Fecal Coliform Bacteria TMDLs for the Maple River and It's Tributaries in LaMoure and Dickey Counties, ND

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1.0 INTRODUCTION AND DESCRIPTION OF THE WATERSHED

The Maple River extends 125 miles from southwest LaMoure county through the northwest and central portion of Dickey county in south central North Dakota. It provides a recreational and agricultural water supply as it flows into South Dakota. Figure 1 shows the location of the Maple River and the Maple River Watershed while Table 1 summarizes the geographical, hydrological and physical characteristics.

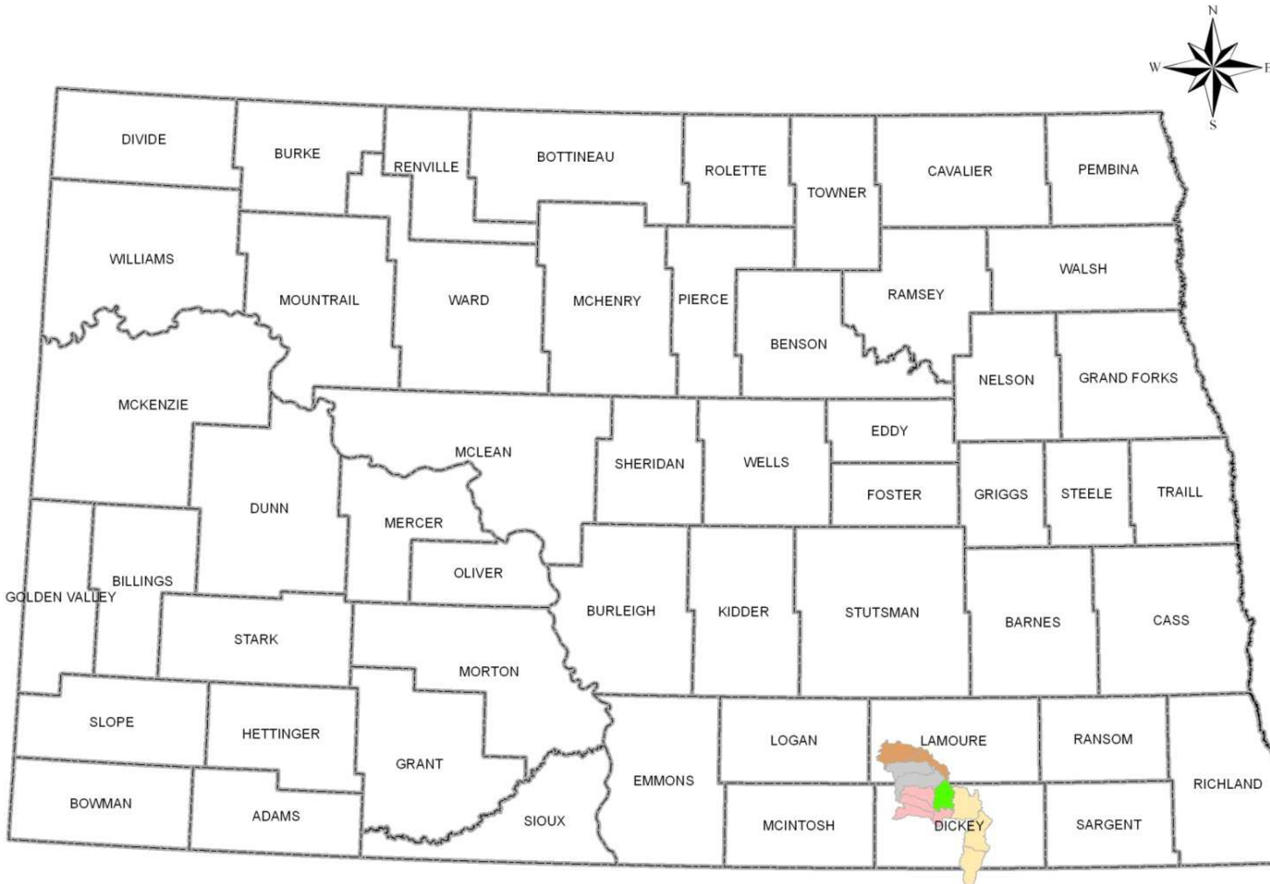

Figure 1. General Location of the Maple River Watershed in North Dakota.

Table 1. General Characteristics of the Maple River and Maple River Watershed

Legal Name	Maple River
Stream Classification	Class II
Major Drainage Basin	Elm River Basin - James River - Missouri River
Nearest Municipality	Edgeley and Ellendale, ND
Assessment Unit IDs	ND-10160004-002-S_00, ND-10160004-013-S_00, ND-10160004-026-S_00, ND-10160004-015-S_00, and ND-10160004-022-S_00
County	LaMoure and Dickey Counties, ND
Eco-Region	Northern Glaciated Plains
Watershed Area	286,560 acres
River Miles	125.31 stream miles
Tributaries	Maple Creek, South Fork of Maple River
Outlets	Elm River
Type of Waterbody	Natural River

1.1 Clean Water Act Section 303(d) Listing Information

As part of the Clean Water Act Section 303(d) Total Maximum Daily Load (TMDL) listing process for 2008, the North Dakota Department of Health (NDDoH) has identified five waterbodies with the Maple River watershed in North Dakota as impaired (Table 2-6). In 2008, the NDDoH assessed these waterbodies as threatened or not supporting recreation use based on total fecal coliform bacteria data (NDDoH, 2008). Information for each of the impaired reaches is summarized in Tables 2-6. Figure 2 shows the listed waterbodies, sampling stations, and corresponding subwatershed boundaries.

Table 2. Section 303(d) TMDL Listing Information for Maple River Waterbody ND-10160004-002-S_00 (NDDoH, 2008).

Assessment Unit ID	ND-10160004-002-S_00
Waterbody Description	Maple River from its confluence with the South Fork Maple River downstream to the ND-SD border.
Size	41.07 miles
Designated Uses Impaired	Recreation
Use Support	Not Supporting
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

Table 3. Section 303(d) TMDL Listing Information for Maple River Waterbody ND-10160004-013-S_00 (NDDoH, 2008).

Assessment Unit ID	ND-10160004-013-S_00
Waterbody Description	Maple River from its confluence with the Maple Creek to its confluence with the South Fork Maple River.
Size	15.79 miles
Designated Uses Impaired	Recreation
Use Support	Fully Supporting but Threatened
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

Table 4. Section 303(d) TMDL Listing Information for Maple River Waterbody ND-10160004-026-S_00) (NDDoH, 2008).

Assessment Unit ID	ND-10160004-026-S_00
Waterbody Description	Maple River from Schlect-Thom Dam downstream to its confluence with Maple Creek.
Size	20.01 miles
Designated Uses Impaired	Recreation
Use Support	Fully Supporting but Threatened
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

Table 5. Section 303(d) TMDL Listing Information for South Fork Maple River Waterbody ND-10160004-015-S_00 (NDDoH, 2008).

Assessment Unit ID	ND-10160004-015-S_00
Waterbody Description	South Fork Maple River from its confluence with three tributaries downstream to its confluence with the Maple River downstream.
Size	14.53 miles
Designated Uses Impaired	Recreation
Use Support	Not Supporting
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

Table 6. Section 303(d) TMDL Listing Information for Maple Creek Waterbody ND-10160004-022-S_00 (NDDoH, 2008).

Assessment Unit ID	ND-10160004-022-S_00
Waterbody Description	Maple Creek downstream to its confluence with the Maple River.
Size	33.91 miles
Designated Uses Impaired	Recreation
Use Support	Not Supporting
Impairment	Fecal Coliform Bacteria
TMDL Priority	High

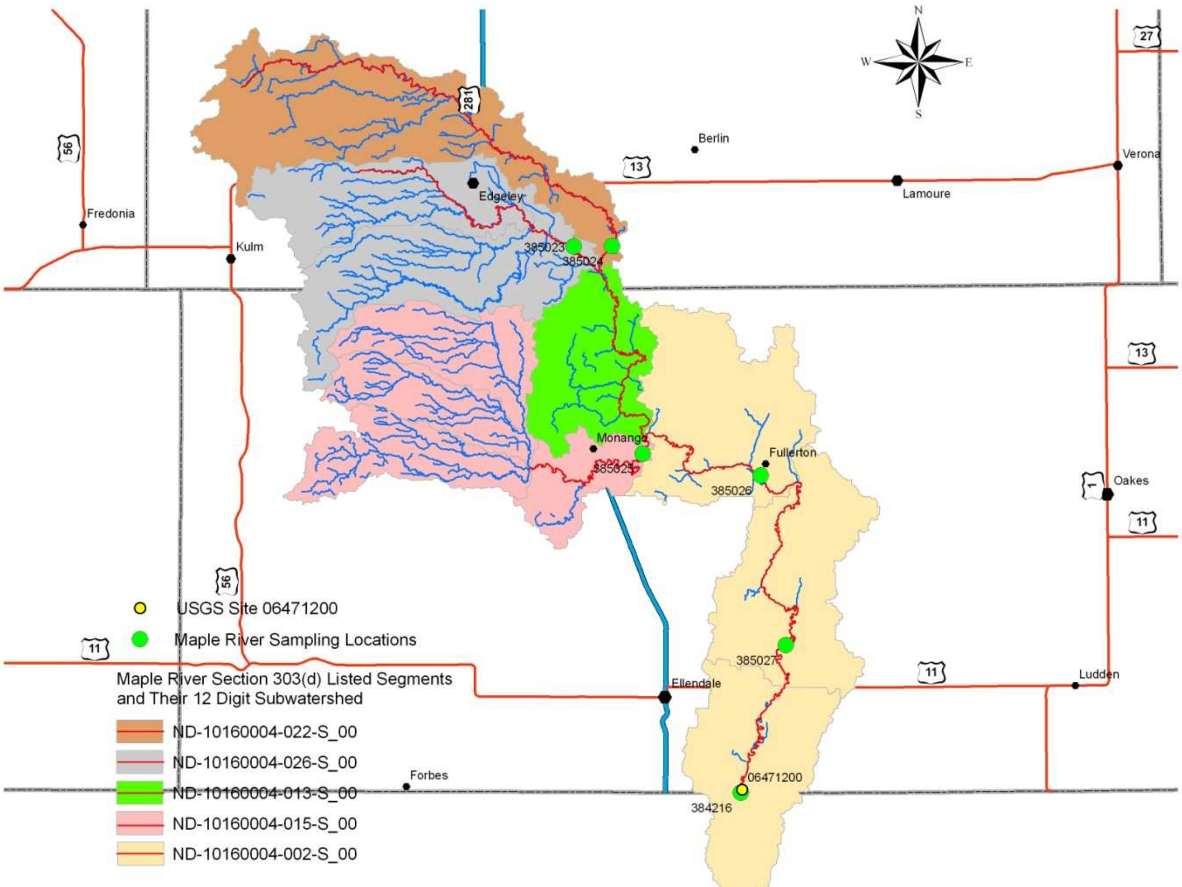

Figure 2. Maple River Subwatersheds, Sampling Sites and Section 303(d) Listed Waterbodies (Note: Tributary streams depicted in blue are not part of the TMDL listed waterbody.)

1.2 Topography

The Maple River watershed lies in the Northern Glaciated Plains ecoregion and is characterized by a flat to gently rolling landscape composed of glacial drift. The sub-humid climatic conditions foster a grassland transition between the tall and shortgrass prairie. Though the till soil is very fertile, agricultural success is subject to annual climatic fluctuations (USGS, 2006).

Figure 3. Temporary and Seasonal Wetlands on the Drift Plains.

Wisconsinan glaciers left a subtle undulating topography and a thick mantle of glacial till. A greater proportion of temporary and seasonal wetlands are found on the drift plains than in the Coteau areas, where semi-permanent wetlands are numerous. Because of the productive soil and level topography, this ecoregion is almost entirely cultivated, with many wetlands drained or simply tilled and planted. The prairie grasses have been largely replaced by fields of spring wheat, barley, sunflowers, and alfalfa. However, valuable waterfowl habitat still remains concentrated in state and federally sponsored waterfowl production areas.

The Maple River watershed is characterized by highly fertile uplands, primarily used for row crop, small grain and livestock production. According to the LaMoure and Dickey County Soil Surveys, the predominate soils in the watershed are from the Barnes-Svea-Hamerly association and the Cavour-Barnes association. These soils are formed on slopes of 0 to 25 percent. They are deep, level to hilly, moderately well drained and medium textured. The soils of these associations are fertile and possess high moisture holding capabilities. They are typically wind-resistant, but are moderately susceptible to water erosion. Annual erosion rates according to NRCS (T) values, range from 3-5 tons/acre/year. Elevation in both counties ranges from about 2,200 feet mean sea level (msl) in the west to 1,300 feet msl in the east. The Maple River watershed is part of the Prairie Pothole Region and the Drift Prairie (USGS, 2006).

1.3 Land Use/Land Cover

The Maple River watershed stretches across two counties in southeastern North Dakota. There are approximately 103,400 acres in LaMoure county and 208,000 acres in Dickey County. Sixty-six (66) percent of these acres are under active cultivation. The remaining thirty-four (34) percent are pasture/rangeland, CRP, hayland, or low density urban development. There are approximately 139 animal feeding operations (AFOs) located within the Maple River watershed.

In 1999, the Natural Resource Conservation Service (NRCS) conducted a riparian and stream assessment on the Maple River and contributing watershed. This assessment evaluated 22 sites along the Maple River. Methods for evaluation included the "Stream Visual Assessment Protocol", Technical Note 99-1 (SVAP) and Bureau of Land Management (BLM) "Process for Assessing Proper Functioning Condition" (PFC).

The results of the NRCS assessment indicated that the Maple River was in a state of degraded riparian health caused by erosion and sedimentation, excessive grazing, poor nutrient/pesticide management, and livestock wastes. The NRCS also identified that the area was lacking "on the ground technical assistance and a watershed conservationist was needed to assist land users in implementing resource management systems on their land."

1.4 Climate and Precipitation

The climate of the region varies significantly depending on the season. Climate data from the period of 1948 through 2006 was obtained from the High Plains Regional Climate Center (HPRCC) for the Fullerton, ND monitoring station (323287) which lies within the watershed. The average daily temperature is 42.5^{o} F, with an average of 71.1^{o} F in July and 9.2 ^{o} F in January. The total annual precipitation is approximately 20.77 inches. Most of this is received from April through September (Figure 4).

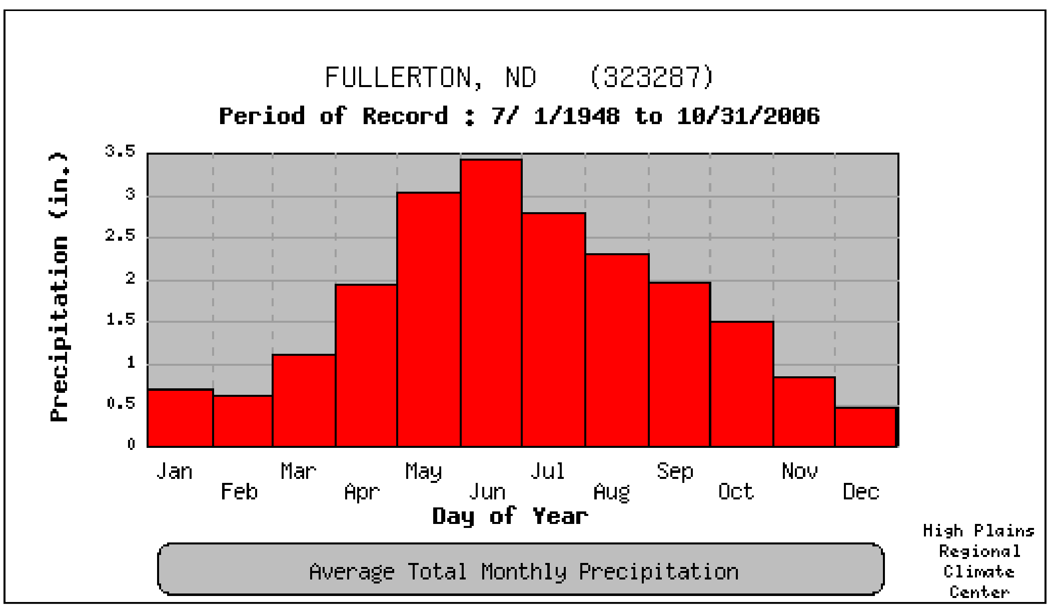

Figure 4. Average Monthly Precipitation at Fullerton, ND.

1.5 Available Water Quality Data

In 2000, six water quality monitoring stations were established in the Maple River watershed (Figure 2, Table 7). A total of 629 fecal coliform samples were collected from 2000 through 2006 (Appendix A).

Table 7. Water Quality Sampling Site Information.

Site ID	Site Location	Number of Samples
385023	Maple River near Edgeley	123
385024	Maple Creek near Edgeley	96
385025	South Fork of Maple River	127
385026	Maple River near Fullerton	79
385027	Maple River near Maple Colony	76
384216	Maple River near the North Dakota/South Dakota border	128

1.5.1 Fecal Coliform Bacteria

Fecal coliform bacteria samples were collected at the six water quality monitoring stations from March through October (2000 – 2006). In total 629 bacteria samples were collected and submitted to the Division of Laboratory Services within the established holding time to be analyzed (Appendix A). The least number of samples collected and analyzed was 76 at the Maple Creek near Maple Colony station (385027), while the greatest number of samples collected was 128 at both the North Dakota/South Dakota state line site (384216).

1.5.2 Mean Daily Stream Flow

Mean daily flow for the period January 1, 2000 through December 5, 2006 was obtained from the United States Geological Survey (USGS) gauging site on the Maple River at the ND-SD border (06471200) (Appendix B). This site is collocated with site 384216. Stream discharge measurements were also collected at sites 385023, 385024, 385025, and 385026 (Appendix C).

2.0 WATER QUALITY STANDARDS

The Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be developed for waters on a state's Section 303(d) list. A TMDL is defined as “the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background” such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded. The purpose of a TMDL is to identify the pollutant load reductions or other actions that should be taken so that impaired waters will be able to attain water quality standards. TMDLs are required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis. Separate TMDLs are required to address each pollutant or cause of impairment (i.e., nutrients, dissolved oxygen).

2.1 Narrative Water Quality Standards

The North Dakota Department of Health has set narrative water quality standards that apply to all surface waters in the state (NDDoH, 2006).

- All waters of the state shall be free from substances attributable to municipal, industrial, or other discharges or agricultural practices in concentrations or combinations that are toxic or harmful to humans, animals, plants, or resident aquatic biota.

- No discharge of pollutants, which alone or in combination with other substances, shall:
  - Cause a public health hazard or injury to environmental resources;
  - Impair existing or reasonable beneficial uses of the receiving water; or
  - Directly or indirectly cause concentrations of pollutants to exceed applicable standards of the receiving waters.

In addition to the narrative standards, the NDDoH has set a biological goal for all surface waters in the state. The goal states that "the biological condition of surface waters shall be similar to that of sites or waterbodies determined by the department to be regional reference sites" (NDDoH, 2006).

2.2 Numeric Water Quality Standards

The Maple River is a Class II stream (NDDoH, 2006). As a Class II stream, "the quality of the waters in this class shall be suitable for the propagation and/or protection of resident fish species and other aquatic biota and for swimming, boating, and other water recreation. The quality of the waters shall be for irrigation, stock watering, and wildlife without injurious effects. After treatment consisting of coagulation, settling, filtration, and chlorination, or equivalent treatment processes, the water quality shall meet the bacteriological, physical, and chemical requirements of the department for municipal or domestic use. Additional treatment for municipal use may be required to meet the drinking water requirements of the Department. Streams in this classification may be intermittent in nature, which would make these waters of limited value for beneficial uses such as municipal water, fish life, or irrigation" (NDDoH, 2006). Numeric criteria have been developed for Class II streams for fecal coliform bacteria. Fecal coliform bacteria standards have been established and are shown in Table 8. The fecal coliform bacteria standard applies only during the recreation season from May 1 to September 30.

Table 8. North Dakota Fecal Coliform Bacteria Standards for Class II Streams.

Parameter	Water Quality Standard	
	Geometric Mean[1]	Maximum[2]
Fecal Coliform Bacteria	200 CFU/100 mL	400 CFU/100 mL

[1] **Expressed as a geometric mean of representative samples collected during any consecutive 30-day period.**

[2] **No more than 10 percent of samples collected during any consecutive 30-day period shall individually exceed the standard.**

3.0 TMDL TARGETS

A TMDL target is the value that is measured to judge the success of the TMDL effort. TMDL targets must be based on state water quality standards, but can also include site-specific values when no numeric criteria are specified in the standard. The following TMDL target for the Maple River is based on the NDDoH water quality standard for fecal coliform bacteria.

TMDL targets have been set for the Maple River in order to restore its recreation uses to fully supporting status. The measure of achievement will be the restoration and maintenance of total fecal coliform bacteria concentrations below the state water quality standards.

3.1 Maple River TMDL Targets

The Maple River and its tributaries are either not supporting or fully supporting but threatened because of total fecal coliform bacteria counts exceeding the North Dakota water quality standard. The North Dakota water quality standard for total fecal coliform bacteria is a 30-day geometric mean of 200 CFU/100 mL during the recreation season which is from May 1 to September 30. In addition, no more than 10 percent of the samples collected within the 30-day period may exceed 400 CFU/100 mL. Therefore, the TMDL target for this report is the fecal coliform standard expressed as the 30-day geometric mean 200 CFUs/100 mL.

4.0 SIGNIFICANT SOURCES

4.1 Point Sources

There is one point source located in the Maple River watershed. Edgeley, North Dakota (population 650) utilizes a secondary treatment system, while the towns of Merricourt, Fullerton and Monango do not have public wastewater treatment systems. Although the city of Ellendale lies within the Maple River watershed it discharges to a tributary that enters the Maple River in South Dakota. While the cities of Edgeley and Ellendale do discharge within the Maple River watershed, their discharges are first to an ephemeral stream. Due to the location of the discharges, no total fecal coliform data are required by their North Dakota Pollutant Discharge Elimination System discharge permits. It is assumed, therefore, that fecal coliform loadings to the Maple River are negligible from these two point sources.

Based on data provided by the NDPDES Program, there are three permitted Confined Animal Feeding Operations (CAFOs) (i.e., facilities permitted for 1000 animal units or greater) and 15 permited AFOs (i.e., less than 1000 animal units) in the Maple River watershed. They are, however, zero discharge facilities and are not deemed a significant point source for purposes of this report.

4.2 Nonpoint Pollution Sources

In 2000, the LaMoure and Dickey Soil Conservation Districts (Districts) implemented a Watershed Assessment Project (Wax, 2001) on the Maple River. The assessment included modeling the land uses and potential impacts using the Agricultural Non-Point Source Pollution Model (AGNPS), water quality and quantity monitoring at six sites, and the collection of fish and macroinvertebrate data for biological assessment. The assessment results reflect the stressors identified in the 1999 ND Unified Watershed Assessment, and the NRCS Stream Assessment of the Maple River. Water quality samples collected showed that the Maple River drainage received and transported high concentrations total fecal coliform bacteria.

Three main conclusions can be drawn from the 2000 Maple River watershed assessment:

1) The types of land uses, primarily livestock grazing and feeding operations, are a significant factor influencing the amount and type of nonpoint source pollution being discharged into the Maple River;

2) The current amounts of nonpoint source pollution are degrading the recreational integrity

of the Maple River; and

3) This water quality degradation can be slowed or possibly reversed by improving livestock management strategies and implementing best management practices (BMPs) in the watershed.

Failing septic systems or direct discharge sewage systems which contribute to fecal coliform bacteria contamination may also be located within the watershed. While their specific location and potential for fecal coliform loading are unknown, these systems may be associated with isolated single-family dwellings and farmsteads located throughout the watershed or within small towns located within the watershed that do not have a centralized sewer system (e.g., Merricourt, Fullerton and Monango).

5.0 TECHNICAL ANALYSIS

In TMDL development, the goal is to define the linkage between the water quality target and the identified source or sources of the pollutant (in this case total fecal coliform bacteria) to determine the load reduction needed to meet the target. To determine the cause-and-effect relationship between the water quality target and the identified source, the "load duration curve" methodology was used. The loading capacity or TMDL is the amount of pollutant (i.e., total fecal coliform bacteria) a waterbody can receive and still meet and maintain water quality standards and beneficial uses. The following technical analysis addresses the total fecal coliform load allocation and the load allocation reductions necessary to achieve the water quality standards target of 200 CFU/100 mL plus a margin of safety.

5.1 Mean Daily Stream Flows

In southcentral North Dakota, rain events are variable and can be sporadic and heavy or light, occurring over a short duration or over several days. Precipitation events of large magnitude, occurring at a faster rate than absorption, contribute to high runoff events. These events are represented by runoff in the high flow regime. The medium flow regime is represented by runoff that contributes to the stream over a longer duration. The low flow regime is characteristic of drought or precipitation events of small duration and/or magnitude that do not contribute to runoff.

Mean daily flows for the period January 1, 2000 through December 5, 2006 were used in the development of the flow duration curve and load duration curve for site 384216 (Maple River at the ND-SD border). These data were obtained from the collocated USGS gauge site (06471200) (Appendix B). For sites 385023, 385024, 385025, and 385026 the mean daily flow record used in flow duration curve development and in the development of the load duration curve was synthesized using regression relationships developed for each site. Simple linear regression relationships were developed for each site using the measured flows at each site paired with the corresponding flow at the USGS site for the same day. Using the daily flow record for the USGS site as the dependent variable a corresponding daily flow was estimated for each site.

While the regression approach was used to synthesize a flow record for sites 385023, 385024, 385025, and 385026, the lack of an adequate number of measured flows prevented this approach at site 385027. For site 385027, the daily flow record was estimated taking the daily flow for the USGS site times a correction factor of 97 percent. This correction factor was calculated based on the average of three discharge measurements taken at site 385027 divided by the corresponding flow at the USGS site for the same day. Therefore, daily flow at site 385027 was estimated as 97 percent of the daily flow at the USGS site.

5.2 Flow Duration Curve Analysis

The flow duration curve serves as the foundation for the load duration curve used in the TMDL. Flow duration curve analysis looks at the cumulative frequency of historic flow data over a specified time period. A flow duration curve relates flow (expressed as mean daily discharge) to the percent of time those mean daily flow values have been met or exceeded. The use of "*percent of time exceeded*" (i.e., duration) provides a uniform scale ranging from 0 to 100 percent, thus accounting for the full range of stream flows. Low flows are exceeded most of the time, while flood flows are exceeded infrequently (USEPA, 2007).

A basic flow duration curve runs from high to low (0 to 100 percent) along the x-axis with the corresponding flow value on the y-axis (Figure 5). Using this approach, flow duration intervals are expressed as a percentage, with zero corresponding to the highest flows in the record (i.e., flood conditions) and 100 to the lowest flows in the record (i.e., drought). Therefore, as depicted in Figure 5, a flow duration interval of fifty (50) percent, associated with a stream flow of 2.1 cfs, implies that 50 percent of all observed mean daily discharge values equal or exceed 2.1 cfs.

Once the flow duration curve is developed for the stream site, flow duration intervals can be defined which can be used as a general indicator of hydrologic condition (i.e., wet vs dry conditions and to what degree). These intervals (or zones) provide additional insight about conditions and patterns associated with the impairment (fecal coliform bacteria in this case) (USEPA, 2007). As depicted in Figure 5, the flow duration curve was divided into three zones, one representing high flows (0-10 percent), another for moderate flows (10-65 percent), and one for low flows (65-70 percent). Based on the flow duration curve analysis, no flow occurred 30 percent of the time (70-100 percent). These flow intervals were defined by examining the range of flows for the site for the period of record and then by looking for natural breaks in the flow record based on the flow duration curve plot (Figure 5). A secondary factor in determining the flow intervals used in the analysis is the number of fecal coliform observations available for each flow interval.

Based on the analysis of the flow duration curve developed for each site, three flow regimes were defined for sites 384216 and 385023 and two flow regimes were defined for sites 385024, 385025, and 385026. These flow regimes were used in the development of the TMDLs for each site (Appendix D). For purposes of this TMDL the high flow regime at all five sites were defined as flows which were exceeded 10 percent or less of the time. For sites 384216 and 385023, where three flow regimes were defined, the low flow regime was also defined. The low flow regime at these two sites were defined as flows which are exceeded 65 percent of the time. Generally, these are flows which are less than 2 cfs. Based on the flow duration curve analysis, no flow occurred 30 percent of the time at all five sites.

