Nutrient and Dissolved Oxygen TMDL for Danzig Dam in Morton and Oliver Counties, North Dakota

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1.0 INTRODUCTION AND DESCRIPTION OF THE WATERSHED

Danzig Dam is located on the headwaters of Hailstone Creek, a tributary of the Big Muddy River, eight miles west of New Salem (Figure 1). Completed in the 1930's by the Works Progress Administration, the 133-acre reservoir is designed for recreational benefits (Table 1 and Figure 2). The watershed for Danzig Dam includes portions of both Morton and Oliver counties.

Danzig Dam's fishery was dominated by carp and bullhead. In 2012, the North Dakota Game and Fish (NDGF) began to draw down the reservoir in preparation for eradication and the installation of a water control structure. Eradication of the undesirable fish began in September of 2013 and restocking the reservoir with northern pike and perch began in 2014. In conjunction with this project, the NDGF also dredged out approximately 20,000 yards of nutrient enriched sediment for the primary purpose of enhancing public fishing access. While limited in scope, these restoration activities are expected to help Danzig Dam continue to maintain its beneficial uses for fishing and recreation.

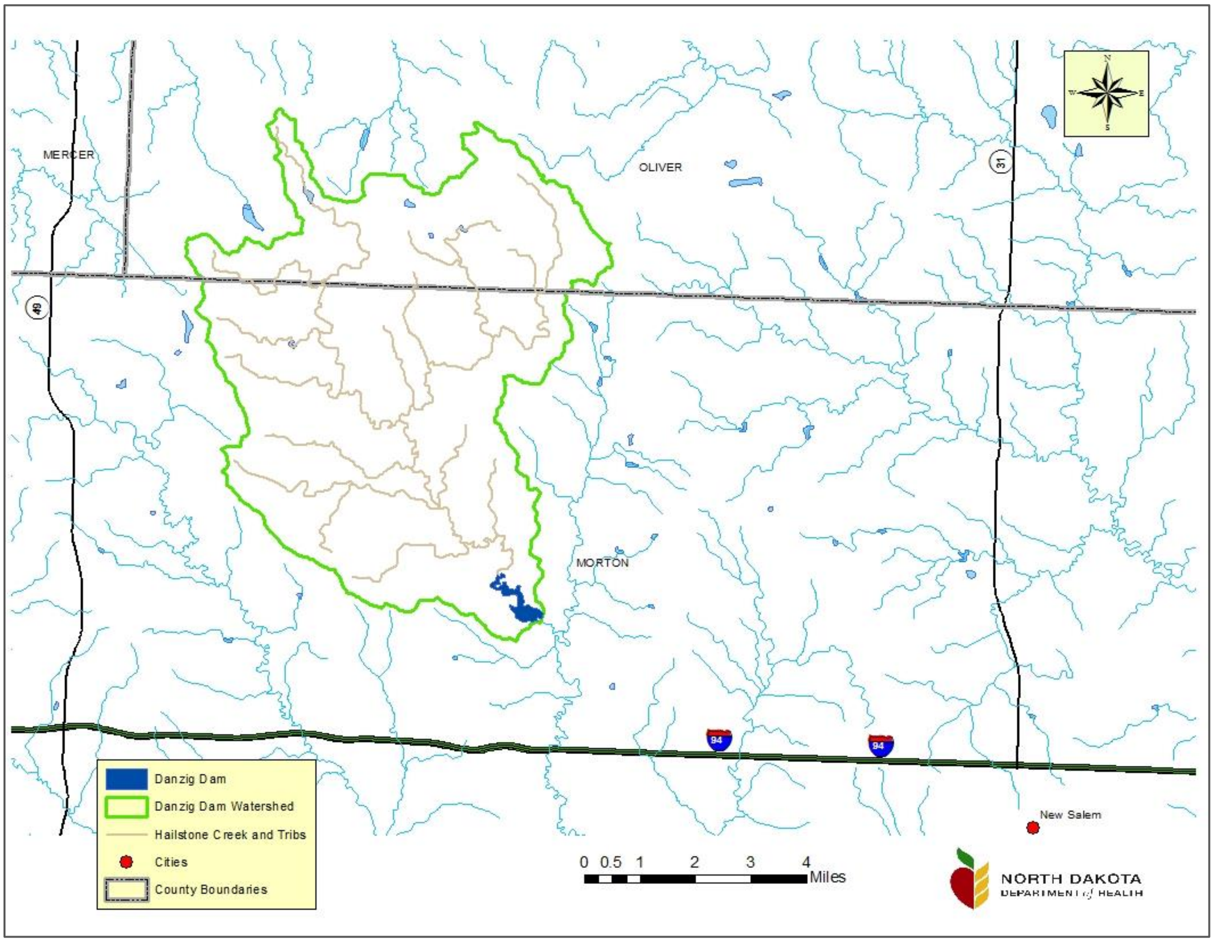

Figure 1. Location of Danzig Dam and Its Watershed.

Table 1. General Characteristics of Danzig Dam and the Danzig Dam Watershed.

Legal Name	Danzig Dam
Major Drainage Basin	Big Muddy Basin
Nearest Municipality	New Salem, North Dakota
Assessment Unit ID	ND-10130203-007-L_00
County Location	Morton and Oliver Counties
Physiographic Region	Northern Great Plains
Latitude	46.89672
Longitude	-101.60165
Watershed Area	27,754 acres
Surface Area	132.7 acres
Average Depth	4.5 feet
Maximum Depth	10.7 feet
Volume	580.5 acre feet
Type of Waterbody	Reservoir
Dam Type	Earthen Dam
Fishery Type	Northern Pike and Yellow Perch

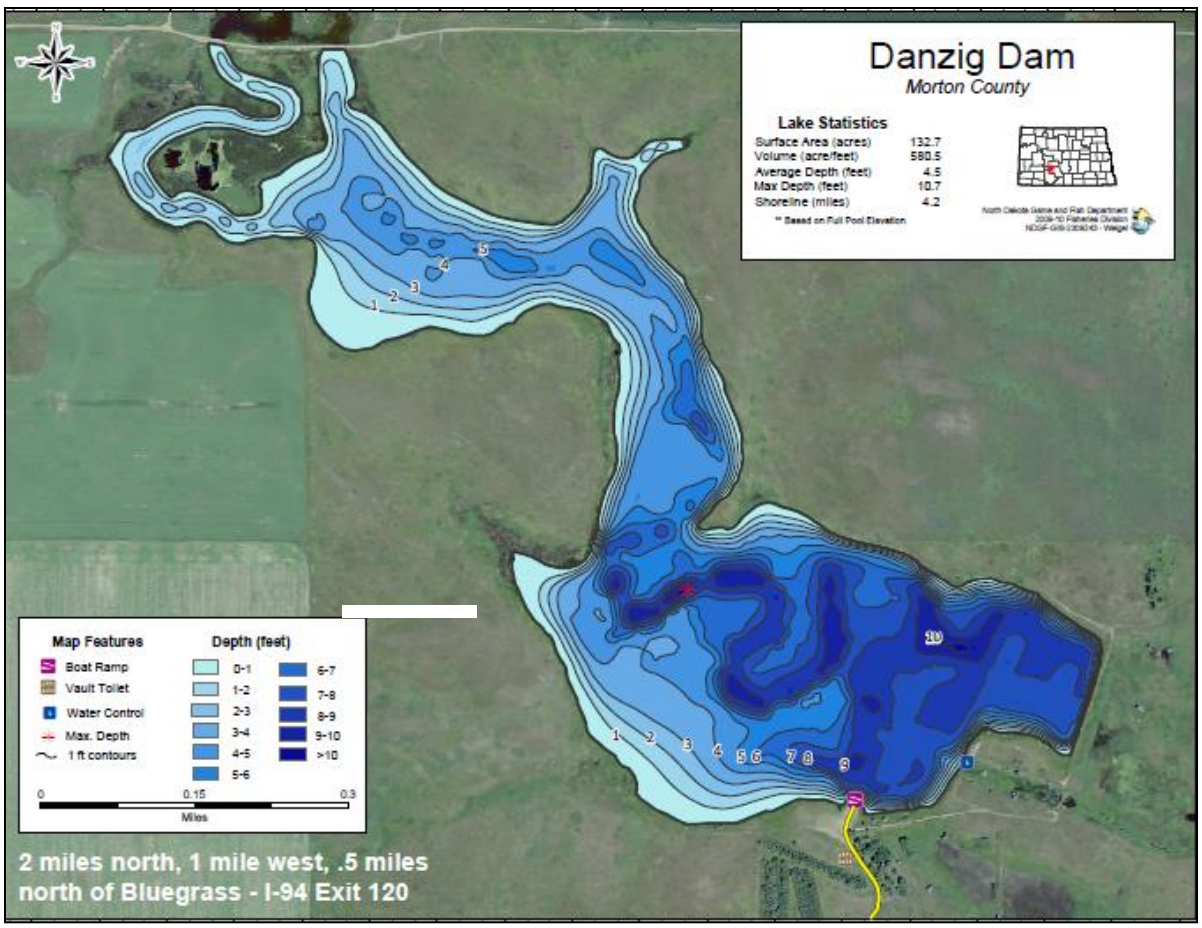

Figure 2. North Dakota Game and Fish Contour Map of Danzig Dam.

1.1 Clean Water Act Section 303(d) Listing Information

Based on the 2014 Section 303(d) list of impaired waters needing total maximum daily loads (TMDLs), the North Dakota Department of ealth (NDDoH) has assessed Danzig Dam as fully supporting, but threatened for fish and other aquatic biota and recreation uses. The impairments are listed as sedimentation/siltation, dissolved oxygen, and nutrients/eutrophication/biological indicators. This TMDL report addresses both the aquatic life and recreation impairments caused by low dissolved oxygen and nutrient/eutrophication/biological indicators. The sediment/siltation impairment will be addressed in a separate report.

Danzig Dam has been classified as a Class 3 warm-water fishery, "capable of supporting natural reproduction and growth of warm-water fishes (i.e., largemouth bass and bluegill) and associated aquatic biota and marginal growth. Some cool water species may also be present." (NDDoH, 2014b).

Table 2. Danzig Dam Section 303(d) Listing Information (NDDoH, 2014a).

Assessment Unit ID	**ND-10130203-007-L_00**
Waterbody Name	**Danzig Dam**
Class	**Class 3, Warm-water fishery**
Impaired Designated Uses	**Fish and Other Aquatic Biota and Recreation**
Use Support	**Fully Supporting, but Threatened**
Impairment	**Nutrient/Eutrophication Biological Indicators; Dissolved Oxygen; Sediment/Siltation**
Priority	**High**

1.2 Topography

The Danzig Dam watershed is characterized as a semi-arid rolling plain of shale, siltstone, and sandstone punctuated by occasional sandstone buttes and badlands. The topography of this area was largely unaffected by glaciations and retains its original soils and complex stream drainage pattern. The soils present belong to the Orders Mollisols and Entisols, and are typically Haploborolls, Calciborolls and Ustorthents.

1.3 Land Use and Ecoregions in the Watershed

The Danzig Dam watershed lies entirely within the Missouri Plateau level IV ecoregion (43a) of the Northwestern Great Plains level III ecoregion (43) (Figure 3).

Within the Northwestern Great Plains level III ecoregion, native grasslands still persist in areas of steep or broken topography, but over most of the ecoregion they have been largely replaced by spring wheat and alfalfa (USGS, 2006). Agriculture is limited by erratic precipitation patterns and limited opportunities for irrigation. Oil and natural gas development is also prevalent in the western part of the region.

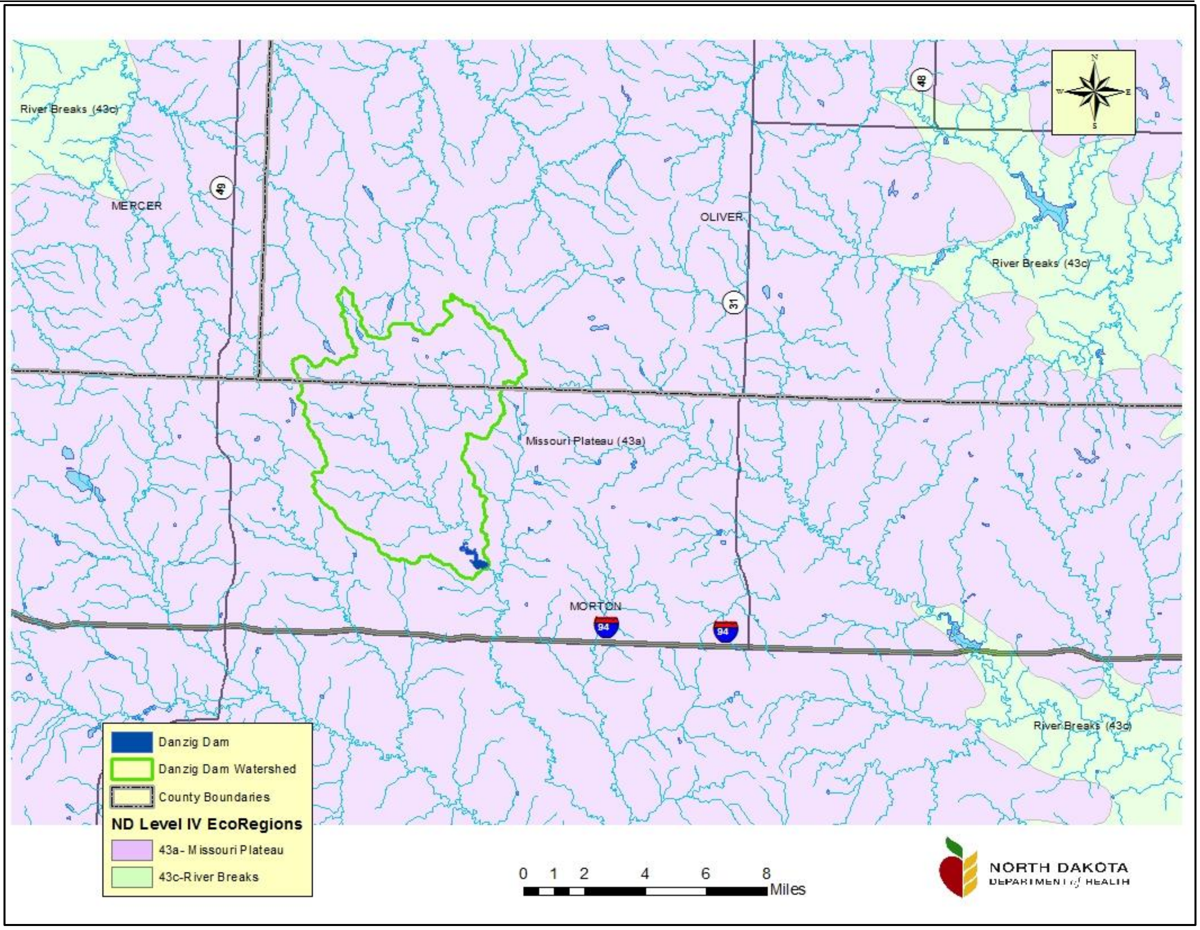

Figure 3. Level IV Ecoregion for the Danzig Dam Watershed.

Land use data obtain from the National Agricultural Statistics Service (NASS) in 2012 indicates that the Danzig Dam watershed is primarily agricultural (95.1 percent), consisting of crop production and livestock grazing. Approximately, 60 percent of the watershed is actively cultivated, with wheat, sunflowers and corn the primary crops grown. Thirty-four (34) percent is in pasture/range/haylands (Tables 3 and 4, Figure 4).

Table 3. Major Land Use Categories in the Danzig Dam Watershed (based on 2012 NASS data).

Major Category	Acres	Percent of Watershed
Cultivated Agriculture	16,767	60.41
Rangeland/Hay	9,498	34.22
Alfalfa	82	0.30
Bare/Urban/Fallow	980	3.53
Water	349	1.26
Trees/Shrubs	78	0.28

Table 4. Land Use Types in the Danzig Dam Watershed (based on 2012 NASS data).

Land Use Type	Acres	Percent of Watershed
Hay/Pasture	9,498	34.22
Alfalfa	82	0.30
Wheat (Spring,Winter, Durum. etc.)	9,567	34.47
Sunflowers	5,173	18.64
Corn	1,365	4.92
Oil Seeds (Flax,Canola, etc.)	400	1.44
Other Small Grains	226	0.81
Beans/Peas	36	0.13
Urban/ Development	929	3.35
Water	349	1.26
Trees/Shrub	78	0.28
Bare/Fallow	51	0.18
TOTAL	27,754	100

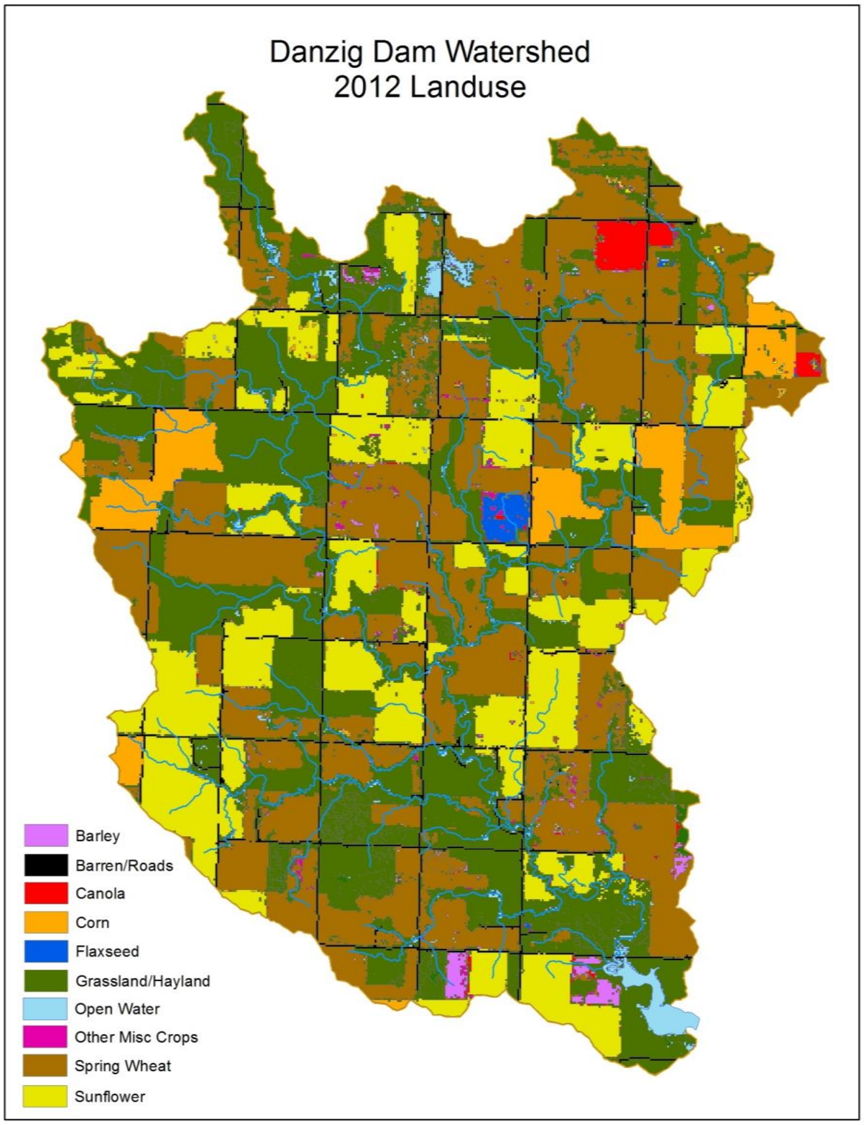

Figure 4. National Agricultural Statistical Survey (2012) Land Use Map for the Danzig Dam Watershed.

