C

2.C CORRECTIVE ACTION PLAN AND WELL DATA

Submit a tabulation of data reasonably available from public records or otherwise known to the applicant on all wells within the area of review, including those on the map required in Attachment B, which penetrate the proposed injection zone. Such data shall include the following:

A description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Director may require. In the case of a new injection well, include the corrective action proposed to be taken by the applicant under 40 CFR 144.55.

RESPONSE

Corrective Action

A corrective action plan is not required for any of the artificial penetrations within the AORs of the proposed Dewey-Burdock wells or the Class V permit area because there are no artificial penetrations to the injection zone within the Class V permit area. If a corrective action plan for any neighboring well becomes necessary in the future, it will be developed according to appropriate regulatory standards and guidelines.

The corrective action plan which would be proposed by Powertech should the potential for fluid migration to occur through the confining layer develop via any future well likely would include the following:

1. The impacted Dewey-Burdock Project Disposal Well will be shut-in.
2. The USEPA, Region 8 UIC Section and the SD DENR will be notified.
3. Following well shut-in, liquid 11e2 waste will be shipped to alternative permitted facilities for off-site treatment and/or disposal as necessary.
4. A contingency plan will be prepared as follows:
    a. Locate well and identify present operator or owner, if any.
    b. Identify mode of failure.
    c. Prepare remedial plan outlining course of action.
    d. The remedial plan will be submitted to the USEPA, Region 8 and SD DENR for approval.
    e. Upon authorization, the remedial plan will be implemented.

Water Wells within AORs

Table C-1 is a tabulation of the known artificial penetrations (water wells) located within the Class V permit area. The deepest formation penetrated by any of these wells is the Unkpapa/Sundance. Due to the absence of wells within the Class V permit area that penetrate either of the targeted injection zones, there is no potential from artificial penetrations for causing any endangerment to a USDW.

Area of Review Oil and Gas Well Data

Table C-2 is a tabulation of the three oil and gas wells permitted within the Dewey-Burdock Project area that are outside the assigned AORs. The plugging records for these wells are included as Appendix B. Plugging records obtained from DENR indicate that each of the wells is plugged to a sufficient depth so as not to allow transmission of fluids from the targeted injection zones to overlying USDWs. Note that none of these wells are located within the proposed Class V permit area. As such, they will not be encompassed in any prospective future AORs of proposed additional Dewey-Burdock Disposal Wells.

TABLE C-1 Known Water Wells Within Class V Permit Area

Well ID	Well Depth (ft)	Formation	Abandoned	Depth to Water (ft)
605	Unknown	Inyan Kara	no	Unknown
606	Unknown	Lakota	yes	0
42	600	Lakota	no	-10
61	525	Lakota	unknown	Unknown
16	330	Lakota	no	158
618	Unknown	Unknown	no	Unknown
15	495	Lakota	yes	0
634	Unknown	Unknown	yes	Unknown
43	350	Lakota	yes	Unknown
14	470	Lakota	unknown	-1
636	Unknown	Unknown	yes	Unknown
637	Unknown	Unknown	no	Unknown
17	156	Fall River	no	Unknown
39	Unknown	Unknown	unknown	Unknown
652	280	Inyan Kara	yes	Unknown
654	Unknown	Inyan Kara	yes	Unknown
659	Unknown	Fall River	yes	Unknown
660	Unknown	Lakota	yes	Unknown
661	Unknown	Lakota	unknown	Unknown
663	550	Lakota	unknown	Unknown
664	360	Fall River	unknown	Unknown
665	252	Fall River	unknown	Unknown
666	441	Lakota	unknown	Unknown
669	550	Lakota	unknown	Unknown
670	395	Fuson	unknown	Unknown
671	350	Fall River	unknown	Unknown
672	376	Fall River	unknown	Unknown
673	440	Fuson	unknown	Unknown
674	570	Lakota	unknown	Unknown
676	23	Alluvial	no	Unknown
683	650	Fall River	no	5
687	608	Fall River	no	Unknown
685	595	Fall River	no	Unknown
682	460	Lakota	no	Unknown
686	428	Lakota	no	Unknown
684	423	Lakota	no	Unknown
690	623	Unkpapa/Sundance	no	-29
692	327	Lakota	no	Unknown
38	494	Lakota	no	-14
609	1000	Lakota	no	7
610	Unknown	Fall River	no	Unknown
619	280	Lakota	no	19
628	Unknown	Inyan Kara	no	Unknown
668	574	Inyan Kara	no	Unknown
698	205	Fall River	no	Unknown
704	955	Unkpapa/Sundance	no	Unknown
703	525	Unkpapa/Sundance	no	Unknown
695	508	Fall River	no	Unknown

TABLE C-1 Known Water Wells Within Class V Permit Area

Well ID	Well Depth (ft)	Formation	Abandoned	Depth to Water (ft)
697	682	Lakota	no	Unknown
691	505	Fall River	no	Unknown
693	910	Unkpapa/Sundance	no	-138
689	730	Lakota	no	-59
681	600	Fall River	no	-13
49	600	Fall River	no	Unknown
688	255	Fall River	no	37
680	436	Lakota	no	39

Source: 2009 Powertech Dewey-Burdock NRC Application

TABLE C-2 Oil and Gas Wells Within Project Area

Well API	Name	Well Depth (ft)	Formation	Well Status
40-047-05095	Earl Darrow #1	2,450	Minnelusa	Plugged and Abandonded
40-047-20071	#34-11 Peterson	2,250	Minnelusa	Plugged and Abandonded
40-047-20065	Lenore Peterson #21-14	2,266	Minnelusa	Plugged back to 850'

2.D MAPS AND CROSS SECTIONS OF USDWs

Submit maps and cross sections indicating the vertical limits of all underground sources of drinking water within the area of review (both vertical and lateral limits for Class I), their position relative to the injection formation and the direction of water movement, where known, in every underground source of drinking water which may be affected by the proposed injection activities.

RESPONSE

The major bedrock aquifers in the Black Hills area include the Deadwood, Madison, Minnelusa, Minnekahta, and Inyan Kara (Carter et al, 2003). These aquifers are regionally extensive in areas surrounding the Black Hills as shown on Figure D-1 (Driscoll et al., 2002). A regional east-west geologic cross section across the Black Hills Uplift is shown on Figure D-2. The location of the cross section A-A' is indicated on Figure D-1. Ground-water flow in the regional aquifer system in the Paleozoic aquifer units (i.e., Deadwood, Madison, Minnelusa, and Minnekahta Formations) is generally interpreted to be radially outward from the outcrops surrounding the Black Hills (Figure D-3). Groundwater recharge from the Black Hills area comingles with groundwater in the Powder River Basin to the west and then migrates northeastward into the Williston Basin where it eventually discharges at lower elevations to the land surface in eastern North Dakota and along the outcrop of the Canadian Shield in Canada.

Only two of these major aquifers, the Madison and Inyan Kara, are considered to be USDWs within the AORs of the Dewey-Burdock Disposal Wells. As discussed below, the Deadwood, Minnelusa, and Minnekahta do not supply water wells in the Dewey-Burdock area and are not considered to be USDWs locally. Further, due to local total dissolved solids (TDS) concentrations in excess of 10,000 mg/l, (shown Table D-1 from the USGS Produced Waters Database [http://energy.cr.usgs.gov/prov/prodwat/data2.htm]), the Minnelusa is not a USDW.

Minor aquifers in the area include the Sundance formation (Driscoll et al., 2002). While some authors differentiate geologically between the Sundance and overlying Unkpapa Formation, they are thought to be hydrogeologically connected and are referred to as the Unkpapa/Sundance in this document. Further, the Unkpapa/Sundance is considered to be the lower-most USDW above the Madison below the Dewey-Burdock Project area.

Deadwood Formation

The Cambrian-age Deadwood Formation consists of massive to thinly-bedded, brown to light-gray sandstone; greenish glauconitic shale; dolomite; and flat-pebble limestone conglomerate. Sandstone with conglomerate occurs locally at the base of the formation. The Deadwood ranges in thickness from 0 to 500 feet (Carter et al., 2003) in the area. Generally, groundwater flow in the Cambrian-Ordovician aquifer system is from the high-altitude recharge areas on the top of the Black Hills radially outward (Figure D-4). Regionally the Deadwood is confined by the Precambrian basement (Williamson and Carter, 2001). It overlies the Precambrian basement and granite wash (where present) and outcrops approximately 20 miles to the northeast of the Dewey-Burdock Project (Figure D-1). As stated previously, the Deadwood is not considered to be a local USDW. Based on available data, there are no known water wells supplied by the Deadwood Formation in the Dewey-Burdock Project area. There are no water quality data available in the area, but it is suspected that water quality declines with depth and distance down-gradient from the recharge at the outcrop. As a result, it is likely that the Deadwood contains dissolved solids in excess of 10,000 mg/l below Sites 1 and 2 and will not meet the USEPA criteria for a USDW. An isopach map of the Deadwood is included as Figure D-5.

Madison Formation

The Mississippian Madison aquifer is contained within the limestones, siltstones, sandstones, and dolomite of the Madison Limestone or Group. Generally, water in the Madison is confined except in outcrop areas and can frequently demonstrate artesian conditions. Groundwater flow in this aquifer system generally is from the recharge areas radially outward from the Black Hills (Figure D-6). Water in the Madison is typically fresh only near the recharge areas, becoming slightly saline to saline as it moves down-gradient (Figure D-7). In the deeper parts of the Williston Basin, the water is a brine with dissolved solids concentrations greater than 300,000 mg/L (Driscoll et al., 2002). Local water quality for the Madison is summarized by analysis of the Edgemont city wells and is presented in Table D-1. Structure contour and isopach maps of the Madison are included as Figures D-8 and D-9, respectively. A potentiometric surface map of the Madison Formation is presented as Figure D-10.

Minnelusa Formation

The Pennsylvanian- and Permian-age Minnelusa Formation consists of yellow to red, cross-stratified sandstone, limestone, dolomite, and shale. The Minnelusa Aquifer occurs primarily in sandstone and anhydrite beds in the upper part of the formation (Williamson and Carter, 2001). Water in this aquifer moves from recharge areas radially outward from the Black Hills and to the northeast to discharge areas in eastern South Dakota (Figure D-6). It is confined above by the Opeche Shale and below by layers of lower permeability in the Minnelusa Formation.

The Minnelusa is referred to as an aquifer but is an oil and gas producer in the Dewey-Burdock area. Table D-2 and Figure D-11 present local water quality data from the USGS Produced Waters Database for the Minnelusa Formation that shows TDS concentrations in excess of 10,000 mg/l in the Dewey-Burdock area. In addition, this formation does not supply water to any local water wells. As such, it is not considered to be a USDW in the Dewey-Burdock area. Structure contour and isopach maps of the Minnelusa are included as Figures D-12 and D-13, respectively. A potentiometric surface map of the Minnelusa Formation is presented as Figure D-14.

It has been postulated that in the vicinity of the Black Hills, there may be communication between the Madison and Minnelusa Formations and even communication from the Minnelusa to the surface via breccia pipes. However, this communication is thought to occur near the outcrop in areas where these formations are near surface. These areas are located well to the north and east of the Project area and up-gradient in the system. Evidence of regional isolation is the contrast between water quality in the Madison and Minnelusa. There is no evidence to suggest that there is communication between these formations locally.

Minnekahta Formation

The Permian-age Minnekahta Limestone is a thin to medium-bedded, fine-grained, purple to gray laminated limestone, which ranges in thickness from 25 to 65 feet (Driscoll et al., 2002). The Minnekahta is considered a major aquifer in parts of the Black Hills area but does not supply any known water wells locally.

Unkpapa/Sundance Formation

The Sundance Formation consists of greenish-gray shale with thin limestone lenses; glauconitic sandstone, with red sandstone near the middle of the formation. The Sundance ranges from 250 to 450 feet thick (Carter et al., 2003). The Unkpapa Sandstone is a massive fine-grained sandstone, 0 to 225 feet thick (Carter et al., 2003). A potentiometric surface map of the Unkpapa is presented as figure D-14a. The Unkpapa/Sundance is considered a minor aquifer in the area. Local water quality data from wells located within the Dewey-Burdock Project are presented in Table D-3.

Inyan Kara Group

Several sandstone units compose the lower Cretaceous aquifer, which is known as the Inyan Kara aquifer in South Dakota. These units are the Lakota and Fall River Formations and the Lakota is divided into the Chilson, Minnewaste, and Fuson Members. Some authors include the Minnewaste Limestone Member regionally, but it is not present below the project area. Generally, water in the Inyan Kara is confined by several thick shale layers of the Graneros Group (including the Skull Creek Shale), except in outcrop areas around structural uplifts, such as the Black Hills Uplift. Regionally, groundwater in the Inyan Kara moves from high-altitude recharge areas to discharge areas in eastern North Dakota and South Dakota. Although the aquifer is wide-spread, it contains little fresh water except in small areas in central and south-central Montana and north and east of the Black Hills uplift. Water in the Inyan Kara is saline in the deeper parts of the Williston and Powder River Basins (Driscoll et al., 2002). Table D-4 presents local water quality data from wells located within the Dewey-Burdock Project. A structure contour map of the Inyan Kara is included as Figure D-15. Isopach maps of each of the units that compose the Inyan Kara are included as Figures D-16, D-17, and D-18. A potentiometric surface map of the Fall River Aquifer is presented as Figure D-19.

Figure D-20 is a cross-section location map that shows A - A' (Figure D-21) and B - B' (Figure D-22) which show the vertical extent of the USDWs across the project area. The lowermost formations (Madison, Englewood, and Deadwood) are not shown due to the lack of deep well logs.

TABLE D-1 Local Water Quality Data - Madison Formation

Summary of Madison well data, Edgemont city water														
		Well ID	BNR/TVA	well 2	well 4	well 5	TVA	well 2	well 4	well 5	Mean	Minimum	Maximum	Std. Dev
		Sample Date	11/6/2002	11/6/2002	11/6/2002	11/6/2002	5/23/2000	5/23/2000	5/23/2000	5/23/2000				
Component		**units**												
Physical properties														
Conductivity	Cond.	umhos/cm	1154	1671	1785	2140	1300	1700	1800	2300	1731.3	1154.0	2300.0	382.1
Hardness			406	503	528	580	410	460	500	560	493.4	406.0	580.0	64.3
pH	pH		7.81	7.7	7.73	7.66	7.15	7.23	7.26	7.37	7.5	7.2	7.8	0.3
TDS	TDS	mg/L	726	1047	1101	1333	690	980	940	1000	977.1	690.0	1333.0	205.0
TSS	TSS	mg/L												
Turbidity	Turbidity	NTU												
Acidity	Acidity													
Alkalinity	CaCO3		188	181	182	180	170	160	160	170	173.9	160.0	188.0	10.5
Carbonate	CO3	mg/L												
Bicarbonate	HCO3	mg/L	229	221	222	220	210	200	200	210	214.0	200.0	229.0	10.7
Chloride	Cl	mg/L	185	255	300	385	150	250	270	360	269.4	150.0	385.0	79.7
Cyanide	CN	mg/L												
Flouride	F	mg/L	0.843	1.1	1.07	1.32	0.9	1.05	1.03	1.2	1.1	0.8	1.3	0.2
Nitrogen, Ammonia	NH3	mg/L												
Nitrogen, Nitrate	NO3	mg/L	0.211	0.086	0.063	<.05	0.15	0.16	0.16	<.1	0.1	0.1	0.2	0.1
Nitrogen, Nitrite	NO2	mg/L					<.01	<.01	<.01	<.01		0.0	0.0	
Sulfate	SO4	mg/L	211	295	309	353	210	300	340	390	301.0	210.0	390.0	64.0
Metals														
Aluminum	Al	mg/L												
Arsenic	As	mg/L	0.006	0.01	0.01	0.008					0.0085	0.0	0.0	0.0019
Calcium	Ca	mg/L	115	150	156	175	100	120	130	140	135.8	100.0	175.0	24.4
Iron	Fe	mg/L	0.05	0.091	<.05	2.53	<0.05	0.09	<.05	2.6	1.1	0.1	2.6	1.4
Magnesium	Mg	mg/L	28.8	31.1	33.7	34.8	30	32	35	36	32.7	28.8	36.0	2.6
Manganese	Mn	mg/L	0.05	0.05	<.05	<.05	<.03	<.03	<.03	0.05	0.05	0.1	0.1	0.00
Mercury	Hg	mg/L												
Lead	Pb	mg/L												
Molybdenum	Mo	mg/L												
Potassium	K	mg/L	10.6	17.3	17.9	23	12	19	20	24	18.0	10.6	24.0	4.7
Selenium	Se	mg/L												
Sodium	Na	mg/L	86.9	161	174	228	88	150	170	200	157.2	86.9	228.0	49.4

Source: Summary of Madison well data, Edgemont city water http://www.sdgs.usd.edu/other/db.html

TABLE D-2 Local Water Quality Data - Minnelusa Formation

API Number	Location					County	Formation Sampled	Sample Method	Test Interval		TDS (mg/L)
	Section	Township	Range	Latitude	Longitude				Top (feet)	Bottom (feet)	
4003305005	34	6S	2E	43.48664	-103.86925	Custer	Minnelusa	DST	1,338	1,375	18,814
4003305010	34	6S	2E	43.48814	-103.86781	Custer	Minnelusa	Production	1,368	1,388	13,512
4003305010	34	6S	2E	43.48814	-103.86781	Custer	Minnelusa	Wellhead	1,356	--	7,740
4003305015	34	6S	2E	43.49021	-103.86926	Custer	Minnelusa	Separator	713	--	7,429
4003305035	30	5S	2E	43.58112	-103.93146	Custer	Minnelusa	Bailer	845	851	4,288
4004705067	15	9S	2E	43.26232	-103.87392	Fall River	Minnelusa	DST	2,692	2,707	24,823
4004705067	15	9S	2E	43.26232	-103.87392	Fall River	Minnelusa	DST	2,692	2,707	24,422
4004705067	15	9S	2E	43.26232	-103.87392	Fall River	Minnelusa	WLT	2,230	2,234	9,803
4004705089	21	7S	1E	43.42595	-103.99711	Fall River	Minnelusa	DST	2,390	2,400	21,391
4004705089	21	7S	1E	43.42595	-103.99711	Fall River	Minnelusa	DST	2,390	2,400	17,279
4004705089	21	7S	1E	43.42595	-103.99711	Fall River	Minnelusa	DST	2,390	2,400	16,652
4004705092	21	7S	2E	43.42964	-103.88318	Fall River	Minnelusa	Unknown	1,415	1,418	10,183
40000185	34	6S	2E	43.48480	-103.86630	Custer	Minnelusa	Separator	713	--	7,427
40000183	34	6S	2E	43.48480	-103.86630	Custer	Minnelusa	Separator	680	--	6,968

Notes:
-- - Data not provided.
Shading indicates duplicate samples.
Source: USGS Produced waters Database; http://energy.cr.usgs.gov/prov/prodwat/data.htm

TABLE D-3 Local Water Quality Data - Unkpapa/Sundance Formation

Well #635				
Analyte	**9/26/07 18:08**	**11/27/07 8:25**	**2/10/08 14:55**	**4/29/08 19:00**
A/C Balance (± 5) (%)	-1.14	-0.831	-0.25	3.52
Alkalinity-Total as CaCO3 (mg/L)	124	118	120	118
Aluminum-Dissolved (mg/L)	<0.1	<0.1	<0.1	<0.1
Ammonia (mg/L)	0.1	0.4	0.5	0.5
Anions (meq/L)	30.4	31.6	33.7	32.8
Antimony-Total (mg/L)			<0.003	<0.003
Arsenic-Dissolved (mg/L)	<0.001	<0.001	<0.001	<0.001
Arsenic-Total (mg/L)			<0.001	0.001
Barium-Dissolved (mg/L)	<0.1	<0.1	<0.1	<0.1
Barium-Total (mg/L)			<0.1	<0.1
Beryllium-Total (mg/L)			<0.001	<0.001
Bicarbonate as HCO3 (mg/L)	151	144	146	144
Boron-Dissolved (mg/L)	0.4	0.4	0.5	0.4
Boron-Total (mg/L)			0.5	0.4
Cadmium-Dissolved (mg/L)	<0.005	<0.005	<0.005	<0.005
Cadmium-Total (mg/L)			<0.005	<0.005
Calcium-Dissolved (mg/L)	110	120	132	136
Carbonate as CO3 (mg/L)	<5	<5	<5	<5
Cations (meq/L)	29.8	31.1	33.5	35.2
Chloride (mg/L)	24	23	26	20
Chromium-Dissolved (mg/L)	<0.05	<0.05	<0.05	<0.05
Chromium-Total (mg/L)			<0.05	<0.05
Conductivity @ 25 C (umhos/cm)	2890	2830	2950	2810
Copper-Dissolved (mg/L)	<0.01	<0.01	<0.01	<0.01
Copper-Total (mg/L)			<0.01	<0.01
Fluoride (mg/L)	0.3	0.3	0.4	0.4
Gross Alpha-Dissolved (pCi/L)	2.5	4.4	14.8	13.2
Gross Beta-Dissolved (pCi/L)	4.3	6.3	10	-8
Gross Gamma-Dissolved (pCi/L)	960	1000	91	
Iron-Dissolved (mg/L)	<0.03	<0.03	<0.03	<0.03
Iron-Total (mg/L)			1.11	1.08
Lead 210-Dissolved (pCi/L)	<1	1.7	<1	
Lead 210-Suspended (pCi/L)	<1	5.1	<1	-9.6
Lead 210-Total (pCi/L)	<1			
Lead-Dissolved (mg/L)	<0.001	0.003	<0.001	<0.001
Lead-Total (mg/L)			<0.001	<0.001
Magnesium-Dissolved (mg/L)	44.3	49	52.3	54.1
Manganese-Dissolved (mg/L)	0.06	0.07	0.06	0.06
Manganese-Total (mg/L)			0.06	0.05
Mercury-Dissolved (mg/L)	<0.001	<0.001	<0.001	<0.001
Mercury-Total (mg/L)	<0.0002	<0.001	<0.001	<0.001
Molybdenum-Dissolved (mg/L)	<0.1	<0.1	<0.1	<0.1
Molybdenum-Total (mg/L)			0.01	<0.1
Nickel-Dissolved (mg/L)	<0.05	<0.05	<0.05	<0.05
Nickel-Total (mg/L)			<0.05	<0.05
Nitrogen, Nitrate as N (mg/L)	<0.1	<0.1	<0.1	<0.05
Nitrogen, Nitrite as N (mg/L)	<0.1	<0.1	<0.1	<0.05
Oxidation-Reduction Potential (mV)		270	129.4	180
pH	7.72	7.64	7.91	8.2
Polonium 210-Dissolved (pCi/L)	<1	1.9	<1	1.1
Polonium 210-Suspended (pCi/L)	<1	<1	<1	
Polonium 210-Total (pCi/L)	<1			
Potassium-Dissolved (mg/L)	7.8	8.3	8.2	7.3
Radium 226-Dissolved (pCi/L)	1.6	0.8	1.3	
Radium 226-Suspended (pCi/L)	0.8	<0.2	0.6	0.3
Radium 226-Total (pCi/L)	2.4			

TABLE D-3 Local Water Quality Data - Unkpapa/Sundance Formation

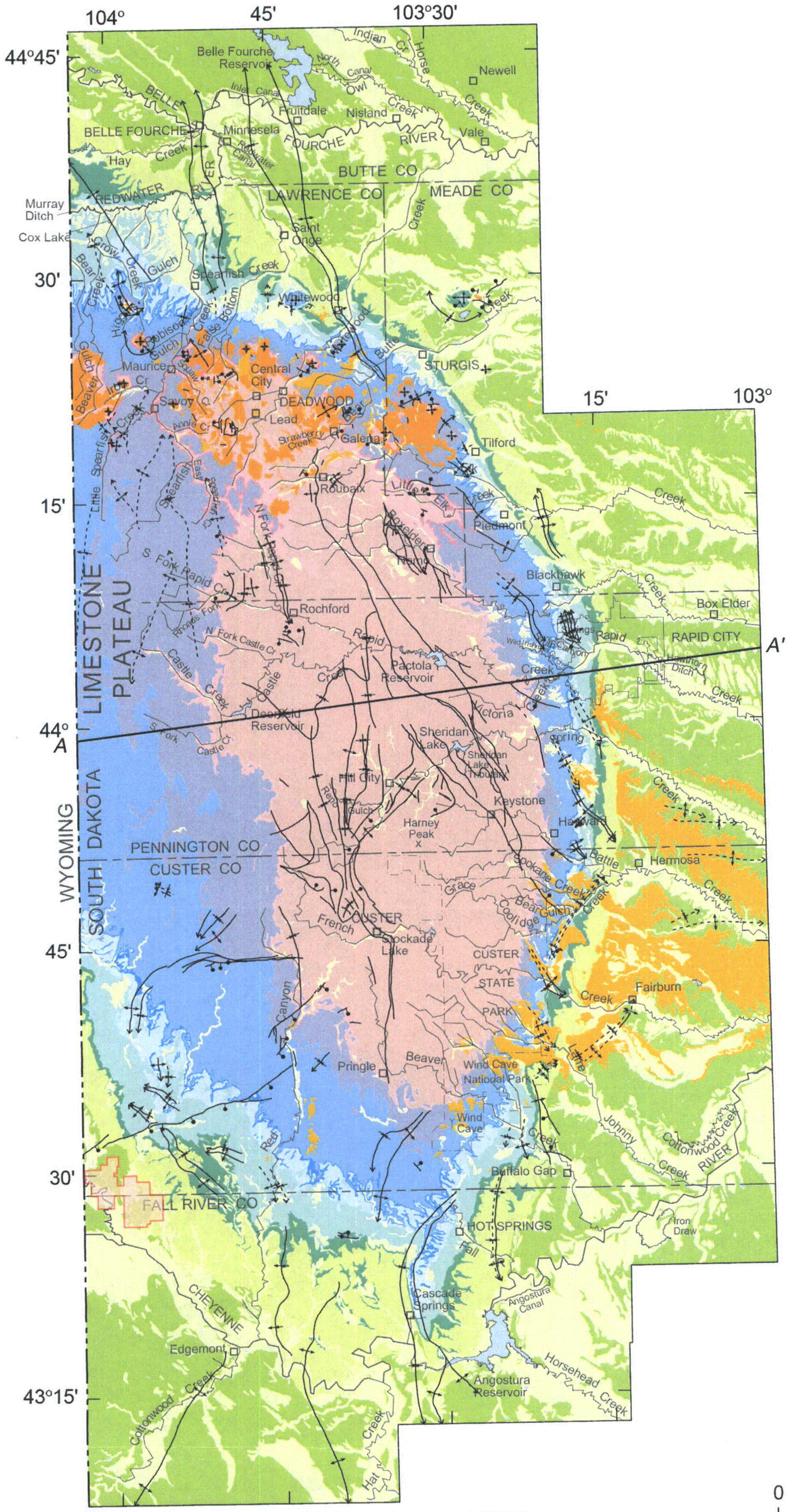
Well #635				
Analyte	**9/26/07 18:08**	**11/27/07 8:25**	**2/10/08 14:55**	**4/29/08 19:00**
Radon 222-Total (pCi/L)		902	806	1070
Selenium-Dissolved (mg/L)	0.001	<0.001	<0.001	<0.001
Selenium-IV-Dissolved (mg/L)		0.001	<0.001	<0.001
Selenium-Total (mg/L)			<0.001	0.001
Selenium-VI-Dissolved (mg/L)		<0.001	<0.001	<0.001
Silica-Dissolved (mg/L)	8.6	9	10	4.9
Silver-Dissolved (mg/L)	<0.005	<0.005	<0.005	<0.005
Silver-Total (mg/L)			<0.005	<0.005
Sodium Adsorption Ratio (SAR) (meq/L)		9.3	9.6	10
Sodium-Dissolved (mg/L)	470	480	515	545
Solids-Total Dissolved Calculated (mg/L)	2040	2120	2270	2280
Solids-Total Dissolved TDS @ 180 C (mg/L)	2200	2300	2300	2200
Strontium-Total (mg.L)			4.2	4.6
Sulfate (mg/L)	1500	1370	1470	1430
TDS Balance (0.80 - 1.20) (dec.%)	1.09	1.08	1.03	0.98
Thallium-Total (mg/L)			<0.001	<0.001
Thorium 230-Dissolved (pCi/L)	<0.2	<0.2	<0.2	0.2
Thorium 230-Suspended (pCi/L)	<0.2	<0.2	<0.2	0.1
Thorium 230-Total (pCi/L)	<0.2			
Thorium 232-Dissolved (pCi/L)	<0.005	<0.005	<0.005	<0.005
Uranium-Dissolved (mg/L)	0.002	0.002	0.0021	0.0017
Uranium-Suspended (mg/L)	<0.0003	<0.0003	<0.0003	<0.0003
Uranium-Total (mg/L)	0.002		0.0021	0.0017
Vanadium-Dissolved (mg/L)	<0.1	<0.1	<0.1	<0.1
Zinc-Dissolved (mg/L)	<0.01	0.02	<0.01	<0.01
Zinc-Total (mg/L)			<0.01	<0.01

Source: Powertech 2008 Class III UIC Permit Application, Appendix F

TABLE D-4 Local Water Quality Data - Inyan Kara Group (Lakota and Fall River Formations)

		Mean			Minimum			Maximum		
	Well	Powertech	TVA	RPD	Powertech	TVA	RPD	Powertech	TVA	RPD
Alkalinity as CaCO3, mg/L	2	181	219	19%	88	200	78%	214	242	12%
	7	171	181	6%	170	171	1%	176	191	8%
	8	166	178	7%	156	166	6%	178	194	9%
	13	159	173	8%	142	160	12%	170	196	14%
	16	153	152	1%	148	144	3%	160	157	2%
	18	179	196	9%	172	180	5%	184	238	26%
	42	178	188	5%	174	179	3%	180	204	13%
	4002	140	158	12%	138	144	4%	144	202	34%
	7002	261	261	0%	250	210	17%	280	300	7%
Conductivity, uS/cm	2	2285	1547	39%	1500	1450	3%	4400	1750	86%
	7	1542	1338	14%	1440	1325	8%	1650	1350	20%
	8	1450	1385	5%	1420	1285	10%	1560	1450	7%
	13	1292	1274	1%	1140	1100	4%	1420	1400	1%
	16	1063	1162	9%	925	1150	22%	1260	1175	7%
	18	1412	1379	2%	1330	1300	2%	1470	1420	3%
	42	1408	1353	4%	1310	1200	9%	1510	1400	8%
	4002	1220	1161	5%	1130	1100	3%	1340	1195	11%
	7002	2328	2339	0%	2200	1925	13%	2480	2500	1%
pH	2	7.91	7.7	3%	7.85	7.16	9%	7.94	8.2	3%
	7	8.11	8.5	5%	8.05	8.3	3%	8.17	8.7	6%
	8	7.95	7.87	1%	7.93	7.59	4%	7.97	8.5	6%
	13	7.9	7.76	2%	7.75	7.48	4%	8.05	8.1	1%
	16	7.46	7.34	2%	7.38	7.31	1%	7.57	7.39	2%
	18	8.08	7.94	2%	8.02	7.69	4%	8.11	8.4	4%
	42	8.02	7.94	1%	7.95	7.67	4%	8.08	8.4	4%
	4002	7.83	7.75	1%	7.65	7.51	2%	8.02	8.5	6%
	7002	7.36	7.44	1%	7.22	7.14	1%	7.56	8	6%
Total Dissolved Solids	2	1750	1043	51%	1100	1004	9%	3600	1113	106%
	7	999	1081	8%	896	1058	17%	1050	1104	5%
	8	1000	965	4%	940	860	9%	1100	1130	3%
	13	878	886	1%	850	792	7%	890	1006	12%
	16	814	846	4%	760	796	5%	940	894	5%
	18	958	909	5%	940	520	58%	990	1118	12%
	42	950	939	1%	930	888	5%	980	1033	5%
	4002	818	773	6%	790	740	7%	850	805	5%
	7002	1875	1843	2%	1800	1690	6%	1900	1970	4%
RPD (Relative Percent Difference) = The absolute difference divided by the average.										

Source: Table 2.7-45: Comparison of Statistics for Selected Constituents between Historic TVA Data and current Powertech Data (2009 Powertech NRC Application)



Base modified from U.S. Geological Survey digital data, 1:100,000
Rapid City, Office of City Engineer map, 1:18,000, 1996
Universal Transverse Mercator projection, zone 13

EXPLANATION

Hydrogeologic Units	Stratigraphic Units	Map Units
Unconsolidated units	QTac	Alluvium and colluvium, undifferentiaed
White River aquifer	Tw	White River Group
Tertiary intrusive units	Tui	Undifferentiated intrusive igneous rocks
Cretaceous-sequence confining unit	Kps	Pierre Shale to Skull Creek Shale, undifferentiated
Inyan Kara aquifer	Kik	Inyan Kara Group
Jurassic-sequence semiconfining unit	Ju	Morrison Formation to Gypsum Spring Formation, undifferentiated
Spearfish confining unit	₮Ps	Spearfish Formation
Minnekahta aquifer	Pmk	Minnekahta Limestone
Opeche confining unit	Po	Opeche Shale
Minnelusa aquifer	PIPm	Minnelusa Formation
Madison aquifer	MDme	Madison (Pahasapa) Limestone and Englewood Formation
Ordovician-sequence semiconfining unit	Ou	Whitewood Formation and Winnipeg Formation
Deadwood aquifer	O€d	Deadwood Formation
Precambrian igneous and metamorphic units	p€u	Undifferentiated metamorphic and igneous rocks

A A' LINE OF GEOLOGIC SECTION

FAULT--Dashed where approximated. Bar and ball on downthrown side.

ANTICLINE--Showing trace of axial plane and direction of plunge. Dashed where approximated.

SYNCLINE--Showing trace of axial plane and direction of plunge. Dashed where approximated.

MONOCLINE--Showing trace of axial plane. Dashed where approximated.

DOME--Symbol size approximately proportional to size of dome. Dome asymmetry indicated by arrow length.

0 10 20 MILES

0 10 20 KILOMETERS

Legend

Dewey-Burdock Permit Boundary

N

From:
Water-Resources Investigations Report 01-4194
by Joyce E. Williamson and Janet M. Carter, 2001

POWERTECH (USA) INC.

Figure D-1
Distribution of Hydrogeologic Units in the Black Hills Area

2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_Fig_D-01.ai	By: JLM	Checked: HD

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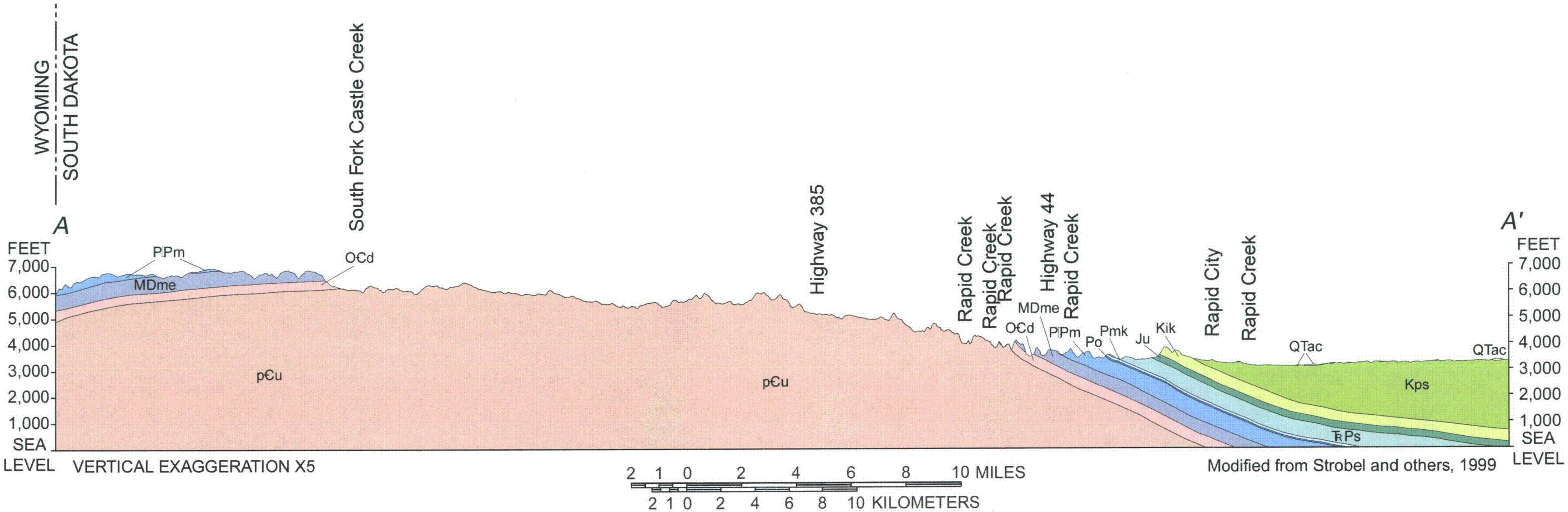

EXPLANATION

Hydrogeologic Units	Stratigraphic Units	Map Units
Unconsolidated units	QTac	Alluvium and colluvium, undifferentiaed
White River aquifer	Tw	White River Group
Tertiary intrusive units	Tui	Undifferentiated intrusive igneous rocks
Cretaceous-sequence confining unit	Kps	Pierre Shale to Skull Creek Shale, undifferentiated
Inyan Kara aquifer	Kik	Inyan Kara Group
Jurassic-sequence semiconfining unit	Ju	Morrison Formation to Gypsum Spring Formation, undifferentiated
Spearfish confining unit	TRPs	Spearfish Formation
Minnekahta aquifer	Pmk	Minnekahta Limestone
Opeche confining unit	Po	Opeche Shale
Minnelusa aquifer	PPm	Minnelusa Formation
Madison aquifer	MDme	Madison (Pahasapa) Limestone and Englewood Formation
Ordovician-sequence semiconfining unit	Ou	Whitewood Formation and Winnipeg Formation
Deadwood aquifer	OЄd	Deadwood Formation
Precambrian igneous and metamorphic units	pЄu	Undifferentiated metamorphic and igneous rocks

From:
Water-Resources Investigations Report 01-4194
(after Stobel et al., 1999, Modified by Driscoll et al., 2002)

POWERTECH (USA) INC.

