

Table 6.1-13 Summary of Niobrara River Flow Measurements 1999 - 2012

Stream Sampling Location	Flow (cubic feet per second [cfs])				
	Average Flow	Minimum Flow		Maximum Flow	
Niobrara River at Wyoming State Line 06454000	3.03 (1.7 – 4.4)	2.4 (0.6 – 5.3)		4.2 (1.6 – 13.0)	
Niobrara River at Agate 06454100 Stream flow data for 2006 – 2010.	10.5 (5.4 – 17.9)	8.1 (0.9 – 20.0)		14.0 (4.8 – 55.0)	
Niobrara River above Box Butte Reservoir 06454500	19.6 (10.1 – 34.9)	14.5 (3.8 – 40.0)		28.3 (8.1 – 129)	
Niobrara River below Box Butte Reservoir 06455500	14.5 (0.7 – 87)	3.8 (0.4 – 84.0)		29.7 (0.54 – 180.0)	
Extremes for Period of Record and By Year (1999 – 2012)¹					
Peak Discharge			Minimum Discharge		Drainage Area
Date	Flow ft ³ /sec	Gage Height feet	Date	ft ³ /sec	Square Miles
Niobrara River at Wyoming State Line (USGS 06454000)					455
3/06/2012	115	Information Not Available	7/11/2012	1.75	
3/11/2011	451	Information Not Available	2/09/2011	2.32	
12/31/2010	10.2	Information Not Available	10/01/2010	2.09	
7/02/2009	11.2	4.56	9/12/2009	1.59	
5/03/2008	18.0	4.80	8/28/2008	1.1	
4/02/2007	7.1	3.34	7/25/2007		
3/30/2006	7.5	3.22	8/24/2006	0.96	
6/13/2005	13.0	4.38	7/23/2005	1.4	
9/05/2004	21.0	3.61 ^e	9/02/2004	0.57	
4/29/2003	8.6	3.10 ^f	8/22-23/2003	1.3	
4/26/2002	12.0	2.94 ^g	8/17-18/2002	1.4	
5/06/2001	11.0	2.76 ^h	9/05/2001	1.6	
2/22/2000	21	3.69	9/18/2000	1.3	
4/28/1999	9.9	2.37 ⁱ	9/15-16/1999	1.4	
8/16/1977	2,120	8.28	8/09/1975	0.54	

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Peak Discharge			Minimum Discharge	Drainage Area	
Date	Flow ft ³ /sec	Gage Height feet	Date	ft ³ /sec	Square Miles
Niobrara River at Agate (USGS 06454100) ^a					840
3/11/2012	35.8	Information Not Available	8/23/2012	1.08	
3/14/2011	223	Information Not Available	8/18/2011	3.32	
2/26/2010	278	Information Not Available	8/14/2010	3.7	
6/14/2009	63	6.18	12/27/2009	5.1	
3/04/2008	23	4.05	8/02-4/2008	3.0	
3/08/2007	20	4.02	5/29/2007	9.6	
7/02/2006	24.6	Information Not Available	2/25/2006	0.83	
12/29/2005	13.5	Information Not Available	11/28/2005	5.48	
2004	ND				
2003	ND				
2002	ND				
2001	ND				
1999	ND				
Niobrara River above Box Butte Reservoir (USGS 06454500)					1,400
1/12/2012	100	Information Not Available	9/02/2012	2.2	
2/01/2011	108	Information Not Available	7/21/2011	5.7	
12/31/2010	57.3	--	12/11/2010	6.3	
7/23/2009	187	5.78	8/21/2009	8.5	
7/09/2008	384	7.26	10/03/2008	8.0	
7/28/2007	41	4.18	7/26/2007	3.8	
11/28/2006	167	5.53 ^b	6/06-07/2006	6.7	
6/13/2005	80	4.41 ^c	5/29/2005	9.6	
3/09/2004	51	3.75 ^d	6/15-16/2004	6.2	
3/20/2003	43	3.58	8/15/2003	5.8	
3/29/2002	53	3.76 ^h	7/31 – 8/02/2002	4.1	
3/14/2001	52	3.79	7/08-09/2001	7.9	
7/11/2000	202	5.59	8/24/2000	8.7	
4/13/1999	45	3.63 ^k	8/13-30/1999	11.0	
7/28/1951	4,950	10.3	9/26/1953	1.6	
Niobrara River below Box Butte Reservoir (USGS 06455500)					460
7/20/2012	160	Information Not Available	5/18/2012	0.63	
7/14/2011	148	Information Not Available	10/30/2011	0.80	
12/31/2010	0.935	--	10/01/2010	0.72	
7/17/2009	157	4.29	11/05/2009	0.56	
7/30/2008	165	4.29	11/05-06/2008	0.56	

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Peak Discharge			Minimum Discharge	Drainage Area	
Date	Flow ft ³ /sec	Gage Height feet	Date	ft ³ /sec	Square Miles
7/15/2007	153	4.23	11/15-16/2007	0.40	
7/17/2006	164	4.26	8/23/2006	0.70	
7/24/2005	143	4.16	10/11/2005	0.63	
7/20/2004	152	4.20	9/12/2004	0.65	
7/16/2003	151	4.14	8/27/2003	0.47	
6/30/2002	170	4.32	9/02-07/2002	0.52	
7/02/1968	616	5.04	Many days in 1947 & 1951	0.1	
8/01/2001	148	4.26	9/27-30/2001	0.64	
7/09/2000	148	4.21	9/14/2000	0.75	
7/27/1999	195	4.43	10/01/1999	0.87	
Period of Record					
Niobrara River at Wyoming State Line (USGS 06454000)			1955 to Quarter 3 2012		
Niobrara River at Agate (USGS 06454100)			3 rd Quarter 2005 – Quarter 3 2012		
Niobrara River above Box Butte Reservoir (USGS 06454500)			Oct. 1946 to Quarter 3 2012		
Niobrara River below Box Butte reservoir (USGS 06455500)			Oct. 1946 to Quarter 3 2012		

^a Stream flow data for 2006 – 2010 in Table 6.1-14; Records are fair, except estimated records are poor.

^b Maximum gage height of 5.64 feet February 10 due to backwater from ice.

^c Maximum gage height of 4.66 feet January 05 due to backwater from ice.

^d Maximum gage height of 4.82 feet due to backwater from ice conditions.

^e Maximum gage height of 4.59 feet due to backwater from ice conditions.

^f Maximum gage height 3.34 feet February 3 due to backwater from ice conditions.

^g Maximum gage height of 3.56 feet due to backwater from ice conditions.

^h Maximum gage height of 4.67 feet on March 1 due to backwater from ice conditions.

ⁱ Maximum gage height of 3.01 feet December 16 due to backwater from ice conditions.

^j Maximum gage height of 2.64 feet from a high water mark.

^k Maximum gage height of 5.07 feet December 20 due to backwater from ice.

^l 2012 data is for Quarters 1 through 3; Quarter 4 data not yet available.

ND = No data

ft³/sec = cubic feet per second

USGS = U.S. Geological survey

Sources: NDNR. 2013.

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Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
Niobrara River at Wyoming State Line (USGS 06454000)												
1999												
Mean	4.03	4.40	5.08	6.85	5.02	5.48	3.24	1.95	2.47	2.94	3.44	3.64
Maximum	4.3	4.40	7.5	8.4	7.7	6.8	6.0	2.8	4.2	3.4	4.6	4.1
Minimum	3.5	3.9	4.2	5.3	3.9	4.1	2.3	1.4	1.6	2.7	2.8	3.2
2000												
Mean	3.66	5.12	5.94	6.79	5.51	3.00	1.97	1.77	1.80	2.54	3.09	2.85
Maximum	4.1	13.0	9.0	12.0	8.9	4.5	2.6	2.1	2.5	3.2	4.8	3.0
Minimum	3.3	3.4	4.8	4.4	4.1	2.5	1.5	1.5	1.3	2.3	2.7	2.6
2001												
Mean	3.08	3.26	5.50	6.07	4.68	3.11	2.36	1.78	2.03	2.56	3.37	3.20
Maximum	3.4	3.7	6.8	9.5	9.0	4.9	3.4	2.0	2.7	2.9	3.9	4.0
Minimum	2.9	2.9	3.6	4.9	3.2	2.5	1.9	1.6	1.6	2.0	2.8	2.7
2002												
Mean	3.36	3.54	3.77	5.09	3.63	2.64	1.98	1.54	1.94	1.86	2.54	3.17
Maximum	3.7	3.8	6.1	7.1	5.1	3.5	2.5	1.6	2.4	2.3	3.4	3.4
Minimum	2.6	3.2	3.2	4.2	3.0	2.0	1.6	1.4	1.5	1.5	1.4	2.9
2003												
Mean	3.23	3.52	4.56	4.66	4.41	3.03	1.87	1.58	2.37	2.45	2.6	2.65
Maximum	3.6	3.8	6.0	6.8	5.6	4.2	2.5	2.5	3.4	2.9	2.6	2.8
Minimum	2.9	3.3	3.5	3.9	3.7	2.3	1.5	1.3	2.0	2.4	2.6	2.6
2004												
Mean	2.85	3.08	3.79	3.12	2.81	1.72	2.18	1.40	2.17	2.6	3.0	3.3
Maximum	3.1	4.0	5.5	3.6	3.3	2.7	6.4	2.1	11.0	3.4	3.3	3.5
Minimum	2.7	2.5	2.0	2.5	2.5	1.1	1.2	0.83	0.57	2.1	2.6	3.0
2005												
Mean	2.9	3.4	3.5	3.4	3.1	3.1	2.1	2.2	1.8	2.0	3.0	2.7
Maximum	3.5	3.6	4.0	5.3	6.3	12.0	3.1	5.3	2.2	2.6	3.3	3.0
Minimum	2.5	3.2	3.2	2.7	2.4	1.8	1.4	1.5	1.5	1.4	2.6	2.2

