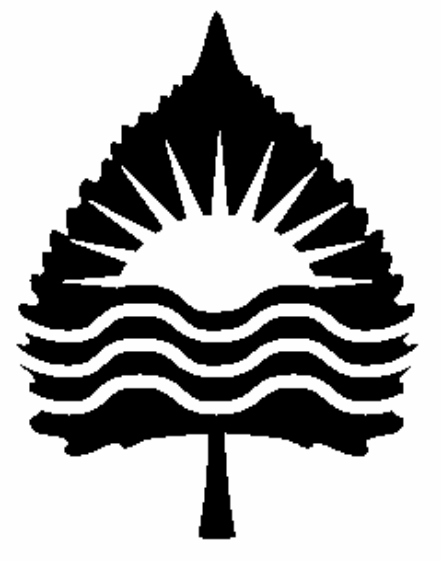

Total Maximum Daily Loads
for
Wagon Train Lake – Lancaster County, Nebraska

Parameters of Concern: Siltation/Sedimentation, Dissolved Oxygen and Nutrients

Pollutants Addressed: Sediment and Phosphorus

Nebraska Department of Environmental Quality
Planning Unit, Water Quality Division

September 2002

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Executive Summary

Wagon Train Lake was included on the 1998 Nebraska Section 303(d) List of Impaired Waters (NDEQ 1998) due to impairment by siltation/sedimentation, low dissolved oxygen/organic enrichment, nutrients, pesticides (atrazine). As such, a total maximum daily load must be developed for each impaired parameter in accordance with the Clean Water Act. This document presents TMDLs for sediment; nutrients (i.e., phosphorus) and organic enrichment/low dissolved oxygen, designed to allow Wagon Train Lake to fully support its designated uses in addition to water quality goals established through the Community Based Watershed Planning Process (citation). The information contained herein should be considered 3 TMDLs that target 2 pollutants. Specifically, sedimentation has been targeted to address the siltation impairment and phosphorus is the pollutant targeted to address the nutrient and organic enrichment/low dissolved oxygen impairments.

Revisions to Title 117 – Nebraska Surface Water Quality Standards criteria will allow the de-listing of Wagon Train Lake for impairment caused by pesticides and therefore it is not necessary to address this pollutant. The de-listing has been included on the proposed 2002 Nebraska Section 303(d) list.

These TMDLs have been prepared to comply with the current (1992) regulations found at 40 CFR Part 130.7.

1. Name and geographic location of the impaired waterbody for which the TMDLs are being developed.
Wagon Train Lake, Section 25, Township 8 North, Range 7 East, Lancaster County, Nebraska, Lat. 40° 37’ 13”, Long. 96° 34’ 55.9”

2. Identification of the pollutant and applicable water quality standard
The pollutants causing the impairment(s) of the water quality standard and designated beneficial uses are sediment and nutrients (phosphorus). Designated uses assigned to Wagon Train Lake include: primary contact recreation, aquatic life Warmwater class A, agriculture water supply class A and aesthetics (NDEQ 2000). Excessive sediment and nutrient inputs have been determined to be impairing the aesthetic and aquatic life beneficial uses. In regards to aquatic life, the applicable dissolved oxygen criterion has been deemed impaired based upon excessive nutrients.

3. Quantification of the pollutant load that may be present in the waterbody and still allows attainment and maintenance of the water quality standards.
Bathymetric survey data and the EUTROMOD water quality model were employed to determine the current and maximum sediment and nutrient loads that if achieved should result in beneficial use attainment. These values are 5,471 tons/year and 262 lbs/year (119 kg/year) for sediment and phosphorus, respectively. Is should be noted, the above are locally derived water quality goals.

4. Quantification of the amount or degree by which the current pollutant load in the waterbody, including upstream sources that is being accounted for as background loading deviates from the pollutant load needed to attain and maintain water quality standards.
The average annual sediment load is exceeding the water quality goal by 16,373 tons/year. Empirical data indicates approximately 21,844 tons/year of sediment is delivered to Wagon Train Lake. This is based upon a desired 75% reduction of the current average annual load.

The total phosphorus load delivered to Wagon Train Lake is estimated to be 21,432 lbs/year. To meet the water quality goals, the average annual loading capacity is 262 lbs/year. To achieve the loading capacity a 98.8% reduction is needed.

5. Identification of the pollutant source categories.
Nonpoint sources of sediment have been identified as the cause of the siltation/sedimentation impairment to Wagon Train Lake. Nonpoint and natural sources have been identified as the cause of the nutrient and dissolved oxygen impairment to Wagon Train Lake.

6. Wasteload allocations for pollutants from point sources.

No point sources discharge in the watershed and therefore the wasteload allocation will be set at zero (0).

7. Load allocations for pollutants from nonpoint sources.

For this TMDL the sediment and phosphorus load allocation were set at 5,471 tons/year and 162 lbs/year, respectively. These allocations were developed using models and empirical data. No specific sediment load allocations were made for natural sources as allowed by 40 CFR Part 130.7. Based upon water quality modeling, a background loading of 100 lbs/year was set as the (natural) allocation for nutrients.

8 A margin of safety.

These TMDLs contain an implicit margin of safety. For the sediment TMDLs, the water quality goals/reductions have been set at a level 5 times greater than necessary to attain full support status. In regards to nutrients, pollutants are discharged from the system via the reservoir's outlet. These TMDLs will assume the nutrients delivered to the waterbody remain, reflecting a worst-case condition.

9. Consideration for seasonal variation.

The pollutants of concern are delivered on a year round basis and the assessment of the data considers annual average conditions. However, watershed model inputs require that seasonal changes (e.g. vegetative cover, precipitation) be accounted for. Because nonpoint sources have been identified as a significant contributor, management practices and implementation will be targeted at those times when the nonpoint source influence is the greatest. This usually revolves around the precipitation events of mid to late spring when there is a high potential for run-off of sediment, phosphorus (attached to sediment), and nitrogen. The effects of the excess pollutant loadings are: large quantities of algae growth occurring during the growing season, dissolved oxygen impairments and sediment reducing the volume of the lake.

10. Allowances for reasonably foreseeable increases in pollutant loads.

There was no allowance for future growth included in these TMDLs.

11. Implementation Plan

Implementation of the reductions for the 2 pollutants is currently underway for Wagon Train Lake and is comprised of 2 phases: 1) in-lake structures and 2) watershed treatment. The in-lake structures were completed as part of the renovation/rehabilitation process and the watershed treatments will be pursued in the near future. To facilitate implementation of the watershed work, the Nebraska Department of Environmental Quality and Natural Resource Conservation Service (NRCS) have entered into a cooperative agreement whereby a dedicated NRCS staff member will work with landowners within the watershed.

The TMDLs included in the following text can be considered "phased TMDLs" and as such are an iterative approach to managing water quality based on the feedback mechanism of implementing a required monitoring plan that will determine the adequacy of load reductions to meet water quality standards and revision of the TMDL in the future if necessary. A description of the future monitoring (Section 5.0) that is planned has been included. .

