Lower Otter Tail River Turbidity Total Maximum Daily Load Report

Water Quality/Impaired Waters #5.02a October 30, 2006

Minnesota Pollution Control Agency

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EXECUTIVE SUMMARY

Section 303(d) of the Clean Water Act requires that States develop Total Maximum Daily Loads (TMDLs) for surface waters that do not meet, and maintain, applicable water quality standards. A TMDL sets the amount of a given pollutant that the water body can withstand without creating an impairment of that surface water's designated use. The TMDL by definition (40 CFR Part 130) is the sum of all Waste Load Allocations (point source) and Load Allocations (non-point source) with the inclusion of a margin of safety and natural background conditions.

The Otter Tail River is located in west-central Minnesota with the mouth of the river at Breckenridge, Minnesota (Fig. 1). The confluence of the Otter Tail River and the Bois de Sioux River at Breckenridge is considered to be the headwaters of the Red River of the North. The Minnesota Pollution Control Agency (MPCA) has listed a stream reach in the Lower Otter Tail River (LOTR) as an impaired water for exceeding the turbidity standard for aquatic life, which is currently set at 25 Nephelometric Turbidity Units (NTU). The 2004 303(d) list identifies the impaired reach as the "Otter Tail River, Breckenridge Lake to Bois de Sioux River", Assessment Unit ID (AUID) 09020103-502. This 8.2 mile segment of the Otter Tail River is the last reach downstream before the confluence with the Bois de Sioux River and will be referred to as the Lower Otter Tail River (LOTR) in this report.

The entire Otter Tail River watershed covers approximately 1,983 square miles (1.27 million acres) in west-central Minnesota. The LOTR sub-watershed contains approximately 52,000 acres. It is the smallest sub-watershed in the Otter Tail River basin and makes up only 4.1% of the area (Fig.2). Land use in the LOTR sub-watershed is dominated by intensive agricultural cropping (90%). An extensive system of drainage ditches has been constructed in this area to promote rapid surface drainage.

The upstream and downstream boundaries for the LOTR are easily distinguishable and serve to provide a smaller watershed for implementation practices. The upstream boundary utilized for this report for the LOTR is the dam of Orwell Reservoir, a USACE flood control impoundment located just southwest of Fergus Falls, Minnesota on the Otter Tail River. The downstream boundary of the LOTR is the confluence of the Otter Tail River with the Bois de Sioux River at Breckenridge. These boundary conditions amount to a study area of approximately 48 river miles at the lower end of the Otter Tail River.

The samples used to list the LOTR for the turbidity impairment were collected from 1992-1994. For this TMDL study, additional work that was done by the U.S. Geological Survey (USGS) from 2001-2003 confirmed the turbidity impairment in the river.

Turbidity is a dimensionless unit and cannot be converted into loads. To use the 25 NTU turbidity standard in a load allocation scenario, a relationship between turbidity and the suspended sediment concentration (SSC) was developed. Using paired turbidity and SSC measurements in the study area, along with regression analysis, a 58.9 mg/l SSC was used for the equivalent 25 NTU estimated measurement.

The USGS estimated that the annual sediment load was 40,400 tons at the sampling site in Breckenridge. Utilizing the flow and load duration curve information, this TMDL will be presented as a tiered solution. This means that there will be a goal for sediment reduction during high flow, a different goal for sediment reduction during moist conditions (sometimes referred to as moderate flows), and no reduction needed for flow conditions that are considered mid-range flows, dry conditions, or low flow.

Examination of the LOTR study area shows that there are no point sources that are contributing directly to the impaired reach. It should also be noted that there are no point sources in the entire watershed from Orwell Reservoir to the confluence with the Bois de Sioux River in Breckenridge. Consequently, the project team decided to address the turbidity impairment through non-point measures.

The turbidity impairment appears to be directly correlated with the increased flows in the critical spring flow event (snow pack melt) and the more severe large storm events (rainfall resulting in stream flows greater than 544 cfs at Breckenridge). The project team theorized that the sediment load was influenced by wind erosion, lack of crop cover during storm events and overland flows.

Monitoring conducted through the Red River Basin water quality monitoring program will be used to measure progress towards achieving the water quality goal. An implementation plan to reduce erosion contributed by overland runoff will be developed separately.

INTRODUCTION

Section 303(d) of the Clean Water Act (CWA) requires that States develop Total Maximum Daily Loads (TMDLs) for surface waters that do not meet, and maintain, applicable water quality standards.

A TMDL sets the amount of a given pollutant that the water body can withstand without creating an impairment of that surface water's designated use. The TMDL by definition (40 CFR Part 130) is the sum of all Waste Load Allocations (point source) and Load Allocations (non-point source) with the inclusion of a margin of safety and natural background conditions. TMDL reports must include the following eight elements to be approved by the U.S. Environmental Protection Agency (EPA):

The TMDL report must:

1. Be designed to implement applicable water quality criteria;
2. Include a total allowable load, as well as individual waste load allocations;
3. Consider the impacts of background pollutant contributions;
4. Consider critical environmental conditions;
5. Consider seasonal environmental variations;
6. Include a margin of safety;
7. Provide opportunity for public participation;
8. Have a reasonable assurance that the TMDL can be met.

In general, the TMDL is developed according to the following relationship:

$$TMDL = WLA + LA + MOS$$

Where:

TMDL =	Total Maximum Daily Load (may be seasonal, for critical conditions, or have other constraints)
WLA =	Waste Load Allocation (point source)
LA =	Load Allocation (non-point source)
MOS =	Margin of Safety (may be implicit and factored into a conservative WLA or LA, or explicit)

PROBLEM STATEMENT

Sediment is a significant water quality problem in the Red River Basin (RRB), with 17 reaches currently listed as impaired for turbidity; several turbidity TMDLs are in progress in the RRB. Impairments lie in each of the region's five ecoregions. Excessive sediment limits all the beneficial uses of streams in the Red River Basin: agriculture, aquatic life, and drinking water supplies.

Suspended sediment is considered a pollutant and in excessive amounts can affect water quality and designated uses of water. Accelerated sedimentation can affect the growth and development of fisheries by reducing spawning areas and food sources, by adding fill in rearing ponds, and by reducing habitat complexity (bed forms). In addition to affecting aquatic life, accelerated sedimentation can result in aggradation, increase the stream channel width/depth ratio and cause bank erosion and failure. Sediment can adversely affect drinking water supplies by causing taste and odor problems, foul treatment systems, and fill reservoirs resulting in loss of storage capacity.

In 1994, the U.S. Geological Survey analyzed instantaneous sediment-loading rates at four sites between the Orwell Dam in Otter Tail County and Breckenridge Lake. There are about 10 small tributaries to the LOTR in this reach. The USGS results showed that suspended sediment concentrations increased downstream of Orwell Dam and that most sediment was deposited during relatively high flow periods in June and July.

The Otter Tail River (from Height of Land Lake to the mouth) is classified as 1C, 2Bd, 3B, 3C, 4A, 4B, 5, and 6 for water quality standards. These classifications pertain to protecting the surface water for drinking water uses (Class 1), aquatic life and recreational uses (Class 2), industrial use and cooling (Class 3), agricultural uses – irrigation and livestock/wildlife watering (Class 4A and 4B), aesthetics and navigation (Class 5), and other uses (Class 6).

Turbidity in water is caused by suspended soil particles, algae, etc., that scatter light in the water column making the water appear cloudy. Excess turbidity can significantly degrade the aesthetic qualities of waterbodies. People are less likely to recreate in waters degraded by excess turbidity. Also, turbidity can make the water more expensive to treat for drinking or food processing uses. Turbidity values that exceed the standard can harm aquatic life. Aquatic organisms may have trouble finding food, gill function may be affected, and spawning beds may be covered. Turbidity is measured in nephelometric turbidity units (NTU). The turbidity standard for the Otter Tail River is 25 NTU.

The Otter Tail River is listed on the 303(d) list Total Maximum Daily Load (TMDL) as an impaired reach for turbidity from <u>Breckenridge Lake to the Bois de Sioux River</u> based on a 1996 stream water quality assessment. This reach of the Otter Tail River is approximately 8.2 miles long and located entirely in Wilkin County in the lower sub-basin (Fig. 1). This reach is bounded by Breckenridge Lake to the east and ends at the confluence with the Bois de Sioux River to the west. The dominant land use of the watershed in this reach is row-crop agriculture. There are numerous field drains that enter the reach at times of highest flow. There is relatively little urban land use in this reach. Several county roads cross the river in this reach.

Four streambank stabilization projects have been installed in the impaired reach recently:

1. Wojtalewicz site upstream from the 11th street bridge,
2. Vertin site upstream from Wojtalewicz site,
3. Conzemius site below the county road 10 bridge, and the
4. Christopher site above Lake Breckenridge.

Each of these projects involved only one side of the stream and varied from about 200 feet to 600 feet in length. Wilkin County Soil and Water Conservation District staff surveyed streambank erosion in the reach by car in Spring 2004; no significant areas of erosion were identified. However, a much more detailed survey would be needed to adequately assess the streambank erosion problem.

HYDROLOGY, GEOLOGY, and SOILS

Soil erosion and sediment loading in streams are concerns in the Red River of the North Basin (RRB) in Minnesota, North Dakota, South Dakota, and Manitoba, Canada. Soil erosion may reduce cropland fertility. Agricultural drainage ditches fill with eroded sediment over time, and require costly ditch maintenance. High suspended sediment concentrations can also adversely affect aquatic ecosystems. Water utilities that use water from the Red River of the North as a source of drinking water must spend more time to treat water that has high sediment concentrations. Lake Winnipeg, in Manitoba, receives most of its tributary sediment loading from the Red River. Eutrophication in southern Lake Winnipeg due to sediment and nutrients (some portion of which are originally sediment-bound) is a concern.

The RRB is set in glacial lake bed, with glaciofluvial and morainal topography. Nearly all of the streams flow through glacial deposits or glacial lake-bed sedimentary deposits, and exhibit channel meanders, cut banks, and point bars, and often fairly turbid waters. Much of the RRB – particularly in the Red River Valley – is cultivated cropland, and soil erosion from cropland also contributes to the sediment load in streams. It is widely accepted that sediment sources in streams in such settings are comprised of sediment that originates both from eroded soil and from erosion of stream-bank sediments. The relative amounts from these two sources in a given stream are seldom known.

Suspended sediment concentrations are often related to streamflow. Higher stream velocities, which correspond to higher streamflows, are potentially more erosive and can carry greater sediment loads than slower-moving water. Also, soil erosion contributes sediment to overland runoff, and higher streamflows result from overland runoff compared to base flow. Often, both streamflow and suspended sediment data for a site are approximately log-normally distributed. Thus, log-transformed concentration and streamflow data are typically used in data analysis.

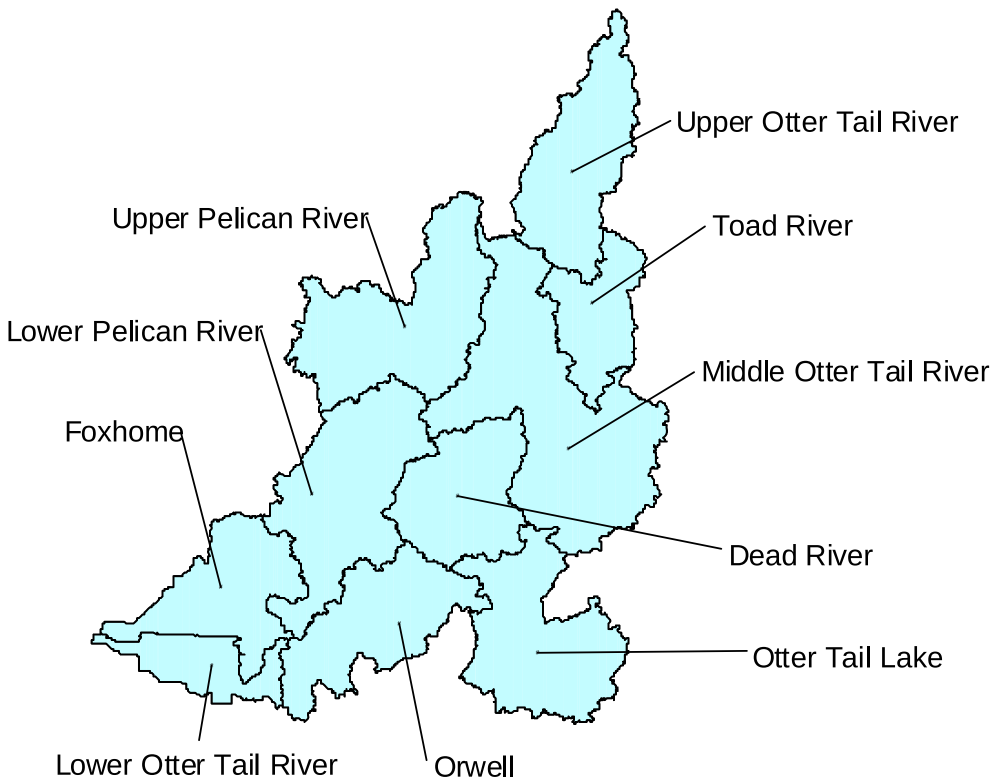
Often the sediment concentrations exhibit hysteresis with respect to streamflow. That is, the concentrations of sediment are higher during periods of rising stage and lower during periods of falling stage during a single runoff event. Colby *(1963)* notes that "Peak concentration of fine material early in the runoff is consistent with the idea that loose soil particles at the beginning of a storm will be eroded by the first directional runoff of an appreciable amount."

The Otter Tail River watershed covers approximately 1,983 square miles (1.27 million acres) of the Red River Basin in west-central Minnesota. The LOTR sub-watershed contains approximately 52,000 acres. It is the smallest sub-watershed in the Otter Tail River basin and makes up only 4.1% of the area (Fig. 2). An extensive system of drainage ditches has been constructed in this sub-basin to promote rapid surface discharge. Between Lake Breckenridge and the gaging station at the end of this reach, flows increase by approximately 10 percent. This increase is primarily due to the field drains entering the river within the reach.

Land use in the LOTR sub-watershed is dominated by intensive agricultural cropping (90%). The main crops grown in this area are spring wheat, soybeans, sugar beets, corn, barley and sunflowers. Areas of deciduous trees (3%) and grasslands (2%) are located near the river. However, less than five percent of the subwatershed is enrolled in agriculture conservation programs. The remaining area is comprised of open water (2%), wetlands (1%) and urban and farmsteads (2%).

Figure 1. Location of the Lower Otter Tail River sub-watershed.

Figure 2. Diagram of Otter Tail River sub-watersheds.



WIND EROSION PROBLEM

Seasonality in sediment data could be related to several physical factors: cropping practices, wind erosion, water erosion and frozen soils during winter. In the RRB, the typical cropland practice is: plant in the spring and harvest and till the soil in the fall. Bare soil, susceptible to both wind and water erosion, covers large areas from fall until the next season's crops grow. Fall months tend to be drier than growing season months, with few heavy rainstorms. Freezing and snow cover minimize, but do not eliminate, erosion during the winter. High winds erode snow and topsoil, which tend to be deposited in ditches and vegetated areas. A portion of winter-eroded soil particularly that deposited in ditches may be readily transported to streams.

Wind erosion of soils may be more acute during spring months, particularly during dry springs, than in winter because frozen soils are less erodible and runoff is uncommon during most winters in the RRB. These considerations combine to result in the greatest soil-erosion rates (from water erosion) expected during runoff events in the spring (before plant growth stabilizes the soils and crop canopy protects soils from the effects of precipitation) and autumn (after harvesting and tillage, when soils are most disturbed if rainfall is greater than normal). Conversely, the lowest soil erosion rates are expected during base flows of winter months, and possibly during mid-summer, when crop vegetation minimizes the erosive effects of direct impact of raindrops. Hence, seasonalility is considered in data analysis.

Long-term results in sediment concentrations could be caused by large-scale changes in tillage practices; changes in rainfall-runoff relations due to changes in land use; and construction of dams that would tend to trap sediments *(Colby and others, 1963)*.

METHODS

For this impaired waters study, the Minnesota Pollution Control Agency entered into a contract with the U.S. Geological Survey, Bismarck, N.D., to conduct water quality analysis, manage and interpret results and provide technical assessment of the data. This contract included the turbidity impaired reach of the Otter Tail River; Ottertail River, Breckenridge Lake to Bois de Sioux River, AUID 09020103-502.

Cooperative Study Partners

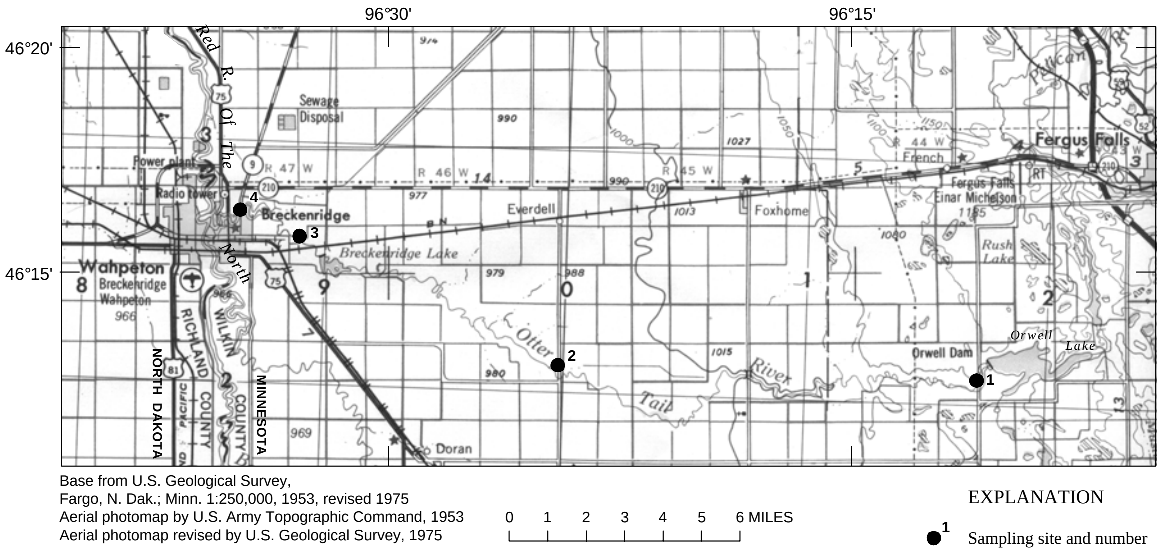
USGS – Personnel working out of Grand Forks and Bismarck ND offices; they scheduled sampling for the study and provided technical assessment.
Wilkin County = SWCD Manager and County Environmental Services assisted with water quality monitoring, data review and interpretation, mapping and definition of sources, load allocations and development of reasonable assurance.
MPCA –Provided funding, project management, contract administration and technical assistance for load allocation.

