses. Because the applicant did not commit to conducting beta surveys in process areas, the following condition has been added to the Dewey-Burdock Project license:

> At least 30 days prior to the preoperational inspection, the licensee shall provide a list of its instrumentation to be used during operations, including the manufacturer, model number or a description, and the range of sensitivity of the radiation survey meters for measuring beta radiation. The licensee shall also provide a plan for conducting beta surveys in process areas.

Based upon the review conducted by the staff as indicated above, the staff is reasonably assured that the applicant's external radiation monitoring program will be consistent with the applicable acceptance criteria in standard review plan Section 5.7.2.3. This reasonable assurance determination is based on the information presented in the approved application, as supplemented by the information discussed in the aforementioned license condition. Therefore, the external radiation monitoring program meets the applicable requirements of 10 CFR Part 20, Subparts B, C, F, J, L, and M, and 10 CFR 40.61.

5.7.4 IN-PLANT AIRBORNE RADIATION MONITORING PROGRAM

5.7.4.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed in-plant radiation monitoring program meets the requirements of 10 CFR Part 20, Subparts B, C, F, and H.

5.7.4.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria in Section 5.7.3.3 of the standard review plan (NRC, 2003b). Regulatory Guide 8.30 also provides guidance on how the applicant can demonstrate compliance with the regulations (NRC, 2002a).

5.7.4.3 Staff Review and Analysis

The applicant's proposed in-plant airborne radiation monitoring program addresses airborne uranium particulate monitoring, radon progeny concentration monitoring, and respiratory protection. In-plant airborne radiation monitoring measures airborne concentrations at various locations in the processing plant to determine necessary posting requirements, respiratory protection needs, and dose assessments. In demonstrating compliance with these requirements, the applicant must provide acceptable methods for determining internal radiation doses, including accounting for the presence of mixtures of contaminants as described in 10 CFR Part 20, Subpart C. Table 1, 10 CFR Part 20, Appendix B, specifies the Derived Air Concentrations (DACs) for each contaminant. Each DAC identifies the concentration for the radionuclide that, if breathed over a course of 2000 hours by a worker, would result in an Annual Limit of Intake (ALI), which equates to the annual occupational dose limit.

5.7.4.3.1 General Program Description

Although the primary operation at the Dewey-Burdock Project will be a wet operation and the lixiviant will be contained within its primary boundary, spills, leaks, and maintenance activities can cause lixiviant/slurry to escape the primary system boundary. Furthermore, yellowcake drying is an operation that could potentially produce airborne uranium. An in-plant airborne radiation monitoring program must be designed to detect contaminants if they escape the primary boundary and become airborne.

The proposed locations of routine airborne particulate and radon progeny sampling are depicted in Figures 5.7-6 to 5.7-9 in Section 5.7.3 of the application (Powertech, 2011a). SER Table 5.7-1 presents the types of surveys, frequencies, and analyses that the applicant will conduct in support of the in-plant radiation-monitoring program. The applicant states that area air sampling frequency will be determined in accordance with Regulatory Guide 8.30 (NRC, 2002a), and the air sampling program will be conducted in accordance with Regulatory Guide 8.25 (NRC, 1992b) (Powertech, 2011a). The remaining subsections in SER Section 5.7.4 describe the staff's detailed analysis of the applicant's specific air monitoring programs.

5.7.4.3.2 Airborne Particulate Uranium Monitoring

Figure TR RAI 5.7.3-3a-1 shows the locations of static monitoring stations for airborne radionuclide areas within the CPP (Powertech, 2011a). Airflow patterns in the facilities will be determined based on locations of air inlets and exhausts relative to sources of airborne radioactive materials. Neutrally buoyant markers may be used to determine airflow patterns. Fixed-location samplers will be evaluated annually to confirm that their locations are still appropriate. Also, whenever any worker areas are altered in size or location, or there is any reason to suspect a change in flow or pattern due to process or equipment changes, the applicant will re-evaluate air flow patterns, and sampling locations will be changed accordingly (Powertech, 2011a).

Air samples will be collected at a height of 0.9 to 1.8 m (3 to 6 ft) between the source and the area occupied by the workers (Powertech, 2011a). The applicant states that in lieu of weekly 30-minute grab samples specified in Regulatory Guide 8.30, weekly low-volume breathing zone samples (lapel samples) will be collected from representative workers in airborne radioactivity areas. The applicant states that the intake of the lapel sampler will be within 0.3 m (1 ft) of the worker's head (Powertech, 2011a).

Table 5.7-1: Summary of Routine In-Plant Radiation Surveys and Monitoring

Type of Survey	Areas to be Surveyed	Frequency	Equipment	Type of Analysis	Estimated LLD
Particulate Air Monitoring: Breathing Zone	As determined by the RSO or required by a RWP	As determined by the RSO or required by a RWP	1. Lapel sampler 2. Alpha counting equipment	Gross alpha	1 x 10^{-11} µCi/ml
On-site Particulate Air Monitoring	In areas shown in Figure 5.7-6 to 5.7-9 and as determined by the RSO	Weekly	Low volume sampler Alpha counting equipment	Gross alpha	1x 10^{-11} µCi/ml
Radon decay products (Working Level)	All buildings normally occupied by workers and as required by an RWP	Monthly for concentrations >0.03 WL and < 0.08 WL. Weekly for concentrations >0.08 WL	Low volume air sampler and filter paper. Alpha counting equipment	Working Level by modified Kusnetz Method	0.03 WL
Fixed Surface Contamination	All occupied buildings at locations designated by the RSO	Weekly	Alpha survey meter	Total alpha	100 dpm/100 cm^2
Removable Surface Contamination	Same as above	Weekly	Swipes or wipes counted on alpha counting equipment	Alpha or beta-gamma	100 dpm/100 cm^2
Personal contamination self survey	Survey hands, feet, clothing	On leaving the restricted area or entering lunchrooms or break areas	Alpha survey meter	Gross alpha, meter set to alarm at 20 cpm	100 dpm/100 cm^2
Equipment Contamination	All surfaces, scan and smears	Prior to release for unrestricted use or use off site	Alpha survey meter GM pancake probe Smears Alpha counting equipment detector, beta gamma detector	Gross alpha and gross beta Removable gross alpha	Fixed Alpha 100 dpm/100 cm^2 500 dpm/100 cm^2 Removable 100 dpm-100 cm^2 Beta Gamma 1000 dpm/100 cm^2
Gamma exposure rate	In plant ((5.7-2 through 5.7-5, Powertech 2009c) see Figure 5.7-1)	Semi-annual except quarterly in designated "Radiation Areas"	Ludlum model 44-38 , Ludlum Model 19 MicroR meter or equivalent	Gamma exposure rate	0.1 mR/hr

Source: (Powertech, 2010a, 2011a)

The applicant states that for non-airborne radioactivity areas within the CPP, it will conduct monthly and weekly monitoring at random locations for in-plant airborne radionuclides via breathing zone monitoring devices assigned to workers performing specific routine tasks (Powertech, 2011a). Air samples will be analyzed for uranium within two working days after sample collection. The lower limit of detection (LLD) of all analyses of air samples will be no greater than 1×10^{-11} µCi/ml. (Powertech 2009c)

The applicant proposed to calculate the LLD for particulate air samples using equation 1, below (Powertech, 2011a).

$$LLD = \frac{3 + 4.65\sqrt{R_b T_s}}{VEKT_s}$$

where:

LLD = the lower limit of detection (µCi/ml)
T_s = the gross counting time or sample counting time (s)
R_b = the background count rate
K = the conversion from disintegrations per second to µCi (3.7 x 104)
E = the counting efficiency (counts per disintegration)
V =the sample volume (ml)

The applicant derived this simplified equation for LLD from the equation to calculate the minimum detectable activity (MDA) presented in Regulatory Guide 8.25 (NRC, 1992a). When performing gross alpha counts on filter samples, the applicant assumed all counts above background to be from natural uranium. The applicant states that the effect of using equation 1 versus the Regulatory Guide 8.30 equation on the LLD is small; however, equation 1 accurately addresses the standard deviation of background count rate (S_b) (Powertech 2009c, 2011a). The staff verified that the equation 1 provided by the applicant is essentially equivalent to equation B-1 in Regulatory Guide 8.30 and provides appropriate expression for the LLD when the background counting time is equal to the sample counting time. The staff concludes that use of equation 1 for LLD is acceptable.

The applicant states that a facility action level of 25 percent of the DAC for particulate radionuclides and 0.08 WL for radon-222 decay products will be established (Powertech, 2011a). If an airborne radionuclide sample exceeds the action level for particulates or radon-222, the RSO will investigate the cause and increase the sampling frequency as appropriate until concentrations are below the action level. An administrative action level will be set at 130 DAC-hours for exposure to particulates and/or radon decay products for any calendar quarter. If the action level is exceeded, the RSO will initiate an investigation into the cause of the occurrence, determine any corrective actions that will reduce future exposures, and document the corrective actions taken. Results of the investigation will be reported to management and the SERP and will be available for NRC inspection. Results of the bioassay program will be used to evaluate the adequacy of the respiratory protection program at the facility. Furthermore, the applicant states that an abnormally high urinalysis result will be investigated to determine the underlying cause and to verify whether records confirm the occurrence of such an exposure. (Powertech, 2011a).

The applicant will use a DAC value to evaluate occupational airborne concentrations. The applicant states that the LLD for natural uranium, Class W, will be less than 1.0×10^{-11} µCi/mL (Powertech, 2009c, 2011a). The staff notes that 1.0×10^{-11} µCi/mL represents less than 10 percent of the DAC for natural uranium, Class W, for inhalation in Table 1 of Appendix B to 10 CFR Part 20. Therefore, the staff has determined that the applicant has adequately established the LLD for uranium in air within the processing plant consistent with Regulatory Guide 8.30 and acceptance criterion (3) of standard review plan Section 5.7.3.3.

The applicant states that the measurement of airborne uranium is performed by gross alpha counting of the air filters using an alpha scaler (Powertech, 2011a). From inspection histories of other ISR facilities, the NRC staff observed that this method does not necessarily differentiate all airborne radioactivity in air samples, including radionuclides that are not uranium. Subpart F in 10 CFR Part 20 specifies that adequate surveys be made to demonstrate that the radiation hazard—in this case, airborne radioactivity—is adequately evaluated so that the appropriate DAC value will be used to control personnel exposures. Because the applicant has not provided this information, the staff is including a license condition to address this issue. This license condition is presented in SER Section 5.7.4.4. The license condition will require the applicant to measure and identify the radionuclides in airborne samples.

Analytical results will be compared to mixture requirements in 10 CFR 20.1204(g) to ensure that the appropriate DAC is used (Powertech, 2011a). If a mixture of radionuclides exists that does not meet the exclusion rule of 10 CFR 20.1204(g), a sum of fractions method will be used to determine the appropriate DAC (Powertech, 2011a).

Based on a review of the applicant's airborne particulate monitoring program, the staff is reasonably assured that the applicant will execute this program in accordance with 10 CFR Part 20, Subpart F. This reasonable assurance determination is based on its acceptable procedures for monitoring airborne uranium and calculating the LLD, and also its commitment to use the mixture rule when appropriate. This determination is also predicated on the fulfillment of the license condition presented in SER Section 5.7.4.4. This information, supplemented by the information required in the aforementioned license condition, is consistent with the acceptance criteria in Section 5.7.3.3 and complies with 10 CFR Part 20, Subparts B and C, 10 CFR 20.1501, and 10 CFR 20.1702.

5.7.4.3.3 Radon Progeny Concentration Monitoring

The applicant states that it will conduct an airborne radiation monitoring program at the project facility that is consistent with the recommendations contained in Regulatory Guide 8.30 (Powertech, 2011a). The monitoring program will consist of monitoring radon decay products as well as airborne particulates. During the first year of operation, the applicant will implement an extensive air particulate program to evaluate and determine area concentrations of key particulates to which workers may be exposed. Breathing zone and particulate monitoring programs are proposed in areas of the CPP where yellowcake is present (application Figure TR RAI 5.7.3-3a-1). The applicant states that the results from the analysis of the air particulate measurements will be utilized to determine whether the engineering controls are maintaining the concentrations to which workers may be exposed ALARA. The applicant states that to maintain ALARA, it will also consider other precautions based on the data from the primary monitoring program, such as access control to some areas, restrictions on working time within specific areas, and the use of personal protective equipment (PPE) for respiratory protection. (Powertech, 2011a)

Application Figures 5.7-6 to 5.7-9 show the proposed monitoring locations where radon decay products are most likely to exceed 0.03 working levels (WL) (Powertech 2011a). In these areas, radon air samples will be collected monthly. Additionally, areas where the radon decay product concentration exceeds 0.08 WL, as indicated by monthly measurements, will be measured for radon decay products weekly. The applicant will also conduct investigations to determine the source of any elevated radon concentrations and appropriate corrective actions will be taken by its RSO. (Powertech, 2011a)

The applicant states that it assumed radon-222 to be the predominant radionuclide expected to be present in the processing plant. Radon samples will be analyzed monthly on an alpha scaler to measure the emission of alpha particles using the modified Kusnetz method (Powertech, 2011a). The Kusnetz method is used in determining and expressing atmospheric concentrations of radon progeny in terms of latent alpha energy. The purpose of the modified Kusnetz method is to reduce the magnitude of the counting error by use of a time factor to back-calculate the true concentration during sampling if nonequilibrium conditions exist (NRC, 2002a). According to the applicant, results of radon progeny sampling will be expressed in WLs, in accordance with 10 CFR Part 20. In Part 20, 1 WL is defined as any combination of short-lived radon-222 progeny in 1 liter of air, without regard to equilibrium, that emits 1.3×10^5 million electron volts of alpha energy (Powertech, 2011a). The staff has reviewed the proposed modified Kusnetz method for the radon progeny monitoring program and has determined that the method is consistent with recommendations in Regulatory Guide 8.30 and in compliance with exposure calculations in 10 CFR 20.1201 and 20.1204.

The applicant stated that the lower limit of detection (LLD) of the instruments used to measure radon-222 with progeny will be less than 0.03 working level (WL) (Powertech, 2009c, 2011a). The staff notes that 0.03 WL represents 10 percent of the DAC for radon-222 with progeny for inhalation listed in Table 1 of Appendix B to 10 CFR Part 20. Regulatory Guide 8.30 recommends that the quantity of air sampled and the method of analysis be 10 percent of the Appendix B limit for radon. The staff determines that the LLD for radon in air is consistent with Regulatory Guide 8.30 and Appendix B and is, therefore, acceptable. However, as discussed in SER Section 5.7.4.3.2, the applicant must verify that alpha radiation measured in the air samples is actually radon progeny. By conducting isotopic analyses of air samples and including longer-lived radon progeny polonium-210 and lead-210 in the analyses, the staff finds that the applicant can obtain data to support the applicant's assumptions for dose calculations that (a) radon will be the primary airborne radioactive material present, and (b) natural uranium will be the primary air particulate present.

Based on the information in the application, the staff is determined that the applicant will properly implement an in-plant radon progeny monitoring program. The applicant commits to radon progeny sampling consistent with Regulatory Guide 8.30 and will use appropriate analytical techniques to measure radon progeny concentrations. Therefore, the information provided in the application is consistent with standard review plan Section 5.7.3.3 and complies with 10 CFR Part 20, Subparts B, C, F, and H.

5.7.4.3.4 Action Levels

The applicant states that the action level for airborne radionuclide concentrations measured minimally on a weekly basis will be 25 percent of the DAC or, in the case of Class W natural uranium, an airborne concentration of 7.5×10^{-11} µCi/ml (Powertech, 2011a). The applicant states that due to the lack of actual operational data, it will assume the natural uranium solubility as Class W for purposes of establishing the initial DAC upon plant startup (Powertech, 2011a). The staff notes that if after operations commence the applicant would like to change the inhalation class, it will be required to demonstrate that such a change is warranted.

The DAC in Table 1 of Appendix B to 10 CFR Part 20 for radon-222 with its progeny present is 0.33 WL. The applicant proposed an action level of 25 percent of the DAC, or 0.08 WL (Powertech, 2011a). The applicant states that air sample results that exceed the action level would result in an investigation of the cause of the elevated concentrations (Powertech, 2011a). The staff finds that the applicant's procedures are consistent with acceptance criterion (1) in standard review plan Section 5.7.4.3 by describing proposed methodologies in accordance with 10 CFR 20.1201 and 20.1204.

The applicant states that it will limit the soluble uranium intake by an individual to 10 mg/week, as specified in 10 CFR 20.1201(e), by ensuring an average airborne uranium concentration limit of 1×10^{-10} µCi/mL (Powertech, 2011a). The applicant states that by assuming all the uranium sampled is soluble, this limit is consistent with the soluble uranium intake limit of 10 mg/week specified in 10 CFR 20.1201(e). The applicant also stated that necessary modifications to the facilities procedures or ALARA program will be developed and implemented in order to further reduce exposures (Powertech, 2011a). However, the staff finds that the applicant has not demonstrated how it will ensure that the weekly uranium intake will be ALARA. Therefore, to ensure compliance with the ALARA requirement in 10 CFR Part 20, the staff is including a license condition, which is discussed in SER Section 5.7.4.4.

Based on the information in the application, the staff is reasonably assured that the applicant will properly develop action levels for airborne radionuclides. The applicant has properly assumed a Class W inhalation class for natural uranium and appropriately developed action levels for natural uranium and radon. However, this reasonable assurance determination is predicated on the fulfillment of the license condition discussed above and presented in SER Section 5.7.4.4.

5.7.4.3.5 Respiratory Protection

In Section 5.7.3-8 of the application, the applicant states that PPE in the form of respiratory protective equipment will be mandatory for workers in areas where the use of process and engineering controls may not be adequate to maintain regulated exposure levels to airborne radioactive and/or toxic materials (Powertech, 2011a). The respiratory protection program will be implemented in accordance with Regulatory Guide 8.15 (NRC, 1999c) and Regulatory Guide 8.31 (NRC, 2002b) and will be administered by the RSO. Work areas exhibiting the potential for overexposures under normal operating conditions are limited to the drying and packaging areas (Powertech, 2011a).

The staff finds that this approach meets the requirements of 10 CFR 20.1702, which requires that, if engineering controls are not practical, the licensee monitor and limit intake by one or more methods in order to maintain the total effective dose equivalent (TEDE) is ALARA. These methods include controlling access, limiting exposure times, the use of respirators, and additional safety measures.

The applicant states that its use of respiratory protection devices will be contemplated only after other measures to limit intake have been considered pursuant to 10 CFR 20.1701 (Powertech, 2011a). If the ALARA evaluation reveals that process and/or engineering controls are not practicable, the applicant will increase monitoring and limit intake by controlling access and exposure time. If it is determined that the use of respirators will optimize the sum of internal dose and other potential risk, the use of a respirator will be implemented in order to keep TEDE ALARA in conformance with Regulatory Guide 8.15 (Powertech, 2011a).

The staff finds the applicant's respiratory protection program to be consistent with the recommendations in Regulatory Guides 8.15 and 8.25 and in compliance with the regulatory requirements in 10 CFR Part 20, Subpart H, Respiratory Protection. The staff finds the applicant also plans to monitor workers' intake by air sampling or bioassay to determine exposure, as required by 20.1204 and 20.1502(b). The staff notes that 10 CFR 20.1703(c)(4)(vii) requires written procedures that address the quality assurance (QA) of respiratory protection equipment in addition to the use and maintenance described by the applicant. The applicant's proposed Quality Assurance Project Plan (QAPP), which is described briefly in Figure TR RAI P&R-16-1 (Powertech, 2011a), is planned for environmental and effluent monitoring following guidance in Regulatory Guide 4.15 (NRC, 2007b). Although the applicant did not specifically address a QA program, the applicant committed to developing and administering a respirator program consistent with requirements in 10 CFR 20.1703 (Powertech, 2011a). The staff finds the applicant's proposed respiratory protection program to be in compliance with 10 CFR Part 20, Subparts B, C, F, and H, and thus, acceptable.

5.7.4.4 Evaluation Findings

The staff reviewed the in-plant airborne radiation monitoring program of the proposed Dewey-Burdock Project in accordance with standard review plan Section 5.7.3.3. The applicant plans to conduct in-plant airborne monitoring pursuant with 10 CFR Part 20, Subpart B, which defines the radiation protection program. This program includes monitoring for the two primary contaminants and the instruments that the applicant will use to collect and analyze the results of the air samples.

The applicant has demonstrated that it will use adequate methods to evaluate the airborne particulate monitoring as required by 10 CFR Part 20, Subpart F. The applicant has identified methods that will meet the occupational dose limit requirements of 10 CFR Part 20, Subpart C, and will control the concentration of radioactive material in air as required in 10 CFR Part 20, Subpart H. Additionally, the applicant has committed to using the sum of fractions method to determine the appropriate DAC if it identifies that a mixture exists that does not meet the exclusion rule in 10 CFR 20.1204(g).

However, because the applicant has not demonstrated that its monitoring program can differentiate between various radionuclides of concern, the following condition is being added to the Dewey-Burdock license:

> The licensee shall conduct radiological characterization of airborne samples for natural U, Th-230, Ra-226, Po-210, and Pb-210 for each restricted area air particulate sampling location at a frequency of once every 6 months for the first 2 years following issuance of the initial license, and annually thereafter to ensure compliance with 10 CFR 20.1204(g). The licensee shall also evaluate changes to plant operations to determine if more frequent radionuclide analyses are required for compliance with 10 CFR 20.1204(g).

The staff finds that although the applicant has demonstrated an acceptable method for ensuring the soluble intake of uranium is limited to comply with 10 CFR 20.1201(e), it has not demonstrated how it will assure that the weekly uranium intake will be ALARA. Therefore, to ensure compliance with the ALARA requirement in 10 CFR 20, the staff includes the following license condition:

> No later than 30 days before the preoperational inspection, the licensee shall submit to the NRC staff, for review and written verification, an acceptable method to ensure the soluble intake of uranium will be ALARA.

In conclusion, the staff is reasonably assured that the applicant will develop and implement an adequate in-plant monitoring program. This reasonable assurance determination is based on the information provided in the application, as supplemented by the information required by the aforementioned license conditions. Therefore, the applicant’s description of its proposed in-plant monitoring program is consistent with standard review plan Section 5.7.3.3 and complies with 10 CFR Part 20, Subparts B, C, F, and H.

5.7.5 EXPOSURE CALCULATIONS

This section discusses the exposure calculations to be performed by the applicant. Workers may be exposed to radioactive material in the air or to loose surface contamination within the restricted area, which may result in an intake of radioactive material into the body. In addition, this section addresses exposure calculations for female workers who declare pregnancy and discusses the calculation of dose to the embryo/fetus.

5.7.5.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed exposure calculation for the Dewey-Burdock Project meets the requirements of Subparts C, F, L, and M of 10 CFR Part 20. Specific regulations that must be followed include 10 CFR 20.1201(e); 10 CFR 20.1204(f); 10 CFR 20.1204(g); and 10 CFR 20.1502.

5.7.5.2 Regulatory Acceptance Criteria

The application was reviewed for compliance with the applicable requirements of 10 CFR Part 20 using the acceptance criteria presented in standard review plan Section 5.7.4.3 (NRC, 2003b). Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure" (NRC, 1999b) and Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus" (NRC, 1992c), provide guidance on how to demonstrate compliance with the regulations.

5.7.5.3 Staff Review and Analysis

5.7.5.3.1 Worker Dose Calculations

The applicant states in application Section 5.7.2 that it will monitor worker exposures by using the following or a combination of the following methods:

- Personal dosimeters,
- area radon progeny concentration measurements as described in application Section 5.7.4.3.3,
- area measurements of gross alpha concentrations in airborne particulate matter as described in application Section 5.7.4.3.1, and
- measurement of radionuclide concentrations in worker breathing zones (Powertech, 2011a).

The applicant will use dosimetry to measure the deep dose equivalent (DDE), which can be used as the effective dose equivalent (EDE) or the external component of occupational exposure (Powertech, 2009c, 2011a). The committed effective dose equivalent (CEDE), or internal dose component of occupational exposure, must be calculated from air sampling results and/or bioassays. Both of these components are needed to determine the total effective dose equivalent (TEDE) (i.e., TEDE = DDE + CEDE) to assess compliance with 10 CFR Part 20 annual occupational dose limits. Direct calculations of the annual dose of inhaled radionuclides may be determined from the DAC concentration of a radionuclide in air, as discussed in SER Section 5.7.4. The applicant committed, in application Section 5.7.4, to assess the DAC for site-specific conditions (Powertech, 2009c). Also, the applicant addressed the determination of external and internal exposure to the embryo/fetus in application Section 5.7.4-4 (Powertech, 2011a).

The staff finds that the applicant's worker dose calculations and recordkeeping procedures are consistent with acceptance criteria (1) and (8) of standard review plan Section 5.7.4.3 (NRC, 2003b) and are consistent with recommendations in Regulatory Guides 8.30 and 8.34. The applicant's dose calculation procedures are in compliance with requirements in 10 CFR 19.13(b) and 10 CFR Part 20, Subparts C, F, L and M.

5.7.5.3.2 External Dose Calculation

The applicant states that worker doses will be calculated annually based on personal dosimetry data and the airborne radionuclide concentration measurements if the TEDE potentially exceeds 10 percent of the annual dose limit specified in 10 CFR Part 20 (Powertech, 2009c). Also, the applicant committed to following Regulatory Guides 8.30 (NRC, 2002a), 8.34 (NRC, 1992c), and 8.36 (NRC, 1992d) (Powertech, 2009c), which address occupational doses to workers and fetuses/embryos. Occupational exposure will be measured with individual personnel dosimeters provided by a vendor accredited by the National Voluntary Laboratory Accreditation Program, as required by 10 CFR Part 20, Subpart F (Powertech, 2009c).

The applicant states that pursuant to 10 CFR 20.1502, employees working at the Dewey-Burdock ISR facility will be monitored for external radiation exposure if they have the potential to receive 10 percent of an applicable limit in a year (Powertech, 2009c). However, the applicant did not describe the frequency that it will monitor the survey data. Consequently, the staff has determined that unmonitored employees could possibly receive a dose in excess of 10 percent of the dose limits prior to the review. Therefore, the staff included a condition in the Dewey-Burdock Project license that addresses unmonitored employees, which may be found in SER Section 5.7.5.4.

Based on a review of the applicant's external dose calculation procedures, the staff is reasonably assured that the applicant will properly perform these calculations. The applicant commits to following staff guidance for these calculations. However, the applicant has not adequately described how it will ensure that unmonitored employees who do not have dosimetry have not exceeded 10 percent of the dose limit. Therefore, the staff will include a license condition requiring the applicant to submit to the NRC for review and approval, procedures by which the applicant will ensure that unmonitored employees will not exceed 10 percent of the dose limits in 10 CFR Part 20, Subpart C. SER Section 5.7.5.4 describes this license condition. The staff's reasonable assurance determination is predicated in part on fulfilling the aforementioned license condition.

5.7.5.3.3 Internal Dose Calculation

The applicant states that the parameters used to evaluate inhalation exposure to radon-222 decay products and to natural uranium will be representative of site conditions as they relate to the maximum production capacity (Powertech, 2011a). This is consistent with the acceptance criterion in standard review plan Section 5.7.4.3 (NRC, 2003b). These calculations will incorporate occupancy time and average airborne concentrations; consequently, both full- and part-time employees (if any) will be considered in these exposure calculations. To obtain internal exposure from radon daughters, the applicant will determine the radon daughter intake, expressed in working level months, by: (1) taking the sum of the product of the average number of working levels in air near the worker's breathing zone and the time that the worker is exposed to the concentration, (2) dividing by the respiratory protection factor, if available, and (3) multiplying by 1/170, where 170 is the number of working hours in a month. In application Section 5.7.4 the applicant has proposed to perform calculations of the committed effective dose equivalents (CEDEs) using one of two methods described in Regulatory Guide 8.30, Section C-3. (Powertech, 2011a)

The applicant has provided equations and input parameters for computing the intake for radon daughter products that are consistent with Regulatory Guide 8.30 and Regulatory Guide 8.34 (Powertech, 2011a). Exposure calculations will incorporate occupancy time and average airborne concentrations. The applicant will assume exposures to airborne natural uranium are calculated using the stochastic ALI or DAC for the "W" class of natural uranium from Table 1 of 10 CFR 20, Appendix B, until the actual lung clearance class of the product has been determined by site-specific analysis (Powertech, 2011a).

Should the applicant choose to alter the inhalation class, simulated lung fluids studies would be required and such information would be submitted to the NRC as part of a license amendment request. However, the applicant is under no obligation to reassess the inhalation class and may use Class W during operations. The staff has determined that this is a conservative assumption consistent with Regulatory Guide 8.30 recommended practices, and thus acceptable.