Monitoring is essential to all TMDLs in order to:

- Assess the future beneficial use status;
- Determine if the water quality is improving, degrading or remaining status quo;
- Evaluate the effectiveness of implemented best management practices.

The additional data collected should be used to determine if the implemented TMDL and watershed management plan have been or are effective in addressing the identified water quality impairments. As well the data and information can be used to determine if the TMDLs have accurately identified the required components (i.e. loading/assimilative capacity, load allocations, in lake response to pollutant loads, etc.) and if revisions are appropriate.

1.0 Introduction

Wagon Train Lake was listed on the 1998 Nebraska Section 303(d) list of impaired waters (NDEQ 1998) as not supporting the assigned beneficial uses with the pollutants of concern being, atrazine pesticides, nutrients, siltation/sedimentation and low dissolved oxygen.

For the 1998 atrazine listing, the applicable water quality criteria applied for was 1 μg/l, which was intended to protect aquatic life during chronic exposures. In 1999, the Nebraska Department of Environmental Quality (NDEQ) proposed and received approval to change the chronic water quality standard found in Title 117 – Nebraska Surface Water Quality Standards (Title 117) from 1 μg/l to 12 μg/l. Using this new standard, the NDEQ's assessment procedures and the existing data, Wagon Train Lake was re-assessed and determined not to be impaired due to atrazine. Therefore, for the 2002 Section 303(d) listing, the parameter will be removed and no total maximum daily load (TMDL) will be developed for atrazine.

Recently, a renovation of Wagon Train Lake took place with the focus of the project being shoreline stabilization and protection, an enhancement of aquatic habitat and reduction in the overall sediment and nutrient loading. For the 2002 listing cycle, an assessment of Wagon Train Lake data and information indicated the waterbody was no longer "impaired" due to sediment. Delisting of the waterbody is proposed for 2002 however, the sediment TMDL will be developed. The project described above addressed in-lake problems and implemented structural controls (i.e. basin, wetlands) to address the pollutants. While in the short term these may be effective, long-term control of sediment and nutrients from the watershed is desired to ensure the lake continually supports beneficial uses. As well, based upon the delivery mechanisms, sediment and nutrient TMDLs often compliment each other that is, reductions and best management practices often target both pollutants simultaneously.

In reservoirs, dissolved oxygen impairments can be the result of accelerated eutrophication. Excessive algae and macrophyte growth add to the oxygen demand. Control of the nutrients should in turn have an affect on the plant growth, which then will affect the oxygen demand. Therefore, based on the above and as required by Section 303(d) of the Clean Water Act and 40 CFR Part 130.7, TMDLs for sediment and nutrients have been developed and contained herein to address the siltation/sedimentation, nutrient(s) and low dissolved oxygen impairments.

1.1 Background Information

Wagon Train Lake is located in Lancaster County, Nebraska (Figure 1.1) and was constructed by the United States Army Corps of Engineers (USACE) primarily as a flood control structure with completion and the initial fill occurring in 1963 (USACE 1995). The waterbody also supports recreation (primary contact, fishing, etc.) as a secondary use. A description of the physical information is provided in Table 1.1. The Nebraska Game and Parks Commission (NGPC) manage the fishery and the immediate surrounding area (727 acres) as a state recreation area. No towns or cites lie within the watershed boundaries however, the City of Hickman (populations 1,188) is approximate 2.5 miles west of Wagon Train Lake. As well, the City of Lincoln (populations ≅ 216,000) is located approximately 12 miles to the northwest.

1.1.1 Waterbody Description

1.1.1.1 Waterbody Name: Wagon Train Lake

Lake Identification Number: LP2-L0030 (Tile 117 – Nebraska Surface Water Quality Standards)

1.1.1.2 Major River Basin: Missouri River

1.1.1.3 Minor River Basin: Lower Platte

1.1.1.4 Hydrologic Unit Code 10200203

1.1.1.5 Assigned Beneficial Uses: Primary contact recreation, Aquatic Life Warmwater Class A, Agricultural Water Supply Class A and Aesthetics (Title 117 – Nebraska Surface Water Quality Standards)

1.1.1.6 Major Tributary: Undesignated Tributary

Figure 1.1 Location of Wagon Train Lake and Watershed in Lancaster County, Nebraska

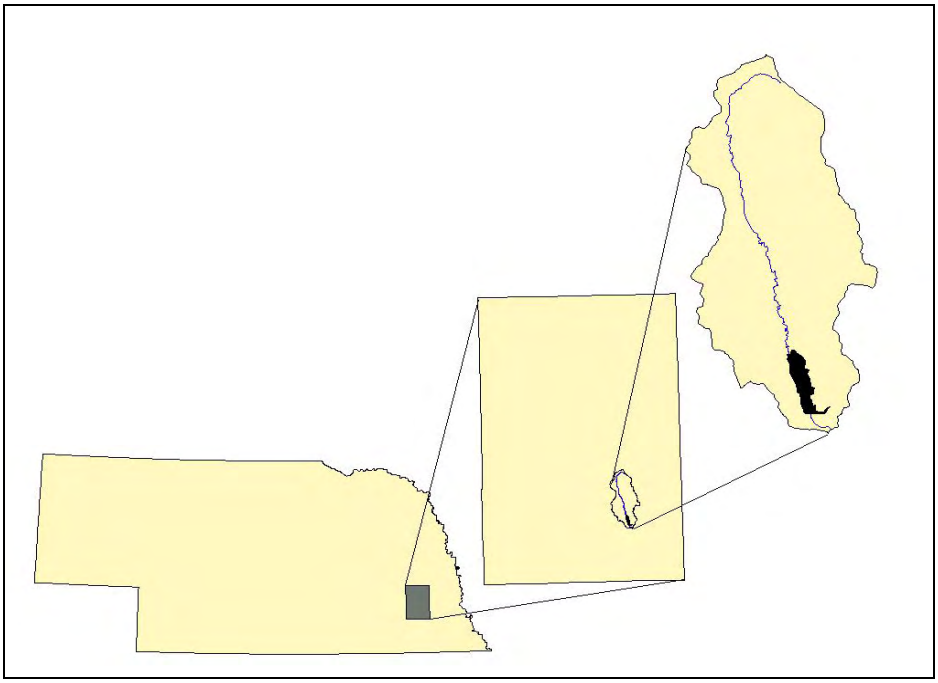


Table 1.1 Physical Description of Wagon Train Lake

Parameter	Wagon Train Lake
State	Nebraska
County	Lancaster
Latitude (center of dam)	40° 37’ 13”
Longitude (center of dam)	96° 34’ 55.9”
Legal Locations (dam)	Section 25, Township 8 North, Range 7 East
Surface Area – 1963	279 acres
Surface Area – 1996	271 acres
Shoreline Length (pre-renovation)	3 mile (approximately)
Mean Depth – 1963	8.14 feet (2.5 meters)
Mean Depth – 1996	6.57 feet (2 meters)
Volume – 1963	2,272 acre/feet
Volume – 1996	1,780 acre/feet
Number of inlets	1
Watershed Area	9,984 acres
Lake to Watershed Ration (pre-renovation/post)	1:31.7 / 36.8

1.1.2 Watershed Characterization

1.1.1.1 Physical Features: Wagon Train Lake has a watershed of approximately 9,984 acres and is located in the Western Corn Belt Plains (Level III) ecoregion as defined by Chapman, et al. (2001). The reservoir was completed in 1963 by the USACE who retains ownership however, the lake's fishery and the surrounding area is managed by the NGPC. General agriculture (e.g. row crops, pasture) historically dominated the land use. Due to the lake's proximity to the City of Lincoln residential acreage development has increased in recent years and the trend is expected to continue.