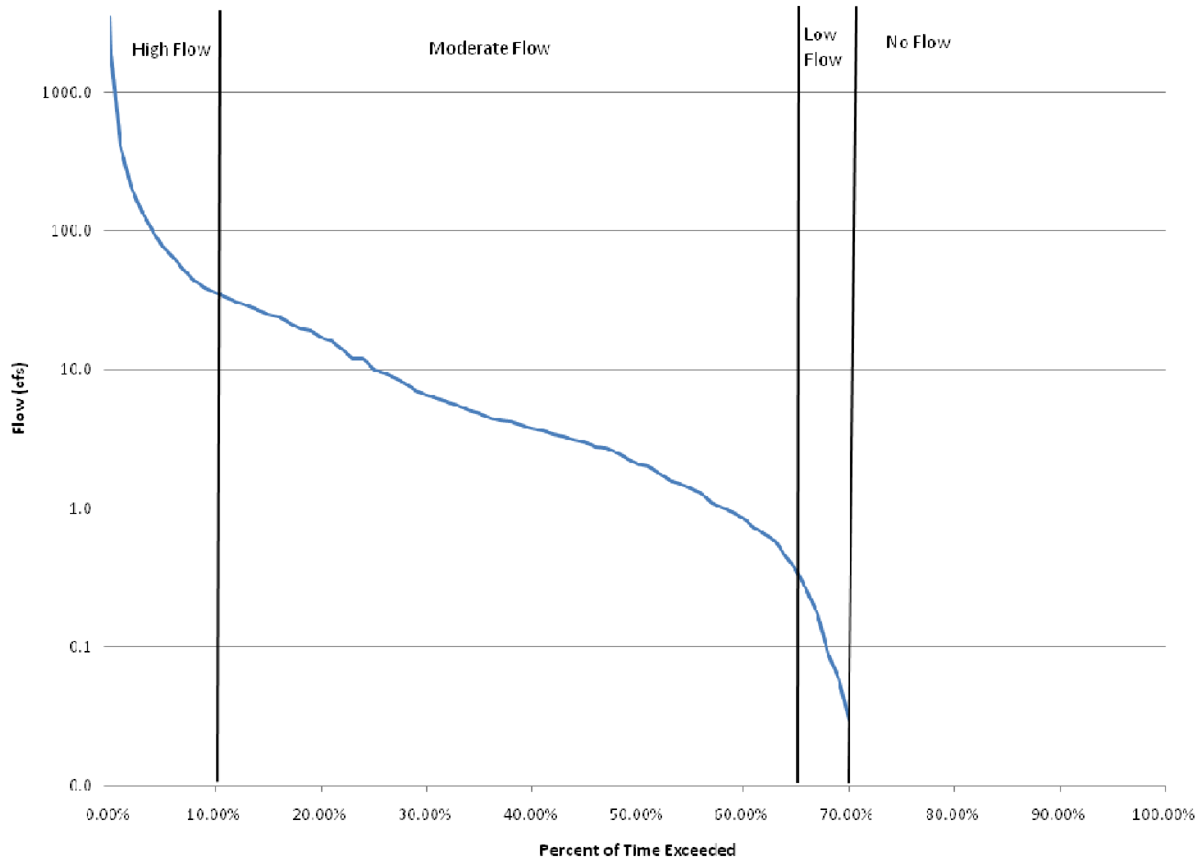

Figure 5. Maple River Flow Duration Curve for USGS Station 06471200 at the ND-SD Border (collocated with site 384216).

5.3 Load Duration Curve Analysis

An important factor in determining nonpoint source pollution loads is variability in stream flows and loads associated with high and moderate to low flow. To better correlate the relationship between the pollutant of concern and the hydrology of the Section 303(d) listed waterbody, a load duration curve was developed for each site representing the waterbody. The load duration curve was derived using the 200 CFU/100 mL TMDL target (i.e., state water quality standard), the daily flow record obtained or synthesized for each site (see Section 5.1), and observed fecal coliform data for each site collected from 2000 through 2006 (May 1-Spetember 30) .

Observed in-stream total fecal coliform bacteria concentrations from monitoring sites 384216, 385027, 385026, 385025, 385024, and 385023 were converted to pollutant loads by multiplying total fecal coliform bacteria concentrations by the daily flow on the date the sample was collected and a conversion factor. These loads are plotted against the percent of time exceeded for the flow on the day of sample collection (Figure 5). Points plotted above the 200 CFU/100 mL TMDL target curve exceed the TMDL target (Figure 6). Points plotted below the curve are meeting the water quality target of 200 CFU/100 mL.

For each flow interval or zone (i.e., high, moderate, low) and each site, a regression relationship was developed between the samples which occur above the TMDL target (200 CFU/100 mL) curve and the corresponding percent exceeded flow. The load duration curve for site 384216 depicting the regression relationship for each flow interval is provided in Figure 6. Load duration curves for the remaining sites are provided in Appendix E. The regression line for each flow interval was then used with the midpoint of the percent exceeded flow for that interval to calculate the existing total fecal coliform bacteria load for that flow interval. For example, in the example provided in Figure 6, the regression relationship between observed fecal coliform bacteria loading and percent exceeded flow for the high flow interval (0-10 percent) is:

Fecal coliform load (expressed as 10^7 CFUs/day) = antilog (5.89 + (-15.76*Percent Exceeded Flow))

Where the midpoint of the flow interval from 0 to 10 percent is 5 percent, the existing fecal coliform load is:

Fecal coliform load (10^7 CFUs/day) = antilog (5.89 + (-15.76*0.05))
= 126,474

The midpoint for the flow interval is also used to estimate the TMDL target load. In the case of the previous example, the TMDL target load for the midpoint or 5 percent exceeded flow derived from the 200 CFU/100 mL TMDL target curve is 37,682 x 10^7 CFUs/day (Figure 6).

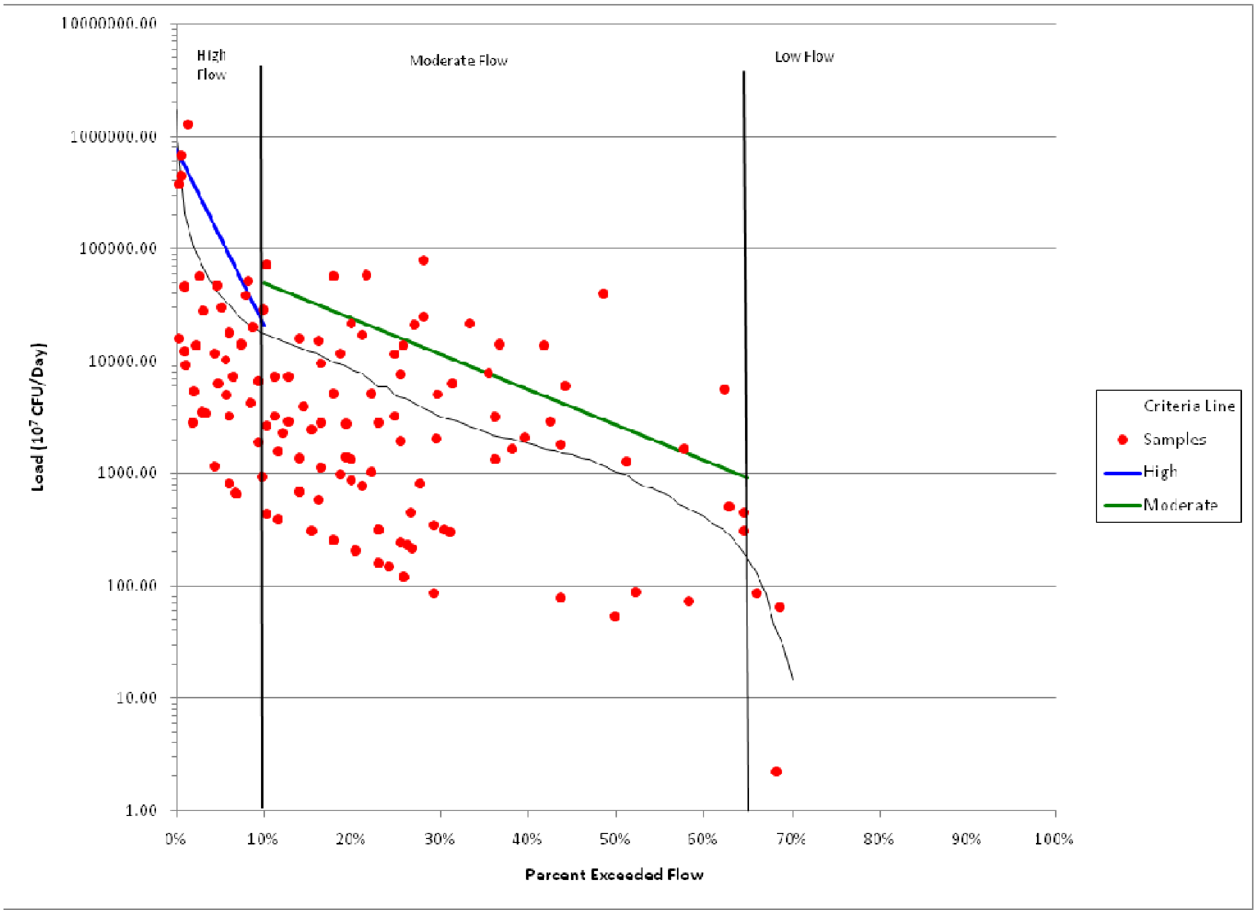

Figure 6. Maple River Load Duration Curve for Monitoring Station 384216 at the ND-SD Border.

5.4 Loading Calculations for Waterbody ND-10160004-013-S_00

Developing the TMDL for Section 303(d) listed waterbody ND-10160004-013-S_00 was complicated by the lack of a monitoring site within the listed segment. Existing loads and TMDL loads for this waterbody for each flow regime were, therefore, estimated by averaging the estimated existing loads for each site immediately upstream (385023, 385024, and 385025) and downstream (385026). The TMDL target load for each flow regime was then calculated by the following equation and are provided in Table 9.

TMDL Load = Average Existing Load – (Average Existing Load * Average Percent Reduction)

Table 9. Existing and TMDL Target Load Calculations (10^7CFUs/day) for Waterbody ND-10160004-013-S_00.

Site	High Flow Regime	Percent Reduction Required to Meet Target for High Flow Regime	Medium-Low Flow Regime	Percent Reduction Required to Meet TMDL Target for the Medium-Low Flow Regime
385023	99,791	74.07 %	3,631	42.50 %
385024	24,541	78.37 %	1,103	75.65 %
385025	28,361	82.85 %	1,593	78.51 %
385026	75,673	65.80 %	10,205	80.90 %
Calculated existing load for ND-10160004-013-S_00[1]	57,092		4,133	
Calculated TMDL target load for ND-10160004-013-S_00[2]	14,119	Average percent reduction[3] 75.27 %	1,265	Average percent reduction[3] 69.39 %

[1] Based on the average existing loads for sites 385023, 385024, 385025, and 385026.
[2] Based on the average percent reduction of sites 385023, 385024, 385025, and 385026.
[3] The average percent reductions shown are estimates based on available data and reasonable assumptions and are to be used as a guide for implementation. The actual reductions needed to meet the applicable water quality standards may be higher or lower depending on the results of future monitoring.

5.5 Loading Sources

In Section 4.0, significant sources of total fecal coliform loading were defined as non-point source pollution originating from livestock. One of the more important concerns regarding non-point sources is variability in stream flows. Variable stream flows often cause different source areas and loading mechanisms to dominate (Cleland, 2003). As previously described, two to three flow regimes (i.e., high and moderate-low) were selected to represent the hydrology of the TMDL watersheds.

By relating runoff characteristics to each flow regime one can infer which sources are most likely to contribute to fecal coliform loading. Animals grazing in the riparian area contribute total fecal coliform bacteria by depositing manure where it has an immediate impact on water quality. Due to the close proximity of manure to the stream or by direct deposition in the stream, riparian grazing impacts water quality at high, medium and low flows (Table 10). In contrast, intensive grazing of livestock in the upland and not in the riparian area has a high potential to impact water quality at high flows and medium impact at moderate flows (Table 10). Exclusion of livestock from the riparian area eliminates the potential of direct manure deposit and therefore is considered to be of high importance at all flows. However, intensive grazing in the upland creates the potential for manure accumulation and availability for runoff at high flows and a high potential for total fecal coliform bacteria contamination.

Since there are no significant point sources believed to be impacting fecal coliform bacteria loading in the watershed, loading sources exceeding the target curve in the medium to low flow regime and those occurring in the high flow regime indicate non-point source pollution. Specific non-point sources of pollution and their potential to contribute total fecal coliform bacteria loads under high, medium and low flow regimes in the Maple River watershed are described in Table 10.

Table 10. Nonpoint Sources of Pollution and Their Potential to Pollute at a Given Flow Regime.

Non-Point Sources	Flow Regime		
	High Flow	Medium Flow	Low Flow
Riparian Area Grazing (Livestock)	H	H	H
Animal Feeding Operations	H	M	L
Manure Application to Crop and Range Land	H	M	L
Intensive Upland Grazing (Livestock)	H	M	L

Note: Potential area to contribute fecal coliform bacteria loads under a given flow regime. (H: High; M: Medium; L: Low)

6.0 MARGIN OF SAFETY AND SEASONALITY

6.1 Margin of Safety

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) regulations require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality." The margin of safety (MOS) can be either incorporated into conservative assumptions used to develop the TMDL (implicit) or added as a separate component of the TMDL (explicit).

To account for the uncertainty associated with known sources and the load reductions necessary to reach the water quality target of 200 CFU/100 mL, a 10 percent explicit margin of safety was used for this TMDL. The MOS was calculated as 10 percent of the TMDL. In other words 10 percent of the TMDL is set aside from the load allocation as a MOS. The 10 percent MOS was derived by taking the difference between the points on the load duration curve using the 200 CFU/100 mL standard and the curve using the 180 CFU/100 mL.

6.2 Seasonality

Section 303(d)(1)(C) of the Clean Water Act and associated regulations require that a TMDL be established with seasonal variations. The Maple River TMDL addresses seasonality because the flow duration curve was developed using seven (7) years of USGS gage data encompassing twelve months of the year. Additionally, the water quality standard is seasonally based on the recreation season from May 1 to September 30 and controls will be designed to reduce coliform loads during the seasons covered by the standard.

7.0 TMDL

The TMDL can be described by the following equation**:**

TMDL = LC = WLA + LA + MOS, where:

LC = loading capacity, or the greatest loading a waterbody can receive without violating water quality standards;
WLA = wasteload allocation, or the portion of the TMDL allocated to existing or future point sources;
LA = load allocation, or the portion of the TMDL allocated to existing or future nonpoint sources;
MOS = margin of safety, or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality. The margin of safety can be provided implicitly through analytical assumptions or explicitly by reserving a portion of loading capacity.

Table 11 provides an outline of the critical elements for each of the five waterbody specific fecal coliform bacteria TMDLs located within the Maple River watershed. Each TMDL was developed based on each waterbody's representative site (Tables 12-18). It should be noted that while waterbody ND-10160004-002-S_00 is represented by three sites (384216, 385027, and 385026), the TMDL for this waterbody is based solely on the most downstream site, located at the ND-SD border (384216) (Table 12). TMDLs for waterbodies ND-10160004-015-S_00, ND-10160004-013-S_00, ND-10160004-022-S_00, and ND-10160004-026-S_00, are presented in Tables 15, 16, 17, and 18, respectively. Each TMDL summary provides an estimate of the existing daily load, an estimate of the average daily loads necessary to meet the water quality target (i.e. TMDL). This load or TMDL includes a load allocation from known non-point sources and a 10 percent margin of safety.

Table 11. TMDL Summary for the Maple River.

Category	Description	Explanation
Beneficial Use Impaired	Recreation	Contact Recreation (i.e. swimming, fishing)
Pollutant	Fecal Coliform Bacteria	See Section 2.1
TMDL Target	200 CFU/100 mL	Based on North Dakota water quality standards
WLA		There are no significant contributing point sources in the watershed.
LA	Nonpoint Source Contributions	Loads are a result of nonpoint sources (i.e., rangeland, pasture land, etc.)
MOS	Explicit	10 percent

Table 12. Fecal Coliform Bacteria TMDL (10^7CFUs/day) for Maple River Waterbody ND-10160004-002-S_00 as Represented by Site 384216 (ND-SD border).

Flow Regime	High Flow	Medium Flow	Low Flow
Existing Load	126,474	6,779	No reduction necessary
TMDL	37,682	2,061	
WLA	0	0	
LA	33,914	206	
MOS	3,768	1,855	

Table 13. Estimated Existing Loads and Load Allocation (LA) (10^7CFUs/day) for Fecal Coliform Bacteria at Maple River Site 385027 (near Maple River Colony).

Flow Regime	High Flow	Medium-Low Flow
Existing Load	313,564	3,318
LA	36,552	1,804

Table 14. Estimated Existing Loads and Load Allocation (LA) (10^7CFUs/day) for Fecal Coliform Bacteria at Maple River Site 385026 (near Fullerton).

Flow Regime	High Flow	Medium-Low Flow
Existing Load	75,672	10,205
LA	25,878	1,949

Table 15. Fecal Coliform Bacteria TMDL (10^7CFUs/day) for Maple River Waterbody ND- 10160004-015-S_00 as Represented by Site 385025 (near Monango).

Flow Regime	High Flow	Medium-Low Flow
Existing Load	28,361	1,593
TMDL	4,863	342
WLA	0	
LA	4,377	308
MOS	486	34

Table 16. Fecal Coliform Bacteria TMDL (10^7CFUs/day) Calculated for Maple River Waterbody ND-10160004-013-S_00.

Flow Regime	High Flow	Medium-Low Flow
Existing Load	57,092	4,133
TMDL	14,119	1,265
WLA	0	0
LA	12,707	1,139
MOS	1,412	126

Table 17. Fecal Coliform Bacteria TMDL (10^7CFUs/day) for Maple Creek Waterbody ND-10160004-022-S_00 as Represented by Site 385024 (near Edgeley).

Flow Regime	High Flow	Medium-Low Flow
Existing Load	24,541	1,103
TMDL	5,309	269
WLA	0	0
LA	4,778	242
MOS	531	27

Table 18. Fecal Coliform Bacteria TMDL (10^7CFUs/day) for Maple River Waterbody ND-10160004-026-S_00 as Represented by Site 385023 (near Edgeley).

Flow Regime	High Flow	Medium Flow	Low Flow
Existing Load	99,791	3,631	No reduction necessary
TMDL	25,878	2,088	
WLA	0	0	
LA	23,290	1,879	
MOS	2,588	209	

8.0 ALLOCATION

There are no known point sources impacting the watershed, therefore, the entire total fecal coliform load for this TMDL was allocated to nonpoint sources in the watershed. The entire nonpoint source load is allocated as a single load because there is not enough detailed source data to allocate the load to individual uses (e.g., animal feeding, septic systems, riparian grazing, upland grazing). To achieve the TMDL targets identified in the report will require the wide spread support and voluntary participation of landowners and residents in the immediate watershed as well as those living upstream. The TMDLs described in this report are a plan to improve water quality by implementing best management practices through non-regulatory approaches. “Best management practices” (BMPs) are methods, measures, or practices that are determined to be a reasonable and cost effective means for a land owner to meet non-point source pollution control needs,” (USEPA, 2001). This TMDL plan is put forth as recommendations for what needs to be accomplished for the Maple River, its tributaries and associated watershed to restore and maintain its recreational uses. Water quality monitoring should continue, in order to measure BMP effectiveness and determine through adaptive management if loading allocation recommendations need to be adjusted.

Non-point source pollution is the sole contributor to elevated total fecal coliform bacteria levels in the Maple River. Three flow regimes (high flows, medium flows, low flows) have been identified for the TMDL. Each flow regime has the capacity to deliver pollutant loads from different sources in the watershed at varying magnitudes. To reduce NPS pollution for each flow regime, specific BMPs are described in Section 8.1 that will mitigate the affects of total fecal coliform loading to the impaired reach.

Controlling non-point sources is an immense undertaking requiring extensive financial and technical support. Provided that technical/financial assistance is available to stakeholders, these BMPs have the potential to significantly reduce total fecal coliform loading to the Maple River. The following describe in detail those BMPs that will reduce total fecal coliform bacteria levels in the Maple River.

8.1 Livestock Management Recommendations

Livestock management BMPs are designed to promote healthy water quality and riparian areas through management of livestock and associated grazing land. Fecal matter from livestock and erosion from poorly managed grazing land and riparian areas can be a significant source of loading to surface water. Precipitation, plant cover, number of animals, and soils are factors that affect the amount of bacteria delivered to a waterbody as a result of livestock. These specific BMPs are known to reduce NPS pollution from livestock. They are:

Livestock exclusion from riparian areas - This practice is established to remove livestock from grazing riparian areas and watering in the stream. Livestock exclusion is accomplished through fencing. A reduction in stream bank erosion can be expected by minimizing or eliminating hoof trampling. A stable stream bank will support vegetation that will hold banks in place and serve a secondary function as a filter from non-point source runoff. Added vegetation will create aquatic habitat and shading for macroinvertebrates and fish. Direct deposit of fecal matter into the stream and stream banks will be eliminated as a result of livestock exclusion by fencing.

Water well and tank development - Fencing animals from stream access requires an alternative water source, installing water wells and tanks satisfies this need. Installing water tanks provides a quality water source and keeps animals from wading and defecating in streams. This will reduce the probability of pathogenic infections to livestock and the environment.

Prescribed grazing - To increase ground cover and ground stability by rotating livestock throughout multiple fields. Grazing with a specified rotation minimizes overgrazing and resulting erosion. The Natural Resources Conservation Service (NRCS) recommends grazing systems to improve and maintain water quality and quantity. Duration, intensity, frequency, and season of grazing can be managed to enhance vegetation cover and litter, resulting in reduced runoff, improved infiltration, increased quantity of soil water for plant growth, and better manure distribution and increased rate of decomposition (NRCS, 1998).

In a study by Tiedemann et al. (1988), as presented by USEPA, (1993), the effects of four grazing strategies on bacteria levels in thirteen watersheds in Oregon were studied during the summer of 1984. Results of the study show that when livestock are managed at a stocking rate of 19 acres per animal unit month with water developments and fencing, bacteria levels were reduced significantly.

Waste management system - Waste management systems can be effective in controlling up to 90 percent of the loading originating from confined animal feeding areas. A waste management system is made up of various components designed to control NPS pollution from concentrated animal feeding operations (CAFOs) and animal feeding operations (AFOs). Diverting clean water from the feeding area and containing dirty water from the feeding area in a pond are typical practices of a waste management system. Manure handling and application procedures are also integral to the waste management system. The application of manure is designed to be adaptive to environmental, soil, and plant conditions to minimize the probability of contamination of surface water.

8.2 Other Recommendations

Vegetative Filter Strip – Vegetated filter strips are used to reduce the amount of sediment, particulate organics, dissolved contaminants, nutrients, and in the case of this TMDL, fecal coliform bacteria to streams. The effectiveness of filter strips and other BMPs in reducing fecal coliform bacteria can be quite successful. Results from a study by Pennsylvania State University (1992a) as presented by USEPA (1993), suggest that vegetative filter strips are capable of removing up to 55 percent of fecal coliform bacteria loading to rivers and streams (Table 19). The ability of the filter strip to reduce contaminants is dependent on field slope, filter strip slope, erosion rate, amount and particulate size distribution of sediment delivered to the filter strip, density and height of vegetation, and runoff volume associated with erosion producing events (NRCS, 2001).

Table 19. Relative Gross Effectiveness[a] of Confined Livestock Control Measures (Pennsylvania State University, 1992a).

Practice[b] Category	Runoff[c] Volume	Total[d] Phosphorus Percent	Total[d] Nitrogen Percent	Sediment Percent	Fecal Coliform Bacteria Percent
Animal Waste System[e]	-	90	80	60	85
Diversion System[f]	-	70	45	NA	NA
Filter Strips[g]	-	85	NA	60	55
Terrace System	-	85	55	80	NA
Containment Structures[h]	-	60	65	70	90

NA = Not Available
a Actual effectiveness depends on site-specific conditions. Values are not cumulative between practice categories.
b Each category includes several specific types of practices.
c - = reduction; + = increase; 0 = no change in surface runoff.
d Total phosphorus includes total and dissolved phosphorus; total nitrogen includes organic-N, ammonia-N, and nitrate-N
e Includes methods for collecting, storing, and disposing of runoff and process-generated wastewater.
f Specific practices include diversion of uncontaminated water from confinement facilities.
g Includes all practices that reduce contaminant losses using vegetative control measures.
h Includes such practices as waste storage ponds, waste storage structures, and waste treatment lagoons.

Septic System – Septic systems provide an economically feasible way of disposing of household wastes where other means of waste treatment are unavailable (e.g., public or private treatment facilities). The basis for most septic systems involves the treatment and distribution of household wastes through a series of steps involving the following:

1. A sewer line connecting the house to a septic tank
2. A septic tank that allows solids to settle out of the effluent
3. A distribution system that dispenses the effluent to a leach field
4. A leaching system that allows the effluent to enter the soil

Septic system failure occurs when one or more components of the septic system do not work properly and untreated waste or wastewater leaves the system. Wastes may pond in the leach field and ultimately run off directly into nearby streams or percolate into groundwater. Untreated septic system waste is a potential source of nutrients (nitrogen and phosphorus), organic matter, suspended solids, and fecal coliform bacteria. Land application of septic system sludge, although unlikely, may also be a source of contamination.

Septic system failure can occur for several reasons, although the most common reason is improper maintenance (e.g. age, inadequate pumping). Other reasons for failure include improper installation, location, and choice of system. Harmful household chemicals can also cause failure by killing the bacteria that digest the waste. While the number of systems that are not functioning properly is unknown, it is estimated that 28 percent of the systems in North Dakota are failing (USEPA, 2002).

9.0 PUBLIC PARTICIPATION

To satisfy the public participation requirement of this TMDL, a hard copy of the TMDL for the five waterbodies of the Maple River watershed and a request for comment was mailed to participating agencies, partners, and to those who request a copy. Those who were provided a copy of the TMDL report either by mail or email included the following:

- LaMoure County Soil Conservation District
- Dickey County Soil Conservation District
- LaMoure County Water Resource Board
- Dickey County Water Resource Board
- North Dakota Game and Fish Department
- South Dakota Department of the Environment and Natural Resources
- US EPA - Region VIII
- USDA-NRCS State Office

In addition to mailing or emailing copies of this TMDL for the listed waterbodies of the Maple River watershed to interested parties, the TMDL was posted on the North Dakota Department of Health, Division of Water Quality web site at: http://www.health.state.nd.us/WQ/sw/Z2_TMDL/TMDLs_Under_PublicComment/B_Under_Public_Comment.htm. A 30 day public notice soliciting comment and participation was published in the following newspapers:

- The Jamestown Sun;
- Dickey County Leader; and
- LaMoure Chronicle

Comments were only received from US EPA Region 8, which were provided as part of their normal public notice review (Appendix F). The NDDoH's response to these comments are provided in Appendix G.

10.0 MONITORING STRATEGY

To insure that the best management practices (BMPs) and technical assistance that are implemented as part of the Section 319 Maple River Watershed Restoration Project are successful in reducing fecal coliform bacteria loadings to levels prescribed in this TMDL, water quality monitoring is being conducted in accordance with an approved Quality Assurance Project Plan (QAPP) (NDDoH, 2003). As prescribed in the QAPP (NDDoH, 2003), weekly monitoring is being conducted at four sites for fecal coliform bacteria and E. coli. In conjunction with the Section 319 Maple River Watershed Implementation Plan, sampling began in October 2000 and will continue through June 2010.

11.0 RESTORATION STRATEGY

In response to the Maple River Watershed Assessment (Wax, 2001) and in anticipation of this completed TMDL, local sponsors successfully applied for and received Section 319 funding for the Maple River Watershed Restoration Project. Beginning in October 2000, local sponsors have been providing technical assistance and implementing BMPs designed to reduce fecal bacteria loadings and to help restore the beneficial uses of the Maple River (i.e., recreation). As the watershed restoration project progresses, water quality data are collected to monitor and track the effects of BMP implementation as well as to judge overall success of the project in reducing fecal coliform bacteria loadings. A QAPP (NDDoH, 2003) has also been developed as part of this watershed restoration project that details the how, when and where monitoring will be conducted to gather the data needed to document success in meeting the TMDL implementation goal(s). As the data are gathered and analyzed, watershed restoration tasks will be adapted, if necessary, to place BMPs where they will have the greatest benefit to water quality and in meeting the TMDL goal(s).