1.4 Climate and Precipitation

The climate of Morton County is semi-arid characterized by warm summers with frequent hot days and occasional cool days. Winters are very cold, influenced by blasts of arctic air surging over the area. Average temperatures range from 10º F in the winter to 70º F in the summer. Precipitation occurs primarily during the warm period and is normally heavy in late spring and early summer. Total average annual precipitation for Morton County is about 17 inches. About 14 inches, or 80 percent, of rain falls between April and September. Average annual snowfall is about 34 inches. Figures 5 and 6 show the total monthly precipitation for the project period (2011-2012) and historic average monthly precipitation (1893-2013) for the area as represented by the High Plains Regional Climate Center (HPRCC) weather station located near New Salem, ND, eight miles to the southwest of the watershed.

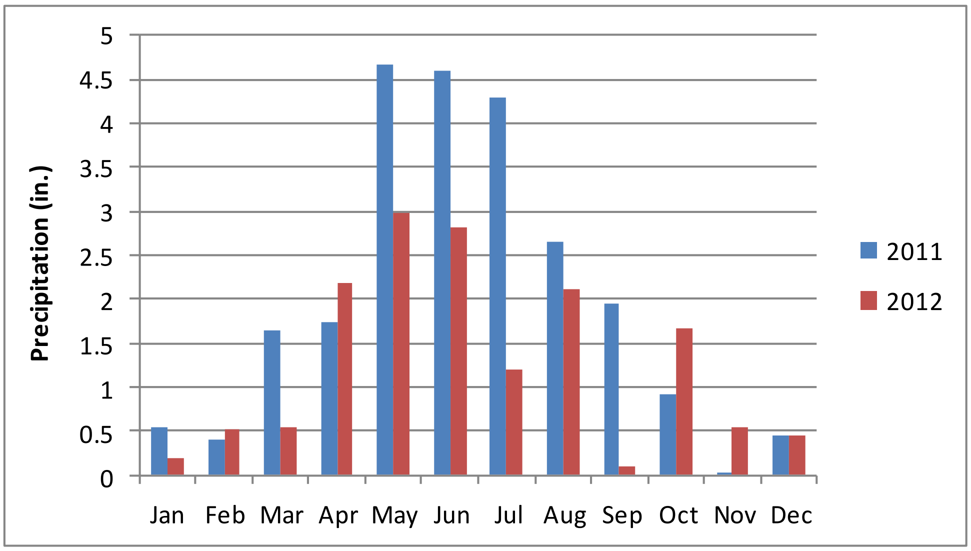

Figure 5. Total Monthly Precipitation (2011-2012) , HPRCC Weather Station, New Salem, ND.

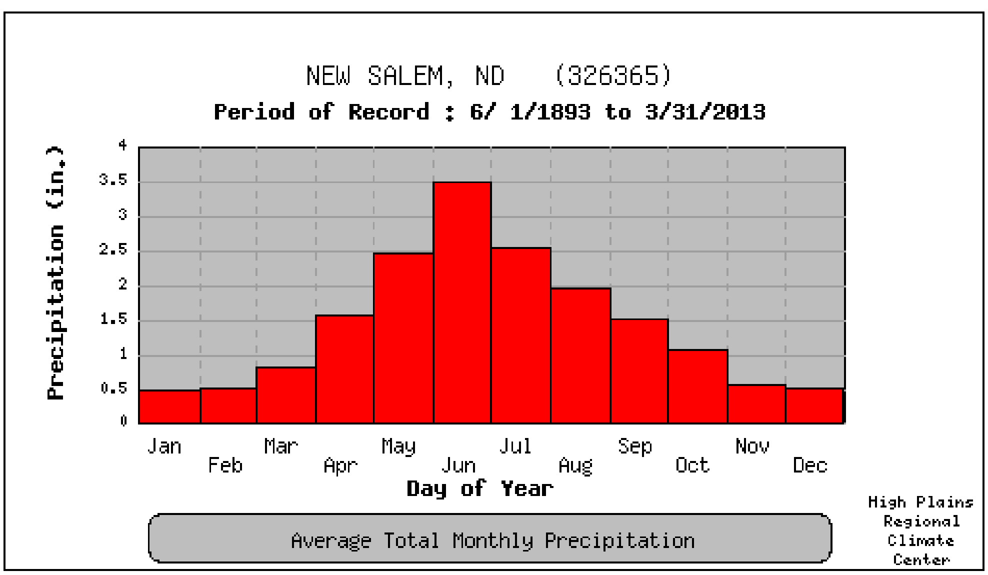

Figure 6. Average Monthly Precipitation (1893-2013), HPRCC Weather Station, New Salem, ND.

1.5 Available Water Quality Data

In 2010, the reservoir was listed on the state's 303(d) list of impaired waters as fully supporting, but threatened for the beneficial uses of recreation and fish and other aquatic biota, due to eutrophication from excessive nutrient loading, low dissolved oxygen and sedimentation.

In 2011, the Morton County Soil Conservation District (SCD) sponsored a water quality assessment and TMDL development project. Based on the sampling plan and procedures described in the Quality Assurance Project Plan (QAPP) (NDDoH, 2011), the SCD collected water quality data at an inlet site (385562), an outlet site (385563), and at one site located in the deepest area of the reservoir (381415) (Figure 7 and Table 5).

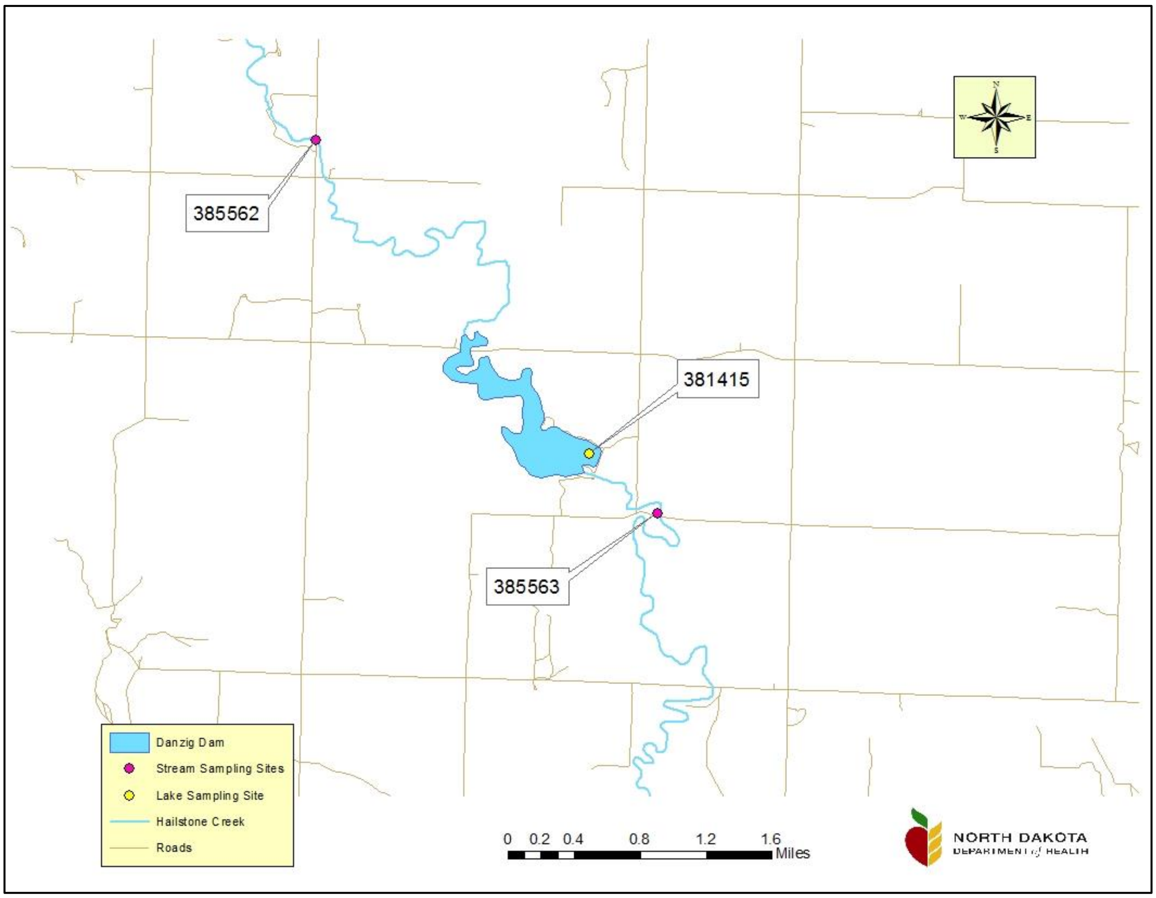

Figure 7. Stream and Lake Sampling Sites for Danzig Dam.

Table 5. General Information on Water Quality Sampling Sites for Danzig Dam.

Sample Site	Site ID	Dates Sampled		Latitude	Longitude
		Start	End		
Stream Sites					
Inlet	385562	April 2011	August 2012	46.923483	-101.638106
Outlet	385563	April 2011	July 2012	46.891713	-101.592709
Lake Site					
Deepest	381415	February 2011	September 2012	46.89672	-101.601650

1.5.1 Stream Water Quality Monitoring

Water quality samples and discharge measurements were taken from the stream sites. Stream parameters analyzed included total nitrogen, total Kjeldahl nitrogen, nitrate-nitrite, ammonia, total phosphorus, and total suspended solids (Tables 6 and 7). Sampling frequency for the stream sampling sites was stratified to coincide with the typical hydrograph for the region. This sampling design resulted in more frequent samples collected during spring and early summer (up to twice a week), typically when stream discharge is greatest, and less frequent samples collected during the summer and fall (once a week or less). Sampling was discontinued during the winter during ice cover. Stream sampling was also terminated if the stream stopped flowing. If the stream began to flow again, water quality sampling was reinitiated.

1.5.2 Stream Discharge

Mean daily discharge was computed from hourly stream stage recordings and discharge rating curves developed for each stream site by the USGS.

Table 6. Summary of Stream Sampling Data, Site 385562 (Inlet).

Parameter (mg/L)	N	Average	Minimum	Maximum	Median
Total Nitrogen	37	1.64	0.94	2.83	1.58
Total Kjeldahl Nitrogen	37	1.48	0.87	1.93	1.51
Nitrate/Nitrite	37	0.160	0.015	1.190	0.015
Ammonia	37	0.026	0.015	0.150	0.015
Total Phosphorus	37	0.090	0.041	0.186	0.080
Total Suspended Solids	36	8.5	2.5	29.0	7.0

Table 7. Summary of Stream Sampling Data, Site 385563 (Outlet).

Parameter (mg/L)	N	Average	Minimum	Maximum	Median
Total Nitrogen	32	1.64	0.53	3.13	1.59
Total Kjeldahl Nitrogen	32	1.47	0.52	2.76	1.52
Nitrate/Nitrite	32	0.171	0.015	1.960	0.030
Ammonia	32	0.068	0.015	0.464	0.037
Total Phosphorus	32	0.141	0.056	0.272	0.132
Total Suspended Solids	31	18.4	6.0	72.0	16.0

1.5.3 Reservoir Water Quality Monitoring

Reservoir water quality monitoring was conducted by the Morton County SCD at one site located in the deepest area of Danzig Dam (381415). Monthly samples were collected between February 2011 and September 2012. The reservoir was sampled twice per month in June and August of 2011.

The Morton County SCD followed the methodology for water quality sampling found in the QAPP for the Hailstone Creek and Danzig Dam TMDL Development and Watershed Assessment Project (NDDoH, 2011).

Nutrient and Chlorophyll-a Data

Based on the data collected in 2011 and 2012, the average total phosphorus concentration for Danzig Dam was 0.113 mg/L. The average total nitrogen concentration was 1.839 mg/L. Since the TMDL target is based on the average growing season chlorophyll-a concentration, statistics were calculated using data collected between April and November. A summary of nutrient and chlorophyll-a data is provided in Table 8.

Secchi Disk Transparency Data

Secchi disk transparency data were collected during the open water period between May 2011 and September 2012. The average Secchi disk transparency was 0.82 meters. The maximum Secchi disk transparency measurement recorded was on July 18, 2011 (2.5 meters), while the minimum measurement was recorded on May 23, 2011 (0.25 meters) (Table 8).

Table 8. Summary of Reservoir Sampling Data, Site 381415 (Deepest Area).

Parameter	N	Average	Minimum	Maximum	Median
Total Phosphorus (mg/L)	16	0.113	0.050	0.218	0.110
Total Nitrogen (mg/L)	16	1.839	1.540	2.310	1.805
Total Kjeldahl Nitrogen (mg/L)	16	1.731	1.075	2.710	1.654
Nitrate/Nitrite (mg/L)	16	0.108	0.015	1.080	0.015
Chlorophyll-a (µg/L)*	11	14.80	0.750	35.20	14.20
Secchi Disk (meters)	12	0.82	0.25	2.50	0.75

*Growing Season, April - November

Dissolved Oxygen and Temperature Data

Dissolved oxygen and temperature were monitored at the deepest site on Danzig Dam from February 2011 through January 2012. Measurements were taken at one meter depth intervals during ice cover and open water periods each time a water quality sample was collected. Figures 8 and 9 illustrate the dissolved oxygen and temperature profiles for the assessment period.

The reservoir thermally stratified in late winter and early spring, and again briefly in July. Thermal stratification is part of a natural cycle in lakes and reservoirs and occurs because of a change in water’s density with temperature. The result is two layers of water with a rapid zone of decreasing temperature between them, usually greater than one degree in half a meter. These distinct layers mean that mixing is not complete throughout the lake profile (i.e. from top to bottom).

Dissolved oxygen levels were below the state water quality standard of 5.0 mg/L in February, March, and May of 2011. Levels dropped to just slightly above the standard in July and early August and then were well above the standard in December of 2011 and January of 2012. These data show intermittent problems with dissolved oxygen levels.

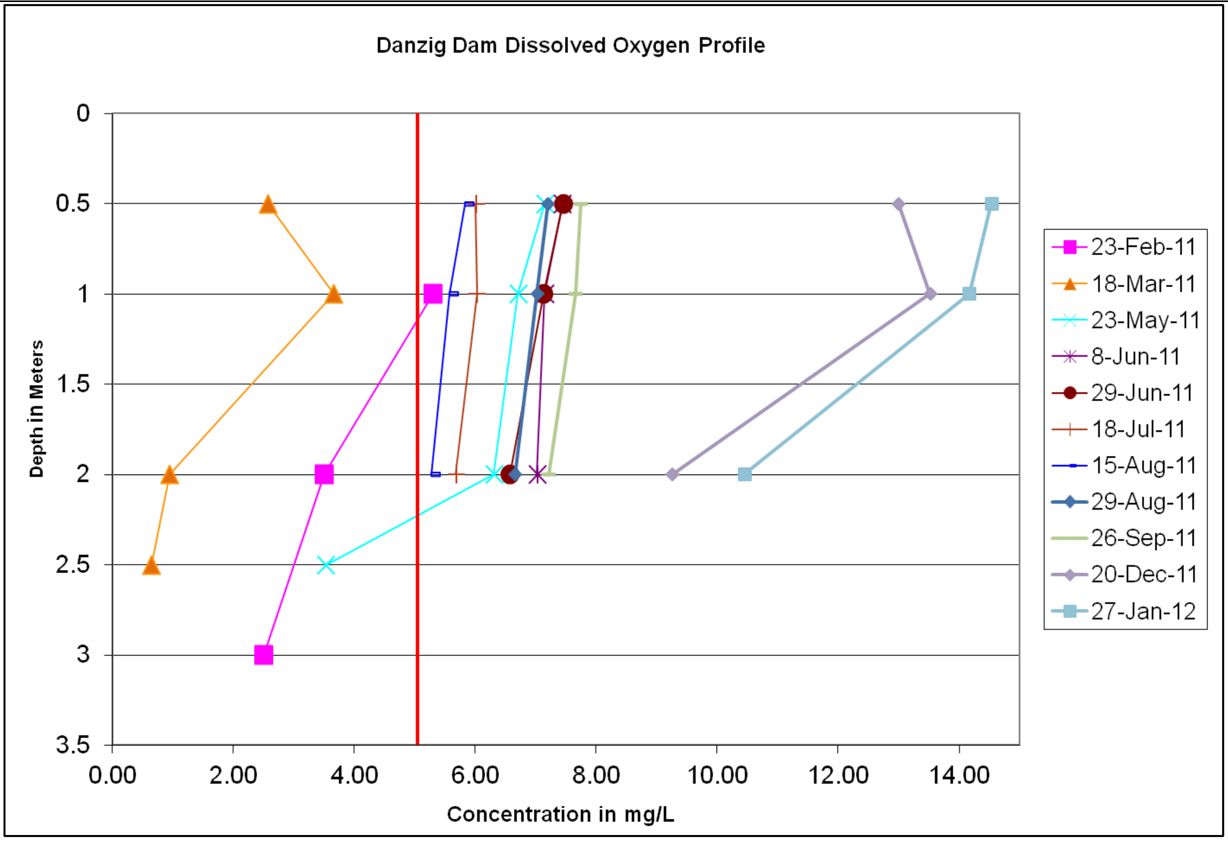

Figure 8. Dissolved Oxygen Profiles for Danzig Dam (2011-2012).

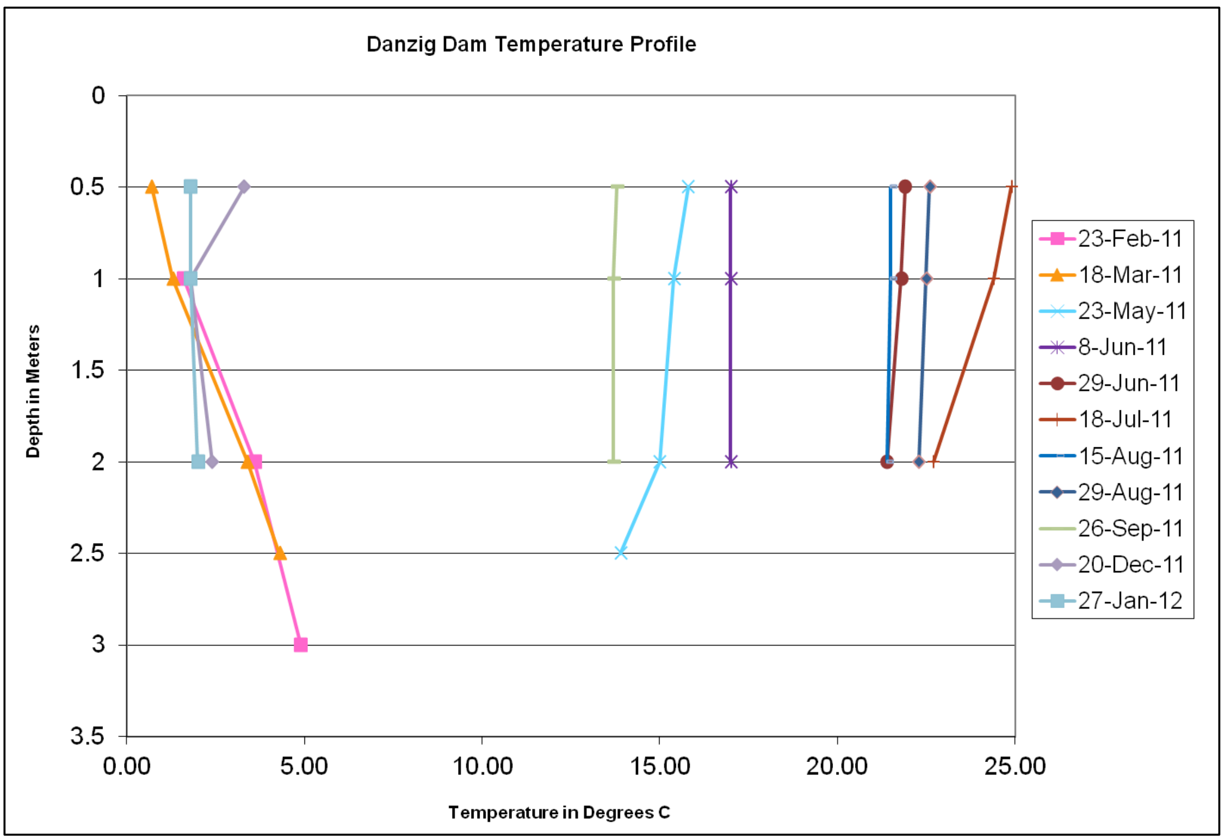

Figure 9. Temperature Profiles for Danzig Dam (2011-2012).