Project Monitoring

Monitoring did confirm that the Lower Otter Tail River does not meet the state standard of 25 NTU for turbidity. Nearly two-thirds of the samples collected at the 11th Street Bridge in Breckenridge exceeded the water quality standard. The results from the USGS work are incorporated into this report *(Nustad, 2004).*

Samples were collected at four sites along the Otter Tail River between Orwell Dam and the Bois de Sioux River (Fig. 3). Site 1 is located just below Orwell Dam, and is U.S. Geological Survey gaging station (05046000). Site 2 is located at the Wilkin County 17 crossing near Everdell (05046270). Site 3 is located at the Wilkin County 10 crossing just below Breckenridge Lake (05046450), and Site 4 is located at 11th St. Bridge in Breckenridge (05046502).

Figure 3. Location of Otter Tail River Turbidity TMDL water-quality sampling sites.



Sample collection began in September of 2001 and concluded June of 2003. Samples were collected on a monthly basis from October through May, and twice a month from June through September. At each site, in-stream physical parameters were measured, and bacteria, water quality, and suspended sediment samples were collected according to USGS protocols *(Wilde and others, 1998).* Discharge was measured during sample collection for all sites except site 1. Site 1 is a continuous recording gaging station, and therefore, daily discharge is available. In September of 2001 a continuous recording gaging station was established at Site 4, and operated for the sampling period. Suspended sediment samples were analyzed by the U.S. Geological Sediment Laboratory in Iowa.

Study Approach

Turbidity was hypothesized to be the result of suspended sediment and algae. Samples were collected and discharge measurements made once a month during October through May, and twice a month during June through September. Samples were collected from four sites in the river reach (Fig 2).

Field parameters and laboratory constituents collected from each site are shown in Table 1. The USGS collected field parameters using procedures described by Wilde and others *(1998, National field manual for the collection of water-quality data; U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9).* Water samples were collected and analyzed for suspended sediment concentration and sand break (percent finer than .062 mm) at the USGS sediment laboratory; and a sample was sent to RMB Environmental Laboratory for chlorophyll-a analysis.

The USGS operates a daily discharge station downstream from Orwell Dam (Site 1, 05046000 Otter Tail River below Orwell Dam near Fergus Falls, MN). Because flows at this site are regulated, a discharge station was established on the Otter Tail River at Breckenridge (11th street). The Orwell Dam site and the Breckenridge site were used to estimate the discharges at the other 2 sites (sites 2 and 3). The discharges were used to determine loads at each site.

Table 1. Field Parameters and Laboratory Constituents Collected from the Otter Tail River for the Turbidity TMDL.

Field Parameters	Laboratory Constituents
Turbidity	**Chlorophyll a**
Temperature	**Sediment concentration**
Specific conductance	**% finer than 0.062 mm**
PH	
Dissolved oxygen	

Data Management

The data collected from the Otter Tail River TMDL sites was published annually in a USGS Water Resources Data report. Final results will be published by USGS as *Total Maximum Daily Loads Data for Selected Gaging Stations in the Upper Red River of the North Basin in Minnesota, September 2001 through September 2003," by William C. Damschen and Rochelle A. Nustad.* The work began in August, 2001 and ended September 2003. The data has also been entered into STORET.

USGS subcontracted with Wilkin County SWCD as local vendors to take measurements with a turbidity meter and transparency tube at the sites listed below.

The U.S. Geological Survey worked with MPCA and the local project team to develop the load reduction for this study. Wilkin County provided additional land use expertise and public outreach.

DISCUSSION

Modeling Turbidity Comparability

A watershed model was initially suggested as the preferred tool for development of the Lower Otter Tail turbidity TMDL. Several watershed models were reviewed, modeling experts were consulted, and the conclusion was reached that the Annualized Agricultural Non Point Source Pollution Model (AnnAGNPS) was the appropriate watershed model for the rural agricultural setting of the Otter Tail watershed. However, due to the data intensiveness of AnnAGNPS and a limited data set, the model was abandoned. Instead, the statistical model S-LOADEST and load duration curve analysis were the tools used for development of the Otter Tail turbidity TMDL.

Flow Data Analysis

In setting a load reduction goal, it is necessary to be comfortable that the data set being considered represents long-term flow conditions reasonably well. The variability of the sampling period of discharge data as compared with the historic period of discharge data can be illustrated by box plots (Fig. 4). The median for the two-year period is higher than

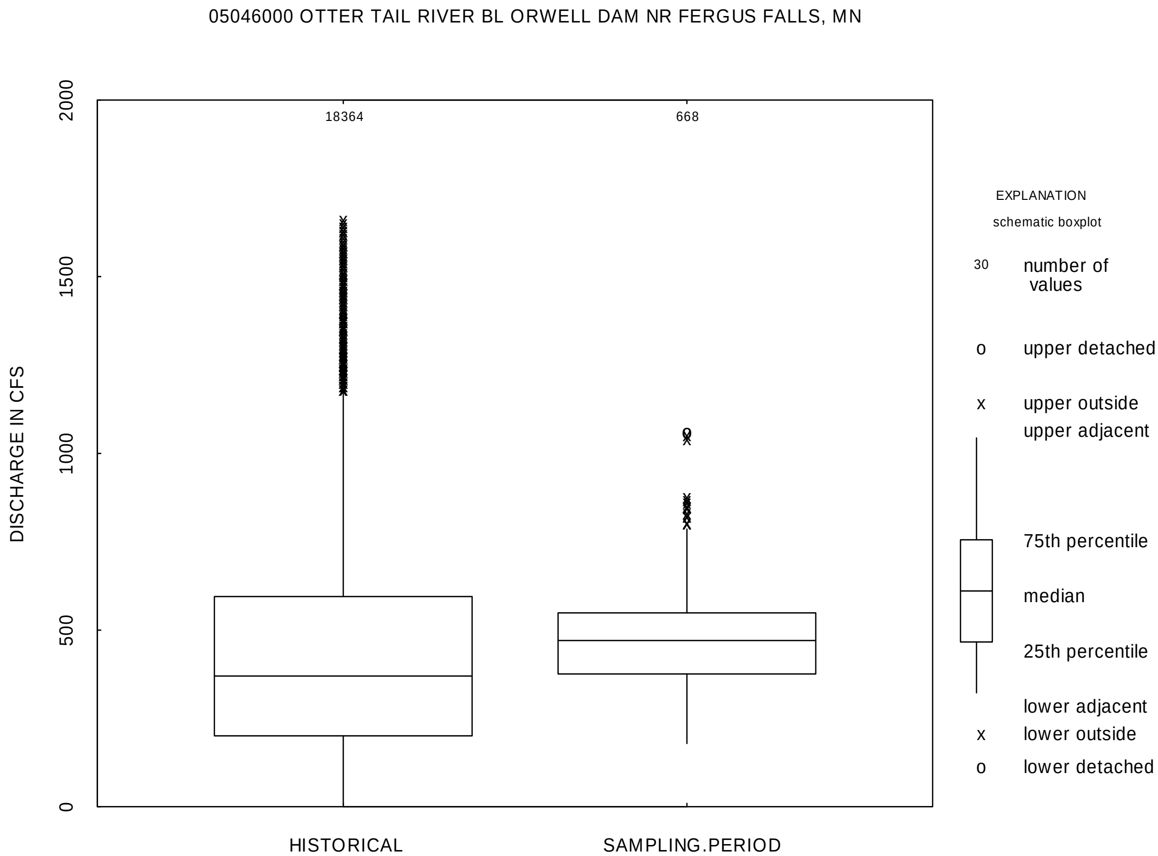


Figure 4. Box plot of historical flow and sampling period data sets for site 1

the historic period, but the interquartile range (box length) of the sampling period falls well within the historic interquartile range. Unsurprisingly, the extreme high flow and low flow conditions were not captured by the two-year data set as indicated by the "whiskers" on the box plot. Considering the relatively short sampling period, and that high-energy precipitation events were not targeted by the sampling schedule, different flow regimes were covered reasonably well.

Turbidity and Suspended Sediment Concentration Relationship

The two-year period of turbidity measurements from sites 3 and 4, which are plotted on the discharge hydrograph from site 4, exhibit the typical relationship of increased turbidity readings with higher flows (Fig. 5). One cause of increased turbidity during high flows is from the higher sediment loads due to increased stream water velocities, shear stress, and stream power-which all result in higher erosional forces *(Bowman, 2000).*

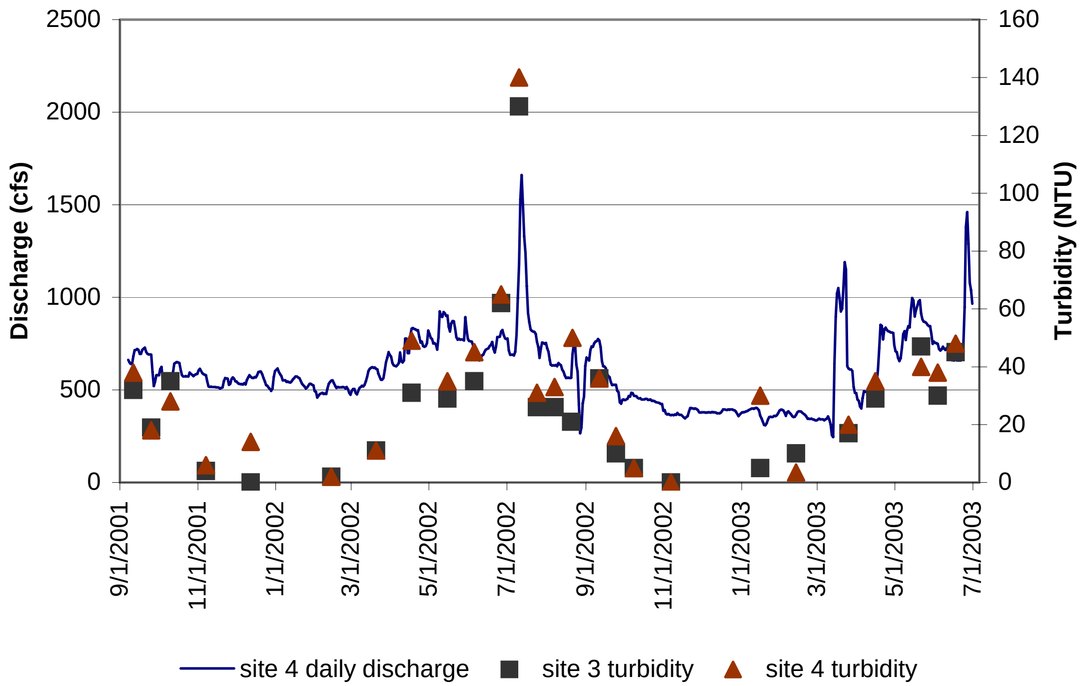


Figure 5. Discharge hydrograph for site 4, and turbidity readings for sites 3 and 4 during the sampling period

Turbidity cannot be converted into loads because it is a dimensionless unit. To use the 25 NTU turbidity standard in a load allocation scenario, a relationship between turbidity and suspended sediment concentration (SSC) must be developed. During the same sampling period for Otter Tail River, data was being collected on other river reaches (Whisky Creek, Rabbit River, and Mustinka River) in the lower Red River Basin. The turbidity measurements were taken at the same time as suspended sediment concentration samples were collected, these are defined as "paired" measurements. Using all paired turbidity and SSC measurements for all sites in the lower Red River Basin during the sampling period, a multiple regression technique was used to develop a model to predict SSC based on turbidity. The R^2 value indicates the strength of the correlation between the two variables. A fairly good correlation between SSC and turbidity is evident by a relatively high R^2 of 0.66. This means that 66% of the SSC measurement is due to variation in turbidity values. Regression equations to predict SSC were developed for each individual site based on the data set as a whole (Table 2).

Table 2. Regression equations to predict SSC in mg/L based on turbidity in NTU for sites 1, 2, 3, and 4.

Site	Regression equation	25 NTU-SSC equivalent
1	Log10 (SSC) =0.3851+0.5082*log10 (turbidity)	15.3 mg/L
2	Log10 (SSC) =0.3949+0.7566*log10(turbidity)	34.7 mg/L
3	Log10 (SSC) = 1.0328+0.5082*log10(turbidity)	67.8 mg/L
4	Log10 (SSC) = 0.6244+0.7566*log10(turbidity)	58.9 mg/L

Different SSC are equivalent to the 25 NTU standard at different sites due to differences in particle size, shape, and water color *(Omega, 2004).* Sites 2, 3, and 4 have relatively similar SSC values corresponding to the 25 NTU standard. However, the relationship of 15.3 mg/L SSC to 25 NTU at site 1 is much different than the other sites. Site 1 is located directly downstream of Orwell dam which causes the particle size (Fig.5), shape, and water color to be visibly and measurably different than the downstream sites.

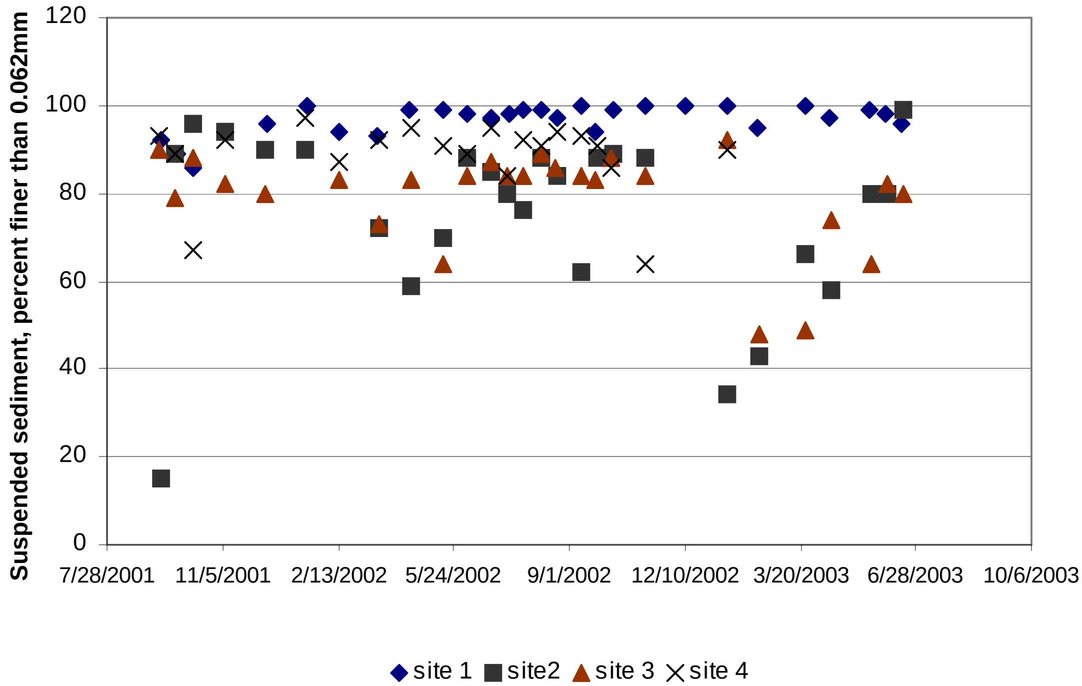


Figure 6. Suspended sediment grain size as measured by percent finer than 0.062 mm for sites 1, 2, 3, and 4

To determine a load reduction goal, one of the 25 NTU-SSC equivalents in Table 2 must be chosen. Site 1 has a noticeably different turbidity/sediment relationship than the other sites, and both sites 1 and 2 are upstream of the impaired reach. The impaired reach begins at site 3, but site 3 is located directly below Lake Breckenridge. Based on the relatively high 25 NTU-SSC equivalent at site 3, it appears that the lake may be affecting the turbidity/sediment relationship. The slightly elevated SSC equivalent may be due to the resuspension of slightly larger sediment particles in the small reservoir. The reservoir formed by a small dam on the Otter Tail River is highly impacted by extensive sedimentation seen in numerous shifting "sand bars". Site 4 is not altered by any physical features, **is within the impaired reach,** and has a moderate value of 58.9 mg/L for the 25 NTU-SSC equivalent. **Thus, <u>58.9 mg/L from site 4 will be used as the 25 NTU-SSC equivalent</u> in determining a load reduction goal.**

S-LOADEST Model

Annual, monthly, and daily sediment loads for the two-year period were estimated at all sites using the S-LOADEST model. S-LOADEST is a model that operates within the statistical package S-PLUS version 6.1 Professional Edition. To estimate loads on a daily basis, a continuous record of daily discharge is required. Site 1 is a historic continuous recording gaging station, and site 4 was a continuous recording gaging station for the two-year study period. Sites 2 and 3 did not have continuous recorders for the two-year study period. A drainage-area ratio was applied to flow differences between site 1 and site 4 to estimate daily flows for sites 2 and 3. Using paired instantaneous discharge measurements and SSC samples, S-LOADEST created a model to predict SSC based on discharge for each site. Estimated loads from the S-LOADEST model fit reasonably well with loads computed from instantaneous samples (measured loads) for all sites (Fig. 7 - 10).