Also, as part of the implementation plan for this TMDL, it is recommended that the permitted point sources (i.e., Edgeley WWTF, 3 CAFOs and 15 AFOs) in the watershed be inspected to ensure that they are being operated in compliance with their permit conditions, and to verify that they aren't significant fecal coliform sources. Currently, the city of Edgeley's waste water treatment facility is inspected for compliance every five years, while all permitted CAFOs (greater than or equal to 1000 animal units) are inspected annually by the NDDoH. Permitted AFOs (<1000 animal units) in the Maple River watershed are inspected on an as needed basis.

12.0 REFERENCES

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Appendix A
Fecal Coliform Bacteria Data Collected in the Maple River Watershed (2000-2006)

Maple River near Edgeley (385023)

Date	Concentration (CFUs/100mL)		Date	Concentration (CFUs/100mL)		Date	Concentration (CFUs/100mL)
03/06/00	5		06/11/01	250		06/09/05	1600
03/13/00	5		06/13/01	250		06/15/05	200
03/15/00	10		06/18/01	1600		06/22/05	110
03/20/00	20		06/20/01	330		06/29/05	450
03/22/00	10		06/25/01	750		07/06/05	370
03/27/00	10		07/02/01	1600		07/13/05	80
03/29/00	5		07/09/01	240		07/18/05	60
04/03/00	5		07/16/01	190		08/22/05	70
04/05/00	20		07/23/01	60		09/06/05	140
04/10/00	5		07/30/01	30		09/20/05	5
04/12/00	10		08/06/01	60		10/04/05	10
04/19/00	10		04/29/02	20		10/18/05	30
04/26/00	30		05/07/02	20		03/22/06	5
05/01/00	370		05/08/02	70		03/29/06	10
05/08/00	1600		05/16/02	80		04/05/06	10
05/15/00	170		05/28/02	40		04/10/06	10
05/22/00	20		05/30/02	30		04/19/06	140
05/31/00	110		06/03/02	5		04/26/06	10
06/05/00	20		03/15/04	5		05/03/06	130
06/20/00	60		03/23/04	10		05/10/06	70
06/28/00	40		03/30/04	30		05/17/06	240
07/05/00	940		04/06/04	20		05/24/06	150
07/10/00	250		04/13/04	5		05/31/06	470
07/17/00	290		04/20/04	10		06/07/06	290
07/25/00	60		04/27/04	5		06/14/06	120
08/08/00	50		05/04/04	5			
10/30/00	80		05/11/04	50			
03/19/01	5		05/18/04	50			
03/21/01	5		05/25/04	280			
03/26/01	5		06/01/04	540			
03/28/01	10		06/08/04	200			
04/04/01	10		06/15/04	150			
04/09/01	140		06/21/04	230			
04/11/01	20		06/29/04	830			
04/16/01	20		07/06/04	1600			
04/18/01	5		07/20/04	90			
04/23/01	70		07/27/04	60			
04/26/01	60		03/31/05	5			
05/01/01	160		04/06/05	5			
05/02/01	100		04/13/05	100			
05/07/01	140		04/20/05	140			
05/09/01	230		04/27/05	210			
05/14/01	100		05/02/05	5			
05/16/01	130		05/11/05	120			
05/21/01	340		05/18/05	110			
05/23/01	140		05/25/05	30			
05/29/01	170		06/01/05	140			
05/30/01	340		06/01/05	10			
06/05/01	130		06/06/05	360			

Maple Creek near Edgeley (385024)

Date	Concentration (CFUs/100mL)		Date	Concentration (CFUs/100mL)
03/06/00	5		03/30/04	90
03/13/00	30		04/06/04	5
03/15/00	30		04/13/04	5
03/20/00	20		04/20/04	5
03/22/00	20		04/27/04	5
03/27/00	5		05/04/04	10
03/29/00	5		05/11/04	530
04/03/00	5		05/18/04	10
04/05/00	10		05/25/04	80
04/10/00	5		06/01/04	210
04/12/00	5		06/08/04	40
04/19/00	5		06/15/04	50
04/26/00	190		06/21/04	10
05/01/00	180		06/29/04	50
05/08/00	400		07/06/04	670
05/15/00	60		07/20/04	220
07/05/00	1600		03/31/05	5
07/10/00	120		04/06/05	5
07/17/00	250		04/13/05	5
07/25/00	210		04/20/05	5
10/30/00	1600		04/27/05	10
03/19/01	5		05/02/05	5
03/21/01	5		05/11/05	10
03/26/01	5		05/18/05	10
03/28/01	40		05/25/05	60
04/04/01	10		06/06/05	350
04/09/01	20		06/09/05	150
04/11/01	5		06/15/05	5
04/16/01	60		06/22/05	5
04/18/01	5		06/29/05	150
04/23/01	20		07/06/05	10
04/26/01	70		07/13/05	90
05/01/01	30		07/18/05	80
05/02/01	20		08/22/05	20
05/07/01	1000		09/06/05	140
05/09/01	100		09/20/05	10
05/14/01	20		03/29/06	5
05/16/01	60		04/05/06	5
05/21/01	180		04/10/06	5
05/23/01	120		04/19/06	120
06/11/01	70		04/26/06	10
06/13/01	340		05/03/06	70
06/18/01	160		05/10/06	40
06/20/01	200		05/17/06	20
08/06/01	830		05/24/06	2400
08/09/01	1600		05/31/06	1400
06/25/02	360		06/07/06	2600
03/15/04	10			
03/23/04	5			

South Fork Maple River (385025)

Date	Concentration (CFUs/100mL)		Date	Concentration (CFUs/100mL)		Date	Concentration (CFUs/100mL)
03/06/00	5		06/05/01	1600		05/25/05	610
03/13/00	20		06/07/01	100		06/01/05	1600
03/15/00	10		06/07/01	700		06/06/05	550
03/20/00	50		06/11/01	1600		06/09/05	1600
03/22/00	110		06/13/01	1600		06/15/05	100
03/27/00	10		06/18/01	930		06/22/05	80
03/29/00	20		06/20/01	1600		06/29/05	1600
04/03/00	20		06/25/01	1600		07/06/05	350
04/05/00	10		07/02/01	1600		07/13/05	1100
04/10/00	10		07/16/01	1600		07/18/05	800
04/12/00	5		07/23/01	1600		08/22/05	430
04/19/00	10		08/09/01	1600		09/06/05	1600
04/26/00	200		08/13/01	1600		09/20/05	340
05/01/00	450		08/15/01	1600		10/04/05	1600
05/08/00	920		10/24/01	10		10/18/05	1600
05/15/00	230		03/13/02	380		03/22/06	5
05/22/00	1300		04/29/02	60		03/29/06	390
05/31/00	1600		05/07/02	1600		04/05/06	210
06/05/00	320		05/08/02	850		04/10/06	80
06/20/00	1600		05/16/02	70		04/19/06	190
06/28/00	1600		09/04/02	1600		04/26/06	240
07/05/00	1600		03/15/04	10		05/03/06	250
07/10/00	820		03/23/04	820		05/10/06	250
07/17/00	670		03/30/04	140		05/17/06	530
07/25/00	1600		04/06/04	40		05/24/06	1700
08/08/00	1600		04/13/04	40		05/31/06	1100
10/30/00	1600		04/20/04	190		06/07/06	3100
03/19/01	110		04/27/04	730		06/14/06	2600
03/21/01	10		05/04/04	450		06/21/06	2100
03/26/01	5		05/11/04	1600		06/28/06	200
03/28/01	20		05/18/04	510		07/05/06	590
04/04/01	30		05/25/04	430			
04/09/01	380		06/01/04	530			
04/11/01	90		06/08/04	1430			
04/16/01	10		06/15/04	280			
04/18/01	5		06/21/04	1600			
04/23/01	5		06/29/04	1600			
04/25/01	30		07/06/04	1600			
05/01/01	50		07/20/04	200			
05/02/01	110		07/27/04	1600			
05/07/01	650		03/31/05	140			
05/09/01	180		04/06/05	5			
05/14/01	120		04/13/05	1600			
05/16/01	260		04/20/05	980			
05/21/01	510		04/27/05	1600			
05/23/01	410		05/02/05	30			
05/29/01	990		05/11/05	450			
05/30/01	480		05/18/05	120			

Maple River near Fullerton (385026)

Date	Concentration (CFUs/100mL)		Date	Concentration (CFUs/100mL)
03/06/00	5		05/29/01	90
03/13/00	10		05/30/01	90
03/15/00	5		06/05/01	370
03/20/00	90		06/07/01	160
03/22/00	120		06/11/01	180
03/27/00	20		06/13/01	220
03/29/00	5		06/18/01	280
04/03/00	10		06/20/01	1600
04/05/00	20		06/25/01	730
04/10/00	5		07/02/01	1600
04/12/00	10		07/09/01	720
04/19/00	5		07/23/01	1600
04/26/00	30		07/30/01	1600
05/01/00	10		08/09/01	1600
05/08/00	740		08/13/01	380
05/15/00	30		08/15/01	1600
05/22/00	100		08/20/01	470
05/31/00	740		08/27/01	1100
06/05/00	950		09/04/01	220
06/20/00	1600		09/10/01	670
06/28/00	1600		10/24/01	10
07/05/00	1600		04/29/02	10
07/10/00	480		05/07/02	20
07/17/00	720		05/08/02	60
07/25/00	70		05/16/02	30
08/08/00	320		05/28/02	130
08/28/00	1600		05/30/02	500
10/30/00	340		06/03/02	380
03/19/01	30		06/11/02	150
03/21/01	190		06/25/02	800
03/26/01	10		07/10/02	1100
03/28/01	20			
04/04/01	10			
04/09/01	350			
04/11/01	80			
04/16/01	30			
04/18/01	40			
04/23/01	10			
04/25/01	30			
04/25/01	20			
05/01/01	10			
05/02/01	10			
05/07/01	440			
05/09/01	330			
05/14/01	30			
05/16/01	90			
05/21/01	1600			
05/23/01	100			

Maple River near Maple Colony (385027)

Date	Concentration (CFUs/100mL)	Date	Concentration (CFUs/100mL)
03/06/00	5	06/07/01	270
03/20/00	140	06/11/01	350
03/22/00	100	06/13/01	530
03/27/00	20	06/18/01	1600
03/29/00	10	06/20/01	140
04/03/00	5	06/25/01	70
04/05/00	5	07/02/01	100
04/10/00	5	07/09/01	60
04/12/00	10	07/16/01	70
04/19/00	5	07/23/01	40
04/26/00	5	07/30/01	1600
05/01/00	20	08/06/01	10
05/08/00	230	08/09/01	1600
05/15/00	80	08/13/01	40
05/22/00	170	08/15/01	30
05/31/00	480	08/20/01	130
06/05/00	190	08/27/01	1600
06/20/00	120	09/04/01	740
06/28/00	40	09/10/01	40
07/05/00	200	10/24/01	5
07/10/00	150	05/08/02	10
07/17/00	160	05/16/02	5
07/25/00	140	05/28/02	10
08/08/00	200	05/30/02	60
08/28/00	20	06/03/02	260
10/30/00	920	06/25/02	430
03/19/01	40	07/10/02	140
03/21/01	90	09/04/02	260
03/26/01	10		
03/28/01	20		
04/04/01	50		
04/09/01	300		
04/11/01	110		
04/16/01	30		
04/18/01	5		
04/23/01	5		
04/25/01	40		
05/01/01	5		
05/02/01	10		
05/07/01	5		
05/09/01	10		
05/14/01	30		
05/16/01	10		
05/21/01	70		
05/23/01	5		
05/29/01	90		
05/30/01	70		
06/05/01	360		

Maple River near ND-SB Border (384216)

Date	Concentration (CFUs/100mL)		Date	Concentration (CFUs/100mL)		Date	Concentration (CFUs/100mL)
03/06/00	5		06/07/01	1600		05/18/05	20
03/13/00	30		06/11/01	150		05/25/05	40
03/15/00	100		06/13/01	440		06/01/05	60
03/20/00	70		06/18/01	70		06/06/05	100
03/22/00	50		06/20/01	200		06/09/05	260
03/27/00	10		06/25/01	230		06/15/05	120
03/29/00	10		07/02/01	80		06/22/05	40
04/03/00	5		07/23/01	160		06/29/05	1600
04/05/00	5		07/30/01	580		07/06/05	140
04/10/00	5		08/13/01	20		07/13/05	110
04/12/00	30		08/15/01	260		07/18/05	40
04/19/00	10		04/29/02	5		08/22/05	30
04/26/00	40		05/07/02	20		09/06/05	30
05/01/00	40		05/08/02	20		09/20/05	40
05/08/00	810		05/16/02	10		10/04/05	120
05/15/00	60		05/28/02	10		10/18/05	20
05/22/00	240		05/30/02	10		03/22/06	5
05/31/00	310		06/03/02	30		03/29/06	5
06/05/00	430		06/11/02	130		04/05/06	20
06/20/00	700		06/17/02	10		04/10/06	5
06/28/00	220		06/25/02	490		04/19/06	5
07/05/00	1300		03/15/04	10		04/26/06	20
07/10/00	1100		03/23/04	10		05/03/06	20
07/17/00	480		03/30/04	30		05/10/06	50
07/25/00	260		04/06/04	5		05/17/06	120
08/08/00	350		04/13/04	20		05/24/06	420
08/28/00	450		04/20/04	5		05/31/06	800
10/30/00	320		04/27/04	10		06/07/06	230
03/19/01	1600		05/04/04	20		06/14/06	1300
03/21/01	1600		05/11/04	290		06/21/06	4100
03/26/01	10		05/18/04	120		06/28/06	6500
03/28/01	10		05/25/04	300		07/05/06	3700
04/04/01	30		06/01/04	320			
04/09/01	290		06/08/04	120			
04/11/01	5		06/15/04	350			
04/18/01	5		06/21/04	20			
04/23/01	10		06/29/04	170			
04/25/01	80		07/06/04	980			
05/01/01	50		07/20/04	610			
05/02/01	30		07/27/04	350			
05/07/01	160		08/10/04	380			
05/09/01	220		03/31/05	10			
05/16/01	60		04/06/05	5			
05/21/01	90		04/13/05	5			
05/23/01	20		04/20/05	10			
05/29/01	20		04/27/05	10			
05/30/01	10		05/02/05	5			
06/05/01	30		05/11/05	90			

Appendix B
Mean Daily Discharge Data and Flow Duration Curve for the Maple River at the ND-SD Border (USGS Site 06471200) (January 1, 2000 – December 5, 2006)

Maple River near ND-SB Border (384216)

Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)
01/01/00	4.80		02/17/00	2.00		04/04/00	55.00		05/21/00	20.00
01/02/00	4.70		02/18/00	2.10		04/05/00	54.00		05/22/00	20.00
01/03/00	4.60		02/19/00	2.30		04/06/00	49.00		05/23/00	17.00
01/04/00	4.10		02/20/00	2.10		04/07/00	46.00		05/24/00	16.00
01/05/00	4.00		02/21/00	2.00		04/08/00	40.00		05/25/00	13.00
01/06/00	3.80		02/22/00	2.00		04/09/00	39.00		05/26/00	12.00
01/07/00	3.50		02/23/00	2.30		04/10/00	36.00		05/27/00	12.00
01/08/00	3.50		02/24/00	3.70		04/11/00	34.00		05/28/00	12.00
01/09/00	3.40		02/25/00	6.00		04/12/00	31.00		05/29/00	11.00
01/10/00	3.40		02/26/00	9.50		04/13/00	30.00		05/30/00	11.00
01/11/00	3.30		02/27/00	9.30		04/14/00	30.00		05/31/00	10.00
01/12/00	3.50		02/28/00	12.00		04/15/00	29.00		06/01/00	11.00
01/13/00	3.20		02/29/00	16.00		04/16/00	28.00		06/02/00	10.00
01/14/00	3.00		03/01/00	38.00		04/17/00	26.00		06/03/00	10.00
01/15/00	3.00		03/02/00	141.00		04/18/00	26.00		06/04/00	12.00
01/16/00	3.10		03/03/00	207.00		04/19/00	28.00		06/05/00	11.00
01/17/00	2.90		03/04/00	178.00		04/20/00	28.00		06/06/00	10.00
01/18/00	2.80		03/05/00	128.00		04/21/00	28.00		06/07/00	9.80
01/19/00	2.90		03/06/00	94.00		04/22/00	29.00		06/08/00	8.30
01/20/00	2.70		03/07/00	69.00		04/23/00	27.00		06/09/00	7.00
01/21/00	2.70		03/08/00	67.00		04/24/00	27.00		06/10/00	6.90
01/22/00	2.70		03/09/00	30.00		04/25/00	29.00		06/11/00	5.70
01/23/00	2.70		03/10/00	42.00		04/26/00	33.00		06/12/00	4.80
01/24/00	2.40		03/11/00	49.00		04/27/00	36.00		06/13/00	3.70
01/25/00	2.30		03/12/00	40.00		04/28/00	33.00		06/14/00	4.40
01/26/00	2.20		03/13/00	36.00		04/29/00	30.00		06/15/00	4.50
01/27/00	2.00		03/14/00	33.00		04/30/00	31.00		06/16/00	5.10
01/28/00	2.00		03/15/00	30.00		05/01/00	30.00		06/17/00	4.80
01/29/00	2.10		03/16/00	28.00		05/02/00	27.00		06/18/00	4.40
01/30/00	2.00		03/17/00	27.00		05/03/00	28.00		06/19/00	4.00
01/31/00	2.00		03/18/00	29.00		05/04/00	28.00		06/20/00	4.60
02/01/00	1.90		03/19/00	33.00		05/05/00	28.00		06/21/00	4.30
02/02/00	2.20		03/20/00	39.00		05/06/00	32.00		06/22/00	4.20
02/03/00	2.60		03/21/00	46.00		05/07/00	32.00		06/23/00	5.00
02/04/00	2.40		03/22/00	59.00		05/08/00	36.00		06/24/00	4.70
02/05/00	2.30		03/23/00	97.00		05/09/00	31.00		06/25/00	5.00
02/06/00	2.40		03/24/00	160.00		05/10/00	29.00		06/26/00	4.30
02/07/00	2.50		03/25/00	226.00		05/11/00	28.00		06/27/00	4.00
02/08/00	2.60		03/26/00	233.00		05/12/00	25.00		06/28/00	3.90
02/09/00	2.80		03/27/00	220.00		05/13/00	26.00		06/29/00	3.30
02/10/00	2.70		03/28/00	179.00		05/14/00	25.00		06/30/00	3.00
02/11/00	2.40		03/29/00	145.00		05/15/00	27.00		07/01/00	2.80
02/12/00	2.20		03/30/00	120.00		05/16/00	27.00		07/02/00	20.00
02/13/00	2.20		03/31/00	103.00		05/17/00	30.00		07/03/00	12.00
02/14/00	2.00		04/01/00	85.00		05/18/00	26.00		07/04/00	8.40
02/15/00	2.20		04/02/00	75.00		05/19/00	22.00		07/05/00	7.90
02/16/00	2.00		04/03/00	66.00		05/20/00	21.00		07/06/00	5.40

Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
07/07/00	5.00	08/23/00	1.10	10/09/00	0.06	11/25/00	3.30
07/08/00	4.60	08/24/00	0.67	10/10/00	0.06	11/26/00	3.00
07/09/00	4.50	08/25/00	0.60	10/11/00	0.05	11/27/00	2.90
07/10/00	21.00	08/26/00	0.45	10/12/00	0.06	11/28/00	3.00
07/11/00	43.00	08/27/00	0.38	10/13/00	0.08	11/29/00	3.40
07/12/00	66.00	08/28/00	0.41	10/14/00	0.09	11/30/00	3.90
07/13/00	92.00	08/29/00	0.31	10/15/00	0.06	12/01/00	4.00
07/14/00	87.00	08/30/00	0.28	10/16/00	0.06	12/02/00	3.90
07/15/00	70.00	08/31/00	0.67	10/17/00	0.05	12/03/00	3.80
07/16/00	54.00	09/01/00	0.37	10/18/00	0.05	12/04/00	3.80
07/17/00	44.00	09/02/00	0.34	10/19/00	0.05	12/05/00	3.70
07/18/00	47.00	09/03/00	0.36	10/20/00	0.05	12/06/00	3.70
07/19/00	47.00	09/04/00	0.36	10/21/00	0.02	12/07/00	3.60
07/20/00	44.00	09/05/00	0.36	10/22/00	0.02	12/08/00	3.50
07/21/00	39.00	09/06/00	0.38	10/23/00	0.03	12/09/00	3.40
07/22/00	35.00	09/07/00	0.41	10/24/00	0.02	12/10/00	3.20
07/23/00	31.00	09/08/00	0.32	10/25/00	0.02	12/11/00	3.00
07/24/00	28.00	09/09/00	0.29	10/26/00	0.42	12/12/00	2.80
07/25/00	24.00	09/10/00	0.23	10/27/00	0.52	12/13/00	2.60
07/26/00	21.00	09/11/00	0.22	10/28/00	0.38	12/14/00	2.30
07/27/00	17.00	09/12/00	0.14	10/29/00	0.39	12/15/00	2.30
07/28/00	15.00	09/13/00	0.12	10/30/00	0.39	12/16/00	2.50
07/29/00	12.00	09/14/00	0.11	10/31/00	0.42	12/17/00	2.50
07/30/00	11.00	09/15/00	0.07	11/01/00	3.00	12/18/00	2.50
07/31/00	9.60	09/16/00	0.06	11/02/00	2.50	12/19/00	2.20
08/01/00	8.10	09/17/00	0.06	11/03/00	1.60	12/20/00	2.00
08/02/00	5.90	09/18/00	0.05	11/04/00	1.10	12/21/00	1.70
08/03/00	5.70	09/19/00	0.05	11/05/00	1.10	12/22/00	1.40
08/04/00	4.90	09/20/00	0.04	11/06/00	3.50	12/23/00	1.30
08/05/00	5.30	09/21/00	0.03	11/07/00	8.80	12/24/00	1.20
08/06/00	4.90	09/22/00	0.10	11/08/00	6.30	12/25/00	1.10
08/07/00	4.00	09/23/00	0.09	11/09/00	6.00	12/26/00	1.00
08/08/00	3.40	09/24/00	0.06	11/10/00	6.00	12/27/00	0.95
08/09/00	2.50	09/25/00	0.06	11/11/00	6.00	12/28/00	0.95
08/10/00	1.80	09/26/00	0.05	11/12/00	6.50	12/29/00	0.90
08/11/00	1.50	09/27/00	0.04	11/13/00	6.50	12/30/00	0.85
08/12/00	1.50	09/28/00	0.03	11/14/00	6.00	12/31/00	0.85
08/13/00	0.80	09/29/00	0.03	11/15/00	5.60		
08/14/00	1.10	09/30/00	0.02	11/16/00	5.30		
08/15/00	1.10	10/01/00	0.03	11/17/00	4.90		
08/16/00	0.96	10/02/00	0.01	11/18/00	4.50		
08/17/00	1.20	10/03/00	0.01	11/19/00	5.00		
08/18/00	0.89	10/04/00	0.02	11/20/00	4.80		
08/19/00	0.82	10/05/00	0.10	11/21/00	4.50		
08/20/00	1.10	10/06/00	0.08	11/22/00	4.10		
08/21/00	1.50	10/07/00	0.08	11/23/00	3.80		
08/22/00	1.30	10/08/00	0.07	11/24/00	3.60		

Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)
01/01/01	0.85		02/17/01	0.57		04/05/01	185.00		05/22/01	30.00
01/02/01	0.82		02/18/01	0.53		04/06/01	190.00		05/23/01	28.00
01/03/01	0.80		02/19/01	0.58		04/07/01	400.00		05/24/01	24.00
01/04/01	0.85		02/20/01	0.59		04/08/01	700.00		05/25/01	22.00
01/05/01	0.88		02/21/01	0.57		04/09/01	950.00		05/26/01	22.00
01/06/01	0.90		02/22/01	0.52		04/10/01	1370.00		05/27/01	22.00
01/07/01	0.94		02/23/01	0.50		04/11/01	1290.00		05/28/01	22.00
01/08/01	0.95		02/24/01	0.53		04/12/01	779.00		05/29/01	23.00
01/09/01	0.98		02/25/01	0.58		04/13/01	566.00		05/30/01	24.00
01/10/01	1.00		02/26/01	0.55		04/14/01	590.00		05/31/01	22.00
01/11/01	1.00		02/27/01	0.55		04/15/01	582.00		06/01/01	22.00
01/12/01	1.00		02/28/01	0.56		04/16/01	433.00		06/02/01	19.00
01/13/01	0.98		03/01/01	0.57		04/17/01	311.00		06/03/01	17.00
01/14/01	0.95		03/02/01	0.61		04/18/01	233.00		06/04/01	15.00
01/15/01	0.98		03/03/01	0.60		04/19/01	191.00		06/05/01	14.00
01/16/01	0.92		03/04/01	0.58		04/20/01	171.00		06/06/01	14.00
01/17/01	0.93		03/05/01	0.59		04/21/01	158.00		06/07/01	15.00
01/18/01	0.99		03/06/01	0.59		04/22/01	146.00		06/08/01	14.00
01/19/01	1.00		03/07/01	0.58		04/23/01	141.00		06/09/01	13.00
01/20/01	0.93		03/08/01	0.54		04/24/01	141.00		06/10/01	14.00
01/21/01	0.88		03/09/01	0.59		04/25/01	142.00		06/11/01	14.00
01/22/01	0.86		03/10/01	0.66		04/26/01	142.00		06/12/01	14.00
01/23/01	0.86		03/11/01	0.71		04/27/01	143.00		06/13/01	16.00
01/24/01	0.76		03/12/01	0.78		04/28/01	136.00		06/14/01	20.00
01/25/01	0.72		03/13/01	0.99		04/29/01	121.00		06/15/01	31.00
01/26/01	0.77		03/14/01	1.60		04/30/01	113.00		06/16/01	41.00
01/27/01	0.73		03/15/01	2.00		05/01/01	96.00		06/17/01	42.00
01/28/01	0.70		03/16/01	2.50		05/02/01	87.00		06/18/01	39.00
01/29/01	0.68		03/17/01	3.00		05/03/01	78.00		06/19/01	37.00
01/30/01	0.75		03/18/01	3.00		05/04/01	70.00		06/20/01	41.00
01/31/01	0.73		03/19/01	3.50		05/05/01	67.00		06/21/01	43.00
02/01/01	0.70		03/20/01	4.00		05/06/01	72.00		06/22/01	40.00
02/02/01	0.60		03/21/01	5.50		05/07/01	77.00		06/23/01	36.00
02/03/01	0.60		03/22/01	13.00		05/08/01	77.00		06/24/01	33.00
02/04/01	0.64		03/23/01	20.00		05/09/01	88.00		06/25/01	28.00
02/05/01	0.66		03/24/01	50.00		05/10/01	143.00		06/26/01	24.00
02/06/01	0.66		03/25/01	100.00		05/11/01	165.00		06/27/01	19.00
02/07/01	0.71		03/26/01	500.00		05/12/01	146.00		06/28/01	17.00
02/08/01	0.77		03/27/01	420.00		05/13/01	127.00		06/29/01	15.00
02/09/01	0.73		03/28/01	380.00		05/14/01	106.00		06/30/01	14.00
02/10/01	0.64		03/29/01	360.00		05/15/01	85.00		07/01/01	11.00
02/11/01	0.61		03/30/01	320.00		05/16/01	70.00		07/02/01	10.00
02/12/01	0.63		03/31/01	280.00		05/17/01	55.00		07/03/01	9.10
02/13/01	0.67		04/01/01	240.00		05/18/01	45.00		07/04/01	8.30
02/14/01	0.62		04/02/01	210.00		05/19/01	40.00		07/05/01	7.30
02/15/01	0.62		04/03/01	200.00		05/20/01	36.00		07/06/01	7.00
02/16/01	0.60		04/04/01	190.00		05/21/01	33.00		07/07/01	6.70

Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
07/08/01	6.00	08/24/01	1.20	10/10/01	0.00	11/26/01	0.00
07/09/01	5.80	08/25/01	0.99	10/11/01	0.00	11/27/01	0.00
07/10/01	5.30	08/26/01	0.76	10/12/01	0.00	11/28/01	0.00
07/11/01	4.70	08/27/01	0.54	10/13/01	0.00	11/29/01	0.00
07/12/01	4.00	08/28/01	0.42	10/14/01	0.00	11/30/01	0.00
07/13/01	2.30	08/29/01	0.38	10/15/01	0.00	12/01/01	0.00
07/14/01	1.60	08/30/01	0.31	10/16/01	0.00	12/02/01	0.00
07/15/01	2.10	08/31/01	0.20	10/17/01	0.00	12/03/01	0.00
07/16/01	2.40	09/01/01	0.11	10/18/01	0.00	12/04/01	0.00
07/17/01	2.30	09/02/01	0.11	10/19/01	0.00	12/05/01	0.00
07/18/01	2.20	09/03/01	0.08	10/20/01	0.00	12/06/01	0.00
07/19/01	2.40	09/04/01	0.04	10/21/01	0.00	12/07/01	0.00
07/20/01	3.00	09/05/01	0.01	10/22/01	0.00	12/08/01	0.00
07/21/01	3.30	09/06/01	0.00	10/23/01	0.00	12/09/01	0.18
07/22/01	3.80	09/07/01	0.00	10/24/01	0.00	12/10/01	2.30
07/23/01	4.20	09/08/01	0.00	10/25/01	0.00	12/11/01	2.50
07/24/01	3.30	09/09/01	0.00	10/26/01	0.00	12/12/01	2.20
07/25/01	2.70	09/10/01	0.00	10/27/01	0.00	12/13/01	2.00
07/26/01	3.30	09/11/01	0.00	10/28/01	0.00	12/14/01	1.80
07/27/01	5.10	09/12/01	0.00	10/29/01	0.00	12/15/01	1.60
07/28/01	6.30	09/13/01	0.00	10/30/01	0.00	12/16/01	1.60
07/29/01	7.60	09/14/01	0.00	10/31/01	0.00	12/17/01	1.50
07/30/01	9.80	09/15/01	0.00	11/01/01	0.00	12/18/01	1.60
07/31/01	7.80	09/16/01	0.00	11/02/01	0.00	12/19/01	1.40
08/01/01	6.30	09/17/01	0.00	11/03/01	0.00	12/20/01	1.30
08/02/01	5.70	09/18/01	0.00	11/04/01	0.00	12/21/01	1.20
08/03/01	5.40	09/19/01	0.00	11/05/01	0.00	12/22/01	1.20
08/04/01	4.00	09/20/01	0.02	11/06/01	0.00	12/23/01	1.10
08/05/01	2.80	09/21/01	0.01	11/07/01	0.00	12/24/01	1.10
08/06/01	2.10	09/22/01	0.01	11/08/01	0.00	12/25/01	1.10
08/07/01	1.60	09/23/01	0.00	11/09/01	0.00	12/26/01	1.10
08/08/01	1.30	09/24/01	0.00	11/10/01	0.00	12/27/01	1.10
08/09/01	1.20	09/25/01	0.00	11/11/01	0.00	12/28/01	1.10
08/10/01	0.88	09/26/01	0.00	11/12/01	0.00	12/29/01	1.00
08/11/01	1.10	09/27/01	0.00	11/13/01	0.00	12/30/01	1.00
08/12/01	1.70	09/28/01	0.00	11/14/01	0.00	12/31/01	0.99
08/13/01	1.80	09/29/01	0.00	11/15/01	0.00		
08/14/01	1.80	09/30/01	0.00	11/16/01	0.00		
08/15/01	2.00	10/01/01	0.00	11/17/01	0.00		
08/16/01	1.30	10/02/01	0.00	11/18/01	0.00		
08/17/01	1.20	10/03/01	0.00	11/19/01	0.00		
08/18/01	1.10	10/04/01	0.00	11/20/01	0.00		
08/19/01	1.10	10/05/01	0.00	11/21/01	0.00		
08/20/01	1.80	10/06/01	0.00	11/22/01	0.00		
08/21/01	2.20	10/07/01	0.00	11/23/01	0.00		
08/22/01	1.80	10/08/01	0.00	11/24/01	0.00		
08/23/01	1.40	10/09/01	0.00	11/25/01	0.00		

Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)
01/01/02	0.94		02/17/02	2.10		04/05/02	3.20		05/22/02	5.20
01/02/02	0.88		02/18/02	2.50		04/06/02	2.80		05/23/02	6.30
01/03/02	0.84		02/19/02	2.80		04/07/02	3.70		05/24/02	5.30
01/04/02	0.80		02/20/02	3.00		04/08/02	3.20		05/25/02	5.20
01/05/02	0.83		02/21/02	2.90		04/09/02	2.90		05/26/02	4.50
01/06/02	0.85		02/22/02	2.70		04/10/02	3.50		05/27/02	3.80
01/07/02	0.81		02/23/02	2.90		04/11/02	3.10		05/28/02	3.20
01/08/02	0.86		02/24/02	2.70		04/12/02	3.30		05/29/02	2.80
01/09/02	1.10		02/25/02	2.50		04/13/02	3.40		05/30/02	2.20
01/10/02	1.10		02/26/02	2.30		04/14/02	4.40		05/31/02	1.50
01/11/02	1.20		02/27/02	2.10		04/15/02	6.40		06/01/02	1.30
01/12/02	1.30		02/28/02	2.00		04/16/02	5.90		06/02/02	1.20
01/13/02	1.50		03/01/02	1.90		04/17/02	5.70		06/03/02	1.00
01/14/02	1.70		03/02/02	1.80		04/18/02	7.80		06/04/02	0.86
01/15/02	1.70		03/03/02	1.70		04/19/02	6.60		06/05/02	0.66
01/16/02	1.70		03/04/02	1.60		04/20/02	6.70		06/06/02	0.52
01/17/02	1.70		03/05/02	1.60		04/21/02	7.00		06/07/02	0.48
01/18/02	1.60		03/06/02	1.60		04/22/02	6.50		06/08/02	0.33
01/19/02	1.60		03/07/02	1.50		04/23/02	7.20		06/09/02	0.25
01/20/02	1.60		03/08/02	1.50		04/24/02	8.00		06/10/02	0.27
01/21/02	1.60		03/09/02	1.40		04/25/02	7.30		06/11/02	0.27
01/22/02	1.60		03/10/02	1.40		04/26/02	7.10		06/12/02	0.21
01/23/02	1.50		03/11/02	1.50		04/27/02	9.40		06/13/02	0.23
01/24/02	1.50		03/12/02	1.70		04/28/02	9.40		06/14/02	0.19
01/25/02	1.50		03/13/02	2.00		04/29/02	9.70		06/15/02	0.15
01/26/02	1.50		03/14/02	2.00		04/30/02	9.40		06/16/02	0.11
01/27/02	1.40		03/15/02	2.10		05/01/02	9.00		06/17/02	0.09
01/28/02	1.30		03/16/02	2.50		05/02/02	7.80		06/18/02	0.07
01/29/02	1.10		03/17/02	2.70		05/03/02	6.10		06/19/02	0.31
01/30/02	1.00		03/18/02	3.10		05/04/02	7.60		06/20/02	0.46
01/31/02	0.95		03/19/02	3.50		05/05/02	7.00		06/21/02	0.36
02/01/02	0.90		03/20/02	4.20		05/06/02	7.40		06/22/02	0.31
02/02/02	0.90		03/21/02	4.30		05/07/02	7.10		06/23/02	0.45
02/03/02	0.90		03/22/02	4.20		05/08/02	9.10		06/24/02	7.50
02/04/02	0.90		03/23/02	4.50		05/09/02	9.50		06/25/02	18.00
02/05/02	0.90		03/24/02	4.50		05/10/02	9.10		06/26/02	12.00
02/06/02	0.90		03/25/02	4.10		05/11/02	9.60		06/27/02	6.90
02/07/02	0.95		03/26/02	3.90		05/12/02	9.70		06/28/02	3.30
02/08/02	1.00		03/27/02	3.90		05/13/02	10.00		06/29/02	2.00
02/09/02	1.20		03/28/02	4.30		05/14/02	9.30		06/30/02	1.40
02/10/02	1.40		03/29/02	4.30		05/15/02	10.00		07/01/02	0.93
02/11/02	1.80		03/30/02	4.30		05/16/02	10.00		07/02/02	0.76
02/12/02	1.80		03/31/02	3.80		05/17/02	9.80		07/03/02	0.61
02/13/02	1.90		04/01/02	3.40		05/18/02	9.50		07/04/02	0.39
02/14/02	1.90		04/02/02	3.70		05/19/02	8.60		07/05/02	0.25
02/15/02	1.90		04/03/02	3.40		05/20/02	7.40		07/06/02	0.20
02/16/02	1.90		04/04/02	3.40		05/21/02	5.10		07/07/02	0.22

Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
07/08/02	0.20	08/24/02	0.00	10/10/02	0.00	11/26/02	0.00
07/09/02	0.13	08/25/02	0.00	10/11/02	0.00	11/27/02	0.00
07/10/02	0.19	08/26/02	0.00	10/12/02	0.00	11/28/02	0.00
07/11/02	0.10	08/27/02	0.00	10/13/02	0.00	11/29/02	0.00
07/12/02	0.07	08/28/02	0.00	10/14/02	0.00	11/30/02	0.00
07/13/02	0.04	08/29/02	0.00	10/15/02	0.00	12/01/02	0.00
07/14/02	0.00	08/30/02	0.00	10/16/02	0.00	12/02/02	0.00
07/15/02	0.00	08/31/02	0.00	10/17/02	0.00	12/03/02	0.00
07/16/02	0.00	09/01/02	0.26	10/18/02	0.00	12/04/02	0.00
07/17/02	0.00	09/02/02	0.23	10/19/02	0.00	12/05/02	0.00
07/18/02	0.00	09/03/02	0.10	10/20/02	0.00	12/06/02	0.00
07/19/02	0.00	09/04/02	0.05	10/21/02	0.00	12/07/02	0.00
07/20/02	0.00	09/05/02	0.03	10/22/02	0.00	12/08/02	0.00
07/21/02	0.00	09/06/02	0.02	10/23/02	0.00	12/09/02	0.00
07/22/02	0.00	09/07/02	0.00	10/24/02	0.00	12/10/02	0.00
07/23/02	0.00	09/08/02	0.00	10/25/02	0.00	12/11/02	0.00
07/24/02	0.00	09/09/02	0.00	10/26/02	0.00	12/12/02	0.00
07/25/02	0.00	09/10/02	0.00	10/27/02	0.00	12/13/02	0.00
07/26/02	0.00	09/11/02	0.00	10/28/02	0.00	12/14/02	0.00
07/27/02	0.00	09/12/02	0.00	10/29/02	0.00	12/15/02	0.00
07/28/02	0.00	09/13/02	0.00	10/30/02	0.00	12/16/02	0.00
07/29/02	0.00	09/14/02	0.00	10/31/02	0.00	12/17/02	0.00
07/30/02	0.00	09/15/02	0.00	11/01/02	0.00	12/18/02	0.00
07/31/02	0.38	09/16/02	0.00	11/02/02	0.00	12/19/02	0.00
08/01/02	0.31	09/17/02	0.00	11/03/02	0.00	12/20/02	0.00
08/02/02	0.12	09/18/02	0.00	11/04/02	0.00	12/21/02	0.00
08/03/02	0.09	09/19/02	0.00	11/05/02	0.00	12/22/02	0.00
08/04/02	0.08	09/20/02	0.00	11/06/02	0.00	12/23/02	0.00
08/05/02	0.04	09/21/02	0.00	11/07/02	0.00	12/24/02	0.00
08/06/02	0.01	09/22/02	0.00	11/08/02	0.00	12/25/02	0.00
08/07/02	0.00	09/23/02	0.00	11/09/02	0.00	12/26/02	0.00
08/08/02	0.00	09/24/02	0.00	11/10/02	0.00	12/27/02	0.00
08/09/02	0.00	09/25/02	0.00	11/11/02	0.00	12/28/02	0.00
08/10/02	0.00	09/26/02	0.00	11/12/02	0.00	12/29/02	0.00
08/11/02	0.00	09/27/02	0.00	11/13/02	0.00	12/30/02	0.00
08/12/02	0.00	09/28/02	0.00	11/14/02	0.00	12/31/02	0.00
08/13/02	0.00	09/29/02	0.00	11/15/02	0.00		
08/14/02	0.00	09/30/02	0.00	11/16/02	0.00		
08/15/02	0.00	10/01/02	0.00	11/17/02	0.00		
08/16/02	0.00	10/02/02	0.00	11/18/02	0.00		
08/17/02	0.00	10/03/02	0.00	11/19/02	0.00		
08/18/02	0.00	10/04/02	0.00	11/20/02	0.00		
08/19/02	0.00	10/05/02	0.00	11/21/02	0.00		
08/20/02	0.00	10/06/02	0.00	11/22/02	0.00		
08/21/02	0.00	10/07/02	0.00	11/23/02	0.00		
08/22/02	0.00	10/08/02	0.00	11/24/02	0.00		
08/23/02	0.00	10/09/02	0.00	11/25/02	0.00		

Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)
01/01/03	0.00		02/17/03	0.00		04/05/03	1.10		05/22/03	169.00
01/02/03	0.00		02/18/03	0.00		04/06/03	0.84		05/23/03	148.00
01/03/03	0.00		02/19/03	0.00		04/07/03	0.69		05/24/03	119.00
01/04/03	0.00		02/20/03	0.00		04/08/03	0.47		05/25/03	90.00
01/05/03	0.00		02/21/03	0.00		04/09/03	0.36		05/26/03	71.00
01/06/03	0.00		02/22/03	0.00		04/10/03	0.44		05/27/03	59.00
01/07/03	0.00		02/23/03	0.00		04/11/03	0.34		05/28/03	52.00
01/08/03	0.00		02/24/03	0.00		04/12/03	0.25		05/29/03	43.00
01/09/03	0.00		02/25/03	0.00		04/13/03	0.17		05/30/03	39.00
01/10/03	0.00		02/26/03	0.00		04/14/03	0.21		05/31/03	31.00
01/11/03	0.00		02/27/03	0.00		04/15/03	0.15		06/01/03	27.00
01/12/03	0.00		02/28/03	0.00		04/16/03	0.50		06/02/03	26.00
01/13/03	0.00		03/01/03	0.00		04/17/03	0.42		06/03/03	23.00
01/14/03	0.00		03/02/03	0.00		04/18/03	0.32		06/04/03	22.00
01/15/03	0.00		03/03/03	0.00		04/19/03	0.42		06/05/03	20.00
01/16/03	0.00		03/04/03	0.00		04/20/03	0.59		06/06/03	20.00
01/17/03	0.00		03/05/03	0.00		04/21/03	0.67		06/07/03	19.00
01/18/03	0.00		03/06/03	0.00		04/22/03	0.92		06/08/03	19.00
01/19/03	0.00		03/07/03	0.00		04/23/03	0.90		06/09/03	18.00
01/20/03	0.00		03/08/03	0.00		04/24/03	0.77		06/10/03	20.00
01/21/03	0.00		03/09/03	0.00		04/25/03	0.51		06/11/03	20.00
01/22/03	0.00		03/10/03	0.00		04/26/03	0.28		06/12/03	26.00
01/23/03	0.00		03/11/03	0.00		04/27/03	0.26		06/13/03	29.00
01/24/03	0.00		03/12/03	0.00		04/28/03	0.21		06/14/03	34.00
01/25/03	0.00		03/13/03	0.00		04/29/03	0.27		06/15/03	38.00
01/26/03	0.00		03/14/03	0.50		04/30/03	0.31		06/16/03	47.00
01/27/03	0.00		03/15/03	1.00		05/01/03	0.30		06/17/03	108.00
01/28/03	0.00		03/16/03	0.96		05/02/03	0.27		06/18/03	137.00
01/29/03	0.00		03/17/03	0.92		05/03/03	0.25		06/19/03	124.00
01/30/03	0.00		03/18/03	0.84		05/04/03	1.10		06/20/03	101.00
01/31/03	0.00		03/19/03	0.47		05/05/03	2.70		06/21/03	84.00
02/01/03	0.00		03/20/03	0.03		05/06/03	8.20		06/22/03	78.00
02/02/03	0.00		03/21/03	0.00		05/07/03	6.60		06/23/03	68.00
02/03/03	0.00		03/22/03	0.00		05/08/03	7.10		06/24/03	61.00
02/04/03	0.00		03/23/03	0.00		05/09/03	32.00		06/25/03	54.00
02/05/03	0.00		03/24/03	0.00		05/10/03	52.00		06/26/03	52.00
02/06/03	0.00		03/25/03	0.00		05/11/03	49.00		06/27/03	57.00
02/07/03	0.00		03/26/03	0.00		05/12/03	45.00		06/28/03	65.00
02/08/03	0.00		03/27/03	0.00		05/13/03	52.00		06/29/03	70.00
02/09/03	0.00		03/28/03	0.00		05/14/03	61.00		06/30/03	70.00
02/10/03	0.00		03/29/03	0.00		05/15/03	59.00		07/01/03	63.00
02/11/03	0.00		03/30/03	0.00		05/16/03	68.00		07/02/03	54.00
02/12/03	0.00		03/31/03	0.00		05/17/03	95.00		07/03/03	45.00
02/13/03	0.00		04/01/03	1.20		05/18/03	128.00		07/04/03	40.00
02/14/03	0.00		04/02/03	2.40		05/19/03	142.00		07/05/03	35.00
02/15/03	0.00		04/03/03	1.80		05/20/03	148.00		07/06/03	32.00
02/16/03	0.00		04/04/03	1.30		05/21/03	161.00		07/07/03	30.00

Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
07/08/03	31.00	08/24/03	0.06	10/10/03	0.00	11/26/03	0.00
07/09/03	33.00	08/25/03	0.04	10/11/03	0.00	11/27/03	0.00
07/10/03	30.00	08/26/03	0.03	10/12/03	0.00	11/28/03	0.00
07/11/03	27.00	08/27/03	0.01	10/13/03	0.00	11/29/03	0.00
07/12/03	26.00	08/28/03	0.00	10/14/03	0.00	11/30/03	0.00
07/13/03	24.00	08/29/03	0.00	10/15/03	0.00	12/01/03	0.00
07/14/03	24.00	08/30/03	0.00	10/16/03	0.00	12/02/03	0.00
07/15/03	23.00	08/31/03	0.00	10/17/03	0.00	12/03/03	0.00
07/16/03	21.00	09/01/03	0.00	10/18/03	0.00	12/04/03	0.00
07/17/03	19.00	09/02/03	0.00	10/19/03	0.00	12/05/03	0.00
07/18/03	17.00	09/03/03	0.00	10/20/03	0.00	12/06/03	0.00
07/19/03	16.00	09/04/03	0.00	10/21/03	0.00	12/07/03	0.00
07/20/03	14.00	09/05/03	0.00	10/22/03	0.00	12/08/03	0.00
07/21/03	13.00	09/06/03	0.00	10/23/03	0.00	12/09/03	0.00
07/22/03	13.00	09/07/03	0.00	10/24/03	0.00	12/10/03	0.00
07/23/03	12.00	09/08/03	0.00	10/25/03	0.00	12/11/03	0.00
07/24/03	11.00	09/09/03	0.00	10/26/03	0.00	12/12/03	0.00
07/25/03	9.50	09/10/03	0.00	10/27/03	0.00	12/13/03	0.00
07/26/03	8.30	09/11/03	0.00	10/28/03	0.00	12/14/03	0.00
07/27/03	7.10	09/12/03	0.00	10/29/03	0.00	12/15/03	0.00
07/28/03	6.30	09/13/03	0.00	10/30/03	0.00	12/16/03	0.00
07/29/03	5.70	09/14/03	0.00	10/31/03	0.00	12/17/03	0.00
07/30/03	4.10	09/15/03	0.00	11/01/03	0.00	12/18/03	0.00
07/31/03	3.40	09/16/03	0.00	11/02/03	0.00	12/19/03	0.00
08/01/03	2.70	09/17/03	0.00	11/03/03	0.00	12/20/03	0.00
08/02/03	2.10	09/18/03	0.00	11/04/03	0.00	12/21/03	0.00
08/03/03	1.50	09/19/03	0.00	11/05/03	0.00	12/22/03	0.00
08/04/03	1.10	09/20/03	0.00	11/06/03	0.00	12/23/03	0.00
08/05/03	0.77	09/21/03	0.00	11/07/03	0.00	12/24/03	0.00
08/06/03	0.58	09/22/03	0.00	11/08/03	0.00	12/25/03	0.00
08/07/03	0.43	09/23/03	0.00	11/09/03	0.00	12/26/03	0.00
08/08/03	0.37	09/24/03	0.00	11/10/03	0.00	12/27/03	0.00
08/09/03	0.51	09/25/03	0.00	11/11/03	0.00	12/28/03	0.00
08/10/03	0.60	09/26/03	0.00	11/12/03	0.00	12/29/03	0.00
08/11/03	0.43	09/27/03	0.00	11/13/03	0.00	12/30/03	0.00
08/12/03	0.32	09/28/03	0.00	11/14/03	0.00	12/31/03	0.00
08/13/03	0.24	09/29/03	0.00	11/15/03	0.00		
08/14/03	0.21	09/30/03	0.00	11/16/03	0.00		
08/15/03	0.23	10/01/03	0.00	11/17/03	0.00		
08/16/03	0.23	10/02/03	0.00	11/18/03	0.00		
08/17/03	0.17	10/03/03	0.00	11/19/03	0.00		
08/18/03	0.15	10/04/03	0.00	11/20/03	0.00		
08/19/03	0.13	10/05/03	0.00	11/21/03	0.00		
08/20/03	0.11	10/06/03	0.00	11/22/03	0.00		
08/21/03	0.11	10/07/03	0.00	11/23/03	0.00		
08/22/03	0.07	10/08/03	0.00	11/24/03	0.00		
08/23/03	0.05	10/09/03	0.00	11/25/03	0.00		

Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)
01/01/04	0.00		02/17/04	0.00		04/04/04	88.00		05/21/04	6.70
01/02/04	0.00		02/18/04	0.00		04/05/04	70.00		05/22/04	6.70
01/03/04	0.00		02/19/04	0.00		04/06/04	55.00		05/23/04	6.40
01/04/04	0.00		02/20/04	0.00		04/07/04	46.00		05/24/04	6.50
01/05/04	0.00		02/21/04	0.00		04/08/04	37.00		05/25/04	6.90
01/06/04	0.00		02/22/04	0.00		04/09/04	42.00		05/26/04	6.30
01/07/04	0.00		02/23/04	0.00		04/10/04	37.00		05/27/04	6.10
01/08/04	0.00		02/24/04	0.00		04/11/04	27.00		05/28/04	5.20
01/09/04	0.00		02/25/04	0.00		04/12/04	22.00		05/29/04	5.30
01/10/04	0.00		02/26/04	0.01		04/13/04	20.00		05/30/04	8.60
01/11/04	0.00		02/27/04	0.06		04/14/04	19.00		05/31/04	21.00
01/12/04	0.00		02/28/04	0.16		04/15/04	17.00		06/01/04	37.00
01/13/04	0.00		02/29/04	0.33		04/16/04	16.00		06/02/04	25.00
01/14/04	0.00		03/01/04	0.71		04/17/04	16.00		06/03/04	19.00
01/15/04	0.00		03/02/04	0.98		04/18/04	15.00		06/04/04	31.00
01/16/04	0.00		03/03/04	1.20		04/19/04	13.00		06/05/04	66.00
01/17/04	0.00		03/04/04	1.50		04/20/04	13.00		06/06/04	65.00
01/18/04	0.00		03/05/04	2.10		04/21/04	12.00		06/07/04	56.00
01/19/04	0.00		03/06/04	3.00		04/22/04	12.00		06/08/04	48.00
01/20/04	0.00		03/07/04	4.70		04/23/04	11.00		06/09/04	41.00
01/21/04	0.00		03/08/04	6.90		04/24/04	11.00		06/10/04	38.00
01/22/04	0.00		03/09/04	10.00		04/25/04	11.00		06/11/04	24.00
01/23/04	0.00		03/10/04	15.00		04/26/04	10.00		06/12/04	21.00
01/24/04	0.00		03/11/04	15.00		04/27/04	8.90		06/13/04	21.00
01/25/04	0.00		03/12/04	15.00		04/28/04	9.20		06/14/04	24.00
01/26/04	0.00		03/13/04	16.00		04/29/04	8.70		06/15/04	45.00
01/27/04	0.00		03/14/04	26.00		04/30/04	7.70		06/16/04	77.00
01/28/04	0.00		03/15/04	38.00		05/01/04	7.30		06/17/04	99.00
01/29/04	0.00		03/16/04	41.00		05/02/04	7.20		06/18/04	99.00
01/30/04	0.00		03/17/04	43.00		05/03/04	6.50		06/19/04	78.00
01/31/04	0.00		03/18/04	47.00		05/04/04	6.50		06/20/04	70.00
02/01/04	0.00		03/19/04	44.00		05/05/04	6.40		06/21/04	66.00
02/02/04	0.00		03/20/04	38.00		05/06/04	6.10		06/22/04	56.00
02/03/04	0.00		03/21/04	26.00		05/07/04	5.30		06/23/04	47.00
02/04/04	0.00		03/22/04	33.00		05/08/04	4.90		06/24/04	40.00
02/05/04	0.00		03/23/04	28.00		05/09/04	4.50		06/25/04	35.00
02/06/04	0.00		03/24/04	29.00		05/10/04	4.20		06/26/04	30.00
02/07/04	0.00		03/25/04	28.00		05/11/04	4.50		06/27/04	28.00
02/08/04	0.00		03/26/04	25.00		05/12/04	5.90		06/28/04	25.00
02/09/04	0.00		03/27/04	25.00		05/13/04	5.50		06/29/04	23.00
02/10/04	0.00		03/28/04	29.00		05/14/04	5.80		06/30/04	20.00
02/11/04	0.00		03/29/04	28.00		05/15/04	4.80		07/01/04	17.00
02/12/04	0.00		03/30/04	68.00		05/16/04	5.80		07/02/04	12.00
02/13/04	0.00		03/31/04	316.00		05/17/04	6.30		07/03/04	8.30
02/14/04	0.00		04/01/04	249.00		05/18/04	7.00		07/04/04	5.60
02/15/04	0.00		04/02/04	173.00		05/19/04	7.10		07/05/04	5.20
02/16/04	0.00		04/03/04	122.00		05/20/04	7.60		07/06/04	8.80