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, sediment).

2.1 Narrative Water Quality Standards

The NDDoH has set narrative water quality standards, which apply to all surface waters in the state. The narrative standards pertaining to nutrient impairments are listed below (NDDoH, 2014b).

- All waters of the state shall be free from substances attributable to municipal, industrial, or other discharges or agricultural practices in concentrations or combinations which 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:
  1) Cause a public health hazard or injury to environmental resources;
  2) Impair existing or reasonable beneficial uses of the receiving waters; or
  3) 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, 2014b).

2.2 Numeric Water Quality Standards

Danzig Dam is classified as a Class 3 warm water fishery. Class 3 fisheries are defined as waterbodies “capable of supporting natural reproduction and growth of warm water fishes (i.e. largemouth bass and bluegill) and associated aquatic biota. Some cool water species may also be present” (NDDoH, 2014b). All classified lakes in North Dakota are assigned aquatic life, recreation, irrigation, livestock watering, and wildlife beneficial uses. The North Dakota State Water Quality Standards (NDDoH, 2014b) state that lakes shall use the same numeric criteria as Class 1 streams, including the state standard for dissolved nitrate as N, of 1.0 mg/L, where up to 10 percent of samples may exceed the 1.0 mg/L. State standards also state that the numeric dissolved oxygen standard of five mg/L as a daily minimum does not apply to the hypolimnion of class 3 and 4 lakes and reservoirs during periods of thermal stratification. As a guideline for lake and reservoir improvement, a chlorophyll-a concentration of 20 µg/L, during the growing season of April – November, is used (Table 9).

Table 9. Numeric Standards Applicable for North Dakota Lakes and Reservoirs (NDDoH , 2014b).

State Water Quality Standard	Parameter	Guidelines	Limit
Numeric Standard for Class I Streams and Classified Lakes	Nitrates (dissolved)	1.0 mg/L	Maximum allowed[1]
Numeric Standard	Dissolved Oxygen	5.0 mg/L	Daily Minimum[2]
Guidelines for Goals in a Lake Improvement or Maintenance Program	Chlorophyll-a	20 µg/L	Goal[3]

[1] "Up to 10% of samples may exceed"
[2] Does not apply to the hypolimnion of Class 3 and 4 lakes and reservoirs during periods of thermal stratification
[3] During the growing season of April through November

3.0 TMDL TARGETS

A TMDL target is the value that is measured to judge the success of the TMDL effort. TMDL targets should 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 sections summarize water quality targets for Danzig Dam based on its linkage to maintaining and attaining all of the reservoir's beneficial uses. When the specific target is met, then the reservoir will meet the applicable water quality standards, including its designated beneficial uses.

3.1 TSI Target Based on Chlorophyll-a

The state's narrative water quality standards (see Section 2.1) form the basis for aquatic life and recreation use assessment for Section 305(b) reporting and Section 303(d) TMDL listing. In the case of this TMDL, the state's narrative water quality standards also form the basis for setting the TMDL target. State water quality standards contain narrative criteria that require lakes and reservoirs to be "free from" substances "which are toxic or harmful to humans, animals, plants, or resident aquatic biota" or are "in sufficient amounts to be unsightly or deleterious." Narrative standards also prohibit the "discharge of pollutants" (e.g., organic enrichment, nutrients, or sediment), "which alone or in combination with other substances, shall impair existing or reasonable beneficial uses of the receiving waters."

Trophic status is a measure of the productivity of a lake or reservoir and is directly related to the level of nutrients (i.e., phosphorus and nitrogen) entering the lake or reservoir from its watershed and/or from the internal recycling of nutrients. Highly productive lakes, termed "hypereutrophic," contain excessive phosphorus and are characterized by dense growths of weeds, blue-green algal blooms, low transparency, and low dissolved oxygen (DO) concentrations. These lakes experience frequent fish kills and are generally characterized as having excessive rough fish populations (carp, bullhead, and sucker) and poor sport fisheries (Table 10). Due to the frequent algal blooms and excessive weed growth, these lakes are also undesirable for recreational uses such as swimming and boating.

Mesotrophic and eutrophic lakes, on the other hand, generally have lower phosphorus concentrations, low to moderate levels of algae and aquatic plant growth, high transparency, and adequate DO concentrations throughout the year. Mesotrophic lakes do not experience algal blooms, while eutrophic lakes may occasionally experience algal blooms of short duration, typically a few days to a week.

Table 10. Water Quality and Beneficial Use Changes That Occur as the Amount of Algae (expressed as Chlorophyll-a concentration) Changes Along the Trophic State Gradient (from Carlson and Simpson, 1996).

TSI Score	Chlorophyll-a (ug/L)	Secchi Disk Transparency (m)	Total Phosphorus (mg/L)	Attributes	Fisheries & Recreation
<30	<0.95	>8	<0.006	**Oligotrophy**: Clear water, oxygen throughout the year in the hypolimnion	Salmonid fisheries dominate
30-40	0.95-2.6	8-4	0.006-0.012	Hypolimnia of shallower lakes may become anoxic	Salmonid fisheries in deep lakes only
40-50	2.6-7.3	4-2	0.012-0.024	**Mesotrophy**: Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60	7.3-20	2-1	0.024-0.048	**Eutrophy**: Anoxic hypolimnia, macrophyte problems possible	Warm-water fisheries only. Bass may dominate.
60-70	20-56	0.5-1	0.048-0.096	Blue-green algae dominate, algal scums and macrophyte problems	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating.
70-80	56-155	0.25-0.5	0.096-0.192	**Hypereutrophy**: (light limited productivity). Dense algae and macrophytes	
>80	>155	<0.25	0.192-0.384	Algal scums, few macrophytes	Rough fish dominate; summer fish kills possible

Therefore, for purposes of this TMDL report, it can be concluded that hypereutrophic lakes do not fully support a sustainable sport fishery and are limited in recreational uses, whereas eutrophic and mesotrophic lakes fully support both aquatic life and recreation use.

Carlson's Trophic State Indices (TSIs), based on Secchi disk depth (transparency), chlorophyll-a concentration, and total phosphorus concentration, are indicators used to assess the level of productivity of a lake or reservoir (Carlson, 1977). Due to the relationship between trophic status indicators and the aquatic community (as reflected by the fishery) or between trophic status indicators and the frequency of algal blooms, trophic status is an effective indicator of aquatic life and recreation use support in lakes and reservoirs.

While the three trophic state indicators, chlorophyll-*a*, Secchi disk transparency, and total phosphorus, used in Carlson's TSI each independently estimate algal biomass and should produce the same index value for a given combination of variable values, they often do not. While transparency and phosphorus may co-vary with trophic state, many times the changes observed in a lake's transparency are not caused by changes in algal biomass, but may be due to particulate sediment suspended in the water column. Total phosphorus may or may not be strongly related to algal biomass due to light limitation and/or nitrogen and carbon limitation. Therefore, neither transparency nor phosphorus is an independent estimator of trophic state (Carlson and Simspon, 1996). For these reasons, the NDDoH gives priority to chlorophyll-*a* as the primary trophic state indicator because this variable is the most accurate of the three at predicting algal biomass (Carlson, 1980).

The same conclusion was also reached by a multi-state project team consisting of lake managers and water quality specialists from North Dakota, South Dakota, Montana, Wyoming and EPA Region 8. This group concluded that for lakes and reservoirs in the plains region of EPA Region 8, an average growing season (April – November) chlorophyll-a concentration of 20 µg/L or less should be the basis for nutrient criteria development for lakes and reservoirs in the plains region (including North Dakota) and that this chlorophyll-a target would be protective of all of a lake or reservoir's beneficial uses, including recreation and aquatic life (Houston Engineering, 2011). The report, prepared by Houston Engineering, also concluded that most lakes and reservoirs in the plains region typically have high total phosphorus concentrations, but maintain relatively low productivity, and that due to this condition, chlorophyll-a is a better measure of a lake or reservoirs trophic status than is total phosphorus (Houston Engineering, 2011).

Water quality data collected in the reservoir in 2011 and 2012 showed an average growing season chlorophyll-a concentration of 14.2 µg/L (TSI Score=56.6) and an average Secchi transparency depth of 0.82 meters (TSI Score=62.9). Based on these data, Danzig Dam is generally assessed as a eutrophic lake (Table 11).

Based only on the total phosphorus data and corresponding TSI value of 72.2, Danzig Dam would be considered a slightly hypereutrophic reservoir (Table 11, Figure 10). However, Carlson and Simpson (1996) suggest that if the phosphorus TSI value is higher than the chlorophyll-a and Secchi disk transparency TSI value (as is the case with Danzig Dam), then algae does not dominate light attenuation, and some other factor, such as nitrogen limitation, zooplankton grazing, or toxics may be limiting algal biomass in the lake (Table 12).

Table 11. Carlson's Trophic State Indices for Danzig Dam.

Parameter	Relationship	Units	TSI Value	Trophic Status
Chlorophyll-a	TSI (Chl-a) = 30.6 + 9.81[ln(Chl-a)]	µg/L	56.6	Eutrophic
Total Phosphorus (TP)	TSI (TP) = 4.15 + 14.42[(ln(TP)]	µg/L	72.2	Hypereutrophic
Secchi Depth (SD)	TSI (SD) = 60 - 14.41[ln(SD)]	Meters	62.9	Eutrophic

TSI < 30 - Oligotrophic (least productive) TSI 30-50 Mesotrophic
TSI 50-65 Eutrophic TSI > 65 - Hypereutrophic (most productive)

Table 12. Relationships Between TSI Variables and Conditions (from Carlson and Simpson, 1996).

Relationship Between TSI Variables	Conditions
TSI(Chl) = TSI(TP) = TSI(SD)	Algae dominate light attenuation; TN/TP ~ 33:1
TSI(Chl) > TSI(SD)	Large particulates, such as *Aphanizomenon* flakes, dominate
TSI(TP) = TSI(SD) > TSI(CHL)	Non-algal particulates or color dominate light attenuation
TSI(SD) = TSI(CHL) > TSI(TP)	Phosphorus limits algal biomass (TN/TP >33:1)
TSI(TP) >TSI(CHL) = TSI(SD)	Algae dominate light attenuation but some factor such as nitrogen limitation, zooplankton grazing or toxics limit algal biomass.

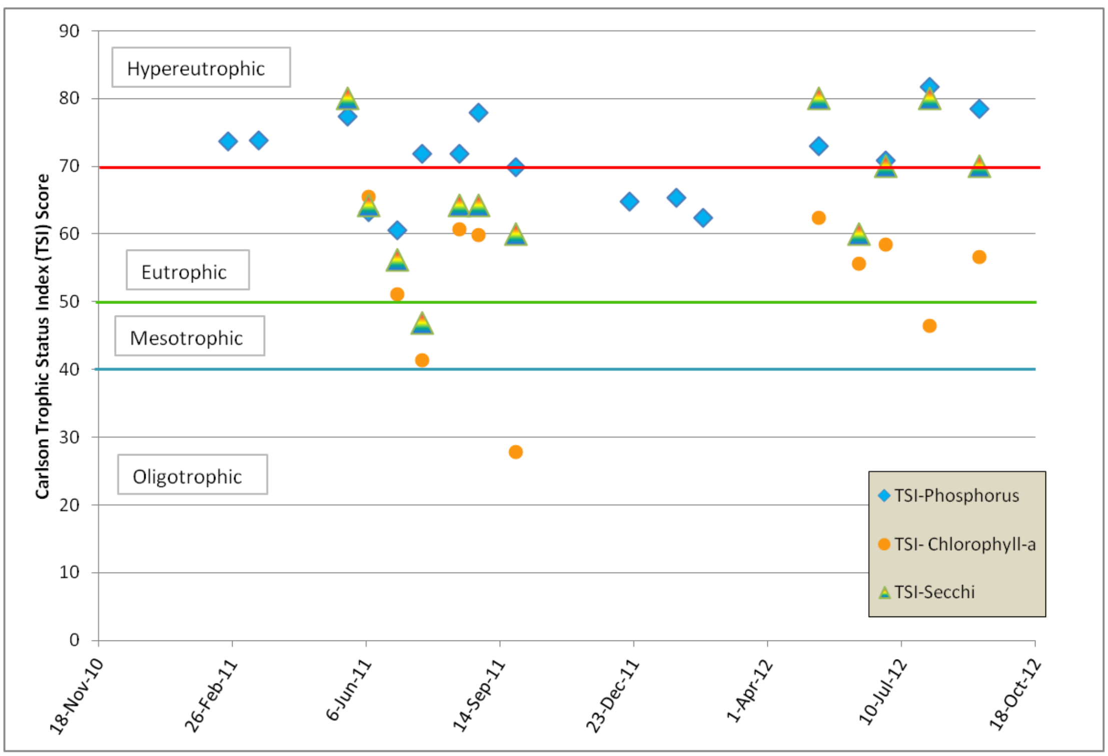

Figure 10. Temporal Distribution of Carlson's TSI Scores for Danzig Dam.

As stated previously, the NDDoH has established an in-lake growing season average chlorophyll-a concentration goal of 20 µg/L for most lake and reservoir nutrient TMDLs, including this TMDL for Danzig Dam. This chlorophyll-a goal corresponds to a chlorophyll-a TSI of 60 which is in the eutrophic range and, as such, will be a trophic state sufficient to maintain both aquatic life and recreation uses of most lakes and reservoirs in the state, including Danzig Dam.

Through the use of a calibrated water quality model like BATHTUB, the total phosphorus load corresponding to an average chlorophyll-a concentration of 20 µg/L can be estimated. Since the observed average chlorophyll-a concentration for Danzig Dam is estimated to be 14.2 µg/L, the TMDL goal and the TMDL equation presented in Section 7.0 was developed assuming no future degradation of water quality within the lake (i.e., a lake protection strategy). Based on this assumption the TMDL target is the predicted average growing season chlorophyll-a concentration of 13.5 µg/L which corresponds to a 10 percent reduction in the current nutrient load.

3.2 Dissolved Oxygen Target

The North Dakota State Water Quality Standard for dissolved oxygen is 5.0 mg/L as a daily minimum, with up to ten percent of representative samples collected during any three year period occurring below this value provided lethal conditions are avoided. This will be the dissolved oxygen target for Danzig Dam.

Based on the 2001 and 2012 data, excluding the samples from a thermally stratified hypolimnion, dissolved oxygen concentrations were below the state standard of 5.0 mg/L in only two of 30 samples, or seven percent (Appendix A). This also supports the lake protection strategy mentioned in Section 3.1.

4.0 SIGNIFICANT SOURCES

There are no known point sources upstream of Danzig Dam. The pollutants of concern originate from nonpoint sources.

5.0 TECHNICAL ANALYSIS

Establishing a relationship between in-lake water quality targets and pollutant source loading is a critical component of TMDL development. Identifying the cause-and-effect relationship between pollutant loads and the water quality response is necessary to evaluate the loading capacity of the receiving waterbody. The loading capacity is the amount of a pollutant that can be assimilated by the waterbody while still attaining and maintaining water quality standards. This section discusses the technical analysis used to estimate existing loads to Danzig Dam and the predicted trophic response of the reservoir to reductions in loading capacity.

5.1 Tributary Load Analysis

To facilitate the management and analysis of tributary inflow and outflow water quality and flow data the FLUX program was employed. The FLUX program, developed by the US Corps of Engineers Waterways Experiment Station (Walker, 1996), provides the user with six calculation techniques to estimate the average mass discharge or loading that passes a given river or stream site. FLUX estimates loadings based on grab sample chemical concentrations and the continuous daily flow record. Load is therefore defined as the mass of a pollutant during a given time period (e.g., hour, day, month, season, year). The FLUX program allows the user, through various iterations, to select the most appropriate load calculation technique and data stratification scheme, either by flow or date, which will give a load estimate with the smallest statistical error, as represented by the coefficient of variation. Output from the FLUX program is then provided as an input file to calibrate the BATHTUB eutrophication response model. For a complete description of the FLUX program the reader is referred to Walker (1996).

5.2 BATHTUB Trophic Response Model

The BATHTUB model (Walker, 1996) was used to predict and evaluate the effects of various nutrient load reduction scenarios on Danzig Dam. BATHTUB performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network. The model accounts for advective and diffusive transport and nutrient sedimentation. Eutrophication related water quality conditions are predicted using empirical relationships previously developed and tested for reservoir applications.

The BATHTUB model is developed in three phases. The first two phases involve the analysis and reduction of the tributary and in-lake water quality data. The third phase involves model calibration. In the data reduction phase, the in-lake and tributary monitoring data collected as part of the project were summarized in a format which serves as an input to the model.

The tributary data were analyzed and reduced by the FLUX program. FLUX uses tributary inflow and outflow water quality and flow data to estimate average mass discharge or loading that passes a river or stream site using six calculation techniques. Load is therefore defined as the mass of pollutant during a given unit of time. The FLUX model then allows the user to pick the most appropriate load calculation technique with the smallest statistical error. Output for the FLUX program is then used to calibrate the BATHTUB model.

The reservoir data were reduced in Microsoft Excel using three computational functions. These include: 1) the ability to display concentrations as a function of depth, location, and date; 2) summary statistics (e.g., mean, median, etc.); and 3) evaluation of the trophic status. The output data from the Excel program were then used as input to calibrate the BATHTUB model.

When the input data from FLUX and Excel programs are entered in to the BATHTUB model, the user has the ability to compare predicted conditions (model output) to actual conditions using general rates and factors. The BATHTUB model is then calibrated by combining tributary load estimates for the project period with in-lake water quality estimates. The model is termed calibrated when the predicted estimates for the trophic response variables are similar to the observed estimates based on data collected during the 2011-2012 assessment project. BATHTUB then has the ability to predict total phosphorus and nitrogen concentrations, chlorophyll-*a* concentration, and Secchi disk depth and the associated TSI scores as a means of expressing trophic response.

As stated above, BATHTUB can compare predicted vs. actual conditions. After calibration, the model was run based on observed concentrations of phosphorus and nitrogen to derive an estimated annual average total phosphorus and total nitrogen load of 733.8 kg and 13,012.2 kg, respectively. The model was then run to evaluate the effectiveness of a number of nutrient reduction alternatives, including: 1) reducing externally derived nutrient loads; 2) reducing internally available nutrients; and 3) reducing both external and internal nutrient loads. (See Appendix B for more detail).

In the case of Danzig Dam, BATHTUB was used to model the reservoir's trophic status response based on reductions in externally derived phosphorus and nitrogen loading. Phosphorus and nitrogen were both used in the simulation model based on their known relationship to eutrophication and also that they are controllable with Best Management Practices (BMPs) implemented in the watershed. Changes in trophic response were evaluated by reducing externally derived nutrient (phosphorus and nitrogen) loading by 10, 25, 50, and 75 percent (Table 13). Simulated reductions in chlorophyll-*a*, Secchi disk depth, and total phosphorus-based TSI scores were achieved by reducing phosphorus and nitrogen concentrations in contributing tributaries and other externally delivered sources. Flow was held constant due to uncertainty in estimating changes in hydraulic discharge with the implementation of BMPs.

Table 13. Observed and Model Predicted Values for Selected Trophic Response Variables Assuming a 10, 25, 50 and 75 Percent Reduction in External Phosphorus and Nitrogen Loading.

