Lake Poinsett Supplemental Water Quality Investigative Report-September 2009

South Dakota Department of Environment and Natural Resources
Water Resources Assistance Program (WRAP)-Watershed Protection

The Lake Poinsett water quality assessment special project was conducted from the spring of 2007 through the summer of 2009. The initial Lake Poinsett Water Quality Investigative Report-January 2009 was finalized prior to the 2009 field season and before DENR received the Lake Poinsett Water Project Districts' applications to modify FC-5 (FC-5A) and to appropriate water from the Big Sioux River to Lake Poinsett (7088-3). As the process progressed, new information and data were acquired during the spring and summer of 2009. Therefore, it is the intention of this supplemental report to provide necessary revisions and incorporate phosphorus loading estimates consistent with both applications from data collected during the 2009 field season.

2007 Phosphorus Load Revisions

In this supplemental report the 2007 phosphorus loading estimates for the existing watershed and Big Sioux River were revised from that presented in the January 2009 report. This report again uses calculations and data from 2007 as a baseline. The original volume in the prior report used to estimate the phosphorus loadings for the Big Sioux River and existing watershed focused strictly on the surface area of Lake Poinsett. It was later realized that in this particular scenario, Lake Poinsett would equalize with Dry Lake which would increase the total volume required to reach outlet elevation. For this exercise, it was deemed necessary to compensate for the additional surface area of Dry Lake and adjust the water volume (23,800 ac-ft) used to calculate the 2007 phosphorus loads. In addition, the Big Sioux River average phosphorus concentration was re-calculated to account for samples collected exclusively during the estimated flow period required to fill Lake Poinsett to outlet elevation. The 2007 phosphorus load scenario was based strictly on the volume required to bring Lake Poinsett to outlet elevation for comparative purposes. No account was given to the provisions later set forth in applications FC-5A and 7088-3 as those applications had not yet been filed.

In 2007, the Big Sioux River was estimated to have been able to fill the entire Lake Poinsett system to outlet elevation over the period March 14th to April 22nd. The average phosphorus concentration based on 5 samples collected exclusively at BSR 18.5 during this time period was calculated at 0.65 mg/L. As a result, the 2007 Big Sioux River phosphorus load was calculated at 42,000 pounds.

For comparison, the same water volume was applied to the average concentrations of Dry Lake (0.34 mg/L) and Lake Albert outflow (0.17 mg/L). The total volume was divided to allocate 75% of the volume to Lake Albert and 25% to Dry Lake. The estimated phosphorus load associated with Lake Albert and Dry Lake was 8,000 and 5,500 pounds, respectively. The cumulative phosphorus load from both sources was estimated at 13,500 pounds. The Big Sioux River phosphorus load would have been roughly 3 times higher than that from the existing watershed (Figure 1).

