APP-045

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April 1, 2013

Mr. Mike Cepak
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Minerals and Mining Program
South Dakota Department of Environment & Natural Resources
523 East Capitol Avenue
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Pierre, SD 57501-3182

Re: Responses to Technical Review Comments
Dewey-Burdock Project Large Scale Mine Permit Application

Dear Mr. Cepak:

On behalf of Powertech (USA) Inc., this letter is provided in response to the technical review comments issued December 14, 2012 and March 1, 2013 for the above-referenced large scale mine (LSM) permit application. For convenience, the comments are provided below in italics followed by the responses. Application replacement pages are enclosed along with an index of changes (three hard copies and one electronic copy on CD). The replacement pages are included as individual PDF files that correspond to the changes shown on the index of changes. For convenience, the enclosed CD also includes a folder with replacement pages incorporated into the application text and appendix files. Only files that were updated as a result of the comment responses are included. In addition, Attachment A provides pre-operational and end-of-production water quality from operating ISR facilities as requested in comment #5.

Technical Comments from December 14, 2012 DENR Comment Letter

1. SDCL 45-6B-33(5) and SDCL 45-6B-92(1): *A meeting was held on December 28, 201[2] with Powertech, the Department of Game, Fish, and Parks, the US Fish and Wildlife Service, and our office to discuss contents of an Avian Monitoring and Mitigation Plan. We understand that Gwen McKee of Thunderbird Wildlife Consulting is currently working on a draft version of the plan. Once a final plan is completed and approved by these agencies, it will become part of the large scale mine permit. It will also need to comply with SDCL 34A-8-8 which authorizes a taking of a bald eagle's nest for very limited circumstances. This statute may therefore determine plan contents as it appears federal permits are valid upon obtaining state authorizations.*

In the December 4 submittal, Powertech states it will establish buffer zones and seasonal restrictions to protect important bald eagle habitat. Currently the nest and "standard" 1/2 mile buffer encompass the Dewey processing plant, well fields, both proposed and standby land application pivots, monitor wells, process water wells, and overhead power lines. It is reasonable to assume there are developmental and operational challenges that Powertech will need to address in the Avian Monitoring and Management Plan to avoid jeopardizing bald eagles during all project phases.

Response: Powertech is preparing a draft Avian Monitoring and Mitigation Plan, which will be submitted separately to the Department of Game, Fish and Parks (GFP), the U.S. Fish and Wildlife Service (USFWS), and DENR for review and input. Based on the December 28, 2012 meeting with all of these agencies, Powertech understands that the plan will require approval by GFP and DENR. USFWS will review the plan and Powertech will incorporate USFWS recommendations to the extent practicable, but USFWS approval will not be required. Powertech will provide a copy of the final plan approved by GFP and DENR as Appendix 5.6-C to the LSM permit application. Sections 5.6.11.1.11 and 5.6.11.2 have been updated to reference this appendix and revise the description of the Avian Monitoring and Mitigation Plan. In addition, Section 5.6.11.2 has been modified to indicate that if Powertech applies for a non-purposeful take permit, the application will be coordinated with GFP and DENR to ensure compliance with SDCL 34A-8 and other applicable rules and regulations.

2. *ARSD 74:29:07:09(6): Will storm water diversions around the ponds in the land application option be necessary to keep storm water out of the ponds during storm events?*

Response: Two new storm water diversions (Diversion Nos. 4 and 5) have been designed for the Dewey area in the land application option (Plates 5.3-17b and 5.3-18). These diversions are designed to keep storm water out of the treated water storage ponds and spare storage pond. In addition, a new diversion has been designed to keep storm water out of the surge pond in the Dewey area in the deep disposal well option (Plate 5.3-17a). These diversions are capable of passing the 2-year, 6-hour storm event without erosion and have the capacity for a 100-year, 24-hour event. In addition, one new diversion (CPP Facility Diversion No. 4) has been designed for the central plant pond (Burdock area) in the land application option. This diversion has been designed for the 6-hour probable maximum precipitation (PMP) event in accordance with ARSD 74:29:07:09(6).

In the Burdock area, drainage areas above the treated water storage ponds are less than 10 acres. There also are small drainage areas between the catchment areas and Dewey treated water storage ponds of less than 10 acres. Diversions are not planned in these areas due to the small drainage area and small size of the associated runoff events. The pond embankments in these cases will extend at least 1 foot above ground, which along with grading and drainage plans will be sufficient to ensure that no runoff will enter any of the ponds up to the 100-year, 24-hour storm event. Prior to construction, Powertech will prepare grading and drainage plans for the ponds and processing facilities and provide copies to DENR. This information has been added to Section 5.3.9.1.

Plates 5.3-1 (Sheets 1 and 2) and 5.3-2 (Sheet 1) have been updated to depict the new diversion alignments. Please note that the affected area boundary for the deep disposal well option (Plate 5.3-2, Sheet 1) has been modified slightly to accommodate Diversion No. 2, the design for which is depicted on Plate 5.3-10a. The change occurs in the NWSE Section 29, T6S, R1E. To compensate for the minor expansion of the proposed affected area boundary near the diversion, the boundary was made smaller just to the west of this area, resulting in no net change in the proposed affected area.

3. *<u>Appendix 6.4-D, Section 1.4</u>: Powertech needs to include a discussion on complying with the vegetative cover and diversity and other requirements of SDCL 45-6B-39. In the discussion, Powertech should include a minimum live vegetative cover value that will be used to assess the success of final reclamation. For other mines in our state, we use a minimum value of 40 percent live vegetative cover.*

Response: Appendix 6.4-D, Section 1.4 (Sustainability of the Reclamation) has been revised to reference SDCL 45-6B-39, which requires that a diverse, effective, and long-lasting vegetative cover be established that is capable of self-regeneration and at least equal in extent of cover to the natural vegetation of the surrounding area. Compliance with SDCL 45-6B-39 requirements is addressed in Appendix 6.4-D, Section 3.0, which lists the requirements needed to demonstrate successful reclamation (cover, species composition, usable forage production, and reclamation sustainability).

Neither SDCL 45-6B-39 nor ARSD 74:29:07:20 specifically identifies the measures to be used to demonstrate that the requirements have been met. As such, regarding the suggested 40 percent minimum value for live vegetative cover, Powertech would prefer to use the reference area concept as presented in Appendix 6.4-D. Except for a small area reclaimed to cropland, the vast majority the disturbed lands will be reclaimed to a rangeland habitat type using the approved upland grassland seed mixture. Baseline vegetation monitoring results in Appendix 3.7-A show that 10 of the 30 upland grassland transects had a total vegetative cover of less than 40 percent, indicating that 40 percent may not be a representative cover value for upland grassland reclamation within the proposed permit area. In addition, climatic conditions (temperature, precipitation, humidity, and wind – as described in Section 3.6.1.1) are variable, which can result in annual variation in the vegetative cover on a reclaimed plot. The reference area concept, which compares the reclaimed areas with similar, nearby native vegetation, does not require the use of a mathematical adjustment for changes in climatic conditions. If changes in climatic conditions have influenced the vegetation, it is assumed that the revegetated area and undisturbed reference areas will have responded similarly to the changes in climatic conditions. The use of a reference area is a widely accepted method used to determine success of the final reclamation. Appendix 6.4-D includes a statement that the vegetative cover requirement of reclamation success must be verified statistically (percent vegetative cover must be within one standard deviation of the percent vegetative cover documented on the reference areas - as determined during the same year as reclamation sampling) in order to meet the cover criterion for bond release.

Further, prior to final bond release Powertech will be required to demonstrate the sustainability of reclamation, including that the reclamation is effective (capable of withstanding the proper stocking rates for 2 consecutive years) and capable of self-regeneration as described in revised Appendix 6.4-D, Section 1.4. Therefore, reclamation success will not be determined based on a single season but through demonstration that it is sustainable and comparable to reference areas.

4. *<u>Section 5.6.3.2</u>: Regarding notice for excursions, the department will require through permit conditions that Powertech give notice to the department through email or phone within 48 hours of any excursions. Written notice with additional details on the excursion will be required within seven days after the excursion. Since the NRC is the*

primary regulatory agency for the well fields, these data packages will be for the department's information only.

Response: Section 5.6.3.2 has been modified to indicate that DENR will be notified by phone or email within 48 hours of the confirmation of an excursion. This will be followed within 7 days by written notification.

Additional Technical Comments

1. Section 5.3.3.4, page 5-49: *The department will require through permit conditions that Powertech submit copies of well field hydrogeologic data and injection authorization data packages to the department prior to the development of each well field. Since the NRC is the primary regulatory agency for the well fields, these data packages will be for the department's information only.*

Response: Section 5.3.3.4 has been modified to indicate that a copy of each well field hydrogeologic data package and injection authorization data package will be submitted to DENR for information purposes. This section also has been modified to indicate that all well field hydrogeologic data packages will be submitted to NRC for review. This revision reflects the most current language in Powertech's draft NRC license.

2. Section 5.3.4.5, page 5-65: *Regarding pond leak detection, the department requests copies of any plans submitted to NRC for response actions to leakage in the pond liners. Typically, the leakage response plans (also called Action Response Plans) would include the actions to be taken at various leakage thresholds. These actions would range from monitoring leakage only to the shutdown and repair of ponds.*

Response: Powertech will be required by NRC license condition to develop standard operating procedures (SOPs) prior to operations for leaks or spills, including pond leakage. Powertech will provide DENR with a copy of the SOP(s) addressing response actions to leakage in the pond liners. Section 5.3.4.5 has been updated to include this commitment. As described in Section 5.3.4.5, Powertech does not anticipate including a range of response actions for a confirmed leak. Upon confirmation of a leak by analysis of the water in the standpipe of a leak detection system, the leak will be reported, the pond will be removed from service, and the pond contents will be transferred to a spare pond with the same level of lining system as the leaking pond. Each of the Dewey and Burdock areas will have a spare pond of equal capacity and lining system as each of the normally operated ponds. The leaking pond will be repaired and tested prior to returning it to service.

Also, regarding pond leakage, we have found it to be helpful at the heap leach gold mines to install automatic or continuous pumping systems in the leakage detection gallery. This will limit build-up of solution in the leak detection gallery and will minimize hydraulic head on the secondary liner.

Response: As described in the previous comment response, any confirmed leak in a primary pond liner will result in taking the pond out of service, transferring its contents to a spare pond, and repairing the leak. If recurring water is present in a leak detection system and it is confirmed through laboratory analysis that it is not caused by a leak (e.g., condensation could collect in the leak detection system), Powertech may elect to install a submersible pump in the leak detection system sump to routinely dewater the leak detection system and minimize the hydraulic head on the secondary liner. The pond design drawings in Appendix 5.3-A and 5.3-B show that an access port and 8-inch diameter PVC pipe will be available to lower a submersible pump into the leak detection sump. This information has been added to Section 5.3.4.5.

3. *Section 5.3.4.5, page 5-71: The department will require through permit conditions that Powertech notify the department of any pond leaks within 48 hours of detection. Since the NRC is the primary regulatory agency for the well fields, this will be for the department's information only.*

Response: Section 5.3.4.5 has been modified to include the commitment to notify DENR within 48 hours of any confirmed pond leak.

4. *Table 5.4-2, page 5-85: Were other metals such as selenium and other radionuclides evaluated for end of production water quality during the development of Table 5.4-2? If so, please include them in the table.*

Response: Powertech has revised Table 5.4-2 in response to this comment and clarification received in a March 12, 2013 conference call. Additional parameters have been added to the end-of-production groundwater quality estimates in Table 5.4-2 as requested including: arsenic, copper, selenium, lead, molybdenum, uranium, vanadium, zinc, gross alpha and radium-226. The land application water quality estimate in Table 5.4-3 also was updated based on the changes to Table 5.4-2. In addition, the text in Section 5.4.1.1.4.1 was updated to reflect the methods used to prepare the tables. Following is a description of these methods.

As noted in the footnote to Table 5.4-3, the end-of-production groundwater quality in the ore zone originally was estimated using a combination of laboratory leach tests and historical end-of-production groundwater quality data from operating ISR facilities in Wyoming and Nebraska. Powertech has revised the estimates to add the requested parameters and use only data from operating ISR facilities. While laboratory leaching studies are useful to support estimates of uranium recovery rates, actual data from operating facilities provide a better estimate of groundwater quality changes due to the various ISR processes (including *in-situ* oxidation and dissolution of uranium and ion exchange in the processing facilities). Laboratory leaching studies generally are not designed to provide accurate estimates of end-of-production groundwater quality. Some of their limitations in this regard include pulverizing ore samples prior to testing (which exposes the ore to air and breaks down some of the sand grains), substituting lixiviant formulations (i.e., sodium-bicarbonate solutions often are used in ambient-pressure leaching studies), substituting simulated groundwater for actual ore zone groundwater, and using lower residence times for chemical reactions. In the case of the Dewey-Burdock Project, use of laboratory leaching studies is limited to estimating uranium recovery rates based on ambient-pressure laboratory tests. While pressurized, column-leach testing was performed, the core

samples had been exposed to air prior to testing and pressures and lixiviant chemistry did not necessarily match *in-situ* conditions. Therefore, the results of these tests are not used in estimating end-of-production groundwater quality.

The revised Table 5.4-2 was prepared using publicly available baseline (pre-operational) and end-of-production groundwater quality data from three ISR facilities in Wyoming (Irigaray Mine, Christensen Ranch and Smith Ranch/Highland Project) and one in Nebraska (Crow Butte Project). Tables 1 and 2 compare the baseline and end-of-production groundwater quality at these facilities. The data sources are provided in Attachment A and summarized as follows:

- Irigaray Mine (Johnson County, WY): baseline and end-of-production water quality data were obtained for individual wells in each of nine mine units that were sampled prior to and at the end of production (these wells are highlighted in Attachment A).
- Christensen Ranch Project (Johnson County, WY): average baseline values or target restoration values (TRVs) were available along with average end-of-production values for each of five mine units. TRVs, which were calculated for each mine unit as a function of the average baseline concentration and variability, were used when average concentrations were not reported.
- Smith Ranch/Highland Project (Converse County, WY), average baseline and end-of-production values were available for one mine unit.
- Crow Butte Project (Dawes County, NE): typical baseline and end-of-production values were available for the overall project.

Table 1. Typical Baseline Groundwater Quality at Wyoming and Nebraska ISR Facilities

Parameter	Units	Irigaray[1]	Christensen Ranch[2]	Smith Ranch/ Highland[3]	Crow Butte[4]
Physical Properties					
pH	s.u.	8.1 - 9.7	8.6 - 10.1	8.1	8.1
TDS	mg/L	353 - 568	412 - 860	350	1,804
EC	µmhos/cm	571 - 900	682 - 1,365	564	2,723
Common Elements and Ions					
Bicarbonate	mg/L	52 - 125	74 - 205	206	401
Carbonate	mg/L	3.2 - 33	4.5 - 120	0.2	0
Chloride	mg/L	10 - 13	4.6 - 11	5.3	202
Sulfate	mg/L	154 - 302	198 - 533	117	737
Calcium	mg/L	4 - 17	7.9 - 26	50	30
Magnesium	mg/L	0.4 - 4.4	0.8 - 4.5	10	5.3
Sodium	mg/L	101 - 175	109 - 240	57	567
Potassium	mg/L	1.4 - 6.8	3.5 - 10	8.0	15
Minor Ions and Trace Elements					
Arsenic	mg/L	<0.001 - 0.016	0.002 - 0.007	<0.001	<0.002
Barium	mg/L	0.019 - 0.072	<0.1	<0.1	<0.1
Cadmium	mg/L	<0.002 - 0.003	<0.01	<0.01	<0.01
Chromium	mg/L	0.0015 - 0.0075	<0.05	<0.05	<0.05
Copper	mg/L	<0.005 - 0.03	<0.01	<0.01	<0.01
Iron	mg/L	<0.02 - 4.1	<0.05 - 0.069	0.052	<0.05
Lead	mg/L	0.005 - 0.032	<0.05	<0.05	<0.05
Molybdenum	mg/L	<0.1	<0.1	<0.1	<0.1
Nickel	mg/L	<0.001 - 0.008	<0.05	<0.05	<0.05
Selenium	mg/L	<0.001 - 0.34	<0.01	<0.001	<0.175
Uranium	mg/L	0.01 - 14	0.0001 - 0.23	0.062	<0.0032
Vanadium	mg/L	<0.1 - 0.34	<0.05 - 0.14	<0.1	<0.1
Zinc	mg/L	0.01 - 0.07	<0.01 - 0.23	<0.01	<0.02
Radiological Parameters					
Goss alpha	pCi/L	ND	ND	ND	ND
Radium-226	pCi/L	5.3 - 144	67.6 - 214	316	11.9

[1] COGEMA (2004); [2] COGEMA (2008); [3] CAMECO (2009); [4] Crow Butte (2007)
ND - no data available

Table 2. Typical End-of-Production Groundwater Quality at Wyoming and Nebraska ISR Facilities

Parameter	Units	Irigaray[1]	Christensen Ranch[2]	Smith Ranch/ Highland[3]	Crow Butte[4]
Physical Properties					
pH	s.u.	6.9 - 7.8	7.3 - 7.7	6.9	7.8
TDS	mg/L	863 - 3,614	3,055 - 3,774	1,672	4,080
EC	µmhos/cm	1,690 - 4,881	4,008 - 4,788	2,580	6,000
Common Elements and Ions					
Bicarbonate	mg/L	469 - 1,463	1,393 - 2,280	824	2,050
Carbonate	mg/L	<0.1	<2	0	<1
Chloride	mg/L	86 - 429	121 - 177	232	600
Sulfate	mg/L	264 - 1,249	784 - 1,089	402	900
Calcium	mg/L	40 - 356	268 - 325	349	77
Magnesium	mg/L	10 - 77	53 - 62	66	23
Sodium	mg/L	262 - 840	598 - 863	83	1,310
Potassium	mg/L	5.9 - 11	9.4 - 13	17	35
Minor Ions and Trace Elements					
Arsenic	mg/L	<0.001 - 0.008	0.011 - 0.12	0.008	0.06
Barium	mg/L	<0.1	0.1	0.1	<0.1
Cadmium	mg/L	<0.01	0.01	0.01	<0.005
Chromium	mg/L	<0.05	0.05	0.1	<0.05
Copper	mg/L	<0.01 - 0.02	0.01	0.01	0.04
Iron	mg/L	<0.05 - 6.9	0.14 - 2.81	0.1	<0.03
Lead	mg/L	<0.05	0.05	0.1	<0.05
Molybdenum	mg/L	<0.1	0.1	0.1	0.5
Nickel	mg/L	<0.05	0.05	0.07	<0.05
Selenium	mg/L	0.05 - 1.05	0.55 - 6.3	0.81	0.07
Uranium	mg/L	0.46 - 22	12 - 18	22	44
Vanadium	mg/L	<0.1	0.22 - 0.61	0.1	2.5
Zinc	mg/L	0.01 - 0.05	0.01 - 0.05	0.11	0.02
Radiological Parameters					
Goss alpha	pCi/L	ND	ND	ND	ND
Radium-226	pCi/L	27 - 565	258 - 526	1,478	1,090

[1] COGEMA (2004); [2] COGEMA (2008); [3] CAMECO (2009); [4] Crow Butte (2007)
ND - no data available

Table 3 calculates the typical change in concentration of various constituents during ISR. The values in Table 3 were added to the typical baseline values in the Dewey and Burdock areas to estimate end-of-production water quality at the Dewey-Burdock Project. These revised estimates are provided in Table 5.4-2. When comparing the previous and revised estimates, most parameters are similar. For example, the revised sulfate estimates are 883 mg/L (Dewey) and 1,751 mg/L (Burdock), which closely matches the previous estimates of 1,000 and 1,800 mg/L, respectively. Notable differences between the previous and revised estimates include:

- TDS: the revised estimate in the Dewey area (3,035 mg/L) is significantly lower than the previous estimate (4,500 mg/L).
- Bicarbonate: the revised estimates (1,531 to 1,624 mg/L) are significantly higher than the previous estimate (25 mg/L). Note that the bicarbonate estimate may be conservatively high, since the Dewey-Burdock project will use a lixiviant comprising groundwater fortified with dissolved oxygen and carbon dioxide instead of a sodium-bicarbonate solution, which is used at some other ISR facilities.
- Chloride: the revised estimates (265 to 267 mg/L) are significantly lower than the previous estimate (1,300 mg/L).
- Sodium: the revised estimates (603 to 676 mg/L) are significantly higher than the previous estimates (190 to 270 mg/L). Note that the sodium estimate may be conservatively high, since the Dewey-Burdock project will use a lixiviant comprising groundwater fortified with dissolved oxygen and carbon dioxide instead of a sodium-bicarbonate solution, which is which is used at some other ISR facilities.
- SAR: the revised estimates (5.6 to 9.5) are higher than the previous estimates (calculated values were 1.4 to 2.4 and estimated end-of-production values were 2.8 to 4.9). These changes are caused by increased estimates of the change in sodium concentrations coupled with decreased estimates of the change in calcium and magnesium. SAR is addressed in the response to comment #9.
- Arsenic: the revised estimate (0.03 mg/L) is higher than the previous estimate (0.01 mg/L).
- Vanadium: the revised estimate is lower than the previous estimate. The vanadium concentration at the end of production will depend on a number of factors including the ratio of vanadium to uranium in the ore, the vanadium leaching kinetics, and Powertech's decision whether or not to recover vanadium. As noted in the Preliminary Economic Assessment of the Dewey-Burdock Project (SRK Consulting, 2012), "Available data do not allow a rigorous determination of the amount of vanadium that will dissolve during commercial leaching."

Table 3. Typical Groundwater Quality Change from Baseline to End-of-Production at Wyoming and Nebraska ISR Facilities

Parameter	Units	Irigaray[1]	Christensen Ranch[2]	Smith Ranch/ Highland[3]	Crow Butte[4]	Average Change
Physical Properties						
pH	s.u.	-1.5	-1.6	-1.2	-0.3	-1.2
TDS	mg/L	2,234	2,677	1,322	2,276	2,127
EC	µmhos/cm	3,291	3,311	2,016	3,277	2,974
Common Elements and Ions						
Bicarbonate	mg/L	1,370	1,642	618	1,649	1,320
Carbonate	mg/L	-12	-35	-0.2	<1	-16
Chloride	mg/L	251	133	227	398	252
Sulfate	mg/L	517	633	285	163	400
Calcium	mg/L	213	284	299	47	211
Magnesium	mg/L	49	56	56	18	45
Sodium	mg/L	543	546	26	743	465
Potassium	mg/L	6.5	5.4	9	20	10.2
Minor Ions and Trace Elements						
Arsenic	mg/L	<0.01	0.035	0.008	0.06	0.027
Barium	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	mg/L	<0.01	<0.01	<0.01	<0.005	<0.01
Chromium	mg/L	<0.05	<0.05	<0.1	<0.05	<0.05
Copper	mg/L	<0.01	<0.01	<0.01	0.035	0.013
Iron	mg/L	0.3	0.8	<0.1	<0.03	0.29
Lead	mg/L	<0.05	<0.05	<0.1	<0.05	<0.05
Molybdenum	mg/L	<0.1	<0.1	<0.1	0.45	<0.2
Nickel	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	mg/L	0.15	3.1	0.81	0.07	1.0
Uranium	mg/L	6.0	14	22	44	22
Vanadium	mg/L	<0.1	0.27	<0.1	2.5	0.72
Zinc	mg/L	0.012	<0.01	0.1	0.02	0.034
Radiological Parameters						
Goss alpha	pCi/L	ND	ND	ND	ND	ND
Radium-226	pCi/L	180	302	1,162	1,078	681

[1] COGEMA (2004); [2] COGEMA (2008); [3] CAMECO (2009); [4] Crow Butte (2007)
ND - no data available

Table 5.4-2. Estimated End-of-Production Groundwater Quality at the Dewey-Burdock Project (Revised)

Parameter	Units	Typical Dewey Baseline[1]	Typical Burdock Baseline[2]	Typical Change[3]	End-of-Production Dewey Estimate	End-of-Production Burdock Estimate
Physical Properties						
pH	s.u.	7.9	7.3	-1.2	6.5 - 7.5	6.5 - 7.5
TDS	mg/L	908	2,293	2,127	3,035	4,420
EC	µmhos/cm	1,323	2,621	2,974	4,297	5,595
Common Elements and Ions						
Bicarbonate[4]	mg/L	211	304	1,320	1,531	1,624
Carbonate	mg/L	<5	<5	-16	<5	<5
Chloride	mg/L	15	13	252	267	265
Sulfate	mg/L	483	1,351	400	883	1,751
Calcium	mg/L	63	386	211	274	597
Magnesium	mg/L	24	124	45	69	169
Sodium[4]	mg/L	211	138	465	676	603
Potassium	mg/L	10	19	10	20	29
Minor Ions and Trace Elements						
Arsenic	mg/L	0.002	0.0045	0.027	0.03	0.03
Barium	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01
Chromium	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	mg/L	<0.01	<0.01	0.013	0.013	0.013
Iron	mg/L	<0.03	0.17	0.291	0.31	0.46
Lead	mg/L	0.007	<0.001	<0.05	<0.05	<0.05
Molybdenum	mg/L	<0.1	<0.1	<0.2	<0.2	<0.2
Nickel	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	mg/L	<0.005	0.0009	1.0	1.0	1.0
Uranium	mg/L	0.01	0.034	22	22	22
Vanadium	mg/L	<0.1	<0.1	0.7	0.7	0.7
Zinc	mg/L	0.01	0.007	0.034	0.04	0.04
Radiological Parameters						
Goss alpha	pCi/L	1,502	4,991	ND	ND	ND
Radium-226	pCi/L	380	1,289	681	1,061	1,970
Calculated Parameters						
SAR (calc.)	unitless	5.7	1.6	ND	9.5	5.6
ESP (calc.)	unitless	6.7	1.0	ND	11.3	6.6
RSC (calc.)	meq/L	-1.7	-24.5	ND	5.9	-16.9

[1] Hydro ID 681 (see Appendix 3.4-G); [2] Hydro ID 680 (see Appendix 3.4-G)

[3] Changes in groundwater quality were calculated based on historical baseline and end-of-production groundwater quality from ISR facilities in Wyoming and Nebraska.

[4] Sodium and bicarbonate estimates may be conservatively high, since the Dewey-Burdock project will use a lixiviant comprising groundwater fortified with dissolved oxygen and carbon dioxide instead of a sodium-bicarbonate solution, which is used at some other ISR facilities.

ND - no data available

Table 5.4-3 presents the estimated land application water quality based on the revisions to Table 5.4-2. Changes to the previous version of this table are indicated in bold text. Most of these changes reflect the previously described changes in estimated end-of-production water quality (e.g., SAR, bicarbonate, chloride, and sodium). The estimated concentrations of metals and trace elements have been revised based on the methodology described above. In most cases the revised estimates are lower than the previous estimates (barium, cadmium, chromium, copper, nickel, and vanadium). In a few cases the revised estimates are higher than the previous estimates (arsenic, iron, molybdenum, and selenium). The revised table also contains several parameters not previously estimated (lead, zinc, and Po-210).

Table 5.4-3. Estimated Land Application Water Quality (Revised)

Parameter	Units	Land Application Water Estimate
Physical Properties		
pH	s.u.	6.5 - 7.5
TDS	mg/L	1,000 - 5,000
EC	µmhos/cm	1,500 - 6,000
Common Elements and Ions		
Bicarbonate	**mg/L**	**500 - 2,000**
Carbonate	mg/L	<1
Chloride	**mg/L**	**100 - 400**
Sulfate	mg/L	500 - 2,000
Calcium	mg/L	200 - 1,000
Magnesium	mg/L	50 - 300
Sodium	**mg/L**	**200 - 1,000**
Potassium	**mg/L**	**10 - 50**
SAR	**unitless**	**5 - 10**
Minor Ions and Trace Elements		
Arsenic	**mg/L**	**<0.03**
Barium	**mg/L**	**<0.1**
Cadmium	**mg/L**	**<0.01**
Chromium	**mg/L**	**<0.05**
Copper	**mg/L**	**<0.02**
Iron	**mg/L**	**<1**
Lead	**mg/L**	**<0.05**
Molybdenum	**mg/L**	**<0.2**
Nickel	**mg/L**	**<0.05**
Selenium	**mg/L**	**<1**
Vanadium	**mg/L**	**<1**
Zinc	**mg/L**	**<0.05**
Radiological Parameters		
Lead-210	pCi/L	<10
Polonium-210	**pCi/L**	**<40**
Radium-226	pCi/L	<60
Thorium-230	pCi/L	<100
U-natural	pCi/L	<300

bold text indicates change from original Table 5.4-3 (September 2012 version).

Note: Estimates of land application water quality were based on Dewey-Burdock Project baseline water quality and historical baseline and end-of-production groundwater quality from ISR facilities in Wyoming and Nebraska, with adjustments as necessary to account for planned post-production water treatments.

5. *Table 5.4-3, page 5-87: Please submit the results from the laboratory scale leach tests conducted on ore samples from the Dewey and Burdock sites and the historic end of production water quality data from in situ sites in Wyoming and Nebraska that were used to develop the land application water quality estimates in the table.*

Response: Attachment A includes historical water quality data from ISR facilities in Wyoming and Nebraska that were used to prepare the revised estimates of end-of-production groundwater quality and land application water quality. As previously described, the leach tests are no longer used for these estimates.

6. *Section 5.6.11.1.5, page 5-156: In the first paragraph of this section, please identify which raptor species are using the nests in close proximity to the mining area.*

Response: Section 5.6.11.1.5 has been revised to include the list of raptor species associated with raptor nests or potential nest sites within the proposed permit boundary and surrounding survey area. These include the great horned owl, long-eared owl, red-tailed hawk, merlin and bald eagle.

7. *Section 5.6.11.1.7, page 5-157: Please identify the birds tracked by the SDNHP.*

Response: Section 5.6.11.1.7 has been revised to indicate that 19 other bird species (non-raptors, non-game, and non-waterfowl/shorebirds) tracked by the South Dakota National Heritage Program (SDNHP) have the potential of occurring in the proposed permit area. These species were indicated in bold in Appendix I to Appendix 3.9-A and include: common poorwill, Lewis' woodpecker, three-toed woodpecker, black-backed woodpecker, olive-sided flycatcher, Cassin's kingbird, Clark's nutcracker, brown creeper, pygmy nuthatch, veery, northern mockingbird, sage thrasher, Sprague's pipit, black-and-white warbler, Virginia's warbler, Brewer's sparrow, Baird's sparrow, McCown's longspur and Cassin's finch. Only one of these species (Clark's nutcracker) was documented in or within 1 mile of the proposed permit area during the baseline survey period. The nutcracker was observed once flying over the proposed permit area, but no known nesting or other targeted use was recorded by this species.

In addition, Sections 5.6.11.1.4, 5.6.11.1.5 and 5.6.11.1.8 through 5.6.11.1.10 have been updated to address the mammals, raptors, waterfowl/shorebirds, reptiles/amphibians, and fish/macro-invertebrates tracked by SDNHP. These are summarized as follows:

- Mammals (Section 5.6.11.1.4): 14 mammal species tracked by SDNHP have the potential of occurring in the proposed permit area (Merriam's shrew, dwarf shrew, long-eared myotis, fringe-tailed myotis, northern myotis, silver-haired bat, Townsend's big-eared bat, northern flying squirrel, northern river otter, meadow jumping mouse, swift fox, black-footed ferret, eastern spotted skunk, and mountain lion). Only the northern river otter was observed in the vicinity of the proposed permit area; this was a carcass observed at the upstream sampling point on Beaver Creek.
- Raptors (Section 5.6.11.1.5): 16 raptor species tracked by SDNHP have the potential of occurring in the proposed permit area (osprey, bald eagle, sharp-shinned hawk, Cooper's hawk, northern goshawk, broad-winged hawk, Swainson's hawk, ferruginous hawk,

golden eagle, merlin, peregrine falcon, prairie falcon, barn owl, northern saw-whet owl, long-eared owl, and burrowing owl). The bald eagle, long-eared owl, and merlin are known or are suspected to have nested in or within 1 mile of the proposed permit area based on evidence (young present) or persistent defensive behavior.

- Waterfowl and shorebirds (Section 5.6.11.1.8): 18 waterfowl/shorebird species tracked by SDNHP have the potential of occurring in the proposed permit area (common loon, horned grebe, American white pelican, great blue heron, black-crowned night heron, green-backed heron, white-faced ibis, bufflehead, hooded merganser, common merganser, whooping crane, mountain plover, piping plover, long-billed curlew, California gull, common tern, black tern, and interior least tern). The long-billed curlew, great blue heron, and American white pelican were documented in or within 1 mile of the proposed permit area during the baseline survey period. The long-billed curlew is suspected to have nested in or within 1 mile of the proposed permit area based on persistent defensive behavior.
- Reptiles and amphibians (Section 5.6.11.1.9): Three reptile species and zero amphibian species tracked by SDNHP have the potential of occurring in the proposed permit area (northern sagebrush lizard, smooth green snake and brown snake). None of these species was observed in or around the proposed permit area.
- Fish and macro-invertebrates (Section 5.6.11.1.10): Appendix II to Appendix 3.9-A shows that one fish species tracked by SDNHP has the potential of occurring in the proposed permit area (plains topminnow). The plains topminnow was captured during fish sampling efforts in the Cheyenne River and the downstream sampling site along Beaver Creek during baseline surveys; both sites are outside of the proposed permit area.

8. *Section 5.6.11.1.11, page 5-160: Please identify the SDNHP species mentioned in the "Species Tracked by SDNHP" section.*

Response: Section 5.6.11.1.11 has been revised as requested to update the discussion on species tracked by SDNHP.

9. *Sections 5.5.6 and 5.5.7, pages 5-113 and 5-113a: During our technical review of the mine permit application, we have had discussions with the Department of Game, Fish, and Parks over its concerns with the bioaccumulation of metals in the food chain, especially selenium. The Custer County Conservation District also expressed concerns over the buildup of salts in the soil profile based on the elevated SAR in the baseline soil data. We also have concerns over the development of saline seep conditions in the land application area over time similar to the alkaline area referenced in the mine permit application.*

   Mr. Michals, GFP, submitted the report "Selenium in a Wyoming Grassland Community Receiving Wastewater from an In Situ Uranium Mine" which was developed by the US Fish and Wildlife Service. This report is the basis of his agency's concerns. Powertech has indicated it has a copy of this report. Please discuss the potential for the impacts described in the report to occur in Powertech's land application area in situ mine site and mitigative measures such as additional treatment to remove selenium prior to land

application. If there will be the potential for similar impacts, please address if Powertech plans to do additional sampling in addition to the soil and vegetative sampling, such as collecting tissue samples of grasshoppers and birds for selenium and other metal analysis.

Response: The USFWS report (Ramirez and Rogers, 2000) describes how selenium concentrations in soil, water, grass, insects, and birds were higher at a land application site associated with a Wyoming ISR facility than at a reference area. There are several key differences between the design and operation of the Wyoming land application site and the proposed Dewey-Burdock Project land application systems that will minimize the potential for similar impacts to occur. These include:

- Water application rate: The Wyoming system reportedly applied 0.25 inch of water per day to a 58-acre land application area. In contrast, the proposed land application rate at the Dewey-Burdock Project is 19 inches over the typical irrigation season of March 29 through October 31 (see Appendix 5.3-A). This equates to 19 inches over 217 days or less than 0.09 inch per day. The potential loading rate for selenium and other constituents of concern is therefore about one-third of that at the Wyoming facility assuming the concentrations are the same.
- Standing water: The USFWS report indicated that standing water and cattails present within the Wyoming ISR facility land application area promoted bird nesting (specifically red-wing blackbirds). The USFWS report recommends preventing ponding water and cattail growth to discourage nesting. Powertech will operate the land application systems at an agronomic rate that will prevent ponding and runoff (see Section 5.4.1.1.2 and GDP Section 5.4). The catchment areas will not be allowed to fill with land applied effluent (see GDP Section 5.4). These commitments are incorporated into draft GDP permit condition #4, which requires Powertech to ensure that the application rate does not cause water to accumulate in the catchment areas or cause excessive ponding in the land application areas during dry conditions. Further, Powertech commits to monitoring the selenium concentration of runoff/snowmelt that accumulates in the catchment areas and dewatering the catchment areas if trigger values are exceeded (see response to comment #15).
- Soil concentration: The reported soil selenium concentration at the Wyoming ISR facility land application system ranged from 2.6 to 4.2 ppm and averaged 3.1 ppm (note that no baseline was given for the Wyoming ISR facility land application system in the USFWS report). In contrast, the range of selenium in soil samples from the proposed Dewey-Burdock land application areas has ranged from non-detect to 3 ppm and averaged 0.6 (Burdock) to 0.8 ppm (Dewey). The average value is approximately the same as the average in the reference area used in the USFWS report. GDP Section 6.4 describes how prior to operation two baseline soil samples at two different depths (0-18" and 18-36") will be collected from each quadrant of each center pivot (8 total samples per pivot). GDP Section 8.3 describes how trigger values will be established as the average baseline concentration plus 2 standard deviations for each sample depth in each pivot area. This calculation will yield a trigger value that is within or close to the range of baseline concentrations. If the soil concentration approaches the trigger value, a mitigation plan will be implemented (see below). Therefore, the soil selenium concentration will be

maintained at levels that are much closer to the reference area in USFWS report than the Wyoming ISR facility land application area.

- Aquatic plants: The USFWS report analyzed pondweed samples from the wastewater storage reservoir associated with the Wyoming ISR facility land application system. It noted that the selenium concentrations were extremely elevated (434 to 508 ppm), representing a potential impact to waterfowl. In the case of the Dewey-Burdock Project, the ponds will be lined and catchment areas will only contain water temporarily following precipitation or snowmelt. Synthetic pond liners will inhibit the growth of aquatic vegetation which might otherwise serve as a potential source of exposure to contaminants via a food pathway.

Following is a summary of the monitoring and mitigation measures that will be implemented at the Dewey-Burdock Project to minimize potential impacts due to selenium bioaccumulation in the land application systems.

1) Effluent monitoring: Prior to operation of the land application systems each year, Powertech will sample the treated water storage ponds and have the samples analyzed for the parameters in Table 6.2-1, including selenium. Each month during operation of the land application systems, effluent samples will be collected and analyzed for the parameters in Table 6.2-1. (See Section 5.5.4.1.)
2) Trigger values in treated water storage ponds: Powertech will implement an avian deterrent system in ponds with dual synthetic liners and establish trigger values for selenium and other parameters in the treated water storage ponds and other ponds with one synthetic liner (see response to comment GFP-1(b)). Avian deterrent systems in the treated water storage ponds will be implemented if trigger values are exceeded.
3) Trigger values in catchment areas: Powertech will establish trigger values for runoff and snowmelt that accumulate in catchment areas (see response to comment #15). The catchment areas will be dewatered if trigger values are exceeded.
4) Agronomic application rate: land application effluent will be applied at an agronomic rate of approximately 19 inches per year, which will help prevent ponding and will limit the quantity of selenium applied per unit area. Excessive ponding will not be allowed per GDP permit condition #4. Ponding and cattails that could promote bird nesting will be avoided.
5) Soil monitoring: soil samples will be collected prior to land application and used to establish trigger values for selenium in each pivot area. These will be based on the average baseline water quality and variation (2 standard deviations). During operation, at least two soil samples will be collected each year from each pivot active that year. Samples will be analyzed for a long list of parameters including selenium (see Section 5.5.6.1).
6) Soil mitigation: should the selenium trigger value be approached in a pivot area, a mitigation plan will be implemented. The contingency plan will include one or more of the following action items (Section 5.6.2.2):
    - Additional sampling
    - Modify operating parameters (e.g., discharge rate, active pivots)
    - Implement water treatment if necessary specifically for selenium (this could potentially include removal or conversion to a non-soluble form)

- Implement a phytoremediation plan to control buildup of selenium in soil
- Excavate soil if above reclamation standards

7) Vegetation monitoring: samples of vegetation will be collected from three pivot areas in each of the Dewey and Burdock areas each year and analyzed for a long list of parameters including selenium (GDP Section 6.5). The monitoring results will be compared to trigger values for selenium and other parameters, which will be provided to DENR for review and approval prior to land application (Section 5.5.7.1).
8) Vegetation mitigation: Powertech will evaluate annual sample results and implement a contingency plan if there is an increasing trend in the selenium concentration or if the trigger value is approached. The contingency plan is similar to that described above for soil monitoring (GDP Section 8.4).
9) Livestock monitoring: Powertech will work with landowners to prevent livestock grazing during operation of the land application systems. Should livestock graze on the areas or consume crops grown in the areas, livestock will be sampled annually and analyzed for constituents that include selenium (GDP Section 6.6).
10) Prairie dog monitoring: Powertech will sample prairie dogs prior to land application system operation and every year during operation as described in the response to comment #GFP-3(a).
11) Wildlife exclusion: Powertech will construct wildlife exclusion fencing around land application areas if monitoring results indicate potential impacts to wildlife (see response to comment #GFP-3(a)).
12) Groundwater monitoring: extensive groundwater monitoring will ensure that selenium does not cause the alluvial groundwater to exceed the SD groundwater quality standard for selenium at the POP zone boundary. This will include vadose zone monitoring beneath each land application area, interior wells, and compliance wells. (See Section 5.5.2.4 and GDP Section 6.1.1).
13) Surface water monitoring: streams and impoundments downgradient from land application systems will be sampled quarterly and analyzed for a long list of parameters including selenium (See Section 5.5.3 and GDP Section 6.2).

Powertech should also consider analyzing samples of water from the land application ponds for metals, common elements such as sodium and chloride, and SAR prior to land application.

Response: As described in the previous comment response, Powertech will analyze samples of water from the treated water storage ponds for the constituents in Table 6.2-1 prior to operation of the land application systems each year. The requested analytes are included in Table 6.2-1 except SAR, which may be calculated from the analysis of sodium, calcium, and magnesium concentrations.

Please discuss the potential for the buildup of salts in the soil profile and the development of saline seep conditions in the land application area. Also, please describe the measures Powertech plans to take to mitigate any problems that develop from salt buildup and saline seep.

Response: Potential salinity impacts in the land application areas are a function of the baseline soil salinity, land applied water quality, leaching practices, and reclamation crop salinity tolerance. Each of these is described below.

Baseline Soil Salinity

Baseline soil salinity profiles for soil samples collected from within or near the Burdock and Dewey land application areas are presented in Figures 1 and 2. These were generated using the laboratory-measured saturation extract electrical conductivity (EC) presented in Appendix 3.3-A. The salinity profiles represent typical soil salinity conditions in this semiarid area, with baseline soil salinity increasing with depth. These figures show that the top 1 to 3 feet, where most of the plant root zone is located, has salinity ranging from about 0.5 dS/m to greater than 5 dS/m. The salinity from 3 to 5 feet below ground surface is considerably higher, ranging from about 5 to 15 dS/m. According to the *Western Fertilizer Handbook* (California Plant Health Association, 2002), soils that have a conductivity of the saturation extract greater than 4 dS/m and exchangeable sodium percentage (ESP) less than 15 are considered saline soils. Figures 1 and 2 show that generally the near-surface soils do not meet this classification, although there are some instances where the baseline salinity in the top 3 feet exceeds 4 dS/m. Note that the highest levels of baseline soil salinity are associated with samples collected in or near drainage bottoms (#41 and #73) and may not be as representative as the other samples of typical land application baseline soil salinity (refer to Plate 3.6-1 for soil sample locations).

Land Application Water Quality

As described in Section 5.4.1.1.4.1, the primary source of land applied water will be production and restoration bleed. Table 4 presents the approximate contribution from various sources over the life of the project and shows that approximately 94% of the land applied water will result from production and restoration bleed. Section 5.4.1.1.4.1 describes how during production the water quality in each well field will transition from baseline to end-of-production water quality. This process will be reversed during groundwater restoration, with the groundwater quality gradually improving to approximately baseline conditions. Table 5.4-2, which has been revised in response to comment #4, presents the estimated end-of-production water quality. Table 5.4-3 (also revised) presents the estimated land application water quality. In terms of salinity, the TDS is expected to range from 1,000 to 5,000 mg/L and the EC from 1,500 to 6,000 μmhos/cm (1.5 to 6 dS/m). The typical salinity level of the land applied water will be significantly lower than the upper values in Table 5.4-3, since multiple well fields typically will undergo production and groundwater restoration at the same time, and thus the quality of water land applied will be a blend of water from multiple well fields, each somewhere between baseline and end-of-production values. Assuming that the end-of-production TDS is 3,000 to 4,500 mg/L and that typical land application water quality will be halfway between this range and the baseline concentration of about 1,200 mg/L, the typical land application water quality is anticipated to have a TDS of 2,000 to 3,000 mg/L.

Figure 1. Baseline Soil Salinity Profiles - Burdock Land Application Area

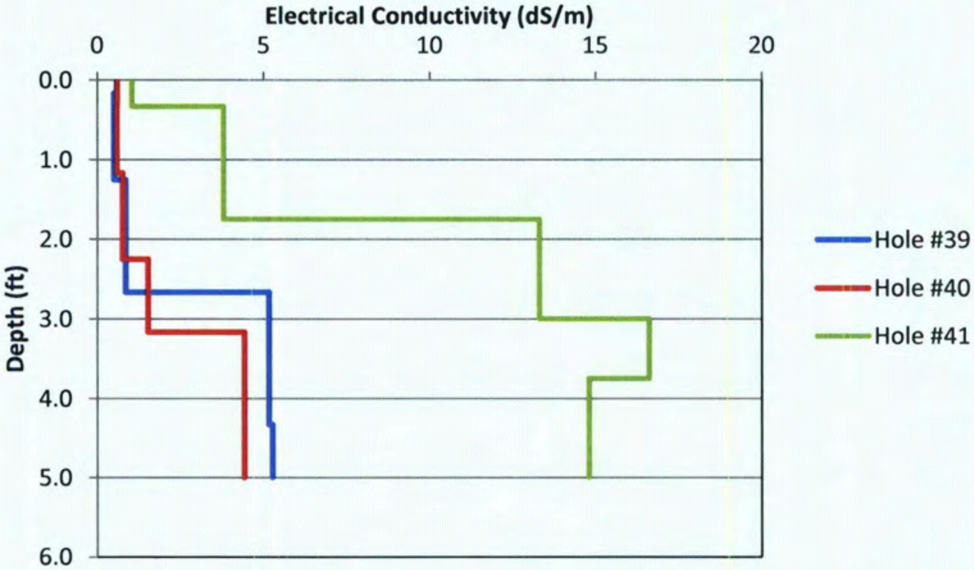


Figure 2. Baseline Soil Salinity Profiles - Dewey Land Application Area

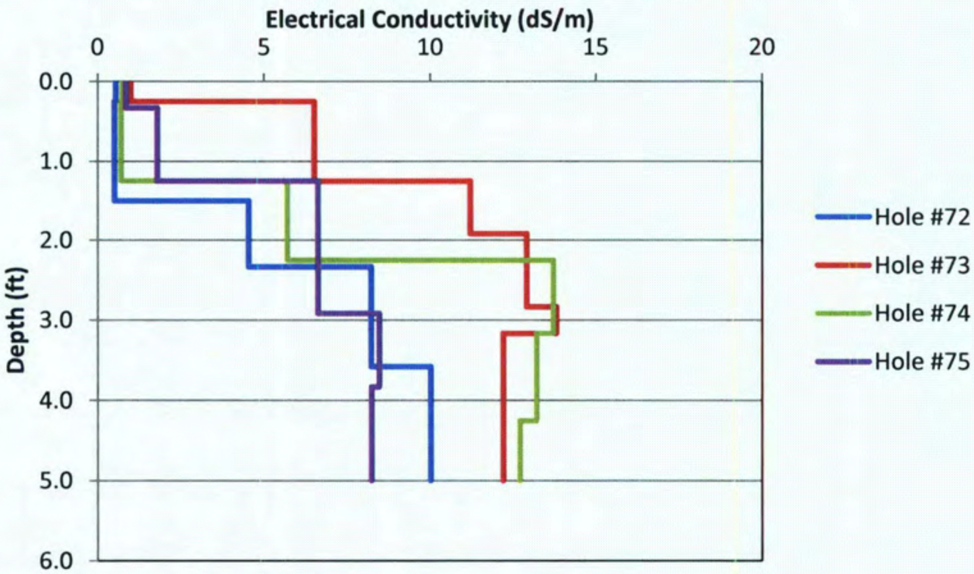


Table 4. Estimated Volume of Land Application Water from Various Sources

Source	Total Volume (acre-feet)	Percent of Total
Groundwater Restoration[1]	1,666	61%
Production Bleed[2]	903	33%
Central Plant[3]	155	6%
Total	**2,724**	**100%**

[1] Appendix 5.6-A, Table 6-1
[2] Estimated as 8,000 gpm maximum gross production rate x 0.875% typical bleed x 8 years
[3] Estimated as 12 gpm x 8 years

Leaching Practices

As described in Section 5.6.2.2, the primary control for soil salinity will be leaching salts below the root zone. Powertech will operate the land application systems to balance the downward migration of water, which has the potential to impact alluvial groundwater, with the leaching that will be used to control salt buildup in the root zone.

Leaching is a well-understood and primary management practice to control soil salinity in the root zone and will be implemented at the Dewey-Burdock Project. Leaching will be used to flush salts out of the root zone before they build up to levels that might affect reclamation success. This may be done using either or both of two primary management procedures:

- Applying land application water at a greater rate than the crop requirement (while also ensuring that the water does not accumulate in catchment areas during dry conditions, in accordance with GDP permit conditions)
- Applying fresh water from the Madison Limestone in conjunction with land applied water

The availability of Madison water for leaching is demonstrated by comparing the maximum requested Madison appropriation amount (551 gpm) with the actual anticipated usage for groundwater restoration and facility usage. As shown in Table 4, the total estimated volume of water extracted during groundwater restoration is 1,666 acre-feet. Since an approximately 1% restoration bleed will be maintained, the estimated requirement of Madison water during restoration is 99% of this amount or 1,649 acre-feet. Over 6.25 years of estimated groundwater restoration (see Figure 5.2-1), this equates to an average requirement for groundwater restoration of 164 gpm. With another 12 gpm used to supply water to the CPP and other facilities (Section 5.6.3.1.1), the total typical requirement is approximately 176 gpm or about 32% of the proposed appropriation. This demonstrates that several hundred gpm of water from the Madison typically will be available under the Madison appropriation if needed for leaching. However, the quantity of Madison water typically used for leaching will be much lower as discussed next.

The quantity of Madison water potentially used for leaching will be relatively small compared to the requested Madison appropriation as demonstrated by the following calculations. As shown in Table 4, the total volume of land applied water is estimated to be 2,724 acre-feet. Over approximately 6 years of concurrent production and restoration (see Figure 5.2-1), this equates to an average annual volume of 454 acre-feet. At an average application rate of 19 inches per year (Section 5.4.1.1.2), the required land application area is approximately 287 acres, or less than half of the proposed maximum primary center pivot area (630 acres). This is an important point to emphasize in terms of potential salinity impacts. The land application systems have been conservatively oversized to handle the peak wastewater generation rate. Under the typical usage scenario, less than half of the design primary pivot area may be required to be under active land application. Therefore, the scope of the potential impacts may be much smaller than if the entire permitted land application area were used regularly. Assuming that 6 inches of Madison water are applied to 300 acres actively irrigated each year, the estimated Madison usage would be 150 acre-feet per year, or only about 17% of the requested maximum annual appropriation volume of 888.8 acre-feet. The 6-inch estimate is based on a rule of thumb that 6 inches of water will leach approximately 50 percent of the salts from the top 1 foot of soil (California Plant Health

Association, 2002). The actual quantity of Madison water used for leaching would be determined during operations based on the annual soil sampling results, quantity of land applied water, type of crops grown, and annual precipitation.