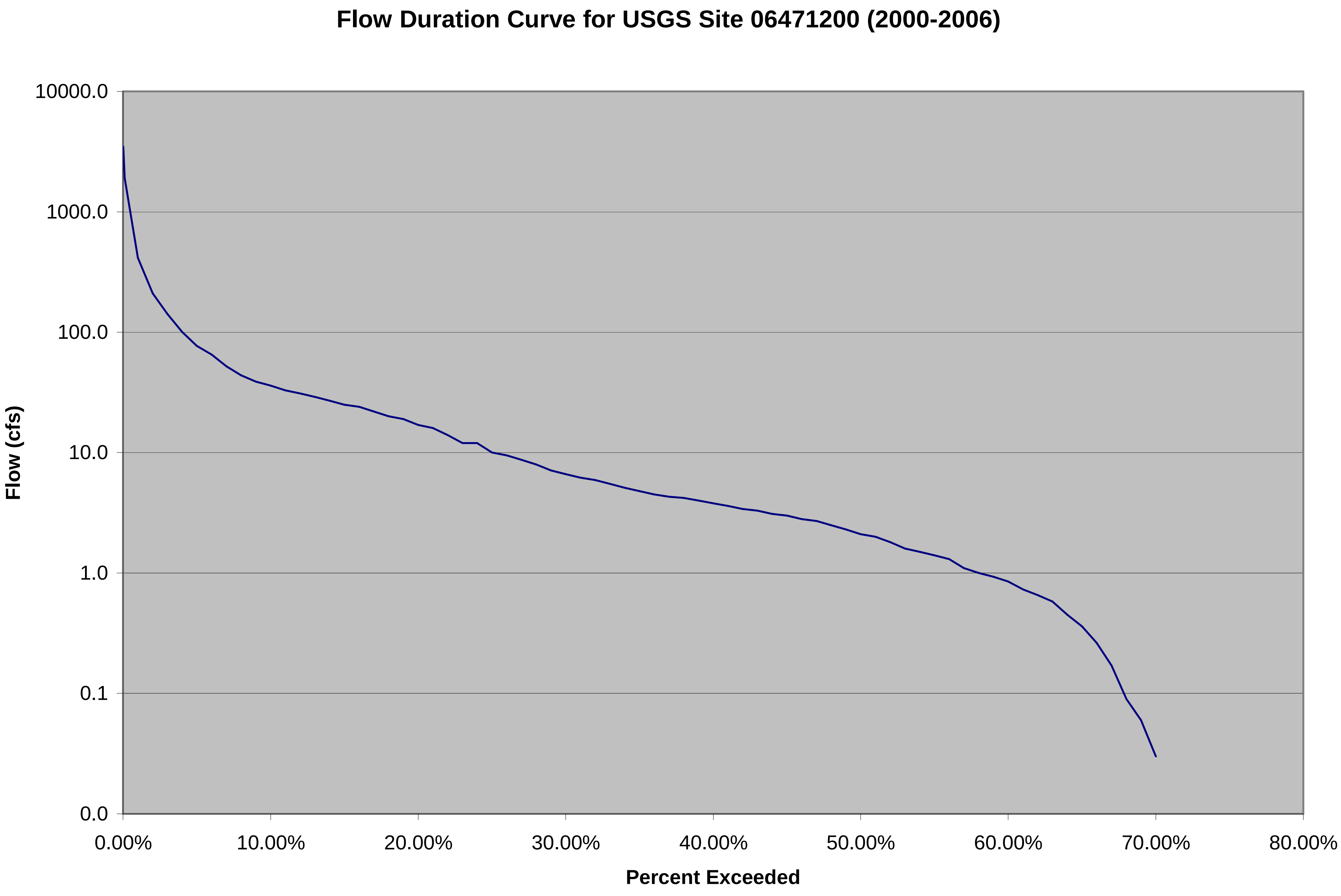
Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)
07/07/04	11.00		08/23/04	0.00		10/09/04	0.00		11/25/04	5.60
07/08/04	9.80		08/24/04	0.00		10/10/04	0.00		11/26/04	5.40
07/09/04	6.90		08/25/04	0.00		10/11/04	0.00		11/27/04	5.00
07/10/04	5.40		08/26/04	0.00		10/12/04	0.00		11/28/04	4.80
07/11/04	4.60		08/27/04	0.00		10/13/04	0.00		11/29/04	4.60
07/12/04	3.80		08/28/04	0.00		10/14/04	0.00		11/30/04	4.40
07/13/04	2.90		08/29/04	0.00		10/15/04	0.00		12/01/04	4.30
07/14/04	3.00		08/30/04	0.00		10/16/04	0.00		12/02/04	4.30
07/15/04	2.60		08/31/04	0.00		10/17/04	0.00		12/03/04	4.30
07/16/04	2.00		09/01/04	0.00		10/18/04	0.00		12/04/04	4.70
07/17/04	1.90		09/02/04	0.00		10/19/04	0.00		12/05/04	4.50
07/18/04	1.50		09/03/04	0.00		10/20/04	0.00		12/06/04	4.30
07/19/04	1.30		09/04/04	0.00		10/21/04	0.00		12/07/04	4.00
07/20/04	1.10		09/05/04	0.00		10/22/04	0.00		12/08/04	3.90
07/21/04	0.97		09/06/04	0.00		10/23/04	0.00		12/09/04	4.10
07/22/04	1.00		09/07/04	0.00		10/24/04	0.00		12/10/04	3.70
07/23/04	0.94		09/08/04	0.00		10/25/04	0.00		12/11/04	3.50
07/24/04	0.79		09/09/04	0.00		10/26/04	0.00		12/12/04	3.70
07/25/04	0.74		09/10/04	0.00		10/27/04	0.00		12/13/04	3.20
07/26/04	0.69		09/11/04	0.00		10/28/04	0.00		12/14/04	3.20
07/27/04	0.59		09/12/04	0.00		10/29/04	0.00		12/15/04	3.40
07/28/04	0.73		09/13/04	0.00		10/30/04	0.00		12/16/04	3.40
07/29/04	0.71		09/14/04	0.00		10/31/04	0.94		12/17/04	3.40
07/30/04	0.68		09/15/04	0.00		11/01/04	5.70		12/18/04	3.30
07/31/04	0.70		09/16/04	0.00		11/02/04	12.00		12/19/04	2.90
08/01/04	0.68		09/17/04	0.00		11/03/04	18.00		12/20/04	2.60
08/02/04	0.67		09/18/04	0.00		11/04/04	31.00		12/21/04	2.50
08/03/04	0.65		09/19/04	0.00		11/05/04	42.00		12/22/04	2.10
08/04/04	0.56		09/20/04	0.00		11/06/04	35.00		12/23/04	1.90
08/05/04	0.43		09/21/04	0.00		11/07/04	28.00		12/24/04	1.70
08/06/04	0.29		09/22/04	0.00		11/08/04	23.00		12/25/04	1.70
08/07/04	0.22		09/23/04	0.00		11/09/04	19.00		12/26/04	1.60
08/08/04	0.17		09/24/04	0.00		11/10/04	18.00		12/27/04	1.50
08/09/04	0.11		09/25/04	0.00		11/11/04	14.00		12/28/04	1.60
08/10/04	0.07		09/26/04	0.00		11/12/04	13.00		12/29/04	1.60
08/11/04	0.04		09/27/04	0.00		11/13/04	11.00		12/30/04	1.70
08/12/04	0.02		09/28/04	0.00		11/14/04	9.90		12/31/04	1.80
08/13/04	0.00		09/29/04	0.00		11/15/04	9.40			
08/14/04	0.00		09/30/04	0.00		11/16/04	8.70			
08/15/04	0.00		10/01/04	0.00		11/17/04	8.10			
08/16/04	0.00		10/02/04	0.00		11/18/04	7.60			
08/17/04	0.00		10/03/04	0.00		11/19/04	7.20			
08/18/04	0.00		10/04/04	0.00		11/20/04	6.90			
08/19/04	0.00		10/05/04	0.00		11/21/04	6.40			
08/20/04	0.00		10/06/04	0.00		11/22/04	6.20			
08/21/04	0.00		10/07/04	0.00		11/23/04	6.00			
08/22/04	0.00		10/08/04	0.00		11/24/04	5.80			

Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
3.00	04/05/05	12.00	05/22/05	33.00	07/08/05	120.00
2.90	04/06/05	12.00	05/23/05	30.00	07/09/05	103.00
2.80	04/07/05	10.00	05/24/05	27.00	07/10/05	87.00
2.70	04/08/05	8.60	05/25/05	25.00	07/11/05	80.00
2.60	04/09/05	8.20	05/26/05	24.00	07/12/05	76.00
2.60	04/10/05	8.60	05/27/05	22.00	07/13/05	66.00
2.50	04/11/05	9.90	05/28/05	21.00	07/14/05	59.00
2.50	04/12/05	10.00	05/29/05	20.00	07/15/05	55.00
2.40	04/13/05	9.80	05/30/05	21.00	07/16/05	49.00
2.40	04/14/05	8.70	05/31/05	21.00	07/17/05	47.00
2.40	04/15/05	9.70	06/01/05	19.00	07/18/05	43.00
2.50	04/16/05	10.00	06/02/05	20.00	07/19/05	38.00
2.90	04/17/05	10.00	06/03/05	24.00	07/20/05	37.00
3.50	04/18/05	9.80	06/04/05	24.00	07/21/05	32.00
4.00	04/19/05	13.00	06/05/05	23.00	07/22/05	28.00
6.00	04/20/05	13.00	06/06/05	21.00	07/23/05	35.00
8.00	04/21/05	12.00	06/07/05	97.00	07/24/05	43.00
8.20	04/22/05	13.00	06/08/05	307.00	07/25/05	73.00
7.00	04/23/05	12.00	06/09/05	695.00	07/26/05	54.00
8.70	04/24/05	12.00	06/10/05	3550.00	07/27/05	60.00
12.00	04/25/05	13.00	06/11/05	3240.00	07/28/05	119.00
17.00	04/26/05	11.00	06/12/05	2250.00	07/29/05	112.00
20.00	04/27/05	9.50	06/13/05	1600.00	07/30/05	94.00
28.00	04/28/05	8.30	06/14/05	1410.00	07/31/05	76.00
34.00	04/29/05	7.60	06/15/05	1290.00	08/01/05	57.00
28.00	04/30/05	7.50	06/16/05	1270.00	08/02/05	43.00
22.00	05/01/05	7.60	06/17/05	1240.00	08/03/05	39.00
20.00	05/02/05	7.10	06/18/05	960.00	08/04/05	30.00
18.00	05/03/05	6.50	06/19/05	672.00	08/05/05	25.00
17.00	05/04/05	5.90	06/20/05	517.00	08/06/05	22.00
16.00	05/05/05	5.80	06/21/05	531.00	08/07/05	20.00
15.00	05/06/05	5.30	06/22/05	466.00	08/08/05	18.00
15.00	05/07/05	5.50	06/23/05	424.00	08/09/05	18.00
14.00	05/08/05	6.40	06/24/05	365.00	08/10/05	16.00
13.00	05/09/05	9.10	06/25/05	309.00	08/11/05	17.00
13.00	05/10/05	11.00	06/26/05	269.00	08/12/05	18.00
12.00	05/11/05	13.00	06/27/05	256.00	08/13/05	19.00
12.00	05/12/05	14.00	06/28/05	211.00	08/14/05	20.00
11.00	05/13/05	24.00	06/29/05	325.00	08/15/05	20.00
11.00	05/14/05	50.00	06/30/05	353.00	08/16/05	19.00
12.00	05/15/05	51.00	07/01/05	282.00	08/17/05	17.00
13.00	05/16/05	44.00	07/02/05	312.00	08/18/05	34.00
13.00	05/17/05	39.00	07/03/05	339.00	08/19/05	39.00
12.00	05/18/05	39.00	07/04/05	265.00	08/20/05	31.00
12.00	05/19/05	40.00	07/05/05	209.00	08/21/05	22.00
12.00	05/20/05	36.00	07/06/05	167.00	08/22/05	19.00
11.00	05/21/05	33.00	07/07/05	141.00	08/23/05	18.00

Date	Flow (cfs)		Date	Flow (cfs)		Date	Flow (cfs)
08/24/05	22.00		10/10/05	5.10		11/26/05	3.20
08/25/05	34.00		10/11/05	5.10		11/27/05	3.20
08/26/05	37.00		10/12/05	5.80		11/28/05	3.10
08/27/05	32.00		10/13/05	6.30		11/29/05	3.00
08/28/05	26.00		10/14/05	6.50		11/30/05	2.90
08/29/05	23.00		10/15/05	6.10		12/01/05	2.90
08/30/05	21.00		10/16/05	5.70		12/02/05	2.80
08/31/05	18.00		10/17/05	5.90		12/03/05	2.70
09/01/05	16.00		10/18/05	6.20		12/04/05	2.70
09/02/05	15.00		10/19/05	5.80		12/05/05	2.60
09/03/05	16.00		10/20/05	5.50		12/06/05	2.70
09/04/05	23.00		10/21/05	5.50		12/07/05	2.70
09/05/05	24.00		10/22/05	5.20		12/08/05	2.60
09/06/05	18.00		10/23/05	4.90		12/09/05	2.90
09/07/05	14.00		10/24/05	4.40		12/10/05	3.10
09/08/05	14.00		10/25/05	4.00		12/11/05	3.30
09/09/05	14.00		10/26/05	3.80		12/12/05	3.60
09/10/05	12.00		10/27/05	3.60		12/13/05	3.60
09/11/05	12.00		10/28/05	3.10		12/14/05	4.00
09/12/05	14.00		10/29/05	3.60		12/15/05	4.20
09/13/05	13.00		10/30/05	3.50		12/16/05	4.40
09/14/05	12.00		10/31/05	3.70		12/17/05	4.40
09/15/05	10.00		11/01/05	3.90		12/18/05	4.30
09/16/05	9.30		11/02/05	3.80		12/19/05	4.20
09/17/05	8.80		11/03/05	3.70		12/20/05	4.20
09/18/05	9.40		11/04/05	3.50		12/21/05	4.20
09/19/05	8.90		11/05/05	3.40		12/22/05	4.30
09/20/05	8.30		11/06/05	3.30		12/23/05	4.30
09/21/05	7.80		11/07/05	3.30		12/24/05	4.30
09/22/05	6.70		11/08/05	3.30		12/25/05	4.40
09/23/05	5.80		11/09/05	3.40		12/26/05	4.40
09/24/05	5.90		11/10/05	3.30		12/27/05	4.50
09/25/05	6.20		11/11/05	3.30		12/28/05	4.50
09/26/05	5.80		11/12/05	3.80		12/29/05	4.60
09/27/05	5.60		11/13/05	3.80		12/30/05	5.00
09/28/05	5.50		11/14/05	3.60		12/31/05	4.90
09/29/05	4.50		11/15/05	3.40			
09/30/05	4.40		11/16/05	3.10			
10/01/05	4.00		11/17/05	2.70			
10/02/05	3.80		11/18/05	2.50			
10/03/05	4.20		11/19/05	2.70			
10/04/05	4.50		11/20/05	2.80			
10/05/05	5.60		11/21/05	3.00			
10/06/05	6.00		11/22/05	3.10			
10/07/05	6.10		11/23/05	3.50			
10/08/05	5.40		11/24/05	2.90			
10/09/05	5.10		11/25/05	3.10			

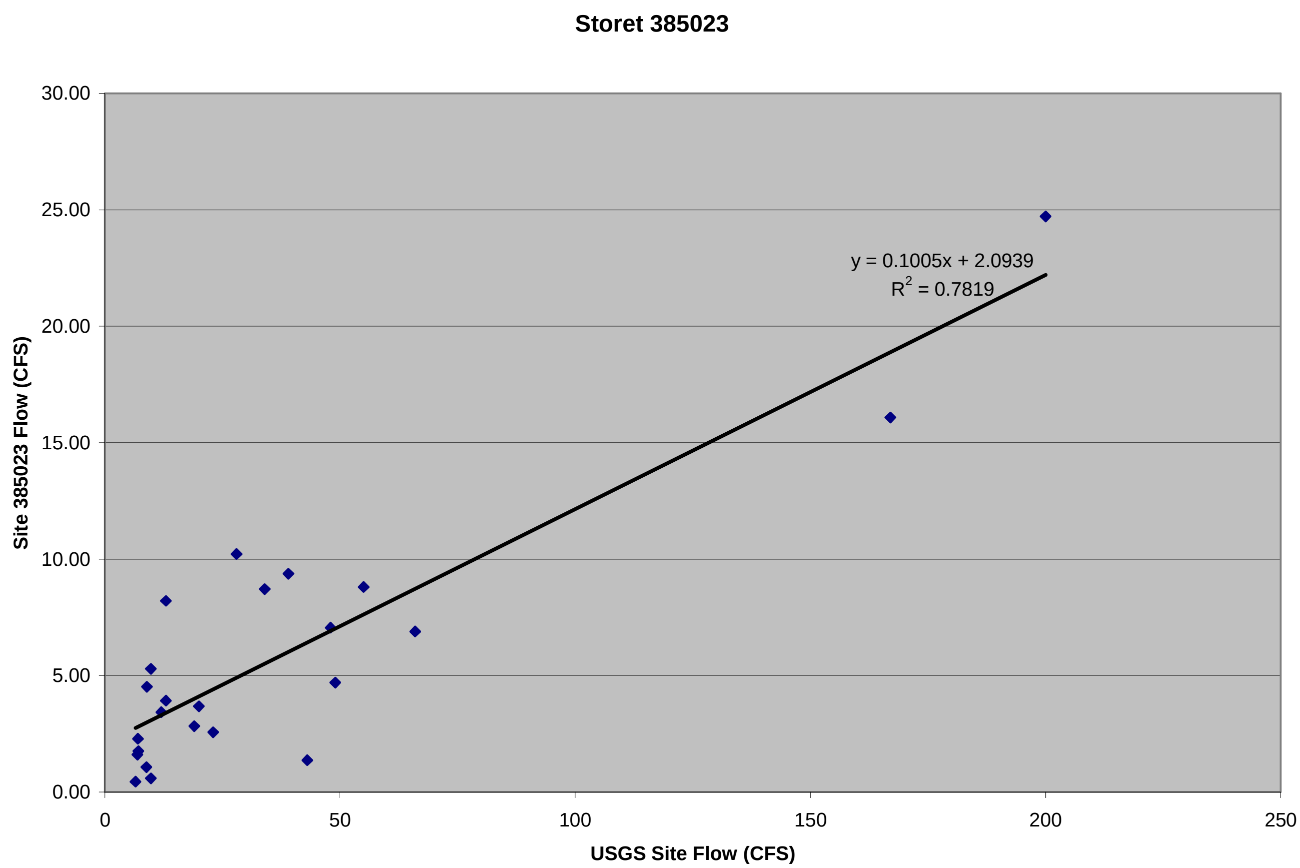
Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
01/01/06	4.90	02/17/06	2.10	04/05/06	32.00	05/22/06	5.70
01/02/06	4.80	02/18/06	1.60	04/06/06	34.00	05/23/06	5.10
01/03/06	4.70	02/19/06	1.40	04/07/06	40.00	05/24/06	6.10
01/04/06	4.50	02/20/06	1.50	04/08/06	32.00	05/25/06	6.50
01/05/06	4.30	02/21/06	1.70	04/09/06	32.00	05/26/06	5.50
01/06/06	4.20	02/22/06	2.20	04/10/06	32.00	05/27/06	4.50
01/07/06	4.30	02/23/06	2.00	04/11/06	31.00	05/28/06	4.00
01/08/06	4.50	02/24/06	2.00	04/12/06	30.00	05/29/06	3.70
01/09/06	4.30	02/25/06	1.80	04/13/06	29.00	05/30/06	3.30
01/10/06	4.30	02/26/06	1.80	04/14/06	27.00	05/31/06	3.10
01/11/06	4.20	02/27/06	1.90	04/15/06	24.00	06/01/06	2.80
01/12/06	4.20	02/28/06	2.20	04/16/06	25.00	06/02/06	2.50
01/13/06	4.10	03/01/06	2.60	04/17/06	21.00	06/03/06	2.10
01/14/06	4.20	03/02/06	2.50	04/18/06	20.00	06/04/06	2.20
01/15/06	4.20	03/03/06	2.50	04/19/06	21.00	06/05/06	2.70
01/16/06	4.30	03/04/06	2.70	04/20/06	21.00	06/06/06	2.90
01/17/06	4.10	03/05/06	3.60	04/21/06	22.00	06/07/06	3.20
01/18/06	4.10	03/06/06	5.60	04/22/06	21.00	06/08/06	3.40
01/19/06	4.10	03/07/06	7.20	04/23/06	20.00	06/09/06	3.20
01/20/06	4.10	03/08/06	10.00	04/24/06	21.00	06/10/06	3.00
01/21/06	4.10	03/09/06	13.00	04/25/06	17.00	06/11/06	3.50
01/22/06	3.70	03/10/06	16.00	04/26/06	16.00	06/12/06	3.50
01/23/06	3.60	03/11/06	24.00	04/27/06	16.00	06/13/06	3.70
01/24/06	3.70	03/12/06	29.00	04/28/06	16.00	06/14/06	4.40
01/25/06	3.70	03/13/06	29.00	04/29/06	16.00	06/15/06	5.20
01/26/06	3.70	03/14/06	34.00	04/30/06	16.00	06/16/06	5.80
01/27/06	4.00	03/15/06	39.00	05/01/06	18.00	06/17/06	6.00
01/28/06	4.20	03/16/06	38.00	05/02/06	19.00	06/18/06	6.30
01/29/06	4.10	03/17/06	39.00	05/03/06	18.00	06/19/06	6.10
01/30/06	4.00	03/18/06	36.00	05/04/06	19.00	06/20/06	6.80
01/31/06	4.30	03/19/06	31.00	05/05/06	19.00	06/21/06	7.90
02/01/06	4.40	03/20/06	26.00	05/06/06	21.00	06/22/06	8.20
02/02/06	4.30	03/21/06	20.00	05/07/06	22.00	06/23/06	8.30
02/03/06	3.90	03/22/06	17.00	05/08/06	25.00	06/24/06	8.60
02/04/06	3.70	03/23/06	18.00	05/09/06	25.00	06/25/06	8.00
02/05/06	3.60	03/24/06	22.00	05/10/06	23.00	06/26/06	5.90
02/06/06	3.40	03/25/06	22.00	05/11/06	21.00	06/27/06	3.80
02/07/06	3.20	03/26/06	24.00	05/12/06	18.00	06/28/06	2.50
02/08/06	3.20	03/27/06	29.00	05/13/06	15.00	06/29/06	1.90
02/09/06	3.10	03/28/06	26.00	05/14/06	14.00	06/30/06	1.60
02/10/06	3.00	03/29/06	25.00	05/15/06	13.00	07/01/06	1.60
02/11/06	3.00	03/30/06	26.00	05/16/06	12.00	07/02/06	1.40
02/12/06	3.00	03/31/06	32.00	05/17/06	11.00	07/03/06	1.10
02/13/06	2.80	04/01/06	30.00	05/18/06	9.00	07/04/06	0.84
02/14/06	2.90	04/02/06	34.00	05/19/06	8.40	07/05/06	0.62
02/15/06	2.90	04/03/06	32.00	05/20/06	7.30	07/06/06	0.36
02/16/06	2.80	04/04/06	31.00	05/21/06	6.40	07/07/06	0.12

Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
07/08/06	0.17	08/24/06	0.00	10/10/06	0.00	11/26/06	0.00
07/09/06	0.06	08/25/06	0.00	10/11/06	0.00	11/27/06	0.00
07/10/06	0.00	08/26/06	0.00	10/12/06	0.00	11/28/06	0.00
07/11/06	0.00	08/27/06	0.00	10/13/06	0.00	11/29/06	0.00
07/12/06	0.00	08/28/06	0.00	10/14/06	0.00	11/30/06	0.00
07/13/06	0.00	08/29/06	0.00	10/15/06	0.00	12/01/06	0.00
07/14/06	0.00	08/30/06	0.00	10/16/06	0.00	12/02/06	0.00
07/15/06	0.00	08/31/06	0.00	10/17/06	0.00	12/03/06	0.00
07/16/06	0.00	09/01/06	0.00	10/18/06	0.00	12/04/06	0.00
07/17/06	0.00	09/02/06	0.00	10/19/06	0.00	12/05/06	0.00
07/18/06	0.00	09/03/06	0.00	10/20/06	0.00		
07/19/06	0.00	09/04/06	0.00	10/21/06	0.00		
07/20/06	0.00	09/05/06	0.00	10/22/06	0.00		
07/21/06	0.00	09/06/06	0.00	10/23/06	0.00		
07/22/06	0.00	09/07/06	0.00	10/24/06	0.00		
07/23/06	0.00	09/08/06	0.00	10/25/06	0.00		
07/24/06	0.00	09/09/06	0.00	10/26/06	0.00		
07/25/06	0.00	09/10/06	0.00	10/27/06	0.00		
07/26/06	0.00	09/11/06	0.00	10/28/06	0.00		
07/27/06	0.00	09/12/06	0.00	10/29/06	0.00		
07/28/06	0.00	09/13/06	0.00	10/30/06	0.00		
07/29/06	0.00	09/14/06	0.00	10/31/06	0.00		
07/30/06	0.00	09/15/06	0.00	11/01/06	0.00		
07/31/06	0.00	09/16/06	0.00	11/02/06	0.00		
08/01/06	0.00	09/17/06	0.00	11/03/06	0.00		
08/02/06	0.00	09/18/06	0.00	11/04/06	0.00		
08/03/06	0.00	09/19/06	0.00	11/05/06	0.00		
08/04/06	0.00	09/20/06	0.00	11/06/06	0.00		
08/05/06	0.00	09/21/06	0.00	11/07/06	0.00		
08/06/06	0.00	09/22/06	0.00	11/08/06	0.00		
08/07/06	0.00	09/23/06	0.00	11/09/06	0.00		
08/08/06	0.00	09/24/06	0.00	11/10/06	0.00		
08/09/06	0.00	09/25/06	0.00	11/11/06	0.00		
08/10/06	0.00	09/26/06	0.00	11/12/06	0.00		
08/11/06	0.00	09/27/06	0.00	11/13/06	0.00		
08/12/06	0.00	09/28/06	0.00	11/14/06	0.00		
08/13/06	0.00	09/29/06	0.00	11/15/06	0.00		
08/14/06	0.00	09/30/06	0.00	11/16/06	0.00		
08/15/06	0.00	10/01/06	0.00	11/17/06	0.00		
08/16/06	0.00	10/02/06	0.00	11/18/06	0.00		
08/17/06	0.00	10/03/06	0.00	11/19/06	0.00		
08/18/06	0.00	10/04/06	0.00	11/20/06	0.00		
08/19/06	0.00	10/05/06	0.00	11/21/06	0.00		
08/20/06	0.00	10/06/06	0.00	11/22/06	0.00		
08/21/06	0.00	10/07/06	0.00	11/23/06	0.00		
08/22/06	0.00	10/08/06	0.00	11/24/06	0.00		
08/23/06	0.00	10/09/06	0.00	11/25/06	0.00		


Flow Duration Curve for USGS Site 06471200 (2000-2006)
10000.0
1000.0
100.0
10.0
1.0
0.1
0.0
Flow (cfs)
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
Percent Exceeded

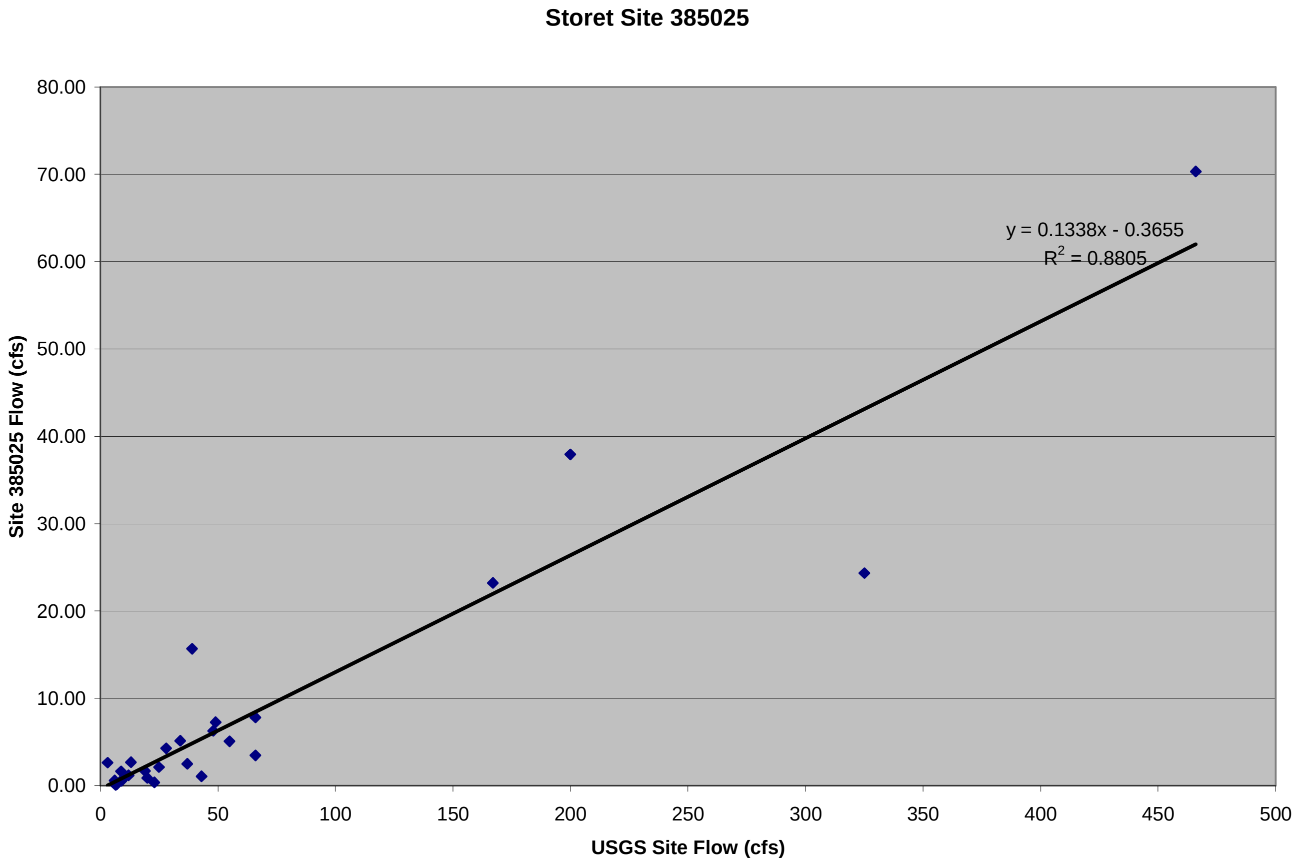
Appendix C
Stream Discharge Measurements and Discharge Regression Relationships for Sites 385023, 385024, 385025, and 385026