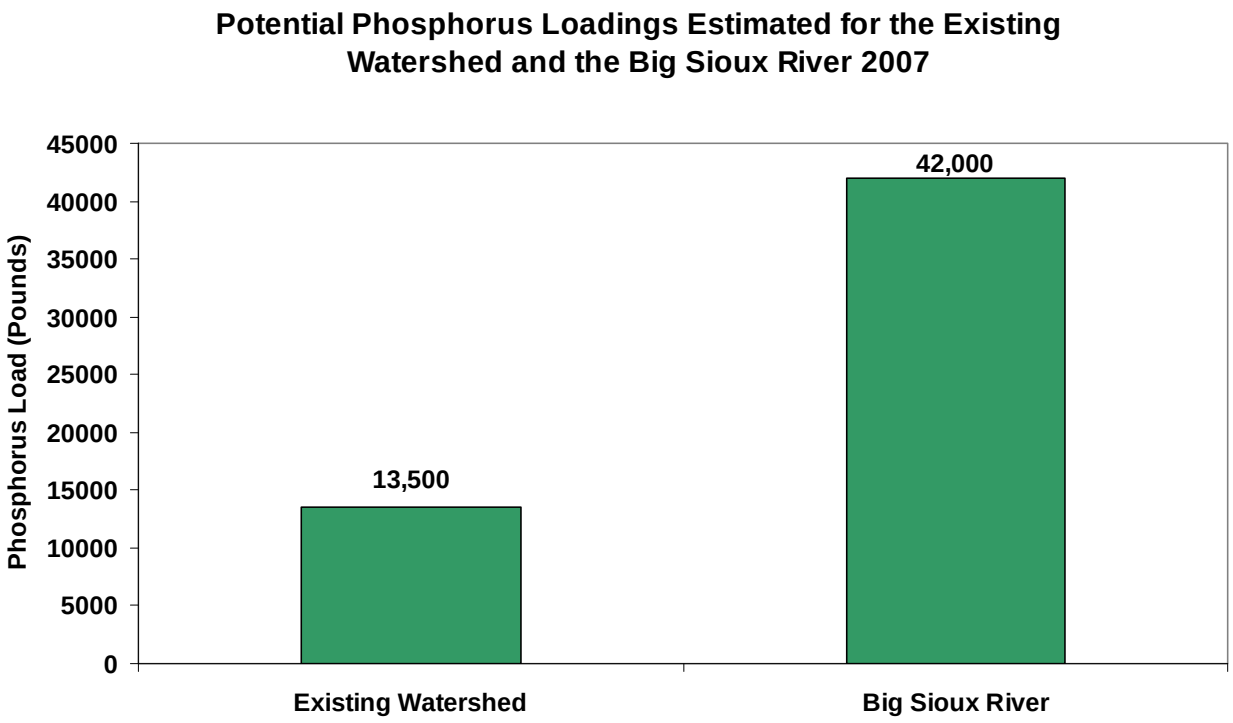

Figure 1. Estimated phosphorus loads for the existing watershed and Big Sioux River from 2007.

The estimated phosphorus loads from the Big Sioux River and the existing watershed were used to simulate a potential in lake phosphorus response. This exercise was performed under the assumption that the outlet gates were open in the spring of 2007. The in lake phosphorus concentration of Lake Poinsett was estimated to have potentially increased from 0.13 mg/L to 0.15 mg/L when subjected to the estimated phosphorus load from the existing watershed (i.e., 13,500 pounds). The in lake phosphorus concentration of Lake Poinsett was estimated to have potentially increased from 0.13 mg/L to 0.27 mg/L with the estimated Big Sioux River phosphorus load (42,000 pounds). Thus, the potential Big Sioux River load may have doubled the in lake phosphorus concentration of Lake Poinsett if inflow would have occurred in 2007.