A single undesignated tributary from the north/northeast feeds Wagon Train Lake. The surface drainage is rapid on the hills and the drainage ways are well defined (NNRC 1974). The aspect is mostly southward towards Hickman Branch (LP2-30200). Two major soils associations are present in the watershed: the Pawnee-Burchard and the Wymore-Pawnee Associations. Soils of the Pawnee-Burchard Association are deep, gently sloping to steep, moderately well drained and well-drained, loamy and clayey soils that formed in glacial till. The Wymore-Pawnee Association are deep, nearly level to strongly sloping, moderately well drained, silty soils that formed in loess and loamy soils that formed in glacial till. Both associations are considered upland soils. As well, water erosion is considered a main hazard for these soils (Brown et al., 1980).

1.1.2.2 Climate: Winters in the watershed are cold with precipitation mainly occurring as snowfall. Summers can be hot but with occasional cool spells. Annual precipitation in the area is approximately 32 inches (DNR Data bank). Rainfall can be periodically heavy during the summer months.

1.1.2.3 Demographics: While no city or village lie in the Wagon Train Lake watershed boundary, Hickman (population 1,188) lies to the west and Lincoln (population 215,928) lies to the northwest. Both municipalities are in Lancaster County, which has shown an approximate 12% growth in the last 10 years.

1.1.2.4 Land Uses: General agriculture, primarily crop production dominates the land use in the watershed. Dryland and irrigated crops consisting of corn, soybeans with lesser extents of pasture and other crops. Residential acreage development has increased in recent years due to the proximity to Lincoln and this trend is expected to continue. An aerial photograph of the watershed is provided in figure 1.1.2.4.

2.0 Sediment TMDL

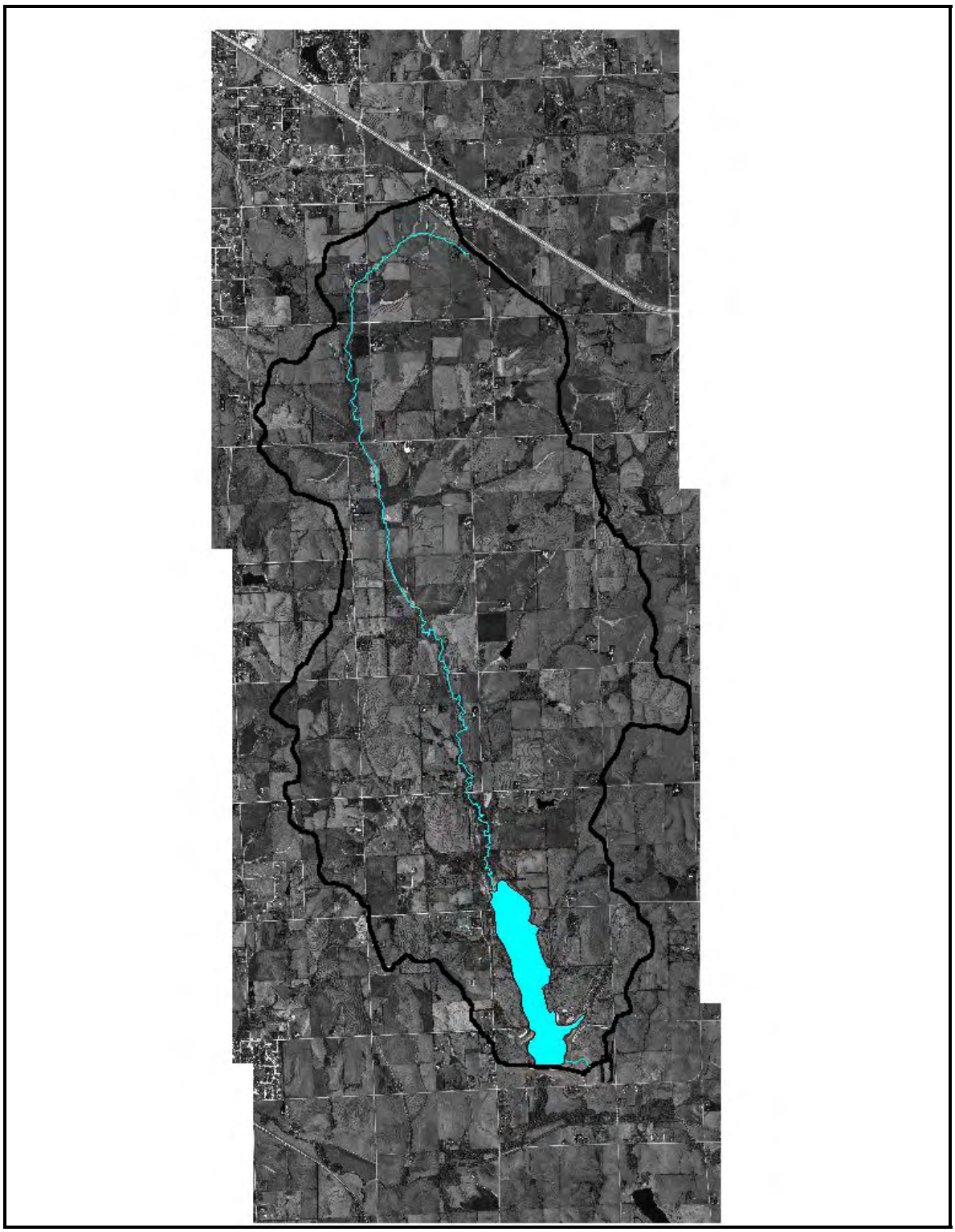
2.1 Problem Identification

This section details the extent and nature of the water quality impairments caused by excessive sedimentation (siltation) in Wagon Train Lake.

2.1.1 Water Quality Criteria Violated and/or Beneficial Uses Impaired: The *Aquatic Life* – Warmwater Class A and *Aesthetics* beneficial uses assigned to Wagon Train Lake are not being met (impaired) due to excessive sedimentation.

2.1.2 Data Sources: Sediment loading estimates for Wagon Train Lake were determined from area-capacity studied conducted by the USACE. Reservoir capacity studies were conducted on Wagon Train Lake in 1963, 1968, 1987 and 1996.