The applicant has proposed to analyze air samples using gross alpha measurements and, potentially, to support its sampling through alpha spectroscopy (Powertech, 2011a). Results of these samples will be compared with the mixture requirements in 10 CFR 20.1204(g) to ensure that the appropriate DAC value is used. If a "mixture" exists that does not meet the exclusion rule of 10 CFR 20.1204(g), a sum of fractions method will be used to determine the appropriate DAC (Powertech, 2011a). The applicant has committed to assume the DAC for thorium-230 (Class W) if a condition occurs where the radionuclide or the mixture of radionuclides are unknown. (Powertech, 2011a) However, the staff has determined that the applicant will need to conduct periodic isotopic airborne sampling and compare the results to 10 CFR 20.1204(g) to ensure that it is using the appropriate DAC from Table 1 of Appendix B to 10 CFR Part 20. This requirement is provided as a license condition, which is discussed in SER Section 5.7.4.4.

The applicant described the method by which it will calculate the worker's soluble uranium intake from airborne uranium concentration. This method involves analyzing air filters using gross alpha and alpha spectroscopy methods (Powertech, 2011a). The applicant states that it will limit the soluble uranium intake by an individual to 10 mg/week, as specified in 10 CFR 20.1201.2(e), by ensuring the average airborne uranium concentration limit is 1×10^{-10} μCi/mL. In application Section 5.7.3.2, the applicant states that the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed 8E-3 μCi-hr/ml multiplied by the specific activity of inhaled uranium (Powertech, 2009c, 2011a). In application Section 5.7.4.3.4, the applicant states that necessary modifications to the facilities procedures or ALARA program will be developed and implemented in order to further reduce exposures (Powertech, 2011a). However, the staff determines that the applicant has not provided a description of how its ALARA program addresses intake of soluble uranium. To address this issue, the staff is including a license condition, as discussed in SER Section 5.7.4.4.

The applicant states that Rn-222 daughter analyses will be performed by the modified Kusnetz Method described in Regulatory Guide 8.30 (Powertech, 2009c, 2011a). The staff has determined that this method is consistent with recommendations in Regulatory Guide 8.30 and is in compliance with exposure calculations in 10 CFR 20.1201 and 20.1204.

The applicant has provided adequate details in application Section 5.7.4.2 on the calculation of internal dose from Rn-222 daughter measurements (Powertech, 2009c). However, as discussed in SER Section 5.7.4.3.2, the applicant must verify that alpha radiation measured is actually radon progeny. By conducting isotopic analyses of air samples and including longer-lived radon progeny polonium-210 and lead-210 in the analyses, the staff finds that the applicant can obtain data to support its assumptions, to be used in dose calculations, that (a) radon will be the primary airborne radioactive material present, and (b) natural uranium will be the primary air particulate present.

Based on the staff's review of the applicant's information, the staff is reasonably assured that the applicant will appropriately calculate internal doses. The applicant has identified the proper equations, analytical techniques, and solubility assumptions. However, the applicant has not provided procedures for confirming use of the proper DAC and how it will maintain uranium intake to ALARA. Therefore, the staff's reasonable assurance determination is predicated on fulfillment of license conditions discussed above and presented in SER Section 5.7.4.4.

5.7.5.3.4 Prenatal and Fetal Dose

The applicant states that the dose equivalent to the embryo/fetus will be determined by monitoring the declared pregnant female (Powertech, 2011a). The applicant will use the deep dose equivalent to the declared pregnant woman during the gestation period and apply this deep dose equivalent to the embryo/fetus for external dose. For internal dose, exposure calculations will be performed in accordance with Regulatory Guide 8.36. The applicant has committed to follow the guidance in Regulatory Guide 8.13 for prenatal radiation exposure. The applicant states that it will calculate the embryo/fetus doses in accordance with NRC Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus." The applicant states that once a woman has declared a pregnancy in writing, it will take steps, including potentially changing the woman's job function, in order to keep doses to the embryo/fetus below regulatory limits contained in 10 CFR 20.1208 and to levels that are ALARA (Powertech, 2011a).

The staff finds that these procedures for calculating and limiting the dose of the pregnant employee and fetus to be acceptable, as they are consistent with the guidance in Regulatory Guide 8.36 and acceptance criterion (4) of standard review plan Section 5.7.4.3 (NRC, 2003b); thus, they must comply with 10 CFR 20.1208.

5.7.5.3.5 Records

The applicant states that records of all dose assessments, including surveys, measurements, bioassays and calculations used in the dose assessments, will be maintained through license termination in accordance with recommendations in Regulatory Guide 8.7 and in formats necessary to demonstrate compliance with 10 CFR 20.2102, 20.2103, 20.2106, and 20.2110 (Powertech, 2011a). The applicant has committed to develop written procedures that are consistent with NUREG-1569, Acceptance Criterion 5.2.3(1), to address reporting requirements in 10 CFR Part 20, Subpart M and 10 CFR 40.60. The applicant states that the specific reporting requirements will include reports of exposures, radiation levels, and concentrations of radioactive material exceeding the constraints or limits (Powertech, 2011a).

The staff finds that the applicant's discussion of monitoring, records, and reports is consistent with acceptance criterion (8) of standard review plan Section 5.7.4.3 and in compliance with the regulatory requirements in 10 CFR Part 20, Subparts F, L, and M. Therefore, the staff finds these procedures acceptable.

5.7.5.4 Evaluation Findings

The staff reviewed the exposure calculations for the proposed Dewey-Burdock facility in accordance with standard review plan Section 5.7.4.3. The applicant has developed an acceptable method for assessing external exposures by measurement with an external personal monitoring device.

The applicant will initially assume that airborne uranium is solubility Class W uranium for purposes of determining the weekly intake of soluble uranium as specified in 10 CFR 20.1201(e) and to determine the DAC and ALI for radiological dose controls. The staff agrees that an assumption of solubility Class W uranium will allow adequate control of worker intake of uranium for radiological dose control and will address the potential for uranium chemical toxicity by limiting the worker intake.

The applicant's program for calculating internal and external exposures to workers is acceptable, except that the applicant has not completely described the methods it will use to comply with 10 CFR 20.1502(a)(1) by ensuring that unmonitored employees without dosimetry have not exceeded 10 percent of the dose limit. Therefore, the staff has included the following license condition that must be fulfilled prior to commencement of operations:

> The licensee shall submit to the NRC staff for review and written verification the procedures by which it will ensure that unmonitored employees will not exceed 10 percent of the dose limits in 10 CFR Part 20, Subpart C.

Based on its review of the information provided in the application, the staff is reasonably assured that the applicant will properly assess doses to workers and fetuses/embryos. This reasonable assurance determination is based on the information provided in the application, as supplemented by information required by the aforementioned license condition. Therefore, the applicant's exposure calculation procedures are consistent with standard review plan Section 5.7.4.3 and the requirements of 10 CFR Part 20, Subparts C, F, L, and M.

5.7.6 BIOASSAY PROGRAM

5.7.6.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed bioassay program for the Dewey-Burdock Project meets the requirements of 10 CFR Part 20, Subparts C, L, and M.

5.7.6.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria in standard review plan Section 5.7.5.3 (NRC, 2003b). Regulatory Guides 8.9 (NRC, 1993a), 8.22 (NRC, 1988b), 8.30 (NRC, 2002a), and 8.34 (NRC, 1992c) provide guidance on meeting the applicable regulations.

5.7.6.3 Staff Review and Analysis

The following sections discuss the applicant's proposed bioassay program, which is designed to monitor and document potential internal uptakes and radiation exposures and to confirm the results of the airborne uranium particulate monitoring program.

5.7.6.3.1 Frequency

In application Section 5.7.5, the applicant states that its bioassay program will follow guidelines set forth in Regulatory Guide 8.22 (NRC, 1988b) and NUREG-0874 (NRC, 1986a) (Powertech, 2009c, 2011a). Bioassays will be accomplished through urinalysis, which will be used to detect exposures to low-temperature fired, relatively soluble uranium compounds. According to the applicant, it will collect urinalysis samples at the following frequencies:

- Baseline urinalysis sample for new employees prior to working at the facility.
- Monthly for employees who have the potential to ingest or inhale yellowcake, or more frequently, as determined by the RSO.
- Upon termination of employment for all employees (Powertech, 2009c, 2011a).

In addition to monthly samples discussed above, urine samples will be collected from workers who were exposed to airborne yellowcake suspected of exceeding the 40-hr weekly limit of $1x10^{-10}$μCi/ml (Powertech, 2011a). The action level for weekly airborne radionuclide concentrations will be 25 percent of the DAC (action level = 7.5×10^{-11} μCi/ml) for Class W natural uranium (Powertech, 2011a). All urine samples will be analyzed for uranium content by a contract laboratory that can achieve a minimum LLD of 5 μg/l (Powertech, 2011a). SER Section 5.7.6.3.2 discusses corrective actions when intake limits are exceeded.

The staff finds that the proposed collection frequency, analysis of urine samples, and LLD are consistent with recommendations in Regulatory Guide 8.22 to ensure occupational exposures are monitored and comply with the limits in 10 CFR Part 20, Subparts C and F.

5.7.6.3.2 Dose Determination

In application Section 5.7.4, the applicant states that it will assign occupational doses to workers using the stochastic inhalation ALI and DAC per Methods 1 and 2 identified in Section C-3 of Regulatory Guide 8.30 (Powertech, 2011a). In accordance with 10 CFR 20.1202 and consistent with Methods 1 and 2 identified in Regulatory Guide 8.30, the applicant will calculate the total effective dose equivalent (TEDE) for all radiation workers by summing the DDE from external radiation and the committed effective dose equivalent (CEDE) from internal radiation. Furthermore, the CEDEs due to inhalation of yellowcake will be determined by either using the stochastic annual limits of intake (ALIs) listed in Table 1 in Appendix B of 10 CFR Part 20 or using the derived air concentrations (DACs) listed in the same table. The applicant states that the dose from the intake will be estimated by multiplying the estimated intake by the appropriate dose conversion contained in Federal Guidance Report No. 11 (EPA, 1988). Intakes of uranium will be estimated using the methods described in Regulatory Guide 8.9 (NRC, 1993b). The applicant also provided the equation that will be used to estimate intakes for urine samples collected over a 24-hour period (Powertech, 2011a).

The applicant states that the following corrective actions, which are consistent with Table 1 in Regulatory Guide 8.22, will be taken if positive bioassay results are confirmed (Powertech, 2011a):

- If a monthly urinalysis is less than 15 μg/L uranium, no action will be taken. If the monthly urinalysis is 15 to 35 μg/L uranium, the cause of the elevated uranium will be identified and corrected.
- A determination will be made as to the potential for exposure of other worker, and bioassays will be conducted as necessary.

- Work assignment limitations and/or respiratory protection will be considered.
- Uranium effluent controls will be also be reviewed for possible improvements.

If the amount of uranium detected in a monthly urinalysis is greater than 35 µg/L, and has been confirmed in two consecutive specimens, then the actions mentioned above will be taken. Additionally, the urine specimen will be tested for albuminuria, and an in vivo count may be obtained. The applicant will consider work restrictions for affected employees until urinary concentrations are below 15 µg/L uranium and laboratory tests for albuminuria are negative. Further uranium effluent controls or respiratory protection requirements will also be considered. The applicant will notify NRC as required (Powertech, 2011a).

The staff finds that the applicant has defined an acceptable method for evaluating events when the applicant confirms positive bioassay urinalysis results and makes a decision to convert the confirmed results to a dose. The staff finds that the applicant's methodology described in the application complies with the requirements in 10 CFR Part 20, Subparts C and F.

5.7.6.3.3 Records and Reporting

10 CFR Part 20, Subparts L and M, require recording and reporting monitoring results for employees who are monitored for internal and/or external exposure as required by 10 CFR Part 20, Subpart C. The applicant states that it will maintain records and reports for the bioassay program consistent with acceptance criterion 5 in standard review plan Section 5.7.6.3 and in accordance with 10 CFR Part 20, Subparts L and M (Powertech, 2011a). Records of all dose assessments will be maintained through license termination (Powertech, 2011a).

All bioassay results, including negative results (i.e., < action level of 15 µg/l), will be retained in employee personnel files (Powertech, 2011a). For confirmed results that exceed the action levels, the applicant will undertake an investigation that will include information obtained from corrective actions, investigations, and follow-up bioassay results, if applicable. The applicant will submit a written report to NRC within 30 days after confirmation of results in excess of action levels. The report will contain estimates of each individual's dose, the levels of radiation and concentrations of radioactive material involved, the cause of the elevated exposures, dose rates or concentrations, and corrective steps taken or planned to prevent a recurrence. As discussed in SER Section 5.7.3, the applicant states that any external dose received by monitored personnel above 10 percent of the dose limits will be reported on NRC Form 5 or in a format which contains all the information listed on NRC Form 5 (Powertech, 2011a).

The staff finds that the applicant's recordkeeping and reporting programs are consistent with recommendations in Regulatory Guide 8.30, meet acceptance criterion (5) of standard review plan Section 5.7.5.3, and meet the regulatory requirements in 10 CFR Part 20, Subparts L and M. Accordingly, the staff finds the applicant's exposure record and reporting program to be acceptable.

5.7.6.3.4 Quality Assurance/Quality Control (QA/QC)

The applicant committed to follow the QA/QC guidance in Regulatory Guide 8.22 (Powertech, 2009c), and the quality assurance program will be audited periodically. The applicant further stated that the contract laboratory's LLD for uranium in urine will be 5 µg/L or less, and the applicant will retain a record of bioassay results and associated QA/QC until license termination and in a form compliant with Regulatory Guide 8.7 (Powertech, 2011a) However, the applicant has not submitted a bioassay QA/QC program for staff review. Therefore, the staff is including a license condition requiring that the applicant prepare a standard procedure for bioassay QA/QC for the staff to review during the preoperational inspection. This license condition is discussed in SER Section 5.7.6.4.

The staff is reasonably assured that the applicant's proposed bioassay QA/QC program will meet the monitoring requirements in 10 CFR 20.1502; exposure limits in 10 CFR 20.1201, 20.1207, or 20.1208; and the recording requirements in 10 CFR 20.2106. This reasonable assurance determination is based on the information provided by the applicant, as supplemented by the information requested in the license condition discussed in SER Section 5.7.6.4.

5.7.6.4 Evaluation Findings

The staff reviewed the bioassay program for the proposed Dewey-Burdock Project in accordance with standard review plan Section 5.7.5.3. The applicant has provided a description of the program for baseline bioassay urinalysis prior to, during, and upon exiting employment. Individuals routinely exposed to yellowcake dust are part of the bioassay program and, as indicated in SER Section 5.7.6.3.1, action levels identified in Table 1 of Regulatory Guide 8.22 will be used at this site. Furthermore, the applicant discussed the manner in which confirmed bioassay (urinalysis) results will be converted and assigned as an internal dose to the individual in accordance with 10 CFR 20.1204(b), 20.1703(c)(2), and 20. 2103(b)(3).

However, the applicant did not provide information regarding the bioassay QA/QC program. Therefore, the staff is including the following condition in the Dewey-Burdock Project license:

> The licensee shall prepare a bioassay QA/QC procedure that is consistent with Regulatory Guide 8.22. This procedure shall be made available for NRC staff review and written verification during the preoperational inspection.

Based on its review of the information provided in the application, the staff is reasonably assured that the applicant will develop and implement an acceptable bioassay program. This reasonable assurance determination is based on the information provided in the application, as supplemented by information required by the aforementioned license condition. Therefore, the applicant's description of its bioassay program is consistent with standard review plan Section 5.7.5.3 and complies with the requirements of 10 CFR Part 20, Subparts C, L, and M.

5.7.7 CONTAMINATION CONTROL PROGRAM

5.7.7.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed contamination control program for the Dewey-Burdock Project meets the requirements of Subparts B, C, and F of 10 CFR Part 20.

5.7.7.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 20, using the acceptance criteria in standard review plan Section 5.7.6.3 (NRC, 2003b). Regulatory Guide 8.30 provides guidance on how compliance with the applicable regulations can be demonstrated (NRC, 2002a).

5.7.7.3 Staff Review and Analysis

This section discusses the applicant's proposed contamination control program. The contamination control program is designed to detect radiological contaminants that have escaped the boundary of the uranium recovery process equipment. The contamination control program addresses loose surface contamination that resides on structures, equipment, materials, or personnel. The purpose of this program is to ensure that contamination will be confined and monitored in known areas and not spread to areas outside the confined area (e.g.,lunchroom, bathrooms, office areas, etc.) or to unrestricted areas.

5.7.7.3.1 Contamination Surveys

In application Section 5.7.6, the applicant proposed a contamination control program that addresses contamination surveys for personnel, plant areas, and material and equipment release (Powertech, 2009c, 2011a).

5.7.7.3.1.1 Personnel Contamination Surveys

The applicant states that personnel leaving the restricted area with potential removable surface contamination will be monitored for skin and clothing contamination to prevent the spread of contamination to unrestricted areas and to keep doses ALARA (Powertech, 2009c). Personnel leaving the restricted area will scan themselves for gross alpha contamination. Any gross alpha contamination on the skin or clothing will be considered removable and is subject to the background concentration limit (Powertech, 2011a). The applicant states that it will establish background level and action levels for each area after facilities have been built. If skin decontamination is required, the RSO will verify that correct procedures were followed and follow up with an investigation, if appropriate. Where alpha contamination is higher than background, decontamination procedures consist of laundering or properly disposing of clothes and washing/scrubbing the soles of shoes. The applicant will document each survey of personnel leaving a restricted area and the subsequent decontamination will be documented. Additionally, radiation protection staff will perform quarterly random surveys of personnel to ensure that the contamination control program is performing adequately (Powertech, 2009c, 2011a).

For tests of removable alpha contamination, the applicant intends to use swipes or wipes that will be counted with an alpha detector designed for sample counting (Powertech, 2011a). The applicant's description of personnel contamination surveys is acceptable to the staff, except with respect to beta-gamma contamination surveys. In application Section 5.7.6.1, the applicant states that since any beta–gamma contamination at a uranium ISR facility must be associated with alpha emitting nuclides, no special monitoring or survey for beta–gamma emitters is required (Powertech, 2011a).

The staff notes that aged yellowcake can remain in certain portions of the facility from spills and maintenance activities and has determined that beta contamination at uranium recovery facilities is a potential radiological hazard. The staff observed that the applicant applied beta release limits to equipment contamination, but not personnel contamination (Powertech, 2009c, 2011a). To ensure compliance with the ALARA requirements in 10 CFR Part 20, the staff is including a license condition discussed in SER Section 5.7.7.4. This license condition will require the applicant to develop, prior to the preoperational inspection, a survey program for beta-gamma contamination for personnel contamination from restricted areas that will meet the requirements of 10 CFR Part 20, Subpart F.

Based on its review of the applicant's personnel contamination survey program, the staff is reasonably assured that this program is sufficient to protect occupational health and safety. This reasonable assurance determination is contingent upon the fulfillment of the license condition presented in SER Section 5.7.7.4 and discussed above.

5.7.7.3.1.2 Plant Area(s) Contamination Surveys

The applicant states that areas will be classified as restricted based on the potential for risks to workers from exposure to radiation and radioactive materials (Powertech, 2011a). Criteria for restricting areas of the facility are as follows:

- Areas in the facility where surface contamination is above 5,000 dpm alpha per 100 cm^2 (averaged over no more than 1 m^2).
- Spots of contamination above 15,000 dpm alpha per 100 cm^2 (averaged over no more than 100 cm2).
- Removable contamination above 1,000 dpm alpha per 100 cm^2 (Powertech, 2011a).

The applicant states that its contamination control program will address potential contamination spreading from restricted areas (process areas as well as general plant areas), from personnel working in those areas, and from equipment and PPE used in those areas (Powertech, 2011a). The applicant proposed to limit the surface contamination within restricted areas that are exposed to the air to a maximum of 220,000 dpm alpha per 100 cm^2. Unrestricted areas (i.e., lunch areas, change rooms, and offices) and restricted areas will be spot checked weekly for removable surface contamination (Powertech, 2010a). During a spot check, if radiation protection staff detects removable surface contamination above background in an unrestricted area, the applicant will clean and resurvey the area for removable surface contamination (Powertech, 2009c, 2011a).

The applicant states that the limits established for alpha and beta-gamma radiation shall apply independently where surface contamination by both alpha and beta-gamma radiation exists (Powertech, 2011a). The applicant proposed to perform beta-gamma surveys for contamination within controlled areas (e.g., wellfields) monthly; the limit for these surveys will be 1,000 dpm/100 cm^{2}. (Powertech, 2009c, 2011a).

Based on its review of the plant area(s) contamination surveys program provided in the application, the staff is reasonably assured that the applicant will perform the appropriate surveys and control radiological contamination. The staff finds that spot surveys comply with the requirements in 10 CFR 20.1501(a)(1), (a)(2)(i), and (a)(2)(ii), which require surveys to evaluate the magnitude and extent of radiation levels and concentrations of radioactive material. The applicant's proposed survey schedule is consistent with the survey frequencies recommended in Regulatory Guide 8.30 and, therefore, the staff finds this acceptable.

5.7.7.3.1.3 Equipment and Materials Contamination Surveys

In application Section 5.7.6-3, the applicant states that equipment leaving restricted areas will be monitored for surface contamination (Powertech, 2011a). Such radiation surveys will be conducted by the RSO, the RST, or a qualified and trained radiation worker under the supervision of the RSO (Powertech, 2011a). However, as discussed in SER Section 5.4.3.3 and SER Section 5.3.4, the use of a qualified and trained radiation worker or designee for any future use of the health physics activity is contingent upon the NRC's review and verification of the designee's training requirements. Since the applicant has not provided the qualifications for such designees, the NRC staff is not approving the use of the designees at this time.

The applicant proposed equipment and materials contamination surveys for alpha radiation and beta-gamma radiation (Powertech, 2009c, 2011a). Equipment found to have the following average radiation levels will be released for unrestricted use:

- At or below 5,000 dpm alpha (or beta-gamma) per 100 cm2 (averaged over no more than 1 m^{2})
- Removable contamination at or below 1,000 dpm alpha (or beta-gamma) per 100 cm^{2}
- Spots (areas 100 cm^{2} or smaller) at or below 15,000 dpm alpha (or beta-gamma) per 100 cm^{2}

Equipment and materials that exceed the contamination limits will undergo further decontamination until the contamination is below the limits or until decontamination yields no reduction in contamination. Equipment with contamination above any of the limits after attempts at decontamination will be disposed of properly. Each survey of equipment leaving a restricted area and the subsequent decontamination will be documented (Powertech, 2009c, 2011a).

Consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(6), the applicant states that it will make a reasonable effort to minimize any radioactive contamination before the use of any covering (Powertech, 2011a). Furthermore, the applicant will not cover radioactivity on equipment or other surfaces with paint, plating, or other material unless contamination levels, as determined by a radioactivity survey and properly documented, are below the limits specified in Enclosure 2 to Policy and Guidance Directive FC-83-23, as updated (NRC, May 28, 2010, pg.

41, Section 6.3, Item #2). Radioactivity of the interior surfaces of pipes, drain lines, or duct work used to convey radionuclides will be measured at all accessible traps, drains, and other appropriate access points that would likely be representative of the radioactivity on the interior surfaces (Powertech, 2011a). If a representative surface cannot be accessed, these items will be considered contaminated and not released for unrestricted use from the site. (Powertech, 2011a).

In application Section 5.7.6.5, the applicant states that the alpha detector used will be able to measure alpha radiation ranging from 100 to 220,000 dpm per 100 cm^2. Regulatory Guide 8.30 recommends that removable alpha contamination levels on respirator facepieces and hoods be less than 100 dpm/100 cm^2. The LLD must be lower than the contamination limit to minimize potential survey errors. Therefore, a license condition, which is discussed in SER Section 5.7.7.4, is included to ensure that the applicant will comply with 10 CFR 20.1501(a)(2)(i), which requires surveys that evaluate the magnitude and extent of radiation levels.

Based on its review of the applicant's proposed program for equipment and materials contamination surveys, the staff is reasonably assured that the applicant will perform the appropriate surveys and control radiological contamination. However, this reasonable assurance determination is predicated on fulfillment of a license condition regarding instrument LLDs and designee qualifications, as discussed in SER Sections 5.3.4 and 5.4.3.3.

5.7.7.3.2 Survey Instruments

The applicant states that it will use portable alpha detectors and beta-gamma detectors for direct measurement of alpha and beta-gamma surface contamination respectively (Powertech, 2009c). For counting removable alpha and beta-gamma swipes, the applicant will use individual alpha and beta-gamma detectors designed for sample counting. According to the applicant, the alpha detectors will have a range from 100 to 220,000 dpm per 100 $cm^{2.}$ For beta-gamma detectors, the range will be from 1000 to 15000 dpm per 100 cm^2. (Powertech, 2009c)

The applicant states that for most gamma surveys it plans to use a Ludlum 19 or equivalent instrument (Powertech, 2009c). The typical operating range for this instrument is 0 – 5,000 µR/hr (Powertech, 2011a). The applicant also stated that for dose rates larger than 5 mrem/hr, a Ludlum model 44-38 or equivalent type of detector coupled with an appropriate rate meter will be used. As shown in application Table TR RAI 5.7.2-1-1, the maximum operating range for the this meter is 50 mR/hr, and this model can be used to perform gamma and beta surveys (Powertech, 2011a).

The applicant states that all survey instrumentation will be calibrated according to the manufacturer's suggested interval or annually, whichever is shorter (Powertech, 2009c). Furthermore, operational checks on the instruments will be performed before each daily use, and the instruments will be operated according to manufacturer's recommendation. (Powertech, 2009c). The applicant states that it will use a battery-operated portable alpha detector to directly measure alpha contamination (Powertech, 2009c). The staff observed that the applicant has not provided the survey capability or scan minimum detectable concentration (MDC) in terms of dpm per 100 cm^2 for survey meters. A scan MDC is a measure of instrument sensitivity for those instruments that collect continuous measurements or scans. As stated in

SER Section 5.7.7.3.1.1, the staff also notes that the applicant did not propose conducting both beta-gamma and alpha contamination surveys for personnel contamination. Therefore, the staff is including a license condition in SER Section 5.7.7.4 that requires, as discussed in SER Section 5.7.7.3.1.1, the applicant to develop a survey program for beta-gamma contamination for personnel contamination.

Based on its review of the applicant's proposed survey instruments, the staff is reasonably assured that the applicant will use appropriate instruments to perform required radiation surveys. However, the applicant did not provide scan MDCs and did not propose beta-gamma surveying for personnel. Therefore, the staff's reasonable assurance determination is predicated on the fulfillment of the license conditions addressing these issues that are presented in SER Section 5.7.7.4.

5.7.7.3.3 Inspections

The applicant states that the RSO or an RSO designee will conduct a daily visual inspection of all work and storage areas in the facility (Powertech, 2009c). The purpose of these inspections is to determine if good radiation practices are being implemented properly, including the following:

- Minimization of contamination through proper housekeeping and cleanup.
- SOPs are being followed.
- Issues identified in prior inspections have been addressed and corrected (Powertech, 2009c).

The applicant states that it will conduct daily visual wellfield inspections of wellfield facilities, including header houses and all visible pipes, connections, and fittings. Leak detection will be performed by daily visual inspection of all above-ground pipes, connections, and fittings by field personnel during their daily site visits (Powertech, 2009c).

The applicant states that the RSO and the Facility Manager (Powertech, 2011a) will perform weekly inspections of all facility areas to examine whether the general radiation control practices are followed and to verify that proposed changes in procedures and equipment are implemented (Powertech, 2009c). The applicant indicated that at least monthly the RSO will review the results of daily and weekly inspections, including a review of all monitoring and exposure data for the month (Powertech, 2009c).

The staff finds that the applicant's approach to contamination surveys is reasonable and complies with 10 CFR Part 20, Subpart F, "Surveys and Monitoring"; Subpart J, "Precautionary Procedures"; and Subpart M, "Reports." Based on the proposed radiation safety program, the staff has reasonable assurance that the applicant can safely operate its facility and is committed to operating safely and minimizing effects to the public and environment in accordance with 10 CFR 40.32(c).

5.7.7.3.4 Records and Reporting

The applicant states that consistent with NUREG-1569, Acceptance Criterion 5.7.6.3(5), it will record and maintain contamination control program information and data as required by 10 CFR

Part 20, Subpart L (Powertech, 2011a). The records will be retained for 3 years after they are made. The applicant will immediately report any event involving source or byproduct materials it possesses that may have caused or threatens to cause any of the conditions listed in 10 CFR 20.2202. The applicant will submit a written report to NRC within 30 days after confirmation of any of the reportable events listed in 10 CFR 20.2203. The report will describe the extent of exposure of individuals to radiation and radioactive material and other information as described in 10 CFR 20.2203.