Figure D-2
Generalized East-West Geologic Cross Section through Black Hills Uplift (A-A')

2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-2.ai	By: JLM	Checked: HD

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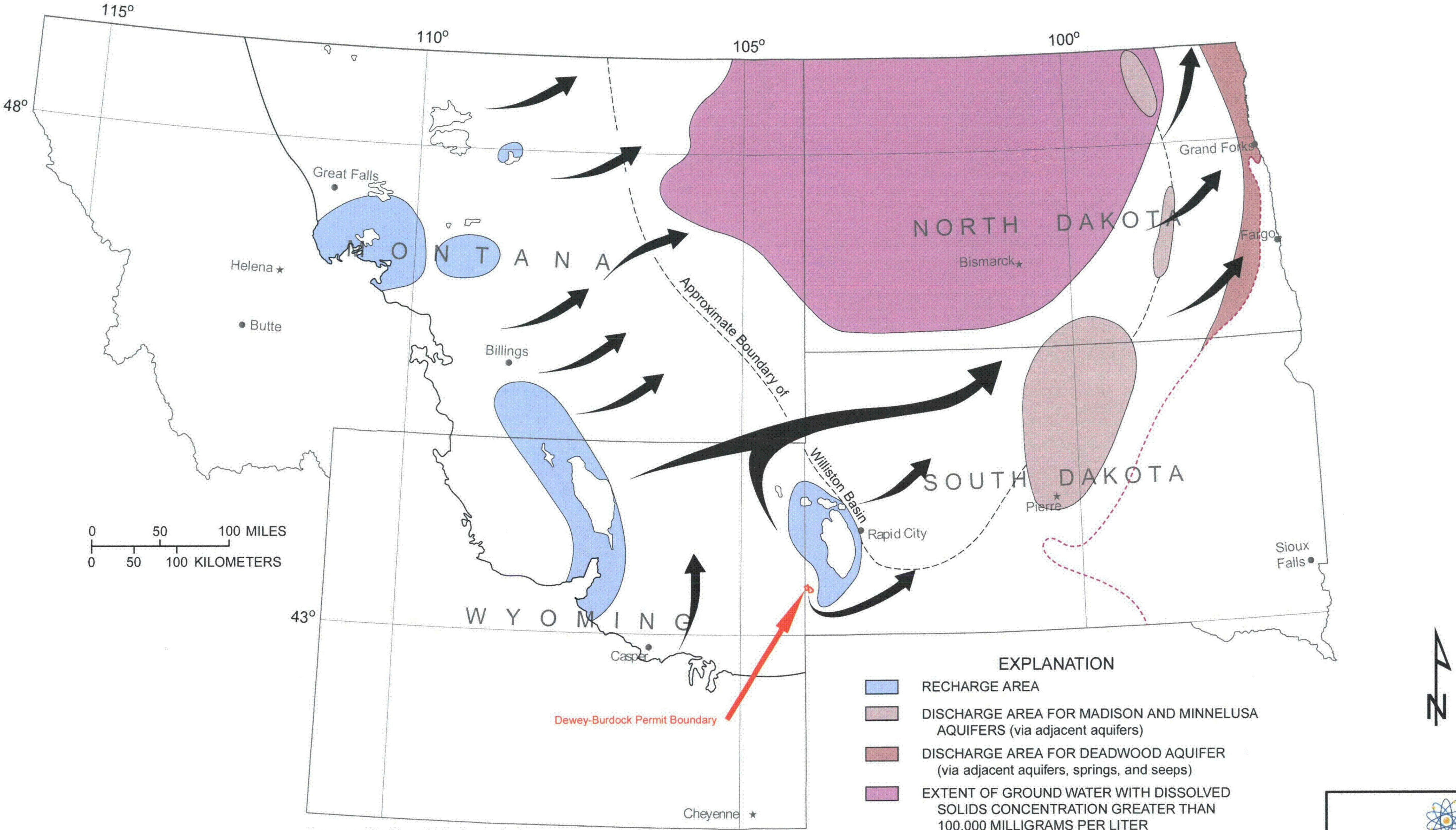

Base modified from U.S. Geological Survey digital data, 1:2,000,000, 1972

EXPLANATION

RECHARGE AREA

DISCHARGE AREA FOR MADISON AND MINNELUSA AQUIFERS (via adjacent aquifers)

DISCHARGE AREA FOR DEADWOOD AQUIFER (via adjacent aquifers, springs, and seeps)

EXTENT OF GROUND WATER WITH DISSOLVED SOLIDS CONCENTRATION GREATER THAN 100,000 MILLIGRAMS PER LITER

EASTERN LIMIT OF DEADWOOD AQUIFER--Dashed where approximately located

DIRECTION OF GROUND-WATER FLOW

From:
Water-Resources Investigations Report 02-4094
(after Downey and Dinwiddie, 1988,
modified by Driscoll et al., 2002)

POWERTECH (USA) INC.

Figure D-3
General Direction of Groundwater Flow in Regional Aquifer System within Paleozoic Aquifer Units

2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010
2010_DB_Class_V_Fig_D-03.ai	By: JLM — Checked: HD

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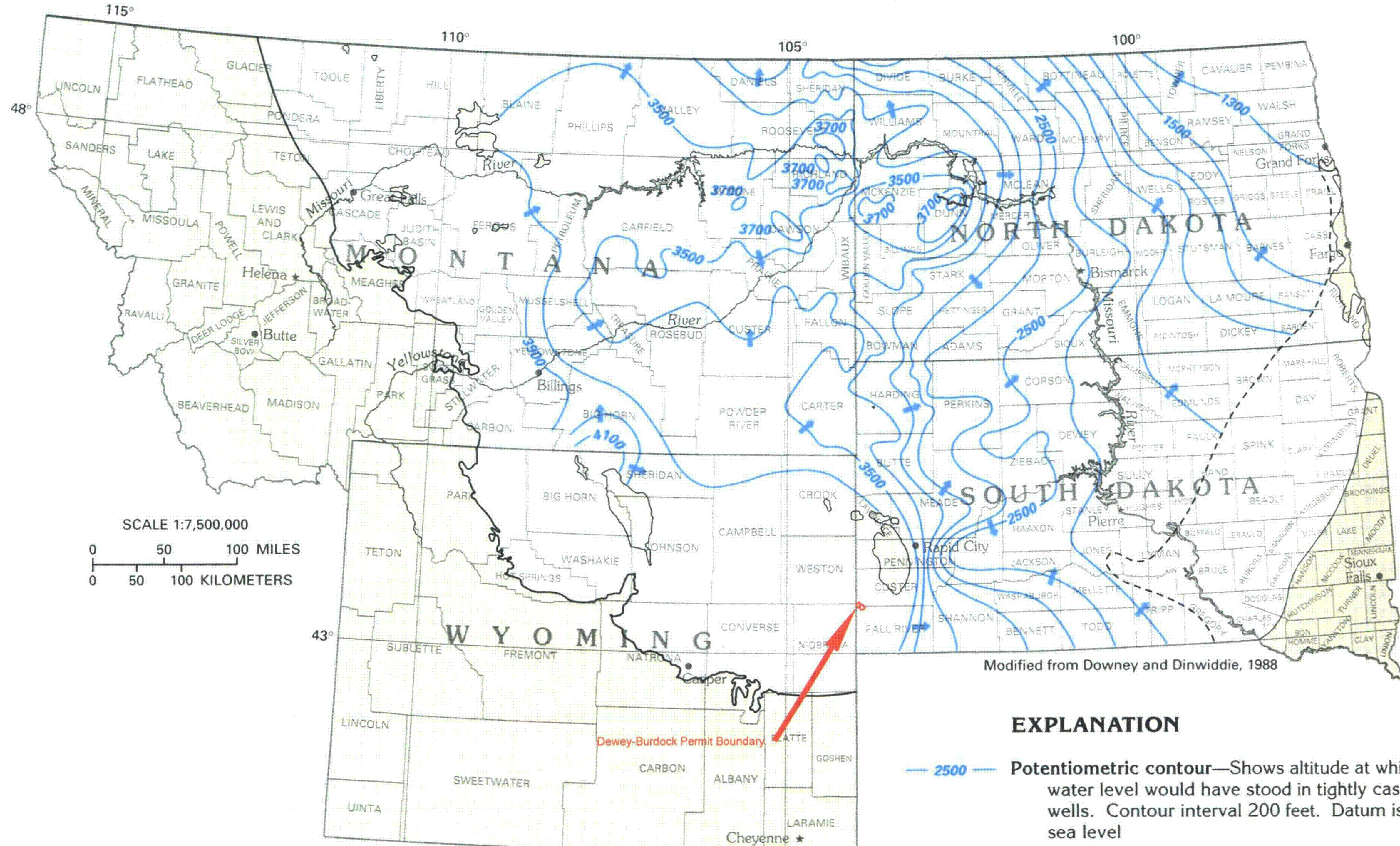

Base modified from U.S. Geological Survey digital data, 1:2,000,000, 1972

EXPLANATION

— 2500 — **Potentiometric contour**—Shows altitude at which water level would have stood in tightly cased wells. Contour interval 200 feet. Datum is sea level

——— - - - **Limit of lower Paleozoic aquifers**—Dashed where approximately located

➡ **Direction of ground-water movement**

From:
Ground Water Atlas of the United States, Segment 8 MT, SD. ND & WY, Hydrologic Investigations Atlas 730-I USGS (by Whitehead, 1996)

POWERTECH (USA) INC.

Figure D-4
Regional Groundwater Flow in Lower Paleozoic Aquifer System, Powder River and Williston Basins
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-04.ai	By: JLM	Checked: HD

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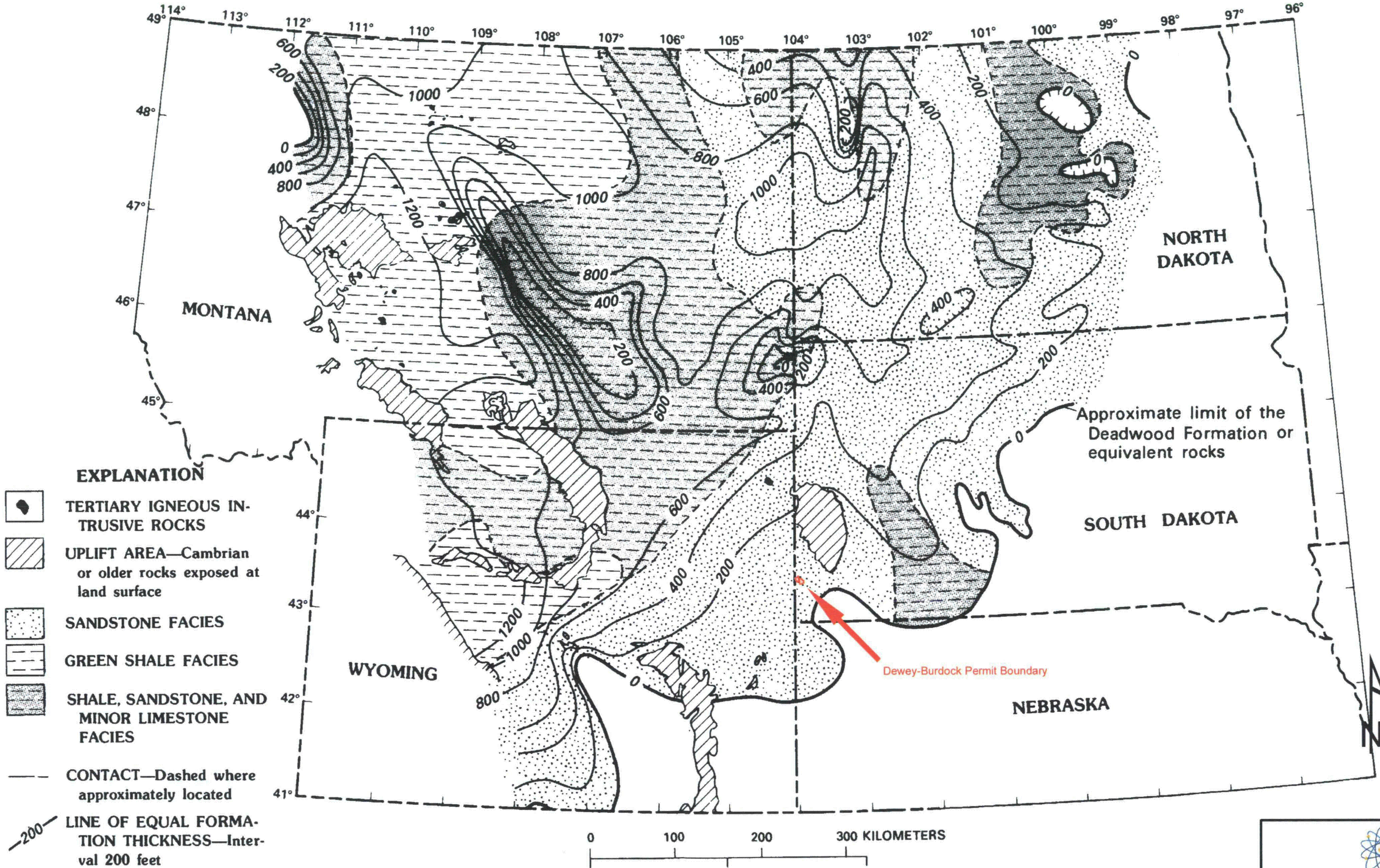

From:
Geological Survey Professional Paper 1273-A
Peterson, 1984

POWERTECH (USA) INC.

Figure D-5
Isopach Map,
Deadwood Formation
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-05.ai	By: JLM	Checked: HD

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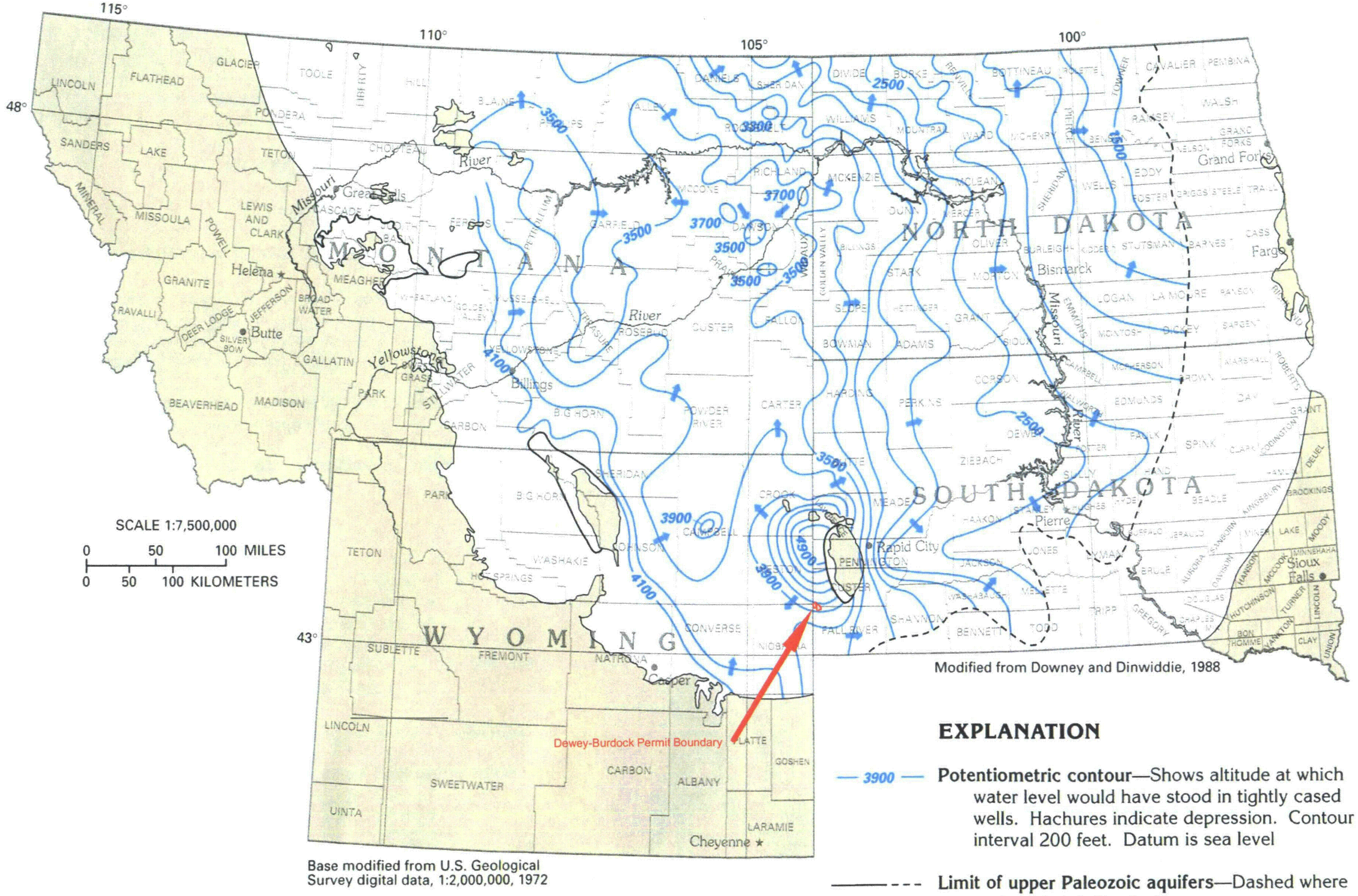

EXPLANATION

— 3900 — **Potentiometric contour**—Shows altitude at which water level would have stood in tightly cased wells. Hachures indicate depression. Contour interval 200 feet. Datum is sea level

—— - - - **Limit of upper Paleozoic aquifers**—Dashed where approximately located

Direction of ground-water movement

From:
Ground Water Atlas of the United States, Segment 8 MT, SD, ND & WY, Hydrologic Investigations Atlas 730-I USGS (by Whitehead, 1996)

POWERTECH (USA) INC.

Figure D-6
Regional Groundwater Flow Pattern in Upper Paleozoic Aquifer System, Powder River and Williston Basins
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-06.ai	By: JLM	Checked: HD

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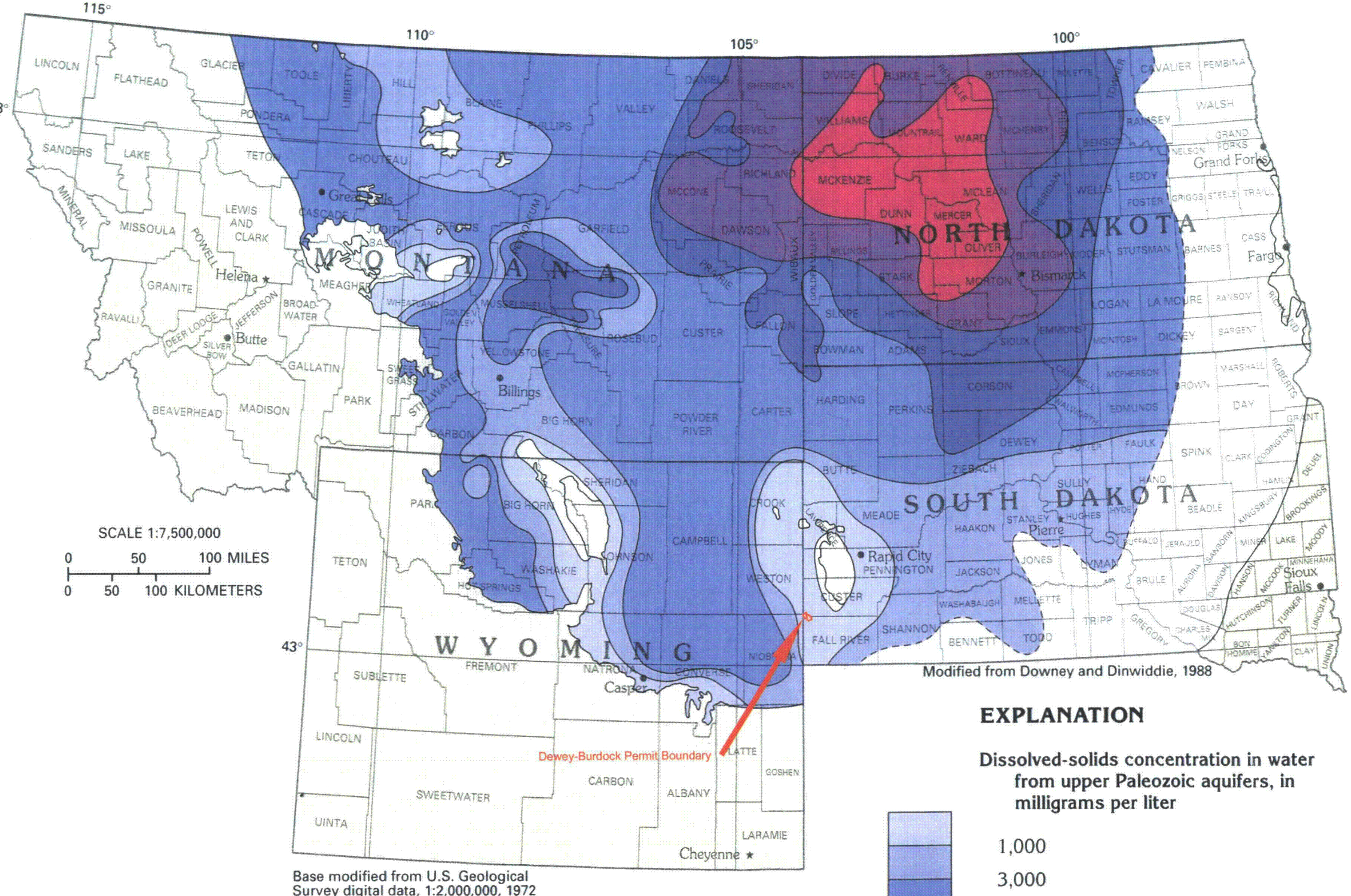

EXPLANATION

Dissolved-solids concentration in water from upper Paleozoic aquifers, in milligrams per liter

- 1,000
- 3,000
- 10,000
- 100,000
- 300,000
- Aquifers absent

From:
Ground Water Atlas of the United States,
Segment 8 MT, SD, ND & WY,
Hydrologic Investigations Atlas 730-I USGS
(by Whitehead, 1996)

POWERTECH (USA) INC.

Figure D-7
Dissolved Solids Concentrations in Upper Paleozoic Aquifer System, Powder River and Williston Basins
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-07.ai	By: JLM	Checked: HD

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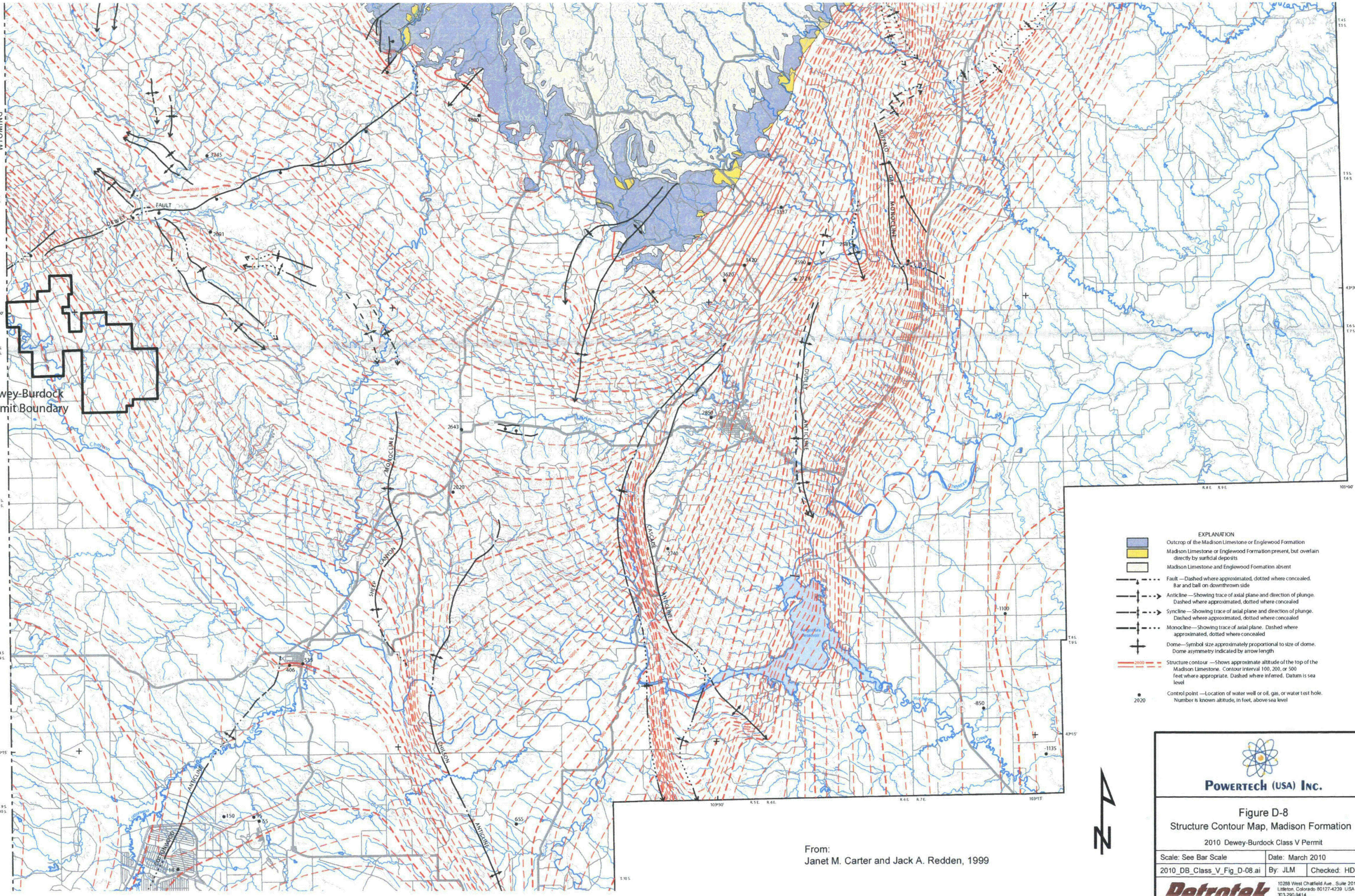

From:
Janet M. Carter and Jack A. Redden, 1999

POWERTECH (USA) INC.

Figure D-8
Structure Contour Map, Madison Formation

2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-08.ai	By: JLM	Checked: HD

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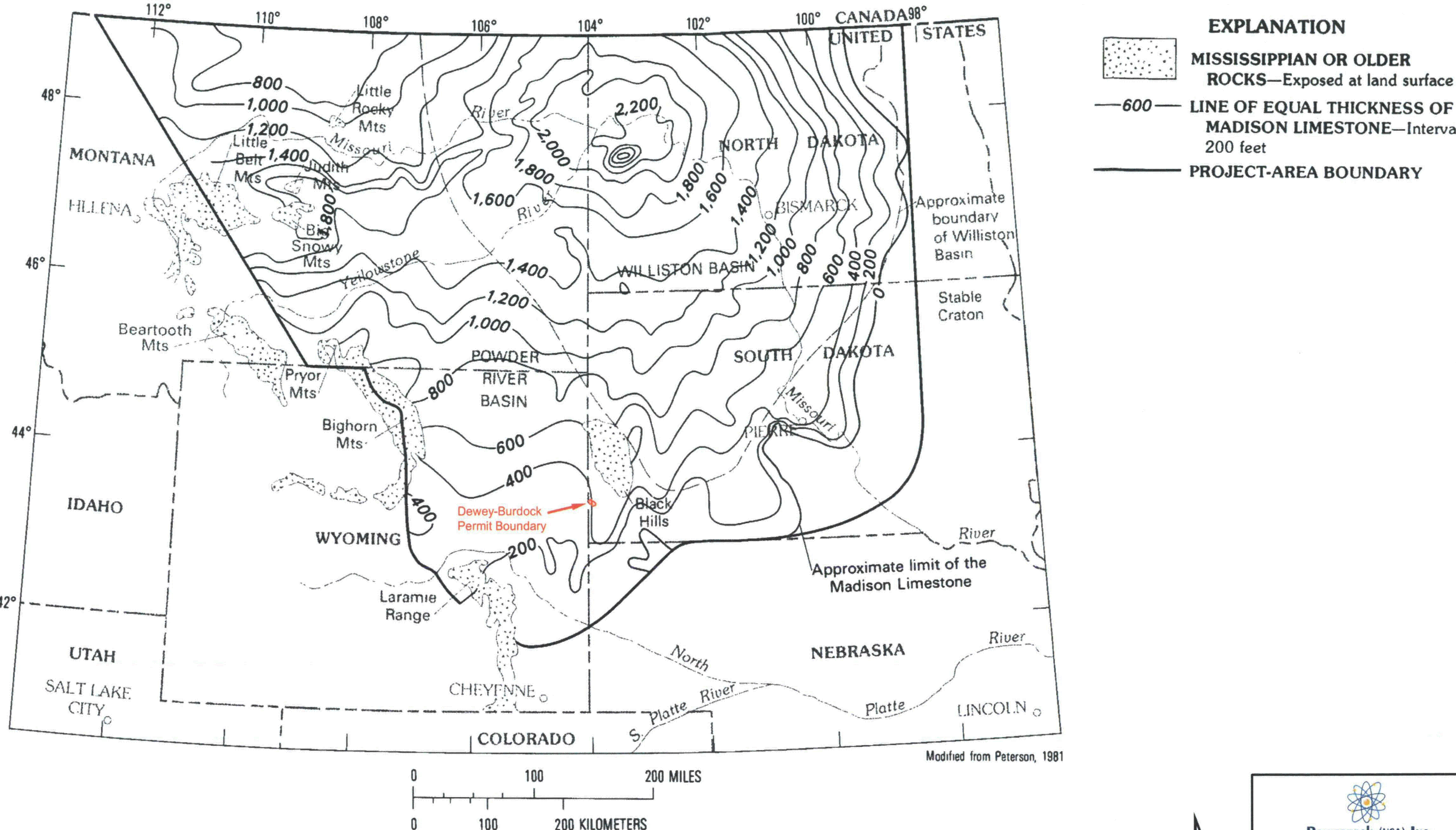

From:
USGS Professional Paper #1402 F

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Figure D-9
Isopach Map, Madison Formation
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010
2010_DB_Class_V_Fig_D-09.ai	By: JLM / Checked: HD

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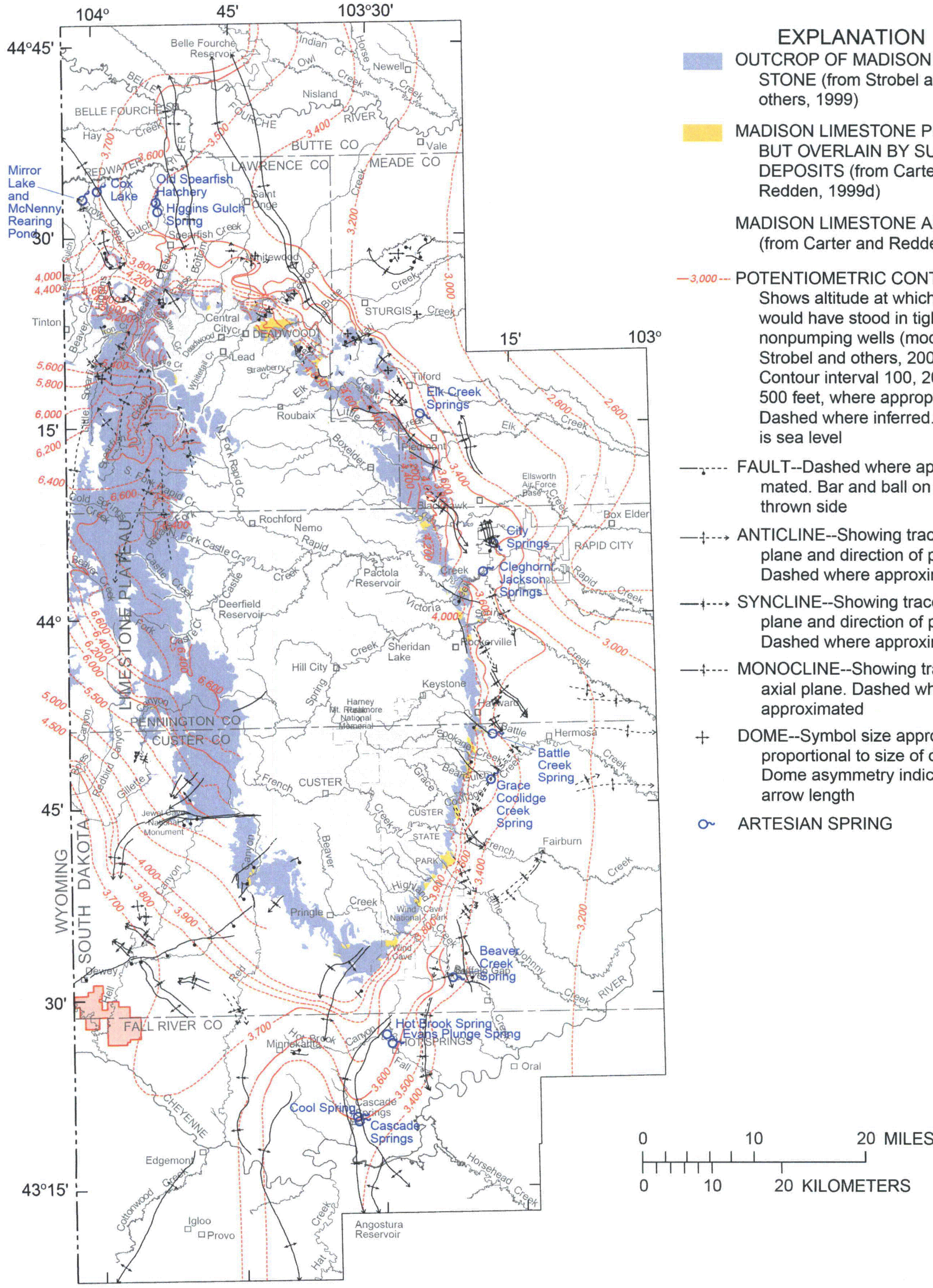

EXPLANATION

- OUTCROP OF MADISON LIMESTONE (from Strobel and others, 1999)
- MADISON LIMESTONE PRESENT, BUT OVERLAIN BY SURFICIAL DEPOSITS (from Carter and Redden, 1999d)
- MADISON LIMESTONE ABSENT (from Carter and Redden, 1999d)
- —3,000— POTENTIOMETRIC CONTOUR--Shows altitude at which water would have stood in tightly cased, nonpumping wells (modified from Strobel and others, 2000a). Contour interval 100, 200, or 500 feet, where appropriate. Dashed where inferred. Datum is sea level
- FAULT--Dashed where approximated. Bar and ball on downthrown side
- ANTICLINE--Showing trace of axial plane and direction of plunge. Dashed where approximated
- SYNCLINE--Showing trace of axial plane and direction of plunge. Dashed where approximated
- MONOCLINE--Showing trace of axial plane. Dashed where approximated
- DOME--Symbol size approximately proportional to size of dome. Dome asymmetry indicated by arrow length
- ARTESIAN SPRING

Base modified from U.S. Geological Survey digital data, 1:100,000, 1977, 1979, 1981, 1983, 1985
Rapid City, Office of City Engineer map, 1:18,000, 1996
Universal Transverse Mercator projection, zone 13

N

Legend

Dewey-Burdock Permit Boundary

From:
Water-Resources Investigations Report 02-4094
(modified by Driscoll et al., 2002)

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Figure D-10
Potentiometrc Surface of the Madison Formation and Locations of Major Artesian Springs
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-10.ai	By: JLM	Checked: HD

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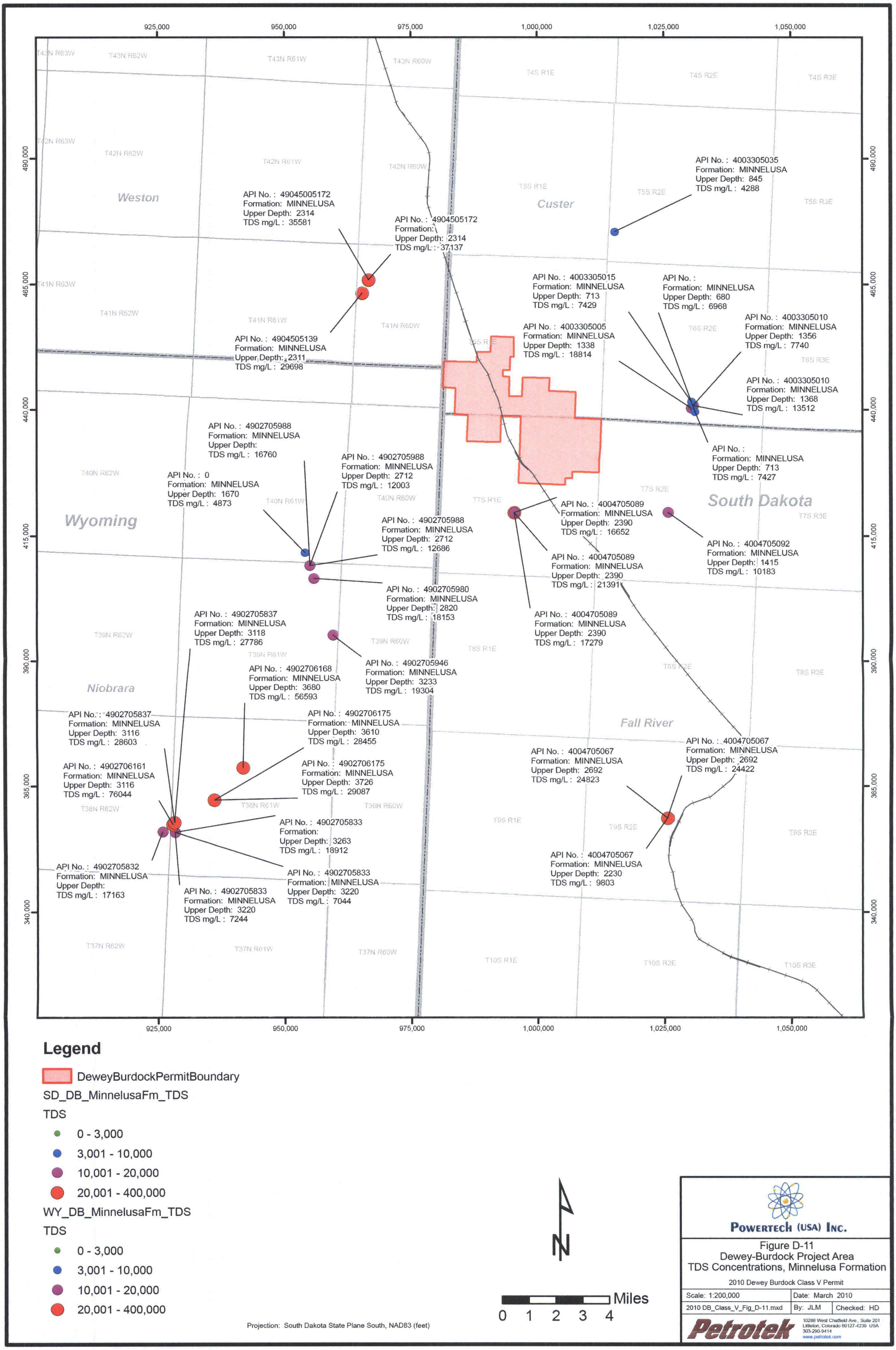