Figure 1.1.2.4 Aerial Photograph of Wagon Train Lake and Watershed



2.1.3 Water Quality Assessment: Nebraska does not have numeric water quality criteria for sediment or total suspended solids but the NDEQ has adopted methods to evaluate the severity of sedimentation in reservoirs. A consideration of the assessment is the overall volume lost of the reservoir multi-purpose pool (conservation pool and sediment pool combined). The NDEQ will include a waterbody on the Section 303(d) list when a 25% volume loss has been reached. For Wagon Train Lake the 1996 volume loss was estimated to be approximately 21.6% (USACE 1997). While the total volume loss criterion has not been exceeded, the calculated sedimentation rate of 0.65%/year does fall into the "moderate" category, which will be described in section 2.1.3.2.

The Nebraska Game and Parks Commission (NGPC) is responsible for the management of the state's fisheries and will expend resources to rehabilitate waterbodies when interested parties or the general public express concerns over degrading recreational opportunities and when the aquatic communities exhibit a shift from the original management scheme (i.e. bass/bluegill to carp/bullhead). Therefore, the public ultimately decides if a waterbody is aesthetically acceptable or un-acceptable. In regards to Wagon Train Lake the NGPC has deemed the waterbody a high priority for renovation and did so following public meetings and the receipt of public comments. The main focus of the renovation will be shoreline stabilization and protection, an enhancement of aquatic habitat and reduction in the overall sediment and nutrient loading.

The 1998 Nebraska Section 303(d) List identified Wagon Train Lake as a high priority and the NDEQ has opted to complete the sediment and nutrient TMDL as an accompaniment to the renovation project. Both the NGPC action and the NDEQ action should result in an enhanced fishery and increase public acceptance and use. As well, the NDEQ has identified the waterbody as a high priority for the development and implementation of nonpoint source pollution management actions. Finally, the Lower Platte South Natural Resource District initiated a community based watershed management plan whereby stakeholders define water quality goals and targets and prioritize implementation activities.

2.1.3.1 Water Quality Conditions: Based on USACE data, Wagon Train Lake's 1963 multi-purpose pool (sediment and conservation) was reported to be ≅2,272 acre/feet. The 1996 bathymetric evaluation determine the volume to be ≅1,780 acre/feet for a realize volume loss of 492 acre/feet or 21.6% loss of the multi-purpose pool. This equates to an average annual volume loss of 0.65%.

2.1.3.2 Severity of Water Quality Problems: As stated, Nebraska has not formally adopted (in Title 117) criteria for sediment, sedimentation or total suspended solids. To evaluate the severity of the sedimentation problem four categories of average annual volume loss/sedimentation rate have been utilized:

Substantial/Severe = ≥ 0.75%/year
Moderate = ≥0.5% but <0.75%
Slight = ≥0.25% to <0.5%
Minimal = <0.25%

Based on the USACE sedimentation survey, Wagon Train Lake falls within the "moderated" category/range.

Along with sedimentation rate, overall lake volume loss is considered when evaluating beneficial use attainment. Review of past NGPC actions indicates the NGPC will generally initiate reservoir rehabilitation (dredging, sediment removal and habitat restoration) when 20-25% of the lake's volume has been lost. This trend while undocumented serves as the guide for the NDEQ in listing waters as impaired on Section 303(d) list as described in the *Methodology for Waterbody Assessment and Developing the 2002 Section 303(d) List of Impaired Waterbodies for Nebraska* (NDEQ 2001).

Section 2.1.3.1 describes that Wagon Train Lake's volume loss was estimated to be 21.6% however, restoration activities were initiated to address the sedimentation problems thus indicating the public's perception was that the lake was less that acceptable.

2.1.4 Potential Pollutant Sources

2.1.4.1 Point Sources: No point sources of sediment or total suspended solids exist in the Wagon Train Lake watershed.

2.1.4.2 Nonpoint Source: Multiple nonpoint sources of sediment have been identified in the Wagon Train Lake watershed. Sources include: sheet and rill erosion, overland run-off from agriculture lands; gully and stream bank erosion.

2.1.4.3 Natural Background Sources: Although natural sources of sediment and total suspended solids exist, background conditions were not separated form the total nonpoint source load.

2.2 TMDL Endpoint

The end point with the sedimentation TMDL is based water quality targets and goals established during the community based watershed management planning process. It should be noted; in the planning process the stakeholder goal setting process uses the NDEQ's water quality standard(s) and assessment criteria as the starting point. As described below, annual volume loss and sedimentation targets in comparison with current sediment load estimates allowed for the determination of the allowable load (desired endpoint) as the associated degree of sediment load reduction needed to attain assigned beneficial uses and the stakeholder's expectations.

2.2.1 Criteria for Assessing Water Quality Attainment

2.2.1.1 Numeric Water Quality Standards/Criteria: As previously stated, Nebraska does not have numeric water quality criteria for sediment or total suspended solids.

2.2.1.2 Quantification of Narrative Water Quality Standards/Criteria: The Warmwater Class A *Aquatic Life* beneficial use is protected through the overall reservoir volume loss and the annual reservoir sedimentation rate utilized by NDEQ during waterbody assessments. In support of the sedimentation assessment criteria, the narrative criteria for the *Aesthetics* beneficial use found in Title 117 state in part "To be aesthetically acceptable, waters shall be free from human induced pollution which causes floating, suspended, colloidal or settleable materials that produce objectionable films, colors, turbidity or deposits" (NDEQ 2002).

2.2.1.3 Local Stakeholder Defined Goals: Local stakeholders established a goal of reducing the sediment loading to Wagon Train Lake by 75%. Using the current average annual load of 21,884 tons/year, a 75% reduction of the long-term average annual load would produce a target load of 5,471 tons per year. If the target load were to be achieved, the average annual volume loss would be reduced from 0.65%/year to 0.16%/year increasing the life span of the waterbody from 119 to 478 years.

2.2.2 Selection of Environmental Conditions

There are no "specific environmental or critical conditions" associated with this sediment TMDL because once the pollutant settles in a reservoir, it is assumed the have an infinite residence time and is present on a year round basis.

2.2.3 Waterbody Loading Capacity

The loading capacity for this TMDL is defined as the amount of sediment Wagon Train Lake can receive on an annual basis and still meet the assigned beneficial use criteria and the in-lake, stakeholder defined water quality targets. In achieving the stakeholder-defined goals, the criteria associated with the assigned beneficial uses will also be met. To achieve a 75% reduction from the current load and an average annual volume loss of 0.16%/year the sediment loading capacity for Wagon Trail Lake is 5,471 tons/year.

2.3 Pollution Source Assessment

For this TMDL, historic and current sediment loading estimates for Wagon Train Lake were determined from the USACE's area capacity studies (USACE 1997). The Agriculture Nonpoint Source (AGNPS) model (Young, et. al 1987) was utilized to provide information on overland and soil erosion in the watershed.

2.3.1 Existing Sediment Load

Using the USACE sedimentation survey data, the pollutant load being delivered to Wagon Train Lake is estimated to be 21,844 tons/year. Of this total load, approximately 170 tons/year is deposited in the flood storage zone, 20,872 tons/year is deposited in the multi-purpose (sediment and recreation) pool and 842 tons/year is discharged through the outlet.

