

MAXIMUM SULFATE LIMIT OF THE SHEYENNE RIVER

SUPPORTING ANALYSIS

The Sheyenne River is a Class IA stream in North Dakota. The quality of the waters in this class shall be the same as the quality of a Class I stream except that treatment for municipal use may also require softening to meet the drinking water requirements of the department.

Under the proposed change, the Sheyenne River will remain a Class IA stream but a segment of the river will be subject to a different criterion for sulfate than is normally applied to Class IA streams. The proposed change allows the maximum sulfate (total) concentration of 750 mg/L (30-day arithmetic average) from the headwaters of the Sheyenne River to 0.1 miles downstream of Baldhill Dam.

The Sheyenne River sulfate concentrations are largely influenced by natural conditions. Runoff from precipitation and snow melt generally decrease sulfate concentrations whereas low flows are dominated by groundwater discharge. Groundwater is more mineralized and contains much higher sulfate concentrations.

From 2005 to present; 565 samples were taken at the Flora site. Of these 167 had a higher sulfate concentration than 450 mg/L; 80 had a higher concentration than 600 mg/L; 45 had a higher concentration than 700 mg/L; and 42 had a higher concentration than 750 mg/L.

This demonstrates that the criterion for sulfate of 450 mg/L is inappropriate because at the time the standard was established the natural background condition was not considered. There is one permitted discharger under section 402 of the Clean Water Act located on the main stem of the river upstream from the Flora site. This municipal discharger with a population of less than 2,000 has low sulfate drinking water and, therefore, has an inconsequential effect on sulfate concentrations at Flora.

There are no municipal, rural water districts, or industrial uses of the Sheyenne River from its headwaters to 0.1 miles downstream of Baldhill Dam. This department is not aware of any plans, preliminary plans or intent in using the Sheyenne River in this reach for these purposes. (Memo, D. Wayne Kern, Appendix A) The department intends to remove the municipal use designation from this reach of the river during the next triennial water quality review process.

The North Dakota State Water Commission reports there are no applications for water appropriation permits on this reach of river. An appropriation of greater than 12.5 acre feet of water requires a permit.

Agriculture use on this reach of the Sheyenne River is mostly livestock watering and a small number of irrigators. North Dakota designates Class III streams as suitable for agriculture use but does not delineate numeric criteria to support that use. Class III streams have a maximum limit of 750 mg/L of sulfate (total) 30-day arithmetic average. The state of Illinois has numeric limits of 2,000 mg/L of sulfate for livestock watering.

North Dakota State University Extension suggests that concentration of 1000 mg/L to 1500 mg/L is protective for most classes of grazing livestock.

This reach of Sheyenne River is designated suitable for the propagation or protection or both of resident fish species and other aquatic biotic.

The state of Illinois developed sulfate criteria for protection of aquatic life (See Ill. Admin. Code tit. 35, § 302.208).

The Environmental Protection Agency (EPA) approved Illinois Water Quality Standards including the permissible sulfate concentrations.

The Illinois' sulfate criteria, which is located in Ill. Admin. Code tit. 35, § 302.208(h), states:

The following concentrations for sulfate must not be exceeded except in receiving waters for which mixing is allowed pursuant to Section 302.102:

- 1) At any point where water is withdrawn or accessed for purposes of livestock watering, the average of sulfate concentrations must not exceed 2,000 mg/L when measured at a representative frequency over a 30 day period.
- 2) The results of the following equations provide sulfate water quality standards in mg/L for the specified ranges of hardness (in mg/L as CaCO₃) and chloride (in mg/L) and must be met at all times:
 - A) If the hardness concentration of receiving waters is greater than or equal to 100 mg/L but less than or equal to 500 mg/L, and if the chloride concentration of waters is greater than or equal to 25 mg/L but less than or equal to 500 mg/L then:
$$C = [1276.7 + 5.508 (\text{hardness}) - 1.457 (\text{chloride})] * 0.65$$
 where, C = sulfate concentration
 - B) If the hardness concentration of waters is greater than or equal to 100 mg/L but less than or equal to 500 mg/L, and if the chloride concentration of waters is greater than or equal to 5 mg/L but less than 25 mg/L, then:
$$C = [-57.478 + 5.79 (\text{hardness}) + 54.163 (\text{chloride})] * 0.65$$
 where C = sulfate concentration
- 3) The following sulfate standards must be met at all times when hardness (in mg/L as CaCO₃) and chloride (in mg/L) concentrations other than specified in (h)(2) are present:
 - A) If the hardness concentration of waters is less than 100 mg/L or chloride concentration of waters is less than 5 mg/L, the sulfate standard is 500 mg/L.