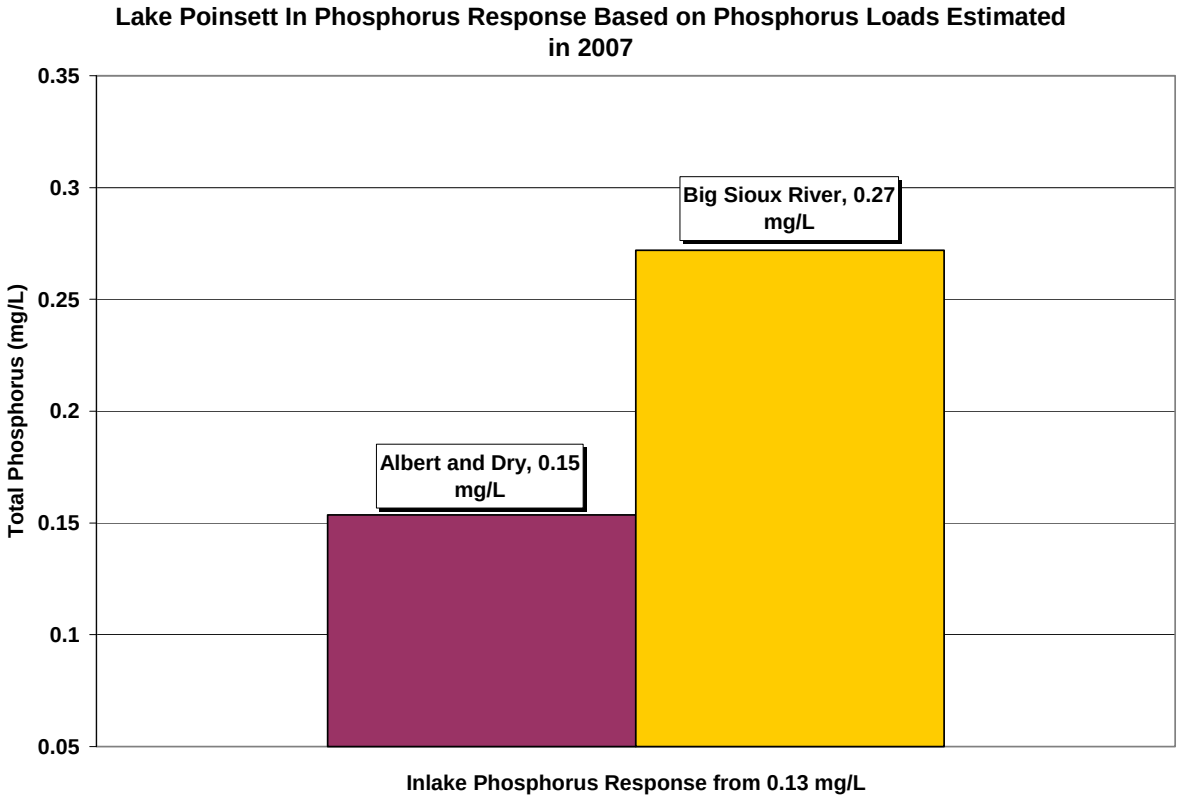

Figure 2. Lake Poinsett in lake phosphorus response to phosphorus load estimates from the existing watershed and the Big Sioux River.

2009 Phosphorus Load Comparison

The Lake Poinsett watershed received significant moisture in the winter and early spring of 2009. The Big Sioux River experienced flood level flows and water levels in Dry Lake and all the western chain of lakes ascended above their outlet elevations. Outflow from Dry Lake and Lake Albert produced enough flow to fill Lake Poinsett to outlet elevation by May 19, 2009. DENR watershed protection monitored water levels and collected phosphorus samples at the Lake Albert outlet, Dry Lake outlet and the Big Sioux River. All sampling methodologies and load calculations were conducted in the same manner described in the January 2009 report. All 2009 water quality data collected to date is available in Appendix A.

During the early spring of 2009, Lake Poinsett was estimated to be 2.5 feet below outlet elevation (1648.0 fmsl). Making the assumption that most of the water required to fill Lake Poinsett to outlet elevation came from Dry Lake and Lake Albert a two part phosphorus load was calculated to represent the existing watershed. Dry Lake and Lake Albert began to contribute flow on March 15, 2009. By April 7th Lake Poinsett had risen

1.6 feet to an elevation of 1649.6 fmsl. The volume associated with this rise in lake level across the surface area of Lake Poinsett (7900 acres) was calculated at 12,640 acre-feet. The average phosphorus concentration from Dry Lake and Lake Albert outflow during this time period was calculated at 0.33 mg/L. The resultant phosphorus load was estimated at 11,300 pounds. After April 7th Lake Poinsett equalized with Dry Lake which increased the entire systems surface area to an estimated 9,875 acres. The water volume required to reach outlet elevation was estimated at 8,888 acre-feet. Dry Lake contributed minimally after April 7th due to backflow from Lake Poinsett. The average phosphorus concentration based exclusively on Lake Albert outflow was calculated from samples collected between April 7th and May 19th. The average phosphorus concentration for this time period was calculated at 0.09 mg/L and the resultant phosphorus load was calculated at 2,200 pounds. The cumulative phosphorus load for the existing watershed was estimated at 13,500 pounds.