2.3.2 Deviance From Loading Capacity

The stakeholder-defined sediment loading capacity is being exceeded by approximately 16,373 tons/year. To achieve the targeted sedimentation rate and an annual volume loss of 0.16% the average annual sediment load must be reduced 75%.

2.3.3 Identification of Pollutant Sources

As stated, no point sources of sediment have been identified in the watershed therefore the pollutant originates from nonpoint sources and natural conditions. (For this TMDL natural background will not be separated from the load allocations.) The AGNPS model was used to estimate gross soil erosion for the Wagon Train Lake watershed on a 40-acre cell basis using the 2001 land use information (Figure 2.3.3).

2.3.3.1 Nonpoint Sources of Sediment

Gross soil erosion and sediment loads were estimated using the AGNPS model based on 2001 land use conditions. The land uses within the watershed includes: corn, soybeans, hay, pasture, CRP, trees (wooded), alfalfa and water.

2.3.4 Linkage of Sources to Endpoint

The average annual sediment load of 21,844 tons/year delivered to Wagon Train Lake has been determined to originate entirely from nonpoint sources. To meet this TMDL's (stakeholder defined) desired endpoint, the annual nonpoint source sediment contribution of 21,844 tons must be reduced by 16,373 tons/year.

2.4 Pollutant Allocation

A TMDL is defined as:

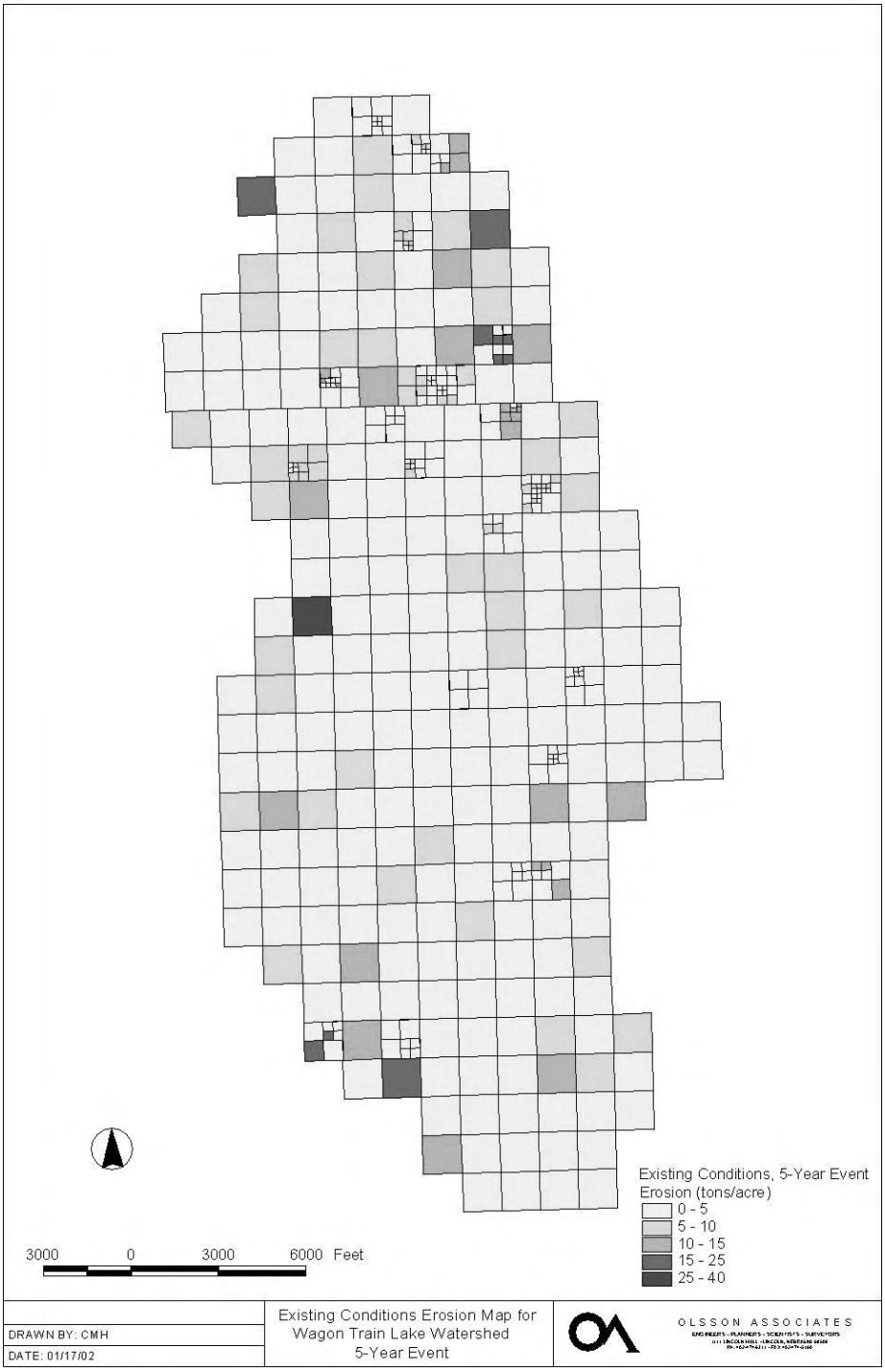
$$\text{TMDL} = \text{Loading Capacity} = \text{WLA} + \text{LA} + \text{Background} + \text{MOS}$$

As stated above, the sediment loading capacity for Wagon Train Lake is 5,471 tons/year and to achieve the defined sediment loading capacity the required allocations are as follows:

2.4.1 Wasteload Allocation

No point sources of sediment exist in the watershed therefore the wasteload allocation (WLA) will be "zero" (0 tons/year).

Figure 2.3.3 Gross Soil Erosion Estimates for the Wagon Train Lake Watershed



2.4.2 Load Allocation

The sediment load allocation distributed among nonpoint sources will be 5,471 tons/year. Base flows carry indiscernible amounts of sediment and thus natural background will not be separated from the load allocation.

2.4.3 Margin of Safety

The margin of safety (MOS) associated with this sediment TMDL will be: the assessment of reservoir sedimentation is based upon both overall volume loss and annual sedimentation rate. Upon meeting the stakeholder defined loading capacity of 0.16%/year the sedimentation rate will be well below the 0.75%/year sedimentation rate that triggers water quality concerns as identified in the *Methodology for Waterbody Assessment and Developing the 2002 Section 303(d) List of Impaired Waterbodies for Nebraska* (NDEQ 2001). The reductions targeted are approximately 5 times greater than required to be deemed fully supporting the beneficial uses.