Some leaching will occur each year through infiltration of precipitation. Leaching efficiency will be enhanced with the use of modern sprinkler technology, including nozzles suspended low over the fields that use low pressure to produce relatively large water droplets, resulting in lower evaporation rates and higher efficiencies. This type of sprinkler system will be required by GDP permit conditions requiring Powertech to minimize the formation of aerosols. Section 5.6.2.2 has been modified to include the following mitigation methods to improve leaching efficiency if needed to control salinity (Ayers and Westcot, 1994):

- Leaching during the cool season when evapotranspiration losses are lower
- Using tillage, including potentially deep tillage if needed
- Applying water intermittently, which favors unsaturated flow that is more efficient than saturated flow for leaching

Reclamation Crop Salinity Tolerance

Table 5 presents the salinity tolerance of the five species of grasses in the reclamation seed mixture. The salinity tolerance ranges from moderately tolerant (two wheatgrass varieties) to moderately sensitive (little bluestem). Since the primary goal of salinity management will be successful reclamation of land application areas, these tolerances will be considered when managing the land application systems.

Table 5. Salinity Tolerance of Reclamation Seed Mixture Species

Species	Salinity Tolerance	Source
Western wheatgrass	moderately tolerant	Ayers and Westcot, 1994
Sideoats grama	moderately sensitive to moderately tolerant	Wynia, 2007
Slender wheatgrass	moderately tolerant	Ayers and Westcot, 1994
Green needlegrass	moderately sensitive to moderately tolerant	Taylor, 2001
Little bluestem	moderately sensitive	Ayers and Westcot, 1994

Evaluation of Potential for Saline Seeps

According to the USDA-NRCS (1983), a saline seep is defined as, "Intermittent or continuous saline water discharge, at or near the soil surface downslope from recharge areas under dryland conditions, that reduces or eliminates crop growth in the affected area because of increased soluble salt concentration in the root zone." The following evaluates the potential for the development of saline seeps as result of land application and presents monitoring and mitigation strategies for potential saline seeps.

A variety of factors make it unlikely that saline seeps will occur as result of land application, including:

- Topography - Most planned center pivots, including all Dewey-area center pivots, are located a significant distance from the nearest topographic relief (typically drainage channels) where saline seeps could potentially occur. Most of the ephemeral drainage channels in the Burdock area are relatively shallow and, with the exception of one

planned ephemeral channel diversion (see Section 5.3.9.1), the channels are located a significant distance from the planned center pivots.

- Water table - Saline seeps typically are associated with shallow water table conditions, which are not typically present near the planned land application areas.
- Bedrock - Saline seeps typically are associated with low-permeability geologic outcrops. Such outcrops are not found in the ephemeral stream channels near the land application areas.
- Recharge - The design land application rate is 19 inches per year, which will result in limited leaching. As described previously, management of the land application systems will balance leaching requirements for root zone salinity control with a moderate application rate to limit potential impacts to groundwater.
- Duration - The duration of land application will be limited, after which the recharge to center pivot areas will revert to precipitation and snowmelt. The estimated duration of peak land application, during concurrent production and groundwater restoration, is approximately 6 years as shown on Figure 5.2-1.

Monitoring systems described in the LSM permit application and GDP will be used to determine the potential for saline seeps to occur. These include tracking the land application rate, monitoring salinity in land application area soils, monitoring water movement through the vadose zone through suction lysimeters, and inspecting catchment areas and land application areas for erosion or leakage. In addition, Powertech will include in each annual land application report an evaluation of the potential for saline seeps (see revised Section 5.7.2.6). This evaluation will include annual surveys of drainage channels near the land application areas for signs of potential saline seeps such as changes in plant species (e.g., increasing presence of foxtail barley), soil/subsoil moisture, salt crystals on the surface, and sloughed hillsides. Should the annual survey show the potential development of a saline seep, Powertech will perform a detailed evaluation, including delineating the extents of the affected area through soil sampling and vegetation surveys. The detailed evaluation will include an assessment of the potential cause and mitigation strategy if caused by land application.

A site-specific mitigation plan will be developed for DENR review and approval if a saline seep occurs. Mitigation will focus on two key areas: recharge and seep reclamation. In terms of recharge, the mitigation plan will address modifying the land application rate in the vicinity of the seep, either through rotating active pivots or reducing the application rate. The effectiveness of recharge mitigation measures will be assessed through water table monitoring. Potential mitigation measures for the affected area of a saline seep include temporarily planting salt-tolerant grasses such as tall wheatgrass in the affected area and grading the area (e.g., temporarily or permanently diverting an ephemeral drainage around the affected area).

In the mine permit application, Powertech proposes trigger points for arsenic and selenium of the baseline average concentration plus two standard deviations. However, the department wants Powertech to develop more specific trigger points for arsenic and selenium as well as other metals, sodium, chloride, and SAR.

Response: Based on clarification received during a March 12, 2013 conference call, Powertech understands that this comment specifically refers to soil trigger values and that the "other metals" in the comment refer to lead, molybdenum and uranium. Section 5.5.6.1 has been modified to include the commitment to establish additional trigger values for land application area soils as listed in Table 6, which is incorporated into the LSM permit application as Table 5.5-7. Proposed trigger values for trace and minor elements are all tied to the baseline concentration and variability as with arsenic and selenium. The trigger value calculations will yield values that are within or close to the range of baseline concentrations, ensuring that the concentrations do not change significantly during land application. For chloride, the proposed trigger value is 250 mg/L (7 meq/L). This value is in the middle of the range of 4-10 meq/L recommended for slight to moderate restriction on use for surface irrigation (California Plant Health Association, 2002). Chloride is a constituent of concern for reclamation and will be managed along with general root zone salinity as described previously. For SAR, the proposed trigger value is 10. Figure 3 plots this value along with the anticipated typical land application water EC (3 to 4 dS/m based on a typical TDS range of 2,000 to 3,000 mg/L) on a diagram showing the potential SAR impacts to the infiltration rate. Figure 3 shows that no impacts are anticipated to the soil infiltration rate at SAR 10 or less.

Table 6. Trigger Values for Land Application Area Soils

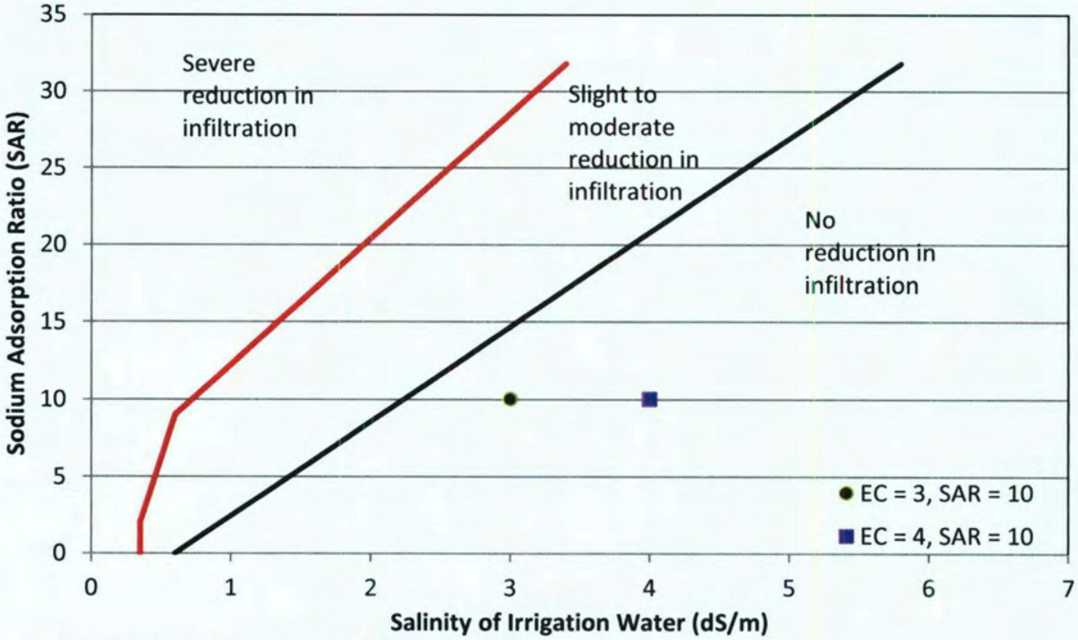
Parameter	Units	Trigger Value
Arsenic	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Lead	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Molybdenum	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Selenium	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Uranium-natural	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Chloride	mg/L	250
SAR	unitless	10

Powertech does not propose to conduct baseline soil sampling in order to establish trigger values prior to permit issuance for the following reasons:

1) Powertech is committed to sampling land application area soils prior to operation as described in Section 5.5.6.1. Results will be provided to DENR along with calculated trigger values for agency review and approval prior to land application. Trigger values for metals/metalloids will be established according to baseline concentrations and variability, and the land application systems will be operated and monitored to ensure that these concentrations do not increase significantly.
2) Land application is the secondary wastewater disposal option and will not be used if sufficient capacity is available in deep disposal wells. If land application is not used, there will be no use for the relatively expensive baseline soil sampling data from land application areas.

3) Minor grading may be performed in the land application areas, potentially resulting in different soil horizons than baseline sampling if conducted prior to grading. Section 5.4.1.1.2 describes how Powertech will evaluate the need for grading during final design of the land application systems and catchment areas.
4) Final design of land application systems could result in revisions to the locations, which may not encompass baseline soil sampling locations conducted prior to final design.

Figure 3. Sodium Adsorption Ratio (SAR) Hazard



Source: California Plant Health Association (2002)

In response to comment #9 several changes have been made to the LSM permit application. The following sections were added:

- 5.5.4.2 Catchment Area Water Quality Monitoring
- 5.5.4.3 Soil and Vegetation Monitoring (including new Table 5.5-6)
- 5.5.4.4 Livestock Monitoring
- 5.5.4.5 Prairie Dog Monitoring
- 5.5.4.6 Groundwater and Surface Water Monitoring

In addition, text in the following sections was modified:

- 5.5.4
- 5.5.6.1 (including new Table 5.5-7)
- 5.5.8
- 5.5.9
- 5.6.2.2

10. *Section 6.3.1.4 and Section 6.3.2.2, page 6-13: Will any of the removed contaminated soils underneath ponds and well houses be replaced at a 1:1 ratio with uncontaminated soils from another source?*

Response: Sections 6.3.1.4 and 6.3.2.2 address reclamation of the ponds and header houses, respectively. These sections describe how during reclamation, the subsoil underneath the pond liners and under and around the header house foundations will be surveyed for contamination. Any materials which do not meet the limits for unrestricted use will be disposed at a licensed disposal facility. Following the surveys and removal of contaminated subsoil (if present), areas formerly excavated for pond construction and header house installation will be backfilled with spoil previously stockpiled from these areas.

The ratio of backfill to excavated spoil material is expected to be approximately 1:1, since there is very low potential for the subsoil around the ponds and header houses to become contaminated. Protective measures to guard against pond leaks are described in Section 5.6.5.1.4 and include liners, leak detection systems for ponds containing untreated wastewater, routine inspections, and SOPs to rapidly dewater a pond if a leak occurs. All ponds will be provided with at least one geosynthetic liner underlain by a clay liner. Ponds containing untreated wastewater, which would have a greater potential to contaminate subsoil if a leak were to occur, will have two geosynthetic liners, a clay liner, and a leak detection system. Routine inspections described in Section 5.3.4.5 include daily inspections of pond liners, daily inspections of pond freeboard to ensure adequate capacity is available, and daily checks for water accumulation in leak detection systems. The potential impacts from a primary liner leak will be minimized by implementing SOPs to take the pond out of use and remove its contents to another pond (refer to the response to comment #2). Sufficient freeboard will be maintained in each type of pond such that the contents of a leaking pond can be transferred to another pond with the same level of lining system. Based on these protective measures, the financial assurance estimate in Appendix 6.7-A was prepared assuming the secondary liners and leak detection systems will not be contaminated. Therefore, the volume of contaminated subsoil requiring removal is assumed to be zero or nearly zero for each pond. It is not anticipated that spoil will have to be borrowed to make up for contaminated subsoil removal.

The subsoil around header house foundations similarly is not expected to require removal due to contamination. Plate 5.3-4 shows how each header house will include a concrete foundation that will contain a leak if it were to develop in the header house piping. Section 5.3.5 describes how each header house will be equipped with external and internal shutdown controls for automatic and remote shutdown in the event of an upset condition such as a pipe break. This section also describes how each header house will include a sump equipped with a water level sensor to alert operators to a leak and automatically shut down the header house. All visible pipes and fittings inside each header house will be inspected daily for potential leaks. These measures will help prevent a leak from affecting the subsoil around the header house foundation. Therefore, the volume of contaminated soil or subsoil around header houses is anticipated to be very low and not require spoil to be borrowed to make up for contaminated soil or subsoil removal. No changes were made to the LSM permit application in response to this comment, since the response clarifies information contained in the application.

11. *<u>Section 6.3.3, page 6-14:</u> Will Powertech keep records of GPS locations of all wells after well plugging is completed to assist in locating the wells during future inspections of the mining area, including postclosure inspections?*

Response: Section 5.7.2.5 has been revised to include the commitment to retain records of the locations of all wells, including injection, production, and monitor wells, throughout the postclosure monitoring period. Well locations will be determined using a survey-grade GPS or equivalent.

12. *<u>Appendix 5.3-A:</u> Regarding the 40 mil liners mentioned in the Appendix, the department suggests using 40 mil LLDPE liners or 60 mil HDPE or LLDPE liners for better puncture resistance. Our experience with 40 mil HDPE liners is that they are prone to punctures and other damage.*

Response: Powertech appreciates the suggestion and will consider using 40 mil LLDPE or 60 mil HDPE liners for ponds with one geosynthetic liner (i.e., ponds that store only treated wastewater such as the treated water storage ponds and spare storage ponds, noting that ponds storing untreated wastewater or used in the water treatment process have been designed with 80 mil primary and 60 mil secondary liners). From the comment and the subsequent clarification of the concerns, Powertech understands that DENR has witnessed problems with 40 mil HDPE liners after many years of service, primarily due to ice. Prior to construction, Powertech will evaluate the relative costs and benefits of the alternate liners and decide whether to include them in the construction plans and specifications. Powertech also has added the commitment to provide as-constructed drawings of the ponds to DENR. Meanwhile, following is a brief summary of the protective measures that will minimize the potential liner damage regardless of the type of liner selected.

Appendix 5.3-B (Pond Construction Specifications, Testing and QA/QC Procedures) describes the liner specifications, installation procedures, and extensive testing procedures. Part 2 - Geosynthetics, Section 4.3 describes the geosynthetic liner specifications. Liners will be UV resistant and provided with a minimum warranty period of 20 years by the contractor. Appendix 5.3-B, Part 2, Section 6.0 describes how the manufacturer will be required to test random samples during production of the pond liners and submit the results to the construction oversight engineer, who will be a South Dakota-licensed professional engineer or an engineer working under the direct supervision of a licensed professional engineer. In addition, the engineer will collect conformance samples of the liner materials delivered to the site and test these for thickness, density, tensile properties, and general conformance with specifications.

Appendix 5.3-B, Part 1 - Earthworks, Section 5.1.2 addresses preparation of the areas to receive geosynthetic liners. In ponds with one geosynthetic liner, these areas will be clay liners at least 12 inches thick. Prior to installing the geosynthetic liner, the clay liner surface will be moistened and proof rolled with a smooth drum roller or similar equipment to ensure that the surface is firm and smooth. Part 2, Section 5.3 requires the area where the liner is installed to be free of sharp particles, rocks, or other debris to the satisfaction of the engineer. Sharp objects will be removed by raking, brooming, or hand picking as necessary. This will ensure that there is minimal potential for punctures during or after installation. The contractor will be required to provide a

supervisor with significant experience in installing flexible lining materials to supervise installation. Care will be taken during installation to minimize the potential for damage or future leaks. Specific requirements include laying out panels to minimize the number of seams, limiting foot traffic, and repairing or replacing any damaged areas during installation.
Part 2, Section 6.0 describes the extensive quality control requirements for geosynthetic liners. These include the previously mentioned random samples by the manufacturer during production, visually inspecting each seam during installation, and testing all seams completed in the field. Any defective seams will be cut out and replaced or patched with an overlying cap. Testing will be conducted on the repaired area to ensure that all seams are installed properly.

During operation, the liners will be protected from damage from wildlife through perimeter fences installed around all lined ponds, including small mammal provisions as discussed in the response to comment #GFP-1(a). Ice formation will be limited by continuously filling the ponds during the winter (treated water storage ponds), passing water through the ponds year around (outlet ponds and surge ponds), or keeping the ponds empty (spare treated water storage ponds). Section 5.3.4.5 in the LSM permit application describes how the pond liners will be inspected daily. Should a leak occur, sufficient capacity will be available in a spare pond to rapidly transfer the contents of the leaking pond in order to make repairs.

13. *<u>Plate 5.3-1, Sheet 1 and Plate 5.3-2, Sheet 1:</u> The topsoil stockpiles shown in these plates appear to be located too close to the ponds. Please submit revised plates with topsoil stockpiles located farther away from the ponds.*

Response: After receiving clarification on this comment, Powertech understands that the concern is with the topsoil stockpiles in the Dewey area. Powertech has revised the topsoil stockpile location in the Dewey area for the land application option as depicted on revised Plate 5.3-1, Sheet 1. The revised location is farther from the ponds and from a drainage channel. As described in Section 5.3.7, topsoil stockpiles will not be located in any drainage channels or other locations subject to flooding. Berms will be constructed around the perimeter of stockpiles to capture runoff and sediment resulting from direct precipitation on the stockpiles and to prevent erosion from runoff.

14. *<u>Plate 5.3-5, Sheet 1:</u> Powertech needs to show that the existing access road from the Dewey Road to the Dewey Satellite Plant will be upgraded to a primary access road. The current map does not show this road being upgraded. Also, will the primary access be used exclusively by the mining operation?*

Response: Plate 5.3-5, Sheet 1 has been updated to extend the Dewey satellite facility primary access road to the permit boundary. This change also is reflected on revised Plate 5.3-1, Sheet 1 and Plate 5.3-2, Sheet 1. Existing roads will be used and upgraded as needed from the S. Dewey Road to the primary access road. These roads will not be used exclusively by the mining operation. The existing roads will be used to access the residence in Section 30, T6S, R1E (currently unoccupied) and for ranch access.

15. *<u>Plates 5.4-1 and 5.4-2:</u> On each plate, please show the wetted perimeter of the normal operating level behind each catchment berm. Also, please show the location of the excess water level markers and the pumps and piping for the excess water. Are there any plans to pump water from the normal operating level if increasing Se, As, SAR, or other trends are noted? Finally, please submit electronic versions of Plates 5.4-1 and 5.4-2 in dwg or ArcMap format.*

Response: Plates 5.4-1 and 5.4-2 have been revised to show the wetted perimeter of the normal operating level. These plates, which were formerly provided along with the requested copies of GDP permit application comment responses, are now being incorporated as LSM permit application plates using the same plate numbers. In addition, Section 5.4.1.1.2 has been revised to reference these plates and discuss catchment area operation. It is important to note that the land application systems will be operated in accordance with GDP permit conditions, which will not allow land applied water to accumulate in the catchment areas during dry conditions. Therefore, the "normal operating level" represents the maximum level allowed to fill with runoff and snowmelt while still maintaining adequate freeboard for the 100-year, 24-hour runoff event. The catchment areas will not be used to store land applied solutions and only will contain water following rainfall or snowmelt events. The normal operating level will be delineated with a clearly visible marker such as a t-post, which will be installed on the catchment berm or another highly visible location.

In some cases, more than one catchment area may be required to contain the 100-year, 24-hour runoff volume. The conceptual catchment area designs in Plates 5.4-1 and 5.4-2 indicate where this might occur. For example, conceptual catchment areas B-11 and B-12 are designed such that overflow is routed to catchment area B-13. In these cases, there will not be a designated normal operating level in the upgradient catchment areas. Any time runoff or snowmelt accumulates in a catchment area without a designated normal operating level it will be dewatered to a downgradient catchment area with a designated normal operating level. It is anticipated that dewatering will occur via gravity discharge through a pipe with the inlet invert elevation at the bottom of the upgradient catchment area. In this case flow would be controlled by a manual valve, normally closed, in the discharge pipe. Following a rainfall or snowmelt event, the valve would be opened and the water drained to the downgradient catchment area at non-erosive velocity. Other alternatives may include pumping or water trucks. As described in Table 1.1-2 under ARSD 74:29:05:14(1), as-constructed plans of the land application systems, including catchment area dewatering systems, will be provided to DENR prior to operation.

If a catchment area fills above the normal operating level, a dewatering program will be initiated. The catchment area will be dewatered, with the excess water conveyed to another catchment area with excess operating capacity or the storage ponds, or pumped to a land application pivot area (primary or standby area). It is anticipated that pumps will be installed in the most downgradient catchment areas, with pump discharge piping routed to the storage ponds. In this case the piping would be installed in the same corridor as the pipelines from the ponds to the pivot areas wherever possible. These pipelines have been added to Plates 5.4-1 and 5.4-2. Alternately water trucks may be used in some circumstances to dewater catchment areas and transfer the contents to the storage ponds or another catchment area. If water trucks are to be used, Powertech will

demonstrate in the as-constructed land application system plans that the catchment areas can be dewatered in a timely manner.

Please note that the conceptual catchment area design in the Dewey area has been revised. The former catchment area D-10 conflicted with the primary access road to the satellite facility. Therefore, the conceptual design for D-10 has been modified and a new catchment area (D-15) has been added. These changes are reflected on the revised Plate 5.4-1. Plates 5.4-1 and 5.4-2 will be provided electronically under separate cover in AutoCAD .dwg format as requested.

To address DENR's comment regarding dewatering catchment areas in the event of increasing concentrations of water quality constituents and to ensure that the water in the catchment areas does not pose a threat to groundwater or wildlife, Powertech proposes to sample the water in catchment areas monthly (when present) and initiate mitigation measures if the water quality exceeds trigger values. Section 5.5.4.2 was added to address catchment area monitoring. Table 7 (added to Section 5.5.4.2 as Table 5.5-6) summarizes the proposed trigger values. The proposed trigger value for EC (4,000 μmhos/cm) is the upper range of the typical land application estimate described previously. The proposed trigger value for SAR is the same as the soil trigger value addressed above. For metals/metalloids, the proposed trigger values are obtained from Raisbeck et al. (2007). These are water quality recommendations protective of livestock and wildlife based on extensive literature review. Parameters listed in Table 7 without trigger values are proposed for monitoring only. If the concentration of any parameter exceeds the trigger value, Powertech will dewater the catchment area as described previously.

By committing to not allowing land application solutions to accumulate in the catchment areas during normal operations, establishing catchment area water quality trigger values and dewatering catchment areas if trigger values are exceeded, the concentrations of constituents in the catchment area soils are not expected to increase significantly. This will be verified through the commitment to sample catchment area soils annually and implement mitigation measures if significant increases in constituent concentrations are observed (see Section 5.5.6.1).

Appendix 1.0-B (Technical Revision List) has been changed to specify that trigger values as well as compliance limits may be modified by technical revision subject to DENR approval.

Table 7. Proposed Sample Parameters and Trigger Values for Water in Catchment Areas

Parameter	Unit	Trigger Value
EC	µmhos/m	4,000
SAR	unitless	10
pH	s.u.	<6.5 or >8.5
Arsenic[1]	mg/L	1
Copper	mg/L	---
Lead	mg/L	---
Molybdenum[1]	mg/L	0.3
Selenium[1]	mg/L	0.1
Uranium[2]	mg/L	0.2
Vanadium	mg/L	---
Zinc	mg/L	---
Gross alpha	mg/L	---
Radium-226	mg/L	---

[1] From Raisbeck et al. (2007)
[2] From Canadian Livestock and Water Quality Guidelines *in* Raisbeck et al. (2007)

Department of Agriculture Comments

Ag-1. Appendix 6.4-C Noxious Weed Control Plan Page 6.4-C-1: In Line 1, the timing statement of the proposed noxious weed inspection is insufficient. Annual inspections should be performed during the active growing season of the weeds. Also, under "Herbicides", the herbicide use and application statement is insufficient. Herbicide application must be performed by South Dakota Certified Licensed Pesticide Applicators. Powertech (USA) must follow all grazing and haying restrictions noted on the product label.

Response: Appendix 6.4-C has been revised as requested to clarify that weed inspections will be performed during the active growing season of the weeds and that herbicide application will be performed by a South Dakota-certified licensed pesticide applicator. The appendix also has been revised to include the commitment to follow all grazing and haying restrictions noted on the herbicide label.

Ag-2. Appendix 6.4-C Noxious Weed Control Plan Page 6.4-C-3, Table 1, Custer County Noxious Weeds: The Custer County noxious weed list is incomplete. White Horehound (Marrubium vulgare) was added to the list by emergency declaration in August 2012 (See Custer County Weed & Pest Board Archive meeting minutes, August 1, 2012: http://www.custercountysd.com/wp-content/uploads/2011/01/Bdmtg080112.doc (page 2)).

Response: Appendix 6.4-C, Table 1 has been revised as requested to include white horehound.

Ag-3. <u>*Appendix 6.4-C Noxious Weed Control Plan Page 6.4-C-4, References:*</u> *The references to SDSU 2010 Weed Control in Pasture and Range is outdated. Please use South Dakota State University Extension, 2013 Weed Control, Pasture and Range: 2012 SDSU Extension, available on the internet as of January 2013:* <u>*http://igrow.org/up/resources/03-3020-2012.pdf*</u>

Response: The references in Appendix 6.4-C have been revised as requested to use the 2013 South Dakota State University Extension reference.

Custer Conservation District Comments

CCCD-1. <u>*Land Reclamation Plan:*</u> *What is the timing and methodology for reclaiming all exploration drill holes? What species will be planted and what will the soil material be?*

Response: Well field reclamation will be carried out in an ongoing process concurrently with ISR operations. Section 6.5 in the LSM permit application describes the reclamation timetable and shows that each well field will be reclaimed following uranium recovery operations. During exploration and delineation drilling, each hole will be plugged according to South Dakota standards before the drilling rig leaves each location. Following construction of the processing facilities, pipelines, and each well field, interim reclamation using the approved seed mixture will be used to temporarily stabilize areas to be disturbed again (see Section 6.4.2). Groundwater will be restored following uranium recovery in each well field. Following regulatory approval of successful groundwater restoration and stability monitoring, wells will be plugged and abandoned, well field pipelines and header houses will be removed, and surface disturbance areas will be reclaimed with the approved reclamation seed mixture.

The postmining land use for the vast majority of disturbed areas will be rangeland. Disturbed areas designated to be reclaimed to rangeland will be reseeded with a permanent seed mixture (see Table 6.4-1). This seed mixture was recommended by the local NRCS office (see Appendix 6.4-B) and approved by all surface owners within the proposed permit area (see Appendix 6.4-A). The reclamation seed mixture will contain western wheatgrass, sideoats gramma, slender wheatgrass, green needlegrass, and little bluestem. Only a small area of cropland is planned to be disturbed. Disturbed cropland will be planted with alfalfa during reclamation. Refer to the following comment response for a description of topsoil handling.

What is the timing and species being used to stabilize the topsoil piles? Also, what is the quantity of soil in each of the stockpiles?

Response: Topsoil stockpiles will be stabilized by seeding with the approved reclamation seed mixture during the first normal period of favorable planting conditions (see Section 6.4.3.4 of the LSM permit application). The estimated topsoil stockpile volumes for the processing facilities and ponds are 100,000 to 200,000 cubic yards in the Burdock area and 50,000 to 100,000 cubic yards in the Dewey area. Additional topsoil stripped during access road and well field

construction will be stockpiled near the access roads and well fields. See Section 5.3.7 in the LSM permit application for further details.

Will all locations be reseeded with the single seed mix, regardless of post mining soil analysis?

Response: A single seed mixture will be used for all interim and final reclamation, except that a small area of cropland disturbance will be restored to alfalfa cropland (see Section 6.4.3.4 of the LSM permit application).

The soil analyses indicate areas of high pH, high conductivity, and SAR values that indicate potential problems. Will these soils be identified during the topsoil stripping process?

Response: Section 6.4.3.2 in the LSM permit application describes how Powertech will analyze topsoil prior to stripping in the processing areas and first well fields to determine whether fertilizer or other amendments will be required to establish and sustain vegetative growth during reclamation. See also Section 6.4.3.4 for a discussion of areas with low vegetative cover densities that likely will have low revegetation potential if disturbed. These include the Darrow Mine surface pits/spoil piles and the "alkali area," which is an isolated area of groundwater discharge to the surface potentially as result of historical exploration drilling. In only very limited areas, which are anticipated to include the historical mine pits and the alkali area (in addition to the processing areas and first well fields discussed previously), Powertech will sample the topsoil and subsoil prior to disturbance. If the evaluation demonstrates that its chemical or physical characteristics would seriously inhibit plant growth and that it is not feasible to remedy by chemical treatment, overburden replacement, or like measures, Powertech will request that the revegetation performance criteria not apply for these limited areas as allowed by SDCL 45-6B-46(2). In all other areas, revegetation will be required to meet the reclamation performance criteria in Appendix 6.4-D. For rangeland, Powertech will be required to demonstrate that reclamation performance criteria are met for vegetative cover, usable forage production, species composition, and sustainability of reclamation to DENR's satisfaction prior to final bond release.

CCCD-2. <u>Land Application Plan:</u> We note that much of the surface water analysis shows high salt content indicating the surrounding soils also are saline.

Response: The response to comment #9 addresses the baseline salinity levels in the land application area soils and mitigation of potential salinity impacts. It describes how the top 1 to 3 feet of the soils typically are non-saline, while deeper soils have considerably higher salinity levels. The salinity levels will be managed in the land application areas by leaching. This may include applying land application water at a greater rate than the crop requirement or applying fresh water from the Madison in conjunction with land applied water. Leaching may be enhanced by applying excess water during the cool season, tillage (including deep tillage), and applying water intermittently. Please note that discharge to surface water from land application systems will not occur. Catchment areas will be constructed downgradient of land application areas to capture runoff up to a 100-year, 24-hour storm event.

Water from the deep wells also indicates properties that would make reclamation more difficult.

Response: The response to comment #9 addresses the anticipated range of salinity in the land application water. Salinity will be managed during land application by adjusting the leaching rate and leaching with fresh water from the Madison as needed in order to ensure that land application areas can be reclaimed.

The areas on the Land Application Exhibits showing where the excess water will be applied has soils that are thin and on the heavy texture side of the triangle.

Response: The LSM permit application (Section 5.4.1.1.2) describes how the soil hydraulic properties in the land application areas will help prevent the migration of water into the alluvial groundwater. Soil sampled from test pits in and around the land application areas predominantly contain clay and silt, with lesser amounts of sand and virtually no gravel to depths of 7 to 10 feet. The hydraulic modeling simulations used to size the land application systems considered permeability measurements from soil samples collected in the land application areas. These simulations predict that the land applied water will not percolate deeper than 8 feet. An important factor in limiting deep percolation will be applying land application water at an agronomic rate of about 19 inches per year. As described in the response to comment #9, the land application system operations will be balanced to limit deep percolation to groundwater while also leaching salts from the top 1 to 3 feet to maintain root zone salinity levels conducive to reclamation.

We are concerned that there will be a buildup of salts in the soil profile which would make revegetation unsuccessful.

Response: Please refer the response to comment #9 and the above comment responses for a description of mitigation measures to control salinity levels in land application soils.

If indicated through analysis, will more appropriate species and soil amendments be applied to help ensure long term land use?

Response: Section 6.4.3.4 in the LSM permit application describes how areas seeded with the reclamation seed mixture will not be treated with any type of soil amendment or irrigated to improve reclamation success unless required in the land application areas. Section 6.4.4 describes revegetation of land application areas. The revegetation technique will depend on the vegetation grown in the land application areas. If native vegetation is irrigated and the species composition of the native vegetation does not change significantly during irrigation, then reseeding is not anticipated to be necessary to meet the reclamation performance criteria. However, if the species composition significantly changes during the course of land application or if crops such as alfalfa or wheatgrass are planted in the land application areas, Powertech will revegetate land application areas using the permanent reclamation seed mixture described previously, prepare a revegetation plan approved by appropriate agencies, or demonstrate that that after land application ceases a permanent, self-perpetuating ground cover at least equal in character and extent to the original will remain.

South Dakota Department of Game, Fish and Parks (GFP) Comments[1]

5.3.4 Ponds
5.3.4.1 Pond Design, Appendix 5.3-A

Comment GFP-1: Pond designs do not address wildlife protection. Add the components into design specifications.

- *GFP-1(a): Fencing: mesh and height for large and small mammal exclusion.*

Response: Section 5.6.11.2 in the LSM permit application has been revised to specifically address pond fencing to exclude large and small mammals. Chain link fences around the facility ponds will be 8' high to exclude large mammals, as shown in the drawings in Appendices 5.3-A and 5.3-B. Powertech commits to installing durable mesh (e.g., woven wire) along the base of the chain link pond fencing for small mammal exclusion. The mesh will extend at least 30 inches above ground and will be buried at least 3 inches to ensure there are no gaps and to discourage burrowing. Section 5.3.4.5 has been revised to indicate that ponds will be inspected daily for wildlife presence or sign of potential wildlife intrusion.

- *GFP-1(b): Bird and wildlife access: level of metals concentration in solution of contained ponds in which ponds will be covered to prevent contact with wildlife.*

Please refer to the response to comment #15 for a discussion of trigger levels in the catchment areas that will trigger dewatering. For the facility ponds, Section 5.6.11.2 has been revised to describe how Powertech will provide an avian deterrent system (physical deterrent such as netting or "bird balls" or hazing system) for ponds used to store untreated water or used in the water treatment process. These are the ponds with dual synthetic liners and include the central plant pond, radium settling ponds, spare ponds, and surge ponds. For ponds storing only treated water, including the treated water storage ponds, spare storage ponds, and outlet ponds, avian deterrent systems will be provided if the water quality exceeds trigger values designed to be protective of wildlife. Table 8 (added to the LSM permit application as Table 5.6-2a) lists the proposed trigger values. These include acute aquatic life criteria recommended by EPA under Section 304(a) of the Clean Water Act and 10 CFR Part 20, Appendix B, Table 2, Column 2 limits for release of radionuclides to the environment. Note that for selenium, the EPA criterion uses a formula that recognizes that selenium's two prevalent oxidized forms, selenite (SeO_3^{2-}) and selenate (SeO_4^{2-}), present differing potentials for aquatic toxicity. In order to demonstrate compliance with the trigger value, Powertech will establish the ratios of selenite and selenate to the total selenium concentration in the treated water ponds and apply the formula noted below Table 8. As described in the response to comment #15, Appendix 1.0-B (Technical Revision List) has been changed to specify that trigger values as well as compliance limits may be modified by technical revision subject to DENR approval.

[1] South Dakota Department of Game, Fish and Parks (GFP) comments to the Department of Environment and Natural Resources, attached to October 31, 2012 DENR procedural completeness review letter.

Table 8. Proposed Trigger Values for Avian Deterrent Systems in Treated Water Ponds[1]

Parameter	Units	Proposed Trigger Value
Arsenic	mg/L	0.34 [(2)]
Selenium	mg/L	Formula [(2)(3)]
Uranium	pCi/L	300 [(4)]
Radium-226	pCi/L	60 [(4)]
Lead-210	pCi/L	10 [(4)]
Polonium-210	pCi/L	40 [(4)]
Thorium-230	pCi/L	100 [(4)]

[1] Including treated water storage ponds, spare storage ponds, and outlet ponds.
[2] EPA Section 304(a) aquatic life criteria (EPA, 2013)
[3] Trigger value = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 0.1859 mg/l and 0.01282 mg/l, respectively (EPA, 2013)
[4] 10 CFR 20, Appendix B, Table 2, Column 2

- *GFP-1(c): Unfenced ponds- provisions to preclude wildlife entrapment*

Response: The only unfenced ponds planned for use at the Dewey-Burdock Project are sediment ponds. As described in Section 5.3.9.3 of the LSM permit application, sediment ponds will be used to capture sediment from disturbed areas within drainage basins of 60 acres or more. They will be designed either as earthen fill dams or incised ponds. Earthen fill dams will pose no risk for wildlife entrapment, since the upgradient channel will be unaffected. Incised ponds will not be constructed at slopes steeper than 3:1 (horizontal:vertical). Powertech does not anticipate that these slopes will pose a risk for entrapment, since they will be unlined and the sediment ponds will not normally store significant quantities of water (Powertech will be required to dewater any sediment pond that fills beyond the designated freeboard capacity required for the 5-year, 24-hour runoff event). Nevertheless, Powertech will design all facilities including sediment ponds and any areas that could accumulate water to avoid wildlife entrapment. Section 5.6.11.2 has been updated to indicate that sediment ponds and any other areas that could accumulate water will be designed to avoid wildlife entrapment.

Table 5.0-2: Regulatory Primacy

<u>Comment GFP-2:</u> Regulatory primacy of the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act is the US Fish & Wildlife Service. The Department of Game, Fish and Parks shall enforce the South Dakota laws pertaining to the protection and propagation of all game animals, game birds, fish, and harmless birds and animals; SDCL 41-3-8 and 34A-8-6.

Response: Table 5.0-2 has been revised to indicate that USFWS and GFP have primacy over specific aspects of ecology. A note below Table 5.0-2 has been added acknowledging that USFWS has regulatory primacy of the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act and that GFP shall enforce the South Dakota laws pertaining to the protection and propagation of all game animals, game birds, fish, and harmless birds and animals.

5.5 Monitoring

<u>Comment GFP-3:</u> *The monitoring and mitigation sections must include wildlife. Develop monitoring plans for:*

- *GFP-3(a): Land application: Bioaccumulation of metals in the terrestrial food chain must be evaluated if land application is use for waste disposal.*

Response: If land application is used for disposal of treated wastewater, Powertech will implement an extensive monitoring system to evaluate the potential for bioaccumulation. Existing commitments in the LSM permit application include the following:

- <u>Land applied effluent</u>: Powertech will collect grab samples every few hours and have them analyzed for a short list of parameters that will indicate changes in effluent water quality. Each month, additional samples will be collected and analyzed for a more extensive parameter list to monitor land applied water quality. (See Section 5.5.4.1.)
- <u>Soil monitoring</u>: Powertech will collect soil samples each year from each land application pivot that was active during that year and from each catchment area. The sample results will be compared to trigger values for selenium, arsenic and other constituents (see Section 5.5.6.1 and the response to comment #9). The trigger values will be based on the preoperational concentrations and will be submitted to DENR for review and approval prior to initiating land application.
- <u>Vegetation monitoring</u>: Vegetation samples will be collected each year from the land application areas and catchment areas and compared to trigger values for arsenic and selenium. The trigger values will be based on the preoperational concentrations and will be submitted to DENR for review and approval prior to initiating land application.

Additional commitments are included in these comment responses. Specifically, Powertech will analyze runoff and snowmelt in the catchment areas and dewater the catchment areas if trigger values are exceeded (see the response to comment #15). Selenium also will be added the list of analytes for fish sampling (see the response to comment #GFP-1(e)).

In addition, Powertech proposes to analyze prairie dogs for potential bioaccumulation if land application is used. Prairie dogs were selected since they have been identified as a primary prey source for raptors and especially for the state-listed bald eagle. Powertech proposes to sample three prairie dogs prior to land application and each year during land application. The prairie dogs will be collected as close as possible to the land application systems. The samples will be analyzed for arsenic, molybdenum, selenium, and uranium. The specific sampling methodology (i.e., whole tissue versus specific organs) will be submitted to DENR and GFP for approval prior to initial sampling. Following pre-operational sampling, Powertech will submit trigger values for review and approval by DENR and GFP. Sections 5.5.4.5 and 5.5.9 were added to provide information on monitoring and mitigation of potential impacts to prairie dogs.

Should monitoring results indicate potential impacts to wildlife, mitigation measures will be implemented as described in the response to comment #9. If wildlife exclusion fencing is used around land application areas, Powertech will submit the fence design to DENR and GFP for approval prior to installation.

- *GFP-3(b): Small mammals: Exposure and ingestion of potentially toxic land application solution, soils and vegetation represents a contaminate exposure pathway in the food chain.*

Response: See the previous comment response. Powertech proposes to sample prairie dogs annually to evaluate the potential for bioaccumulation and exposure in the food chain.

- *GFP-3(c): Migratory birds: Exposure risk of toxic levels of metal and metalloids from land application solution storage.*

Response: See the response to previous comments. Powertech proposes to establish trigger values in catchment areas and dewater the catchment areas if trigger values are reached. Trigger values also will be established in treated water storage ponds, above which avian deterrent systems will be used. Avian deterrent systems will be provided in ponds storing untreated water or used as part of the treatment process. In addition, Powertech routinely will monitor land applied water, soil and vegetation and implement mitigation measures if trigger values are exceeded.

- *GFP-3(d): Raptors: annual nest surveys of project area and buffer.*

Response: The avian monitoring and mitigation plan will include a commitment for annual nest surveys. This is anticipated to include annual monitoring of all known raptor nests within the permit area and 0.5-mile perimeter and annual searches for new nests within 0.5 mile of current year disturbance and proposed disturbance for the following year. Please see also the response to December 2012 comment #1.

- *GFP-3(e): Fish: Proposed collection and analysis methods for fish tissue will be consistent with the project's baseline sampling protocols.*

Response: Section 5.5.9 of the LSM permit application has been modified to provide more detail regarding operational fish sampling that will be conducted in accordance with NRC license requirements. These requirements include collecting fish species identified with the potential for human consumption (green sunfish and channel catfish) semiannually if present in water bodies that may be subject to seepage or surface drainage from potentially contaminated areas. It is anticipated that this will include downstream locations on Beaver Creek and the Cheyenne River. In addition to the NRC license-required analyte list of natural uranium, radium-226, lead-210, polonium-210, and thorium-230, fish samples will be analyzed for selenium and the results provided to DENR and GFP.

In addition, Powertech commits to sampling fish and macro-invertebrates in the unlikely event that a spill or leak results in solutions reaching Beaver Creek. Sampling will be conducted according to a sampling and analysis plan approved by DENR and GFP.

5.5.7 Vegetation Sampling
5.5.7.1 Land Application Systems

<u>The application states</u>: *Soil and vegetation samples will be collected annually from the land application areas.*
<u>*Comment GFP-4:*</u> *The application needs to address concentrations of land applied metals in soil, vegetation and biota in which land application mitigation will occur.*

Response: Trigger values for soil and vegetation are addressed in the LSM permit application and these comment responses (i.e., see the response to comment #9). Powertech will establish these trigger values based on the pre-operational concentrations. Trigger values for prairie dogs will be established following pre-operational sampling and submitted to DENR and GFP for review and approval.

5.6.11 Ecological Resources

<u>*Comment GFP-5:*</u> *This section needs to consider facilities becoming an attractive nuisance for wildlife. The species referenced in this section tend to have a high tolerance of human activity and could be attracted to food and water sources created by ponds and land application areas.*

Response: Section 5.6.11.2 has been modified to address mitigation measures for potential impacts to wildlife from ponds and land application areas. Methods to address ponds becoming an attractive nuisance for wildlife have been described previously in these comment responses. These include fencing to exclude large and small mammals and avian deterrent systems for all ponds with dual synthetic liners and for treated water storage ponds if the water quality exceeds trigger values.

Powertech does not anticipate that land application areas will pose a risk to wildlife on the basis that water will be treated to meet the standards of release for radionuclides to the environment and will contain low concentrations of metals and trace elements such as arsenic and selenium. Potential impacts will be evaluated through extensive monitoring described in the response to comment #GFP-3(a), including land applied effluent, catchment areas, soil, vegetation, and prairie dogs. Monitoring results will be compared to trigger values and mitigation measures will be implemented if trigger values are exceeded (see response to comment #9). If wildlife exclusion fencing is used around land application areas, Powertech will submit the fence design to DENR and GFP for approval prior to installation.

Based on Powertech management experience at operating ISR facilities, revegetated well fields are likely to attract wildlife. Powertech does not foresee any risk to wildlife or equipment in the well fields, since all pipelines will be buried and well head equipment will be protected by enclosures. Design of well field perimeter fencing to permit big game passage is described in the response to comment #GFP-11.

5.6.11.1.2 Wildlife and Fisheries

The application states: *Advanced planning of construction siting and activities in concert with continued monitoring can reduce impacts further and assist with the development of mitigation options, if necessary. Potential impacts to these species and others are discussed in greater detail in the following sections.*
Comment GFP-6: *Advanced wildlife mitigation planning, construction siting, and monitoring should consist of approved written plans and incorporated in the mine permit application. Operations or construction activities failing to preemptively minimize wildlife impacts could result in a direct violation of federal and state wildlife laws.*

Response: The Avian Monitoring and Mitigation Plan that will be approved by GFP and reviewed by DENR and USFWS will provide written plans for wildlife mitigation planning, construction siting, and monitoring. This plan will be incorporated into the LSM permit application as Appendix 5.6-C. See also the response to December 2012 comment #1.

5.6.11.1.5 Raptors

The application states: *ISR activities in the permit area would not impact regional raptor populations, though individual birds or pairs may be affected by ISR activities causing raptors to abandon nest sites proximate to disturbance.*
Comment GFP-7: *These activities constitute violation of State and federal laws protecting bird and raptors species and need to be acknowledged and addressed in the permit application. Specifically, activities' causing a "take" constitutes a violation of the federal Migratory Bird Treaty Act. Bald eagle abandonment of an active nest violates provisions of the Bald and Golden Eagle Protection Act. Bald eagles State threatened species protection is found in ARSD 41:10:02 and SDCL 34A-8.*

Response: Section 5.6.11.1.5 has been modified to indicate that a written avian monitoring and mitigation plan will be followed to prevent potential impacts to raptors. In addition, Section 5.6.11.2 has been modified to indicate that if Powertech applies for a non-purposeful take permit, the application will be coordinated with GFP and DENR to ensure compliance with SDCL 34A-8 and other applicable rules and regulations. See also the response to December 2012 comment #1.

The application states: *Powertech (USA) will develop a bald eagle mitigation plan for review and verification by SDGF&P.*
Comment GFP-8: *Plan approval should be incorporated in to the permit application.*

Response: Sections 5.6.11.1.5 and 5.6.11.2 have been revised to specify that the avian monitoring and mitigation plan will be approved by GFP and DENR and the approved plan incorporated into the permit application as Appendix 5.6-C. See also the response to December 2012 comment #1.

5.6.11.1.11 Threatened, Endangered, or Candidate Species and Species Tracked by SDNHP State-Listed Species

Comment GFP-9: Only one bald eagle nest is documented within the permit area. A second, "alternative" nest is located near NE,NE,NE Section 31-T6S-R1E. Discussion of current plans regarding developments within suggested buffers need to be recognized in the permit application and mitigation coordinated with GFP.

Response: The avian monitoring and mitigation plan addresses the bald eagle nest described in the comment. This nest is currently being used and is being carefully monitored in accordance with the draft plan. Further, Powertech is currently avoiding all activity within 0.5 mile of the nest site to avoid potential disruption of the nesting pair. These activities are being coordinated with GFP.

5.6.11.2 Mitigation of Potential Ecological Resources Impacts

The application states: If direct impacts to raptors or other migratory bird species of concern occur, a Monitoring and Mitigation Plan for those species will be prepared and approved by the USFWS.
Comment GFP-10: As previously stated these activities constitute violation of State and federal laws protecting bird and raptors species. Mitigation of activities and monitoring plans need to be in place prior to construction and operation.

Response: As described previously, a written avian monitoring and mitigation plan that is approved by GFP and DENR will be incorporated into the LSM permit application. See also the response to December 2012 comment #1.

General comments:

Comment GFP-11: Barbed wire perimeter fencing should account for big game movement.

Response: Section 5.6.11.2 includes the commitment to design fencing to permit big game passage to the extent practicable. This section has been revised to include more details regarding the anticipated fence design, including: a bottom, smooth wire at least 15" to 16" above ground for pronghorn passage, a top wire no more than 42" high to facilitate passage of deer and elk, and an 11" to 12" space between the top two wires to prevent entanglement. These designs will apply to any new barbed wire perimeter fencing, which Powertech plans to construct around each well field as shown in the permit application (e.g., see Plates 5.3-1 and 5.3-2). While Powertech does not plan to construct perimeter fencing around the entire permit boundary, any new or replacement barbed wire perimeter fencing constructed by Powertech will consider big game passage.

Comment GFP-12: Annually wildlife monitoring and mitigation activities will be reported.

Response: Section 5.7.2.6 has been revised to include wildlife reporting requirements. Powertech will prepare an annual wildlife report for GFP and DENR that will address:

1) Bald Eagles and Other Nesting Raptors
    a. Results of annual monitoring of all known raptor nests and annual searches for new nests based on existing and planned disturbance, including a map showing current nest locations and conditions (intact, former) and the most recent 5-year history of each nest site, subject to data availability
    b. Discussion of surface disturbance and project activities within buffer distances of raptor nests
    c. Other monitoring requirements as listed in Appendix 5.6-C
2) Waterfowl and Shorebirds
    a. Operation and effectiveness of avian deterrent systems for facility ponds and results of water quality monitoring in treated water storage ponds if avian deterrent systems are not used
    b. Other monitoring requirements as listed in Appendix 5.6-C
3) Breeding Birds and Other Avian Species of Concern or Interest
    a. Results of clearance surveys for ground-nesting species in areas of planned disturbance
    b. Observations of avian species tracked by the SDNHP (location, habitat, etc.)
    c. Other monitoring requirements as listed in Appendix 5.6-C
4) Prairie Dogs and Lagomorphs
    a. Mapping and monitoring results of prairie dog colonies in and within 1.0 mile of permit area
    b. Description of prairie dog management efforts in and within 1.0 mile of permit area
    c. Results of annual nocturnal spotlight surveys for lagomorphs
5) Land Application (if used)
    a. Annual land application monitoring results (effluent, catchment areas, soil, vegetation, and prairie dogs) evaluating potential bioaccumulation of selenium and other metalloids/metals, and description of mitigation measures (if required).
6) Wildlife Mortalities
    a. Description of any wildlife mortalities observed within the permit area (see response to comment #GFP-13).

Comment GFP-13: Mortalities will be reported to GFP within 24 hours.

Response: Section 5.7.2.6 has been revised to include the commitment to report any wildlife mortalities within the permit area to GFP by phone and/or email with 24 hours.

Comment GFP-14: The application permit does not address mitigation of ore zone formation leakage caused by improperly plugged exploration drilling holes.

Response: A new section has been added to the LSM permit application to address mitigation of potential impacts from historical exploration holes (Section 5.3.3.9). In addition to summarizing information contained elsewhere in the application, this section presents some new information describing how TVA drill holes were plugged in accordance with State of South Dakota standards. Following is a summary of Section 5.3.3.9, Approach to Well Field Development with Respect to Exploration Holes.

Powertech has extensive information about the location of exploration holes within the permit area. A map of historical exploration holes is provided as Figure 3.2-7, and a detailed inventory is provided as Appendix 3.2-A. The vast majority of historical drill holes were plugged and abandoned in accordance with State of South Dakota requirements in place during drilling. Historical TVA drilling and Powertech's exploration drilling were conducted through DENR-issued Permits to Explore. These permits required exploration holes to be plugged with bentonite or cement grout. An exploration bond was held by the State to ensure the proper plugging of all exploration holes. A 1989 letter from TVA to DENR describes how to the best of TVA's knowledge, all TVA test holes were properly plugged and abandoned in accordance with applicable regulations. The letter has been added to the LSM permit application as Appendix 3.2-D. The letter discusses attempted mitigation of the one drill hole known to be seeping to the surface in the "alkali area." Throughout the entire proposed permit area, there is only one recorded instance ("alkali area") where water seepage to the surface is suspected to have come from an exploration hole (refer to Section 3.4.2.2.3).

Prior to developing each well field, Powertech will use best available information and best professional practices to locate exploration holes or wells in the vicinity of the planned well field, including historical records, color infrared imagery, field investigations, and potentiometric surface evaluation and pump testing conducted for each well field. Section 5.3.3.3 describes the procedures that Powertech will follow to demonstrate that the production and injection wells are hydraulically isolated from overlying and underlying aquifers. These include static potentiometric water level evaluations to identify any anomalous conditions indicative of leakage across aquitards; water quality sampling and evaluation to identify any potential areas of leakage; and drawing down the production zone sand unit through pump testing while recording the presence or lack of response in vertical monitor wells to evaluate vertical confinement. This information will be contained within well field hydrogeologic data packages submitted to NRC for review and verification/approval and submitted to DENR prior to operating each well field (see Section 5.3.3.4).