Date	Measured Flow (cfs) USGS Site	Site 385023
4/6/2000	49	4.70
4/11/2000	34	8.71
6/7/2000	9.8	0.58
4/3/2001	200	24.71
3/23/2004	28	10.22
4/6/2004	55	8.80
4/13/2004	20	3.68
4/27/2004	8.9	4.52
5/4/2004	6.5	0.44
5/18/2004	7	2.28
5/25/2004	6.9	1.61
6/8/2004	48	7.06
6/21/2004	66	6.89
6/29/2004	23	2.57
7/6/2004	8.8	1.08
4/6/2005	12	3.43
4/13/2005	9.8	5.29
4/20/2005	13	3.92
5/2/2005	7.1	1.76
5/11/2005	13	8.21
5/18/2005	39	9.37
6/1/2005	19	2.83
7/6/2005	167	16.08
7/18/2005	43	1.36



Date	Measured Flow (cfs)	
	USGS Site	Site 385024
4/6/2000	49	5.56
4/3/2001	200	28.88
4/27/2004	8.9	1.43
5/18/2004	7	0.45
5/25/2004	6.9	0.43
4/13/2005	9.8	3.34
4/20/2005	13	3.63
5/11/2005	13	2.37
5/18/2005	39	7.01
7/18/2005	43	1.87

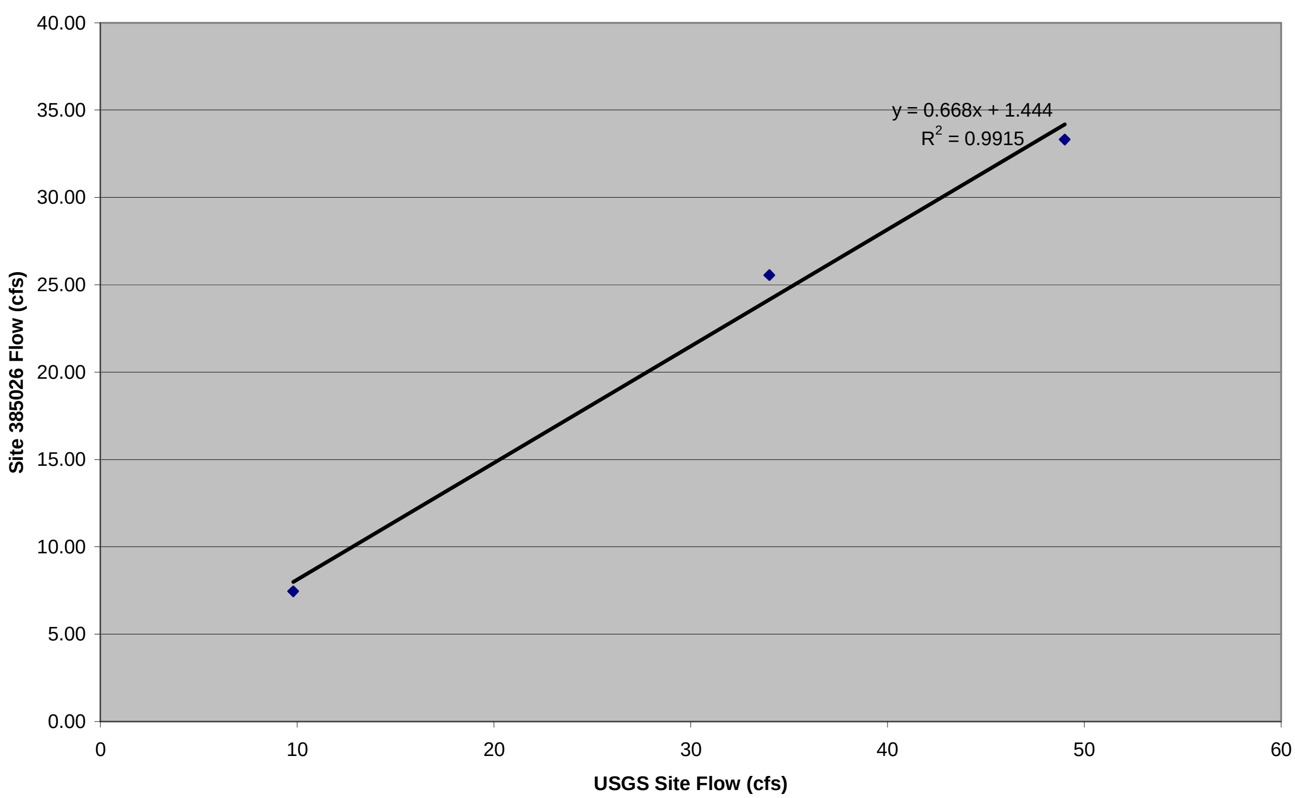
	Measured Flow (cfs)	
Date	USGS Site	Site 385025
4/6/2000	49	7.28
4/11/2000	34	5.15
4/3/2001	200	37.93
3/23/2004	28	4.28
4/6/2004	55	5.08
4/13/2004	20	0.88
4/27/2004	8.9	0.56
4/27/2004	8.9	0.56
5/4/2004	6.5	0.09
5/18/2004	7	0.22
5/25/2004	6.9	0.17
6/1/2004	37	2.50
6/8/2004	48	6.27
6/21/2004	66	7.81
6/29/2004	23	0.39
7/6/2004	8.8	1.65
4/6/2005	12	1.18
4/13/2005	9.8	0.86
4/20/2005	13	2.69
5/2/2005	7.1	0.23
5/18/2005	39	15.70
5/25/2005	25	2.14
6/1/2005	19	1.70
6/22/2005	466	70.32
6/29/2005	325	24.35
7/6/2005	167	23.20
7/13/2005	66	3.48
7/18/2005	43	1.07
5/24/2006	6.1	0.61
5/31/2006	3.1	2.63



Storet Site 385025
y = 0.1338x - 0.3655
R2 = 0.8805
Site 385025 Flow (cfs)
USGS Site Flow (cfs)
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
50
100
150
200
250
300
350
400
450
500

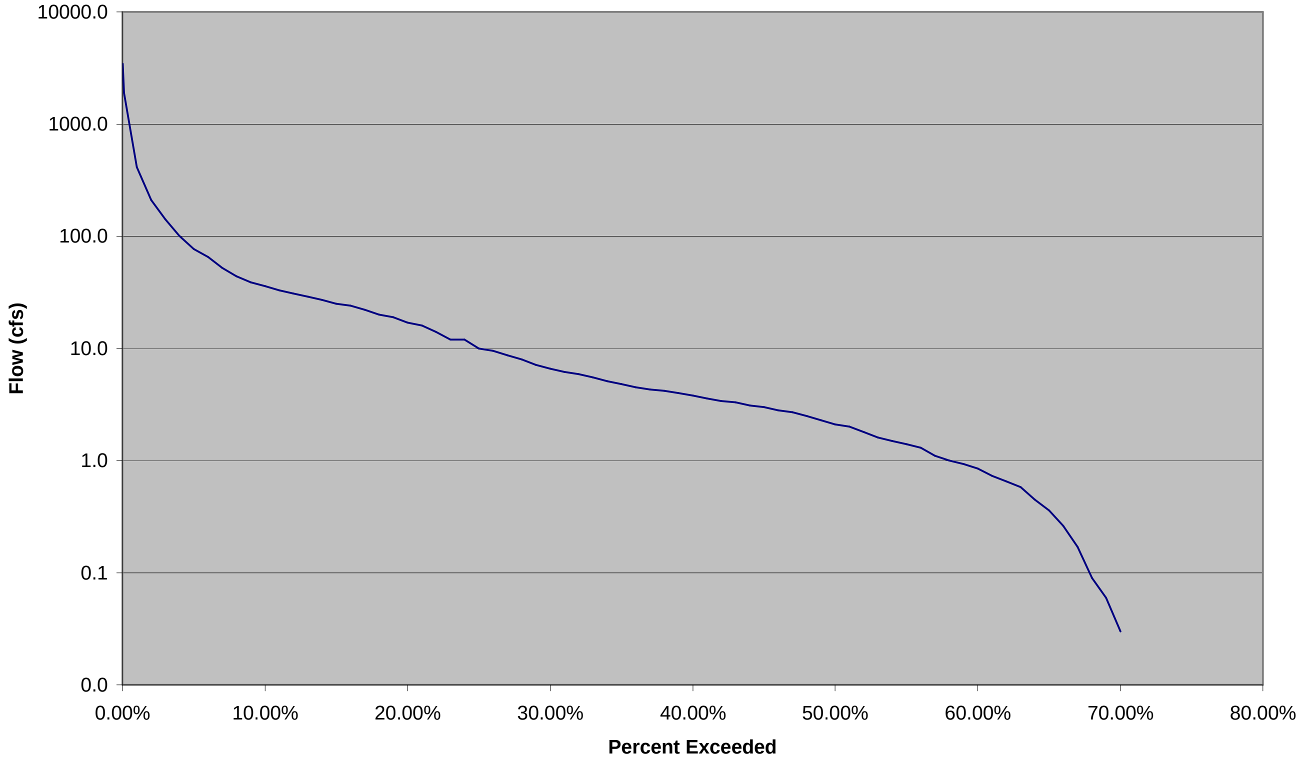
Date	Measured Flow (cfs)	
	USGS Site	Site 385026
4/6/2000	49	33.31
4/11/2000	34	25.56
6/7/2000	9.8	7.46

Storet Site 385026

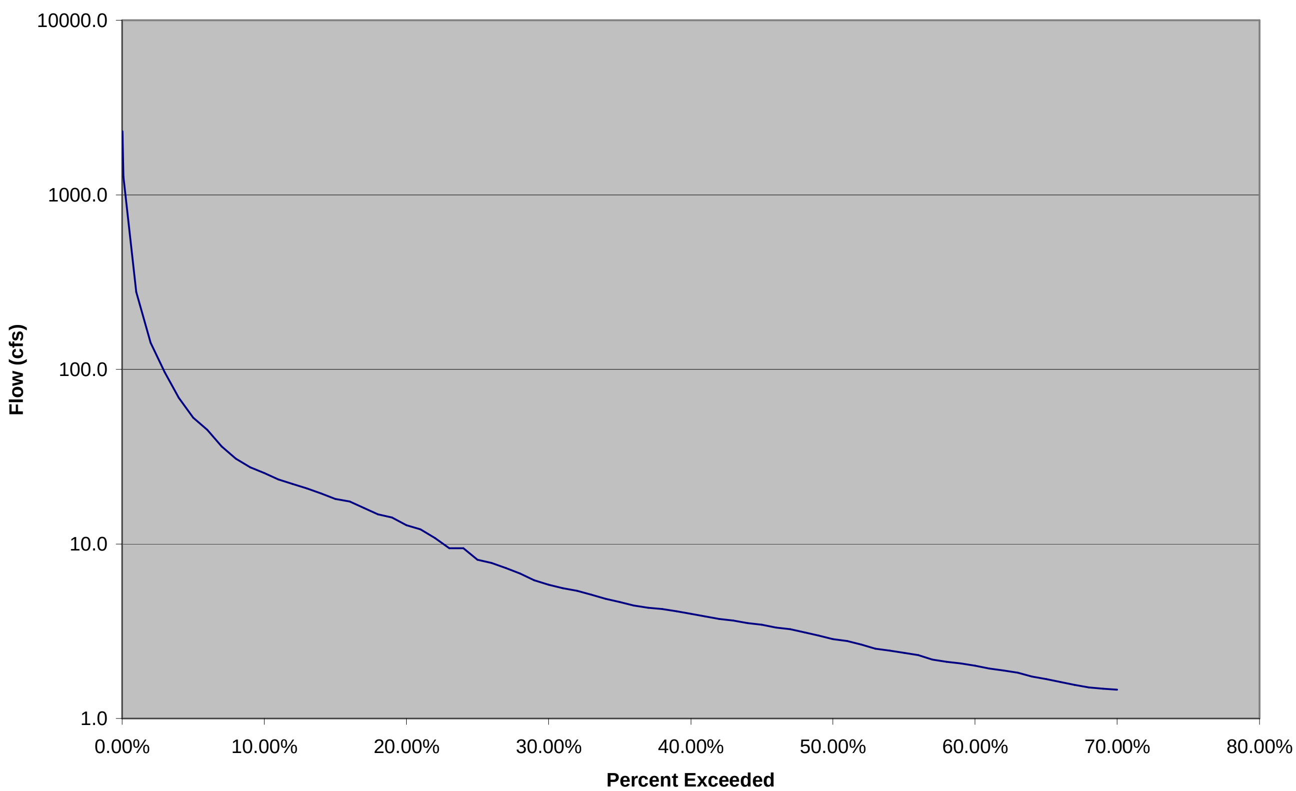


Appendix D
Flow Duration Curves for Sites 384216, 385023, 385024, 385025, 385026, and 385027

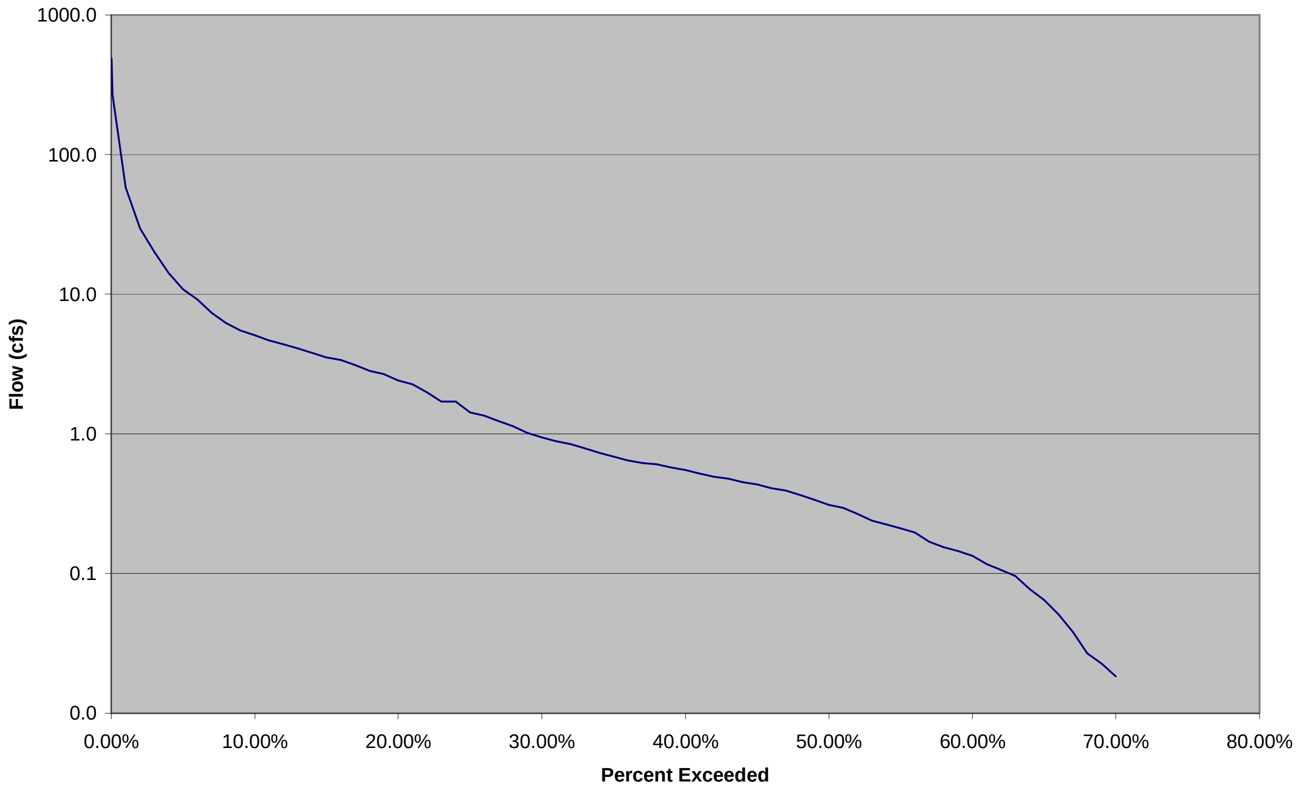
Flow Duration Curve for Site 384216 (USGS Site 06471200)
(Data from 2000-2006)



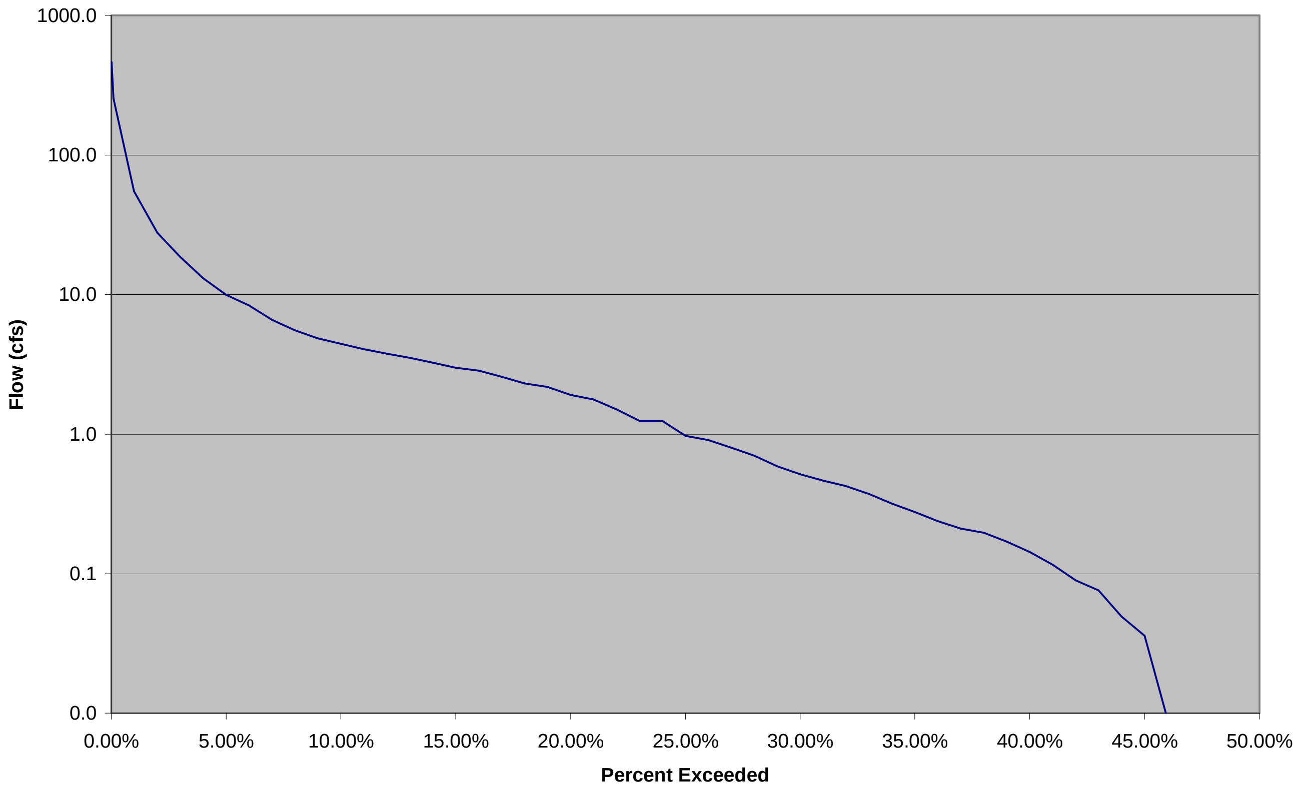
Flow Duration Curve for Site 385023



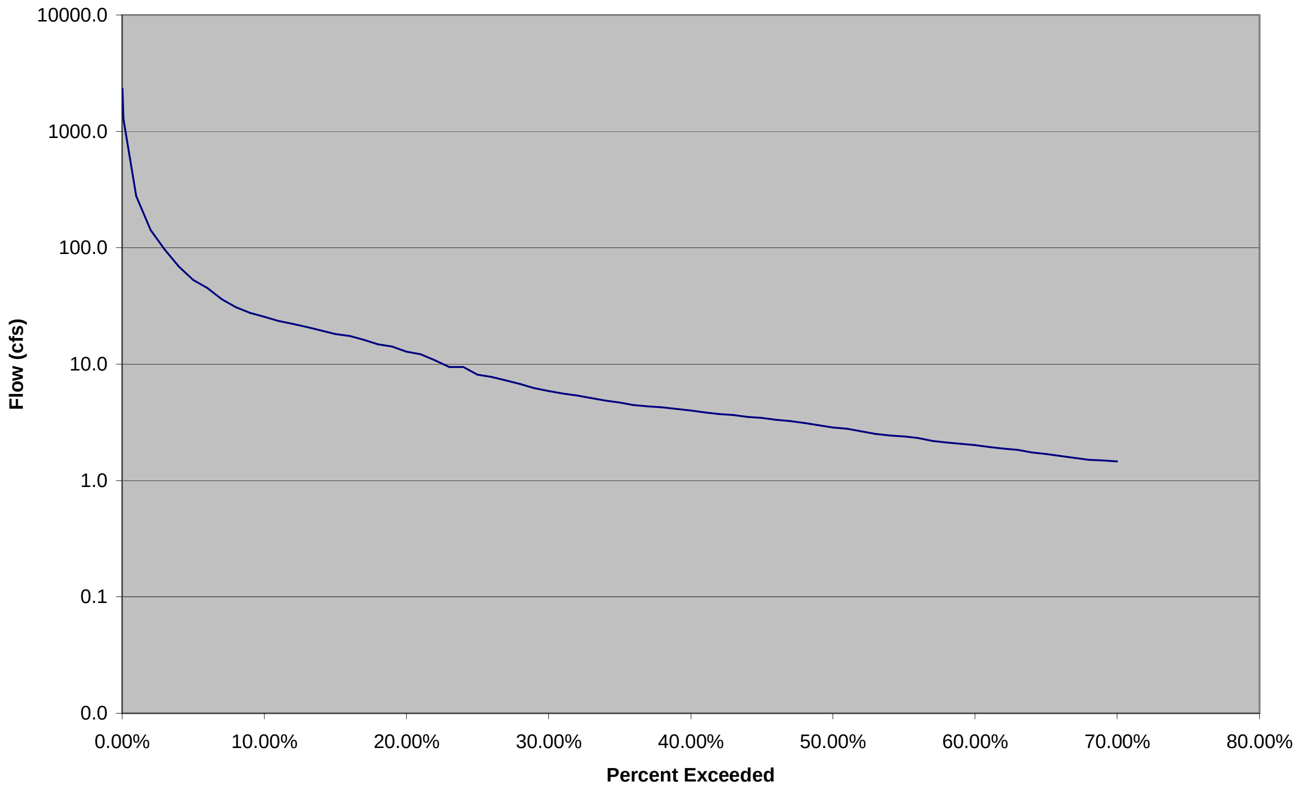
Flow Duration Curve for Site 385024



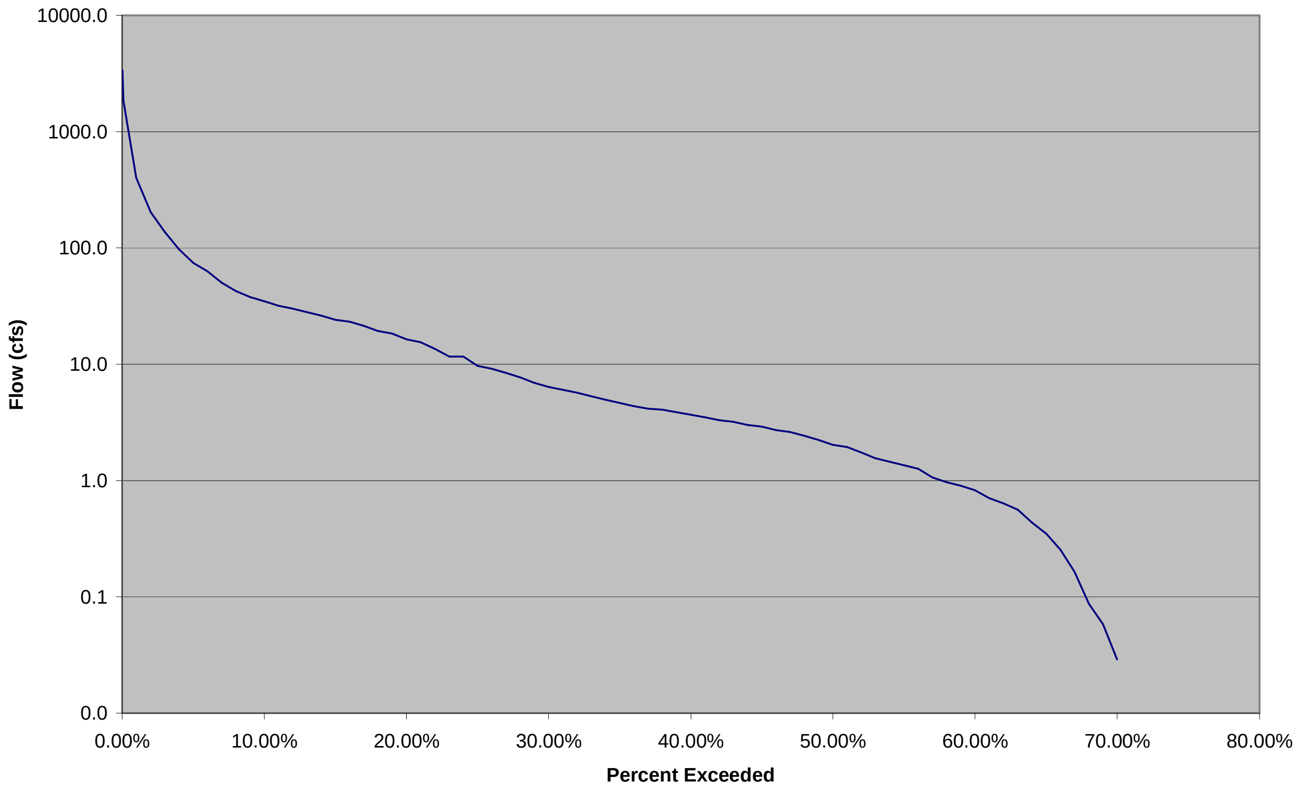
Flow Duration Curve for Site 385025



Flow Duration Curve for Site 385026



Flow Duration Curve for Site 385027



Appendix E
Load Duration Curves, Estimated Existing Loads, TMDL Targets and Percentage of Reduction Required for Sites 384216, 385023, 385024, 385025, 385026, and 385027

Existing Loads, TMDL Targets and Percentage of Reduction Required[1]

	Load (10^7 CFU/Day)			385023
	Median Percentile	Existing	TMDL	Percent Reduction
High	5.01 percent	99790.85	25878.40	74.07 percent
Moderate	37.50 percent	3630.96	2087.84	42.50 percent
Low				
			Total	68.80 percent

	Load (10^7 CFU/Day)			385024
	Median Percentile	Existing	TMDL	Percent Reduction
High	5.01 percent	24541.30	5308.84	78.37 percent
Mod-Low	40.00 percent	1103.15	268.60	75.65 percent
			Total	77.79 percent

	Load (10^7 CFU/Day)			385025
	Median Percentile	Existing	TMDL	Percent Reduction
High	5.01 percent	28360.86	4863.02	82.85 percent
Mod-Low	28.00 percent	1592.80	342.34	78.51 percent
			Total	82.12 percent