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Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
2006												
Mean	2.9	3.0	4.2	3.5	3.2	2.2	1.9	1.5	2.0	2.7	2.8	2.9
Maximum	3.3	4.3	6.7	5.5	4.2	4.3	4.1	3.0	3.1	3.0	3.2	3.3
Minimum	2.6	2.7	3.5	2.6	2.7	1.5	1.4	0.96	1.7	2.3	2.4	2.5
2007												
Mean	2.8	2.9	3.4	3.7	2.9	1.9	1.6	1.3	1.5	2.2	2.3	2.0
Maximum	3.4	3.5	5.3	6.2	3.1	2.2	2.8	1.7	1.9	2.7	2.8	2.3
Minimum	2.4	2.3	2.8	3.2	2.3	1.6	0.82	1.0	1.1	1.6	1.7	1.7
2008												
Mean	2.3	3.2	3.0	2.9	4.1	2.9	2.2	1.7	1.7	2.0	2.4	2.6
Maximum	3.0	4.1	4.2	4.1	6.9	4.9	2.8	2.6	2.5	2.5	2.8	3.2
Minimum	1.4	2.0	2.4	2.3	2.4	2.1	1.8	1.1	1.3	1.6	2.1	2.2
2009												
Mean	2.6	3.2	6.6	3.6	3.3	3.7	3.4	2.2	1.8	2.2	2.6	2.7
Maximum	3.7	3.8	12.0	4.6	4.5	4.9	6.7	2.5	2.0	1.9	2.5	2.6
Minimum	1.9	2.1	3.5	3.0	2.9	2.3	2.0	2.0	1.6	2.5	2.7	3.1
2010 ^a												
Mean	2.9	2.9	3.6	3.5	3.9	4.0	2.3	2.0	1.8	2.4	2.8	2.9
Maximum	3.0	4.5	4.6	3.7	4.6	7.4	2.9	2.1	2.1	2.11	2.7	2.8
Minimum	2.4	2.4	3.4	3.4	3.2	2.5	2.0	1.9	1.9	2.73	2.9	3.0
2011 ^a												
Mean	3.3	17.6	16.6	5.1	7.3	5.4	3.4	2.8	2.7	3.2	3.7	3.7
Maximum	4.5	136	142	5.7	11.4	8.1	4.5	2.9	2.8	3.6	3.8	3.9
Minimum	2.8	3.1	5.2	4.9	4.7	4.3	2.7	2.7	2.5	2.9	3.4	3.2
2012 ^{a, b}												
Mean	3.8	3.9	7.2	3.5	3.1	2.2	2.0	2.1	2.2	NA	NA	NA
Maximum	3.9	4.3	46.3	3.8	3.7	2.7	2.2	2.3	2.5	NA	NA	NA
Minimum	3.6	3.7	3.7	3.0	2.6	1.9	1.8	2.0	1.9	NA	NA	NA

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
Niobrara River at Agate (USGS 06454100)												
2006												
Mean	13.0	13.6	19.0	14.7	9.3	5.9	6.0	4.1	6.0	6.1	9.5	9.9
Maximum	14.0	17.0	21.0	20.0	13.0	10.0	14.0	5.9	7.9	7.4	12.0	11.0
Minimum	11.0	0.9	17.0	12.0	5.1	3.8	2.1	3.0	4.5	5.1	5.7	8.2
2007												
Mean	9.7	9.6	14.7	13.3	8.3	6.2	3.4	4.1	5.5	6.8	8.3	7.7
Maximum	10.0	14.0	17.0	18.0	11.0	8.4	4.8	5.6	6.2	8.0	9.0	9.0
Minimum	9.0	8.0	11.0	11.0	6.1	2.9	2.2	2.8	4.7	6.0	7.0	7.0
2008												
Mean	7.0	8.1	14.8	10.9	9.4	10.8	5.4	4.9	7.8	8.0	8.8	7.1
Maximum	7.0	14.0	18.0	13.0	17.0	16.0	8.0	7.0	9.0	9.2	11.0	10.0
Minimum	7.0	7.0	13.0	7.0	6.0	8.0	4.0	3.0	6.0	6.8	7.0	5.1
2009												
Mean	6.2	10.1	15.3	19.6	12.1	21.2	9.9	8.1	8.6	14.1	15.4	10.2
Maximum	7.3	15.0	18.0	28.0	19.0	55.0	15.0	5.7	9.7	19.0	22.0	12.0
Minimum	5.2	7.3	15.0	15.0	5.3	9.4	6.5	11.0	7.4	10.0	11.0	11.0
2010 ^a												
Mean	10.7	12.1	25.7	24.1	20.5	17.5	8.5	5.8	6.6	8.7	11.3	12.7
Maximum	11.0	20.0	31.0	31.0	27.0	33.0	11.0	7.0	8.0	7.0	8.0	10.0
Minimum	10.0	11.0	20.0	19.0	11.0	8.0	7.0	4.0	6.0	12.0	14.0	15.0
2011												
Mean	12.6	22.9	32.3	18.2	24.8	14.8	7.5	5.9	7.2	10.4	14.3	11.6
Maximum	16	63	102	22	36	25	10	9	10	13.3	15.7	14.4
Minimum	10	12	20	16	17	9	6	4	6	6.86	12.4	10.1
2012 ^b												
Mean	9.6	6.2	11.6	6.2	3.7	3.5	2.5	2.9	3.6	N/A	N/A	N/A
Maximum	11.8	7.1	31.4	8.6	4.9	5.1	3.7	4.1	5.2	N/A	N/A	N/A
Minimum	7.2	5.3	6.9	4.8	2.3	2.1	2.0	1.6	2.6	N/A	N/A	N/A

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
Niobrara River above Box Butte Reservoir (USGS 06454500)												
1999												
Mean	26.9	34.1	34.4	36.6	26.3	22.2	18.3	12.5	18.9	21.9	24.9	26.5
Maximum	30	39	37	43	37	31	26	17	22	25	28	29
Minimum	19	28	32	40	15	14	13	11	14	18	21	24
2000												
Mean	28.1	32.3	42.7	43.1	47.7	15.0	15.6	11.2	11.4	19.8	22.9	18.4
Maximum	31	40	60	65	74	24	44	17	15	33	29	22
Minimum	20	20	36	33	30	8.8	11	8.7	9.3	10	18	16
2001												
Mean	22.7	25.6	40.8	43.0	28.8	15.8	13.9	9.04	10.9	16.7	20.1	21.9
Maximum	28	28	48	48	47	22	28	11	14	19	22	24
Minimum	19	23	29	38	11	11	9.4	7.9	8.2	11	18	17
2002												
Mean	22.1	25.7	32.2	35.7	19.5	9.47	6.33	6.27	10.1	11.2	16.8	19.9
Maximum	25	32	47	45	31	11	8.7	8.1	15	14	21	22
Minimum	19	21	21	21	10	8.2	4.1	4.1	6.4	10	14	19
2003												
Mean	20.1	23.8	31.9	28.0	22.6	12.2	9.18	7.84	8.48	10.4	14.0	16.4
Maximum	23	26	41	39	31	15	12	9.5	9.7	12	15	18
Minimum	18	20	23	21	13	9.8	7.6	5.8	7.0	9.1	12	15
2004												
Mean	17.5	19.7	31.4	19.8	10.5	8.6	10.2	10.0	13.1	17.0	16.8	17.4
Maximum	19	37	46	26	16	15	14	16	16	18	18	18
Minimum	16	16	24	15	7.1	6.2	7.1	6.9	8.8	16	15	17
2005												
Mean	18.9	26.3	27.5	32.4	23.6	33.4	12.3	14.2	13.6	16.5	18.9	16.3
Maximum	24	28	30	49	43	72	17	17	15	19	23	21
Minimum	15	24	26	28	9.6	14	9.7	10	13	14	14	12