If it is determined that an unplugged exploration hole has the potential to impact the control and containment of ISR solutions, Powertech will plug and abandon or mitigate the exploration hole (see Section 5.6.3.2). It is not surprising that there is little evidence of unplugged holes in the proposed permit area, due to the well-known natural tendency of drill holes to seal themselves by collapsing and swelling of the formations.

Thank you for the prompt and thorough technical review. Please direct any questions regarding these comment responses to John Mays at (303) 790-7528 or Jack Fritz at (307) 672-0761.

Sincerely,

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References:

Ayers, R.S. and D.W. Westcot, 1994, Water Quality for Agriculture, FAO (Food and Agriculture Organization of the United Nations) Irrigation and Drainage Paper 29, Rev. 1. Available from the Internet on 9 March 2013: http://www.fao.org/docrep/003/T0234E/T0234E00.htm.

California Plant Health Association, 2002, *Western Fertilizer Handbook*, 9th ed., Interstate Publishers, Danville, IL.

CAMECO Resources, 2009, Mine Unit B Ground Water Restoration Report, Smith Ranch-Highland Uranium Project, August 5, 2004. Available from the NRC ADAMS document server under accession no. ML091831100.

COGEMA Mining, Inc., 2004, Irigaray Mine Wellfield Restoration Report, Permit to Mine No. 478, July 26, 2004, Prepared by COGEMA Mining, Inc., Petrotek Engineering Corporation and Hydrosolutions, Inc., July 2004. Available from the NRC ADAMS document server under accession nos. ML053270037 and ML053270041.

_____, 2008, Wellfield Restoration Report, Christensen Ranch Project, Wyoming, Prepared by COGEMA Mining, Inc. and Petrotek Engineering Corporation, March 5, 2008. Available from the NRC ADAMS document server under accession nos. ML081060131, ML081060132 and ML081060140.

Crow Butte Resources, Inc., 2007, Application for Amendment of USNRC Source Materials License SUA-1534, North Trend Expansion Area, Technical Report, May 30, 2007. Available from the NRC ADAMS document server under accession no. ML071760349.

EPA (U.S. Environmental Protection Agency), 2013, Aquatic Life Criteria Table. Available from the Internet on 25 March 2013: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm#L.

Raisbeck, M.F., S.L. Riker, C.M. Tate, R. Jackson, M.A. Smith, K.J. Reddy and J.R. Zygmunt, 2007, Water Quality for Wyoming Livestock and Wildlife. Available from the Internet on 23 March 2013: http://www.uwyo.edu/ces/pubs/b1183/index.html.

Ramirez, P., Jr. and B. Rogers, Selenium in a Wyoming Grassland Community Receiving Wastewater from an In Situ Uranium Mine, USFWS Region 6, Contamination Program, Contamination Report No. R6/715C/00, September 2000.

SRK Consulting (U.S.), Inc., 2012, NI 43-101 Technical Report, Preliminary Economic Assessment, Dewey-Burdock Project, April 17, 2012. Available from the SEDAR filing system as of June 2012: http://www.sedar.com.

USDA-NRCS (U.S. Department of Agriculture, Natural Resources Conservation Service), 1983, Saline-Seep Diagnosis, Control, and Reclamation, Conservation Research Report No. 30, May 1983. Available from the Internet on 9 March 2013: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044791.pdf.

Taylor J.L., 2001, Naessella viridula, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Available from the Internet on 9 March 2013: http://www.fs.fed.us/database/feis/plants/graminoid/nasvir/all.html#139.

Wynia, R., 2007, Plant Guide: Side-oats grama (*Bouteloua curtipendula*), USDA NRCS Manhattan Plant Materials Center, Manhattan, Kansas. Available from the Internet on 9 March 2013: http://plants.usda.gov/plantguide/pdf/pg_bocu.pdf.

Attachment A

Historical Baseline and End-of-Production Groundwater Quality at Operating ISR Facilities

Irigaray Mine

Source: COGEMA Mining, Inc., 2004, Irigaray Mine Wellfield Restoration Report, Permit to Mine No. 478, July 26, 2004, Prepared by COGEMA Mining, Inc., Petrotek Engineering Corporation and Hydrosolutions, Inc., July 2004. Available from the NRC ADAMS document server under accession nos. ML053270037 and ML053270041.

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	AP-3				AP-4				AP-5			
Production Unit:	UNIT 1				UNIT 1				UNIT 1			
Sample Date:	1976				1976				1976			
Major Ions mg/l:												
Ca	7.3	7.3	7.3	9.6	9.1	9.4	9.4	14.1	2.3	1.6	1.8	5.4
Mg	0.8	0.8	0.8	0.8	0.9	0.9	1	1.2	< 0.1	< 0.1	< 0.1	0.26
Na	128	127	125	134	128	125	126	145	125	127	128	130
K	2.4	2.1	2.1	2.5	1.9	2.5	1.9	2.4	3.6	5.3	4.9	3.6
CO3	2.2	1.2	4.2	16.1	3.6	1.3	3.9	12.4	6.4	21	19.5	28.5
HC03	73.6	79.2	71.7	98.3	77.4	84.2	82.2	118	44.8	14.2	20.8	75.9
SO4	200	195	193	185	206	201	202	210	195	225	228	180
Cl	12.3	12.3	13	8.9	12.3	12	11.8		12.8	12.8	13	9.2
NH4	< 0.2	< 0.2	< 0.2	0.1	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2	< 0.2	0.15
NO2 (N)	0.02	< 0.02	0.02	0.25	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
NO3 (N)	0.4	0.35	0.53	0.3	0.44	0.58	0.66	0.65	0.4	0.35	0.31	0.2
F	0.28	0.28	0.28	0.68	0.31	0.33	0.33	0.35	0.28	0.3	0.28	0.25
SiO2	3.9	3.8	3.75	3.8	4.3	4.2	4.6	4.4	3.2	3.85	4	3.4
TDS	380	358	372	394	386	386	388	438	350	338	308	364
Cond. (umho/cm)	605	615	620	610	630	535	618	670	600	638	625	610
Alk. (as CaC03)	92	98	92	93.6	98	102	102	106.8	84	92	94	85.4
pH (units)	8.70	8.40	9.00	8.50	8.90	8.40	8.90	9.00	9.50	10.40	10.20	9.70
Trace Metals mg/l:												
Al												
As	< 0.01	0.012	0.012	0.022	0.082	0.095	0.094	0.105	< 0.01	< 0.01	< 0.01	< 0.005
Ba	0.016	0.016	0.011	< 0.01	< 0.01	0.015	0.02	0.022	< 0.01	0.043	0.036	0.022
B	0.225	0.1	0.095	0.06	0.109	0.077	0.117	0.08	0.113	0.118	0.11	0.06
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Cr	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Cu	< 0.005	0.005	< 0.005	< 0.005	< 0.005	0.009	0.012	< 0.005	< 0.005	< 0.005	0.009	< 0.005
Fe	0.036	0.436	0.518	0.20	0.04	0.206	0.559	0.019	0.071	0.21	0.314	0.115
Pb	0.002	0.008	0.008	0.005	< 0.002	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Mn	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Mo	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02
Ni	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Se	0.022	0.024	0.02	0.174	0.266	0.418	0.283	2.0*	0.057	0.043	0.035	0.218
V	< 0.05	< 0.05	< 0.05	0.08	0.21	0.29	0.31	0.55	0.12	0.1	0.09	0.09
Zn	< 0.02	< 0.02	< 0.02	0.017	< 0.02	< 0.02	< 0.02	< 0.009	< 0.02	< 0.02	< 0.02	< 0.009
Radiometric pCi/l:												
U (mg/l)	3.35	3.4	3.46	5.17	9.73	11.89	14.05	18.6	0.56	0.32	0.33	0.33
Ra 226	43	51	59	76	77	125	165	210	22	22	22	28
Ra 226 +/-	7	7	8	8	8	15	20	20	5	5	5	5

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	AP-10				DI-4				DI-12		
Production Unit:	UNIT 1				UNIT 2				UNIT 2		
Sample Date:	1976				1978				1978		
Major Ions mg/l:											
Ca	7.5	6.8	6.7	8.8	5.9	3.9	4.2	5.8	8.8	8.3	7.5
Mg	1	0.9	0.9	1.19	0.12	0.12	0.13	0.31	1.1	0.96	0.9
Na	121	127	125	131	100	97	105	118	113	102	112
K	1.9	1.7	1.7	2.3	2	1.7	1.9	1.3	2	1.7	1.8
CO3	1.5	0.8	1.9	12.4	40	31	38	5	5	5	6
HCO3	79.1	84.1	78.9	102.1	39	57	39	116	131	131	115
SO4	188	189	195	180	221	153	156	157	174	168	165
Cl	13.3	13.5	13.8	9.4	12	11.4	12.3	13	7	5.3	11
NH4	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
NO2 (N)	0.24	< 0.02	< 0.02	< 0.02	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
NO3 (N)	0.35	0.44	0.44	0.27	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
F	0.28	0.28	0.33	0.28	0.43	0.4	0.42	0.37	0.33	0.35	0.35
SiO2	3.45	3.75	3.65	3.3	10.6	10.4	9.6	7.4	9.9	10.2	10
TDS	368	410	358	390	413	338	348	367	388	368	373
Cond. (umho/cm)	595	580	580	600	739	608	640	636	661	623	641
Alk. (as CaC03)	90	96	96	93.6	131	145	127	95	215	215	199
pH (units)	8.50	8.20	8.60	9.10	9.90	9.80	9.80	8.00	8.60	8.60	8.50
Trace Metals mg/l:											
Al											
As	< 0.01	< 0.01	< 0.01	0.009	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ba	0.023	0.015	0.015	0.022	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B	0.134	0.125	0.099	0.04	0.01	0.01	0.01	0.05	0.02	< 0.01	< 0.01
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.013	< 0.002	< 0.002	< 0.002	< 0.002
Cr	< 0.002	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	0.063	0.063	< 0.005	< 0.005	< 0.005
Cu	< 0.005	< 0.005	0.005	< 0.005	0.013	0.013	0.025	< 0.005	0.009	0.025	0.022
Fe	2.0	0.651	0.332	1.2	0.07	0.05	0.41	0.06	0.05	0.08	0.07
Pb	< 0.002	0.008	< 0.002	0.002	< 0.005	< 0.005	0.014	0.014	< 0.005	< 0.005	< 0.005
Mn	< 0.025	< 0.025	0.025	0.038	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Mo	< 0.02	< 0.02	< 0.02	< 0.02	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ni	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Se	0.022	< 0.01	0.011	0.066	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
V	< 0.05	< 0.05	< 0.05	0.07	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zn	< 0.02	< 0.02	< 0.02	0.009	< 0.02	< 0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02
Radiometric pCi/l:											
U (mg/l)	0.83	1.38	0.93	1.51	0.198	0.103	0.131	0.03	0.067	0.054	0.053
Ra 226	35	26	17	34	44	45	35.5	24	78.3	48.1	83.6
Ra 226 +/-	3	2	2	8	1.7	1.7	1.5	2.0	2.5	2.0	2.3

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	DP-7			EI-34			DI-21			
Production Unit:	UNIT 2			UNIT 2			UNIT 3			
Sample Date:	1978			1978			1978			
Major Ions mg/l:										
Ca	9.1	8.6	8.5	10.3	9.1	8.7	5.6	6.2	7.9	6.5
Mg	1.5	1.3	1.2	2.1	1.8	1.7	0.02	0.04	0.02	0.17
Na	112	99	106	110	103	110	100	95	104	118
K	2	1.4	1.8	2.2	1.8	2.1	3	2.2	2.4	1.3
CO3	12	5	10	9	8	11	96	73	49	16.8
HC03	104	124	107	132	131	107	5	5	5	75.6
SO4	185	170	167	180	176	173	144	140	136	150
Cl	12.4	12.2	11.1	12	12.5	11.4	12	12.7	11.5	13
NH4	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.2	0.2	0.2	0.07
NO2 (N)	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
NO3 (N)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
F	0.35	0.35	0.3	0.31	0.31	0.31	0.36	0.35	0.36	0.39
SiO2	8.1	5.6	10.2	8.3	9.6	9.8	13.7	13.1	6.7	7.8
TDS	395	366	371	401	389	382	378	346	321	353
Cond. (umho/cm)	691	631	641	695	667	665	755	674	622	631
Alk. (as CaC03)	191	203	193	232	228	194	160	122	82	90
pH (units)	8.80	8.80	8.70	8.70	8.70	8.60	10.80	10.90	11.00	8.40
Trace Metals mg/l:										
Al										0.07
As	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ba	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B	0.01	0.01	0.01	0.02	0.02	0.02	< 0.01	0.01	< 0.01	0.07
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Cr	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cu	0.011	0.021	0.012	0.037	0.04	0.032	0.021	0.02	0.022	< 0.005
Fe	0.36	0.13	0.09	0.50	0.14	0.54	0.04	0.03	0.04	0.10
Pb	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Mn	< 0.005	< 0.005	< 0.005	0.007	0.022	0.146	< 0.005	< 0.005	< 0.005	< 0.005
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Mo	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ni	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Se	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
V	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zn	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02
Radiometric pCi/l:										
U (mg/l)	0.464	0.346	0.274	0.096	0.086	0.089	0.014	0.014	< 0.01	0.03
Ra 226	23.9	25.2	21.5	84.8	70.6	64.5	21.7	20.7	23.2	14
Ra 226 +/-	1.2	1.4	1.2	2.3	2.0	2.0	1.2	1.2	1.2	1.0

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	DI-27			FI-60			FI-62		
Production Unit:	UNIT 3			UNIT 4			UNIT 4		
Sample Date:	1978			1978			1978		
Major Ions mg/l:									
Ca	9.5	9.7	9	10.1	5.6	4.7	6.3	7.7	7.1
Mg	2	2.2	2.1	2.5	0.52	0.65	1.4	1.3	1.2
Na	101	96	105	105	113	115	102	110	117
K	2.2	2.4	2.2	4	1.8	2.1	3.5	2.6	2.8
CO3	6	6	9	31	17	26	20	21	26
HC03	128	132	114	95	76	61	101	82	76
SO4	168	156	160	189	180	189	179	179	177
Cl	11.9	12.3	11.9	12.2	13.4	13	12.4	13.2	13.2
NH4	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1
NO2 (N)	< 0.03	0.082	0.055	0.052	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
NO3 (N)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
F	0.38	0.38	0.36	0.28	0.27	0.28	0.27	0.28	0.28
SiO2	10.3	10.6	10.4	8.3	7.8	7.8	8.3	9.6	7.2
TDS	376	363	368	401	379	389	385	387	391
Cond. (umho/cm)	645	620	637	711	669	699	675	685	705
Alk. (as CaC03)	220	227	202	113	91	93.5	116.5	102	106
pH (units)	8.70	8.70	8.60	9.20	9.30	9.30	9.10	9.40	9.20
Trace Metals mg/l:									
Al									
As	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ba	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B	< 0.01	< 0.01	< 0.01	0.02	0.03	0.01	0.02	0.02	0.02
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Cr	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cu	0.021	0.018	0.017	0.036	0.028	0.02	0.033	0.03	0.019
Fe	0.77	3.37	1.81	0.46	0.07	0.65	0.06	0.13	0.04
Pb	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Mn	0.023	0.093	0.048	0.012	0.006	0.01	< 0.005	< 0.005	< 0.005
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Mo	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ni	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Se	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
V	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zn	< 0.02	< 0.02	0.02	0.03	0.03	0.03	< 0.02	< 0.02	< 0.02
Radiometric pCi/l:									
U (mg/l)	0.057	0.039	0.035	0.032	0.039	0.043	0.232	0.192	0.164
Ra 226	17	34	25.7	29.2	34.6	22.9	33	38	31.2
Ra 226 +/-	1.2	1.5	1.4	0	1.5	1.2	1.5	1.5	1.4

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	FI-64				FI-66			FI-67			
Production Unit:	UNIT 4				UNIT 4			UNIT 4			
Sample Date:	1978				1978			1978			
Major Ions mg/l:											
Ca	5.5	5	3.5	8.4	4.2	2.4	2.1	5.3	3.7	3.5	6.8
Mg	0.34	0.32	0.14	0.48	1.4	0.61	0.47	1.8	1.1	0.75	0.32
Na	98	112	118	125	104	113	111	106	117	115	126
K	2.8	3.1	3.1	1.5	2.9	3.5	3.6	3.9	3.2	3.3	1.5
CO3	37	38	41	13.2	25	31	34	41	30	33	14.4
HC03	46	37	34	89.1	78	69	63	54	61	52	89.1
SO4	177	185	171	164	176	180	171	182	195	186	182
Cl	12.5	13.2	13.1	13	12.3	13.1	12.3	11.7	12.8	12.7	13
NH4	0.2	< 0.1	0.2	< 0.1	< 0.1	0.1	0.1	0.2	0.1	0.1	< 0.1
NO2 (N)	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.01
NO3 (N)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
F	0.3	0.28	0.28	0.35	0.28	0.27	0.27	0.27	0.28	0.28	0.32
SiO2	8.4	14.8	17.2	7.5	11.5	8.7	10.7	11.9	11.1	11.5	7.8
TDS	366	391	385	379	378	388	378	392	406	393	398
Cond. (umho/cm)	666	705	697	673	666	697	680	713	724	706	702
Alk. (as CaC03)	99	94	96.5	95	105.5	108	108	112.5	100	97.5	97
pH (units)	9.70	9.90	9.90	8.10	9.30	9.70	9.80	9.90	9.60	9.80	6.10
Trace Metals mg/l:											
Al											
As	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ba	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B	0.02	0.01	0.02	0.03	0.01	0.02	0.02	0.02	0.01	0.01	0.07
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Cr	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cu	0.026	0.017	0.027	0.007	< 0.005	0.025	0.023	0.014	0.015	0.018	0.005
Fe	0.69	0.16	0.02	0.02	< 0.02	0.27	0.11	0.06	0.13	0.07	0.71
Pb	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Mn	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005	0.013
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Mo	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ni	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Se	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
V	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zn	< 0.02	0.07	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.06	0.06	< 0.01
Radiometric pCi/l:											
U (mg/l)	0.02	0.032	0.036	0.05	0.045	0.055	0.055	0.017	0.024	0.023	0.02
Ra 226	34.5	56.6	53.1	0	19.2	22.5	23	66.1	73	67.1	87
Ra 226 +/-	1.5	1.9	1.9	0.3	1.0	1.2	1.2	2.0	2.1	2.0	3.0

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	GI-76			GI-82			GI-105			GI-122		
Production Unit:	UNIT 4			UNIT 5			UNIT 5			UNIT 5		
Sample Date:	1978-1979			1982			1979			1979		
Major Ions mg/l:												
Ca	6.4	6.1	6.8	5.1	4.6	3.3	6.6	12.1	12.9	7.3	8.0	8.1
Mg	0.85	0.8	0.84	0.55	0.53	0.37	0.56	1.03	1.11	0.67	0.83	0.87
Na	116	117	121	121	120	118	117	116	120	129	115	125
K	1.5	0.92	1.7	2.4	2.6	3.0	1.9	2.0	1.7	1.7	1.8	1.8
CO3	8.4	11.4	8.7	30.7	25.7	26.6	11	32.9	25.2	9.6	14.4	10.6
HC03	101.3	95.4	108.4	60	49.8	45.3	88	52.9	68.3	85.4	92.1	91.5
SO4	178	174	178	168	174	171	164	169	165	176	165	195
Cl	12.8	12.2	11.9	13.2	12.7	11.7	12.7	12	15.1	10.7	10.7	11.6
NH4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
NO2 (N)												
NO3 (N)	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
F	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
SiO2	8.3	6.4	9.1	11.4	11.2	10.8	6	4.3	4.1	7	7.2	7.3
TDS	394	401	402	427	362	357	370	322	390	375	379	420
Cond. (umho/cm)	625	623	586	558	615	602	619	605	662	612	645	647
Alk. (as CaC03)	97.1	97.2	96	100.4	83.7	81.5	105.8	98.2	98	86	92.5	92.6
pH (units)	8.70	8.80	8.50	9.40	9.30	9.30	9.50	9.40	9.60	9.00	8.90	8.90
Trace Metals mg/l:												
Al	< 0.05	< 0.05	< 0.05	0.05	0.06	< 0.05	2.3	0.17	0.4	0.09	0.25	1.57
As	< 0.002	< 0.002	< 0.002	0.001	0.001	< 0.001	0.003	< 0.002	< 0.002	0.002	0.002	0.002
Ba	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.12	0.06	0.06	< 0.05	< 0.05	0.06
B	< 0.01	< 0.01	< 0.01	0.07	0.07	0.08	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002
Cr	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cu	< 0.005	< 0.005	< 0.005	0.03	0.03	0.03	0.007	< 0.005	< 0.005	0.002	0.004	0.015
Fe	0.04	0.03	0.02	0.04	0.05	0.03	3.95	0.21	0.8	0.19	0.41	3.17
Pb	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.007
Mn	0.006	0.007	0.007	< 0.005	< 0.005	< 0.005	0.08	< 0.005	0.02	< 0.005	0.008	0.041
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Mo	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Ni	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.01
Se				< 0.001	< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
V	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zn	0.02	0.01	< 0.01	0.01	0.01	0.01	0.03	0.01	0.02	< 0.01	< 0.01	0.02
Radiometric pCi/l:												
U (mg/l)	0.02	0.01	< 0.01	0.01	0.04	0.06	0.03	< 0.01	< 0.01	0.02	0.02	0.02
Ra 226	4.6	6.3	4.9	8.3	5.3	6.3	3.9	2.3	3.5	4	6	10
Ra 226 +/-	1.1	1.3	1.1	0.7	0.6	0.6	0.6	0.5	0.6	0.4	0.5	0.6

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	HI-50					HI-53					HI-57				
Production Unit:	UNIT 6					UNIT 6					UNIT 8				
Sample Date:	03-Dec-87	22-Dec-87	14-Jan-88	02-Feb-88	23-Feb-88	05-Oct-87	08-Sep-87	16-May-79	02-Jun-79	06-Jun-79	20-Jun-79	28-Jun-79	05-Jul-79	17-Dec-87	05-Jan-88
Major Ions mg/l:															
Ca	3.2	3.4	3.1	5.0	5.0	4.9	5.0	13.9	12.2	11.3	8.7	12.4	14.7	23.1	24.7
Mg	0.38	0.41	0.58	0.61	0.67	0.48	0.5	1.05	0.75	1.0	0.53	0.7	0.8	2.6	2.7
Na	126	126	130	127	126	112	110	119	115	114	124	128	133	248	242
K	1.9	2.2	1.5	1.6	1.4	1.3	1.2	3.7	2.6	3.0	2.1	1.9	1.9	3.5	3
CO3	8.5	7	2.4	2.4	2.8	3.0	2.3	22.6	24.1	25.0	19.9	24	18.8	0	0
HC03	83.7	91.8	106	107	106	110	127	62.2	69.8	55	97	73.2	77.5	82.7	82.7
SO4	175	171	181	174	181	140	137	165	164	162	163	168	180	504	493
Cl	11.8	9.9	10.4	9.6	10.8	8.8	7.8	13.2	12.4	11.6	12.8	12.9	11.5	10.5	9
NH4	0.07	0.14	0.27	0.14	0.27	0.21	0.18	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.29	0.26
NO2 (N)	0.1	<0.02	<0.04	<0.03	0.02	0.06	<0.03	<1.0	<1.0	<1.0	<1.00	<1.00	<1.00	<0.04	<0.02
NO3 (N)															
F	0.3	0.29	0.27	0.34	0.26	0.2	0.48	0.3	0.3	0.3	0.30	0.20	0.30	0.16	0.15
SiO2	9.8	9.8	10.5	8.8	9.2	9.2	9	9.5	6.3	12	6	9.4	7.7	9.2	9.4
TDS	352	384	368	360	386	348	324	408.4	370.8	319.6	420.4	424.2	446.1	784	766
Cond. (umho/cm)	627	623	668	660	642	535	490	625	616	586	632	637	632	1257	1343
Alk. (as CaC03)	83.8	87.8	91	91.8	91.8	95.8	108	96.2	98.2	86.7	96.1	100	94.5	67.8	67.8
pH (units)	9.34	9.22	8.7	8.68	8.75	8.77	8.59	9.1	9.1	9.3	9.4	9.3	9.3	7.66	7.75
Trace Metals mg/l:															
Al	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.93	0.42	0.37	<0.05	<0.05	<0.05	<0.10	<0.10
As	0.005	0.004	0.002	0.003	0.002	<0.001	<0.001	<0.002	<0.002	<0.002	0.003	0.002	0.003	0.002	0.002
Ba	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.09	0.07	<0.05	<0.05	<0.05	<0.10	<0.10
B	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.1	<0.1
Cd	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.01	<0.01
Cr	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.05
Cu	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.007	<0.005	<0.005	0.013	0.008	0.013	<0.01	<0.01
Fe	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.4	0.72	0.61	<0.02	<0.02	<0.02	<0.05	<0.05
Pb	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.05
Mn	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01
Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.001	<0.001
Mo	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Ni	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.05	<0.05
Se	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.004	0.005	<0.002	<0.002	<0.002	<0.001	<0.001
V	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
Zn	<0.01	<0.01	<0.01	0.03	<0.01	0.2	<0.01	0.11	0.02	0.02	0.01	<0.01	0.01	<0.01	<0.01
Radiometric pCi/l:															
U (mg/l)	0.0355	0.0326	0.0221	0.0335	0.0192	0.007	0.004	0.0594	0.0424	0.0424	0.6106	0.7971	1.0176	0.624	0.394
Ra 226	14.9	14.9	16.6	19.9	37.6	7.1	1.3	21	20	19	90	96	77	247.7	203.7
Ra 226 +/-	1.1	0.9	0.9	1.2	1.7	0.8	0.4	1	1	1	3	3	3	3.8	3.6

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	HI-62					HP-24					HP-59				
Production Unit:	UNIT 6					UNIT 6					UNIT 6				
Sample Date:	16-Aug-79	23-Aug-79	28-Aug-79	04-Mar-88	15-Mar-88	03-Dec-87	22-Dec-87	04-Jan-88	02-Feb-88	23-Feb-88	27-Sep-79	03-Oct-79	10-Oct-79	03-Mar-88	15-Mar-88
Major Ions mg/l:															
Ca	7	6.5	11.9	14.7	10.7	5.9	5.8	5.8	6.8	7.4	26.5	27.1	19	7.7	7
Mg	0.57	0.41	1.6	0.31	0.09	0.66	0.63	0.62	0.64	0.94	7.1	9	4.4	0.8	0.43
Na	119	116	117	128	130	130	121	124	128	135	164	147	138	138	131
K	2.9	2.9	4.4	11	13	1.9	1.8	1.7	0.4	1.1	2.1	3	1.8	4.1	11.4
CO3	27.6	23.4	46.8	28.8	36.4	2.9	1.6	1.1	2.7	3	3.8	7.3	6.7	4.4	3.7
HC03	70.5	80.8	53.7	58.1	44.3	113	109	109	104	96.2	121.8	131.5	103.7	113	102
SO4	148	162	165	191	182	178	168	178	185	215	300	300	255	194	195
Cl	9.8	10.2	11.5	11	12.1	11.9	9.4	9.8	10.2	10.5	10.9	12.8	10.5	12.2	11.8
NH4	< 0.5	< 0.5	< 0.5	0.27	0.31	0.21	0.29	0.22	0.2	0.37	< 0.5	< 0.5	< 0.5	1.88	0.17
NO2 (N)	< 1.00	< 1.00	< 1.00	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 1	< 1	< 1	0.03	< 0.02
NO3 (N)															
F	0.30	0.30	0.30	0.30	0.26	0.32	0.34	0.28	0.40	0.29	0.30	0.30	0.30	0.30	0.23
SiO2	7.4	7.5	7.5	8.8	8.8	8.1	8.3	9.8	8.8	8.3	8.5	8.2	8.2	9	8.6
TDS	338	384	423	440	398	380	356	380	370	430	581	575	510	450	370
Cond. (umho/cm)	574	578	586	729	679	853	608	642	673	702	870	858	798	715	628
Alk. (as CaC03)	101.1	105.3	122	101	106	98	92	91.2	89.8	84.2	106.2	119.8	96.2	100	90
pH (units)	9.4	9.5	9.4	10	10.2	8.74	8.5	8.34	8.75	8.8	8.3	8.9	8.4	8.9	8.9
Trace Metals mg/l:															
Al				< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.05	4.25	< 0.05	< 0.10	< 0.10
As	0.002	0.002	0.002	0.003	0.008	0.001	0.001	0.001	0.001	0.001	< 0.002	0.002	< 0.002	< 0.001	< 0.001
Ba				< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
B				< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1
Cd				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.003	0.003	0.002	< 0.01	< 0.01
Cr				< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.005	0.01	< 0.05	< 0.05	< 0.05
Cu				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.005	0.008	< 0.005	< 0.01	< 0.01
Fe	3.4	5.4	11.8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.08	9.33	0.04	< 0.05	< 0.05
Pb				< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.014	0.014	0.01	< 0.05	< 0.05
Mn				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.034	0.19	0.019	< 0.01	< 0.01
Hg				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001
Mo				< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Ni				< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.01	0.02	< 0.01	< 0.05	< 0.05
Se	< 0.002	< 0.002	0.002	0.003	0.004	< 0.001	< 0.001	< 0.001	0.001	< 0.001	0.002	0.002	0.002	< 0.001	< 0.001
V				< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Zn				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.05	< 0.01	< 0.01	< 0.01
Radiometric pCi/l:															
U (mg/l)	0.0085	0.017	0.0254	0.0083	0.0104	0.0619	0.0623	0.0226	0.033	0.0326	0.0254	0.0678	0.017	0.0817	0.082
Ra 226	10	13	10	33.6	33.2	18.8	17.5	15.8	22.2	27.7	42	35	32	85.1	75.9
Ra 226 +/-	0.8	0.8	0.7	1.5	3.9	1.1	1	0.9	1.3	1.8	2	2	1	2.4	6

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	HP-87					JP-15					JP-28				
Production Unit:	UNIT 6					UNIT 7					UNIT 7				
Sample Date:	11-Oct-79	17-Oct-79	25-Oct-79	03-Dec-87	29-Sep-87	27-Dec-79	20-Jan-80	10-Jan-80	16-Jun-87	01-Jul-87	18-Oct-79	24-Oct-79	31-Oct-79	11-Jun-87	30-Jun-87
Major Ions mg/l:															
Ca	8.6	7.6	7.4	6.9	7.4	33.6	19.3	28.4	11.6	11	14.1	9.6	9	7	6.8
Mg	0.95	0.89	1.03	0.83	0.83	5.2	5.67	4.4	2	1.8	1.45	1.11	1.15	0.61	0.64
Na	125	130	128	137	135	256	280	275	174	174	140	131	123	125	128
K	1.3	1.5	1.5	2	1.8	4.3	3.9	4.2	2.3	2.1	1.6	1.5	1.6	1.9	1.8
CO3	10.8	7.8	3.6	1.7	0	2.4	4.2	1.8	0	1.3	5.1	2.1	6.5	2.2	0
HC03	89.6	99.4	104.9	118	119	32.8	47.6	37.2	81.6	96.7	105.2	106.4	100	99.5	110
SO4	171	177	189	193	182	609	624	600	306	293	215	203	183	176	179
Cl	10.6	10.8	10.5	12.8	13.6	10.7	10.9	10.3	10.9	11.1	11	10.5	10.5	9.1	11.3
NH4	< 0.5	< 0.5	< 0.5	0.1	0.17	< 0.5	< 0.5	< 0.5	0.19	0.24	< 0.5	< 0.5	< 0.5	0.24	0.27
NO2 (N)	< 1	< 1	< 1	< 0.03	< 0.02	< 1	< 1	< 1	< 0.03	< 0.02	< 1	< 1	< 1	0.07	< 0.02
NO3 (N)															
F	0.30	0.30	0.30	0.29	0.28	0.2	0.2	0.2	0.26	0.15	0.30	0.30	0.30	0.21	0.22
SiO2	8.6	8.6	8.6	9	9	8.3	9.4	7.5	9	9	8.8	8.6	8.6	9.4	9.4
TDS	382.6	398.8	434	408	390	1054.4	1020.4	934.2	600	584	476	453.8	381.9	378	422
Cond. (umho/cm)	619	613	617	665	651	1465	1427	1415	900	917	697	648	639	626	674
Alk. (as CaC03)	91.4	94.5	92	99.8	97.8	30.9	46	33.5	66.9	81.6	94.6	90.8	92.6	85.5	90.2
pH (units)	8.7	6.6	8.2	8.49	8.06	9	9.2	8.4	8.2	8.47	8.4	8.2	6.2	8.68	8.15
Trace Metals mg/l:															
Al				< 0.10	< 0.10				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
As	0.002	0.002	0.002	0.003	0.004	< 0.002	0.002	< 0.002	0.004	< 0.001	< 0.002	< 0.002	< 0.002	0.004	< 0.001
Ba				< 0.10	< 0.10				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
B				< 0.1	< 0.1				< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1
Cd				< 0.01	< 0.01				< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01
Cr				< 0.05	< 0.05				< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
Cu				< 0.01	< 0.01				< 0.01	< 0.01	0.005	< 0.005	< 0.005	< 0.01	< 0.01
Fe	0.64	0.13	0.38	< 0.05	< 0.05	0.1	0.04	0.08	< 0.05	< 0.05	0.13	0.19	0.08	< 0.05	< 0.05
Pb				< 0.05	< 0.05				< 0.05	< 0.05	0.005	0.008	< 0.005	< 0.05	< 0.05
Mn				< 0.01	< 0.01				< 0.01	< 0.01	0.007	0.007	< 0.005	< 0.01	< 0.01
Hg				< 0.001	< 0.001				< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001
Mo				< 0.10	< 0.10				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Ni				< 0.05	< 0.05				< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05
Se	0.002	0.002	0.002	< 0.001	< 0.001	0.007	< 0.002	< 0.002	< 0.001	< 0.001	0.005	< 0.002	< 0.002	0.008	0.003
V				< 0.10	< 0.10				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Zn				< 0.01	< 0.01				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Radiometric pCi/l:															
U (mg/l)	0.008	0.0169	0.0169	0.0275	0.0362	0.0254	0.0084	0.0254	0.0125	0.017	0.0678	0.0848	0.1102	0.442	0.361
Ra 226				9.6	5.2	9	8	9	3.9	3.8	54	42	44	46.4	42.8
Ra 226 +/-				0.9	0.7	0.7	0.7	0.7	0.6	0.7	2	2	2	1.9	2.6

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality
for Irigaray Units 1 through 9

Well I.D.:	JP-47					JP-50					JP-53				
Production Unit:	UNIT 7					UNIT 7					UNIT 7				
Sample Date:	16-Jan-80	22-Jan-80	29-Jan-80	11-Jun-87	30-Jun-87	27-Dec-79	02-Jan-80	10-Jan-80	11-Jun-87	30-Jun-87	16-Jan-80	22-Jan-80	29-Jan-80	16-Jun-87	01-Jul-87
Major Ions mg/l:															
Ca	7.4	6.7	7.4	5.7	5.7	6.1	6.5	6.4	7.1	5.9	7	9.2	6.6	6.4	6.6
Mg	0.76	0.76	0.77	0.53	0.6	0.57	0.56	0.58	0.77	0.64	0.77	1.12	0.72	0.77	0.77
Na	129	136	135	125	127	121	121	124	125	127	117	137	123	127	129
K	1.6	1.5	1.5	2.1	2	1.5	1.3	1.3	1.8	1.8	6.4	1.7	1.4	1.4	1.5
CO3	7.8	9.6	3.9	2.8	2	8.4	5.4	7.2	2.1	1.7	5.5	6.2	5.4	1.2	0
HC03	86.6	87.6	95.8	90.2	90.5	96	103.1	95.2	99.8	113.4	106.1	112.2	104.3	97.3	111
SO4	200	204	213	179	182	179	174	180	179	176	170	189	175	180	179
Cl	10.7	10.4	10.6	11.1	11.5	10.8	12	10.1	11.4	10.6	10.9	10.5	10.7	11.4	11.1
NH4	< 0.5	< 0.5	< 0.5	0.22	0.2	< 0.5	< 0.5	< 0.5	0.12	0.13	< 0.5	< 0.5	< 0.5	0.09	0.19
NO2 (N)	< 1	< 1	< 1	< 0.03	< 0.02	< 1	< 1	< 1	< 0.04	< 0.02	< 1	< 1	< 1	< 0.02	< 0.02
NO3 (N)															
F	0.30	0.30	0.30	0.20	0.25	0.30	0.30	0.30	0.19	0.22	0.30	0.30	0.30	0.33	0.20
SiO2	7.9	5.6	7.6	9	9	7.5	8.8	7.5	9.2	8.8	8.2	5.6	5.9	9	9.2
TDS	404.8	401.2	432.6	358	404	402.8	363.2	345.6	350	400	378.8	398.6	392	406	406
Cond. (umho/cm)	653	653	660	622	667	615	601	621	619	654	615	649	599	643	658
Alk. (as CaC03)	84	88	85	78.9	77.8	92.8	94	90	85.5	96	96.2	102.4	94.5	81.9	91
pH (units)	8.7	9	8.9	6.62	8.69	9.1	6.9	8.8	8.6	8.52	8.7	6.7	8.7	8.43	6.15
Trace Metals mg/l:															
Al	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10				< 0.10	< 0.10	0.05	< 0.05	< 0.05	< 0.10	< 0.10
As	0.003	0.003	0.002	0.008	< 0.001	0.002	< 0.002	0.002	0.005	0.002	< 0.002	< 0.002	< 0.002	0.002	< 0.001
Ba	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
B	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1				< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1
Cd	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01				< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01
Cr	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05				< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
Cu	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01				< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01
Fe	0.02	0.02	0.02	< 0.05	< 0.05	0.02	< 0.02	0.03	< 0.05	< 0.05	0.1	0.04	0.03	< 0.05	< 0.05
Pb	< 0.005	0.005	0.005	< 0.05	< 0.05				< 0.05	< 0.05	0.005	0.007	0.008	< 0.05	< 0.05
Mn	< 0.005	< 0.005	0.005	< 0.01	< 0.01				< 0.01	< 0.01	0.009	0.013	0.008	< 0.01	< 0.01
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001				< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001
Mo	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Ni	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05				< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05
Se	0.005	< 0.002	< 0.002	< 0.001	< 0.001	0.002	< 0.002	< 0.002	< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001
V	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Zn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Radiometric pCi/l:															
U (mg/l)	0.0932	0.0593	0.0678	0.0355	0.0722	0.1017	0.1187	0.1611	0.0997	0.142	0.0763	0.0593	0.0508	1.577	0.0665
Ra 226	13	17	20	13.9	18	28	22	22	14.9	18.9	46	44	43	32.1	24.7
Ra 226 +/-	1	1	1	1.1	1.6	1	1	1	1.1	1.5	2	2	2	1.6	1.7

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality for Irigaray Units 1 through 9

Well I.D.:	JP-57					JP-63					KI-128				
Production Unit:	UNIT 7					UNIT 7					UNIT 8				
Sample Date:	16-Jan-80	22-Jan-80	29-Jan-80	11-Jun-87	30-Jun-87	20-Dec-79	26-Dec-79	02-Jan-80	11-Jun-87	30-Jun-87	19-Jun-80	25-Jun-80	20-Jul-80	15-Oct-87	06-Nov-87
Major Ions mg/l:															
Ca	6.8	6.9	6.9	6	6.1	7.6	7.4	7.5	7.7	6.5	10.9	6.3	5.5	5.7	5.8
Mg	0.87	0.92	0.94	0.77	0.78	0.84	0.81	0.86	0.16	0.23	0.77	0.78	0.72	0.88	0.86
Na	118	132	130	126	130	129	130	130	130	130	130	121	123	128	127
K	6.1	1.2	1.4	1.7	1.6	1.87	1.8	1.7	1.8	1.7	1.3	1.3	1.32	1.6	1.5
CO3	6	8.4	7.2	1.9	1.3	5.1	4.8	3.9	8	5.3	42	9	12.7	2.7	3
HC03	99.8	98.7	101.3	114.2	126.8	99.6	98.8	101.6	82.5	91.2	50.02	94.2	81.9	109	114
SO4	180	188	188	173	171	204	209	198	191	194	177	177	171	176	171
Cl	10.5	10.4	10.6	10.9	11.3	10.7	10.9	10.8	10.8	11.3	13.5	14	11.3	10	10.9
NH4	< 0.5	< 0.5	< 0.5	0.16	0.16	< 0.5	< 0.5	< 0.5	0.15	0.15	< 0.5	< 0.5	< 0.5	0.11	0.16
NO2 (N)	< 1	< 1	< 1	< 0.08	< 0.02	< 1	< 1	< 1	< 0.03	< 0.02	< 1	< 1	< 1	0.03	< 0.02
NO3 (N)															
F	0.30	0.30	0.30	0.19	0.23	0.30	0.30	0.30	0.19	0.21	0.3	0.3	0.3	0.22	0.28
SiO2	5.7	7.5	7.7	9.2	9	7.5	8.1	8.3	11.3	11.6	8.1	8.6	8.5	9.4	9
TDS	390.8	384.2	394.4	368	426	443.6	447	385.2	392	434	406.2	387.9	383.2	354	380
Cond. (umho/cm)	632	621	615	622	648	663	655	641	659	693	682	623	602	658	620
Alk. (as CaC03)	91.8	94.8	95	96.9	106.2	89.3	89	89.8	81.9	84.2	111	92.2	88.4	94.2	98.8
pH (units)	9	8.9	8.8	8.55	8.34	8.8	9	8.5	9.22	9.1	9.8	8.8	8.9	8.73	8.76
Trace Metals mg/l:															
Al	0.08	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
As	0.005	0.002	0.003	0.003	< 0.001	< 0.002	< 0.002	< 0.002	0.002	< 0.001	0.003	0.003	0.002	0.002	0.001
Ba	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
B	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1
Cd	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01
Cr	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
Cu	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01
Fe	0.11	< 0.02	0.03	< 0.05	< 0.05	< 0.03	0.02	0.05	< 0.05	< 0.05	< 0.02	0.08	1	< 0.05	< 0.05
Pb	0.007	0.006	0.006	< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	0.005	0.005	0.005	< 0.05	< 0.05
Mn	0.008	< 0.005	0.005	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01	0.009	0.005	0.007	0.01	< 0.01
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001
Mo	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Ni	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05
Se	< 0.002	0.003	< 0.002	0.001	< 0.001	< 0.002	0.002	0.007	< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001
V	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Zn	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01
Radiometric pCi/l:															
U (mg/l)	0.2968	0.1611	0.1441	0.0455	0.0405	0.0593	0.0508	0.0593	0.0386	0.0506	0.0848	0.0339	0.1526	0.0062	0.0164
Ra 226	33	30	29	31	34	15	13	10	10.2	10.6	61	58	47	50	36.9
Ra 226 +/-	2	2	1	1.5	2	0.9	0.9	0.8	0.9	1.1	4	4	4	2.5	1.5

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality
for Irigaray Units 1 through 9

Well I.D.:	KP-29					KP-44					KP-50				
Production Unit:	UNIT 8					UNIT 8					UNIT 8				
Sample Date:	02-Apr-80	09-Apr-80	16-Apr-80	15-Oct-87	06-Nov-87	23-Apr-80	30-Apr-80	07-May-80	14-Oct-87	05-Nov-87	23-Apr-80	30-Apr-80	07-May-80	08-Oct-87	27-Oct-87
Major Ions mg/l:															
Ca	11.4	9.24	8.9	4.8	4.8	10.6	10.7	10.3	5.2	5.4	6.6	6.7	6.3	4.7	5.3
Mg	1.03	1.02	1.11	0.59	0.63	1.2	1.14	1.07	0.69	0.71	0.9	0.8	0.81	0.53	0.46
Na	149	142	142	130	130	143	144	142	124	129	124	119	119	129	128
K	2.8	2.4	2.6	1.8	1.8	1.8	2.2	2.3	1.7	1.7	1.5	1.54	1.7	1.9	2.2
CO3	20.4	14.6	9.5	5	4.3	20.04	23.4	13.2	4.1	4.1	10.6	9.9	7.4	3.1	4.3
HC03	79.4	88.1	100.2	101	112	72.47	68.2	85.8	106	109	97.4	97.2	100.3	107	103
SO4	231	222	219	178	179	234	228	233	174	177	174	165	174	178	184
Cl	10.2	10.6	10.4	10.4	10.2	10.2	10.3	9.5	10.4	10.6	10.4	10.1	10.3	9.6	10.8
NH4	< 0.5	< 0.5	< 0.5	0.23	0.17	< 0.5	< 0.5	< 0.5	0.1	0.21	< 0.5	< 0.5	< 0.5	0.1	0.16
NO2 (N)	< 1	< 1	< 1	< 0.03	< 0.02	< 1	< 1	< 1	< 0.03	< 0.02	< 1	< 1	< 1	< 0.02	< 0.02
NO3 (N)															
F.	0.3	0.3	0.3	0.21	0.28	0.3	0.3	0.3	0.48	0.28	0.3	0.3	0.3	0.26	0.29
SiO2	8.1	7.9	8	9	8.8	8.9	8.7	8.1	9.4	9.4	8.1	6.3	8.2	9	8.6
TDS	480	460.6	481.6	402	374	482.2	488.4	503.8	376	366	384.4	387.4	412.4	402	432
Cond. (umho/cm)	754	715	699	645	629	722	775	769	645	632	593	627	627	639	623
Alk. (as CaC03)	99.1	88.1	97.9	91.6	99.6	92.8	95.6	92.3	93.8	96.2	97.4	96.3	94.6	93.4	92.2
pH (units)	9.2	9.2	8.8	9.03	8.92	9.2	9.2	8.6	6.92	8.91	8.9	8.8	8.6	8.8	8.96
Trace Metals mg/l:															
Al	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
As	< 0.002	< 0.002	< 0.002	0.002	0.001	< 0.002	< 0.002	< 0.002	0.001	0.001	0.004	0.002	< 0.002	0.007	0.005
Ba	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
B	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1
Cd	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01
Cr	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	0.005	0.005	0.005	< 0.05	< 0.05	< 0.005	0.005	0.005	< 0.05	< 0.05
Cu	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01
Fe	< 0.02	< 0.02	0.02	< 0.05	< 0.05	0.21	0.08	0.02	< 0.05	< 0.05	0.08	0.05	0.04	< 0.05	< 0.05
Pb	< 0.005	< 0.005	0.008	< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
Mn	< 0.005	< 0.005	0.005	0.02	< 0.01	0.09	0.008	0.005	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01
Hg	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001
Mo	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Ni	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05
Se	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001
V	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Zn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.03	0.01	< 0.01	0.01	< 0.01	0.03	< 0.01	< 0.01	0.02	< 0.01
Radiometric pCi/l:															
U (mg/l)	0.0084	0.0084	0.0084	0.0057	0.012	0.0169	0.0084	0.0763	0.0003	0.0067	0.178	0.0763	0.0169	0.0052	0.0341
Ra 226	11	11	11	4.9	4.7	11	12	16	11.4	8.4	32	33	36	59.7	30.8
Ra 226 +/-	0.9	1	1	0.8	0.6	2	3	2	0.8	0.7	5	5	5	1.9	1.6

APPENDIX A
TABLE A-1

**Individual Well Baseline Water Quality
for Irigaray Units 1 through 9**

Well I.D.:	KP-63					KP-70				
Production Unit:	UNIT 8					UNIT 8				
Sample Date:	06-Feb-80	12-Feb-80	20-Feb-80	08-Oct-87	27-Oct-87	18-Mar-80	25-Mar-80	01-Apr-80	08-Oct-87	27-Oct-87
Major Ions mg/l:										
Ca	5.7	5.4	5.5	7.1	5.9	9.9	10.2	9.1	7	13.6
Mg	0.55	0.57	0.58	0.72	0.59	0.92	0.88	0.67	0.6	0.03
Na	118	120	118	123	125	132	132	137	122	130
K	1.4	1.5	1.4	1.3	1.3	1.5	1.7	1.2	6.4	17.5
CO3	8.4	7.2	6	0	1.3	15.6	15.8	38.4	12	8.5
HC03	97.4	101.3	101.3	117	110	83.3	85.2	41.5	98.5	23.7
SO4	174	176	174	177	178	213	212	207	175	166
Cl	10.3	10.2	10.5	9.7	9.7	10.4	10.4	10.1	9.7	11.7
NH4	< 0.5	< 0.5	< 0.5	0.33	0.2	< 0.5	< 0.5	< 0.5	0.13	0.2
NO2 (N)	< 1	< 1	< 1	< 0.28	< 0.03	< 1	< 1	< 1	0.04	< 0.02
NO3 (N)										
F	0.3	0.3	0.3	0.11	0.32	0.3	0.3	0.3	0.24	0.32
SiO2	8	7.9	7.8	9	8.6	8.5	7.7	8.7	8.9	7.9
TDS	380.4	344	444.6	372	408	434	443.2	434.4	400	446
Cond. (umho/cm)	577	567	620	645	605	700	712	685	669	791
Alk. (as CaC03)	93.8	95	93	96.2	92.4	94.3	96.2	99	102	136
pH (units)	8.7	8.8	8.6	8.2	8.4	9.2	9.1	9.6	9.42	10.7
Trace Metals mg/l:										
Al				< 0.10	< 0.10	< 0.05	0.08	0.06	< 0.10	0.20
As	0.002	0.003	0.002	0.002	0.002	< 0.002	< 0.002	< 0.002	0.004	0.003
Ba				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
B				< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1
Cd				< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01
Cr				< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05
Cu				< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01
Fe	0.23	8.72	2.92	< 0.05	< 0.05	< 0.02	< 0.02	0.05	< 0.05	< 0.05
Pb				< 0.05	< 0.05	< 0.005	< 0.005	0.005	< 0.05	< 0.05
Mn				< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01
Hg				< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001
Mo				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Ni				< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05
Se	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	0.001	< 0.001
V				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10
Zn				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Radiometric pCi/l:										
U (mg/l)	0.0254	0.0508	0.0508	< 0.0003	0.0217	0.0169	0.0254	0.0508	0.119	0.12
Ra 226	18	42	18	4.9	13.1	67	75	51	44.7	87.1
Ra 226 +/-	1	2	1	0.6	1.1	2	2	2	1.8	3.1

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality
for Irigaray Units 1 through 9