The Lake Poinsett Water Project District submitted applications FC-5A and 7088-3 to amend flood control permit FC-5 and appropriate inflow from the Big Sioux River to Lake Poinsett. Application number FC-5A proposes to change the current operation of outlet gates to allow inflow from the Big Sioux River to Lake Poinsett. Application number 7088-3 proposes to appropriate 16,000 acre-feet of inflow annually from the Big Sioux River during the period March 15th to May 15th considering the lake level does not exceed outlet elevation and flow is available.

A 2009 Big Sioux River phosphorus load estimate was developed to take into account the proposed provisions described under applications FC-5A and 7088-3. Big Sioux River flood flows were estimated to have been able to contribute 16,000 acre-feet of inflow to Lake Poinsett during the period March 17th to March 26th. The average phosphorus concentration from 5 samples collected at BSR 18.5 during this time period was calculated at 0.7 mg/L. The potential Big Sioux River phosphorus load was estimated at 30,500 pounds.

The proposed water volume allocation (16,000 acre-feet) from the Big Sioux River would have increased the lake level from 1648.0 fmsl to 1649.6 fmsl. The additional 0.9 feet of water required to fill the entire Lake Poinsett system to outlet elevation would have been contributed by the existing watershed. The remaining water volume was calculated at 8,888 acre-feet. Since the existing watershed was previously estimated to have contributed 12,640 acre-feet by April 7th it is assumed that the Big Sioux River and existing watershed would have filled Lake Poinsett to outlet elevation sometime in early April.

The average phosphorus concentration for the existing watershed was based on samples collected from Dry Lake and Lake Albert outflow over the period March 17th to April 3rd. The average phosphorus concentration was calculated at 0.35 mg/L. The resultant phosphorus load for the existing watershed was calculated at 8,500 pounds. The potential combined phosphorus load from the existing watershed and Big Sioux River was estimated at 39,000 pounds. This cumulative phosphorus load is nearly 3 times higher than that estimated exclusively from the existing watershed (13,500 pounds) for 2009

(Figure 4). Based on a mass balance equation the in lake phosphorus concentration of Lake Poinsett was estimated to have potentially doubled with the combined Big Sioux River and existing watershed phosphorus load (39,000 pounds) (Figure 5).