Weston
Custer
Wyoming
South Dakota
Niobrara
Fall River
API No. : 49045005172
Formation: MINNELUSA
Upper Depth: 2314
TDS mg/L : 35581
API No. : 4904505172
Formation:
Upper Depth: 2314
TDS mg/L : 37137
API No. : 4904505139
Formation: MINNELUSA
Upper Depth: 2311
TDS mg/L : 29698
API No. : 4003305035
Formation: MINNELUSA
Upper Depth: 845
TDS mg/L : 4288
API No. : 4003305015
Formation: MINNELUSA
Upper Depth: 713
TDS mg/L : 7429
API No. :
Formation: MINNELUSA
Upper Depth: 680
TDS mg/L : 6968
API No. : 4003305010
Formation: MINNELUSA
Upper Depth: 1356
TDS mg/L : 7740
API No. : 4003305005
Formation: MINNELUSA
Upper Depth: 1338
TDS mg/L : 18814
API No. : 4003305010
Formation: MINNELUSA
Upper Depth: 1368
TDS mg/L : 13512
API No. :
Formation: MINNELUSA
Upper Depth: 713
TDS mg/L : 7427
API No. : 4902705988
Formation: MINNELUSA
Upper Depth:
TDS mg/L : 16760
API No. : 4902705988
Formation: MINNELUSA
Upper Depth: 2712
TDS mg/L : 12003
API No. : 0
Formation: MINNELUSA
Upper Depth: 1670
TDS mg/L : 4873
API No. : 4902705988
Formation: MINNELUSA
Upper Depth: 2712
TDS mg/L : 12686
API No. : 4004705089
Formation: MINNELUSA
Upper Depth: 2390
TDS mg/L : 16652
API No. : 4004705092
Formation: MINNELUSA
Upper Depth: 1415
TDS mg/L : 10183
API No. : 4004705089
Formation: MINNELUSA
Upper Depth: 2390
TDS mg/L : 21391
API No. : 4902705980
Formation: MINNELUSA
Upper Depth: 2820
TDS mg/L : 18153
API No. : 4004705089
Formation: MINNELUSA
Upper Depth: 2390
TDS mg/L : 17279
API No. : 4902705837
Formation: MINNELUSA
Upper Depth: 3118
TDS mg/L : 27786
API No. : 4902705946
Formation: MINNELUSA
Upper Depth: 3233
TDS mg/L : 19304
API No. : 4902706168
Formation: MINNELUSA
Upper Depth: 3680
TDS mg/L : 56593
API No. : 4902705837
Formation: MINNELUSA
Upper Depth: 3116
TDS mg/L : 28603
API No. : 4902706175
Formation: MINNELUSA
Upper Depth: 3610
TDS mg/L : 28455
API No. : 4902706161
Formation: MINNELUSA
Upper Depth: 3116
TDS mg/L : 76044
API No. : 4902706175
Formation: MINNELUSA
Upper Depth: 3726
TDS mg/L : 29087
API No. : 4004705067
Formation: MINNELUSA
Upper Depth: 2692
TDS mg/L : 24823
API No. : 4004705067
Formation: MINNELUSA
Upper Depth: 2692
TDS mg/L : 24422
API No. : 4902705833
Formation:
Upper Depth: 3263
TDS mg/L : 18912
API No. : 4004705067
Formation: MINNELUSA
Upper Depth: 2230
TDS mg/L : 9803
API No. : 4902705832
Formation: MINNELUSA
Upper Depth:
TDS mg/L : 17163
API No. : 4902705833
Formation: MINNELUSA
Upper Depth: 3220
TDS mg/L : 7044
API No. : 4902705833
Formation: MINNELUSA
Upper Depth: 3220
TDS mg/L : 7244
925,000
950,000
975,000
1,000,000
1,025,000
1,050,000
490,000
465,000
440,000
415,000
390,000
365,000
340,000
Legend
DeweyBurdockPermitBoundary
SD_DB_MinnelusaFm_TDS
TDS
0 - 3,000
3,001 - 10,000
10,001 - 20,000
20,001 - 400,000
WY_DB_MinnelusaFm_TDS
TDS
0 - 3,000
3,001 - 10,000
10,001 - 20,000
20,001 - 400,000
N
0 1 2 3 4 Miles
Projection: South Dakota State Plane South, NAD83 (feet)
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Figure D-11
Dewey-Burdock Project Area
TDS Concentrations, Minnelusa Formation
2010 Dewey Burdock Class V Permit
Scale: 1:200,000
Date: March 2010
2010 DB_Class_V_Fig_D-11.mxd
By: JLM
Checked: HD
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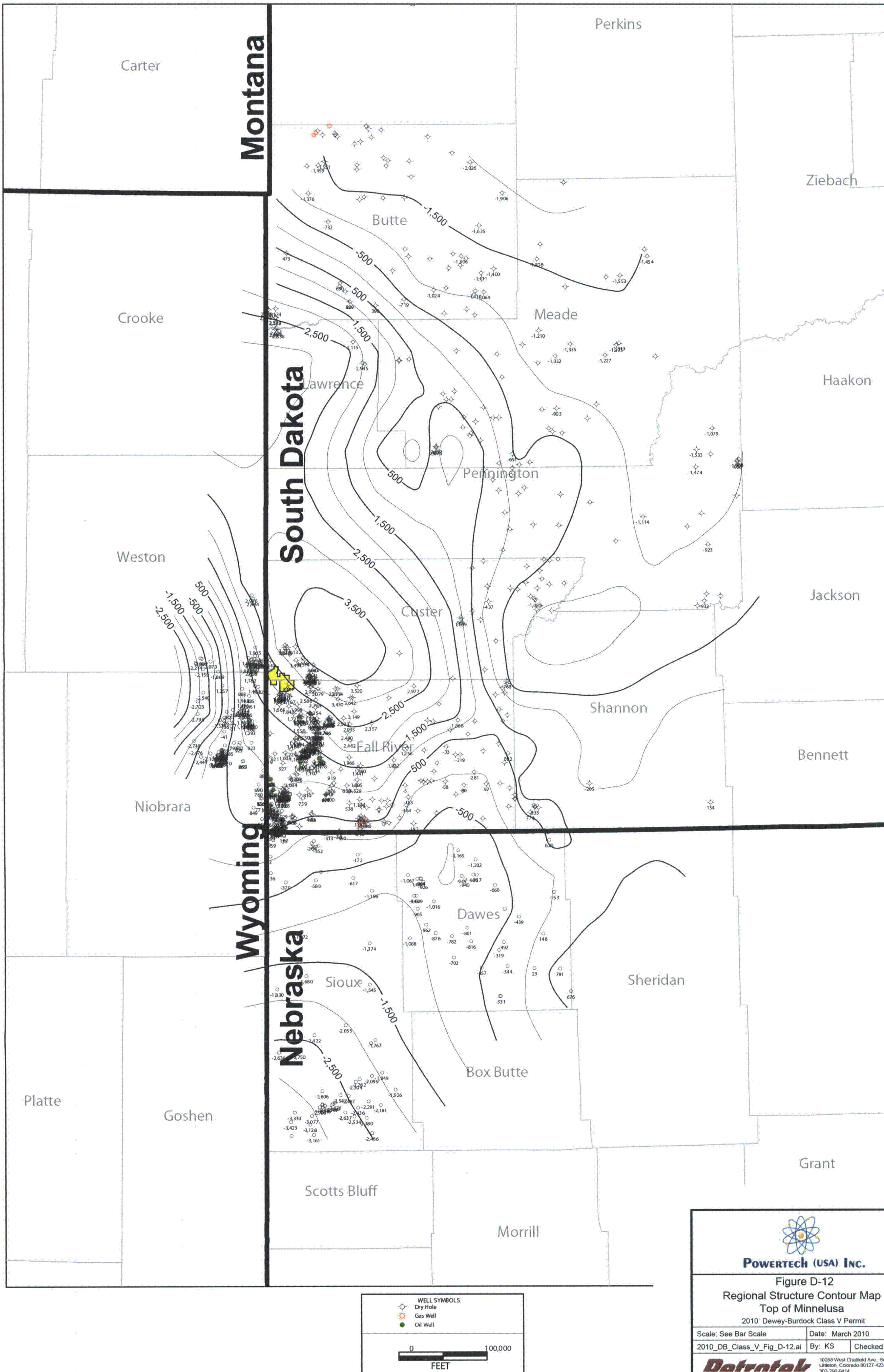

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Figure D-12
Regional Structure Contour Map
Top of Minnelusa
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-12.ai	By: KS	Checked: HD

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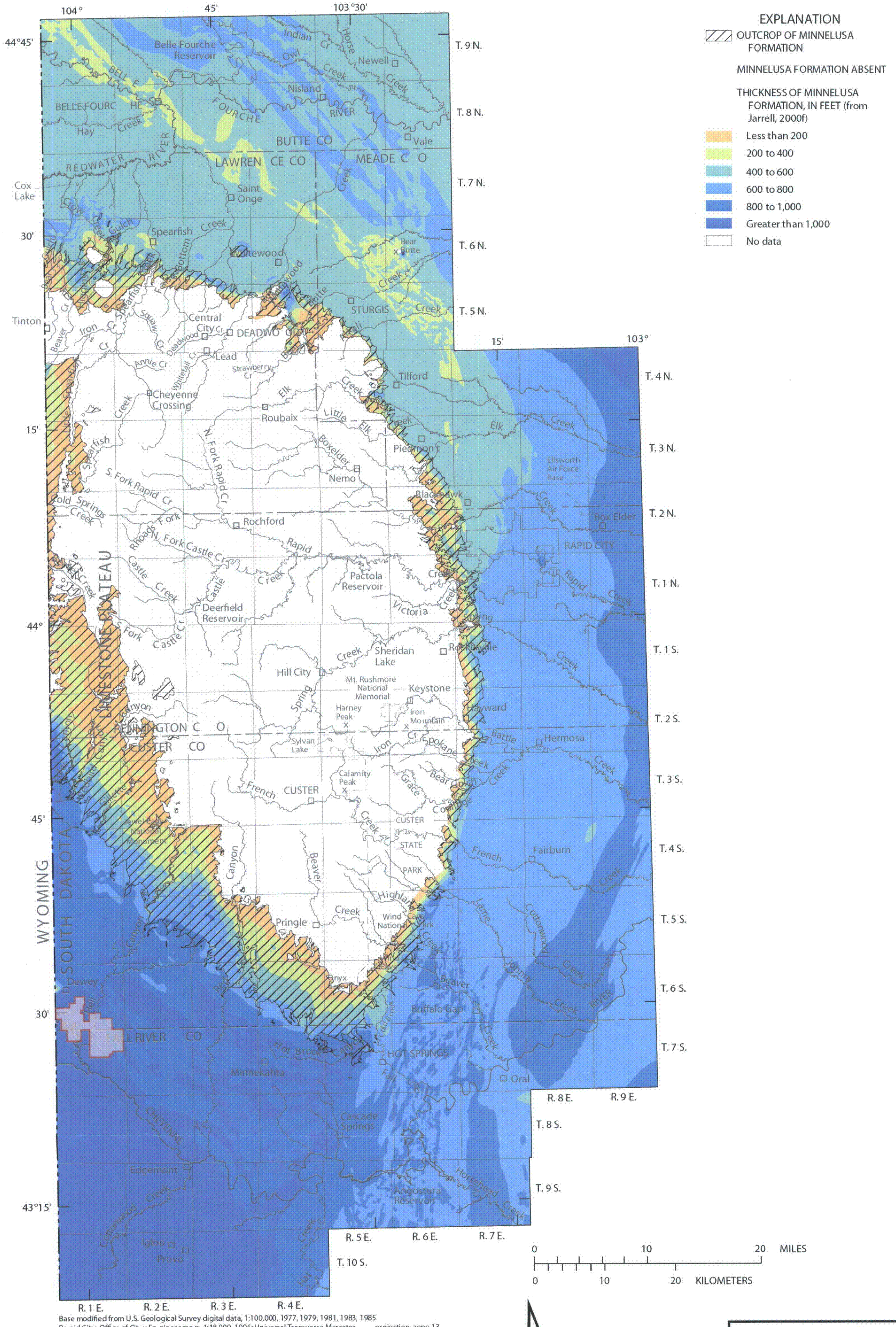

Legend

Dewey-Burdock Permit Boundary

From:
Water-Resources Investigations Report 02-4094
(modified by Driscoll et al., 2002)

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Figure D-13
Isopach Map of the Minnelusa Formation
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010
2010_DB_Class_V_Fig_D-13.ai	By: JLM / Checked: HD

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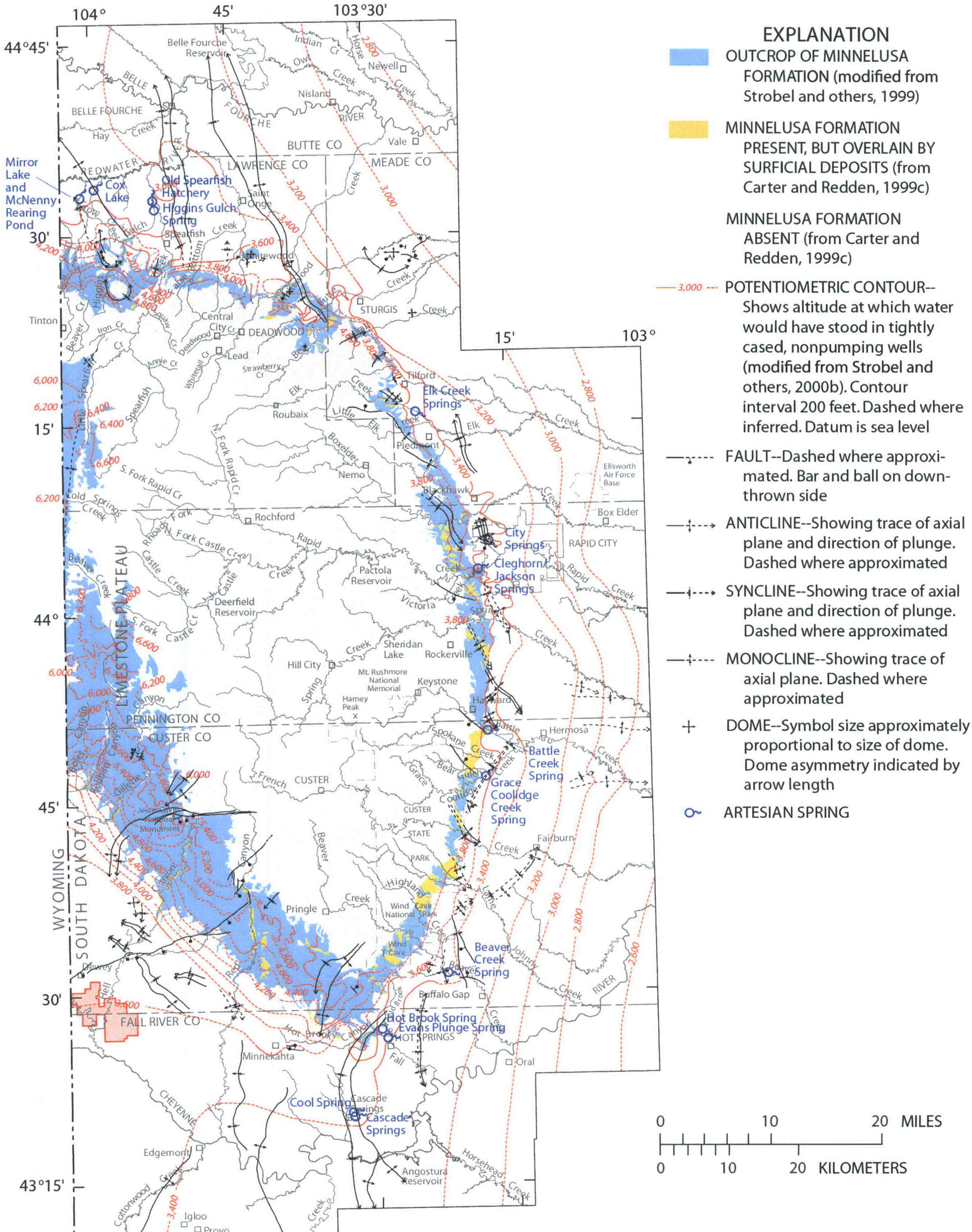

Base modified from U.S. Geological Survey digital data, 1:100,000, 1977, 1979, 1981, 1983, 1985
Rapid City, Office of City Engineer map, 1:18,000, 1996
Universal Transverse Mercator projection, zone 13

Legend

Dewey-Burdock Permit Boundary

From:
Water-Resources Investigations Report 02-4094
(modified by Driscoll et al., 2002)

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Figure D-14
Potentiometrc Surface of the Minnelusa Formation and Locations of Major Artesian Springs
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010
2010_DB_Class_V_Fig_D-14.ai	By: JLM / Checked: HD

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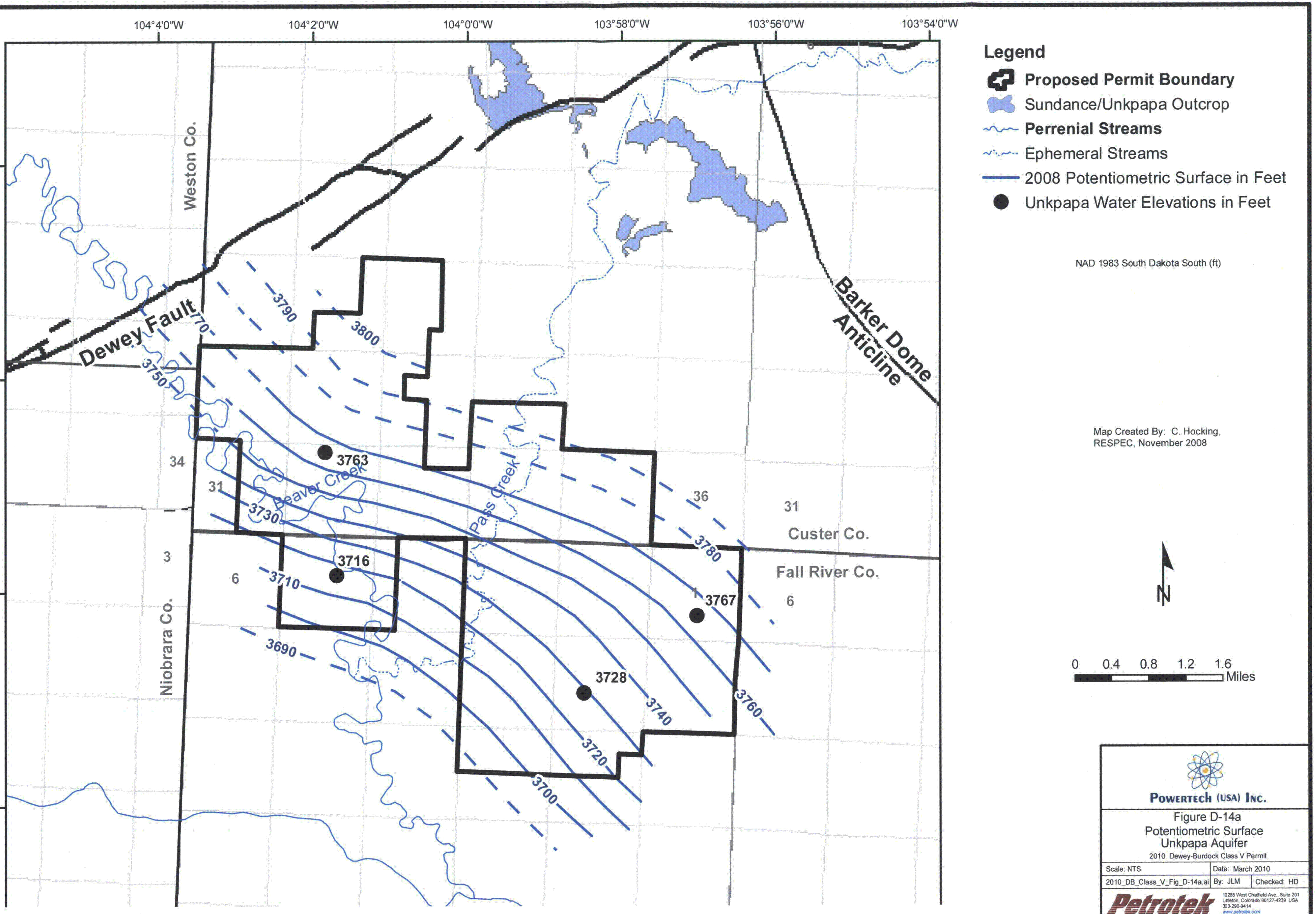

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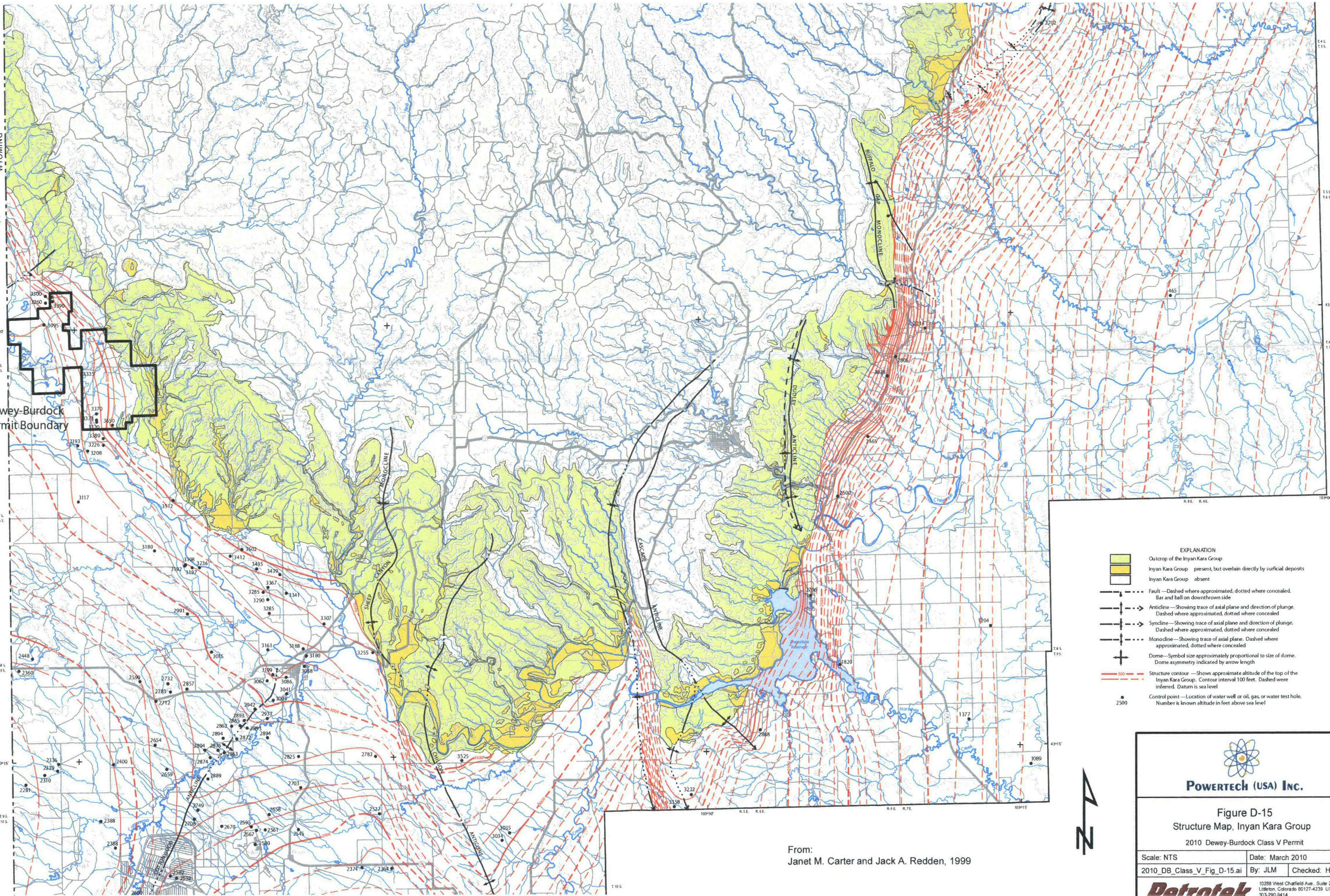
Figure D-14a
Potentiometric Surface
Unkpapa Aquifer

2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010	
2010_DB_Class_V_Fig_D-14a.ai	By: JLM	Checked: HD

Petrotek



From:
Janet M. Carter and Jack A. Redden, 1999

POWERTECH (USA) INC.

Figure D-15
Structure Map, Inyan Kara Group

2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010	
2010_DB_Class_V_Fig_D-15.ai	By: JLM	Checked: HD

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10288 West Chatfield Ave., Suite 201
Littleton, Colorado 80127-4239 USA
303-290-9414
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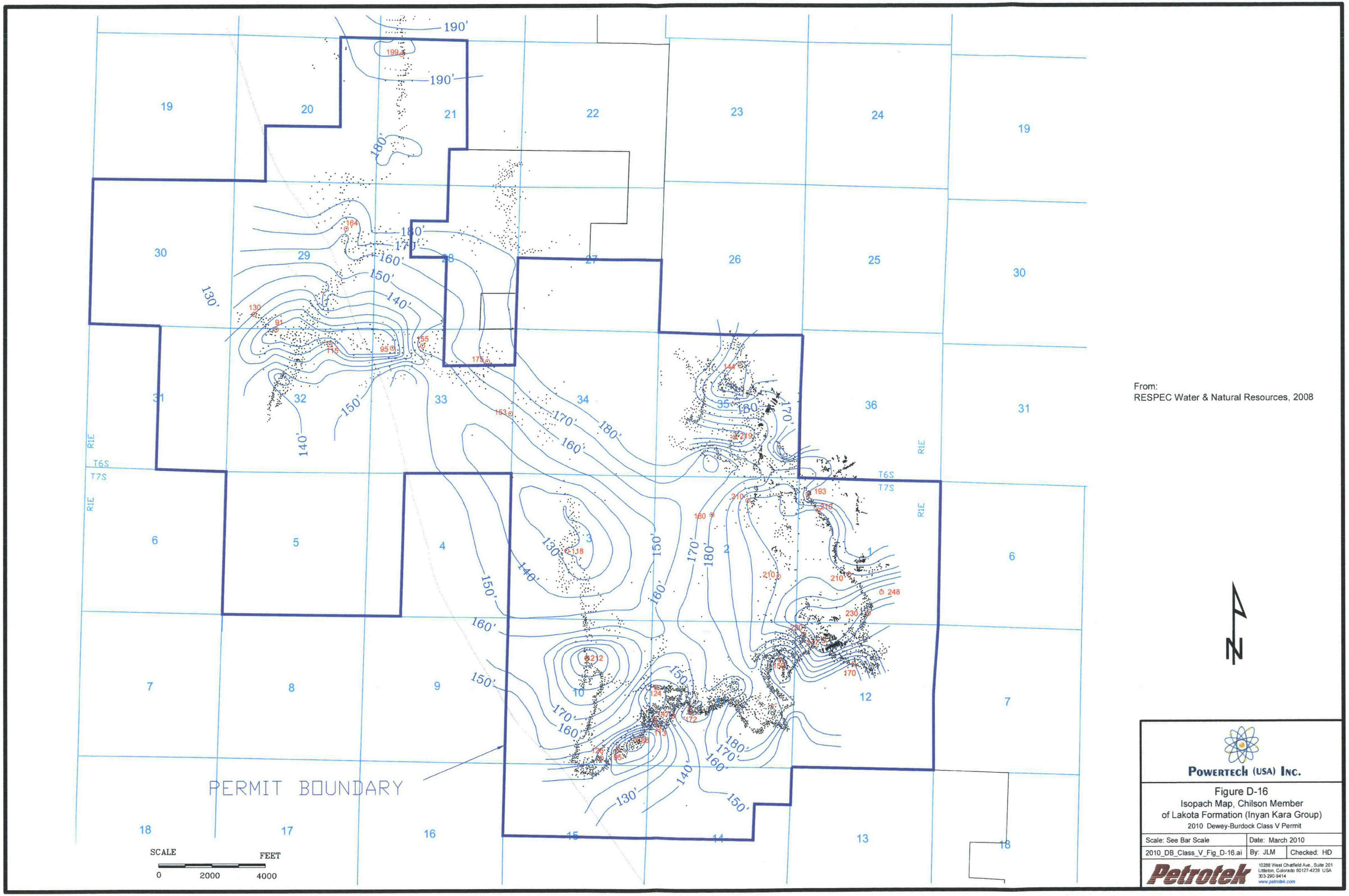

POWERTECH (USA) INC.

Figure D-16
Isopach Map, Chilson Member
of Lakota Formation (Inyan Kara Group)
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-16.ai	By: JLM	Checked: HD

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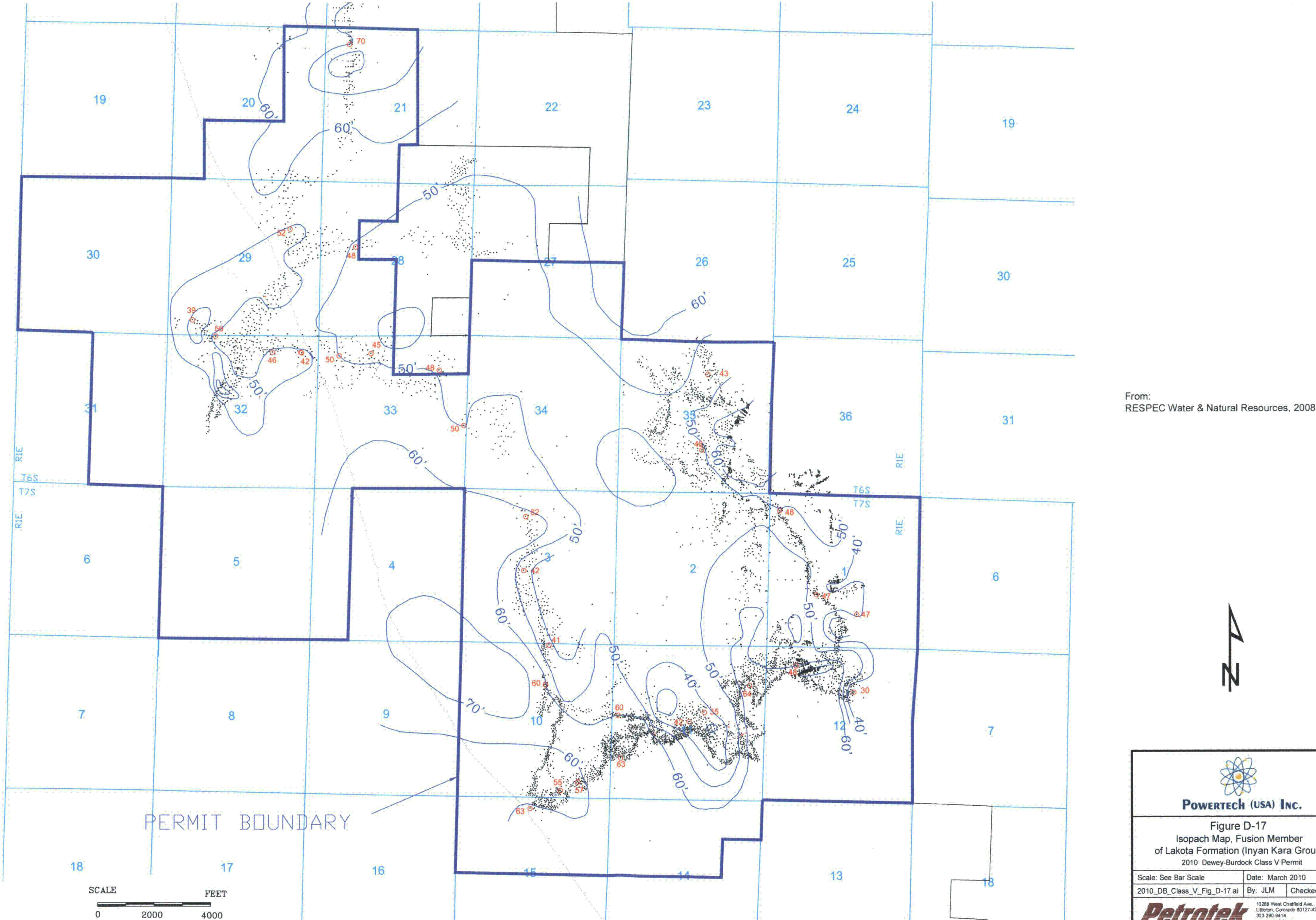

Powertech (USA) Inc.

Figure D-17
Isopach Map, Fusion Member
of Lakota Formation (Inyan Kara Group)
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010	
2010_DB_Class_V_Fig_D-17.ai	By: JLM	Checked: HD

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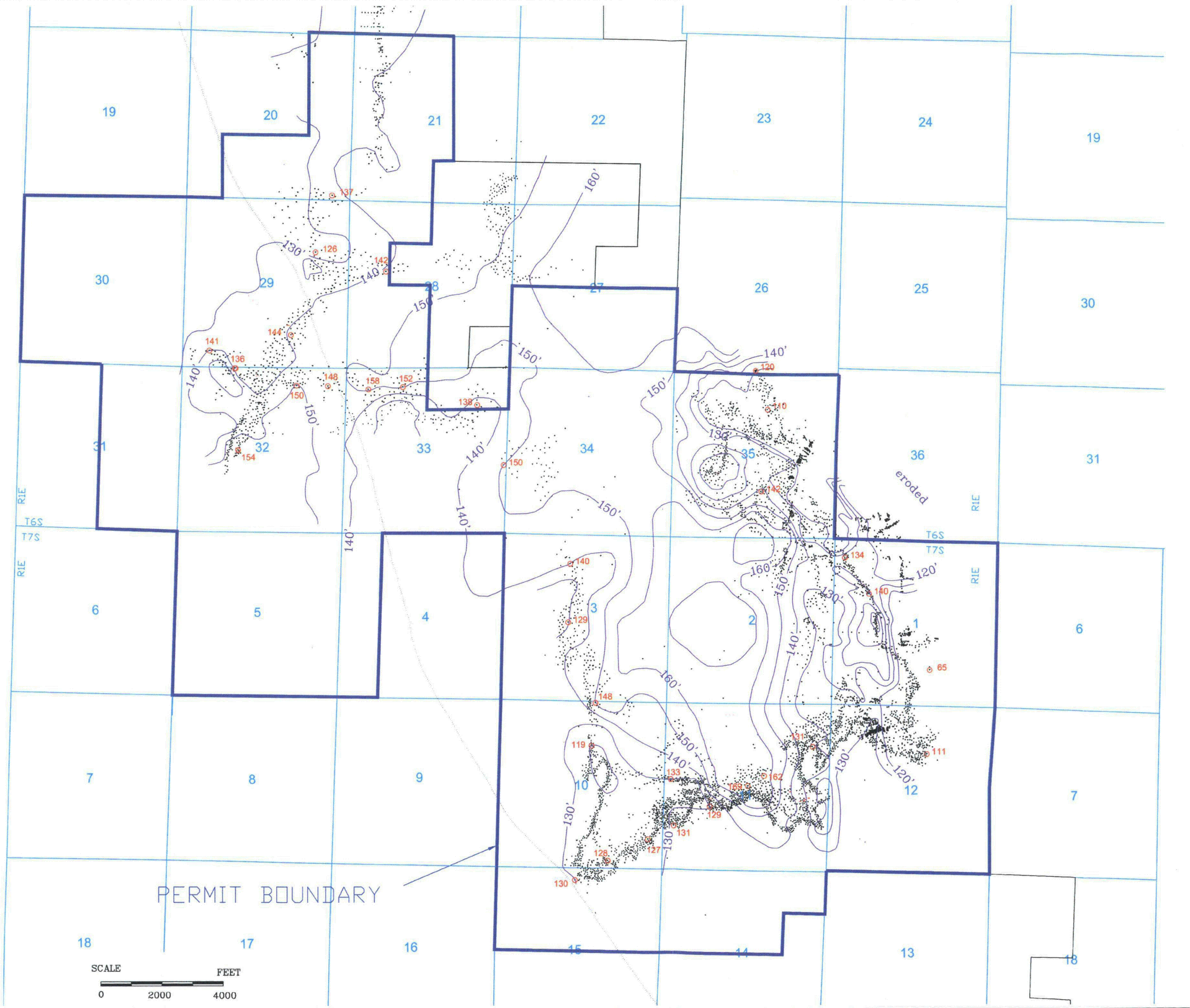

POWERTECH (USA) INC.