Well I.D.:	LI-51					LP-13					LP-20				
Production Unit:	UNIT 9					UNIT 9					UNIT 9				
Sample Date:	14-Jan-81	20-Jan-81	28-Jan-81	19-Nov-87	09-Dec-87	21-Oct-80	28-Oct-80	05-Nov-80	19-Nov-87	09-Dec-87	14-Jan-81	21-Jan-81	28-Jan-81	02-Sep-87	09-Oct-87
Major Ions mg/l:															
Ca	5.2	5.4	5.4	5.4	4.9	9.2	9.1	8.5	9.5	8.4	6.9	6.8	6.7	5.1	5.7
Mg	0.55	0.58	0.59	0.76	0.75	0.58	0.61	0.81	0.15	0.2	0.37	0.47	0.55	0.37	0.29
Na	128	115	125	129	122	125	129	126	134	130	120	124	125	131	129
K	1.9	1.8	1.8	1.4	2.7	1.4	1.7	1.7	1.7	3.1	2.7	2.6	2.2	2.9	2.6
CO3	15	12	12	0	1.2	19.2	36.6	18	0	9.2	21.6	17	14.4	8.1	0
HCO3	82.1	89.1	88.9	118	110	83.4	60.4	83.9	144	107	68.3	84.9	89.1	93.9	121
SO4	183	188	183	180	174	180	180	180	180	180	183	174	171	181	171
Cl	10.8	10.6	10.5	10.8	10.5	10.4	10.7	10.9	11	11.2	10.4	10.6	10.4	11.9	10.6
NH4	< 0.5	< 0.5	< 0.5	0.1	0.14	< 0.5	< 0.5	< 0.5	0.1	< 0.05	< 0.5	< 0.5	< 0.5	0.56	0.87
NO2 (N)	< 1	< 1	< 1	0.03	0.03	< 1	< 1	< 1	< 0.04	< 0.02	< 1	< 1	< 1	< 0.05	0.02
NO3 (N)															
F	0.32	0.31	0.31	0.28	0.29	0.20	0.20	0.20	0.25	0.28	0.33	0.30	0.30	0.38	0.38
SiO2	7.43	8.4	7.1	9.2	9.2	10.1	9.48	9.39	10.1	9.8	7.21	7.1	7.21	8.6	9.4
TDS	418.6	434.8	402	366	402	410.7	417.4	391.4	392	422	421.4	422.4	385.2	390	404
Cond. (umho/cm)	640	637	639	632	626	630	651	630	659	655	635	631	621	588	644
Alk. (as CaCO3)	92.3	93	92.9	95.2	92.4	100.4	110.5	98.8	118	104	94	98	97.2	91.4	99.6
pH (units)	8.2	8.7	8.8	8.58	8.36	9.2	9.2	9.2	7.2	9.27	9.1	9	8.9	9.27	8.3
Trace Metals mg/l:															
Al				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10				< 0.10	< 0.10
As	0.002	0.002	< 0.002	0.001	0.001	0.003	< 0.002	< 0.002	0.003	0.003	< 0.002	0.003	0.002	< 0.002	< 0.001
Ba				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10				< 0.10	< 0.10
B				< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.1				< 0.1	< 0.1
Cd				< 0.01	< 0.01	0.003	0.003	0.003	< 0.01	< 0.01				< 0.01	< 0.01
Cr				< 0.05	< 0.05	< 0.005	< 0.005	< 0.005	< 0.05	< 0.05				< 0.05	< 0.05
Cu				< 0.01	< 0.01	< 0.005	< 0.005	< 0.005	< 0.01	< 0.01				< 0.01	< 0.01
Fe	0.08	0.02	0.04	< 0.05	< 0.05	0.57	0.08	0.02	< 0.05	< 0.05	0.37	0.53	0.23	< 0.05	< 0.05
Pb				< 0.05	< 0.05	0.035	0.03	0.03	< 0.05	< 0.05				< 0.05	< 0.05
Mn				< 0.01	< 0.01	0.006	< 0.005	< 0.005	< 0.01	< 0.01				< 0.01	< 0.01
Hg				< 0.001	< 0.001	< 0.0002	< 0.0002	< 0.0002	< 0.001	< 0.001				< 0.001	< 0.001
Mo				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10				< 0.10	< 0.10
Ni				< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.05	< 0.05				< 0.05	< 0.05
Se	0.004	< 0.002	< 0.002	< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001	< 0.002	< 0.002	0.005	< 0.001	< 0.001
V				< 0.10	< 0.10	< 0.05	< 0.05	< 0.05	< 0.10	< 0.10				< 0.10	< 0.10
Zn				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01				0.03	0.01
Radiometric pCi/l:															
U (mg/l)	0.0169	0.0169	0.0084	0.0287	0.0183	0.0508	0.0339	0.0254	0.0459	0.031	0.1187	0.1187	0.0593	0.24	0.0366
Ra 226	18	20.1	14	17.5	12	75	71	75	85.4	53.7	40	38	28	14.2	10.7
Ra 226 +/-	1.3	1.3	1.1	1.5	0.9	11	9	11	2.8	1.8	1.9	1.9	1.6	1	0.8

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality
for Irigaray Units 1 through 9

Well I.D.:	LP-24					LP-22				
Production Unit:	UNIT 9					UNIT 9				
Sample Date:	21-Oct-80	28-Oct-80	05-Nov-80	19-Nov-87	09-Dec-87	21-Oct-80	28-Oct-80	05-Nov-80	11-Sep-87	09-Oct-87
Major Ions mg/l:										
Ca	8.4	7.7	7.2	4.7	4.4	7.2	6.8	6.1	4.9	4.7
Mg	0.31	0.34	0.43	0.47	0.5	0.44	0.5	0.55	0.63	0.62
Na	124	124	123	132	126	125	125	128	127	128
K	1.9	2	1.9	1.4	2.2	2.3	2.8	2.3	1.8	1.7
CO3	18.9	15.9	9.9	0	2.9	20.4	20.4	14.4	5.2	0
HC03	87.4	86.3	95.9	114	106	73.2	73.2	86.4	105	122
SO4	174	183	183	180	171	180	183	183	174	166
Cl	10.6	11.1	11.2	12.2	11	10.7	11	11.1	11	10.2
NH4	< 0.5	< 0.5	< 0.5	0.16	0.13	< 0.5	< 0.5	< 0.5	0.18	0.33
NO2 (N)	< 1	< 1	< 1	< 0.04	< 0.02	< 1	< 1	< 1	0.02	0.03
NO3 (N)										
F				0.26	0.26	0.2	0.2	0.2	0.22	0.26
SiO2				9.6	9.8	9.01	8.82	9.01	10.1	9.6
TDS	446.4	411.4	395.2	396	404	436	418	383	392	402
Cond. (umho/cm)	644	645	742	645	634	630	637	621	601	625
Alk. (as CaC03)	99.8	97.3	95.2	93.8	92.2	94	94	94.8	95.6	99.8
pH (units)	9.2	9	8.9	8.9	8.77	9.3	9.1	9.1	9.03	8.22
Trace Metals mg/l:										
Al				< 0.10	< 0.10				< 0.10	< 0.10
As				0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001
Ba				< 0.10	< 0.10				< 0.10	< 0.10
B				< 0.1	< 0.1				< 0.1	< 0.1
Cd				< 0.01	< 0.01				< 0.01	< 0.01
Cr				< 0.05	< 0.05				< 0.05	< 0.05
Cu				< 0.01	< 0.01				< 0.01	< 0.01
Fe				< 0.05	< 0.05	1.05	0.83	< 0.02	< 0.05	< 0.05
Pb				< 0.05	< 0.05				< 0.05	< 0.05
Mn				< 0.01	< 0.01				< 0.01	< 0.01
Hg				< 0.001	< 0.001				< 0.001	< 0.001
Mo				< 0.10	< 0.10				< 0.10	< 0.10
Ni				< 0.05	< 0.05				< 0.05	< 0.05
Se				< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001
V				< 0.10	< 0.10				< 0.10	< 0.10
Zn				< 0.01	< 0.01				0.02	0.03
Radiometric pCi/l:										
U (mg/l)				0.0688	0.0711	0.0508	0.0508	0.0508	0.0794	0.0437
Ra 226				87.1	57.7	35	33	27	21.9	36.8
Ra 226 +/-				2.8	1.9	6	9	10	1.2	1.5

APPENDIX A
TABLE A-1

Individual Well Baseline Water Quality
for Irigaray Units 1 through 9

Well I.D.:	LP-43					LP-63				
Production Unit:	UNIT 9					UNIT 9				
Sample Date:	03-Dec-80	10-Dec-80	16-Dec-80	12-Nov-87	02-Dec-87	28-Oct-80	12-Nov-80	18-Nov-80	12-Nov-87	02-Dec-87
Major Ions mg/l:										
Ca	16.4	10.9	11.6	4.7	5	8.8	7.8	7.5	6.6	6.5
Mg	2.9	2.42	2.9	0.68	0.77	0.72	0.77	0.77	0.71	0.77
Na	139	131	137	127	131	124	129	122	123	124
K	2.4	2.1	2.2	1.7	2.4	2.1	1.8	1.7	1.2	2.9
CO3	15.1	20.4	14.9	5.3	5	28.8	15.6	12.2	3.7	2.2
HC03	75.6	41.5	75.8	104	106	59.5	82.4	90.4	109	108
SO4	243	243	231	171	181	183	192	189	177	178
Cl	10.9	11.3	11.1	11.8	12.2	10.6	11.4	10.9	11.5	11.2
NH4	< 0.5	< 0.5	0.5	0.17	0.13	< 0.5	< 0.5	< 0.5	0.28	0.29
NO2 (N)	< 1	< 1	< 1	0.02	< 0.03	< 1	< 1	< 1	0.02	< 0.03
NO3 (N)										
F	0.3	0.3	0.3	0.27	0.29	0.2	0.2	0.2	0.29	0.30
SiO2	6.46	7.23	7.51	9.8	9.4	9.01	8.65	8.17	8.8	9
TDS	427	464.4	442	386	412	422.6	397.6	424.6	416	416
Cond. (umho/cm)	751	712	707	675	634	651	640	634	661	634
Alk. (as CaC03)	87.3	68	66.9	95	96	96.8	93.5	94.5	98	92
pH (units)	8.6	9.5	9.1	9.04	9.01	9.2	9	9	8.86	8.64
Trace Metals mg/l:										
Al				< 0.10	< 0.10				< 0.10	< 0.10
As	0.006	0.01	0.006	0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001
Ba				< 0.10	< 0.10				< 0.10	< 0.10
B				< 0.1	< 0.1				< 0.1	< 0.1
Cd				< 0.01	< 0.01				< 0.01	< 0.01
Cr				< 0.05	< 0.05				< 0.05	< 0.05
Cu				< 0.01	< 0.01				< 0.01	< 0.01
Fe	3.3	0.2	0.87	< 0.05	< 0.05	< 0.02	0.23	1.72	< 0.05	< 0.05
Pb				< 0.05	< 0.05				< 0.05	< 0.05
Mn				< 0.01	< 0.01				< 0.01	< 0.01
Hg				< 0.001	< 0.001				< 0.001	< 0.001
Mo				< 0.10	< 0.10				< 0.10	< 0.10
Ni				< 0.05	< 0.05				< 0.05	< 0.05
Se	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001	< 0.002	< 0.002	< 0.002	< 0.001	< 0.001
V				< 0.10	< 0.10				< 0.10	< 0.10
Zn				0.02	0.07				< 0.01	0.03
Radiometric pCi/l:										
U (mg/l)	0.195	0.254	0.2035	0.042	0.0447	0.025	0.025	0.017	< 0.0003	0.0023
Ra 226	86.4	105	76.4	26.9	28.5	44	40	90	38.9	35.4
Ra 226 +/-	3.1	3.5	3.1	1.5	1.4	14	11	18	1.8	1.6

A A
T -2
POST-MINING RESULTS
IRIGARAY DESIGNATED RESTORATION WELLS

POST - MINING

Well I.D.:	AP-4	BP-4	CP-10	DI-27	DI-90	DP-28	DP-29	FP-6	FI-82	FI-132	GI-76	GI-82	GP-9	GI-134	HI-53	HI-57
Production Unit:	Unit 1	Unit 1	Unit 2	Unit 3	Unit 2	Unit 2	Unit 3	Unit 3	Unit 4	Unit 4	Unit 5	Unit 5	Unit 5	Unit 5	UNIT 6	UNIT 6
Sample Date:	05/18/90	05/18/90	05/18/90	05/21/90	05/18/90	05/18/90	05/21/90	05/18/90	05/21/90	05/21/90	05/21/90	05/18/90	05/21/90	05/21/90	04/15/95	04/15/95
Major Ions mg/l:																
Ca	150.0	137.0	17.4	210.0	190.0	138.0	200.0	160.0	154	107	117	40.4	210	230	262	240
Mg	49.5	39.8	3.9	51.9	45.1	40.9	50.3	48.8	49.1	22.7	30.3	9.8	46.4	40.4	60	54
Na	570	587	239	655	690	582	614	610	610	417	511	262	619	760	771	732
K	8.0	9.3	17.0	10.8	15.1	9.2	10.2	10.6	9.5	6.3	6.5	10.8	8.8	14.4	9.2	8.8
CO_3	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 1.0	< 1.0
HCO_3	1337	1244	297	1371	1098	1152	1298	1252	1264	913	996	469	1391	1879	1731	1692
SO_4	551	604	175	638	708	504	659	532	646	413	431	264	554	487	784	738
Cl	426	378	141	414	437.0	419	433	425	429	224	275	86.2	371	303	287	260
NH_4	91.4	84.3	6.7	69.8	52.8	68.9	68.5	66.3	82.5	60.2	44.8	23.5	29.0	0.35	0.81	0.98
NO_2 (N)	0.03	0.02	0.01	0.58	0.80	0.02	0.09	0.37	0.03	0.01	0.01	0.01	0.01	0.01	< 0.10	< 0.10
NO_3 (N)	0.34	0.08	0.04	17.70	23.00	6.40	2.82	6.25	2.88	< 0.01	0.01	1.41	0.03	0.49	< 0.10	< 0.10
F	< 0.10	< 0.10	0.17	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.1	< 0.1	0.13	< 0.1	< 0.10	< 0.10	< 0.10
SiO_2	9.8	10.1	12.0	9.2	10.9	9.6	14.1	8.8	12.8	8.6	6.8	7.3	11.1	20.1	13.6	11
TDS	2314	2248	721	2637	2579	2198	2507	2289	2404	1664	1781	863	2400	2624	3027	2912
Cond. (mmho/cm)	4208	4118	1421	4468	4432	3984	4435	4062	4402	2989	3239	1690	4062	4292	4326	4187
Alk. (as $CaCO_3$)	1096	1020	244	1124	900	944	1064	1026	1036	748	816	384	1140	1540	1419	1387
pH (units)	6.88	6.82	6.14	6.98	6.86	7.02	7.00	6.98	7.20	7.54	7.32	7.43	7.42	6.76	7.19	6.90
Trace Metals mg/l:																
Al	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.12	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
As	0.003	0.028	0.012	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.007	0.003	0.004	0.074	< 0.001	< 0.001	< 0.001
Ba	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
B	< 0.10	< 0.10	< 0.10	0.11	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.11	0.14	0.12
Cd	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cr	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cu	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01
Fe	6.90	5.40	0.07	0.22	0.44	< 0.05	0.51	0.07	0.12	0.40	0.05	0.06	2.30	0.06	< 0.050	< 0.050
Pb	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Mn	4.4	1.4	0.03	1.10	0.81	0.79	1.10	0.64	0.01	0.55	0.48	0.14	2.30	0.96	1.420	1.330
Hg	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Mo	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10
Ni	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Se	0.068	0.015	< 0.001	1.054	0.387	0.824	1.054	0.368	0.008	0.002	0.012	0.035	0.003	0.703	0.043	0.027
V	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Zn	0.03	0.03	0.02	0.05	0.08	0.03	0.05	0.04	0.01	0.05	0.04	0.05	0.04	0.27	< 0.01	0.02
Radiometric pCi/l:																
U (mg/l)	4.952	8.865	0.785	8.254	1.636	3.485	8.254	10.394	4.158	17.425	2.935	0.459	24.456	3.546	5.271	5.835
Ra 226	429	464	14.1	210.0	118	71.2	210	58.3	170	118	100	43	57.8	262	127	276
Ra 226+/-	9.0	9.2	0.9	5.8	4.7	3.6	5 8	3.3	5.2	4.4	4.0	2.9	3.1	6.5	3.8	5.6

A A
T 2

POST-MINING RESULTS
IRIGARAY DESIGNATED RESTORATION WELLS

POST - MINING

Well I.D.:	HI-62	HP-59	HP-87	JI-91	JP-26	JP-53	JP-57	JP-63	KP70B	KI-128	KP-44	LI-51	LP-13	LP-22	LP-63	LP43	MEAN
Production Unit:	UNIT 6	UNIT 6	UNIT 6	UNIT 7	UNIT 7	UNIT 7	UNIT 7	UNIT 7	UNIT 7	UNIT 8	UNIT 8	Unit 9	Unit 9	Unit 9	Unit 9	Unit 9	Units 1-9
Sample Date:	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	04/15/95	
Major Ions mg/l:																	
Ca	175	212	232	239	242	257	267	276	290	168	267	262	231	274	356	262	199.2
Mg	36	40	53	54	54	56	50	60	61	34.5	59	62	39	67	77	64	45.7
Na	551	714	711	700	711	796	828	780	787	489	730	759	569	768	840	714	627
K	9.2	8.3	8.8	8.8	9.1	8.7	9	10	9.6	5.9	9	9.3	9	9.3	10.3	8.7	9.3
CO_3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.6
HCO_3	1151	1592	1725	1578	1529	1384	1737	1744	1478	1077	1704	1882	1370	1812	1617	1543	1342.6
SO_4	533	620	621	723	771	873	884	877	850	560	777	681	617	840	1249	920	638.9
Cl	211	264	244	238	227	265	266	258	274	135	260	266	174	260	261	241	277.3
NH_4	0.81	1.49	0.87	1.32	2.01	0.88	0.8	1.27	0.71	0.64	1.2	0.73	1.39	0.97	1.21	1.07	23.2
NO_2 (N)	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.7
NO_3 (N)	0.11	< 0.10	0.37	< 0.10	< 0.10	0.11	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 2.4
F	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 1.0
SiO_2	13	18.4	13.4	12.4	15.6	11	15.4	14.2	13.2	9.4	14.5	12	15.4	12.2	16.9	12	12.0
TDS	2126	2611	2726	2866	2866	3167	3120	3107	3165	1878	2907	2975	2342	3199	3614	3013	2450.6
Cond. (mmho/cm)	3161	3856	3984	4027	4080	4411	4336	4411	4465	2798	4198	4294	3386	4411	4881	4208	3794.6
Alk. (as $CaCO_3$)	943	1305	1414	1294	1254	1135	1424	1429	1212	885	1397	1543	1123	1485	1325	1265	1100.6
pH (units)	7.33	7.26	7.43	7.16	7.15	7.77	7.10	7.15	7.99	7.46	7.32	7.54	7.44	7.43	7.43	7.55	7.1
Trace Metals mg/l:																	
Al	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 1.04
As	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	0.008	< 0.001	< 0.001	0.002	< 0.641
Ba	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 1.07
B	0.11	0.17	0.18	0.11	0.12	0.12	0.12	0.13	0.12	0.09	0.11	0.1	0.1	0.11	0.11	0.1	< 0.4
Cd	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.979
Cr	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 1.02
Cu	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.83
Fe	< 0.050	3.680	< 0.050	< 0.050	< 0.050	< 0.050	0.300	< 0.050	< 0.050	0.570	< 0.050	< 0.050	< 0.050	< 0.050	0.090	0.310	< 1.10
Pb	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 1.02
Mn	1.160	0.810	0.930	1.650	2.780	1.570	1.020	2.480	1.600	0.990	1.380	0.960	1.290	1.260	2.120	1.750	1.25
Hg	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.971
Mo	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 1.07
Ni	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 1.02
Se	0.097	0.005	0.3	0.054	0.028	0.21	0.032	0.025	0.211	0.067	0.702	0.294	0.022	0.162	0.234	0.099	< 0.25
V	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 1.07
Zn	0.03	0.01	0.01	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.03	0.02	< 0.06
Radiometric pCi/l:																	
U (mg/l)	10.71	2.614	1.583	1.536	0.71	17.44	21.75	3.054	14.2	7.027	0.596	5.961	13.32	5.501	13.39	7.048	7.41
Ra 226	134	510	27.1	145	178	160	465	278	236	213	141	57.2	565	196	173	208	200.5
Ra 226+/-	3.9	7.6	1.8	4	4.5	5.6	8.3	5.6	5.1	4.9	4	2.4	8.4	4.5	4.2	4.6	4.9

Christensen Ranch Project

Source: COGEMA Mining, Inc., 2008, Wellfield Restoration Report, Christensen Ranch Project, Wyoming, Prepared by COGEMA Mining, Inc. and Petrotek Engineering Corporation, March 5, 2008. Available from the NRC ADAMS document server under accession nos. ML081060131, ML081060132 and ML081060140.

Table 4.2 Target Restoration Values for Mine Unit 2, North and South, Christensen Ranch, Wyoming

Parameter	TRV MU2 North	TRV MU2 South	Average TRV	% Difference avg to south
Major Cations/Anions				
Ca (mg/l)	9.04	11.45	10.25	-10.5
Mg (mg/l)	0.56	0.98	0.77	**-21.4**
Na (mg/l)	155.5	173.4	164.4	-5.2
K (mg/l)	5.75	4.34	5.1	17.5
CO3 (mg/l)	32.86	15.06	24.0	**59.4**
HC03 (mg/l)	262.1	148.2	205.1	**38.4**
SO4 (mg/l)	253.5	349.7	301.6	-13.8
Cl (mg/l)	9.7	10.5	10.1	-3.8
NH4 (mg/l)	0.08	0.16	0.12	**-25.0**
NO2 (N) (mg/l)	0.1	0.1	0.10	0.0
NO3 (N) (mg/l)	0.1	0.14	0.12	-14.3
F (mg/l)	0.28	0.2	0.24	**20.0**
SiO2 (mg/l)	8.77	7	7.9	12.9
General Water Quality Parameters				
TDS (mg/l)	795.6	822	808.8	-1.6
Cond. (umho/cm)	1090.3	1640.5	1365.4	-16.8
Alk. (as CaC03 (mg/l))	127.5	115.4	121.4	5.2
pH (units)	9.2	8.9	9.1	2.2
Trace Metals				
Al (mg/l)	0.1	0.1	0.1	0.0
As (mg/l)	0.002	0.002	0.002	0.0
Ba (mg/l)	0.1	0.1	0.1	0.0
B (mg/l)	0.1	0.1	0.1	0.0
Cd (mg/l)	0.010	0.010	0.01	0.0
Cr (mg/l)	0.05	0.05	0.05	0.0
Cu (mg/l)	0.01	0.01	0.01	0.0
Fe (mg/l)	0.05	0.05	0.05	0.0
Pb (mg/l)	0.05	0.05	0.05	0.0
Mn (mg/l)	0.01	0.01	0.01	0.0
Hg (mg/l)	0.001	0.001	0.001	0.0
Mo (mg/l)	0.1	0.1	0.1	0.0
Ni (mg/l)	0.05	0.05	0.05	0.0
Se (mg/l)	0.004	0.002	0.003	**50.0**
V (mg/l)	0.1	0.1	0.1	0.0
Zn (mg/l)	0.01	0.01	0.01	0.0
Radionuclides				
U (mg/l)	0.04	0.028	0.034	**21.4**
Ra 226 (pCi/l)	214	214	214	0.0

Table 5-1. Restoration and Stability Monitoring Water Quality Results, Mine Unit 2, Christensen Ranch, Wyoming

	Active Restoration Monitoring				Stability Monitoring			
	Post Mining	Post GWS	Post RO	Post Reductant	Round 1	Round 2	Round 3	Round 4
Major Ions mg/l:								
Ca	285.8	160.0	36.4	32.3	52.6	64.6	65.7	63.3
Mg	53.1	33.7	6.7	3.9	5.7	7.5	8.0	7.9
Na	696.4	522.6	140.7	63.2	88.7	105.5	106.4	109.2
K	9.4	6.5	2.0	1.2	1.2	1.4	1.4	1.5
CO3	1.0	1.0	1.0	1.0	1.2	1.2	1.0	1.0
HC03	1898.8	1376.0	365.3	172.4	210.1	237.5	260.5	273.0
SO4	784.1	504.9	108.8	78.4	155.6	194.2	191.8	175.7
Cl	122.9	77.1	15.0	7.4	7.8	8.5	8.5	8.6
NH4	0.52	0.35	0.08	0.17	0.14	0.10	0.10	0.10
NO2 (N)	0.12	0.10	0.11	0.10	0.10	0.10	0.10	0.10
NO3 (N)	0.22	0.39	0.10	0.10	0.10	0.31	0.10	0.10
F	0.10	0.12	0.12	0.10	0.10	0.10	0.10	0.10
SiO2	12.6	7.8	6.2	7.4	4.8	10.8	10.5	10.8
TDS	3054.6	2143.6	509.4	297.5	435.4	542.4	569.2	548.4
Cond. (umho/cm)	4007.8	3032.2	806.8	464.4	627.8	796.9	786.0	792.6
Alk. (as CaC03)	1484.9	1128.4	302.0	143.8	170.9	195.0	213.7	224.2
pH (units)	7.51	7.90	7.85	7.69	7.51	7.77	7.82	7.76
Trace Metals mg/l:								
Al	0.10	0.10	0.13	0.18	0.10	0.10	0.10	0.10
As	0.12	0.09	0.01	0.02	0.01	0.01	0.01	0.01
Ba	0.10	0.10	0.12	0.37	0.49	0.50	0.50	0.50
B	0.10	0.11	0.10	0.07	0.06	0.04	0.06	0.06
Cd	0.010	0.005	0.005	0.003	0.002	0.002	0.002	0.002
Cr	0.05	0.05	0.05	0.02	0.01	0.01	0.01	0.01
Cu	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fe	0.14	0.40	0.14	0.43	1.19	1.06	0.66	0.57
Pb	0.05	0.05	0.05	0.03	0.02	0.02	0.02	0.02
Mn	0.66	0.37	0.17	0.27	0.38	0.41	0.39	0.34
Hg	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mo	0.10	0.11	0.10	0.05	0.02	0.02	0.02	0.02
Ni	0.12	0.05	0.05	0.03	0.01	0.01	0.01	0.01
Se	6.33	2.40	1.29	0.01	0.01	0.01	0.01	0.01
V	0.24	0.10	0.10	0.10	0.10	0.10	0.09	0.10
Zn	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Radiometric								
U (mg/l)	11.75	12.58	3.33	0.76	0.28	0.26	0.27	0.36
Ra 226 (pCi/l)	257.7	191.4	161.2	219.6	228.2	351.3	295.3	223.9

Numeric values represent the mean of all designated restoration wells for the specified phase of restoration

Table 5-1. Restoration and Stability Monitoring Water Quality Results, Mine Unit 3, Christensen Ranch, Wyoming

	Active Restoration Monitoring			Stability Monitoring			
	Post Mining	Post GWS	Post RO	Round 1	Round 2	Round 3	Round 4
Major Ions mg/l:							
Ca	325.0	248.8	47.8	34.2	44.6	46.5	46.6
Mg	60.4	55.5	10.4	4.6	6.1	6.3	6.2
Na	863.1	748.1	227.5	89.8	102.1	109.1	109.0
K	9.7	13.1	3.2	1.2	1.5	1.5	1.6
CO3	0.5	1.0	1.2	5.0	5.0	5.0	5.0
HC03	2280.4	1996.0	622.6	164.1	182.3	208.1	222.6
SO4	909.9	735.2	127.7	147.8	189.8	184.7	174.8
Cl	155.4	119.2	23.8	5.8	5.8	6.4	5.6
NH4	1.14	0.68	0.11	0.10	0.13	0.36	0.11
NO2 (N)	0.10	0.10	0.12	0.05	0.07	0.05	0.16
NO3 (N)	0.10	0.11	0.10	0.05	0.05	0.05	0.05
F	0.10	0.10	0.12	0.10	0.10	0.10	0.10
SiO2	16.2	10.7	8.0	16.1	16.5	17.2	16.3
TDS	3773.7	3122.0	772.0	408.9	544.7	492.6	492.6
Cond. (umho/cm	4787.9	4338.0	1162.9	588.4	683.6	707.1	713.3
Alk. (as CaC03)	1869.3	1637.8	510.6	134.6	149.5	170.4	182.2
pH (units)	7.40	7.49	7.84	7.64	7.63	7.59	7.67
Trace Metals mg/l:							
Al	0.10	0.10	0.11	0.10	0.10	0.10	0.10
As	0.02	0.08	0.00	0.01	0.01	0.01	0.01
Ba	0.10	0.10	0.10	0.46	0.46	0.46	0.50
B	0.10	0.10	0.10	0.06	0.07	0.07	0.07
Cd	0.010	0.005	0.005	0.002	0.002	0.002	0.002
Cr	0.05	0.05	0.05	0.01	0.01	0.01	0.01
Cu	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fe	2.81	0.85	0.16	0.50	0.53	0.39	0.28
Pb	0.05	0.05	0.05	0.02	0.02	0.02	0.02
Mn	0.69	0.58	0.14	0.12	0.13	0.13	0.12
Hg	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mo	0.10	0.10	0.10	0.02	0.02	0.02	0.02
Ni	0.05	0.05	0.05	0.01	0.01	0.01	0.01
Se	4.34	2.18	1.36	0.01	0.02	0.02	0.01
V	0.61	0.25	0.15	0.02	0.03	0.04	0.03
Zn	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Radiometric							
U (mg/l)	15.58	17.45	3.70	0.21	0.12	0.13	0.12
Ra 226 (pCi/l)	516.1	280.1	192.9	205.2	209.0	209.2	195.6

Numeric values represent the mean of all
designated restoration wells for the specified phase of restoration

Table A-1-Stability Monitoring Water Quality Results for Designated Restoration Wells, MU 3, Christensen Ranch, Wyoming

MU-3 Ore Zone Baseline Well
Water Quality - Round 1 Stability

Well ID: Location: Sample Date:		MU-3 Baseline Mean	3D12-1 Mod 32 10/19/2004	3G13-1 Mod 32 10/19/2004	3J26-1 Mod 32 10/20/2004	3L16-1 Mod 31 10/19/2004	3L20-1 Mod 31 10/19/2004	3N25-1 Mod 31 10/19/2004	3O37-2 Mod 33 10/20/2004
Major Ions	**Units**								
Ca	mg/L	7.85	67	35	23	36	23	11	49
Mg	mg/L	0.9	12	4	5	3.0	2.0	2	3
Na	mg/L	134.69	101	90	116	84	62	71	73
K	mg/L	3.52	2.0	1.0	1.0	< 1.0	< 1.0	< 1.0	< 1.0
CO3	mg/L	119.57	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
HCO3	mg/L	108.62	188	221	115	186	118	110	111
So4	mg/L	198.2	257	96	222	104	89	91	181
Cl	mg/L	9.1	4.0	8.0	6	9.0	5.0	5.0	4.0
NH4	mg/L	0.07	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
NO2 (N)	mg/L	0.04	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
NO3 (N)	mg/L	0.01	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
F	mg/L	0.21	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1
SiO2	mg/L	8.33	19.3	17.7	19.5	12.2	9.7	14.1	22.9
TDS	mg/L	411.58	610	390	490	370	260	270	430
Cond.	umhos/cm	681.72	819	576	731	546	412	398	605
Alk.	mg/L	99.16	154	181	95	153	96	90	91
pH	s.u.	8.89	7.6	7.7	7.3	7.8	7.6	7.7	7.8
Trace Metals, Dissolved									
Al	mg/L	0.01	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
As	mg/L	0.0026	0.021	< 0.005	< 0.005	< 0.005	< 0.005	0.008	< 0.005
Ba	mg/L	0.1	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
B	mg/L	0.1	0.04	0.06	0.07	0.05	0.06	0.05	0.10
Cd	mg/L	0.01	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Cr	mg/L	0.05	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cu	mg/L	0.0103	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fe	mg/L	0.069	1.59	0.34	0.17	0.15	< 0.05	0.39	1.10
Pb	mg/L	0.05	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Mn	mg/L	0.01	0.18	0.05	0.08	0.03	0.02	0.04	0.10
Hg	mg/L	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Mo	mg/L	0.1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ni	mg/L	0.05	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Se	mg/L	0.0019	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005
V	mg/L	0.1015	0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Zn	mg/L	0.0125	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Radionuclides, Dissolved									
Uranium	mg/L	0.00011	0.0488	0.202	0.0224	0.264	0.0185	0.0296	0.0634
Ra 226	pCi/L	81.3	570	174.3	108.4	110.9	21.4	147.2	235
Ra 226 =/-	pCi/L		17	9.0	5.0	5.1	3.2	8.4	11
Data Quality									
A/C Balance	%		1.29	1.59	0.48	1.56	1.59	0.28	1.22
Anions	meq		8.53	5.83	6.68	5.47	5.83	3.83	5.71
Cations	meq		8.75	6.02	6.62	5.65	6.02	3.80	5.85
TDS Calc.	mg/L		530	340	430	330	340	230	370
TDS Balance	dec %		1.15	1.15	1.14	1.12	1.15	1.17	1.162

Table 4.2 Target Restoration Values for Mine Unit 4, Christensen Ranch, Wyoming

Parameter	Target Restoration Value
Major Cations/Anions	
Ca (mg/l)	14.5
Mg (mg/l)	1.64
Na (mg/l)	151.7
K (mg/l)	10.3
CO3 (mg/l)	24.1
HC03 (mg/l)	152.9
SO4 (mg/l)	238.2
Cl (mg/l)	11.1
NH4 (mg/l)	1.20
NO2 (N) (mg/l)	0.10
NO3 (N) (mg/l)	0.21
F (mg/l)	0.30
SiO2 (mg/l)	12.7
General Water Quality Parameters	
TDS (mg/l)	508.2
Cond. (umho/cm)	802.7
Alk. (as CaC03 (mg/l))	119.0
pH (units)	10.05
Trace Metals	
Al (mg/l)	0.1
As (mg/l)	0.007
Ba (mg/l)	0.1
B (mg/l)	0.1
Cd (mg/l)	0.01
Cr (mg/l)	0.05
Cu (mg/l)	0.01
Fe (mg/l)	0.05
Pb (mg/l)	0.05
Mn (mg/l)	0.01
Hg (mg/l)	0.001
Mo (mg/l)	0.1
Ni (mg/l)	0.050
Se (mg/l)	0.010
V (mg/l)	0.1
Zn (mg/l)	0.228
Radionuclides	
U (mg/l)	0.23
Ra 226 (pCi/l)	83.0

Table 5-1. Restoration and Stability Monitoring Water Quality Results, Mine Unit 4, Christensen Ranch, Wyoming

	Active Restoration Monitoring			Stability Monitoring			
	Post Mining	Post GWS	Post RO	Round 1	Round 2	Round 3	Round 4
Major Ions mg/l:							
Ca	320.8	153.2	21.4	39.8	42.7	44.1	42.7
Mg	57.9	33.3	4.5	8.5	9.0	9.1	9.1
Na	690.8	442.9	139.3	221.5	241.1	220.5	226.6
K	12.5	7.0	2.8	6.7	4.0	3.9	3.6
CO3	1.0	3.4	1.9	0.9	1.2	1.5	1.7
HC03	1881.7	1133.5	255.4	434.3	453.3	452.1	446.5
SO4	886.3	511.4	144.3	219.1	225.8	213.4	210.5
Cl	176.9	77.9	14.5	19.2	20.4	19.6	19.3
NH4	0.74	0.32	0.15	0.13	0.12	0.17	0.20
NO2 (N)	0.10	0.10	0.10	0.10	0.10	0.10	0.09
NO3 (N)	0.15	0.35	0.10	0.11	0.10	0.10	0.12
F	0.10	0.12	0.13	0.13	0.12	0.12	0.12
SiO2	13.1	10.6	10.0	14.3	9.3	9.2	9.3
General Water Quality							
TDS (mg/l)	3225.8	1944.3	463.9	760.0	805.3	772.0	774.7
Cond. (umho/cm)	4276.7	2712.3	699.6	1151.9	1180.5	1073.8	1124.5
Alk. (mg/l as CaC03)	1548.3	933.2	211.2	356.7	372.1	370.8	366.4
pH (units)	7.69	7.94	7.84	8.02	7.89	8.07	8.01
Trace Metals mg/l:							
Al	0.10	0.10	0.10	0.11	0.10	0.10	0.11
As	0.011	0.059	0.013	0.006	0.005	0.006	0.006
Ba	0.10	0.10	0.10	0.50	0.50	0.50	0.50
B	0.10	0.10	0.10	0.09	0.12	0.06	0.06
Cd	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Cr	0.05	0.05	0.05	0.01	0.01	0.01	0.01
Cu	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fe	0.22	0.34	0.11	0.87	0.35	0.20	0.36
Pb	0.05	0.05	0.05	0.02	0.02	0.02	0.02
Mn	0.65	0.33	0.12	0.18	0.13	0.15	0.14
Hg	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mo	0.10	0.10	0.10	0.02	0.02	0.02	0.02
Ni	0.05	0.05	0.05	0.01	0.01	0.01	0.01
Se	3.04	2.12	0.30	0.28	0.26	0.21	0.21
V	0.27	0.31	0.17	0.12	0.13	0.09	0.07
Zn	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Radiometric							
U (mg/l)	17.55	13.19	2.85	3.71	3.53	3.91	3.83
Ra 226 (pCi/l)	286.2	198.7	71.2	107.8	170.2	141.3	114.1

Numeric values represent the mean of all designated restoration wells for the specified phase of restoration

Table 5-1. Restoration and Stability Monitoring Water Quality Results, Mine Unit 5, Christensen Ranch, Wyoming

	Active Restoration Monitoring			Stability Monitoring			
	Post Mining	Post GWS	Post RO	Round 1	Round 2	Round 3	Round 4
Major Ions mg/l:							
Ca	267.6	263.4	23.3	33.9	31.4	32.9	35.6
Mg	54.3	49.4	5.1	7.0	6.3	6.4	7.2
Na	598.4	605.2	118.7	146.7	151.3	161.4	157.0
K	12.7	26.4	2.9	3.2	3.8	3.4	4.0
CO3	1.0	1.1	1.5	1.4	2.3	1.8	1.2
HC03	1392.9	1296.2	248.8	316.8	331.1	333.9	356.6
SO4	981.0	905.8	119.1	144.5	145.1	151.6	159.0
Cl	129.4	110.7	7.8	11.0	10.8	11.0	11.4
NH4	0.39	0.39	0.12	0.18	0.21	0.16	0.10
NO2 (N)	0.10	0.15	0.10	0.10	0.10	0.10	0.09
NO3 (N)	0.11	0.10	0.10	0.10	0.11	0.10	0.12
F	0.12	0.12	0.15	0.13	0.15	0.13	0.10
SiO2	10.5	10.5	6.0	6.7	3.0	3.0	7.1
General Water Quality							
TDS (mg/l)	3074.4	2607.2	418.8	529.2	552.8	567.6	589.2
Cond. (umho/cm)	4047.3	3517.1	659.0	839.6	817.8	821.7	944.6
Alk. (mg/l as CaC03)	1143.9	1062.8	205.1	260.7	274.4	275.5	293.1
pH (units)	7.63	7.50	8.01	7.98	8.07	8.11	8.10
Trace Metals mg/l:							
Al	0.10	0.12	0.10	0.10	0.10	0.10	0.11
As	0.011	0.003	0.015	0.020	0.013	0.010	0.008
Ba	0.10	0.10	0.28	0.50	0.50	0.50	0.50
B	0.10	0.10	0.08	0.05	0.06	0.06	0.07
Cd	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Cr	0.05	0.05	0.03	0.01	0.01	0.01	0.01
Cu	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Fe	0.55	0.71	0.05	0.05	0.14	0.09	0.10
Pb	0.05	0.05	0.04	0.02	0.02	0.02	0.02
Mn	0.55	0.56	0.04	0.06	0.09	0.07	0.08
Hg	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mo	0.10	0.10	0.06	0.02	0.02	0.02	0.02
Ni	0.05	0.05	0.03	0.01	0.01	0.01	0.01
Se	0.55	0.51	0.53	0.49	0.52	0.35	0.41
V	0.22	0.22	0.23	0.18	0.16	0.15	0.12
Zn	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Radiometric							
U (mg/l)	12.61	18.09	1.43	2.16	2.43	2.39	2.05
Ra 226 (pCi/l)	475.7	356.9	217.7	194.4	218.8	210.6	238.0

Numeric values represent the mean of all designated restoration wells for the specified phase of restoration

Table A-1. Stability Monitoring Water Quality Results for Designated Restoration Wells, Mine Unit 5, Christensen Ranch, Wyoming

Ore Zone Baseline Well

Groundwater Quality - Stability Round #1 Round one consists of all Nov-2003 results.

Well I.D.	BASELINE		BASELINE		BASELINE		5AM78-2		5AE80-1		5AG68-1		5AL66-1		AP-02	
Production Unit		MU-5		MU-5		MU-5	Mod 51		Mod 51		Mod 51		Mod 51		Mod 52	
Sample Date	MINUMUM		MAXIMUM			MEAN		11/11/03		11/11/03		11/11/03		11/11/03		11/12/03
Major Ions mg/l:																
Ca	<	0.05		24.117		10.219		15.3		59.6		23.5		34.2		48.5
Mg	<	0.01		3.721		1.371		3.5		10.8		5.1		7.6		10.2
Na		101.1		191.68		146.39		70.9		207		104		124		214
K	<	0.1		19.851		4.22		1.3		3.8		2.5		2.1		4.3
CO3	<	0.1		61.85		7.255	<	1.0	<	1.0	<	1.0	<	1.0	<	1.0
HC03		29.444		217.596		123.52		149		472		265		309		409
SO4		82.859		348.161		215.51		69.2		229		68.2		104		248
Cl		3.502		11.942		7.722		7		20.7		6.9		12		14.7
NH4	<	0.05		0.722		0.143		0.1	<	0.1	<	0.1		0.20		0.2
NO2 (N)	<	0.10	<	0.10	<	0.10	<	0.1	<	0.1	<	0.1	<	0.1	<	0.1
NO3 (N)	<	0.10		16.793		0.125	<	0.10	<	0.10	<	0.10	<	0.10	<	0.10
F	<	0.10		0.307		0.184		0.1	<	0.1		0.1		0.1	<	0.1
SiO2		4.549		12.271		8.41		5.4		8.4		3.7		4.6		7.4
TDS		276.942		619.338		448.14		250		790		370		470		780
Cond. (umho/cm)		405.757		1095.003		750.38		408		1180		573		724		1270
Alk. (as CaC03)		54.896		158.403		106.649		122		387		218		253		336
pH (units)		7.349		10.157		8.753		7.7		7.90		7.70		7.80		8.1
Trace Metals mg/l:																
Al	<	0.10	<	0.10	<	0.1	<	0.1	<	0.1	<	0.1	<	0.1	<	0.1
As	<	0.001		0.006		0.002		0.014		0.029		0.040		0.026	<	0.005
Ba	<	0.10	<	0.10	<	0.10	<	0.5	<	0.5	<	0.5	<	0.5	<	0.5
B	<	0.10	<	0.10	<	0.10		0.05		0.06		0.04		0.05		0.04
Cd	<	0.01	<	0.01	<	0.01	<	0.002	<	0.002	<	0.002	<	0.002	<	0.002
Cr	<	0.05	<	0.05	<	0.05	<	0.01	<	0.01	<	0.01	<	0.01	<	0.01
Cu	<	0.01	<	0.01	<	0.01	<	0.01	<	0.01	<	0.01	<	0.01	<	0.01
Fe	<	0.05	<	0.05	<	0.05	<	0.05	<	0.05	<	0.05	<	0.05	<	0.05
Pb	<	0.05	<	0.05	<	0.05	<	0.02	<	0.02	<	0.02	<	0.02	<	0.02
Mn	<	0.01	<	0.01	<	0.01		0.05		0.15		0.05		0.07		0.05
Hg	<	0.001	<	0.001	<	0.001	<	0.001	<	0.001	<	0.001	<	0.001	<	0.001
Mo	<	0.10	<	0.10	<	0.10	<	0.02	<	0.02	<	0.02	<	0.02	<	0.02
Ni	<	0.05	<	0.05	<	0.05	<	0.01	<	0.01	<	0.01	<	0.01	<	0.01
Se	<	0.001		0.026		0.002		0.457		0.190		0.688		0.961		0.007
V	<	0.10		0.14		0.14		0.3		0.5		0.4		0.1	<	0.1
Zn	<	0.01		0.107		0.015		0.02	<	0.01	<	0.01		0.02	<	0.01
Radiometric pCi/l:																
U (mg/l)	<	0.0003		0.0763		0.0232		0.73		1		1.82		1.17		1.250
Ra 226	<	0.2		289.79		67.588		205		97		89.7		61.6		68.5
Ra 226+/-								8.7		4.5		4.2		3.5		3.8
Data Quality																
A/C Balance(+-5)				%				0.970		0.420		1.65		1.3		1.480
Anions				meq				4.09		13.09		5.97		7.57		12.29
Cations				meq				4.17		12.98		6.17		7.77		12.66
TDS Calculated				mg/L				240		760		340		440		740
TDS Balance (0.80 - 1.20)				dec %				1.040		1.04		1.09		1.07		1.050

Table 5-1. Restoration and Stability Monitoring Water Quality Results, Mine Unit 6, Christensen Ranch, Wyoming

	Active Restoration Monitorin		Stability Monitoring			
	Post Mining	Post GWS	Round 1	Round 2	Round 3	Round 4
Major Ions mg/l:						
Ca	292.2	406.0	41.6	51.7	54.6	54.8
Mg	61.6	109.0	9.3	11.2	11.6	12.0
Na	662.6	829.0	159.5	176.0	186.4	188.5
K	11.8	19.8	3.4	3.7	3.7	4.0
CO3	1.0	1.0	5.0	5.0	5.0	5.0
HC03	1420.4	1870.0	286.8	311.9	336.6	337.6
SO4	1089.1	1600.0	216.6	254.1	267.5	296.1
Cl	120.6	155.0	8.2	9.4	8.9	10.4
NH4	0.38	0.56	0.10	0.26	0.12	0.13
NO2 (N)	0.10	1.30	0.05	0.05	0.05	0.05
NO3 (N)	0.17	0.12	0.06	0.08	0.08	0.06
F	0.10	0.30	0.11	0.11	0.11	0.10
SiO2	12.14	15.10	8.89	9.76	10.02	9.84
TDS	3292.2	4070.0	598.3	686.8	718.3	717.7
Cond. (umho/cm	4297.2	5220.0	856.6	978.5	1054.1	1082.8
Alk. (as CaC03)	1165.2	1530.0	235.1	256.0	275.9	277.1
pH (units)	7.34	8.07	7.79	7.80	7.85	7.98
Trace Metals mg/l:						
Al	0.10	0.40	0.10	0.10	0.10	0.10
As	0.03	0.12	0.01	0.01	0.01	0.01
Ba	0.10	0.10	0.50	0.50	0.50	0.50
B	0.10	0.10	0.07	0.08	0.08	0.07
Cd	0.005	0.005	0.002	0.002	0.002	0.002
Cr	0.05	0.05	0.01	0.01	0.01	0.01
Cu	0.01	0.01	0.01	0.01	0.01	0.01
Fe	0.70	1.89	0.37	0.43	0.42	0.45
Pb	0.05	0.05	0.02	0.02	0.02	0.02
Mn	0.61	1.43	0.20	0.27	0.29	0.30
Hg	0.001	0.001	0.001	0.001	0.001	0.001
Mo	0.10	0.10	0.02	0.02	0.02	0.02
Ni	0.05	0.21	0.01	0.01	0.01	0.01
Se	1.09	3.71	0.10	0.11	0.09	0.08
V	0.49	1.30	0.08	0.08	0.06	0.06
Zn	0.02	0.04	0.01	0.01	0.01	0.01
Radiometric						
U (mg/l)	12.57	49.00	0.85	0.97	1.05	1.18
Ra 226 (pCi/l)	526.4	1120.0	179.2	192.2	171.5	181.0

Numeric values represent the mean of all
designated restoration wells for the specified phase of restoration

Table A-1. Stability Monitoring Water Quality Results for Designated Restoration Wells, MU6, Christensen Ranch, Wyoming

Ore Zone Baseline Well Groundwater Quality - Stability Round 1

Well I.D. / Module / Sample Date		BLW MEAN Revised 6/25/1999	6M29-1 MOD 61 06/21/05	6M34-1 MOD 61 06/21/05	6O26-1 MOD61 06/21/05	6P30-2 MOD 61 06/28/05	6R21-1 MOD61 06/21/05	6T17-1 MOD61 06/21/05	6T23-4 MOD 61 06/21/05	6T35-1 MOD 61 06/21/05	6U20-2 MOD 61 06/27/05	6V24-1 MOD61 06/22/05
Major Ions mg/l:	**Units**											
Ca	mg/L	26.28	100	15	21	25	32	15	34	22	15	6
Mg	mg/L	4.52	24	2.0	3.0	6.0	6.0	3.0	7.0	3.0	3.0	1.0
Na	mg/L	240.40	373	35	35	124	176	116	76	36	87	38
K	mg/L	6.21	7.0	< 1.0	< 1.0	3.0	4.0	3.0	1.0	< 1.0	2.0	< 1.0
CO3	mg/L	4.50	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 1.0
HC03	mg/L	74.21	629	56	33	293	262	295	179	27	218	8.0
SO4	mg/L	533.14	499	66	101	104	232	51	108	122	57	91
Cl	mg/L	4.58	18	1.0	1.0	8.0	10	3.0	7.0	1.0	4.0	1.0
NH4	mg/L	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.01	< 0.1	< 0.1	< 0.1	< 0.1
NO2 (N)	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
NO3 (N)	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.31	< 0.05
F	mg/L	0.14	< 0.1	< 0.1	< 0.1	0.1	< 0.1	0.3	< 0.1	< 0.1	< 0.1	< 0.1
SiO2	mg/L	4.50	6.0	11.2	14.3	4.5	6.7	4.6	9.4	10.6	4	17.6
TDS	mg/L	859.84	1350	170	220	420	580	260	410	120	260	150
Cond. (umho/cm)	umhos/cm	1263.25	1800	247	303	661	852	518	522	300	454	238
Alk. (as CaC03)	mg/L	70.09	516	46	27	240	214	241	147	22	179	7.0
pH (units)	s.u.	8.59	8.1	7.5	7.3	8.0	8.1	8.1	7.9	7.30	8.1	6.8
Trace Metals mg/l:												
Al	mg/L	< 0.050	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
As	mg/L	0.002	< 0.005	< 0.005	0.019	0.017	< 0.005	0.006	< 0.005	< 0.005	0.018	< 0.005
Ba	mg/L	< 0.050	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
B	mg/L	< 0.100	0.08	0.05	0.06	0.06	0.06	0.07	0.06	0.07	0.07	0.07
Cd	mg/L	< 0.050	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Cr	mg/L	< 0.050	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Cu	mg/L	< 0.050	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fe	mg/L	< 0.050	< 0.05	0.21	1.08	< 0.05	< 0.05	< 0.05	1.89	0.71	< 0.05	0.5
Pb	mg/L	< 0.005	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Mn	mg/L	< 0.050	0.29	0.12	0.22	0.06	0.08	0.05	0.87	0.68	0.03	0.03
Hg	mg/L	< 0.00020	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Mo	mg/L	< 0.050	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Ni	mg/L	< 0.050	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Se	mg/L	< 0.001	0.008	< 0.005	< 0.005	0.659	0.015	0.096	< 0.005	< 0.005	0.187	< 0.005
V	mg/L	< 0.050	< 0.02	< 0.02	0.03	0.28	0.03	0.10	0.03	< 0.02	0.52	< 0.02
Zn	mg/L	< 0.010	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Radiometric pCi/l:												
U (mg/l)	mg/L	0.0112	4.96	0.0139	0.0188	0.828	0.684	1.71	0.192	0.0272	0.541	0.0081
Ra 226	pCi/L	103.8	261.3	87.6	880	93.1	80.1	50.7	26.4	302	54.1	142.9
Ra 226+/-	pCi/L		9.6	5.5	17	5.6	5.2	4.2	3.2	10.0	4.5	7.3
Data Quality												
A/C Balance(+-5)	%		4.770	0.100	0.150	0.360	2.410	1.250	1.930	1.210	0.810	0.010
Anions	meq		21.22	2.31	2.69	7.19	9.40	5.98	5.37	3.02	4.91	2.07
Cations	meq		23.35	2.42	2.84	7.14	9.86	6.13	5.58	2.95	4.83	2.08
TDS Calculated	mg/L		1330	150	180	410	590	340	320	200	280	140
TDS Balance (0.80 - 1.20)	dec %		1.015	1.133	1.222	1.024	0.983	0.765	1.281	0.600	0.928	1.071

Smith Ranch/Highland Project

Source: CAMECO Resources, 2009, Mine Unit B Ground Water Restoration Report, Smith Ranch-Highland Uranium Project, August 5, 2004. Available from the NRC ADAMS document server under accession no. ML091831100.