The applicant states that in accordance with recommendations in Regulatory Guide 8.7 and in formats necessary to demonstrate compliance with 10 CFR 20.2102, 20.2103, 20.2106, and 20.2110, it will maintain records of all dose assessments—including any surveys, measurements, bioassays and calculations used in the dose assessments—through license termination (Powertech, 2011a).

NRC staff has determined that the applicant's recordkeeping and reporting activities are consistent with the guidance in Regulatory Guide 8.30 and comply with the requirements in 10 CFR Part 20, Subparts L and M. These activities also comply with 10 CFR 40.32(b), which requires the applicant to be trained and experienced to protect health and minimize danger to life or property. Therefore, the staff finds the recordkeeping and reporting element of the applicant's program to be acceptable.

5.7.7.4 Evaluation Findings

The staff reviewed the contamination control program for the proposed Dewey-Burdock Project in accordance with standard review plan Section 5.7.6.3. The staff finds that the applicant has identified controls for preventing contamination from leaving a restricted area using survey equipment and instrumentation appropriate for natural uranium. The applicant has proposed to conduct contamination surveys in clean areas, use appropriate survey equipment, and use an appropriate survey and inspection schedule to detect and control radiological contamination.

The staff finds that the applicant has described its radiation protection program in sufficient detail by following the survey guidance in Regulatory Guide 8.30 (NRC, 2002a). The staff also finds that the applicant's contamination control program is acceptable and that the applicant will appropriately survey, detect, and control radiological contamination, as required by 10 CFR Part 20, Subparts B, C, F and 10 CFR 40.32(c). However, the applicant has not addressed beta-gamma contamination in personnel surveys. Therefore, the staff is including the following condition in the Dewey-Burdock Project license:

> No later than 30 days before the preoperational inspection, the licensee shall develop a survey program for beta-gamma contamination for personnel exiting from restricted areas that will meet the requirements of 10 CFR Part 20, Subpart F.

Additionally, the applicant did not provide proper scan MDCs for its survey equipment; therefore, the staff is adding the following condition to the license:

> The licensee shall provide, for NRC staff review and written verification, the surface contamination detection capability (scan MDC) for radiation survey meters used for contamination surveys to release equipment and materials for

unrestricted use and for personnel contamination surveys. The detection capability in the scanning mode for the alpha and beta-gamma radiation expected shall be provided in terms of dpm per 100 cm^2.

Based on its review of the information provided in the application, the staff is reasonably assured that the applicant will appropriately survey, detect, and control radiological contamination. This reasonable assurance determination is based on the information provided in the application, as supplemented by information required by the aforementioned license conditions. Therefore, the applicant's description of its contamination control program is consistent with standard review plan Section 5.7.6.3 and complies with the requirements of 10 CFR Part 20, Subparts B, C, and F.

5.7.8 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAM

During the course of the evaluation, the staff determined that overlap existed among the areas of review and acceptance criteria in standard review plan Sections 4.1, 5.7.1, and 5.7.7 (NRC, 2003b). As discussed in SER Section 5.7.2, the staff reduced the overlap in the SER by limiting the discussion of the staff's review of the effluent control techniques to SER Section 4.1 and effluent monitoring to SER Section 5.7.8.

5.7.8.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed airborne effluent and environmental monitoring program for the Dewey-Burdock Project meets the requirements of 10 CFR 20.1003, 20.1301, 20.1302, 20.1101(d), 20.1501, 40.65, and Criteria 7 and 8 of Appendix A to 10 CFR Part 40.

5.7.8.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Parts 20 and 40, using the acceptance criteria in standard review plan Section 5.7.7.3 and applicable acceptance criteria in standard review plan Section 4.1.3 (NRC, 2003b). Regulatory Guides 4.14 (NRC, 1980) and 8.37 (NRC, 1993b) provide guidance on how the applicant can comply with the applicable regulations.

5.7.8.3 Staff Review and Analysis

The following sections discuss the applicant's proposed airborne effluent and environmental monitoring program. This includes radiation monitoring outside of the plant area during operations and monitoring environmental media within the plant area, at the boundary of the facility, and at a background location.

5.7.8.3.1 Airborne Effluent Monitoring

Aside from the reporting requirements in 10 CFR 40.65, an applicant must provide details on how they will perform surveys sufficient to demonstrate compliance with 10 CFR 20.1302, which requires compliance with dose limits for individual members of the public. An applicant must also demonstrate compliance with 10 CFR 20.1501, which requires surveys that are reasonable under the circumstances to evaluate concentrations or quantities of radioactive materials and the potential radiological hazards. To comply with 10 CFR 20.1302(a), applicants must demonstrate that they will conduct appropriate surveys of radioactive materials in effluents released to unrestricted and controlled areas. For point sources (e.g., a defined stack or pipe), the release point will generally be the effluent discharge point (i.e., where the uncontrolled effluent is released to the air). If the effluent is discharged to a restricted area, the applicant may propose measuring or calculating the effluent quantities or concentrations (a) at the effluent discharge point or (b) at the unrestricted/controlled area boundary. If the effluent is measured or calculated at the discharge point, the applicant may use (a) this undiluted value or (b) an appropriate model to estimate the concentrations to which people are exposed. For dose calculations, the applicant may also propose taking direct measurements at the unrestricted area boundary. Regulatory Guide 8.37 (NRC, 1993b) provides additional guidance on airborne radioactive effluent monitoring.

The applicant initially stated that the five proposed operational monitoring locations shown in application Figure 5.7.7-2-1 are the same as the corresponding preoperational monitoring locations (Powertech, 2011a). Subsequently, as explained in Section 5.7.8.3.2.1 of this SER, the applicant proposed two additional operational sampling locations (Powertech, 2012e, 2013a). The applicant stated that quarterly composite of weekly filter changes will be analyzed for natural uranium, radium-226, thorium -230 and lead-210 (Powertech, 2012e). Consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1), the applicant will also sample for radon-222 using passive track-etch detectors located at each air monitoring station on a monthly basis (Section TR RAI 5.7.7-6 of Powertech, 2011a).

The applicant will conduct an airborne radiation monitoring program that is consistent with the recommendations contained in Regulatory Guide 8.30 (Powertech, 2011a). The monitoring program will consist of monitoring radon decay products as well as airborne particulate monitoring (Powertech, 2011a). The applicant stated that radon gas will be evolved at the locations where the lixiviant solution is initially exposed to atmospheric pressure and ambient temperatures (Powertech, 2009d). The applicant stated that these locations constitute primary release points and are expected to include the ion exchange vessels into which the lixiviant is directed for loading of the uranium onto resin and the elevated shaker screens that will receive the loaded resin prior to elution (Powertech, 2009d, NMA 2007, Brown 1982, 2007, 2008). The applicant stated that the radon emissions from the resin transfer operation will be exhausted using a dedicated ventilation system and released via a primary release point on or near the roof of the facility (Powertech, 2011a). The applicant stated that potential release points as well as general air in the plant will be routinely sampled for radon and decay products to assure concentration levels are maintained ALARA (Powertech, 2011a).

The applicant stated that working level (WL) measurements for radon decay products will be made on a monthly basis in areas where radon decay product concentrations are likely to exceed the LLD of 0.03 WL as described in Regulatory Guide 8.30 (Powertech, 2011a). TR Figures 5.7-6 to 5.7-9 present the monitoring locations where radon decay products could possibly exceed 0.03 WL. The applicant also stated that areas where the radon decay product concentration exceeds 0.08 WL, as indicated by the monthly WL measurements, will be measured for radon decay products on a weekly basis. (Powertech, 2011a).

The applicant will perform radiochemical analysis on filters collected from the point of discharge for Natural U, Th-230, Ra-226 and Pb-210 to ensure radionuclide effluent releases are maintained ALARA (Powertech, 2009c, 2011a). The applicant will estimate the airborne release of radon from process operations using the above methods and as described in Regulatory Guide 3.59 (Powertech, 2011a). As part of routine process performance, it will monitor all important parameters used to estimate the airborne releases in addition to monitoring the vacuum dryer and emission control systems for the dryer. Consistent with 10 CFR 40.65, the applicant has committed to provide the results of airborne radionuclide release surveys, including location and strength (i.e., quantity of each radionuclide in Ci/yr) of point and diffuse airborne emissions. (Powertech, 2009c, 2011a).

The staff notes that with the exception of uranium packaging, operations frequently occur while the processing facility doors are open and ventilation systems are exhausting air from the buildings. The staff has determined that the applicant has not adequately discussed how the facility would be monitored for airborne releases for these sources. Therefore, the staff is including a license condition presented in Section 5.7.8.4 to ensure that the facility does not exceed the effluent concentrations in 10 CFR Part 20, Appendix B, Table 2, or the applicable 10 CFR 20.1301 public dose limits in the unrestricted areas. SER Section 5.7.8.4 presents this license condition.

The applicant stated that due to the difficulty in measuring low-level radon-222 concentrations resulting from site activities within the varying background radon-222 concentrations in and around the project area, it would model the dose to the receptor of concern using MILDOS-AREA as needed (Powertech, 2011a). Inputs into MILDOS-AREA will be the location and strength of source terms based on estimated airborne releases, the updated site-specific meteorological data, and receptor location (Powertech, 2011a). While the staff agrees that licensees are permitted to estimate doses through calculations, calculations must be confirmed through periodic sampling; otherwise, the staff cannot determine with sufficient certainty that doses to the public are below the 10 CFR 20.1301 limits. Sampling of effluents is a clear recommendation in the staff's guidance. For example, Regulatory Guide 3.59 states that the staff prefers "reliable monitoring data when available" (NRC, 1987).

Based on information provided by the applicant, the staff is reasonably assured that the applicant will monitor airborne effluents and control doses to the public in accordance with 10 CFR 20.1301. This determination is based on calculations provided by the applicant showing that doses from its operations will not exceed public dose limits and its commitment to perform operational effluent monitoring. Regarding stack sampling, the applicant did not propose stack sampling consistent with standard review plan Section 5.7.7.3, and as described in Regulatory Guide 4.14 (NRC, 1980). The staff discusses in-plant monitoring for occupational exposures and doses in SER Section 5.7.3, and as stated above, certain samplers and monitors will be located in specific areas outside the plant. While additional stack sampling is recommended, the staff notes that licensees have flexibility in meeting the requirements of 10 CFR 40.65 and 10 CFR 20.1301, and the currently proposed sampling program could be part of the applicant's compliance strategy. Therefore, the staff is including a license condition as presented in Section 5.7.8.4, which requires the applicant to provide NRC with the precise manner in which effluents will be quantified. The staff is reasonably assured that the applicant will measure and quantify effluents from the Dewey-Burdock Project based, in part, on its current in-plant and exterior monitoring programs. This reasonable assurance determination is contingent upon the applicant's fulfillment of the license conditions in SER Section 5.7.8.4.

5.7.8.3.2 Environmental Monitoring

5.7.8.3.2.1 Air Particulate Sampling

The applicant initially proposed an operational environmental monitoring program consisting of five air monitoring stations and twelve radon sampling locations (using Track-etch detectors). Five of these radon sample sites are co-located with the air particulate samplers (Powertech, 2011a). Subsequently, in Section 1 of its Supplemental Sampling Plan, the applicant proposed to revise the environmental monitoring program (Powertech, 2012e). Specifically, in Figure 1, the applicant presents two additional operational air monitoring stations (Powertech, 2012e). In its comments on "Dewey-Burdock Project Draft Supplemental Environmental Impact Statement" (In p.7-2, line 13 on page 66 of 72), the applicant reiterated its commitment to install two additional air particulate sampling locations (Powertech, 2012e, 2013a).

The applicant stated that quarterly composites of weekly filter changes will be analyzed for natural uranium, Th-230, Ra-226, and Pb-210, consistent with Regulatory Guide 4.14 (NRC, 1980, Powertech, 2012e). The applicant stated that, consistent with Regulatory Guide 4.14 and NUREG-1569, Acceptance Criterion 5.7.7.3(1), it will sample for radon-222 using passive track-etch detectors located at each air monitoring station on a monthly basis (Section TR RAI 5.7.7-6 of Powertech, 2011a).The applicant stated that the proposed operational air monitoring locations (air particulate and radon-222) will be same as the corresponding pre-operational monitoring locations (Section TR RAI 6.7.7-2 of Powertech, 2011a).

The staff finds that the proposed locations of the airborne effluent monitoring stations are consistent with guidance in Regulatory Guide 4.14, Sections 1.1.1 and 2.1.2 (NRC, 1980). The staff also finds that the applicant's proposed air particulate and radon environmental monitoring program meets the operational environmental monitoring requirements in Criterion 7 of Appendix A to 10 CFR Part 40.

5.7.8.3.2.2 Soil Sampling

Regulatory Guide 4.14, Table 2, suggests that soil sampling should be conducted in five or more locations that are the same as for air particulate sampling (NRC, 1980). It suggests collecting annual grab samples and analyzing for natural uranium, Ra-226, and Pb-210. The applicant has committed to collecting surface soil samples annually during operations at the five air particulate sampling locations and analyzing them for natural uranium, Ra-226, and Pb-210 in accordance with Regulatory Guide 4.14 (Powertech, 2009c, 2011a). Maximum LLDs for the analyses will be consistent with the recommendations of RG 4.14 (NRC, 1980). The staff finds that the soil sampling frequency and locations proposed by the applicant are consistent with Regulatory Guide 4.14 and, therefore, acceptable.

5.7.8.3.2.3 Sediment Sampling

Regulatory Guide 4.14, Table 2, suggests that sediment sampling be conducted as an annual grab sample from each water body identified for surface water sampling (NRC, 1980).

Sediment samples should be analyzed for natural uranium, Th-230, Ra-226, and Pb-210. The applicant has committed to conducting annual sediment sampling during operations at the proposed surface water monitoring locations (Powertech, 2011a). Application Table TR RAI 2.9-43a-1 provides the locations of the 24 impoundments proposed for operational monitoring, and application Table TR RAI 2.9-43b-2 presents the stream sampling sites proposed for operational monitoring. The applicant stated that all sediment samples will be analyzed for natural uranium, Th-230, Ra-226, and Pb-210, which is consistent with Regulatory Guide 4.14 (Powertech, 2011a).

The staff has determined that the applicant's proposed sediment sampling is acceptable, because it is consistent with Regulatory Guide 4.14 recommended practices.

5.7.8.3.2.4 Food and Fish Sampling

Where a significant pathway to man is identified, Regulatory Guide 4.14 suggests analyzing three of each type of crop, livestock, etc., raised within 3 km of the mill site (NRC, 1980). Samples should be collected at the time of harvest or slaughter and analyzed for Ra-226 and Pb-210. Note (o) in Regulatory Guide 4.14, Table 2 clarifies that an exposure pathway should be considered important if the predicted dose to an individual would exceed 5 percent of the applicable radiation protection standard (NRC, 1980). For purposes of analyzing doses to the public from food and fish, the dose limit in 10 CFR 20.1301 is 100 mrem/yr total effective dose equivalent (TEDE). Therefore, an exposure pathway should be considered important if the predicted dose to an individual would exceed 5 mrem/yr TEDE.

The applicant has committed to sample livestock annually, which will include cattle, pigs and any other livestock present at the time of sampling, consistent with guidance in Regulatory Guide 4.14 (Powertech, 2011a). Annual grab samples collected at the time of harvest or slaughter will be analyzed for natural uranium, Ra-226Th-230, Pb-210 and Po-210. Furthermore, fish samples will be analyzed semiannually provided that fish are present in water bodies that may be subject to seepage or surface drainage from potentially contaminated areas. The applicant will sample fish species identified with the potential for human consumption (green sunfish and channel catfish) semiannually, if present in water bodies potentially affected by contamination. If the analysis of livestock tissue supported by the annual MILDOS-AREA modeling indicates grazing animals demonstrate no significant exposure pathway, with the approval of the NRC, the applicant intends to modify the monitoring program appropriately according to Regulatory Guide 4.14 (Powertech, 2011a).

While chickens also are present within 3.3 km of the project area, the applicant does not propose to sample them, as they are fed grains not originating from the project area and are not considered grazing animals (Powertech, 2011a). The applicant has identified game animals (pronghorn, wild turkey, etc.); however, it does not propose to sample them due to their migratory nature and relatively large home range in relation to the size of the project area. Game animals would not be a significant pathway to humans; however, the applicant will confirm this determination through annual MILDOS-AREA modeling.

Based on the information provided by the applicant, the staff is reasonably assured that the applicant will implement a food and fish sampling program consistent with Regulatory Guide 4.14. The staff finds that sampling game animals and poultry is not necessary at this time as part of the operational monitoring program. Furthermore, the staff finds that the livestock and fish sampling methodology and frequency are consistent with Regulatory Guide 4.14 recommended practices and are therefore acceptable. However, the staff will require that the applicant specify in its airborne effluent and environmental monitoring program (required by the license condition presented in SER Section 5.7.8.4) particular conditions that will trigger the need for the applicant to conduct operational poultry and game animals sampling. Therefore, the staff's reasonable assurance determination is predicated on the fulfillment of the aforementioned license condition.

5.7.8.3.2.5 Vegetation Sampling

Where a significant pathway to man is identified, Regulatory Guide 4.14 suggests analyzing vegetation or forage from animal grazing areas near the mill site in the direction of the highest predicted airborne radionuclide concentrations (NRC, 1980). Samples should be collected three times during the grazing season and analyzed for Ra-226 and Pb-210. Note (o) in Regulatory Guide 4.14, Table 2 (NRC, 1980) clarifies that an exposure pathway should be considered important if the predicted dose to an individual would exceed 5 percent of the applicable radiation protection standard. Individual members of the public are subject to the dose limits in 10 CFR 20.1301. Pursuant to 10 CFR 20.1301, the dose limit is 100 mrem/yr TEDE.

Therefore, an exposure pathway should be considered important if the predicted dose to an individual would exceed 5 mrem/yr TEDE. The applicant did not propose to perform any vegetation sampling during operations. In application Section 5.7.7-10, the applicant stated that based on MILDOS-AREA results, the TEDE from all pathways is less than 5 percent of the applicable radiation protection standard and that the ingestion pathway from crops would not likely exceed 5 percent of the applicable radiation protection standard (NRC, 1980). Furthermore, if the preoperational garden vegetable soil sample results described in the response to TR RAI 2.9-12 (supported by MILDOS-AREA modeling) demonstrate no significant exposure pathway, the applicant will not sample crops, including vegetable gardens, as part of the operational monitoring program.

The staff finds the applicant's reason for not collecting vegetation or forage samples during operations to be acceptable. Consequently, the staff will require that the applicant specify in its airborne effluent and environmental monitoring program, required by the license condition presented in SER Section 5.7.8.4, particular conditions that will trigger the need for the applicant to conduct operational vegetation sampling. The applicant would also have to provide supporting analysis to verify that sampling soil can replace vegetation sampling.

5.7.8.3.2.6 Direct Radiation

Regulatory Guide 4.14, Table 2 suggests using five or more passive integrating radiation devices at the same locations that are used for air particulate sampling. The passive integrating radiation devices should be changed out on a quarterly basis and measured for gamma exposure rate.

As described in TR RAI 5.7.7-2-1, the applicant will utilize thermoluminescent dosimeters (TLDs) or equivalent dosimeters that will be co-located with the air particulate samplers (Powertech, 2011a). These environmental dosimeters will be low-level TLDs provided by a

National Voluntary Laboratory Accreditation Program (NVLAP) approved provider. The dosimeters will be exchanged quarterly and the results will be used to assess quarterly gamma exposure rates at each of the sites. The staff finds that the direct radiation monitoring locations are consistent with Regulatory Guide 4.14 and, therefore, acceptable.

5.7.8.4 Evaluation Findings

NRC staff reviewed the airborne effluent and environmental monitoring program for the proposed Dewey-Burdock ISR facility in accordance with standard review plan Section 5.7.7.3 and the applicable parts of Section 4.1.3. The applicant will sample radon, air particulates, surface soils, sediment, and direct radiation, as recommended in Regulatory Guide 4.14. The applicant provided justification for not sampling poultry, game animals, and vegetation and forage samples. The applicant did not completely describe, however, its methods for measuring and quantifying all radiological effluents or its methods for calculating doses to the public in unrestricted areas.

Although the applicant has demonstrated that its radon and air particulate monitoring program is consistent with Regulatory Guide 4.14 (NRC, 1980), as described in Section 5.7.8.3.1 of the SER, the NRC staff cannot conclude that its stack monitoring and confirmatory sampling is adequate to accurately quantify the effluents from the Dewey-Burdock Project. Therefore, the NRC staff is including the following license conditions to ensure that an adequate effluent and environmental monitoring program is in place consistent with Regulatory Guide 4.14 (NRC, 1980);

> The licensee shall submit the results of its annual review of its radiation protection program content and implementation performed in accordance with 10 CFR 20.1101(c). These results shall include an analysis of doses to individual members of the public, with reference to the standards in 10 CFR 20.1301 and 10 CFR 20.1302.
>
> No later than 30 days before the preoperational inspection, the licensee shall provide, to the NRC staff, for review and written verification, written procedures for its airborne effluent and environmental monitoring program that:
>
> A. Discuss how, in accordance with 10 CFR 40.65, the quantity of the principal radionuclides from all point and diffuse sources will be accounted for in, and verified by, surveys and/or monitoring.
>
> B. Evaluate the member(s) of the public likely to receive the highest exposures from licensed operations consistent with 10 CFR 20.1302.
>
> C. Discuss and identify how radon (radon-222) progeny will be factored into analyzing potential public dose from operations consistent with 10 CFR Part 20, Appendix B, Table 2.

D. Discuss how, in accordance with 10 CFR 20.1501, the occupational dose (gaseous and particulate) received throughout the entire License Area from licensed operations will be accounted for, and verified by, surveys and/or monitoring.

Based on the staff's review of the applicant's airborne effluent and environmental monitoring program, the staff is reasonably assured that the applicant will appropriately measure airborne effluents and doses to the public, as required in 10 CFR 20.1101(b), 20.1302, 20.1501, and 20.1502, and Table 2 to Appendix B of 10 CFR Part 20, and consistent with SRP Section 5.7.7.3. This reasonable assurance determination is contingent upon the applicant's fulfillment of the aforementioned license conditions.

5.7.9 OPERATIONAL GROUNDWATER AND SURFACE WATER MONITORING PROGRAMS

5.7.9.1 Regulatory Requirements

The staff determines if the applicant has demonstrated that the proposed groundwater and surface water monitoring program for the Dewey-Burdock Project meets the requirements of 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 5B(5), Criterion 7 and Criterion 7A.

5.7.9.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the review procedures in Section 5.7.8.2 and acceptance criteria in Section 5.7.8.3 of the standard review plan (NRC, 2003b).

5.7.9.3 Staff Review and Analysis

The applicant has described the operational groundwater and surface water monitoring programs to be implemented at the Dewey-Burdock Project. Preoperational monitoring is conducted as part of the site characterization and is addressed in SER Section 2.5. Whereas restoration monitoring is conducted during groundwater restoration and is addressed in SER Section 6.1.

5.7.9.3.1 Commission-Approved Background Well Sampling – Production Zone

The applicant will undertake background groundwater sampling to establish the Commission-approved background (CAB) concentrations per 10 CFR Part 40, Appendix A, Criterion 5B(5). CAB sampling will consist of collecting groundwater samples from a subset of wells in the production zone that will later serve as extraction wells (Powertech, 2011a). Such subsets will consist of at least 1 well per 1.6 ha (4 ac) of wellfield patterns or 6 wells, whichever is greater. In cases of wellfields smaller than 2.4 ha (6 ac), CAB wells will be spaced at 1 well per 0.4 ha (1 ac). The applicant will collect 4 samples from each well at least 14 days apart, and the samples will be analyzed for the parameters listed in Table 5.7-2 (Powertech, 2011a).

Table 5.7-2: List of Baseline Parameters

Major Ions	Trace and Minor Elements	Radiological Parameters
Alkalinity	Arsenic	Radium 226
Bicarbonate	Barium	Gross Alpha – Total
Carbonate	Boron	Gross Beta – Total
Sulfate	Cadmium	
Chloride	Chromium	
Nitrate	Copper	
Sodium	Fluoride	
Calcium	Iron	
Magnesium	Lead	
Potassium	Manganese	
	Mercury	
Physical Properties	Molybdenum	
Conductivity	Nickel	
pH	Selenium	
Total Dissolved Solids (TDS)	Silver	
	Uranium	
	Vanadium	
	Zinc	

Source: (Powertech, 2011a)

The applicant states that, prior to calculating CAB concentrations, it will analyze the groundwater analytical data to determine if heterogeneities exist within production areas (Powertech, 2012c). If such heterogeneities exist, the applicant will calculate CAB concentrations for individual production areas, as opposed to the entire production unit or wellfield. Heterogeneities will be assessed using statistical tests. Furthermore, the applicant will statistically evaluate groundwater analytical data for outliers, and if outliers are identified, it will assess the cause. Outliers will be removed from the data set only if they are determined to be invalid (Powertech, 2012c).

Regarding the methods for calculating CAB concentrations, the applicant states that it will establish baseline water quality as the average on a parameter-by-parameter basis for the entire production zone, for each subzone, or on a well-by-well basis (Powertech, 2012c). The applicant may also use other statistical analysis tools, such as EPA's ProUCL 4.0, to establish baseline water quality based on the distribution of sample results on a parameter-by-parameter basis (Powertech, 2012c). The staff accepts the use of an average value or some other value developed by an acceptable, alternative, statistical analysis.

The staff has determined that the proposed well spacing, sampling frequency, and parameters for CAB production zone sampling is consistent with the acceptance criteria in standard review plan Section 5.7.8.3. Furthermore, the applicant's proposed procedures for calculating CAB concentrations are also consistent with standard review plan Section 5.7.8.3. Therefore, the aforementioned information complies with 10 CFR Part 40, Appendix A, Criteria 5B(5), 7, and 7A. The staff has included a license condition that memorializes the methods for assessing CAB concentrations, which is discussed in SER Section 5.7.9.4.

5.7.9.3.2 CAB and Excursion Well Sampling

Application Figures TR RAI 5.7.8-12-2 and TR RAI 5.7.8-12-4 show the anticipated monitoring well network for the Burdock and Dewey areas, respectively (Powertech, 2011a). The applicant proposes a series of perimeter monitoring wells around the production zone, overlying monitoring wells, and underlying monitoring wells. Overlying monitoring well spacings will range from 1 per 1.6 ha (4 ac) for the first overlying aquifer to 1 per 3.2 ha (8 ac) for subsequent overlying aquifers. The applicant proposes an underlying aquifer well spacing of 1 per 1.6 ha (4 ac) (Powertech, 2011a).

During wellfield-specific aquifer tests used to prepare wellfield hydrologic packages, certain features may be identified as locations of "greatest potential for excursion." (Powertech, 2011a) Criteria for identifying such features could include the following:

- Areas that may be associated with leakage around an injection well.
- Areas where confining units may be uncharacteristically thin.
- Areas that may be associated with leakage through improperly abandoned boreholes.
- Areas identified during hydrologic testing as having hydraulic communication with the overlying or underlying aquifers.

Therefore, in addition to the 1 per 1.6 ha (4 ac) well spacing, the above criteria could also be used to locate specific overlying or underlying monitoring wells (Powertech, 2011a).

As discussed in SER Section 3.1.3, the perimeter monitoring network wells will be installed approximately 122 m (400 ft) outside the wellfield, and each well will be separated by approximately 122 m (400 ft) (Powertech, 2011a). Perimeter wells will be screened across an entire ore zone—either the Chilson or Fall River ore zone—but not both. Application Figures TR RAI 5.7.8-12-2 and TR RAI 5.7.8-12-4 present the proposed perimeter well network for the Burdock and Dewey areas, respectively (Powertech, 2011a). Analyses regarding perimeter well spacing and distance from the production zone are presented in SER Section 3.1.

Prior to operations, the applicant will calculate upper control limits (UCLs) for certain excursion parameters that are analyzed to detect potential excursions (Powertech, 2011a). To calculate UCLs, the applicant will collect 4 groundwater samples from all monitoring wells at least 14 days apart and analyze the samples for the parameters shown in SER Table 5.7-2. UCLs for the excursion parameters (conductivity, chloride, total alkalinity) will be calculated as the mean plus 5 standard deviations for each parameter. UCLs will be specific to a production zone. For chloride, the UCL will be the mean plus 5 standard deviations or the mean plus 15 mg/l, whichever is greater (Powertech, 2011a).