Variable	Observed	Predicted Current	Predicted Reduction			
			10%	25%	50%	75%
Total Phosphorus as P (mg/L) [1]	0.113	0.113	0.102	0.085	0.058	0.030
Total Nitrogen as N (mg/L) [1]	1.839	1.839	1.663	1.398	0.957	0.517
TN:TP Ratio	16.3	16.3	16.3	16.4	16.5	17.2
Chlorophyll-*a* (μg/L)[1]	14.2	15.0	13.5	11.3	7.7	4.0
Secchi Disk Depth (meters)[1]	0.82	0.80	0.9	1.0	1.5	3.0
Carlson's TSI for Phosphorus	72.2	72.3	70.8	68.3	62.6	53.2
Carlson's TSI for Chlorophyll-*a*	56.6	57.2	56.2	54.4	50.6	44.2
Carlson's TSI for Secchi Disk	62.9	63.4	62.0	59.4	53.8	44.4

[1] Average

In order to keep the predicted chlorophyll-a concentration from going above the current observed average (no degradation) for Danzig Dam and to account for the variability in chlorophyll-a between the observed and predicted value, using the BATHTUB model 10% reduction in external total phosphorus and nitrogen load would be the best lake protection strategy. This would result in the total phosphorus load being reduced from 733.8 kg/yr to 662.0 kg/year and total nitrogen load being reduced from 13,012.2 kg/year to 11,764.7

kg/year. The reduction would result in the predicted chlorophyll-a average of 13.5 μg/L with all TSI targets near or below the eutrophic level (Figure 11).

It is generally accepted that a total nitrogen (TN) to total phosphorus (TP) ratio of 14:1 is an optimal balance in freshwater ecosystems and that ratios greater than 14:1 is phosphorus limited and less than 14:1 is nitrogen limiting (Downing and McCauley, 1996). A 10 percent reduction in total phosphorus and total nitrogen loading will also maintain a TN:TP ratio of 16.3:1 which is considered slightly phosphorus limited (Table 13).

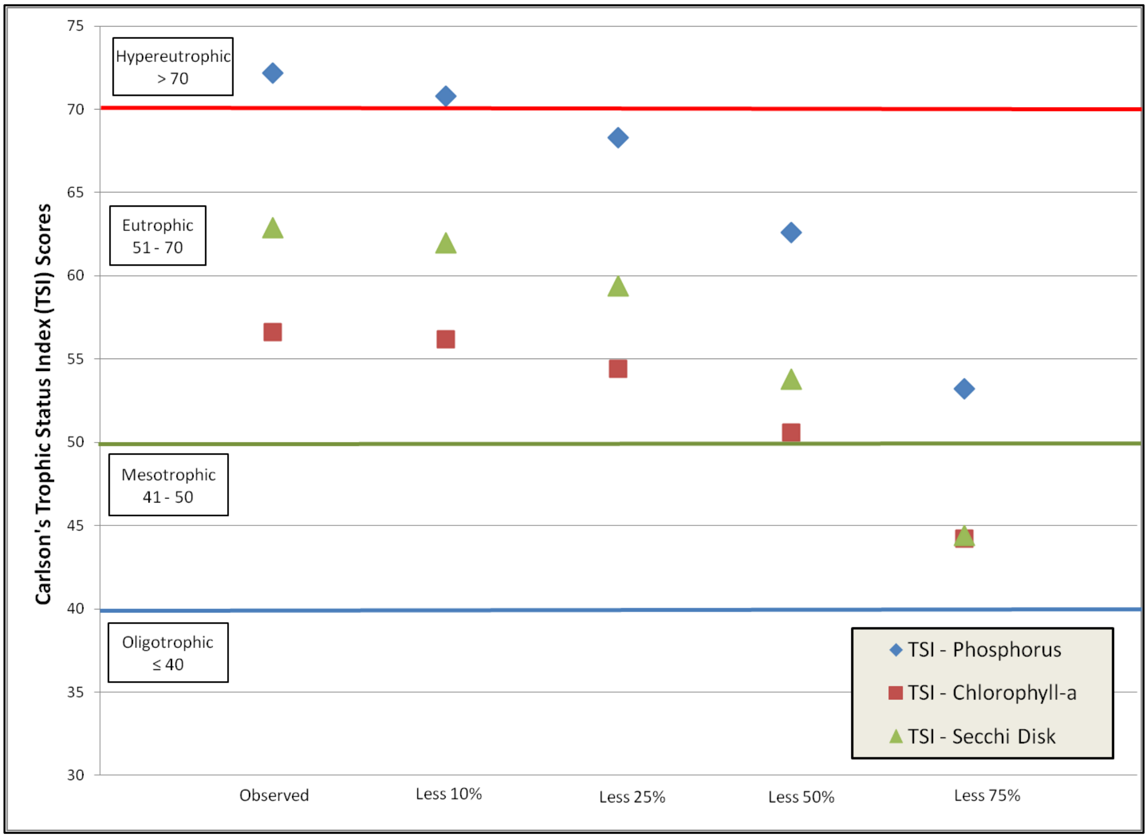

Figure 11. Predicted Trophic Response Measured by Carlson's TSI Scores to Phosphorus and Nitrogen Load Reductions of 10, 25, 50 and 75 Percent.

5.3 AnnAGNPS Watershed Model

The Annualized Agricultural NonPoint Source Pollution (AnnAGNPS) model was developed by the USDA Agricultural Research Service and Natural Resource Conservation Service (NRCS). The AnnAGNPS model consists of a system of computer models used to predict nonpoint source pollution (NPS) loadings within agricultural watersheds. The continuous simulation surface runoff model contains programs for: 1) input generation and editing; 2) "annualized" pollutant loading model; and 3) output reformatting and analysis.

The AnnAGNPS model uses batch processing, continual-simulation, and surface runoff pollutant loading to generate amounts of water, sediment, and nutrients moving from land areas (cells) and flowing into the watershed stream network at user specified locations (reaches) on a daily basis. The water, sediment, and chemicals travel throughout the specified watershed outlets. Feedlots, gullies, point sources, and impoundments are special components that can be included in the cells and reaches. Each component adds water, sediment, or nutrients to the reaches.

The AnnAGNPS model is able to partition soluble nutrients between surface runoff and infiltration. Sediment-attached nutrients are also calculated in the stream system. Sediment is divided into five particle size classes (clay, silt, sand, small aggregate, and large aggregate) and are moved separately through the stream reaches.

AnnAGNPS uses various models to develop an annualized load in the watershed. These models account for surface runoff, soil moisture, erosion, nutrients, and reach routing. Each model serves a particular purpose and function in simulating the NPS processes occurring in the watershed.

To generate surface runoff and soil moisture, the soil profile is divided into two layers. The top layer is used as the tillage layer and has properties that change (bulk density, etc.). While the remaining soil profile makes up the second layer with properties that remain static. A daily soil moisture budget is calculated based on rainfall, irrigation, and snow melt runoff, evapotranspiration, and percolation. Runoff is calculated using the NRCS Runoff Curve Number equation. These curve numbers can be modified based on tillage operations, soil moisture, and crop stage.

Overland sediment erosion was determined using a modified watershed-scale version of Revised Universal Soil Loss Equation (RUSLE) (Gerter and Theurer, 1998).

A daily mass balance for nitrogen (N), phosphorus (P), and organic carbon (OC) are calculated for each cell. Major components of N and P considered include plant uptake N and P, fertilization, residue decomposition, and N and P transport. Soluble and sediment absorbed N and P are also calculated. Nitrogen and phosphorus are then separated into organic and mineral phases. Plant uptake N and P are modeled through a crop growth stage index (Bosch et. al. 1998).

The reach routing model moves sediment and nutrients through the watershed. Sediment routing is calculated based upon transport capacity relationships using the Bagnold stream power equation (Bagnold, 1966). Routing of nutrients through the watershed is accomplished by subdividing them into soluble and sediment attached components and are based on reach travel time, water temperature, and decay constant. Infiltration is also used to further reduce soluble nutrients. Both the upstream and downstream points of the reach are calculated for equilibrium concentrations by using a first order equilibrium model.

AnnAGNPS uses 34 different categories of input data and over 400 separate input parameters to execute the model. The input data categories can be split into five major classifications: climatic data, land characterization, field operations, chemical characteristics, and feedlot operations. Climatic data includes precipitation, maximum and minimum air temperature, relative humidity, sky cover, and wind speed. Land characterization consists of soil characterization, curve number, RUSLE parameters, and watershed drainage characterization. Field operations contain tillage, planting, harvest, rotation, chemical operations, and irrigation schedules. Finally, feedlot operations require daily manure rates, times of manure removal, and residue amount from previous operations.

Input parameters are used to verify the model. Some input parameters may be repeated for each cell, soil type, land use, feedlot, and channel reach. Default values are available for some input parameters, others can be simplified because of duplication. Daily climatic input data can be obtained through weather generators, local data, and/or both. Geographical input data including cell boundaries, land slope, slope direction, and land use can be generated by GIS or DEM (Digital Elevation Models).

Output data is expressed through an event based report for stream reaches and a source accounting report for land or reach components. Output parameters are selected by the user for the desired watershed source locations (specific cells, reaches, feedlots, point sources, or gullies) for any simulation period. Source accounting for land or reach components are calculated as a fraction of a pollutant load passing through any reach in the stream network that came from the user identified watershed source locations. Event based output data is defined as event quantities for user selected parameters at desired stream reach locations.

AnnAGNPS was utilized for the Danzig Dam Water Quality and Watershed Assessment project. The Danzig Dam watershed delineation began with downloading a 30-meter digital elevation model (DEM) of Morton County. Delineation is defined as drawing a boundary and dividing the land within the boundary into subwatersheds in such a matter that each subwatershed has uniformed hydrological parameters (land slope, elevation, etc.)

Land use and soil digital images were then used to extract the dominate identification of land use and soil for each subwatershed. This process is achieved by overlaying Landsat and soil images over the subwatershed file. Each dominant soil is then further identified by its physical and chemical soil properties found in a database called National Soils Information System (NASIS) developed by the NRCS. Dominant land use identification input parameters were obtained using Revised Universal Soil Loss Equation (RUSLE).

A three year simulation period was run on the Danzig Dam watershed at its present condition to provide a best estimation of the current land use practices applied to the soils and slopes of the watershed to obtain nutrient loads from the individual cells as well as the watershed as a whole. Crop rotations were determined from 2011 and 2012 crop data from the National Agricultural Statistical Service (NASS). Over 54 different crop rotations and 29 fertilizer application rates were used to simulate current watershed land use conditions within the Danzig Dam watershed.

Climate data was derived from the North Dakota Agricultural Weather Network (NDAWN) weather station located in New Salem, ND from January 2010 through December 2013.

The compiled data were used to assess the watershed to identify “critical cells” (those with the highest nutrient loads) located in the watershed for potential best management practice (BMP) implementation (Figures 12 and 13). Critical cells were determined to be cells in the watershed providing an estimated annual phosphorus yield of 0.056 lbs/acre/year or greater and/or an estimated annual nitrogen yield of 6.79 lbs/acre/year.

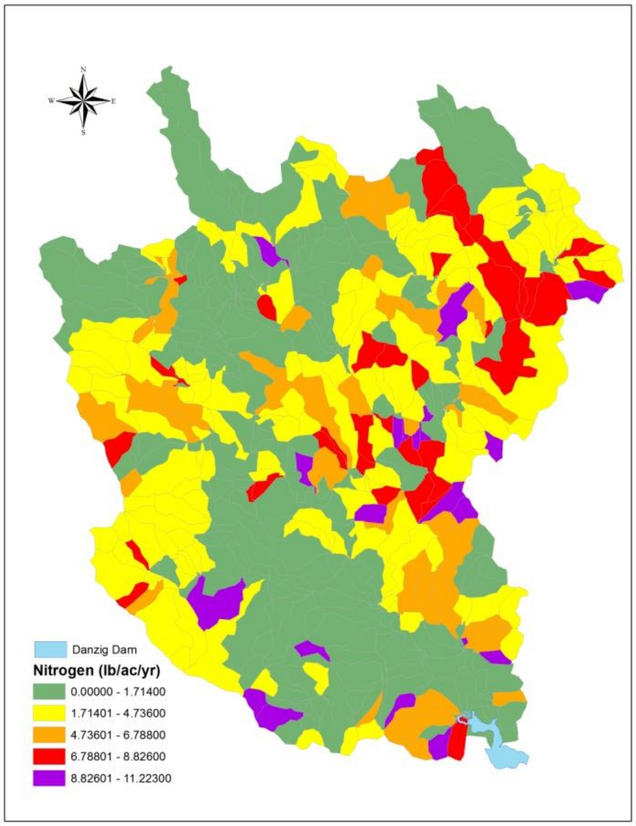

Figure 12. AnnAGNPS Modeled Nitrogen Yields in the Danzig Dam Watershed.

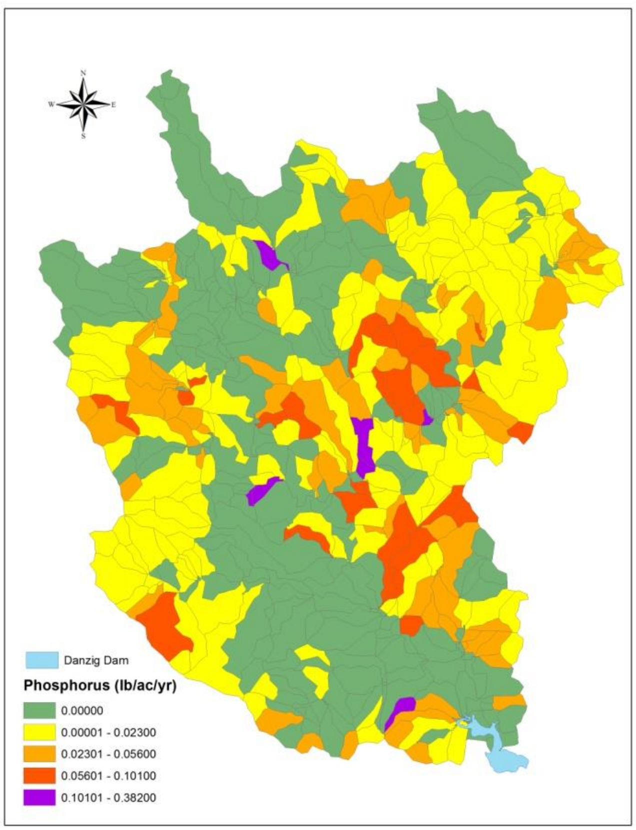

Figure 13. AnnAGNPS Modeled Phosphorus Yields in the Danzig Dam Watershed.

5.4 Dissolved Oxygen

In addition to nutrients, Danzig Dam is also listed as impaired for aquatic life use due to low dissolved oxygen concentrations (NDDoH, 2014a). Data collected during February and March 2011 confirms this assessment (Figure 8, Appendix A) with concentrations below the 5.0 mg/L standard throughout the entire water column.

For Danzig Dam, and for other eutrophic lakes and reservoirs, low dissolved oxygen levels are directly related to excessive nutrient loading. The cycling of nutrients in aquatic ecosystems is largely determined by oxidation-reduction (redox) potential and the distribution of dissolved oxygen and oxygen-demanding particles (Dodds, 2002). Dissolved oxygen gas has a strong affinity for electrons, and thus influences biogeochemical cycling and the biological availability of nutrients to primary producers such as algae. High levels of nutrients can lead to eutrophication, which is defined as the undesirable growth of algae and other aquatic plants. In turn, eutrophication can lead to increased biological oxygen demand and oxygen depletion due to the respiration of microbes that decompose the dead algae and other organic material. Under ice cover, bacteria can consume more oxygen than photosynthesis can replenish under the limited light and reaeration conditions of thick ice and snow cover.

AGNPS and BATHTUB models indicate that excessive nutrient loading is responsible for the low dissolved oxygen levels in Danzig Dam. Wetzel (1983) summarized, “The loading of organic matter to the hypolimnion and sediments of productive eutrophic lakes increases the consumption of dissolved oxygen. As a result, the oxygen content of the hypolimnion is reduced progressively during the period of summer stratification.”

Carpenter et al. (1998), has shown that nonpoint sources of phosphorous has lead to eutrophic conditions for many lake/reservoirs across the U.S. One consequence of eutrophication is oxygen depletions caused by decomposition of algae and aquatic plants. They also document that a reduction in nutrients will eventually lead to the reversal of eutrophication and attainment of designated beneficial uses. However, the rates of recovery are variable among lakes/reservoirs. This supports the NDDoH’s viewpoint that decreased nutrient loads at the watershed level will result in improved oxygen levels, the concern is that this process takes a significant amount of time (5-15 years).

In Lake Erie, heavy loadings of phosphorous have impacted the lake severely. Monitoring and research from the 1960’s has shown that depressed hypolimnetic dissolved oxygen levels were responsible for large fish kills and large mats of decaying algae. Bi-national programs to reduce nutrients into the lake have resulted in a downward trend of the oxygen depletion rate since monitoring began in the 1970’s. The trend of oxygen depletion has lagged behind that of phosphorous reduction, but this was expected
(See: http://www.epa.gov/glnpo/lakeerie/dostory.html).

Nürnberg (1995a, 1995b, 1997, 1998), developed a model that quantified duration (days) and extent of lake oxygen depletion, referred to as an anoxic factor (AF). This model showed that AF is positively correlated with average annual total phosphorous concentrations. The AF may also be used to quantify response to watershed restoration measures which makes it very useful for TMDL development. Nürnberg (1995a) developed several regression models that show nutrients control all trophic state indicators related to oxygen and phytoplankton in lakes and reservoirs. These models were developed from water quality characteristics using a suite of North American lakes. NDDoH has calculated the morphometric parameters such as surface area (A_o = 132.7 acres; 0.54 km^2), mean depth (z = 4.5 feet; 1.37 meters), and the ratio of mean depth to the surface area ($z/A_o^{0.5}$ = 1.86) for Danzig Dam which show that these parameters are within the range of lakes used by Nürnberg. Based on this information, NDDoH is confident that Nürnberg's empirical nutrient-oxygen relationship holds true for North Dakota lakes and reservoirs. The NDDoH is also confident that prescribed BMPs will reduce external loading of nutrients to Danzig Dam which will reduce algae blooms, thereby reducing hypolimnetic oxygen depletions rates resulting in increase oxygen levels over time.

As levels of phosphorus are reduced by the implementation of best management practices, dissolved oxygen levels will improve. This is supported by the research of Thornton, et al (1990). They state that, "…as organic deposits were exhausted, oxygen conditions improved."

6.0 MARGIN OF SAFETY AND SEASONALITY

6.1 Margin of Safety

Section 303(d) of the Clean Water Act and EPA's 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 that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality." The margin of safety (MOS) can either be incorporated into conservative assumptions used to develop the TMDL (implicit) or added as a separate component of the TMDL (explicit). For the purposes of this nutrient TMDL, a MOS of 10 percent of the loading capacity will be used as an explicit MOS.

Assuming the existing phosphorus and nitrogen load to Danzig Dam from tributary sources and internal cycling is 733.8 kg and 13,012.2 kg, respectively, and the TMDL target is the predicted average growing season chlorophyll-a concentration of 13.5 µg/L, then a "protection strategy" reduction of 10 percent in total phosphorus and nitrogen loading would result in TMDL target loading capacities of 662.0 kg/year for total phosphorus and 11,764.7 kg/year for total nitrogen. Based on a 10 percent explicit margin of safety (MOS), the total phosphorus MOS for the Danzig Dam TMDL would be 66.2 kg and the total nitrogen MOS would be 1,176.5 kg.

Monitoring and adaptive management during the implementation phase, along with post-implementation monitoring related to the effectiveness of the TMDL controls, will be used to ensure the attainment of the targets.

6.2 Seasonality

Section 303(d)(1)(C) of the Clean Water Act and the EPA's regulations require that a TMDL be established with seasonal variations. The Danzig Dam TMDL addresses seasonality because the BATHTUB and AnnAGNPS models incorporate seasonal differences in their prediction of annual total phosphorus and nitrogen loadings. . Seasonality is also addressed through the differences in sampling frequency in each season, as well as the growing season chlorophyll-a goal used as a target for the nutrient TMDL.

7.0 TMDL

Table 14 summarizes the nutrient TMDL for Danzig Dam in terms of loading capacity, wasteload allocations, load allocations, and a margin of safety. The TMDL can be generically 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 non-point sources;

MOS margin of safety, or an accounting of the 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 the loading capacity.