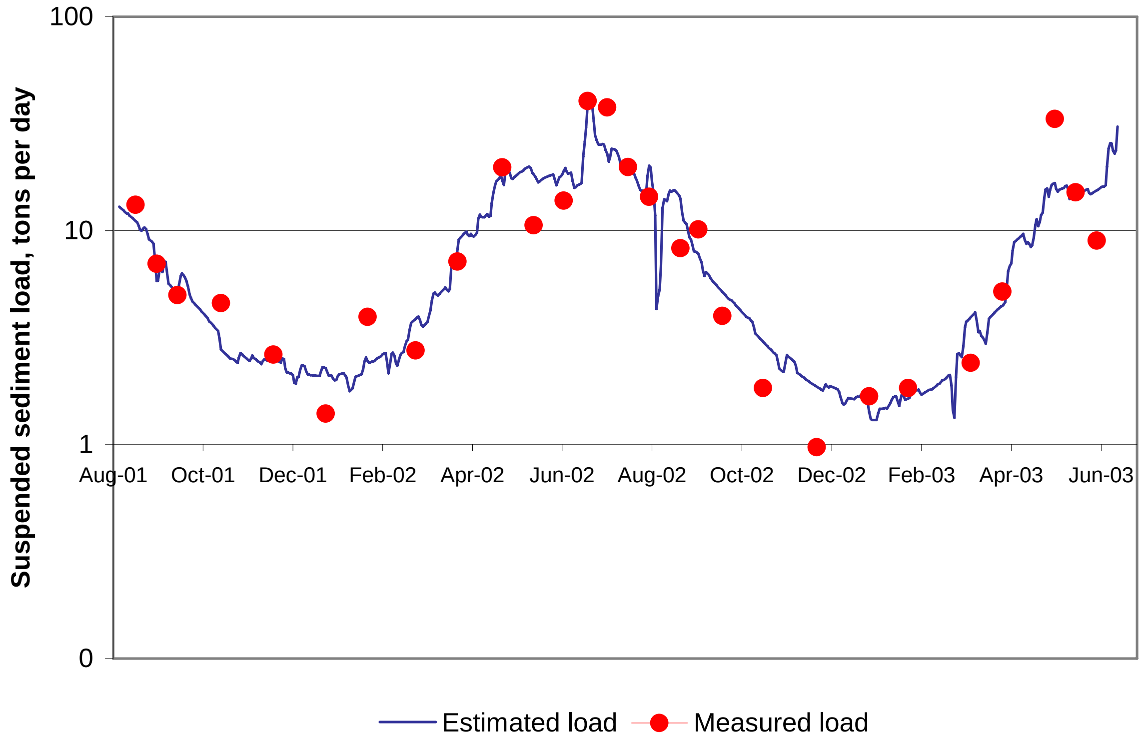


Figure 7. Estimated loads and measured loads for site 1

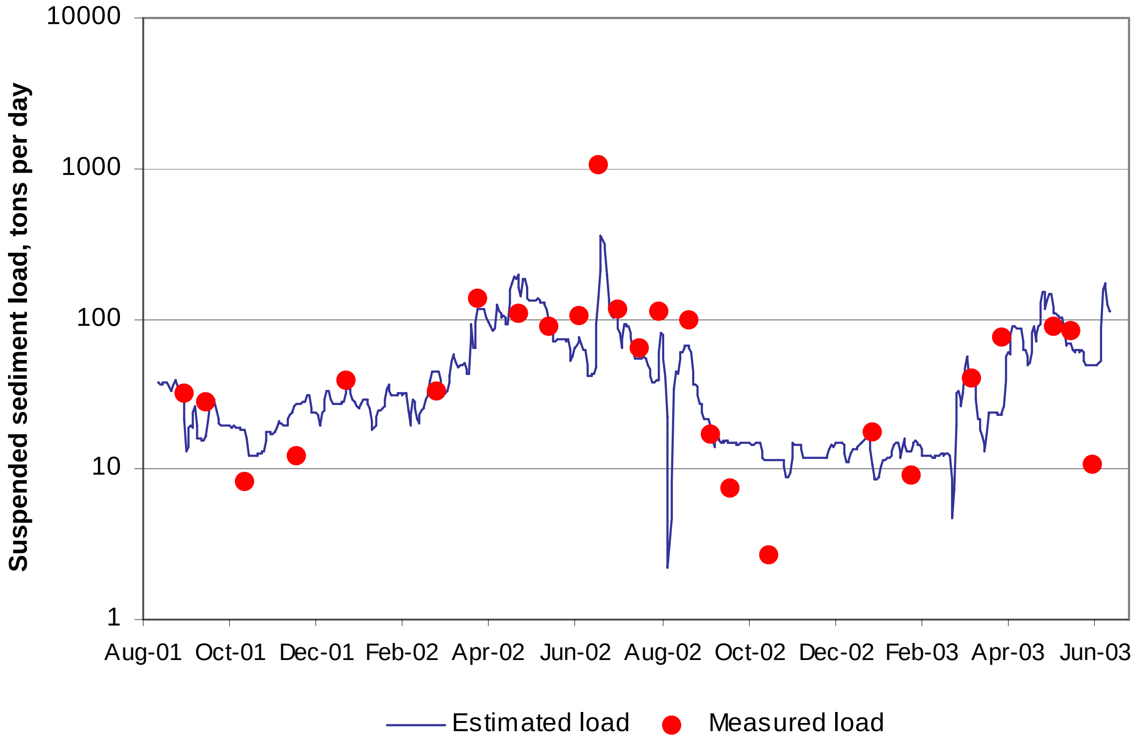


Figure 8. Estimated loads and measured loads for site 2

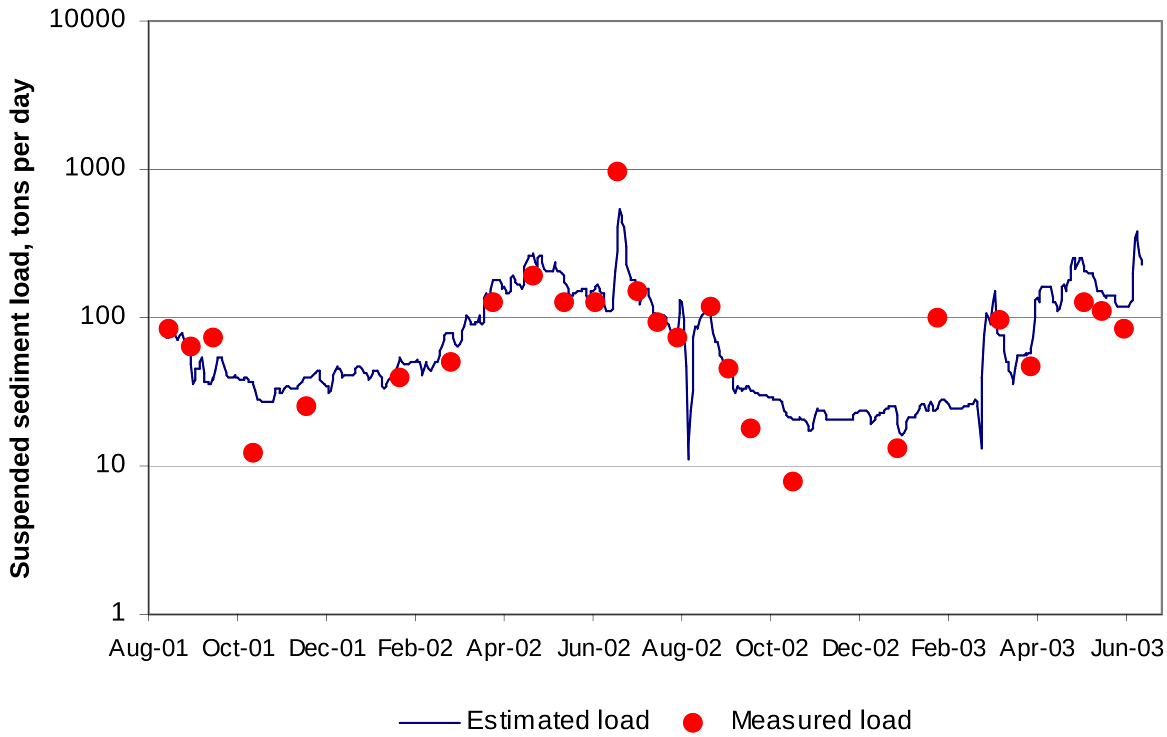


Figure 9. Estimated loads and measured loads for site 3

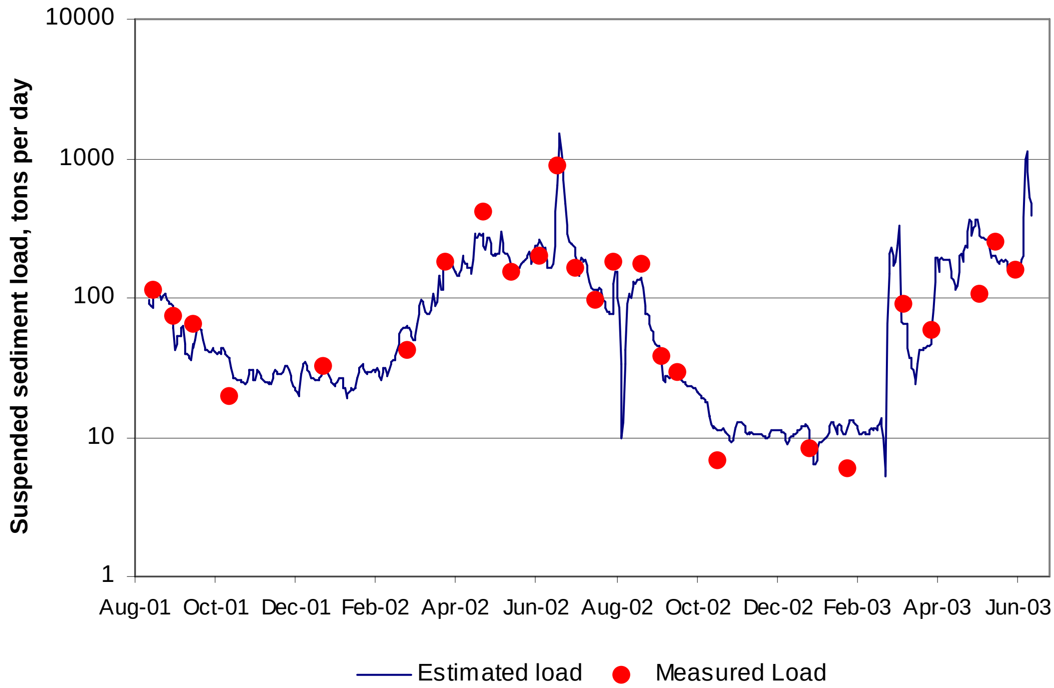


Figure 10. Estimated loads and measured loads for site 4

Annual loads increase considerably between site 1 and site 2 and also between site 2 and 3 (Table 3). A much smaller increase in load occurs between sites 3 and 4.

Table 3. Estimated loads computed from S-LOADEST for sites 1, 2, 3 and 4

Site	Estimated load in tons of sediment from 10/01/01-9/30/02 (full year)	Estimated load in tons of sediment from 10/01/02-06/30/03 (partial year)
1	3400	1600
2	20,000	9300
3	34,900	19,100
4	40,400	23,900

Duration Curve Analysis

Due to the wide range of variability that occurs in stream flows, hydrologists have long been interested in knowing seasonal patterns, as well as the percentage of days in a year when given flows occur. Seasonal flow patterns and the TMDL process are implicitly connected. A traditional load is the product of flow, concentration, and a conversion factor. Thus, analysis of flow patterns plays a major role when considering seasonal variation in TMDL development.

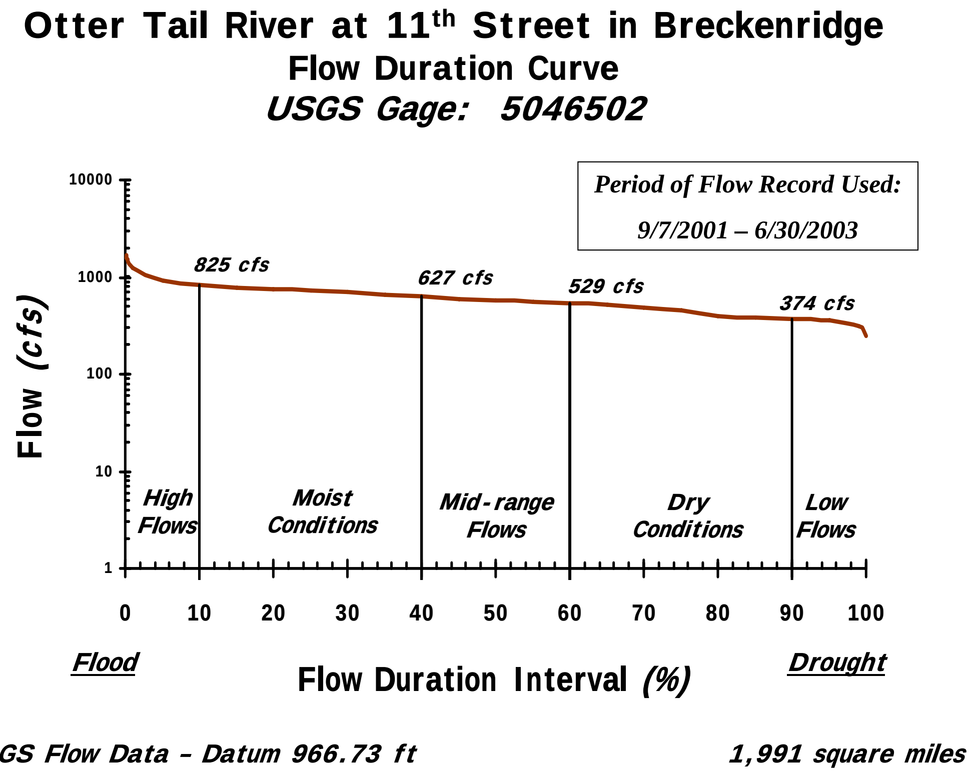
One means of flow analysis is the use of flow duration curves. Duration curves describe the percentage of time during which specified flows are equaled or exceeded *(Leopold, 1994)*. Flow duration analysis looks at the cumulative frequency of historic flow data over a specified period. Duration analysis results in a curve, which relates flow values to the percent of time those values have been met or exceeded. Thus, the full range of stream flows is considered. Low flows are exceeded a majority of the time, whereas floods are exceeded infrequently.

The initial flow duration curves plot flow values on the y-axis against the percent of time the flow is exceeded in the flow record. Flow duration curve development typically uses daily average discharge rates, which are sorted from the highest value to the lowest. Using this convention, flow duration intervals are expressed as percentage, with zero corresponding to the highest stream discharge in the record (i.e. flood conditions) and 100 to the lowest (i.e. drought conditions). Thus, a flow duration interval of sixty percent associated with a stream discharge of 529 cubic feet per second (cfs) implies that sixty percent of all observed stream discharge values equal or exceed 529 cfs (see Figure 11).

Flow duration curve intervals can be grouped into several broad categories or zones. These zones provide additional insight about conditions and patterns associated with the impairment. For example, the duration curve in Figure 11 consists of five zones: one representing ***high flows*** ***(0-10%),*** another for ***moist conditions*** ***(10-40%),*** one covering ***mid-range flows*** ***(40-60%),*** another for ***dry conditions*** ***(60-90%),*** and one representing ***low flows*** ***(90-100%).***

A flow duration curve was completed for the Otter Tail River gage site at 11th Street in Breckenridge for the two year flow record obtained in the project (Figure 11).

Figure 11.



The flow duration curve for the Otter Tail River gage site below the Orwell Dam was then plotted with the 11th Street curve as an additional means of comparing flows during the sampling period compared to the long term record (Figures 12, 13, and 14). Figure 12 would infer that the 2-year duration curve at the downstream site (11th Street) was quite different from the long term duration curve at the upstream site (below Orwell Dam). However, by plotting a duration curve for the 2-year project period for the upstream site, we see that the duration curves for the two sites in the two years are quite similar (Figure 13). The duration curves for the two sites in the sampling period are quite similar indicating that the flow relationship between the two sites is good. Figure 14 provides a comparison of the flows in the study period compared to the period of record flows. The plots in Figure 14 can be used to draw similar conclusions as the box plots in Figure 4 of this report. The median flow during the sampling period was somewhat higher than the median for the historical record. Flows did not get as low or as high in the sampling period as they did in the historical record.

Figure 12.

Otter Tail River at 11^{th} Street & below Orwell Dam

Flow Duration Curves

USGS Gage: 5046502 & 5046000

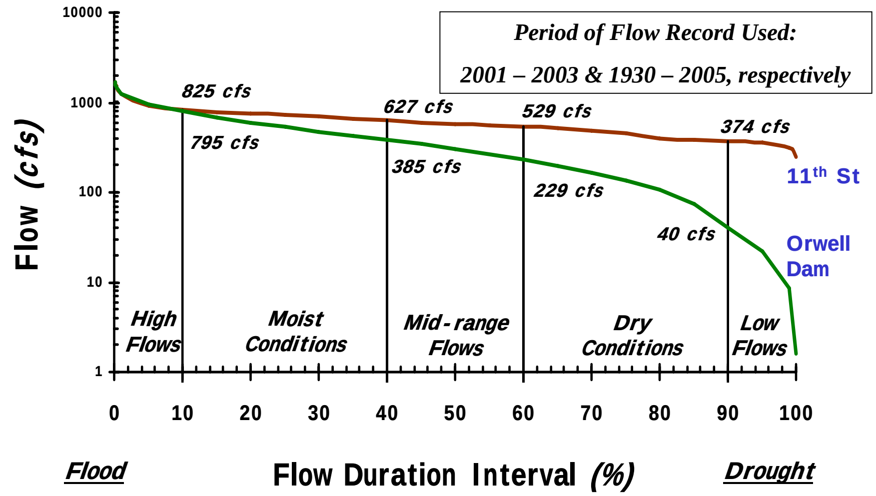


Figure 13.