During operations all monitoring wells will be sampled twice per month for the excursion parameters (Powertech, 2011a). An excursion has occurred if at least two excursion parameters exceed the respective UCLs in any monitoring well. A verification sample will be collected within 48 hours, and if the result is negative, a second verification sample will be collected within the next 48 hours. If both verification samples are negative, the original excursion detection is deemed an error. If either verification sample confirms the excursion, the well is placed on excursion status. (Powertech, 2011a)

The staff has reviewed the applicant's plans for performing CAB and excursion monitoring for the Dewey-Burdock Project. The applicant has presented an appropriate monitoring well network, appropriate criteria for siting wells, and an appropriate CAB and excursion sampling scheme. However, the staff is clarifying the operational excursion monitoring program. Although, the applicant states that it will collect operational excursion samples twice monthly, the standard review plan states that samples should be collected every 2 weeks (NRC, 2003b). The staff determined that samples collected twice monthly, and no more than 14 days apart, is sufficiently consistent with the recommendations in the standard review plan. Therefore, the staff is modifying the standard license condition regarding excursions to clarify that operational excursion samples will be collected no more than 14 days apart in any given month.

The applicant has also properly stated the criteria for identifying excursions. For reasons stated in SER Section 2.4, the staff is not requiring underlying monitoring wells for aquifers below the Morrison Formation. Furthermore, corrective actions for excursions are discussed in SER Section 7.3.2.1. Based on the staff's review of the information provided by the applicant, the staff is reasonably assured that the applicant will implement an appropriate CAB and excursion sampling program. This reasonable assurance determination is based on the information provided in the application as supplemented by the modified standard license condition. Therefore, the staff finds the applicant's description of the CAB and excursion monitoring programs is consistent with standard review plan Section 5.7.8.3. Therefore, the aforementioned information complies with 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 5B(5), Criterion 7, and Criterion 7A. The modified license condition that memorializes the requirements for excursion monitoring is discussed in SER Section 5.7.9.4.

5.7.9.3.3 Wellfield Aquifer Test Procedures and Hydrologic Packages

The applicant has proposed the following procedures for performing aquifer tests in wellfields after installation but prior to lixiviant injection (Powertech, 2011a). Prior to aquifer testing, the applicant will perform the following tasks:

- Delineation drilling at a spacing approximately equivalent to wellfield pattern size; all delineation holes will be plugged and abandoned.
- Detailed mapping of the ore bodies and the lithology of overlying and underlying sand units and aquitards.
- Revise conceptual geology and hydrogeology.
- Design the production and injection wells.
- Design the monitor well system.
- Specify all monitor well locations and screened intervals.
- Install all monitor wells and production wells used during pump testing.
- Plug and abandon all water supply wells that are within 0.4 km (0.25 mi) of the wellfield; also plug and abandon all water supply wells that have been determined through preliminary evaluation to potentially impact, or to potentially be impacted by, ISR operations. (Powertech, 2011a)

During the aquifer tests, the applicant will monitor the following types of wells (Powertech, 2011a):

- Pumping wells.
- Monitoring wells within the production zone, minimum density = 1 per 1.6 ha (4 ac).
- Perimeter production zone monitoring wells.
- Monitoring wells in the immediately overlying non-production zone sand unit, minimum density = 1 per 1.6 ha (4 ac).
- Monitoring wells in each subsequently overlying non-production zone sand unit, minimum density = 1 per 3.2 ha (8 ac).
- Monitoring wells in the alluvium, if present, minimum density = 1 per 3.2 ha (8 ac).
- Monitoring wells in the immediately underlying non-production zone sand unit, if the production zone does not occur immediately above the Morrison Formation, minimum density = 1 per 1.6 ha (4 ac).
- Any additional wells installed for investigating other hydrogeologic features.
- Any other wells in the proximity of the wellfield that have been identified as having the potential to impact or be impacted by ISR operations (Powertech, 2011a).

The applicant will use pressure transducers to monitor water levels in all wells used for the aquifer tests (Powertech, 2011a). Static water levels will be measured to detect leakage across aquitards. Furthermore, four water samples will be collected from each monitor well and analyzed for the parameters in SER Table 5.7-2. Water quality will also be evaluated to identify any potential areas of leakage across aquitards due to improperly plugged boreholes or wells (Powertech, 2011a).

The applicant will evaluate the aquifer test data for the following purposes (Powertech, 2011a):

- Demonstrate hydraulic connection across the production zone and between the production and injection wells and all perimeter monitor wells.
- Confirm that all monitor wells can suitably detect an excursion.
- Verify the geologic conceptual model for the wellfield.
- Evaluate vertical confinement and hydraulic isolation between the production zone and overlying and underlying units.
- Demonstrate that solutions can be controlled with a typical wellfield bleed.
- Calculate the hydraulic conductivity, storativity, and transmissivity of the production zone sand unit.
- Evaluate anisotropy within the production zone sand unit.
- Calculate anticipated drawdown during ISR operations at typical bleed rates.
- Detect potentially improperly plugged wells or exploration boreholes.

Pumping test data and results will be included in the Wellfield Hydrogeologic Data Packages (Powertech, 2011a) The applicant proposes the following specific items to be included in the hydrogeologic data packages:

- A description of the proposed wellfield (location, extent, etc.).
- Map(s) showing the proposed production and injection well patterns and locations of all monitor wells.
- Geologic cross sections and cross section location maps.

- Isopach maps of the production zone aquifer and overlying and underlying confining units.
- Discussion of aquifer test procedures, including well completion reports.
- Discussion of the results and conclusions of aquifer tests, including raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and, when appropriate, directional transmissivity data and graphs.
- Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns.
- Baseline water quality information including proposed UCLs for monitor wells and target restoration goals (TRGs).
- Any other information pertinent to the proposed wellfield area tested will be included and discussed (Powertech, 2011a).

The staff is including a license condition regarding the preparation of wellfield packages. This condition is discussed in SER Section 3.1.4.

The staff reviewed the applicant's procedures for conducting post-licensing wellfield aquifer tests and its proposed wellfield hydrologic package content. The staff determines that the aquifer test and analysis procedures are adequate to determine production zone confinement and monitoring network adequacy. Furthermore, the proposed wellfield hydrologic package contains the necessary information for the staff to understand wellfield hydraulics and the ability of the applicant to monitor, detect, and remediate excursions. Based on the staff's review of the information provided by the applicant, the staff determines that this information is consistent with standard review plan Section 5.7.8.3. Therefore, the information in the application complies with 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 5B(5), Criterion 7, and Criterion 7A.

5.7.9.3.4 Other Operational Groundwater Monitoring

The applicant has proposed to sample wells unrelated to production (Powertech, 2011a). The types of wells incorporated into this groundwater monitoring network include domestic, stock, and monitoring wells. Domestic wells will be sampled quarterly, and samples will be analyzed for the parameters presented in SER Table 5.7-2. Application Figure TR RAI 5.7.8-17-1 presents domestic well sampling locations. Stock wells will be sampled quarterly, and samples will be analyzed for the excursion parameters, chloride, conductivity, and total alkalinity. Application Figure TR RAI 5.7.8-17-2 presents stock well sampling locations. Other non-production monitoring wells will be sampled quarterly, and samples will be analyzed for the parameters presented in SER Table 5.7-2. Application Figures TR RAI 5.7.8-17-3 through TR RAI 5.7.8-17-3-6 present monitoring well sampling locations in each aquifer. Table 5.7-3 likewise presents a list of proposed monitoring well sampling locations, excluding domestic and stock wells (Powertech, 2011a).

Table 5.7-3: List of Non-Production Monitoring Wells

Well ID	Aquifer	Description
43	Chilson	Downgradient of Triangle Pit
631	Fall River	Putnam big pump stock
676	Alluvium	Pass Creek Spencer alluvial
677	Alluvium	Putnam alluvial
678	Alluvium	Pass Creek alluvial
679	Alluvium	Pass Creek Doran alluvial
680	Lakota	Burdock pump test
681	Fall River	Dewey pump test
688	Fall River	Burdock pump test west piezo
689	Lakota	Dewey pump test north piezo
690	Unkpapa	
693	Unkpapa	
694	Fall River	School House NW
695	Fall River	Putnam east
696	Lakota	School House SE
697	Lakota	Putnam west
698	Fall River	weather station
703	Unkpapa	
705	Chilson	Upgradient Well
706	Fall River	Upgradient Well
707	Alluvium	Downgradient of Triangle Pit
708	Alluvium	Downgradient of Land App.
709	Alluvium	Downgradient of Wellfield
3026	Lakota	Daniel new stock
Proposed	Alluvium	Upgradient Well
Proposed	Alluvium	Downgradient of Wellfield
Proposed	Alluvium	Downgradient of Wellfield
Proposed	Alluvium	Downgradient of Land App.
Proposed	Fall River	Downgradient of Triangle Pit
Proposed	Fall River	Downgradient of Darrow Pit
Proposed	Chilson	Downgradient of Darrow Pit

Source: (Powertech, 2011a)

The staff reviewed the additional groundwater monitoring information referred to above. Although standard review plan Section 5.7.8.3 does not contain criteria specific to non-production zone monitoring, this additional monitoring complies with 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 7, and the ALARA principle. Therefore, the staff finds this additional monitoring program acceptable.

5.7.9.3.5 Operational Surface Water Monitoring

During ISR operations, 24 impoundments and 10 stream sampling sites, depicted on Exhibit 5.7-I, will be monitored as part of the operational monitoring program (Powertech, 2011a). As described in SER Section 2.4, the applicant sampled 11 impoundments and 8 stream locations within and surrounding the project area. Table 5.7-4 is the list of impoundments and stream locations sampled during the preoperational baseline sampling.

Table 5.7-4: Operational Surface Water Quality Sampling Locations

Site ID	Coordinates (FT)		Use
	Easting	Northing	
Subimpoundments			
Sub01	998654	446816	stock pond
Sub02	1001071	443526	Triangle Mine Pit
Sub03	1005005	438448	mine dam
Sub04	1002542	437518	stock pond
Sub05	1004591	437191	mine dam
Sub06	1006665	437019	Darrow Mine pit
Sub07	1009312	434360	stock dam
Sub08	1004195	427057	stock pond
Sub09	1004640	427089	stock pond
Sub10	1005961	421367	stock pond
Sub11	1009659	432225	stock pond
Stream Sampling Locations			
BVC01	989871	428716	Beaver Creek downstream
BVC04	965366	460922	Beaver Creek upstream
CHR01	985098	423010	Cheyenne River upstream
CHR05	1015626	405925	Cheyenne River downstream
PSC01	996764	436205	Pass Creek downstream
PSC02	1002722	452563	Pass Creek upstream
BEN01	1015872	416196	Bennett Canyon
UNT01	1007565	422482	Unnamed Tributary

Source: (Powertech, 2011a)
Note: Coordinates are in South Dakota State Plane System

Since the preoperational sampling phase, the applicant has added 13 more impoundments and 2 more stream sampling points to its operational surface water monitoring program. SER Table 5.7-5 presents a list of these additional sites, and SER Exhibit 5.7-1 presents the site locations (Powertech, 2011a).

Table 5.7-5: Additional Operational Surface Water Sampling Locations

Site ID	Distance from CPP (m/ft)
Subimpoundments	
Sub 20	1,915/6,281 South
Sub 21	1,944/6,375 Southwest
Sub 22	2,458/8,063 Southwest
Sub 29	2,372/7781 North
Sub 30	1,486/4,875 Southeast
Sub 31	686/2,250 South

Site ID	Distance from CPP (m/ft)
Sub 32	1,572/5,156 Southeast
Sub 33	1,000/3,281 Southeast
Sub 34	314/1,031 Southwest
Sub 35	1,486/4,875 Southwest
Sub 40	1,229/4,031 West
Sub 49	1,201/3,938 West
Sub 50	1,486/4,875 West
Stream Samples	
BVC11	*Beaver Creek downstream*
BVC14	*Beaver Creek upstream*
PSC11	*Pass Creek downstream*
PSC12	*Pass Creek upstream*
UNT02	Unnamed Tributary
UNT03	Unnamed Tributary

Source: (Powertech, 2011a)

Note: Italics indicate locations that replace preoperational sampling locations.

As stated in SER Section 2.4, the applicant will be required, by license condition, to collect 12 months of Criterion 7 baseline samples prior to operations for any new sampling location. During construction and operations, all 24 impoundments identified for operational monitoring will be visited on a quarterly basis (Powertech, 2011a). Grab samples collected from the impoundments will be analyzed for dissolved and suspended natural uranium, radium-226, thorium-230, lead-210 and polonium-210. In the event that a sample cannot be collected from an impoundment during the quarterly visit, the reason will be stated on a field sheet and reported accordingly (Powertech, 2011a).

A total of 10 stream sampling sites are proposed for operational monitoring (Powertech, 2011a). The applicant is proposing six sites not previously included in the Criterion 7 baseline monitoring program. The new sites will be upstream and downstream on both Beaver Creek and Pass Creek, as well as two additional sites on unnamed tributaries in the southeast portion of the project area (see application Exhibit 5.7-1). Grab samples will be collected quarterly from the sites on Beaver Creek (BVC11 and BVC14) and the Cheyenne River (CHR01 and CHR05), while passive samplers (single-stage samplers) will be installed at all other stream sampling sites between the months of April and October. All water samples collected from the sites will be analyzed for dissolved and suspended uranium, radium-226, thorium-230, lead-210, and polonium-210 (Powertech, 2011a).

The staff has reviewed the applicant's operational surface water monitoring program and finds it acceptable. The applicant has proposed a sufficient number of surface water monitoring locations, sufficient sampling frequency, and adequate sample parameters to monitor potential impacts from the proposed ISR operations. For new sampling locations, Criterion 7 baseline data will be collected prior to construction, as stated in SER Section 2.4. Based on the staff's review of the applicant's information presented above, the staff determines that this information is consistent with standard review plan Section 5.7.8.3 and complies with 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 7, and Criterion 7A.10 CFR Part 40, Appendix A, Criterion 7.

5.7.9.4 Evaluation Findings

The NRC staff has completed its review of the surface water and groundwater monitoring programs at the Dewey-Burdock Project. This review included an evaluation of the acceptance criteria outlined in standard review plan Section 5.7.8.3. The applicant has defined an acceptable groundwater and surface water sampling program. The staff is including license conditions that memorialize certain aspects of the operational groundwater and surface water monitoring programs.

The first License condition discusses the establishment of Commission-approved background concentrations:

> Establishment of Commission-Approved Background Water Quality. Prior to injection of lixiviant in each production wellfield, as defined by the licensee, the licensee shall establish Commission-approved background groundwater quality data for the ore zone, overlying aquifers, underlying aquifers, alluvial aquifers (where present), and the perimeter monitoring areas. Commission-approved background will be performed in accordance with Section 5.7.8 of the approved license application.

The second license condition discusses the establishment of UCLs:

> Establishment of UCLs. Prior to injection of lixiviant into each production wellfield, as defined by the licensee, the licensee shall establish excursion control parameters and their respective upper control limits (UCLs) in the designated overlying aquifer, underlying aquifer, and perimeter monitoring areas in accordance with Section 5.7.8 of the approved license application. Unless otherwise determined, the default excursion parameters are chloride, conductivity, and total alkalinity. The UCLs shall be established for each excursion control parameter and for each well based on the mean plus five standard deviations of the data collected for LC 11.3. The UCL for chloride can be set at the sum of the background mean concentration and either (a) five standard deviations or (b) 15 mg/L, whichever sum provides the higher limit.

The third standard license condition discusses excursion monitoring:

Excursion Monitoring. Monitoring for excursions shall occur twice monthly, and at least 10 days apart during operations, for all wells where UCLs have been established per Section 5.7.8 of the approved license application. If a designated monitor well is not sampled within 14 days of a previous sampling event, the reasons for this postponement shall be documented. Sampling shall not be postponed for more than 5 days.

If the concentrations of any two excursion indicator parameters exceed their respective UCL or any one excursion indicator parameter exceeds its UCL by 20 percent, then the excursion criterion is exceeded and a verification sample shall be taken from that well within 48 hours after results of the first analyses are received. If the verification sample confirms that the excursion criterion is exceeded, then the well is placed on excursion status. If the verification sample does not confirm that the excursion criterion is exceeded, a third sample shall be taken within 48 hours after the results of the verification sample are received. If the third sample shows that the excursion criterion is exceeded, the well is placed on excursion status. If the third sample does not show that the excursion criterion is exceeded, the first sample shall be considered to be an error and routine excursion monitoring is resumed (the well is not placed on excursion status).

Upon confirmation of an excursion, the licensee shall notify NRC, as discussed below, implement corrective action, and increase the sampling frequency for the excursion indicator parameters at the well on excursion status to at least once every 7 days. Corrective actions for confirmed excursions may be, but are not limited to, those described in Section 5.7.8 of the approved license application. An excursion is considered corrected when concentrations of all indicator parameters are below the concentration levels defining the excursion for three consecutive weekly samples.

If an excursion is not corrected within 60 days of confirmation, the licensee shall either (a) terminate injection of lixiviant within the wellfield until an excursion is corrected; or (b) increase the surety in an amount to cover the full third-party cost of correcting and cleaning up the excursion. The surety increase shall remain in force until the NRC has verified that the excursion has been corrected and remediated. The written 60-day excursion report shall identify which course of action the licensee is taking. Under no circumstances does this condition eliminate the requirement that the licensee must remediate the excursion to meet groundwater protection standards as required by LC 10.6 for all constituents established per LC 11.3.

> The licensee shall notify the NRC Project Manager (PM) by telephone or email within 24 hours of confirming a lixiviant excursion, and by letter within 7 days from the time the excursion is confirmed, pursuant to LC 11.6 and 9.3. A written report describing the excursion event, corrective actions taken, and the corrective action results shall be submitted to the NRC within 60 days of the excursion confirmation. For all wells that remain on excursion after 60 days, the licensee shall submit a report as discussed in LC 11.1(A).

In addition to the information discussed in the aforementioned license conditions, the applicant provided appropriate aquifer test procedures and wellfield hydrologic data package content. The staff notes that under 10 CFR 40.65, the applicant will be required to submit semiannual effluent monitoring reports that identify the quantity of principal radionuclides released to unrestricted areas in liquid (including groundwater) and gaseous effluents.

Based on the information provided in the application and on the staff’s detailed review of the groundwater and surface water monitoring programs at the Dewey-Burdock Project, and contingent upon the applicant meeting the license conditions described above, the staff concludes that the groundwater and surface water monitoring programs are acceptable and comply with 10 CFR 40.32(c), 10 CFR 40.41(c), 10 CFR Part 40, Appendix A, Criterion 5B(5), Criterion 7, and Criterion 7A.

5.7.10 QUALITY ASSURANCE (QA)

5.7.10.1 Regulatory Requirements

Staff's analysis will determine if the applicant has demonstrated that the proposed quality assurance program for the Dewey-Burdock Project meets the requirements of 10 CFR 20.1101, 10 CFR Part 20 Subpart L, and Subpart M.

5.7.10.2 Regulatory Acceptance Criteria

The staff reviewed the application for compliance with applicable requirements of 10 CFR Part 40, using acceptance criteria outlined in Section 5.7.9.3 of the standard review plan, NUREG-1569 (NRC, 2003b). Regulatory Guide 4.15 provides guidance on demonstrating compliance with the applicable regulations (NRC, 2007).

5.7.10.3 Staff Review and Analysis

The applicant states that it will establish a quality assurance program at the facility consistent with the recommendations in Regulatory Guide 4.15 (Powertech, 2009c). This QA program will be designed to ensure that all radiological and nonradiological measurements that support the various monitoring programs are reasonably valid and of a defined quality. The quality assurance program will address the following RG 4.15 elements:

- Organizational structure, responsibilities, and qualifications of both the management and the operational personnel.
- Specifications and qualifications of personnel.
- SOPs used in the monitoring programs.
- Records of samples, from collection to shipping to analysis.
- Records of quality control of the sample analyses, including results of quality control blanks, duplicates, and cross-checks performed by other laboratories.
- Calibration and operation of equipment used in obtaining samples and measuring radiation.
- Data verification and validation procedures.
- Data and calculations used to determine concentrations of radioactive materials and radiation doses due to occupational exposure. (Powertech, 2009c)

Quality assurance procedures will be defined for the following programs:

- External Monitoring Program
- Airborne Radiation Monitoring Program
- Contamination Control Program
- Airborne Effluent and Environmental Monitoring Program
- Management Control Program (Powertech, 2009c)

Additionally, the applicant states that the quality assurance recommendations contained in Regulatory Guides 4.14 (NRC, 1980) and 8.22 (NRC, 1988b) will be incorporated in the environmental monitoring and bioassay programs, respectively (Powertech, 2009c). In general, the quality control requirements for a specific activity will be incorporated into the SOP for that activity (Powertech, 2009c).

The applicant provided the following table of contents for its proposed quality assurance plan (Powertech, 2011a):

1. Policy
2. Table of Contents
3. Introduction
    - 3.1 Purpose
    - 3.2 Scope
    - 3.3 Relationship to Other Plans
    - 3.4 Reference Documents
4. Regulatory Requirements
    - 4.1 Regulations
    - 4.2 Regulatory Guidance
5. Organization and Personnel
    - 5.1 Organizational Structure
    - 5.2 Personnel Responsibilities
    - 5.3 Personnel Qualifications
    - 5.4 Personnel Training and Certifications
6. Procedures and Instructions
7. Records and Recordkeeping
    - 7.1 Records Management Plan
    - 7.2 Record Retention Requirements
8. Sampling and Analysis
    - 8.1 Environmental Media
        - 8.1.1 Sampling Methods and Procedures
        - 8.1.2 Sample Containers, Preservation and Holding Times
        - 8.1.3 Field Measurements
        - 8.1.4 Decontamination Procedures and Materials
    - 8.2 Occupational Health and Safety Monitoring
9. Radionuclide Analysis
    - 9.1 Onsite Laboratory
    - 9.2 Contract Laboratory
10. Instruments and Equipment
    - 10.1 Calibration
    - 10.2 Maintenance
11. Data Management
    - 11.1 Data Validation
    - 11.2 Qualification of Data
    - 11.3 Anomalous Data
12. Assessment and Oversight
    - 12.1 Review and Improvement
    - 12.2 Assessment and Corrective Actions (Powertech, 2011a)

The applicant will audit the quality assurance program periodically (Powertech, 2009c). Audits will be conducted by individuals qualified in radiochemistry and monitoring techniques; however, auditors will not have direct responsibilities in the areas being audited. Results of the audits will be documented and made available to members of management with authority to enact any changes needed (Powertech, 2009c).

The staff reviewed the applicant's quality assurance information provided in the application. Although the applicant discussed the contents of a quality assurance plan, such a plan is not included in the application. Therefore, the staff has included a license condition regarding the need for a quality assurance plan, which is discussed in SER Section 5.7.10.4. Based on the information provided in the application, the staff is reasonably assured that the applicant will provide a satisfactory quality assurance plan. This reasonable assurance determination is based on the fulfillment of the license condition presented in SER Section 5.7.10.4 and the description of the plan contents, which will be based on regulatory guides cited above.

5.7.10.4 Evaluation Findings

NRC has completed its review of the proposed quality assurance plan for the Dewey-Burdock Project. This review included an evaluation using the review procedures in standard review plan Section 5.7.9.2 and the acceptance criteria outlined in the standard review plan Section 5.7.9.3. The staff observes that the applicant has not provided a quality assurance plan in its Dewey-Burdock Project application. However, the applicant's description of its quality assurance plan and its commitments to use recommendations in Regulatory Guides 4.14, 4.15, and 8.22 provide reasonable assurance that the applicant will produce a satisfactory plan. To ensure a plan is submitted to, and reviewed by the staff, the following condition is added to the license:

> At least 60 days prior to the preoperational inspection, the licensee will submit a completed Quality Assurance Project Plan (QAPP) to the NRC for review to verify that the QAPP will be consistent with Regulatory Guide 4.15 (as revised).

5.8 REFERENCES

NRC (1977). Regulatory Guide 8.10, “Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable,” Revision 1. (ADAMS Accession No. ML003139563).

NRC (1980). Regulatory Guide 4.14, Radiological Effluent and Environmental Monitoring at Uranium Mills. (ADAMS Accession No. ML003739941).

NRC (1981). Regulatory Guide 10.1, Compilation of Reporting Requirements for Persons Subject to NRC Regulations. (ADAMS Accession No. ML003740185).

NRC (1986a). NUREG-0874, Internal Dosimetry Model for Applications to Bioassay at Uranium Mills. (ADAMS Accession No. ML093240418).

NRC (1987). Regulatory Guide 3.59, Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations (ADAMS Accession No. ML003739503).

NRC (1988b). Regulatory Guide 8.22, Bioassay at Uranium Mills, Revision 1. (ADAMS Accession No. ML003739586).

NRC (1992a). NUREG/CR-5512, Residual Radioactive Contamination from Decommissioning. (ADAMS Accession No. ML071090442).

NRC (1992b). Regulatory Guide 8.25, Air Sampling in the Workplace (ADAMS Accession No. ML003739616).

NRC (1992c). Regulatory Guide 8.34, Monitoring Criteria and Methods To Calculate Occupational Radiation Doses. (ADAMS Accession No. ML090770221).

NRC (1992d). Regulatory Guide 8.36 - Radiation Dose to the Embryo/Fetus (ADAMS Accession No. ML003739548).

NRC (1993a). Regulatory Guide 8.9, Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program, Revision 1. (ADAMS Accession No. ML003739554).

NRC (1993b). Regulatory Guide 8.37, ALARA Levels for Effluents from Materials Facilities (ADAMS Accession No. ML003739553).

NRC (1996). Regulatory Guide 8.29, Instruction Concerning Risks from Occupational Radiation Exposure, Revision 1. (ADAMS Accession No. ml003739438).

NRC (1999b). Regulatory Guide 8.13, Instruction Concerning Prenatal Radiation Exposure, Revision 3. (ADAMS Accession No. ML003739505).
NRC (1999c). Regulatory Guide 8.15, Acceptable Programs for Respiratory Protection. (ADAMS Accession No. ML003739528).

NRC (2002a). Regulatory Guide 8.30, “Health Physics Surveys in Uranium Recovery Facilities,” Revision 1. (ADAMS Accession No. ML021260524).

NRC (2002b). Regulatory Guide 8.31, Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities Will Be as Low as Is Reasonably Achievable (ADAMS Accession No. ML021260630).

NRC (2003b). NUREG 1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Washington, DC. (ADAMS Accession No. ML031550302).

NRC (2005). Regulatory Guide 8.7, “Instructions for Recording and Reporting Occupational Radiation Exposure Data,” Revision 2. (ADAMS Accession No. ML052970092).

NRC (2007). Regulatory Guide 4.15 - Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) -- Effluent Streams and the Environment (ADAMS Accession No. ML071790506).

Powertech (2009c). Powertech Dewey-Burdock Application. February 28, 2009 (ADAMS Accession No. ML091200014 - Package).

Powertech (2010a). Dewey-Burdock Project Supplement to Application for Uranium Recovery License Dated February 2009. August 10, 2010 (ADAMS Accession No. ML092870160 - Package).

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Powertech (2012c). Revised Response to Request for Additional Information - Heterogenieties in background data and statstics for calculating background. June 27, 2012 (ADAMS Accession No. ML12179A534.

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6.0 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

Application Section 6.0, Appendix 6.6-A, and Appendix 6.6-B represent a general decommissioning plan for the Dewey-Burdock Project (Powertech, 2009c, 2011a). The applicant will be required to submit an updated plan that accounts for "as-built" conditions to the NRC staff for review and approval at least 12 months prior to the start of actual site decommissioning.

6.1 PLANS AND SCHEDULES FOR GROUNDWATER RESTORATION

6.1.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed plans and schedules for groundwater quality restoration for the Dewey-Burdock Project meet the requirements of 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.2 REGULATORY ACCEPTANCE CRITERIA

Staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the review procedures in Section 6.1.2 and acceptance criteria in Section 6.1.3 of the standard review plan.

6.1.3 STAFF REVIEW AND ANALYSIS

This section discusses the applicant's proposed plans for restoration activities at the Dewey-Burdock Project. This discussion includes proposed restoration standards, restoration methods, restoration effectiveness, estimates of the number of pore volumes needed to complete restoration, restoration and stability monitoring, wastewater disposal, well plugging and abandonment, and the preliminary restoration schedule.

6.1.3.1 Restoration Standards and Restoration Target Values

The applicant proposes a primary goal for restoration to return production zone groundwater quality to levels consistent with Commission-approved background (CAB)(or Target Restoration Goals as referred to by the applicant) per 10 CFR Part 40, Appendix A, Criterion 5B(5) or a drinking water standard, whichever is higher (Powertech, 2011a). CAB concentrations will be developed using statistical analyses (ASTM Standard D 6312) of the background data for each indicator constituent (Powertech, 2011a). SER Section 5.7.9 describes the applicant's methods for calculating CAB concentrations. If neither the CAB nor drinking water standards can be achieved, then the applicant will submit an application for an alternate concentration limit (ACL) by providing the relevant information described in 10 CFR Part 40, Appendix A, Criterion 5B(6), at a minimum (Powertech, 2011a).