Table 4: Groups of Mine Unit B Post Restoration Water Quality

Group I – Meet Baseline

Parameter	Units	BASELINE (Oct/Nov 1987)	END MINING (July 1991)	MU-B AVG of MPs (June 28, 2004)	CLASS I	CLASS II	CLASS III	HUP MP-Well Baseline AVG
Ca *	mg/l	49.5	349	80.7				82.1
Mg *	mg/l	10.2	65.5	16.7				16.8
Na	mg/l	57.2	83.4	43.4				43.0
K	mg/l	8.0	16.7	5.8				9.8
CO3	mg/l	0.15	0.0	< 1				0.072
SO4	mg/l	117	402	64.2	250.0	200.0	3000.0	207
NO2	mg/l	0.01	0.1	< 0.1	1.0		10.0	0.04
NO3	mg/l	0.14	0.3	< 0.1	10.0			0.09
F	mg/l	0.22	0.1	0.17	1.4-2.4			0.22
SiO2	mg/l	15.8	18.8	14.2				17.2
COND *	µmho/cm	564	2580	665				728
Al	mg/l	< 0.1	0.1	< 0.1		5.0	5.0	< 0.1
Ba	mg/l	< 0.1	0.1	< 0.1	1.0			< 0.1
B	mg/l	< 0.1	0.1	< 0.1	0.75	0.75	5.0	< 0.1
Cd	mg/l	< 0.01	0.01	< 0.005	0.01	0.010	0.050	< 0.01
Cr	mg/l	< 0.05	0.1	< 0.05	0.05	0.10	0.05	< 0.05
Cu	mg/l	< 0.01	0.01	< 0.01	1.00	0.20	0.50	< 0.01
Pb	mg/l	< 0.05	0.1	< 0.05	0.05	5.00	0.10	< 0.05
Hg	mg/l	< 0.001	0.0	< 0.001	0.002		0.00005	< 0.001
Mo	mg/l	< 0.1	0.1	< 0.1				< 0.1
Ni	mg/l	< 0.05	0.07	< 0.05		0.20		< 0.05
Ra 226 *	pCi/l	316	1478	437	5	5	5	480
V	mg/l	< 0.1	0.1	< 0.1		0.10	0.10	< 0.1
Zn	mg/l	< 0.01	0.11	< 0.01	5.00	2.00	25.00	< 0.01

* Parameter Meets Project Wide MP - Well Baseline Average

Group II - Meet Class I or Class II

Parameter	Units	BASELINE (Oct/Nov 1987)	END MINING (July 1991)	MU-B AVG of MPs (June 28, 2004)	CLASS I	CLASS II	CLASS III	HUP MP-Well Baseline AVG
NH4	mg/l	0.16	0.52	0.46	0.5			0.13
Cl	mg/l	5.3	232	16.8	250.0	100.0	2000.0	3.7
TDS	mg/l	350	1672	397	500	2000	5000	477
pH	std. units	8.12	6.9	7.1	6.5-9.0	4.5-9.0	6.5-8.5	7.9
As	mg/l	< 0.001	0.008	0.058	0.050	0.100	0.200	0.002
Fe	mg/l	0.052	0.1	1.3	0.30	5.00		0.05
Se	mg/l	< 0.001	0.806	0.009	0.01	0.020	0.050	0.004
U nat	mg/l	0.062	22.3	1.79	5.00	5.00	5.00	0.492

Group III - Exceed Class I or Class II or no Standard

Parameter	Units	BASELINE (Oct/Nov 1987)	END MINING (July 1991)	MU-B AVG of MPs (June 28, 2004)	CLASS I	CLASS II	CLASS III	HUP MP-Well Baseline AVG
HCO3	mg/l	206	824	319				200
ALK	mg/l	171	686	261				165
Mn	mg/l	0.032	0.9	0.36	0.05	0.20		0.03

Crow Butte Project

Source: Crow Butte Resources, Inc., 2007, Application for Amendment of USNRC Source Materials License SUA-1534, North Trend Expansion Area, Technical Report, May 30, 2007. Available from the NRC ADAMS document server under accession no. ML071760349.

Table 2.7-15: Anticipated Changes in Water Quality During Mining

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

Dewey-Burdock Project
Large Scale Mine Permit Application
Revision Index

Responses to December 12, 2012 and March 1, 2013 Technical Review Comments

Volume	Page, Map or other Permit Entry to be Removed	Page, Map or other Permit Entry to be Added	Description of Change
1	p. i-xxiii	p. i-xxv	Update Table of Contents to accommodate replacement pages.
1	p. 5-3	p. 5-3	Technical comment GFP-2 - Update Table 5.0-2 to add USFWS and SDGF&P to regulatory primacy of ecology; add note #6.
1	p. 5-49, 50	p. 5-49, 50	Technical comment 1 - Added commitment to provide copies of well field hydrogeologic data packages and injection authorization data packages to DENR for information purposes; indicated that all well field packages will be provided to NRC for review and approval or verification.
1	p. 5-59	p. 5-59, 59a	Technical comment GFP-14 - Added Section 5.3.3.9, Approach to Well Field Development with Respect to Historical Exploration Holes.
1	p. 5-60	p. 5-60	Technical comment 12 - Added commitment to provide as-constructed pond drawings to DENR.
1	p. 5-71	p. 5-71, 71a	Technical comment 2 - Added commitment to provide copies of SOPs addressing pond leakage to DENR; discussed potential recurring water in a leak detection system. Technical comment 3 - Added commitment to notify DENR within 48 hours of the confirmation of a pond leak.
	p. 5-78, 78a	p. 5-78, 78a, 78b	Technical comment 2 (December) - Added references to new diversion designs, discussion of diversions around treated water storage ponds and surge ponds, and commitment to provide copies of grading and drainage plans addressing small drainage areas around ponds.
1	p. 5-83 through 83e	p. 5-83 through 83f	Technical comment 15 - Added reference to conceptual catchment area designs in Plates 5.4-1 and 5.4-2 and dicussion of catchment area operation.
1	p. 5-85 through 87	p. 5-85 through 87	Technical comment 4 - Updated Tables 5.4-2 and 5.4-3 depicting estimated end-of-production groundwater quality and land application water quality; updated text to reflect the methods used to prepare the tables.
1	p. 5-110	p. 5-110	Technical comment 9 - Updated name of Section 5.5.4 to include other aspects of land application system monitoring besides effluent.
1	p. 5-112	p. 5-112 through 112b	Technical comment 9 - Added Sections 5.5.4.2 through 5.5.4.6 to address monitoring associated with land application systems, including catchment area water quality, soil/vegetation, livestock, prairie dogs, and groundwater/surface water. Technical comment 15 - Added Table 5.5-6 listing trigger values for catchment areas and commitment to dewater catchment areas if trigger values are exceeded. Technical comment GFP-3(a), (b) - Added discussion on prairie dog sampling.
1	p. 5-113, 113a	p. 5-113, 113a	Technical comment 9 - Added Table 5.5-7 listing trigger values for land application area soils.

Dewey-Burdock Project
Large Scale Mine Permit Application
Revision Index

Responses to December 12, 2012 and March 1, 2013 Technical Review Comments

Volume	Page, Map or other Permit Entry to be Removed	Page, Map or other Permit Entry to be Added	Description of Change
1	p. 5-114, 115	p. 5-114, 114a, 115	Technical comment 9 - Added discussion on livestock sampling associated with land application systems. Technical comment GFP-3(a), (b) - Added Section 5.5.9 discussing prairie dog sampling for potential bioaccumulation. Technical comment GFP-3(e) - Added commitment to analye fish samples for selenium and to sample fish and macro-invertebrates in the unlikely event that a spill reaches Beaver Creek.
1	p. 5-119, 120	p. 5-119, 120	Technical comment 9 - Added further discussion on leaching methods to mitigate potential salinity impacts; added discussion on annual evaluation for potential saline seeps. Technical comment 4 - Updated the anticipated SAR range in land applied water.
1	p. 5-132	p. 5-132	Technical comment 4 (December) - Modified commitment to notify DENR within 48 hours of a verified excursion.
1	p. 5-155 through 160	p. 5-155 through 162	Technical comment 1 (December) - Added reference to Avian Monitoring and Mitigation Plan (Appendix 5.6-C) in Sections 5.6.11.1.5 and 5.6.11.1.11. Technical comment 6 - Added list of raptor species associated with raptor nests or potential nest sites to Section 5.6.11.1.5. Technical comment 7 - Added discussions of species tracked by SDNHP to Sections 5.6.11.1.4, 5.6.11.1.5 and 5.6.11.1.7 through 5.6.11.1.10. Technical comment 8 - Updated discussion on species tracked by SDNHP in Section 5.6.11.1.11. Technical comment GFP-9 - Updated discussion of bald eagle nests within proposed permit area in Section 5.6.11.1.11.
1	p. 5-161, 161a, 162	p. 5-162a through 162d	Technical comment 1 (December) - Added summary of Avian Monitoring and Mitigation Plan (Appendix C). Technical comment GFP-1(a) - Added description of facility pond fencing to exclude large and small mammals. Technical comment GFP-1(b), 3(c) - Added Table 5.6-2a listing trigger values for avian deterrent systems for treated water ponds. Technical comment GFP-11 - Added description of barbed wire perimeter fencing to permit big game passage.
1	p. 5-172	p. 5-172	Technical comment 11 - Added commitment to retain records of locations of all injection, production and monitor wells throughout the postclosure monitoring period.
1	p. 5-173	p. 5-173	Technical comment 9, GFP-3(b) - Updated annual environmental monitoring report to include results of all livestock and wildlife sampling.

Dewey-Burdock Project
Large Scale Mine Permit Application
Revision Index

Responses to December 12, 2012 and March 1, 2013 Technical Review Comments

Volume	Page, Map or other Permit Entry to be Removed	Page, Map or other Permit Entry to be Added	Description of Change
1	p. 5-175	p. 5-175, 175a	Technical comment 9, GFP-3(a) - Updated annual land application report to include all applicable monitoring results, evaluation of potential increasing trends and bioacumulation, description of mitigation measures, and evaluation for potential saline seeps. Technical comment GFP-12 - Added annual wildlife report description. Technical comment GFP-13 - Added commitment to notify SDGF&P of any wildlife mortailities within 24 hours.
1	p. 7-2	p. 7-2	Added EPA reference on aquatic life criteria.
1	p. 7-5	p. 7-5	Added Raisbeck reference on livestock and wildlife quality criteria.
3	Plate 5.3-1 (Sheets 1,2)	Plate 5.3-1 (Sheets 1,2)	Technical comment 2 (December) - Updated diversions. Technical comment 13 - Updated topsoil stockpile location (Sheet 1). Technical comment 14 - Updated Dewey primary access road (Sheet 1).
3	Plate 5.3-2 (Sheet 1)	Plate 5.3-2 (Sheet 1)	Technical comment 2 (December) - Updated diversions; updated affected area boundary near Diversion 2 (Sheet 1). Technical comment 14 - Updated Dewey primary access road (Sheet 1).
3	Plate 5.3-5 (Sheet 1)	Plate 5.3-5 (Sheet 1)	Technical comment 14 - Updated Dewey primary access road (Sheet 1).
3a	---	Plate 5.3-17a	Technical comment 2 (December) - Updated diversion designs.
3a	---	Plate 5.3-17b	Technical comment 2 (December) - Updated diversion designs.
3a	---	Plate 5.3-18	Technical comment 2 (December) - Updated diversion designs.
3a	---	Plate 5.3-19	Technical comment 2 (December) - Updated diversion designs.
3a	---	Plate 5.4-1	Technical comment 15 - Updated conceptual catchment area designs.
3a	---	Plate 5.4-1	Technical comment 15 - Updated conceptual catchment area designs.
4	App. 1.0-B, p. 1.0-B-1,2	App. 1.0-B, p. 1.0-B-1,2	Technical comment 15, GFP-1(b) - Updated technical revision list to specify that trigger values as well as compliance limits may be modified by technical revision subject to DENR approval.
4	---	App. 3.2-D	Technical comment GFP-14 - Added 1989 letter from TVA to DENR regarding TVA historical exploration hole plugging.
6	App. 6.4-C, p. 6.4-C-1 through 4	App. 6.4-C, p. 6.4-C-1 through 4	Technical comment Ag-1 - Updated noxious weed control plan, including clarification that yearly inspections will be performed during the active growing season of weeds, herbicide application will be performed by a SD-licensed pesticide applicator and grazing/haying restrictions on herbicide labels will be followed. Technical comment Ag-2 - Updated Custer County noxious weed list. Technical comment Ag-3 - Updated SDSU Extension 2013 reference.
6	App. 6.4-D, p. 6.4-D-1,2	App. 6.4-D, p. 6.4-D-1,2	Technical commet 3 (December) - Updated Section 1.4, Sustainability of the Reclamation, to address SDCL 45-6B-39.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF PLATES

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF APPENDICES

TABLE OF CONTENTS (Continued)

Table 5.0-2: Regulatory Primacy

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

Notes:

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

Measurements during pump testing will include instantaneous and totalized flow, periodic pressure transducer measurements, barometric pressure, and time. A step rate test will be performed initially. There will be an initial stabilization phase with no flow, a stress period of constant flow, and a recovery period with no flow.

Pump Test Evaluation

Evaluation of pump test data will address the following:

1) Demonstration of hydraulic connection between the production and injection wells and all perimeter monitor wells and across the production zone.
2) Verification of the geologic conceptual model for the well field.
3) Evaluation of the vertical confinement and hydraulic isolation between the production zone and overlying and underlying units.
4) Calculation of the hydraulic conductivity, storativity, and transmissivity of the production zone sand unit.
5) Evaluation of anisotropy within the production zone sand unit.

5.3.3.4 Well Field Hydrogeologic Data Packages

Pump testing data and results will be included in the well field hydrogeologic data packages, which will be prepared in accordance with NRC license requirements. Upon completion of field data collection and laboratory analysis, the well field hydrogeologic data packages will be assembled and submitted for review by the Safety and Environmental Review Panel (SERP) for evaluation. The SERP is described in Section 5.7.2.3. The SERP evaluation will determine whether the results of the hydrologic testing and the planned ISR operations are consistent with standard operating procedures and technical requirements stated in the NRC license. The evaluation will include review of the potential impacts to human health and the environment. Following SERP evaluation, well field hydrogeologic data packages will be submitted to NRC for review and approval/verification in accordance with NRC license requirements. A copy of each well field package also will be submitted to DENR for information purposes. The well field hydrogeologic data package and written SERP evaluation will be maintained at the site and available for regulatory agency review.

Each well field hydrogeologic data package will contain the following:

1) A description of the proposed well field (location, extent, etc.).

2) Map(s) showing the proposed production and injection well patterns and locations of all monitor wells.
3) Geologic cross sections and cross section location maps.
4) Isopach maps of the production zone sand and overlying and underlying confining units.
5) Discussion of how pump testing was performed, including well completion reports.
6) Discussion of the results and conclusions of the pump testing, including pump testing raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and, when appropriate, directional transmissivity data and graphs.
7) Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns.
8) Baseline water quality information including proposed upper control limits (UCLs) for monitor wells and target restoration goals (TRGs).
9) Any other information pertinent to the proposed well field area tested will be included and discussed.

In addition to the well field hydrogeologic data packages, Powertech (USA) will prepare and submit injection authorization data packages to EPA for each well field. The injection authorization data packages will contain much of the information described previously for well field hydrogeologic data packages, including well field designs, pump testing results, calculated formation fracture pressure for each header house and the designated maximum injection pressure for each header house. A copy of each injection authorization data package will be submitted to DENR for information purposes.

5.3.3.5 Well Field Operation

Refer to Section 5.1.3 for an overview of well field operations. The following sections describe key operating provisions in greater detail, including hydraulic well field control, injection pressure, and the water balance.

5.3.3.5.1 Hydraulic Well Field Control

Powertech (USA) will maintain hydraulic control of each well field from the first injection of lixiviant through the end of aquifer restoration. During uranium recovery, the groundwater removal rate in each well field will exceed the lixiviant injection rate, creating a cone of depression within each well field. During aquifer restoration, the groundwater removal rate in each well field will exceed the injection rate of permeate and clean makeup water from the Madison Limestone or another suitable formation. If there are any delays between uranium recovery and aquifer restoration, production wells will continue to be operated as needed to

Chilson. This unit is at least 200 feet beneath the base of the Fuson Shale and is well below the historical mining disturbance in the Fall River Formation.

Powertech (USA) also will install and sample operational monitor wells in the Fall River, Chilson, and alluvium between the surface (open-pit) mines and well field areas. For additional information, refer to Section 5.5.2.3.

5.3.3.8 Approach to Well Field Development with Respect to Alluvium

This section summarizes Powertech (USA)'s approach to well field development in areas of Beaver Creek and Pass Creek alluvium, including alluvial characterization, pump testing, and operational monitoring. This section consolidates information presented elsewhere in the application and includes references to the applicable sections.

Alluvial Characterization

Powertech (USA) completed an alluvial drilling program in 2011 to characterize the thickness, extents, and saturated thickness (if water was present) of the alluvium along Beaver Creek and Pass Creek. Alluvial characteristics will be further evaluated during well field delineation drilling described in Section 5.3.3.3.

Pump Testing

As described in Section 5.3.3.3, an extensive pump testing program will be designed and implemented prior to operation of each well field to evaluate the hydrogeology and assess the ability to operate the well field. Monitor wells will be completed in the alluvium, if present.

Operational Monitoring

Section 5.3.3.1.2.2 describes how alluvium will be treated as an overlying hydrogeologic unit and monitored appropriately during operational groundwater monitoring. Powertech (USA) also will monitor potential changes in alluvial water quality throughout the permit area through the monitoring network described in Section 5.5.2.3.

5.3.3.9 Approach to Well Field Development with Respect to Historical Exploration Holes

Powertech (USA) has extensive information about the location of exploration holes within the permit area. A map of historical exploration holes is provided as Figure 3.2-7, and a detailed inventory is provided as Appendix 3.2-A. The vast majority of historical drill holes were plugged and abandoned in accordance with State of South Dakota requirements in place during drilling. Historical TVA drilling and Powertech (USA)'s exploration drilling were conducted through

DENR-issued Permits to Explore. These permits required exploration holes to be plugged with bentonite or cement grout. An exploration bond was held by the State to ensure the proper plugging of all exploration holes. A 1989 letter from TVA to DENR describes how to the best of TVA's knowledge, all TVA test holes were properly plugged and abandoned in accordance with applicable regulations. The letter discusses attempted mitigation of the one drill hole known to be seeping to the surface in the "alkali area." Throughout the entire proposed permit area, there is only one recorded instance ("alkali area") where water seepage to the surface is suspected to have come from an exploration hole (refer to Section 3.4.2.2.3).

Prior to developing each well field, Powertech (USA) will use best available information and best professional practices to locate exploration holes or wells in the vicinity of the planned well field, including historical records, color infrared imagery, field investigations, and potentiometric surface evaluation and pump testing conducted for each well field. Section 5.3.3.3 describes the procedures that will be followed to demonstrate that the production and injection wells are hydraulically isolated from overlying and underlying aquifers. These include static potentiometric water level evaluations to identify any anomalous conditions indicative of leakage across aquitards; water quality sampling and evaluation to identify any potential areas of leakage; and drawing down the production zone sand unit through pump testing while recording the presence or lack of response in vertical monitor wells to evaluate vertical confinement. This information will be contained within well field hydrogeologic data packages submitted to NRC for review and verification/approval and submitted to DENR prior to operating each well field (see Section 5.3.3.4).

If it is determined that an unplugged exploration hole has the potential to impact the control and containment of ISR solutions, Powertech (USA) will plug and abandon or mitigate the exploration hole (see Section 5.6.3.2). It is not surprising that there is little evidence of unplugged holes in the permit area, due to the well-known natural tendency of drill holes to seal themselves by collapsing and swelling of the formations.

5.3.4 Ponds

<u>5.3.4.1 Pond Design</u>

Lined ponds will be used to temporarily store liquid waste generated at the Satellite Facility and CPP. The pond lining systems will vary according to pond use. Ponds containing untreated liquid waste or ponds used in the treatment process (e.g., radium settling ponds) will be provided with two geosynthetic liners, a clay liner, and a leak detection system. Ponds containing treated water

will be provided with a single geosynthetic liner underlain by a clay liner. The pond capacity will vary according to the liquid waste disposal option. Greater capacity is required for the land application option, since liquid waste will be stored during times of year when the land application systems are not operated.

The pond design for both liquid waste disposal options is summarized below. Appendix 5.3-A provides detailed pond design information, and Appendix 5.3-B contains pond construction specifications, testing and QA/QC procedures. Section 5.3.4.2 provides detailed descriptions of pond sizing calculations. Powertech (USA) will provide as-constructed drawings of the ponds to DENR.

Land Application Option

The land application disposal option will include the following ponds:

- **Two (2) Radium Settling Ponds** - one near each land application area (Dewey and Burdock). Each pond will have an operating capacity of 39.4 acre-feet. Radium settling ponds for the land application disposal option were designed such that a single pond has sufficient capacity for radium removal of the entire project-wide wastewater stream at the maximum expected production bleed of 3% while maintaining a minimum retention time of 14.1 days.
- **Two (2) Spare Ponds** - one at each area. Each pond will have an operating capacity of 39.4 acre-feet. The spare ponds will be designed with the same dimensions and liner system as the radium settling ponds so that they can be used as either spare radium settling ponds or spare central plant ponds.
- **Two (2) Outlet Ponds** - one at each area. Each pond will have an operating capacity of 4.9 acre-feet. The outlet ponds will be designed to temporarily store treated water from the radium settling ponds and provide extra capacity for the radium settling ponds during large precipitation events.
- **Eight (8) Storage Ponds** - four at each area. Each pond will have an operating capacity of 63.8 acre-feet. The storage ponds will be used to store treated water during the winter months when no liquid waste disposal by land application systems is available. The total storage required at each area was obtained using the SPAW model, which is discussed in more detail in Appendix 5.3-A and the GDP.
- **Two (2) Spare Storage Ponds** - one at each area. Each pond will have an operating capacity of 63.8 acre-feet. The spare storage ponds will be designed with the same dimensions and liner system as the storage ponds so that they can be used in the event of an upset condition.
- **One (1) Central Plant Pond** - located at the CPP, with an operating capacity of 36.2 acre-feet. The storage capacity design for the central plant pond allows for over 18 months of CPP liquid waste storage, which will be required during initial uranium

Powertech (USA) will be required by NRC license conditions to develop standard operating procedures (SOPs) prior to operations for leaks or spills, including pond leakage. Powertech (USA) will provide DENR with a copy of the SOP(s) addressing response actions to leakage in the pond liners. Following is a summary of the procedures that will be followed in the event of a pond leak. 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. The indicator parameters will be chloride and conductivity. If the analysis confirms a leak, a secondary sample shall 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. In addition, Powertech (USA) will notify DENR by phone or email of any pond leak within 48 hours of the confirmation. A pond removed from service because of a confirmed leak will be dewatered by transferring the contents to a spare pond. Regardless of the disposal option used at the project, the Dewey and Burdock areas each will have a spare pond of identical capacity, construction, and dimensions as the primary radium settling ponds. At the Burdock area, the spare pond also may serve as a spare for the central plant pond.

If recurring water is present in a leak detection system and it is confirmed through laboratory analysis that it is not caused by a leak (e.g., condensation could collect in the leak detection system), Powertech (USA) may elect to install a submersible pump in the leak detection system sump to routinely dewater the leak detection system and minimize the hydraulic head on the secondary liner. The pond design drawings in Appendix 5.3-A and 5.3-B show that an access port and 8-inch diameter PVC pipe will be available to lower a submersible pump into the leak detection sump.

5.3.5 Instrumentation and Emergency Shutdown

Powertech (USA) will install automated control and data recording systems at the Satellite Facility and CPP which will provide centralized monitoring and control of the process variables including the flow rate and pressure of production, injection, and waste streams. The systems will include alarms and automatic shutoffs to detect and control a potential release or spill.

Pressure and flow sensors will be installed, for the purpose of leak detection, on the main trunklines that connect the CPP and Satellite Facility to the well fields. In addition, the flow rate of each production and injection well will be measured automatically. Measurements will be collected and transmitted to both the CPP and Satellite Facility control systems. Should pressures

or flows fluctuate outside of normal operating ranges, alarms will provide immediate warning to operators which will result in a timely response and appropriate corrective action.

Both external and internal shutdown controls will be installed at each header house to provide for operator safety and spill control. The external and internal shutdown controls will be designed for automatic and remote shutdown of each header house. 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.

An external header house shutdown will activate an electrical disconnect switch located on the outside of the header house or at the transformer pole which will shut down all electrical power to the header house. This will mitigate potential electrical hazards while de-energizing the header

submergence. Figures 5.3-10 and 5.3-11 show that all ISR wells and monitor wells will be sealed.

Estimates of peak flood discharges and water levels produced by floods on Pass Creek, Beaver Creek and local small drainages are provided in Section 3.5.2.3 and Appendix 3.5-A. Plate 3.5-1 depicts the modeled flood inundation areas for all surface water features during the 100-year, 24-hour storm event in relation to proposed facilities and infrastructure. As described in Appendix 3.5-A, HEC-HMS models were used to calculate peak discharges, and HEC-RAS models were used to compute water-surface profiles and inundated areas for the respective runoff events.

Any disturbance to the prevailing hydrologic balance of the affected land and of the surrounding area and to the quality and quantity of water in surface water systems both during and after ISR operations and during reclamation will be minimized in accordance with SDCL 45-6B-41. No diversions will be constructed on perennial stream channels, and only relatively minor quantities of surface runoff will be captured in sediment ponds. Therefore, little or no impacts to the surface water hydrologic balance will occur. Surface water quality will be protected through erosion control BMPs and sediment control measures described below. Section 5.6.5 describes mitigation measures to protect surface and groundwater from potential leaks or spills.

5.3.9.1 Diversion Channels

Following is a description of the diversion channels that will be constructed within the permit area for the processing facilities and ephemeral stream channels.

Diversion channel designs for the processing facilities are provided on Plates 5.3-13, 5.3-14, and 5.3-19. These supersede the diversion channel designs for the processing facilities in Appendix 5.3-B. In accordance with ARSD 74:29:07:09(6), the diversions around the CPP, Satellite Facility and associated radium settling ponds and central plant pond have been designed for the 6-hour PMP event. Diversions were not designed for the PMP event around the storage ponds or spare storage ponds, since a) these ponds will store only treated water en route to the land application that will not contain radionuclides in excess of allowable discharge limits, b) the treated water storage ponds are not associated with uranium processing or wastewater treatment, and c) NRC guidance in Regulatory Guide 3.11 indicates that diversion designs for isolated areas where pond failure would neither jeopardize human life nor create damage to property or the environment beyond Powertech (USA)'s financial assurance capabilities do not need to use extremely conservative flood design criteria. Powertech (USA) will not change the use of the treated water storage ponds or spare storage ponds without obtaining DENR authorization through a technical revision or permit amendment, the application for which would include

diversion designs for the 6-hour PMP event. In the land application option, no diversions will be required around the processing facilities or radium settling ponds due to the small drainage area above these facilities.

Plates 5.3-17b and 5.3-18 depict diversions designed to keep storm water out of the treated water storage ponds and spare storage pond in the Dewey area (land application option). Plate 5.3-17a depicts a diversion for the Dewey area surge pond (deep disposal well option). These diversions are capable of passing the 2-year, 6-hour storm event without erosion and have the capacity for a 100-year, 24-hour event. In the Burdock area, drainage areas above the treated water storage ponds and surge pond are less than 10 acres. There are also small drainage areas between the catchment areas and Dewey treated water storage ponds of less than 10 acres. Diversions are not planned in these areas due to the small drainage area and small size of the associated runoff events. The pond embankments in these cases will extend at least 1 foot above ground, which along with grading and drainage plans will be sufficient to ensure that no runoff will enter any of the ponds up to the 100-year, 24-hour storm event. Prior to construction, Powertech (USA) will prepare grading and drainage plans for the ponds and processing facilities and provide copies to DENR.

With the exception of Beaver Creek, all stream channels within the permit area are ephemeral. Pass Creek above the permit area could be considered intermittent, but it is ephemeral within the permit area since there is no groundwater component and flows only occur in response to precipitation or snowmelt events. No diversions are planned on Beaver Creek or Pass Creek, and no diversions are planned on perennial or intermittent streams.

Plates 5.3-6 and 5.3-7 provide the locations of planned ephemeral stream channels within the permit area. The designs for the diversions associated with the initial well fields and land application areas are presented on Plates 5.3-9 through 5.3-11. Diversion designs for future well fields, if needed, will be provided to DENR for review and verification prior to construction.

Diversions of ephemeral channels will be designed to maintain channel velocities equal to or less than 5 feet per second for the discharge from a 2-year, 6-hour precipitation event and have the ability to contain the discharge from a 100-year, 24-hour precipitation event.

Interim revegetation will be performed on the bottoms and side slopes of all diversions to reduce erosion. In instances where the diversion channel velocity during the design storm exceeds 5 feet per second, other erosion control measures will be implemented such as geosynthetic liners, geosynthetic filter media, or riprap. Diversions will be constructed with 3:1 or shallower side slopes to reduce the risk of slope failure, promote interim revegetation, and allow safe passage for humans, wildlife and livestock. Diversion bottom elevations will tie to undisturbed upstream

and downstream channel elevations to eliminate increased erosion potential. Diversions will not discharge onto topsoil or spoil stockpiles or other unconsolidated material such as newlyreclaimed areas. Culvert or bridge crossings over the diversions are not planned. If it becomes necessary to cross a diversion in the future, Powertech will submit design drawings to DENR for review and approval prior to construction.

5.3.9.2 Erosion Control

Powertech (USA) will minimize erosion of disturbed, reclaimed and native areas through proper land management and farming techniques. Typically, following ground disturbance, areas will be prepared and seeded as soon as possible to reduce the possibility of erosion. Also, erosion control measures will be used to reduce overland flow velocity, reduce runoff volume or trap sediment. Examples include rip-rap, vegetative sediment filters, check dams, mulches, cover crops, and other measures. Plates 5.3-6 through 5.3-8 show the sediment control measures that will be used in the permit area.

used (typically November through early March). Additional design information for the land application systems is presented in the GDP. Figure 5.3-1 depicts the proposed facilities in the land application option.

Each of the two land application systems will have up to 315 acres of irrigated area and an additional 65 acres of center pivots on standby. Each of the two land application systems is designed for an average annual application rate of 310 gpm and an instantaneous application rate of 297 to 653 gpm.

Plates 5.4-1 and 5.4-2 depict the conceptual catchment area designs in the Dewey and Burdock areas, respectively. The conceptual designs are described in the GDP and consist of earthen berms located at or near the downgradient edges of the center pivot areas. Sufficient capacity for containment of the 100-year, 24-hour runoff event will be provided for all land application areas. Plates 5.4-1 and 5.4-2 show that most conceptual catchment area designs include excess capacity beyond that required for 100-year, 24-hour runoff storage resulting from the upgradient drainage area. In these cases, the conceptual catchment area designs include a designated "normal operating level," which is the maximum level allowed to fill with runoff and snowmelt while still maintaining adequate freeboard for the 100-year, 24-hour runoff event. The catchment areas will not be used to store land applied solutions and only will contain water following rainfall or snowmelt events in accordance with GDP permit conditions. The normal operating level will be delineated with a clearly visible marker such as a t-post, which will be installed on the catchment berm or another highly visible location.

In some cases, more than one catchment area may be used to contain the 100-year, 24-hour runoff volume. In these cases, there will not be a designated normal operating level in the upgradient catchment areas. Any time runoff or snowmelt accumulates in a catchment area without a designated normal operating level it will be dewatered to a downgradient catchment area with a designated normal operating level. It is anticipated that dewatering will occur via gravity discharge through a pipe with the inlet invert elevation at the bottom of the upgradient catchment area. In this case flow would be controlled by a manual valve, normally closed, in the discharge pipe. Following a rainfall or snowmelt event, the valve would be opened and the water drained to the downgradient catchment area at non-erosive velocity. Other alternatives may include pumping or water trucks. As described in Table 1.1-2 under ARSD 74:29:05:14(1), as-constructed plans of the land application systems, including catchment area dewatering systems, will be provided to DENR prior to operation.

If a catchment area fills above the normal operating level, a dewatering program will be initiated. The catchment area will be dewatered, with the excess water conveyed to another catchment area with excess operating capacity or the storage ponds, or pumped to a land application pivot area (primary or standby area). It is anticipated that pumps will be installed in the most downgradient catchment areas, with pump discharge piping routed to the storage ponds. In this case the piping would be installed in the same corridor as the pipelines from the ponds to the pivot areas wherever possible. These pipelines are shown on Plates 5.4-1 and 5.4-2. Alternately water trucks may be used in some circumstances to dewater catchment areas and transfer the contents to the storage ponds or another catchment area. If water trucks are to be used, Powertech will demonstrate in the as-constructed land application system plans that the catchment areas can be dewatered in a timely manner. A catchment area also will be dewatered if the water quality exceeds trigger values protective of livestock and wildlife as described in Section 5.5.4.2.

In the land application option, groundwater withdrawn during aquifer restoration will not be treated with RO. Instead, the aquifer restoration water will be disposed directly in land application systems following treatment to remove uranium and radium. The water balance for the land application option is presented in Section 5.3.3.5.3.

Following is a summary of how the proposed land application systems satisfy specific site evaluation and compatibility criteria in ARSD 74:29:05:16.

Potential Impacts to Wildlife Grazing in Land Application Areas (ARSD 74:29:05:16(1))

Potential impacts to wildlife grazing in the land application areas will be minimized through treating the land application effluent prior to application, monitoring vegetation within land application areas, and evaluating the monitoring results annually to detect potential increasing trends in constituent concentrations. As a condition of the GDP, the land application water quality will be required to meet effluent limits established by DENR that are protective of groundwater quality. Section 5.4.1.1.4.1 describes the anticipated land application water quality. Trace metal concentrations are anticipated to be at or below ARSD 74:54:01:04 human health standards. Radionuclide concentrations will be below 10 CFR Part 20, Appendix B, Table 2, Column 2 effluent limits for release of radionuclides to the environment. The suitability of land application vegetation to wildlife grazing will be verified through annual vegetation monitoring in the land application areas. Section 5.5.6.2 describe how vegetation in the land application areas will be sampled each year. Section 5.5.6.2 describes how this information will be evaluated annually and the results reported to DENR to determine whether there is any risk to wildlife.

Compatibility with Site Geology and Soils ((ARSD 74:29:05:16(2) and (4))

The site geology is well suited to land application. The depth to alluvial groundwater, where encountered, is greater than the maximum anticipated infiltration depth of the land application water. The Graneros Group shales will prevent the land application water from reaching bedrock aquifers. The thickness of the Graneros Group is approximately 500 to 550 feet beneath the proposed Dewey land application area and approximately 25 to 250 feet beneath the proposed Burdock land application area. Refer to Cross Sections 3.2-23 through 3.2-27, which depict the thickness of the Graneros within the proposed land application areas.

Geologic conditions make it unlikely that land applied water will reach the alluvium. These conditions include the limited presence of alluvium in the Dewey land application area and the thickness and composition of the material beneath the land application areas. In the Dewey area, most of the planned primary pivot areas do not overlie alluvium. Of the 315 acres of primary center pivots planned in the Dewey area, only about 55 acres (17 percent) occur within the extents of mapped alluvium (refer to Figure 6.1-1 in the GDP application). While most of the planned Dewey standby pivot areas overlie mapped alluvium, the potential for land applied water to reach the alluvium in the standby areas is much lower, since Powertech (USA) does not anticipate using these areas regularly.

In all potential land application areas (Dewey and Burdock), the thickness and composition of the material between the pivot areas and alluvial groundwater, where present, will act to prevent land applied water from reaching alluvial groundwater. In the Burdock area, the depth to the top of the alluvial gravel within the planned pivot areas ranges from about 12 to 35 feet and is typically 15 to 25 feet. The depth to alluvial groundwater, where present, is typically 13 to 35 feet. In the Dewey area, there are only limited areas in which the planned pivot areas overlie saturated alluvium. Based on ambient sampling conducted in support of the GDP application, the depth to alluvial groundwater, where present beneath the potential Dewey pivot areas, is anticipated to be at least 18 feet. By comparison, the SPAW model simulations predict that the land application water will not percolate deeper than 8 feet.

The soil hydraulic properties beneath the land application areas will help prevent the migration of water into the alluvial groundwater. Soils sampled from test pits in and around the land application areas predominantly contain clay and silt, with lesser amounts of sand and virtually no gravel to depths of 7 to 10 feet. The SPAW modeling simulations considered permeability measurements from soil samples collected in the land application areas.

<u>Compatibility with Groundwater and Surface Water Systems (ARSD 74:29:05:16(3)</u>

Land applied water has a very low potential to reach groundwater or to flow through the alluvium and reach Beaver Creek or Pass Creek based on geologic conditions, Powertech (USA)'s commitment to plug and abandon existing wells within the land application areas, operating plans, and the implementation of extensive monitoring systems. Each of these is described below with the exception of geologic conditions, which was described previously.

Plugging and Abandoning Existing Wells

Powertech (USA) has not identified any existing wells within the proposed Dewey land application area. Within the proposed Burdock land application area, there are two existing wells, including one former domestic well (well 43) and one stock well (well 15). Prior to operation of the Burdock land application system, both of these wells will be plugged and abandoned with bentonite or cement grout in accordance with the procedures in ARSD 74:02:04:67. This will eliminate the potential for vertical migration of land applied solutions through existing wells.

Operating Plans

The land application rate has been designed specifically to minimize percolation below the rooting zone. The typical application rate is about 19 inches during the land application season of approximately April through October. This is a typical agronomic rate for growing alfalfa and grasses in this region.

Monitoring Systems

Groundwater monitoring will allow Powertech (USA) to track the movement of land applied water through the subsoil beneath the land application areas, determine whether land applied water reaches the alluvium, and track changes in alluvial water quality within the POP zones to prevent migration of land applied water outside of the POP zones or into Beaver Creek or Pass Creek. Monitoring systems will include suction lysimeters installed beneath each land application and catchment area to track the movement of water through the subsoil, interior wells to track changes in alluvial water quality within the POP zones, and compliance wells established at the downgradient edges of the POP zones. Monitoring results from suction lysimeters and interior wells will provide early detection of potential migration of land applied water into and through the alluvium. Early detection of potential impacts will allow Powertech (USA) to adjust the operating parameters, such as the rate of application to various pivots, to avoid potential impacts to alluvial groundwater outside of the POP zone and to avoid potential impacts to Beaver Creek or Pass Creek.

The alluvial groundwater monitoring program associated with the GDP also will detect any potential impacts to Cheyenne River alluvium. The mapped Beaver Creek and Pass Creek alluvium are contiguous with the Cheyenne River alluvium, and the position of the interior and compliance monitor wells will ensure that any land applied water entering Beaver Creek or Pass Creek alluvium will be detected. There is no pathway for land applied water to eventually reach the Cheyenne River alluvium without first passing a compliance well. Further, Powertech (USA) will monitor other alluvial wells farther downgradient in the Beaver Creek and Pass Creek alluvium (e.g., wells 677 and 678). Periodic monitoring of these downgradient alluvial wells will allow detection of any potential impacts from the land applied water on Beaver Creek, Pass Creek, or Cheyenne River alluvium.

If the results of monitoring show that groundwater outside of the POP zone or surface water in Beaver Creek or Pass Creek have potential to be impacted, Powertech (USA) will initiate a corrective action plan as described in the GDP application. Potential corrective actions include adjusting operating parameters and/or initiating a pump back or pump and treat system to recover alluvial groundwater.

Compatibility of Slopes with Land Application Systems (ARSD 74:29:05:16(5))

In the proposed Dewey land application area, the average slope is approximately 3.5 percent. The maximum slope is between 15 and 25 percent in a small area (approximately 5 acres) at the northern edge of one proposed land application area (refer to page 5.3-B-42 in Appendix 5.3-B). In the proposed Burdock land application area, the average slope is approximately 2 percent. Only about 2 acres of the proposed Burdock land application area has a slope greater than 15 percent (refer to page 5.3-B-43 in Appendix B). These slopes will be compatible with center pivot irrigation.

During final design of the land application systems and catchment areas, Powertech (USA) will evaluate any areas with slopes greater than 15 percent to determine whether they can be avoided or whether they require mitigation. The evaluation will consider the maximum manufacturer-recommended slope based on the center pivot climbing capability and ground clearance requirements. It also will consider whether regrading will be necessary to reduce the potential for runoff and erosion. It is currently anticipated that approximately 5 acres in the proposed Dewey land application area and 2 acres in the proposed Burdock land application area will be regraded to a maximum slope of 15 percent unless these areas are avoided during final design.

Potential for Erosion (ARSD 74:29:05:16(6))

The potential for erosion within the land application areas will be minimized through siting land application areas in relatively flat terrain, maintaining vegetation, optimizing the irrigation rate to avoid runoff, using low-impact sprinkler heads, and capturing any runoff in catchment areas. The average slopes in the proposed land application areas are 2 to 3.5 percent. Small areas with slopes greater than 15 percent are anticipated to be regraded to minimize the potential for erosion and to meet the maximum manufacturer-recommended slopes for the center pivots. Relatively flat slopes along with maintenance of the land application areas in a vegetated state will limit the potential for erosion. The land application water will be applied at an agronomic rate to prevent runoff into the catchment areas. Should runoff from precipitation or snowmelt occur, the runoff and sediment will be captured in the catchment areas and will not reach perennial or ephemeral stream channels.

Daily inspections of the land application areas and catchment berms during operation of the land application systems will determine whether there are any unplanned effects such as erosion.

Distance to Flowing Streams (ARSD 74:29:05:16(7))

Beaver Creek is the only flowing stream within the proposed permit area. The minimum distance from a proposed Dewey land application area to Beaver Creek is approximately 280 feet. The minimum distance from a proposed Burdock land application area to Beaver Creek is approximately 1.1 miles.

Potential Impacts to Adjacent Land Uses (ARSD 74:29:05:16(8))

Land uses adjacent to the proposed land application areas includes livestock grazing on rangeland and recreational use (primarily hunting) on private lands. No effects from land application on adjacent land uses are anticipated due to the operation of land application systems to minimize overspray and due to Powertech (USA)'s commitment to limit hunting within the proposed permit area. Section 3.1.2 describes how Powertech (USA) will work with BLM, SDGF&P and private landowners to limit hunting within the proposed permit area to the extent practicable.

The land application systems have been sited and will be operated to avoid any potential impacts to nearby cropland. No cropland is within or immediately adjacent to the proposed land application areas, and the land application systems will be operated to avoid overspray as a condition of the GDP. As described above, potential impacts to alluvial groundwater will be limited by geologic conditions, plugging existing wells, applying water at an agronomic rate, and

extensive monitoring. This in turn will prevent potential impacts to adjacent cropland via groundwater pathways.

Consideration of Weather Conditions (ARSD 74:29:05:16(9))

Prior to operation of the land application systems, Powertech (USA) will develop a standard operating procedure (SOP) for land application system operation that will include provisions to minimize overspray outside of the center pivot areas. The SOP will include using the results of meteorological monitoring (wind speed, wind direction and temperature) to modify operating parameters. It will include maximum wind speed/wind direction combinations for land application system operation. The SOP also will address precipitation thresholds to avoid land application during heavy or prolonged precipitation events. Temperature thresholds also will be included to avoid land application when water cannot infiltrate due to frozen ground.

5.4.1.1.3 Wastewater Treatment

Prior to discharge to the storage ponds, Powertech (USA) will treat all wastewater associated with ISR operations to meet the requirements of 10 CFR 20, Appendix B, Table 2, Column 2, which are the established limits for discharge of radionuclides to the environment and include limits for natural uranium, radium-226, lead-210 and thorium-230 (see Table 5.4-1). Powertech (USA) anticipates that the GDP will include effluent limits established according to ARSD 74:54:01:04 groundwater standards and ambient alluvial water quality. Treatment will be accomplished by ion exchange for uranium removal followed by radium removal through co-precipitation with barium sulfate in radium settling ponds. It is not anticipated that thorium-230, lead-210 or other radionuclides will be present at concentrations above the limits. If concentrations in the storage ponds are above the release limits, the effluent will be treated as necessary to satisfy the GDP limits.

5.4.1.1.4 Treated Wastewater Quality

The types of wastewater that will be disposed in the DDWs or land application systems include production bleed, groundwater generated during aquifer restoration, affected groundwater generated during well development, and liquid process waste such as resin transfer water and the brine generated during uranium processing. Of these, the largest contributors will be the production bleed and groundwater generated during aquifer restoration.

Table 5.4-2 presents the estimated end-of-production water quality in the ISR well fields. This represents the untreated water quality extracted from the ore zone at the end of uranium recovery and at the beginning of aquifer restoration. This table represents the worst-case water quality

Table 5.4-2. Estimated End-of-Production Groundwater Quality

Parameter	Units	Typical Dewey Baseline[1]	Typical Burdock Baseline[2]	Typical Change[3]	End-of-Production Dewey Estimate	End-of-Production Burdock Estimate
Physical Properties						
pH	s.u.	7.9	7.3	-1.2	6.5 - 7.5	6.5 - 7.5
TDS	mg/L	908	2,293	2,127	3,035	4,420
EC	µmhos/cm	1,323	2,621	2,974	4,297	5,595
Common Elements and Ions						
Bicarbonate[4]	mg/L	211	304	1,320	1,531	1,624
Carbonate	mg/L	<5	<5	-16	<5	<5
Chloride	mg/L	15	13	252	267	265
Sulfate	mg/L	483	1,351	400	883	1,751
Calcium	mg/L	63	386	211	274	597
Magnesium	mg/L	24	124	45	69	169
Sodium[4]	mg/L	211	138	465	676	603
Potassium	mg/L	10	19	10	20	29
Minor Ions and Trace Elements						
Arsenic	mg/L	0.002	0.0045	0.027	0.03	0.03
Barium	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	mg/L	<0.005	<0.005	<0.01	<0.01	<0.01
Chromium	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	mg/L	<0.01	<0.01	0.013	0.013	0.013
Iron	mg/L	<0.03	0.17	0.291	0.31	0.46
Lead	mg/L	0.007	<0.001	<0.05	<0.05	<0.05
Molybdenum	mg/L	<0.1	<0.1	<0.2	<0.2	<0.2
Nickel	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	mg/L	<0.005	0.0009	1.0	1.0	1.0
Uranium	mg/L	0.01	0.034	22	22	22
Vanadium	mg/L	<0.1	<0.1	0.7	0.7	0.7
Zinc	mg/L	0.01	0.007	0.034	0.04	0.04
Radiological Parameters						
Goss alpha	pCi/L	1,502	4,991	ND	ND	ND
Radium-226	pCi/L	380	1,289	681	1,061	1,970
Calculated Parameters						
SAR (calc.)	unitless	5.7	1.6	ND	9.5	5.6
ESP (calc.)	unitless	6.7	1.0	ND	11.3	6.6
RSC (calc.)	meq/L	-1.7	-24.5	ND	5.9	-16.9

[1] Hydro ID 681 (see Appendix 3.4-G); [2] Hydro ID 680 (see Appendix 3.4-G)

[3] Changes in groundwater quality were calculated based on historical baseline and end-of-production groundwater quality from ISR facilities in Wyoming and Nebraska.

[4] Sodium and bicarbonate estimates may be conservatively high, since the Dewey-Burdock project will use a lixiviant comprising groundwater fortified with dissolved oxygen and carbon dioxide instead of a sodium-bicarbonate solution, which is used at some other ISR facilities.

ND - no data available

encountered in the well fields, and it was used to estimate the range of concentrations of the treated effluent proposed for land application after accounting for treatment and blending.

5.4.1.1.4.1 Land Application Water Quality

The typical water quality during land application will be better than that shown in Table 5.4-2, since the water quality will be continually improving during aquifer restoration. Table 5.4-3 presents the anticipated land application water quality. The upper values shown in this table represent the estimated worst-case water quality to be land applied. The typical land application water quality will be better than the upper values, since multiple well fields typically will be in various stages of production and aquifer restoration at one time, with water quality gradually degrading toward the worst case during production and gradually improving to approximately baseline water quality during restoration. In addition, Madison water may be used at any time to improve the land application water quality.

It is anticipated that trace metal concentrations will be at or below ARSD 74:54:01:04 human health standards. In addition, the effluent concentration limits will be met for the release of radionuclides to the environment as defined in 10 CFR Part 20, Appendix B, Table 2, Column 2. This will be accomplished through treating the water as described previously.

The values shown in Tables 5.4-2 and 5.4-3 were estimated by Powertech (USA) based on historical baseline and end-of-production water quality data from other ISR facilities in Wyoming and Nebraska, with adjustments as necessary to account for planned post-production water treatment(s).

The primary source of land application water, production and restoration bleed, will result from multiple well fields undergoing differing phases of production and restoration. During production, the concentrations of dissolved constituents in each well field will gradually increase from the baseline quality to the post-production quality estimated in Table 5.4-2. During restoration, the water quality will be returned to approximately baseline water quality. The water from multiple well fields will be combined in the storage ponds, where increasing concentrations from producing well fields will be offset by decreasing concentrations from well fields undergoing restoration. This, combined with adequate pond capacity, will ensure that the land application water has relatively consistent water quality throughout the project duration. Additional information is found in the GDP.

Table 5.4-3. Estimated Land Application Water Quality

Parameter	Units	Land Application Water Estimate
Physical Properties		
pH	s.u.	6.5 - 7.5
TDS	mg/L	1,000 - 5,000
EC	µmhos/cm	1,500 - 6,000
Common Elements and Ions		
Bicarbonate	mg/L	500 - 2,000
Carbonate	mg/L	<1
Chloride	mg/L	100 - 400
Sulfate	mg/L	500 - 2,000
Calcium	mg/L	200 - 1,000
Magnesium	mg/L	50 - 300
Sodium	mg/L	200 - 1,000
Potassium	mg/L	10 - 50
SAR	unitless	5 - 10
Minor Ions and Trace Elements		
Arsenic	mg/L	<0.03
Barium	mg/L	<0.1
Cadmium	mg/L	<0.01
Chromium	mg/L	<0.05
Copper	mg/L	<0.02
Iron	mg/L	<1
Lead	mg/L	<0.05
Molybdenum	mg/L	<0.2
Nickel	mg/L	<0.05
Selenium	mg/L	<1
Vanadium	mg/L	<1
Zinc	mg/L	<0.05
Radiological Parameters		
Lead-210	pCi/L	<10
Polonium-210	pCi/L	<40
Radium-226	pCi/L	<60
Thorium-230	pCi/L	<100
U-natural	pCi/L	<300

Note: Estimates of land application water quality were based on Dewey-Burdock Project baseline water quality and historical baseline and end-of-production groundwater quality from ISR facilities in Wyoming and Nebraska, with adjustments as necessary to account for planned post-production water treatments.

5.5.3.2 Reporting

Powertech (USA) will provide DENR with the results of all operational surface water monitoring, including impoundment and stream sampling results. These will be provided in the annual environmental monitoring report described in Section 5.7.2.6.

5.5.4 Land Application System Monitoring

The following describes the monitoring programs that will be implemented if land application is used as a wastewater disposal option. Land application system reporting also is described.

5.5.4.1 Land Applied Effluent Monitoring

Powertech (USA) will collect and analyze effluent water quality samples using a progressive sampling schedule that includes volume-based grab samples in accordance with ARSD 74:29:05:15 and time-based grab samples designed to detect any changes in the land application water quality. ARSD 74:29:05:15 specifies the following sampling requirements: "Sampling of solution to be applied to the land shall consist of not less than one grab sample per 100,000 gallons of solution. If less than 100,000 gallons is to be applied to land, at least one grab sample must be taken and analyzed for the required parameters. Each grab sample must be of sufficient volume so the sample can be split. Each split of the sample must be of a volume sufficient to allow for analysis for all operational monitoring parameters. At every fifth sampling, one split sample of each five consecutive grab samples shall be preserved and analyzed for the required monitoring parameters." To meet these requirements, Powertech (USA) proposes to collect a grab sample of the water pumped from the storage ponds to the land application systems at a frequency of at least one sample per 100,000 gallons. This will be accomplished by manually filling the sample containers or installing an automated grab sampler. At every fifth sampling, five consecutive grab samples will be composited and analyzed for the parameters shown in Table 5.5-5.

Justification for a relatively small list of sample parameters for the volume-based grab sampling is based on the large storage capacity available in the storage ponds at each land application site. Based on an anticipated land application rate of 297 to 653 gpm, grab samples representing each 100,000 gallons of effluent will be collected every 2.6 to 5.6 hours, and composite samples representing each 500,000 gallons of effluent will be collected every 12.8 to 28.1 hours. By comparison, the available storage capacity at each site will be 247.2 ac-ft, which is equal to 86 to 188 days of water storage at the typical pumping rates of 297 to 653 gpm, respectively. Changes

in water quality in the storage ponds will occur very slowly, since the storage capacity far exceeds the pumping rate and since changes in well field water quality will occur slowly. The primary source of land application water, production and restoration bleed, will result from multiple well fields undergoing differing phases of uranium recovery and aquifer restoration. This water will be combined in the storage ponds, where increasing concentrations in water quality constituents from well fields undergoing production will tend to be offset by decreasing concentrations in water quality constituents from well fields undergoing aquifer restoration.