7.1 Nutrient TMDL

Based on data collected in 2011 and 2012, the existing total phosphorus and total nitrogen loads to Danzig Dam are estimated to be 733.8 kg/year and 13,012.2 kg/year, respectively. Assuming a 10 percent reduction in total phosphorus and total nitrogen load will result in a predicted average growing season chlorophyll-a concentration of 13.5 µg/L and this chlorophyll-a concentration will protect and maintain Danzig Dam's beneficial uses, the total phosphorus and total nitrogen TMDLs or loading capacities are 662.0 kg/year and 11,764.7 kg/year, respectively. Assuming 10 percent of the loading capacities are explicitly assigned to the MOSs and there are no point sources in the watershed, all of the remaining loading capacities are assigned to the nonpoint source load allocation (Table 14).

In November 2006 EPA issued a memorandum "Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No. 05-5015 (April 25, 2006) and Implications for NPDES Permits," which recommends that all TMDLs and associated load allocations and wasteload allocations include a daily time increment in conjunction with other appropriate temporal expressions that may be necessary to implement the relevant water quality standard. While the NDDoH believes that the appropriate temporal expression for nutrient loading to lakes and reservoirs is as an annual load, the phosphorus and nitrogen TMDLs have also been expressed as daily loads. In order to express the phosphorus and nitrogen TMDLs as daily loads, the annual tot phosphorus loading capacity of 662.0 kg/year was divided by 365 days. Based on this analysis, the phosphorus TMDL, expressed as an average daily load, is 1.8 kg/day with the load allocation equal to 1.6 kg/day and the MOS equal to 0.2 kg/day. Similarly, the total nitrogen TMDL, expressed as a daily load, is 32.2 kg/day with the load allocation equal to 29.0 kg/day and the MOS equal to 3.2 kg/day.

Table 14. Summary of the Total Phosphorus and Total Nitrogen TMDLs for Danzig Dam.

Category	Total Phosphorus (kg/year)	Total Nitrogen (kg/year)	Explanation
Existing Load	733.8	13,012.2	From observed data
Loading Capacity	662.0	11,764.7	Total load estimated from the BATHTUB model analysis predicted to maintain an average growing season chlorophyll-a concentration of 13.5 µg/L
Wasteload Allocation	0	0	No point sources in the contributing watershed
Load Allocation	595.8	11,835.7	Entire loading capacity minus MOS is allocated to nonpoint sources
MOS	66.2	1,176.5	10% of the loading capacity (kg/year) is reserved as an explicit margin of safety

7.2 Dissolved Oxygen TMDL

As a result of the direct influence of eutrophication on increased biological oxygen demand and microbial respiration, it is expected that by attaining the phosphorus and nitrogen load reductions necessary to meet the chlorophyll-a concentration target for Danzig Dam, the dissolved oxygen standard will be met. A 10 percent reduction in total phosphorus and total nitrogen loading to Danzig Dam is expected to maintain or slightly lower the current algal biomass levels in the water column, thereby reducing the hypolimnetic oxygen demand exerted by the decomposition of these primary producers (see Section 5.4 for additional justification). The predicted reduction in biological oxygen demand is therefore assumed to result in compliance with the dissolved oxygen standard.

8.0 ALLOCATION

A 10 percent nutrient load reduction target was established for the Danzig Dam watershed. This reduction was set based on the BATHTUB model, which predicted that under similar hydraulic conditions, an external nutrient load reduction of 10 percent would lower Carlson's chlorophyll-a TSI from 56.6 (equivalent to an average growing season chlorophyll-a concentration of 14.2 µg/L) to 56.2 (equivalent to an average growing season chlorophyll-a concentration of 13.5 µg/L).

Using the AnnAGNPS model, it was determined that cells with a phosphorus yield of 0.056 lbs/acre/year or greater and/or cells with a nitrogen yield of 6.79 lbs/acre/year are priority areas in the watershed (Figure 13). These are the critical cells which should be targeted and further examined by an watershed implementation project to determine the necessity and types of BMP's to be implemented.

The TMDL in this report is a plan to improve water quality by implementing BMPs through a volunteer, incentive-based approach. This TMDL plan is put forth as a recommendation for what needs to be accomplished for Danzig Dam and its watershed to meet and protect its beneficial uses. Water quality monitoring should continue to assess the effects of the recommendations made in this TMDL. Through adaptive management monitoring may indicate that loading capacity recommendations provided in this report may need to be adjusted to protect Danzig Dam.

9.0 PUBLIC PARTICIPATION

To satisfy the public participation requirements of this TMDL, a letter was sent to the following participating agencies notifying them that the draft report was available for review and public comment. Those included in the mailing are as follows:

- Morton and Oliver County Soil Conservation Districts;
- Morton and Oliver County Water Resource Boards;
- North Dakota Game and Fish Department;
- Natural Resource Conservation Service (State Office); and
- U.S. Environmental Protection Agency, Region VIII.

In addition to notifying specific agencies of this draft TMDL report's availability, the TMDL was posted on the North Dakota Department of Health, Division of Water Quality web site at http://www.ndhealth.gov/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 Bismarck Tribune.

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

10.0 MONITORING

To insure that the BMPs implemented as a part of any watershed restoration plan will reduce nutrient levels, water quality monitoring will be conducted in accordance with an approved QAPP.

Specifically, monitoring will be conducted for all variables that are currently causing impairments to the beneficial uses of the waterbody. Once a watershed restoration plan (e.g., 319 PIP) is implemented, monitoring will be conducted in the lake/reservoir beginning two years after implementation and extending five years after the implementation project is complete.

11.0 TMDL IMPLEMENTATION STRATEGY

Implementation of TMDLs is dependent upon the availability of Section 319 NPS funds or other watershed restoration programs (e.g., USDA EQIP), as well as securing a local project sponsor and the required matching funds. Provided these three requirements are in place, a project implementation plan (PIP) is developed in accordance with the TMDL and submitted to the North Dakota Nonpoint Source Pollution Task Force and US EPA for approval. The implementation of the best management practices contained in the NPS PIP is voluntary.

Therefore, success of any TMDL implementation project is ultimately dependent on the ability of the local project sponsor to find cooperating producers.

Monitoring is an important and required component of any PIP. As a part of the PIP, data are collected to monitor and track the effects of BMP implementation as well as to judge overall project success. QAPPs detail the strategy of how, when and where monitoring will be conducted to gather the data needed to document the TMDL implementation goal(s). As data are gathered and analyzed, watershed restoration tasks are adapted to place BMPs where they will have the greatest benefit to water quality.

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Appendix A
Water Quality Data

Temperature and Dissolved Oxygen Data

Date	Depth (meter)	Temperature (°C)	Dissolved Oxygen (mg/L)
23-Feb-11	1	1.6	5.3
23-Feb-11	2	3.6	3.5
23-Feb-11	3	4.9	2.5
18-Mar-11	0.5	0.7	2.57
18-Mar-11	1	1.3	3.66
18-Mar-11	2	3.4	0.95
18-Mar-11	2.5	4.3	0.65
23-May-11	0.5	15.8	7.15
23-May-11	1	15.4	6.71
23-May-11	2	15	6.31
23-May-11	2.5	13.9	3.53
08-Jun-11	0.5	17	7.44
08-Jun-11	1	17	7.15
08-Jun-11	2	17	7.02
29-Jun-11	0.5	21.9	7.45
29-Jun-11	1	21.8	7.13
29-Jun-11	2	21.4	6.57
18-Jul-11	0.5	24.9	6.01
18-Jul-11	1	24.4	6.03
18-Jul-11	2	22.7	5.68
15-Aug-11	0.5	21.5	5.83
15-Aug-11	1	21.5	5.57
15-Aug-11	2	21.4	5.27
29-Aug-11	0.5	22.6	7.2
29-Aug-11	1	22.5	7.02
29-Aug-11	2	22.3	6.66
26-Sep-11	0.5	13.8	7.74
26-Sep-11	1	13.7	7.66
26-Sep-11	2	13.7	7.21
20-Dec-11	0.5	3.3	13
20-Dec-11	1	1.8	13.52
20-Dec-11	2	2.4	9.26
27-Jan-12	0.5	1.8	14.53
27-Jan-12	1	1.8	14.17
27-Jan-12	2	2	10.45
Total Samples			35
Percent of Samples below 5.0 mg/L			17%

Danzig Dam 2011-2012 Summary Statistics

	NH3-4	NO2+NO3	INORG-N	ORG-N	TN	TD-P	TP	CHL-A	Secchi (m)
Average	0.107	0.108	0.215	1.624	1.839	0.088	0.113	14.6	0.8
Minimum	0.015	0.015	0.030	1.060	1.540	0.039	0.050	0.750	0.250
Maximum	0.570	1.080	1.210	2.140	2.310	0.170	0.218	35.200	2.500
Median	0.026	0.015	0.052	1.628	1.805	0.085	0.110	13.500	0.750

Date	NH3-4	NO2+NO3	INORG-N	ORG-N	TN	TD-P	TP	CHL-A	Secchi (m)
2/23/2011	0.532	0.015	0.547	1.353	1.9	0.097	0.124	11.8	
3/18/2011	0.57	0.17	0.74	1.06	1.8	0.098	0.126		
5/23/2011	0.13	1.08	1.21	1.1	2.31	0.126	0.161		0.25
6/8/2011	0.015	0.015	0.03	1.51	1.54	0.047	0.06	35.2	0.75
6/29/2011	0.116	0.22	0.336	1.304	1.64	0.039	0.05	8.01	1.3
7/18/2011	0.134	0.015	0.149	1.401	1.55	0.085	0.109	3	2.5
8/15/2011	0.015	0.06	0.075	1.765	1.84	0.086	0.11	21.4	0.75
8/29/2011	0.015	0.015	0.03	1.7	1.73	0.129	0.166	19.8	0.75
9/26/2011	0.015	0.03	0.045	1.585	1.63	0.074	0.095	0.75	1
12/20/2011	0.037	0.015	0.052	2.118	2.17	0.052	0.067		
1/24/2012	0.015	0.015	0.03	2.14	2.17	0.055	0.07		
2/13/2012	0.04	0.015	0.055	1.755	1.81	0.044	0.057		
5/9/2012	0.036	0.015	0.051	1.529	1.58	0.092	0.118	25.6	0.25
6/8/2012								12.8	1
6/28/2012	0.015	0.015	0.03	1.67	1.7	0.080	0.102	17.1	0.5
7/31/2012	0.015	0.015	0.03	1.92	1.95	0.170	0.218	5	0.25
9/6/2012	0.015	0.015	0.03	2.07	2.1	0.136	0.174	14.2	0.5

Danzig Dam 2011-2012 Inlet Site (385562) Summary Statistics

	NH3-4	NO2+NO3	INORG-N	ORG-N	TN	TD-P	TP	CHL-A	Secchi (m)
Average	0.026	0.160	0.187	1.450	1.637	0.070	0.090	8.542	514.808
Minimum	0.015	0.015	0.030	0.858	0.935	0.032	0.041	2.500	5.000
Maximum	0.150	1.190	1.340	1.915	2.830	0.145	0.186	29.000	8000.000
Median	0.015	0.015	0.045	1.490	1.580	0.062	0.080	7.000	75.000
25th Percentile	0.015	0.015	0.030	1.175	1.260	0.048	0.062	2.500	50.000
50th Percentile	0.015	0.015	0.045	1.490	1.580	0.062	0.080	7.000	75.000
75th Percentile	0.015	0.100	0.135	1.690	1.920	0.087	0.112	11.250	310.000

Date	NH3-4	NO2+NO3	INORG-N	ORG-N	TN	TD-P	TP	TSS
4/18/2011	0.015	0.12	0.135	0.858	0.993	0.048	0.062	9
4/28/2011	0.015	0.04	0.055	0.924	0.979	0.032	0.041	2.5
5/5/2011	0.015	0.015	0.03	1.01	1.04	0.032	0.041	2.5
5/11/2011	0.015	0.015	0.03	1.11	1.14	0.038	0.049	2.5
5/12/2011	0.015	0.015	0.03	1.15	1.18	0.041	0.053	2.5
5/16/2011	0.015	0.015	0.03	1.14	1.17	0.035	0.045	9
5/17/2011	0.015	0.015	0.03	1.12	1.15	0.037	0.047	2.5
5/23/2011	0.015	0.69	0.705	1.175	1.88	0.087	0.112	7
5/31/2011	0.077	1.07	1.147	1.213	2.36	0.115	0.148	29
6/7/2011	0.015	0.015	0.03	1.32	1.35	0.062	0.079	2.5
6/9/2011	0.015	0.015	0.03	1.23	1.26	0.060	0.077	6
6/16/2011	0.15	1.19	1.34	1.49	2.83	0.116	0.149	11
6/23/2011	0.015	1.08	1.095	1.705	2.8	0.098	0.126	2.5
6/27/2011	0.046	0.59	0.636	1.804	2.44	0.084	0.108	9
7/12/2011	0.015	0.08	0.095	1.885	1.98	0.069	0.088	2.5
7/19/2011	0.015	0.015	0.03	1.68	1.71	0.056	0.072	2.5
7/26/2011	0.015	0.24	0.255	1.875	2.13	0.138	0.177	6
8/3/2011	0.015	0.015	0.03	1.68	1.71	0.077	0.099	14
8/4/2011	0.015	0.015	0.03	1.69	1.72	0.101	0.129	7
8/10/2011	0.015	0.015	0.03	1.91	1.94	0.115	0.148	7
8/17/2011	0.039	0.015	0.054	1.816	1.87	0.145	0.186	7
8/25/2011	0.015	0.05	0.065	1.475	1.54	0.063	0.081	8
9/2/2011	0.038	0.1	0.138	1.362	1.5	0.077	0.099	8
9/15/2011	0.015	0.015	0.03	1.31	1.34	0.053	0.068	6
9/21/2011	0.015	0.04	0.055	1.495	1.55	0.076	0.097	22
3/29/2012	0.015	0.015	0.03	0.905	0.935	0.052	0.067	13
4/4/2012	0.015	0.03	0.045	1.635	1.68	0.062	0.08	10
4/11/2012	0.015	0.015	0.03	1.43	1.46	0.051	0.065	12
4/17/2012	0.015	0.015	0.03	1.59	1.62	0.060	0.077	15
4/26/2012	0.042	0.015	0.057	1.513	1.57	0.058	0.074	15
5/3/2012	0.045	0.1	0.145	1.605	1.75	0.067	0.086	7
5/10/2012	0.076	0.17	0.246	1.714	1.96	0.075	0.096	2.5
5/16/2012	0.033	0.015	0.048	1.872	1.92	0.088	0.113	
5/31/2012	0.015	0.015	0.03	1.47	1.5	0.044	0.056	6
6/4/2012	0.015	0.015	0.03	1.55	1.58	0.037	0.048	14
7/18/2012	0.015	0.03	0.045	1.915	1.96	0.105	0.135	23
8/14/2012	0.015	0.015	0.03	1.04	1.07	0.034	0.043	2.5

Danzig Dam 2011-2012 Outlet Site (385563) Summary Statistics

	NH3-4	NO2+NO3	INORG-N	ORG-N	TN	TD-P	TP	CHL-A	Secchi (m)
Average	0.068	0.171	0.239	1.400	1.639	0.110	0.141	18.387	93.409
Minimum	0.015	0.015	0.030	0.500	0.530	0.044	0.056	6.000	5.000
Maximum	0.464	1.960	2.424	2.745	3.130	0.212	0.272	72.000	600.000
Median	0.037	0.030	0.068	1.472	1.590	0.103	0.132	16.000	65.000
25th Percentile	0.015	0.015	0.030	1.141	1.433	0.088	0.113	12.000	42.500
50th Percentile	0.037	0.030	0.068	1.472	1.590	0.103	0.132	16.000	65.000
75th Percentile	0.065	0.060	0.125	1.559	1.680	0.133	0.170	22.000	100.000

Date	NH3-4	NO2+NO3	INORG-N	ORG-N	TN	TD-P	TP	TSS
4/28/2011	0.07	0.015	0.085	1.105	1.19	0.097	0.124	11
5/5/2011	0.015	0.015	0.03	1.22	1.25	0.105	0.134	16
5/12/2011	0.015	0.03	0.045	1.015	1.06	0.092	0.118	7
5/16/2011	0.015	0.015	0.03	1.05	1.08	0.073	0.094	14
5/17/2011	0.015	0.015	0.03	1.08	1.11	0.071	0.091	12
5/23/2011	0.145	1	1.145	1.115	2.26	0.147	0.188	23
6/7/2011	0.061	0.03	0.091	1.149	1.24	0.048	0.062	8
6/9/2011	0.043	0.015	0.058	1.322	1.38	0.074	0.095	6
6/16/2011	0.464	1.96	2.424	0.706	3.13	0.176	0.226	28
6/23/2011	0.342	0.95	1.292	1.078	2.37	0.112	0.143	12
6/27/2011	0.115	0.61	0.725	1.605	2.33	0.137	0.176	12
7/12/2011	0.107	0.04	0.147	1.413	1.56	0.096	0.123	23
7/19/2011	0.145	0.07	0.215	1.365	1.58	0.111	0.142	26
7/26/2011	0.065	0.06	0.125	1.545	1.67	0.147	0.188	12
8/4/2011	0.015	0.015	0.03	1.46	1.49	0.135	0.173	72
8/10/2011	0.015	0.015	0.03	1.52	1.55	0.101	0.13	17
8/17/2011	0.057	0.16	0.217	1.493	1.71	0.184	0.236	13
8/25/2011	0.054	0.04	0.094	1.506	1.6	0.128	0.164	16
9/2/2011	0.015	0.03	0.045	1.615	1.66	0.159	0.204	28
9/15/2011	0.036	0.04	0.076	1.484	1.56	0.089	0.114	22
9/21/2011	0.015	0.05	0.065	2.745	2.81	0.212	0.272	14
3/29/2012	0.015	0.015	0.03	0.5	0.53	0.044	0.056	16
4/4/2012	0.065	0.06	0.125	1.495	1.62	0.098	0.125	18
4/11/2012	0.03	0.04	0.07	1.44	1.51	0.107	0.137	20
4/17/2012	0.015	0.07	0.085	1.585	1.67	0.109	0.14	9
4/26/2012	0.056	0.015	0.071	1.489	1.56	0.114	0.146	22
5/3/2012	0.035	0.015	0.05	1.55	1.6	0.096	0.123	22
5/10/2012	0.038	0.015	0.053	1.597	1.65	0.099	0.127	10
5/16/2012	0.05	0.015	0.065	1.765	1.83	0.132	0.169	
5/31/2012	0.015	0.015	0.03	1.42	1.45	0.051	0.065	15
6/4/2012	0.015	0.015	0.03	1.63	1.66	0.079	0.101	22
7/18/2012	0.015	0.015	0.03	1.75	1.78	0.086	0.11	24

Appendix B
BATHTUB Analysis for Danzig Dam

Danzig Dam

Overall Water Balance — **Averaging Period = 2.00 years**

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance $(hm3/yr)^2$	CV -	Runoff m/yr
1	1	1	Hailstone Inlet	93.3	6.4	0.00E+00	0.00	0.07
2	4	1	Hailstone Outlet	111.6	7.6	0.00E+00	0.00	0.07
3	1	1	Ungauged Inflow	18.3	1.3	0.00E+00	0.00	0.07
PRECIPITATION				0.5	0.1	0.00E+00	0.00	0.20
TRIBUTARY INFLOW				111.6	7.6	0.00E+00	0.00	0.07
***TOTAL INFLOW				112.1	7.7	0.00E+00	0.00	0.07
GAUGED OUTFLOW				111.6	7.6	0.00E+00	0.00	0.07
ADVECTIVE OUTFLOW				0.5	0.1	0.00E+00	0.00	0.19
***TOTAL OUTFLOW				112.1	7.7	0.00E+00	0.00	0.07
***EVAPORATION					0.0	0.00E+00	0.00	