- B) If the hardness concentration of waters is greater than 500 mg/L and the chloride concentration of waters is 5 mg/L or greater, the sulfate standard is 2,000 mg/L.
- C) If the combination of hardness and chloride concentrations of existing waters are not reflected in subsection (h)(3)(A) or (B), the sulfate standard may be determined in a site-specific rulemaking pursuant to section 303(c) of the Federal Water Pollution Control Act of 1972 (Clean Water Act), 33 USC 1313, and Federal Regulations at 40 CFR 131.10(j)(2).

The Illinois' method for determining permissible sulfate concentrations supports our conclusion that 750 milligrams per liter sulfate (total) is not only protective but more than adequate to protect aquatic life.

Data from April 2008 to July 2009 from the Sheyenne River near Flora, Bremen, Cooperstown, below Baldhill Dam and the Devils Lake outlet were used to calculate sulfate concentrations that are protective of aquatic life (Table 1).

Table 1

Site	Chloride				Hardness				N	Sulfate Criterion (mg/L)	
	Min	Max	Mean	Median	Min	Max	Mean	Median		(min H & min Cl)	(min H & max Cl)
1	10.9	103.0	86.0	96.2	202	658	551	562	20	1106	1455
2	6.8	22.4	15.3	16.3	227	537	349	337	39	1057	1605
3	12.7	44.8	25.6	24.95	281	547	432	439	38	1467	1793
4	11.7	40.8	19.5	17.4	292	478	400	417	39	1473	1836
5	9.6	27.2	18.8	19.25	183	565	407	417	38	988	1459

1. Devils Lake State Outlet
2. Sheyenne River Below Baldhill Dam
3. Sheyenne River Near Bremen
4. Sheyenne River Near Cooperstown
5. Sheyenne River Near Flora

Location Map – Appendix B

The formula found in the Illinois Water Quality Standards where chloride concentration in mg/L, and hardness concentration (in mg/L as calcium carbonate) was used to calculate the sulfate criteria. The data expressed in minimum, maximum, mean, and median concentrations unequivocally support the proposed 750 mg/L criterion for sulfate.

The formula is presented in a different way (Table 2) which provides an alternative more user friendly method for determining protective aquatic life criterion. In addition to the formula and tabular method, the calculations are also provided in graphic form (Figure 1).

Table 2

Hardness =	500										
	Chloride	5	6	13	15	24	25	50	100	200	500
	sulfate	2020	2055	2302	2372	2689	2596	2572	2525	2430	2146.
Hardness =	400										
	Chloride	5	6	13	15	24	25	50	100	200	500
	sulfate	1644	1679	1925	1996	2313	2238	2214	2167	2072	1788
Hardness =	300										
	Chloride	5	6	13	15	24	25	50	100	200	500
	sulfate	1267	1302	1549	1619	1936	1880.	1856	1809	1714	1430
Hardness =	200										
	Chloride	5	6	13	15	24	25	50	100	200	500
	sulfate	891	926	1173	1243	1560	1522	1498	1451.	1356	1072
Hardness =	100										
	Chloride	5	6	13	15	24	25	50	100	200	500
	sulfate	515	550	796	867	1183	1164	1140	1093	998	714
Ag Use	sulfate	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

If hardness is <100 mg/L or chloride is < 5 mg/L, the sulfate std = 500 mg/L

If hardness is > 500 and chloride is > or equal to 5 mg/L then the sulfate standard is 2000 mg/L