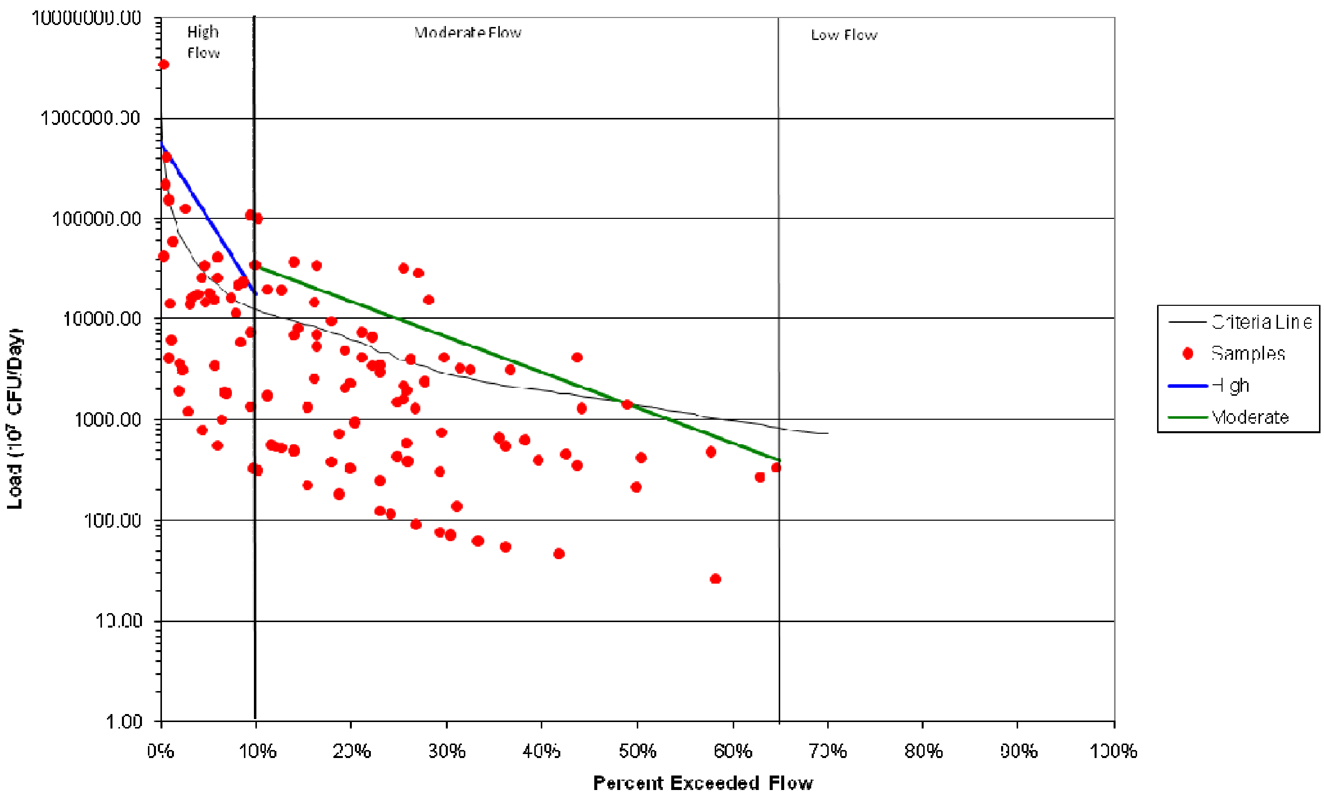
	Load (10^7 CFU/Day)			385026
	Median Percentile	Existing	TMDL	Percent Reduction
High	5.01 percent	75672.88	25878.40	65.80 percent
Mod-Low	40.00 percent	10205.20	1948.91	80.90 percent
			Total	72.56 percent

	Load (10^7 CFU/Day)			385027
	Median Percentile	Existing	TMDL	Percent Reduction
High	5.01 percent	313563.80	36551.77	88.34 percent
Mod-Low	40.00 percent	3318.10	1803.85	45.64 percent
			Total	85.79 percent

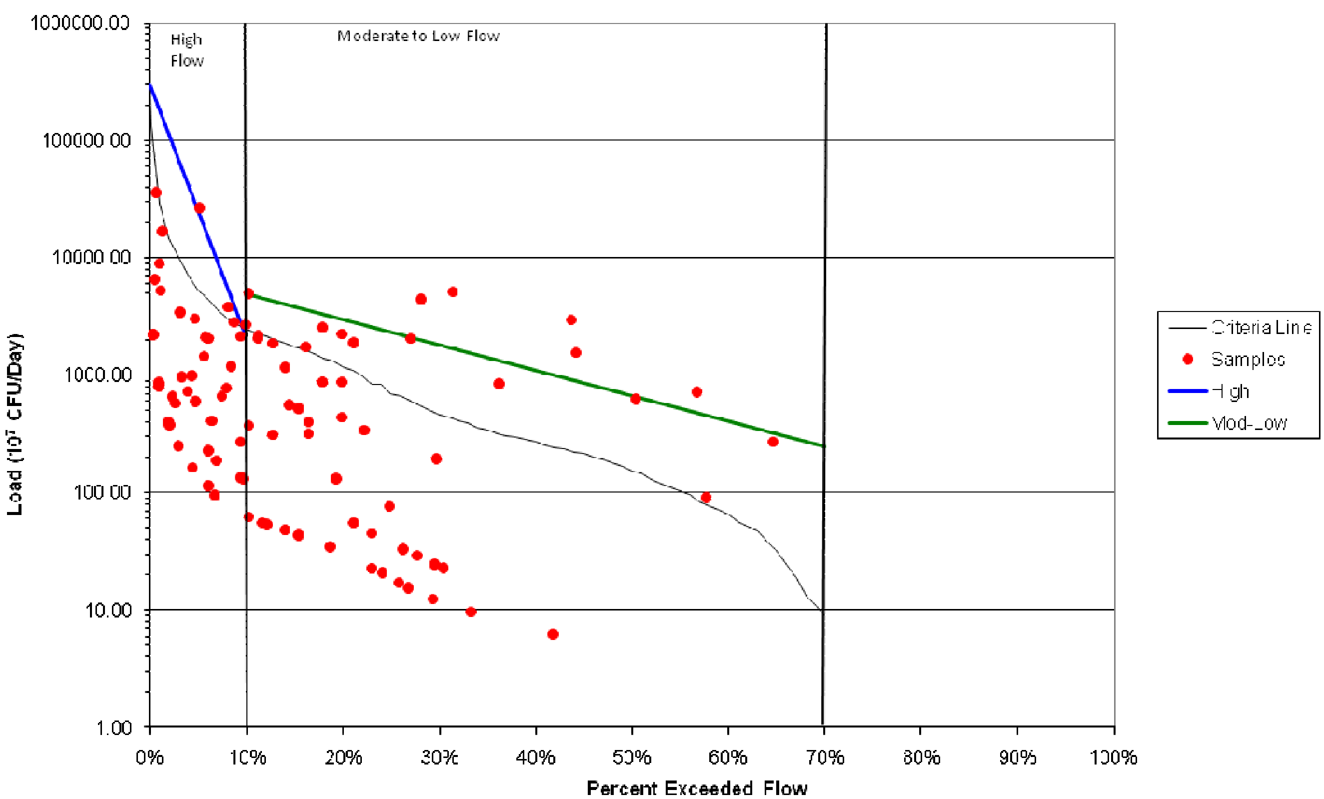
	Load (10^7 CFU/Day)			384216
	Median Percentile	Existing	TMDL	Percent Reduction
High	5.01 percent	126473.63	37682.24	69.86 percent
Moderate	40.00 percent	5084.41	1859.64	63.42 percent
Low				
			Total	68.60 percent

[1]The average percent reductions shown are estimates based on available data and reasonable assumptions and are to be used as a guide for implementation. The actual reductions needed to meet the applicable water quality standards may be higher or lower depending on the results of future monitoring.

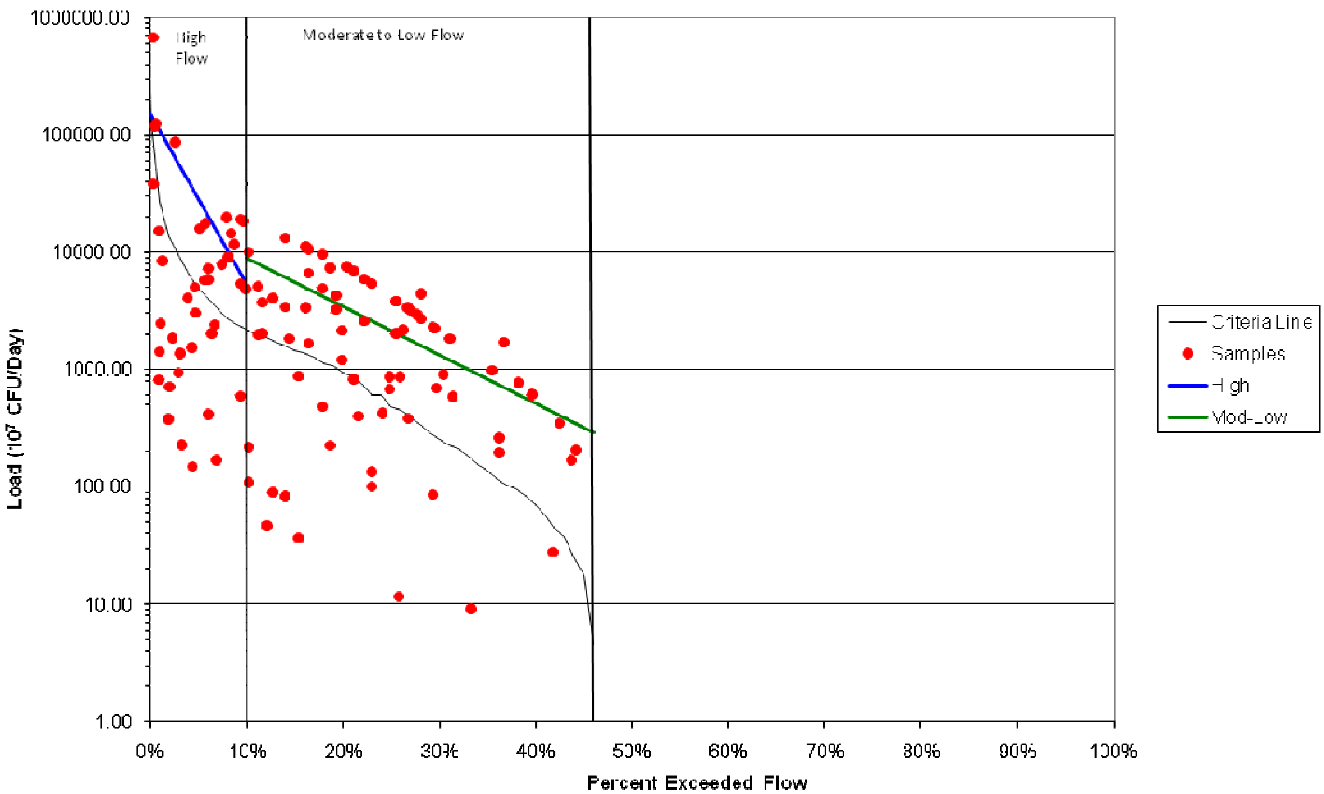
Load Duration Curve for Site 385023



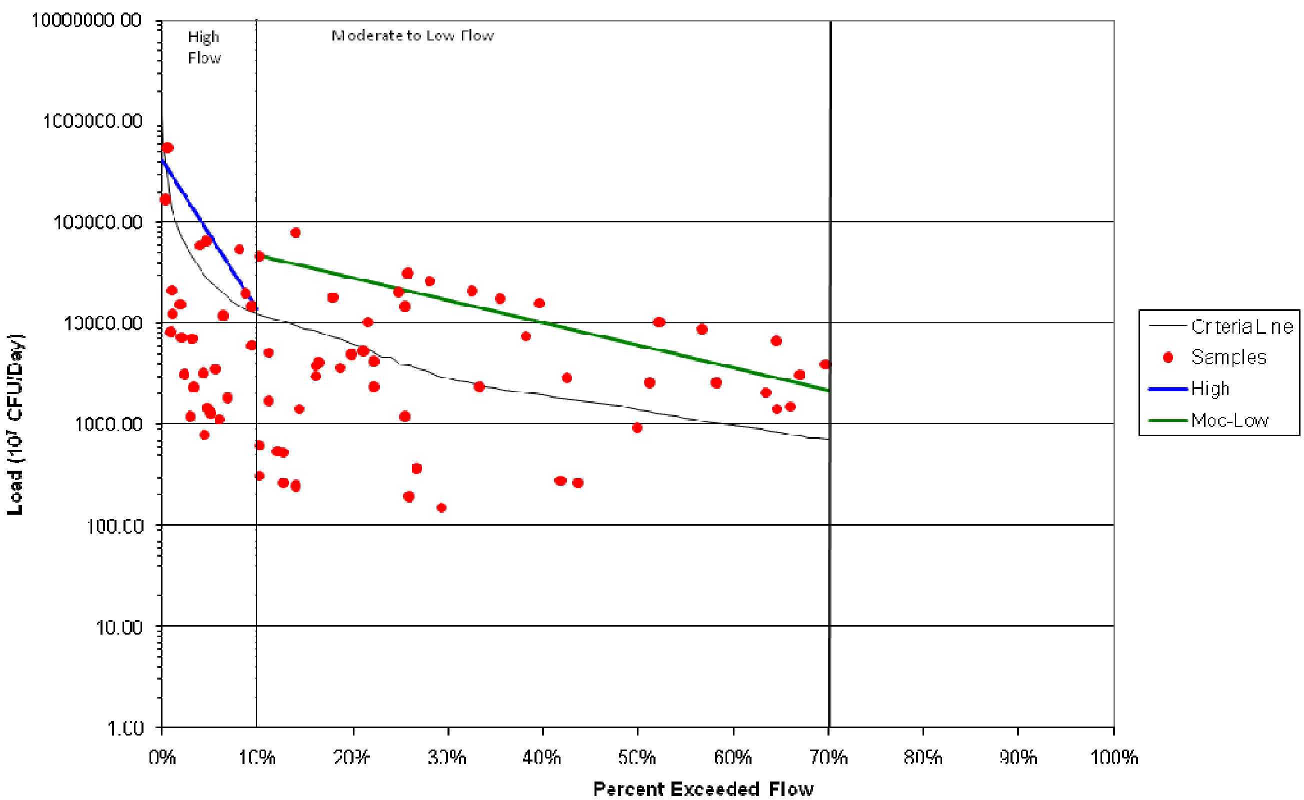
Load Duration Curve for Site 385024

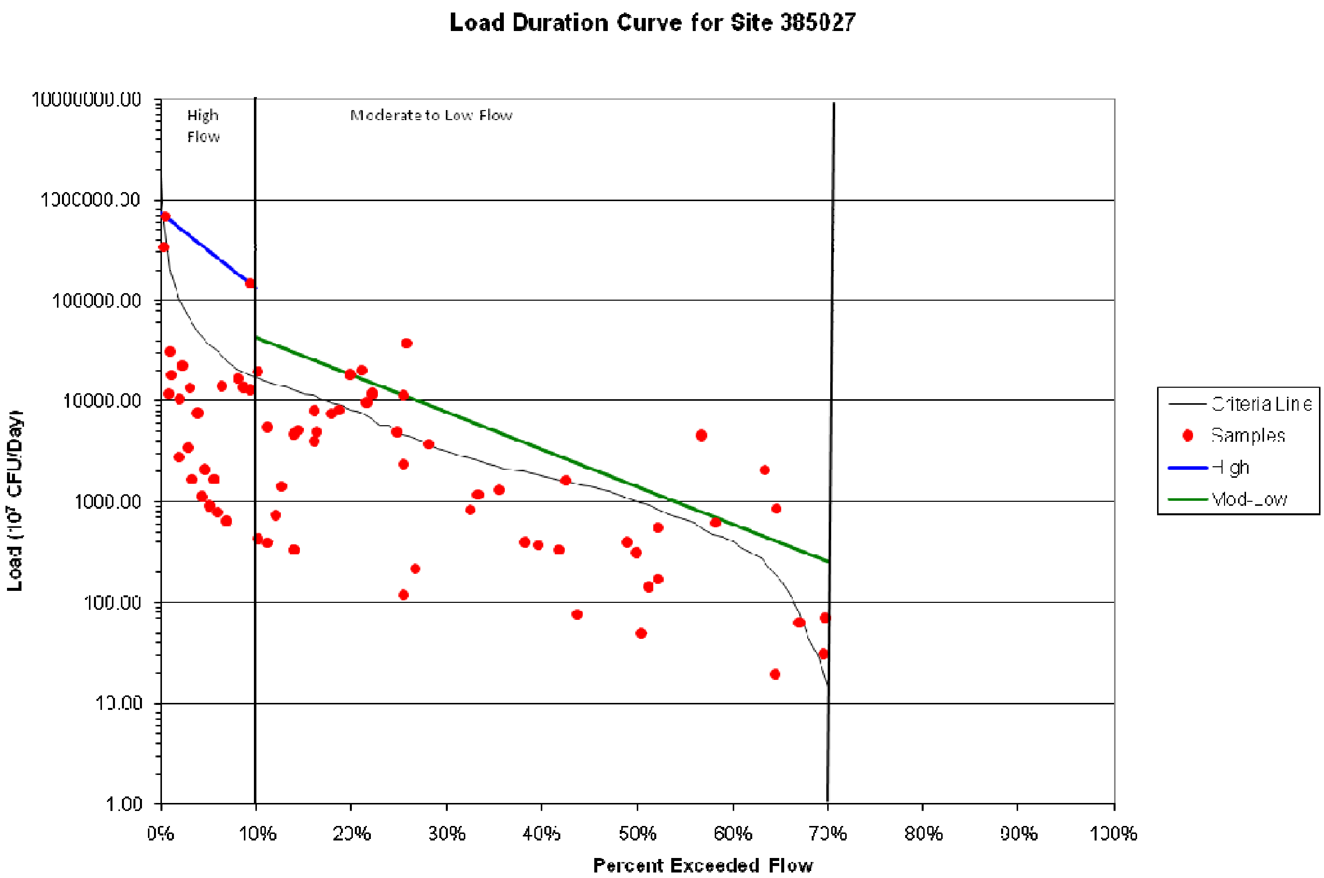


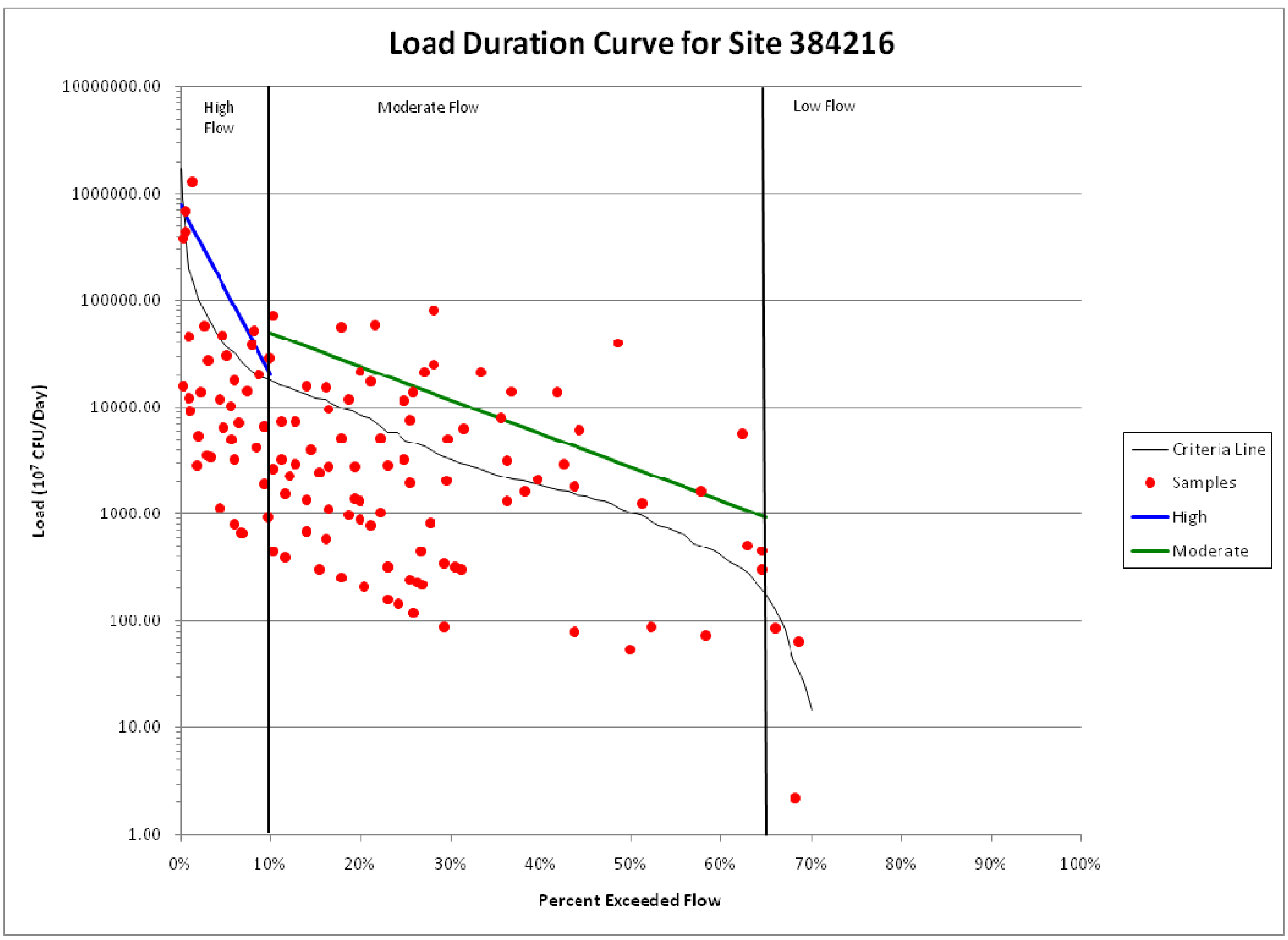
Load Duration Curve for Site 385025



Load Duration Curve for Site 385026




Load Duration Curve for Site 385027
10000000.00
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
High
Flow
Moderate to Low Flow
Load (10⁷ CFU/Day)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Exceeded Flow
Criteria Line
Samples
High
Mod-Low


Load Duration Curve for Site 384216
10000000.00
1000000.00
100000.00
10000.00
1000.00
100.00
10.00
1.00
High
Flow
Moderate Flow
Low Flow
Load (10⁷ CFU/Day)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Exceeded Flow
Criteria Line
Samples
High
Moderate

Appendix F
US EPA Region 8 Public Notice Review and Comments

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	**Fecal Coliform Bacteria TMDL - Maple River and Tributaries, North Dakota**
Submitted by:	**Mike Ell, North Dakota Department of Health**
Date Received:	**August 3, 2009**
Review Date:	**August 27, 2009**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Public Notice Draft**
Notes:	

Reviewers Final Recommendation(s) to EPA Administrator (used for final review only):

- ☐ Approve
- ☐ Partial Approval
- ☐ Disapprove
- ☐ Insufficient Information

Approval Notes to Administrator:

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the minimum submission requirements and TMDL elements identified in the following 8 sections:

1. Problem Description
   - 1.1. TMDL Document Submittal Letter
   - 1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   - 1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   - 4.1. Data Set Description
   - 4.2. Waste Load Allocations (WLA)
   - 4.3. Load Allocations (LA)
   - 4.4. Margin of Safety (MOS)
   - 4.5. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

Under Section 303(d) of the Clean Water Act, waterbodies that are not attaining one or more water quality standard (WQS) are considered “impaired.” When the cause of the impairment is determined to be a pollutant, a TMDL analysis is required to assess the appropriate maximum allowable pollutant loading rate. A TMDL document consists of a technical analysis conducted to: (1) assess the maximum pollutant loading rate that a waterbody is able to assimilate while maintaining water quality standards; and (2) allocate that assimilative capacity among the known sources of that pollutant**.** A well written TMDL document will describe a path forward that may be used by those who implement the TMDL recommendations to attain and maintain WQS.

Each of the following eight sections describes the factors that EPA Region 8 staff considers when reviewing TMDL documents. Also included in each section is a list of EPA's minimum submission requirements relative to that section, a brief summary of the EPA reviewer's findings, and the reviewer's comments and/or suggestions. Use of the verb "must" in the minimum submission requirements denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable.

This review template is intended to ensure compliance with the Clean Water Act and that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Problem Description

A TMDL document needs to provide a clear explanation of the problem it is intended to address. Included in that description should be a definitive portrayal of the physical boundaries to which the TMDL applies, as well as a clear description of the impairments that the TMDL intends to address and the associated pollutant(s) causing those impairments. While the existence of one or more impairment and stressor may be known, it is important that a comprehensive evaluation of the water quality be conducted prior to development of the TMDL to ensure that all water quality problems and associated stressors are identified. Typically, this step is conducted prior to the 303(d) listing of a waterbody through the monitoring and assessment program. The designated uses and water quality criteria for the waterbody should be examined against available data to provide an evaluation of the water quality relative to all applicable water quality standards. If, as part of this exercise, additional WQS problems are discovered and additional stressor pollutants are identified, consideration should be given to concurrently evaluating TMDLs for those additional pollutants. If it is determined that insufficient data is available to make such an evaluation, this should be noted in the TMDL document.

1.1 TMDL Document Submittal Letter

When a TMDL document is submitted to EPA requesting formal comments or a final review and approval, the submittal package should include a letter identifying the document being submitted and the purpose of the submission.

Minimum Submission Requirements.

☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.

☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.

☐ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute**.** The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The public notice draft Maple River fecal coliform TMDL was submitted to EPA for review during the public notice period via an email from Mike Ell, NDDoH on August 3, 2009. The email included the draft TMDL document and a public notice announcement requesting review and comment.

COMMENTS: None

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

The TMDL document should provide an unambiguous description of the waterbody to which the TMDL is intended to apply and the impairments the TMDL is intended to address. The document should also clearly delineate the physical boundaries of the waterbody and the geographical extent of the watershed area studied. Any additional information needed to tie the TMDL document back to a current 303(d) listing should also be included.

Minimum Submission Requirements:

☒ The TMDL document should clearly identify the pollutant and waterbody segment(s) for which the TMDL is being established. If the TMDL document is submitted to fulfill a TMDL development requirement for a waterbody on the state's current EPA approved 303(d) list, the TMDL document submittal should clearly identify the waterbody and associated impairment(s) as they appear on the State's/Tribe's current EPA approved 303(d) list, including a full waterbody description, assessment unit/waterbody ID, and the priority ranking of the waterbody. This information is necessary to ensure that the administrative record and the national TMDL tracking database properly link the TMDL document to the 303(d) listed waterbody and impairment(s).

☒ One or more maps should be included in the TMDL document showing the general location of the waterbody and, to the maximum extent practical, any other features necessary and/or relevant to the understanding of the TMDL analysis, including but not limited to: watershed boundaries, locations of major pollutant sources, major tributaries included in the analysis, location of sampling points, location of discharge gauges, land use patterns, and the location of nearby waterbodies used to provide surrogate information or reference conditions. Clear and concise descriptions of all key features and their relationship to the waterbody and water quality data should be provided for all key and/or relevant features not represented on the map

☐ If information is available, the waterbody segment to which the TMDL applies should be identified/geo-referenced using the National Hydrography Dataset (NHD). If the boundaries of the TMDL do not correspond to the Waterbody ID(s) (WBID), Entity_ID information or reach code (RCH_Code) information should be provided. If NHD data is not available for the waterbody, an alternative geographical referencing system that unambiguously identifies the physical boundaries to which the TMDL applies may be substituted.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Maple River its tributaries are a stream system located in LaMoure and Dickey Counties, in south central North Dakota. Maple River is part of the larger James River basin in the Elm sub-basin (HUC 10160004). The North Dakota segments of Maple River and Maple Creek flow approximately 125 miles until it reaches the state border with South Dakota, and the total drainage area is 286,560 acres. There are five 303(d) listed segments of Maple River, they include: 1) Maple Creek from its headwaters to its confluence with the Maple River (ND-10160004-022-S_00); 2) South Fork Maple River from its confluence with three tributaries downstream to its confluence with the Maple River (ND-10160004-015-S_00); 3) Maple River from Schlect-Thom Dam downstream to its confluence with Maple Creek (ND-10160004-026-S_00); 4) Maple River from its confluence with Maple Creek to its confluence with the South Fork Maple River (ND-10160004-013-S_00); and 5) Maple River from its confluence with the South Fork Maple River downstream to the ND-SD border (ND-10160004-002-S_00). All five segments are listed as high priority for TMDL development.

The designated use for the listed segments of the Maple River and its tributaries are based on the Class II stream classification in the ND water quality standards (NDCC 33-15-02.1-09). The segments were included on the ND 2008 303(d) list for fecal coliform bacteria which is impairing primary contact recreation uses.

COMMENTS: The maps in Figures 2 and 5 are useful to a point, but they lack the labels needed to clearly identify each listed segment. We found it difficult to tell which shaded area corresponds with which listed segment without using Google maps or other maps not included in the TMDL to find, for example, what part of the watershed contains Schlect-Thom Dam. We recommend adding additional landmarks and segment labels to one or more of the maps in the TMDL document.

1.3 Water Quality Standards

TMDL documents should provide a complete description of the water quality standards for the waterbodies addressed, including a listing of the designated uses and an indication of whether the uses are being met, not being met, or not assessed. If a designated use was not assessed as part of the TMDL analysis (or not otherwise recently assessed), the documents should provide a reason for the lack of assessment (e.g., sufficient data was not available at this time to assess whether or not this designated use was being met).