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Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
2006												
Mean	19.9	22.8	35.9	29.0	15.6	11.0	9.6	8.1	10.1	11.1	15.0	13.6
Maximum	26	27	42	39	34	22	13	11	12	13	17	15
Minimum	12	19	23	11	10	6.7	8.1	6.9	8.7	10	11	13
2007												
Mean	15.9	18.4	26.8	22.9	13.4	8.3	8.4	6.4	6.7	9.4	10.8	10.9
Maximum	19	22	30	27	20	18	20	8.6	14	10	14	16
Minimum	14	15	22	19	7.8	4.2	3.8	4.5	5.4	8	9.9	10
2008												
Mean	11.2	12.4	25.2	27.6	24.0	16.0	13.5	9.0	10.9	11.3	14.4	11.8
Maximum	15	19	33	42	110	28	50	9	12	13	18	14
Minimum	9.7	11	20	10	13	12	10	9	9.8	9.7	13	9.6
2009												
Mean	12.5	16.4	24.2	57.1	24.5	28.0	29.6	14.7	13.4	23.2 ^a	29.2 ^a	20.7 ^a
Maximum	16	20	30	129	41	50	92	28	19	35 ^a	42 ^a	23 ^a
Minimum	9.8	13	21	28	9.8	9.3	11	8.5	9.3	14 ^a	21 ^a	16 ^a
2010 ^a												
Mean	15.8	13.9	52.1	43.5	43.0	41.2	18.8	11.7	9.8	13.1	22.4	22.2
Maximum	23	35	104	75	82	76	28	21	11	9.1	17.8	18.4
Minimum	13	9	36	28	23	14	12	8	9	22.3	27.0	26.0
2011 ^a												
Mean	17.9	20.9	49.5	36.8	48.4	34.7	12.5	10.7	12.1	16.1	12.3	26.4
Maximum	26.7	26	68.1	43.3	95.2	59	25.7	13	31.4	19	26.7	42.1
Minimum	12.7	14	37.4	32	26	24.7	7.23	6.99	6.88	12.6	2.26	21.3
2012 ^{a, b}												
Mean	27.4	24.6	40.1	27.5	11.2	7.5	5.8	5.7	5.8	N/A	N/A	N/A
Maximum	83.2	38.9	49.1	45.8	13.6	8.8	6.9	6.4	7.0	N/A	N/A	N/A
Minimum	15.2	17.4	23.5	12.3	8.4	6.9	5.2	5.0	3.3	N/A	N/A	N/A

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Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
Niobrara River below Box Butte Reservoir (USGS 06455500)												
1999												
Mean	1.14	1.25	1.30	1.41	1.27	1.11	96.6	104	7.23	0.93	0.93	0.93
Maximum	1.2	1.4	1.4	1.7	1.4	1.3	180	128	89	1.0	1.0	.95
Minimum	1.1	1.1	1.2	1.3	1.2	1.0	1.0	64	0.95	0.85	0.86	0.87
2000												
Mean	0.94	0.99	1.15	1.22	1.23	13.7	116	84.5	3.55	0.74	0.79	0.72
Maximum	0.97	1.1	1.3	1.9	1.6	110	145	122	64	0.84	0.82	0.78
Minimum	0.90	0.93	1.1	1.1	1.1	1.1	84	61	0.75	0.70	0.75	0.67
2001												
Mean	0.71	0.70	0.74	0.79	0.87	0.79	83.1	105	14.4	0.65	0.66	0.66
Maximum	0.73	0.72	0.76	0.86	0.97	1.1	144	146	67	0.80	0.74	0.70
Minimum	0.67	0.70	0.72	0.72	0.82	0.72	0.76	68	0.64	0.60	0.64	0.64
2002												
Mean	0.71	0.69	0.74	0.79	0.78	18.9	121	57.4	0.59	0.54	0.56	0.54
Maximum	0.73	0.72	0.79	0.92	0.92	148	161	108	0.91	0.54	0.62	0.57
Minimum	0.64	0.66	0.70	0.76	0.73	0.70	76	0.53	0.52	0.52	0.54	0.52
2003												
Mean	0.53	0.56	0.60	0.71	0.72	0.71	96.9	77.3	0.86	0.77	0.75	0.74
Maximum	0.54	0.57	0.67	0.96	0.82	0.76	146	125	3.4	0.85	0.77	0.78
Minimum	0.52	0.54	0.57	0.64	0.67	0.67	0.63	0.47	0.49	0.72	0.71	0.70
2004												
Mean	0.77	0.77	0.82	0.88	0.84	0.86	71.8	65.9	2.21	0.71	0.71	0.72
Maximum	0.79	0.84	1.0	0.93	0.89	0.93	143	119	45	0.85	0.74	0.77
Minimum	0.74	0.74	0.73	0.85	0.77	0.76	0.87	0.75	0.65	0.63	0.66	0.69
2005												
Mean	0.76	0.79	0.82	0.93	0.95	1.0	76	76.3	13.1	0.77	0.79	0.83
Maximum	0.82	0.89	0.87	1.4	1.2	1.5	140	129	104	0.89	1.1	1.1
Minimum	0.69	0.72	0.79	0.83	0.79	0.94	0.88	0.87	0.69	0.74	0.74	0.79

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
2006												
Mean	0.77	0.82	0.85	0.92	0.93	9.3	111.6	47	14.0	0.54	0.46	0.60
Maximum	0.84	1.1	0.87	1.0	1.1	69	158	109	77	0.61	0.58	0.64
Minimum	0.72	0.80	0.81	0.85	0.86	0.85	70	0.70	0.72	0.45	0.40	0.53
2007												
Mean	0.66	0.73	0.87	0.77	0.79	1.2	94.6	24.7	0.59	0.63	0.68	0.67
Maximum	0.80	0.83	1.0	0.87	0.86	9.7	147	127	0.62	0.69	0.79	0.80
Minimum	0.63	0.65	0.74	0.69	0.72	0.76	1.2	0.63	0.56	0.58	0.56	0.62
2008												
Mean	0.64	0.63	0.75	0.87	0.97	0.95	70.0	30.6	0.67	0.63	0.69	0.67
Maximum	0.68	0.69	0.83	0.94	1.2	1.1	157	140	0.84	0.74	0.80	0.78
Minimum	0.59	0.60	0.69	0.80	0.90	0.90	0.75	0.64	0.61	0.62	0.61	0.60
2009												
Mean	0.64	0.67	0.72	0.95	0.98	1.0	60.2	69.0	6.24	0.79 ^a	0.82 ^a	0.80 ^a
Maximum	0.69	0.68	0.80	1.3	1.1	1.2	135	132	29	0.9 ^a	0.85 ^a	0.93 ^a
Minimum	0.62	0.65	0.68	0.77	0.88	0.96	0.90	0.85	0.72	0.75 ^a	0.78 ^a	0.83 ^a
2010 ^a												
Mean	0.77	0.81	0.87	0.78	1.1	1.24	45.8	108.7	0.75	0.78	0.81	0.83
Maximum	0.79	0.86	0.89	1.41	1.2	1.88	165	165	0.96	0.74	0.78	0.80
Minimum	0.73	0.78	0.84	0.90	0.95	1.02	1.23	18.6	0.73	0.83	0.83	0.90
2011 ^a												
Mean	0.9	0.9	0.9	1.0	1.1	1.3	100	76.8	20	2.4	0.9	0.9
Maximum	0.9	0.9	1.0	1.1	2.1	2.3	138	115	109	31.2	0.9	0.9
Minimum	0.8	0.8	0.9	0.9	1.0	1.2	1.1	1.0	0.9	0.8	0.9	0.9
2012 ^{a, b}												
Mean	0.9	1.0	0.9	0.9	3.5	15.9	141.5	46.2	0.7	N/A	N/A	N/A
Maximum	0.9	1.0	1.1	1.0	30.8	88.7	157	142	0.8	N/A	N/A	N/A
Minimum	0.9	0.9	0.8	0.7	0.6	0.8	95.1	0.7	0.7	N/A	N/A	N/A

Notes:

^a Provisional data starting 10/01/2010 – no QA/QC by the NDNR at the time of posting (Williams 2013).