Figure D-18
Isopach Map, Fall River Formation
(Inyan Kara Group)
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010
2010_DB_Class_V_Fig_D-18.ai	By: JLM / Checked: HD

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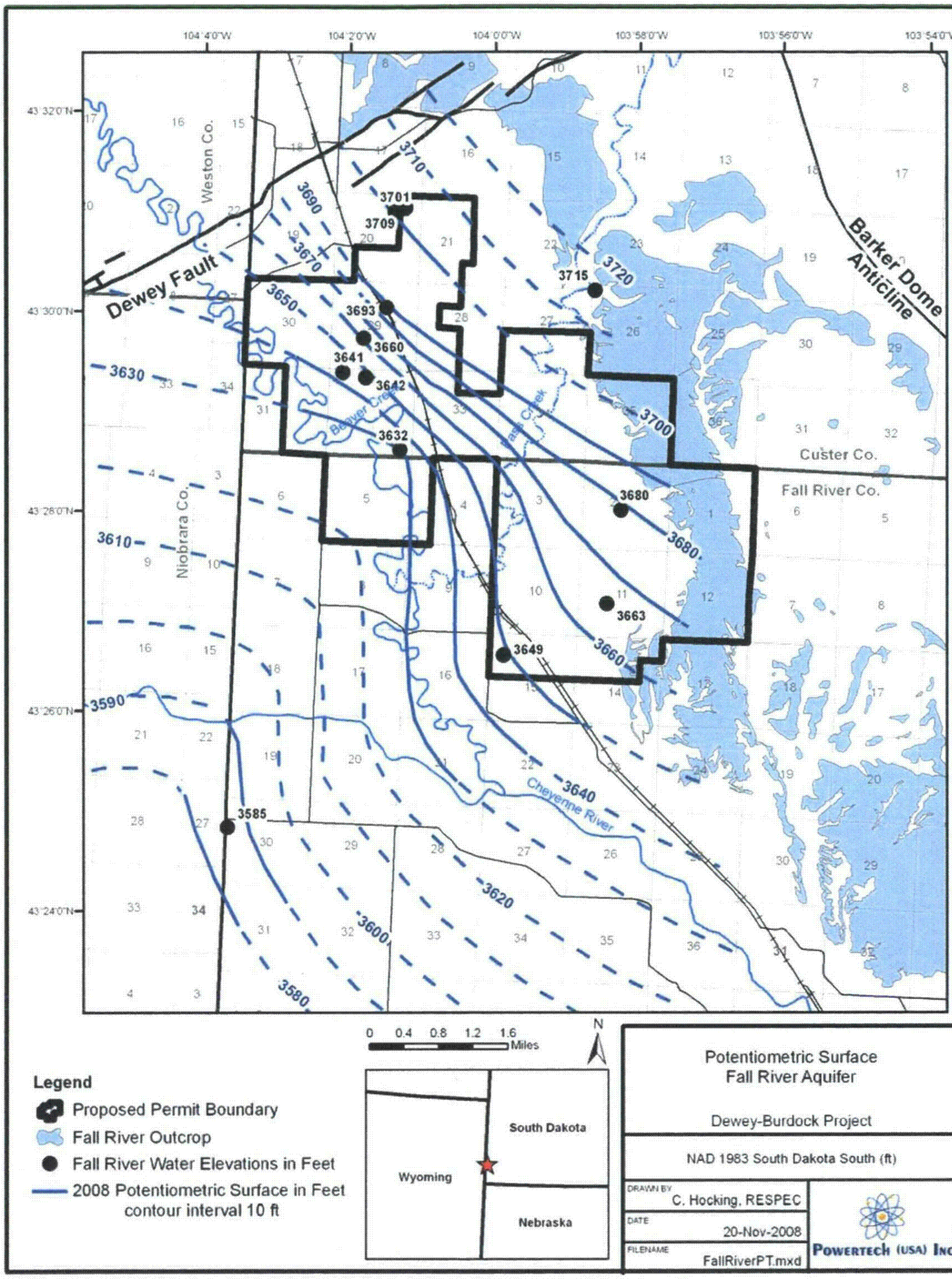

Note: Potentiometric surface based on average water level values at the project site. Contours are dashed where approximate.

Source:
2009 NRC Application
Powertech (USA) Inc.
Figure 2.7-14
RESPEC Data

POWERTECH (USA) INC.

Figure D-19
Potentiometric Surface Inyan Kara Group
(aka Fall River Aquifer)
2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010
2010_DB_Class_V_Fig_D-19.ai	By: JLM Checked: HD

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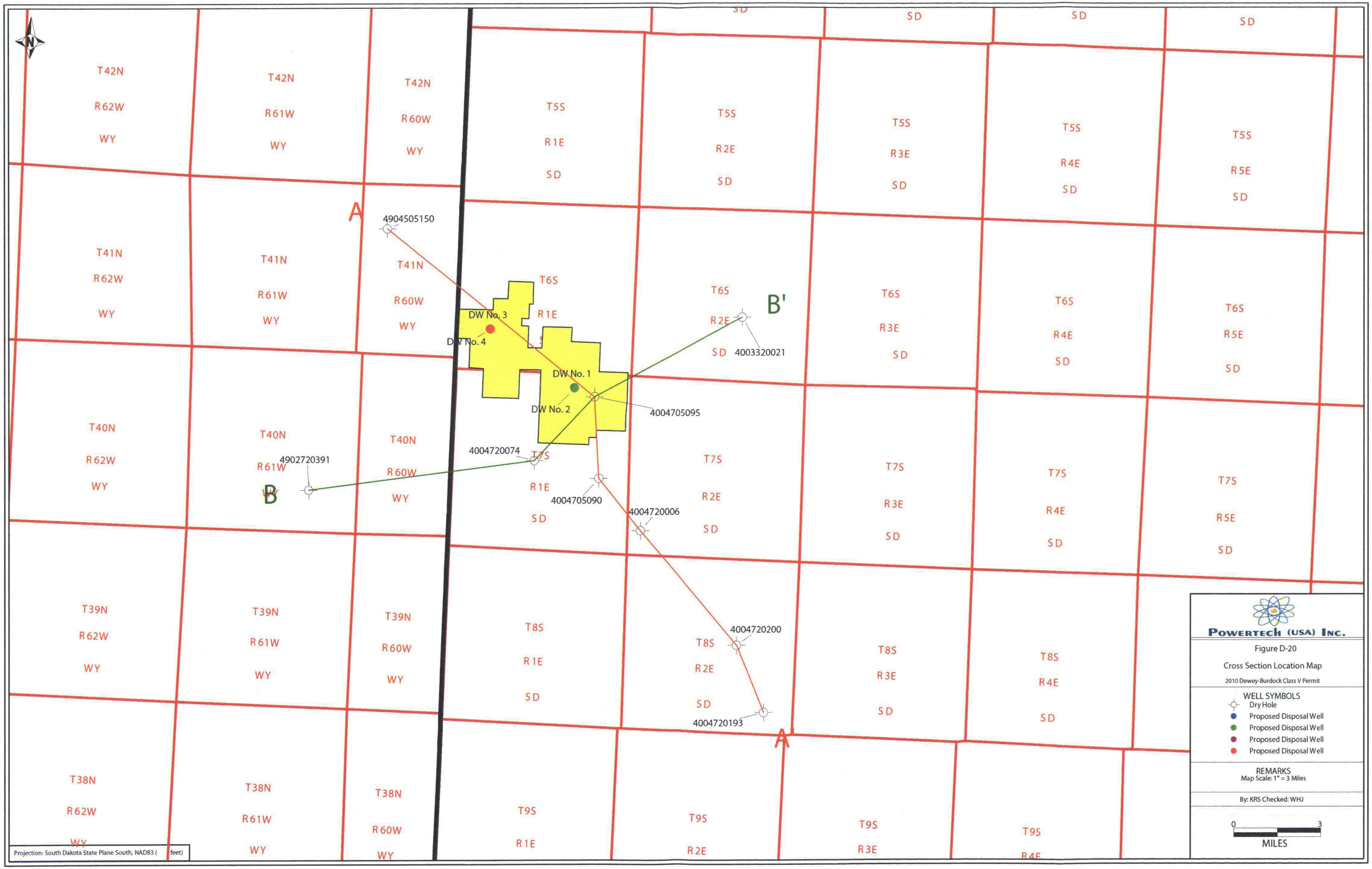
N
T42N R62W WY
T42N R61W WY
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T5S R1E SD
T5S R2E SD
T5S R3E SD
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T5S R5E SD
T41N R62W WY
T41N R61W WY
T41N R60W WY
T6S R1E SD
T6S R2E SD
T6S R3E SD
T6S R4E SD
T6S R5E SD
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T40N R61W WY
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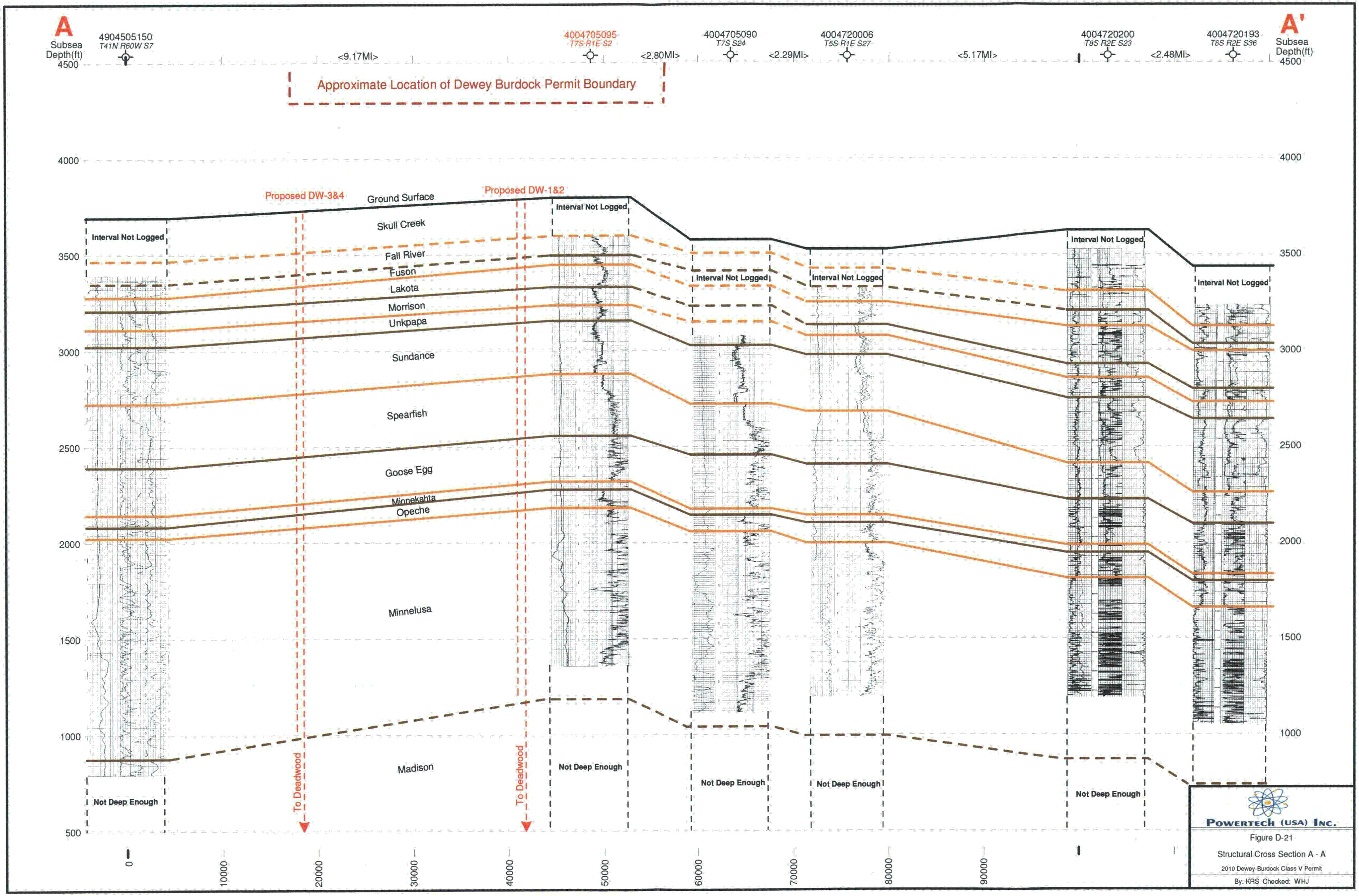
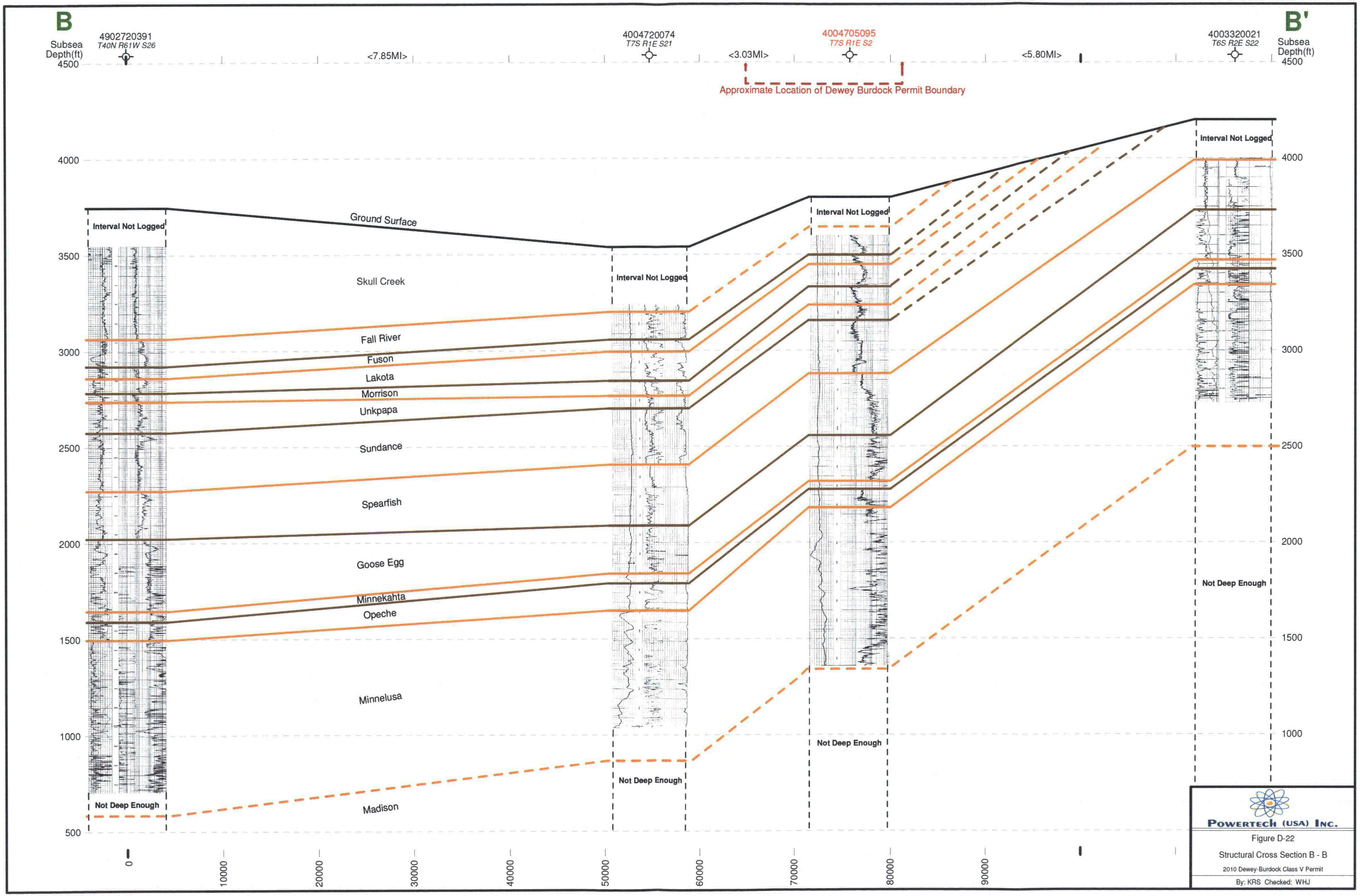
T38N R62W WY
T38N R61W WY
T38N R60W WY
T9S R1E
T9S R2E
T9S R3E
T9S
A
4904505150
DW No. 3
DW No. 4
DW No. 1
DW No. 2
B'
4003320021
4004705095
4004720074
4902720391
B
4004705090
4004720006
4004720200
4004720193
A
Powertech (USA) Inc.
Figure D-20
Cross Section Location Map
2010 Dewey-Burdock Class V Permit
WELL SYMBOLS
Dry Hole
Proposed Disposal Well
Proposed Disposal Well
Proposed Disposal Well
Proposed Disposal Well
REMARKS
Map Scale: 1" = 3 Miles
By: KRS Checked: WHJ
0
3
MILES
Projection: South Dakota State Plane South, NAD83 (feet)



POWERTECH (USA) INC.
Figure D-21
Structural Cross Section A - A
2010 Dewey-Burdock Class V Permit
By: KRS Checked: WHJ



Powertech (USA) Inc.

Figure D-22

Structural Cross Section B - B

2010 Dewey-Burdock Class V Permit

By: KRS Checked: WHJ

E

2.E NAME AND DEPTH OF USDWs

For Class II Wells (Not Applicable to this Application)

2.F MAPS AND CROSS SECTIONS OF GEOLOGIC STRUCTURE

Submit maps and cross sections detailing the geologic structure of the local area (including the lithology of injection and confining intervals) and generalized maps and cross sections illustrating the regional geologic setting.

RESPONSE

Regional Setting

The Dewey-Burdock Project area is located on the southwestern flanks of the Black Hills Uplift. As shown on Figure F-1, the Black Hills are within the Great Plains physiographic province. A generalized geologic cross-section through the Black Hills is included as Figure D-2.

The Black Hills area of South Dakota and Wyoming is the principal recharge area for the regional bedrock aquifer systems and strongly influences the hydrology of western South Dakota and northeastern Wyoming. Because of its higher elevation, the Black Hills area receives greater precipitation than the surrounding areas. The average annual precipitation increases from 16 to 17 inches in the Dewey-Burdock area to greater than 28 inches in the northern Black Hills near the town of Lead. Many streams in western South Dakota originate in the Black Hills.

Geologic Setting

The present-day structural features of the Northern Great Plains are directly related to the geologic history of the Cordilleran platform, which is a part of the stable interior of the North American Continent. The present-day structure probably was controlled by the pre-existing structural grain in the Precambrian basement and modified during the Laramide orogeny (Downey, 1984).

During Paleozoic time, the area generally was a broad, flat plain, covered by shallow warm seas. Numerous disconformities during Paleozoic time indicate intermittent transgressions and regressions when seas advanced from west to east in response to tectonic activity. Deposits generally were beach, shallow marine, carbonate, and evaporite units (Redden and Lisenbee, 1996).

During Cretaceous time, the area was covered by a north-south trending sea, which extended from the Gulf of Mexico to the Arctic Ocean (Downey, 1986). During Late Cretaceous time, this sea was at its widest extent; marine deposition, however, was interrupted by frequent east-west regressions (Anna, 1986).

The Northern Great Plains area was part of the Cordilleran platform through most of Paleozoic time. The Williston Basin, which covers parts of North Dakota, South Dakota, southern Saskatchewan, southwestern Manitoba, and eastern Montana, began to take shape during Ordovician time. Other major Jurassic and Cretaceous (pre-Laramide) paleostructural elements include the Powder River Basin, the Central Montana trough and uplift, the Cedar Creek anticline, and the Alberta shelf (Anna, 1986) (Figure F-1).

The Laramide orogeny, which affected the eastern Rocky Mountains, began during Late Cretaceous time and continued in the Eocene period (Redden and Lisenbee, 1996). The Laramide orogeny was characterized by large-scale warping, deep erosion of uplifts and deposition of orogenic sediments in the major basins (Tweto, 1975). Most, if not all, pre-Laramide structural features were reactivated and became more prominent during the Laramide orogeny (Anna, 1986). During the Laramide orogeny, the Bighorn and Laramie Mountains, the Black Hills, and the Central

Montana uplifts formed, and the Williston and Powder River Basins were downwarped into essentially their present configuration (Anna, 1986).

The Black Hills Uplift forms a northwest trending dome about 125 miles long by 60 miles wide. The formation of the uplift deformed the entire sedimentary sequence from Cambrian to late Cretaceous. Subsequent erosion of the dome has exposed the rock units which dip radially outward in successive elliptical outcrops surrounding the central Precambrian granitic core. Differential weathering has further resulted in the present day topography of concentric ellipsoids of valleys under softer rocks and ridges held up by more competent units (R.B. Smith & Assoc., Inc., 2005).

Superimposed on the Black Hills Uplift are numerous folds plunging radially outward. Local structures of this type include the Chilson Anticline and Sheep Canyon Monocline east of the community of Edgemont, and the Cottonwood Creek Anticline trending southwest from the community of Edgemont (Figures D-8 and D-15).

Two major structural zones, Dewey and Long Mountain, are conspicuous within the project area and consist principally of a series of en echelon faults. The Barker Dome Anticline, which forms a productive oil field in the Minnelusa, is located approximately 3 miles to the northeast of the Project (Figure D-19).

As noted, the uranium mineralization within the Dewey-Burdock deposit occurs in the Lower Cretaceous Fall River and Lakota Formations as a classic roll front deposit.

Topography and Elevation

In the southern and western portion of the Dewey-Burdock Project area, the terrain is undulating to moderately incised. The eastern and northern portions of the project area, being further into the uplift, are cut by narrow canyons. Only four or five significant drainages likely exist within the project area (R.B. Smith & Assoc., Inc., 2005).

The change in elevation across the project area is approximately 200 feet. The lower elevation of 3,600 feet above mean sea level (amsl) occurs on the south and west sides of the project area; the highest elevation of approximately 3,800 feet amsl is in the northeast portion.

Stratigraphy

The geologic section in the southwestern portion of South Dakota is shown in Table F-1 and described in the following sections from oldest to youngest rocks. Note that rocks deposited after the Skull Creek Shale are not generally present in the Dewey-Burdock Project area. Specific details regarding the geologic column are provided here from deepest (oldest) to surface.

Precambrian

Precambrian rocks form the basement in the northern Great Plains and are exposed in the central core of many of the mountain ranges including the Black Hills Uplift, but lie greater than 15,000 feet below land surface at the center of the Williston Basin to the north of the Black Hills.

The oldest stratigraphic units in the Dewey-Burdock project area are Precambrian igneous and metamorphic rocks, composed primarily of metasediments, including schists and graywackes. The Precambrian rock surface was eroded to a gentle undulating plain at the beginning of the Paleozoic Era and the overlying Paleozoic and Mesozoic strata were deposited on the Precambrian surface as nearly horizontal beds. Subsequent uplift during the Laramide orogeny and erosion have exposed the Precambrian rocks in the central core of the Black Hills, with the Paleozoic and Mesozoic sedimentary rocks, as noted, exposed in roughly concentric rings around the uplifted Precambrian core (Driscoll et al., 2002). The Precambrian basement forms the lower confinement below the Deadwood Formation.

Deadwood Formation (Cambrian)

The Cambrian-age Deadwood Formation consists of massive to thinly-bedded, brown to light-gray sandstone; greenish glauconitic shale; flaggy dolomite; and flat-pebble limestone conglomerate. Sandstone with conglomerate occurs locally at the base of the formation. Regionally, the Deadwood ranges in thickness from 0 to 500 feet (Carter et al., 2003). Locally the Deadwood is estimated to be approximately 100' thick (Figure A-4) and has approximately 85' of 11% porosity. Limited data are available, and no wells penetrate to basement through the Cambrian section on site.

In the northern and central Black Hills, the Deadwood Formation is disconformably overlain by Ordovician rocks, which include the Whitewood and Winnipeg Formations. The Winnipeg Formation is absent in the southern Black Hills and the Whitewood Formation has been eroded and is not present south of Rapid City. In the southern Black Hills, the Deadwood Formation is unconformably overlain by the Devonian- and Mississippian-age Englewood Formation, which in turn, is overlain by the Madison Limestone (Driscoll et al., 2002).

Winnipeg and Whitewood (Red River) Formations (Ordovician)

As noted, the Ordovician Winnipeg and Whitewood (Red River) Formations are absent in the Dewey-Burdock Project area. Elsewhere these formations consist of green shale with siltstone (Carter et al., 2003).

Englewood Formation (Devonian - Mississippian)

The Englewood Formation consists of pink to buff limestone with shale at its base and ranges from about 30 to 60 feet thick (Carter et al., 2003). Locally, the Englewood is projected to be approximately 34' thick and is the upper confining layer above the Deadwood Formation (Figure A-4).

Madison (Pahasapa) Limestone (Mississippian)

The Mississippian-age Madison Limestone consists of a sequence of marine carbonates and evaporites deposited mainly in a shallow, warm-water environment. It is a massive, gray to buff limestone, and locally dolomitic. The Madison Limestone was exposed at land surface for approximately 50 million years. During this period, significant erosion, soil development, and karstification occurred, resulting in the formation of numerous caves and fractures within the upper part of the formation. The thickness of the Madison increases from south to north in the Black Hills area and ranges from almost zero on the southeastern flank of the Black Hills Uplift to 1,000 feet of thickness east of Belle Fourche. Locally, the Madison is approximately 295' thick (Figure A-4). Because the Madison Limestone was exposed to erosion and karstification for millions of years, its contact with the overlying Minnelusa Formation is unconformable. Collapse features within the Madison and Minnelusa Formations may hydraulically interconnect the two formations (Driscoll et al., 2002) at some locations near the outcrop of the Black Hills. However, local data suggest that these two formations are hydrologically isolated in the Project area.

Minnelusa Formation (Permian - Pennsylvanian)

The Pennsylvanian- and Permian-age Minnelusa Formation consists of yellow to red, cross-stratified sandstone, limestone, dolomite, and shale. The middle and lower parts of the formation consists of shale and anhydrite. The upper portion of the Minnelusa may also contain anhydrite, which generally has been removed by dissolution in or near the outcrop areas, occasionally forming collapse features filled with breccia.

The Minnelusa Formation was deposited in a coastal environment; dune structures at the top of the formation may represent beach sediments. The thickness of the Minnelusa increases from north to south and ranges from 375 feet near Belle Fourche to 1,175 feet near Edgemont. In the northeastern part of the central Black Hills, little anhydrite occurs in the subsurface due to a change in depositional environment. On the south and southwest sides of the Black Hills Uplift, the thickness of clastic units increases and a thick section of anhydrite occurs. In the southern Black Hills, the upper part of the Minnelusa Formation is disconformably overlain by the Permian-age Opeche Shale, which, in turn, is overlain by the Minnekahta Limestone (Driscoll et al., 2002; Carter et al., 2003).

Locally, the Minnelusa is 1,150' thick. The upper portion of the formation has three lobes that total approximately 164' of 21% porosity. The lower 560' appear to have relatively lower porosity and serve as lower confinement (Figure A-3).

Opeche Shale (Permian)

The Opeche Shale consists of red shale and sandstone and ranges in thickness from 25 to 150 feet (Carter et al., 2003). Locally, the Opeche Shale is approximately 95' thick (Figure A-2) and forms the upper confinement above the Minnelusa.

Minnekahta Limestone (Permian)

The Permian-age Minnekahta Limestone is a thin to medium-bedded, fine-grained, purple to gray laminated limestone, which ranges in thickness from 25 to 65 feet. The Minnekahta is overlain by the Spearfish Formation of Triassic- and Permian-age (Driscoll et al., 2002). Locally, the Minnekahta is approximately 40' thick (Figure A-2).

Spearfish Formation (Triassic/Permian)

The Spearfish Formation consists of red silty shale, soft red sandstone, and siltstone with gypsum and thin limestone layers near its base and ranges from about 375 to 800 feet thick (Carter et al., 2003). Locally, the Spearfish is approximately 320' thick (Figure A-2).

Gypsum Springs Formation (Jurassic)

The Gypsum Springs Formation of Jurassic age consists of red siltstone, gypsum, and limestone and is 0 to 45 feet thick (Carter et al., 2003).

Unkpapa/Sundance Formation

Some authors differentiate geologically between the Unkpapa and Sundance Formations, but they are thought to be connected hydrogeologically. As such, they are referenced as one formation elsewhere in this document in regard to hydrogeology and discussion of the lowermost USDW locally.

Sundance Formation (Jurassic)

The Sundance Formation consists of greenish gray shale with thin limestone lenses; glauconitic sandstone, with red sandstone near the middle of the formation. The Sundance ranges from 250 to 450 feet thick (Carter et al., 2003). Locally, the Sundance is approximately 280' thick (Figure A-2).

Unkpapa Sandstone (Jurassic)

The Unkpapa Sandstone is a massive fine-grained sandstone, 0 to 225 feet thick (Carter et al., 2003). Locally, the Unkpapa is approximately 80' thick (Figure A-2).

Morrison Formation (Jurassic)

The Morrison Formation ranges from 0 to 220 feet thick and consists of green to maroon shale with thin sandstone beds (Carter et al., 2003). Locally, the Morrison is approximately 135' thick (Figure A-2).

Inyan Kara Group (Cretaceous)

The Inyan Kara Group includes the Lakota and Fall River Formations. In aggregate, the Inyan Kara Group ranges from 135 to 900 feet thick in the Black Hills area (Driscoll et al., 2002) and is the host rock for the uranium mineralization in the Dewey-Burdock Project area. Locally, the Inyan Kara is approximately 235' thick (Figures D-16 – D-18).

The basal Lakota Formation consists of yellow, brown, and reddish-brown, massive to thinly bedded sandstone, pebble conglomerate, siltstone, and claystone of fluvial origin. Locally, the formation contains fine-grained limestone and coal and ranges in thickness from 35 to 700 feet (Carter et al., 2003). The basal Chilson Member of the Lakota Formation is a fluvial sequence which grades upward into marginal marine sediments. The upper Fuson Member of the Lakota Formation is composed of shale with minor beds of fine-grained sandstone and siltstone.

The overlying Fall River Formation consists of massive to thin-bedded, brown to reddish-brown sandstone, 10 to 200 feet thick. The formation is thinly bedded at the top and massive at the bottom (Carter et al., 2003).

Graneros Group (Cretaceous)

The Graneros Group includes the Skull Creek Shale, Muddy/Newcastle Sandstone, Mowry Shale, and Belle Fourche Shale, which outcrop as a series of concentric rings outward from the Precambrian core of the Black Hills uplift. The Skull Creek Shale consists of dark-gray to black siliceous shale, 150 to 270 feet thick (Carter et al., 2003).The Muddy/Newcastle Sandstone is a brown to light-yellow and white sandstone, 0 to 150 feet thick (Carter et al., 2003) and is present regionally but not over the project area. The Newcastle Sandstone is not present over the project area. The Mowry Shale is a light-gray siliceous shale with fish scales and thin layers of bentonite, and ranges from 125 to 230 feet thick (Carter et al., 2003).The Belle Fourche Shale is a gray shale with scattered limestone concretions and clay-spur bentonite at the base and is approximately 150 to 850 feet thick (Carter et al., 2003). Locally, the Skull Creek and Mowry are present and range in thickness from approximately 60' to 525' across the Dewey-Burdock Project area. The Graneros Group is bedrock regionally; some limited alluvium is found along drainages.

Regional Structure

As described previously, the Black Hills Uplift is a dome structure with the rock units dipping outward, away from the central core. In detail, subsequent and attendant local doming caused by local intrusions disrupts the general dip of the units. Tensional stress created fault zones with considerable displacement from one side of the zone to the other, often a distance of three or four miles. The Dewey fault zone is a zone of major displacement. The faulting drops the uranium host units of the Inyan Kara several hundred feet where the oxidation reduction contact that formed the Dewey-Burdock mineralization is terminated (R.B. Smith & Assoc., Inc., 2005). Some authors (Carter et al., 1999, Figure D-8) show this fault continuing to depth. However, others (SDGS, Figure F-2) do not show deep displacement. In addition, there is little if any displacement shown on the Minnelusa structure contour map (Figure D-12). Even if some offset is present at the Minnelusa depth, this fault system is far enough from the proposed wells such that the impact of the fault on reservoir behavior is considered minimal.

Table F-1 presents a USGS stratigraphic column in the Black Hills area. Table F-2 presents a listing of projected depths (BGS) to top of major formations below the Dewey-Burdock Disposal Wells sites, based on tops and thicknesses determined from the Type Logs (#1 West Mule Creek [T39N, R61W, Section 2], the Sun Lance- Nelson Estate #1 [T7S, R1E, Section 21], the Earl Darrow #1 Well [T7S R1E, Section 2]), and uranium exploration wells across the project area.

Note that all depths are projections based on regional data, and may vary from site-specific conditions. Therefore, actual formation top depths below ground surface may vary from those presented in Table F-2 and will be evaluated during well installation and testing.

This permit application requests injection into two zones: the Deadwood and granite wash (if present) and the Minnelusa. It is anticipated that each injection zone will be accessed via a separate well.

Precambrian and Cambrian Units (Lower Confining Zone and Injection Zone)

<u>Precambrian</u>

The oldest stratigraphic units in the Dewey-Burdock project area are the Precambrian igneous and metamorphic rocks, composed primarily of metasediments, including schists and graywackes. The Precambrian rock surface was eroded to a gentle undulating plain at the beginning of the Paleozoic Era and the overlying Paleozoic and Mesozoic strata were deposited on the Precambrian surface as nearly horizontal beds. Subsequent uplift during the Laramide orogeny and erosion exposed the Precambrian rocks in the central core of the Black Hills, with the Paleozoic and Mesozoic sedimentary rocks, as noted, exposed in roughly concentric rings around the uplifted Precambrian core (Driscoll et al., 2002). The Precambrian basement is estimated to occur at about 3,195' (Site 1) – 3,530' (Site 2) below ground surface at the Dewey-Burdock Disposal Well sites, and would serve as a lower confining zone. A structure contour map of the Precambrian is included as Figure F-2.

<u>Cambrian</u>

The Cambrian-age Deadwood Formation consists of massive to thinly-bedded, brown to light-gray sandstone; greenish glauconitic shale; flaggy dolomite; and flat-pebble limestone conglomerate. Sandstone with conglomerate occurs locally at the base of the formation. The Deadwood, along with the granite wash below should it be present, is the proposed Injection Zone for DW Nos. 2 and 4. It is expected to be approximately 100' thick below the Dewey-Burdock Project and is expected to occur at about 3,095' below Site 1 and 3,430' below Site 2. Injection would occur from approximately 3,100' - 3,195' at Site 1 and 3,435' - 3,530' at Site 2 (Figures M-2 and M-4). Based on Type Log #3, the effective porosity of the Deadwood is estimated to be approximately 85' thick at about 11% porosity (Figure A-4). Due to the fact that there are little local data available for the Deadwood, the assumed formation parameters and estimated depths and thicknesses will be confirmed during the drilling of DW No. 1. A regional isopach map of the Deadwood is included as Figure D-5.

Devonian - Mississippian Unit (Upper Confining Zone)

The Englewood Formation consists of pink to buff limestone with shale at its base and ranges from about 30 to 60 feet thick (Carter et al., 2003). The Englewood is estimated to occur from 3,060' – 3,095' below Site 1 and 3,395' – 3,430' below Site 2. As shown on the lower portion of Type Log #3 from northeastern Wyoming, the upper 6' of the Deadwood and the approximately 34' thick Englewood Formation (Figure A-4) would provide approximately 40' of confining zone below the over-pressured Madison Formation.

Pennsylvanian – Permian Units (Lower Confining Zone, Injection Zone, and Upper Confining Zone)

The Pennsylvanian- and Permian-age Minnelusa Formation consists of yellow to red, cross-stratified sandstone, limestone, dolomite, and shale. The middle and lower parts of the formation consists of shale and anhydrite. In the southern Black Hills, the upper part of the Minnelusa Formation is disconformably overlain by the Permian-age Opeche Shale. (Driscoll et al., 2002; Carter et al., 2003). Structure and isopach maps are presented as Figures D-12 and D-13, respectively.

<u>Lower Confining Zone</u>

Based on correlation of the Type Log #1 and Type Log #2 (Figures A-2 and A-3), the Minnelusa Formation is expected to occur at approximately 1,615' below Site 1 and 1,950' below Site 2 and expected to be approximately 1,150' thick. Based on type logs, the lower 560' appears to consist of interbedded tight sand and shale layers. Due to an apparent lack of porosity and permeability, this lower interval would not be targeted for injection but would serve as the lower confining zone above the Madison. Formation testing during the drilling process of DW No. 1 would be used to confirm the suitability of this section as a confining zone.

<u>Injection Zone</u>

The upper portion of the Minnelusa, the targeted zone for injection, is expected to occur from 1,615' - 2,205' below Site 1 and from 1,950' - 2,540' below Site 2 (Figures M-1 and M-3). The Type Logs indicate that there are three porous zones that total 164' in the upper 590' of the formation that range in porosity from approximately 21 to 33% (Figures A-2 and A-3). For the purpose of calculating the AORs, a conservative estimate of 21% was used. Depths, thicknesses and other parameters will be confirmed through formation testing during the drilling of DW No. 1.

<u>Upper Confining Zone</u>

The Opeche Shale consists of red shale and sandstone and ranges in thickness from 25 to 150 feet (Carter et al., 2003). As shown on Type Log #1 located within the Dewey-Burdock Project (Figure A-2), the formation is approximately 95' thick. The Opeche Shale is expected to occur at 1,520' below Site 1 and 1,855' below Site 2 and would serve and the upper confining zone above the Minnelusa Formation. The regional extent of the Opeche Shale is shown on Figures D-21 and D-22.

Structural Geology and Faulting

As described previously, the Black Hills Uplift is a dome structure with the rock units dipping outward, away from the central core. Subsequent local doming caused by local intrusions disrupts the general dip of the units. Tensional stress created fault zones with considerable displacement from one side of the zone to the other, often a distance of three or four miles. The strata below the Dewey-Burdock Project dips 2–6 degrees to the southwest away from the domal uplift.

The northeast to southwest trending Dewey fault zone, a few miles to the north of the town of Dewey, is a zone of major displacement. It is a steeply dipping to vertical normal fault with the north side uplifted approximately 500'. Some authors (USGS, 1999) show this fault continuing to depth. However, others (SDGS, Figure F-2) do not show displacement. In addition, there is little if any displacement shown on the Minnelusa structure contour map (Figure D-12). Even if some offset is present at the Minnelusa depth, this fault system is far enough from the proposed wells such that the impact of the fault on reservoir behavior would be minimal.

The Long Mountain Structural Zone is located 7 miles southwest of the project area. It trends northeast – southwest and contains several small surface faults in the Inyan Kara. No faults were identified in the area on structure maps of the underlying Minnelusa or Deadwood Formations. There are no identified faults that occur within the AORs or the Dewey-Burdock Project area.

Seismic Activity

The Dewey-Burdock area of southwestern South Dakota has been designated as a relatively minor seismic risk area by the USGS (http://earthquake.usgs.gov/earthquakes/states/south_dakota/hazards.php). The proposed area has a peak acceleration of 10-12 percent g. While South Dakota does have a comparatively higher rate of seismicity than other northern plains states, earthquakes tend to be relatively rare and of low to moderate magnitude, and no active faults have been mapped in the vicinity. No data are available to suggest that seismic activity presents a risk for injection at the Dewey-Burdock Project. Figures F-3 and F-4 present seismic and peak ground acceleration maps of South Dakota.