2.4.4 Sediment TMDL Summary

TMDL/Waterbody Loading Capacity = 0 tons/year (WLA) + 5,471 tons/year (LA & Natural Background) + Implicit Margin of Safety

3. Nutrient TMDL to Address Nutrient and Low Dissolved Oxygen/Organic Enrichment Impairments

3.1 Problem Identification

Wagon Train Lake was included on the 1998 Section 303(d) list as being impaired by excessive nutrients and low dissolved oxygen. In-lake conditions indicate accelerated eutrophication caused by excessive nutrient loading. The linkage between accelerated eutrophication and water quality impairments has been repeatedly documented (USEPA 1999). Eastern Nebraska reservoirs classified as being eutrophic or hypereutrophic are generally high in phosphorus, particularly in agricultural watersheds that produce high sediment yields. Wagon Train Lake watershed modeling and in-lake conditions have resulted in phosphorus being the targeted parameter of concern. The following sections detail the extent and nature of the water quality impairments related to accelerated eutrophication in Wagon Train Lake.

3.1.1 Water Quality Impairments

Wagon Train Lake's assigned beneficial uses for Warmwater A (WWA) Aquatic Life was listed as impaired based upon assessment of the available data to the applicable (WWA) dissolved oxygen criteria (5.0 mg/l) being violated (NDEQ 1998).

3.1.2 Data Sources

The NDEQ, NGPC and USACE have collected various water quality data and information on a semi-regular basis as far back and the 1970's but mainly from 1990 through 1998. NDEQ has continued to collect such information in accordance with basin rotation and other priorities. The existing data includes, water transparency, dissolved oxygen, temperature, conductivity, pH, pesticides, chlorophyll *a*, nitrogen series, dissolved and total phosphorus and total suspended solids.

3.1.3 Water Quality Data Assessment

Beneficial use assessment procedures utilized in preparing the 1998 Section 303(d) list of impaired waters for dissolved oxygen require that concentrations be measured in a "top-to-bottom" profile above the stratified layer. Measurements are then averaged and compared to the 1-day minimum aquatic life criteria of 5.0 mg/l, applicable from April 1 to September 30 (NDEQ 2000). At least 10 data points obtained in the previous 5 years was required for the assessment to be considered "monitored". Should greater than 10% of the profile averages fall below the criteria, the waterbody was considered to be partially supporting the *Aquatic Life* WWA beneficial use and thus included on the Section 303(d) list. It should be noted, the waterbody was retained on the 2002 Section 303(d) list based upon the lack of sufficient data to delist.

Nebraska currently does not have numeric water quality criteria for nutrients however; a biomass trophic state index (TSI) (Carlson 1977; Carlson and Simpson 1996) is used as the metric for evaluating this source/stressor. TSI's calculated from transparency (secchi depth), chlorophyll *a*, and total phosphorus concentration data, were utilized to infer whether algal growth was nutrient or light limited (if the three indices are approximately equal, it can be inferred that algal growth is phosphorus limited (USEPA 1999)). Also, the average of the three TSI scores is used as a single measure of lake conditions (e.g., oligotrophic, mesotrophic, eutrophic or hypereutrophic) as described in Carlson and Simpson (1996). The following classification is used to interpret the TSI:

Trophic State Index Score	Trophic Status	Assessment Criteria	NDEQ Beneficial Use Attainment Status
<40	Oligotrophic	2 of 3 parameters	Full Support
>35 but <45	Mesotrophic	2 of 3 parameters	Full Support
>45	Eutrophic	2 of 3 parameters	Full Support
>60	Hypereutrophic	2 of 3 parameters	Partial Support

3.1.3.1 Water Quality Conditions

Fifteen (15) growing season (May through September) dissolved oxygen profiles were available for Wagon Train Lake from 1990 and 1996-1998. Assessments of the profiles indicate four (4) of the average concentrations were less than 5.0 mg/l for a 27% excursion rate.

Trophic State Indices scores for Wagon Train Lake using average growing season in-lake data collected from 1996-98 include:

Parameter	TSI Score
Secchi depth (meters)	74.7
Chlorophyll *a* (mg/m^3)	53.8
Total Phosphorus (μg/l)	75.4
Mean TSI	**68.0**

With a mean TSI score of 68.0, the waterbody is considered hypereutrophic and because at least 2 of the 3 parameters are greater than the hypereutrophic threshold, the waterbody is considered partially supporting the aesthetic and aquatic life beneficial uses.

One interpretation of the TSI scores (TSI-total phosphorus = TSI-secchi depth > TSI-chlorophyll *a*) is that nonalgal particulate or dissolved color dominate light attenuation (EPA 1999). As indicated in the previous section, Wagon Train Lake has also been listed as impaired by excessive sedimentation. As well, the median total suspended solids concentrations in at the deepwater site have been observed to be as high as 42 mg/l.

While algae production may be interpreted to be "light limited", measured in-lake phosphorus concentrations are similar to other lakes in the area where phosphorus is the limiting parameter. Therefore, phosphorus has been determined to be the parameter targeted for reduction to address both the nutrient and dissolved oxygen impairments. It should be noted, although phosphorus is the nutrient targeted for reduction, the controls implemented to reduce phosphorus should also reduced nitrogen (and other nutrient) contributions.

3.1.4 Potential Pollutant Sources

3.1.4.1 Point Source: No point sources have been identified in the Wagon Train Lake watershed.

3.1.4.2 Nonpoint Sources: Multiple nonpoint phosphorus sources have been identified in the Wagon Train Lake watershed that includes: stream bank and gully erosion, agricultural, and other land uses (i.e., grasslands, wooded, etc.).

3.1.4.3 Natural Sources: Natural background/sources was based upon the contribution of phosphorus as estimated by EUTROMOD modeling techniques.

3.2 TMDL Endpoint

The endpoint for the nutrient and dissolved oxygen TMDL is based upon both narrative and numeric criteria and stakeholder defined water quality goals. As described below, phosphorus loading targets in comparison with current load estimates allowed for the determination of an acceptable load (desired endpoint) and the needed reduction necessary to attain full support designation and the stakeholder-defined goals.

3.2.1 Criteria for Assessing Water Quality Attainment

3.2.1.1 Numeric Water Quality Criteria: The1-day minimum dissolved oxygen criteria of 5.0 mg/l associated with the WWA – Aquatic life beneficial use is the applicable numeric water quality criteria.

3.2.1.2 Quantification of Narrative Water Quality Criteria: As previously outlined in Section 3.1.3, Nebraska does not have numeric water quality standards for nutrients. However, Nebraska's water quality standards for "Aesthetics" states in part, "To be aesthetically acceptable, waters shall be free from human-induced pollution which causes floating, suspended, colloidal, or settleable materials that produce objectionable films, colors, turbidity, or deposits (NDEQ 2000).

The application of the "Aesthetics" beneficial use is through the assessment of a lake's trophic status using Carlson's trophic state index (TSI) as described in Section 3.1.3. In order for a water body to achieve a "full support status", 2 of 3 TSI parameters must be less than 60.

Ultimately, the public will decide if a waterbody is aesthetically acceptable or un-acceptable. Therefore, the goals/endpoints used for these TMDLs (nutrients and dissolved oxygen) have been established by the Wagon Train Lake Water Quality Advisory Council.