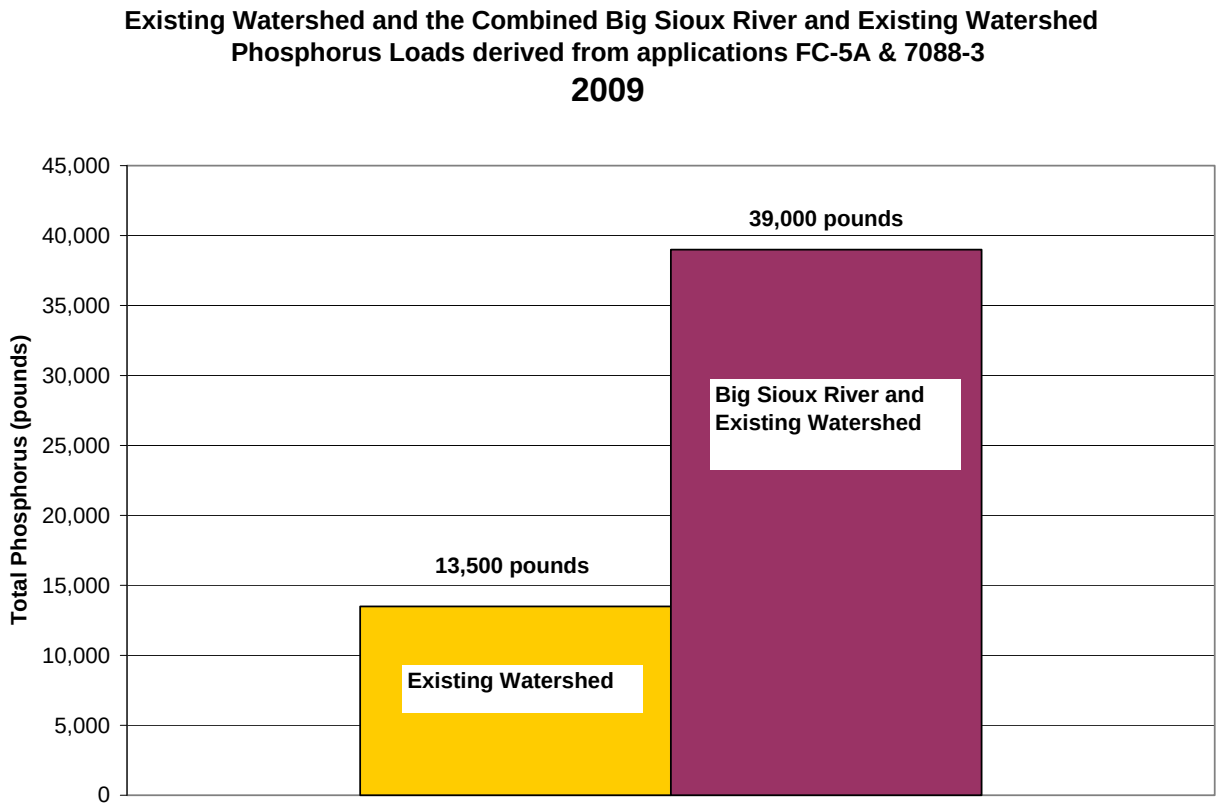

Figure 4. Phosphorus load comparison between existing watershed and the Big Sioux River and existing watershed based on provisions set-forth in applications FC-5A and 7088-3.