Otter Tail River at 11^{th} Street & below Orwell Dam

Flow Duration Curves

USGS Gage: 5046502 & 5046000

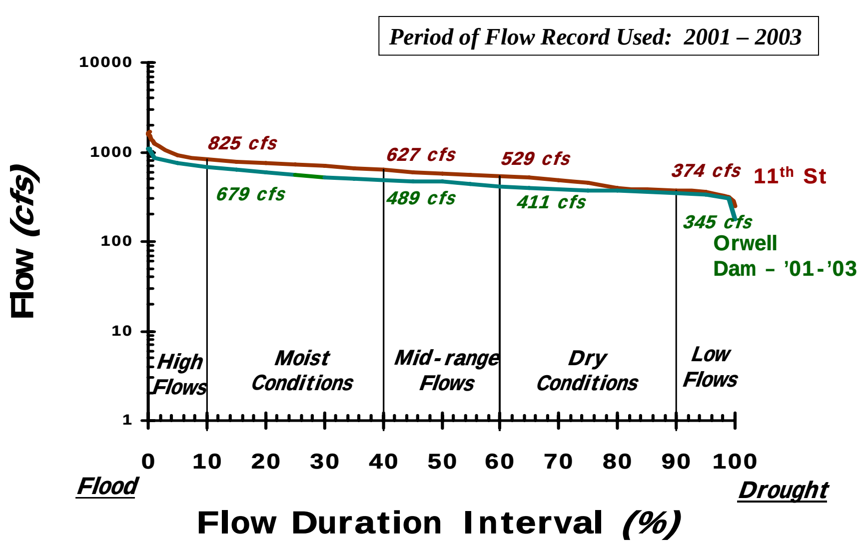
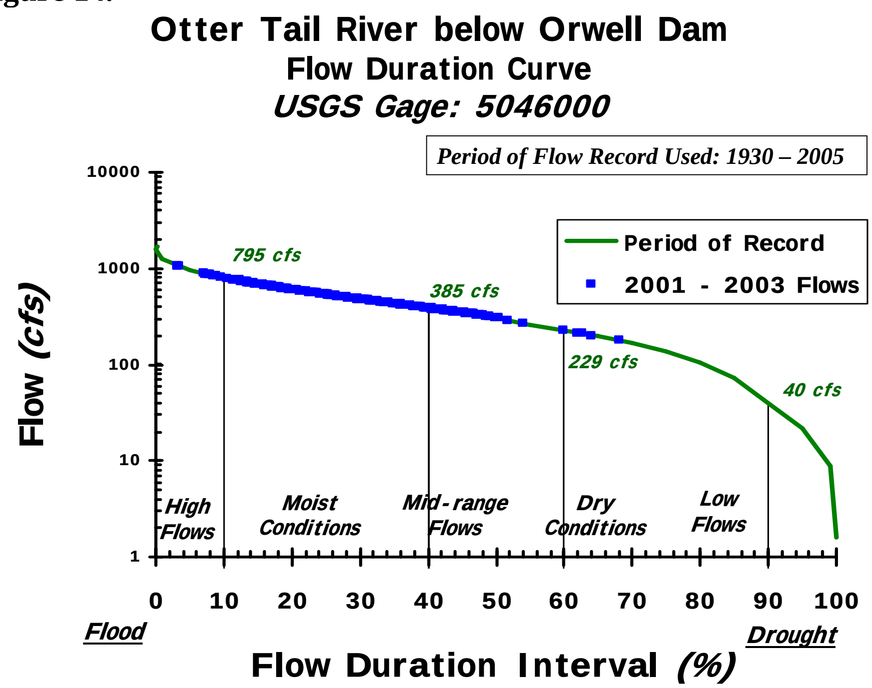


Figure 14.



Water quality samples were collected by the USGS once every two weeks during the study period. Figure 15 shows the location on the hydrograph that the samples were collected. The sampling frequency did not provide for adequate sampling across the range of flows, especially in terms of sampling event flows. Using the base flow analysis tool, HYSEP, only one sample was collected during a runoff event where surface runoff (storm flow) was estimated to be greater than 40% of the total flow. Note that USEPA Hydrologist Bruce Cleland typically estimates storm flow to be represented by a sample when HYSEP estimates that greater than 50% of the total flow is due to storm flows. (Note that HYSEP is a fairly simple hydrograph separation method for estimating base flow and surface runoff flow in a hydrograph. It does not differentiate intermediate subsurface flows.)

Figure 16 plots the sample SSC concentrations with the flow duration curve and the target SSC concentration. The graph also shows the median and 95th percentile values for the sample data in each flow duration category. The one sample identified as a storm flow sample had the highest SSC concentration and sampled flow of the project data set. The sampled SSC concentrations did not exceed the target concentration during low flow, dry conditions, or mid-range flow conditions as delineated by the identified percentile categories in the graph. SSC concentrations in the moist conditions and high flow categories, on the other hand, were almost always above the target concentration. The figure also identifies the sample concentrations as spring (March – May) or rest of the year samples. Concentrations in the two periods appear to be quite similar over the range of sampled flows.

Figure 15.

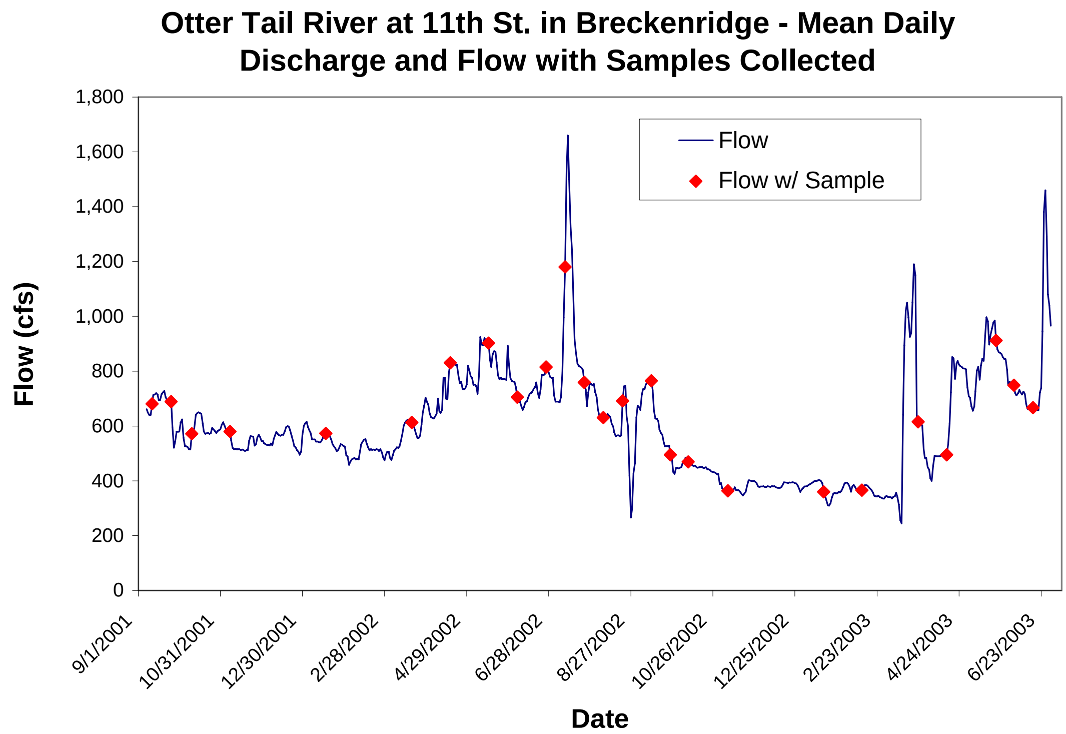


Figure 16.

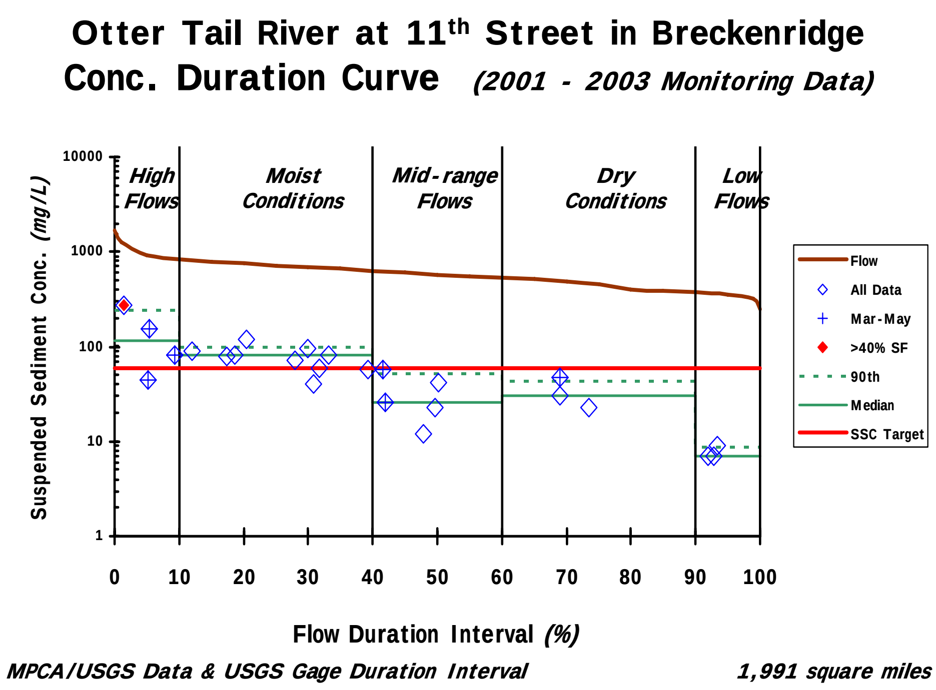
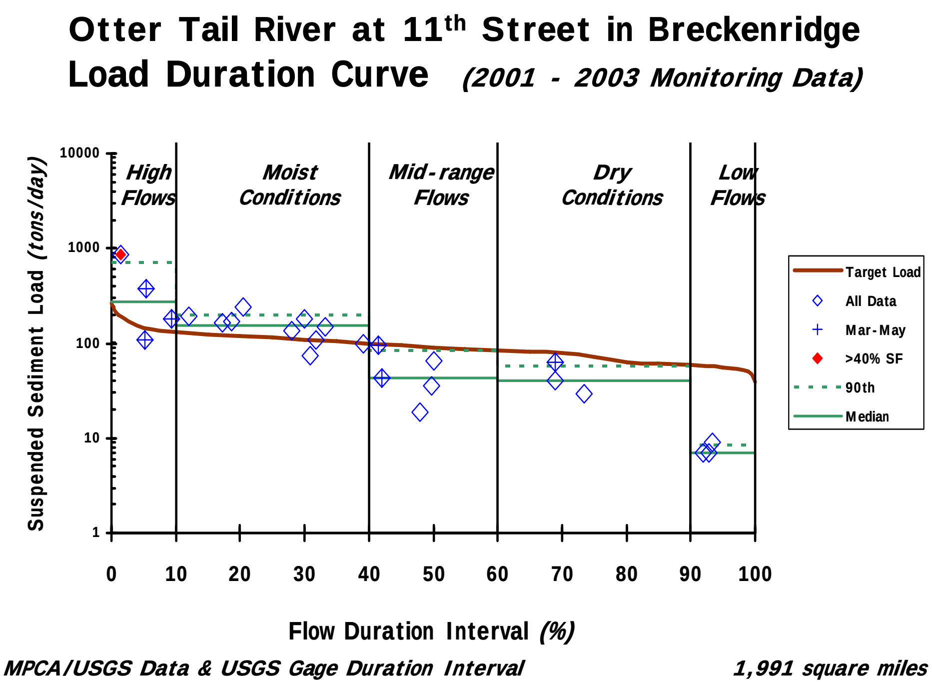


Figure 17 presents the data as a load duration curve and calculated loads for each sample. Note that the curve and relative position of the sample loads is similar to that of the flow duration curve and sample concentrations plotted in Figure 16.

Figure 17.



RESULTS

TMDL Targets

The TMDL is calculated for the lower Otter Tail River using suspended sediment concentration (SSC) as a surrogate measure for turbidity. As previously presented, the correlation of turbidity data to suspended sediment concentration data in the Otter Tail River at Site 4 provides an estimated SSC of 58.9 mg/l when turbidity is 25 NTU. The flow component of the load calculation is obtained in the flow duration analysis process described above.

Given that the maximum load that can be carried in the river (i.e., the TMDL) at any given time is directly calculated as the target concentration times flow, the maximum load on any individual day is determined by the daily flow present. The TMDL is shown graphically as a load duration curve (Figure 17) where the flow values for each flow duration interval are multiplied by the target SSC concentration of 58.9 mg/l. To specify the TMDL as selected discrete values, the median flow duration interval for the flow duration zones can be used to represent the loading capacity for each zone. The total loads of SSC allowable in the river at 11th Street for the low flow, dry conditions, mid-range flows, moist conditions, and high flow zones are 56, 72, 91, 114, and 145 tons per day, respectively.

As seen in the figures, the moist conditions and high flow zones are the only zones in which loads exceeding the carrying capacity of the river were measured. Assuming that the sampling results are representative of the water quality conditions in the reach, the primary concern for excess loading to the river occurs in the moist conditions and high flow zones of the load duration curve. The sampling approach actually did not provide a representative sample of the runoff event flows, but additional samples in these conditions would be expected to show exceedances of the target load at the higher flows.

The next step in completing the TMDL is to determine the waste load allocation (WLA), load allocation (LA), and margin of safety (MOS) for each category.

Waste Load Allocation

Given that the Orwell Reservoir acts like a sink for most sediment and solids from the upstream watershed, it provides an upper boundary condition for the Lower Otter Tail River turbidity impairment. All National Pollutant Discharge Elimination System (NPDES) permitted point sources in the watershed are located upstream of the Orwell Reservoir and, therefore, are not included in this TMDL. The city of Breckenridge wastewater treatment facility (WWTP) has a NPDES permit, but discharges to a ditch tributary to the Red River downstream of the Otter Tail River. The city of Foxhome is located in the Lower Otter Tail River direct drainage area, but does not have an NPDES permitted treatment facility. Neither Foxhome or Everdell are expected to ever require NPDES permitted treatment facilities. The wasteload allocation for total suspended solids for municipal wastewater treatment facilities in the Lower Otter Tail River watershed is, therefore, zero.

Stormwater from MS4 communities is now to be included in the wasteload allocation of TMDLs. Cities under 5,000 people are generally not designated as MS4s. As such, the city of Breckenridge with a population of 3,559 in 2000 is not a MS4. To avoid the need to revise the TMDL to provide a WLA to Breckenridge if it was to be designated a MS4, a WLA based on the ratio of the area of the city to the area of the lower Otter Tail River watershed was assigned. The city and the LOTR are approximately 1,400 and 52,000 acres, respectively. Assuming an equivalent per acre contribution of sediment from the watershed, less than 3 (2.7) percent of the contributing area could be from an area contributing to urban stormwater runoff. Continuing with this line of assumptions, a possible wasteload allocation for urban stormwater could be 3% of the total allowable load (TMDL). This would not account for the contribution of sediment from stream bank and channel erosion which would be part of the load allocation. Given that a gross estimate of sediment load by source indicates that stream bank and channel erosion may account for 40 to 50 percent of the sediment contribution to the river, the urban stormwater component could be lowered by about 50 percent. Thus, a conservative WLA for urban stormwater yet to be designated as a point source would be about 1½ percent of the TMDL. Note that a WLA is provided to provide for some future growth that could push the city into a MS4 status. The wasteload allocations for SSC in the river at 11th Street for the low flow, dry conditions, mid-range flows, moist conditions, and high flow zones are calculated below (Table 4).

Table 4. LOTR Stormwater WLA

Flow Zone	TMDL*	WLA for Stormwater**
Low flow	56	1
Dry conditions	72	1
Mid-range flows	91	1
Moist conditions	114	2
High flow	145	2

* Units: tons/day
** 1.5% of TMDL

Margin of Safety

Under section 303(d) of the Clean Water Act, a "margin of safety" (MOS) is required as part of a TMDL. The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. The margin of safety for each flow category is calculated as the difference between the median flow duration interval and minimum flow duration interval in each zone. For the low flow zone, this reflects the lowest flow observed over the period of record. The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. Because the allocations are a direct function of flow, accounting for potential flow variability is an appropriate way to address the MOS. This is done for each of the five flow zones (Table 5).

Table 5. Margin of Safety

Flow Zone	Median Load*	Minimum Load*	Difference (MOS)*
Low flow	56	38.8	17
Dry conditions	72	59.3	12
Mid-range flows	91	83.8	7
Moist conditions	114	99.3	15
High flow	145	130.7	14

* Units: tons/day

Load Allocation

The load allocation for each flow category equals the TMDL minus the WLA minus the MOS (Table 6). The load allocation includes nonpoint pollution sources that are not subject to NPDES permit requirements, as well as “natural background” sources. The nonpoint pollution sources are largely related to wind and water erosion of upland soils, riparian area erosion, and stream bank and channel erosion.