Water quality criteria (WQC) are established as a component of water quality standard at levels considered necessary to protect the designated uses assigned to that waterbody. WQC identify quantifiable targets and/or qualitative water quality goals which, if attained and maintained, are intended to ensure that the designated uses for the waterbody are protected. TMDLs result in maintaining and attaining water quality standards by determining the appropriate maximum pollutant loading rate to meet water quality criteria, either directly, or through a surrogate measurable target. The TMDL document should include a description of all applicable water quality criteria for the impaired designated uses and address whether or not the criteria are being attained, not attained, or not evaluated as part of the analysis. If the criteria were not evaluated as part of the analysis, a reason should be cited (e.g. insufficient data were available to determine if this water quality criterion is being attained).

Minimum Submission Requirements:

☒ The TMDL must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the anti-degradation policy. (40 C.F.R. §130.7(c)(1)).

☒ The purpose of a TMDL analysis is to determine the assimilative capacity of the waterbody that corresponds to the existing water quality standards for that waterbody, and to allocate that assimilative capacity between the significant sources. Therefore, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)).

Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or assessment methodologies may be erroneous. However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Maple River segments addressed by these TMDLs are impaired based on fecal coliform concentrations for primary contact recreational uses. Maple River and its tributaries are Class II streams. Numeric criteria have been developed for Class II streams for fecal coliform bacteria. Fecal coliform bacteria standards have been established and are shown in Table 8 below. Discussion of additional applicable water quality standards for Maple River can be found on pages 8 and 9 of the TMDL.

Table 8. North Dakota Fecal Coliform Bacteria Standards for Class II Streams.

Parameter	Water Quality Standard	
	Geometric Mean[1]	Maximum[2]
Fecal Coliform Bacteria	200 CFU/100 mL	400 CFU/100 mL

[1] Expressed as a geometric mean of representative samples collected during any consecutive 30-day period.

[2] No more than 10 percent of samples collected during any consecutive 30-day period shall individually exceed the standard.

COMMENTS: None.

2. Water Quality Targets

TMDL analyses establish numeric targets that are used to determine whether water quality standards are being achieved. Quantified water quality targets or endpoints should be provided to evaluate each listed pollutant/water body combination addressed by the TMDL, and should represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the water quality target. For pollutants with narrative standards, the narrative standard should be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include a variety of targets representing water column sediment such as TSS, embeddeness, stream morphology, up-slope conditions and a measure of biota).

Minimum Submission Requirements:

☒ The TMDL should identify a numeric water quality target(s) for each waterbody pollutant combination. The TMDL target is a quantitative value used to measure whether or not the applicable water quality standard is attained.

Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. Occasionally, the pollutant of concern is different from the parameter that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as a numerical dissolved oxygen criterion). In such cases, the TMDL should explain the linkage between the pollutant(s) of concern, and express the quantitative relationship between the TMDL target and pollutant of concern. In all cases, TMDL targets must represent the attainment of current water quality standards.

☐ When a numeric TMDL target is established to ensure the attainment of a narrative water quality criterion, the numeric target, the methodology used to determine the numeric target, and the link between the pollutant of concern and the narrative water quality criterion should all be described in the TMDL document. Any additional information supporting the numeric target and linkage should also be included in the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The water quality targets for this TMDL are based on the numeric water quality standards for fecal coliform bacteria based on the primary contact recreational beneficial use for Maple River and its tributaries. The target for the Maple River segments included in the TMDL document is the fecal coliform standard expressed as the 30-day geometric mean of 200 CFU/100 mL. While the standard is intended to be expressed as the 30-day geometric mean, the target was used to compare to values from single grab samples. This ensures that the reductions necessary to achieve the target will be protective of both the acute (single sample value) and chronic (geometric mean of 5 samples) standards.

COMMENTS: None.

3. Pollutant Source Analysis

A TMDL analysis is conducted when a pollutant load is known or suspected to be exceeding the loading capacity of the waterbody. Logically then, a TMDL analysis should consider all sources of the pollutant of concern in some manner. The detail provided in the source assessment step drives the rigor of the pollutant load allocation. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each significant source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each significant source (or source category) should be identified and quantified to the maximum practical extent. This may be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach may be appropriate. The approach should be clearly defined in the document.

Minimum Submission Requirements:

☒ The TMDL should include an identification of all potentially significant point and nonpoint sources of the pollutant of concern, including the geographical location of the source(s) and the quantity of the loading, e.g., lbs/per day. This information is necessary for EPA to evaluate the WLA, LA and MOS components of the TMDL.

☒ The level of detail provided in the source assessment should be commensurate with the nature of the watershed and the nature of the pollutant being studied. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of both the natural background loads and the nonpoint source loads.

☒ Natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g. measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified, characterized, and properly quantified.

☒ The sampling data relied upon to discover, characterize, and quantify the pollutant sources should be included in the document (e.g. a data appendix) along with a description of how the data were analyzed to characterize and quantify the pollutant sources. A discussion of the known deficiencies and/or gaps in the data set and their potential implications should also be included.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The TMDL document includes the following landuse breakdown in the watershed: 66 percent cropland under active cultivation, and 34 percent pasture/rangeland, CRP, hayland or low density development. The nonpoint source assessment identifies the significant contributor of the fecal coliform load in the watershed as primarily coming from the landuses where livestock grazing and feeding operations are located in the watershed. A total of 139 animal feeding areas were identified in the Maple River watershed.

There is one point source located in the Maple River watershed which is from the Edgeley wastewater treatment facility (WWTF). Edgeley's discharge is from a population of 650, and is to an ephemeral stream at the headwaters of Maple River. Due to the small size and location of the discharge it is considered a negligible source of fecal coliform loading. There are also 3 permitted concentrated animal feeding operations (CAFOs) and 15 permitted animal feeding operations (AFOs) in the watershed. Their permits require no discharge so they are not considered significant point sources in the TMDL document.

COMMENTS: The potential pathogen contributions from septic systems should be considered and explained in the document. If most of the towns in the watershed do not have centralized wastewater collection systems, then septic systems can be potential contributors. Also, as part of the implementation plan for this TMDL we recommend that the permitted point sources (i.e., Edgeley WWTF, 3 CAFOs and

15 AFOs) in the watershed be inspected to ensure that they are being operated in compliance with their permit conditions, and to verify that they aren't significant fecal coliform sources.

4. TMDL Technical Analysis

TMDL determinations should be supported by a robust data set and an appropriate level of technical analysis**.** This applies to **all** of the components of a TMDL document. It is vitally important that the technical basis for **all** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

A TMDL analysis determines the maximum pollutant loading rate that may be allowed to a waterbody without violating water quality standards. The TMDL analysis should demonstrate an understanding of the relationship between the rate of pollutant loading into the waterbody and the resultant water quality impacts. This stressor → response relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and load allocations needs to be clearly articulated and supported by an appropriate level of technical analysis. Every effort should be made to be as detailed as possible, and to base all conclusions on the best available scientific principles.

The pollutant loading allocation is at the heart of the TMDL analysis. TMDLs apportion responsibility for taking actions by allocating the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways, such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or division of responsibility.

The pollutant loading allocation that will result in achievement of the water quality target is expressed in the form of the standard TMDL equation:

$$TMDL = \sum LAs + \sum WLAs + MOS$$

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

MOS = The portion of the Load Capacity allocated to the Margin of safety.

Minimum Submission Requirements:

- ☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).
- ☒ The total loading capacity of the waterbody should be clearly demonstrated to equate back to the pollutant load allocations through a balanced TMDL equation. In instances where numerous LA, WLA and seasonal TMDL capacities make expression in the form of an equation cumbersome, a table may be substituted as long as it is clear that the total TMDL capacity equates to the sum of the allocations.
- ☐ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.
- ☒ It is necessary for EPA staff to be aware of any assumptions used in the technical analysis to understand and evaluate the methodology used to derive the TMDL value and associated loading allocations. Therefore, the TMDL document should contain a description of any important assumptions (including the basis for those assumptions) made in developing the TMDL, including but not limited to:

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
(4) present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

☒ The TMDL document should contain documentation supporting the TMDL analysis, including an inventory of the data set used, a description of the methodology used to analyze the data, a discussion of strengths and weaknesses in the analytical process, and the results from any water quality modeling used. This information is necessary for EPA to review the loading capacity determination, and the associated load, wasteload, and margin of safety allocations.

☒ TMDLs must take critical conditions (e.g., steam flow, loading, and water quality parameters, seasonality, etc…) into account as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe the approach used to determine both point and nonpoint source loadings under such critical conditions. In particular, the document should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

☐ Where both nonpoint sources and NPDES permitted point sources are included in the TMDL loading allocation, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document must include a demonstration that nonpoint source loading reductions needed to implement the load allocations are actually practicable [40 CFR 130.2(i) and 122.44(d)].

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Maple River watershed TMDL describes how the fecal coliform loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segments.

The TMDL loads and loading capacities were derived using the load duration curve (LDC) approach. To better correlate the relationship between the pollutant of concern and the hydrology of the Section 303(d) listed waterbody, a LDC was developed for each monitoring site within the five listed segments. All LDCs were derived using the 200 CFU/100 mL TMDL target (i.e., state water quality standard), the daily flow record obtained or synthesized for each site, and the observed fecal coliform data collected from the six water quality monitoring stations (see Figure 5 of the TMDL document) from 2000 through 2006.

Mean daily flows for the period January 1, 2000 through December 5, 2006 were used in the development of the flow duration curve and LDC for site 384216 (Maple River at the ND-SD border). This data was obtained from the collocated USGS gauge site (06471200) (see Appendix B of the TMDL document). For sites 385023, 385024, 385025, and 385026 the mean daily flow record used in flow duration curve development and in the development of the load duration curve was synthesized using regression relationships developed for each site. Simple linear regression relationships were developed for each site using the measured flows at each site paired with the corresponding flow at the USGS site for the same day. Using the daily flow record for the USGS site as the dependent variable a corresponding daily flow was estimated for each site.

For each flow regime and each site, a linear regression relationship was developed between the samples above the TMDL target (200 CFU/100 mL) curve and the percent exceeded flow. The linear regression line was then used with the percent exceeded of the flow to calculate existing total fecal coliform bacteria load for each flow regime and site as well as the total fecal coliform load for each flow regime and site necessary to reach the TMDL target concentration of 200 CFU/100 mL.

Developing the TMDL loads for segment ND-10160004-013-S_00 was complicated by the lack of a monitoring site within the listed segment. Existing loads and TMDL loads for this waterbody for each flow regime were, therefore, estimated by averaging the estimated existing loads for each site immediately upstream (385023, 385024, and 385025) and downstream (385026). The TMDL target load for each flow regime was then calculated (see Table 10 in the TMDL document).

Each LDC was divided into 2 or 3 distinct flow regimes. The resulting curves represent a flow-variable TMDL target across the flow regimes shown in the TMDL document. For each Maple River and tributary segment covered by the TMDL document, the LDC is a dynamic expression of the allowable load for any given daily flow. Loading capacities were derived from this approach for each segment at each flow regime. Tables 12, 15, 16, 17, and 18 show the loading capacity loads (or TMDL loads) for each listed segment of the Maple River and its tributaries.

COMMENTS: It is not clear why 2 or 3 flow zones were used in the LDCs for these TMDLs. Page 11 of the document explains ***how*** the flow regimes were defined for each site, but no explanation is given for ***why*** 2 or 3 zones were used. A brief explanation of why 2 or 3 flow zones were used (e.g., based on the shape of the curve, no flow at low end of curve, etc) should be added to the document.

From the information provided on page 12 of the document, it is not clear how the linear regression line is used in determining the required percent reductions needed for LDC. NDDoH is asked to clarify the information and include a description as to how the percent reduction calculation is made using the linear regression line. Was the midpoint of each flow zone used to find the point on the regression line to represent the current load, and the midpoint of LDC line used to represent the loading capacity? Then the difference between the two was used to derive the percent reductions shown in Appendix E?

4.1 Data Set Description

TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis. An inventory of the data used for the TMDL analysis should be provided to document, for the record, the data used in decision making. This also provides the reader with the opportunity to independently review the data. The TMDL analysis should make use of all readily available data for the waterbody under analysis unless the TMDL writer determines that the data are not relevant or appropriate. For relevant data that were known but rejected, an explanation of why the data were not utilized should be provided (e.g., samples exceeded holding times, data collected prior to a specific date were not considered timely, etc…).

Minimum Submission Requirements:

☒ TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and appropriate water quality criteria.

☒ The TMDL document submitted should be accompanied by the data set utilized during the TMDL analysis. If possible, it is preferred that the data set be provided in an electronic format and referenced in the document. If electronic submission of the data is not possible, the data set may be included as an appendix to the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Maple River TMDL data description and summary are included tables throughout the document for all five listed segments. The recent water quality monitoring was conducted over the period from January 2000 to December 2006 and included a total of 629 fecal coliform samples. The data set also includes the 7 years of flow record on the Maple River from the USGS gauging site at the ND-SD border. Stream discharge measurements were also collected at four other locations in the watershed. The flow data was used to develop a load duration curves for the Maple River and tributary segments

COMMENTS: None.

4.2 Waste Load Allocations (WLA):

Waste Load Allocations represent point source pollutant loads to the waterbody. Point source loads are typically better understood and more easily monitored and quantified than nonpoint source loads. Whenever practical, each point source should be given a separate waste load allocation. All NPDES permitted dischargers that discharge the pollutant under analysis directly to the waterbody should be identified and given separate waste load allocations. The finalized WLAs are required to be incorporated into future NPDES permit renewals.

Minimum Submission Requirements:

☒ EPA regulations require that a TMDL include WLAs for all significant and/or NPDES permitted point sources of the pollutant. TMDLs must identify the portion of the loading capacity allocated to individual existing and/or future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☒ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: There is one point source located in the Maple River watershed which is from the Edgeley wastewater treatment facility (WWTF). Edgely's discharge is from a population of 650, and is to an ephemeral stream at the headwaters of Maple River. Due to the small size and location of the discharge it is considered a negligible source of fecal coliform loading. There are also 3 permitted concentrated animal feeding operations (CAFOs) and 15 permitted animal feeding operations (AFOs) in the watershed. Their permits require no discharge so they are not considered significant point sources in the TMDL document. Therefore, the WLA for this TMDL is zero.

COMMENTS: None.

4.3 Load Allocations (LA):

Load allocations include the nonpoint source, natural, and background loads. These types of loads are typically more difficult to quantify than point source loads, and may include a significant degree of uncertainty. Often it is necessary to group these loads into larger categories and estimate the loading rates based on limited monitoring data and/or modeling results. The background load represents a composite of all upstream pollutant loads into the waterbody. In addition to the upstream nonpoint and upstream natural load, the background load often includes upstream point source loads that are not given specific waste load allocations in this particular TMDL analysis. In instances where nonpoint source loading rates are particularly difficult to quantify, a performance-based allocation approach, in which a detailed monitoring plan and adaptive management strategy are employed for the application of BMPs, may be appropriate.

Minimum Submission Requirements:

☒ EPA regulations require that TMDL expressions include LAs which identify the portion of the loading capacity attributed to nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Load allocations may be included for both existing and future nonpoint source loads. Where possible, load allocations should be described separately for natural background and nonpoint sources.

☒ Load allocations assigned to natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g., measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified and given proper load or waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The TMDL document includes the following landuse breakdown in the watershed: 66 percent cropland under active cultivation, and 34 percent pasture/rangeland, CRP, hayland or low density development. The nonpoint source assessment identifies the significant contributor of the fecal coliform load in the watershed as primarily coming from the landuses where livestock grazing and feeding operations are located in the watershed. A total of 139 animal feeding areas were identified in the Maple River watershed. Tables 12, 15, 16, 17, and 18 show the load allocations for each listed segment of the Maple River and its tributaries, at 2 or 3 different flow regimes. Specific non-point sources of pollution and their potential to contribute total fecal coliform bacteria loads under high, medium and low flow regimes in the Maple River watershed are described in Table 9 of the TMDL document.

COMMENTS: None.

4.4 Margin of Safety (MOS):

Natural systems are inherently complex. Any mathematical relationship used to quantify the stressor → response relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty and error. To compensate for this uncertainty and ensure water quality standards will be attained, a margin of safety is required as a component of each TMDL. The MOS may take the form of a explicit load allocation (e.g., 10 lbs/day), or may be implicitly built into the TMDL analysis through the use of conservative assumptions and values for the various factors that determine the TMDL pollutant load → water quality effect relationship. Whether explicit or implicit, the MOS should be supported by an appropriate level of discussion that addresses the level of uncertainty in the various components of the TMDL technical analysis, the assumptions used in that analysis, and the relative effect of those assumptions on the final TMDL. The discussion should demonstrate that the MOS used is sufficient to ensure that the water quality standards would be attained if the TMDL pollutant loading rates are met. In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).

Minimum Submission Requirements:

☒ TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

- ☐ If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.
- ☒ If the MOS is explicit, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.

☐ If, rather than an explicit or implicit MOS, the TMDL relies upon a phased approach to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Maple River TMDL includes explicit MOSs for each listed segment derived by calculating 10 percent of the loading capacity. The explicit MOSs for the listed segments of the Maple River watershed are included in Tables 12, 15, 16, 17, and 18.

COMMENTS: None.

4.5 Seasonality and variations in assimilative capacity:

The TMDL relationship is a factor of both the loading rate of the pollutant to the waterbody and the amount of pollutant the waterbody can assimilate and still attain water quality standards. Water quality standards often vary based on seasonal considerations. Therefore, it is appropriate that the TMDL analysis consider seasonal variations, such as critical flow periods (high flow, low flow), when establishing TMDLs, targets, and allocations.

Minimum Submission Requirements:

☒ The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variability as a factor. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: By using the load duration curve approach to develop the TMDL allocations, seasonal variability in fecal coliform loads are taken into account. Highest steam flows typically occur during late spring, and the lowest stream flows occur during the winter months. Also, the TMDL is seasonal since the fecal coliform criteria are in effect from May 1 to September 30, therefore the TMDLs are only applicable during that period.

COMMENTS: None.

5. Public Participation

EPA regulations require that the establishment of TMDLs be conducted in a process open to the public, and that the public be afforded an opportunity to participate. To meaningfully participate in the TMDL process it is necessary that stakeholders, including members of the general public, be able to understand the problem and the proposed solution. TMDL documents should include language that explains the issues to the general public in understandable terms, as well as provides additional detailed technical information for the scientific community. Notifications or solicitations for comments regarding the TMDL should be made available to the general public, widely circulated, and clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for approval, a copy of the comments received by the state and the state responses to those comments should be included with the document.

Minimum Submission Requirements:
☒ The TMDL must include a description of the public participation process used during the development of the TMDL (40 C.F.R. §130.7(c)(1)(ii)).

☐ TMDLs submitted to EPA for review and approval should include a summary of significant comments and the State's/Tribe's responses to those comments.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The TMDL document includes a summary of the public participation process that has occurred. It describes the opportunities the public had to be involved in the TMDL development process. Copies of the draft TMDL document were mailed to stakeholders in the watershed during public comment. Also, the draft TMDL document was posted on NDoDH's Water Quality Division website, and a public notice for comment was published in four newspapers.

COMMENTS: None.

6. Monitoring Strategy

TMDLs may have significant uncertainty associated with the selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL document to articulate the means by which the TMDL will be evaluated in the field, and to provide for future supplemental data that will address any uncertainties that may exist when the document is prepared.

Minimum Submission Requirements:

☒ When a TMDL involves both NPDES permitted point source(s) and nonpoint source(s) allocations, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring.

☒ Under certain circumstances, a phased TMDL approach may be utilized when limited existing data are relied upon to develop a TMDL, and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL. EPA recommends that a phased TMDL document or its implementation plan include a monitoring plan and a scheduled timeframe for revision of the TMDL. These elements would not be an intrinsic part of the TMDL and would not be approved by EPA, but may be necessary to support a rationale for approving the TMDL. http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: Implementation of best management practices (BMPs) and technical assistance are specified in the Section 319 Maple River Watershed Restoration Project. To make sure those BMPs are successful in reducing fecal coliform bacteria loadings to levels prescribed in the TMDL document, water quality monitoring is being conducted in accordance with an approved Quality Assurance Project Plan (QAPP). As prescribed in the QAPP, weekly monitoring is being conducted at four sites for fecal coliform bacteria and E. coli. The sampling began in October 2000 and will continue through June 2010.

COMMENTS: None.

7. Restoration Strategy

The overall purpose of the TMDL analysis is to determine what actions are necessary to ensure that the pollutant load in a waterbody does not result in water quality impairment. Adding additional detail regarding the proposed approach for the restoration of water quality <u>is not</u> currently a regulatory requirement, but is considered a value added component of a TMDL document. During the TMDL analytical process, information is often gained that may serve to point restoration efforts in the right direction and help ensure that resources are spent in the most efficient manner possible. For example, watershed models used to analyze the linkage between the pollutant loading rates and resultant water quality impacts might also be used to conduct "what if" scenarios to help direct BMP installations to locations that provide the greatest pollutant reductions. Once a TMDL has been written and approved, it is often the responsibility of other water quality programs to see that it is implemented. The level of quality and detail provided in the restoration strategy will greatly influence the future success in achieving the needed pollutant load reductions.

Minimum Submission Requirements:

☒ EPA is not required to and does not approve TMDL implementation plans. However, in cases where a WLA is dependent upon the achievement of a LA, "reasonable assurance" is required to demonstrate the necessary LA called for in the document is practicable). A discussion of the BMPs (or other load reduction measures) that are to be relied upon to achieve the LA(s), and programs and funding sources that will be relied upon to implement the load reductions called for in the document, may be included in the implementation/restoration section of the TMDL document to support a demonstration of "reasonable assurance".

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: In response to the Maple River Watershed Assessment, and in anticipation of this completed TMDL, local sponsors successfully applied for and received Section 319 funding for the Maple River Watershed Restoration Project. Beginning in October 2000, local sponsors have been providing technical assistance and implementing BMPs designed to reduce fecal bacteria loadings and to help restore the beneficial uses of the Maple River (i.e., recreation). Water quality data has been collected to monitor and track the effects of BMP implementation as well as to judge overall success of the project in reducing fecal coliform bacteria loadings. A QAPP has also been developed as part of this watershed restoration project that details the how, when and where monitoring will be conducted to gather the data needed to document success in meeting the TMDL implementation goal(s). As the data are gathered and analyzed, watershed restoration tasks will be adapted, if necessary, to place BMPs where they will have the greatest benefit to water quality and in meeting the TMDL goal(s). All permitted CAFOs (greater than or equal to 1000 animal units) are inspected annually by the NDDoH. Permitted AFOs (<1000 animal units) in the Maple River watershed are inspected as needed.

COMMENTS: None.

8. Daily Loading Expression

The goal of a TMDL analysis is to determine what actions are necessary to attain and maintain WQS. The appropriate averaging period that corresponds to this goal will vary depending on the pollutant and the nature of the waterbody under analysis. When selecting an appropriate averaging period for a TMDL analysis, primary concern should be given to the nature of the pollutant in question and the achievement of the underlying WQS. However, recent federal appeals court decisions have pointed out that the title TMDL implies a "daily" loading rate. While the most appropriate averaging period to be used for developing a TMDL analysis may vary according to the pollutant, a daily loading rate can provide a more practical indication of whether or not the overall needed load reductions are being achieved. When limited monitoring resources are available, a daily loading target that takes into account the natural variability of the system can serve as a useful indicator for whether or not the overall load reductions are likely to be met. Therefore, a daily expression of the required pollutant loading rate is a required element in all TMDLs, in addition to any other load averaging periods that may have been used to conduct the TMDL analysis. The level of effort spent to develop the daily load indicator should be based on the overall utility it can provide as an indicator for the total load reductions needed.

Minimum Submission Requirements:

☒ The document should include an expression of the TMDL in terms of a daily load. However, the TMDL may also be expressed in temporal terms other than daily (e.g., an annual or monthly load). If the document expresses the TMDL in additional "non-daily" terms the document should explain why it is appropriate or advantageous to express the TMDL in the additional unit of measurement chosen.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Maple River fecal coliform TMDL document includes daily loads expressed as colonies per day for the five listed segments in the watershed. The daily TMDL loads are included in TMDL section (Section 7.0) of the document.

COMMENTS: None.

Appendix G

NDDoH's Response to Comments Received from the US EPA Region 8

EPA REGION 8 COMMENT: The maps in Figures 2 and 5 are useful to a point, but they lack the labels needed to clearly identify each listed segment. We found it difficult to tell which shaded area corresponds with which listed segment without using Google maps or other maps not included in the TMDL to find, for example, what part of the watershed contains Schlect-Thom Dam. We recommend adding additional landmarks and segment labels to one or more of the maps in the TMDL document.

NDDoH Response: Figure 2 has been revised with additional detail defining the Section 303(d) TMDL listed segments and their sub-watersheds. The figure also includes monitoring sites and the USGS flow gauging site. Figure 5 has been removed as it was duplicative with the information provided in Figure 2.

Figure 1 has also been modified to better describe the location of the Maple River watershed.

EPA Region 8 Comment: The potential pathogen contributions from septic systems should be considered and explained in the document. If most of the towns in the watershed do not have centralized wastewater collection systems, then septic systems can be potential contributors. Also, as part of the implementation plan for this TMDL we recommend that the permitted point sources (i.e., Edgeley WWTF, 3 CAFOs and 15 AFOs) in the watershed be inspected to ensure that they are being operated in compliance with their permit conditions, and to verify that they aren't significant fecal coliform sources.

NDDoH Response: The following paragraph describing the potential for failed septic systems to contribute was added to Section 4.0:

> "Failing septic systems or direct discharge sewage systems which contribute to fecal coliform bacteria contamination may also be located within the watershed. While their specific location and potential for fecal coliform loading are unknown, these systems may be associated with isolated single-family dwellings and farmsteads located throughout the watershed or within small towns located within the watershed that do not have a centralized sewer system (e.g., Merricourt, Fullerton and Monango)."

In addition, additional language dealing with the allocation to septic systems was added to Section 8.2. It read as follows:

> "Septic System – Septic systems provide an economically feasible way of disposing of household wastes where other means of waste treatment are unavailable (e.g., public or private treatment facilities). The basis for most septic systems involves the treatment and distribution of household wastes through a series of steps involving the following:
>
> 1. A sewer line connecting the house to a septic tank
> 2. A septic tank that allows solids to settle out of the effluent
> 3. A distribution system that dispenses the effluent to a leach field
> 4. A leaching system that allows the effluent to enter the soil
>
> Septic system failure occurs when one or more components of the septic system do not work properly and untreated waste or wastewater leaves the system. Wastes may pond in the leach field and ultimately run off directly into nearby streams or percolate into groundwater. Untreated septic system waste is a potential source of nutrients (nitrogen and phosphorus), organic matter, suspended solids, and fecal coliform bacteria. Land application of septic system sludge, although unlikely, may also be a source of contamination.
>
> Septic system failure can occur for several reasons, although the most common reason is improper maintenance (e.g. age, inadequate pumping). Other reasons for failure include

> improper installation, location, and choice of system. Harmful household chemicals can also cause failure by killing the bacteria that digest the waste. While the number of systems that are not functioning properly is unknown, it is estimated that 28 percent of the systems in North Dakota are failing (USEPA, 2002)."

The last paragraph of Section 11.0, Restoration Strategy, was rewritten to further describe how implementation will include the inspection of permitted facilities.

EPA Region 8 Comment: It is not clear why 2 or 3 flow zones were used in the LDCs for these TMDLs. Page 11 of the document explains ***how*** the flow regimes were defined for each site, but no explanation is given for ***why*** 2 or 3 zones were used. A brief explanation of why 2 or 3 flow zones were used (e.g., based on the shape of the curve, no flow at low end of curve, etc) should be added to the document.

From the information provided on page 12 of the document, it is not clear how the linear regression line is used in determining the required percent reductions needed for LDC. NDDoH is asked to clarify the information and include a description as to how the percent reduction calculation is made using the linear regression line. Was the midpoint of each flow zone used to find the point on the regression line to represent the current load, and the midpoint of LDC line used to represent the loading capacity? Then the difference between the two was used to derive the percent reductions shown in Appendix E?

NDDoH Response: An additional section was added to Section 5.0, Technical Analysis. This new section, added as Section 5.2, describes the flow duration curve analysis, which is a precursor to the load duration curve analysis. This new section describes how the flow intervals used in the load duration curve are selected.

Additional language was also added to the "Load Duration Curve Analysis" section, now 5.3, which describes with an example of how the existing and TMDL loads are calculated from the regression line and the TMDL target curve. This section also describes how the midpoint for the flow interval is selected.