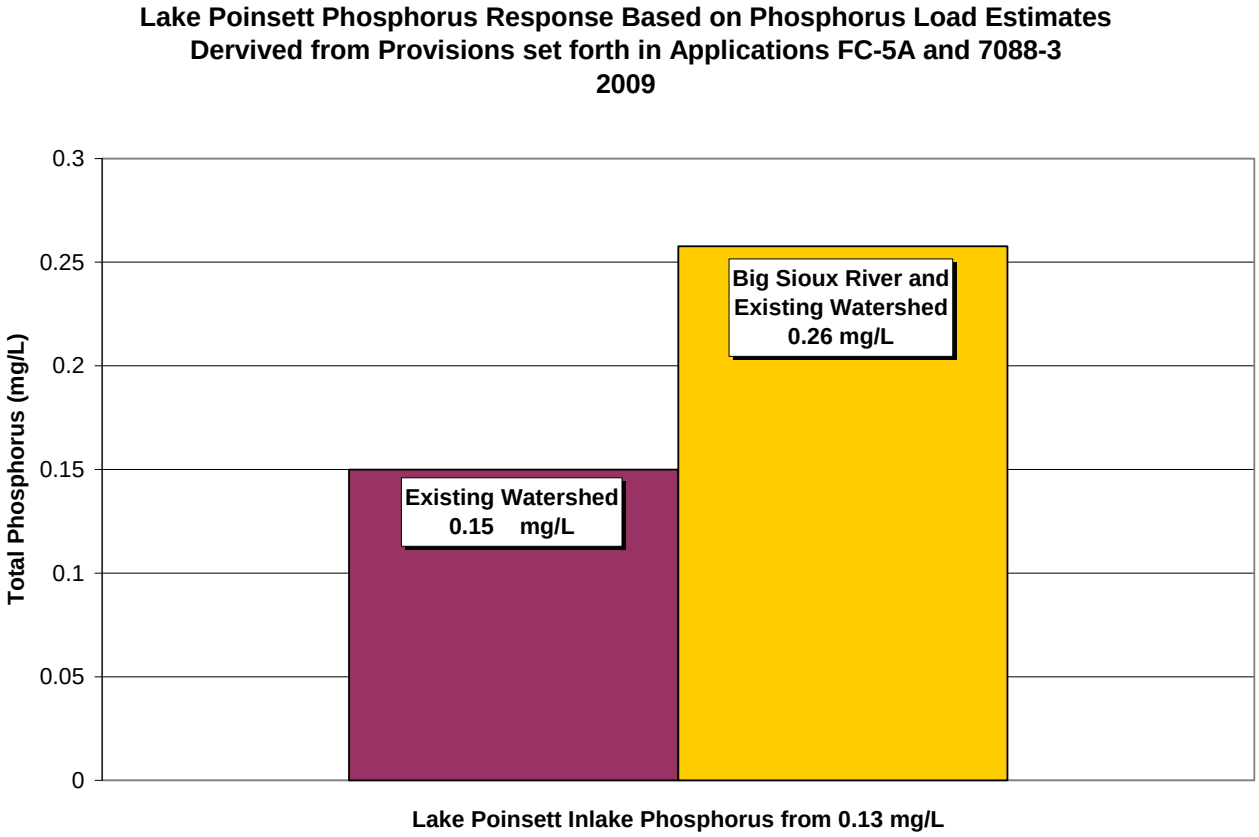

Figure 5. Lake Poinsett in lake phosphorus response comparisons based on phosphorus loads estimated from the existing watershed and from the combined Big Sioux River and existing watershed taking into account provisions set forth in applications FC-5A and 7088-3.

Hydrologic conditions experienced in 2007 and 2009 offered insight as to how potential Big Sioux River inflows could increase phosphorus loading to Lake Poinsett. Both years yielded consistent results in terms of estimated phosphorus loading between the existing watershed and the Big Sioux River. It was demonstrated that if the outlet gates would have been operated as proposed by applications FC-5A and 7088-3 in the spring of 2009, the Big Sioux River could have contributed to a phosphorus load 3 times higher than that estimated exclusively from the existing watershed. Potential increased phosphorus loading from the Big Sioux River would negate ongoing efforts to reduce phosphorus loading to Lake Poinsett. Furthermore, increased phosphorus loading from the Big Sioux River could contribute to the increase risk of frequent and intense algae blooms, favoring communities dominated by nuisance blue-greens. This could directly compound impacts related to lake aesthetics and recreational activities such as swimming, boating and fishing.