Table 6. Load Allocation

Flow Zone	TMDL*	WLA for Stormwater*	MOS*	LA*
Low flow	56.1	1	17	38
Dry conditions	71.6	1	12	59
Mid-range flows	90.6	1	7	83
Moist conditions	114.1	2	15	97
High flow	144.6	2	14	129

* Units: tons/day

Source Analysis

The turbidity impairment in the Lower Otter Tail River is a result of increased sediment loads during, or immediately after, high flows and large storm events. The excess sediment, causing the turbidity standard exceedence, is from fine grained sediments contributed from a variety of nonpoint sources. There are generally four ways that the sediment is being delivered to the river from the landscape:

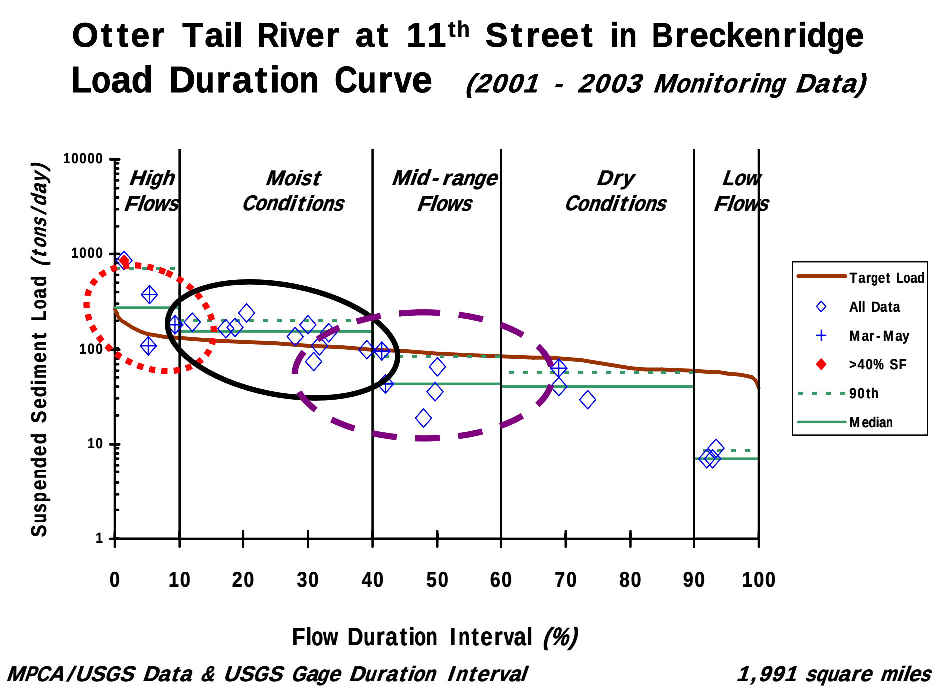
- Wind erosion- this is a critical issue for this watershed, especially with what is deposited in the ditches in the winter and early spring and then runs off with the snowmelt or rain events.
- Sheet and Rill erosion-this is erosion caused by the larger or more intense storm events that are capable of carrying the sediment all the way from the flat landscape to the river in a single event or multiple events.
- Ditch and Gully-type erosion-this is the erosion at the confluence of the field ditches and the receiving tributary.
- Streambank erosion- this is the erosion from the river channel itself that is associated with peak flows.

Bruce Cleland of US EPA *(personal communication, and Cleland 2002)* has indicated that a weight of evidence relationship between the load duration curve intervals (Low Flow, Dry Conditions, Mid-range Flows, Moist Conditions and High flows) and the proximity or energy required by types of sources to be significant loaders may be used to support targeting implementation measures. To use the weight of evidence process the relationships that exist for any one source between proximity (transport) and the ratio of stream loading must be better understood. Not all of the sources will dominate the conditions of a river during all duration curve intervals. The understanding of when the source is expected to be a dominant factor is used. For instance, during the low flow and dry conditions, point sources and/or directly connected individual septic tanks would contribute a larger percentage of a key parameter. Similar judgment has been put forward for suspended sediment contributions from the watershed.

Figure 18 duplicates Figure 17 with the addition of three key transport discussions. The discussions are developed as a weight of evidence application for known sources and expected occurrence in the watershed.

1. The purple dashed line ellipse indicates the area where materials are typically transported from close proximity erosion areas in the watershed. Mid-range flows usually represent the rise of a hydrograph as it progresses out of the dry condition range and enters into wetter conditions. The zone of land use that is most likely to contribute during this period would be the riparian corridor of the river. This is because limited upland soil saturation and quite possibly soil erosion has yet to take place during the early period of storm events or in smaller events that can only deliver localized eroded soils.
2. The black solid line ellipse indicates the area where material loading typically originates from both upland soils which under these wetter conditions are now saturated and begin contributing to the more efficient transport of eroded materials and continuing to move riparian corridor eroded materials.
3. The red dotted line ellipse indicates the material loading which indicates bank or river bluff contributions. Sufficient energy exists at these flow regimes to cause mass wasting and the break down of consolidated materials such as glacial lake clay deposits.

Figure 18. Using the Load Duration Curve to Discuss Contributing Erosion Zones



The contributions from wind erosion would occur across any of these three regimes depicted by the ellipses if the carrying capacity of the river flows was not already exceeded by the suspended sediment load from other sources.

Based on the SSC sampling results in the 2001 – 2003 monitoring period, the table below gives the calculated median and 90th percentile load for each flow duration interval zone (Table 7). The table also calculates the percent reduction in SSC load needed to meet the LA for each zone.

Table 7.

Flow Zone	LA*	Median Sampled Load*	90th Percentile Sampled Load*	Median Percent Reduction	90th Percentile Percent Reduction
Low flow	38	7	8	0	0
Dry conditions	59	40	58	0	0
Mid-range flows	83	43	83	0	0
Moist conditions	97	156	200	38	52
High flow	129	276	720	53	82

* Units: tons/day

The TMDL calculations and SSC load estimates provide loading information developed from the monitoring data. The assessment of sources using the duration curve analyses provides a general or typical evaluation of likely pollutant sources. A more detailed estimate of loads would require the use of a watershed assessment tool or model.

Reserve Capacity/Growth

The Minnesota State Demographic Center predicts the population of Wilkin County to **decrease** from 1%-3% over the next 10-20 years. There are not any predicted growth areas within the watershed of the LOTR for this turbidity TMDL. There are also no planned wastewater discharges into the LOTR. Because of these projections for the future of the LOTR watershed, there are no reserve capacity projections needed for this study. The key elements of this TMDL now and in the future are non-point source load reductions.

BEST MANAGEMENT PRACTICES

Local resource managers agreed that the preferred strategy to achieve the load reduction is to target management practices to reduce the loading during the more intense events. Measures need to be taken that prevent sediment carried by the wind from entering ditches and streams, and to dissipate the energy of precipitation during extreme storm events.

We believe it is reasonable to target management measures to reduce the loading during the more intense events. Therefore, we need to install barriers that prevent material carried by wind from entering streams and ditches, and assure that movement of precipitation during extreme events can be stored for even a short time close to where it falls.

Work will continue to determine precisely what the relative contributions are from the different sources of erosion (wind, sheet, gully, and streambank), the measures that have been discussed to help control the first three are widely accepted and include:

- Soil conservation practices designed to reduce wind erosion;
- Investigation or evaluation of an erosion ordinance in Wilkin County;
- Riparian practices such as buffer strips that will stabilize the riparian area.
- Promote the use of BMPs such as cover crops, residue management, minimum and no-tillage, conservation cropping, field windbreaks, etc…that reduce wind and water erosion.
- Promote local, state, and federal programs that retire land prone to erosion.

Measures which are needed to reduce streambank erosion are:

- BMPs to hold the water back and release it slower into the drainage system. Soil and surface water storage can come from practices like residue management, native grass plantings, wetland creation, wetland restorations, water and sediment control structures, and road ditch culvert downsizing.
- Channel restoration practices which will help to stabilize streambank erosion could be undertaken to speed up the development of an in-channel flood plain, increase sinuosity, restore stability, and help to return the river to a more natural form. Measures such as armoring the banks with bioengineering techniques or managing the thalweg with rock weirs or veins need to be considered. These techniques should be a part of a larger effort of encouraging stream functions such as restoring meander access to a working flood plain and reintroducing pool riffle-and-run characteristics.

It is very important to note that if we only reduce upland soil erosion loading and do not reintroduce stream stability features, streambank erosion may accelerate. Volume and velocity are roughly balanced by sediment size and/or sediment load being moved. This is how nature balances the greater energy of stream flow by providing opposing sources of greater resistance.

Finally, Luther Aadland of the DNR suspects that bank erosion contributions are likely substantial, due in large part to the 1954 channelization of the Lower Otter Tail. Like other similar channelization projects in the basin, the Otter Tail has downcut in the upper part of the project area and in the river upstream. The long term solution is to both buffer and remeander the channel. The lower portion has oxbows that could be reconnected.

The upper portion would need to be approached differently and remeandering could be initiated within the existing channel and adjacent areas. Until the river is remeandered or remeanders on its own (this may take centuries) turbidity problems are likely to be prevalent.

Changes such as these could be monitored by the use of surveyed cross-sections and bank pins in combination with aerial photography. Pfankuch's erodibility index could then be applied to quantify sediment yield from bank erosion. Overlaying aerial photos over time would add perspective to the rate of remeandering and bank movement.

REASONABLE ASSURANCE

Other than the Otter Tail River, this area of Wilkin County does not have an abundance of surface water resources. Because of the scarcity of surface water resources in this region there is a substantial ongoing effort to protect and enhance what exists.

Wilkin County and the Wilkin County SWCD participated in the Otter Tail River Watershed Improvement Project which made recommendations to protect and enhance surface waters through enforcement of local, state and federal regulations and through the use of existing programs (CRP, EQIP, etc.).

Wilkin County participates in the Red River Basin Water Quality Monitoring Network, which will measure progress toward achieving the turbidity requirement. In addition, the Wilkin SWCD is investigating how to quantify erosion transported by precipitation, including overland and streambank erosion, and is developing a demonstration project investigating effectiveness of various agricultural best management practices. As these tools are developed, they will be incorporated into the management of the sub-watershed.

The further evaluation of streambank erosion and hydrologic modifications will be done through an adaptive management approach as funding and time allow.

The local project sponsor will meet quarterly with researchers and the MPCA to review progress and semi-annually thereafter to review achievement of the water quality goal.

FUTURE MONITORING

Monitoring conducted through the Red River Basin water quality monitoring program will be used to measure progress towards achieving the water quality goal. This monitoring will compliment the SSC monitoring that was done by the USGS during their two years of study. This monitoring will also be targeted towards developing the relationship between sediment sources in the watershed.

There is a keen interest in measurement of changes in channel morphology and this will be pursued when funding allows.

Additional water quality monitoring in the watershed will be done through the MPCA's Milestone monitoring program.

During the two years of USGS work, there was not a concentrated effort on catching precipitation events. Another monitoring idea for the future would be for the installation of a continuous turbidity monitor, provided funds could be allocated for this. This monitor would capture all precipitation events as well as all flow regimes. To parallel the reduction goals derived from this study, SSC would need to be collected, and discharge measurements made for the first couple of years of operation of the turbidity monitor.

PUBLIC PARTICIPATION

The Red River Basin Water Quality Team is leading development of Total Maximum Daily Load studies in the Red River Basin for the Minnesota Pollution Control Agency. The Basin Team is an informal association of water quality "stakeholders", who are defined as representatives of local, state, regional and federal government, industry, special interests and local property owners. In the LOTR, the prime contact for public information and participation has been Wilkin County, through its Local Water Plan and its Soil and Water Conservation District.

We asked local stakeholders:

1. What do you think of our approach? Is it reasonable, fair and understandable?
2. Do you think we should estimate a sediment load for each transport method? Or set a general goal? We have to provide a justification for whichever approach we choose; but stakeholder acceptance is key.
3. Once we set sediment reduction targets, what do you think are the best ways to achieve those targets – what practices do you recommend and where should they be implemented?

The Red River Basin Water Quality Team held four meetings in the Otter Tail watershed during the study portion. As results were finalized, study representatives from MPCA and U.S. Geological Survey met in Breckenridge with city and county officials to review results. Results were presented formally to the Wilkin County Board of Commissioners, the Wilkin County Soil and Water Supervisors, the Wilkin County Local Water Planning Task Force, and the City of Breckenridge. Comments from these meetings have been incorporated in this report.

This report will be published on the MPCA's Red River Basin web site and the content has been presented to Wilkin County before the report submission to EPA. This report will be formally public noticed in October-November 2006.

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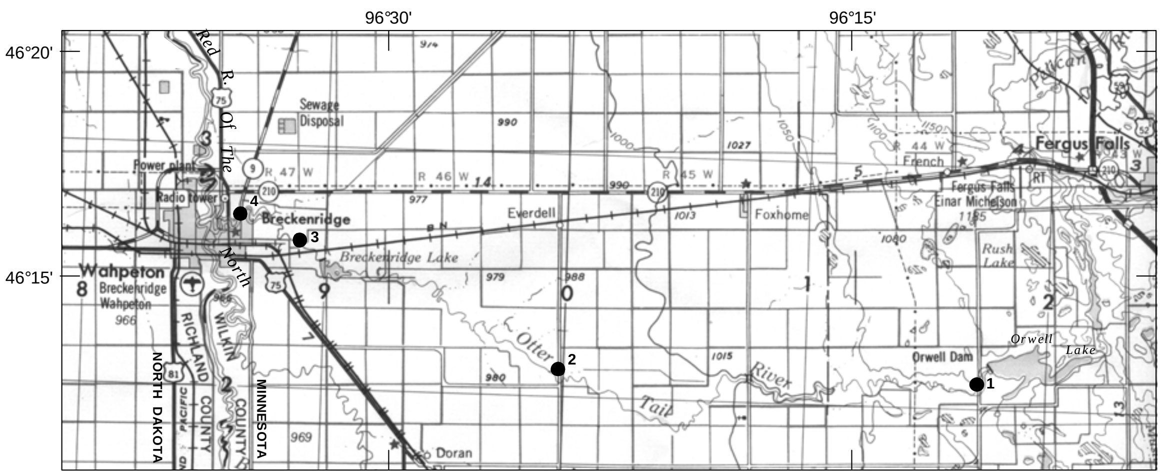
Wilde, F.D., Radtke, D.B., Gibs, J., and Iwatsubo, R.T., eds., 1998, National field manual for the collection of water quality: U.S. Geological Survey Techniques of Water-Resources Investigations, bk. 9, chap. A1-A9, various pagination.

APPENDIX

I. USGS Sites:

05046000	Otter Tail River just below Orwell Dam (1)
05046270	Otter Tail River at the Wilkin County 17 crossing (2)
05046450	Otter Tail River just below Breckenridge Lake (3)
05046502	Otter Tail River at 11th Street Bridge in Breckenridge (4)



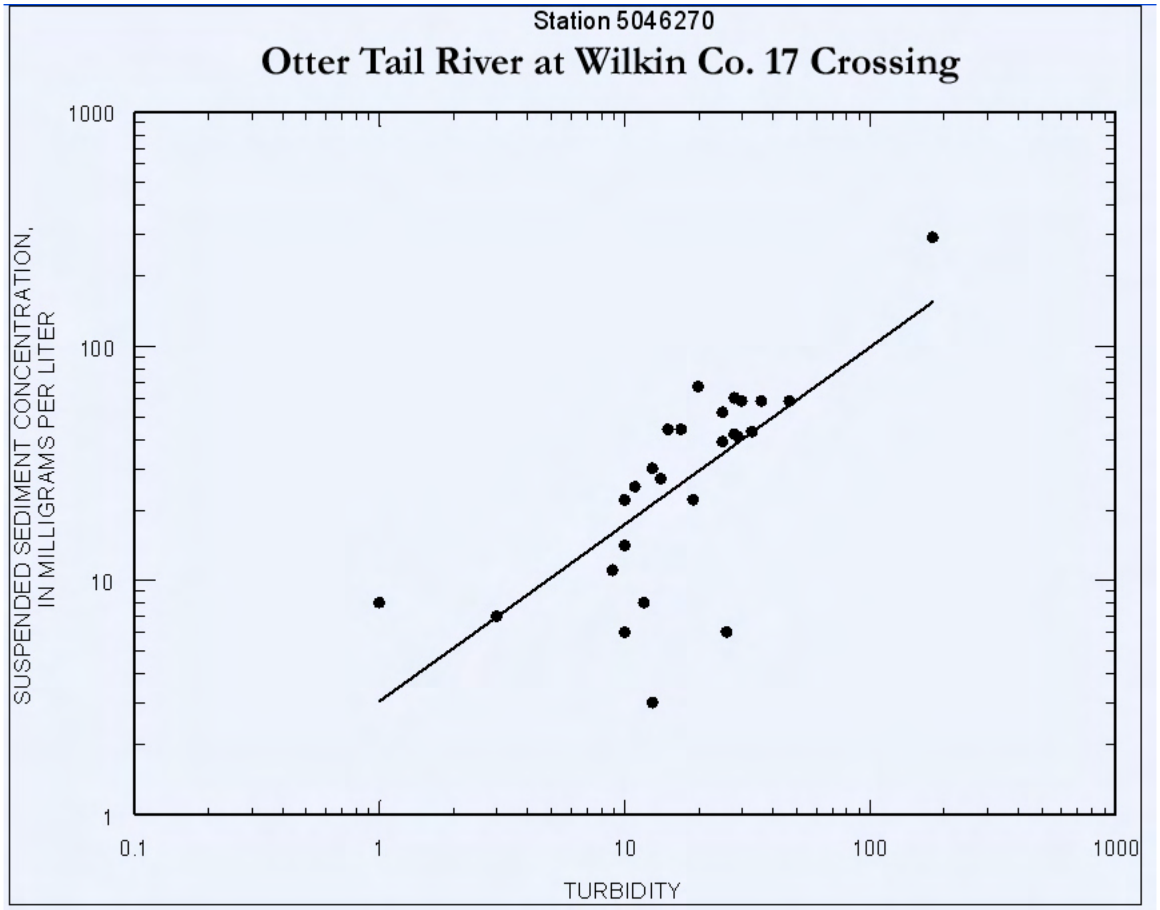
Base from U.S. Geological Survey,
Fargo, N. Dak.; Minn. 1:250,000, 1953, revised 1975
Aerial photomap by U.S. Army Topographic Command, 1953
Aerial photomap revised by U.S. Geological Survey, 1975