^b Data only available for January through September, 2013 (Williams 2013).

N/A = Not Available from NDNR (Williams 2013).

USGS = U.S. Geological Survey

NDNR = Nebraska Department of Natural Resources

QA/QC = quality assurance/quality control

Source: NDNR 2011a; Lindeman 2011; Williams 2013

Table 6.1-15 NDEQ 2002 Field Measurements of pH and Dissolved Oxygen for Station Number SNI4NIOBR402 (Niobrara River above Box Butte Reservoir)

Measurement Date/Time	Parameter	Result	Units
1/2/2002 12:40:00 PM	pH-Field	8.08	s.u.
1/3/2002 10:30:00 AM	pH-Field	8.06	s.u.
1/3/2002 12:14:00 PM	pH-Field	8.06	s.u.
1/7/2002 8:45:00 AM	Dissolved Oxygen (Winkler)	8.09	mg/L
1/8/2002 2:30:00 PM	pH-Field	8.1	s.u.
1/10/2002 2:35:00 PM	pH-Field	8.1	s.u.
2/5/2002 7:30:00 AM	pH-Field	8.05	s.u.
2/5/2002 3:15:00 PM	pH-Field	8.1	s.u.
2/5/2002 4:15:00 PM	pH-Field	8.0	s.u.
2/5/2002 4:30:00 PM	pH-Field	8.0	s.u.
3/4/2002 10:15:00 AM	pH-Field	8.0	s.u.
3/5/2002 10:45:00 AM	pH-Field	8.07	s.u.
3/5/2002 11:00:00 AM	pH-Field	8.08	s.u.
3/5/2002 12:35:00 PM	pH-Field	8.07	s.u.
3/7/2002 8:20:00 AM	pH-Field	8.09	s.u.
4/1/2002 10:45:00 AM	pH-Field	8.05	s.u.
4/3/2002 3:00:00 PM	pH-Field	8.09	s.u.
5/7/2002 8:36:00 AM	pH-Field	8.05	s.u.
5/7/2002 9:00:00 AM	pH-Field	8.01	s.u.
5/7/2002 10:30:00 AM	pH-Field	8.07	s.u.
5/7/2002 10:59:00 AM	pH-Field	8.05	s.u.
5/9/2002 11:00:00 AM	pH-Field	8.04	s.u.
6/11/2002 11:40:00 AM	Dissolved Oxygen (Winkler)	8.03	mg/L
6/12/2002 11:00:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
6/12/2002 11:30:00 AM	Dissolved Oxygen (Winkler)	8.09	mg/L
6/12/2002 1:35:00 PM	pH-Field	8.0	s.u.
6/17/2002	pH-Field	8.0	s.u.
6/18/2002 9:25:00 AM	pH-Field	8.07	s.u.
6/18/2002 9:51:00 AM	pH-Field	8.02	s.u.
7/8/2002 9:10:00 AM	Dissolved Oxygen (Winkler)	8.0	mg/L
7/9/2002 8:45:00 AM	pH-Field	8.07	s.u.
7/9/2002 5:15:00 PM	pH-Field	8.06	s.u.
7/9/2002 6:20:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/10/2002 2:15:00 PM	pH-Field	8.04	s.u.
7/16/2002 9:18:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/16/2002 12:50:00 PM	pH-Field	8.08	s.u.
7/16/2002 1:00:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/16/2002 1:00:00 PM	pH-Field	8.03	s.u.
7/18/2002 10:25:00 AM	pH-Field	8.06	s.u.
8/5/2002 2:45:00 PM	pH-Field	8.08	s.u.

Table 6.1-15 NDEQ 2002 Field Measurements of pH and Dissolved Oxygen for Station Number SNI4NIOBR402 (Niobrara River above Box Butte Reservoir)

Measurement Date/Time	Parameter	Result	Units
8/6/2002 11:45:00 AM	pH-Field	8.06	s.u.
8/6/2002 12:00:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
8/7/2002 2:30:00 PM	Dissolved Oxygen (Winkler)	8.01	mg/L
9/3/2002 7:25:00 AM	pH-Field	8.0	s.u.
9/3/2002 11:45:00 AM	pH-Field	8.02	s.u.
9/3/2002 2:00:00 PM	pH-Field	8.05	s.u.
9/10/2002 11:45:00 AM	pH-Field	8.04	s.u.
9/11/2002 9:45:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
9/11/2002 10:15:00 AM	pH-Field	8.02	s.u.
10/7/2002 11:20:00 AM	pH-Field	8.04	s.u.
10/7/2002 1:00:00 PM	pH-Field	8.06	s.u.
10/7/2002 1:45:00 PM	pH-Field	8.07	s.u.
10/7/2002 2:40:00 PM	pH-Field	8.0	s.u.
10/8/2002 12:00:00 PM	pH-Field	8.08	s.u.
11/4/2002 9:45:00 AM	pH-Field	8.02	s.u.
11/4/2002 11:00:00 AM	pH-Field	8.09	s.u.
11/5/2002 10:30:00 AM	pH-Field	8.01	s.u.
11/5/2002 2:30:00 PM	pH-Field	8.01	s.u.
11/5/2002 3:00:00 PM	pH-Field	8.05	s.u.
11/8/2002 8:45:00 AM	pH-Field	8.0	s.u.
12/2/2002 8:05:00 AM	pH-Field	8.09	s.u.
12/2/2002 9:15:00 AM	pH-Field	8.03	s.u.
12/2/2002 10:30:00 AM	pH-Field	8.04	s.u.
12/2/2002 12:20:00 PM	pH-Field	8.01	s.u.
12/2/2002 12:30:00 PM	pH-Field	8.06	s.u.
12/2/2002 1:30:00 PM	pH-Field	8.04	s.u.
12/2/2002 3:00:00 PM	pH-Field	8.06	s.u.
12/3/2002 10:00:00 AM	pH-Field	8.07	s.u.

Notes:

mg/L = milligrams per liter

NDEQ = Nebraska Department of Environmental Quality

s.u. = standard unit

Source: Ihrie 2013a

Table 6.1-16 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2002

Constituent	Unit	6/07/2022	7/08/2002	8/06/2002	9/03/2002	10/07/2002	11/04/2002	12/02/2002	RL
Major Ions									
Calcium, Dissolved	mg/L	ND	45.7	ND	ND	44.6	ND	ND	0.15
Chloride, Total	mg/L	4.01	3.90	4.09	4.05	4.44	4.88	4.97	0.15
Magnesium, Dissolved as Mg	mg/L	ND	7.65	ND	ND	7.79	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.059	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.95	1.03	0.84	0.80	1.22	1.37	1.23	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	0.059	<0.04	0.041	0.043	<0.04	0.046	<0.04	0.04
Sodium, Dissolved	mg/L	ND	23.2	ND	ND	23.3	ND	ND	0.15
Physical Properties									
Specific Conductance	µmhos/cm @25°C	367	244	369	368	361	397	410	N/A
Alkalinity, Total	mg/L	176	162	170	172	169	184	193	N/A
Chemical Oxygen Demand (COD)	mg/L	<12	<12	<12	<12	<12	<12	12.5	12
Dissolved Oxygen, Field	mg/L	9.31	7.89	9.4	10.46	9.73	12.66	12.06	N/A
pH, Field	s.u.	8.34	7.5	8.11	8.22	8.29	8.48	8.17	N/A
Suspended Solids, Total (TSS)	mg/L	9.5	14	11.5	5.5	18.5	33	20	N/A
Temperature, Water (Field)	°C	22.7	29	20.8	16.9	16.4	3.54	3.84	N/A
Turbidity, Lab	NTU	6.64	8.73	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	ND	ND	5.7	6.2	10.8	17	13.5	N/A
Metals									
Arsenic, Dissolved	ug/L	ND	<10	ND	ND	<10	ND	ND	10
Cadmium, Dissolved	µg/L	ND	<1	ND	ND	<1	ND	ND	1
Chromium, Dissolved	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Copper	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Lead, Dissolved	µg/L	ND	<5	ND	ND	<5	ND	ND	5
Mercury, Dissolved as Hg	µg/L	ND	<1	ND	ND	<1	ND	ND	1
Nickel, Dissolved	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Selenium, Total	µg/L	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	<1	ND	ND	<1	ND	ND	1