In addition to the volume-based effluent sampling, Powertech (USA) will collect grab samples monthly during operation of each land application system and have them analyzed for the parameters listed in Table 6.2-1. In addition to the parameters in Table 6.2-1, monthly effluent samples will be analyzed for compliance with the anticipated NRC effluent limits listed in Table 5.4-1. These anticipated NRC effluent limits are the 10 CFR Part 20, Appendix B, Table 2, Column 2 established limits for discharge of radionuclides to the environment.

Prior to operation of the land application systems each year, Powertech (USA) will sample the storage ponds and have the samples analyzed for the parameters in Table 6.2-1.

5.5.4.2 Catchment Area Water Quality Monitoring

Powertech (USA) will sample the water in catchment areas monthly (when present) and initiate mitigation measures if the water quality exceeds trigger values, which are listed in Table 5.5-6. Parameters listed in Table 5.5-6 without trigger values will be monitoring only. If the concentration of any parameter exceeds the trigger value, Powertech will dewater the catchment area as described in Section 5.4.1.1.2.

5.5.4.3 Soil and Vegetation Monitoring

Section 5.5.6.1 describes the soil monitoring program for land application areas. Monitoring results will be compared to trigger values and a contingency plan (described in Section 5.6.2.2) will be implemented if trigger values are approached. Section 5.5.6.2 and GDP Section 6.5 describe the vegetation monitoring program for land application areas. Samples of vegetation will be collected from three pivot areas in each of the Dewey and Burdock areas each year during land application system operation and evaluated for increasing trends in constituent concentrations and comparison with trigger values for specific constituents of concern. Contingency measures described in GDP Section 8.4 will be implemented if increasing trends are observed or trigger values are approached.

Table 5.5-6: Sample Parameters and Trigger Values for Water in Catchment Areas

Parameter	Unit	Trigger Value
EC	µmhos/m	4,000
SAR	unitless	10
pH	s.u.	<6.5 or >8.5
Arsenic[1]	mg/L	1
Copper	mg/L	---
Lead	mg/L	---
Molybdenum[1]	mg/L	0.3
Selenium[1]	mg/L	0.1
Uranium[2]	mg/L	0.2
Vanadium	mg/L	---
Zinc	mg/L	---
Gross alpha	mg/L	---
Radium-226	mg/L	---

[1] From Raisbeck et al. (2007)
[2] From Canadian Livestock and Water Quality Guidelines *in* Raisbeck et al. (2007)

5.5.4.4 Livestock Monitoring

Section 5.5.8 describes how livestock will be sampled annually if allowed to graze in the land application areas or consume crops grown the areas.

5.5.4.5 Prairie Dog Monitoring

Section 5.5.9 describes how Powertech (USA) will sample prairie dogs prior to initial land application and every year during land application system operation to evaluate the potential impacts to prairie dogs and the potential for bioaccumulation in the terrestrial food chain.

5.5.4.6 Groundwater and Surface Water Monitoring

Sections 5.4.1.1.2 and 5.5.2.4 describes the groundwater monitoring programs associated with the land application systems, including suction lysimeters installed beneath each land application and catchment area to track the movement of water through the subsoil, interior wells to track changes in alluvial water quality within the POP zones, and compliance wells established at the downgradient edges of the POP zones. Section 5.5.3 and GDP Section 6.2 describe how streams and impoundments downgradient from land application systems will be sampled during operations.

5.5.4.7 Land Application System Reporting

Powertech (USA) will establish and maintain records and prepare and submit reports for land application system operation in accordance with the requirements of ARSD 74:29:05. Refer to Section 5.7.2.6 for a description of land application system reporting, including written notice to implement land application and a written report following each land application cycle, which is defined as the last land application operational period during each calendar year. Additional reporting will be done in accordance with DENR requirements in the approved GDP.

5.5.5 Pond Monitoring

Section 5.3.4.5 describes the monitoring and inspection program that will be implemented to document pond conditions, including inspections of liners, liner slopes and other earthwork features; measurement of pond freeboard to ensure that adequate containment capacity is available; monitoring for water accumulation in leak detection systems; and routine inspections of leak detection system functionality, embankment settlement, and slope stability.

5.5.6 *Soil Sampling*

5.5.6.1 Land Application Systems

If land application is used to dispose treated wastewater, soil sampling will occur as described in the GDP. Baseline soil samples will be collected prior to operation of each land application system. During operation, soil samples will be collected each year from each land application pivot that was active during that year. Soil samples also will be collected from each catchment area each year.

Potential impacts will be mitigated by monitoring soil concentrations during operations and implementing a contingency plan if concentrations approach trigger values. The proposed trigger values are provided in Table 5.5-7. In addition, Powertech (USA) will monitor additional constituents listed in Table 6.4-1 of the GDP. Powertech (USA) will analyze the annual monitoring results and propose additional trigger values if increasing trends are observed. This analysis will be completed annually and provided in the written report submitted to DENR each year that is described in Section 5.7.2.6.

Table 5.5-7: Trigger Values for Land Application Area Soils

Parameter	Units	Trigger Value
Arsenic	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Lead	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Molybdenum	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Selenium	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Uranium-natural	mg/kg-dry	Baseline average concentration plus 2 standard deviations
Chloride	mg/L	250
SAR	unitless	10

5.5.6.2 General Permit Area Soil Sampling

During operation, Powertech (USA) will collect and analyze soil samples from the air particulate monitoring locations as required by the NRC license. The anticipated sample requirements include sampling surface soils (0-5 cm) annually from each air particulate monitoring location once per year and having the samples analyzed for natural uranium, radium-226, and lead-210. This sampling will provide detection of potential aerial deposition of radionuclides from the Dewey-Burdock Project.

In addition, as described in Section 6, Powertech (USA) will conduct radiological surveys during decommissioning to identify areas for cleanup operations. A pre-reclamation survey will be used to identify cleanup areas, and a post-reclamation survey will be used to ensure that radium and

other radionuclides do not exceed NRC standards. The radiological surveys will use gamma-ray detectors that are calibrated to soil radium-226 concentrations.

5.5.6.3 Vegetable Garden Soil Sampling

In accordance with NRC license conditions, Powertech (USA) will sample vegetable garden soil within 2 miles (3.3 km) of the permit area prior to operations. Plant-to-soil concentration factors will be then be used to estimate the levels of radionuclide concentrations in locally grown vegetables. Powertech (USA) anticipates modifying the NRC monitoring program to exclude vegetable garden soil sampling if the pre-operational sample results along with modeling potential radiological impacts demonstrate no significant exposure pathway from vegetable gardens to potential human receptors.

5.5.7 Vegetation Sampling

5.5.7.1 Land Application Systems

If land application is used to dispose treated wastewater, vegetation sampling will occur as described in the GDP. Vegetation samples will be collected annually from the land application areas. Vegetation samples also will be collected from each catchment area each year. Powertech (USA) will monitor for the potential buildup of metals, metalloids, and radionuclides in irrigated vegetation. The vegetation sampling parameters are listed in Table 6.5-1 of the GDP application. Metals and metalloids to be monitored include natural uranium, selenium and arsenic. Prior to operation, Powertech (USA) will develop trigger values for arsenic and selenium based on the preoperational concentrations and the variability in each parameter. Should routine operational monitoring indicate an increasing trend in constituent concentrations with potential to approach trigger values, a contingency plan will be implemented as described in Section 8.4 of the GDP application. The proposed trigger values will be provided to DENR for review and approval prior to initiating land application. The results of annual monitoring and evaluation of potential increasing trends will be provided in the written report submitted to DENR each year that is described in Section 5.7.2.6.

5.5.7.2 General Permit Area Vegetation Sampling

During operation, Powertech (USA) will collect and analyze vegetation samples from the air particulate monitoring locations as required by the NRC license. The anticipated sample requirements include sampling vegetation annually from each air particulate monitoring location once per year and having the samples analyzed for radium-226 and lead-210. The air particulate monitoring locations are located in areas having the highest predicted airborne radionuclide concentrations due to operation of the Dewey-Burdock Project.

In addition, Powertech (USA) will sample general grazing vegetation during the first year of operations in accordance with NRC license conditions. Powertech (USA) anticipates modifying the NRC monitoring program to exclude vegetation or forage sampling after the first year of operations if the initial monitoring results demonstrate that there is no ingestion pathway from grazing animals to potential human receptors. This will not impact vegetation sampling described in 5.5.7.1.

5.5.8 Livestock

In accordance with NRC license conditions, Powertech (USA) will collect livestock samples during the first year of operations for comparison to baseline. The anticipated sample requirements include collecting tissue samples at the time of slaughter of cattle, pigs and other livestock grazing within the permit area and analyzing samples for natural uranium, radium-226, lead-210, polonium-210 and thorium-230. Powertech (USA) anticipates modifying the NRC monitoring program to exclude livestock sampling after the first year of operations if the initial monitoring results demonstrate that there is no ingestion pathway from grazing animals to potential human receptors.

If land application is used and livestock is allowed to graze on the land application areas or consume crops grown in the areas, livestock will be sampled annually during land application system operation and analyzed for constituents listed in GDP Table 6.6-1 including selenium.

5.5.9 *Wildlife*

Powertech (USA) will analyze prairie dogs for potential bioaccumulation if land application is used. Prairie dogs were selected since they have been identified as a primary prey source for raptors and especially for the state-listed bald eagle. Three prairie dogs will be sampled prior to land application and each year during land application. The prairie dogs will be collected as close as possible to the land application systems. The samples will be analyzed for arsenic, molybdenum, selenium, and uranium. The specific sampling methodology (i.e., whole tissue versus specific organs) will be submitted to DENR and SDGF&P for approval prior to initial sampling. Following pre-operational sampling, Powertech (USA) will submit trigger values for review and approval by DENR and GFP. Should monitoring results indicate potential impacts to wildlife, mitigation measures will be implemented as described in Section 5.6.2.2. An additional mitigation measure that will be considered if potential impacts to wildlife are identified is wildlife exclusion fencing around the land application areas. If wildlife exclusion fencing is used around land application areas, Powertech will submit the fence design to DENR and SDGF&P for approval prior to installation.

Powertech (USA) will collect samples of fish species with the potential for human consumption in accordance with NRC license conditions. The anticipated sample requirements include semiannual sampling of species with the potential for human consumption (green sunfish and channel catfish) if present in water bodies potentially affected by contamination. Analytes required by the NRC license are anticipated to include natural uranium, radium-226, lead-210, polonium-210 and thorium-230. In addition, Powertech (USA) will analyze all fish samples for selenium.

In the unlikely event that a spill or leak results in solutions reaching Beaver Creek, Powertech (USA) will sample fish and macro-invertebrates for potential impacts according to a sampling and analysis plan approved by DENR and SDGF&P.

5.5.10 *Air Monitoring*

Powertech (USA) will conduct an airborne radiation monitoring program at the Dewey-Burdock Project in accordance with NRC license conditions. The airborne radiation monitoring program will be designed to detect potential worker doses from radon and radionuclide particulates. It will include measurement of radon decay products and radionuclide particulates in the facilities and at effluent release points (e.g., vents).

Powertech (USA) also will conduct an airborne effluent and environmental monitoring program in accordance with NRC license conditions. The anticipated sampling requirements include continuously operating air monitoring stations located around the permit boundary. Filters from air particulate samplers operating continuously will be analyzed quarterly for natural uranium, thorium-230, radium-226, and lead-210. Radon gas will be measured monthly using passive track-etch detectors at each air monitoring station.

5.5.11 Meteorological Monitoring

The meteorological station at the site will continue to be operated by SDSU, or Powertech (USA) may install and operate a new meteorological station. A meteorological station within the permit area will be operated in accordance with NRC license requirements.

5.6 Potential Impacts and Mitigation

5.6.1 Land Use

5.6.1.1 Potential Land Use Impacts

Rangeland and agricultural cropland are the primary land uses within the permit area and the surrounding area. A portion of the land within the permit area will be temporarily converted from its previous use as rangeland and cropland to ISR use on a progressive, phased basis during construction and operation of ISR well fields, processing facilities, and associated infrastructure. However, most of the permit area will be undisturbed, and surface operations (e.g., wells and processing facilities) will affect only a small portion of it. Section 5.3.7 describes the total anticipated disturbance (topsoil stripping) area over the life of the project.

The land likely will experience an increase in human activity also contributing to land disturbance. The disturbance associated with drilling, pipeline installation, and facility construction will be limited and temporary as vegetation will be re-established through concurrent reclamation. The construction of access roads will be minimized to the extent possible by using and upgrading existing roads.

Operation of the project facilities will restrict the use of a portion of the land as rangeland and cropland for the duration of operations. This includes fenced well field areas, facility areas, and land application areas. This temporary change in land use will last until these areas are reclaimed and released for unrestricted use. Given the relatively small size of the impacted areas, the exclusion of grazing from well field and facility areas over the course of the project is

- Reestablish temporary or permanent native vegetation as soon as possible after disturbance utilizing the latest technologies in reseeding and sprigging, such as hydroseeding (refer to Section 6.4.3.4).
- Decrease runoff from disturbed areas by using structures to temporarily divert and/or dissipate surface runoff from undisturbed areas (refer to Section 5.3.9).
- Retain sediment within the disturbed areas by using silt fencing, sediment ponds, and other ASCMs (refer to Section 5.3.9).
- Fill pipeline and utility trenches with appropriate material and regrade and reseed surface soon after completion.
- Drainage design will minimize potential for erosion by creating slopes less than 4 to 1 and/or provide rip-rap or other soil stabilization controls.
- Construct roads using techniques that will minimize erosion, such as surfacing with a gravel road base, constructing stream crossings at right angles with adequate embankment protection and culvert installation.
- Implement spill prevention and cleanup standard operating procedures to minimize soil contamination from vehicle accidents and/or well field spills or leaks; collect and monitor soils and sediments for potential contamination including areas used for land application, transport routes for yellowcake and ion exchange resins, and well field areas where spills or leaks are possible.
- Excavate contaminated soil as described in Section 6.3.3 and replace with uncontaminated soil as needed.
- Specific mitigation measures for potential soil impacts from land application are addressed in the GDP and summarized as follows:
    - The expected land application water quality is described in Section 5.4.1.1.4.1. With an anticipated TDS concentration of 1,000 to 5,000 mg/L, the water will pose a low to moderate risk to the growth of moderately salt-sensitive crops such as alfalfa. Soil salinity levels will be controlled by blending the land application water in the ponds and by leaching salts below the root zone during land application. Powertech (USA) will operate the land application systems to balance the downward migration of water, which has potential alluvial groundwater impacts, with the leaching that will be used to control salt buildup in the root zone. Madison water may be used in leaching, and the leaching efficiency may be improved by leaching during the cool season, applying water intermittently rather than continuously, and using tillage, including potentially deep tillage.
    - The anticipated SAR levels in the land application water are 5 to 10, which should pose a low risk to soil infiltration rates. Should soil SAR increase and pose a risk to soil infiltration, Powertech (USA) will apply amendments such as sulfur or gypsum at agronomic rates.

- Since Powertech (USA) will treat the land application water to meet effluent limits, including the 10 CFR 20, Appendix B, Table 2, Column 2 standards for release of radionuclides to the environment, it is unlikely that radionuclides will build up to potentially harmful levels. This will be verified through operational soil monitoring and additional surveys during decommissioning.
- During decommissioning, Powertech (USA) will conduct land cleanup in accordance with NRC license and DENR permit requirements. This includes cleaning up surface soils to standards for radium-226 and natural uranium that will be established as conditions in the NRC license as protective of human health and the environment. This applies to the entire permit area and is not limited to the land application areas.
- The concentrations of metals and metalloids, including arsenic and selenium, are anticipated to be low as shown in Table 5.4-3 Nevertheless, there is potential for buildup of metals and metalloids over time in the land application areas. Potential impacts will be mitigated by monitoring soil concentrations during operations and implementing a contingency plan if concentrations approach trigger values. The contingency plan will consist of one or more of the following items:
  - Verify sample results and precisely delineate affected areas through additional soil sampling and analysis.
  - Modify land application system operating parameters to reduce the discharge rate in specific pivots or throughout the land application area.
  - Implement water treatment if necessary for radionuclides, metals or metalloids.
  - Implement a phytoremediation plan to control buildup of selenium in soil.
  - Excavate soil contaminated above the reclamation standards established in the NRC license and LSM permit and dispose excavated soil in an appropriately permitted disposal facility.
- Powertech (USA) may apply fertilizer to the land application areas to maximize crop production and maintain adequate soil fertility.
- Powertech (USA) will prepare an annual report evaluating the potential for saline seeps near the land application areas (see Section 5.7.2.6) and develop a site-specific mitigation plan for DENR review and approval if a saline seep occurs.

5.6.3 Groundwater

5.6.3.1 Potential Groundwater Impacts

Potential groundwater impacts include groundwater consumption, drawdown in nearby water supply wells, and potential groundwater quality impacts. Each of these is discussed below.

- Proper plugging and abandonment of all wells which do not pass MIT or that become unnecessary for use;
- Proper plugging and abandonment of exploration holes with potential to impact ISR operations; and
- Sampling monitor wells located within the overlying and underlying hydrogeologic units on a frequent schedule.

These controls work together to prevent and detect ISR solution migration. Plugging any exploration holes that pose the potential to impact the control and containment of ISR solutions prevents connection of the production zone to overlying and underlying units. The EPA UIC requirements for MIT assure proper well construction, which is the first line of defence for maintaining appropriate pressure without leakage. Sampling the monitor wells will enable early detection of any ISR solutions should an excursion occur.

Excursion Corrective Actions

Powertech (USA) will implement the following corrective action plan for excursions occurring during production or restoration operations. Corrective actions to correct and retrieve an excursion may include but will not be limited to:

- Adjusting the flow rates of the production and injection wells to increase the aquifer bleed in the area of the excursion;
- Terminating injection into the portion of the well field affected by the excursion;
- Installing pumps in injection wells in the portion of the well field affected by the excursion to retrieve ISR solutions;
- Replacing injection or production wells; and
- Installing new pumping wells adjacent to the well on excursion status to recover ISR solutions.

In the event of an excursion, the sampling frequency will be increased to weekly. NRC will be notified within 24 hours by telephone or email and within 7 days in writing from the time an excursion is verified. DENR will be notified within 48 hours by telephone or email and within 7 days in writing from the time an excursion is verified. In addition, if the excursion has potential to affect a USDW, EPA will be notified verbally within 24 hours and in writing within 5 days. A written report describing the excursion event, corrective actions taken and the corrective action results will be submitted to all involved regulatory agencies within 60 days of the excursion confirmation.

If wells are still on excursion status when the report is submitted, the report also will contain a schedule for submittal of future reports describing the excursion event, corrective actions taken,

SDGF&P does not consider the permit area to be within the crucial habitat range of any big game species. A letter from SDGF&P confirming this statement and updating the status of big game species as of May 2010 is provided in Appendix 5.6-B. Sightings of those species in that vicinity are often seasonal and less common.

5.6.11.1.4 Other Mammals

As indicated in Appendix I to Appendix 3.9-A, 14 mammal species tracked by SDNHP have the potential of occurring in the permit area (Merriam's shrew, dwarf shrew, long-eared myotis, fringe-tailed myotis, northern myotis, silver-haired bat, Townsend's big-eared bat, northern flying squirrel, northern river otter, meadow jumping mouse, swift fox, black-footed ferret, eastern spotted skunk, and mountain lion). Only the northern river otter was observed in the vicinity of the permit area; this was a carcass observed at the upstream sampling point on Beaver Creek.

Medium-sized mammals (such as lagomorphs, canids, and badgers) may be displaced temporarily to other habitats during the initial construction activities. Direct losses of some small mammal species (e.g., voles, ground squirrels, mice) may be higher than for other wildlife due to their more limited mobility and likelihood that they would retreat into burrows when disturbed, and thus be potentially impacted by topsoil scraping or staging activities. However, given the limited area expected to be disturbed by the project, such impacts would not be expected to result in major changes or reductions in mammalian populations for small or medium-sized animals. This is supported by NRC guidance in NUREG-1910 (NRC, 2009), which states, "Displaced species may re-colonize in adjacent, undisturbed areas or return to their previously occupied habitats after construction ends and suitable habitats are reestablished." Few bats were recorded in the area despite extra efforts to observe them during the baseline surveys. Those that were seen were near water bodies near treed habitats, which are not currently scheduled for disturbance. The mammalian species known to be, or potentially, present in the permit area have shown an ability to adapt to human disturbance in varying degrees, as evidenced by their continued presence in other mining and residential areas of similar, or greater, disturbance levels elsewhere in the region. Additionally, small mammal species in the area have a high reproductive potential and tend to re-occupy and adapt to altered and/or reclaimed areas quickly.

5.6.11.1.5 Raptors

As indicated in Appendix I to Appendix 3.9-A, 16 raptor species tracked by SDNHP have the potential of occurring in the permit area (osprey, bald eagle, sharp-shinned hawk, Cooper's hawk, northern goshawk, broad-winged hawk, Swainson's hawk, ferruginous hawk, golden eagle, merlin, peregrine falcon, prairie falcon, barn owl, northern saw-whet owl, long-eared owl, and burrowing owl). The bald eagle, long-eared owl, and merlin are known or are suspected to have nested in or within 1 mile of the permit area based on evidence (young present) or persistent defensive behavior.

ISR activities in the permit area would not impact regional raptor populations. As described in Section 3.9.2 and in Appendix 3.9-A, five confirmed, intact (i.e., material present) raptor nests or potential nest sites were located in the permit area and two additional nest sites (one confirmed and one potential) were recorded in the one-mile survey perimeter. The species represented by these nests or potential nest sites include great-horned owls, long-eared owls, red-tailed hawks, merlins, and bald eagles. Monitoring and mitigation measures presented in the Avian Monitoring and Mitigation Plan (Appendix 5.6-C) will be used to avoid potential impacts to individual birds or pairs such as raptors abandoning nest sites proximate to disturbance, injury or mortaility due to colissions with project-related vehicular traffic, and indirect impacts such as reduction or avoidance of foraging habitats for nesting birds. Additional information is provided in Section 5.6.11.2 and Appendix 5.6-C. Surface disturbance will only occur in a small percentage of the overall permit area, and the low density of nesting raptors relative to the apparent availability of suitable habitat suggests that alternate nesting habitat is available for all known nesting raptor species in the permit area.

Except for the bald eagle, the same species that nest in the permit area are known to regularly nest and fledge young at or near surface mines and ISR facilities throughout the region. Those efforts have succeeded due to a combination of raptors becoming acclimated to the relatively consistent levels of disturbance and gradual encroachment of production operations, and successfully executed state-of-the-art mitigation techniques to maintain viable raptor territories and protect nest productivity. Some individuals nest on active production facilities themselves, including both great horned owls and red-tailed hawks. The lack of bald eagle examples is more likely related to the general absence of nesting bald eagles in the vicinity, rather than an increased sensitivity to production activities. Bald eagles are discussed further in Section 5.6.11.1.11. Due to the paucity of river cliffs in the permit area, falcons and other raptors known to nest in that habitat are not as abundant as those that nest in trees or even on the ground.

Based on the location of known nest sites relative to future construction sites, no raptor nests will be disturbed physically by the project during either construction or operations. Additionally,

Powertech (USA) has incorporated the baseline wildlife information into the planning process and sited plant facilities (areas of greatest sustained future disturbance) outside the recommended buffer zone for raptor nests in the permit area, including the bald eagle nest site identified in the baseline survey. Since the baseline survey was completed, a new bald eagle nest has been documented in the permit area. This is described in Section 5.6.11.1.11 and Appendix 5.6-C. Some new infrastructure will be located within the suggested buffer areas. However, pipelines will be buried, and new overhead power lines will be constructed using designs and specifications to reduce injuries and mortalities on overhead power lines. Land application center pivots, if used, can be put into place prior to the nesting season, and run automatically with little human contact once they are turned on. Additionally, new roads, power lines, and pipelines will be constructed in the same corridors to the extent possible to reduce overall disturbance, and along existing access roads when available to minimize new surface disturbance.

5.6.11.1.6 Upland Game Birds

ISR activities in the permit area would potentially impact the foraging and nesting habitat of mourning doves, though such disturbance is not expected to have any marked impacts on this species. No woody corridors will be disturbed by the proposed activities, and additional trees are present in the cottonwood gallery along the Cheyenne River, located approximately 2 miles south of the permit area. Additionally, doves are not restricted to treed habitats, nor are they subject to any special mitigation measures for habitat loss.

Annual monitoring surveys conducted by SDGF&P biologists and a year-round baseline study for the project have demonstrated that sage-grouse do not currently inhabit that area, and have not for many years. As described previously, those surveys encompassed the entire permit area and the vast majority of its 2.0-km (1.2-mi) perimeter, particularly as part of baseline monitoring. The nearest known sage-grouse lek is approximately 6 miles north of the permit area (SDGF&P records). Given the lack of sage-grouse observations in the area and the scattered stands of marginal quality sage-grouse habitat, the project will not result in negative impacts to existing or potential sage-grouse leks, or important sagebrush habitats.

5.6.11.1.7 Other Birds

As indicated in Appendix I to Appendix 3.9-A, 19 other bird species (non-raptors, non-game, and non-waterfowl/shorebirds) tracked by SDNHP have the potential of occurring in the permit area. These include: common poorwill, Lewis' woodpecker, three-toed woodpecker, black-backed woodpecker, olive-sided flycatcher, Cassin's kingbird, Clark's nutcracker, brown

creeper, pygmy nuthatch, veery, northern mockingbird, sage thrasher, Sprague's pipit, black-and-white warbler, Virginia's warbler, Brewer's sparrow, Baird's sparrow, McCown's longspur and Cassin's finch. Only one of these species (Clark's nutcracker) was documented in or within 1 mile of the permit area during the baseline survey period. The nutcracker was observed once flying over the permit area, but no known nesting or other targeted use was recorded by this species.

Direct impacts could include injury or mortality due to encounters with vehicles or heavy equipment during construction or maintenance operations. Indirect impacts could include habitat loss or fragmentation and increased noise and activity that may temporarily deter use of the area by some species. Surface disturbance would be relatively minimal and would be greatest during construction. Enforced speed limits and use of common right-of-way corridors will reduce impacts to wildlife throughout the year, particularly during the breeding season.

5.6.11.1.8 Waterfowl and Shorebirds

As indicated in Appendix I to Appendix 3.9-A, 18 waterfowl/shorebird species tracked by SDNHP have the potential of occurring in the permit area (common loon, horned grebe, American white pelican, great blue heron, black-crowned night heron, green-backed heron, white-faced ibis, bufflehead, hooded merganser, common merganser, whooping crane, mountain plover, piping plover, long-billed curlew, California gull, common tern, black tern, and interior least tern). The long-billed curlew, great blue heron, and American white pelican were documented in or within 1 mile of the permit area during the baseline survey period. The long-billed curlew is suspected to have nested in or within 1 mile of the permit area based on persistent defensive behavior.

Construction and operation of the ISR project would have a negligible effect on migrating and breeding waterfowl and shorebirds. Existing habitat is limited and seasonally available in the permit area, so it does not currently support large groups or populations of these species. Multiple approaches are being considered to minimize impacts to wildlife that may be associated with the operation of the ponds. Any new treated water sources could enhance current habitat conditions for these species, though such effects would be temporary in nature.

5.6.11.1.9 Reptiles and Amphibians

As indicated in Appendix I to Appendix 3.9-A, three reptile species and zero amphibian species tracked by SDNHP have the potential of occurring in the permit area (northern sagebrush lizard,

smooth green snake and brown snake). None of these species was observed in or around the permit area.

As with waterfowl, potential habitat for aquatic and semi-aquatic amphibians and reptiles is limited within the permit area and occurs primarily along Beaver Creek in the western portion of the area. Other water bodies are ephemeral, and thus offer only short-term habitat. Activities associated with the project are not expected to disturb existing surface water or alter the topography in the area. Those species residing in rocky outcrops located in potential disturbance areas could be impacted by construction and maintenance operations. However, few non-aquatic herptile species were observed in the permit area and surrounding perimeter. Any impacts that would occur would affect individuals, but would not likely impact the population as a whole.

5.6.11.1.10 Fish and Macro-Invertebrates

As indicated in Appendix II to Appendix 3.9-A, one fish species tracked by SDNHP has the potential of occurring in the permit area (plains topminnow). The plains topminnow was captured during fish sampling efforts in the Cheyenne River and the downstream sampling site along Beaver Creek during baseline surveys; both sites are outside of the permit area.

The planned locations for new facilities and infrastructure do not overlap any perennial aquatic features; therefore, no loss of aquatic habitat would occur as the result of their construction. The risk of impaired water quality will be reduced or avoided through project siting, and implementation of standard construction erosion and sediment control measures. The location of project facilities (CPP, Satellite Facility, pipelines, well fields, access roads and power lines), as well as the proposed land application sites (center pivot irrigation sites), will avoid direct impacts to perennial streams.

Due to the arid climate and proposed location of new project facilities, operation of the well fields is not expected to alter aquatic habitat or water quality in perennial streams. No surface water will be diverted for use in the operation, and no process water will be discharged into aquatic habitat.

Pass Creek provides only seasonal drainage and does not support fish or significant amphibian habitat. Some of the proposed land application sites west of the Satellite Facility would be located in general proximity to Beaver Creek, the primary aquatic habitat in the project vicinity. All land application areas will be surrounded by catchment areas that will prevent runoff. Beaver Creek will not be directly affected by the well field operations or land application sites.

Section 3.5.4.1.1 describes how Beaver Creek and the Cheyenne River near the permit area are classified as warmwater, semipermanent fisheries. No coldwater fisheries are present in the permit area, and no impacts to coldwater fisheries will occur as a result of the Dewey-Burdock Project.

5.6.11.1.11 Threatened, Endangered, or Candidate Species and Species Tracked by SDNHP

Federally Listed Species

As described in the preceding sections of this document, no federally listed vertebrate species were documented in the project survey area (permit area and 1-mile perimeter) during the year-long survey period, or during previous targeted surveys conducted for the original claims (TVA, 1979). Additionally, the USFWS has issued a block clearance for black-footed ferrets in all black-tailed prairie dog colonies in South Dakota except northern Custer County, and in the entire neighboring state of Wyoming. That clearance indicates that ferrets do not currently, and are not expected to, occupy the permit area. The project area also is not within any proposed ferret reintroduction sites. Only one small black-tailed prairie dog colony was present in the permit area itself during the 2007-2008 baseline surveys, and local landowners are actively working to remove the animals from their lands. Consequently, the proposed project will have no direct, indirect, or cumulative effects on black-footed ferrets.

State-Listed Species

ISR activities within the permit area are not likely to adversely affect bald eagles, the only state-listed species known to inhabit the permit area. Bald eagles were documented at winter roosts and an active nest within the permit area during the 2007-2008 baseline surveys. One additional nest site has been identified in the permit area since the baseline inventories were conducted. Appendix 5.6-C discusses both nest sites and includes monitoring and mitigation measures to avoid potential impacts, including pre-disturbance monitoring, monitoring during construction and operation, siting facilities outside of the buffer area and constructing facilities outside of the breeding season where possible, among others. No more than two or three bald eagles were observed during any given winter survey conducted during the baseline period or more recent (winter 2012/2013) monitoring, despite the numerous available (and unoccupied) mature trees along Beaver Creek, Pass Creek, and the pine breaks located in and near the permit area.

Potential direct impacts to bald eagles include the potential for injury or mortality to individual birds foraging in the permit area due to electrocutions on, or collisions with, new overhead power lines or collisions with vehicles due to increased traffic during construction and/or operation of new facilities. The potential for electrocution or collision with power lines will be

reduced by using current Avain Power Line Interaction Committee (APLIC) recommendations for overhead power line construction. Enforced speed limits during all phases of the project will reduce the potential for vehicular impacts. Although not expected, disturbance activities near an active nest could result in abandonment and, thus, the loss of eggs or young. The increased human presence and noise associated with construction activities, if conducted while eagles are wintering within the area, could displace individual eagles from using the area during that period. Monitoring and mitigation of these potential impacts are addressed in Appendix 5.6-C.

Given the low number of wintering and nesting bald eagles in the permit area, potential impacts would be limited to individuals rather than a large segment of the population. The use of existing or overlapping right-of-way corridors along with best management practices will minimize potential direct impacts associated with overhead power lines. If necessary, the majority of other potential impacts could be mitigated if construction activities were conducted outside the breeding season and/or winter roosting months, or outside the daily roosting period, should eagles be present near construction. Any bald eagles that might roost or nest in the area once the project is operational would be doing so in spite of continuous and ongoing human disturbance, indicating a tolerance for such activities.

Indirect impacts as a result of noise and human presence associated from project-related operations could include area avoidance by avian species. Potential winter foraging habitat could be further fragmented by linear disturbances such as overhead power lines and new roads associated with the project. Given the size of the project, those disturbances would occur within narrow corridors over relatively short distances. Nevertheless, the use of common right-of-way corridors to consolidate new infrastructure will reduce these potential indirect impacts.

The only other state-listed species recorded in the general area was the river otter. An otter carcass was discovered lodged in debris in the stream channel at fisheries sampling station BVC04 in mid-April 2008. That site is approximately 12 river miles upstream from the permit area boundary in eastern Wyoming. The carcass had washed away by the July 2008 fisheries sampling session. The monthly sampling at BVC04 during the monitoring period confirmed no additional observations of otters. Likewise, no evidence of otters was report by biologists along any drainage elsewhere in the survey area during the year-long baseline survey period. Given the fact that no stream channels will be physically impacted in the permit area, the lack of otter sightings or sign in the permit area itself, and the stringent water processing and water quality monitoring that will occur, this project is not likely to directly or indirectly impact river otters.

Species Tracked by SDNHP

As indicated in Appendices I and II to Appendix 3.9-A, 71 vertebrate wildlife species tracked by the SDNHP have been documented or have the potential of occurring in the permit area. These are described in the previous sections and are summarized briefly as follows:

- Mammals: Of the 14 mammal species tracked by SDNHP that could potentially occur in the permit area, only the northern river otter has been documented in the general vicinity during or since the baseline inventory (see Section 5.6.11.1.4 and discussion above under State-listed species).
- Raptors: Of the 16 raptor species tracked by SDNHP that could potentially occur in the permit area, three (bald eagle, long-eared owl, and merlin) are known or are suspected to have nested in or within 1 mile of the permit area (see Section 5.6.11.1.5 and discussion above under State-listed species). Potential nesting habitat is present in the area for other tracked raptor species, but no nests of those species have been documented to date.
- Waterfowl/shorebirds/waterbirds: Of the 18 waterfowl/shorebird/waterbird species tracked by SDNHP that could potentially occur in the permit area, only three (long-billed curlew, great blue heron, and American white pelican) were documented in or within 1 mile of the permit area during the baseline survey period (see Section 5.6.11.1.8). At least one additional species (mountain plover) could occur in the area, but none has been recorded to date.
- Other birds: Of the 19 other bird species species tracked by SDNHP that could potentially occur in the permit area, only the Clark's nutcracker was documented in or within 1 mile of the permit area during the baseline survey period (see Section 5.6.11.1.7).
- Reptiles and amphibians: Of three reptile species tracked by SDNHP that could potentially occur in the permit area, none was observed during baseline surveys. No amphibian species tracked by SDNHP have been identified with potential to occur in the permit area (see Section 5.6.11.1.9).
- Fish and macro-invertebrates: The plains topminnow is the only fish species tracked by SDNHP that could potentially occur in the area (see Section 5.6.11.1.10).

The seven SDNHP species recorded in or flying over the permit area could potentially experience the same type of direct and/or indirect impacts from construction and operation of the proposed operation as those described previously for other species: e.g., injury, mortality, avoidance, displacement and increased competition for resources. Those potential impacts will be minimized by the timing, extent, and duration of the proposed activities. Enforced speed limits during all phases of the project will further reduce potential impacts to wildlife throughout the year, particularly during the breeding season. Once facilities and infrastructure are in place, animals remaining in the permit area would demonstrate an acclimation to those disturbances.

5.6.11.2 Mitigation of Potential Ecological Resources Impacts

The following is a list of proposed mitigation measures for such potential impacts:

- Design barbed wire perimeter fencing to permit big game passage to the extent practicable. Unless otherwise approved by DENR and SDGF&P, the design will include: a bottom, smooth wire at least 15" to 16" above ground for pronghorn passage, a top wire no more than 42" high to facilitate passage of deer and elk, and a space at least 11" to 12" between the top two wires to prevent entanglement.
- Provide fencing around facility ponds to exclude large and small mammals, including installing durable mesh (e.g., woven wire) along the base of the chain link pond fencing for small mammal exclusion. The mesh will extend at least 30 inches above ground and will be buried at least 3 inches below ground or will extend horizontally along the ground away from the fence to ensure there are no gaps and to discourage burrowing.
- Design all facilities including sediment ponds and any areas that could accumulate water to avoid wildlife entrapment.
- Use existing roads when possible and limit construction of new access roads to provide for access to more than one well site or well field, if possible.
- Enforce speed limits to minimize collisions with wildlife, especially during the breeding season.
- Adhere to the provisions of the Avian Monitoring and Mitigation Plan (Avian Plan) approved by SDGF&P and DENR and reviewed by USFWS. A copy of the approved plan is provided in Appendix 5.6-C and briefly summarized as follows.
    - Purpose: The primary purpose of the Avian Plan is to address potential impacts to nesting bald eagles in the proposed permit area and surrounding area, since the bald eagle is a South Dakota-listed threatened species. The Avian Plan also addresses monitoring and mitigation of potential impacts to other avian species of concern, including other nesting raptors, breeding birds, waterfowl/shorebirds, species tracked by the SDNHP, and migratory birds other than raptors.
    - Monitoring: Ensure that monitoring and survey data are available for the life of the mine to accomplish the following goals:
        - Bald eagles
            - Conduct pre-construction monitoring to determine normal habitat use and movements, the location and status of nests and winter roost sites, the occurrence and outcome of nesting bald eagle pairs, existing disturbance activities, and eagles' response to existing activities.
            - Conduct monitoring during construction and operations to document disturbance activities within buffer areas and eagles' response to those activities.

- Other nesting raptors
  - Conduct annual monitoring of all known raptor nests and annual searches for new nests based on existing and planned disturbance.
  - Document disturbance activities within buffer areas and raptors' response to those activities during facility construction and operation to identify additional mitigation measures to address potential impacts.

- Mitigation of potential impacts
  - Bald eagles and other nesting raptors
    - Identify local breeding seasons for each nesting raptor species.
    - Establish buffer zones for each raptor nest depending on species and screening options (terrain, trees, etc.).
    - Consider nest buffers in facility planning, including consolidating infrastructure within buffer zones, siting facilities outside of the buffer zones, and scheduling activities outside of the breeding season within buffer zones to the extent possible.
    - Use current APLIC recommendations for overhead power line construction to reduce the possibility of electrocution and collision.
    - Authorize "stop work" authority to biologist if project activities are at risk of impacting nesting raptors.
    - Address prey abundance and potential impacts to raptors through potential bioaccumulation or other potential impacts to prairie dogs.
    - Reestablish the ground cover necessary to attract and sustain a suitable raptor prey base.
    - Powertech (USA) may apply for a USFWS-issued permit and any necessary State permits for non-purposful/incidental eagle take, the application for which would demonstrate that the proposed activity meets the requirements of 50 CFR § 22.26, which contain the federal requirements for non-purposeful take. Any non-purposeful take permit application will be coordinated with SDGF&P and DENR to ensure compliance with SDCL 34A-8 and other applicable rules and regulations
  - Waterfowl and shorebirds
    - Implement an avian deterrent system such as physical barriers (netting or "bird balls") or aversion technology (sound/visual hazing system) for all ponds containing untreated wastewater or ponds used in the treatment process (i.e., central plant pond, radium settling ponds, spare ponds, and surge ponds). These are ponds that include dual synthetic liners and leak detection systems. For ponds storing only treated water (i.e., treated water storage ponds, spare storage ponds, and outlet ponds), avian deterrent

systems will be provided if the water quality exceeds trigger values designed to be protective of wildlife. Trigger values are provided in Table 5.6-2a.

- Establish trigger values for water in catchment areas and dewater catchment areas if trigger values are exceeded (see Section 5.5.4.2)

▪ Breeding birds

- Conduct surveys for nesting species in areas of planned disturbance and schedule disturbance activities outside of the breeding season where possible.

Table 5.6-2a: Trigger Values for Avian Deterrent Systems in Treated Water Ponds

Parameter	Units	Trigger Value
Arsenic	mg/L	0.34 (2)
Selenium	mg/L	Formula (2)(3)
Uranium	pCi/L	300 (4)
Radium-226	pCi/L	60 (4)
Lead-210	pCi/L	10 (4)
Polonium-210	pCi/L	40 (4)
Thorium-230	pCi/L	100 (4)

[1] Treated water ponds include, treated water storage ponds, spare storage ponds, and outlet ponds.
[2] EPA Section 304(a) aquatic life criteria (EPA, 2013)
[3] Trigger value = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 0.1859 mg/l and 0.01282 mg/l, respectively (EPA, 2013)
[4] 10 CFR 20, Appendix B, Table 2, Column 2

- Restore pre-mining native habitats for species that nest and forage in those vegetative communities.
- Restore diverse landforms, replace topsoil, and construct brush piles, snags, and/or rock piles to enhance habitat for wildlife.
- Conduct weed control as needed to limit the spread of undesirable and invasive, non-native species on disturbed areas.

Adjusting the timing of various construction, operational, and reclamation activities to avoid the breeding season can also be an effective way to minimize impacts related to such activities in the permit area. As a practical matter, worker crews conducting construction or reclamation activities typically work during daylight hours, so potential impacts to year-round residents, particularly more nocturnal species such as bats, rodents and others, should not be increased significantly. Following completion of construction in a given area, access roads would be blocked with berms or fencing to prevent use by casual traffic. Site reclamation/ decommissioning, including surface reclamation, will be completed in the same manner, with activities timed to minimize disturbance to nesting or migrating species. Relevant agency standards for reclamation will be followed and this phased, systematic approach will allow more mobile wildlife species to relocate into adjoining, undisturbed habitat and then return following completion of construction or reclamation in a particular area. Thus, the sequential, phased nature of this approach will decrease potential direct and indirect impacts on all wildlife species and their habitat.

5.6.12 Cultural Resources

<u>5.6.12.1 Potential Cultural Resources Impacts</u>

As discussed in Section 3.11, a Level III Cultural Resources Evaluation was conducted in the permit area. Personnel from the Archaeology Laboratory, Augustana College, Sioux Falls, South Dakota, conducted on-the-ground field investigations between April 17 and August 3, 2007. Potential impacts to historic and cultural resources will be minimized by implementing the mitigation measures described below.

package will be submitted to NRC for review. All well field packages and written SERP evaluations will be maintained at the site and available for regulatory review.

The SERP will have the authority to raise issues regarding the health and safety of the workers, general public, and/or the environment due to the operation of the facility to the Facility Manager and the Vice President of Environmental Health & Safety Resources.

An annual report will be prepared which describes actions taken by the SERP including changes to operating procedures, the facility, or tests and experiments that involve safety or the environment enacted since the previous report was issued. The report also will document the reason for each change, whether the change required an NRC license amendment, and the basis for determination.

5.7.2.4 Radioactive Material Postings

All entrances to the facility will be conspicuously posted with the following statement: "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL."

5.7.2.5 Recordkeeping

All records will be maintained as hard copy originals or stored electronically.

The following information will be permanently maintained both on-site and at an off-site location until NRC license termination:

- Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.
- Records of spills, excursions, facility stoppages, contamination events, and unusual occurrences.
- Records of inspections of ponds.
- Records of the occupational monitoring.
- Information related to the radiological characterization of the facility.
- Drawing and photographs of structures, equipment, restricted areas, well fields, and storage areas with radioactive materials and all of their modifications.
- Records of survey and calibrations will be maintained for at least 3 years.

In addition, records of the locations of all injection, production, and monitor wells will be retained throughout the postclosure monitoring period. Well locations will be determined using a survey-grade GPS or equivalent.

All records will be stored in manner to prevent record loss from fire, flood, or other unforeseen events beyond the control of Powertech (USA). All records will be legible throughout the retention period described above.

5.7.2.6 Reporting

Powertech (USA) has committed to developing written operating procedures within the management control program to address all NRC license reporting requirements. These will be prepared after NRC license issuance but prior to ISR operations. Specific reporting requirements will include items such as reports of theft or loss of licensed material, notification of incidents, reports of exposures of radioactive material exceeding limits, and effluent monitoring reporting.

Powertech (USA) will prepare and submit reports in accordance with the requirements of SDCL 45-6B-36, ARSD 74:29:05:18 and ARSD 74:29:05:20. The following reports will be provided to DENR at the specific frequency.

Updated Baseline Surface and Groundwater Report

Powertech (USA) has committed to collecting additional surface water and groundwater samples prior to operations (refer to Sections 5.5.2 and 5.5.3). The results will be provided to DENR in an updated baseline surface and groundwater report prior to ISR operations.

Annual Environmental Monitoring Report

Powertech (USA) will prepare and provide to DENR an annual environmental monitoring report, which will include the results of the following operational monitoring programs.

- Operational groundwater monitoring, including domestic wells, stock wells, irrigation wells and monitor wells.
- Operational surface water monitoring, including streams and impoundments.
- Soil sampling, including soil samples collected from the air particulate monitoring locations and from the land application areas (if used).
- Vegetation sampling, including vegetation samples collected from the air particulate monitoring locations and from the land application areas (if used).
- Livestock and wildlife sampling.
- Environmental air monitoring, including air particulate and radon gas sampling at operational environmental air monitoring stations.

Per ARSD 74:29:05:20, Powertech (USA) will submit a written report to DENR following each land application cycle, which is defined as the last land application operational period during each calendar year. Prior to the end of each year, Powertech (USA) will prepare and submit a written report including the following information for each of the land application systems (Dewey and Burdock):

1) The total amount of land application solution applied;
2) The total hydraulic loading rate per acre;
3) The total metals loading rate per acre, including all of the trace and minor elements and radiological parameters in Table 6.2-1;
4) The duration of the land application cycle;
5) All environmental monitoring data associated with the land application systems, including effluent, catchment area water, soils, vegetation, and wildlife monitoring;
6) Evaluation of potential increasing trends in constituent concentrations and potential for bioaccumulation;
7) Description of any mitigation measures implemented;
8) Evaluation of the potential development of saline seeps, including the results of annual surveys of drainage channels near the land application areas for signs of potential saline seeps; and
9) A general discussion of the success of the system.

Well Completion Reports

Powertech (USA) will submit well completion reports within 1 month of completing each injection, production, or monitor well. Well completion will be defined as the point at which the well screen has been installed and initial well development has occurred. In accordance with SDCL 46-6-11, the well completion reports will be provided to DENR on a form supplied by the Chief Engineer.

Well Plugging Reports

Powertech (USA) will provide an annual well plugging report to DENR including the following elements for each plugged well in accordance with ARSD 74:02:04:71:

1) The name and complete mailing address of the owner;
2) The legal description of the well or hole location;
3) The completion date;
4) The casing or hole size, type of well, and well or hole depth;
5) A general description of the condition of the well;
6) A description of the plugging procedure;
7) The grout or material used to plug the well or test hole; and
8) The date and the signature of the license representative.

Wildlife Report

Powertech (USA) will prepare an annual wildlife report for SDGF&P and DENR that will address:

1) Bald Eagles and Other Nesting Raptors
    a. Results of annual monitoring of all known raptor nests and annual searches for new nests based on existing and planned disturbance, including a map showing current nest locations and conditions (intact, former) and the most recent 5-year history of each nest site, subject to data availability
    b. Discussion of surface disturbance and project activities within buffer distances of raptor nests
    c. Other monitoring requirements as listed in Appendix 5.6-C
2) Waterfowl and Shorebirds
    a. Operation and effectiveness of avian deterrent systems for facility ponds and results of water quality monitoring in treated water storage ponds if avian deterrent systems are not used
    b. Other monitoring requirements as listed in Appendix 5.6-C
3) Breeding Birds and Other Avian Species of Concern or Interest
    a. Results of clearance surveys for ground-nesting species in areas of planned disturbance
    b. Observations of avian species tracked by the SDNHP (location, habitat, etc.)
    c. Other monitoring requirements as listed in Appendix 5.6-C
4) Prairie Dogs and Lagomorphs
    a. Mapping and monitoring results of prairie dog colonies in and within 1.0 mile of permit area
    b. Description of prairie dog management efforts in and within 1.0 mile of permit area
    c. Results of annual nocturnal spotlight surveys for lagomorphs
5) Land Application (if used)
    a. Annual land application monitoring results (effluent, catchment areas, soil, vegetation, and prairie dogs) evaluating potential bioaccumulation of selenium and other metalloids/metals, and description of mitigation measures (if required).
6) Wildlife Mortalities
    a. Description of any wildlife mortalities observed within the permit area

In addition, Powertech (USA) will report any wildlife mortalities to SDGF&P within 24 hours by telephone and/or email.

Postclosure Monitoring Report

During postclosure monitoring, Powertech (USA) will provide an annual report to DENR describing the following:

Davis, 2011, personal communication between James F. Davis, former Susquehanna Western geologist, and Jim Bonner, Powertech (USA) Inc., April 15, 2011.

DENR (South Dakota Department of Environment and Natural Resources), 2005, Standard Operating Procedures for Field Samplers, Volume I, Tributary and In-Lake Sampling Techniques, February 2005.

DeVoto, R.H., 1978, Uranium Geology and Exploration, Colorado School of Mines Press, Golden Colorado.

Dorn, R.D., 2001, *Vascular Plants of Wyoming*, 3rd Edition, Mountain West Publishing, Cheyenne, Wyoming, 289 p.

DOT (U.S. Department of Transportation), 1995, Highway Traffic Noise Analysis and Abatement Policy and Guidance, Federal Highway Administration, Office of Environment and Planning, Noise and Air Quality Branch, June 1995.

Downey, J.S., 1984, Geohydrology of the Madison and Associated Aquifers in Parts of Montana, North Dakota, South Dakota, and Wyoming, USGS Professional Paper 1273-G, 47 p.

Driscoll, D.G., J.M. Carter, J.E. Williamson and L.D. Putnam, 2002, Hydrology of the Black Hills Area, South Dakota, USGS Water-Resources Investigations Report 02-4094, 158 p.

Driscoll, F.M, 1986, *Groundwater and Wells*, Johnson Filtration Systems, Inc., St. Paul, MN, 1089 p.

EPA (U.S. Environmental Protection Agency), 2013, Aquatic Life Criteria Table. Available from the Internet on 25 March 2013: http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm#L.

_____, 1974, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA 550/9-74-004.

ESI (Environmental Simulations Incorporated), 2003, Aquifer^{Win32} aquifer test analysis software.

Flynn, K.M., W.H. Kirby and P.R. Hummel, 2006, User's Manual for Program PeakFQ Annual Flood-Frequency Analysis using Bulletin 17B Guidelines, USGS, Techniques and Methods Book 4, Chapter B4, 42 p.

Gott, G.B., D.E. Wilcott and C.G. Bowles, 1974, Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota and Wyoming, USGS Professional Paper 763, prepared on behalf of the U.S. Atomic Energy Commission.

Greene, E.A., 1993, Hydraulic Properties of the Madison Aquifer System in the Western Rapid City Area, South Dakota, USGS Water-Resources Investigations Report 93-4008, 56 p.

Halford, K.J. and E.L. Kuniansky, 2002, Documentation of Spreadsheets for the Analysis of Aquifer-test and Slug-test Data, USGS Open-File Report 02-197.

Rahn, P.H., 1985, Ground Water Stored in the Rocks of Western South Dakota, *in* F.J. Rich (ed.), *Geology of the Black Hills, South Dakota and Wyoming* (2nd ed.): Geological Society of America, Field Trip Guidebook, American Geological Institute, p. 154-174.