3.2.1.3 Local Stakeholder Defined Goals: Through stakeholder meetings held in the Wagon Train Lake watershed, in-lake water quality goals were established. Specifically, the public established the goal of a water transparency of 35 inches (0.89 meters). Given this stakeholder objective, the growing season average conditions for total phosphorus and chlorophyll *a* were determined using a spreadsheet modification of the EUTROMOD model. The required conditions are presented in Table 3.2.1.3.

Table 3.2.1.3 Wagon Train Lake Stakeholder Defined Water Quality Goals

TSI Parameter	Desired In-Lake Condition (growing season)	TSI Score	Mean TSI Score
Transparency (Secchi depth)	35 inches (0.89 meters)	61.7	****
Chlorophyll *a*	9.47 mg/m^3	52.7	****
Total phosphorus	20 µg/l	47.3	****
			53.9

3.2.2 Selection of Critical Environmental Conditions

The "critical condition" for which this nutrient TMDL applies is the entire year. An annual loading period was utilized in modeling Wagon Train Lake's assimilative capacity and for estimating loading reductions necessary to meet in-lake water quality targets. This approach also takes into consideration that nutrients being lost from the water column and trapped in the bottom sediments have the potential to re-enter the water column at a later time. However, implementation of non-point source controls will target those times when a large percent of the loading is occurring.

3.2.3 Waterbody Pollutant Loading Capacity

The loading capacity for this nutrient TMDL is defined as the amount of phosphorus Wagon Train Lake can receive on an annual basis and still meet the applicable water quality criteria, assigned beneficial use criteria and established in-lake water quality targets. Utilizing the EUTROMOD (Reckhow 1992) model, the meet the secchi, chlorophyll *a* and phosphorus goals, the loading capacity for phosphorus, for Wagon Train Lake is 262 lbs/year (119 kg/year).

3.3 Pollutant Source Assessment

For this nutrient TMDL, the phosphorus loading was estimated using a combination of models and chemical data. The two models utilized were AGNPS and EUTROMOD.

3.3.1 Existing Pollutant Load

The average annual phosphorus load is estimated to be 21,432 lbs/year (9,722 kg/year). This value was estimated using the AGNPS and EUTROMOD models and calibrated to long-term, in-lake conditions.

3.3.2 Deviance From Loading Capacity

The targeted waterbody loading capacity for phosphorus, to meet the in-lake goals is 262 lbs/year and the modeled average annual load is 21,432 lbs/year. The loading capacity is being exceeded by 21,170 lbs/year and to achieve the loading capacity, a 98.8% reduction from the current phosphorus load is needed.

3.3.3 Identification of Pollutant Sources

Because no point sources have been identified in the Wagon Train Lake watershed, the pollutant load is believed to originate from nonpoint sources. Typically, areas with high sediment yields also produce significant phosphorus loads. Using 2001 land use information, the AGNPS model estimated sediment loads from 40-acre cells within the watershed. The results were previously illustrated in Figure 2.3.3.

3.3.3.1 Nonpoint Sources of Phosphorus

The 2001 land uses within the watershed includes: corn, soybeans, hay, pasture, CRP, trees (wooded), alfalfa and water.

3.3.4 Linkage of Sources to Endpoints

The average annual phosphorus load of 21,432 lbs/year (9,972 kg/year) to Wagon Train Lake has been determined to originate entirely from nonpoint sources. To meet the desired endpoint for the TMDL, the annual nonpoint source phosphorus contributions must be reduced 98.78% (21,170 lbs) down to 262 lbs/year (119 kg/year).

3.4 Pollutant Allocation

A TMDL is defined as:

$$\text{TMDL} = \text{Loading Capacity} = \text{WLA} + \text{LA} + \text{Background} + \text{MOS}$$

As stated above, the phosphorus loading capacity for Wagon Train Lake is 262 lbs/year (119 kg/year). To achieve the defined phosphorus loading capacity the required allocations are contained in the following sections.

3.4.1 Wasteload Allocation

No point sources of phosphorus discharge in the Wagon Train Lake watershed therefore the wasteload allocation (WLA) will be “zero” (0).

3.4.2 Load Allocation

The phosphorus load allocation distributed among the nonpoint sources within the watershed will be 162 lbs/year (73.5 kg/year).

3.4.3 Natural Background

Utilizing annual precipitation, waterbody surface area and precipitation concentration the natural background load of phosphorus was determined to be approximately 100 lbs/year (44.9 kg/year).

3.4.4 Margin of Safety

The margin of safety for the nutrient TMDL will be: phosphorus can be discharged from the Wagon Train Lake/Reservoir outlet without being utilized. While this reduction is realized in the system, the TMDL will not account for this and assume the phosphorus load delivered to the lake remains available for algae production.

3.4.5 Nutrient (Phosphorus) TMDL Summary

TMDL/Waterbody Loading Capacity = 0 lbs/year (WLA) + 162 lbs/year (LA) + 100 lbs/year (Natural Background) + Implicit Margin of Safety

4.0 Implementation Plan

The implementation plan to meet the water quality goals for Wagon Train Lake has been segregated into to two parts: 1) in-lake structures/treatment and 2) watershed treatments.

At this time the rehabilitation/restoration of Wagon Train Lake has been completed and during that process the following actions or structures were created:

- Shoreline stabilization
- In-lake sediment basin
- In flow wetland areas

The second part of the process includes the verification/identification of critical erosion areas (as defined by the AGNPS modeling) and contributors and installing the watershed treatments necessary to control the load. This process will not only reduce the overall load to Wagon Train Lake but will also increase the lifespan and efficiencies of the in-lake treatments. The Natural Resource Conservation Service (NRCS) and the NDEQ have agreed to devote one full time employee (FTE) that will specifically oversee implementation of watershed treatments within the Wagon Train Lake watershed.

4.1 Reasonable Assurances

Effective management of nonpoint source pollution in Nebraska necessarily requires a cooperative and coordinated effort by many agencies and organizations, both public and private. Each organization is uniquely equipped to deliver specific services and assistance to the citizens of Nebraska to help reduce the effects of nonpoint source pollution on the State's water resources. Appendix A lists those entities that may be included in the implementation process. These agencies have been identified as being responsible for program oversight or fund allocation that may be useful in addressing and reducing sedimentation and nutrient delivery to Wagon Train Lake. Participation will depend on the agency/organization's program capabilities.

5.0 Future Monitoring

Monitoring of Wagon Train Lake will be conducted in the future to determine if the water quality is improving, degrading or remaining status quo. As well, monitoring will be conducted to evaluate the effectiveness of implemented best management practices (BMPs). The NDEQ has entered into an agreement with the USACE whereby the USACE will conduct monthly monitoring throughout the growing season and forward the results to NDEQ for assessment. Also, the USACE will periodically evaluate the impacts of sedimentation (bathymetry). The lake was drained to accommodate the rehabilitation and restoration activities and because of this, monitoring by the USACE will begin once the lake has refilled. Along with the USACE monitoring, NDEQ may periodically conduct monitoring to evaluate the effectiveness of BMPs (i.e. in-lake basins).