The applicant will address the following information in ACL application:

(a) Potential adverse effects on groundwater quality, considering:

- physical and chemical characteristics of the waste in the licensed site including its potential for migration.
- hydrogeological characteristics of the facility and surrounding land.
- quantity of groundwater and the direction of groundwater flow.
- proximity and withdrawal rates of groundwater users.
- current and future uses of groundwater in the area.
- existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality.
- potential for health risks caused by human exposure to waste constituents.
- potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents.
- persistence and permanence of the potential adverse effects.

(b) Potential adverse effects on hydraulically-connected surface water quality, considering:

- volume and physical and chemical characteristics of the waste in the licensed site.
- hydrogeological characteristics of the facility and surrounding land.
- quantity and quality of groundwater, and the direction of groundwater flow.
- patterns of rainfall in the region.
- proximity of the licensed site to surface waters.
- current and future uses of surface waters in the area and any water quality standards established for those surface waters.
- existing quality of surface water including other sources of contamination and the cumulative impact on surface water quality.
- potential for health risks caused by human exposure to waste constituent.
- potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents.
- persistence and permanence of the potential adverse effects. (Powertech, 2011a)

The applicant intends to follow NRC guidance and policy in effect at the time that an ACL would be requested and mentions the NRC staff Technical Position on Alternate Concentration Limits for Title II Uranium Mills (NRC, 1996) (Powertech, 2011a).

The applicant provides a list of CAB parameters that is presented in SER Section 5.7.9. Analytical methods for each parameter are presented in application Table TR RAI 6.1-1 (Powertech, 2011a). CAB concentrations will be established using the wellfield statistical average (Powertech, 2011a). However, other methods of establishing CAB will be considered or utilized depending on the nature of the collected data (Powertech, 2012c).

Based on the information provided in the application, the staff determines that the applicant will use the correct restoration standards and will properly calculate CAB concentrations. The staff also determined that the applicant has appropriately identified the procedures for applying for ACLs. The staff notes that the applicant specified a branch technical position regarding ACL applications; however, NUREG-1620 contains more precise guidance on ACL application development (NRC, 2003a). The staff finds that the discussion of restoration standards is consistent with Section 6.1.3 of the standard review plan and complies with 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.3.2 Restoration Methods

The applicant proposes two different restoration strategies depending on the liquid waste disposal method it utilizes (Powertech, 2011a). For the deep well disposal option, the restoration method will primarily be groundwater extraction, reverse osmosis (RO) treatment of the extraction stream, and reinjection of the permeate. Prior to RO treatment, extracted groundwater from one or more wellfield will be treated by ion exchange (IX) to remove uranium and other dissolved species. Treated water (permeate) from the RO units will be reinjected into the wellfields. Brine or reject will be treated for radium removal, and subsequently disposed by deep well injection (Powertech, 2011a).

Regarding the land application option, the primary restoration method will include groundwater sweep (extraction) with reinjection of natural water from the Madison Aquifer (Powertech, 2011a). Extracted groundwater will treated by IX and then radium removal in the settling ponds. Settling pond effluent will be disposed in the land application system, which will consist of irrigated crop circles (Powertech, 2011a).

Groundwater restoration is used in part to recover flare, which is lixiviant that might have migrated beyond the extraction zone, but not as far as the monitoring wells. To recover flare, the applicant states that it will extract higher rates of groundwater (Powertech, 2011a). For example, the applicant states that it may recover up to 1 additional pore volume to recover flare resulting in an average restoration bleed of 17 percent (Powertech, 2011a).

Based on the information provided in the application, the staff determines that the applicant will use appropriate groundwater restoration techniques at the Dewey-Burdock Project. The applicant presented its restoration methods considering the disposal options and accounted for flare that could occur during operations. Therefore, the staff finds that the discussion of restoration methods is consistent with Section 6.1.3 of the standard review plan and complies with 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.3.3 Effectiveness of Groundwater Restoration Methods

The applicant includes examples of existing ISR licensed facilities at which restoration has been successful and approved by the regulatory agencies as analogues to their proposed methods (Powertech, 2011a). Those examples are as follows:

- The Ruth R & D Project was a Wyoming pilot test conducted by Uranerz USA, Inc. in the early 1980s. Restoration consisted of groundwater sweep, RO treatment with permeate injection, and reductant injection.

- The Crow Butte R&D Project also used RO treatment with permeate injection to achieve successful aquifer restoration.

- The Bison Basin Commercial ISR Uranium Mine also used RO treatment with permeate injection.

The staff notes that the applicant is essentially eliminating the groundwater sweep phase and instead using groundwater treatment immediately. The staff finds this strategy acceptable as immediate treatment could reduce the number of pore volumes required for restoration. However, most commercial scale restorations completed to date have used groundwater sweep prior to treatment; therefore, direct analogs are difficult to develop.

Direct analogs are also difficult to develop, because the restoration end-point is now different. Earlier ISR restorations used background as the restoration standards, and when background was not achievable during restoration, it was necessary to establish class-of-use concentrations. Class-of-use standards are constituent concentrations generally developed by the individual states as a means of defining water quality for various uses of groundwater (i.e., drinking, irrigation, livestock watering). Class-of-use standards are no longer acceptable as a second-tier restoration standard. Instead, alternate concentration limits (ACLs) are the second-tier standard. Consequently, direct comparisons of previous restoration actions and the proposed project are not necessarily possible. A review of recent restoration data from the Cameco Smith Ranch/Highland Uranium Project, indicates that contaminant concentrations in groundwater can be substantially reduced using the methods proposed by the applicant (Cameco, 2012).

In assessing the potential for groundwater restoration, the staff reviewed a geochemical modeling report on the Dewey-Burdock site prepared by the USGS, under contract by the USEPA (Johnson, R. H., 2011). In its published work to date, USGS determined that the amount of oxygen remaining in the aquifer (production zone) after restoration is a key factor in stability. If some oxygen remains in the production zone, "some uranium is found in the groundwater." If no dissolved oxygen remains then "uranium is not found in solution." (Johnson, R. H., 2011)

The staff determines that the restoration method will be effective in depleting excess oxygen from the production zone and minimizing constituent concentrations. The applicant will have a sufficient number of extraction wells to remove contaminants and dissolved oxygen. Injecting permeate will also increase hydraulic gradients, which will aid in contaminant removal. Furthermore, because the current groundwater at the Dewey-Burdock Project does not contain dissolved oxygen (Johnson, R. H., 2011, 2012), long-term stability can be maintained because the geochemical conditions that dissolve and transport uranium do not occur naturally outside the production zone.

Therefore, based on the information provided in the application, the staff determines that the applicant's proposed groundwater restoration methods will effectively restore groundwater to the standards presented in 10 CFR Part 40, Appendix A, Criterion 5B(5). Furthermore, the applicant's proposed restoration methods are consistent with Section 6.1.3 of the standard review plan and comply with 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.3.4 Pore Volume Estimates

The applicant presented estimates of the size of one pore volume and the number of pore volumes required for restoration (Powertech, 2011a). Pore volume size was calculated by multiplying the wellfield pattern area x wellfield thickness x porosity x flare factor. Values for these parameters are as follows:

- Wellfield Area – varies
- Average Thickness – 1.4 m (4.6 ft)
- Porosity – 0.30
- Flare – 1.44

For the first year surety, 1 pore volume is 49,205,000 L (13,000,000 gal) (Powertech, 2011a).

The staff generally concurs with the formula for calculating a pore volume. However, the staff notes that the "average thickness" parameter may underestimate the actual volume of certain wellfields. The applicant defines "average thickness" as the thickness of the mineralized zone (Powertech, 2011a). This value should actually be the thickness of the screened interval, and the size of a pore volume should be calculated for each individual wellfield. The staff is including a license condition discussed in SER Section 6.1.4 that stipulates the requirement for wellfield-specific pore volumes. The staff notes that applicant incorporated a flare factor into its pore volume calculations; flare factors are discussed in SER Section 3.1.3.6.

The applicant defines the restoration composite (RC, total number of gallons required for restoration) as the number of gallons in one pore volume x number of pore volumes needed for restoration (Powertech, 2011a). The applicant estimates that 6 pore volumes will be required to restore wellfields. The applicant justifies this figure by stating that it is consistent with the best practicable technology that includes the following operational practices:

- Daily balancing of injection and extraction flow rates during production. This flow rate balancing is designed to ensure that a proper aquifer bleed is maintained both at the wellfield level and also within each 5-spot pattern within the wellfield.

- Timeliness of beginning restoration operations. For any particular wellfield, aquifer restoration operations will begin as soon as is reasonably possible following the cessation of recovery operations.

- Maintenance of aquifer bleeds. Hydraulic control of wellfields through the net withdrawal of the aquifer bleed stream will be continuously maintained from the beginning of recovery operations until the end of active aquifer restoration (Powertech, 2011a).

The staff acknowledges that previous restoration projects have required more than 6 pore volumes to restore aquifers. However, the staff has observed some recent restoration efforts that indicate 6 pore volumes may be sufficient. These efforts are utilizing similar restoration techniques to those proposed by the applicant. Therefore, the staff finds that 6 pore volumes is an acceptable initial estimate.

The staff notes the pore volume estimate is a significant factor in calculating the surety amount. Surety amounts are reviewed annually. Therefore, if actual restoration volumes exceed 6 pore volumes, the applicant is required to increase the surety amount pursuant to 10 CFR 40, Appendix A, Criterion 9.

Based on the information provided in the application, the staff is reasonably assured the applicant will calculate pore volumes correctly and will be able to restore wellfield within the estimate pore volume estimate. This reasonable assurance determination is predicated in part on fulfilling the license condition discussed in SER Sections 3.1.3.7 and 3.1.4. Information provided by the applicant, as supplemented by the license condition, is consistent with Section 6.1.3 of the standard review plan and comply with 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.3.5 Groundwater Restoration Monitoring

The applicant will conduct excursion monitoring during restoration by sampling monitoring wells every 60 days; samples will be analyzed for the indicator upper control limit (UCL) parameters (Powertech, 2011a). Procedures for confirming and reporting excursions will be the same as those for production excursion monitoring.

The applicant will also perform aquifer restoration monitoring program to document the progress of aquifer restoration (Powertech, 2011a). During active aquifer restoration, each wellfield will be monitored on a frequency sufficient to determine the success of aquifer restoration, optimize the efficiency of aquifer restoration, and determine if any areas of the wellfield need additional attention. At the beginning of aquifer restoration, water levels will be measured and groundwater samples analyzed for all parameters listed in SER Table 5.7-2 in the same wells used in calculate CAB concentrations. Thereafter, samples will be collected and analyzed for all or selected parameters, as needed (Powertech, 2011a).

Results of the active restoration monitoring will be used to evaluate potential areas of flare or hot spots (Powertech, 2011a). The applicant states that if potential flare or hot spots are identified, appropriate corrective measures will be taken. Such actions may include adjusting the flows in the area, changing wells from injection to production or vice-versa, or adjusting the restoration bleed in specific areas (Powertech, 2011a).

Based on the information provided in the application, the staff determines that the applicant's proposed restoration monitoring is sufficient to monitor restoration progress. While the applicant does not specify a sampling interval, it states that it will collect a sufficient number of samples to demonstrate that restoration is working satisfactorily. Therefore, the staff is allowing the applicant flexibility in the restoration sampling interval, contingent upon the applicant's ability to comply with a standard license condition that requires the applicant to inform the NRC of restoration progress. The applicant's proposed restoration monitoring is consistent with Section 6.1.3 of the standard review plan and complies with 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.3.6 Restoration Stabilization Monitoring

The applicant proposed a groundwater stability monitoring program consisting of 12 months with quarterly sampling (Powertech, 2011a). The applicant will collect 5 samples from each monitoring well, and stability will be assessed using average constituent concentrations for each wellfield. Hot spots will be evaluated based on the results from individual wells (Powertech, 2011a).

During the restoration stability period, perimeter ring monitoring wells and those in the overlying and underlying aquifers will be sampled once every 60 days for the UCL indicator parameters of chloride, total alkalinity (or bicarbonate), and conductivity (Powertech, 2011a). Production zone wells used to determine CAB concentrations will be sampled quarterly and analyzed for the water quality parameters listed in application Table 6.1-1. The applicant will consider a wellfield stable if the mean constituent concentration of each water quality parameter meets the CAB concentration for each quarter of sampling (Powertech, 2011a).

The applicant will use linear regression analysis for each monitored constituent measured in the production zone baseline wells to determine if the concentration of a given constituent exhibits a significantly increasing trend during the stability period (Powertech, 2011a). If a constituent exhibits a strongly increasing trend (for pH a strongly increasing or decreasing trend), the applicant commits to corrective actions. Such actions could include extending the stability period or undertaking active restoration (Powertech, 2011a).

The applicant acknowledges the potential for hot spots to occur and addresses them in the following manner (Powertech, 2011a). First, the applicant will identify any area as a hot spot if a constituent concentration exceeds the mean production zone concentration plus two standard deviations for that particular constituent. For pH, the indication of a hot spot will be plus or minus two standard deviations (Powertech, 2011a).

If the applicant identifies hot spots, it will conduct additional evaluations, such as collecting additional water samples, analysis of additional parameters, trend analyses, or flow and transport modeling. Based on the results of the evaluation, the applicant may perform additional stability monitoring or restoration. The applicant states that if it sufficiently demonstrates that hot spots will not affect water quality outside of the exempted aquifer and the restoration criteria are otherwise met without increasing trends, then no additional action will be taken.

The staff finds the applicant's proposed stabilization monitoring program is satisfactory, as it provides the necessary means of assessing the success of wellfield restoration. However, the staff notes two issues. First, if a constituent concentration does not meet the CAB or drinking water standard, then the applicant must apply for an ACL. Second, the applicant cannot remove wellfield infrastructure necessary for groundwater restoration until the NRC staff approves the restoration. If necessary infrastructure is removed prematurely, the applicant must either replace the equipment or include the cost for replacing the equipment in its financial assurance estimate.

Based on the information provided in the application, the staff determines that the applicant's proposed methods for assessing stability are acceptable. Furthermore, the applicant's proposed stability assessment program is consistent with Section 6.1.3 of the standard review plan and comply with 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.3.7 Well Plugging and Abandonment

The applicant's standard operating procedures will include plugging and abandoning all boreholes completed during the process of exploration and delineation drilling and any wells that fail MITs that cannot be repaired (Powertech, 2011a). Plugging and abandonment (P&A) procedures will include plugging all wells or exploration holes with bentonite or cement grout. Grout composition will meet the well abandonment standards of the State of South Dakota, including Chapter 74:11:08 (Capping, Sealing, and Plugging Exploration Test Holes) and Section 74:29:11:18 (Requirements for Plugging Drill Holes and Repair, Conversion, and Plugging Wells) of the South Dakota Administrative Rules. Cementing will be completed from total depth to surface using a drill pipe. (Powertech, 2011a)

Records will be kept of each well or exploration hole cemented including at a minimum the following information:

- well or hole ID, total depth, and location
- driller, company, or person doing the cementing work
- total volume of cement placed down hole
- viscosity and density of the slurry used

The applicant will complete well P&A by removing surface casings and setting a cement plug to a depth 1.8 m (6 ft) below the ground (Powertech, 2011a).

Based on the information provided in the application, the staff determines that the applicant's proposed P&A are acceptable. Furthermore, the applicant's proposed P&A methods are consistent with Section 6.1.3 of the standard review plan and comply with 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.3.8 Restoration Schedule

The applicant included a Gant-type chart to depict the proposed restoration schedule in the application (Powertech, 2011a). In application Figure 6.1-1, the applicant presents its production and restoration schedule for all wellfields at the Dewey-Burdock Project. In its schedule the applicant predicts that active restoration will require 4 months followed by 1 year of stabilization monitoring, 1 year for regulatory approval, and 1 year for decommissioning (Powertech, 2011a).

Based on its review of the restoration methods and water balance, the staff determines that restoration within 4 months is unlikely. According to the applicant's information, 1 pore volume is 49,205,000 L (13,000,000 gal); therefore, 6 pore volumes, which is the anticipated restoration volume is 295 million L (78,000,000 gal). Assuming 4 months of restoration, the applicant must extract and treat 1,685 Lpm (445 gpm) to achieve restoration in one wellfield. However, the applicant's stated treatment capacity is 946 Lpm (250 gpm) in each of the Dewey and Burdock areas for a total of 1,893 Lpm (500 gpm) for the entire Dewey-Burdock Project. Due to these limitations, the applicant is unable restore more than 1 wellfield in total at any given time.

The staff determines the proposed restoration schedule is unacceptable because the application at Figure 6.1-1 indicates more than one wellfield will be in restoration during the course of operations at the Dewey-Burdock Project. The staff has included a license condition discussed in SER Section 6.1.4 that requires, prior to operations, the applicant to provide a revised schedule that coincides with the proposed restoration flow. The new schedule must also be incorporated into the initial financial assurance estimate.

The applicant acknowledges in its application that restoration schedules for ISRs are governed by the requirements in 10 CFR 40.42 (Powertech, 2011a). This regulation requires that licensees complete site decommissioning or the decommissioning of a separate building or outdoor area within 24 months. If this is not possible, the licensee must apply to the NRC staff for an alternate schedule approval per 10 CFR 40.42(h)(2)(i).

Based on the information provided in the application, the staff is reasonably assured that the applicant will develop an acceptable restoration schedule. This reasonable assurance determination is predicated on the fulfillment of the license condition presented in SER Section 6.1.4. The staff notes that the applicant must revisit the restoration schedule as part of its first surety estimate, which is approved prior to operations. The staff determines that the applicant's proposed restoration schedule as supplemented by information required by license condition is consistent with Section 6.1.3 of the standard review plan and complies with 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.1.4 EVALUATION FINDINGS

NRC staff has completed its review of the plans and schedules for groundwater quality restoration proposed for use at the Dewey-Burdock Project. The staff performed this review using the acceptance criteria in standard review plan Section 6.1.3. Areas of review included the proposed restoration standards, restoration methods, effectiveness of groundwater restoration methods, pore volume estimates, groundwater restoration monitoring, restoration stabilization monitoring, well plugging and abandonment, and restoration schedule. The staff finds the applicant's plans to address these areas of review acceptable.

The staff determines that the applicant did not commit to calculating wellfield-specific pore volumes. Furthermore, the staff finds that calculating pore volumes using the average thickness instead of the well-screen interval is not acceptable. Properly calculated and wellfield-specific pore volumes are required for surety estimates. Therefore, the staff has included these requirements in a license condition that is presented in SER Section 3.1.4. In addition, the staff determines a 4-month restoration is unlikely to be achieved due to insufficient restoration flow capacity. Therefore, the staff is including language regarding the need for a reasonable restoration period in a standard license condition, which is also discussed in SER Section 3.1.4.

Based on its review of the information provided in the application, the staff is reasonably assured that the applicant will restore groundwater to the NRC's restoration standards of 10 CFR Part 40, Appendix A, Criterion 5B(5). This reasonable assurance determination is based on information provided in the application and supplemented by information required by the aforementioned license conditions. Therefore, the staff finds these procedures to be consistent with the applicable acceptance criteria in standard review plan Section 6.1.3 (NRC, 2003b) and requirements of 10 CFR 40.32(c), 10 CFR 40.42, and 10 CFR Part 40, Appendix A, Criterion 5B.

6.2 PLANS FOR RECLAIMING DISTURBED LANDS

6.2.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed plans for reclaiming disturbed lands for the Dewey-Burdock Project meet the requirements of 10 CFR 40.42 and 10 CFR, Appendix A, Criteria 6(6) and 6(7).

6.2.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria in standard review plan Section 6.2.3 (NRC, 2003b).

6.2.3 STAFF REVIEW AND ANALYSIS

The applicant provided general strategies for reclaiming disturbed lands (Powertech, 2009c). Of the total 4,282 ha (10,580 ac) encompassed in the license boundary, 28 ha (68 ac) will be disturbed prior to the first year of operation, and 48 ha (108 ac) of land will be disturbed during the life of the project. Accounting for the land application areas, if needed, the maximum land disturbance is 187 ha (463 ac). Land disturbances will be associated with wellfield installation, the CPP, satellite plant, and waste handling structures (i.e., ponds, land application areas) (Powertech, 2009c).

Once structures, pipelines, wells, tanks, and other equipment are removed, the applicant will regrade these areas, place topsoil, and grade the final contours (Powertech, 2009c). The applicant will contour land where surface disturbance has occurred to restore it to a configuration that would blend in with the natural terrain. The applicant will then revegetate disturbed areas using seed mixes developed in consultation with the SD DENR and local land owners (Powertech, 2009c). The ultimate reclamation goal is to return all lands disturbed by the Dewey-Burdock operations to their preoperational land use for livestock grazing and wildlife habitat (Powertech, 2009c). The staff noted in SER Section 2.4.3.1.3, that existing drainages will be altered in areas designated for land application and the satellite plant. Therefore, the staff included a condition in the license requiring that these drainages be restored to the original conditions, which is discussed in SER Section 2.4.4.

Prior to any surface reclamation, the applicant will perform pre-reclamation surveys to identify areas requiring reclamation (Powertech, 2011a). The applicant will pay special attention to diversion ditches, surface impoundments, wellfields, process structures, storage areas, onsite transportation routes, and liquid waste disposal areas. Instruments and techniques for pre-reclamation radiological surveys will be the same or similar to those used to survey the project area for preoperational radiological conditions and are discussed in SER Section 2.6. The applicant will also consider results from operational monitoring and any other information (i.e., spill records) that provides insight to areas with the greatest potential to be contaminated. The applicant will use a sampling grid of 100 m^2 (1,075 ft^2) for soil and other procedures to ensure that radium and other radionuclides will not exceed the standards in 10 CFR Part 40, Appendix A, Criterion 6(6). Guidance for sample size and other techniques provided in NUREG-1575 will be used as reference for the pre-reclamation radiological survey (Powertech, 2011a).

Pre-reclamation survey results will be used to identify candidate areas for cleanup operations (Powertech, 2011a). The applicant specified general procedures for interpretation of the pre-reclamation survey results, which are summarized as follows:

- Pursuant to 10 CFR Part 40, Appendix A, Criterion 6(6), the radium-226 content in soils, averaged over areas of 100 m^2 (1,075 ft^2), will not exceed the background concentration by more than the following:
    - 5 pCi/g of radium-226 averaged over the first 15 cm (6 in) below the surface, and
    - 15 pCi/g of radium-226 averaged over 15-cm (6-in) thick layers more than 15 cm below the surface.
    - For areas that meet the radium cleanup criteria, but exhibit elevated thorium-230 concentrations, the applicant will develop a separate cleanup criterion for thorium-230.

- Cleanup criteria for uranium in soils will be developed based on radium-226 concentrations using the benchmark dose assessment method in standard review plan Appendix E. (NRC, 2003b)

- The surface mine area in the northeast portion of the Dewey-Burdock project area and a naturally anomalous area in the northern portion of the Dewey-Burdock project area exhibit higher background concentrations than the rest of the license area. Therefore, the applicant may calculate background values that are specific to these areas. These background values will be presented in the final decommissioning plan.

- Survey methods for cleanup operations will be designed to provide 95 percent confidence that any residual radionuclides on the project area will be identified and cleaned up (Powertech, 2011a).

The applicant commits to addressing non-radiological hazards in the planning and implementation processes of site decommissioning and closure (Powertech, 2011a). Any non-radiological hazardous waste determined to be byproduct material will be disposed of offsite at a licensed byproduct material disposal site in accordance with NRC's directive in 10 CFR Part 40, Appendix A, Criterion 2. Non-radiological hazardous waste that is not byproduct material will be disposed offsite at a permitted hazardous waste disposal facility. Potentially hazardous liquid wastes such as used oil, hydraulic fluid, cleaners, solvents and degreasers will be recycled or disposed offsite at an appropriately permitted hazardous or solid waste disposal facility. In the land-application areas, residual non-radiological metal concentrations are not expected to exceed the respective EPA soil screening levels (SSLs). The final decommissioning plan will provide greater detail on the reclamation of areas containing non-radiological hazardous constituents (Powertech, 2011a).

The applicant commits to submitting a final decommissioning plan to the NRC staff for review and approval at least 12 months before the planned commencement of final decommissioning of the site, as well as, prior to decommissioning a wellfield (Powertech, 2009c). Soils, vegetation, and radiological baseline data will be used to develop cleanup criteria to be used in final reclamation. Reclamation activities for disturbed lands will consist of plugging and abandoning all wells, establishing soil cleanup criteria, surveying for contaminated soils and removing contaminated soils to a licensed disposal facility, performing final surveys, re-contouring disturbed areas, and re-vegetating disturbed areas (Powertech, 2009c).

The applicant will develop a Quality Assurance Project Plan (QAPP) for the site that addresses all aspects of decommissioning (Powertech, 2011a). The applicant commits to preparing a QAPP in accordance with Regulatory Guide 4.15 (NRC, 2007). The program will be designed to ensure that decommissioning allows for unrestricted release of the site at the time of license termination (Powertech, 2011a). SER Section 5.7.10 discusses the QAPP and provides the license condition requiring the preparation of the plan.

At the conclusion of site decommissioning and surface reclamation, a report will be prepared by the applicant that contains all documentation required by NRC's regulations (Powertech, 2009c). Records of contaminated materials transported to a licensed disposal site are required to be maintained for five years, or by the period required by applicable regulations at the time of decommissioning (Powertech, 2009c).

Based on the staff's review of information provided in the application, the staff determines that the proposed plans are acceptable and are in compliance with NRC regulations. The applicable regulations are, as follows: 10 CFR 40.32(c), which requires applicant proposed equipment, facilities, and procedures to be adequate to protect health and minimize danger to life or property; 10 CFR Part 40, Appendix A, Criterion 6(6), which identifies cleanup criteria requirements; and 10 CFR Part 40, Appendix A, Criterion 6(7), which requires a licensee to consider radiological hazards during closure. License conditions regarding updated decommissioning plans are included in SER Section 6.2.4 to memorialize commitments made by the applicant.

The staff notes that certain information not currently available will be required in the final decommissioning plan: the thorium-230 cleanup standard, background values for anomalous and surface mining areas, and soil screening levels (SSLs) non-radiological metals. The staff has included a requirement for a thorium-230 cleanup standard, if needed, as part of the license condition discussed in SER Section 6.2.4. SER Section 4.2.3.2 addresses the need for a solid byproduct material disposal agreement. The staff finds the applicant's surface reclamation discussion is consistent with standard review plan Section 6.2.3 and, therefore, complies with 10 CFR Part 40, Appendix A, Criteria 6(6) and (7), and 10 CFR 40.32(c).

6.2.4 Evaluation Findings

The staff reviewed the plans for reclaiming disturbed land on the proposed Dewey-Burdock Project in accordance with standard review plan Section 6.2.3 (NRC, 2003b). The applicant described various aspects of reclamation activities at the site, including plugging and abandoning all wells, surveying for contaminated soils and removing contaminated soils to a licensed disposal facility, performing final surveys, recontouring disturbed areas, salvaging and replacing topsoil, and revegetating disturbed areas.

The applicant's plan is preoperational in nature. Because of the dynamic nature of ISR operations, the finished facility may differ from initial preoperational plans. To ensure that decommissioning and reclamation conform to any facility changes made during the life of the Dewey-Burdock Project, the applicant commits to submitting a final decommissioning plan at least 12 months prior to the start of any site decommissioning, reclamation or groundwater restoration activity. The applicant's proposed decommissioning, decontamination, reclamation, and groundwater restoration plans, as well as commitments to provide detailed final plans, provide the staff reasonable assurance the applicant will properly decommission the Dewey-Burdock Project. The following standard condition in the Dewey-Burdock Project license memorializes these commitments:

> At least 12 months prior to initiation of any planned final site decommissioning, reclamation, or groundwater restoration, the licensee shall submit a detailed decommissioning plan for NRC staff review and approval. The plan shall represent as-built conditions at the Dewey-Burdock Project.

The staff has included a license condition for revised site decommissioning, decontamination, and reclamation to include cleanup criteria for radionuclides other than radium and also the need to restore stream channels to the original morphology, as discussed in SER Section 2.4.3.1:

> Within 90 days of receipt of an NRC license, the licensee will submit to the NRC for review and approval a revised decommissioning, decontamination, and reclamation plan. The revised plan will include soil cleanup criteria for radionuclides other than radium based on the radium benchmark dose method, as well as procedures for monitoring beta-gamma contamination on equipment, structures, and material released for unrestricted use. The soil cleanup criteria, based on the radium benchmark dose methodology for U and other radionuclides, will demonstrate that residual radioactivity in soil meets the criteria in 10 CFR Part 40, Appendix A, Criterion 6(6). The revised plan will also include procedures for restoring stream channels to their original geomorphology.