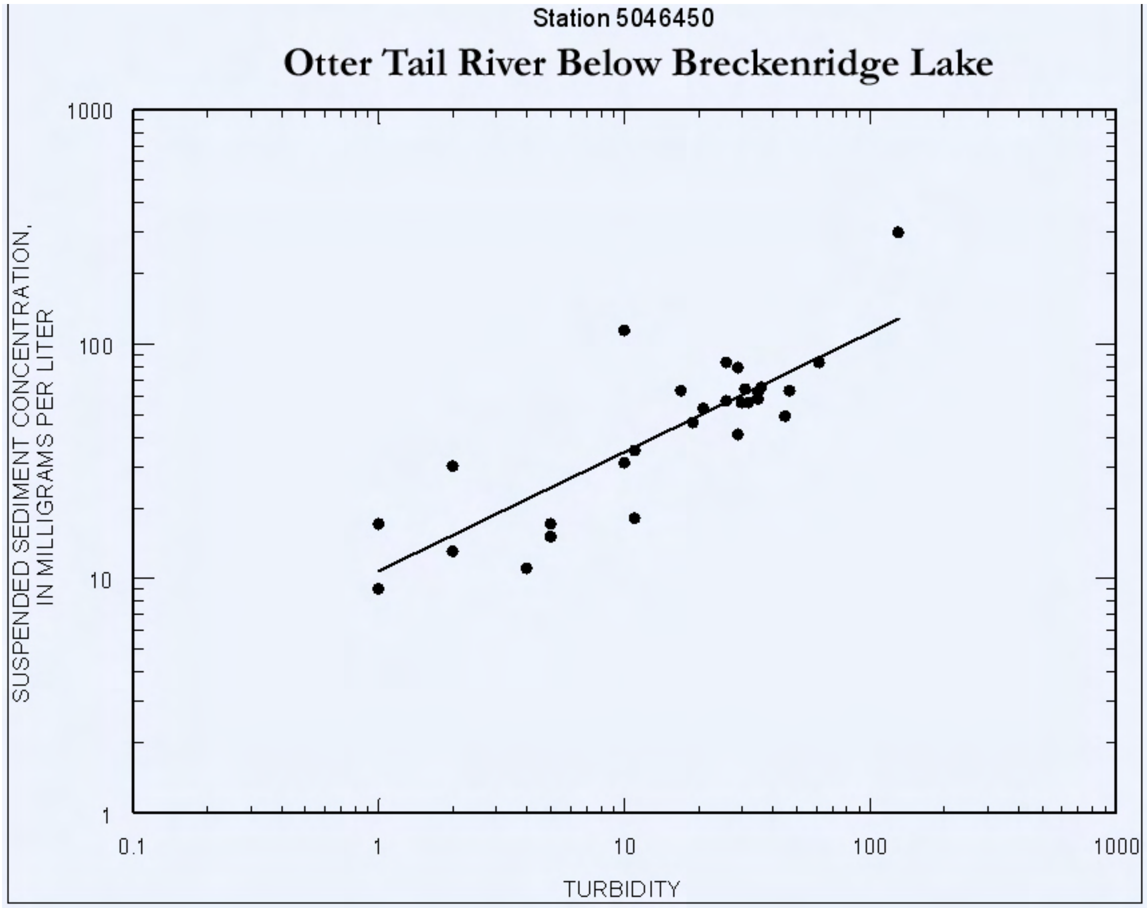
0 1 2 3 4 5 6 MILES

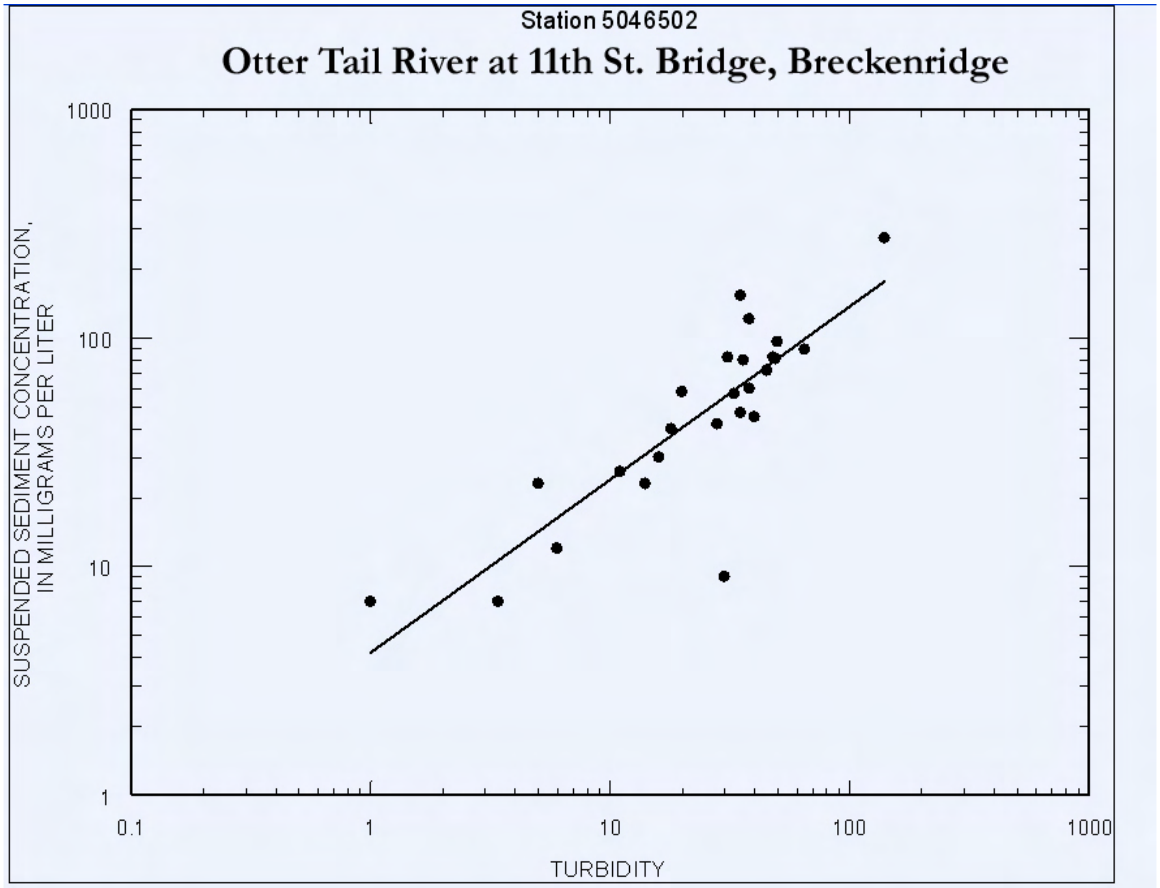
EXPLANATION

● 1 Sampling site and number

II. Suspended Sediment Concentration/Turbidity Plots at USGS Sites




Station 5046450
Otter Tail River Below Breckenridge Lake
SUSPENDED SEDIMENT CONCENTRATION,
IN MILLIGRAMS PER LITER
1000
100
10
1
0.1
1
10
100
1000
TURBIDITY


Station 5046502
Otter Tail River at 11th St. Bridge, Breckenridge
1000
100
10
1
0.1
1
10
100
1000
SUSPENDED SEDIMENT CONCENTRATION,
IN MILLIGRAMS PER LITER
TURBIDITY

III. USGS Water Quality and Discharge Data

05046000 OTTER TAIL RIVER BELOW ORWELL DAM NEAR FERGUS FALLS, MN

LOCATION.--Lat 46°12'35", long 96°11'05", in NE$^1/_4$ sec. 34, T.132 N., R.44 W., Otter Tail County, Hydrologic Unit 09020103, on left bank 0.7 mile downstream from Orwell Dam on County Highway 15, 6.1 miles downstream from Dayton Hollow Dam, 8 miles southwest of Fergus Falls, and 11.1 miles downstream from Pelican River.

DRAINAGE AREA.--1,740 mi^2.

WATER-QUALITY RECORDS

PERIOD OF RECORD.--September 2001 through June 2003.

WATER-QUALITY DATA, WATER YEAR OCTOBER 2000 THROUGH SEPTEMBER 2001

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 deg C (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
SEP 2001													
12...	1110	489	20	9.9	8.6	398	19.4	20.0	0.82	<0.050	<0.050	<0.050	<0.010
26...	0900	370	6.0	10.5	8.5	409	10.8	15.3	0.81	0.050	<0.050	<0.050	<0.010

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
SEP 2001								
12...	<0.005	0.059	E4k	E10k	E5k	21.0	92	10
26...	<0.005	0.045	E5k	E10k	E2k	13.8	89	7

Remark codes used in this table:
- < -- Less than
- E -- Estimated value

Value qualifier codes used in this table:
- k -- Counts outside acceptable range

WATER-QUALITY DATA, WATER YEAR OCTOBER 2001 THROUGH SEPTEMBER 2002

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 deg C (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
OCT 2001													
10...	1500	370	1.0	10.9	8.3	423	10.0	11.8	0.69	<0.040	--	<0.050	<0.008
NOV													

08...	0815	340	6.0	12.5	8.2	472	0.5	6.7	0.75	<0.050	<0.050	<0.050	<0.010
DEC													
13...	0900	489	0.0	14.5	8.0	500	-5.1	1.6	0.69	<0.050	<0.050	0.130	<0.010
JAN 2002													
17...	0920	518	0.0	14.0	8.0	479	-8.6	1.4	0.67	0.080	0.080	0.130	<0.010
FEB													
14...	0900	488	0.0	10.6	7.8	474	1.5	2.0	0.74	0.090	0.110	0.130	<0.010
MAR													
18...	1520	511	0.0	14.5	8.1	473	-4.5	2.2	0.84	0.130	0.130	0.100	<0.010
APR													
15...	1715	663	3.0	12.4	8.0	422	24.5	8.8	0.71	<0.050	<0.050	0.050	<0.010
MAY													
15...	1630	813	17	13.4	8.2	426	23.5	12.1	0.73	<0.050	<0.050	<0.050	<0.010
JUN													
05...	1615	654	3.0	9.6	8.3	418	27.0	19.3	0.72	<0.050	<0.050	<0.050	<0.010
25...	1345	568	6.0	8.7	8.3	410	37.5	24.0	0.96	0.100	0.120	0.060	<0.010
JUL													
11...	0900	1,070	7.0	8.3	8.4	386	--	24.2	0.88	0.140	0.140	0.070	<0.010
24...	1530	635	21	8.0	8.1	395	20.7	24.8	0.98	0.130	0.130	<0.050	<0.010
AUG													
07...	1530	565	8.0	9.1	8.3	396	26.0	23.0	0.80	<0.050	<0.050	<0.050	<0.010
21...	1300	668	6.0	9.0	8.3	393	23.4	21.0	0.65	<0.050	<0.050	<0.050	<0.010
SEP													
11...	1600	614	12	9.0	8.3	392	27.3	23.0	0.66	<0.050	<0.050	<0.050	<0.010
23...	1530	418	2.0	10.0	8.4	406	15.0	16.6	0.65	<0.050	<0.050	<0.050	0.010

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
OCT 2001								
10...	<0.002	<0.006	E46k	E15k	E25k	6.43	86	5
NOV								
08...	<0.005	0.037	E26k	E18k	52	16.6	94	5
DEC								
13...	0.007	0.041	--	--	--	10.3	96	2
JAN 2002								
17...	0.014	0.033	--	--	--	2.90	100	1
FEB								
14...	0.006	0.033	--	--	--	4.97	94	3
MAR								
18...	0.009	0.037	--	--	--	5.66	93	2
APR								
15...	<0.005	0.039	<2	<2	E17k	9.95	99	4
MAY								
15...	<0.0	0.047	E40k	E12k	E4k	9.68	99	9

	05							
JUN								
05...		0.007	0.029	<1	E2k	E1k	8.36	98	6
25...		0.027	0.081	E79k	E35k	67	11.6	97	9
JUL								
11...		0.061	0.106	E17k	<7	405	5.71	98	14
24...		0.047	0.102	<1	E2k	E3k	10.5	99	22
AUG								
07...		0.032	0.091	<1	E4k	24	17.2	99	13
21...		0.016	0.064	E1k	E5k	E14k	11.0	97	8
SEP								
11...		0.015	0.064	1k	1k	E14k	14.2	100	5
23...		0.012	0.068	<2	E6k	E18k	14.1	94	9

Remark codes used in this table:
< -- Less than
E -- Estimated value
Value qualifier codes used in this table:
k -- Counts outside acceptable range

WATER-QUALITY DATA, WATER YEAR OCTOBER 2002 THROUGH SEPTEMBER 2003

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 deg C (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
OCT 2002													
09...	1100	370	0.0	11.5	8.3	410	9.9	10.7	0.66	<0.050	<0.050	<0.050	<0.010
NOV													
05...	1430	340	7.0	14.3	8.2	457	1.7	1.9	0.69	<0.050	<0.050	<0.050	<0.010
DEC													
11...	0945	360	0.0	14.7	8.1	467	0.0	1.5	0.88	0.070	0.070	0.140	<0.010
JAN 2003													
15...	1615	311	1.0	15.7	7.9	478	-15.0	1.5	0.69	<0.050	<0.050	0.190	<0.010
FEB													
10...	1735	340	0.0	14.8	7.9	496	-18.1	1.1	0.78	<0.050	<0.050	0.130	<0.010
MAR													
24...	1630	446	--	14.3	7.8	463	13.1	6.0	1.0	0.140	0.140	0.150	<0.010
APR													
14...	1650	384	21	12.1	8.3	425	31.4	10.6	--	<0.050	<0.050	<0.050	<0.050
MAY													
19...	1730	770	35	10.2	8.3	418	16.0	15.8	0.93	<0.050	<0.050	<0.050	<0.010
JUN													
02...	1700	623	6.1	9.1	8.4	419	22.0	19.0	0.85	<0.050	<0.050	0.380	<0.010
16...	1700	556	16	8.6	8.4	409	27.3	22.9	0.78	<0.050	<0.050	<0.050	<0.010

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
OCT 2002								
09...	0.005	0.037	<1	<4	1k	7.47	99	4
NOV								
05...	<0.005	0.034	13k	11k	5k	9.92	100	2
DEC								
11...	0.009	0.042	--	--	--	12.6	100	1
JAN 2003								
15...	0.009	0.038	--	--	--	3.39	100	2
FEB								
10...	<0.005	0.037	--	--	--	12.1	95	2
MAR								
24...	0.019	0.068	--	--	--	8.70	100	2
APR								
14...	<0.005	0.042	E1k	<1	<1	12.9	97	5
MAY								
19...	<0.005	0.071	<4	<1	4k	12.6	99	16
JUN								
02...	0.006	0.044	E2k	E1k	E1k	9.04	98	9
16...	0.009	0.067	100k	28	68	9.04	96	6

Remark codes used in this table:

< -- Less than

E -- Estimated value

Value qualifier codes used in this table:

k -- Counts outside acceptable range

05046270 OTTER TAIL RIVER NEAR EVERDELL, MN

LOCATION.--Lat 46°13'00", long 96°24'31", NW1/4 SW1/4 sec. 25, T. 132 N, R. 46 W., Wilkin County, Hydrologic Unit 09020103, 3.5 miles south of Everdell on Wilkin County Highway 17.

DRAINAGE AREA.--1,772 mi^2.

WATER-QUALITY RECORDS

PERIOD OF RECORD.--September 2001 through June 2003.

WATER-QUALITY DATA, WATER YEAR OCTOBER 2000 THROUGH SEPTEMBER 2001

Date	Time	Instantaneous discharge, cfs (00061)	Turbidity, water, unfltrd field, NTU (61028)	Dissolved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conductance, wat unf uS/cm 25 deg C (00095)	Temperature, air, deg C (00020)	Temperature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
SEP 2001													
11...	1400	--	--	--	--	--	--	--	--	--	--	--	--
12...	0910	490	22	8.0	8.4	416	16.5	18.0	0.87	<0.050	<0.050	<0.050	<0.010
17...	1000	--	--	--	--	--	--	--	--	--	--	--	--
23...	0945	--	--	--	--	--	--	--	--	--	--	--	--
25...	1450	532	10	10.8	8.5	419	18.0	14.7	0.75	<0.050	<0.050	<0.050	<0.010

Date	Orthophosphate, water, fltrd, mg/L as P (00671)	Phosphorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coliform, M-FC 0.7u MF col/ 100 mL (31625)	Fecal streptococci KF MF, col/ 100 mL (31673)	Chlorophyll a phytoplankton, acid m, ug/L (32211)	Suspnd. sediment, sieve diametr percent <.063mm (70331)	Suspended sediment concentration mg/L (80154)
SEP 2001								
11...	--	--	*29k	*33k	*104	--	--	--
12...	<0.005	0.107	110	140	84	26.2	15	--
17...	--	--	*200k	*130	*84	--	--	--
23...	--	--	*78	*86	*46	--	--	--
25...	<0.005	0.049	31k	18k	4k	9.84	89	22

Remark codes used in this table:
< -- Less than

Value qualifier codes used in this table:
* -- Collected and analyzed by Wilkin County Soil and Water Conservation District
k -- Counts outside acceptable range

WATER-QUALITY DATA, WATER YEAR OCTOBER 2001 THROUGH SEPTEMBER 2002

Date	Time	Instantaneous discharge, cfs (00061)	Turbidity, water, unfltrd field, NTU (61028)	Dissolved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conductance, wat unf uS/cm 25 deg C (00095)	Temperature, air, deg C (00020)	Temperature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
OCT 2001													
02...	1115	--	--	--	--	--	--	--	--	--	--	--	--
10...	1045	--	--	--	--	--	--	--	--	--	--	--	--