6.0 Public Participation

The availability of the TMDLs in draft form was published in the Lincoln Journal Star (printed August 3, 2002) with the public comment period running from August 1, 2002 to September 4, 2002. These TMDLs were also made available to the public on the NDEQ's Internet site and announcement letters were mailed to interested stakeholders.

One comment letter was received from the United States Fish and Wildlife Service regarding the lack of a TMDL for atrazine and the applicability of the water quality criterion. The comment is not applicable to the TMDL and is a water quality standards issue therefore, no modifications or additions were made to the document as a result of the comment.

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Appendix A – Federal, State Agency and Private Organizations Included in TMDL Implementation.

FEDERAL

- Bureau of Reclamation
- Environmental Protection Agency
- Fish and Wildlife Service
- Geological Survey
- Department of Agriculture - Farm Services Agency
- Department of Agriculture - Natural Resources Conservation Service

STATE

- Nebraska Association of Resources Districts
- Department of Agriculture
- Department of Environmental Quality
- Department of Roads
- Department of Water Resources
- Department of Health and Human Services
- Environmental Trust
- Game and Parks Commission
- Natural Resources Commission
- University of Nebraska Institute of Agriculture and Natural Resources (IANR)
- UN-IANR: Agricultural Research Division
- UN-IANR: Cooperative Extension Division
- UN-IANR: Conservation and Survey Division
- UN-IANR: Nebraska Forest Service
- UN-IANR: Water Center and Environmental Programs

LOCAL

- Natural Resources Districts
- County Governments (Zoning Board)
- City/Village Governments

NON-GOVERNMENTAL ORGANIZATIONS

- Nebraska Wildlife Federation
- Pheasants Forever
- Nebraska Water Environment Association
- Nebraska Corn Growers Association, Wheat Growers, etc.
- Nebraska Cattlemen's Association, Pork Producers, etc
- Other specialty interest groups
- Local Associations (i.e. homeowners associations)

Appendix B – Watershed Load Estimation Based on In-lake Phosphorus Concentration

Wagon Train Lake	Input data in green cells		Phosphorus (mg/l)	Chlorophyll a	Secchi Depth	Secchi Depth (inches)
Lake Volume (ac-ft)	1780	Predicted	0.1375	24.52	0.26	10.2
Surface Acres (acres)	271	Monitored In-lake Value	0.1400	10.62	0.36	14
Detention Time (years)	0.54	% Similar	0.98	0.43	0.72	
Watershed P Loading (lbs)	21333					
Volumetric Water Load (10^6 m^3/yr)	*4.066*		TSI - phosphorus	TSI - chlorophyll *a*	TSI - secchi	MEAN TSI
Lake Volume (10^6 m^3)	*2.196*	Predicted	75.1	62.0	79.4	72.2
Mean Depth (ft)	*6.57*	Monitored In-lake Value	75.4	53.8	74.7	68.0
Mean Depth (m)	*2.002*	% Similar	1.00	0.87	0.94	0.94
Annual Precipitation	32.3					
Watershed P Loading (kg)	9677		Watershed load to meet in-lake p concentration (lbs)	Watershed load to meet in-lake Chlorophyll *a* (lbs)	Watershed load to meet in-lake secchi (lbs)	
Precipitation P Load (kg)	*44.9*		21333	265	3405	
Septic P Load (kg)	*0*		Load Summary			
WWTF P Load (kg)	*0*		Minimum	265		
Total P Loading (kg)	*9722*		Mean	8334		
Total P Loading (lbs)	*21432.0*		Median	3405		
Expected Total P-in	*2.391*		Maximum	21333		

Appendix C – Total Phosphorus Load Reduction to Meet Secchi Depth Goal

Wagon Train Lake	Input data in green cells		Phosphorus (mg/l)	Chlorophyll a	Secchi Depth	Secchi Depth (inches)
Reduction %	98.78	Predicted	0.0210	9.40	0.892	35.1
Lake Volume (ac-ft)	1780	Water Quality Goals	0.0200	9.47	0.89	35
Surface Acres (acres)	271	% Similar	0.95	0.99	1.00	
Detention Time (years)	0.54					
Watershed P Loading (lbs)	21333		TSI - phosphorus	TSI - chlorophyll *a*	TSI - secchi	MEAN TSI
Reduced Watershed Load (lbs)	*260.3*	Predicted	48.1	52.6	61.6	54.1
Volumetric Water Load (10^6 m^3/yr)	*4.066*	Water Quality Goals	47.3	52.7	61.7	53.9
Lake Volume (10^6 m^3)	*2.196*	% Similar	0.98	1.00	1.00	1.00
Mean Depth (ft)	*6.57*					
Mean Depth (m)	*2.002*		Phosphorus load Reduction to meet p concentration water quality goal (lbs)	Phosphorus load reduction to meet Chlorophyll *a* water quality goal (lbs)	Phosphorus load reduction to meet secchi measurement goal (lbs)	
Watershed P Loading (kg)	9677		98.86	98.76	98.78	
Precipitation P Load (kg)	44.9		Reduction Summary			
Septic P Load (kg)	*0*		Minimum	98.76		
WWTF P Load (kg)	*0*		Mean	98.80		
Total Reduced P Loading (kg)	*118.6*		Median	98.78		
Total Reduced P Loading (lbs)	*261.5*		Maximum	98.86		
Expected Total P-in	*0.029*					

Appendix D – Watershed Phosphorus Load Reduction to Meet Secchi Depth Goal

Wagon Train Lake	Input data in green cells		Phosphorus (mg/l)	Chlorophyll a	Secchi Depth	Secchi Depth (inches)
Reduction %	99.24	Predicted	0.0210	9.40	0.892	35.1
Lake Volume (ac-ft)	1780	Water Quality Goals	0.0200	9.47	0.89	35
Surface Acres (acres)	271	% Similar	0.95	0.99	1.00	
Detention Time (years)	0.54					
Watershed P Loading (lbs)	21333		TSI - phosphorus	TSI - chlorophyll *a*	TSI - secchi	MEAN TSI
Reduced Watershed Load (lbs)	*162.1*	Predicted	48.1	52.6	61.6	54.1
Volumetric Water Load (10^6 m^3/yr)	*4.066*	Water Quality Goals	47.3	52.7	61.7	53.9
Lake Volume (10^6 m^3)	*2.196*	% Similar	0.98	1.00	1.00	1.00
Mean Depth (ft)	*6.57*					
Mean Depth (m)	*2.002*		Watershed load Reduction to meet p concentration water quality goal (lbs)	Watershed load reduction to meet Chlorophyll *a* water quality goal (lbs)	Watershed load reduction to meet secchi measurement goal (lbs)	
Reduced Watershed Load (kg)	73.53		99.32	99.22	99.24	
Precipitation P Load (kg)	*44.9*		Reduction Summary			
Septic P Load (kg)	*0*		Minimum	99.22		
WWTF P Load (kg)	*0*		Mean	99.26		
Total Reduced P Loading (kg)	*118.4*		Median	99.24		
Total Reduced P Loading (lbs)	*261.1*		Maximum	99.32		
Expected Total P-in	*0.029*					