Based on the information provided in the application, as supplemented by the information required by the aforementioned license condition, the staff determines that the applicant's plans for reclaiming disturbed lands are consistent with the acceptance criteria in standard review plan Section 6.2.3 and comply with 10 CFR 40.42 and 10 CFR Part 40, Appendix A, Criteria 6(6) and 6(7).

6.3 REMOVAL AND DISPOSAL OF STRUCTURES, WASTE MATERIAL, AND EQUIPMENT

6.3.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed plans for removal and disposal of structures, waste material, and equipment at the Dewey-Burdock Project meet the requirements of 10 CFR 40.32(c).

6.3.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria in standard review plan Section 6.3.3 (NRC, 2003b).

6.3.3 STAFF REVIEW AND ANALYSIS

As described in application Section 6.3.2, the applicant will evaluate areas within buildings showing evidence of possible penetration of process solutions causing subsurface contamination (Powertech, 2009c). If building materials, slabs, and soils beneath the slabs are not contaminated, these materials will be released for unrestricted use, provided the building surfaces meet the release criteria and radiological monitoring requirements of the final decommissioning plan, discussed in SER Section 6.2.3. Where contaminated material is present, the buildings will be demolished, the slabs removed, and the underlying soils removed (if contaminated). Materials contaminated above release limits will be prepared for offsite disposal at a licensed disposal facility (Powertech, 2009c). The applicant states that concrete slabs will be surveyed and if found to contain radionuclides in excess of the release limits, an attempt will be made to decontaminate the concrete slab(s). If after a second survey radionuclides are in excess of the release limits, the concrete will be broken up and disposed of at a licensed byproduct material disposal site. When surveys indicate radionuclides are below release limits, slabs may be disposed in an appropriately permitted landfill, used for fill, or left in place for use by the landowner (Powertech, 2011a).

The applicant states decontamination methods may include a combination of washing, high pressure sprays, or steam cleaning (Powertech, 2009c). Cleaned surfaces will be air-dried prior to radiological monitoring. The applicant will reduce surface contamination as far below applicable limits as practical, and committed to apply ALARA principle to its decommissioning activities. In application Section 6.3, the applicant committed to perform all decommissioning activities in accordance with the NRC license, Titles 10 and 49 of the CFR, and other applicable regulatory requirements (Powertech, 2009c).

The applicant states that a contamination control program will be in place to control residual contamination (Powertech, 2009c). This program will be consistent with the program used during operations, but will focus on structures and equipment in order to identify potential hazards prior to decommissioning. Salvageable building materials, equipment, pipe, and other materials to be released for unrestricted use will be surveyed for alpha and beta-gamma contamination in accordance with NRC guidance (Powertech, 2009c).

The applicant will use surface contamination release limits provided in Enclosure 2 to Policy and Guidance Directive FC-82-23 (as updated) to release material and equipment that has potentially come into contact with licensed material (Powertech, 2011a). In order to be approved for unrestricted use after decommissioning, structures must meet Criterion 6(6) of Appendix A to 10 CFR Part 40, which sets out release limits for contamination on structural surfaces. Acceptable dose-based surface contamination release limits will be established using the RESRAD-Build model or an equivalent model and must be provided in the final

Decommissioning Plan, which will be submitted 12 months prior to any planned decommissioning, reclamation, and groundwater restoration (Powertech, 2011a).

The applicant established an acceptable program for the measurement and control of residual contamination on structures and equipment, and this program is discussed in Section 5.7.7 of this SER. All buildings, equipment, or scrap that are likely to be contaminated, but which are difficult to accurately assess, will be assumed to be contaminated in excess of limits and will be treated accordingly. Equipment that cannot be transferred or decontaminated for unrestricted use will be disposed of at a licensed disposal facility. Transportation of waste will comply with Title 49 of the Code of Federal Regulations (Transportation) and other applicable regulations. Waste materials that are non-salvageable and meet the requirements of unrestricted release will be sent to a municipal landfill. The applicant must document origin, date of generation, results of radiological surveys and ultimate destinations of all disposed items. A standard license condition detailing the requirements for the release of material for unrestricted release is included in the license (SER Appendix A).

6.3.4 EVALUATION FINDINGS

The staff reviewed the procedures for removing and disposing of structures and equipment at the Dewey-Burdock Project and determined the procedures are consistent with standard review plan Section 6.3.3. The staff concludes that the applicant will properly release structures, materials, and equipment for unrestricted use based on its proposed use of proper release limits, surveying techniques, and surveying equipment. The applicant has established an acceptable program for the measurement and control of residual alpha and beta-gamma contamination on structures and equipment, consistent with standard review plan Section 6.3.3. Therefore, the staff determines that the applicant’s procedures for removing and disposing of materials from the Dewey-Burdock Project is consistent with standard review plan Section 6.3.3 and complies with 10 CFR 40.32(c).

6.4 POST RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS

6.4.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has demonstrated that the proposed methods for conducting post reclamation and decommissioning radiological surveys for the Dewey-Burdock Project meet the requirements of 10 CFR Part 40, Appendix A, Criterion 6(6).

6.4.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for compliance with the applicable requirements of 10 CFR Part 40, using the acceptance criteria in standard review plan Section 6.4.3 (NRC, 2003b).

6.4.3 STAFF REVIEW AND ANALYSIS

6.4.3.1 Cleanup Methodology and Criteria

The applicant commits to comply with the cleanup standard in 10 CFR Part 40, Appendix A, Criterion 6(6) and maintain residual radiological constituent concentrations ALARA (Powertech, 2011a). The applicant's final decommissioning plan will contain methods for post-reclamation gamma ray surveys. Gamma ray surveys for excavation control monitoring and final cleanup status will be designed to be consistent with standard review plan acceptance criteria 6.4.3(1), 6.4.3(3), and 6.4.3(5), including the use of a methodology for gamma-ray surveys for excavation control monitoring and final status surveys that will provide 95 percent confidence that the survey units will meet the cleanup guidelines. The applicant states that if more than one residual radionuclide is present in the same 100 m^2 (1,075 ft^2) area, the sum of the ratios for each radionuclide of concentration present to the concentration limit will not exceed 1 to be in compliance with 10 CFR Part 40, Appendix A, Criterion 6(6). (Powertech, 2011a)

The applicant states that it used RESRAD Version 6.4 computer code (RESRAD) to model the Dewey-Burdock Project site and calculate the maximum annual dose rate from the current radium cleanup standard (Powertech, 2009c). Supporting documentation for determination of the radium benchmark dose and the natural uranium soil standard is attached in application Appendix 6.4-A. The maximum dose from radium-226 contaminated soil at the 5 pCi/g above background cleanup standard, as determined by RESRAD, for the residential farmer scenario was 38.1 mrem/yr. This dose was based on the 5 pCi/g surface (0 to 6-inch) radium-226 standard and was noted at time, t = 0 years. Using RESRAD, the applicant calculated a natural uranium radiation concentration that results in a dose of 38.1 mrem/yr. This natural uranium is 537 pCi/g. (Powertech, 2009c)

Although the applicant has not calculated a thorium-230 standard, the applicant commits to provide a concentration criterion for thorium-230 in its final decommissioning plan (Powertech, 2011a). As with natural uranium, the thorium-230 when combined with all other radionuclides is required to meet radium cleanup standards pursuant to 10 CFR Part 40, Appendix A, Criterion 6(6) (Powertech, 2011a). Additionally, a final decommissioning plan must be submitted at least 12 months prior to the initiation of any site decommissioning or reclamation, as stated in a license condition in SER Section 6.2.4.

Based on the staff's review of the applicant's cleanup methodology and criteria, the staff determines the methodologies for developing criteria and the resulting criteria are acceptable. These factors and the license condition in SER 6.2.4 that requires a thorium-230 criterion be provided in the final decommissioning plan, provide the basis for a reasonable assurance determination the applicant will develop and utilize cleanup criteria for the Dewey-Burdock Project, as required by NRC regulations. The staff has found the applicant's cleanup methodology and criteria to be consistent with standard review plan Section 6.4.3 and to be in accordance with 10 CFR Part 40, Appendix A, Criterion 6(6).

6.4.3.2 Uranium Chemical Toxicity Assessment

The applicant evaluated the uranium chemical toxicity effects from uranium exposure to determine the appropriate cleanup level for uranium in soils (Powertech, 2009c). The applicant calculated the benchmark dose assessment using RESRAD with the farmer scenario, which assumes that a future farm will be located on the site and the diet of the farm family will consist of 25 percent of the meat, fruits, and vegetables grown at the site. Model results show soil containing 537 pCi/g of natural uranium will result in an intake of approximately 0.14 mg/day. The applicant proposed a limit of 230 pCi/g of natural uranium in soil with a goal of 150 pCi/g averaged in the top 15 cm soil layer and 230pCi/g averaged to the subsurface soil at depths greater than 15cm. The proposed limits are lower than the 537 pCi/g used to compute the radium benchmark dose. The applicant states that the total annual uranium intake from all considered food sources from the site is 52.4 mg/yr (Powertech, 2009c).

Based on the staff's review of the applicant's uranium toxicity assessment, the staff determines that the method for assessing uranium toxicity and refining the cleanup criteria are acceptable. Therefore, the applicant's uranium toxicity assessment and criteria are consistent with standard review plan Section 6.4.3 and in compliance with 10 CFR Part 40, Appendix A, Criterion 6(6).

6.4.4 EVALUATION FINDINGS

The staff reviewed the methodologies for conducting post-reclamation and decommissioning radiological surveys for the proposed Dewey-Burdock Project in accordance with standard review plan Section 6.4.3. The applicant has developed acceptable methodologies for verification of cleanup that demonstrate that the radium concentration in the upper 15 cm [5.9 in.] of soil will not exceed 5 pCi/g and in subsequent 15 cm [5.9 in.] layers will not exceed 15 pCi/g. Also, the cleanup of other residual radionuclides in soil will meet the criteria developed with the radium benchmark dose approach found in (standard review plan Appendix E) and will include a demonstration of ALARA.

The applicant also committed to calculating cleanup criteria for thorium-230. Thorium-230 criteria will be included in the final decommissioning plan, as required by the license condition described in SER Section 6.2.4. The applicant also assessed uranium chemical toxicity and refined the cleanup criteria to account for the uranium intake standard of 10 mg per week, as defined in 10 CFR Part 20. The staff determines that the information regarding post-reclamation and post-decommissioning surveys is consistent with the acceptance criteria in standard review plan Section 6.2.3, and, therefore, complies with 10 CFR Part 40, Appendix A, Criterion 6(6).

6.5 FINANCIAL ASSURANCE

6.5.1 REGULATORY REQUIREMENTS

The staff determines if the applicant's proposed financial assurance for the Dewey-Burdock Project meets the requirements of 10 CFR Part 40, Appendix A Criterion 9.

6.5.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for consistency with the applicable regulations in 10 CFR Part 40 using the acceptance criteria in standard review plan Section 6.5.3 (NRC, 2003b).

6.5.3 STAFF REVIEW AND ANALYSIS

Application Appendix 6.6-a contains the financial assurance estimate (Powertech, 2011a). The applicant provided an initial cost estimate of its financial assurance, which covers the first wellfields in the Dewey and Burdock areas from construction through decommissioning (Powertech, 2011a). SER Table 6-1 shows a summary of the decommissioning costs for these wellfields.

Table 6-1: Summary of Decommissioning Costs for BWF-1 and DWF-1

Activity	Disposal Option	
	Disposal Wells	Land application
Facility Decommissioning		
Salvageable Equipment	$242,000	$242,000
Non-salvageable building & equipment disposal	$710,080	$1,123,580
Byproduct material disposal	$466,609	$527,831
Restore contaminated areas	$570,300	$1,429,100
Operations & Maintenance		
RO treatment with permeate injection	$897,873	--
Groundwater sweep with Madison injection	--	$555,700
Wellfield Reclamation		
Wellfield plugging & closure	$751,300	$751,300
Remove surface equipment & reclamation	$975,050	$975,050
Other Costs		
Radiological survey and environmental monitoring	$10,300	$24,400
Project mgmt. & miscellaneous	$968,700	$968,700
Labor, 35% overhead, 10% contractor profit	$1,337,000	$1,337,000
Contingency @ 15%	$1,039,382	$1,190,199
Total Decommissioning Cost Estimate	$7,968,594	$9,124,861

Source: (Powertech, 2011a)

Cost estimates provided in the application are based on available information and standard industry practices at the time of the application (Powertech, 2011a). Such information sources include the 2009 RS Means handbooks, vendor quotes, and other calculations. Electrical power costs provided by the applicant were based on analyses of power costs and then rounded upward. Disposal costs assume that solid byproduct material will be disposed at the Energy Fuels, Inc. White Mesa mill in Blanding, Utah. The applicant states that it will incorporate the cost estimate into a final restoration action plan (RAP), to be submitted with a final revised application that consolidates previous information submitted in RAI responses and applicant-generated documents. (Powertech, 2011a)

The total estimate for decommissioning the entire Dewey-Burdock Project is approximately $56,000,000 for the disposal well option only and $64,000,000 for the land application option only. These decommissioning cost estimates are reasonable considering the number and size of the wellfield areas proposed for this project. Because the applicant has not negotiated a byproduct disposal agreement, the staff has imposed a standard license condition requiring the execution and maintenance of a byproduct disposal agreement. The cost estimates provided by the applicant are generally consistent with outline provided in Appendix C of the standard review plan (NRC, 2003b).

Financial surety arrangements must be established prior to the commencement of operations at the Dewey-Burdock, in accordance with the requirements of 10 CFR Part 40, Appendix A, Criterion 9. The applicant has not yet established a financial surety instrument, however, it commits to doing so prior to the commencement of operations (Powertech, 2011a). The applicant intends to use an irrevocable letter of credit; however, it does not committing to this type of instrument, at this time (Powertech, 2011a). Per 10 CFR Part 40, Appendix A, Criterion 9, uranium recovery licensees may use one of three surety instruments or a combination of these instruments including, trust funds, surety bonds, and irrevocable letters of credit.

The applicant also commits to providing annual financial assurance updates to NRC staff, including any revisions to financial assurance cost estimates due to the following:

- inflation
- changes in contractor costs
- changes in material costs
- changes in restoration elements such as pore volumes (Powertech, 2011a)

The applicant also makes the following commitments to:

- Automatically extend the financial assurance instrument for the previously approved financial assurance amount until NRC approves the revised financial assurance cost estimates, if NRC staff has not approved its proposed revisions thirty (30) days prior to the expiration date of the existing financial assurance instrument;
- revise the financial assurance instrument no later than ninety (90) days after NRC approval of any revised decommissioning plan, if the revised cost estimate exceeds the amount of existing financial assurance costs;
- submit for NRC staff review an updated financial assurance package to cover any planned expansion or operational change not included in the previous annual financial assurance update at least ninety (90) days prior to beginning associated construction;
- provide NRC staff with copies of financial assurance-related information submitted to the State of South Dakota and/or EPA, including a copy of the financial assurance review or final financial assurance package (Powertech, 2011a).

The staff has reviewed the financial assurance information provided by the applicant. The applicant provided detailed cost information based on standard sources, vendor costs, and research. It committed to providing updates annually and when otherwise necessary, and will provide the actual surety instrument prior to operation. The staff, therefore, determines the financial assurance information is consistent with the acceptance criteria in standard review plan Section 6.5.3 and complies with 10 CFR Part 40, Appendix A, Criterion 9.

6.5.4 EVALUATION FINDINGS

Based on the information provided in the application and the staff's review of the decommissioning cost estimate for the Dewey-Burdock Project, the staff concludes the amount of the proposed financial assurance and its methods of estimation are acceptable and consistent with 10 CFR Part 40, Appendix A, Criterion 9, which requires that financial assurance arrangements be established by each operator. Maintaining adequate financial assurance is an important aspect of facility operations; therefore, compliance with the applicable regulations will be required through a standard license condition presented in SER Appendix A.

6.6 REFERENCES

Raymond H. Johnson (2011). Reactive Transport Modeling for the Proposed Dewey-Burdock Uranium In-Situ Recovery Mine, Edgemont, South Dakota. *International Mine Water Association, Mine Water - Managing the Challenges*.

Raymond H. Johnson (2012). *Geochemical data from groundwater at the proposed Dewey Burdock uranium in-situ recovery mine, Edgemont, South Dakota*.

NRC (1996). *Regulatory Guide 8.29, Instruction Concerning Risks from Occupational Radiation Exposure, Revision 1*. (ADAMS Accession No. ml003739438).

NRC (2003a). *NUREG-1620, Rev. 1, Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978*. (ADAMS Accession No. ML031550522).

NRC (2003b). *NUREG 1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Washington, DC.* (ADAMS Accession No. ML031550302).

NRC (2007). *Regulatory Guide 4.15 - Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) -- Effluent Streams and the Environment* (ADAMS Accession No. ML071790506).

Powertech (2009c). *Powertech Dewey-Burdock Application*. February 28, 2009 (ADAMS Accession No. ML091200014 - Package).

Powertech (2010a). *Dewey-Burdock Project Supplement to Application for Uranium Recovery License Dated February 2009*. August 10, 2010 (ADAMS Accession No. ML092870160 - Package).

Powertech (2011a). *Revised Responses to the Request for Additional Information (RAI) for the Technical Report (TR); Powertech (USA) Inc.'s Proposed Dewey-Burdock Project.* 08/01/2011 (ADAMS Accession No. ML112071064).

Powertech (2012c). *Revised Response to Request for Additional Information - Heterogenieties in background data and statstics for calculating background*. June 27, 2012 (ADAMS Accession No. ML12179A534.

7.0 ACCIDENTS

7.1 REGULATORY REQUIREMENTS

The staff determines if the applicant has addressed potential accidents at the proposed Dewey-Burdock Project and has demonstrated that the facility will meet the requirements of 10 CFR 40.32(c), which requires that the applicant's proposed procedures be adequate to protect public health and minimize danger to life or property should an accident occur.

7.2 REGULATORY ACCEPTANCE CRITERIA

The staff reviewed the application for consistency with applicable regulations of 10 CFR Part 40, using the acceptance criteria in standard review plan Section 7.5.3 (NRC, 2003b).

7.3 STAFF REVIEW AND ANALYSIS

Chapter 7.0 of the standard review plan addresses environmental effects of a proposed ISR. Because this SER addresses safety aspects of the proposed Dewey-Burdock Project, most of the information requested in Chapter 7.0 is addressed in the Supplemental Environmental Impact Statement ((NRC, 2013b). However, this chapter will address accident scenarios and the manner in which the applicant is proposing to detect, avoid, and mitigate accidents.

As part of its analysis, the applicant reviewed the following accident scenarios:

- chemical accidents
- groundwater contamination
- wellfield spills
- transportation accidents
- radioactive waste accidents
- natural disasters
- processing plant releases
- fires and explosions
- wildfires

7.3.1 Chemical Accidents
SER Table 7-1 presents the bulk chemicals to be stored onsite.

Table 7-1: Chemicals and Quantities Stored at the Dewey-Burdock Project

Chemical Name	No. Tanks	Unit Storage Capacity	Units	Usage Rate ton/yr	Hazard Classification
Burdock CPP and Wellfields					
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 WellFields					
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

Source: (Powertech, 2011a)

Chemicals that have the potential to impact radiological safety include hydrochloric acid, sulfuric acid, hydrogen peroxide, and sodium hydroxide (Powertech, 2011a). Oxygen, because of its ability to support combustion, also requires special handling. The applicant states that it will design and install chemical storage and feeding systems per 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). By adhering to these standards, the applicant states that it will ensure the safety of employees and members of the public, both with regard to the specific chemicals and to the potential release of radioactive materials in the event of an accident. In addition all tanks and storage areas will be clearly labeled (Powertech, 2011a).

Chemicals that have the potential to impact radiological safety and that are stored at each location are as follows:

- The hydrogen peroxide system will include a storage tank and delivery pump. The hydrogen peroxide storage tank will be located in the chemical storage area outside the CPP and will be isolated from acid storage areas. The tank area will include a concrete secondary containment basin designed to contain at least 110 percent of the tank volume. Hydrogen peroxide is a strong oxidizer, can be very reactive and is easily decomposable. Its hazardous decomposition products include oxygen, heat, and steam.

- Sulfuric acid and/or hydrochloric acid will be used in the precipitation circuit of the CPP to break down the uranium carbonate complexes. Hazards 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 one or more storage tanks and delivery pumps. The storage tank will be located adjacent to the CPP in the chemical storage area, and will include a lined concrete secondary containment basin designed to contain at least 110 percent of the largest tank volume. Sulfuric acid will be purchased and stored as standard commercial grade concentrated acid (approximately 93 percent H_2SO_4 by weight). Tank and piping materials will be designed to resist corrosion from these acids. The applicant will develop and implement an emergency response plan and emergency notification procedures in the event of an accidental release.

- The sodium hydroxide system will include a storage tank and delivery pump. The storage tank will be located adjacent to the CPP in the chemical storage area in a concrete secondary containment basin designed to contain at least 110 percent of the tank volume. This secondary containment basin will be separate from the containment basins for other chemical systems. Sodium hydroxide will be purchased as aqueous caustic soda and will be pumped directly into the storage tank from the supplier's tanker trucks.

- Liquid oxygen will be stored within the wellfields. The primary hazard associated with oxygen is fire since it is a strong oxidizer in the presence of combustible materials. To reduce the risk to radiological safety from an accident, oxygen will be stored near the wellfields. Barriers will be used to prevent impacts to oxygen storage tanks 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. Oxygen will be stored in storage vessels designed, fabricated, tested, and inspected in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Powertech, 2011a).

The staff has reviewed the applicant's information regarding chemical accidents and finds it acceptable. The applicant has presented the chemicals that could potentially affect radiological health and safety and the manner in which accidents are avoided or mitigated. Avoidance and mitigation measures include use of industry codes and standards for tanks and piping, use of secondary containment, and physical isolation of potentially reactive chemicals. This information is consistent with standard review plan Section 7.5.3 and complies with 10 CFR 40.32(c).

7.3.2 GROUNDWATER CONTAMINATION

7.3.2.1 Excursions

Vertical and horizontal excursions of barren and pregnant lixiviant have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized during the ISR process. Cause of excursions could include unbalanced injection/extraction in the production zone, discontinuities in confining layers and mechanical integrity failures. The applicant has incorporated the following design features to detect and avoid excursions:

- Wellfield Bleed - During normal ISR operations, inward hydraulic gradients are maintained by the wellfield bleed, such that groundwater flow is towards the production zone from the edges of the wellfield. This inward gradient helps minimize the chance of a horizontal excursion occurring.

- Monitoring Well Network - To reduce the likelihood and minimize the consequences of potential horizontal excursions, a ring of monitoring wells will be installed within and encircling the production zone to enable early detection of excursions. Monitoring wells will also be installed in overlying and underlying aquifers to detect and minimize the consequences of vertical excursions.

- Mechanical Integrity Tests – to detect and minimize the consequences of well integrity failures, mechanical integrity tests (MITs) will be conducted on injection and production wells to ensure that production fluids are not leaking from the well casing.

In the event of an excursion, the applicant will immediately begin corrective actions after the excursion is confirmed and notify the NRC staff within 24 hours by telephone or email, and in writing within 30 days. Corrective actions could include the following:

- Sampling frequency will be increased to weekly.
- Pumping rates of production wells in the area of the excursion will increase.
- The net bleed will be increased.
- Individual wells will be pumped to enhance recovery of ISR solutions.
- And an excursion report will be prepared for the staff (Powertech, 2011a).

The applicant states that, if corrective actions are not effective at retrieving the excursion within 60 days, it will suspend injecting lixiviant into the production zone adjacent to the excursion until the excursion is retrieved and the UCL parameters are not exceeded (Powertech, 2011a).

7.3.2.2 Spills

Types of spills that could potentially impact groundwater during operations include: a leak in a storage pond, a release of pregnant and/or barren leach fluid, a release of injection or production solutions from associated piping, spills, and potential well rupture. Potential impacts of contamination to shallow aquifers and surrounding soils may result from one or a combination of these types of spills. The likelihood of spills is minimized by way of rigorous safety training, and employing all necessary preventative procedures such as maintaining injection pressures below casing and formation rupture pressures, monitoring pressure in the header houses with instrumentation equipped with alarms and interlocks for early warning and maintaining operating pressures so as to minimize the likelihood for potential impacts to shallow groundwater.

7.3.2.3 Land Application

Land application of treated wastewater could potentially cause radiological or other constituents, such as selenium or other metals, to accumulate in soils or infiltrate into shallow aquifers. Land application is subject to effluent limits in 10 CFR Part 20, Appendix B, and the requirements of a groundwater discharge permit issued by the State of South Dakota. NRC has reviewed the proposed GDP submitted by the applicant to the SD DENR, as discussed in SER Section 4.2.3.1. This plan contains groundwater monitoring requirements that are sufficient to meet NRC's regulations, detect groundwater contamination, and avoid contamination of drinking water supplies.

SER Section 4.2.3.1 also discusses the SPAW model created by the applicant to study groundwater flow from the land application area into the shallow subsurface. This model incorporates various soil profiles from test pits (Powertech, 2010a). Results of the SPAW modeling indicated that the soil moisture content at the base of the Dewey and Burdock soil profiles was also less than field capacity for all cases that were modeled, and no percolation was observed beyond the base of the soil profile. Therefore, the applicant assumes that no lateral movement of water would occur along the bedrock surface, and that water would not move vertically into the bedrock, and therefore there would be no leaching of trace elements beyond the base of the soil profile. Based on the above information, there will be no migration pathway of licensed material to groundwater beneath the land application pivot sites, thereby eliminating any potential of exposure and risk to human health and the environment. (Powertech, 2010a)

The staff reviewed the applicant's information regarding groundwater contamination and finds that it acceptable. The applicant has identified appropriate accident scenarios for groundwater contamination and presented acceptable methods for detection and avoidance including monitoring well networks, pressure sensors on piping networks, and well integrity tests. Therefore, the staff finds that this information is consistent with the acceptance criteria in standard review plan Section 7.5.3 and complies with 10 CFR 40.32(c).

7.3.4 WELLFIELD SPILLS

Wellfield spills could be caused by failure of a process pipeline within the wellfield, which could result in the discharge of pregnant or barren lixiviant to the surface (Powertech, 2009c). To minimize the amount of process fluid that is lost should a failure occur, high and low pressure alarms and shutoffs as well as flowmeters will be installed on pipelines between the wellfield and the CPP. Should a failure occur and the amount and/or concentration of the process fluid lost constitute an environmental concern, then the affected area would have the contaminated soil surveyed and removed for disposal. Pipeline failure is minimized by burying the pipeline 0.61 to 1.5 m (2 to 5 ft) below ground surface and inspecting and testing the piping prior to burial. Pressure test results for the piping will be documented. Corrosion free high density polyethylene (HDPE) or similar piping will be used to further reduce the chance of pipeline failure (Powertech, 2009c).

Small leaks at pipe joints and fittings in the header houses or at wellheads may also occur occasionally. These leaks may drip process solutions onto the underlying soil until they are identified and repaired. SER Section 3.1 discusses the applicant's proposed wellfield inspection program, and SER Section 3.1.4 presents a license condition requiring documentation of these inspections. Small leaks rarely result in contamination of the underlying soil; however, the applicant will survey affected soil for contamination, and, if contamination is detected, the soil will be appropriately removed. Furthermore, in application Section 5.7.1.3, the applicant states that it will develop a response plan for wellfield spills that will include procedures for notification, spill containment and recovery, post spill sampling and cleanup, and reporting.

Based on its review, the staff concludes that the proposed designs, measures, and responses addressing potential wellfield spills at Dewey-Burdock are acceptable. The applicant will use appropriate piping materials to minimize corrosion, gauges to measure pressure, inspections procedures, and responses to detect and mitigate leaks. Therefore, the staff finds that this information is consistent with the acceptance criteria in standard review plan Section 7.5.3 and complies with 10 CFR 40.32(c).

7.3.5 TRANSPORTATION ACCIDENTS

The applicant considered the potential for transportation accidents involving shipments of ion exchange resins, yellowcake slurry, chemicals, fuels, and radioactive wastes (Powertech, 2009c). The applicant identified several procedures and actions to prevent transportation accidents, including maintaining vehicles in good operating condition, using properly trained and licensed drivers, inspecting vehicles prior to shipment, and following DOT hazardous materials shipping provisions (Powertech, 2009c).