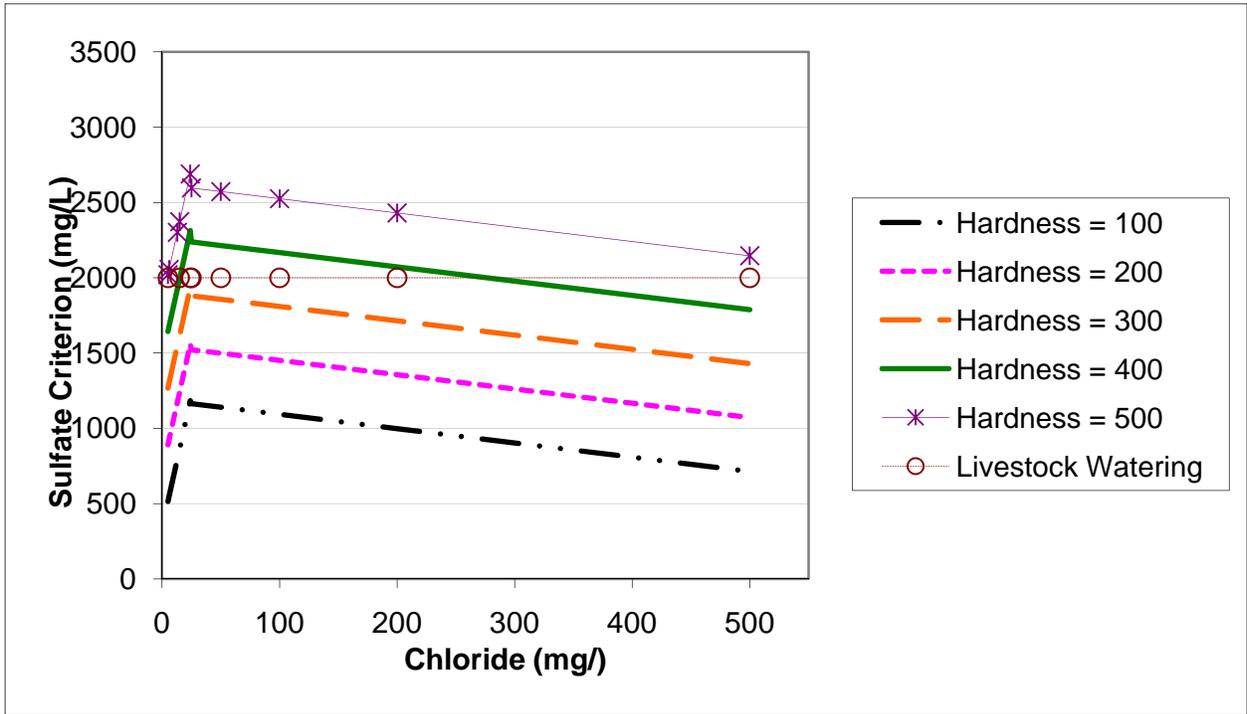


Figure 1

Appendix A

INTRADEPARTMENTAL MEMORANDUM

TO: L. David Glatt, P.E., Chief
Environmental Health Section

FROM: D. Wayne Kern, P.E., Director
Division of Municipal Facilities

RE: Use of Sheyenne River Upstream of Lake Ashtabula as a Drinking Water Source

DATE: September 2, 2009

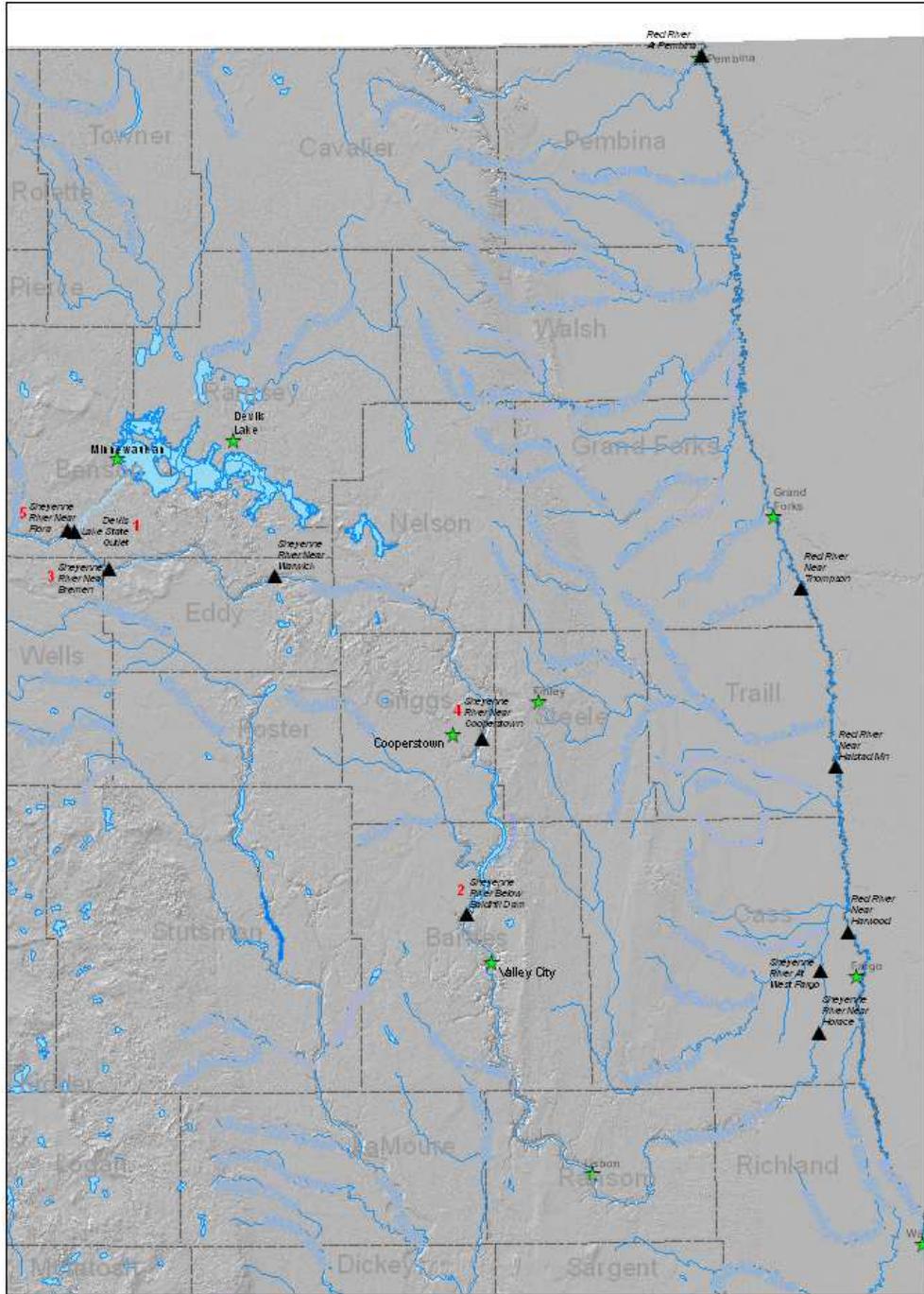
This concerns the above-referenced matter. Presently, there are no public water systems (PWSs) that use the Sheyenne River upstream of Lake Ashtabula as a drinking water source. I am also not aware of any plans on the part of PWSs to utilize this stretch of the Sheyenne River as a drinking water source.

PWSs that utilize surface water are subject to strict treatment and monitoring requirements under the federal Safe Drinking Water Act (SDWA) and its implementing regulations. Private water supplies are not subject to the SDWA. However, whether for public or private use, surface water must undergo substantial treatment to render it safe and aesthetically acceptable for drinking water purposes.

Please contact me if you have questions or need additional information on this matter.

DWK

Location Map



- ▲ Monitoring Stations
- ★ City
- Devils Lake Outlet
- Dam or Weir
- Stream or River
- Lake or Pond
- Reservoir
- County Boundary

APPENDIX B

Sheyenne River to Red River of the North
and Red River of the North to the Canadian Border
North Dakota