Overall Mass Balance Based Upon Observed Outflow & Reservoir Concentrations
Component: TOTAL P

Trb	Type	Seg	Name	Load kg/yr	% Total	Load Variance $(kg/yr)^2$	% Total	CV	Conc mg/m^3	Export $kg/km^2/yr$
1	1	1	Hailstone Inlet	573.3	78.1%	0.00E+00		0.00	90.0	6.1
2	4	1	Hailstone Outlet	861.1		1.50E+05		0.45	113.0	7.7
3	1	1	Ungauged Inflow	144.4	19.7%	0.00E+00		0.00	115.5	7.9
PRECIPITATION				16.1	2.2%	6.49E+01	100.0%	0.50	152.4	30.0
TRIBUTARY INFLOW				717.7	97.8%	0.00E+00		0.00	94.2	6.4
***TOTAL INFLOW				733.8	100.0%	6.49E+01	100.0%	0.01	95.0	6.5
GAUGED OUTFLOW				861.1	117.3%	0.00E+00		0.00	113.0	7.7
ADVECTIVE OUTFLOW				11.8	1.6%	0.00E+00		0.00	113.0	22.0
***TOTAL OUTFLOW				872.9	119.0%	0.00E+00		0.00	113.0	7.8
***RETENTION				-139.1		6.49E+01		0.06		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.1133
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	17.7
Reservoir Conc (mg/m3)	113	Retention Coef.	-0.190

Overall Mass Balance Based Upon Observed Outflow & Reservoir Concentrations
Component: TOTAL N

Trb	Type	Seg	Name	Load kg/yr	% Total	Load Variance $(kg/yr)^2$	% Total	CV	Conc mg/m^3	Export $kg/km^2/yr$
1	1	1	Hailstone Inlet	10427.7	80.1%	0.00E+00		0.00	1637.0	111.8
2	4	1	Hailstone Outlet	14013.2		5.95E+07		0.55	1839.0	125.6
3	1	1	Ungauged Inflow	2047.5	15.7%	0.00E+00		0.00	1638.0	111.9
PRECIPITATION				537.0	4.1%	7.21E+04	100.0%	0.50	5080.0	1000.0
TRIBUTARY INFLOW				12475.2	95.9%	0.00E+00		0.00	1637.2	111.8
***TOTAL INFLOW				13012.2	100.0%	7.21E+04	100.0%	0.02	1684.3	116.0
GAUGED OUTFLOW				14013.2	107.7%	0.00E+00		0.00	1839.0	125.6
ADVECTIVE OUTFLOW				192.3	1.5%	0.00E+00		0.00	1839.0	358.0
***TOTAL OUTFLOW				14205.4	109.2%	0.00E+00		0.00	1839.0	126.7
***RETENTION				-1193.3		7.21E+04		0.23		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.1040
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	19.2
Reservoir Conc (mg/m3)	1839	Retention Coef.	-0.092

Danzig Dam

Predicted & Observed Values Ranked Against CE Model Development D

Segment:	**1**	**Main Lake**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	112.8	0.45	82.9%	113.0		83.0%
TOTAL N MG/M3	1839.0	0.55	82.9%	1839.0		82.9%
C.NUTRIENT MG/M3	88.0	0.35	87.0%	88.1		87.1%
CHL-A MG/M3	15.0	0.52	72.9%	14.6		71.7%
SECCHI M	0.8	0.45	33.9%	0.8		34.6%
ORGANIC N MG/M3	1624.6	0.34	99.2%	1624.0		99.2%
TP-ORTHO-P MG/M3	25.1	0.35	42.6%	25.0		42.4%
ANTILOG PC-1	970.9	0.77	85.3%	949.6		84.9%
ANTILOG PC-2	7.3	0.22	59.2%	7.2		58.6%
(N - 150) / P	15.0	0.74	42.6%	14.9		42.5%
INORGANIC N / P	2.4	5.53	0.6%	2.4		0.6%
TURBIDITY 1/M	0.9		66.7%	0.9		66.7%
ZMIX * TURBIDITY	1.2		10.9%	1.2		10.9%
ZMIX / SECCHI	1.7	0.46	4.0%	1.7		3.8%
CHL-A * SECCHI	11.8	0.28	58.2%	11.7		57.6%
CHL-A / TOTAL P	0.1	0.26	27.1%	0.1		25.6%
FREQ(CHL-a>10) %	63.5	0.49	72.9%	61.8		71.7%
FREQ(CHL-a>20) %	22.0	1.13	72.9%	20.7		71.7%
FREQ(CHL-a>30) %	7.7	1.60	72.9%	7.1		71.7%
FREQ(CHL-a>40) %	2.9	1.97	72.9%	2.6		71.7%
FREQ(CHL-a>50) %	1.2	2.26	72.9%	1.1		71.7%
FREQ(CHL-a>60) %	0.5	2.51	72.9%	0.5		71.7%
CARLSON TSI-P	72.3	0.09	82.9%	72.3		83.0%
CARLSON TSI-CHLA	57.2	0.09	72.9%	56.9		71.7%
CARLSON TSI-SEC	63.4	0.10	66.1%	63.2		65.4%

Danzig Dam - Minus 10%

Overall Water Balance — **Averaging Period = 2.00 years**

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance $(hm3/yr)^2$	CV -	Runoff m/yr
1	1	1	Hailstone Inlet	93.3	6.4	0.00E+00	0.00	0.07
2	4	1	Hailstone Outlet	111.6	7.6	0.00E+00	0.00	0.07
3	1	1	Ungauged Inflow	18.3	1.3	0.00E+00	0.00	0.07
PRECIPITATION				0.5	0.1	0.00E+00	0.00	0.20
TRIBUTARY INFLOW				111.6	7.6	0.00E+00	0.00	0.07
***TOTAL INFLOW				112.1	7.7	0.00E+00	0.00	0.07
GAUGED OUTFLOW				111.6	7.6	0.00E+00	0.00	0.07
ADVECTIVE OUTFLOW				0.5	0.1	0.00E+00	0.00	0.19
***TOTAL OUTFLOW				112.1	7.7	0.00E+00	0.00	0.07
***EVAPORATION					0.0	0.00E+00	0.00	

Overall Mass Balance Based Upon Component: **Observed TOTAL P** — **Outflow & Reservoir Concentrations**

Trb	Type	Seg	Name	Load kg/yr	% Total	Load Variance $(kg/yr)^2$	% Total	CV	Conc mg/m^3	Export $kg/km^2/yr$
1	1	1	Hailstone Inlet	516.0	77.9%	0.00E+00		0.00	81.0	5.5
2	4	1	Hailstone Outlet	861.1		1.22E+05		0.41	113.0	7.7
3	1	1	Ungauged Inflow	129.9	19.6%	0.00E+00		0.00	103.9	7.1
PRECIPITATION				16.1	2.4%	6.49E+01	100.0%	0.50	152.4	30.0
TRIBUTARY INFLOW				645.9	97.6%	0.00E+00		0.00	84.8	5.8
***TOTAL INFLOW				662.0	100.0%	6.49E+01	100.0%	0.01	85.7	5.9
GAUGED OUTFLOW				861.1	130.1%	0.00E+00		0.00	113.0	7.7
ADVECTIVE OUTFLOW				11.8	1.8%	0.00E+00		0.00	113.0	22.0
***TOTAL OUTFLOW				872.9	131.9%	0.00E+00		0.00	113.0	7.8
***RETENTION				-210.9		6.49E+01		0.04		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.1256
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	15.9
Reservoir Conc (mg/m3)	113	Retention Coef.	-0.319

Overall Mass Balance Based Upon Component: **Observed TOTAL N** — **Outflow & Reservoir Concentrations**

Trb	Type	Seg	Name	Load kg/yr	% Total	Load Variance $(kg/yr)^2$	% Total	CV	Conc mg/m^3	Export $kg/km^2/yr$
1	1	1	Hailstone Inlet	9384.9	79.8%	0.00E+00		0.00	1473.3	100.6
2	4	1	Hailstone Outlet	14013.2		4.86E+07		0.50	1839.0	125.6
3	1	1	Ungauged Inflow	1842.8	15.7%	0.00E+00		0.00	1474.2	100.7
PRECIPITATION				537.0	4.6%	7.21E+04	100.0%	0.50	5080.0	1000.0
TRIBUTARY INFLOW				11227.7	95.4%	0.00E+00		0.00	1473.4	100.6
***TOTAL INFLOW				11764.7	100.0%	7.21E+04	100.0%	0.02	1522.8	104.9
GAUGED OUTFLOW				14013.2	119.1%	0.00E+00		0.00	1839.0	125.6
ADVECTIVE OUTFLOW				192.3	1.6%	0.00E+00		0.00	1839.0	358.0
***TOTAL OUTFLOW				14205.4	120.7%	0.00E+00		0.00	1839.0	126.7
***RETENTION				-2440.8		7.21E+04		0.11		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.1150
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	17.4
Reservoir Conc (mg/m3)	1839	Retention Coef.	-0.207

Danzig Dam - Minus 10%

Predicted & Observed Values Ranked Against CE Model Development Datas

Segment:	**1**	**Main Lake**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	101.8	0.45	79.9%	113.0		83.0%
TOTAL N MG/M3	1662.7	0.55	78.6%	1839.0		82.9%
C.NUTRIENT MG/M3	79.2	0.35	84.0%	88.1		87.1%
CHL-A MG/M3	13.5	0.52	68.3%	14.6		71.7%
SECCHI M	0.9	0.45	39.0%	0.8		34.6%
ORGANIC N MG/M3	1528.6	0.32	98.9%	1624.0		99.2%
TP-ORTHO-P MG/M3	23.6	0.34	40.1%	25.0		42.4%
ANTILOG PC-1	803.5	0.76	81.8%	949.6		84.9%
ANTILOG PC-2	7.3	0.22	60.0%	7.2		58.6%
(N - 150) / P	14.9	0.75	42.2%	14.9		42.5%
INORGANIC N / P	1.7	7.91	0.2%	2.4		0.6%
TURBIDITY 1/M	0.9		66.7%	0.9		66.7%
ZMIX * TURBIDITY	1.2		10.9%	1.2		10.9%
ZMIX / SECCHI	1.6	0.46	2.7%	1.7		3.8%
CHL-A * SECCHI	11.8	0.28	58.2%	11.7		57.6%
CHL-A / TOTAL P	0.1	0.26	27.1%	0.1		25.6%
FREQ(CHL-a>10) %	57.1	0.57	68.3%	61.8		71.7%
FREQ(CHL-a>20) %	17.4	1.25	68.3%	20.7		71.7%
FREQ(CHL-a>30) %	5.5	1.73	68.3%	7.1		71.7%
FREQ(CHL-a>40) %	2.0	2.10	68.3%	2.6		71.7%
FREQ(CHL-a>50) %	0.8	2.40	68.3%	1.1		71.7%
FREQ(CHL-a>60) %	0.3	2.66	68.3%	0.5		71.7%
CARLSON TSI-P	70.8	0.09	79.9%	72.3		83.0%
CARLSON TSI-CHLA	56.2	0.09	68.3%	56.9		71.7%
CARLSON TSI-SEC	62.0	0.11	61.0%	63.2		65.4%

Danzig Dam - Minus 25%

Overall Water Balance					Averaging Period =	2.00	years	
				Area	Flow	Variance	CV	Runoff
Trb	Type	Seg	Name	km^2	hm^3/yr	$(hm3/yr)^2$	-	m/yr
1	1	1	Hailstone Inlet	93.3	6.4	0.00E+00	0.00	0.07
2	4	1	Hailstone Outlet	111.6	7.6	0.00E+00	0.00	0.07
3	1	1	Ungauged Inflow	18.3	1.3	0.00E+00	0.00	0.07
PRECIPITATION				0.5	0.1	0.00E+00	0.00	0.20
TRIBUTARY INFLOW				111.6	7.6	0.00E+00	0.00	0.07
***TOTAL INFLOW				112.1	7.7	0.00E+00	0.00	0.07
GAUGED OUTFLOW				111.6	7.6	0.00E+00	0.00	0.07
ADVECTIVE OUTFLOW				0.5	0.1	0.00E+00	0.00	0.19
***TOTAL OUTFLOW				112.1	7.7	0.00E+00	0.00	0.07
***EVAPORATION					0.0	0.00E+00	0.00	

Overall Mass Balance Based Upon				Observed		Outflow & Reservoir Concentrations				
Component:				TOTAL P						
				Load		Load Variance			Conc	Export
Trb	Type	Seg	Name	kg/yr	% Total	$(kg/yr)^2$	% Total	CV	mg/m^3	$kg/km^2/yr$
1	1	1	Hailstone Inlet	430.0	77.6%	0.00E+00		0.00	67.5	4.6
2	4	1	Hailstone Outlet	861.1		8.55E+04		0.34	113.0	7.7
3	1	1	Ungauged Inflow	108.3	19.5%	0.00E+00		0.00	86.6	5.9
PRECIPITATION				16.1	2.9%	6.49E+01	100.0%	0.50	152.4	30.0
TRIBUTARY INFLOW				538.3	97.1%	0.00E+00		0.00	70.6	4.8
***TOTAL INFLOW				554.4	100.0%	6.49E+01	100.0%	0.01	71.8	4.9
GAUGED OUTFLOW				861.1	155.3%	0.00E+00		0.00	113.0	7.7
ADVECTIVE OUTFLOW				11.8	2.1%	0.00E+00		0.00	113.0	22.0
***TOTAL OUTFLOW				872.9	157.5%	0.00E+00		0.00	113.0	7.8
***RETENTION				-318.5		6.49E+01		0.03		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.1500
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	13.3
Reservoir Conc (mg/m3)	113	Retention Coef.	-0.575

Overall Mass Balance Based Upon				Observed		Outflow & Reservoir Concentrations				
Component:				TOTAL N						
				Load		Load Variance			Conc	Export
Trb	Type	Seg	Name	kg/yr	% Total	$(kg/yr)^2$	% Total	CV	mg/m^3	$kg/km^2/yr$
1	1	1	Hailstone Inlet	7820.8	79.1%	0.00E+00		0.00	1227.8	83.8
2	4	1	Hailstone Outlet	14013.2		3.44E+07		0.42	1839.0	125.6
3	1	1	Ungauged Inflow	1535.6	15.5%	0.00E+00		0.00	1228.5	83.9
PRECIPITATION				537.0	5.4%	7.21E+04	100.0%	0.50	5080.0	1000.0
TRIBUTARY INFLOW				9356.4	94.6%	0.00E+00		0.00	1227.9	83.8
***TOTAL INFLOW				9893.4	100.0%	7.21E+04	100.0%	0.03	1280.6	88.2
GAUGED OUTFLOW				14013.2	141.6%	0.00E+00		0.00	1839.0	125.6
ADVECTIVE OUTFLOW				192.3	1.9%	0.00E+00		0.00	1839.0	358.0
***TOTAL OUTFLOW				14205.4	143.6%	0.00E+00		0.00	1839.0	126.7
***RETENTION				-4312.1		7.21E+04		0.06		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.1368
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	14.6
Reservoir Conc (mg/m3)	1839	Retention Coef.	-0.436

Danzig Dam - Minus 25%

Predicted & Observed Values Ranked Against CE Model Development Datas

Segment:	**1**	**Main Lake**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	85.2	0.45	73.9%	113.0		83.0%
TOTAL N MG/M3	1398.2	0.55	69.9%	1839.0		82.9%
C.NUTRIENT MG/M3	65.9	0.36	77.8%	88.1		87.1%
CHL-A MG/M3	11.3	0.52	59.7%	14.6		71.7%
SECCHI M	1.0	0.45	48.1%	0.8		34.6%
ORGANIC N MG/M3	1384.6	0.30	98.2%	1624.0		99.2%
TP-ORTHO-P MG/M3	21.4	0.32	36.1%	25.0		42.4%
ANTILOG PC-1	580.6	0.75	74.5%	949.6		84.9%
ANTILOG PC-2	7.5	0.22	61.4%	7.2		58.6%
(N - 150) / P	14.6	0.76	41.3%	14.9		42.5%
INORGANIC N / P	0.2	58.87	0.0%	2.4		0.6%
TURBIDITY 1/M	0.9		66.7%	0.9		66.7%
ZMIX * TURBIDITY	1.2		10.9%	1.2		10.9%
ZMIX / SECCHI	1.3	0.46	1.3%	1.7		3.8%
CHL-A * SECCHI	11.8	0.28	58.2%	11.7		57.6%
CHL-A / TOTAL P	0.1	0.26	27.1%	0.1		25.6%
FREQ(CHL-a>10) %	45.7	0.72	59.7%	61.8		71.7%
FREQ(CHL-a>20) %	11.0	1.45	59.7%	20.7		71.7%
FREQ(CHL-a>30) %	3.0	1.96	59.7%	7.1		71.7%
FREQ(CHL-a>40) %	1.0	2.34	59.7%	2.6		71.7%
FREQ(CHL-a>50) %	0.3	2.65	59.7%	1.1		71.7%
FREQ(CHL-a>60) %	0.1	2.91	59.7%	0.5		71.7%
CARLSON TSI-P	68.3	0.09	73.9%	72.3		83.0%
CARLSON TSI-CHLA	54.4	0.09	59.7%	56.9		71.7%
CARLSON TSI-SEC	59.4	0.11	51.9%	63.2		65.4%

Danzig Dam - Minus 50%

Overall Water Balance — **Averaging Period = 2.00 years**

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	Hailstone Inlet	93.3	6.4	0.00E+00	0.00	0.07
2	4	1	Hailstone Outlet	111.6	7.6	0.00E+00	0.00	0.07
3	1	1	Ungauged Inflow	18.3	1.3	0.00E+00	0.00	0.07
PRECIPITATION				0.5	0.1	0.00E+00	0.00	0.20
TRIBUTARY INFLOW				111.6	7.6	0.00E+00	0.00	0.07
***TOTAL INFLOW				112.1	7.7	0.00E+00	0.00	0.07
GAUGED OUTFLOW				111.6	7.6	0.00E+00	0.00	0.07
ADVECTIVE OUTFLOW				0.5	0.1	0.00E+00	0.00	0.19
***TOTAL OUTFLOW				112.1	7.7	0.00E+00	0.00	0.07
***EVAPORATION					0.0	0.00E+00	0.00	

Overall Mass Balance Based Upon **Observed** **Outflow & Reservoir Concentrations**
Component: **TOTAL P**

Trb	Type	Seg	Name	Load kg/yr	% Total	Load Variance (kg/yr)^2	% Total	CV	Conc mg/m^3	Export kg/km^2/yr
1	1	1	Hailstone Inlet	286.6	76.5%	0.00E+00		0.00	45.0	3.1
2	4	1	Hailstone Outlet	861.1		3.92E+04		0.23	113.0	7.7
3	1	1	Ungauged Inflow	72.2	19.3%	0.00E+00		0.00	57.8	3.9
PRECIPITATION				16.1	4.3%	6.49E+01	100.0%	0.50	152.4	30.0
TRIBUTARY INFLOW				358.8	95.7%	0.00E+00		0.00	47.1	3.2
***TOTAL INFLOW				374.9	100.0%	6.49E+01	100.0%	0.02	48.5	3.3
GAUGED OUTFLOW				861.1	229.6%	0.00E+00		0.00	113.0	7.7
ADVECTIVE OUTFLOW				11.8	3.2%	0.00E+00		0.00	113.0	22.0
***TOTAL OUTFLOW				872.9	232.8%	0.00E+00		0.00	113.0	7.8
***RETENTION				-497.9		6.49E+01		0.02		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.2217
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	9.0
Reservoir Conc (mg/m3)	113	Retention Coef.	-1.328

Overall Mass Balance Based Upon **Observed** **Outflow & Reservoir Concentrations**
Component: **TOTAL N**