10...	1240	384	14	9.8	8.1	439	10.0	11.5	0.76	<0.040	--	E.030	E.004
15...	1000	--	--	--	--	--	--	--	--	--	--	--	--
24...	0930	--	--	--	--	--	--	--	--	--	--	--	--
29...	0920	--	--	--	--	--	--	--	--	--	--	--	--
NOV													
05...	0915	--	--	--	--	--	--	--	--	--	--	--	--
07...	1400	440	3.0	12.7	8.2	489	9.5	6.8	0.71	<0.050	0.270	<0.050	<0.010
DEC													
12...	1600	577	0.0	14.3	8.2	501	-2.8	0.7	0.72	0.050	0.050	0.130	<0.010
JAN 2002													
16...	1715	481	13	13.1	8.1	485	-4.3	-0.3	0.77	0.080	0.090	0.140	<0.010
FEB													
13...	1630	--	15	11.4	7.8	474	9.9	0.8	0.65	0.080	0.090	0.120	<0.010
MAR													
20...	0910	560	19	12.6	8.0	475	-5.3	0.2	0.68	0.120	0.120	0.160	<0.010
APR													
17...	1350	768	20	11.3	8.0	438	18.5	11.2	0.76	<0.050	<0.050	<0.050	<0.010
MAY													
07...	0810	--	--	--	--	--	--	--	--	--	--	--	--
13...	0800	--	--	--	--	--	--	--	--	--	--	--	--
15...	1510	932	33	12.9	8.2	447	24.9	12.7	0.93	<0.050	<0.050	0.050	<0.010
20...	0840	--	--	--	--	--	--	--	--	--	--	--	--
28...	0830	--	--	--	--	--	--	--	--	--	--	--	--
JUN													
03...	0920	--	--	--	--	--	--	--	--	--	--	--	--
05...	1415	742	17	9.7	8.3	430	25.9	19.0	0.81	<0.050	<0.050	<0.050	<0.010
10...	0830	--	--	--	--	--	--	--	--	--	--	--	--
17...	0900	--	--	--	--	--	--	--	--	--	--	--	--
26...	1400	677	36	8.6	8.2	420	31.0	25.6	0.86	<0.050	<0.050	0.130	0.010
JUL													
01...	0930	--	--	--	--	--	--	--	--	--	--	--	--
08...	0930	--	--	--	--	--	--	--	--	--	--	--	--
10...	1200	1,340	180	6.5	8.1	360	18.2	23.5	1.5	0.080	0.080	0.420	0.020
15...	0930	--	--	--	--	--	--	--	--	--	--	--	--
24...	1415	706	28	7.6	8.0	418	27.5	23.9	0.84	0.070	0.060	0.160	0.020
30...	0920	--	--	--	--	--	--	--	--	--	--	--	--
AUG													
05...	0715	--	--	--	--	--	--	--	--	--	--	--	--
07...	1345	605	25	9.2	8.3	409	27.0	23.1	1.1	<0.050	<0.050	0.070	<0.010
12...	0750	--	--	--	--	--	--	--	--	--	--	--	--
19...	0750	--	--	--	--	--	--	--	--	--	--	--	--
21...	1155	707	30	8.1	8.2	403	22.2	20.8	0.88	<0.050	<0.050	<0.050	<0.010
26...	0850	--	--	--	--	--	--	--	--	--	--	--	--
SEP													
03...	0900	--	--	--	--	--	--	--	--	--	--	--	--
09...	0910	--	--	--	--	--	--	--	--	--	--	--	--
11...	1440	690	25	9.4	8.3	402	28.0	22.9	0.82	<0.050	<0.050	<0.050	<0.010
16...	0810	--	--	--	--	--	--	--	--	--	--	--	--
25...	1205	447	10	10.0	8.3	420	8.7	13.1	0.61	<0.050	<0.050	<0.050	<0.010
30...	0915	--	--	--	--	--	--	--	--	--	--	--	--

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
OCT 2001								
02...	--	--	*54k	*46k	*160	--	--	--
10...	--	--	*300	*210	*>10,000	--	--	--
10...	<0.02	E.06	310	360	6,900	7.72	96	27
15...	--	--	*61k	*70k	*120	--	--	--
24...	--	--	*56k	*15k	*63k	--	--	--
29...	--	--	*48k	*27k	*205	--	--	--
NOV								
05...	--	--	*7k	*9k	*54	--	--	--
07...	<0.005	0.035	15k	32k	54	14.0	94	7
DEC								
12...	0.005	0.040	--	--	--	10.6	90	8
JAN 2002								
16...	0.017	0.057	--	--	--	5.35	90	30
FEB								
13...	0.007	0.067	--	--	--	5.35	87	44
MAR								
20...	0.011	0.062	--	--	--	6.91	72	22
APR								
17...	<0.005	0.075	--	52	9k	16.3	59	67
MAY								
07...	--	--	*16k	*2k	*16k	--	--	--
13...	--	--	*6k	*2k	*19k	--	--	--
15...	<0.005	0.080	<1	6k	24	10.5	70	43
20...	--	--	*8k	*14k	*16k	--	--	--
28...	--	--	*6k	*12k	*35k	--	--	--
JUN								
03...	--	--	*19k	*36k	*62	--	--	--
05...	0.011	0.076	20k	31	30	8.84	88	44
10...	--	--	*33k	*63k	*76k	--	--	--
17...	--	--	*40k	*63k	*50k	--	--	--
26...	0.030	0.115	79k	57	40	9.09	85	58
JUL								
01...	--	--	*88k	*54k	*197	--	--	--
08...	--	--	*1,600k	*1,100	*7,000	--	--	--
10...	0.108	0.402	4,000k	1,400	7,000	11.5	80	291
15...	--	--	*83k	*94k	*440	--	--	--
24...	0.052	0.129	20k	51	115	7.96	76	60
30...	--	--	*22k	*21k	*117k	--	--	--
AUG								
05...	--	--	*26k	*31k	*<10k	--	--	--
07...	0.032	0.110	46k	42	114k	12.8	88	39
12...	--	--	*6k	*20k	*124	--	--	--
19...	--	--	*45k	*31k	*96	--	--	--
21...	0.018	0.106	16k	85	200	12.3	84	58
26...	--	--	*45	*58	*125	--	--	--
SEP								
03...	--	--	*42	*40	*112	--	--	--
09...	--	--	*80	*58	*149	--	--	--

11...	0.022	0.086	25k	46	88	10.5	62	52
16...	--	--	*66	*100	*112	--	--	--
25...	0.011	0.056	48k	48	97	10.2	88	14
30...	--	--	*56	*80	*84	--	--	--

Remark codes used in this table:

<	-- Less than
E	-- Estimated value
>	-- Greater than

Value qualifier codes used in this table:

*	-- Collected and analyzed by Wilkin County Soil and Water Conservation District
k	-- Counts outside acceptable range

WATER-QUALITY DATA, WATER YEAR OCTOBER 2002 THROUGH SEPTEMBER 2003

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 deg C (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
OCT 2002													
07...	0830	--	--	--	--	--	--	--	--	--	--	--	--
09...	0920	348	12	10.8	8.2	441	0.5	8.3	0.80	<0.050	<0.050	<0.050	<0.010
15...	0845	--	--	--	--	--	--	--	--	--	--	--	--
21...	1100	--	--	--	--	--	--	--	--	--	--	--	--
28...	0830	--	--	--	--	--	--	--	--	--	--	--	--
NOV													
05...	1715	333	13	14.3	8.2	478	1.1	1.7	0.61	<0.050	<0.050	<0.050	<0.010
DEC													
11...	0830	--	10	12.6	8.0	481	-3.0	-0.3	0.83	0.080	0.080	0.140	<0.010
JAN 2003													
16...	1010	302	10	14.6	8.0	489	-17.0	-0.3	0.94	0.080	0.080	0.190	<0.010
FEB													
12...	1045	303	8.9	13.2	7.6	490	-16.5	-0.3	0.90	0.080	0.080	0.150	<0.010
MAR													
25...	1500	593	11	--	8.2	474	7.9	6.0	0.92	0.120	0.120	0.160	<0.010
APR													
15...	1340	479	47	12.1	8.2	446	20.7	12.2	0.83	<0.050	<0.050	<0.050	<0.010
MAY													
07...	0950	--	--	--	--	--	--	--	--	--	--	--	--
12...	0800	--	--	--	--	--	--	--	--	--	--	--	--
20...	0750	--	--	--	--	--	--	--	--	--	--	--	--
21...	0950	809	29	9.5	8.3	449	15.0	13.8	0.92	<0.050	<0.050	<0.050	<0.010
29...	0820	--	--	--	--	--	--	--	--	--	--	--	--
JUN													
02...	1315	--	--	--	--	--	--	--	--	--	--	--	--
03...	1405	739	28	9.2	8.0	437	22.5	19.0	0.84	<0.050	<0.050	<0.050	<0.010
09...	0815	--	--	--	--	--	--	--	--	--	--	--	--
17...	1430	658	26	8.8	8.2	430	28.5	25.5	0.93	<0.050	<0.050	<0.050	<0.010
23...	0800	--	--	--	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA, WATER YEAR OCTOBER 2002 THROUGH SEPTEMBER 2003—CONTINUED

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
OCT 2002								
07...	--	--	*E25k	*73	*200	--	--	--
09...	<0.005	0.040	E23k	27	E16k	7.39	89	8
15...	--	--	*10k	*30k	*40	--	--	--
21...	--	--	*20k	*E8k	*199	--	--	--
28...	--	--	*34k	*56	*60	--	--	--
NOV								
05...	0.008	0.041	22k	17k	8k	11.0	88	3
DEC								
11...	<0.005	0.036	--	--	--	12.6	83	6
JAN 2003								
16...	0.012	0.052	--	--	--	7.48	34	22
FEB								
12...	0.005	0.042	--	--	--	14.6	43	11
MAR								
25...	0.012	0.089	<4k	--	--	5.94	66	25
APR								
15...	<0.005	0.053	E4k	E4k	E6k	17.7	58	58
MAY								
07...	--	--	*E17k	*44	*E26k	--	--	--
12...	--	--	*E8k	*E21k	*E31k	--	--	--
20...	--	--	*E8k	*E24k	*E33k	--	--	--
21...	0.006	0.084	E20k	E7k	E27k	14.5	80	41
29...	--	--	*E13k	*E22k	*E5k	--	--	--
JUN								
02...	--	--	*E14k	*E9k	*E20k	--	--	--
03...	0.007	0.074	<1	E18k	E45k	9.39	80	42
09...	--	--	*E31k	*E31k	*44	--	--	--
17...	0.012	0.090	E40k	27	60	9.39	99	6
23...	--	--	*E170k	*96	*405	--	--	--

Remark codes used in this table:

< -- Less than

E -- Estimated value

Value qualifier codes used in this table:

* -- Collected and analyzed by Wilkin County Soil and Water Conservation District

k -- Counts outside acceptable range

05046450 OTTER TAIL RIVER ABOVE BRECKENRIDGE, MN

LOCATION.--Lat 46°15'42", long 96°32'45", SE$^1/_4$ NW$^1/_4$ sec. 11, T. 132 N, R. 47 W., Wilkin County, Hydrologic Unit 09020103, 1.5 miles east of Breckenridge on Wilkin County Highway 10.

DRAINAGE AREA.--1,848 mi^2.

WATER-QUALITY RECORDS

PERIOD OF RECORD.--September 2001 through June 2003.

WATER-QUALITY DATA, WATER YEAR OCTOBER 2000 THROUGH SEPTEMBER 2001

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 deg C (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
SEP 2001													
11...	1330	--	--	--	--	--	--	--	--	--	--	--	--
11...	1520	564	32	9.7	8.4	412	25.0	20.0	0.77	<0.050	<0.050	<0.050	<0.010
17...	0945	--	--	--	--	--	--	--	--	--	--	--	--
23...	0930	--	--	--	--	--	--	--	--	--	--	--	--
25...	1230	513	19	10.0	8.5	419	16.0	13.9	0.83	<0.050	<0.050	<0.050	<0.010

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
SEP 2001								
11...	--	--	*60k	*34k	*48	--	--	--
11...	0.005	0.086	50k	56	20k	13.6	90	56
17...	--	--	*62k	*48	*70	--	--	--
23...	--	--	*51k	*91	*80	--	--	--
25...	<0.005	0.066	96	53k	41k	13.9	79	46

Remark codes used in this table:

< -- Less than

Value qualifier codes used in this table:

* -- Collected and analyzed by Wilkin County Soil and Water Conservation District

k -- Counts outside acceptable range

WATER-QUALITY DATA, WATER YEAR OCTOBER 2001 THROUGH SEPTEMBER 2002

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 deg C (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
OCT 2001													
02...	1045	--	--	--	--	--	--	--	--	--	--	--	--

10...	1030	--	--	--	--	--	--	--	--	--	--	--	--
10...	1215	468	35	9.7	8.2	412	10.5	12.2	0.97	<0.040	--	E.030	<0.008
15...	0945	--	--	--	--	--	--	--	--	--	--	--	--
24...	0845	--	--	--	--	--	--	--	--	--	--	--	--
29...	0910	--	--	--	--	--	--	--	--	--	--	--	--
NOV													
05...	0900	--	--	--	--	--	--	--	--	--	--	--	--
07...	1115	411	4.0	11.4	8.2	489	9.8	6.3	0.69	<0.050	0.390	<0.050	<0.010
DEC													
12...	1400	545	0.0	13.9	8.0	502	-0.4	2.3	0.75	<0.050	<0.050	0.140	<0.010
JAN 2002													
16...	1415	--	11	13.0	8.0	486	-2.0	-0.3	0.69	0.080	0.080	0.140	<0.010
FEB													
13...	1530	488	2.0	11.2	7.9	482	8.5	-0.3	0.82	0.090	0.090	0.130	<0.010
MAR													
20...	1110	525	11	13.6	8.2	481	-2.0	0.1	0.81	0.120	0.120	0.160	<0.010
APR													
17...	1050	729	31	10.3	8.0	442	10.8	11.7	0.99	<0.050	<0.050	<0.050	<0.010
MAY													
07...	0825	--	--	--	--	--	--	--	--	--	--	--	--
13...	0745	--	--	--	--	--	--	--	--	--	--	--	--
15...	1225	910	29	11.8	8.2	450	20.1	11.7	0.95	<0.050	<0.050	0.070	<0.010
20...	0915	--	--	--	--	--	--	--	--	--	--	--	--
28...	0915	--	--	--	--	--	--	--	--	--	--	--	--
JUN													
03...	0900	--	--	--	--	--	--	--	--	--	--	--	--
05...	1205	751	35	8.3	8.4	434	23.5	18.7	0.92	<0.050	<0.050	<0.050	<0.010
10...	0830	--	--	--	--	--	--	--	--	--	--	--	--
17...	0900	--	--	--	--	--	--	--	--	--	--	--	--
26...	1130	569	62	8.2	8.1	422	28.9	24.6	0.90	<0.050	0.060	0.160	0.010
JUL													
01...	0910	--	--	--	--	--	--	--	--	--	--	--	--
08...	0910	--	--	--	--	--	--	--	--	--	--	--	--
10...	1420	1,190	130	6.8	8.1	341	17.8	23.5	1.1	<0.050	0.060	0.400	0.020
15...	0930	--	--	--	--	--	--	--	--	--	--	--	--
24...	1155	677	26	7.4	8.1	423	24.0	22.5	0.95	0.060	0.050	0.190	0.010
29...	0845	--	--	--	--	--	--	--	--	--	--	--	--
AUG													
05...	0845	--	--	--	--	--	--	--	--	--	--	--	--
07...	1130	604	26	8.6	8.3	412	28.7	21.7	0.98	<0.050	<0.050	<0.050	<0.010
12...	0740	--	--	--	--	--	--	--	--	--	--	--	--
19...	0740	--	--	--	--	--	--	--	--	--	--	--	--
20...	1730	510	21	9.1	8.2	410	23.0	20.1	0.76	<0.050	<0.050	<0.050	<0.010
26...	0840	--	--	--	--	--	--	--	--	--	--	--	--
SEP													
03...	0850	--	--	--	--	--	--	--	--	--	--	--	--
09...	0840	--	--	--	--	--	--	--	--	--	--	--	--
11...	1225	667	36	8.5	8.5	405	27.0	21.4	0.71	<0.050	<0.050	0.060	<0.010
16...	0745	--	--	--	--	--	--	--	--	--	--	--	--
24...	1700	544	10	10.5	8.3	418	18.8	14.4	0.67	<0.050	0.050	<0.050	<0.010
30...	0845	--	--	--	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA, WATER YEAR OCTOBER 2001 THROUGH SEPTEMBER 2002—CONTINUED

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
OCT 2001								
02...	--	--	*240	*110	*320	--	--	--
10...	--	--	*310	*250	*>10,000	--	--	--
10...	<0.002	0.09	380k	380	2780	7.17	88	58
15...	--	--	*61k	*47k	*190	--	--	--
24...	--	--	*46k	*12k	*54k	--	--	--
29...	--	--	*23k	*13k	*100	--	--	--
NOV								
05...	--	--	*27k	*5k	*66	--	--	--
07...	<0.005	0.037	11k	15k	43k	12.3	82	11
DEC								
12...	<0.005	0.046	--	--	--	9.24	80	17
JAN 2002								
16...	0.012	0.055	--	--	--	3.76	78	18
FEB								
13...	0.008	0.055	--	--	--	6.62	83	30
MAR								
20...	0.011	0.062	--	--	--	6.11	73	35
APR								
17...	<0.005	0.094	25k	56k	5k	18.5	83	64
MAY								
07...	--	--	*9k	*4k	*20k	--	--	--
13...	--	--	*2k	*10k	*67	--	--	--
15...	<0.005	0.099	6k	12k	37k	12.3	64	79
20...	--	--	*13k	*15k	*30k	--	--	--
28...	--	--	*9k	*20k	*40	--	--	--
JUN								
03...	--	--	*30k	*62	*151	--	--	--
05...	0.009	0.091	10k	47	59	13.2	84	62
10...	--	--	*44k	*61k	*116	--	--	--
17...	--	--	*15k	*40k	*94k	--	--	--
26...	0.032	0.130	130k	100	74	11.2	87	83
JUL								
01...	--	--	*100k	*80	*192	--	--	--
08...	--	--	*650	*590	*3300	--	--	--
10...	0.101	0.420	1,200	1,300k	11,600k	10.1	84	298
15...	--	--	*67k	*74k	*433	--	--	--
24...	0.049	0.158	67	61	180	11.9	84	83
29...	--	--	*61k	*40k	*79k	--	--	--
AUG								
05...	--	--	*72	*38	*<10k	--	--	--
07...	0.029	0.115	17k	31	90	16.6	89	57
12...	--	--	*54k	*47k	*108	--	--	--
19...	--	--	*27k	*45k	*66k	--	--	--
20...	0.018	0.093	E1k	17k	76	10.6	86	53
26...	--	--	*48k	*82	*116	--	--	--
SEP								

03...	--	--	*34k	*92	*192	--	--	--	
09...	--	--	*40k	*62	*223	--	--	--	
11...	0.019	0.105	28k	32k	116	6.11	84	65	
16...	--	--	*48k	*85	*87	--	--	--	
24...	0.012	0.066	<2k	42	54	9.91	83	31	
30...	--	--	*93	*120	*139	--	--	--	