TABLE F-1 Stratigraphic Section – Black Hills Area, South Dakota

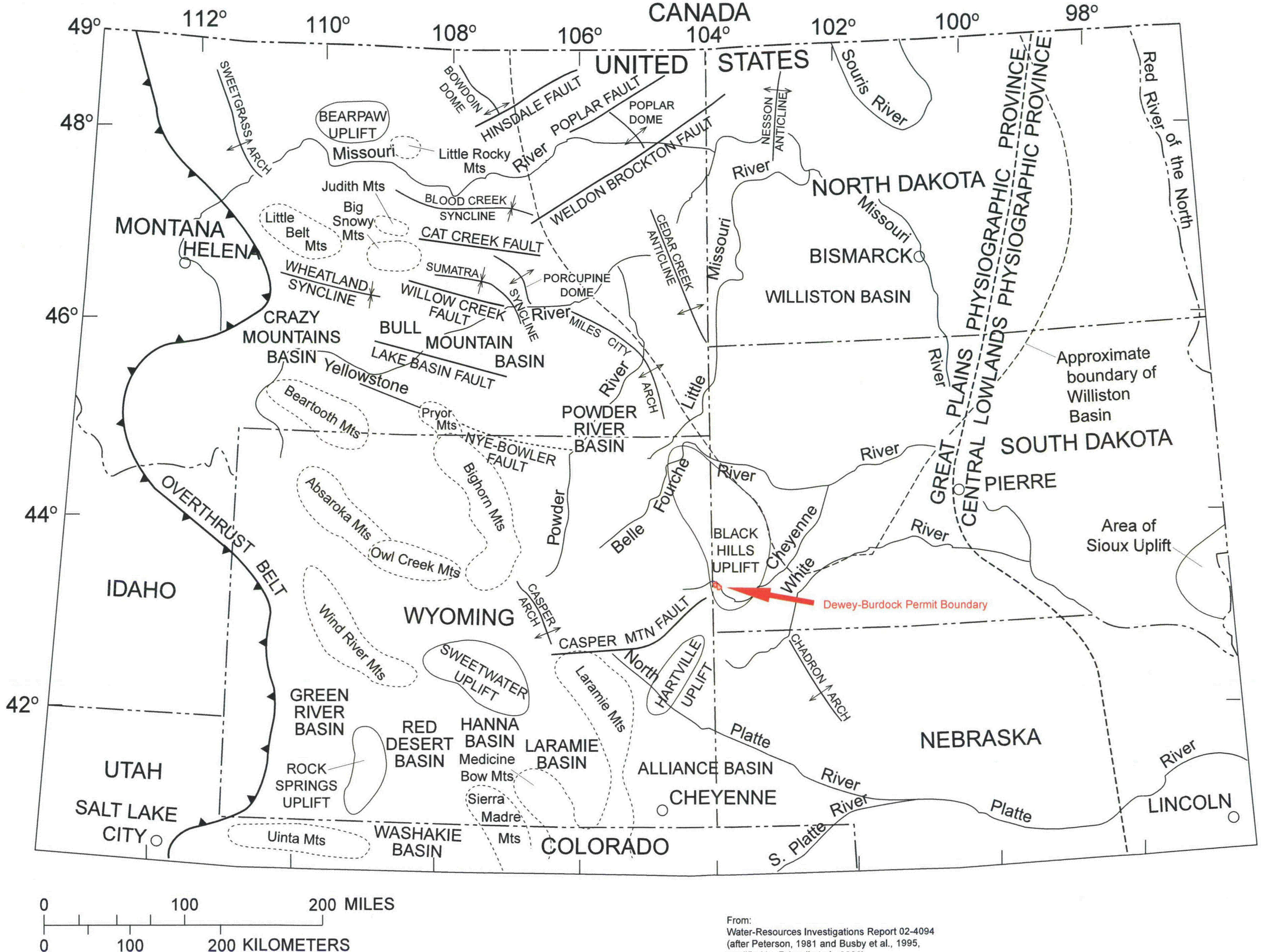
ERA	SYSTEM	STRATIGRAPHIC UNIT		THICK-NESS IN FEET	DESCRIPTION
CENOZOIC	Quaternary & Tertiary (?)	Undifferentiated alluvium, terraces, and colluvium		0-50	Sand, gravel, boulders, & clay
CENOZOIC	Tertiary	White River Group		0-300	Light colored clays with sandstone channel fillings & local sandstone lenses
CENOZOIC	Tertiary	Intrusive Igneous Rocks		--	Includes rhyolite, latite, trachyte & phonolite
MESOZOIC	Cretaceous	Pierre Shale		1,200-2,700	Principal horizon of limestone lenses giving teepee buttes
					Dark gray shale containing concretions
					Widely scattered limestone masses, giving small teepee buttes.
					Black fissile shale with concretions
MESOZOIC	Cretaceous	Niobrara Formation		80-300	Impure chalk & calcareous shale
MESOZOIC	Cretaceous	Carlile Shale	Turner Sandy Member	350-750	Light-gray shale with numerous large concretions & sandy layers
			Wall Creek Member		Dark-gray shale
MESOZOIC	Cretaceous	Greenhorn Formation		225-380	Impure slabby limestone. Weathers buff
					Dark-gray calcareous shale with thin Oman Lake limestone at base.
MESOZOIC	Cretaceous	Graneros Group	Belle Fourche Shale	150-850	Gray shale with scattered limestone concretions
					Clay spur bentonite at base
		Graneros Group	Mowry Shale	125-230	Light-gray siliceous shale. Fish scales and thin layers of bentonite.
		Graneros Group	Muddy/New-castle Sandstone	0-150	Brown to light-yellow and white sandstone
		Graneros Group	Skull Creek Shale	150-270	Dark-gray to black siliceous shale
MESOZOIC	Cretaceous	Inyan Kara	Fall River Formation	10-200	Massive to thin-bedded, slabby, brown to reddish-brown sandstone
		Inyan Kara	Lakota Formation	35-700	thinly bedded sandstone, pebble conglomerate, siltstone, and claystone. Locale fine-grained limestone and coal
MESOZOIC	Jurassic	Morrison Formation		0-220	Green to maroon shale. Thin sandstone
MESOZOIC	Jurassic	Unkpapa Sandstone		0-225	Massive fine-grained sandstone
MESOZOIC	Jurassic	Sundance Formation		250-450	Greenish-gray shale, thin limestone lenses
					Glauconitic sandstone; red sandstone near middle
MESOZOIC	Jurassic	Gypsum Spring Formation		0-45	Red siltstone, gypsum, & limestone
MESOZOIC / PALEOZOIC	Triassic / Permian	Spearfish Formation		375-800	Red sandy shale, soft red sandstone & siltstone with gypsum and thin limestone layers; Gypsum locally near base.
PALEOZOIC	Permian	Minnekahta Limestone		25-65	Thin to medium bedded, fine-crystalline, purplish-gray, laminated limestone
PALEOZOIC	Permian	Opeche Shale		25-150	Red shale & sandstone
PALEOZOIC	Permian / Pennsylvanian	Minnelusa Formation		375-1,175	Yellow to red cross-bedded sandstone, limestone, & anhydrite locally at top.
					Interbedded sandstone, limestone, dolomite, shale, and anhydrite
					Red shale with interbedded limestone & sandstone at base.
PALEOZOIC	Mississippian	Madison (Pahasapa) Limestone		250-1,000	Massive light-colored limestone, Dolomite in part. Cavernous in upper part
PALEOZOIC	Devonian	Englewood Formation		30-60	Pink to buff limestone. Shale locally at base
PALEOZOIC	Ordovician	Whitewood (Red River) Formation		0-225	Buff dolomite & limestone
PALEOZOIC	Ordovician	Winnipeg Formation		0-150	Green shale with siltstone
PALEOZOIC	Cambrian	Deadwood Formation		0-500	Massive to thin-bedded brown to light-gray sandstone. Greenish glauconitic shale, flaggy dolomite, limestone, & flat-pebble limestone conglomerate. Sandstone with conglomerate locally at base.
PRE-CAMBRIAN		Undifferentiated Igneous & Metamorphic Rocks		--	Schist, slate, quartzite, and arkosic grit. Intruded by diorite, metamorphosed to amphibolite, and by granite & pegmatite

Source: Carter, J.M., and D.G. Driscoll, 2003. *Ground-Water Resources in the Black Hills Area, South Dakota.* U.S. Geological Survey Water-Resources Investigations Report 03-4049.

TABLE F-2 Proposed Dewey-Burdock Disposal Wells Projected Formation Depth Summary

	DW Nos. 1 and 2 (Based on Well FBS170 and Typelogs)			DW Nos. 3 and 4 (Based on Well DWA140 and Typelogs)		
Formation	Depth of Top (ft) AMSL	Depth of Top (ft) BGS	Est. Thickness (ft)	Depth of Top (ft) AMSL	Depth of Top (ft) BGS	Est. Thickness (ft)
Skull Creek Shale	3710	0	190	3650	0	525
Fall River	3520	190	125	3125	525	125
Lakota	3395	315	110	3000	650	110
Morrison	3285	425	135	2890	760	135
Unkpapa	3150	560	80	2755	895	80
Sundance	3070	640	280	2675	975	280
Spearfish	2790	920	320	2395	1255	320
Goose Egg	2470	1240	240	2075	1575	240
Minnekahta Limestone	2230	1480	40	1835	1815	40
Opeche Shale	2190	1520	95	1795	1855	95
Minnelusa	2095	1615	1150	1700	1950	1150
Madison (Pahasapa)	945	2765	295	550	3100	295
Englewood	650	3060	35	255	3395	35
Deadwood	615	3095	100	220	3430	100
Granite Wash	TBD	TBD	TBD	TBD	TBD	TBD
Precambrian	515	3195	N/A	120	3530	N/A

Note: Estimates Based on Powertech Cross-sections (Class III application), the #1West Mule Creek Well (API: 4902705978, T39N R61W Sec 2) the Lance-Nelson Estate #1 Well (API:4004705089, T7S R1E Sec 21), and the Earl Darrow #1 Well (API: 4004705095, T7S R1E Sec 2)



From:
Water-Resources Investigations Report 02-4094
(after Peterson, 1981 and Busby et al., 1995,
modified by Driscoll et al., 2002)

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Figure F-1
Regional Geologic Structure Map

2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010
2010_DB_Class_V_Fig_F-01.ai	By: JLM — Checked: HD

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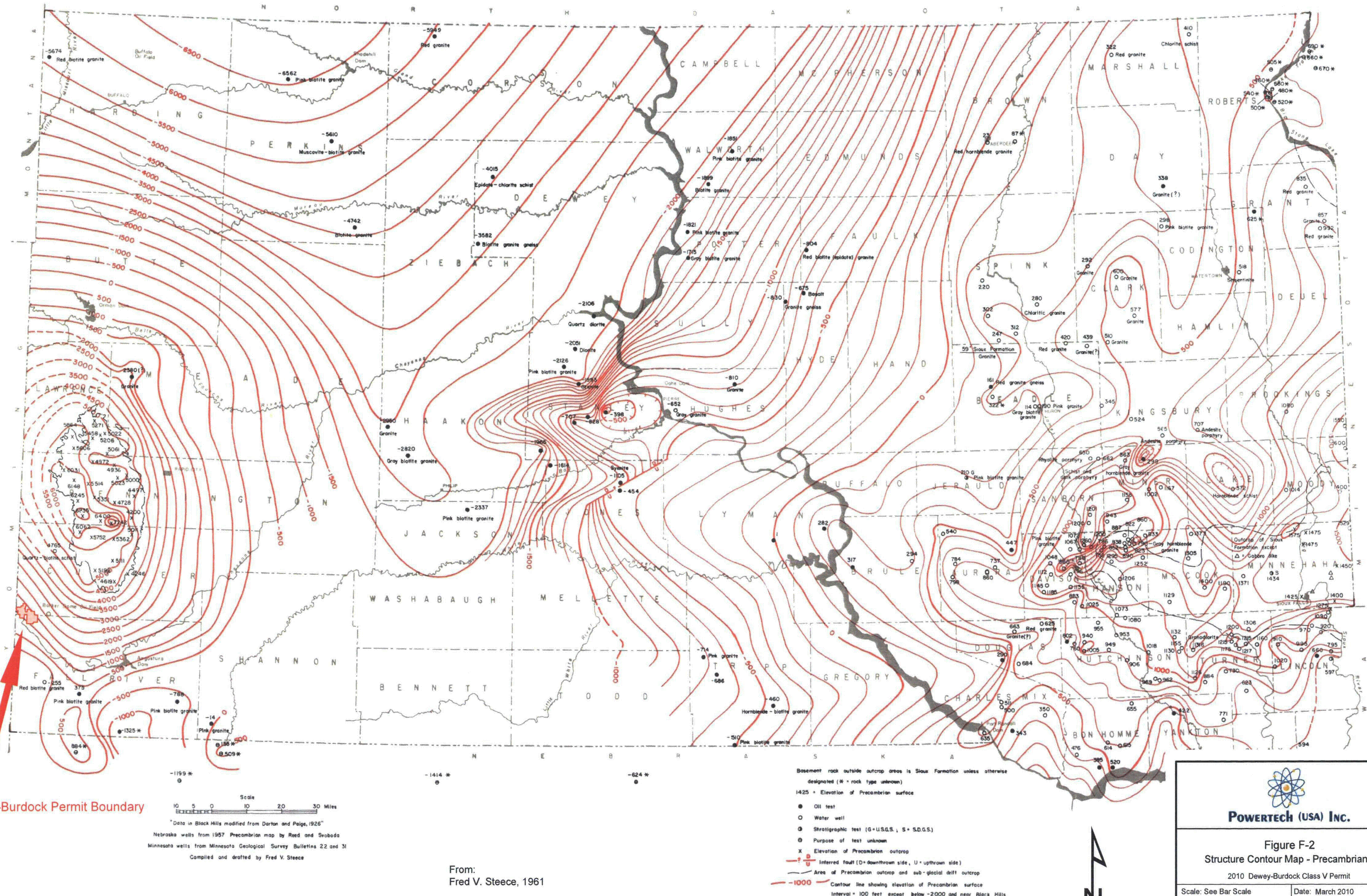

From:
Fred V. Steece, 1961

POWERTECH (USA) INC.

Figure F-2
Structure Contour Map - Precambrian

2010 Dewey-Burdock Class V Permit

Scale: See Bar Scale	Date: March 2010
2010_DB_Class_V_Fig_F-02.ai	By: JLM Checked: HD

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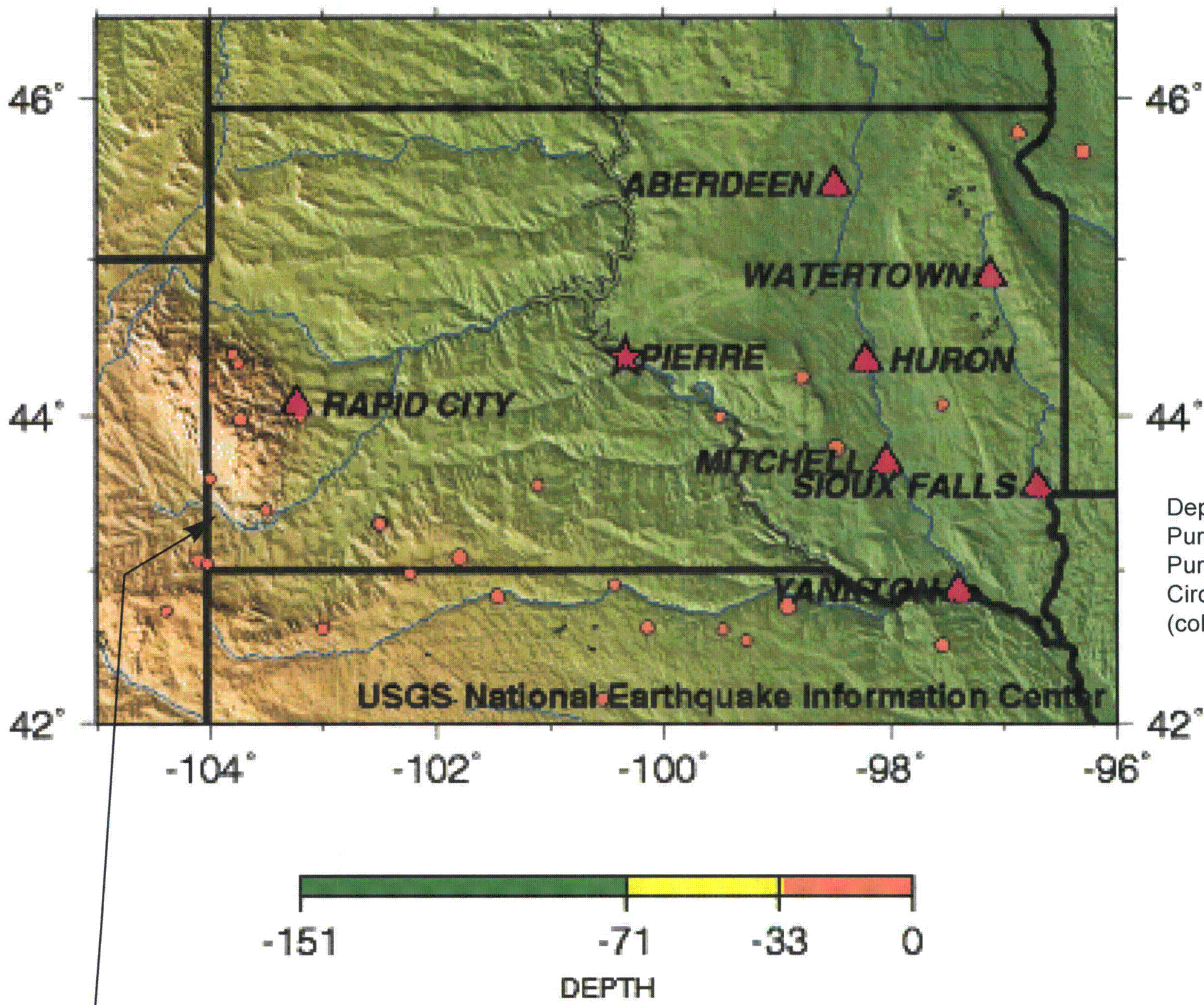
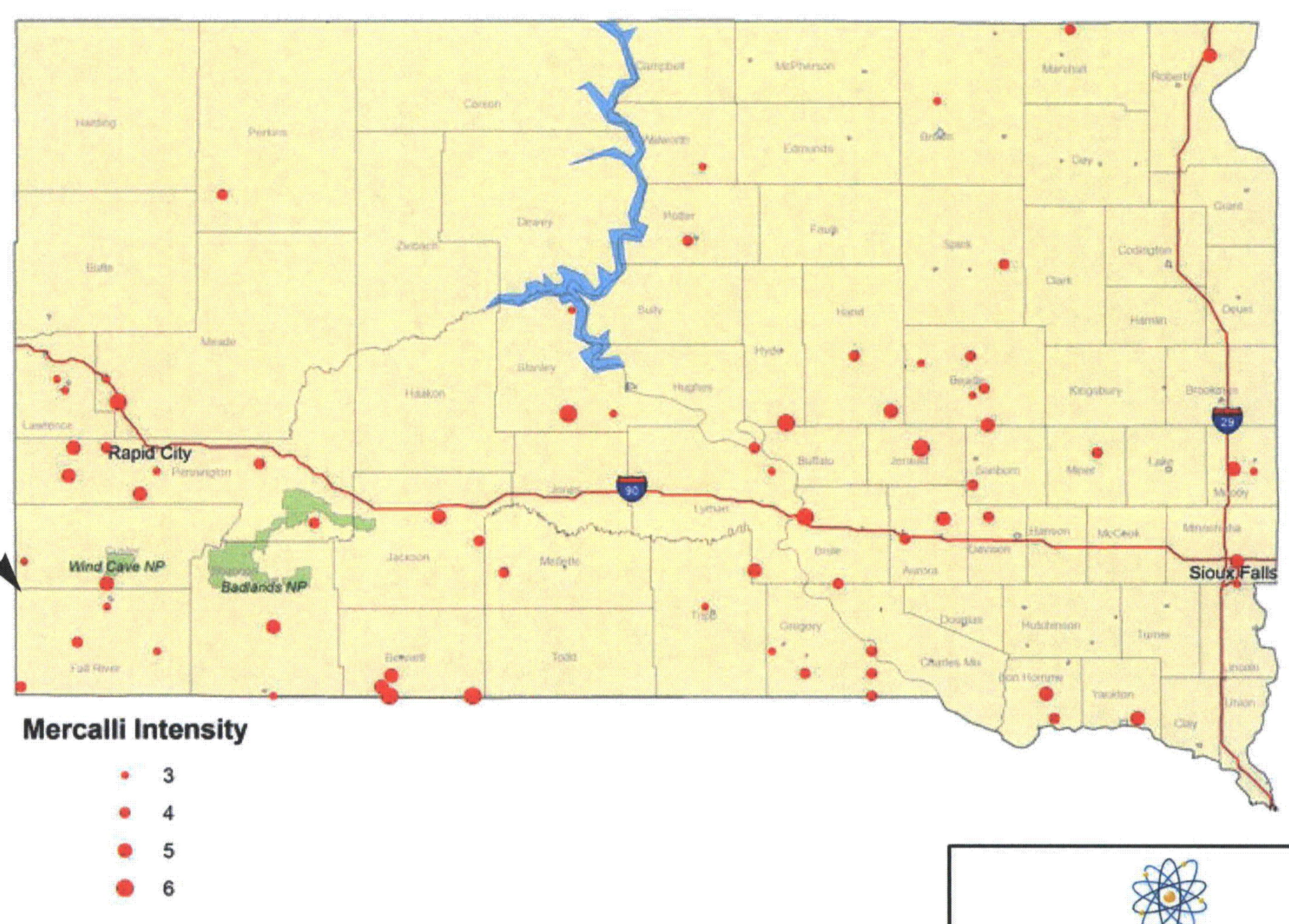
Seismicity of South Dakota
1990 - 2006



Depth is in kilometers.
Purple Triangles: Cities
Purple Star: Capital City
Circles: Earthquakes
(color represents depth range)

Dewey Burdock Project Location

Earthquakes in South Dakota (1872 - 2007)



Map Source: USGS website
Earthquake locations are from the USGS/NEIC PDE catalog.

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Figure F-3
Seismicity of South Dakota, 1990-2006; and Earthquakes in South Dakota, 1872-2007
2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010
2010_DB_Class_V_Fig_F-03.ai	By: JLM / Checked: HD

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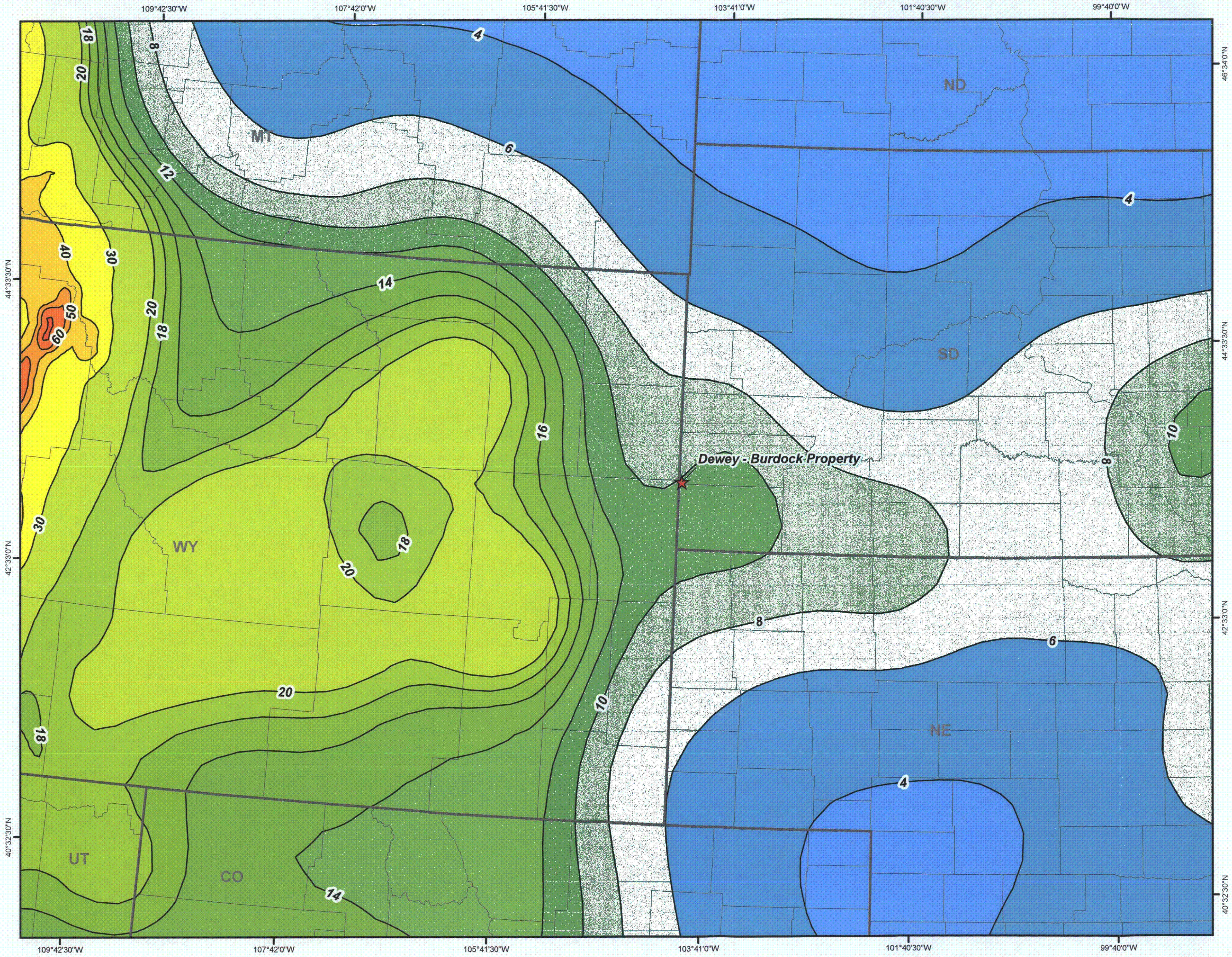

Projection: South Dakota State Plane South, NAD83 (feet)

Legend

% G

- 160-200
- 120-160
- 80-120
- 60-80
- 50-60
- 40-50
- 30-40
- 20-30
- 18-20
- 16-18
- 14-16
- 12-14
- 10-12
- 8-10
- 6-8
- 4-6
- 2-4
- 0-2

Contour Data from: USGS, National Seismic Hazard Maps - 2002

N

0 25 50 75 100 Miles

POWERTECH (USA) INC.

Figure F-4
Peak Ground Acceleration (PGA), Illustrating 2% Probability of Exceedance in the Next 50 Years
2010 Dewey-Burdock Class V Permit

Scale: 1:3,000,000	Date: March 2010	
2010_DB_Class_V_Fig_F-04.mxd	By: JLM	Checked: HD

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2.G GEOLOGIC DATA ON INJECTION AND CONFINING ZONES

For Class II Wells (Not Applicable to this Application)

2.H OPERATING DATA

Submit the following proposed operating data for each well (including all those to be covered by area permits): (1) average and maximum daily rate and volume of the fluids to be injected; (2) average and maximum injection pressure; (3) nature of annulus fluid; (4) for Class I wells, source and analysis of the chemical, physical, radiological and biological characteristics, including density and corrosiveness, of injection fluids. If the information is proprietary, maximum concentrations only may be submitted, but all records must be retained.

RESPONSE

Maximum Injection Pressure

Each well has been designed for operation under positive pressure to be supplied by using an injection pump. Since no site-specific data are available, the default value of 0.68 psi/ft will be used for the fracture gradient of the Minnelusa Formation as suggested by the University of Wyoming Enhanced Oil Recovery Institute (http://eori.uwyo.edu/database.asp). Due to a lack of data for the Deadwood Formation, the same fracture gradient will be applied to that formation. Should formation testing in DW No. 1 indicate that the use of an alternate fracture gradient is appropriate, the calculations will be modified accordingly based on site-specific data. Injection fluid is assumed to be comprised of a brine with a maximum specific gravity of 1.008 (SG of 15,000 mg/l TDS brine) that fills the tubing from the surface to the depth of the injection zone. Maximum wellhead injection pressure for each well is calculated and presented in Table H-1. These calculations include allowances for pressure loss in tubing due to friction.

Based on the calculated wellhead fracture pressure values listed in Table H-1 (assuming a maximum continuous specific gravity of 1.008), it is requested that a maximum wellhead injection pressure of 424 psi, 816 psi, 512 psi, and 904 psi be authorized for future injection activities at DW Nos. 1 (Minnelusa), 2 (Deadwood), 3 (Minnelusa),and 4 (Deadwood), respectively. It is requested that injection limitation be defined by these surface pressures, not by rate.

Average Rates, Volumes and Pressures

The range of injection rates and pressures is expected to fluctuate depending on the demands of the ISL project along with variables related to the well and the reservoir conditions. Injection rates are projected to average between 50 and 75 gpm based on continuous operations. However, injection may occur in a periodic or "batch mode" depending on demand.

Average injection pressures during active operations are expected to range from approximately 300 to 800 psi depending on the permitted injection pressure, history of recent well capacity demands, and the condition of the well and the injection reservoirs.

Annulus Pressure

Annulus pressure will be maintained at a minimum of 100 psi above tubing pressure, <u>except</u> during the course of workovers and/or maintenance operations.

Nature of Annulus Fluid

In the proposed Dewey-Burdock Wells, the annulus space between the injection tubing and the well protection casing will be sealed and filled with fresh water containing a corrosion inhibitor, an oxygen scavenger and a biocide as may be deemed necessary by the operator. Annulus fluids will include Baker Petrolite CRW0037F or Unichem Technihib 366W corrosion inhibitors and bactericides, CRW 132 oxygen scavenger, A-303 corrosion inhibitor, Knockout 50 oxygen scavenger, and Bacban 3 Biocides or suitable equivalents. No permit condition regarding specific brands or fluid additives are requested or required.

Monitoring the pressure changes in the sealed annulus space is a means of verifying the continued mechanical integrity of the well. The monitoring equipment material will be non-corrosive, not subject to biologic degradation, and preferably non-freezing at winter temperatures. At this time, methanol, diesel, heat tracing, and/or a wellhouse heater may be used at the wellhead and annulus tank system to manage any potential for weather related problems in the surface equipment.

Each well is to be operated, and operating data reported, according to the requirements outlined in Table H-2.

Injectate Characteristics

The proposed wells are intended for management of ISL mining related wastewater from the Powertech Dewey-Burdock Project. The density of the injectate is estimated to be up to 1.008 (SG of 15,000 mg/l TDS brine). The Dewey-Burdock ISL Project is not yet an operating mine, so an example analysis of the injectate is not available. As such, the following paragraph and Table H-3 describing typical liquid waste from ISL facilities from the USNRC, NUREG-1910, Vol. 1, GEIS, Section 2.7.2, has been included in this document. As required by applicable law, Powertech will treat to radionuclide standards outlined in 10 CFR 20, Appendix B, Table 2.

2.7.2 Liquid Wastes

Liquid wastes from ISL facilities are generated during all phases of uranium recovery; construction, operations, aquifer restoration, and decommissioning. Liquid wastes may contain elevated concentrations of radioactive and chemical constituents. Table 2.7-3 shows estimated flow rates and constituents in liquid waste steams for the Highland ISL facility (NRC, 1978). Liquid waste streams are predominantly production bleed (1 to 3 percent of the process flow rate) and aquifer restoration water (NRC, 1997a). Additional liquid waste streams are generated from well development, flushing of depleted eluant to limit impurities, resin transfer wash, filter washing, uranium precipitation process wastes (brine), and plant wash down water.

TABLE H-1 Maximum Injection Pressure for Dewey-Burdock Disposal Wells

	DW No. 1	DW No. 2	DW No. 3	DW No. 4
Fracture Gradient (psi/ft)	0.68	0.68	0.68	0.68
Injection Depth (ft)	1615	3100	1950	3435
Fluid Specific Gravity	1.008	1.008	1.008	1.008
Water Gradient (psi/ft)	0.433	0.433	0.433	0.433
Calculated Fracture Pressure (psi)	1098	2108	1326	2336
Hydrostatic Pressure of Fluid Column (psi)	705	1353	851	1499
Pressure Loss in Tubing (psi)	31	61	38	67
Maximum Injection Pressure at Surface (psi)	424	816	512	904

TABLE H-2 Operating, Monitoring, and Reporting Requirements for Dewey-Burdock Disposal Wells

Characteristic	Value	Minimum Monitoring Frequency	Minimum Reporting Frequency
Average Injection Rate	2,571 bpd max.	Continuous	quarterly
Instantaneous Injection Rate	1.7 bpm max.	Continuous	quarterly
Cumulative Volume	2,571 bpd max.	Continuous	quarterly
Max. Injection Pressure	Well Specific	Continuous	quarterly
Ave. Injection Pressure	Well Specific	Continuous	quarterly
Annulus Pressure*	100 psig min.	Continuous	quarterly
Annulus/Tubing Pressure Differential	100 psig min.	Continuous	quarterly
Sight Glass Level	Visible	daily when operated	quarterly
Annulus Fluid Addition Or Removal	-	Daily	quarterly
Chemical Composition of Injected Fluids	-	quarterly	within 30 days of sampling
Physical Characteristics of Injected Fluids	-	quarterly	within 30 days of sampling

* Except during maintenance and workover operations

TABLE H-3 Example Analysis of Injectate from Typical ISR Project

Table 2.7-3. Estimated Flow Rates and Constituents in Liquid Waste Streams for the Highland *In-Situ* Leach Facility*

	Water Softener Brine	Resin Rinse	Elution Bleed	Yellowcake Wash Water	Restoration Wastes
Flow Rate, gal/min	1	<3	3	7	450
As, ppm					0.1–0.3
Ca, ppm	3,000–5,000				
Cl, ppm	15,000–20,000	10,000–15,000	12,000–15,000	4,000–6,000	
CO_3, ppm		500–800			300–600
HCO_3, ppm		600–900			400–700
Mg, ppm	1,000–2,000				
Na, ppm	10,000–15,000	6,000–11,000	6,000–8,000	3,000–4,000	380–720
NH_4, ppm			640–180		
Se, ppm					0.05–0.15
Ra-226, pCi/L	<5	100–200	100–300	20–50	50–100
SO_4, ppm					100–200
Th-230, pCi/L	<5	50–100	10–30	10–20	50–150
U, ppm	<1	1–3	5–10	3–5	<1
Gross Alpha, pCi/L					2,000–3,000
Gross Beta, pCi/L					2,500–3,500

*NRC. NUREG–0489, "Final Environmental Statement Related to Operation of Highland Uranium

I

2.I FORMATION TESTING PROGRAM

Describe the proposed formation testing program. For Class I wells the program must be designed to obtain data on fluid pressure, temperature, fracture pressure, other physical, chemical, and radiological characteristics of the injection matrix and physical and chemical characteristics of the formation fluids.

RESPONSE

The DW No. 1 is to be installed and tested in the year 2011 according to applicable regulations and permit requirements. Subsequent wells likely will be installed and tested in 2011 or following years. Static pressure of the Minnelusa and Deadwood Formations along with estimates of various injection interval characteristics such as porosity and permeability are to be determined via core and pressure transient testing, while native brine chemistry and characteristics are to be determined based on acquisition of fluid samples. Additional fluid samples and static pressures will be taken from surrounding formations to establish characteristics and water quality. Characteristics of the potential injection intervals are also to be evaluated based on conducting geophysical well logging. Additional details regarding the well logging are presented in Response 2.L, Construction Details. The proposed target injection interval for DW Nos. 1 and 3 is the Minnelusa Formation and the proposed target injection interval for DW Nos. 2 and 4 is the Deadwood and granite wash. As further described in Section 2.L, the DW No. 1 will be drilled to basement to allow testing of both proposed targets then plugged back with cement to above the Madison Formation before being completed with perforations of the cased hole in the Minnelusa.

After the open hole section has been drilled, but prior to conducting any injection testing, injection interval fluid will be produced from the well using a submersible pump, swabbing or wireline testing equipment. Based on fluid loss during drilling and field conditions, target production volumes for obtaining representative samples will be adjusted in the field, based on conditions encountered. Field parameters including pH and conductivity will also be monitored at surface as fluid is recovered to determine when representative sampling is practical. Formation fluid samples generally will be subjected to analysis for the following parameters (Note: not all parameters will be analyzed for all samples):

- Alkalinity, Arsenic, Barium, Bicarbonate, Cadmium, Calcium, Carbonate, Chloride, Chromium, Conductivity, Copper, Hardness, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Nitrate, as (N), pH, Potassium, Uranium, Radium 226, Radium 228, Selenium, Silica as SiO2, Sodium, Specific Gravity, Strontium, Sulfur, TDS, TSS, Zinc, BTEX, Oil and Grease

Annual Part I mechanical integrity testing for the Dewey-Burdock wells will include reservoir monitoring as specified in 40 CFR 146.13 (d) in addition to static annulus pressure testing. Powertech (USA), Inc. will provide the agency with a minimum of 30 days notice of annual testing. Notice is to include proposed procedures for testing. Although test procedures or methods may be changed based on approval by Region 8 USEPA staff, the following procedure will be utilized for the first such testing to be performed:

1. Conduct Wellsite Safety Meeting

   A. Prior to commencement of field activities, conduct safety meeting with contractors and personnel to be involved with field services and MIT testing. Ensure that all safety procedures are understood and review days work activities.

2. Conduct Fall-Off Test

A. Record data regarding historical test well injection at typical operating conditions (constant rate preferred). Rate, temperature and specific gravity versus time will be sampled and recorded during the injection period. Cumulative volume injected will also be recorded. Continue injection for a minimum of approximately 2 - 6 hours. Additional time may be required depending on the nature of formation characteristics estimated from fluid sampling activities. Note that significant rate variations may yield poor quality data or require more complicated analysis techniques.

B. Rig-up downhole pressure gauge(s) and run in the well to the testing/recording depth.

C. Obtain final stabilized injection pressure for a minimum of one hour. Ensure that the gauge temperature readings have also stabilized.

D. After gauge recordings are stable, cease injection and monitor pressure fall-off. Instantaneous shut-in yields best results. Continue monitoring pressure for a minimum of six hours or until a valid observation of fall-off curve is observed.