Table 6.1-16 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2002

Constituent	Unit	6/07/2002	7/08/2002	8/06/2002	9/03/2002	10/07/2002	11/04/2002	12/02/2002	RL
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow									
Gage Height	inches	3.07	3.0	3.0	3.02	3.11	3.18	3.29	N/A
Stream Discharge	cfs	ND	ND	ND	ND	ND	ND	ND	N/A

Notes:

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

umhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ = Nebraska Department of Environmental Quality

RL = reporting limit

Source: Ihrie 2013a

Table 6.1-17 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2003

Constituent	Unit	Jan 13	Feb 1	Mar 7	Apr 8	May 5	Jun 9	Jul 7	Aug 5	Sept 8	Oct 6	Nov 3	Dec 1	RL
Major Ions														
Calcium, Dissolved	mg/L	58.2	ND	ND	54.7	ND	ND	46.3	ND	47.8	ND	ND	ND	0.15
Chloride, Total	mg/L	4.5	4.6	5.2	5.7	6.1	5.0	4.8	4.8	4.3	4.6	4.68	5.2	1.0
Magnesium, Dissolved	mg/L	9.18	ND	ND	10.3	ND	ND	7.99	ND	ND	8.28	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.08	0.05	0.05	<0.05	0.11	<0.05	0.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.34	1.26	1.26	0.48	0.59	0.76	0.97	1.00	1.11	1.14	1.18	1.13	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	0.53	0.56	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	<0.04	0.06	0.04	0.04	<0.04	0.05	0.08	0.07	0.04	0.06	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	23.4	ND	ND	25.2	ND	ND	24.6	ND	ND	24.6	ND	ND	0.15
Physical Properties														
Specific Conductance	µmhos/cm @25°C	400	377	402	429	440	388	374	343	ND	384	383	420	N/A
Alkalinity	mg/L	207	180	199	212	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	<12	<12	<12	20.3	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	12.19	11.52	11.69	9.72	9.57	8.65	8.27	8.06	ND	9.41	9.88	9.9	N/A
pH, Field	s.u.	8.2	7.76	8.17	8.36	8.37	8.45	8.1	8.2	ND	8.18	8.0	8.17	N/A
Suspended Solids, Total (TSS)	mg/L	9.0	23.5	13.0	18.5	20.0	12.5	35.0	36.0	12.0	22.5	5.0	8.0	N/A
Temperature, Water (Field)	°C	3.84	3.92	4.02	10.55	11.11	21.09	22.26	24.52	ND	10.49	4.17	3.76	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	6.01	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	0.2	16.1	6.6	10	12.4	10.5	24.8	41.9	ND	35.3	8.9	8.5	N/A
Metals, Dissolved														
Arsenic, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Cadmium, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1
Chromium, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Copper, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Lead, Dissolved	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Mercury, Dissolved as Hg	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1
Nickel, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1

Table 6.1-17 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2003

Constituent	Unit	Jan 13	Feb 1	Mar 7	Apr 8	May 5	Jun 9	Jul 7	Aug 5	Sept 8	Oct 6	Nov 3	Dec 1	RL
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	<10	ND	ND	<10	ND	ND	10
Stream Flow														
Gage Height	inches	3.25	3.35	3.3	3.49	3.33	ND	3.07	3.05	3.05	3.11	3.14	3.19	N/A
Stream Discharge	cfs	ND	27	23.3	39	25.5	13.6	10.3	9.04	9.44	11.8	13.6	16.3	N/A

Notes:

cfs = cubic feet per second

µg/L = micrograms per liter

mg/L = milligrams per Liter

NTU = Nephelometric Turbidity Units

s.u. = standard unit

µmhos/cm = micromhos per centimeter

< = less than

NA = No data

N/A = not applicable

ND = not detected

NDEQ = Nebraska Department of Environmental Quality

RL = reporting limit

Source: Ihrle 2013a

Table 6.1-4 Summary of Water Quality for the Marsland Expansion Area and Vicinity (2011-2013)

Constituent	Units	Private Wells in AOR ^a		MEA Wells ^b		MEA Wells ^c	
		Arikaree Group and Brule Formations		Brule Formation		Basal Sandstone of Chadron Formation	
		Range	Mean	Range	Mean	Range	Mean
Calcium	mg/l	21-73	38.9	5-32	12.7	2 - 19	6.52
Magnesium ^d	mg/l	3 - 13	8.8	<1 U - 7	2.2	<1 U - 3	1.06
Sodium	mg/l	8 - 49	19.8	24-156	89.7	298 - 550	408
Potassium	mg/l	2 -13	4.2	4 - 12	9.1	8 - 41	19.5
Bicarbonate as HCO ₃	mg/l	160 - 480	201.9	48 - 202	150.2	125 - 918	348
Sulfate	mg/l	3 - 44	10.2	2 - 62	37.9	45 - 396	173
Chloride	mg/l	2 - 9	3.5	2 - 63	24.6	137 - 605	270
Conductivity @ 25 °C	µmhos/cm	241 - 578	329.9	307 - 763	482	1340 - 2740	1848
Total Dissolved Solids @ 180 C	mg/l	202 - 400	250.2	200 - 537	341	778 - 1420	1086
Total Dissolved Solids Calculated	mg/l	166 - 870	270.7	241 - 567	376	770 - 1470	1096
pH	s.u.	7.64 - 8.5	8.1	8.19 - 10.00	9.03	8.25 - 10	8.87
Cations	meq/l	2.75 - 6.29	3.6	3.24 - 7.36	4.94	13.5 - 25	18.7
Anions	meq/l	2.94 - 6.71	3.7	3.1 - 7.44	4.99	13.6 - 24.6	17.9
Uranium, Suspended ^d	mg/l	<0.0003 U - 0.001	0.00021	<0.0003 U - 0.0017	0.00025	<0.0003 U - 0.0843	0.00246
Uranium, Dissolved ^d	mg/l	0.0028 - 0.0373	0.00745	0.002 - 0.0095	0.0052	<0.0003 U - 0.084	0.00828
Radium-226, Dissolved ^d	pCi/l	<0.1 U - 9.5	0.21	<0.10 - 0.66	0.22	<0.1 - 390	30
Radium-226, Suspended ^d	pCi/l	<0.06 U - 0.2	0.07	<0.1 U - 0.6	0.14	<0.1 - 45	1.82
Uranium Activity, Dissolved ^d	uCi/mL	3.8E-10 - 18.1	1.3349	1.3E-09 - 6.4E-09	3.8E-09	<2.0E-10 - 6.2	3.87E-10 ^e
Uranium Activity, Suspended ^d	uCi/mL	<2.0E-10 - 0.4	.000151 ^e	<2.0E-10 - 1.2E-09	1.59E-10	<2.0E-10 - 6.2	0.151

Notes:

^a 57 private water supply wells (700, 702, 703, 704, 705, 706, 707, 714, 715, 716, 719, 720, 721, 722, 723, 725, 727, 728, 730, 731, 732, 733, 734, 735, 736, 737, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 750, 752, 753, 754, 755, 759, 760, 777, 788, 794, 795, 799, 802, 809, 810, 811, 815, 821, 836, 841, 845) (March 24, 2011 - March 21, 2013).

^b 10 CBR MEA Brule monitor wells (BOW-2010-1, BOW-2010-2, BOW-2010-3, BOW-2010-4A, BOW-2010-5, BOW-2010-6, BOW-2010-7, BOW-2010-8 (March 4 - May 3, 2011).

^c 12 CBR MEA Basal Chadron monitor wells (Monitor-1, Monitor-2, Monitor-3, Monitor-4A, Monitor-5, Monitor-6, Monitor-7, Monitor-8, Monitor-9, Monitor-10, Monitor-11, CPW-2010-1) (March 12, 2011 - August 20, 2012).

^d Values less than detection limits reduced by one-half in order to provide a conservative estimate.