7.3.5.1 Yellowcake Shipments

The applicant states that all shipments to and from the Dewey-Burdock Project will be transported by only licensed and certified commercial drivers and subject to both federal and state transportation regulations (Powertech, 2009c). Yellowcake will be transported in 55-gallon (208-L)(Powertech, 2009c) drums to a conversion facility in Metropolis, Illinois or Port Hope, Ontario, Canada, for refining and conversion. Shipping yellowcake to Canada requires a separate export license under 10 CFR Part 110. Yellowcake shipments will be classified as

Low Specific Activity (LSA) material and will be handled in accordance with NRC and DOT regulations. The applicant has committed to use a specialized third-party transportation company to transport the yellowcake from the project to a conversion facility. Specific routes are to be determined upon agreements made within the transportation companies' contract. This company will meet all safety controls and regulations promulgated by 10 CFR 71.5. (Powertech, 2009c)

The worst case accident scenario involving yellowcake shipments would involve the release of yellowcake into the environment due to the breach of one or more drums containing yellowcake during transportation. The applicant will develop an Emergency Preparedness Program that will be implemented should a transportation accident occur. The applicant will provide training that includes technical instruction on field monitoring, sampling, decontamination procedures, communication, and other related skills necessary to safely handle a transportation emergency concerning shipments of yellowcake (Powertech, 2011a).

7.3.5.2 Resin

The applicant states that the Dewey-Burdock Project will be equipped with resin stripping facilities; therefore, only shipments involving the barren or eluted resin will be transported to the this site (Powertech, 2009c). Consequences are likely to be lower for trucks transporting barren or eluted resin because the risk of contamination is minimal. Both barren and eluted resin shipments will be handled in accordance with NRC and DOT regulations. Resin shipping procedures would be the same general as those for yellowcake shipments (Powertech, 2009c).

The IX resin will be shipped to and from the project in a tank truck. The NRC calculated the probability of an accident involving a truck transporting uranium-loaded resin from a SF to a CPP at 0.009 in any year (NRC, 2001). The potential environmental impacts from an accident involving the shipment of IX resin could impact primarily the top soil in the area contaminated by the spill and the subsequent modification to the vegetation structure and the salvage of the top soil. This is scenario would only take place if tanker trucks ruptured

The applicant did not discuss resin shipments between the Dewey satellite and the Burdock CPP. While the Burdock CPP contains resin elution equipment, the Dewey satellite plant does not. Consequently, the applicant must transport uranium loaded resin from the satellite plant to the CPP for processing. NRC analyzed this scenario along with other transportation scenarios and determined that the consequences of accidents involving such shipments are low. This is primarily because the uranium is bonded to the resin and the resin is wet, which prevent air dispersion. Furthermore, such spills are easily remediated by simple excavation and removal. However, the applicant must develop procedures for such spills, as required by standard license condition, and the staff will review this procedure during the preoperational inspection

Based on its review, the staff concludes that the applicant's assessment of transportations accidents is acceptable. The applicant provided reasonable transportation accident scenarios and commitments to develop procedures and train responsible personnel in mitigating transportation accidents. Furthermore, NRC staff's assessments, as documented in NUREG/CR-6733 determined that transportation accidents pose risks of cancer mortalities approximately 70 percent below general cancer mortality rate of 0.002. Therefore, the staff finds that this information is consistent with the acceptance criteria in standard review plan Section 7.5.3 and complies with 10 CFR 40.32(c).

7.3.6 Fires and Explosions

The applicant discussed the potential for fires and explosions at the Dewey-Burdock Project. According to the applicant an explosion, could result from: a prematurely sealed drum of yellowcake, dryer explosion, use of propane in the thermal fluid heater or space heaters, or mixing of oxygen gas with combustible materials (Powertech, 2011a).

The applicant states that an explosion from a drum of yellowcake has the greatest potential to impact radiological safety of the workers (Powertech, 2011a). Such an accident occurred at Cameco's Blind River processing facility on June 23, 2012. According to the report, a drum lid blew off as it was loosened expelling approximately 26kg of yellowcake from drum, some of which was inhaled and ingested by an employee (CNSC, 2012). Blood uranium samples indicated that the worker could have ingested more than 10 mg in that event, which exceeds the weekly U.S. standard for uranium ingestion (10 mg/week) (CNSC, 2012).

The applicant will develop a standard operating procedure for measuring the temperature in yellowcake drums prior to drum sealing (Powertech, 2011a). Proposed vacuum dryers for the Dewey-Burdock Project operate at lower temperatures and are not directly fed by gas; therefore pose less of a hazard for explosion. The applicant states that in the unlikely event of an unmitigated explosion accident of a yellowcake dryer, doses to the workers could have a moderate impact depending on the type of accident, but exposure to the general public would result in a dose below the 10 CFR Part 20 public dose limit, resulting in only a small impact to the public (Powertech, 2011a).

The following are some of the measures the applicant will take to prevent fires and explosions within process facilities:

- Design criteria for chemical storage and feeding systems will include applicable sections of the International Building Code, International Fire Code, OSHA regulations, RCRA regulations, and Homeland Security regulations.
- Propane fired heating devices will be installed to meet applicable NFPA/FM safety standards.
- Oxygen tanks will be located a safe distance from the CPP and other storage tanks and will be designed to meet industry standards of NFPA-50.
- Cleaning of equipment for oxygen storage and conveyance systems will follow the standards specified in CGA G-4.1.
- Emergency response procedures will be developed for oxygen accidents. All employees who may be exposed to hazards associated with oxygen will be properly trained with regard to the hazards, accident prevention and mitigation, and emergency response procedures.
- Header houses will be equipped with fans to provide continuous ventilation in order to prevent buildup of oxygen.

- Oxygen lines to each header house will be equipped with automatic low pressure shut-off valves to minimize the delivery of oxygen through a broken pipe or a valve stuck in the open position, which could potentially supply oxygen to a fire.
- Procedures will be in place for confined space work or hot work for monitoring of oxygen build-up prior to start of work.
- Fire extinguishers will be placed at accessible locations in all buildings and vehicles for quick response and training will be provided for appropriate personnel in use of fire extinguishers.
- Facility personnel and local emergency responders will receive training for responding to a fire or explosion.
- CPP facilities will be designed to contain and reduce the exposures to individuals in the event of an accident.
- To protect facilities from wildfires, all its facility buildings will be located within an area that is maintained in a vegetation-free state by the use of a crushed aggregate or asphalt surface and by appropriate weed-control measures (Powertech, 2011a).

Emergency response procedures will be implemented and employees will be directed as to what actions to perform in the event of an accident (Powertech, 2011a). The applicant states that emergency response plan will include descriptions of the provisions of 29 CFR Part 1910 (Powertech, 2011a).

Based on its review, the staff concludes that the applicant's assessment of fires and explosions is acceptable. The applicant provided reasonable accident scenarios and commitments to develop procedures and train responsible personnel in the mitigating transportation accidents. Commitments for developing procedures are memorialized in a standard license condition regarding standard operating procedures. The staff will review these procedures during the preoperational inspection. Furthermore, NRC staff's assessments, as documented in NUREG/CR-6733 determined that occupational exposures would likely exceed limits in a dryer explosion and drum rupturing (depending on the location of the employees). However, doses to members of the public would not exceed the 10 CFR 20.1301 limits because yellowcake will largely precipitate from the air due to its density. Therefore, the staff finds that this information is consistent with the acceptance criteria in standard review plan Section 7.5.3 and complies with 10 CFR 40.32(c).

7.3.7 NATURAL EVENTS

The applicant considered certain natural events in its accident analysis including tornados, freezing temperatures, wind storms, and winter storms (Powertech, 2011a). Regarding tornados, the probability of a tornado occurring at the site is approximately one per 100,000 years (Powertech, 2009c, 2011a). The applicant states that considering the relative remoteness of the proposed Dewey-Burdock Project, the potential consequences of a tornado strike will be considerably less than if the facilities were in a more populated area. The applicant cited NUREG-6733/CR that stated that the risk of a tornado strike on an ISR facility was very low and that no design or operational changes were necessary to mitigate the potential risks, but that it was important to locate chemical storage tanks far enough from each other to prevent contact of reactive chemicals in the event of an accident (Powertech, 2011a).

The applicant also cited NUREG-0706, where the staff analyzed the risk from a tornado strike. In NUREG-0706, the staff determines that ISR facilities were not designed to withstand tornado strength winds and assumed that an inventory of 45,000 kg (99,000 lb) of yellowcake was present on-site and that 15 percent (11,400 kg) or 26, 208-L (55-gal) drums of the yellowcake was dispersed by the tornado. The applicant concluded that the most significant risk from natural events at the proposed Dewey-Burdock Project is a tornado that dispersed yellowcake (Powertech, 2009c, 2011a).

The applicant states that it will prepare and have available onsite for NRC inspectors an Emergency Response Plan that will contain emergency procedures to be followed in the event of severe weather or other emergencies (Powertech, 2011a). Included in the plan will be procedures for notification of personnel, evacuation procedures, damage inspection and reporting. In the event of a report of a tornado sighting in the vicinity of the facility, the RSO, RST and/or Safety Engineer will ensure that the proper alarm (preset signal) has been sounded at both the Burdock and Dewey facilities. Additionally, all supervisors will be personally contacted via phone or radio and advised of the emergency. The supervisors and radiation safety staff will direct the employees' evacuation to one or more previously-specified nearby locations. Assessing potential damage will include radiological surveys and assessment of potential non-radiological hazards as well. If a tornado is observed, the applicant will notify NRC, DENR, BLM and other regulatory agencies as appropriate (Powertech, 2011a).

Regarding wintery conditions, outdoor winter temperatures at the project area will at times be below freezing (Powertech, 2011a). The applicant states that all tanks and pipelines that contain fluids subject to freezing will be warmed by heat trace to maintain the contents above the freezing point of the material. Header houses, valve vaults, and wellhead covers will contain electric heaters to prevent freezing temperatures from occurring in these structures. Furthermore, storms with high winds and snowfall may cause blizzard conditions. While the applicant states that these events do not present a higher potential for chemical accidents, the applicant will delay chemical deliveries until safe driving conditions exist (Powertech, 2011a).

Based on its review, the staff concludes that the applicant's assessment of risks from natural events is acceptable. The applicant provided reasonable accident scenarios of natural events and commitments to develop procedures and train responsible personnel in the mitigating transportation accidents. Furthermore, NRC staff's assessments, as documented in NUREG/CR-6733 determined that accidents from tornados pose low cancer risks because conservatively modeled doses to the public are very low (NRC, 2001). Therefore, the staff finds that this information is consistent with the acceptance criteria in standard review plan Section 7.5.3 and complies with 10 CFR 40.32(c).

7.4 EVALUATION FINDINGS

The staff reviewed potential accidents that could occur at the Dewey-Burdock Project in accordance with acceptance criteria in standard review plan Section 7.5.3. The applicant cites information in NUREG-0706 and NUREG/CR-6733 as the bases for the accident consequences at the Dewey-Burdock project. The staff concludes that these accident consequences analyses are applicable to the Dewey-Burdock project.

Based on the information provided in the application and the detailed review conducted by the staff as indicated above, the applicant's designs, plans, and training are acceptable and are in compliance with 10 CFR 40.32(c), which requires that the applicant's proposed equipment, facilities, and procedures be adequate to protect health and minimize danger to life or property. Staff notes that SOPs regarding accidents are required as part of a standard license condition. The staff will review these SOPs prior to or during the preoperational inspection.

7.5 REFERENCES

CNSC (2012). Letter to CNSC regarding June 23, 2012 Uranium Contamination Event and Action Level Exceedence. (ADAMS Accession No.

NRC (2001). NUREG/CR-6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees. (ADAMS Accession No. ML012840152).

NRC (2003b). NUREG 1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Washington, DC. (ADAMS Accession No. ML031550302).

NRC (2013b). NUREG-1910, Supplement 4 - Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota: Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities. (ADAMS Accession No. ML12312A039 and ML12312A040).

Powertech (2009c). Powertech Dewey-Burdock Application. February 28, 2009 (ADAMS Accession No. ML091200014 - Package).

Powertech (2010a). Dewey-Burdock Project Supplement to Application for Uranium Recovery License Dated February 2009. August 10, 2010 (ADAMS Accession No. ML092870160 - Package).

Powertech (2011a). Revised Responses to the Request for Additional Information (RAI) for the Technical Report (TR); Powertech (USA) Inc.'s Proposed Dewey-Burdock Project. 08/01/2011 (ADAMS Accession No. ML112071064).

APPENDIX A

STANDARD LICENSE CONDITIONS

License Condition	Administrative Conditions
9.1	The authorized place of use shall be the licensee's Dewey-Burdock Project in Fall River and Custer Counties, South Dakota. The licensee shall conduct operations within the license boundaries shown in Figure 1.4-1 of the approved license application.
9.2	The licensee shall conduct operations in accordance with the commitments, representations, and statements contained in the license application dated February 28, 2009 (Accession No. ML091200014), which is supplemented by the submittals dated August 10, 2009 (Accession No. ML092870160); June 28, 2011 (Accession No. ML112071064); February 27, 2012 (Accession No. ML120620195); April 11, 2012 (Accession No. ML121030013); June 13, 2012 (Accession No. ML12173A038); June 27, 2012 (Accession No. ML12179A534); and October 19, 2012 (Accession No. ML12305A056). The approved application and supplements are, hereby, incorporated by reference, except where superseded by specific conditions in this license. The licensee must maintain at least one copy of its complete, updated, and approved license application at the licensed facility. Unless otherwise specified, all references to the "license application" refer to the current, updated application including updates made per License Condition (LC) 9.4. Whenever the words "will" or "shall" are used in the above referenced documents, it shall denote a requirement.
9.3	All written notices and reports sent to the U.S. Nuclear Regulatory Commission (NRC) as required under this license and by regulation shall be addressed as follows: ATTN: Document Control Desk, Director, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. An additional copy shall be submitted to: Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission, Two White Flint North, 11545 Rockville Pike, Mail Stop T-8F5, Rockville, MD 20852-2738. Incidents and events that require telephone notification shall be made to the NRC Operations Center at (301) 816-5100 (collect calls accepted).
9.4	Change, Test, and Experiment License Condition A) The licensee may, without obtaining a license amendment pursuant to 10 CFR 40.44, and subject to conditions specified in (B) of this condition:

License Condition	Administrative Conditions
	i Make changes to the facility as described in the license application; ii Make changes to the procedures as described in the license application; and iii Conduct tests or experiments not described in the license application. B) The licensee shall obtain a license amendment pursuant to 10 CFR 40.44 prior to implementing a proposed change, test, or experiment if the change, test, or experiment would: i Result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the license application; ii Result in more than a minimal increase in the likelihood of occurrence of a malfunction of a facility structure, equipment, or monitoring system (SEMS) important to safety previously evaluated in the license application; iii Result in more than a minimal increase in the consequences of an accident previously evaluated in the license application; iv Result in more than a minimal increase in the consequences of a malfunction of an SEMS previously evaluated in the license application; v Create a possibility for an accident of a different type than any previously evaluated in the license application; vi Create a possibility for a malfunction of an SEMS with a different result than previously evaluated in the license application; vii Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER), environmental impact statement (EIS), environmental assessment (EA) or technical evaluation reports (TERs) or other analysis and evaluations for license amendments. viii For purposes of this paragraph as applied to this license, SEMS means any SEMS that has been referenced in a staff SER, TER, EA, or EIS and supplements and amendments thereof. C) Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with the NRC staff's previous conclusions, or the basis of or analysis leading to those conclusions, regarding actions, designs, or design configurations analyzed and selected in the site or facility SER, TER, and EIS or EA. This includes all supplements and amendments to the license, as well as all SERs, TERs, EAs, and EISs associated with amendments to this license. D) The licensee's determinations concerning (B) and (C) of this condition shall be made by a Safety and Environmental Review Panel (SERP). The SERP shall consist of a minimum of three individuals. One member of the SERP shall

License Condition	Administrative Conditions
	have expertise in management (e.g., a Plant Manager) and shall be responsible for financial approval for changes; one member shall have expertise in operations and/or construction and shall have responsibility for implementing any operational changes; and one member shall be the radiation safety officer (RSO) or equivalent, with the responsibility of assuring changes conform to radiation safety and environmental requirements. Additional members may be included in the SERP, as appropriate, to address technical aspects such as groundwater or surface water hydrology, specific earth sciences, and other technical disciplines. Temporary members or permanent members, other than the three above-specified individuals, may be consultants. E) The licensee shall maintain records of any changes made pursuant to this condition until license termination. These records shall include written safety and environmental evaluations made by the SERP that provide the basis for determining changes are in compliance with (B) of this condition. The licensee shall furnish, in an annual report to the NRC, a description of such changes, tests, or experiments, including a summary of the safety and environmental evaluation for each. In addition, the licensee shall annually submit to the NRC changed pages, which shall include both a change indicator for the area changed (e.g., a bold line vertically drawn in the margin adjacent to the portion actually changed) and a page change identification (date of change, change number, or both) for, the operations plan and reclamation plan of the approved license application that reflects changes made under this condition.
9.5	<u>Financial Assurance</u>. The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR Part 40, Appendix A, Criterion 9, to adequately cover the estimated costs of, decommissioning and decontamination, if accomplished by a third party. This surety arrangement shall cover offsite disposal of radioactive solid process or evaporation pond residues, and groundwater restoration pursuant to 10 CFR Part 40, Appendix A, Criterion 5B (5). The surety shall also include the costs associated with all soil and water sampling analyses necessary to confirm the accomplishment of decontamination. Proposed annual updates to the financial assurance amount, consistent with 10 CFR Part 40, Appendix A, Criterion 9, shall be provided to the NRC 90 days prior to the anniversary date. The financial assurance anniversary date for the Dewey-Burdock Project will be the date on which the first surety instrument is approved by the NRC. If the NRC has not approved a proposed revision 30 days prior to the expiration date of the existing financial assurance arrangement, the licensee shall extend the existing arrangement, prior to expiration, for 1 year. Along with each proposed revision or annual update of the financial assurance estimate, the licensee shall submit supporting documentation, showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation, maintenance of a minimum 15-percent contingency of the financial assurance estimate, changes in engineering plans, activities performed, and any other conditions affecting the estimated costs for site closure. Within 90 days of NRC approval of a revised closure (decommissioning) plan and its cost estimate, the licensee shall submit, for NRC review and approval, a

License Condition	Administrative Conditions
	proposed revision to the financial assurance arrangement if estimated costs exceed the amount covered in the existing arrangement. The revised financial assurance instrument shall then be in effect within 30 days of written NRC approval of the documents. At least 90 days prior to beginning construction associated with any planned expansion or operational change that was not included in the annual financial assurance update, the licensee shall provide, for NRC review and approval, an updated estimate to cover the expansion or change. The licensee shall also provide the NRC with copies of financial-assurance-related correspondence submitted to the U.S. Environmental Protection Agency, a copy of the U.S. Environmental Protection Agency's financial assurance review, and the final approved financial assurance arrangement. The licensee also must ensure that the financial assurance instrument, where authorized to be held by a state or other Federal agency, identifies the NRC-related portion of the instrument and covers the activities discussed earlier in this license condition. The basis for the cost estimate is the NRC-approved site decommissioning and reclamation plan and any NRC-approved revisions to the plan. Reclamation and decommissioning cost estimates and annual updates should follow the outline in Appendix C, "Recommended Outline for Site-Specific In Situ Leach Facility Reclamation and Stabilization Cost Estimates," to NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications—Final Report." The licensee shall continuously maintain an approved surety instrument for the Dewey-Burdock Project, in favor of the NRC except for plugging and abandoning of all Class III and Class V injection wells, which will be maintained in favor of the U.S. Environmental Protection Agency. The initial surety estimate shall be submitted for NRC staff review and approval within 90 days of license issuance, and the surety instrument shall be submitted for NRC staff review and approval 90 days prior to commencing operations. The initial surety estimate shall include a reasonable estimate for the duration of groundwater restoration based on current experiences at licensed ISR facilities.
9.6	Release of surficially contaminated equipment, materials, or packages for unrestricted use shall be in accordance with the NRC guidance document "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," (the Guidelines) dated April 1993 (ADAMS Accession No. ML003745526) or suitable alternative procedures approved by NRC prior to any such release. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides shall apply independently. Personnel performing contamination surveys for items released for unrestricted use shall meet the qualifications for health physics technicians or radiation safety officers defined in Regulatory Guide 8.31 (as revised). Personal effects (e.g., notebooks and flash lights) which are hand carried need not be subjected to the qualified individual survey or evaluation, but these items should be subjected to the

License Condition	Administrative Conditions
	same survey requirements as the individual possessing the items. Regulatory Guide 8.30 (as revised), Table 2, shall apply to the removal to unrestricted areas of equipment, materials, or packages that have the potential for accessible surface contamination levels above background. The licensee shall submit to the NRC for review and written verification a contamination control program. The program shall provide sufficient detail to demonstrate how the licensee will maintain radiological controls over the equipment, materials, or packages that have the potential for accessible surface contamination levels above background, until they have been released for unrestricted use as specified in the Guidelines, and what methods will be used to limit the spread of contamination to unrestricted areas. The contamination control program shall demonstrate how the licensee will limit the spread of contamination when moving or transporting potentially contaminated equipment, materials, or packages (pumps, valves, piping, filters, etc.) from restricted or controlled areas through uncontrolled areas. The licensee shall receive written verification of the licensee's contamination control program from the NRC prior to implementing such a program in lieu of the recommendations in RG 8.30. The licensee may identify a qualified designee(s) to perform surveys, associated with the licensee's contamination control program when moving or transporting potentially contaminated equipment, materials, or packages from restricted or controlled areas through uncontrolled areas and back into controlled or restricted areas. The qualified designee(s) shall have education, training, and experience, in addition to general radiation worker training, as specified by the licensee. The education, training, and experience required by the licensee for qualified designees shall be submitted to the NRC for review and written verification. The licensee shall receive written verification of its qualified designee(s) training program from the NRC prior to its implementation.
9.7	The licensee shall follow the guidance set forth in the current versions of NRC Regulatory Guides 8.22, "Bioassay at Uranium Recovery Facilities," 8.30, "Health Physics Surveys in Uranium Recovery Facilities," and 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposure at Uranium Recovery Facilities will be As Low As Is Reasonably Achievable (ALARA)" or NRC-approved equivalent measures.
9.8	Cultural Resources. Before engaging in any developmental activity not previously assessed by the NRC, the licensee shall administer a cultural resource inventory if such survey has not been previously conducted and submitted to the NRC. All disturbances associated with the proposed development will be completed in compliance with the National Historic Preservation Act (as amended) and its implementing regulations (36 CFR Part 800), as well as the Archaeological Resources Protection Act (as amended) and its implementing regulations (43 CFR Part 7). In order to ensure that no unapproved disturbance of cultural resources occurs, any work resulting in the discovery of previously unknown cultural artifacts shall cease. The artifacts shall be inventoried and evaluated in accordance with 36 CFR Part 800, and no disturbance of the area shall occur until the licensee has received authorization from the NRC, the South Dakota State Historic Preservation

License Condition	Administrative Conditions
	Officer, and the Bureau of Land Management to proceed. The licensee shall comply with the terms and conditions included in a Programmatic Agreement (PA) executed on April 7, 2014 (ADAMS Accession No. ML14066A344) developed to protect cultural resources within the Dewey-Burdock project boundary. If the PA is terminated, the licensee shall comply with Stipulation 16(c) of the PA. Therefore, in the event the PA is terminated, Powertech is required to follow the terms and conditions provided in the PA for on-going ground-disturbing activities, and is not permitted to begin ground-disturbing activities in unevaluated areas, until the NRC completes consultation and a new PA is executed, or the NRC has requested, taken into account, and responded to the comments of the ACHP under 36 CFR § 800.7(c)(4).
9.9	The licensee shall dispose of solid byproduct material from the Dewey-Burdock Project at a site that is licensed by the NRC or an NRC Agreement State to receive byproduct material. The licensee's approved solid byproduct material disposal agreement must be maintained on site. In the event that the agreement expires or is terminated, the licensee shall notify the NRC within seven working days after the date of expiration or termination. A new agreement shall be submitted for NRC staff review and written verification within 90 days after expiration or termination, or the licensee will be prohibited from further lixiviant injection.
9.10	The results of the following activities, operations, or actions shall be documented: sampling; analyses; surveys or monitoring; survey/ monitoring equipment calibrations; reports on audits and inspections; all meetings and training courses; and any subsequent reviews, investigations, or corrective actions required by NRC regulation or this license. Unless otherwise specified in a license condition or applicable NRC regulation, all documentation required by this license shall be maintained at the site until license termination, and is subject to NRC review and inspection.
9.11	The licensee is hereby exempted from the requirements of 10 CFR 20.1902(e) for areas within the facility, provided that all entrances to the facility are conspicuously posted with the words, "CAUTION: ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."
10.1	The licensee shall use a lixiviant composed of native groundwater and a combination of carbon dioxide and gaseous oxygen, as specified in the approved license application.
10.2	<u>Facility Throughput.</u> The Dewey-Burdock Project throughput shall not exceed an average annual flow rate of 4,000 gallons per minute, excluding restoration flow. The annual production of yellowcake shall not exceed 1 million pounds.
10.3	At least 12 months prior to initiation of any planned final site decommissioning, reclamation, or groundwater restoration, the licensee shall submit a detailed decommissioning plan for NRC staff review and approval. The plan shall represent as-built conditions at the Dewey-Burdock Project.
10.4	The licensee shall have written standard operating procedures (SOPs) prior to operations for: A) All routine operational activities involving radioactive and nonradioactive materials associated with licensed activities that are handled, processed, stored, or transported by employees;

License Condition	Administrative Conditions
	B) All routine nonoperational activities involving radioactive materials, including in-plant radiation protection, quality assurance for the respirator program, and environmental monitoring; and C) Emergency procedures for potential accidents/unusual occurrences, including significant equipment or facility damage, pipe breaks and spills, loss or theft of yellowcake or sealed sources, significant fires, and other natural disasters. The SOPs shall include appropriate radiation safety practices to be followed in accordance with 10 CFR Part 20. SOPs for operational activities shall enumerate pertinent radiation safety practices to be followed. Current copies of the SOPs shall be kept in the area(s) of the production facility where they are utilized. These SOPs are subject to inspection, including the preoperational inspection specified in LC 12.3.
10.5	Mechanical Integrity Tests (MITs). The licensee shall construct all wells in accordance with methods described in Sections 3.1.2.2 and 3.1.2.3 of the approved license application. The licensee shall perform well MITs on each injection and production well before the wells are utilized and on wells that have been serviced with downhole drilling or reaming equipment or procedures that could damage the well casing. Additionally, the licensee shall retest each well at least once every 5 years. The licensee shall perform MITs in accordance with Section 3.1.2.4 of the licensee's approved license application. Any failed well casing that cannot be repaired to pass the MIT shall be appropriately plugged and abandoned in accordance with Section 6.1.8 of the approved license application.
10.6	Groundwater Restoration. The licensee shall conduct groundwater restoration activities in accordance with Section 6.1 of the approved license application. Permanent cessation of lixiviant injection in a production area would signify the licensee's intent to shift from the principal activity of uranium recovery to the initiation of groundwater restoration and decommissioning for any particular production area. If the licensee determines that these activities are expected to exceed 24 months for any particular production area, the licensee shall submit an alternate schedule request that meets the requirements of 10 CFR 40.42. Restoration Standards. Hazardous constituents in the groundwater shall be restored to the numerical groundwater protection standards required by 10 CFR Part 40, Appendix A, Criterion 5B(5). In submitting any license amendment application requesting review and approval of proposed alternate concentration limits (ACLs) pursuant to Criterion 5B(6), the licensee must show that it has first made practicable effort to restore the specified hazardous constituents to the background or maximum contaminant levels (whichever is greater). Restoration Stability Monitoring. The licensee shall conduct sampling of all constituents of concern on a quarterly basis during restoration stability monitoring. The sampling shall include the specified production zone aquifer wells. The applicant shall continue the stability monitoring until the data show that the most recent four consecutive quarters indicate no statistically significant increasing trend for all constituents of concern that would lead to an exceedance above the respective standard in 10 CFR Part 40, Appendix A, Criterion B(5).