Appendix A

2009 Water Quality Data

Sample Location	Date	Code	Dissolved Oxygen (mg/L)	pH s.u.	Total Phosphorus (mg/L)	Total suspended solids (mg/L)
Dry Lake Outlet	03/24/2009	DLO	14.92	7.8	0.381	11
Dry Lake Outlet	04/03/2009	DLO	10.75	8.03	0.321	33
Dry Lake Outlet	05/07/2009	DLO	14.55	8.52	0.101	4
Dry Lake Outlet	06/05/2009	DLO	9.41	8.57	0.136	11
Lake Albert Outlet-Hwy 81	03/17/2009	LAO	4.15	7.36	0.416	4
Lake Albert Outlet-Hwy 81	03/18/2009	LAO	3.5	6.93	0.415	12
Lake Albert Outlet-Prairie Quay	03/17/2009	LAOPQ	6.45	7.48	0.379	14
Lake Albert Outlet-Prairie Quay	03/18/2009	LAOPQ	6.07	6.93	0.364	9
Lake Albert Outlet-Prairie Quay	03/19/2009	LAOPQ	4.26	7.09	0.409	6
Lake Albert Outlet-Prairie Quay	03/24/2009	LAOPQ	8.3	7.4	0.277	33
Lake Albert Outlet-Prairie Quay	04/03/2009	LAOPQ	10.7	8.05	0.345	40
Lake Albert Outlet-Prairie Quay	04/07/2009	LAOPQ	13.3	8.07	0.168	7
Lake Albert Outlet-Prairie Quay	04/15/2009	LAOPQ	11.02	7.98	0.112	11
Lake Albert Outlet-Prairie Quay	04/22/2009	LAOPQ	10.9	7.99	0.088	6
Lake Albert Outlet-Prairie Quay	04/30/2009	LAOPQ	9.99	7.97	0.073	<3
Lake Albert Outlet-Prairie Quay	05/07/2009	LAOPQ	6.55	7.68	0.072	<3
Lake Albert Outlet-Prairie Quay	05/12/2009	LAOPQ	3.05	7.52	0.074	3
Lake Albert Outlet-Prairie Quay	05/19/2009	LAOPQ	4.75	7.52	0.084	5
Lake Albert Outlet-Prairie Quay	06/05/2009	LAOPQ	2.45	7.41	0.108	<3
Lake Albert Outlet-Prairie Quay	06/11/2009	LAOPQ	2.66	7.44	0.103	4
Lake Albert Outlet-Prairie Quay	06/17/2009	LAOPQ	2.7	7.4	0.132	<3
Lake Albert Outlet-Prairie Quay	06/25/2009	LAOPQ	3.3	7.49	0.243	14
Lake Albert Outlet-Prairie Quay	07/01/2009	LAOPQ	1.34	7.41	0.12	3
Lake Albert Outlet-Prairie Quay	07/08/2009	LAOPQ	0.4	7.55	0.179	3
Lake Albert Outlet-Prairie Quay	07/15/2009	LAOPQ	0.9	7.6	0.18	8
Lake Albert Outlet-Prairie Quay	07/22/2009	LAOPQ	0.9	7.7	0.183	6
Lake Albert Outlet-Prairie Quay	07/31/2009	LAOPQ	0.55	7.73	0.219	9
Lake Albert Outlet-Prairie Quay	08/06/2009	LAOPQ	0.4	7.7	0.27	4
Lake Albert Outlet-Prairie Quay	08/12/2009	LAOPQ	8.01	7.69	0.302	5
Lake Albert Outlet Culverts	03/17/2009	LOACULV	5.25	7.31	0.32	7
Lake Albert Outlet Culverts	03/18/2009	LOACULV	8	6.96	0.254	10
Big Sioux River	03/17/2009	BSR 18.5	10	7.62	0.717	54
Big Sioux River	03/18/2009	BSR 18.5	9.88	7.3	0.661	110
Big Sioux River	03/19/2009	BSR 18.5	9.88	7.55	0.531	62
Big Sioux River	03/23/2009	BSR 18.5	8.9	7.76	0.934	140
Big Sioux River	03/24/2009	BSR 18.5	10.82	7.72	0.668	100
Big Sioux River	04/03/2009	BSR 18.5	10.19	8.01	0.182	6
Big Sioux River	04/07/2009	BSR 18.5	14.83	8.23	0.286	32
Big Sioux River	04/15/2009	BSR 18.5	14.1	8.62	0.24	43
Big Sioux River	04/22/2009	BSR 18.5	12.9	8.47	0.212	26
Big Sioux River	04/30/2009	BSR 18.5	12.86	8.39	0.2	20
Big Sioux River	05/07/2009	BSR 18.5	11.16	8.57	0.212	13
Big Sioux River	05/12/2009	BSR 18.5	10.86	8.5	0.267	59
Boswell Ditch Gates	03/17/2009	T38	11.15	7.8	0.269	33
Boswell Ditch Gates	03/18/2009	T38	11.35	7.18	0.55	35
Boswell Ditch Gates	03/19/2009	T38	11.4	7.4	0.505	29
Boswell Ditch Gates	03/23/2009	T38	9.3	7.74	0.852	192
Boswell Ditch Gates	03/24/2009	T38	13.08	7.72	0.632	82