^e All data collected during Quarter 3 2012 was recorded with a RL of 0.2, average reported using RL of 2.0E-10 to prevent bias

mg/l = milligrams/liter
meq/l = milliequivalents per liter
pCi/l = picocuries per liter

<0.0003 U = non-detect result and detection limit
µmhos/cm = micromhos per centimeter
s.u. = standard units

AOR = Area of Review
CBR = Crow Butte Resources, Inc.
MEA = Marsland Expansion Area

Table 6.1-7 Water Levels - Arikaree Group, Brule Formation and Basal Sandstone of Chadron Formation

Well	TOC Elevation (ft amsl)	2/22/11 Water Level (ft TOC)	2/22/11 Groundwater Elevation (ft amsl)	10/17/13 Water Level (ft TOC)	10/17/13 Groundwater Elevation (ft amsl)
ARIKAREE GROUP					
AOW-1	4261.64	--	--	126.4	4135.24
AOW-3	4351.97	--	--	142.2	4209.77
AOW-4	4161.91	--	--	87.3	4074.61
AOW-5	4125.42	--	--	72.0	4053.42
AOW-6	4068.60	--	--	20.0	4048.60
AOW-7	4243.94	--	--	DRY	4093.94
AOW-8	4365.02	--	--	71.7	4293.32
AOW-9	4146.41	--	--	74.9	4071.51
AOW-10	4198.60	--	--	113.3	4085.30
AOW-11	4091.02	--	--	35.4	4055.62
BRULE FORMATION					
BOW 2010-1	4260.10	125.74	4134.36	124.9	4135.20
BOW 2010-2	4324.96	150.03	4174.93	151.4	4173.56
BOW 2010-3	4352.80	137.20	4215.60	139.6	4213.20
BOW-2010-4	4163.13	86.65	4076.48	--	--
BOW 2010-4A	--	--	--	93.7	4069.43
BOW 2010-5	4127.88	71.19	4056.69	74.0	4053.88
BOW 2010-6	4100.43	49.30	4051.13	50.3	4050.13
BOW-2010-7	4248.37	--	--	155.6	4092.77
BOW-2010-8	4369.29	--	--	74.0	4295.29
BOW-2013-9	4145.90	--	--	74.6	4071.30
BOW-2013-10	4197.84	--	--	113.8	4084.04
BOW-2013-11	4091.87	--	--	37.4	4054.47
BASAL SANDSTONE OF CHADRON FORMATION					
CPW-2010-1	4261.35	551.63	3709.72	565.3	3696.05
CPW-2010-1A	4263.28	--	--	567.0	3696.28
Monitor 1	4103.28	387.65	3715.63	399.4	3703.88
Monitor 2	4199.50	484.99	3714.51	500.3	3699.20
Monitor 3	4261.40	550.90	3710.50	565.5	3695.90
Monitor 4A	4329.72	618.09	3711.64	634.3	3695.42
Monitor 5	4340.80	628.87	3711.93	645.4	3695.40
Monitor 6	4216.40	502.80	3713.60	518.2	3698.20
Monitor 7	4246.28	531.20	3715.08	548.0	3698.28
Monitor 8	4355.90	644.97	3710.93	660.5	3695.40
Monitor 9	4367.02	656.54	3710.48	669.7	3697.32
Monitor 10	4163.99	449.01	3714.98	465.0	3698.99
Monitor 11	4128.07	412.74	3715.33	427.9	3700.17

NOTES:

Groundwater elevations for the Brule Formation and Basal Chadron Sandstone are based on depth to water measurements.

TOC = top of casing

ft TOC = feet below top of casing

ft amsl = feet above mean sea level

DRY = measurable water not present in well at time of sampling

Table 6.1-8 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:	BOW 2010-1		BOW 2010-1		BOW 2010-1		BOW 2010-2		BOW 2010-2		BOW 2010-2		BOW 2010-3		BOW 2010-3		BOW 2010-3			
	Date Collected:		3/9/2011		3/24/2011		4/6/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
	Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	
RADIONUCLIDES-DISSOLVED																				
Lead 210	pCi/L	<0.7	0.7	<0.8	0.8	<0.7	0.7	<0.7	0.7	<0.8	0.8	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8	
Lead 210 precision (±)	pCi/L	0.4		0.5		0.4		0.4		0.5		0.5		0.4		0.5		0.5		
Lead 210 MDC	pCi/L	0.7		0.8		0.7		0.7		0.8		0.8		0.7		0.8		0.8		
Polonium 210	pCi/L	<0.7	0.7	<1.2	1.2	<0.5	0.5	<0.7	0.7	<0.9	0.9	<0.6	0.6	<0.6	0.6	<0.9	0.9	<0.7	0.7	
Polonium 210 precision (±)	pCi/L	0.4		0.4		0.4		0.3		0.5		0.4		0.2		0.7		0.4		
Polonium 210 MDC	pCi/L	0.7		1.2		0.5		0.7		0.9		0.6		0.6		0.9		0.7		
Radium 226	pCi/L	<0.15	0.15	0.66	0.14	<0.1	0.1	0.31	0.15	0.26	0.1	<0.21	0.21	0.38	0.15	0.23	0.11	<0.22	0.22	
Radium 226 precision (±)	pCi/L	0.1		0.19		0.06		0.14		0.11		0.09		0.15		0.11		0.1		
Radium 226 MDC	pCi/L	0.15		0.14		0.1		0.15		0.1		0.21		0.15		0.11		0.22		
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.2	0.2	
Thorium 230 precision (±)	pCi/L	0.06		0.06		0.07		0.09		0.04		0.08		0.08		0.07		0.1		
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.2		
Uranium	mg/L	0.0032	0.0003	0.0024	0.0003	0.002	0.0003	0.0031	0.0003	0.0032	0.0003	0.0035	0.0003	0.0041	0.0003	0.0035	0.0003	0.0041	0.0003	
Uranium Activity	uCi/mL	2.20E-09	2.00E-10	1.60E-09	2.00E-10	1.30E-09	2.00E-10	2.10E-09	2.00E-10	2.20E-09	2.00E-10	2.40E-09	2.00E-10	2.80E-09	2.00E-10	2.40E-09	2.00E-10	2.80E-09	2.00E-10	
RADIONUCLIDES-SUSPENDED																				
Lead 210	pCi/L	<1.2	1.2	<0.8	0.8	<0.9	0.9	<1.3	1.3	<0.9	0.9	<0.7	0.7	<1.2	1.2	<0.9	0.9	<0.7	0.7	
Lead 210 precision (±)	pCi/L	0.7		0.5		0.5		0.8		0.6		0.4		0.7		0.6		0.4		
Lead 210 MDC	pCi/L	1.2		0.8		0.9		1.3		0.9		0.7		1.2		0.9		0.7		
Polonium 210	pCi/L	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.2	0.2	0.3	0.2	
Polonium 210 precision (±)	pCi/L	0.2		0.2		0.2		0.2		0.3		0.2		0.2		0.2		0.2		
Polonium 210 MDC	pCi/L	0.3		0.2		0.2		0.3		0.3		0.2		0.2		0.2		0.2		
Radium 226	pCi/L	0.14	0.13	0.21	0.09	<0.1	0.1	<0.14	0.14	0.28	0.09	<0.14	0.14	<0.14	0.14	0.15	0.08	<0.14	0.14	
Radium 226 precision (±)	pCi/L	0.1		0.09		0.06		0.08		0.1		0.08		0.09		0.08		0.06		
Radium 226 MDC	pCi/L	0.13		0.09		0.1		0.14		0.09		0.14		0.14		0.08		0.14		
Thorium 230	pCi/L	<0.05	0.05	<0.1	0.1	0.3	0.1	<0.06	0.06	0.2	0.1	<0.1	0.1	<0.08	0.08	<0.1	0.1	<0.1	0.1	
Thorium 230 precision (±)	pCi/L	0.05		0.1		0.2		0.05		0.1		0.1		0.05		0.1		0.08		
Thorium 230 MDC	pCi/L	0.05		0.1		0.1		0.06		0.1		0.1		0.08		0.1		0.1		
METALS, SUSPENDED																				
Uranium	mg/L	0.0004	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	0.0017	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	
Uranium Activity	uCi/mL	2.90E-10	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	1.20E-09	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL - Analyte reporting limit.