E. Stop test data acquisition, pull gauges from the well, rig-down and release equipment.

3. Annulus Pressure Test

A. Stabilize well pressure and temperature.

B. If required, arrangements will be made for a representative from the USEPA to be present to witness this testing.

C. Install ball valve or similar type "bleed" valve on annulus gate valve. Pressurize annulus to a minimum of 100 psig with liquid and shut-in pump side gate valve. If typical operating annulus pressures are above 100 psi, higher pressures acceptable to the agency and compatible with the well completion configuration will be utilized. Pressure to be used will be detailed in proposed procedures supplied with notification of testing. Install USEPA-certified gauge on "bleed" type valve. The annulus may need to be pressurized and bled off several times to ensure an absence of air. Monitor and record pressure for one hour. Pressure may not fluctuate more than 10 percent during the one-hour test. At the conclusion of the test, lower the annulus pressure to normal operating pressure.

2.J STIMULATION PROGRAM

Outline any proposed stimulation program.

RESPONSE

No specific stimulation program is currently scheduled for the proposed Dewey-Burdock Disposal Wells. Injection is utilized elsewhere within the region in the proposed Minnelusa Formation injection interval. Based on typical operations, hydrochloric acid or mud acid (HCl/HF) stimulation or other stimulations of the injection interval may be required as part of the original completion to achieve desired injection capacity or as maintenance during operations. If necessary to maintain desired injectivity, mechanical well clean out or acidization of a similar nature to programs used in other injectors may be conducted to reduce injection pressures. The USEPA will be notified prior to any stimulation activities being conducted in the well.

K

2.K INJECTION PROCEDURES

Describe the proposed injection procedures including pump, surge tank, etc.

RESPONSE

The Dewey-Burdock wells are to be dedicated to the injection of fluids derived from the Dewey-Burdock ISL Project. Details regarding the waste stream, surface equipment and practices to be followed for operation of the well are presented in this attachment. Note that additional details regarding the wellhead, annulus components and surface facilities of the system are provided in Response 2.M of this document. Additional details regarding operating parameters for the system are included in Attachment H of this document.

Surface Facility Description

The Dewey-Burdock ISL facility is located in Custer and Fall River Counties, South Dakota, 13 miles north-northwest of Edgemont (Figure 1). Figure K-1 is a generalized process flow diagram of the major surface facility components. They consist of storage and pretreatment facilities, screens/filters and pumps with high pressure flow lines to the wellhead, and associated monitoring equipment.

Injection Procedures

Fluids will be collected at the Dewey-Burdock plant facilities and transported via existing flow line to the well sites. Depending on fluid quality and well performance, fluids may be routed through filters prior to injection into the wells. Fluids will then be transferred from a final head tank to the suction end of an injection pump. Injection will take place at desired flow rates with a maximum injection pressure not to exceed those specified in Table H-1 as previously indicated in this document (see Response 2.H). Higher pressures may be requested depending on site-specific test data obtained during well installation. Figure K-1 includes a general flow diagram of proposed instrumentation.

Well Operating Procedures, Alarms and Annulus Pressure Maintenance

It is anticipated that each well will be automated, but may also be operated manually. Operators will start the injection process by opening necessary valves to allow the pumps to be started, or for the wells to draw fluid from the storage tanks. Restraints will be incorporated into the well monitoring systems to meet UIC regulations and permit conditions. The automated control system will include control switches to alarm the operator if certain operating conditions are encountered. For regulatory purposes, a high injection pressure switch (set below the permit maximum) and a low annulus differential switch (set above the permit minimum) will shut-off injection pump power and will alarm the operator so that the well can be fully isolated and secured. In the event that any of the permit condition related set points are exceeded, injection operations will cease until the problem is identified, corrected, and the system is then manually restarted by an operator when compliance is verified.

Annulus pressure in the well system will be maintained with a nitrogen bottle attached to an annulus fluid reservoir (head tank). On days when injection takes place, annulus fluid level will be monitored in the annulus fluid head tank by the use of a level indicator or a sight glass, and additions or subtractions of fluid from the annulus tank will be recorded for monitoring purposes and reported on a quarterly basis per permit requirements.

If the proposed Dewey-Burdock Disposal Wells are monitored and operated remotely, the following special conditions shall be applicable to each well. For the purpose of this permit, remote monitoring is defined as injection into the wells when a trained operator is not present on site property and able to perceive shut-down alarms and able to physically respond to the well controls or the wellhead within 15 minutes of a compliance alarm condition.

1. Local operating system and remote monitoring system: If remote monitoring is to be used to operate the well, an automatic pager designed to alert designated on-call, off-site personnel in the event of a well alarm or shut-in shall be onsite and equipped with a back-up power supply.

2. Response to automatic shut-downs: Alarm shut-downs of the operating well related to permit compliance conditions of the well shall be investigated on-site by a trained operator within three (3) hours of pager notification of the occurrence.

3. Loss of power to the control system: In the event of a power failure beyond the capability of the back-up power supply shuts down the control system, the well shall be shut-in.

4. Loss of dial tone: If the automatic pager cannot get a dial tone for 90 minutes, the well shall automatically be shut-in.

5. Restart of the well after an automatic shut-in: Restart of the well after a shut-in related to a permit condition alarm (including, but not limited to, injection pressure, annulus differential pressure, loss of dial tone for more than 90 minutes or control system power failure) shall require the physical presence of the operator on-site before the well can be restarted.

6. Restart of the well after non-permit condition related or scheduled shut-ins: If the well is shut-in for more than 48 hours for circumstances unrelated to permit conditions, restart of the well shall require the physical presence of the operator on-site.

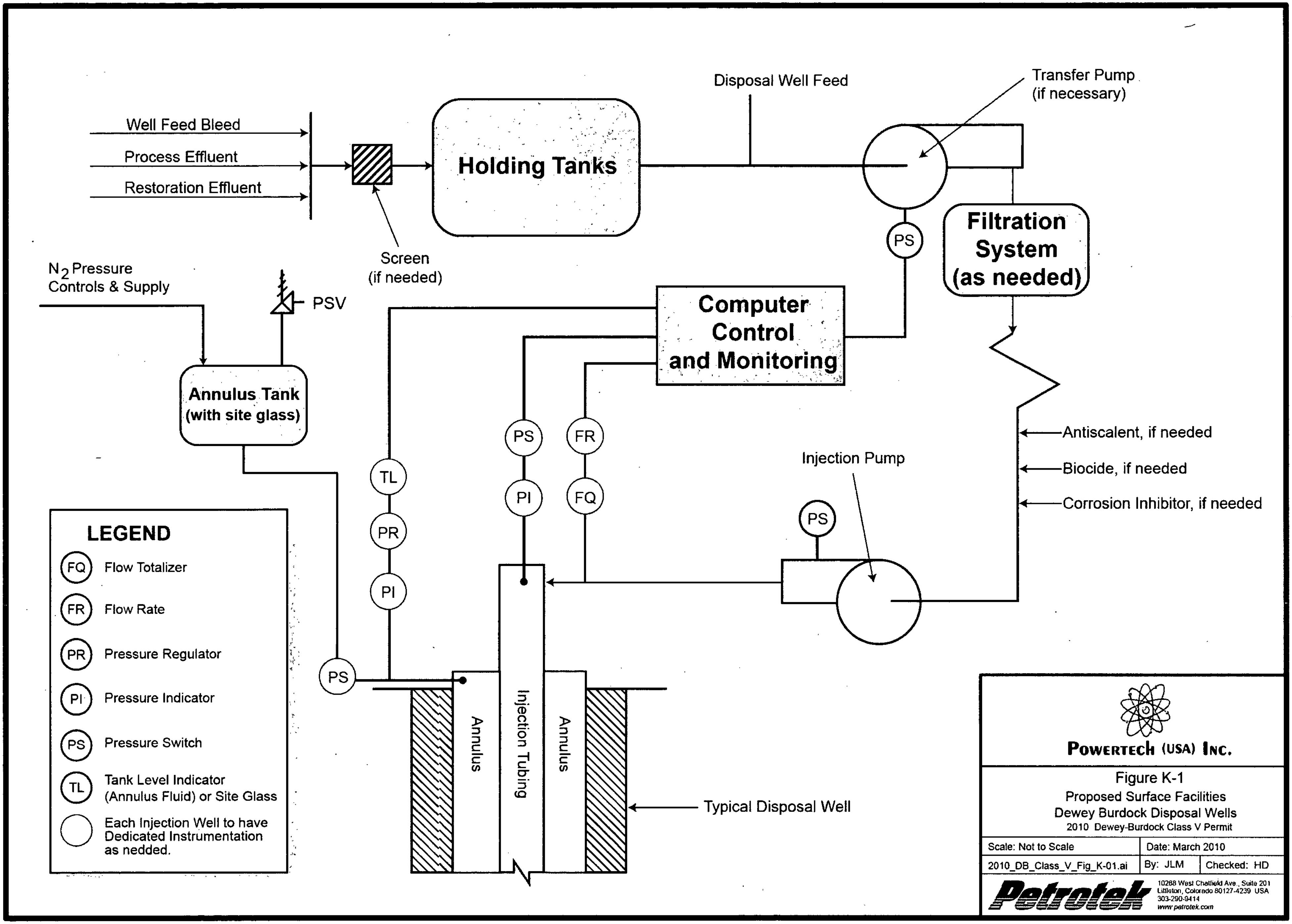
7. Monthly operator inspections: If fluid injection occurs during the period of any month and the well is being monitored remotely, a trained operator shall physically visit the site to inspect the facility at a minimum frequency of not less than once per month. This inspection shall verify the correct operation of the remote monitoring system by review of items such as, but not limited to, a comparison of the values shown on mechanical gauges with those reported by the remote operating system. Unless annulus pressure changes by more than 10 percent per week while the well is injecting, only one annulus fluid level per week shall be required to be taken, recorded and reported when injection takes place.

8. When the well is not actively being used for injection, one annulus tank fluid level measurement shall be taken, recorded and reported per month unless annulus fluid pressure decreases more than 10 percent per month. In such cases of increased annulus pressure change, annulus fluid level measurements shall be taken, recorded and reported twice per month.

9. When not in use by a trained well operator, offloading connections shall be secured and shall be locked at the valves leading to waste water tanks so that access is restricted to trained well operators.

10. In the event of well shut-down, it may become necessary to transport fluid by truck to an

alternate well site within the proposed Class V permit area. Offloading of fluid from transports can only occur with a trained operator physically present on site. A waste related log sheet and/or waste manifest file will be maintained documenting that a trained well operator allowed fluid to be unloaded. At a minimum, waste log entries are to include operator name, date, time, truck identification and approximate volume.


Well Feed Bleed
Process Effluent
Restoration Effluent
Screen (if needed)
Holding Tanks
Disposal Well Feed
Transfer Pump (if necessary)
PS
Filtration System (as needed)
N_2 Pressure Controls & Supply
PSV
Computer Control and Monitoring
Annulus Tank (with site glass)
TL
PR
PI
PS
PI
FR
FQ
Antiscalent, if needed
Biocide, if needed
Corrosion Inhibitor, if needed
Injection Pump
PS
PS
Annulus
Injection Tubing
Annulus
Typical Disposal Well
LEGEND
FQ Flow Totalizer
FR Flow Rate
PR Pressure Regulator
PI Pressure Indicator
PS Pressure Switch
TL Tank Level Indicator (Annulus Fluid) or Site Glass
Each Injection Well to have Dedicated Instrumentation as nedded.
POWERTECH (USA) INC.
Figure K-1
Proposed Surface Facilities
Dewey Burdock Disposal Wells
2010 Dewey-Burdock Class V Permit
Scale: Not to Scale
Date: March 2010
2010_DB_Class_V_Fig_K-01.ai
By: JLM
Checked: HD
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2.L CONSTRUCTION PROCEDURES

Discuss the construction procedures (according to §146.12 for Class I, §146.22 for Class II, and §146.32 for Class III) to be utilized. This should include details of the casing and cementing program, logging procedures, deviation checks, and the drilling, testing and coring programs, and proposed annulus fluid (Request and submission of justifying data must be made to use an alternative to a packer for Class I).

RESPONSE

The proposed Dewey-Burdock Disposal Wells are to be newly installed Class V wells. DW Nos. 1 and 2 will be constructed at Site 1 DW No. 1 located in the NE ¼ of the NW ¼ of the SW ¼ of Section 2, T 7 S, R 1 E, Fall River County, South Dakota DW Nos. 3 and 4 will be constructed at Site 2 located in the SE ¼ of the NW ¼ of the SW ¼ of Section 29, T 6 S. R 1 E, Custer County, South Dakota (Figures B-2 and B-2a). In the event that additional wells are required to inject at the requested 300 gpm site rate, locations within the proposed Class V permit area will be determined at a later date.

At Site 1, ground level is estimated to be approximately 3,710' above mean sea level (AMSL); Kelly Bushing (KB) will be dependent on rig size and availability. DW No. 1 will be drilled to a Total Depth (TD) of approximately 3,195' BGS to the top of the Precambrian basement. Following testing procedures in the Minnelusa, Madison, and Deadwood formations, the well will be completed in the Minnelusa Formation. DW No. 2 will be drilled to a TD of approximately 3,195', or to the top of the Precambrian basement, and completed in the Deadwood and granite wash.

At Site 2, ground level is estimated to be approximately 3,650' above mean sea level (AMSL); Kelly Bushing (KB) will be dependent on rig size and availability. DW No.3 will be drilled to a TD of approximately 2,740' BGS through the top 790' of the Minnelusa and completed in that formation. DW No. 4 will be drilled to a TD of approximately 3,530' BGS, or to the top of the Precambrian basement, and completed in the Deadwood and granite wash.

The drilling program for each well will include the addition of a tracer in the drilling mud to enable evaluation of all formation fluid sample quality as well as instructions for conducting deviation checks or surveys at regular intervals throughout the drilling process. Casing and cementing depths are summarized in Table L-1 and Figures M-1 through M-4 and the logging program is presented in Table L-2. Each well will incorporate centralizers on casing and cement with a minimum of 20% excess where applicable as described in the DW No. 1 section below. The nature of the proposed annulus fluid is described at the end of this section.

Drilling, Casing and Testing Program

The primary objective for DW No. 1 is to drill to basement and conduct formation testing of target injection zones, verify assumed parameters, and confirm the presence and suitability of confining zones. The DW No. 1 will then be plugged back to the top of the Madison and completed as a Minnelusa injection well.

DW No. 1

The 13 3/8" conductor casing will be set at approximately 60'. A 12 ¼" surface hole will then be drilled to the top of the Minnelusa at an anticipated depth of 1,615'. The surface casing, 9 5/8-inch, 61 lb/ft, J-55 grade, ST&C, or suitable equivalent will be cemented to surface using Class A cement with additives from the top of the Minnelusa Formation.

An 8 ½" hole will be drilled out of the surface casing through the Minnelusa Formation to near the top of the Madison at a depth of approximately 2,765' (Figure M-1). Openhole testing and logging (Table L-2) will be conducted in the Minnelusa to determine optimum zones for injection in the upper portion of the formation. Fluid sampling using wireline equipment or other methods as dictated by equipment availability and hole conditions will also be conducted to assess formation fluid quality. A tracer will be added to the drilling mud to enable evaluation of the fluid sample quality. In addition, the lower portion of the Minnelusa will be tested to determine the suitability to serve as a confining zone. Once testing procedures have been completed, 7" 20 -26 lb/ft, J-55, ST&C, or suitable equivalent intermediate casing will be run to the base of the Minnelusa at approximately 2,765' and will be cemented to surface based on 20% excess using Class A cement with additives. Additional excess cement, if any, will be pumped based on field conditions. It is anticipated that a float shoe will be used with a float collar one or two joints up from the bottom and that centralizers will be placed a minimum of one every fifth joint.

After the production casing string has been cemented, a cement bond log will be conducted to document cement circulation placement. The cement will be drilled out of the intermediate string and a 6 ¼" hole will be drilled through the Madison, Englewood, Deadwood, and granite wash to TD at approximately 3,195' at the top of the Precambrian basement. Further formation testing, logging, and fluid sampling will be conducted in the Madison and Deadwood Formations to assess formation properties and fluid characteristics and confirm suitability for use of the Deadwood as an injection zone for subsequent wells. Once formation testing is completed, the well will be plugged back to the base of the Minnelusa at approximately 2,765'. Table L-1 presents a summary of drilling, casing, and cementing depths.

During completion operations, the upper portion of the Minnelusa will be perforated. The perforation intervals will likely occur from 1,615' – 2,205', but will ultimately be determined after logging and formation testing. A packer will be set at a depth of approximately 1,535' inside the 7" production string casing. Injection tubing with a diameter of 2 7/8" is proposed for the completion. As appropriate, coated tubing and a coated packer may be used to manage potential corrosion issues. A radioactive tracer survey and a temperature log will then be conducted to establish baseline conditions and initial external mechanical integrity. A pressure transient build up/falloff test will also be conducted to derive estimates of formation pressure and properties (See Response 2.I). The proposed well schematic for DW No. 1 is presented in Figure M-1.

DW No. 2

The primary objective for DW No. 2 is to be drilled to basement and is to be completed as an injection well in the Deadwood Formation.

After 13 3/8" conductor casing is set at approximately 60', 12 ¼" surface hole will be drilled through the Minnelusa to the top of the Madison at approximately 2,765'. Following openhole logs, 9 5/8" surface casing will be set and cemented from approximately 2,765' to surface. An 8 ½" bit will be used to drill to an estimated TD of 3,200' at the top of the Precambrian basement. Following logging, formation testing, and fluid sampling, 5 ½" casing will be run and cemented from TD to approximately 2,465', or 300' above the top of the Madison. The well would be completed in the Deadwood and granite wash. Proposed drilling, casing, and cementing depths are summarized in Table L-1. A proposed well schematic including completion details for DW No. 2 is presented in Figure M-2.

DW No. 3

The primary objective for DW No. 3 is to be drilled through part of the Minnelusa and is to be completed as an injection well in the porous zones in the upper portion of that formation.

Conductor casing (9 5/8") will be set at approximately 60'. An 8 ½" bit will then be used to drill to an estimated TD of 2,740', or approximately 200' below the base of the effective porosity of the Minnelusa Formation. . Following logging, formation testing, and fluid sampling, 5 ½" casing will be run and cemented from TD to surface. Proposed drilling, casing, and cementing depths are summarized in Table L-1. A proposed well schematic including completion details for DW No. 3 is presented in Figure M-3.

DW No. 4

The primary objective for DW No. 4 is to be drilled to basement and is to be completed as an injection well in the Deadwood Formation.

After 13 3/8" conductor casing is set at approximately 60', 12 ¼" surface hole will be drilled through the Minnelusa to the top of the Madison at approximately 3,100'. Following openhole logs, 9 5/8" surface casing will be set and cemented from approximately 3,100 to surface. An 8 ½" bit will be used to drill to an estimated TD of 3,530' at the top of the Precambrian basement. Following logging, formation testing, and fluid sampling, 5 ½" casing will be run and cemented from TD to approximately 2,800', or approximately300' above the top of the Madison. The well would be completed in the Deadwood and granite wash. Proposed drilling, casing, and cementing depths are summarized in Table L-1. A proposed well schematic including completion details for DW No. 4 is presented in Figure M-4.

Additional wells will be constructed, logged, and tested as described above.

Nature of Annulus Fluid

In the proposed Dewey-Burdock wells, the annulus space between the injection tubing and the well protection casing will be sealed and filled with fresh water containing a corrosion inhibitor, an oxygen scavenger and a biocide, as needed. Annulus fluids will include Baker Petrolite CRW0037F or Unichem Technihib 366W corrosion inhibitors and bactericides, CRW 132 oxygen scavenger, A-303 corrosion inhibitor, Knockout 50 oxygen scavenger, and Bacban 3 Biocides or suitable equivalents. No permit conditions regarding specific brands or fluid additives are requested or required.

TABLE L-1 Subsurface Well Construction Details

	Site 1		Site 2	
	DW No. 1	**DW No. 2**	**DW No. 3**	**DW No. 4**
Conductor (in)	13 3/8	13 3/8	9 5/8	13 3/8
Depth (ft)	60	60	60	60
Surface Hole (in)	12 1/4	12 1/4	n/a	12 1/4
Depth (ft)	1615	2765	n/a	3100
Surface Casing (in)	9 5/8	9 5/8	n/a	9 5/8
Cement Interval (ft)	0-1615	0-2765	n/a	0-3100
Production Hole (in)	8 1/2	8 1/2	8 1/2	8 1/2
Depth (ft)	2765	3195	2740	3530
Production Casing (in)	7	5 1/2	5 1/2	5 1/2
Cement Interval (ft)	0-2765	2465-3195	0-2740	2800-3530
Open Hole (ft)	6 1/4	n/a	n/a	n/a
Total Depth (ft)	3195	3195	2740	3530
PBTD (ft)	2765	n/a	n/a	n/a
Injection Interval	Minnelusa	Deadwood	Minnelusa	Deadwood

TABLE L-2 List of Proposed Logs for Dewey-Burdock Disposal Wells

Description	Depth Run at DW No. 1 (ft, BGS)	Depth Run at DW No. 2 (ft, BGS)	Depth Run at DW No. 3 (ft, BGS)	Depth Run at DW No. 4 (ft, BGS)
Dual Induction Laterolog Gamma Ray, BHC Sonic, Formation Density, and Caliper Logs (openhole before production casing)	0-1,615	0-2,765	0-2,740	0-3,100
Cement Bond Log (Surface casing)	0-1,615	0-2,765	0-2,740	0-3,100
Dual Indution LateroLog, SP, Gamma Ray, BHC Sonic, Formation Density, Compensated Neutron, and Caliper Log (openhole before production casing)	1615-3195	2765-3195	0-2740	3100-3530
If required, Fracture Finder ID Log (openhole before production casing)	1615-3195	2765-3195	0-2740	3100-3530
Cement Bond Log and Casing Inspection Log (productioncasing)	0-2765	0-3195	0-2740	0-3530
Temperature Log	0-2765	surf-TD	surf-TD	surf-TD
Radioactive Tracer Log*	Production casing	Production casing	Production casing	Production casing
Pressure/Temperature Gradient and Pressure Transient Falloff test	Injection Intervals	Injection Intervals	Injection Intervals	Injection Intervals

Note: all depths are estimated based on area type logs
* RAT run in and approximately 500' above injection zone

M

2.M CONSTRUCTION DETAILS

Submit schematic or other appropriate drawings of the surface and subsurface construction details of the well.

RESPONSE

Figure M-1 presents a schematic of the proposed subsurface construction details of Dewey-Burdock Disposal Well No. 1 (DW No. 1) to be completed in the Minnelusa Formation. Figure M-2 presents the proposed construction of DW No. 2 to be completed in the Deadwood and granite wash. Figure M-3 presents the proposed construction of DW No. 3 to be completed in the Minnelusa Formation. Figure M-4 presents the proposed construction of DW No. 4 to be completed in the Deadwood and granite wash. Figures M-5 and K-1 present details regarding the wellhead and the surface facilities associated with the wells.

Subsurface Well Construction Details

The proposed DW No. 1 will likely be drilled, tested and completed during the year 2011. Drilling of subsequent wells has not been scheduled, but will likely occur in 2011 and following years. Details regarding proposed well construction are presented in Response 2.L.

Surface Well Construction Details

Each proposed wellhead will consist of a standard 7" SOW x 11" 3M or 5 ½" SOW x 7 1/16" 3M casing head or suitable equivalent. The wellhead will include a landing joint with a 2 7/8" slips and pack-off which will act as the upper seal to the 7" x 2 7/8" annulus. There will be two 2" flanged outlets with ball valves or suitable equivalents for access to the annulus. One outlet is to be connected to the annulus fluid system, and the second is to be accessible for annulus fluid sampling and annulus pressure tests. Figure M-5 is a diagram of the proposed wellhead assembly.

Annulus Monitoring System

The proposed annulus monitoring system will consist of an annulus fluid tank with a level indicator or site glass, pressure transducers and gauges, a nitrogen regulator and a nitrogen supply cylinder. The systems will be installed on the wellhead, in the wellhouse building, or in the adjacent facilities building.

1. In addition to the annulus pressure operating and monitoring requirements, an interlock system will be installed to prevent the well from being operated if permit conditions are exceeded or if unsafe conditions exist. Several operating systems will have preset limits, which can be adjusted depending upon specific

Annulus pressure in this system will be maintained with a nitrogen blanket supplied from pressurized nitrogen cylinders. In the event of power failure, positive pressure can still be maintained on the annulus.

A data acquisition system will be used to monitor injection rate, injection pressure, annulus pressure and simultaneous differential pressure. Maximum, minimum and average values for each of the four parameters along with total volume will be recorded at least once every fifteen minutes. Pressure transducers located near the wellhead and downstream of any pumping devices will be used to measure pressures. Flow rate is to be measured utilizing an inline turbine meter and totalizer or equivalent. In the case of a manned operation, well operators will be required to visually inspect the recorder and computer on a weekly basis when injection occurs to verify proper operation. The annulus tank level and any annulus fluid added to the system will be recorded by the well operators.

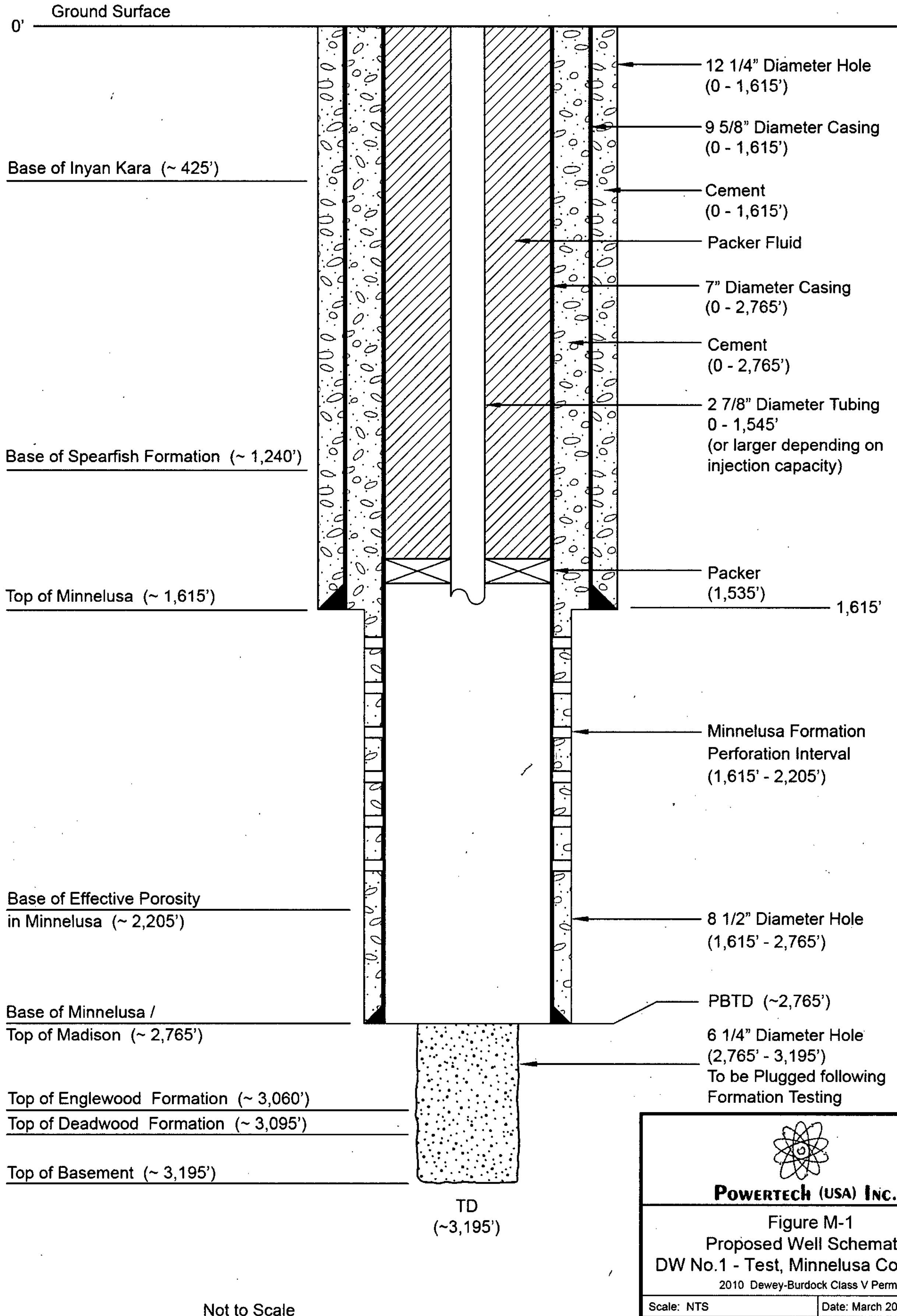
A backup power source (battery) will be used to ensure continuous collection of operating and well alarm data for up a minimum of 30 minutes should power failure occur. In the event that a power failure persists past the ability of the battery systems to allow power, the well will be shut-in, and upon discovery of the shut-in readings will be recorded a minimum of once every day until power is restored to the monitoring equipment.

The annulus tank will have sufficient reservoir capacity to accommodate double the anticipated volume fluctuations due to temperature and pressure limitations. Pressure will be maintained through the use of high-pressure nitrogen cylinders. The cylinders will be replaced and recharged as required. The annulus tank is to be equipped with a level indicator or a full length armored reflex sight glass, a pressure relief valve, and an independent liquid fill nozzle.

In the event that any of the permit conditions are exceeded, including injection pressure or differential pressure a visual alarm light will be illuminated at the well building. In addition, the computerized data acquisition system will be coupled to a telephone autodialer that will send a page to the operator to ensure that the condition is communicated. Upon an alarm condition, injection will be stopped by the operator until the problem is identified, corrected, and the system manually restarted.

Mechanical Integrity

Part I and Part II mechanical integrity demonstrations will be conducted as discussed in Response 2.L and 2.P of this document.



POWERTECH (USA) INC.

Figure M-1
Proposed Well Schematic,
DW No.1 - Test, Minnelusa Completion
2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010
2010_DB_Class_V_Fig_M-01.ai	By: JLM / Checked: HD

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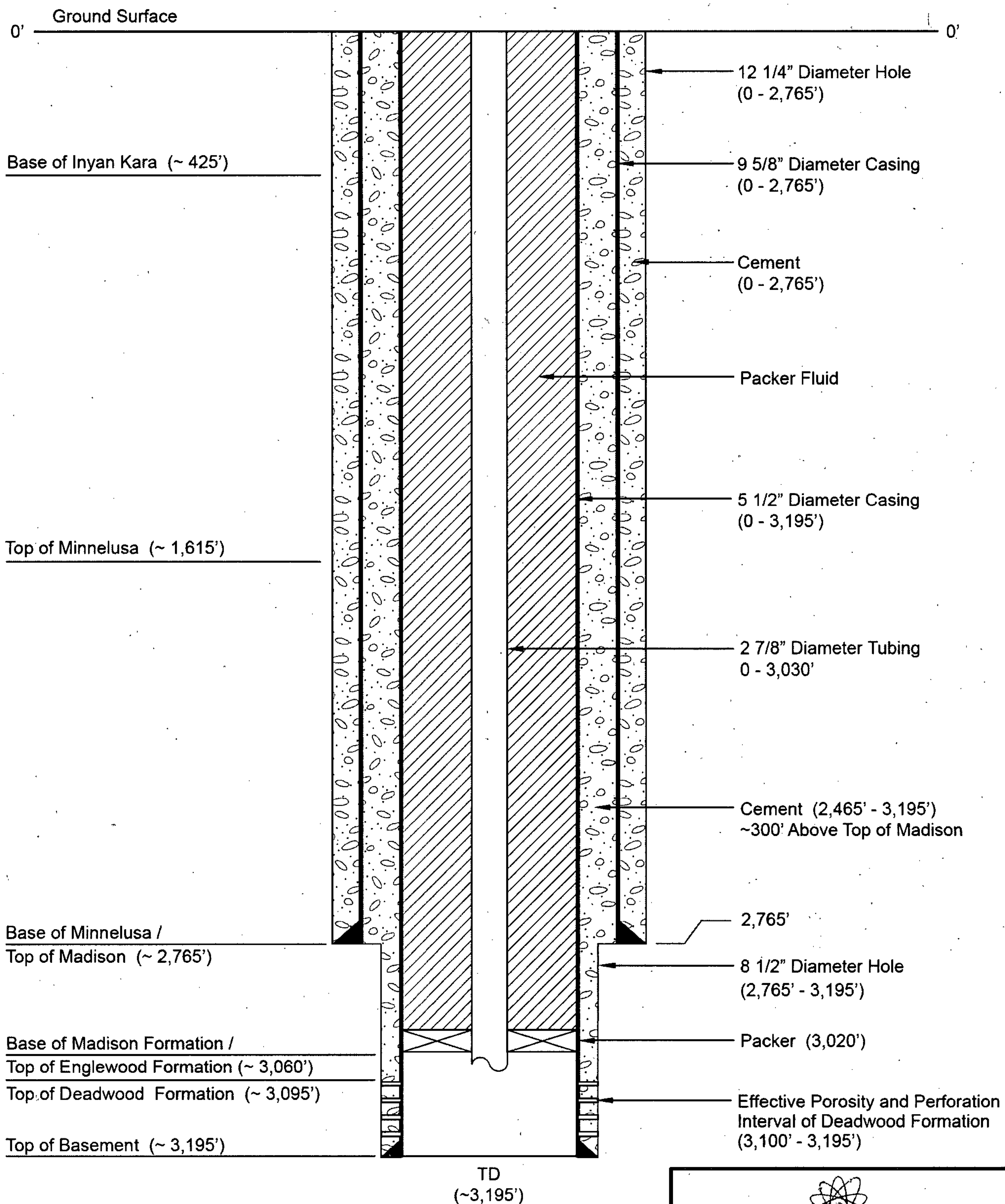

Not to Scale

POWERTECH (USA) INC.

Figure M-2
Proposed Well Schematic,
DW No.2 - Deadwood Completion
2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010	
2010_DB_Class_V_Fig_M-02.ai	By: JLM	Checked: HD

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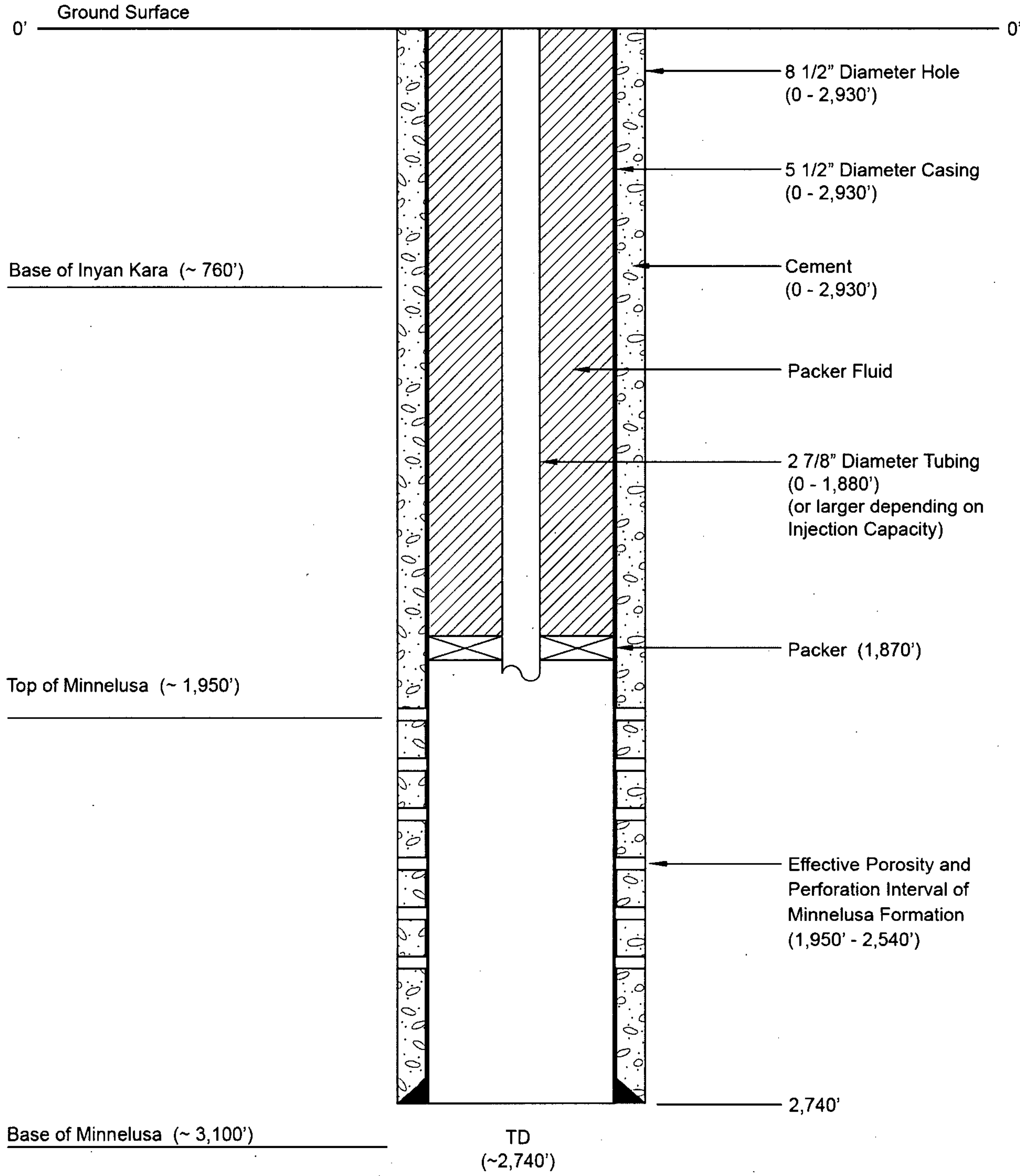

Not to Scale

POWERTECH (USA) INC.