Raisbeck, M.F., S.L. Riker, C.M. Tate, R. Jackson, M.A. Smith, K.J. Reddy and J.R. Zygmunt, 2007, Water Quality for Wyoming Livestock and Wildlife. Available from the Internet on 23 March 2013: http://www.uwyo.edu/ces/pubs/b1183/index.html.

Rao, A.R. and K.H. Hamed, 2000, *Flood Frequency Analysis*, CRC Press.

Reher, C.A., 1981, Archaeological Survey and Testing Project for the Silver King Mine, A Summary Report, Tennessee Valley Authority, Casper, WY.

Renard, K.G., G.R. Foster and G.A. Weesies (coordinators), 1990, Predicting Soil Erosion by Water – A Guide to Conservation Planning with the Revised Soil Loss Equation, in preparation, USDA Agricultural Research Service.

Ries, K.G. III and M.Y. Crouse, 2002, The National Flood Frequency Program, Version 3: A Computer Program for Estimating Magnitude and Frequency of Floods for Ungaged Sites, USGS Water-Resources Investigations Report 02-4168, 42 p.

Robbins, C.S., B. Bruun and H.S. Zim, 1966, *Birds of North America: A Guide to Field Identification*, Golden Press, New York, 340 p.

Rom, L., T. Church and M. Church (editors), 1996, Black Hills National Forest Cultural Resources Overview, U.S. Department of Agriculture, Forest Service, Black Hills National Forest Supervisor's Office, Custer, SD.

Schnabel, R.W. and L.J. Charlesworth, Jr., 1963, Geology of the Burdock Quadrangle, South Dakota, USGS Survey Bulletin 1063-F, Plate 17.

Schreiner, L.C. and J.T. Riedel, 1978, Hydrometeorological Report No. 51 – Probable Maximum Precipitation Estimates, United States East of the 105th Meridian, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and U.S. Department of the Army Corps of Engineers, Washington D.C. p. 48-77.

SDDOT (South Dakota Department of Transportation), 2012, 2011 Statewide Traffic Flow map. Available from the Internet as of September 2012: http://www.sddot.com/transportation/highways/traffic/

SDSU (South Dakota State University), 2008, Automatic Weather Data Network archived hourly data. Available from the Internet as of December 2008: http://climate.sdstate.edu/climate_site/climate.htm.

South Dakota Ornithological Union, 1991, *The Birds of South Dakota*, 2nd Edition, Aberdeen, SD.

Spencer, 2011, personal communication between Donald Spencer and Jim Bonner, Powertech (USA) Inc., April 28, 2011.

Stokes, D.W. and L.Q. Stokes, 1996, *Field Guide to Birds: Western Region*, Little, Brown and Co., New York.

POWERTECH (USA) Inc.
DEWEY-BURDOCK PROJECT
Technical Revisions

Powertech (USA) Inc. proposes the following list of technical revisions for which the Board of Minerals and Environment will authorize the Department of Environment and Natural Resources (department) to review and approve pursuant to ARSD 74:29:03:16.

1. Modify monitoring plans, locations, parameters, and time frames;
2. Modify monitoring analytical methods, limits of detection and reporting requirements;
3. Modify compliance limits or trigger values for chemical parameters;
4. Modify the chemicals added to the lixiviant to include alternative oxidizing agents such as hydrogen peroxide and alternate complexing agents such as sodium bicarbonate;
5. Modify plans and specifications for permitted facilities;
6. Submitting and modifying quality control and quality assurance plans;
7. Add contiguous, affected land within the permit boundary with the total of such additions not to exceed twenty (20) percent of the permitted affected land area of 2,528 acres for this permit if deep disposal wells are used without land application to dispose treated wastewater or 3,793 acres for this permit if land application is used. The maximum amount of expansion allowed without land application (20% of 2,528 acres) is 252.8 acres, and the maximum amount of expansion allowed with land application (20% of 3,793 acres) is 379.3 acres;
8. Modify the mine plan within the constraints of ARSD 74:29:03;
9. Modify or relocate diversions or erosion, sedimentation, or drainage control structures;
10. Modify or relocate ancillary facilities within the permit boundary, including equipment storage areas, parking lots, office buildings, septic systems, perimeter fencing, utilities (phone lines, natural gas lines, power lines, water lines), sediment ponds, and stockpiles;
11. Modify well field configurations within permitted disturbance limits;
12. Modify mine designs and disturbance areas to include contiguous areas of potential ore;
13. Modify the recovery process within the processing facilities to improve performance, recovery or environmental aspects, including the potential recovery of vanadium;
14. Relocate processing facilities to improve operations aspects and recovery;
15. Relocate chemical or petroleum storage areas;
16. Develop and implement other mineral processing technologies that would improve both economic and environmental aspects;
17. Modify or relocate roads within the permit boundary;
18. Modify or relocate pipelines and utilities within the permit boundary;
19. Modify topsoil stripping plans and relocate topsoil and spoil stockpiles;
20. Modify the size of area to be worked at any one time;
21. Modify dust control measures;
22. Modify operating time tables for proposed operations;
23. Modify groundwater restoration methods or schedule;
24. Change, modify, develop, enhance, or increase water treatment technology and water treatment regimens;
25. Modify water usage and sources as allowed by water rights permits;
26. Modify water storage capacity and pond configurations;
27. Modify the size and configuration of the land application areas and catchment areas;
28. Modify the reclamation plan within the constraints of ARSD 74:29:03;
29. Modify the reclamation time tables for proposed reclamation and decommissioning;
30. Implementing new and improved reclamation techniques as they are developed;
31. Modify seeding mixtures or rates;

32. Use irrigation, fertilizer or nurse crops in reclamation;
33. Modify reclamation or vegetation performance standards;
34. Relocate, add or remove reference areas used to establish revegetation success;
35. Modify stocking guidelines and reclamation success standards to reflect climatic conditions;
36. Modify reclamation monitoring techniques;
37. Modify livestock carrying capacities of surrounding areas;
38. Modify areas designated with postmining land uses of rangeland or agricultural or horticultural cropland.
39. Modify designated crop types for areas designated with postmining land use of agricultural or horticultural cropland.
40. Modify reporting procedures and parameters as allowed within the mining laws and mine permit; and
41. Modifying postclosure plans and monitoring time frames;

Powertech (USA) understands that technical revisions must comply with ARSD 74:29:03:03 and must be submitted to the department in writing. The department shall approve, disapprove, conditionally approve, or request additional information deemed necessary to approve technical revisions within 30 days of receipt.

APPENDIX 3.2-D

TVA Exploration Hole Plugging Correspondence

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Silver King Mines, Inc.

P. O. Box 49

Edgemont, South Dakota 57735

December 21, 1989

DEC 27 1989

Uranium Operations
Casper, Wyoming

CFW [illegible]

Mr. Robert D. Townsend, Program Chief
Exploration and Mining Program
South Dakota Department of Water and
Natural Resources
Joe Foss Building
523 E. Capitol
Pierre, South Dakota 57501

RE: EX-5 BOND RELEASE

Dear Mr. Townsend:

I am writing as a follow up to my October 13, 1989 letter to you regarding SKM's request for a bond release on EX-5. We are providing the following additional information that was requested by Tom Durkin in his telephone conversation with Doug Yoder of TVA.

1. As previously reported, to the best of our knowledge the 36 holes mentioned in my October 13, 1989 letter have been properly plugged with low shrink, high sulfate resistant cement grout from the bottom of the hole to within three feet of the surface. The upper three feet of the holes were filled with suitable soil materials.

2. In addition, to the best of our knowledge <u>all</u> of the TVA test holes, whether drilled prior to or after issuance of the EX-5 in 1979, were properly plugged according to the applicable state regulations at the time of drilling. In fact, during the course of the drilling program your department asked SKM to work with the Department to develop and upgrade the State plugging standards. As a result of that combined effort, during which the Department was actively involved in working with SKM and monitoring the drilling program, the State plugging standards changed and evolved. Once again, however, at any given time the hole plugging was conducted in full compliance with the then existing State requirements.

Burdock Area Test Holes

3. A brief history of the Burdock test holes is as follows: On June 30, 1986 we submitted our closing report to the DWNR and made reference to addressing the concern expressed by Peterson and Son, Inc. regarding the seepage occuring in the "alkali area" of their property. On September 12, 1986 we submitted to you our investigation of the problem and our proposed plan of mitigation. The TVA contracted with a Newcastle, Wyoming drilling company which carried out the mitigation plan. That work was observed by DWNR inspectors and reported in inspection reports of October 16, 1987 (Tom Durkin) and November 13, 1987 (Dale Snyder).

4. As was noted in those inspection reports, extensive mitigation was conducted at the Burdock site including redrilling of the test holes and replugging them with cement. Tom Durkin's report states that "TVA is very definitely making an earnest attempt to rectify the problem. From field observance it is my opinion that it may be impossible to have every hole redrilled and replugged to depth."

5. To date, TVA has already expended a substantial amount of time and money in trying to rectify the seepage problem. In addition, we have consulted with our attorney, Marv Truhe, as to the proper course of action under these circumstances. Tom Durkin's inspection report states that if reclamation proves unsuccessful then an alternative may be the working out of suitable compensation to the landowner. Dale Snyder's subsequent report also discusses the extensive redrilling efforts and mentions the possible reasons for the continuing water leakage including joints and fractures in the soil, lateral underground infiltration water into the area, or test holes which were not properly plugged. As has been previously pointed out, there are "pre-TVA' exploration drill holes in this area that were left by prior mineral lessees before the State's plugging standards were enacted. Dale Snyder's report also mentions the option of landowner compensation.

6. TVA is now convinced that further redrilling efforts would not be successful in completely eliminating the seepage and has therefore adopted the alternate course of action suggested in the DWNR reports, namely mitigation of the site and compensation to the landowner. We continued negotiations with the landowner this year and on July 12, 1989 reached an agreement whereby a berm was constructed and TVA paid the landowner $7372.00 in full settlement for all damages which had occurred or which may occur as a result of the seepage. Enclosed is a copy of the TVA letter to Peterson and Son, Inc. dated July 12, 1989 (a copy of which was also sent on that date to Tom Durkin). Enclosed also is a copy of the Memorandum of Damage Settlement in which TVA has also agreed to monitor the area for a period of five years and also to maintain the berm that controls the seepage.

Pre-Permit Test Hole

7. As you know, an old test hole (not in the alkali area) which was drilled on the Peterson property several years prior to the issuance of EX-5 is now apparently seeping. That test hole was drilled in March of 1976 and is identified as PT-31. We are currently working with Mr. Peterson to mitigate the seepage and/or compensate him for any potential damages. As indicated, however, the reclamation of this test hole is unrelated to the EX-5 bond release matter.

In conclusion, we feel that whatever seepage that still may be occurring in that area is not as a result of TVA's exploration drill holes. Regardless of whether the seepage is from pre-TVA test holes or from other sources, however, TVA has done everything possible regarding redrilling and replugging efforts, has paid the landowner for all damages sustained, and has received the landowner's approval of the reclamation, including berm construction and maintenance, and ongoing monitoring for a five-year period. Accordingly, we would request your recommendation of approval for the release of the bond at this time. If you still have additional questions following your review of this information, we would be available to meet with you in Pierre to discuss this further.

I also want to advise you that as of December 31, 1989, I will no longer be working for SKM. TVA's decommissioning project in Edgemont is now complete. The SKM/TVA contract for the project will terminate and the Edgemont office of SKM will close at the end of the year. Any further contacts with SKM regarding EX-5 will be handled by Gary Cummings. Gary was formerly general manager for SKM in Edgemont and was the general superintendent in charge of the EX-5 drilling program. He was also involved in the developments outlined in paragraph 2 above. Gary's address and phone number are as follows: Alta Gold Co., P.O. Box 382, Ruth, Nevada, 89319, (702) 289-4470. In addition, TVA has requested that all future correspondence from the State to SKM regarding this matter be copied to Chuck Wolff, Manager of Uranium Operations, Tennessee Valley Authority, P.O. Box 2957, Casper, Wyoming, 82602. Thank you for your consideration and we will wait to hear from you.

Sincerely,

Kurtis T. Barker

Kurtis T. Barker
General Manager
Wyoming/South Dakota Projects

MDT/dlg
KTB; 171,89

cc: T. L. Hayslett
D. H. Marks
C. E. Wolff
M. D. Yoder
M. R. P. Central Files
M. D. Truhe
G. W. Cummings
S. R. Havenstrite

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NOXIOUS WEED CONTROL PLAN

Powertech (USA) will maintain an active weed control program based on a yearly inspection of the property during the active growing season of weeds to identify the locations of weed growth and on the treatment of weed infestations, with an emphasis on noxious weeds. An effective weed control program utilizes a number of management practices. The following plan outlines the various weed management techniques that could be implemented at the Dewey-Burdock Project. Consultation letters indicating that the plan has been reviewed and approved by the Custer and Fall River County Weed and Pest Boards are included with this appendix.

Noxious weeds will be controlled throughout the life of the Dewey-Burdock Project to reduce the seed source available to invade reclaimed areas. A list of the South Dakota state noxious weeds and the Custer and Fall River counties locally noxious weeds is provided in Table 1. It is anticipated that herbicides will be the primary method utilized to control weeds, but all weed control methods listed below will be considered.

Herbicides are important tools for controlling noxious weeds. Selective herbicides kill a specific type of plant and they perform best if conditions are favorable for plant growth (South Dakota State University Extension, 2013). Since some of these herbicide treatments, especially those targeting broadleaf weeds, also remove all or many of the desirable forbs or legumes, Powertech (USA) will selectively use herbicides, thereby reducing the potential impacts to beneficial plant species. Herbicide application will be performed by a South Dakota-certified licensed pesticide applicator. Powertech (USA) will follow all grazing and haying restrictions on the herbicide label. Combined with proper grazing management and other control tactics, proper use of herbicides can encourage the recovery of reseeded areas that have become infested with weeds. Powertech (USA) will use herbicides that are labeled for the target weed and registered for use on pasture and range and will follow recommended application rates to ensure control of undesirable forage while limiting potential desirable vegetative species impacts.

Prescribed grazing is the application of livestock grazing at a specified season, duration, and intensity to accomplish specific vegetation management goals. By itself, grazing will rarely, if ever, completely eradicate invasive plants. However, when grazing treatments are combined with other control techniques, such as herbicides or biological control, severe infestations can be reduced and small infestations may be eliminated (Frost and Launchbaugh, 2003). A successful grazing prescription should cause significant damage to the target plant, limit irreparable damage to the surrounding vegetation, be consistent with livestock production goals, and be integrated with other control methods as part of an overall weed management strategy. Prescribed grazing

for weed control requires grazing when the weed is most palatable to livestock and most susceptible to defoliation (Frost and Launchbaugh, 2003).

Deferred grazing gives the grasses the opportunity to build up root reserves, develop more topgrowth and produce more herbage (South Dakota State University Extension, 2013). In some pastures, desirable native species no longer abundant will become re-established during the rest period. Deferred grazing can be used in conjunction with other improvement practices to speed recovery.

Mowing, chopping, or clipping temporarily removes weed topgrowth (South Dakota State University Extension, 2013). This system stops seed production but has different effects on the weeds. Annual forbs can be controlled by cutting below the lowest leaf early in the growing season. Undesirable annual grasses should be mowed after the seed stalk has elongated but prior to seed formation. Mowing perennial weeds one time usually reduces seed production; repeated mowing reduces vigor and slows spread. Clipping perennials like Canada thistle or leafy spurge in the spring works well as a set up for fall herbicides when moisture encourages new growth. Digging or chopping works well for scattered biennial thistle. Musk thistle rosettes can be stopped when the root is cut several inches below ground level. This technique requires more labor and is limited to small patches or scattered plants (South Dakota State University Extension, 2013).

Biological control is another weed control tool, especially for noxious weeds. Biological control utilizes natural enemies as a means of weakening or killing the host plant. Insects have been the most common approach to biological control in South Dakota (South Dakota State University Extension, 2013). Noxious weeds that have approved biological control agents (insects) in the state include leafy spurge, musk thistle, Canada thistle, toadflax, St. Johnswort, and biennial knapweeds. South Dakota currently has a collection and release program for leafy spurge flea beetles *(Aphthona* species), coordinated by the South Dakota Department of Agriculture (South Dakota State University Extension, 2013). Powertech (USA) will consult with the Custer and Fall River County Weed and Pest Boards if the use of flea beetles on leafy spurge is considered.

Table 1: South Dakota, Custer County and Fall River County Lists of Noxious Weeds

SOUTH DAKOTA NOXIOUS WEEDS
(South Dakota Department of Agriculture, 2012)

Leafy spurge (*Euphorbia esula*)
Canada thistle (*Cirsium arvense*)
Perennial sow thistle (*Sonchus arvensis*)
Hoary cress (*Cardaria draba*)
Russian knapweed (*Centaurea repens*)
Purple loosestrife (*Lythrum salicaria*)
Saltcedar (*Tamarix aphylla, T. chinensis, T. gallica, T. parviflora and T. ramosissima*)

CUSTER COUNTY LOCALLY NOXIOUS WEEDS
(Custer County, 2012; National Park Service, 2011)

Absinth wormwood (*Artemisia absinthium*)
Black henbane (*Hyoscyamus niger*)
Bull thistle (*Cirsium vulgare*)
Chicory (*Cichorium intybus*)
Common Burdock (*Arctium minus*)
Common mullein (*Verbascum thapsus*)
Common tansy (*Tanacetum vulgare*)
Dalmatian toadflax (*Linaria dalmatica*)
Diffuse knapweed (*Centaurea diffusa*)
Field bindweed (*Convolvulus arvensis*)
Giant knotweed (*Polygonum sachalinense*)
Houndstongue (*Cynoglossum officinale*)
Musk thistle (*Carduus nutans*)
Phragmites (*Phragmites australis*)
Plumeless thistle (*Carduus acanthoides*)
Poison hemlock (*Conium maculatum*)
Puncturevine (*Tribulus terrestris*)
Scotch thistle (*Onopordum acanthium*)
Spotted knapweed (*Centaurea maculosa*)
Sulfur cinquifoil (*Potentilla*)
St. Johnswort (*Hypericum perforatum*)
White horehound (*Marrubium vulgare*)
Yellow toadflax (*Linaria vulgaris*)

FALL RIVER COUNTY LOCALLY NOXIOUS WEEDS
(Fall River County, 2012)

Common mullein (*Verbascum thapsus*)
Dalmatian toadflax (*Linaria dalmatica*)
Scotch thistle (*Onopordum acanthium*)

References

Custer County, 2012, Custer County Weed and Pest Board archive meeting minutes, August 1, 2012, available on the Internet as of March 2013: http://www.custercountysd.com/wp-content/uploads/2011/01/Bdmtg080112.doc.

Fall River County, 2012, Noxious Weeds and Pests, available on the Internet as of June 2012: http://fallriver.sdcounties.org/weed-pest/noxious-weeds-and-pests/.

Frost, R.A. and K.L. Launchbaugh, 2003, Prescription Grazing for Rangeland Weed Management - A New Look at an Old Tool, *Rangelands*, 25 (6), available on the Internet as of June 2012: http://www.cnrhome.uidaho.edu/documents/Prescription%20grazing%5B1%5D.pdf&pid=74891&doc=1.

National Park Service, U.S. Department of the Interior, 2011, Jewel Cave National Monument - Natural Resource Condition Assessment, Natural Resource Report NPS/JECA/NRR—2011/477, available on the Internet as of June 2012: http://www.nature.nps.gov/water/nrca/assets/docs/JECA_NRCA_final.pdf.

South Dakota Department of Agriculture, 2012, State Noxious Weeds, available on the Internet as of June 2012: http://www.sdda.sd.gov/Ag_Services/Plant-Protection/Weed%20and%20Pest/State-Noxious-Weeds.aspx.

South Dakota State University Extension, 2013, 2013 Weed Control, Pasture and Range, available on the Internet as of March 2013: http://igrow.org//up/resources/03-3020-2012.pdf.

DEWEY-BURDOCK PROJECT RECLAMATION PERFORMANCE CRITERIA

1.0 INTRODUCTION

The primary goal of the reclamation program is to rehabilitate the affected land to a condition that meets the selected postmining land uses (ARSD 74:29:07:01). The designated postmining land uses include rangeland (ARSD 74:29:07:20) and agricultural or horticultural crops (ARSD 74:29:07:21). This appendix presents the reclamation performance criteria to establish the success of revegetation for each of these postmining land uses. For agricultural and horticultural cropland, the final bond release criteria will be a demonstration that the productive capacity is equal to or exceeds that of similar crop production areas in the surrounding region for two consecutive crop years. For rangeland, four criteria will be used to establish successful revegetation: vegetative ground cover, usable forage production, species composition and reclamation sustainability. Each of these is briefly described in the following subsections. Section 2 describes the specific methodology to measure reclamation performance for rangeland, Section 3 describes the comparison process, and Section 4 provides references.

1.1 Vegetative Cover

To meet final bond release criteria for rangeland, the total vegetative cover (not including noxious weed) in a revegetated unit must equal or exceed the total vegetative cover on reference areas.

1.2 Usable Forage Production

To meet final bond release criteria, the reclaimed rangeland must support a livestock carrying capacity equivalent to reference areas (ARSD 74:29:07:20). The carrying capacity will be determined by measuring the usable forage production (biomass of usable forage) of the land. Usable forage is defined as the average palatability of individual plant taxa (for consumption by cattle) based on the U.S. Forest Service publication, "Check List, Palatability Table and Standard Symbol List of Colorado and Wyoming Range Plants (USFS, 1937). As indicated in the publication, the list is appropriate for plants of the Black Hills of South Dakota.

1.3 Species Composition

According to ARSD 74:29:07:06, postmine vegetative species and composition must be appropriate for the designated postmining land use. Species composition of the reclamation will be measured to document that species present are appropriate for the rangeland postmining land use.

1.4 Sustainability of the Reclamation

Disturbed lands will be revegetated in accordance with SDCL 45-6B-39, which requires that a diverse, effective, and long lasting vegetative cover be established that is capable of self-regeneration and at least equal in extent of cover to the natural vegetation of the surrounding

area. Compliance with the cover requirement will be demonstrated using the reference area concept, as described in Section 3.0 below. As stated in ARSD 74:29:07:20, rangeland reclamation will be complete when the reclaimed range is capable of withstanding proper stocking rates for 2 consecutive years prior to bond release. Disturbance will be reclaimed using methods outlined in Section 6.4 of the LSM permit application and monitored using methods described below. These reclamation techniques and monitoring methods were developed in accordance with SDCL 45-6B-39 and ARSD 74:29:07:20 and will ensure that adequate cover, species composition, usable forage production, and reclamation sustainability will be attained on the reclamation.

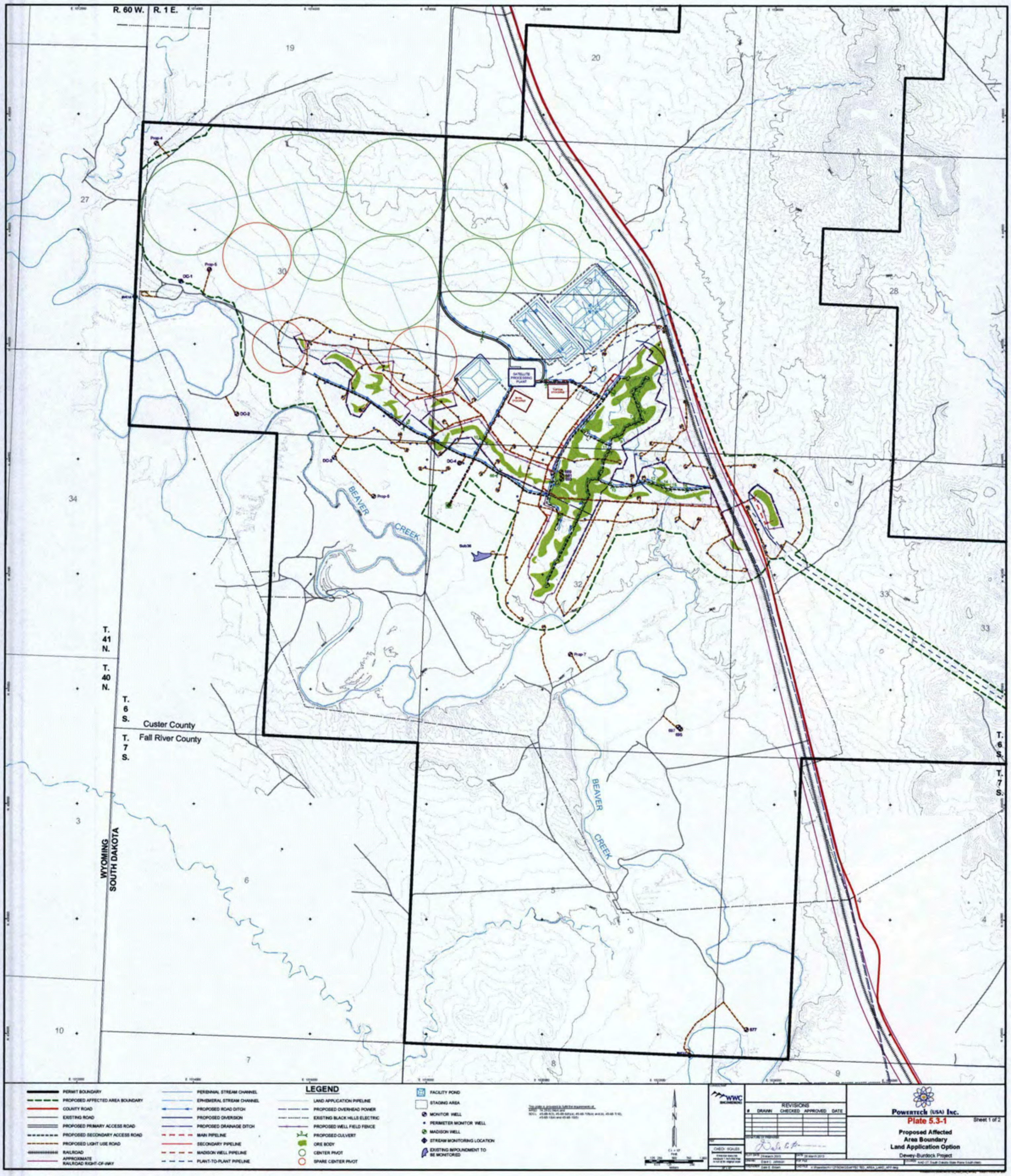
2.0 SAMPLING METHODOLOGY

2.1 Vegetative Cover

The initial step in determining the success of the rangeland revegetation is to determine vegetative cover and production using line transect/point-intercept transects. Due to the two distinct configurations of reclamation (large area parcels associated with well fields and facilities) and linear parcels associated with corridor disturbance, transect locations will be determined based on the configuration of the reclamation unit. Linear reclamation units will be no wider than an average of 50 feet over the length of the unit.

Large Area Parcels: For each 10 acres of revegetated rangeland, one randomly located line transect/point-intercept transect will be used to collect percent absolute vegetative cover data. For parcels of revegetated rangeland smaller than 10 acres, one transect will be used. Transects will be located randomly in the field within each 10-acre unit using a computerized systematic grid (through AutoCAD or ArcGIS). These computer-generated random numbers will be uploaded to a hand-held GPS unit for actual location in the field. Random numbers between 1 and 360 will be generated to determine cover transect direction, and compasses will be used to orient transects to the nearest 1/8 of 360° in the field. Each 50-meter transect will represent a single sample point. Transects that exceeded the boundaries of the vegetation community being sampled will be redirected back into its vegetation community at a 90° angle from the original transect direction at the point of intercept. In instances where a 90° angle of reflection does not place the transect within the sampled community, a 45° angle of reflection will be used. Percent cover measurements will be taken from point-intercepts at 1-meter intervals along the 50-meter transect. Transect locations will be submitted to DENR for review and verification prior to sampling.

Linear Parcels: One 50-meter transect will be located for each 1,640 feet (500 meters) of linear rangeland reclamation unit. The initial transect of a linear unit will be randomly located in the field within the first 50 feet of the unit using a computerized systematic grid (through AutoCAD or ArcGIS). These computer-generated random numbers will be uploaded to a hand-held GPS unit for actual location in the field. Subsequent transects will start 1,640 feet from the end of the preceding transect until a transect no longer fits entirely within the linear unit. Percent cover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T. 6 S.
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Custer County
Fall River County
WYOMING
SOUTH DAKOTA
BEAVER CREEK
SATELLITE PROCESSING PLANT
LEGEND
PERMIT BOUNDARY
PROPOSED AFFECTED AREA BOUNDARY
COUNTY ROAD
EXISTING ROAD
PROPOSED PRIMARY ACCESS ROAD
PROPOSED SECONDARY ACCESS ROAD
PROPOSED LIGHT USE ROAD
RAILROAD
APPROXIMATE RAILROAD RIGHT-OF-WAY
PERENNIAL STREAM CHANNEL
EPHEMERAL STREAM CHANNEL
PROPOSED ROAD DITCH
PROPOSED DIVERSION
PROPOSED DRAINAGE DITCH
MAIN PIPELINE
SECONDARY PIPELINE
MADISON WELL PIPELINE
PLANT-TO-PLANT PIPELINE
LAND APPLICATION PIPELINE
PROPOSED OVERHEAD POWER
EXISTING BLACK HILLS ELECTRIC
PROPOSED WELL FIELD FENCE
PROPOSED CULVERT
ORE BODY
CENTER PIVOT
SPARE CENTER PIVOT
FACILITY POND
STAGING AREA
MONITOR WELL
PERIMETER MONITOR WELL
MADISON WELL
STREAM MONITORING LOCATION
EXISTING IMPOUNDMENT TO BE MONITORED
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POWERTECH (USA) INC.
Plate 5.3-1
Sheet 1 of 2
Proposed Affected Area Boundary Land Application Option
Dewey-Burdock Project


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PROPOSED SECONDARY ACCESS ROAD
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APPROXIMATE RAILROAD RIGHT-OF-WAY
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EPHEMERAL STREAM CHANNEL
PROPOSED ROAD DITCH
PROPOSED DIVERSION
PROPOSED DRAINAGE DITCH
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LAND APPLICATION PIPELINE
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MADISON WELL
STREAM MONITORING LOCATION
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DRAWN CHECKED APPROVED DATE
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POWERTECH (USA) INC.
Plate 5.3-1
Sheet 2 of 2
Proposed Affected Area Boundary Land Application Option
Dewey-Burdock Project


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Custer County
Fall River County
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SOUTH DAKOTA
BEAVER CREEK
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PROPOSED AFFECTED AREA BOUNDARY
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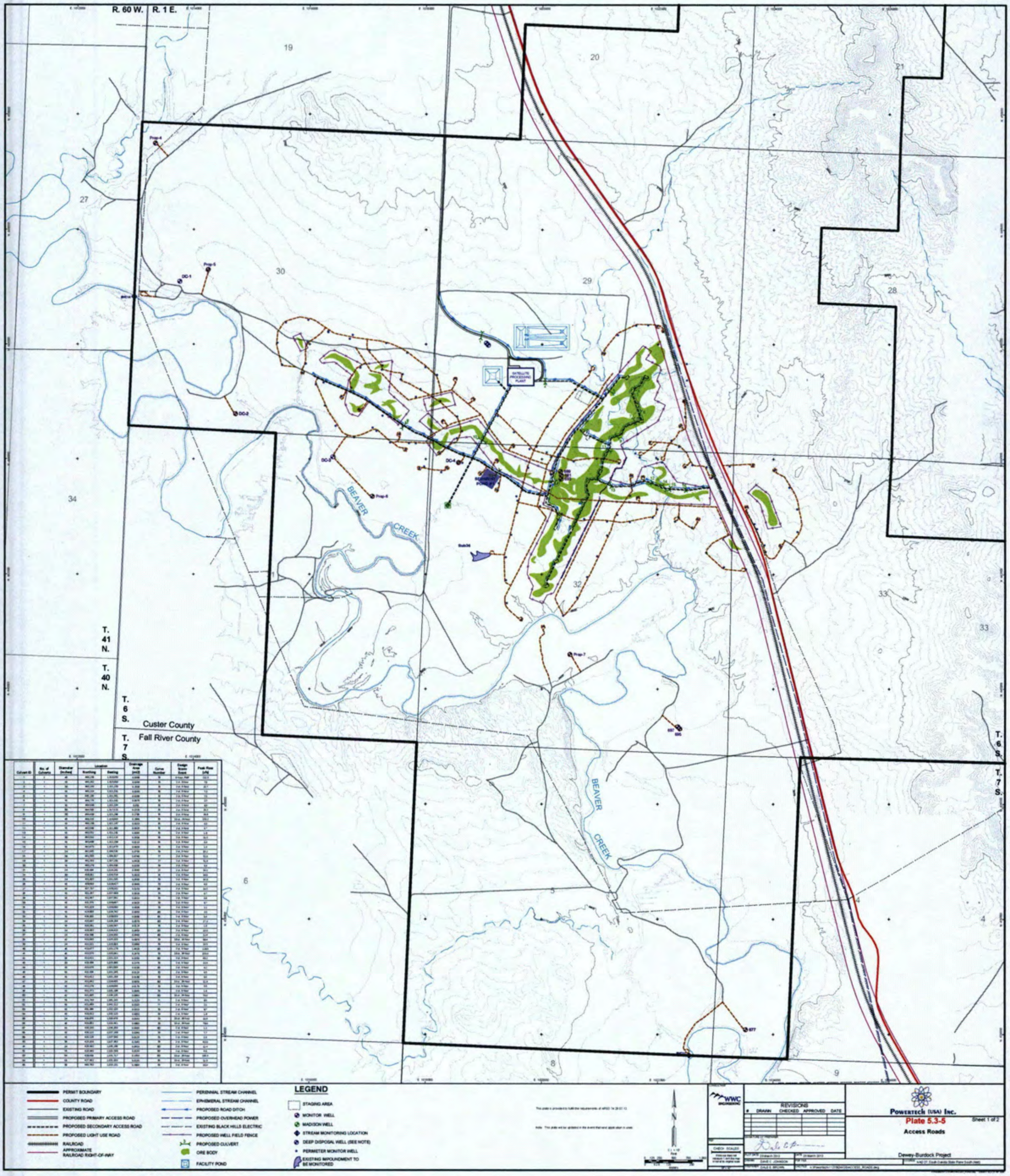
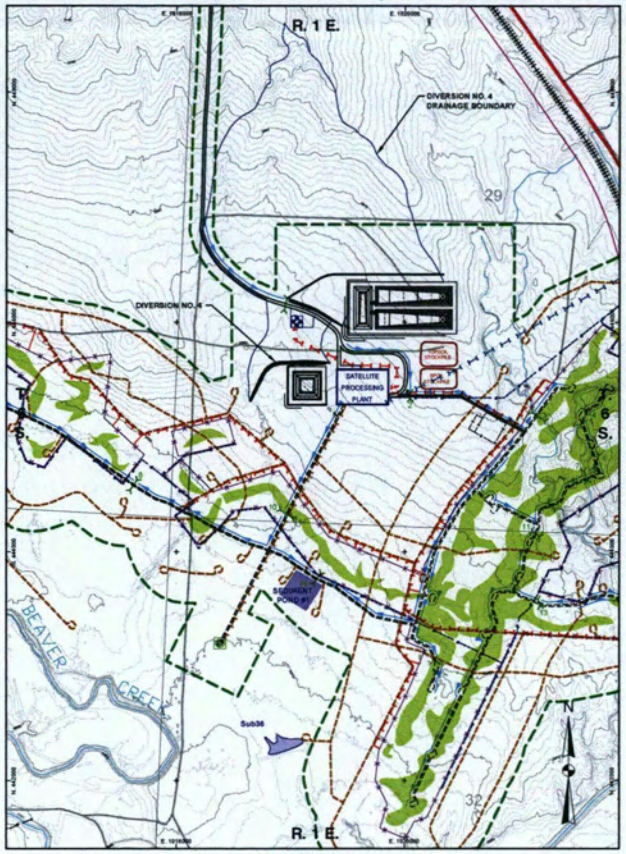
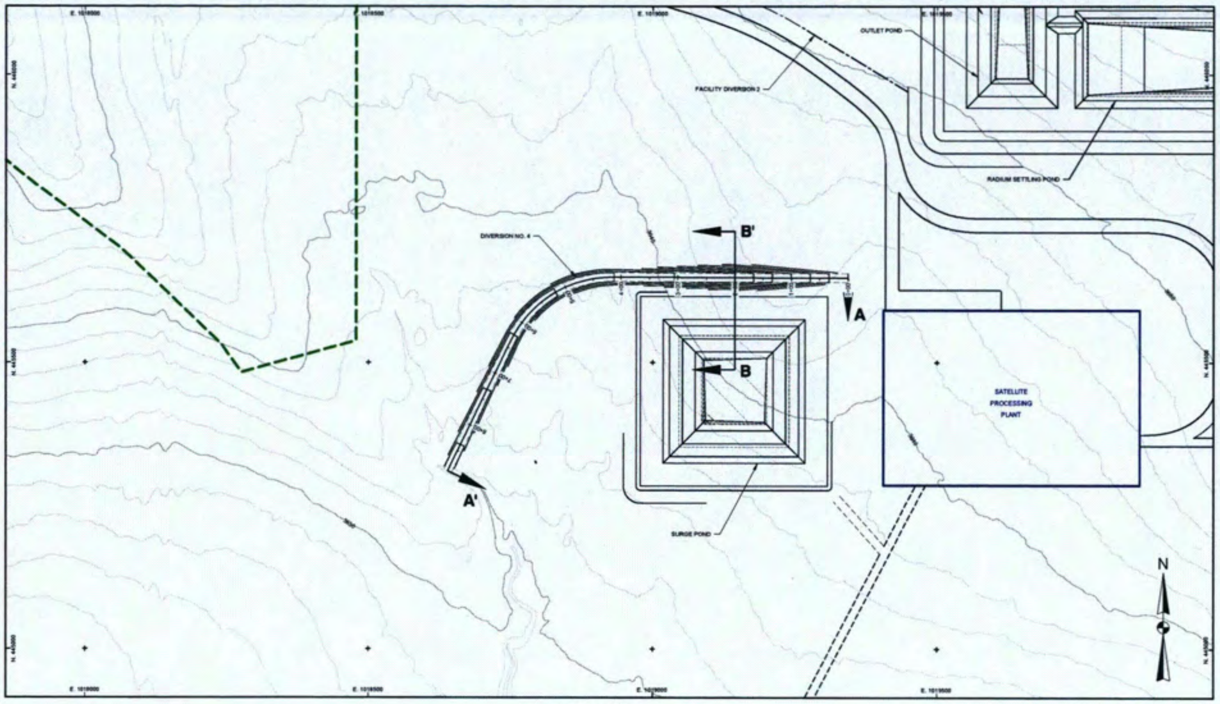
PROPOSED WELL FIELD FENCE
PROPOSED CULVERT
ORE BODY
FACILITY POND
STAGING AREA
MONITOR WELL
PERIMETER MONITOR WELL
MADISON WELL
STREAM MONITORING LOCATION
EXISTING IMPOUNDMENT TO BE MONITORED
DEEP DISPOSAL WELL
WWC ENGINEERING
REVISIONS
DRAWN CHECKED APPROVED DATE
CHECK SCALES
POWERTECH (USA) INC.
Plate 5.3-2
Sheet 1 of 2
Proposed Affected Area Boundary Deep Disposal Well Option
Dewey-Burdock Project


R. 60 W.
R. 1 E.
19
20
21
27
30
29
28
34
32
33
6
5
4
7
8
9
T. 41 N.
T. 40 N.
T. 6 S.
T. 7 S.
Custer County
Fall River County
BEAVER CREEK
SATELLITE PROCESSING PLANT
Prop-4
Prop-5
Prop-6
Prop-7
DC-1
DC-2
DC-3
DC-4
677
Culvert ID
No. of Culverts
Diameter (inches)
Location
Northing
Easting
Drainage Area (mi2)
Curve Number
Design Storm Event
Peak Flow (cfs)
LEGEND
PERMIT BOUNDARY
COUNTY ROAD
EXISTING ROAD
PROPOSED PRIMARY ACCESS ROAD
PROPOSED SECONDARY ACCESS ROAD
PROPOSED LIGHT USE ROAD
RAILROAD
APPROXIMATE RAILROAD RIGHT-OF-WAY
PERENNIAL STREAM CHANNEL
EPHEMERAL STREAM CHANNEL
PROPOSED ROAD DITCH
PROPOSED OVERHEAD POWER
EXISTING BLACK HILLS ELECTRIC
PROPOSED WELL FIELD FENCE
PROPOSED CULVERT
ORE BODY
FACILITY POND
STAGING AREA
MONITOR WELL
MADISON WELL
STREAM MONITORING LOCATION
DEEP DISPOSAL WELL (SEE NOTE)
PERIMETER MONITOR WELL
EXISTING IMPOUNDMENT TO BE MONITORED
WWC ENGINEERING
REVISIONS
DRAWN CHECKED APPROVED DATE
CHECK SCALES
DAVE C. JOHNSON
DALE E. BROWN
POWERTECH (USA) Inc.
Plate 5.3-5
Sheet 1 of 2
Access Roads
Dewey-Burdock Project



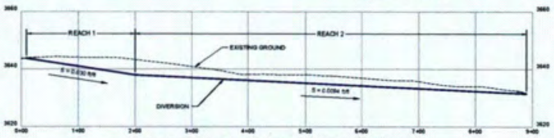
DRAINAGE AREA

SCALE: 1" = 500'
C. I. = 2'



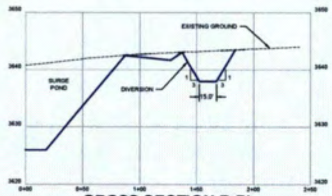
SITE PLAN

SCALE: 1" = 100'



SECTION A-A' DIVERSION PROFILE

SCALE: HORZ. 1" = 100', VERT. 1" = 20'



CROSS SECTION B-B'

SCALE: HORZ. 1" = 50', VERT. 1" = 10'

DIVERSION CROSS SECTIONS

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

REACH 1

2-yr, 6-hr		100-yr, 24-hr	
Q = 36.7 cfs	A = 7.59 ft²	Q = 164.4 cfs	A = 20.25 ft²
n = 0.030	WP = 17.93 ft	n = 0.030	WP = 21.99 ft
S = 0.030 ft/ft	R = 0.42 ft	S = 0.030 ft/ft	R = 0.92 ft
b = 15 ft	V = 4.84 fps	b = 15 ft	V = 8.12 fps
	Yn = 0.46 ft		Yn = 1.11 ft

REACH 2

2-yr, 6-hr		100-yr, 24-hr	
Q = 36.7 cfs	A = 11.03 ft²	Q = 164.4 cfs	A = 30.04 ft²
n = 0.030	WP = 19.11 ft	n = 0.030	WP = 24.69 ft
S = 0.0094 ft/ft	R = 0.58 ft	S = 0.0094 ft/ft	R = 1.22 ft
b = 15 ft	V = 3.33 fps	b = 15 ft	V = 5.47 fps
	Yn = 0.65 ft		Yn = 1.53 ft

LEGEND

- PROPOSED AFFECTED AREA BOUNDARY
- COUNTY ROAD
- EXISTING ROAD
- PROPOSED PRIMARY ACCESS ROAD
- PROPOSED SECONDARY ACCESS ROAD
- MAIN PIPELINE
- MADISON WELL PIPELINE
- APPROXIMATE RAILROAD RIGHT-OF-WAY
- PLANT-TO-PLANT PIPELINE
- PROPOSED LIGHT USE ROAD
- PROPOSED OVERHEAD POWER
- PROPOSED WELL FIELD FENCE
- PERENNIAL STREAM CHANNEL
- EPHEMERAL STREAM CHANNEL
- PROPOSED ROAD DITCH
- RAILROAD
- ORE BODY
- DDW WELL
- MADISON WELL
- STAGING AREA
- PROPOSED CULVERT
- EXISTING IMPOUNDMENT TO BE MONITORED

HYDROLOGIC DESIGN STORM CALCULATIONS

SWS NO.	DRAINAGE BASIN PARAMETERS			2-YR, 6-HR STORM			100-YR, 24-HR STORM		
	DRAINAGE AREA (sq-mi)	CURVE NO. (CN)	WATERSHED LAG TIME (Min)	2-YR, 6-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)	100-YR, 24-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)
DDW4-1	0.115	79	21.76	1.45	36.7	3.1	4.8	164.4	18.9

NOTE: RUNOFF VOLUMES AND PEAK INFLOWS WERE COMPUTED BY THE HEC-HMS COMPUTER PROGRAM USING THE SCS TYPE II RAINFALL DISTRIBUTION.

This plate is provided to fulfill the requirements of ARSD 74:29:07:09 (7).

CONSULTANT: WWC ENGINEERING

REVISIONS				
#	DRAWN	CHECKED	APPROVED	DATE

SIGNATURE OF PREPARER: Dale E Brown

CHECK SCALES — If this bar does not measure 1 inch this map is not at its original scale

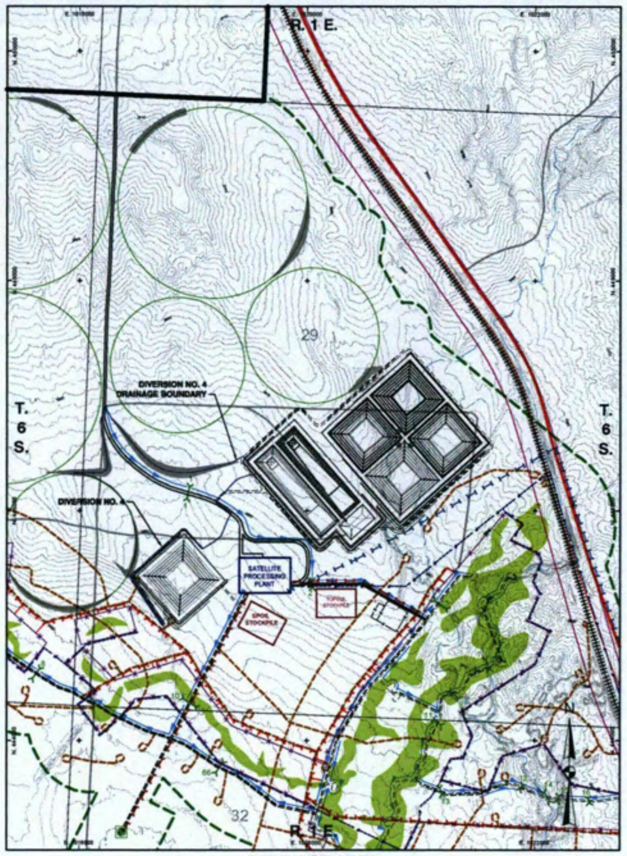
PLOT DATE: 29 March 2013
DATE: 29 March 2013
DRAWN: RODNEY VENTLING
PREPARER: DALE E. BROWN
COORDS: NAD 27, South Dakota State Plane South (feet)
CAD FILE: K:\Powertech\11270\DWGS\DIV-4_DDW\DDW_DIV4_EXHIBIT.dwg

Powertech (USA) Inc.

Plate 5.3-17a

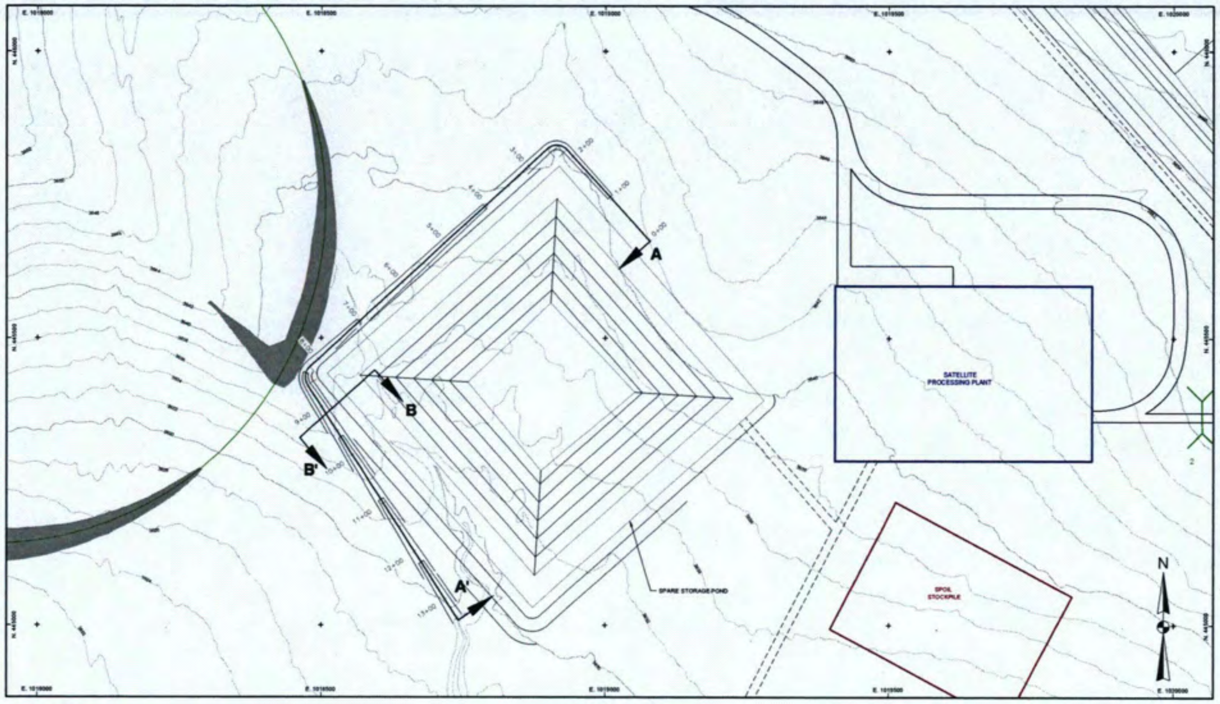
Diversion No. 4
Deep Disposal Well Option

Dewey-Burdock Project



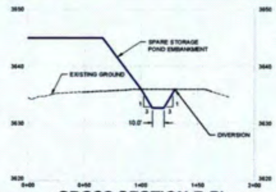
DRAINAGE AREA

SCALE: 1" = 500'
C. I. = 2'



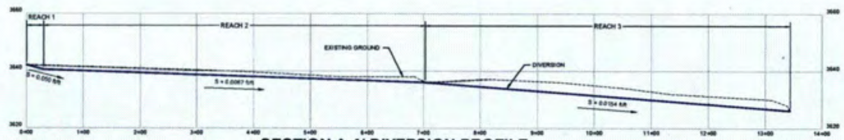
SITE PLAN

SCALE: 1" = 100'
C. I. = VARIES



CROSS SECTION B-B'

SCALE: HORZ. 1" = 50', VERT. 1" = 10'



SECTION A-A' DIVERSION PROFILE

SCALE: HORZ. 1" = 100', VERT. 1" = 20'

DIVERSION CROSS SECTIONS

$$Q = \frac{1.49}{n} AR^{2/3}S^{1/2}$$

REACH 1

2-yr, 6-hr		100-yr, 24-hr	
Q = 4.4 cfs	A = 1.49 ft²	Q = 36.1 cfs	A = 5.69 ft²
n = 0.030	WP = 10.91 ft	n = 0.030	WP = 13.13 ft
S = 0.050 ft/ft	R = 0.14 ft	S = 0.050 ft/ft	R = 0.43 ft
b = 10 ft	V = 2.94 fps	b = 10 ft	V = 6.34 fps
	Yn = 0.14 ft		Yn = 0.50 ft

REACH 2

2-yr, 6-hr		100-yr, 24-hr	
Q = 4.4 cfs	A = 2.80 ft²	Q = 36.1 cfs	A = 11.13 ft²
n = 0.030	WP = 11.65 ft	n = 0.030	WP = 15.57 ft
S = 0.0067 ft/ft	R = 0.24 ft	S = 0.0067 ft/ft	R = 0.71 ft
b = 10 ft	V = 1.57 fps	b = 10 ft	V = 3.24 fps
	Yn = 0.26 ft		Yn = 0.88 ft

REACH 3

2-yr, 6-hr		100-yr, 24-hr	
Q = 4.4 cfs	A = 2.16 ft²	Q = 36.1 cfs	A = 8.41 ft²
n = 0.030	WP = 11.29 ft	n = 0.030	WP = 14.40 ft
S = 0.0154 ft/ft	R = 0.19 ft	S = 0.0154 ft/ft	R = 0.58 ft
b = 10 ft	V = 2.04 fps	b = 10 ft	V = 4.29 fps
	Yn = 0.20 ft		Yn = 0.70 ft

LEGEND

- PERMIT BOUNDARY
- PROPOSED AFFECTED AREA BOUNDARY
- COUNTY ROAD
- EXISTING ROAD
- PROPOSED PRIMARY ACCESS ROAD
- PROPOSED SECONDARY ACCESS ROAD
- MAIN PIPELINE
- MADISON WELL PIPELINE
- PLANT-TO-PLANT PIPELINE
- PROPOSED LIGHT USE ROAD
- PROPOSED OVERHEAD POWER
- PROPOSED WELL FIELD FENCE
- EPHEMERAL STREAM CHANNEL
- PROPOSED ROAD DITCH
- RAILROAD
- APPROXIMATE RAILROAD RIGHT-OF-WAY
- CENTER PIVOT
- CATCHMENT BERM
- ORE BODY
- MADISON WELL
- STAGING AREA
- PROPOSED CULVERT

HYDROLOGIC DESIGN STORM CALCULATIONS

SWS NO.	DRAINAGE BASIN PARAMETERS			2-YR, 6-HR STORM			100-YR, 24-HR STORM		
	DRAINAGE AREA (sq-mi)	CURVE NO. (CN)	WATERSHED LAG TIME (Min)	2-YR, 6-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)	100-YR, 24-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)
LA4-1	0.027	79	19.77	1.45	4.4	0.4	4.8	36.1	3.8

NOTE: RUNOFF VOLUMES AND PEAK INFLOWS WERE COMPUTED BY THE HEC-HMS COMPUTER PROGRAM USING THE SCS TYPE II RAINFALL DISTRIBUTION.