License Condition	Administrative Conditions
	Notwithstanding the LC 9.4 change process, the licensee shall not implement any changes to groundwater restoration or post-restoration monitoring plans without written NRC verification that the criteria in LC 9.4 do not require a license amendment. The licensee shall submit all changes to groundwater restoration or post-restoration monitoring plans to the NRC staff, for review and written verification, at least 60 days prior to commencement of groundwater restoration in a production area.
10.7	The licensee shall maintain a net inward hydraulic gradient at a wellfield as measured from the surrounding perimeter monitoring well ring starting when lixiviant is first injected into the production zone and continuing until initiation of the stabilization period.
10.8	The licensee is permitted to construct and operate storage and treatment ponds, as described in Section 4.2 of the approved license application. Routine pond inspections will be conducted consistent with inspection procedures described in Regulatory Guide 3.11.
10.9	The licensee shall establish and conduct an effluent and environmental monitoring program in accordance with those programs described in Section 5.7.8 and Section 5.7.7 of the approved license application.
11.1	In addition to reports required to be submitted to NRC or maintained on-site by Title 10 of the Code of Federal Regulations, the licensee shall prepare the following reports related to operations at the facility: A) Quarterly reports that include a summary of excursion parameter concentrations, wells placed on or removed from excursion status, corrective actions taken, and the results obtained for all wells that were on excursion status during that quarter. These reports shall be submitted to NRC within 60 days following completion of the reporting period. B) Semiannual reports that discuss the status of wellfields in operation (including last date of lixiviant injection), progress of wellfields in restoration and restoration progress, status of any long-term excursions, and a summary of MITs during the reporting period. These reports shall be submitted to NRC within 60 days following completion of the reporting period. C) Quarterly reports summarizing daily flow rates for each injection and production well and injection manifold pressures on the entire system. These reports shall be made available for inspection upon request. D) Consistent with Regulatory Position 2 of Regulatory Guide 4.14, semiannual reports that summarize the results of the operational effluent and environmental monitoring program. The licensee shall submit these reports consistent with the terms of Regulatory Guide 4.14.
11.2	The licensee shall submit to the NRC the results of its annual review of its radiation protection program content and implementation performed in accordance with 10 CFR 20.1101(c). These results shall include an analysis of dose to individual members of the public consistent with 10 CFR 20.1301 and 10 CFR 20.1302.

License Condition	Administrative Conditions
11.3	Establishment of Commission-Approved Background Water Quality. Prior to injection of lixiviant in each production wellfield, as defined by the licensee, the licensee shall establish Commission-approved background groundwater quality data for the ore zone, overlying aquifers, underlying aquifers, alluvial aquifers (where present), and the perimeter monitoring areas. Commission-approved background sampling will be performed in accordance with Section 5.7.8 of the approved license application, and samples shall be analyzed for the parameters listed in Table 6.1-1 of the approved application. The licensee shall submit any revisions to its Commission-approved background water quality sampling plan to the NRC staff for review and approval.
11.4	Establishment of UCLs. Prior to injection of lixiviant into each production wellfield, as defined by the licensee, the licensee shall establish excursion parameters and their respective upper control limits (UCLs) in the designated overlying aquifer(s), underlying aquifer, and perimeter monitoring areas in accordance with Section 5.7.8 of the approved license application. Unless otherwise determined, the site-specific excursion parameters are chloride, conductivity, and total alkalinity. The UCLs shall be established for each excursion control parameter and for each well based on the mean plus five standard deviations of the data collected for LC 11.3. The UCL for chloride can be set at the sum of the background mean concentration and either (a) five standard deviations or (b) 15 mg/L, whichever sum provides the higher limit. The licensee shall submit any revisions to its plan for establishing UCLs to the NRC staff for review and approval.
11.5	Excursion Monitoring. Monitoring for excursions shall occur twice monthly, and no more than 14 days apart in any given month during operations, for all wells where UCLs have been established per Section 5.7.8 of the approved license application. If a designated monitor well is not sampled within 14 days of a previous sampling event, the reasons for this postponement shall be documented. Sampling shall not be postponed for more than 5 days. If the concentrations of any two excursion indicator parameters exceed their respective UCL or any one excursion indicator parameter exceeds its UCL by 20 percent, the excursion criterion is exceeded and a verification sample shall be taken from that well within 48 hours after results of the first analyses are received. If the verification sample confirms that the excursion criterion is exceeded, the well shall be placed on excursion status. If the verification sample does not confirm that the excursion criterion is exceeded, a third sample shall be taken within 48 hours after the results of the verification sample are received. If the third sample shows that the excursion criterion is exceeded, the well shall be placed on excursion status. If the third sample does not show that the excursion criterion is exceeded, the first sample shall be considered an error and routine excursion monitoring will be resumed (the well is not placed on excursion status). Upon confirmation of an excursion, the licensee shall notify NRC, as discussed below, implement corrective action, and increase the sampling frequency for the excursion indicator parameters at the well on excursion status to at least once every 7 days. Corrective actions for confirmed excursions may be, but are not

License Condition	Administrative Conditions
	limited to, those described in Section 5.7.8 of the approved license application. An excursion is considered corrected when concentrations of all indicator parameters are below the concentration levels defining the excursion for three consecutive weekly samples. If an excursion is not corrected within 60 days of confirmation, the licensee shall either (a) terminate injection of lixiviant within the wellfield until the excursion is corrected; or (b) increase the surety in an amount to cover the full third-party cost of correcting and cleaning up the excursion. The surety increase shall remain in force until the NRC has verified that the excursion has been corrected and remediated. The written 60-day excursion report shall identify which course of action the licensee is taking. Under no circumstances does this condition eliminate the requirement that the licensee remediate the excursion to meet groundwater protection standards as required by LC 10.6 for all constituents established per LC 11.3. The licensee shall notify the NRC Project Manager (PM) by telephone or email within 24 hours of confirming a lixiviant excursion, and by letter within 7 days from the time the excursion is confirmed, pursuant to LC 11.6 and 9.3. A written report describing the excursion event, corrective actions taken, and the corrective action results shall be submitted to the NRC within 60 days of the excursion confirmation. For all wells that remain on excursion status after 60 days, the licensee shall submit a report as discussed in LC 11.1(A).
11.6	Until license termination, the licensee shall maintain documentation on unplanned releases of source or byproduct material (including process solutions) and process chemicals. Documented information shall include, but not be limited to, the date, spill volume, total activity of each radionuclide released, radiological survey results, soil sample results (if taken), corrective actions, results of postremediation surveys (if taken), a map showing the spill location and the impacted area, and an evaluation of NRC reporting criteria. The licensee shall have written procedures for evaluating the consequences of the spill or incident/event against 10 CFR Part 20, Subpart M, “Reports,” and 10 CFR 40.60 reporting criteria. If the criteria are met, the licensee shall report to the NRC Operations Center as required. If the licensee must report any production area excursion or spill of source material, byproduct material, or process chemicals that may have an impact on the environment, or any other incident/event, to any State or other Federal agency, the licensee shall make a report to the NRC Headquarters Project Manager (PM) by telephone or electronic mail (e-mail) within 24 hours. In accordance with LC 9.3, this notification shall be followed, within 30 days of the notification, by submittal of a written report to NRC Headquarters detailing the conditions leading to the spill or incident/event, corrective actions taken, and results achieved.
12.1	Prior to commencement of operations in any production area, the licensee shall obtain all necessary permits, licenses, and approvals from the appropriate regulatory authorities. The licensee shall also submit a copy of all permits for its

License Condition	Administrative Conditions
	Class III and Class V underground injection wells to the NRC.
12.2	Prior to commencement of operations, the licensee shall coordinate emergency response requirements with local authorities, fire department, medical facilities, and other emergency services. The licensee shall document these coordination activities and maintain such documentation on-site.
12.3	The licensee shall not commence operations until the NRC performs a preoperational inspection to confirm, in part, that written operating procedures and approved radiation safety and environmental monitoring programs are in place, and that preoperational testing is complete. The licensee should notify the NRC, at least 90 days prior to the expected commencement of operations, to allow the NRC sufficient time to plan and perform the preoperational inspection.
12.4	The licensee shall identify the location, screen depth, and estimated pumping rate of any new groundwater wells or new use of an existing well within the license area and within 2 kilometers (1.25 miles) of any proposed wellfield boundary, as measured from the perimeter monitoring well ring, since the application was submitted to the NRC. The licensee shall evaluate the impact of ISR operations to potential groundwater users and recommend any additional monitoring or other measures to protect groundwater users. The evaluation shall be submitted to the NRC for review within 6 months of discovery of such well use.
12.5	Prior to commencement of operations, the licensee shall submit the qualifications of radiation safety staff members for NRC staff review and written verification.
12.6	Prior to commencement of operations, the licensee shall submit a copy of the solid byproduct material disposal agreement to the NRC.

APPENDIX B

STAFF ANALYSIS OF POWERTECH GROUNDWATER MODEL

March 19, 2013

MEMORANDUM TO: Stephen J. Cohen, Team Leader
Uranium Recovery Licensing Branch
Division of Waste Management and
Environmental Protection
Office of Federal and State Materials and
Environmental Management Programs

FROM: John L. Saxton, Hydrogeologist **/RA/**
Uranium Recovery Licensing Branch
Division of Waste Management and
Environmental Protection
Office of Federal and State Materials and
Environmental Management Programs

SUBJECT: EVALUATION OF THE NUMERIC GROUNDWATER FLOW MODEL, POWERTECH (USA), INC., DEWEY-BURDOCK PROJECT, FALL RIVER AND CUSTER COUNTIES, SOUTH DAKOTA

Introduction

Nuclear Regulatory Commission (NRC) staff evaluated the numeric groundwater flow model submitted by Powertech (USA), Inc. (Powertech) in support of its license application for the Dewey-Burdock Project. Documentation on the numeric model was submitted in a report entitled *Numerical Modeling of Hydrogeologic Conditions: Dewey-Burdock Project, South Dakota,* which is dated February 2012 (ML120062A096). In addition to the report, the applicant submitted electronic files associated with the model. The electronic files consist of native Groundwater Vistas files (the commercially available pre- and post-processing available software used by the applicant to prepare the model, and native input and output MODFLOW files.

Staff's evaluation consists of the following:

(1) Verify the data presented in the applicant's modeling report by independently running the model and comparing the results of this analysis with those documented in the report.
(2) Analyze the conceptual model for, and design of the numeric model, including geometry, hydraulic parameters and boundary conditions, with respect to appropriateness for the hydraulic setting or possible bias in the applicant's evaluation.
(3) If warranted, revise the model to confirm or test the validity of the applicant's assumptions.

CONTACT: John Saxton, FSME/DWMEP
(301) 415-0697

Background

The applicant's numeric groundwater flow model is a finite difference (MODFLOW) complex, regional-scale groundwater flow model. The model consists of 4 layers, 525 rows and 523 columns. The overall dimensions are 100,000 feet in the east-west direction, 100,000 feet in the north-south direction, and from 4303.13 to -71.4 feet in elevation, represented in the model vertical direction. The regional scale to this model was necessary because the Dewey-Burdock Project is located in close proximity of the eastern limits of the aquifer (Inyan Kara Group) to be subjected to the ISR operations. Consequently, the cells dimensions were either 100 feet by 100 feet, 100 feet by 400 feet or 400 feet by 400 feet.

The layering was assigned to various hydrogeologic units as follows:

Layer 1 Graneros Group (overlying aquifer)
Layer 2 Fall River Formation (upper production zone)
Layer 3 Fuson Shale of the Lakota Formation (intermediate zone)
Layer 4 Chilson Member of the Lakota Formation (lower production zone)

The Fall River and Lakota formations are collectively referred to as the Inyan Kara Group.

The underlying confining layer is the Morrison Formation. The Morrison Formation is a regionally extensive, thick (100 feet) sequence of relatively impermeable shales. The applicant states that the Morrison Formation effectively inhibits the downward migration of fluids from the production aquifer. The base of the numeric model, which is a no-flow boundary, is the top of the Morrison Formation.

The hydraulic properties for layers 2 and 4 are based on the geology, historic pumping tests and model calibration. The hydraulic properties for layers 1 and 3 are assumed values based on estimates for the geology.

Model boundaries consist of constant flux (well) boundaries, general head boundaries (GHBs), and recharge. Simulated wells consist of two groups. The first group consists of private water supply wells within the modeled area; this group includes 57 wells distributed through the model. The flux (i.e., pumping rate) and screened depth were assigned to layer 2 or 4 based on the available data. The pumping rates for this group varied from 0.056 to 16.2 gpm, for a cumulative flux of 132.8 gpm. This group of wells was held constant for all simulations. The second group of wells consists of simulated production wells used in predictive simulations. The pumping rates and locations varied based on the operating status for a stress period in the predictive simulations. The GHBs were place in cells along the perimeter of active cells in layers 2 and 4. The model contains a total of 2,382 GHB cells.

The model was calibrated to a static steady-state simulation and was verified through transient simulations based on drawdown from historic pumping tests. The model is subjected to a sensitivity analysis using parameters for recharge and GHB conditions. Several predictive simulations were then performed using net withdrawal rates for various simulated production scenarios. In addition, predictive simulations were performed to evaluate the hydraulic influence of a hypothetical breccia, if one were located within the license area.

Staff's Verification

Staff reviewed the model geometry, hydraulic properties and parameters and locations of the boundaries. Several minor discrepancies were noted between the electronic files and the report (Table 1). In general, the discrepancies represent minor errors and are common for complex models. Most of the discrepancies would not appreciably impact the model predictions; however, staff was concerned about the abnormal drawdown adjacent to the GHB conditions (Figure 1). The abnormal drawdown may be attributed to discrepancies noted in the recharge, storativity or GHBs (see Table 1), or, conflicts with the starting head file.[1]

Staff corrected the model for discrepancies in recharge, storativity and GHBs, and established starting heads for the predictive simulation using the output from the steady-state calibration simulation. Correcting the model affected the predicted drawdowns in the Fall River Formation and Chilson Member, as shown in Figure 2 and Figure 3, respectively. The effect of the corrected model on the Fall River Formation model-predicted drawdown is to increase the drawdown by approximately 1 foot. The effect on the Chilson Member model-predicted drawdown is less than that for the Fall River Formation.

Staff's evaluation

Based on the applicant's report, the objectives for the numeric modeling include the following:

- Enhance understanding of the Fall River and Chilson aquifer systems with respect to:
  - regional and local flow patterns
  - recharge and discharge boundaries
  - overall water budget (available and sustainable resources)
- Evaluate potential hydraulic impacts (e.g. drawdown and potential dewatering) from production and restoration operations on both the local and regional scale;
- Compare hydraulic impacts of variable bleed rates and production rates on the Fall River and Chilson aquifers;
- Assess potential communication (if any) between the Fall River and Chilson aquifers during production and restoration activities;
- Determine the level of interference between wellfields that could occur with simultaneous production and restoration operations;
- Evaluate the potential impacts of ISR operations to an open pit mine located within the Project Area that intercepts Fall River groundwater;
- Assess the potential hydraulic impacts that would result from a breccia pipe recharge to the Fall River and Chilson aquifers (as hypothesized by Gott et al [1974]) within the Project Area.

Staff finds that the modeling effort is sufficient for the first three objectives but is not sufficient for the latter four objectives. Staff agrees that the maximum model predicted drawdown at the specified bleed is a reasonable estimate.

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[1] The output files had listed several dry cells, but the starting head file may not have included those dry cells. The starting head file is important for the predictive simulations because the initial stress period was not steady state.

For the potential communication between Fall River and Chilson aquifers, the model assumes hydraulic properties for the Fuson Shale and it cannot simulate drawdown reported for an older pumping test. An assumption is that the observed drawdown is attributed to boreholes and thus cannot be simulated by the numeric model.

For the level of interference between wellfields, the model demonstrates that the drawdown is isolated but to establish the level of interference, the potentiometric heads need to be determined and particle tracking is a useful tool for this evaluation. The applicant did not report model predicted heads or performed particle tracking. (It is my understanding that this analysis is reported elsewhere.)

For the open pit mine, the model includes GHB conditions to simulate the pit. The GHB conditions resulted in minimal (essentially zero) drawdown at the pit. Staff finds that the pit should have been modeled without boundary conditions and/or boundary-condition parameters that would not influence the results to better estimate the impacts.

Finally, the staff does not agree with the breccia pipe modeling presented by the applicant. Although the staff agrees that a breccia pipe will create a water level anomaly in the Fall River and Chilson potentiometric surfaces, the staff does not agree that it will be a mound. The applicant modeled a breccia pipe by assuming that a 200 gpm flow from a breccia pipe would enter the Fall River or Chilson aquifers. However, In general, the potentiometric surface of the Inyan Kara aquifer (Fall River or Chilson aquifers) (Strobel, et.al., 2000) is higher than that of the Minnelusa aquifer (Driscoll, et.al., 2002), from where a breccia pipe would originate. Consequently, a potentiometric surface depression, not a mound, would be realized if a breccia pipe connected the Minnelusa and Inyan Kara aquifers. Regardless of whether the anomaly is a mound or depression, such an anomaly, and therefore a breccia pipe, would be detected during the Criterion 5B(5) Commission-approved background sampling phase of the proposed Dewey-Burdock operations because of the increased sampling density. However, the staff has not found any information indicating that breccia pipes occurred at the Dewey-Burdock Project.

References

Daniel G. Driscoll, Janet M. Carter, Joyce E. Williamson, and Larry D. Putnam. 2002. Hydrology of the Black Hills Area, South Dakota. Water-Resources Investigations Report 02-4094. U.S. Geological Survey and South Dakota Department of Environment and Natural Resources and the West Dakota Water Development District.

Strobel, M.L., Galloway, J.M., Hamade, G.R., and Jarrell, G.J. 2000. Potentiometric Surface of the Inyan Kara Aquifer in the Black Hills Area, South Dakota. Hydrologic Investigations Atlas HA-745-A. U.S. Geological Survey and South Dakota Department of Environment and Natural Resources and the West Dakota Water Development District.

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<u>References</u>

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DATE	2/15/13	2/19/13	3/19/13

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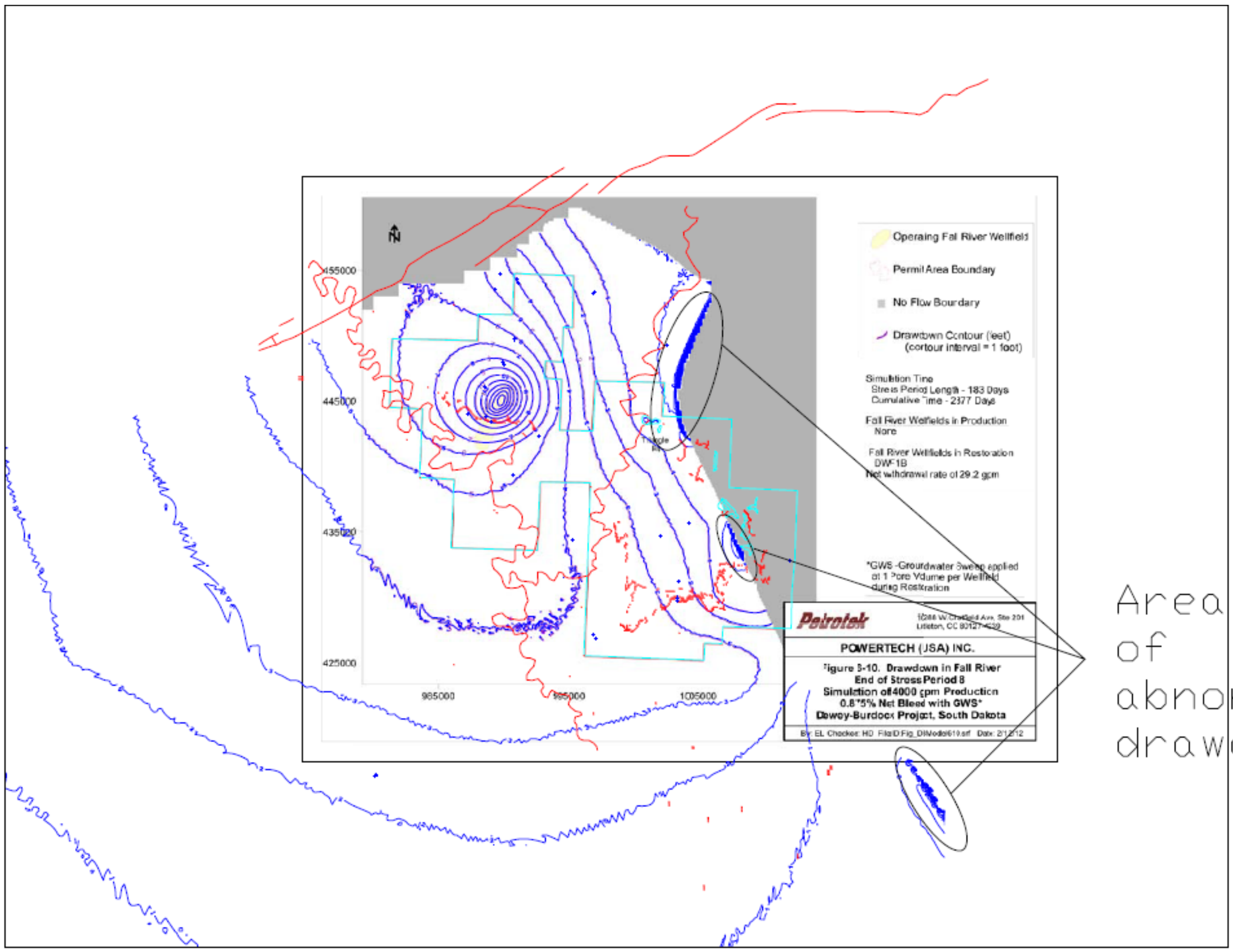

Area of abnormal drawdown

Figure 1. Comparison of the Reported Dradown and Drawdown from the modeling Software

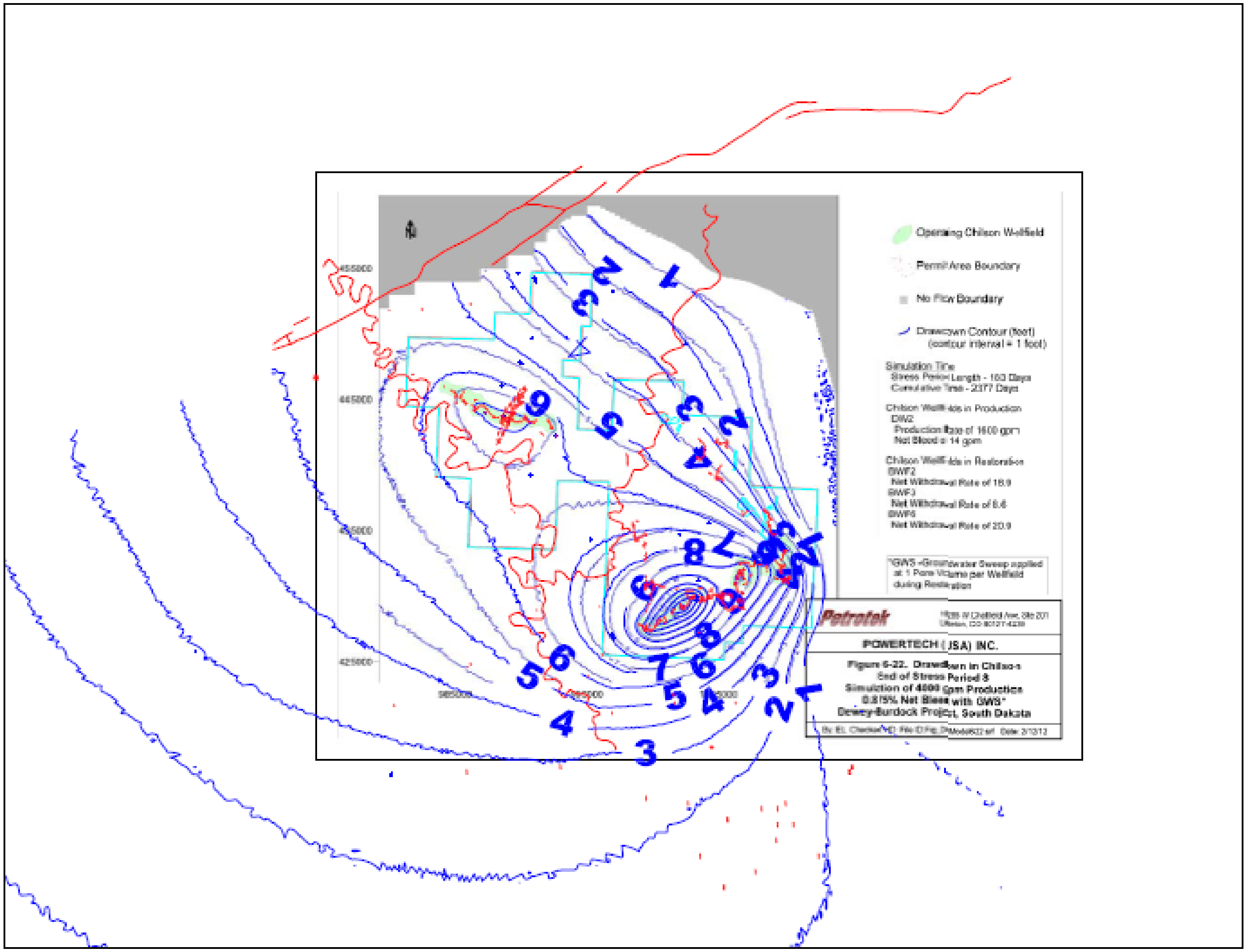

Figure 2. Corrected Model presdicted drawdown in the Chilson Memeber

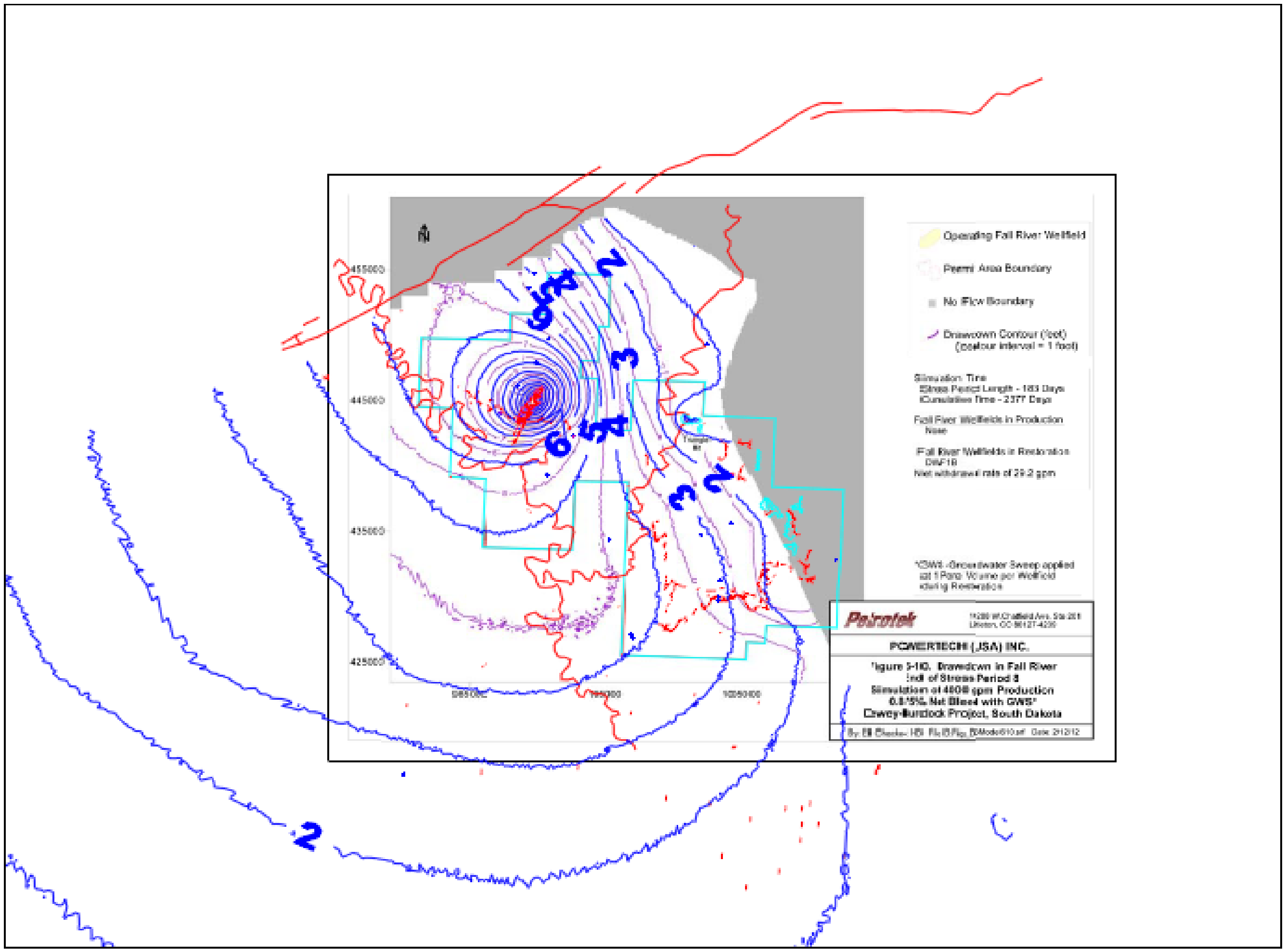

Figure 3. Corrected Model presdicted drawdown in the Fall River Formation