Trb	Type	Seg	Name	Load kg/yr	% Total	Load Variance (kg/yr)^2	% Total	CV	Conc mg/m^3	Export kg/km^2/yr
1	1	1	Hailstone Inlet	5213.8	77.0%	0.00E+00		0.00	818.5	55.9
2	4	1	Hailstone Outlet	14013.2		1.62E+07		0.29	1839.0	125.6
3	1	1	Ungauged Inflow	1023.8	15.1%	0.00E+00		0.00	819.0	55.9
PRECIPITATION				537.0	7.9%	7.21E+04	100.0%	0.50	5080.0	1000.0
TRIBUTARY INFLOW				6237.6	92.1%	0.00E+00		0.00	818.6	55.9
***TOTAL INFLOW				6774.6	100.0%	7.21E+04	100.0%	0.04	876.9	60.4
GAUGED OUTFLOW				14013.2	206.8%	0.00E+00		0.00	1839.0	125.6
ADVECTIVE OUTFLOW				192.3	2.8%	0.00E+00		0.00	1839.0	358.0
***TOTAL OUTFLOW				14205.4	209.7%	0.00E+00		0.00	1839.0	126.7
***RETENTION				-7430.9		7.21E+04		0.04		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.1997
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	10.0
Reservoir Conc (mg/m3)	1839	Retention Coef.	-1.097

Danzig Dam - Minus 50%

Predicted & Observed Values Ranked Against CE Model Development Datase

Segment:	**1**	**Main Lake**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	57.6	0.45	58.1%	113.0		83.0%
TOTAL N MG/M3	957.4	0.55	47.2%	1839.0		82.9%
C.NUTRIENT MG/M3	43.8	0.37	60.1%	88.1		87.1%
CHL-A MG/M3	7.7	0.52	39.6%	14.6		71.7%
SECCHI M	1.5	0.45	68.0%	0.8		34.6%
ORGANIC N MG/M3	1144.6	0.26	95.8%	1624.0		99.2%
TP-ORTHO-P MG/M3	17.6	0.28	28.8%	25.0		42.4%
ANTILOG PC-1	285.7	0.73	54.7%	949.6		84.9%
ANTILOG PC-2	7.9	0.22	64.9%	7.2		58.6%
(N - 150) / P	14.0	0.79	38.8%	14.9		42.5%
INORGANIC N / P	0.0	0.55	0.0%	2.4		0.6%
TURBIDITY 1/M	0.9		66.7%	0.9		66.7%
ZMIX * TURBIDITY	1.2		10.9%	1.2		10.9%
ZMIX / SECCHI	0.9	0.46	0.2%	1.7		3.8%
CHL-A * SECCHI	11.8	0.28	58.2%	11.7		57.6%
CHL-A / TOTAL P	0.1	0.26	27.1%	0.1		25.6%
FREQ(CHL-a>10) %	23.0	1.11	39.6%	61.8		71.7%
FREQ(CHL-a>20) %	3.2	1.94	39.6%	20.7		71.7%
FREQ(CHL-a>30) %	0.6	2.48	39.6%	7.1		71.7%
FREQ(CHL-a>40) %	0.1	2.89	39.6%	2.6		71.7%
FREQ(CHL-a>50) %	0.0	3.21	39.6%	1.1		71.7%
FREQ(CHL-a>60) %	0.0	3.49	39.6%	0.5		71.7%
CARLSON TSI-P	62.6	0.10	58.1%	72.3		83.0%
CARLSON TSI-CHLA	50.6	0.10	39.6%	56.9		71.7%
CARLSON TSI-SEC	53.8	0.12	32.0%	63.2		65.4%

Danzig Dam - Minus 75%

Overall Water Balance — **Averaging Period = 2.00 years**

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	Hailstone Inlet	93.3	6.4	0.00E+00	0.00	0.07
2	4	1	Hailstone Outlet	111.6	7.6	0.00E+00	0.00	0.07
3	1	1	Ungauged Inflow	18.3	1.3	0.00E+00	0.00	0.07
PRECIPITATION				0.5	0.1	0.00E+00	0.00	0.20
TRIBUTARY INFLOW				111.6	7.6	0.00E+00	0.00	0.07
***TOTAL INFLOW				112.1	7.7	0.00E+00	0.00	0.07
GAUGED OUTFLOW				111.6	7.6	0.00E+00	0.00	0.07
ADVECTIVE OUTFLOW				0.5	0.1	0.00E+00	0.00	0.19
***TOTAL OUTFLOW				112.1	7.7	0.00E+00	0.00	0.07
***EVAPORATION					0.0	0.00E+00	0.00	

Overall Mass Balance Based Upon **Observed** **Outflow & Reservoir Concentrations**
Component: **TOTAL P**

Trb	Type	Seg	Name	Load kg/yr	% Total	Load Variance (kg/yr)^2	% Total	CV	Conc mg/m^3	Export kg/km^2/yr
1	1	1	Hailstone Inlet	143.3	73.3%	0.00E+00		0.00	22.5	1.5
2	4	1	Hailstone Outlet	861.1		1.07E+04		0.12	113.0	7.7
3	1	1	Ungauged Inflow	36.1	18.5%	0.00E+00		0.00	28.9	2.0
PRECIPITATION				16.1	8.2%	6.49E+01	100.0%	0.50	152.4	30.0
TRIBUTARY INFLOW				179.4	91.8%	0.00E+00		0.00	23.5	1.6
***TOTAL INFLOW				195.5	100.0%	6.49E+01	100.0%	0.04	25.3	1.7
GAUGED OUTFLOW				861.1	440.4%	0.00E+00		0.00	113.0	7.7
ADVECTIVE OUTFLOW				11.8	6.0%	0.00E+00		0.00	113.0	22.0
***TOTAL OUTFLOW				872.9	446.4%	0.00E+00		0.00	113.0	7.8
***RETENTION				-677.3		6.49E+01		0.01		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.4252
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	4.7
Reservoir Conc (mg/m3)	113	Retention Coef.	-3.464

Overall Mass Balance Based Upon **Observed** **Outflow & Reservoir Concentrations**
Component: **TOTAL N**

Trb	Type	Seg	Name	Load kg/yr	% Total	Load Variance (kg/yr)^2	% Total	CV	Conc mg/m^3	Export kg/km^2/yr
1	1	1	Hailstone Inlet	2606.9	71.3%	0.00E+00		0.00	409.3	27.9
2	4	1	Hailstone Outlet	14013.2		4.77E+06		0.16	1839.0	125.6
3	1	1	Ungauged Inflow	511.9	14.0%	0.00E+00		0.00	409.5	28.0
PRECIPITATION				537.0	14.7%	7.21E+04	100.0%	0.50	5080.0	1000.0
TRIBUTARY INFLOW				3118.8	85.3%	0.00E+00		0.00	409.3	27.9
***TOTAL INFLOW				3655.8	100.0%	7.21E+04	100.0%	0.07	473.2	32.6
GAUGED OUTFLOW				14013.2	383.3%	0.00E+00		0.00	1839.0	125.6
ADVECTIVE OUTFLOW				192.3	5.3%	0.00E+00		0.00	1839.0	358.0
***TOTAL OUTFLOW				14205.4	388.6%	0.00E+00		0.00	1839.0	126.7
***RETENTION				-10549.7		7.21E+04		0.03		

Overflow Rate (m/yr)	14.4	Nutrient Resid. Time (yrs)	0.3701
Hydraulic Resid. Time (yrs)	0.0952	Turnover Ratio	5.4
Reservoir Conc (mg/m3)	1839	Retention Coef.	-2.886

Danzig Dam - Minus 75%

Predicted & Observed Values Ranked Against CE Model Development I

Segment:	**1**	**Main Lake**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	30.1	0.45	30.2%	113.0		83.0%
TOTAL N MG/M3	516.7	0.55	15.0%	1839.0		82.9%
C.NUTRIENT MG/M3	21.4	0.44	26.2%	88.1		87.1%
CHL-A MG/M3	4.0	0.52	13.4%	14.6		71.7%
SECCHI M	3.0	0.45	90.7%	0.8		34.6%
ORGANIC N MG/M3	904.5	0.19	89.7%	1624.0		99.2%
TP-ORTHO-P MG/M3	13.9	0.21	20.8%	25.0		42.4%
ANTILOG PC-1	88.7	0.71	21.9%	949.6		84.9%
ANTILOG PC-2	8.7	0.22	71.6%	7.2		58.6%
(N - 150) / P	12.2	0.90	31.3%	14.9		42.5%
INORGANIC N / P	0.1	0.71	0.0%	2.4		0.6%
TURBIDITY 1/M	0.9		66.7%	0.9		66.7%
ZMIX * TURBIDITY	1.2		10.9%	1.2		10.9%
ZMIX / SECCHI	0.5	0.46	0.0%	1.7		3.8%
CHL-A * SECCHI	11.8	0.28	58.2%	11.7		57.6%
CHL-A / TOTAL P	0.1	0.26	27.1%	0.1		25.6%
FREQ(CHL-a>10) %	3.7	1.89	13.4%	61.8		71.7%
FREQ(CHL-a>20) %	0.2	2.83	13.4%	20.7		71.7%
FREQ(CHL-a>30) %	0.0	3.43	13.4%	7.1		71.7%
FREQ(CHL-a>40) %	0.0	3.87	13.4%	2.6		71.7%
FREQ(CHL-a>50) %	0.0	4.22	13.4%	1.1		71.7%
FREQ(CHL-a>60) %	0.0	4.51	13.4%	0.5		71.7%
CARLSON TSI-P	53.2	0.12	30.2%	72.3		83.0%
CARLSON TSI-CHLA	44.2	0.11	13.4%	56.9		71.7%
CARLSON TSI-SEC	44.4	0.15	9.3%	63.2		65.4%

Appendix C
US EPA Region 8 TMDL Review Form and Decision Document

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	**Nutrient and Dissolved Oxygen TMDL for Danzig Dam in Morton and Oliver Counties, North Dakota**
Submitted by:	**North Dakota Department of Health, Division of Water Quality**
Date Received:	**November, 2015**
Review Date:	**April 25, 2016**
Reviewer:	**Truskowski**
Rough Draft / Public Notice / Final Draft?	**Public Notice Draft**
Notes:	

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

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

Approval Notes to the 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 TMDL review elements identified in the following 8 sections:

1. Problem Description
   a. ...TMDL Document Submittal
   b. Identification of the Waterbody, Impairments, and Study Boundaries
   c. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   a. Data Set Description
   b. Waste Load Allocations (WLA)
   c. Load Allocations (LA)
   d. Margin of Safety (MOS)
   e. 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 review elements 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 this review form 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 form 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

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

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☐ 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 ☐ N/A

Summary: EPA received notice that the Danzig Dam TMDL was placed on Public Notice on November 18, 2015.

Comments: No comments.

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.

Review Elements:

☒ 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

<u>Summary:</u>

Danzig Dam is listed on the 2014 Section 303(d) list of impaired waters needing total maximum daily loads (TMDLs), the North Dakota Department of Health (NDDoH) has assessed Danzig Dam as fully supporting, but threatened for fish and other aquatic biota and recreation uses. The impairments are listed as sedimentation/siltation, dissolved oxygen, and nutrients/eutrophication/biological indicators. The TMDL document addresses both the aquatic life and recreation impairments caused by low dissolved oxygen and nutrient/eutrophication/biological indicators.
Danzig Dam has been classified as a Class 3 warm-water fishery, "capable of supporting natural reproduction and growth of warm-water fishes (i.e., largemouth bass and bluegill) and associated aquatic biota and marginal growth. Some cool water species may also be present."

Danzig Dam Section 303(d) Listing Information

Assessment Unit ID: ND-10130203-007-L_00 Waterbody
Name: Danzig Dam
Class: Class 3, Warm-water fishery
Impaired Designated Uses: Fish and Other Aquatic Biota and Recreation
Use Support: Fully Supporting, but Threatened
Impairment: Nutrient/Eutrophication Biological Indicators; Dissolved Oxygen;
Sediment/Siltation Priority: High

Danzig Dam is located on the headwaters of Hailstone Creek, a tributary of the Big Muddy River, eight miles west of New Salem. The watershed for Danzig Dam includes portions of both Morton and Oliver counties.

The Danzig Dam watershed is characterized as a semi-arid rolling plain of shale, siltstone, and sandstone punctuated by occasional sandstone buttes and badlands. The topography of this area was largely unaffected by glaciations and retains its original soils and complex stream drainage pattern. The soils present belong to the Orders Mollisols and Entisols, and are typically Haploborolls, Calciborolls and Ustorthents.

The Danzig Dam watershed lies entirely within the Missouri Plateau level IV ecoregion (43a) of the Northwestern Great Plains level III ecoregion (43). Within the Northwestern Great Plains level III ecoregion, native grasslands still persist in areas of steep or broken topography, but over most of the ecoregion they have been largely replaced by spring wheat and alfalfa. Agriculture is limited by erratic precipitation patterns and limited opportunities for irrigation.

Land use data obtain from the National Agricultural Statistics Service in 2012 indicates that the Danzig Dam watershed is primarily agricultural (95.1 percent), consisting of crop production and livestock grazing. Approximately, 60 percent of the watershed is actively cultivated, with wheat, sunflowers and corn the primary crops grown, 34 percent is in pasture/range/haylands.

Figures 1, and 3 of the TMDL document show the location of Danzig Dam and its watershed. Figure 4 and Table 4 shows the land use in the watershed. Figure 2 provides a contour map of the lake although it is unclear if the contours were measured before or after dredging which occurred starting in 2012. Figure 7 shows the location of sampling points used in the TMDL sampling.

Comments:

The maps should include a scale in order to allow the reviewer to better determine the location of the sampling points and other watershed features. The text should clearly state the locations of the sampling points. The text of the document states that the sampling points are at an inlet site, an outlet site, and one site located in the deepest part of the reservoir. However, Figure 7 shows three sampling sites, the first apparently well upstream of the reservoir inlet and one well downstream of the outlet, please clarify the location such that the text and Figure 7 are consistent.

In Table 1, please indicate if the surface area, average depth, etc. are pre- or post-dredging. Please indicate if Figure 7 is pre- or post-dredging

In Section 1.5, it appears that the water quality and TMDL development project was initiated prior to the dredging of the lake. Please discuss how the dredging affects the conclusions of the TMDL document.

In Section1.5.3, the data collected in 2011 and 2012 resulted in an average total phosphorus concentration for the Danzig Dam of 0.113 mg/l, and an average total nitrogen concentration of 1.839 mg/l. These data were collected prior to the dredging of Danzig Dam. Please discuss the anticipated effect of the dredging on these concentrations.

Please discuss the effect of the dredging of Danzig Dam on the dissolved oxygen and temperature data for the lake.

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).

Review Elements:

- ☒ 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 identified 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:

Section 2.1 of the TMDL document describes the narrative standards applicable to all surface waters in North Dakota. The narrative standards are:

- All waters of the state shall be free from substances attributable to municipal, industrial, or other discharges or agricultural practices in concentrations or combinations which 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:
  1) Cause a public health hazard or injury to environmental resources;
  2) Impair existing or reasonable beneficial uses of the receiving waters; or
  3) 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".

In addition to the narrative standards, Section 2.2 describes the numerical standards applicable to Danzig Dam:

> Danzig Dam is classified as a Class 3 warm water fishery. Class 3 fisheries are defined as waterbodies "capable of supporting natural reproduction and growth of warm water fishes (i.e. largemouth bass and bluegill) and associated aquatic biota. Some cool water species may also be present". All classified lakes in North Dakota are assigned aquatic life, recreation, irrigation, livestock watering, and wildlife beneficial uses. The North Dakota State Water Quality Standards state that lakes shall use the same numeric criteria as Class 1 streams, including the state standard for dissolved nitrate as N, of 1.0 mg/L, where up to 10 percent of samples may exceed the 1.0 mg/L. State standards also state that the numeric dissolved oxygen standard of five mg/L as a daily minimum does not apply to the hypolimnion of class 3 and 4 lakes and reservoirs during periods of thermal stratification. As a guideline for lake and reservoir improvement, a chlorophyll-a concentration of 20 µg/L, during the growing season of April – November, is used.

Table 9. Numeric Standards Applicable for North Dakota Lakes and Reservoirs

State Water Quality	Parameter	Guidelines	Limit
Numeric Standard for Class I Streams and	Nitrates (dissolved)	1.0 mg/L	Maximu m
Numeric Standard	Dissolved Oxygen	5.0 mg/L	Daily Minimu
Guidelines for Goals in a Lake Improvement or Maintenance Program	Chlorophyll-a	20 µg/L	Goal[3]

[1] "Up to 10% of samples may exceed"
[2] Does not apply to the hypolimnion of Class 3 and 4 lakes and reservoirs during periods of thermal stratification
[3] During the growing season of April through November

Comments: No comments.

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, embeddedness, stream morphology, up-slope conditions and a measure of biota).

Review Elements:

☒ 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:

Based on studies of the relationships between Trophic State Indices, including a collaborative study by EPA and several Region 8 states, the NDDoH has established an in-lake growing season average chlorophyll-a concentration goal of 20 µg/L for most lake and reservoir nutrient TMDLs, including this TMDL for Danzig Dam. This chlorophyll-a goal corresponds to a chlorophyll-a TSI of 60 which is in the eutrophic range and, as such, will be a trophic state sufficient to maintain both aquatic life and recreation uses of most lakes and reservoirs in the state, including Danzig Dam.

Through the use of a calibrated water quality model like BATHTUB, the total phosphorus load corresponding to an average chlorophyll-a concentration of 20 µg/L can be estimated. Since the observed average chlorophyll-a concentration for Danzig Dam is estimated to be 14.2 µg/L, the TMDL goal and the TMDL equation presented in Section 7.0 was developed assuming no future degradation of water quality within the lake (i.e., a lake protection strategy). Based on this assumption the TMDL target is the predicted average growing season chlorophyll-a concentration of 13.5 µg/L which corresponds to a 10 percent reduction in the current nutrient load.

The North Dakota State Water Quality Standard for dissolved oxygen is 5.0 mg/L as a daily minimum, with up to ten percent of representative samples collected during any three year period occurring below this value provided lethal conditions are avoided. This will be the dissolved oxygen target for Danzig Dam.

Based on the 2011 and 2012 data, excluding the samples from a thermally stratified hypolimnion, dissolved oxygen concentrations were below the state standard of 5.0 mg/L in only two of 30 samples, or seven percent.

Comments:

How was thermal stratification determined from the data, please discuss the criteria for determining stratification. Which data were excluded as a result?

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 identified source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each identified source (or source category) should be specified and quantified. 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.

Review Elements:

☒ The TMDL should include an identification of the 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 the anthropogenic sources of the pollutant of concern have been identified, characterized, and 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:

According to Section 4.0 of the TMDL document, there are no known point sources in the Danzig Dam watershed, all the pollutants of concern are due to nonpoint sources, and the TMDL is based largely on the use of models to predict the contributions of the pollutants to the TMDL document.

The Annualized Agricultural NonPoint Source Pollution (AnnAGNPS) model consists of a system of computer models used to predict nonpoint source pollution (NPS) loadings within agricultural watersheds. AnnAGNPS was utilized for the Danzig Dam Water Quality and Watershed Assessment project. AnnAGNPS uses 34 different categories of input data and over 400 separate input parameters to execute the model. The input data categories can be split into five major classifications: climatic data, land characterization, field operations, chemical characteristics, and feedlot operations. Climatic data includes precipitation, maximum and minimum air temperature, relative humidity, sky cover, and wind speed. Land characterization consists of soil characterization, curve number, RUSLE parameters, and watershed drainage characterization. Field operations contain tillage, planting, harvest, rotation, chemical operations, and irrigation schedules. Finally, feedlot operations require daily manure rates, times of manure removal, and residue amount from previous operations.

AnnAGNPS assess the watershed to identify "critical cells" (those with the highest nutrient loads) located in the watershed for potential best management practice implementation (Figures 12 and 13). Critical cells were determined to be cells in the watershed providing an estimated annual phosphorus yield of 0.056 lbs/acre/year or greater and/or an estimated annual nitrogen yield of 6.79 lbs/acre/year.