Remark codes used in this table:
- < -- Less than
- E -- Estimated value
- \> -- Greater than

Value qualifier codes used in this table:
- * -- Collected and analyzed by Wilkin County Soil and Water Conservation District
- k -- Counts outside acceptable range

WATER-QUALITY DATA, WATER YEAR OCTOBER 2002 THROUGH SEPTEMBER 2003

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 deg C (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
OCT 2002													
07...	0815	--	--	--	--	--	--	--	--	--	--	--	--
08...	1505	387	5.0	10.9	8.2	442	11.6	10.8	0.62	<0.050	<0.050	<0.050	<0.010
15...	0815	--	--	--	--	--	--	--	--	--	--	--	--
21...	1020	--	--	--	--	--	--	--	--	--	--	--	--
28...	0810	--	--	--	--	--	--	--	--	--	--	--	--
NOV													
06...	1230	323	0.0	13.9	8.1	481	5.0	1.8	0.67	<0.050	<0.050	<0.050	<0.010
DEC													
10...	1615	--	2.0	13.6	8.3	474	8.5	-0.3	0.86	<0.050	0.110	0.120	<0.010
JAN 2003													
15...	1435	321	5.0	14.7	7.6	501	-13.0	-0.3	0.89	0.070	0.070	0.160	<0.010
FEB													
12...	1330	329	10	12.8	7.2	510	-10.5	-0.3	0.77	0.060	0.060	0.150	<0.010
MAR													
25...	1105	569	17	--	7.7	478	9.6	5.7	1.1	0.120	0.140	0.180	<0.010
APR													
15...	1145	431	29	9.9	8.3	444	17.0	12.3	0.81	<0.050	<0.050	<0.050	<0.010
MAY													
07...	0930	--	--	--	--	--	--	--	--	--	--	--	--
12...	0800	--	--	--	--	--	--	--	--	--	--	--	--
20...	0740	--	--	--	--	--	--	--	--	--	--	--	--
21...	1230	753	47	9.3	8.3	455	23.0	14.5	0.93	<0.050	<0.050	0.060	<0.010
29...	0810	--	--	--	--	--	--	--	--	--	--	--	--
JUN													
02...	1243	--	--	--	--	--	--	--	--	--	--	--	--
03...	1150	729	30	8.3	8.2	436	20.0	18.0	0.88	<0.050	<0.050	<0.050	<0.010
09...	0745	--	--	--	--	--	--	--	--	--	--	--	--
17...	1215	648	45	7.2	8.0	436	25.0	23.0	0.98	<0.050	<0.050	<0.050	<0.010
23...	0800	--	--	--	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA, WATER YEAR OCTOBER 2002 THROUGH SEPTEMBER 2003—CONTINUED

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
OCT 2002								
07...	--	--	*88	*74	*310	--	--	--
08...	0.005	0.049	64	62	13k	6.07	88	17
15...	--	--	*33k	*46	*77	--	--	--
21...	--	--	*23k	*46	*28k	--	--	--
28...	--	--	*9k	*12k	*72	--	--	--
NOV								
06...	<0.005	0.039	8k	--	--	8.36	84	9
DEC								
10...	<0.005	0.043	--	--	--	13.2	60	13
JAN 2003								
15...	0.011	0.016	--	--	--	8.02	92	15
FEB								
12...	<0.005	0.052	--	--	--	16.6	48	114
MAR								
25...	0.012	0.105	--	--	--	18.2	49	63
APR								
15...	<0.005	0.073	12k	18k	11k	14.9	74	41
MAY								
07...	--	--	*E8k	*88	*E34k	--	--	--
12...	--	--	*E20k	*E25k	*68	--	--	--
20...	--	--	*E18k	*E24k	*100	--	--	--
21...	0.006	0.090	E7k	E37k	E31k	13.9	64	63
29...	--	--	*E24k	*E21k	*E26k	--	--	--
JUN								
02...	--	--	*E24k	*44	*46	--	--	--
03...	0.005	0.089	<1k	40	49	12.9	82	56
09...	--	--	*E37k	*64	*60	--	--	--
17...	0.009	0.207	E140k	64	76	12.9	80	49
23...	--	--	*240	*200	*395	--	--	--

Remark codes used in this table:
< -- Less than
E -- Estimated value

Value qualifier codes used in this table:
* -- Collected and analyzed by Wilkin County Soil and Water Conservation District
k -- Counts outside acceptable range

05046502 OTTER TAIL RIVER AT 11th STREET IN BRECKENRIDGE, MN

WATER-QUALITY RECORDS

PERIOD OF RECORD.--September 2001 through June 2003.

WATER-QUALITY DATA, WATER YEAR OCTOBER 2000 THROUGH SEPTEMBER 2001

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 degC (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
SEP 2001													
11...	1215	713	38	9.0	8.5	412	22.5	18.8	0.79	<0.0 50	<0.0 50	<0.0 50	<0.0 10
11...	1300	--	--	--	--	--	--	--	--	--	--	--	--
17...	0930	--	--	--	--	--	--	--	--	--	--	--	--
23...	0900	--	--	--	--	--	--	--	--	--	--	--	--
25...	1020	696	18	9.7	8.5	418	13.1	13.8	0.77	<0.0 50	<0.0 50	<0.0 50	<0.0 10

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
SEP 2001								
11...	<0.0 05	0.093	80	80k	28k	15.2	95	60
11...	--	--	*30	*38	*95	--	--	--
17...	--	--	*150 k	*74k	*64	--	--	--
23...	--	--	*100	*85k	*120	--	--	--
25...	<0.0 05	0.070	120	140	92	12.8	95	40

Remark codes used in this table:

< -- Less than

Value qualifier codes used in this table:

* -- Collected and analyzed by Wilkin County Soil and Water Conservation District

k -- Counts outside acceptable range

WATER-QUALITY DATA, WATER YEAR OCTOBER 2001 THROUGH SEPTEMBER 2002

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 degC (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
OCT 2001													
02...	1015	--	--	--	--	--	--	--	--	--	--	--	--
10...	1030	570	28	9.6	8.2	424	11.0	12.4	0.72	<0.0 40	--	E.03 0	<0.0 08
10...	1035	--	--	--	--	--	--	--	--	--	--	--	--
15...	0930	--	--	--	--	--	--	--	--	--	--	--	--

24...	0810	--	--	--	--	--	--	--	--	--	--	--	--
29...	0900	--	--	--	--	--	--	--	--	--	--	--	--
NOV													
05...	0845	--	--	--	--	--	--	--	--	--	--	--	--
07...	0850	608	6.0	11.5	8.4	482	8.3	6.2	0.87	<0.050	<0.050	<0.050	<0.010
DEC													
12...	1105	--	8.4	12.9	8.1	503	-0.9	-0.3	0.68	<0.050	<0.050	0.140	<0.010
JAN 2002													
16...	1245	528	14	--	8.1	492	-1.8	-0.3	0.72	0.080	0.080	0.140	<0.010
FEB													
13...	1245	499	2.0	11.5	7.9	480	7.0	-0.3	0.77	0.070	0.080	0.120	<0.010
MAR													
20...	1320	607	11	14.0	8.2	482	-2.8	0.5	0.79	0.120	0.120	0.170	<0.010
APR													
17...	1050	837	49	9.8	8.2	436	9.0	13.0	0.94	<0.050	<0.050	<0.050	<0.010
MAY													
07...	0840	--	--	--	--	--	--	--	--	--	--	--	--
13...	0730	--	--	--	--	--	--	--	--	--	--	--	--
15...	0955	1,000	35	11.5	8.2	453	14.5	12.2	1.1	<0.050	<0.050	0.080	<0.010
20...	0930	--	--	--	--	--	--	--	--	--	--	--	--
28...	0930	--	--	--	--	--	--	--	--	--	--	--	--
JUN													
03...	0830	--	--	--	--	--	--	--	--	--	--	--	--
05...	0945	793	45	8.0	8.3	434	20.0	19.0	0.88	<0.050	<0.050	<0.050	<0.010
10...	0830	--	--	--	--	--	--	--	--	--	--	--	--
17...	0900	--	--	--	--	--	--	--	--	--	--	--	--
26...	0850	829	65	7.1	8.3	420	24.5	25.1	1.1	<0.050	<0.050	0.130	<0.010
JUL													
01...	0900	--	--	--	--	--	--	--	--	--	--	--	--
10...	1635	1,210	140	6.3	8.1	338	18.8	22.9	1.6	0.050	0.060	0.390	0.020
15...	0830	--	--	--	--	--	--	--	--	--	--	--	--
18...	0900	--	--	--	--	--	--	--	--	--	--	--	--
24...	0930	754	31	7.3	8.1	422	20.5	22.5	0.99	<0.050	<0.050	0.180	0.010
29...	0830	--	--	--	--	--	--	--	--	--	--	--	--
AUG													
05...	0830	--	--	--	--	--	--	--	--	--	--	--	--
07...	0920	636	33	8.1	8.4	410	22.8	21.1	0.90	<0.050	<0.050	<0.050	<0.010
12...	0730	--	--	--	--	--	--	--	--	--	--	--	--
19...	0730	--	--	--	--	--	--	--	--	--	--	--	--
21...	0940	694	50	7.8	8.2	386	22.5	20.4	0.86	<0.050	<0.050	<0.050	<0.010
26...	0830	--	--	--	--	--	--	--	--	--	--	--	--
SEP													
03...	0840	--	--	--	--	--	--	--	--	--	--	--	--
09...	0830	--	--	--	--	--	--	--	--	--	--	--	--
11...	0955	812	36	8.0	8.3	405	19.9	21.3	0.83	<0.050	<0.050	0.050	<0.010
16...	0730	--	--	--	--	--	--	--	--	--	--	--	--
25...	0940	477	16	9.8	8.5	418	7.1	13.0	0.64	<0.050	0.050	<0.050	<0.010
30...	0830	--	--	--	--	--	--	--	--	--	--	--	--

WATER-QUALITY DATA, WATER YEAR OCTOBER 2001 THROUGH SEPTEMBER 2002—CONTINUED

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
OCT 2001								
02...	--	--	*260	*130	*310	--	--	--
10...	<0.02	E.06	360	670	1,170	6.14	95	42
10...	--	--	*600k	*1,700	*>10,000	--	--	--
15...	--	--	*76k	*41k	*120	--	--	--
24...	--	--	*39k	*16k	*48k	--	--	--
29...	--	--	*11k	*20k	*76	--	--	--
NOV								
05...	--	--	*20k	*15k	*114	--	--	--
07...	<0.005	0.038	10k	6k	56k	10.5	85	12
DEC								
12...	<0.005	0.054	--	--	--	9.99	86	21
JAN 2002								
16...	0.013	0.044	--	--	--	3.45	90	23
FEB								
13...	0.008	0.049	--	--	--	4.15	--	--
MAR								
20...	0.011	0.065	--	--	--	5.07	93	26
APR								
17...	<0.005	0.119	20k	10k	50	19.9	89	81
MAY								
07...	--	--	*9k	*4k	*13k	--	--	--
13...	--	--	*13k	*20k	*89	--	--	--
15...	<0.005	0.101	17k	51k	42	10.8	67	153
20...	--	--	*15k	*15k	*34k	--	--	--
28...	--	--	*20k	*13k	*61k	--	--	--
JUN								
03...	--	--	*20k	*56	*165	--	--	--
05...	0.011	0.098	36k	53	71	10.7	92	72
10...	--	--	*25k	*62k	*132	--	--	--
17...	--	--	*E130k	*63k	*148	--	--	--
26...	0.028	0.140	200k	100	200	14.1	97	89
JUL								
01...	--	--	*E43	*110	*253	--	--	--
10...	0.108	0.425	2,900	>6,000	9,800	16.0	87	274
15...	--	--	*42k	*120k	*606	--	--	--
18...	--	--	*990	*150k	*500	--	--	--
24...	0.048	0.154	10k	23	215	9.69	92	82
29...	--	--	*58k	*84k	*139k	--	--	--
AUG								
05...	--	--	*53	*47	*<10k	--	--	--
07...	0.025	0.119	37	25	209	19.2	95	57
12...	--	--	*28k	*32k	*104	--	--	--
19...	--	--	*49k	*23k	*116	--	--	--
21...	0.018	0.140	420	420	660	15.0	91	96

26...	--	--	*51k	*50	*144	--	--	--
SEP								
03...	--	--	*44k	*92	*207	--	--	--
09...	--	--	*26k	*60k	*320	--	--	--
11...	0.020	0.115	28k	21k	142	11.7	89	80
16...	--	--	*31k	*60	*112	--	--	--
25...	0.012	0.072	41	140	112	9.59	95	30
30...	--	--	*52	*140	*145	--	--	--

Remark codes used in this table:
- < -- Less than
- E -- Estimated value
- > -- Greater than

Value qualifier codes used in this table:
- * -- Collected and analyzed by Wilkin County Soil and Water Conservation District
- k -- Counts outside acceptable range

WATER-QUALITY DATA, WATER YEAR OCTOBER 2002 THROUGH SEPTEMBER 2003

Date	Time	Instan-taneous dis-charge, cfs (00061)	Tur-bidity, water, unfltrd field, NTU (61028)	Dis-solved oxygen, mg/L (00300)	pH, water, unfltrd field, std units (00400)	Specif. conduc-tance, wat unf uS/cm 25 degC (00095)	Temper-ature, air, deg C (00020)	Temper-ature, water, deg C (00010)	Ammonia + org-N, water, unfltrd mg/L as N (00625)	Ammonia water, fltrd, mg/L as N (00608)	Ammonia water, unfltrd mg/L as N (00610)	Nitrite + nitrate water fltrd, mg/L as N (00631)	Nitrite water, fltrd, mg/L as N (00613)
OCT 2002													
07...	0800	--	--	--	--	--	--	--	--	--	--	--	--
08...	1710	477	5.0	10.8	8.2	453	9.3	11.0	0.69	<0.050	<0.050	<0.050	<0.010
15...	0800	--	--	--	--	--	--	--	--	--	--	--	--
21...	1015	--	--	--	--	--	--	--	--	--	--	--	--
28...	0800	--	--	--	--	--	--	--	--	--	--	--	--
NOV													
06...	0955	359	0.0	14.0	8.0	485	1.0	0.7	0.66	<0.050	<0.050	<0.050	<0.010
JAN 2003													
15...	1045	344	30	13.7	7.2	439	-17.0	0.3	0.77	0.160	0.160	0.120	<0.010
FEB													
12...	1625	314	3.4	12.9	7.9	510	-7.0	-0.3	0.88	0.060	0.060	0.150	<0.010
MAR													
25...	0955	587	20	--	7.9	480	9.6	6.0	1.2	0.120	0.170	0.170	<0.010
APR													
15...	0935	467	35	9.5	8.5	445	9.4	11.8	0.81	<0.050	<0.050	<0.050	<0.010
MAY													
07...	0745	--	--	--	--	--	--	--	--	--	--	--	--
12...	0800	--	--	--	--	--	--	--	--	--	--	--	--
20...	0730	--	--	--	--	--	--	--	--	--	--	--	--
21...	1440	888	40	9.8	8.2	475	24.5	16.0	0.89	<0.050	<0.050	0.070	<0.010
28...	0800	--	--	--	--	--	--	--	--	--	--	--	--
JUN													
02...	1100	--	--	--	--	--	--	--	--	--	--	--	--
03...	0935	767	38	7.8	8.3	437	16.5	17.4	0.96	<0.050	<0.050	<0.050	<0.010
09...	0730	--	--	--	--	--	--	--	--	--	--	--	--
17...	1000	714	48	6.9	8.1	436	22.5	23.6	1.0	<0.050	<0.050	<0.050	<0.010
23...	0800	--	--	--	--	--	--	--	--	--	--	--	--

Date	Ortho-phos-phate, water, fltrd, mg/L as P (00671)	Phos-phorus, water, unfltrd mg/L (00665)	E coli, m-TEC MF, water, col/ 100 mL (31633)	Fecal coli-form, M-FC 0.7u MF col/ 100 mL (31625)	Fecal strep-tococci KF MF, col/ 100 mL (31673)	Chloro-phyll a phyto-plank-ton, acid m, ug/L (32211)	Suspnd. sedi-ment, sieve diametr percent <.063mm (70331)	Sus-pended sedi-ment concen-tration mg/L (80154)
OCT 2002								
07...	--	--	*110	*99	*400	--	--	--
08...	0.006	0.052	42k	68	38	6.81	84	23
15...	--	--	*32k	*46	*88	--	--	--
21...	--	--	*60k	*48	*29k	--	--	--
28...	--	--	*80	*E31k	*E38k	--	--	--
NOV								
06...	0.036	0.037	17k	14k	19k	8.65	92	7
JAN 2003								
15...	0.012	0.049	--	--	--	7.28	91	9
FEB								
12...	<0.005	0.050	--	--	--	17.0	94	7
MAR								
25...	0.062	0.134	--	--	--	16.2	93	58
APR								
15...	<0.005	0.084	E16k	E12k	E15k	12.5	91	47
MAY								
07...	--	--	*8k	*E31k	*62	--	--	--
12...	--	--	*E36k	*E34k	*111	--	--	--
20...	--	--	*E10k	*E40k	*137	--	--	--
21...	0.006	0.087	E21k	E18k	E25k	13.4	86	45
28...	--	--	*E16k	*E24k	*50	--	--	--
JUN								
02...	--	--	*44	*E31k	*84	--	--	--
03...	0.005	0.154	E24k	E22k	67	15.1	64	121
09...	--	--	*E42k	*E41k	*69	--	--	--
17...	0.010	0.128	E130k	160	196	15.1	90	82
23...	--	--	*230	*210	*478	--	--	--

Remark codes used in this table:
- < -- Less than
- E -- Estimated value

Value qualifier codes used in this table:
- * -- Collected and analyzed by Wilkin County Soil and Water Conservation District
- k -- Counts outside acceptable range