Figure M-3
Proposed Well Schematic,
DW No.3 - Minnelusa Completion

2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010	
2010_DB_Class_V_Fig_M-03.ai	By: JLM	Checked: HD

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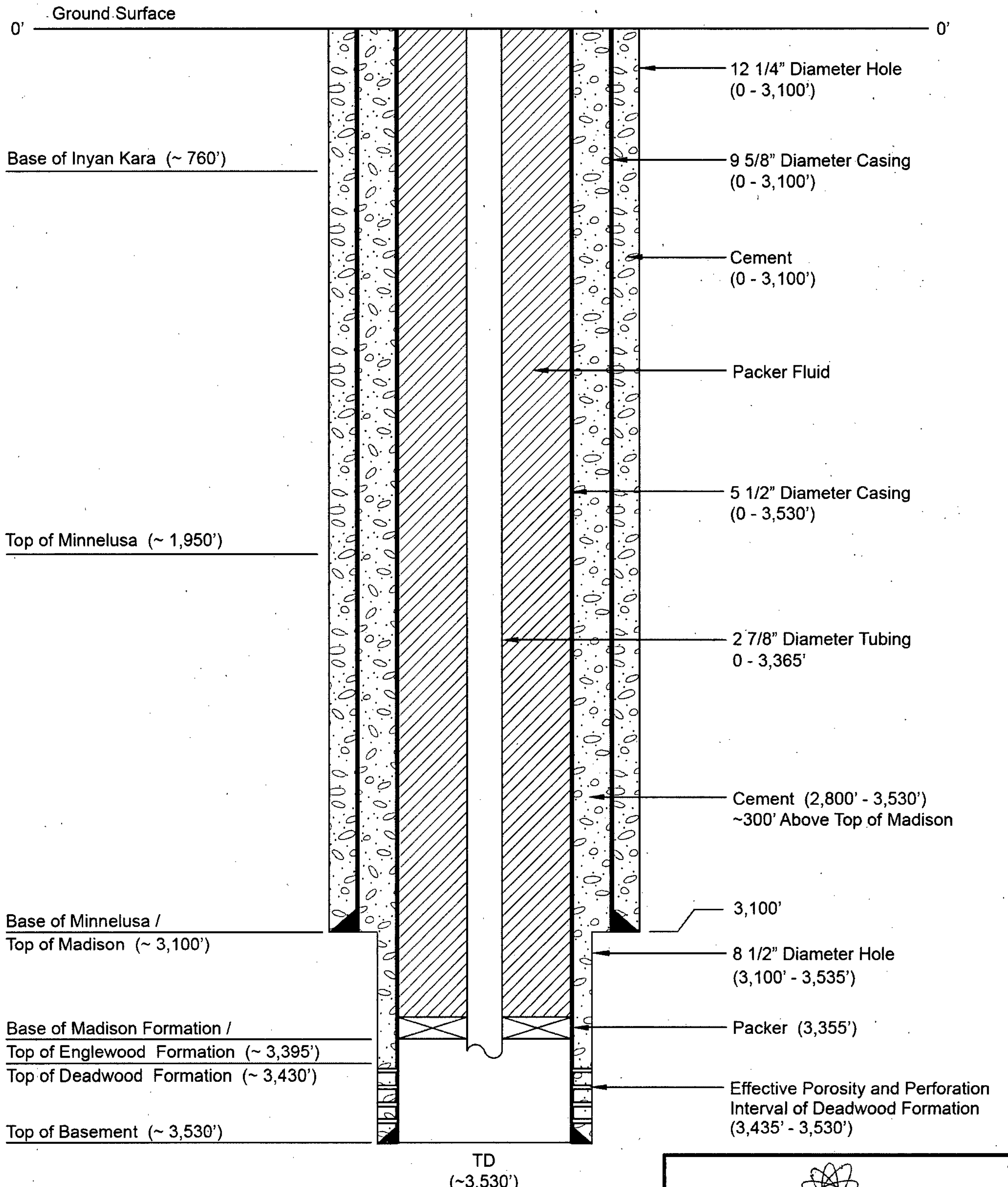

Not to Scale

POWERTECH (USA) INC.

Figure M-4
Proposed Well Schematic,
DW No.4 - Deadwood Completion
2010 Dewey-Burdock Class V Permit

Scale: NTS	Date: March 2010	
2010_DB_Class_V_Fig_M-04.ai	By: JLM	Checked: HD

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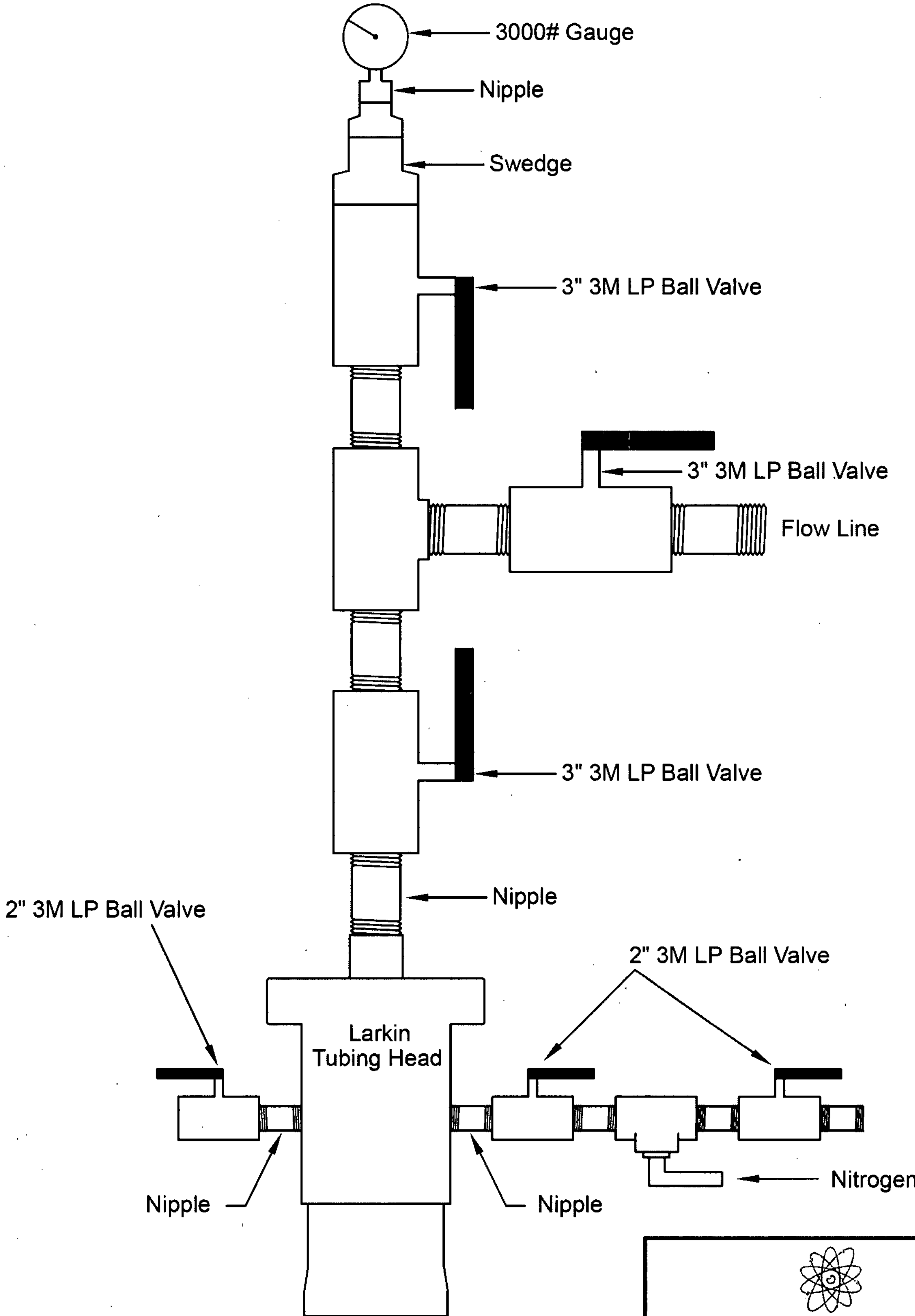

NOT TO SCALE

POWERTECH (USA) INC.

Figure M-5
Preliminary Wellhead Schematic
Dewey Burdock Disposal Wells
2010 Dewey-Burdock Class V Permit

Scale: Not to Scale	Date: March 2010	
2010_DB_Class_V_Fig_m-05.ai	By: JLM	Checked: HD

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N

2.N CHANGES IN INJECTED FLUID

For Class III wells (Not Applicable to this Application)

0

2.O PLANS FOR WELL FAILURES

Outline contingency plans (proposed plans, if any, for Class II) to cope with all shut-ins or well failures, so as to prevent migration of fluids into any USDW.

RESPONSE

The proposed Powertech Dewey–Burdock Disposal Wells will be operated from limited tank storage at common Class I well operating pressures. The following summarizes the plan to address failure of any well to protect the surface environment and prevent migration of injected fluids into any USDW:

Powertech (USA), Inc
Dewey-Burdock Project, South Dakota
Proposed Dewey-Burdock Disposal Wells Contingency Plan

1. Monitoring and periodic routine investigative procedures will be performed on the injection wells as required by applicable laws, permits and regulations. Pertinent data will be reviewed regularly by qualified operators and forwarded to the agencies as required. Monitoring and testing will be designed to assure well integrity and safe operation.

2. If a well fails required continuous monitoring or periodic testing standards, the well will be shut-in and the agency notified according to applicable regulations and permit conditions. After investigation into the cause for the failure, work plans will be prepared and reviewed with the regulators for repairing the problem.

3. If a workover is performed on a well, mechanical integrity testing will be conducted as required by applicable regulations before the well is returned to service. Copies of all work reports and logs will be forwarded to the regulatory agencies per applicable requirements.

4. During the period of time required for a well workover or for shut-ins due to MIT failure, the contingency plans of the facility will include the following:

    a. If shut-in period is sufficiently brief, the fluids accumulated during this period of time will be routed to another well or held in storage at the facility.

    b. If required due to length of shut-in and multiple well failures, mining operations will be altered to reduce wastewater disposal requirements and/or alternate offsite disposal will be arranged.

Should the mode of failure be beyond the limits of economic feasibility to repair, the guidelines for plugging and abandonment in Attachment Q will be followed.

2.P MONITORING PROGRAM

Discuss the planned monitoring program. This should be thorough, including maps showing the number and location of monitoring wells as appropriate and discussion of monitoring devices, sampling frequency, and parameters measured. If a manifold monitoring program is utilized, pursuant to §146.23(b)(5), describe the program and compare it to individual well monitoring.

RESPONSE

The monitoring program proposed for injection operations at this site focuses on the active injection wells themselves. No monitoring program specifically focused on the investigation of injectate containment via dedicated monitor wells is warranted, based on site-specific conditions nor is one proposed. A variety of data will be collected to monitor the injection well operations. This monitoring will take place through utilizing both periodic and continuous techniques.

Mechanical Integrity and Periodic Testing

Periodic monitoring is to be performed to conform to both Part I and Part II mechanical integrity requirements. Annual testing including reservoir monitoring and annulus pressure testing will be conducted once each calendar year in addition to Part II testing which will be performed once each fifth calendar year and will include one of the following logs (temperature, noise, RAT, or oxygen activation) per applicable non-hazardous well regulations. Casing inspection logs may be conducted to investigate corrosion if it is determined to be necessary due to operational or regulatory concerns when tubing is already removed from the borehole during a workover or stimulation.

Annual Part I mechanical integrity testing for the Dewey-Burdock wells will include reservoir monitoring as specified in 40 CFR 146.13 (d) in addition to static or dynamic annulus pressure testing. Although test procedures or methods may be changed based on request of the permittee and approval by Region 8 USEPA staff, the following procedure is expected to be typical for such monitoring. Powertech will provide the agency with a minimum of 30 days notice of annual testing (when practical) to allow the agency to witness testing. Such notice is to include proposed procedures for testing.

1. Conduct Well Site Safety Meeting

   A. Prior to commencement of field activities, conduct safety meeting with contractors and personnel to be involved with field services and MIT testing. Ensure that all safety procedures are understood and review days work activities.

2. Conduct Reservoir (Fall-Off or Static) Pressure Test

   A. For fall-off, record data regarding test well injection at typical operating conditions (constant rate). Rate, temperature and fluid consistency will be recorded during the injection period. Cumulative volume injected should also be recorded. Continue injection for a minimum of approximately 2- 6 hours. Note that significant rate variations may yield poor quality data or require more complicated analysis techniques.

   B. Rig-up pressure gauge and run in well to a depth approved by USEPA consistent with historical measurements.

C. For pressure transient fall-off, obtain final stabilized injection pressure for a minimum of 1 hour. Ensure that the gauge temperature readings have also stabilized.

D. After gauge recordings are stable, cease injection and monitor pressure fall-off. Continue monitoring pressure for a minimum of 6 hours or until a valid observation of fall-off curve is observed. For static survey, the well will be shut-in for a minimum of 24 hours before testing. Static data will be collected by using downhole gauges at an approved depth consistent with past measurements as approved by USEPA.

E. Stop test data acquisition, rig-down and release equipment.

3. Annulus Pressure Test

A. Stabilize well pressure and temperature.

B. As practical, arrangements will be made for a representative from the USEPA to be present to witness this testing.

C. Pressurize annulus to a minimum 100 psi with liquid and shut-in valve. Install certified gauge on "bleed" type valve. The annulus may need to be pressurized and bled off several times to ensure an absence of air. Monitor and record pressure for one hour. Pressure may not fluctuate more than 10 percent during the one-hour test. At the conclusion of the test, lower the annulus pressure to normal operating pressure.

Part II (5 year) mechanical integrity demonstration for the well will be accomplished via an approved test method(s) such as temperature log, or noise log, or oxygen activation log. Powertech (USA), Inc. will provide the agency with a notice of Part II testing to allow the agency to witness data collection activities. Although Powertech may utilize any acceptable method per USEPA Region 8 procedure approval, at this time it is proposed that temperature logging be utilized for future Part II mechanical integrity testing. Differential temperature logging to be conducted as follows:

1. Conduct Differential Temperature Log.

A. Shut-in well for stabilization (minimum of 24 hours) prior to running base temperature log.

B. Rig-up temperature log and run base log from approximately 500' above the injection zone to total depth. Pull tool to surface and shut-in master valve.

C. Rig down equipment and return the well to normal operations.

Continuous and Operational Monitoring

The proposed wells will have one long string protective casing extending into the injection interval with cement isolating all permeable intervals. As previously noted in this document, the annulus area between the protective casings and injection tubing string is to be filled with treated fresh water. The annulus pressure is to be continually monitored to detect any leaks in the tubing or casing. If leaks develop during injection, pressurized annulus fluid would be injected into the permitted injection interval, and injected fluids would not be able to contact the production string casing above the permitted injection zone. Injectate should therefore have no potential for leakage into un-permitted formations. Details regarding the proposed system components are provided in Attachments L and M of this document.

Monitoring of physical parameters associated with injection operations will be conducted pursuant to 40.CFR.146 regulations. At a minimum the monitoring will include, injection pressure, annulus pressure, injection rate, injection volume, annulus level, and injectate characteristics. Details regarding this monitoring follow. Automatic shutdown capability as specified in Attachment K of this document will be operated to ensure that maximum pressure or minimum annulus differential requirements are not exceeded.

Annulus and Injection Pressure

Both the injection pressure and the annulus pressure are to be recorded continuously for each well. Electronic pressure transducers will be placed in pressure taps on the annulus system and injection flow lines. A signal will be sent from these transducers to a digital recorder and/or a chart recorder. The automated control system data will be visually inspected a minimum of once daily for anomalies when the well is operating. As part of the process and controls, the monitoring system will record maximum, minimum and average information. Differential pressures are to be obtained by comparison of simultaneous readings of the annulus and injection pressure transducer readings obtained for the wells.

Injection Rate and Volume

The flow rate to each well will be determined by a liquid flow meter designed for continuous monitoring. Flow rate is to be measured in the flow line to each well. The instrument will send signals to the process control system that calculates cumulative volume. Powertech reserves the right to substitute equivalent or superior equipment to fulfill these data measurement functions at any time.

Annulus Tank Levels

The annulus tank in each well system will have sufficient reservoir capacity to accommodate the anticipated volume fluctuations due to operating temperature and pressure limitations. The annulus tank is to be equipped with an armored reflex sight glass, pressure relief valve and independent liquid fill nozzle. If any annulus fluid is added, it will be recorded by the well operators on an operator log sheet. Annulus tank level is to be recorded a minimum of weekly when injection occurs.

Waste Characterization and Analysis

Injectate characteristics will be monitored by collecting samples per the approved waste analysis plan entered as part of the administrative record for this permit. The waste analysis to be conducted is intended to provide representative data regarding average injectate chemical constituents.

WASTE ANALYSIS PLAN

(WAP)

Powertech (USA) Inc.

Dewey-Burdock Project

Custer and Fall River Counties, South Dakota

March 2010

TABLE OF CONTENTS

1.0 INTRODUCTION

1.A. Background

The purpose of this Waste Analysis Plan (WAP) is to characterize the non-hazardous wastewater that will be injected into the proposed new Powertech (USA) Inc. (Powertech) Dewey-Burdock Disposal Wells at the Dewey-Burdock Project, South Dakota. Powertech will be responsible for ensuring this WAP is implemented. The wells are proposed as non-hazardous, non-commercial Class V industrial disposal wells that are to be dedicated to the injection of fluids generated in association with in-situ leach (ISL) uranium mining.

Powertech will operate the wells under this Waste Analysis Plan in accordance with Title 40 of the Code of Federal Regulations (40 CFR), Section 146.13 that requires operators of Class I (and likely Class V) underground injection wells to monitor and analyze the fluids injected into the well "to yield representative data of their characteristics." This Waste Analysis Plan has been prepared to fulfill the specifications of 40 CFR 146.68 such that the plan presents parameters for which the waste will be analyzed, methods that will be used to test for these parameters, and methods that will be used to obtain representative samples of the waste to be analyzed.

1.B. Waste Source

This WAP applies to wastes that are non-hazardous under the Resource Conservation and Recovery Act (RCRA). The anticipated water chemistry of the injected waste stream is presented in the table below. This table was excerpted from NUREG-0489 and represents a typical waste stream for an ISL facility. Minor concentrations of corrosion inhibitors, scale inhibitors, and/or biocides may be used as needed to maintain the wells in optimum condition.

Table 2.7-3. Estimated Flow Rates and Constituents in Liquid Waste Streams for the Highland *In-Situ* Leach Facility*

	Water Softener Brine	Resin Rinse	Elution Bleed	Yellowcake Wash Water	Restoration Wastes
Flow Rate, gal/min	1	<3	3	7	450
As, ppm					0.1–0.3
Ca, ppm	3,000–5,000				
Cl, ppm	15,000–20,000	10,000–15,000	12,000–15,000	4,000–6,000	
CO_3, ppm		500–800			300–600
HCO_3, ppm		600–900			400–700
Mg, ppm	1,000–2,000				
Na, ppm	10,000–15,000	6,000–11,000	6,000–8,000	3,000–4,000	380–720
NH_4, ppm			640–180		
Se, ppm					0.05–0.15
Ra-226, pCi/L	<5	100–200	100–300	20–50	50–100
SO_4, ppm					100–200
Th-230, pCi/L	<5	50–100	10–30	10–20	50–150
U, ppm	<1	1–3	5–10	3–5	<1
Gross Alpha, pCi/L					2,000–3,000
Gross Beta, pCi/L					2,500–3,500

*NRC. NUREG–0489, "Final Environmental Statement Related to Operation of Highland Uranium Solution Mining Project, Exxon Minerals Company, USA." Washington, DC: NRC. November 1978.

The wastes consist of operational and restoration bleed streams and liquid waste from plant processes from ISL uranium mining operations, including but not limited to: normal overproduction (wellfield bleed) streams, yellowcake wash water, bleed from eluant and precipitation circuits, sumps, membrane cleaning solutions, laboratory waste, reverse osmosis brine, groundwater sweep solutions and plant washdown water from the Dewey-Burdock Project. Dewey-Burdock operation wastes will be generated by operations covered under a pending South Dakota Department of Environment and Natural Resources (DENR) Permit to Mine, EPA and DENR Class III UIC Permits, a BLM Plan of Operations, and a pending U.S. Nuclear Regulatory Commission (NRC) Source Material License. These waste streams are benefication wastes, exempt from RCRA regulation under the Bevill Amendment found in 40 CFR 261.4(b)(7).

2.0 PROCEDURES

2.A. Waste Collection and Volume Monitoring

Gathering flowlines will be directed to collection tanks at the site, and on occasion, vacuum trucks or other equipment utilized for remediation activities at the site will transfer fluid into a collection tank. Transfer from trucks will only be conducted with a trained operator physically present on site.

As discussed in the main text of the Class V permit application, a recorder will be utilized to continuously monitor injection pressure, annulus pressure, flow rate and totalized cumulative volumes. A summary of recorded data will be provided to the EPA per applicable permit requirements. Records of (1) daily volume of any fluids managed at the facility will be recorded and (2) a total monthly volume of injectate calculated based on data maintained in the records will be noted in the monthly well reports made to EPA.

2.B. Waste Characterization

At a minimum, the following composition parameters will be monitored once quarterly for any quarterly period that fluid is injected. These parameters shall include:

pH
total dissolved solids
total suspended solids
specific gravity
arsenic
barium
bicarbonate alkalinity
calcium
chloride
iron
lead
mercury
radium-226
selenium
sodium
sulfate
thorium-230
uranium
vanadium

For the purpose of this Waste Analysis Plan, the first quarter shall be considered the first three calendar months of the year, and the remaining quarters shall be considered subsequent divisions of the year into three-month segments. If fluids are not injected into the Dewey-Burdock Disposal Wells during a calendar year, sample or analyses will be required.

2.C. Sampling and Analysis

Powertech, or contracted personnel will collect necessary waste stream samples. All sampling procedures will be conducted at the direction of the selected, certified analytical laboratory and in accordance with acceptable US EPA procedures. The sampler's name, sampling point, and date sampled will be documented in chain-of-custody paperwork. Samples will be collected with the grab method.

The table included below summarizes the analytical method and sampling frequency for typical parameters that may be included in the waste sampling for a particular waste source.

WASTE SAMPLING METHODS

Test Parameter	Test Method	Units
Total Dissolved Solids, TDS	EPA 160.1	mg/L
Total Suspended Solids, TSS	EPA 160.2	mg/L
Specific Gravity	ASTM2710F	-
Sodium	EPA 6010 B	mg/L
Calcium	EPA 6010 B	mg/L
Bicarbonate	EPA 310.1	mg/L
Sulfate	EPA 300.0	mg/L
Chloride	EPA 325.3	mg/L
Iron (Fe)	EPA 200.7	mg/L
Mercury (Hg)	EPA 7470	mg/L
Arsenic (As)	EPA 6010 B	mg/L
Corrosivity (D002)	SW-846 1110,9045	pH units
pH	EPA 150.1	pH units
Barium	EPA 6010 B	mg/L
Lead	EPA 239.2	mg/L
Radium	EPA 903.0	pCi/L
Selenium	EPA 270.2	mg/L
Thorium	ATSM D3972-90M	mg/L
Uranium	ATSM D3972-90M	μg/L
Vanadium	EPA 6010 B	mg/L

Note: Powertech reserves the right to select use of the cited method or method with equal or greater detection limit

Samples will be collected from a sample tap in the flowline downstream of final filtration or from a sample tap at the wellheads.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

3.A. General Sampling and Analytical Information

The sampling protocol will be followed by properly trained personnel conducting the sample collection and analysis. Powertech will adhere to guidelines set forth in "Test Methods for Evaluating Solid Waste", SW-846 and 'Methods for Chemical Analysis of Water and Wastes", EPA 600/4-79/020 as appropriate. Approved sample preservation techniques from 40 CFR 136.3 will be followed as appropriate. These will include preservation in plastic or glass sample containers provided by the laboratory and storage in a sample refrigerator or cooler for shipment to the laboratory. Powertech reserves the option to choose suitable laboratories for testing provided equivalent quality assurance/quality control (QA/QC) standards are met.

Standard chain of custody protocols will be followed for waste collection, transport and analysis. Below are summaries of the minimum sampling and analysis protocols which will be followed for each characterization parameter:

Labeling

1. Sample name, date and time
2. Name of sample collector; (include sampling company name if not Powertech);
3. Sample collection method;
4. Sample collection point;

Reporting

1. Sample preservation technique, as appropriate;
2. Analytical method for parameter detection/quantification;
3. Analytical method accuracy and quantification limits; and
4. Field documentation of sampling.

The following are QA/QC parameters which will be followed to ensure the adequacy of the sampling and analytical techniques for wellhead sampling and analysis described in this plan.

3.B. Sampling Controls

1. Equipment Blanks

If possible, quarterly grab samples will be obtained directly from the sample tap or valve being used to access the tank or containment vessel and not be transferred to any secondary container or device before being stored in the sample container to be shipped to the laboratory. In this case, no equipment blanks will be required. If not, equipment blanks will be taken as deemed appropriate by Powertech for the purpose of detecting potential cross contamination due to improper decontamination of sampling equipment. After sampling, any secondary container or sampling device used will be decontaminated according to the sampling plan protocol. The sampling device will then be rinsed with deionized water and the rinsate collected in a sample container for transport to the laboratory for analysis of, at a minimum, the same parameters chosen in the sampling plan above.

2. Trip Blanks

In the case of suspect analysis from any laboratory, trip blanks will be used and will be sample containers filled with Type II reagent grade water at the laboratory, sealed at the laboratory, which accompany the sample containers used throughout the sampling event. The sample containers shall be handled in the same manner as the samples. Trip blank(s) will be sent to the laboratory for analysis of, at a minimum, the same parameters chosen in the sampling plan above. A minimum of one (1) trip blank per sampling event will be utilized, if necessary.

3. Sample Duplicates

On advance written demand of EPA, duplicate samples will be taken to assess the QA/QC of the laboratory conducting the analysis. Such samples will be drawn from the same site from which primary samples are taken. Duplicate samples, if taken, will be split from the original sample in a manner to emphasize sample representativeness. The duplicate will be labeled with a sample number that will not conflict with the other samples, but will not be discernable to the laboratory as a duplicate sample. If requested by EPA, one duplicate sample per sampling event will be taken and analyzed for the same parameters listed in the sampling plan.

4. Sample Chain-of-Custody Protocol

Sample chain-of-custody will be followed at all times during the sampling and subsequent analysis. Chain-of-custody will be used to document the handling and control necessary to identify and trace a sample from collection to final analytical results.

3.C. Analytical Controls

1. Equipment Calibration

Selected laboratories will maintain QA/QC data in accordance with that laboratory's Q/A plan regarding the frequency and type of instrument calibration performed at the laboratory and in the field. Any calibration of thermometers, gauges, chromatographs, spectrometers and other meters will be conducted according to appropriate instrument manufacturer specifications and manufacturer recommended frequencies or as dictated by applicable laboratory Q/A plans.

2. Data Reduction

The process of transcription of the raw data into the reportable units will be conducted by the laboratory in accordance with that laboratory's Q/A plan. Data reduction utilized in the analysis and reporting process will be presented in the reports to the US EPA for each sampling event and parameter tested by the specific laboratory used at the time.

3. Data Verification

Data verification will be conducted in accordance with the selected laboratory's Q/A plan after each sampling event by assigned laboratory personnel. Typical procedures will include review of chain-of-custody forms, equipment calibration records and data completeness. Spot checks of raw data versus reported data may be performed to review math accuracy, significant numbers and reporting units. In addition, certified laboratory standard quality assurance/quality control checklists will be utilized per the selected laboratory's Q/A plan for individual test methods such as blanks, standards, and comparisons of internal lab test duplicate results. Problems with any of these items will be indicated in the report to the agency.

4. Internal Quality Control

Certified quality control samples may be run periodically in accordance with the selected laboratory's Q/A plan with sample batches obtained from appropriate commercial sources, or appropriate regulatory entities. Internal quality control will be addressed as required by the selected laboratory's Q/A plan and will typically include disclosure of the laboratory's use of blanks, blind standards, matrix spikes and matrix spike duplicates, preparation of reagents, and laboratory duplicate or replicate analyses.

3.D. Actions

1. Corrective Actions

Corrective actions will be implemented by laboratories if the analytical or sampling method does not achieve laboratory standards or Powertech objectives. Actions may entail re-sampling the waste stream and/or re-analyzing the fluid for a particular parameter, re-calibrating an analytical device, or other appropriate actions. Action levels will be taken in accordance with SW 846 or other approved EPA methods.

2. Reports to US EPA, Region 8 and DENR

Reports to US EPA will contain results, data and sampling descriptions regarding the accuracy, completeness and repeatability of the reported analytical results. The report will contain a table that specifies the type of sample (blank, waste, etc.), sampling date, sampling location, analytical method, method detection limit and analytical result. The results of analyses and all accompanying data, including chain-of-custody forms, will be reported to US EPA with the next monthly operating report submitted to the agency after the receipt of the final sample analysis report from the laboratory. This submittal to the agency will typically be within sixty (60) days of the sampling event, unless prior arrangements have been made with the agency due to conditions beyond the control of the operator that prohibit such reporting.

Q

2.Q PLUGGING AND ABANDONMENT PLAN

Submit a plan for plugging and abandonment of the well Including (1) describe the type, number, and placement (including the elevation of the top and bottom) of plugs to be used; (2) describe the type, grade, and quantity of cement to be used; and (3) describe the method to be used to place plugs, including the method used to place the well in a state of static equilibrium prior to placement of the plugs. Also, for a Class III well that underlies or is in an exempted aquifer, demonstrate adequate protection of USDWs. Submit this information on USEPA Form 7520-14, Plugging and Abandonment Plan.

RESPONSE

The following completed copies of US EPA Form 7520-14 and Plugging and Abandonment Plan, are submitted to satisfy this requirement. The modifications made to this form are to provide consistency with all available and current information. Costs based on recent third party estimates which are associated with the plugging and abandonment of the wells per the following procedures are presented in the completed plugging forms, Table Q-1, and in Response 2.R of this document.

The following is the proposed plan for plugging and abandonment of the proposed Powertech non-hazardous Dewey-Burdock Disposal Wells. Note that cement volume is based on the well with the largest casing capacity (DW No. 1) and would be less than stated herein for DW Nos. 2, 3, 4, and additional disposal wells. Plugging assumes filling casing with cement from top to bottom.

1. Install a test gauge on the annulus to perform a static pressure test. Ensure that the annulus is fluid filled and that the well has been shut-in for a minimum of 24 hours. Pressurize annulus to approximately 500 psig and isolate from the annulus system. Monitor annular pressure for one hour. The test will be successful if the pressure change is less than 10 percent of the starting pressure.

2. Prepare well and location for plugging. Remove wellhouse, well monitoring equipment and wellhead injection piping.

3. Move in and rig-up workover rig, mud pump, circulating pit and pipe racks as necessary. Flush well with approximately 100 bbl of brine.

4. Remove wellhead and release slips.

5. Release injection packer. Displace annular fluid from well into injection formation by flushing with approximately 100 bbl of brine.

6. Pull and lay down the injection tubing and packer.

7. Pump approximately 384 sacks (calculated for disposal well with largest casing capacity) of Class A cement with 4 percent bentonite (14.1 ppg, 1.55 cf/sx yield) into cased hole in 2 – 3 stages from the bottom up.

8. Cut off wellhead approximately 3' BGL and weld cap with permanent marker on casing.

9. Rig down and move out pulling unit and equipment.

10. Submit required plugging records to USEPA and SD DENR

Post-Closure Care Requirements

Powertech will provide notification of closure for the Class V wells to USEPA, Region 8, the SD DENR and the local zoning authorities. Included with the notification will be information regarding the nature of the historic injected waste stream, identification of the depths of the injection and confining zones, well schematics and plugging records. Powertech will retain, for a period of three years following the Class V well closure, records reflecting the nature, composition and volume of all injected fluids. Upon request of the director of USEPA, Region 8, Powertech will then deliver the records to the director at the conclusion of the retention period, or dispose of such records.

FORM 7520-14 PROPOSED WELL PLUGGING AND ABANDONMENT

OMB No. 2040-0042 Approval Expires 12/31/2011

EPA

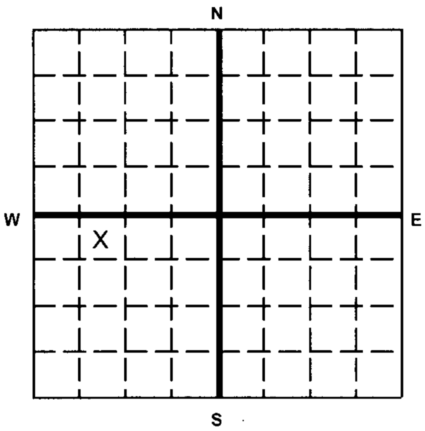
United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
Dewey-Burdock Disposal Well No. 1 (DW No. 1)
310 2nd Avenue, Edgemont, SD, 57735

Name and Address of Owner/Operator
Powertech (USA), Inc.
5575 DTC Parkway, Suite 140, Greenwood Village, CO, 80111

Locate Well and Outline Unit on Section Plat - 640 Acres



State: South Dakota
County: Fall River
Permit Number: TBD

Surface Location Description
☐ 1/4 of ne 1/4 of nw 1/4 of sw 1/4 of Section 2 Township 7S Range 1E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location 845 ft. frm (N/S) S Line of quarter section
and 998 ft. from (E/W) W Line of quarter section.

TYPE OF AUTHORIZATION
- ☐ Individual Permit
- ☑ Area Permit
- ☐ Rule

Number of Wells 4-8

Lease Name: Dewey-Burdock

WELL ACTIVITY
- ☐ CLASS I
- ☐ CLASS II
  - ☐ Brine Disposal
  - ☐ Enhanced Recovery
  - ☐ Hydrocarbon Storage
- ☐ CLASS III

Well Number: TBD

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
7	26	2765	2765	6.276

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- ☐ The Balance Method
- ☐ The Dump Bailer Method
- ☐ The Two-Plug Method
- ☑ Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	6.276						
Depth to Bottom of Tubing or Drill Pipe (ft	2765						
Sacks of Cement To Be Used (each plug)	383						
Slurry Volume To Be Pumped (cu. ft.)	594						
Calculated Top of Plug (ft.)	0						
Measured Top of Plug (if tagged ft.)							
Slurry Wt. (Lb./Gal.)	14.1						
Type Cement or Other Material (Class III)	Class A						

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
Perforated Interval: 1615'	2205'		

Estimated Cost to Plug Wells
$100,000

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possiblity of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Richard Blubaugh, Vice President - Environmental		

OMB No. 2040-0042 Approval Expires 12/31/2011

EPA

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Dewey-Burdock Disposal Well No. 2 (DW No. 2) 310 2nd Avenue, Edgemont, SD, 57735	Powertech (USA), Inc. 5575 DTC Parkway, Suite 140, Greenwood Village, CO, 80111

Locate Well and Outline Unit on Section Plat - 640 Acres

N

W X E

S

State	County	Permit Number
South Dakota	Fall River	TBD

Surface Location Description

1/4 of ne 1/4 of nw 1/4 of sw 1/4 of Section 2 Township 7S Range 1E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location 796 ft. frm (N/S) S Line of quarter section
and 1019 ft. from (E/W) W Line of quarter section.

TYPE OF AUTHORIZATION

- [ ] Individual Permit
- [x] Area Permit
- [ ] Rule

Number of Wells 4-8

Lease Name Dewey-Burdock

WELL ACTIVITY

- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number TBD

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
5.5	17	3195	3195	4.892

METHOD OF EMPLACEMENT OF CEMENT PLUGS

- [ ] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [x] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	4.892						
Depth to Bottom of Tubing or Drill Pipe (ft	3195						
Sacks of Cement To Be Used (each plug)	270						
Slurry Volume To Be Pumped (cu. ft.)	418						
Calculated Top of Plug (ft.)	0						
Measured Top of Plug (if tagged ft.)							
Slurry Wt. (Lb./Gal.)	14.1						
Type Cement or Other Material (Class III)	Class A						

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
Perforated Interval: 3100'	3195'		

Estimated Cost to Plug Wells

$100,000

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possiblity of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Richard Blubaugh, Vice President - Environmental		

OMB No. 2040-0042 Approval Expires 12/31/2011

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Dewey-Burdock Disposal Well No. 3 (DW No. 3) 310 2nd Avenue, Edgemont, SD, 57735	Powertech (USA), Inc. 5575 DTC Parkway, Suite 140, Greenwood Village, CO, 80111

Locate Well and Outline Unit on Section Plat - 640 Acres

N

W E

X

S

State	County	Permit Number
South Dakota	Custer	TBD

Surface Location Description

[ ] 1/4 of se 1/4 of nw 1/4 of sw 1/4 of Section 29 Township 6S Range 1E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location 430 ft. frm (N/S) S Line of quarter section
and 1021 ft. from (E/W) W Line of quarter section.

TYPE OF AUTHORIZATION

- [ ] Individual Permit
- [x] Area Permit
- [ ] Rule

Number of Wells 4-8

Lease Name Dewey-Burdock

WELL ACTIVITY

- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number TBD

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
5.5	17	2740	2740	4.892

METHOD OF EMPLACEMENT OF CEMENT PLUGS

- [ ] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [x] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	4.892						
Depth to Bottom of Tubing or Drill Pipe (ft	2740						
Sacks of Cement To Be Used (each plug)	231						
Slurry Volume To Be Pumped (cu. ft.)	358						
Calculated Top of Plug (ft.)	0						
Measured Top of Plug (if tagged ft.)							
Slurry Wt. (Lb./Gal.)	14.1						
Type Cement or Other Material (Class III)	Class A						

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
Perforated Interval: 3100'	3195'		

Estimated Cost to Plug Wells

$100,000

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibliity of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Richard Blubaugh, Vice President - Environmental		

OMB No. 2040-0042 Approval Expires 12/31/2011

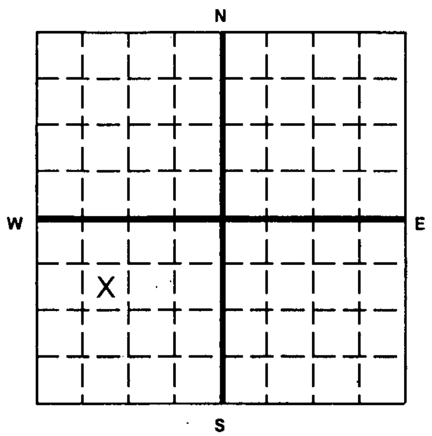
EPA

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Dewey-Burdock Disposal Well No. 4 (DW No. 4) 310 2nd Avenue, Edgemont, SD, 57735	Powertech (USA), Inc. 5575 DTC Parkway, Suite 140, Greenwood Village, CO, 80111

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
South Dakota	Custer	TBD

Surface Location Description

___ 1/4 of se 1/4 of nw 1/4 of sw 1/4 of Section 29 Township 6S Range 1E

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface
Location 395 ft. frm (N/S) S Line of quarter section
and 1057 ft. from (E/W) W Line of quarter section.