AGNPS and BATHTUB models indicate that excessive nutrient loading is responsible for the low dissolved oxygen levels in Danzig Dam. As levels of phosphorus are reduced by the implementation of best management practices, dissolved oxygen levels will improve. This is supported by the research of Thornton, et al (1990). They state that, "…as organic deposits were exhausted, oxygen conditions improved."

Comments:

Please describe how the dredging of the lake affects the TMDL. Was the data used for the modelling collected before or after the dredging? If the data were collected before dredging, are there plans to collect additional data to ensure the modelling is still applicable to the lake?

Please include in an appendix all of the water quality data collected which were used to develop the TMDL.

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the 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:

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

Where:

TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin Of Safety

Review Elements:

☒ 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:

AnnAGNPS was utilized for the Danzig Dam Water Quality and Watershed Assessment project. The AnnAGNPS model uses batch processing, continual-simulation, and surface runoff pollutant loading to generate amounts of water, sediment, and nutrients moving from land areas (cells) and flowing into the watershed stream network at user specified locations (reaches) on a daily basis. The water, sediment, and chemicals travel throughout the specified watershed outlets. Feedlots, gullies, point sources, and impoundments are special components that can be included in the cells and reaches. Each component adds water, sediment, or nutrients to the reaches.

A daily mass balance for nitrogen (N), phosphorus (P), and organic carbon (OC) are calculated for each cell. Major components of N and P considered include plant uptake N and P, fertilization, residue decomposition, and N and P transport. Soluble and sediment absorbed N and P are also calculated. Nitrogen and phosphorus are then separated into organic and mineral phases. Plant uptake N and P are modeled through a crop growth stage index.

A three year simulation period was run on the Danzig Dam watershed at its present condition to provide a best estimation of the current land use practices applied to the soils and slopes of the watershed to obtain nutrient loads from the individual cells as well as the watershed as a whole. Crop rotations were determined from 2011 and 2012 crop data from the National Agricultural Statistical Service. Over 54 different crop rotations and 29 fertilizer application rates were used to simulate current watershed land use conditions within the Danzig Dam watershed.

The compiled data were used to assess the watershed to identify "critical cells" (those with the highest nutrient loads) located in the watershed for potential best management practice (BMP) implementation. Critical cells were determined to be cells in the watershed providing an estimated annual phosphorus yield of 0.056 lbs/acre/year or greater and/or an estimated annual nitrogen yield of 6.79 lbs/acre/year.

For Danzig Dam, and for other eutrophic lakes and reservoirs, low dissolved oxygen levels are directly related to excessive nutrient loading. The cycling of nutrients in aquatic ecosystems is largely determined by oxidation-reduction (redox) potential and the distribution of dissolved oxygen and oxygen-demanding particles (Dodds, 2002). Dissolved oxygen gas has a strong affinity for electrons, and thus influences biogeochemical cycling and the biological availability of nutrients to primary producers such as algae. High levels of nutrients can lead to eutrophication, which is defined as the undesirable growth of algae and other aquatic plants. In turn, eutrophication can lead to increased biological oxygen demand and oxygen depletion due to the respiration of microbes that decompose the dead algae and other organic material. Under ice cover, bacteria can consume more oxygen than photosynthesis can replenish under the limited light and reaeration conditions of thick ice and snow cover.

AGNPS and BATHTUB models indicate that excessive nutrient loading is responsible for the low dissolved oxygen levels in Danzig Dam.

<u>Comments:</u>

It appears that most of the data used in the models were collected prior to the dredging of the lake. As stated in the TMDL document, "…as organic deposits were exhausted, oxygen conditions improved." Since much of the organic material in the lake has been mechanically removed, does additional data need to be collected in order to determine if the impairment has been temporarily removed? Discuss how the dredging affects the results and conclusions of the models used.

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…).

Review Elements:

☒ 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

<u>Summary:</u>

In 2011, the Morton County Soil Conservation District (SCD) sponsored a water quality assessment and TMDL development project. Based on the sampling plan and procedures described in the Quality Assurance Project Plan, the SCD collected water quality data at an inlet site (385562), an outlet site (385563), and at one site located in the deepest area of the reservoir (381415).

Water quality samples and discharge measurements were taken from the stream sites. Stream parameters analyzed included total nitrogen, total Kjeldahl nitrogen, nitrate-nitrite, ammonia, total phosphorus, and total suspended solids (see Tables 6 and 7 in the TMDL document). Sampling frequency for the stream sampling sites was stratified to coincide with the typical hydrograph for the region.

Reservoir water quality monitoring was conducted by the Morton County SCD at one site located in the deepest area of Danzig Dam (381415). Monthly samples were collected between February 2011 and September 2012. The reservoir was sampled twice per month in June and August of 2011.

A summary of nutrient and chlorophyll-a data is provided in Table 8. Secchi disk transparency data were collected during the open water period between May 2011 and September 2012.

Dissolved oxygen and temperature were monitored at the deepest site on Danzig Dam from February 2011 through January 2012.

Comments:

Please provide all of the collected water quality data in an appendix to the TMDL document.

In Section1.5.1 please expand the discussion on the sampling frequency, it isn't clear how often samples were taken for the project.

In Section1.5.3 were the lake samples taken to coincide with the stream sampling?

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.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and 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 are no point sources identified in the TMDL document, all sources appear to be nonpoint source pollution.

Comments: No comments.

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.

Review Elements:

☒ 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 the 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:

To facilitate the management and analysis of tributary inflow and outflow water quality and flow data the FLUX program was employed. The FLUX program, developed by the US Corps of Engineers Waterways Experiment Station, provides the user with six calculation techniques to estimate the average mass discharge or loading that passes a given river or stream site. FLUX estimates loadings based on grab sample chemical concentrations and the continuous daily flow record. Load is therefore defined as the mass of a pollutant during a given time period (e.g., hour, day, month, season, year). The FLUX program allows the user, through various iterations, to select the most appropriate load calculation technique and data stratification scheme, either by flow or date, which will give a load estimate with the smallest statistical error, as represented by the coefficient of variation. Output from the FLUX program is then provided as an input file to calibrate the BATHTUB eutrophication response model.

A 10 percent nutrient load reduction target was established for the Danzig Dam watershed. This reduction was set based on the BATHTUB model, which predicted that under similar hydraulic conditions, an external nutrient load reduction of 10 percent would lower Carlson’s chlorophyll-a TSI from 56.6 (equivalent to an average growing season chlorophyll-a concentration of 14.2 μg/L) to 56.2 (equivalent to an average growing season chlorophyll-a concentration of 13.5 μg/L).

Using the AnnAGNPS model, it was determined that cells with a phosphorus yield of 0.056 lbs/acre/year or greater and/or cells with a nitrogen yield of 6.79 lbs/acre/year are priority areas in the watershed (Figure 13). These are the critical cells which should be targeted and further examined by a watershed implementation project to determine the necessity and types of BMP's to be implemented.

Comments:

More data should be collected during an implementation project to better target best management practice installation to ensure the most load reduction for the money spent in the watershed.

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).

Review Elements:

☒ 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).

☒ <u>If the MOS is implicit</u>, 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.

☐ <u>If the MOS is explicit</u>, 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:

Assuming the existing phosphorus and nitrogen load to Danzig Dam from tributary sources and internal cycling is 733.8 kg and 13,012.2 kg, respectively, and the TMDL target is the predicted average growing season chlorophyll-a concentration of 13.5 µg/L, then a "protection strategy" reduction of 10 percent in total phosphorus and nitrogen loading would result in TMDL target loading capacities of 662.0 kg/year for total phosphorus and 11,764.7 kg/year for total nitrogen. Based on a 10 percent explicit margin of safety (MOS), the total phosphorus MOS for the Danzig Dam TMDL would be 66.2 kg and the total nitrogen MOS would be 1,176.5 kg.

Comments: No comments.

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.

Review Elements:

☐ 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:

The Danzig Dam TMDL addresses seasonality because the BATHTUB and AnnAGNPS models incorporate seasonal differences in their prediction of annual total phosphorus and nitrogen loadings.

Comments:

Please explain further how seasonality is addressed in the models, there appears to be no discussion in the Technical Analysis section regarding how the models address seasonality.

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.

Review Elements:

☒ 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:

To satisfy the public participation requirements of this TMDL, letters were sent to the following participating agencies notifying them that the draft report was available for review and public comment. Those included in the mailing were as follows:

(6) Morton and Oliver County Soil Conservation Districts;
(7) Morton and Oliver County Water Resource Boards;
(8) North Dakota Game and Fish Department;
(9) Natural Resource Conservation Service (State Office); and
(10) U.S. Environmental Protection Agency, Region VIII.

In addition to notifying specific agencies of this draft TMDL report's availability, the TMDL was posted on the North Dakota Department of Health, Division of Water Quality web site at http://www.ndhealth.gov/. A 30 day public notice soliciting comment and participation was also published in the Mandan News (Morton County).

Comments: No comments.

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.

Review Elements:

- ☐ 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:

To insure that the BMPs implemented as a part of any watershed restoration plan will reduce nutrient levels, water quality monitoring will be conducted in accordance with an approved QAPP.

Specifically, monitoring will be conducted for all variables that are currently causing impairments to the beneficial uses of the waterbody. Once a watershed restoration plan (e.g., 319 PIP) is implemented, monitoring will be conducted in the lake/reservoir beginning two years after implementation and extending five years after the implementation project is complete.

Comments:

Since the monitoring used to collect the data for this TMDL document was done prior to the dredging of the lake, additional monitoring should be done prior to the development of a nonpoint source project to ensure the lake is still impaired.

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 is not 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.

Review Elements:

☒ 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:

Implementation of TMDLs is dependent upon the availability of Section 319 NPS funds or other watershed restoration programs (e.g., USDA EQIP), as well as securing a local project sponsor and the required matching funds. Provided these three requirements are in place, a project implementation plan (PIP) is developed in accordance with the TMDL and submitted to the North Dakota Nonpoint Source Pollution Task Force and US EPA for approval. The implementation of the best management practices contained in the NPS PIP is voluntary. Therefore, success of any TMDL implementation project is ultimately dependent on the ability of the local project sponsor to find cooperating producers.

Comments: No comments.

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.

Review Elements:

☒ 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:

While the NDDoH believes that the appropriate temporal expression for nutrient loading to lakes and reservoirs is as an annual load, the phosphorus and nitrogen TMDLs have also been expressed as daily loads. In order to express the phosphorus and nitrogen TMDLs as daily loads, the annual total phosphorus loading capacity of 662.0 kg/year was divided by 365 days. Based on this analysis, the phosphorus TMDL, expressed as an average daily load, is 1.8 kg/day with the load allocation equal to 1.6 kg/day and the MOS equal to 0.2 kg/day. Similarly, the total nitrogen TMDL, expressed as a daily load, is 32.2 kg/day with the load allocation equal to 29.0 kg/day and the MOS equal to 3.2 kg/day.

Comments: No comments.

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

USEPA Region 8 Comments

Review Document Section 1.2:

The maps should include a scale in order to allow the reviewer to better determine the location of the sampling points and other watershed features. The text should clearly state the locations of the sampling points. The text of the document states that the sampling points are at an inlet site, an outlet site, and one site located in the deepest part of the reservoir. However, Figure 7 shows three sampling sites, the first apparently well upstream of the reservoir inlet and one well downstream of the outlet, please clarify the location such that the text and Figure 7 are consistent.

In Table 1, please indicate if the surface area, average depth, etc. are pre- or post-dredging. Please indicate if Figure 7 is pre- or post-dredging

In Section 1.5, it appears that the water quality and TMDL development project was initiated prior to the dredging of the lake. Please discuss how the dredging affects the conclusions of the TMDL document.

In Section1.5.3, the data collected in 2011 and 2012 resulted in an average total phosphorus concentration for the Danzig Dam of 0.113 mg/l, and an average total nitrogen concentration of 1.839 mg/l. These data were collected prior to the dredging of Danzig Dam. Please discuss the anticipated effect of the dredging on these concentrations.

Please discuss the effect of the dredging of Danzig Dam on the dissolved oxygen and temperature data for the lake.

NDDoH Response to Comments:

Some maps are for illustrative purposes (e.g. Land Use Map) to show composition using averages and a scale was not included. The contour map is provided by the North Dakota Game and Fish Department, which conducted the dredging and did not see a need to change the map. For others showing sampling sites, a scale was added.

As with all of the North Dakota TMDLs, Inlet and Outlet are a category of sites. Access is limited in a rural state such as North Dakota and the inlet/outlet sites are chosen based on access. In the text of the document before Figure 7, it is clearly stated that the inlet site is 385562 and the outlet site is 385563. Both of those sites are identified on the map in Figure 7 by the site number. The latitude and longitude of each site is also provided in Table 5. No further clarification is needed.

All data in this TMDL is from the assessment conducted in 2011 and 2012. No further water quality data has been collected, so no information is available about the water quality post-dredging. The amount of dredge material taken from the reservoir is so small that it does not change the dimensions of reservoir. Approximately 20,000 cubic yards of sediment were taken out of the reservoir. Based on an estimated lake volume of 25,286,542 cubic yards (580.5 ac ft), the volume of sediment removed due to dredging amounts to around 0.08% of the total lake volume. The dredging was done by the North Dakota Game and Fish as a part of their fish restoration efforts and not by the NDDoH. Further, dredging was limited to three small areas along the lakes shoreline for the primary purpose of enhancing public fishing access and was not done as a lake restoration of water quality improvement practice. Mention of the dredging project was included just as a resource should any future watershed implementation efforts take place. No further discussion was included because no other information was available. As with any TMDL, this document it is meant to convey a condition at the time of sampling, as changes in any watershed are continuous and will be addressed through future assessment or implementation projects. Comments were added in Section 1.0 to clarify this. Also, while the dredging might provide some limited short-term improvement to water quality, the initial conditions that caused the nutrient loading to the reservoir still exist.

USEPA Region 8 Comments
Review Document Section 2.0:

How was thermal stratification determined from the data, please discuss the criteria for determining stratification. Which data were excluded as a result?

NDDoH Response to Comments:

Information was added to Section 1.5.3 of the TMDL to better define thermal stratification. No data was excluded.

USEPA Region 8 Comments
Review Document Section 3.0:
Please describe how the dredging of the lake affects the TMDL. Was the data used for the modeling collected before or after the dredging? If the data were collected before dredging, are there plans to collect additional data to ensure the modeling is still applicable to the lake?

Please include in an appendix all of the water quality data collected which were used to develop the TMDL.

NDDoH Response to Comments:
As mentioned in the NDDoH Response to Comments above in Section 1.2, there is no further information available to discuss how the dredging will affect the lake, and will need to be further investigated in future assessment or implementation projects. The TMDL is based on available data from 2011 and 2012. While dredging may provide some improved to water quality within the reservoir, the root cause of the reservoirs problems remains nutrient loading from the watershed and conservation practices throughout the watershed will still need to be implemented prevent further water quality degradation and to maintain beneficial uses. Because of this, the modeling is still applicable to the reservoir and the AnnAGNPS model is still appropriate for addressing nutrient inputs to the lake from the watershed and is included to identify target areas to address during implementation. The BATHTUB model may change slightly with more recent data, as all models do, but the TMDL target was derived to assume no future degradation, since the chlorophyll concentration goal is already being met.

Nutrient and chlorophyll data were added to Appendix A.

USEPA Region 8 Comments
Review Document Section 4.0:
It appears that most of the data used in the models were collected prior to the dredging of the lake. As stated in the TMDL document, "…as organic deposits were exhausted, oxygen

conditions improved." Since much of the organic material in the lake has been mechanically removed, does additional data need to be collected in order to determine if the impairment has been temporarily removed? Discuss how the dredging affects the results and conclusions of the models used.

NDDoH Response to Comments:

The NDDoH does not agree that "much" of the organic material was removed and in fact the volume of sediment removed from the reservoir through dredging was quite small when compared to total lake volume. Additional data is always useful, but as mentioned previously, is not currently available. No speculation on affects of dredging will be included without additional data. The results and conclusions of this TMDL remain unchanged.

USEPA Region 8 Comments

Review Document Section 4.1:

Please provide all of the collected water quality data in an appendix to the TMDL document.

In Section1.5.1 please expand the discussion on the sampling frequency, it isn't clear how often samples were taken for the project.

In Section1.5.3 were the lake samples taken to coincide with the stream sampling?

NDDoH Response to Comments:

As addressed above, additional water quality data were added to the Appendix A.

Section 1.5.1 has NDDoH standard wording for frequency of sample collection. The total number of samples collected is indicated in Tables 6, 7, and 8. A variety of environmental factors influence when the actual sample is taken, including but not limited to stream flow, rain, road conditions, etc. As such, there is not a set pattern to offer here and a description of the actual sample dates would be lengthy. Some wording was added to helps clarify this, but as the spring sampling tries to capture flow as well as storm events it can vary, but is more frequent (up to twice a week). As rainfall is significantly less in later summer and fall, sampling once per week is usually enough, though sometimes streams can go dry between rainfall events, where no sampling occurs at all. There are also issues that can arise with equipment and personnel that changes or limits sampling in a given week. Actual sampling dates have been included with the water quality data provided in Appendix A.

In Section 1.5.3 it states that lake/reservoir samples are collected twice per month in spring and once per month in the fall and winter. Further lake samples were collected on their own schedule and were not meant to coincide with stream samples. Since lake samples require a boat, and there is only one person taking the samples, collecting stream samples on the same day as lake samples was not possible.

USEPA Region 8 Comments

Review Document Section 4.3:

More data should be collected during an implementation project to better target best management practice installation to ensure the most load reduction for the money spent in the watershed.

NDDoH Response to Comments:

This comment is addressed in Section 10.0, Monitoring, and Section 11.0, TMDL Implementation Strategy.

USEPA Region 8 Comments
Review Document Section 4.5:
Please explain further how seasonality is addressed in the models, there appears to be no discussion in the Technical Analysis section regarding how the models address seasonality.

NDDoH Response to Comments:
In Section 4.5 of the EPA Review Document it states. "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."

This document addresses seasonal variation, specifically critical flow periods, in a variety of ways. Section 6.2 of the TMDL states that both BATHTUB and AnnAGNPS models incorporate seasonal differences in their prediction of annual total phosphorus and nitrogen loadings. In Section 5.2, the discussion of the BATHTUB model indicates that tributary data is analyzed and reduced by the FLUX program, which uses inflow and outflow water quality data, and then used to calibrate the BATHTUB model. Since the FLUX program relies on flow data, which varies by season, this seasonality is used to calibrate the BATHTUB model. Section 5.3 discusses how the AnnAGNPS model used climate data, including precipitation, air temp, and wind speed, as well as field operations such as chemical operation and irrigation schedules. These also have seasonal differences which are incorporated into the model. It also discusses how AnnAGNPS uses this specific data to create an annualized loading model which is necessary since the TMDL requires a daily load, not one based on season. An additional sentence was added to Section 6.2 of the TMDL to state that the sampling frequency also accounts for seasonality.

It is not the intent of the TMDL to explain in great detail how each of the models is compiled or operates. There are references if the reader wishes to learn more about each models components and requirements. It is stated in the TMDL that the NDDoH does address seasonality in the TMDL, especially differences in flow period, and does so through the use of the BATHTUB and AnnAGPS models, sampling frequency, as well as a growing season average chlorophyll-a goal, used as the nutrient TMDL target.

USEPA Region 8 Comments
Review Document Section 6.0:
Since the monitoring used to collect the data for this TMDL document was done prior to the dredging of the lake, additional monitoring should be done prior to the development of a nonpoint source project to ensure the lake is still impaired.

NDDoH Response to Comments:
While it is possible that the dredging improved water quality in the reservoir, it does not address how the reservoir became impaired in the first place. If contributions from the watershed are not addressed, it is not reasonable to assume that the lake is no longer impaired or will remain so, thereby eliminating the need of a nonpoint source project even if additional monitoring prior to an implementation project indicated improvement. Monitoring is conducted as a part of all Section 319 Nonpoint Source projects.