This plate is provided to fulfill the requirements of ARSD 74:29:07:09 (7).

CONSULTANT: WWC ENGINEERING

REVISIONS

#	DRAWN	CHECKED	APPROVED	DATE

SIGNATURE OF PREPARER: Dale E. Brown

CHECK SCALES

PLOT DATE: 29 March 2013
DATE: 29 March 2013
DRAWN: RODNEY VENTLING
PREPARER: DALE E. BROWN
CAD FILE: K:\Powertech\01270\DWG\DIV-4_LA\DIV_4_EXHIBIT.dwg

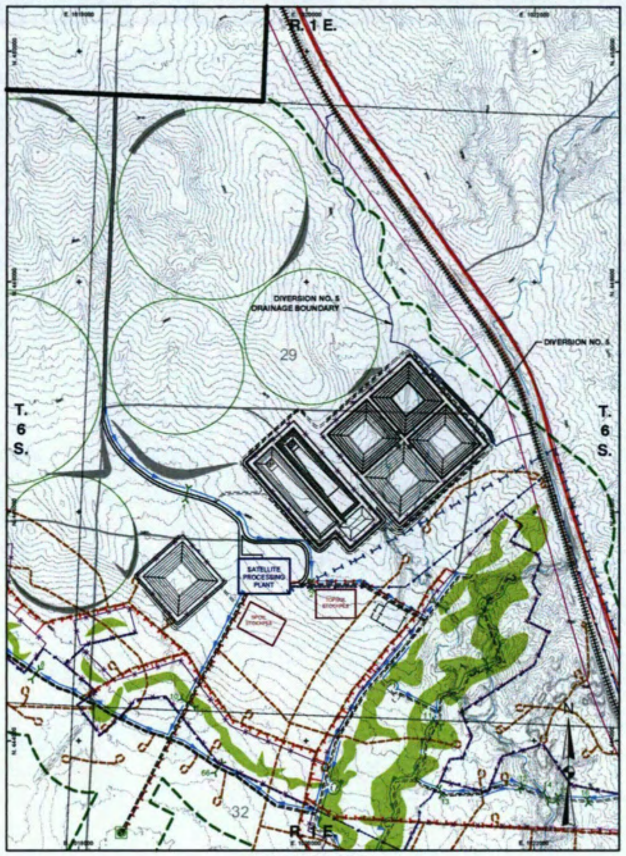
POWERTECH (USA) INC.

Plate 5.3-17b

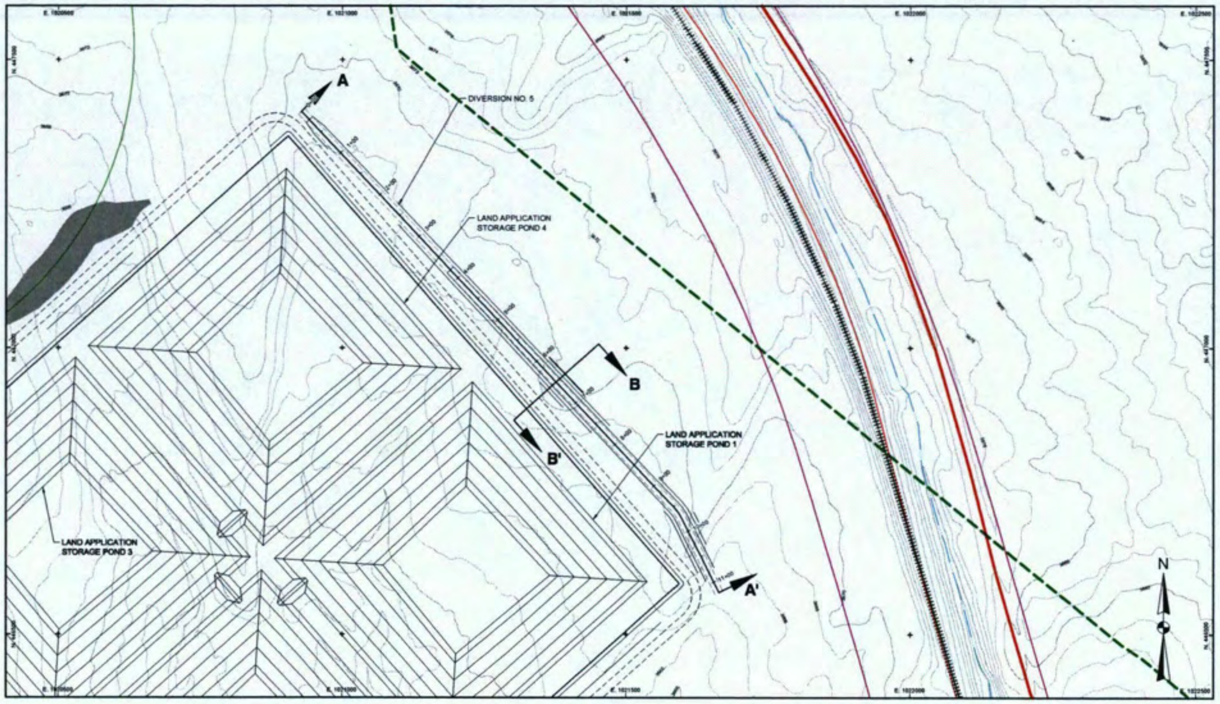
Diversion No. 4
Land Application Option

Dewey-Burdock Project

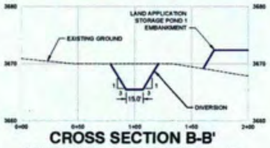
COORDS: NAD 27, South Dakota State Plane South (feet)



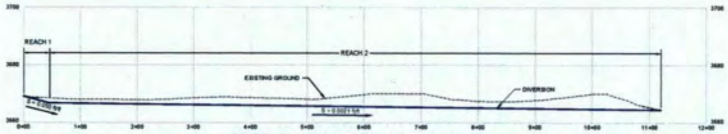
DRAINAGE AREA
SCALE: 1" = 500'
C. I. = 2'



SITE PLAN
SCALE: 1" = 100'
C. I. = VARIES



CROSS SECTION B-B'
SCALE: HORZ. 1" = 50', VERT. 1" = 10'



SECTION A-A' DIVERSION PROFILE
SCALE: HORZ. 1" = 100', VERT. 1" = 20'

LEGEND

- PERMIT BOUNDARY
- PROPOSED AFFECTED AREA BOUNDARY
- COUNTY ROAD
- EXISTING ROAD
- PROPOSED PRIMARY ACCESS ROAD
- PROPOSED SECONDARY ACCESS ROAD
- MAIN PIPELINE
- MADISON WELL PIPELINE
- PLANT-TO-PLANT PIPELINE
- PROPOSED LIGHT USE ROAD
- PROPOSED OVERHEAD POWER
- PROPOSED WELL FIELD FENCE
- EPHEMERAL STREAM CHANNEL
- PROPOSED ROAD DITCH
- RAILROAD
- APPROXIMATE RAILROAD RIGHT-OF-WAY
- CENTER PIVOT
- CATCHMENT BERM
- ORE BODY
- MADISON WELL
- STAGING AREA
- PROPOSED CULVERT

DIVERSION CROSS SECTIONS

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

REACH 1

2-yr, 6-hr		100-yr, 24-hr	
Q = 8.1 cfs	A = 2.51 ft^2	Q = 62.5 cfs	A = 9.06 ft^2
n = 0.030	WP = 16.03	n = 0.030	WP = 18.45 ft
S = 0.050 ft/ft	R = 0.16 ft	S = 0.050 ft/ft	R = 0.49 ft
b = 15 ft	V = 3.22 fps	b = 15 ft	V = 6.9 fps
	Yn = 0.16 ft		Yn = 0.54 ft

REACH 2

2-yr, 6-hr		100-yr, 24-hr	
Q = 8.1 cfs	A = 6.76 ft^2	Q = 62.5 cfs	A = 25.88 ft^2
n = 0.030	WP = 17.63 ft	n = 0.030	WP = 23.58 ft
S = 0.0021 ft/ft	R = 0.38 ft	S = 0.0021 ft/ft	R = 1.10 ft
b = 15 ft	V = 1.2 fps	b = 15 ft	V = 2.41 fps
	Yn = 0.42 ft		Yn = 1.36 ft

HYDROLOGIC DESIGN STORM CALCULATIONS

SWS NO.	DRAINAGE BASIN PARAMETERS			2-YR, 6-HR STORM			100-YR, 24-HR STORM		
	DRAINAGE AREA (sq-mi)	CURVE NO. (CN)	WATERSHED LAG TIME (Min)	2-YR, 6-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)	100-YR, 24-HR PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)
LAS-1	0.055	80	27.74	1.45	8.1	0.9	4.8	62.5	8.0

NOTE: RUNOFF VOLUMES AND PEAK INFLOWS WERE COMPUTED BY THE HEC-HMS COMPUTER PROGRAM USING THE SCS TYPE II RAINFALL DISTRIBUTION.

This plate is provided to fulfill the requirements of ARSD 74:29:07:09 (7).

CONSULTANT: WWC ENGINEERING

REVISIONS				
#	DRAWN	CHECKED	APPROVED	DATE

CHECK SCALES

SIGNATURE OF PREPARER

PLOT DATE: 29 March 2013 | DATE: 29 March 2013
DRAWN: RODNEY VENTLING
PREPARER: DALE E. BROWN
CAD FILE: K:\Powertech\11270\DWGS\DIV-5_LA\DIV_5_EXHIBIT.dwg

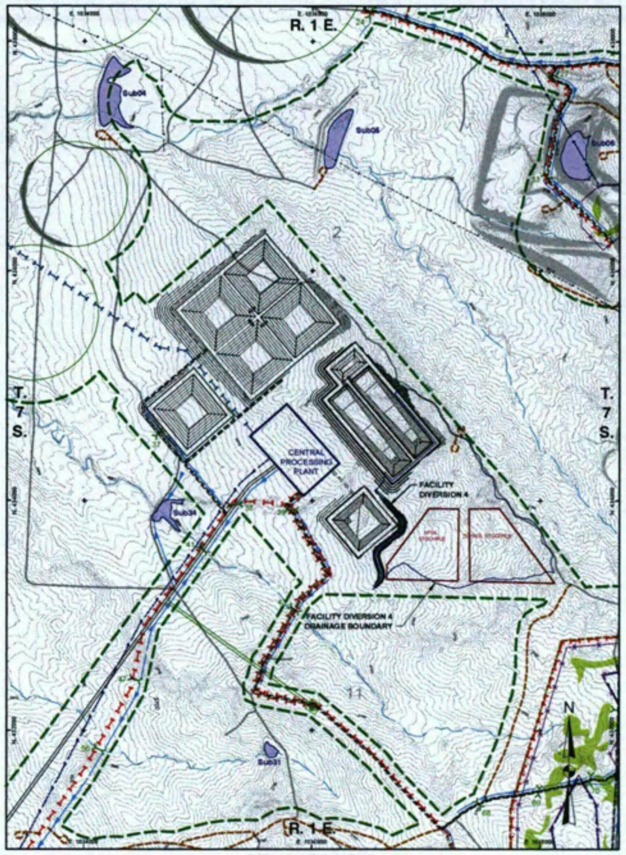
POWERTECH (USA) INC.

Plate 5.3-18

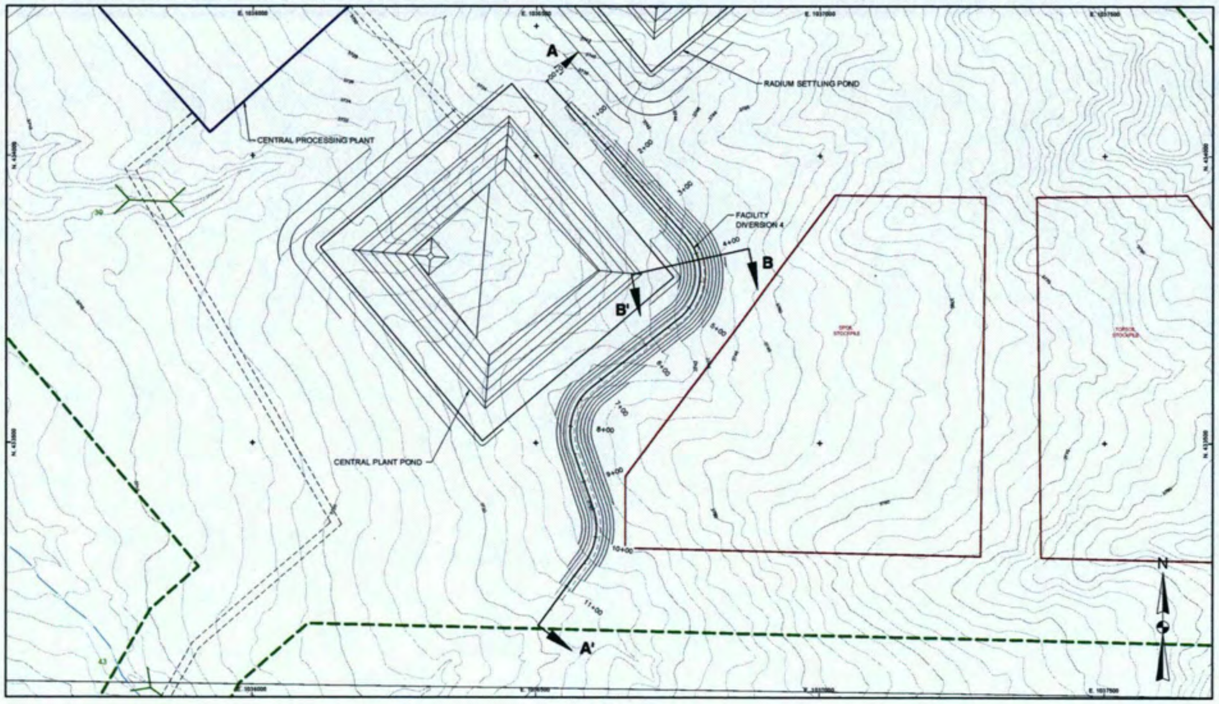
Diversion No. 5
Land Application Option

Dewey-Burdock Project

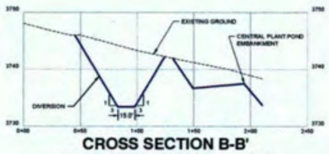
COORDS: NAD 27, South Dakota State Plane South (feet)



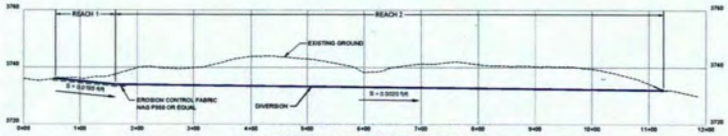
DRAINAGE AREA
SCALE: 1" = 500'
C. I. = 10'



SITE PLAN
SCALE: 1" = 100'
C. I. = VARIES



CROSS SECTION B-B'
SCALE: HORZ. 1" = 50', VERT. 1" = 10'



SECTION A-A' DIVERSION PROFILE
SCALE: HORZ. 1" = 100', VERT. 1" = 20'

FACILITY DIVERSION 4 CROSS SECTIONS

$$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$$

REACH 1

6-hr, PMP

Q = 819.2 cfs A = 71.85 ft²
n = 0.030 WP = 33.94 ft
S = 0.0195 ft/ft R = 2.12 ft
b = 15 ft V = 11.4 fps
Yn = 3.00 ft

REACH 2

6-hr, PMP

Q = 819.2 cfs A = 164.2 ft²
n = 0.030 WP = 48.58 ft
S = 0.0020 ft/ft R = 3.38 ft
b = 15 ft V = 4.99 fps
Yn = 5.31 ft

LEGEND

- PROPOSED AFFECTED AREA BOUNDARY
- EXISTING ROAD
- PROPOSED SECONDARY ACCESS ROAD
- PROPOSED PRIMARY ACCESS ROAD
- MAIN PIPELINE
- MADISON WELL PIPELINE
- PROPOSED LIGHT USE ROAD
- DITCH CENTERLINE
- OVERHEAD POWER
- PROPOSED OVERHEAD POWER
- PROPOSED WELL FIELD FENCE
- EPHEMERAL STREAM CHANNEL
- PROPOSED ROAD DITCH
- CENTER PIVOT
- CATCHMENT BERM
- ORE BODY
- MADISON WELL
- PROPOSED CULVERT
- EXISTING IMPOUNDMENT TO BE MONITORED

HYDROLOGIC DESIGN STORM CALCULATIONS

SWS NO.	DRAINAGE BASIN PARAMETERS: DRAINAGE AREA (sq-mi)	CURVE NO. (CN)	WATERSHED LAG TIME (Min)	6-YR, PMP: 6-HR, PMP PRECIP. (in)	PEAK INFLOW (cfs)	RUNOFF VOLUME (ac-ft)
FD4	0.049	80	11.42	22.1	819.2	51.6

NOTE: RUNOFF VOLUMES AND PEAK INFLOWS WERE COMPUTED BY THE HEC-HMS COMPUTER PROGRAM.

This plate is provided to fulfill the requirements of ARSD 74:29:07:05 (6).

CONSULTANT: WWC ENGINEERING

REVISIONS

#	DRAWN	CHECKED	APPROVED	DATE

SIGNATURE OF PREPARER: [signature]

CHECK SCALES

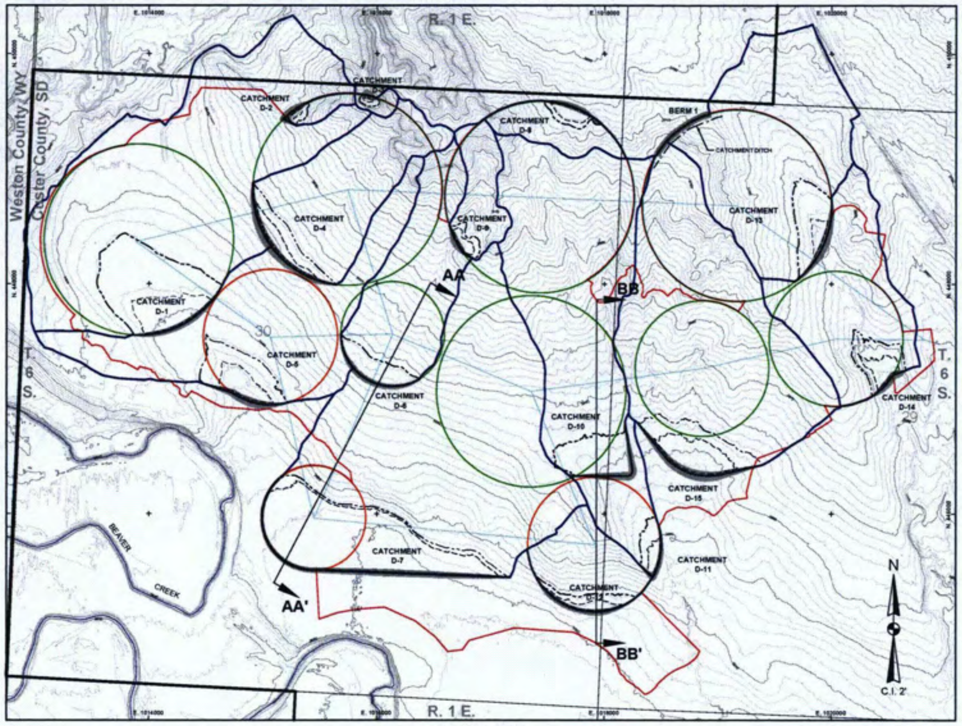
PLOT DATE: 29 March 2013 | DATE: 29 March 2013
DRAWN: RODNEY VENTLING
PREPARER: DALE E. BROWN
CAD FILE: K:\Powertech\01270\DWGS\CCP_FAC_DIV\CPP_FAC_DIV.dwg
COORDS: NAD 27, South Dakota State Plane South (feet)

Powertech (USA) Inc.

Plate 5.3-19

CPP Facility Diversion No. 4
Land Application Option

Dewey-Burdock Project



PLAN VIEW

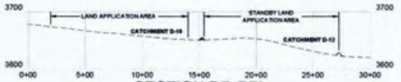
Feet: 0 250 500 1,000 1,500 2,000
Meters: 0 125 250 500

LEGEND

- PERMIT BOUNDARY
- PRIMARY LAND APPLICATION AREA
- STANDBY LAND APPLICATION AREA
- DRAINAGE BOUNDARY
- PIPELINE
- GENERAL CATCHMENT BOUNDARY
- NORMAL OPERATING LEVEL (RUNOFF /SNOWMELT ONLY)
- MAXIMUM WATER LEVEL
- CATCHMENT BERM FOOTPRINT

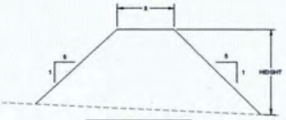
SECTION AA-AA'

SCALE: HORZ. 1" = 500', VERT. 1" = 100'



SECTION BB-BB'

SCALE: HORZ. 1" = 500', VERT. 1" = 100'



HEIGHT (FT)	X (ft)
≤5	5
6-8	8
8-10	10
>10	15

TYPICAL CATCHMENT BERM SECTION

NTS

Dewey Land Application Catchment Summary

Catchment Designation	Drainage Area (acres)	Drainage Area (mi²)	2-Year Runoff Volume (acre-ft)	100-Year Runoff Volume (acre-ft)	Catchment Area (acres)	Catchment Capacity (acre-ft)	Catchment Height (ft)	2-Year Depth (ft)
D-1	99.41	0.16	3.04	19.53	13.76	23.39	5.0	2.0
D-2	2.05	0.00	0.33	0.82	0.44	0.94	7.3	3.0
D-3	1.38	0.00	0.22	0.53	0.28	0.59	9.5	3.0
D-4	30.36	0.05	0.95	6.10	3.47	8.16	9.0	3.0
D-5	50.38	0.08	1.52	9.76	5.64	12.97	7.5	3.5
D-6	29.03	0.05	0.95	6.10	2.71	4.93	5.6	2.5
D-7	100.98	0.16	3.04	19.53	22.06	71.39	5.8	1.0
D-8	8.17	0.01	0.19	1.22	1.26	2.17	5.4	1.5
D-9	9.28	0.01	0.19	1.22	0.94	1.76	8.0	2.0
D-10	62.17	0.10	1.90	12.20	4.83	9.84	6.5	3.5
D-11	10.08	0.02	0.38	2.44	1.65	2.49	4.8	1.5
D-12	13.84	0.02	0.38	2.44	2.01	3.12	6.0	2.0
D-13	51.60	0.08	1.52	9.76	4.38	10.63	7.5	3.0
D-14	32.45	0.05	0.95	6.10	3.39	7.64	6.8	2.0
D-15	74.84	0.12	2.28	14.64	6.94	20.83	8.8	3.5
		Total:	17.84	112.41	75.66	180.85		

Notes:
1. Overflow from Catchment D-6 will be routed to Catchment D-5.
2. Overflow from Catchment D-10 will be routed to Catchment D-7.

CATCHMENT D-1 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3639.5	0.04			0.00
		0.37	0.19	
3640.0	0.69			0.19
		1.05	0.53	
3640.5	1.41			0.72
		1.86	0.93	
3641.0	2.30			1.65
		2.88	1.44	
3641.5	3.46			3.09
		4.27	2.14	
3642.0	5.07			5.23
		5.98	2.99	
3642.5	6.89			8.22
		7.87	3.94	
3643.0	8.84			12.16
		9.99	5.00	
3643.5	11.13			17.16
		12.45	6.23	
3644.0	13.76			23.39

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-2 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3679.5	0.00			0.00
		0.02	0.01	
3680.0	0.04			0.01
		0.06	0.03	
3680.5	0.08			0.04
		0.10	0.05	
3681.0	0.12			0.09
		0.15	0.08	
3681.5	0.17			0.17
		0.20	0.10	
3682.0	0.22			0.27
		0.25	0.13	
3682.5	0.27			0.40
		0.30	0.15	
3683.0	0.32			0.55
		0.35	0.18	
3683.5	0.38			0.73
		0.41	0.21	
3684.0	0.44			0.94

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-3 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3703.5	0.01			0.00
		0.02	0.01	
3704.0	0.03			0.01
		0.04	0.02	
3704.5	0.05			0.03
		0.06	0.03	
3705.0	0.07			0.06
		0.09	0.05	
3705.5	0.10			0.11
		0.12	0.06	
3706.0	0.14			0.17
		0.16	0.08	
3706.5	0.17			0.25
		0.19	0.10	
3707.0	0.20			0.35
		0.22	0.11	
3707.5	0.24			0.46
		0.26	0.13	
3708.0	0.28			0.59

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-4 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3659.0	0.00			0.00
		0.10	0.10	
3660.0	0.19			0.10
		0.37	0.37	
3661.0	0.54			0.47
		0.85	0.85	
3662.0	1.15			1.32
		1.52	1.52	
3663.0	1.87			2.84
		2.26	2.26	
3664.0	2.65			5.10
		3.06	3.06	
3665.0	3.47			8.16

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-5 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3631.0	0.00			0.00
		0.02	0.01	
3631.5	0.04			0.01
		0.14	0.07	
3632.0	0.23			0.08
		0.32	0.16	
3632.5	0.40			0.24
		0.52	0.26	
3633.0	0.63			0.50
		0.78	0.39	
3633.5	0.93			0.89
		1.18	0.59	
3634.0	1.43			1.48
		1.67	0.84	
3634.5	1.91			2.32
		2.13	1.07	
3635.0	2.34			3.39
		2.58	1.29	
3635.5	2.82			4.68
		3.11	1.56	
3636.0	3.39			6.24
		3.74	1.87	
3636.5	4.09			8.11
		4.47	2.24	
3637.0	4.84			10.35
		5.24	2.62	
3637.5	5.64			12.97

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-6 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3654.0	0.02			0.00
		0.06	0.03	
3654.5	0.09			0.03
		0.17	0.09	
3655.0	0.25			0.12
		0.37	0.19	
3655.5	0.49			0.31
		0.64	0.32	
3656.0	0.79			0.63
		0.98	0.49	
3656.5	1.17			1.12
		1.34	0.67	
3657.0	1.51			1.79
		1.69	0.85	
3657.5	1.87			2.64
		2.07	1.04	
3658.0	2.27			3.68
		2.49	1.25	
3658.5	2.71			4.93

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-7 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3619.5	0.46			0.00
		2.17	1.09	
3620.0	3.88			1.09
		4.69	2.35	
3620.5	5.49			3.44
		6.31	3.16	
3621.0	7.12			6.60
		8.34	4.17	
3621.5	9.55			10.77
		11.06	5.78	
3622.0	12.56			16.55
		14.46	7.23	
3622.5	15.35			23.78
		16.14	8.07	
3623.0	16.92			31.85
		17.67	8.84	
3623.5	18.41			40.69
		19.22	9.61	
3624.0	20.02			50.30
		20.57	10.29	
3624.5	21.12			60.59
		21.59	10.80	
3625.0	22.06			71.39

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-8 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3702.0	0.00			0.00
		0.04	0.02	
3702.5	0.08			0.02
		0.14	0.07	
3703.0	0.19			0.09
		0.27	0.14	
3703.5	0.34			0.23
		0.43	0.22	
3704.0	0.51			0.45
		0.59	0.30	
3704.5	0.67			0.75
		0.75	0.38	
3705.0	0.83			1.13
		0.93	0.47	
3705.5	1.02			1.60
		1.14	0.57	
3706.0	1.26			2.17

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-9 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3691.5	0.01			0.00
		0.03	0.02	
3692.0	0.05			0.02
		0.08	0.04	
3692.5	0.11			0.06
		0.15	0.08	
3693.0	0.19			0.14
		0.24	0.12	
3693.5	0.29			0.26
		0.35	0.18	
3694.0	0.42			0.44
		0.47	0.24	
3694.5	0.52			0.68
		0.58	0.29	
3695.0	0.64			0.97
		0.71	0.36	
3695.5	0.77			1.33
		0.86	0.43	
3696.0	0.94			1.76

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-10 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3648.0	0.00			0.00
		0.03	0.02	
3648.5	0.05			0.02
		0.10	0.05	
3649.0	0.15			0.07
		0.24	0.12	
3649.5	0.33			0.19
		0.47	0.24	
3650.0	0.60			0.43
		0.76	0.38	
3650.5	0.91			0.81
		1.08	0.54	
3651.0	1.25			1.35
		1.46	0.73	
3651.5	1.66			2.08
		1.92	0.96	
3652.0	2.17			3.04
		2.45	1.23	
3652.5	2.73			4.27
		3.03	1.52	
3653.0	3.33			5.79
		3.67	1.84	
3653.5	4.00			7.63
		4.42	2.21	
3654.0	4.83			9.84

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-11 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3638.5	0.02			0.00
		0.09	0.05	
3639.0	0.15			0.05
		0.23	0.12	
3639.5	0.31			0.17
		0.43	0.22	
3640.0	0.54			0.39
		0.66	0.33	
3640.5	0.78			0.72
		0.90	0.45	
3641.0	1.02			1.17
		1.15	0.58	
3641.5	1.28			1.75
		1.47	0.74	
3642.0	1.65			2.49

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-12 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3624.5	0.02			0.00
		0.06	0.03	
3625.0	0.09			0.03
		0.14	0.07	
3625.5	0.19			0.10
		0.30	0.15	
3626.0	0.40			0.25
		0.54	0.27	
3626.5	0.69			0.52
		0.81	0.41	
3627.0	0.95			0.93
		1.11	0.56	
3627.5	1.26			1.49
		1.44	0.72	
3628.0	1.61			2.21
		1.81	0.91	
3628.5	2.01			3.12

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-13 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3681.5	0.03			0.00
		0.13	0.07	
3682.0	0.23			0.07
		0.33	0.17	
3682.5	0.43			0.24
		0.53	0.27	
3683.0	0.63			0.51
		0.75	0.38	
3683.5	0.86			0.89
		0.99	0.50	
3684.0	1.12			1.39
		1.31	0.66	
3684.5	1.49			2.05
		1.68	0.84	
3685.0	1.87			2.89
		2.09	1.05	
3685.5	2.31			3.94
		2.56	1.28	
3686.0	2.80			5.22
		3.07	1.54	
3686.5	3.33			6.76
		3.58	1.79	
3687.0	3.83			8.55
		4.11	2.06	
3687.5	4.38			10.61

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-14 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3666.0	0.21			0.00
		0.30	0.15	
3666.5	0.39			0.15
		0.49	0.25	
3667.0	0.59			0.40
		0.69	0.35	
3667.5	0.79			0.75
		0.97	0.49	
3668.0	1.14			1.24
		1.29	0.65	
3668.5	1.43			1.89
		1.58	0.79	
3669.0	1.72			2.68
		1.88	0.94	
3669.5	2.03			3.62
		2.22	1.11	
3670.0	2.40			4.73
		2.66	1.33	
3670.5	2.91			6.06
		3.15	1.58	
3671.0	3.39			7.64

INACTIVE CAPACITY; 100-yr FREEBOARD

CATCHMENT D-15 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3647.5	0.01			0.00
		0.09	0.05	
3648.0	0.16			0.05
		0.27	0.14	
3648.5	0.37			0.19
		0.51	0.26	
3649.0	0.64			0.45
		0.81	0.41	
3649.5	0.98			0.86
		0.91	0.46	
3650.0	0.83			1.32
		1.32	0.66	
3650.5	1.81			1.98
		2.04	1.02	
3651.0	2.27			3.00
		2.52	1.26	
3651.5	2.77			4.26
		3.06	1.53	
3652.0	3.34			5.79
		3.60	1.80	
3652.5	3.85			7.59
		4.12	2.06	
3653.0	4.38			9.65
		4.67	2.34	
3653.5	4.95			11.99
		5.26	2.63	
3654.0	5.57			14.62
		5.93	2.96	
3654.5	6.28			17.57
		6.61	3.26	
3655.0	6.94			20.83

INACTIVE CAPACITY; 100-yr FREEBOARD

NOTES:
1. INACTIVE CAPACITY IS THE AVAILABLE STORAGE CAPACITY FOR EACH CATCHMENT AREA ALLOWING ADEQUATE FREEBOARD CAPACITY FOR THE 100-YEAR, 24-HOUR STORM RUNOFF.
2. THE GENERAL CATCHMENT BOUNDARY THAT IS SHOWN IS THE SAME AS SHOWN ON FIGURES IN THE GDP APPLICATION. THE ACTUAL BOUNDARY WILL VARY DEPENDING UPON THE FINAL DESIGN OF THE CATCHMENT AREAS. THE CONCEPTUAL CATCHMENT AREA DESIGN SHOWN ON THIS PLATE IS WITHIN THE GENERAL CATCHMENT BOUNDARY.

This plate is provided to fulfill the requirements of ARSD 74:29:02:04, ARSD 74:29:05:14(4) and SDCL 45-6B-6(8).

CONSULTANT: WWC ENGINEERING

REVISIONS

#	DRAWN	CHECKED	APPROVED	DATE

SIGNATURE OF PREPARER: Dale E. Brown

CHECK SCALES — If this bar does not measure 1 inch this map is not at its original scale

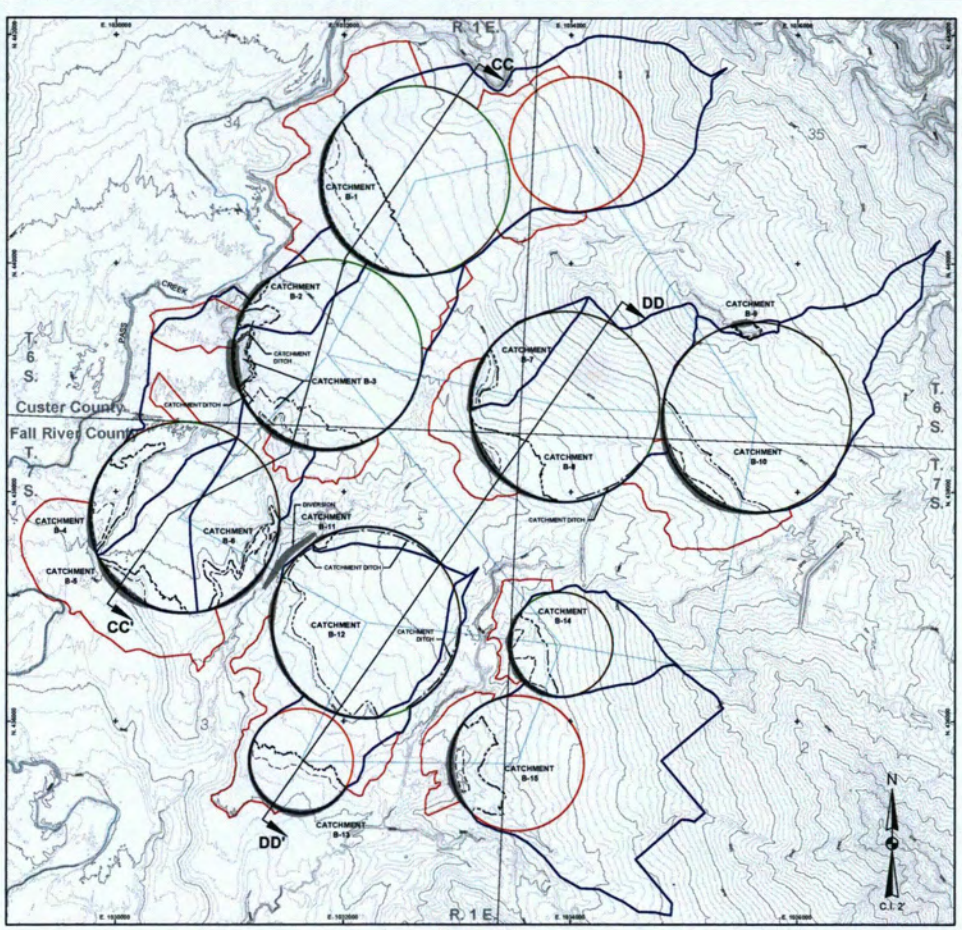
PLOT DATE: 28 March 2013 | DATE: 28 March 2013
DRAWN: Dave C. Johnson
PREPARER: Dale E. Brown
CAD FILE: K:\Powertech\11270\DWGS\CATCHMENT_PONDS.dwg
COORDS: NAD 27, South Dakota State Plane South (feet)

POWERTECH (USA) INC.

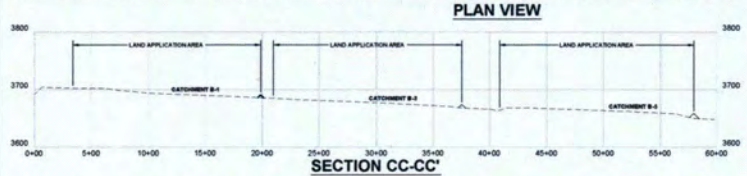
Plate 5.4-1

Conceptual Catchment Area Design
Dewey Land Application Area

Dewey-Burdock Project

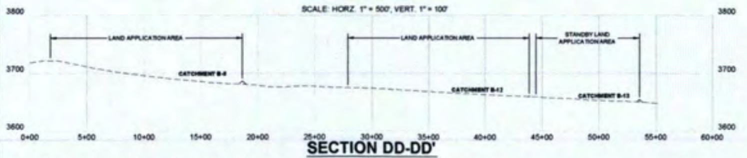


PLAN VIEW



SECTION CC-CC'

SCALE: HORZ. 1" = 500', VERT. 1" = 100'



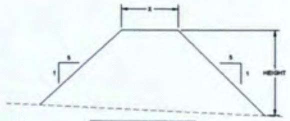
SECTION DD-DD'

SCALE: HORZ. 1" = 500', VERT. 1" = 100'

Feet: 0, 250, 500, 1,000, 1,500, 2,000
Meters: 0, 125, 250, 500

LEGEND

- PRIMARY LAND APPLICATION AREA
- STANDBY LAND APPLICATION AREA
- DRAINAGE BOUNDARY
- PIPELINE
- GENERAL CATCHMENT BOUNDARY
- NORMAL OPERATING LEVEL (RUNOFF /SNOWMELT ONLY)
- MAXIMUM WATER LEVEL
- CATCHMENT BERM FOOTPRINT



HEIGHT (FT)	X (ft)
≤6	6
6-8	8
8-10	10
>10	15

TYPICAL CATCHMENT BERM SECTION

NTS

CATCHMENT B-1 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3686.0	0.40			0.00
3686.5	1.89	1.13	0.57	0.57
3687.0	3.17	2.49	1.25	1.82
3687.5	4.85	3.81	1.96	3.78
3688.0	6.15	5.40	2.70	6.48
3688.5	8.09	7.12	3.56	10.04
3689.0	9.78	8.93	4.47	14.51
3689.5	11.50	10.64	5.32	19.83
3690.0	13.24	12.37	6.19	26.02

CATCHMENT B-2 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3670.5	0.01			0.00
3671.0	0.04	0.03	0.02	0.02
3671.5	0.08	0.06	0.03	0.05
3672.0	0.14	0.11	0.06	0.11
3672.5	0.21	0.18	0.09	0.20
3673.0	0.29	0.25	0.13	0.33
3673.5	0.47	0.38	0.19	0.52
3674.0	0.49	0.48	0.24	0.76
3674.5	0.83	0.66	0.33	1.09
3675.0	1.01	0.92	0.46	1.55
3675.5	1.21	1.11	0.56	2.11

CATCHMENT B-3 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3664.0	0.16			0.00
3664.5	0.23	0.20	0.10	0.10
3665.0	0.27	0.25	0.13	0.23
3665.5	0.32	0.30	0.15	0.38
3666.0	0.37	0.35	0.18	0.56
3666.5	0.44	0.41	0.21	0.77
3667.0	0.49	0.47	0.24	1.01
3667.5	0.55	0.52	0.26	1.27
3668.0	0.61	0.58	0.29	1.56
3668.5	0.67	0.64	0.32	1.88
3669.0	0.76	0.72	0.36	2.24
3669.5	0.94	0.85	0.43	2.67
3670.0	1.44	1.19	0.60	3.27
3670.5	1.99	1.72	0.86	4.13
3671.0	2.54	2.27	1.14	5.27
3671.5	3.20	2.87	1.44	6.71
3672.0	4.12	3.66	1.83	8.54
3672.5	5.70	4.91	2.46	11.00
3673.0	6.93	6.32	3.16	14.16

CATCHMENT B-4 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3653.5	0.01			0.00
3654.0	0.20	0.11	0.06	0.06
3654.5	0.44	0.32	0.16	0.22
3655.0	0.65	0.55	0.28	0.50
3655.5	0.94	0.80	0.40	0.90
3656.0	1.61	1.28	0.64	1.54
3656.5	2.89	2.25	1.13	2.67
3657.0	3.54	3.21	1.61	4.28
3657.5	4.25	3.90	1.95	6.23
3658.0	4.99	4.62	2.31	8.54

CATCHMENT B-5 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3652.0	0.05			0.00
3652.5	0.16	0.11	0.06	0.06
3653.0	0.28	0.22	0.11	0.17
3653.5	0.41	0.35	0.18	0.35
3654.0	0.56	0.49	0.25	0.60
3654.5	0.69	0.63	0.32	0.92
3655.0	0.84	0.77	0.39	1.31
3655.5	0.99	0.92	0.46	1.77
3656.0	1.16	1.08	0.54	2.31
3656.5	1.41	1.29	0.65	2.96
3657.0	1.70	1.56	0.78	3.74
3657.5	2.11	1.91	0.95	4.69
3658.0	2.39	2.25	1.13	5.82

CATCHMENT B-6 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3652.5	0.02			0.00
3653.0	0.04	0.03	0.02	0.02
3653.5	0.05	0.05	0.03	0.05
3654.0	0.14	0.10	0.05	0.10
3654.5	0.68	0.41	0.21	0.31
3655.0	1.10	0.89	0.45	0.76
3655.5	1.55	1.33	0.67	1.43
3656.0	2.36	1.96	0.98	2.41
3656.5	2.89	2.63	1.32	3.73
3657.0	3.33	3.11	1.56	5.29
3657.5	3.82	3.58	1.79	7.08
3658.0	4.39	4.11	2.06	9.14

CATCHMENT B-7 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3687.5	0.03			0.00
3688.0	0.22	0.13	0.07	0.07
3688.5	0.43	0.33	0.17	0.24
3689.0	0.66	0.55	0.28	0.52
3689.5	0.90	0.78	0.39	0.91
3690.0	1.15	1.03	0.52	1.43
3690.5	1.46	1.31	0.66	2.09

CATCHMENT B-8 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3679.5	0.00			0.00
3680.0	0.08	0.04	0.02	0.02
3680.5	0.20	0.14	0.07	0.09
3681.0	0.37	0.29	0.15	0.24
3681.5	0.60	0.49	0.25	0.49
3682.0	0.92	0.76	0.38	0.87
3682.5	1.29	1.11	0.56	1.43
3683.0	1.66	1.48	0.74	2.17
3683.5	2.09	1.88	0.94	3.11
3684.0	2.69	2.39	1.20	4.31
3684.5	3.26	2.97	1.49	5.80
3685.0	3.77	3.52	1.76	7.56
3685.5	4.31	4.04	2.02	9.58
3686.0	4.94	4.63	2.32	11.90

CATCHMENT B-9 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3726.5	0.01			0.00
3727.0	0.03	0.02	0.01	0.01
3727.5	0.06	0.05	0.03	0.04
3728.0	0.10	0.08	0.04	0.08
3728.5	0.13	0.12	0.06	0.14
3729.0	0.16	0.15	0.08	0.22
3729.5	0.20	0.18	0.09	0.31
3730.0	0.23	0.22	0.11	0.42
3730.5	0.31	0.27	0.14	0.56
3731.0	0.38	0.35	0.18	0.74
3731.5	0.47	0.43	0.22	0.96
3732.0	0.56	0.52	0.26	1.22

CATCHMENT B-10 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3705.0	0.08			0.00
3705.5	0.31	0.20	0.10	0.10
3706.0	0.69	0.50	0.25	0.35
3706.5	1.15	0.92	0.46	0.81
3707.0	1.60	1.38	0.69	1.50
3707.5	2.11	1.86	0.93	2.43
3708.0	2.64	2.38	1.19	3.62
3708.5	3.30	2.97	1.49	5.11
3709.0	3.92	3.61	1.81	6.92
3709.5	4.57	4.25	2.13	9.05
3710.0	5.27	4.92	2.46	11.51
3710.5	6.10	5.69	2.85	14.36
3710.6	6.26	6.18	0.62	14.98

CATCHMENT B-11 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3661.5	0.00			0.00
3662.0	0.03	0.02	0.01	0.01
3662.5	0.06	0.05	0.03	0.04
3663.0	0.11	0.09	0.05	0.09
3663.5	0.16	0.14	0.07	0.16
3664.0	0.25	0.21	0.11	0.27

CATCHMENT B-12 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3656.5	0.04			0.00
3657.0	0.16	0.10	0.05	0.05
3657.5	0.04	0.10	0.05	0.10
3658.0	0.00	0.02	0.01	0.11
3658.5	1.47	0.74	0.37	0.48
3659.0	2.35	1.91	0.96	1.43
3659.5	3.38	2.87	1.44	2.87
3660.0	4.47	3.93	1.97	4.84
3660.5	6.79	5.63	2.82	7.66

CATCHMENT B-13 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3648.5	0.00			0.00
3649.0	0.08	0.04	0.02	0.02
3649.5	0.25	0.17	0.09	0.11
3650.0	0.54	0.40	0.20	0.31
3650.5	0.94	0.74	0.37	0.68
3651.0	1.47	1.21	0.61	1.29
3651.5	2.13	1.80	0.90	2.19
3652.0	3.00	2.57	1.29	3.48
3652.5	4.32	3.66	1.83	5.31
3653.0	5.31	4.82	2.41	7.72
3653.5	6.27	5.79	2.90	10.62
3654.0	7.36	6.82	3.41	14.03

CATCHMENT B-14 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3674.0	0.06			0.00
3674.5	0.11	0.08	0.04	0.04
3675.0	0.26	0.19	0.10	0.14
3675.5	0.29	0.28	0.14	0.28
3676.0	0.89	0.59	0.30	0.58
3676.5	1.56	1.23	0.62	1.20
3677.0	2.02	1.79	0.90	2.10
3677.5	2.49	2.26	1.13	3.23
3678.0	3.10	2.80	1.40	4.63
3678.5	3.93	3.52	1.76	6.39

CATCHMENT B-15 AREA CAPACITY TABLE

ELEVATION (ft)	AREA (ac)	AVG. AREA (ac)	CAPACITY (ac-ft) INCR.	CAPACITY (ac-ft) ACCUM.
3655.5	0.50			0.00
3656.0	0.55	0.53	0.27	0.27
3656.5	0.61	0.58	0.29	0.56
3657.0	0.67	0.64	0.32	0.88
3657.5	0.73	0.70	0.35	1.23
3658.0	0.79	0.76	0.38	1.61
3658.5	0.86	0.83	0.42	2.03
3659.0	0.92	0.89	0.45	2.48
3659.5	0.99	0.96	0.48	2.96
3660.0	1.06	1.03	0.52	3.48
3660.5	1.26	1.16	0.58	4.06
3661.0	1.52	1.39	0.70	4.76
3661.5	1.89	1.71	0.86	5.62
3662.0	2.34	2.12	1.06	6.68
3662.5	2.92	2.63	1.32	8.00
3663.0	3.45	3.19	1.60	9.60
3663.5	4.02	3.74	1.87	11.47
3664.0	4.70	4.36	2.18	13.65
3664.5	5.41	5.06	2.53	16.18

Burdock Land Application Catchment Summary

Catchment Designation	Drainage Area (acres)	Drainage Area (mi^2)	2-Year Runoff Volume (acre-ft)	100-Year Runoff Volume (acre-ft)	Catchment Area (acres)	Catchment Capacity (acre-ft)	Catchment Height (ft)	2-Year Depth (ft)
B-1	107.88	0.17	4.47	29.85	13.24	26.02	5.1	2.0
B-2	12.24	0.02	0.59	2.81	1.21	2.11	7.6	3.0
B-3	45.91	0.07	1.86	9.82	6.93	14.16	11.0	4.5
B-4	33.24	0.05	1.32	7.03	4.99	8.54	8.0	2.5
B-5	17.38	0.03	0.79	4.21	2.39	5.82	8.9	2.5
B-6	24.15	0.04	1.05	5.63	4.39	9.14	5.1	3.0
B-7	9.58	0.01	0.28	1.45	1.46	2.09	3.5	1.5
B-8	48.09	0.08	2.27	11.60	4.94	11.90	8.6	4.0
B-9	1.36	0.00	[illegible]	0.46	0.56	1.22	6.0	2.5
B-10	64.09	0.10	2.84	14.50	6.26	14.98	8.3	3.0
B-11	3.15	0.00	0.51	1.26	0.25	0.27	4.0	2.5
B-12	44.24	0.07	1.65	8.85	6.79	7.66	6.0	2.5
B-13	29.15	0.04	1.14	5.80	7.36	14.03	6.2	2.5
B-14	22.41	0.04	1.14	5.80	3.93	6.39	6.5	2.5
B-15	70.46	0.11	3.12	15.95	5.41	16.18	8.6	4.5
		Total	22.94	[illegible]	70.10	140.51		

Notes:
1. Overflow from Catchment B-2 will be routed to Catchment B-3.
2. Overflow from Catchment B-11 will be routed to Catchment B-12.
3. Overflow from Catchment B-12 will be routed to Catchment B-13.

NOTES:
1. INACTIVE CAPACITY IS THE AVAILABLE STORAGE CAPACITY FOR EACH CATCHMENT AREA ALLOWING ADEQUATE FREEBOARD CAPACITY FOR THE 100-YEAR, 24-HOUR STORM RUNOFF.
2. THE GENERAL CATCHMENT BOUNDARY THAT IS SHOWN IS THE SAME AS SHOWN ON FIGURES IN THE GDP APPLICATION. THE ACTUAL BOUNDARY WILL VARY DEPENDING UPON THE FINAL DESIGN OF THE CATCHMENT AREAS. THE CONCEPTUAL CATCHMENT AREA DESIGN SHOWN ON THIS PLATE IS WITHIN THE GENERAL CATCHMENT BOUNDARY.

This plate is provided to fulfill the requirements of ARSD 74:29:02:04, ARSD 74:29:05:14 (4) and SDCL 45-6B-6(4).

WWC ENGINEERING

#	DRAWN	CHECKED	APPROVED	DATE
REVISIONS				

CHECK SCALES

Drawn: 29 March 2013 — Dave C. Johnson
Date: 29 March 2013
Preparer: Dale E. Brown

POWERTECH (USA) INC.

Plate 5.4-2

Conceptual Catchment Area Design
Burdock Land Application Area

Dewey-Burdock Project

NAD 27, South Dakota State Plane South (feet)