Table 6.1-8 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:	BOW 2010-4A		BOW 2010-4A		BOW 2010-4A		BOW 2010-5		BOW 2010-5		BOW 2010-5		BOW 2010-6		BOW 2010-6		BOW 2010-6			
	Date Collected:		4/5/2011		4/19/2011		5/3/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
	Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	
RADIONUCLIDES-DISSOLVED																				
Lead 210	pCi/L	<0.7	0.7	<1.9	1.9	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8	
Lead 210 precision (±)	pCi/L	0.4		1.1		0.5		0.4		0.5		0.5		0.4		0.5		0.5		
Lead 210 MDC	pCi/L	0.7		1.9		0.8		0.7		0.8		0.8		0.7		0.8		0.8		
Polonium 210	pCi/L	<1.1	1.1	<0.7	0.7	<0.5	0.5	<0.6	0.6	<0.6	0.6	<0.5	0.5	<0.5	0.5	<0.9	0.9	<0.6	0.6	
Polonium 210 precision (±)	pCi/L	0.6		0.5		0.5		0.3		0.3		0.3		0.3		0.5		0.3		
Polonium 210 MDC	pCi/L	1.1		0.7		0.5		0.6		0.6		0.5		0.5		0.9		0.6		
Radium 226	pCi/L	<0.2	0.2	0.2	0.1	<0.1	0.1	0.36	0.15	0.41	0.11	<0.16	0.16	<0.13	0.13	0.34	0.11	<0.17	0.17	
Radium 226 precision (±)	pCi/L	0.1		0.1		0.09		0.15		0.13		0.08		0.08		0.12		0.08		
Radium 226 MDC	pCi/L	0.2		0.1		0.1		0.15		0.11		0.16		0.13		0.11		0.17		
Thorium 230	pCi/L	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	
Thorium 230 precision (±)	pCi/L	0.1		0.09		0.09		0.06		0.07		0.09		0.08		0.06		0.1		
Thorium 230 MDC	pCi/L	0.2		0.2		0.1		0.1		0.1		0.1		0.1		0.1		0.1		
Uranium	mg/L	0.0095	0.0003	0.0053	0.0003	0.0061	0.0003	0.0061	0.0003	0.0075	0.0003	0.0076	0.0003	0.0052	0.0003	0.0055	0.0003	0.0058	0.0003	
Uranium Activity	uCi/mL	6.40E-09	2.00E-10	3.60E-09	2.00E-10	4.10E-09	2.00E-10	4.10E-09	2.00E-10	5.10E-09	2.00E-10	5.20E-09	2.00E-10	3.60E-09	2.00E-10	3.70E-09	2.00E-10	3.90E-09	2.00E-10	
RADIONUCLIDES-SUSPENDED																				
Lead 210	pCi/L	<1.1	1.1	<0.9	0.9	<1.1	1.1	<1.2	1.2	<0.9	0.9	<0.7	0.7	<1.2	1.2	<1.1	1.1	<0.7	0.7	
Lead 210 precision (±)	pCi/L	0.7		0.5		0.6		0.7		0.5		0.4		0.7		0.6		0.4		
Lead 210 MDC	pCi/L	1.1		0.9		1.1		1.2		0.9		0.7		1.2		1.1		0.7		
Polonium 210	pCi/L	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.2	0.2	
Polonium 210 precision (±)	pCi/L	0.08		0.1		0.1		0.1		0.1		0.1		0.2		0.2		0.08		
Polonium 210 MDC	pCi/L	0.2		0.2		0.3		0.3		0.2		0.2		0.2		0.3		0.2		
Radium 226	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.13	0.13	0.14	0.08	<0.15	0.15	<0.13	0.13	0.16	0.08	<0.13	0.13	
Radium 226 precision (±)	pCi/L	0.07		0.05		0.07		0.08		0.08		0.06		0.08		0.08		0.05		
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.13		0.08		0.15		0.13		0.08		0.13		
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.07	0.07	<0.1	0.1	<0.1	0.1	<0.05	0.05	<0.2	0.2	<0.1	0.1	
Thorium 230 precision (±)	pCi/L	0.08		0.09		0.06		0.04		0.09		0.06		0.04		0.1		0.07		
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.07		0.1		0.1		0.05		0.2		0.1		
METALS, SUSPENDED																				
Uranium	mg/L	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	
Uranium Activity	uCi/mL	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL - Analyte reporting limit.

Table 6.1-8 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

	Location ID:	BOW 2010-7		BOW 2010-7		BOW 2010-7		BOW 2010-8		BOW 2010-8		BOW 2010-8	
	Date Collected:	4/5/2011		4/19/2011		5/3/2011		4/5/2011		4/19/2011		5/3/2011	
	Formation:	BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED													
Lead 210	pCi/L	<0.7	0.7	<0.9	0.9	<0.8	0.8	<0.7	0.7	<0.9	0.9	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.4		0.5		0.5		0.4		0.5		0.5	
Lead 210 MDC	pCi/L	0.7		0.9		0.8		0.7		0.9		0.8	
Polonium 210	pCi/L	<1.1	1.1	<0.6	0.6	<0.9	0.9	<1.1	1.1	<1.1	1.1	<0.6	0.6
Polonium 210 precision (±)	pCi/L	0.7		0.3		0.7		0.5		0.9		0.3	
Polonium 210 MDC	pCi/L	1.1		0.6		0.9		1.1		1.1		0.6	
Radium 226	pCi/L	<0.1	0.1	0.5	0.1	0.6	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.06		0.1		0.2		0.08		0.08		0.1	
Radium 226 MDC	pCi/L	0.1		0.1		0.2		0.2		0.1		0.1	
Thorium 230	pCi/L	<0.1	0.1	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.07		0.08		0.1		0.07		0.09		0.09	
Thorium 230 MDC	pCi/L	0.1		0.2		0.1		0.1		0.2		0.2	
Uranium	mg/L	0.0059	0.0003	0.0049	0.0003	0.0049	0.0003	0.0075	0.0003	0.007	0.0003	0.0069	0.0003
Uranium Activity	uCi/mL	4.00E-09	2.00E-10	3.30E-09	2.00E-10	3.30E-09	2.00E-10	5.00E-09	2.00E-10	4.70E-09	2.00E-10	4.70E-09	2.00E-10
RADIONUCLIDES-SUSPENDED													
Lead 210	pCi/L	<1.1	1.1	<0.9	0.9	<0.9	0.9	<1.1	1.1	<0.9	0.9	<0.9	0.9
Lead 210 precision (±)	pCi/L	0.7		0.6		0.5		0.7		0.5		0.5	
Lead 210 MDC	pCi/L	1.1		0.9		0.9		1.1		0.9		0.9	
Polonium 210	pCi/L	<0.2	0.2	0.5	0.2	<0.2	0.2	<0.2	0.2	<0.4	0.4	<0.2	0.2
Polonium 210 precision (±)	pCi/L	0.02		0.3		0.2		0.2		0.2		0.07	
Polonium 210 MDC	pCi/L	0.2		0.2		0.2		0.2		0.4		0.2	
Radium 226	pCi/L	0.6	0.1	0.3	0.1	0.2	0.1	0.3	0.1	<0.1	0.1	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.1		0.1		0.1		0.09		0.05		0.07	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1	
Thorium 230	pCi/L	0.2	0.1	0.2	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.3	0.1
Thorium 230 precision (±)	pCi/L	0.1		0.1		0.08		0.09		0.07		0.1	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1	
METALS, SUSPENDED													
Uranium	mg/L	0.0005	0.0003	0.0004	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003
Uranium Activity	uCi/mL	3.70E-10	2.00E-10	3.20E-10	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL - Analyte reporting limit.

Table 6.1-9 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID: Date Collected: Formation:	BOW 2010-1		BOW 2010-1		BOW 2010-1		BOW 2010-2		BOW 2010-2		BOW 2010-2		BOW 2010-3		BOW 2010-3		BOW 2010-3		
	3/9/2011		3/24/2011		4/6/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011		
	BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																			
Alkalinity Total as CaCO ₃	mg/L	211	1	217	1	212	1	187	1	187	1	182	1	177	1	145	1	171	1
Bicarbonate as HCO ₃	mg/L	139	1	67	1	48	1	152	1	122	1	148	1	154	1	94	1	144	1
Carbonate as CO ₃	mg/L	58	1	97	1	104	1	38	1	52	1	37	1	31	1	41	1	32	1
Chloride	mg/L	44	1	55	1	63	1	27	1	32	1	31	1	38	1	37	1	32	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.6	0.1	0.5	0.1	0.5	0.1
Magnesium	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.3	0.1	1.3	0.1	1.3	0.1	<0.1	0.1	1.1	0.1	1.1	0.1	1	0.1	0.5	0.1	0.8	0.1
Potassium	mg/L	12	1	12	1	12	1	11	1	12	1	11	1	12	1	10	1	10	1
Silica	mg/L	105	0.2	108	0.2	110	0.2	85.9	0.2	95.1	0.2	88.1	0.2	79.3	0.2	86.5	0.2	87	0.2
Sodium	mg/L	144	1	156	1	145	1	107	1	112	1	107	1	126	1	109	1	118	1
Sulfate	mg/L	60	2	61	2	62	2	37	2	39	2	37	1	60	2	60	2	60	2
PHYSICAL PROPERTIES																			
Conductivity @ 25 °C	umhos/cm	682	1	724	1	763	1	518	1	542	1	515	1	584	1	527	1	550	1
pH	s.u.	9.56	0.01	9.88	0.01	10	0.01	9.32	0.01	9.58	0.01	9.38	0.01	9.22	0.01	9.57	0.01	9.41	0.01
Total Dissolved Solids @ 180 °C	mg/L	456	10	508	10	537	10	377	10	396	10	342	10	411	10	375	10	374	10
METALS, DISSOLVED																			
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.018	0.001	0.017	0.001	0.014	0.001	0.005	0.001	0.004	0.001	0.005	0.001	0.01	0.001	0.009	0.001	0.009	0.001
Barium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Boron	mg/L	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.3	0.1
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
Calcium	mg/L	5	1	5	1	5	1	7	1	6	1	6	1	7	1	5	1	5	1
Chromium	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Copper	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Manganese	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Mercury	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Molybdenum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nickel	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Selenium	mg/L	0.021	0.001	0.021	0.001	0.016	0.001	0.002	0.001	0.001	0.001	ND	0.001	0.006	0.001	0.003	0.001	0.003	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Zinc	mg/L	0.04	0.01	0.04	0.01	0.08	0.01	0.03	0.01	0.07	0.01	0.06	0.01	0.05	0.01	0.15	0.01	0.11	0.01
DATA QUALITY																			
A/C Balance (± 5)	%	0.0283		0.476		-3.96		0.0154		-0.717		-0.824		1.57		-0.182		0.062	
Anions	meq/L	6.83		7.29		7.44		5.3		5.57		5.37		5.95		5.27		5.65	
Cations	meq/L	6.83		7.36		6.87		5.3		5.49		5.29		6.14		5.25		5.66	
Solids Total Dissolved Calculated	mg/L	532		567		560		410		439		418		454		420		442	