TYPE OF AUTHORIZATION

- [ ] Individual Permit
- [x] Area Permit
- [ ] Rule

Number of Wells 4-8

Lease Name Dewey-Burdock

WELL ACTIVITY

- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number TBD

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
5.5	17	3530	3530	4.892

METHOD OF EMPLACEMENT OF CEMENT PLUGS

- [ ] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [x] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	4.892						
Depth to Bottom of Tubing or Drill Pipe (ft	3530						
Sacks of Cement To Be Used (each plug)	297						
Slurry Volume To Be Pumped (cu. ft.)	461						
Calculated Top of Plug (ft.)	0						
Measured Top of Plug (if tagged ft.)							
Slurry Wt. (Lb./Gal.)	14.1						
Type Cement or Other Material (Class III)	Class A						

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
Perforated Interval: 3435'	3530'		

Estimated Cost to Plug Wells

$100,000

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
Richard Blubaugh, Vice President - Environmental		

TABLE Q-1 Estimated Plugging Cost for Dewey-Burdock Disposal Wells

FIELD OPERATIONS	Unit Cost	Units Req'd.	Total Cost
Subcontractors - Direct bill to Powetech			
Mob/demob & Location Preparation	$6,000	1	$6,000
Workover Rig and Associated Equipment (days)	$5,000	4	$20,000
Rental Tools (days)	$2,500	4	$10,000
Rental Tubing Inspection	$6,000	1	$6,000
Falloff Test	$6,500	1	$6,500
RAT Log	$4,500	1	$4,500
Trucking	$4,000	1	$4,000
Contract Labor	$2,000	2	$4,000
Cement (384 sx), pumping & equipment	$9,600	1	$9,600
Contingency	$8,000	1	$8,000
Total Estimated Subcontractor Charges			$78,600
Test Design and Project Management (hours)	$115	24	$2,760
Supervision (days)	$850	5	$4,250
Travel (hours)	$115	8	$920
Field Truck and Fuel (days)	$150	6	$900
Per Diem (days)	$100	6	$600
Data Analysis (lump sum)	$2,000	1	$2,000
Report Preparation (hours)	$115	24	$2,760
Total Estimated Petrotek Charges			$14,190
TOTAL ESTIMATED COST PER WELL			**$92,790**
TOTAL ESTIMATED COST FOR FOUR WELLS			**$371,160**

Assumptions:

P&A costs are for well with largest casing capacity (DW No. 1); other P&A costs would be lower
Subcontractors will bill Powertech directly - otherwise a 12.5% markup will apply.
Field activities can be completed in 5 days; otherwise T&M rates will apply.
Falloff test is required if > 6 months since last test; RAT log required if > 2 years since last log.
The well is cemented from bottom to top in 2 - 3 stages.
Powertech will be responsible for disposal of all well equipment.

R

2.R NECESSARY RESOURCES

Submit evidence such as a surety bond or financial statement to verify that the resources necessary to close, plug, or abandon the well is available.

RESPONSE

Powertech will provide a surety instrument equal to the estimated cost for plugging and abandonment of the proposed disposal wells as a condition prior to the commencement of construction. A detailed plugging and abandonment estimate is presented as Table Q-1. The annual updates of Powertech's financial surety estimate will be reviewed and approved by both the USEPA and the U.S. Nuclear Regulatory Commission once a license is issued.

With respect to continued demonstration of financial assurance, the surety instrument will be maintained as required by applicable regulations. Within ninety (90) days after the close of each fiscal year, the permittee will obtain verification that the amount used for financial assurance is sufficient to address updated plugging and abandonment costs and will submit updated financial assurance information if the cost of plugging and abandonment has exceeded the existing financial assurance. In such an event, the information submitted to the Director will consist of a letter from the permittee regarding the change in the financial assurance requirements, verification from the appropriate financial institution regarding the increased financial assurance and a copy of the independent geologist or engineering estimate of the updated plugging and abandonment costs.

S

2.S AQUIFER EXEMPTIONS

If an aquifer exemption is requested, submit data necessary to demonstrate that the aquifer meets the following criteria: (1) does not serve as a source of drinking water; (2) cannot now, and will not in the future, serve as a source of drinking water; and (3) the TDS content of the ground water is more than 3,000 and less than 10,000 mg/l and is not reasonably expected to supply a public water system. Data to demonstrate that the aquifer is expected to be mineral or hydrocarbon producing, such as general description of the mining zone, analysis of the amenability of the mining zone to the proposed method, and time table for proposed development must also be included. For additional information on aquifer exemptions, see 40 CFR 144.7 and 146.04.

RESPONSE

Based on available information at this time, no aquifer exemption is requested for the injection zones at this site. All formations of the injection zone are expected to contain brines with TDS concentrations in excess of 10,000 mg/l. As discussed in Response 2.L, laboratory analyses of fluid samples taken from the Minnelusa and Deadwood Formations will be submitted as part of the completion reports for these wells.

2.T EXISTING EPA PERMITS

List program and permit number of any existing EPA permits, for example. NPDES, PSD, RCRA, etc.

RESPONSE

Powertech (USA) Inc. currently retains no permits for the South Dakota facility. As facility construction is pursued, applicable permits will be obtained as necessary.

U

2.U DESCRIPTION OF BUSINESS

Give a brief description of the nature of the business.

RESPONSE

This UIC Permit application is being submitted by Powertech (USA) Inc., a South Dakota Corporation and a USA subsidiary of the Canadian parent company, Powertech Uranium Corporation. Powertech Uranium Corp. is a mineral exploration and development company that, through its Denver-based subsidiary, Powertech (USA) Inc., holds the Dewey-Burdock uranium deposit in South Dakota, the Centennial Project in Colorado and the Dewey Terrace and Aladdin projects in Wyoming. The company's key personnel have over 200 years of combined experience in the uranium industry throughout the United States, and have permitted more than a dozen *in situ* recovery operations in the United States for production. For more information, refer to the Powertech website at http://www.powertechuranium.com.

The corporate office is located in Vancouver, British Columbia and the United States headquarters office is located in Greenwood Village, Colorado. Powertech maintains an exploration office in Hot Springs, South Dakota and operations offices in Wellington, Colorado and Edgemont, South Dakota (addresses shown below). Powertech is a publicly traded company on the Toronto Stock Exchange (TSX) as PWE and the Frankfurt Stock Exchange as P8A.

COLORADO-DTC Powertech (USA) Inc. 5575 DTC Parkway, Suite 140 Greenwood Village, CO 80111	SOUTH DAKOTA EDGEMONT Powertech (USA) Inc. 310 2nd Avenue P.O. Box 812 Edgemont, SD 57735	NEW MEXICO Powertech (USA) Inc. 8910 Adams Street NE Albuquerque, NM 87113
COLORADO WELLINGTON Powertech (USA) Inc. 8305 6th Street P.O. Box 1066 Wellington, CO 80549	SOUTH DAKOTA HOT SPRINGS Powertech (USA) Inc. 145 N. Chicago, Suite C P.O. Box 723 Hot Springs, SD 57747	

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Downey, J.S., 1986. *Geohydrology of bedrock aquifers in the northern Great Plains in parts of Montana, North Dakota, South Dakota, and Wyoming.* U.S. Geological Survey Professional Paper 1402-E.

Driscoll, D.G., J.M. Carter, J.E. Williamson, and L.D. Putnam. 2002. *Hydrology of the Black Hills Area, South Dakota.* U.S. Geological Survey Water-Resources Investigations Report 02-4094.

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PERMIT APPLICATION APPENDICES

APPENDIX A

DENR LETTER

South Dakota
GREAT FACES. GREAT PLACES.

received
3/1/2010

DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES
PMB 2020
JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3182
www.state.sd.us/denr

February 23, 2010

Mr. Richard E. Blubaugh
Vice President EH&S Resources
Powertech (USA) Inc.
5575 DTC Parkway, Suite 140
Greenwood Village, CO 80111

Re: Dewey-Burdock Project, Class V Well Rules

Dear Mr. Blubaugh:

This letter is in response to your January 4, 2010 letter concerning South Dakota's ARSD 74:55:02 Underground Injection Control Class V Rules regarding waste disposal well installation and operation.

- The Class V rules do not require state approval of a Class V well and do not require a surety arrangement.

- The Class V rules allow injection subject to SDCL 34A-2 governing the prevention of pollution of the waters of the state. This being the case, Powertech will need to ensure any Class V injection will not pollute the waters of the state. Powertech could show this through an EPA approved Class V permit.

- The Class V rules state Powertech will need to notify the department of the well within 30 days of well completion.

- Pursuant to South Dakota's In situ Leach Mining Rules, ARSD 74:29:11:03 (6), as part of its mine permit application, Powertech will need to provide information regarding the composition of all known and anticipated wastes and procedures for their disposal. This includes Class V injection.

DENR is coordinating with EPA and NRC where possible to streamline the permitting process, reduce duplication, and reach the same technical and scientific conclusions.

Sincerely,

Bill Markley

Bill Markley, Ground Water Quality Program Administrator

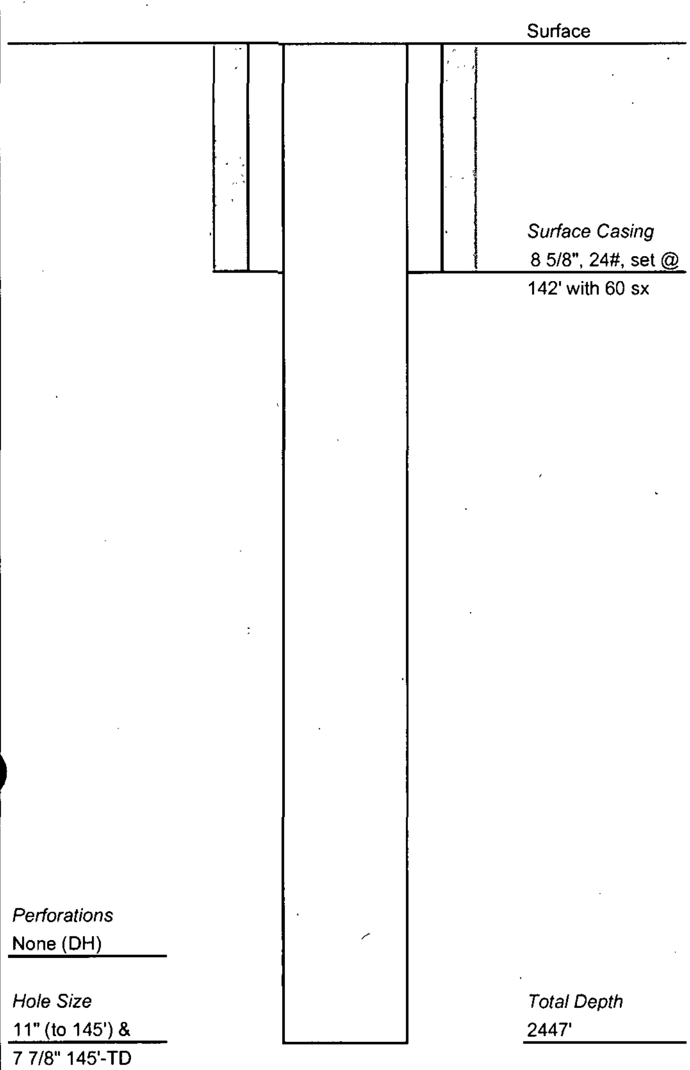
cc: Valois Shea, US Environmental Protection Agency Region VIII
Ronald Burrows, US Nuclear Regulator Commission

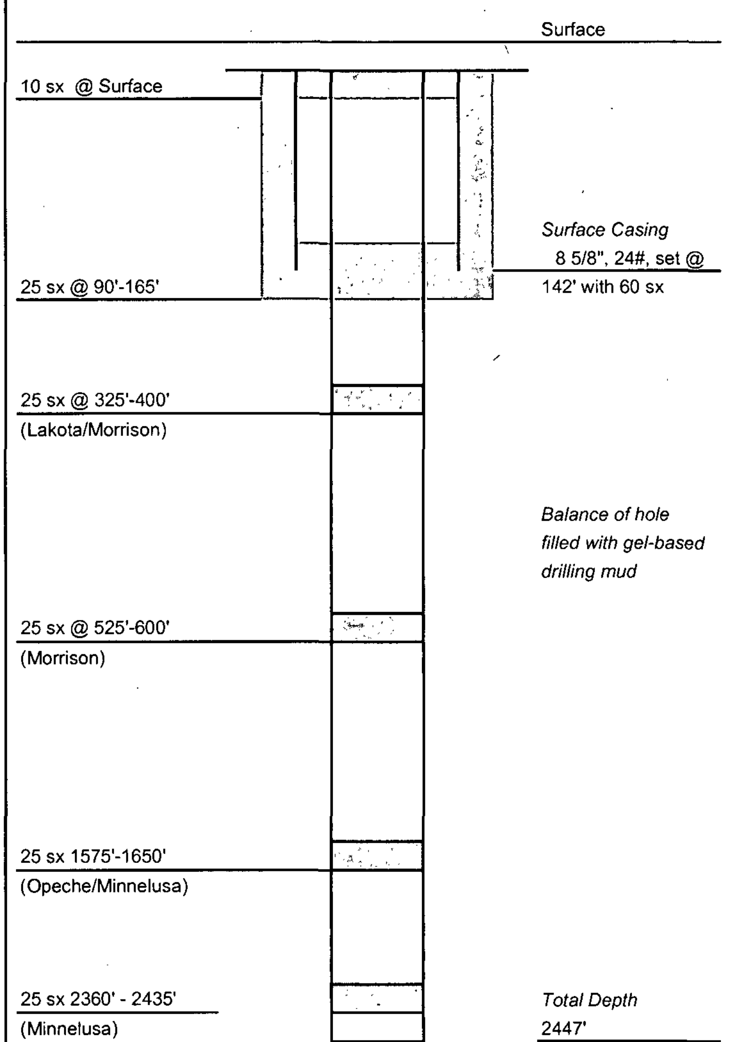
APPENDIX B

OIL AND GAS WELLS PLUGGING RECORDS

ORIGINAL WELL CONSTRUCTION DURING OPERATION	PLUGGING AND ABANDONMENT CONSTRUCTION

API No. 4004705095
2-7S-1E





Feet of cement from Plugging Report
Mud wt. Unknown

PLUGGING RECORD

Operator	Address
George Dolezal, Jr.	1121 Tower Building, Denver, Colorado

Name of Lease	Well No.	Field & Reservoir
Karl Farrow	1	Wildcat

Location of Well	Sec-Twp-Rge or Block & Survey	County
C - [illegible] Section 2- [illegible]		Fall River

Application to drill this well was filed in name of	Has this well ever produced oil or gas	Character of well at completion (initial production): Oil (bbls/day)	Gas (MCF/day)	Dry?
George Dolezal, Jr.	No			Y

Date plugged:	Total depth	Amount well producing when plugged: Oil (bbls/day)	Gas (MCF/day)	Water (bbls./day)
August 19, 19[illegible]	2,[illegible]'	None	None	None

Name of each formation containing oil or gas. Indicate which formation open to well-bore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used indicate zones squeeze cemented, giving amount cement.

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped etc)	Packers and shoes
8-5/8"	142'	None	142'		

Was well filled with mud-laden fluid, according to regulations?	Indicate deepest formation containing fresh water.
Yes	

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

USE REVERSE SIDE FOR ADDITIONAL DETAIL

Executed this the 27th day of August, 1964

State of [illegible]

County of [illegible]

Signature of Affiant: George Dolezal Jr

Before me, the undersigned authority, on this day personally appeared George Dolezal, Jr. known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 27th day of August, 1964

SEAL My Commission expires May 26, 1968

My commission expires

Notary Public in and for Denver

County, State of Colorado

DO NOT WRITE BELOW THIS LINE

M. 11 17 1965

OIL AND GAS BOARD OF THE STATE OF SOUTH DAKOTA

INSTRUCTIONS

File 3 copies of this form with Secretary, Oil and Gas Board, Pierre.

Cement Plugs Set As Follows:

25 Sacks	-	2435' to 2360'
25 Sacks	-	1650' to 1575'
25 Sacks	-	600' to 525'
25 Sacks	-	400' to 325'
25 Sacks	-	165' to 90'

Dry Hole Marker and 10 sacks at surface.
Balance of hole filled with gel-base drilling mud.

Operator: George Dolezal Jr., Sun Oil Co., etal.

Lease: No. 1 Earl Darrow

Location: C SE SE Section 2, T. 7S. R. 1E.
660' FSL 660' FEL
Fall River County, South Dakota.

Elevation: Ground 3792'
K. B. 3797'

Contractor: Baker Drilling Company
Rig No. 3 - Sullivan draw works
Tool Pusher: Jim Baker
Drillers: Don Garhart
Ed Buchannan

Spud Date: July 24, 1964

Completion Date: August 19, 1964

Casing: 140' 8-5/8" used 24# @ 142' ground with 60 sacks of regular cement.

Hole Size: 11" cable tool hole to 145'
7-7/8" from 145' to total depth.

Mud: Mo-Mar Mud Company
Casper, Wyoming
J. M. Bunce Engineer
Gel base

Logging: Drilling time: From surface casing to total depth (Geolograph)

Schlumberger: Dual Induction-Laterlog 147' to 2442'

Schlumberger: Sonic Log-Gamma Ray 147' to 2441'

Samples: 10-foot samples 140 - 2100 feet
5-foot samples 2100 - 2250 feet
10-foot samples 2250 - 2450 feet

Samples on file at AmStrat in Denver.

Geology: Well site geology by S. D. Ayres

Lost Circulation: Lost minor amounts of mud from 1630' to total depth.

2446' - Schlumberger

Status: Plugged and Abandoned

Plugs: 2435' to 2360' - 25 sacks
1650' to 1575' - 25 sacks
600' to 525' - 25 sacks
400' to 325' - 25 sacks
165' to 90' - 25 sacks
Dry-hole marker and 10 sacks at surface.

Drill Stem Tests: Schlumberger Formation Tester
1688' to 1690.5' Converse sand.
Tool open 30 minutes
Tool shut in 23 minutes
Recovered 600 cc mud
Pressures 0

Cores: Core #1-2155' to 2206'.
First Leo zone (see sample desc.)

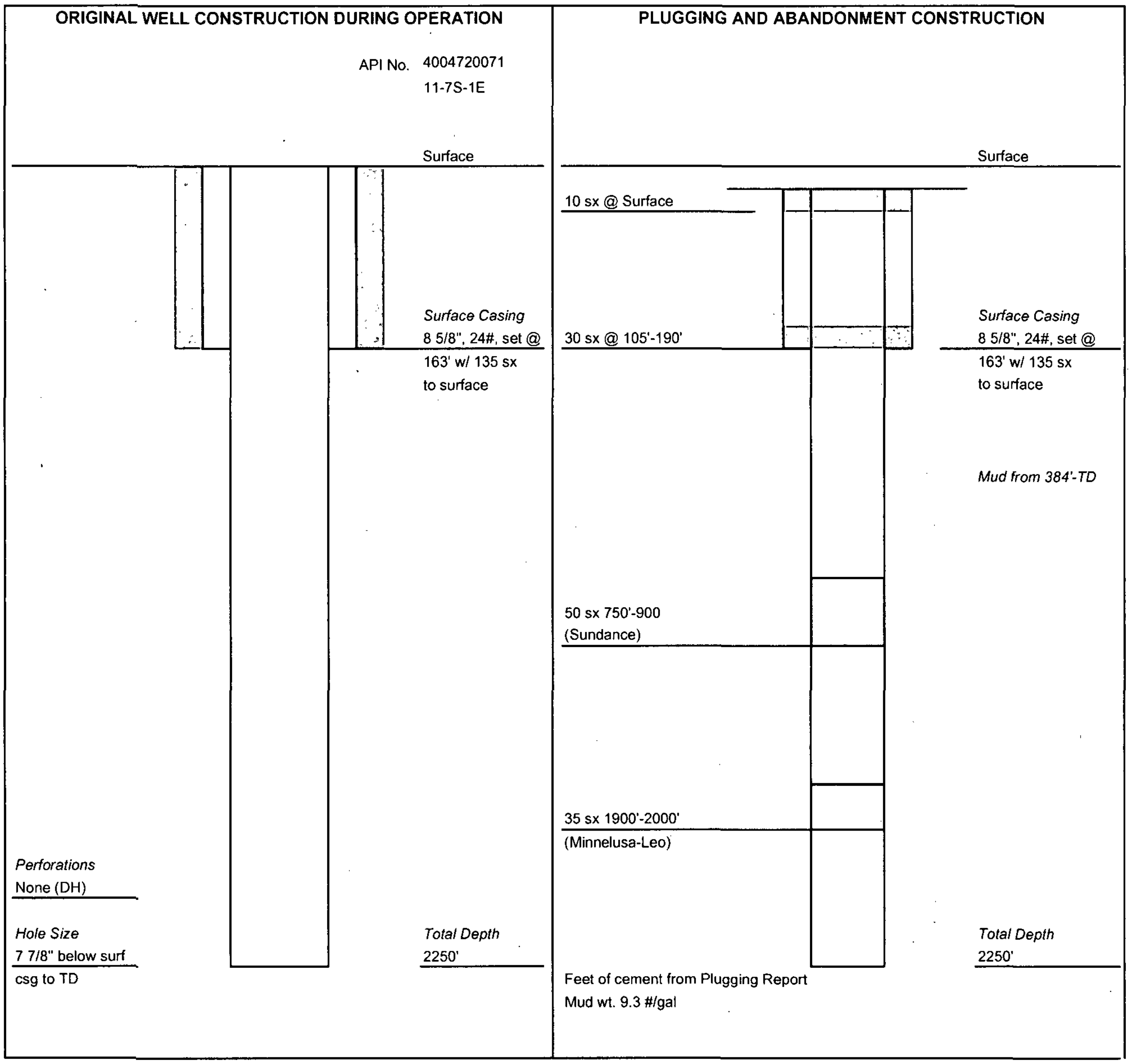
ELECTRIC LOG FORMATION TOPS

Formation	Depth	Datum
Fuson	300	+3497
Lakota	350	+3447
Morrison	425	+3372
Sundance	640	+3157
Spearfish	918	+2879
Goose Egg	1240	+2557
Minnekahta	1479	+2318
Opeche	1520	+2277
Minnelusa	1616	+2181
Red Shale Marker	2032	+1765

GEOLOGICAL SUMMARY

The subject well was drilled to a total depth of 2450 feet within a sand that would possibly coorelate with the Third Leo sandstone of the Pennsylvanian stratigraphic section in the Lance Creek field.

The Dakota sandstone between the base of the surface casing and 300 feet gave no indications of oil staining


ORIGINAL WELL CONSTRUCTION DURING OPERATION
API No. 4004720071
11-7S-1E
Surface
Surface Casing
8 5/8", 24#, set @
163' w/ 135 sx
to surface
Perforations
None (DH)
Hole Size
7 7/8" below surf
csg to TD
Total Depth
2250'
PLUGGING AND ABANDONMENT CONSTRUCTION
Surface
10 sx @ Surface
30 sx @ 105'-190'
Surface Casing
8 5/8", 24#, set @
163' w/ 135 sx
to surface
Mud from 384'-TD
50 sx 750'-900
(Sundance)
35 sx 1900'-2000'
(Minnelusa-Leo)
Total Depth
2250'
Feet of cement from Plugging Report
Mud wt. 9.3 #/gal

REPORT ON WELLS

☐ OIL WELL ☐ GAS WELL ☐ ---------------- ☒ DRY	Peterson WELL NO. 34-11
OPERATOR AQUARIUS RESOURCES CORPORATION	FIELD AND POOL, OR WILDCAT Wildcat
ADDRESS 307 Conroy Building, Casper, Wyoming 82601	NO. ACRES IN LEASE 1080.00
LOCATION (In feet from nearest lines of section or legal subdivision, where possible) 660' FSL, 2217' FEL Section 11-7S-1E	¼ ¼ SEC. TWP. RGE. SW SE 11-7S-1E
ELEVATIONS (D.F., R.K.B., R.T., GRD., etc.; how determined) 3679' Gr., 3689' K.B.	COUNTY Fall River

INDICATE BELOW BY CHECK MARK NATURE OF REPORT, NOTICE OR OTHER DATA

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
TEST WATER SHUT-OFF		SHOOT OR ACIDIZE		WATER SHUT-OFF		SHOOTING OR ACIDIZING	
FRACTURE TREAT		REPAIR WELL		FRACTURE TREATMENT		REPAIRING WELL	
MULTIPLE COMPLETE		PULL OR ALTER CASING				ALTERING CASING	
ABANDON	X						

(Note: Report results of multiple completion on Well Completion or Recompletion and Log Form—Form 4)

DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work)

Water was encountered in all porous zones drilled. The Leo sand had excellent porosity but yielded sulphur water when tested. Proposed plugging as approved by telephone is as follows:

35 sx	1900-2000	Minnelusa-Leo
50 sx	750- 900	Sundance
30 sx	105- 190	base of surface casing
10 sx	Surface plug & erect dry hole marker	

I hereby certify that the foregoing as to any work or operation performed is a true and correct report of such work or operation.

SIGNED John F. Trotter TITLE President DATE December 23, 1976

DO NOT WRITE BELOW THIS LINE

Approved Jan. 4, 1977
Date

OIL AND GAS BOARD OF THE STATE OF SOUTH DAKOTA

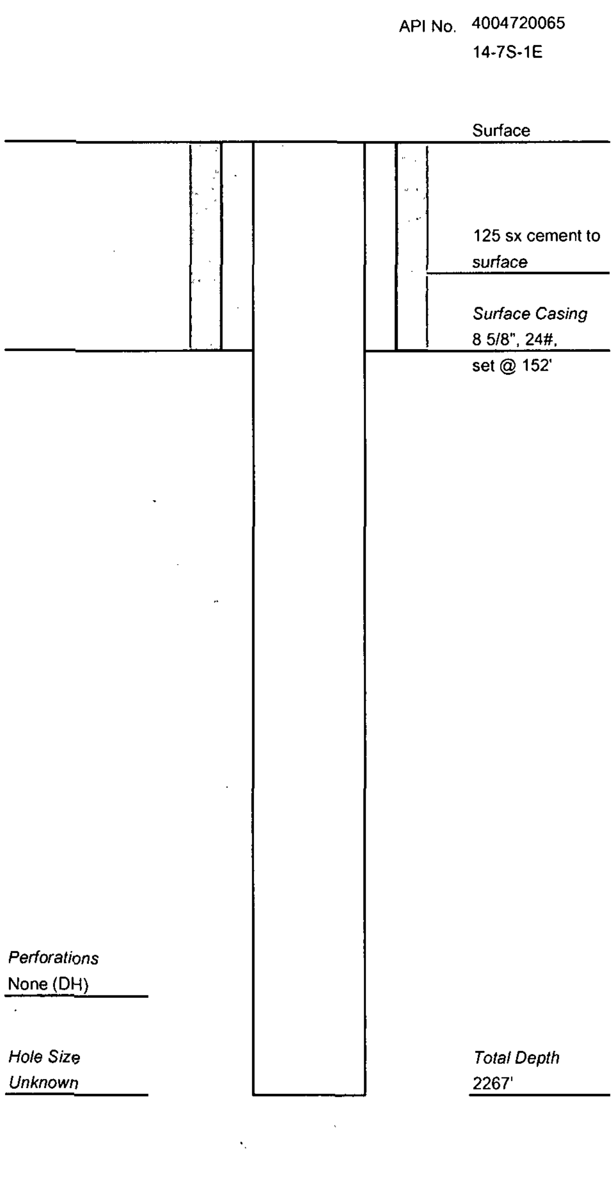
Fred V. Steece ~~Secretary~~
Supervisor

CONDITIONS, IF ANY:

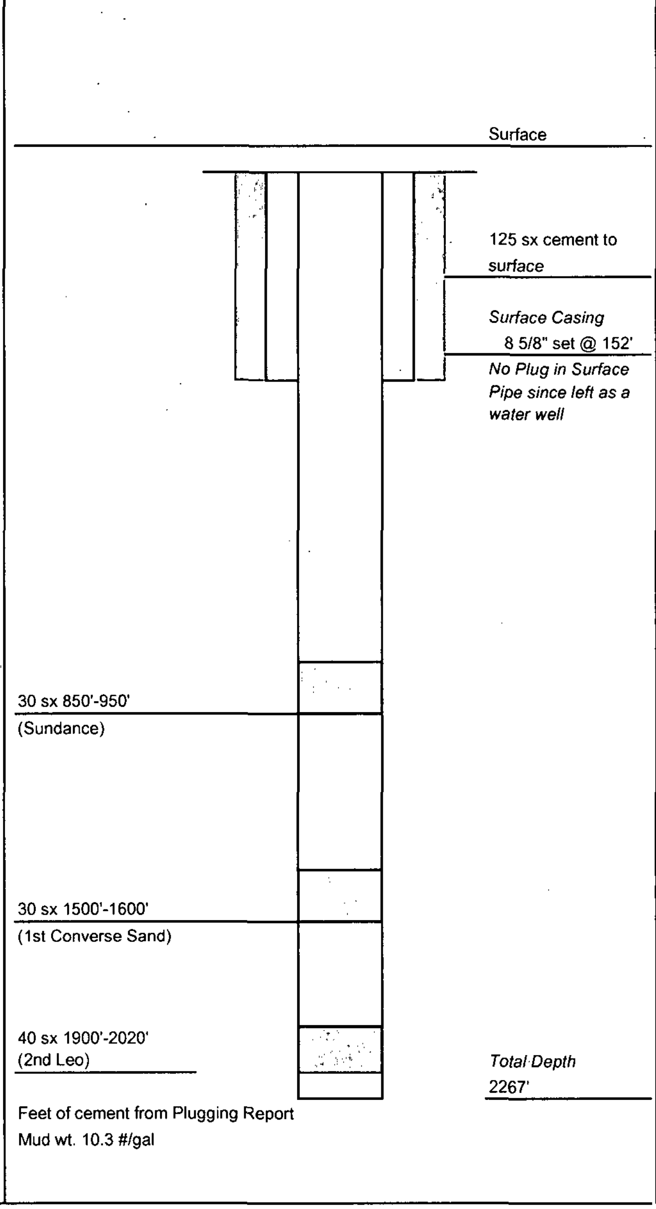
See Instructions On Reverse Side

Well:	#34-11 Peterson
Location:	C/SW SE; 660' FSL, 2217' FEL Section 11, T. 7S., R. 1E. Fall River County, South Dakota
Area:	Wildcat (Driftwood Canyon Prospect)
Elevation:	3679' Ground, 3689' K.B.
Spudded:	December 9, 1976 (7:30 A.M.)
Ceased Drilling:	December 22, 1976 (3:30 A.M.)
Completed:	December 23, 1976 (12:30 A.M.)
Status:	P & A
Total Depth:	2250' driller, 2248' log
Casing:	8-5/8" surface casing set @ 163'
Hole Size:	7-7/8" below surface to TD
Contractor:	A. O. Bullock Drilling Co. - Rig #1 Tool Pusher - Ray Cottrell Drillers - Larry Halligan, D. F. Ellsworth, Chuck Sides
Drilling Mud:	Wyoming Mud Co., Casper, Wyo. Gel-Chemical from 384' to TD Engineer - Bruce Johnson
Lost Circulation:	Lost Circulation for 5½ hours @ 384'.
Coring:	No cores cut.
Drill Stem Tests:	Halliburton Services DST #1; 2nd Leo, 2060'-2082' (adjusted to log from 2068'-2090') Rec. 125' muddy water, 1838' black sulfur water. Engineer - D. R. Rook, Gillette, Wyoming
Logs:	Schlumberger Well Surveying Corp. Ran Dual Induction-Laterlog from 2248' to base of surface casing. Ran Borehold Compensated Sonic Log w/caliper from 2248' to base of surface casing. Ran Gamma Ray log from base of surface casing to surface. Engineer - Craig Rang, Gillette, Wyo.
Samples:	All samples were delivered to American Stratigraphic Co., Casper, Wyo., for shipment to their Billings, Montana office where a cut will be made for the South Dakota State Geologist.

ORIGINAL WELL CONSTRUCTION DURING OPERATION



PLUGGING AND ABANDONMENT CONSTRUCTION



Operator	Address
POWER RESOURCES CORPORATION	1660 So. Albion, Suite 827, Denver, CO 80222

Name of Lease	Well No.	Field & Reservoir
Lenore Peterson	21-14	Wildcat

Location of Well	Sec-Twp-Rge or Block & Survey	County
NENW Sec. 14 - T. 7 S.- R. 1 E.		Fall River

Application to drill this well was filed in name of	Has this well ever produced oil or gas	Character of well at completion (initial production): Oil (bbls/day)	Gas (MCF/day)	Dry?
Power Resources Corporation	No			Yes

Date plugged:	Total depth	Amount well producing when plugged: Oil (bbls/day)	Gas (MCF/day)	Water (bbls./day)
December 2, 1975	2266	None	None	None

Name of each formation containing oil or gas. Indicate which formation open to well-bore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used Indicate zones squeeze cemented, giving amount cement.
Morrison		339	
Basal Sundance Sand		862	950-850 30 Sacks
First Converse Sand		1571	1650-1500 30 Sacks
Base 2nd Converse Sand		1722	1900-2020 40 Sacks
2nd Leo Sand		2099-2113	Traces Yellow Fluorescence

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, ripped etc)	Packers and shoes
8-5/8	152	-0-	152		

Was well filled with mud-laden fluid, according to regulations?

Indicate deepest formation containing fresh water.

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

Well plugged back to 850. Land owner, Lenore Peterson, Star Route, Edgemont, So. Dakota, has furnished letter to So. Dakota Geological Survey at Rapid City requesting use of well as a fresh water well. Mr. G. Allen Nelson has presented a detailed Geologic Well Report by letter dated 2 January 1976.

USE REVERSE SIDE FOR ADDITIONAL DETAIL

Executed this the 12th day of January, 19

State of Colorado

County of Denver

R.A. Bausham, V.P.
Signature of Affiant

Before me, the undersigned authority, on this day personally appeared .... known to me to be the person whose name is subscribed to the above instrument, who being by me duly sworn on oath states, that he is duly authorized to make the above report and that he has knowledge of the facts stated therein, and that said report is true and correct.

Subscribed and sworn to before me this 12th day of January, 1976

My commission expires My Commission expires Sept. 29, 1979

Notary Public in and for Denver County, Denver, Colo

DO NOT WRITE BELOW THIS LINE

Approved Jan. 23, 1976
Date

OIL AND GAS BOARD OF THE STATE OF SOUTH DAKOTA

Fred V. Steece

Elevation: 3639 ground.
3647 K.B.

Type Well: Wildcat.

Spud Date: 10:00 P.M., December 11, 1975.

Completion Date: 9:00 P.M., December 26, 1975.

Casing Record: Ran 8 5/8" surface casing. Set at 152 ground. Cemented with 125 sacks of regular cement with 3% Calcium chloride. Pipe set at 152 ground. 24# casing.

Total Depth: 2269 Driller.
2267 Schlumberger.

Deepest Formtion Penetrated: Lower Leo Section.

Depth Datum: 3647 K.B.

Well Status: Plugged and abandoned(left as water well for landowner).

Mud Program: Drilled out from under surface with water. Continued drilling with native mud down to 1070 in Spearfish red beds. Converted to a red bed between between 1070 and 1283 in the Goose Egg formation after getting stuck at 1283. Added 1 sack of soda ash, 5 Rayvan, 4 caustic soda, 1 can suf-drill, and 25 sacks of gel. Above 1283 a water-flow was continually thinning mud, particularly when mud pump was shut down on trips for bit.
Between 1625 in the Converse Massive Anhydrite and 1729 in middle Converse tourly treatment was Gel, 1 sack caustic soda, 1 soda ash, 1 Rayvan, and mud weight was 9.4-9.6 and vis. was 36 to 37.
At 2045 to 2078 in upper Leo wt. was 9.7 and vis. was 46, with tourly treatments of 1 sack of soda ash, 1 Rayvan, 1 caustic soda, and 4 CMC to get water loss down to 5 cc. or less before Second Leo was reached at approximately 2100.
At 2105 in Second Leo Sand main objective wt. was 10.0, vis. 36, and water loss 6.0 . Water flow from up the hole continued to create problems in maintain-good quality mud.
Logs were run without any hole trouble. Wt. was 10.3, vis. 85, and water loss 7.2.
Mud furnished by Pro-Mud, Casper; Phil Hogan, engineer.

Drill-Stem
Tests: (None).

Logs: Schlumberger Borehole Compensated Sonic Log was run from T.D. up to base of surface casing on a 5" scale 40-70-100, and on a 5" scale 40-90-140 from T.D. up to 1400 above Minnekahta. Gamma Ray Log and Caliper Log were also run with Sonic Log. Two repeats were run from T.D. up to 1980 first and then from T.D. up to 1400 on a 40-90-140 scale.
Dual Induction Laterolog was run second and did not work. 8 hours were spent waiting for a second tool to arrive. A 2" scale was run from T.D. to base of surfac pipe, and a 5" scale over same interval was also run, with a repeat from T.D. up to 1900.
Engineer: Don Marquez, Gillette.

Plugging Record: 40 sacks from 2020 to 1900 across the Red Marker.
30 sacks from 1600 to 1500 across top of the First Converse Sand.
30 sacks from 950 to 850 acorss Basal Sand of the Sundance.
Cementing by Halco, Gillette
(No plug in surface pipe since left as water well).

Contractor and
Rig Equipment: Farnsworth & Kaiser, Newcastle, Wyoming.
U-34 rig.
3½" IF drill pipe.
5⅞" drill collars totaling 341'.
Mud pump GD FXQ with 6" liners and 16" stroke.
Radios on rig and at Newcastle base plus in pusher's pickup.
Mud pump trailer-mounted.
Rig trailer-mounted.
Buzz Farnsworth, pusher-owner.

Sample Storage: One cut of samples were sent to American Stratigraphic in Casper.
One cut of samples were sent to the South Dakota Geologic Survey in Vermillion.

Drilling Time
Records: Original copy of Star Recording 1' drilling time charts is on file in Denver office of G.A. Nelson.

APPENDIX D

HISTORICAL PHOTO, CITY OF EDGEMONT WATER WELL


March-19-1913
PHOTO BY KOLLER.
EDGEMONT. S. DAK.
EDGEMONT DEEP WELL
575 GAL. PER MIN.
TEMPERATURE 126. F.
PRESSURE 94 lbs. Sq. In.
DEPTH 2983 FT.
2983 FT.. TODAY.
NORBECK & NICHOLSON Co.
CONT. REDFIELD, S. DA.