Notes:
mg/L = milligrams per Liter
umhos/cm = micromhos per centimeter
s.u. = standard unit
meq/L = milliequivalents per Liter
RL = Analyte Reporting Limit

Table 6.1-9 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID: Date Collected: Formation:	BOW 2010-4A		BOW 2010-4A		BOW 2010-4A		BOW 2010-5		BOW 2010-5		BOW 2010-5		BOW 2010-6		BOW 2010-6		BOW 2010-6		
	4/5/2011		4/19/2011		5/3/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011		
	BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																			
Alkalinity Total as CaCO ₃	mg/L	175	1	131	1	125	1	151	1	151	1	152	1	144	1	143	1	143	1
Bicarbonate as HCO ₃	mg/L	180	1	95	1	114	1	174	1	170	1	177	1	165	1	159	1	168	1
Carbonate as CO ₃	mg/L	16	1	32	1	19	1	5	1	7	1	4	1	6	1	7	1	3	1
Chloride	mg/L	24	1	33	1	28	1	7	1	7	1	5	1	2	1	10	1	10	1
Fluoride	mg/L	0.5	0.1	0.5	0.1	0.5	0.1	0.6	0.1	0.5	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.6	0.1
Magnesium	mg/L	2	1	<1	1	<1	1	7	1	7	1	7	1	7	1	7	1	7	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.2	0.1	1.2	0.1	1.1	0.1	0.9	0.1	0.9	0.1	0.9	0.1	1	0.1	1	0.1	1	0.1
Potassium	mg/L	11	1	9	1	8	1	4	1	5	1	4	1	4	1	5	1	5	1
Silica	mg/L	78.2	0.2	70.6	0.2	75.6	0.2	72.1	0.2	83.9	0.2	78.6	0.2	67.4	0.2	73.7	0.2	71.5	0.2
Sodium	mg/L	100	1	95	1	84	1	26	1	28	1	27	1	24	1	25	1	25	1
Sulfate	mg/L	50	2	50	1	49	1	9	1	9	1	9	1	2	1	10	1	10	1
PHYSICAL PROPERTIES																			
Conductivity @ 25 °C	umhos/cm	514	1	474	1	446	1	313	1	307	1	307	1	320	1	309	1	310	1
pH	s.u.	8.92	0.01	9.4	0.01	9.31	0.01	8.23	0.01	8.34	0.01	8.19	0.01	8.31	0.01	8.5	0.01	8.27	0.01
Total Dissolved Solids @ 180 °C	mg/L	358	10	345	10	316	10	231	10	228	10	200	10	216	10	225	10	206	10
METALS, DISSOLVED																			
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.015	0.001	0.014	0.001	0.015	0.001	0.003	0.001	0.004	0.001	0.003	0.001	0.005	0.001	0.005	0.001	0.005	0.001
Barium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.1
Boron	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
Calcium	mg/L	13	1	7	1	6	1	29	1	29	1	29	1	31	1	31	1	32	1
Chromium	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Copper	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Manganese	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Mercury	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Molybdenum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nickel	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Selenium	mg/L	0.009	0.001	0.011	0.001	0.012	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Zinc	mg/L	<0.01	0.01	0.01	0.01	<0.01	0.01	0.06	0.01	0.09	0.01	0.1	0.01	0.03	0.01	0.06	0.01	0.07	0.01
DATA QUALITY																			
A/C Balance (± 5)	%	1.48		0.755		-1.89		-3.95		-1.58		-1.82		2.6		-1.63		-1.34	
Anions	meq/L	5.3		4.7		4.4		3.51		3.48		3.45		3.1		3.43		3.44	
Cations	meq/L	5.46		4.77		4.24		3.24		3.37		3.33		3.27		3.32		3.34	
Solids Total Dissolved Calculated	mg/L	409		368		256		269		285		277		248		271		269	

Notes:
mg/L = milligrams per Liter
umhos/cm = micromhos per centimeter
s.u. = standard unit
meq/L = milliequivalents per Liter
RL = Analyte Reporting Limit

Table 6.1-9 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID: Date Collected: Formation:	BOW 2010-7		BOW 2010-7		BOW 2010-7		BOW 2010-8		BOW 2010-8		BOW 2010-8		
	4/5/2011		4/19/2011		5/3/2011		4/5/2011		4/19/2011		5/3/2011		
	BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS													
Alkalinity Total as CaCO ₃	mg/L	190	1	185	1	180	1	182	1	182	1	179	1
Bicarbonate as HCO ₃	mg/L	202	1	182	1	191	1	198	1	172	1	189	1
Carbonate as CO ₃	mg/L	15	1	21	1	14	1	12	1	24	1	14	1
Chloride	mg/L	23	1	28	1	25	1	7	1	13	1	9	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.5	0.1	0.5	0.1	0.5	0.1
Magnesium	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.2	0.1	1	0.1	1	0.1	0.8	0.1	0.6	0.1	0.7	0.1
Potassium	mg/L	11	1	10	1	9	1	10	1	12	1	10	1
Silica	mg/L	80.9	0.2	76.9	0.2	80.1	0.2	81.4	0.2	76.3	0.2	80.2	0.2
Sodium	mg/L	118	1	119	1	106	1	83	1	90	1	79	1
Sulfate	mg/L	55	2	54	2	52	2	27	1	24	1	24	1
PHYSICAL PROPERTIES													
Conductivity @ 25 °C	umhos/cm	547	1	540	1	535	1	407	1	428	1	410	1
pH	s.u.	8.76	0.01	9	0.01	8.93	0.01	8.65	0.01	9.15	0.01	8.93	0.01
Total Dissolved Solids @ 180 °C	mg/L	376	10	411	10	376	10	306	10	326	10	299	10
METALS, DISSOLVED													
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.028	0.001	0.029	0.001	0.03	0.001	0.006	0.001	0.005	0.001	0.006	0.001
Barium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Boron	mg/L	0.2	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
Calcium	mg/L	8	1	5	1	6	1	11	1	8	1	9	1
Chromium	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Copper	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Manganese	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Mercury	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
Molybdenum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nickel	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Selenium	mg/L	0.21	0.001	0.22	0.001	0.235	0.001	ND	0.001	ND	0.001	ND	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Zinc	mg/L	<0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	0.01
DATA QUALITY													
A/C Balance (± 5)	%	1.35		0.159		-2.68		0.681		0.853		-2.91	
Anions	meq/L	5.72		5.71		5.48		4.46		4.57		4.39	
Cations	meq/L	5.88		5.73		5.2		4.52		4.65		4.14	
Solids Total Dissolved Calculated	mg/L	439		430		312		355		356		241	

Notes:

- mg/L = milligrams per Liter
- umhos/cm = micromhos per centimeter
- s.u. = standard unit
- meq/L = milliequivalents per Liter
- RL = Analyte Reporting Limit

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