Total Maximum Daily Loads
for
Antelope Creek: LP2-20900

Parameters of Concern: Total Ammonia and *E. coli*

Nebraska Department of Environmental Quality
Planning Unit, Water Quality Division

June 2007

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Executive Summary

Antelope Creek was included in the 2006 Nebraska Surface Water Quality Integrated Report (NDEQ 2006a) in Category 5 as impaired by excessive, ammonia, conductivity, copper, selenium and *E.* coli. As such, total maximum daily loads (TMDLs) must be developed in accordance with the Clean Water Act. TMDLs will not be developed for conductivity, selenium and copper based on data uncertainty and the potential for a use attainability analysis. The information contained herein should be considered two TMDLs.

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.
Lower Platte River Basin: Antelope Creek, LP2-20900. Lancaster County, NE.

2. Identification of the pollutant and applicable water quality standard
The pollutants causing the impairment(s) of the water quality standards and designated beneficial uses (for which TMDLs will be developed) are: total ammonia and *E. coli* bacteria. Designated uses assigned to the above-identified segments include: primary contact recreation, aquatic life Warmwater class B, agriculture and industrial water supply class A and aesthetics (NDEQ 2006b). Excessive total ammonia and *E. coli* has been determined to be impairing the aquatic life and primary contact recreation beneficial uses, respectively.

3. Quantification of the pollutant load that may be present in the waterbody and still allows attainment and maintenance of the water quality standards.
The allowable pollutant load is based upon the available stream flow volume. That is, loading capacities are developed for each flow by multiplying the water quality standard (WQS) by the selected stream flow and a conversion factor (C) with the equation being:

$$\text{Loading capacity} = \text{WQS} * \text{Flow} * \text{C}$$

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.
Assessment of total ammonia data indicates 13 of 61 values exceed the applicable criteria. The 2004 recreation season *E. coli* geometric mean is 3,433/100 ml

5. Identification of the pollutant source categories.
Based on the 2001 issuance of the MS4 permit to the City of Lincoln, the main contributing source is considered to be point source in origin.

6. Wasteload allocations for pollutants from point sources.
For ammonia, the wasteload allocation will be the balance of loading capacity minus the load allocations. For *E. coli* the wasteload allocations for point source discharges will be equivalent to the water quality criteria associated with the primary contact recreation beneficial use – a geometric mean of 126/100 ml.

7. Load allocations for pollutants from nonpoint sources.

The load allocations assigned to the ammonia TMDL will be based upon the stream flow volume and will be defined as:

$$LA_i = Q_i * C_s * C$$

Where:
LA_i = load allocations at the i^{th} flow
Q_i = stream flow at the i^{th} flow
C_s = seasonal ammonia criteria
C = conversion factor

The load allocations assigned to these TMDLs will be based upon the stream flow volume and will be defined as:

$$LA_i = Q_i * 126/100 \text{ ml} * C$$

Where:
LA_i = load allocations at the i^{th} flow
Q_i = stream flow at the i^{th} flow
126/100 ml = applicable/target water quality criteria for *E. coli* from Title 117
C = conversion factor

8. A margin of safety.

These TMDLs contain an implicit and explicit margin of safety. For ammonia, the reduction necessary to support the beneficial use will be applied to all ammonia loadings, not just those conditions where violations have been observed. Also, since the watershed is covered under the City of Lincoln MS4 permit, the LA resembles a margin of safety rather than an allocation.

For *E. coli* the targeted reduction will focus on achieving 90% of the water quality target (≤113/100 ml).

9. Consideration for seasonal variation.

Application of ammonia criteria in the TMDL will be segregated into a spring, summer and winter season.

The water quality criteria are only applicable during the Title 117 defined recreation season that starts May 1 and ends September 30. Because of this, the water quality and stream volume data was limited to this time period.

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 ammonia and *E. coli* will be carried out the auspice of the National Pollutant Discharge Elimination System.

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 4.0) 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 TMDLs has been or is 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 capacity, load allocations, etc.) and if revisions are appropriate.

1.0 Introduction

Antelope Creek was included in Category 5 of the on the 2006 Nebraska Surface Water Quality Integrated Report (IR) (NDEQ 2006a). Category 5 waterbodies are deemed impaired and in need of a TMDL. Data collected in from 2002-2005 indicate the primary contact recreation beneficial use; the aquatic life beneficial use and the agriculture beneficial use are impaired with the pollutants of concern being *E. coli* bacteria, ammonia, copper, selenium and conductivity, respectively.

At this time TMDLs will not be prepared for copper, selenium and conductivity based on the below rationale.

Copper – The 2006 IR stated 4 of 13 samples exceeded the chronic water quality criteria. Review of the data revealed 6 of the 14 samples being labeled with an "M" remark code. The "M" code is defined as inconclusive analysis due to matrix interference and suggests the sample be re-collected. The NDEQ has made the decision to discard this data however; the assessment procedures did not include this.

After removing these data points, only eight remain with two exceeding the applicable criteria. The assessment of waters with less than 10 data points with one or two values that exceed criteria are considered Category 3 waterbodies – insufficient information. Thus no TMDL is needed and the correction will be made in the 2008 IR.

Selenium – Similar to copper, several selenium values were labeled with the "M" remark code. Once the remarked data was removed, only 7 data point remained with 3 values exceeded the water quality. Based on the assessment procedures utilized by NDEQ, the data set is suitable for the identification of the impairments. However, the data set is not sufficient to complete the TMDL.

As well, in December 2004 EPA proposed a revision of the chronic criteria for selenium with the application being a fish tissue concentration. The status of this revision is still draft and the assessment of Antelope Creek selenium to the new criteria is unknown. Rather than proceed, the NDEQ will delay the development of a TMDL until the criteria are finalized. The waterbody will remain in Category 5 as impaired by selenium.

Conductivity – The 2006 IR notes that (Need to Check Mike's Data Assessment). Antelope Creek has been characterized as being "quite salty" and with the groundwater infiltrating the stream to have a total dissolved solids concentration of about 30,000 mg/l (NNRC 1973). A simple analysis of the available data shows a statistically significant trend (95% confidence interval) of decreasing conductivity with increasing stream flow. Other streams in the area have similar characteristics and have been classified with the Agriculture Class B beneficial use.

The above evidence suggests that excessive conductivity may be more a function of the geology or other natural conditions. Rather than complete a TMDL, the information will be forwarded to the Water Quality Standards Coordinator for review. Options available include identification of a natural condition and a category 4C assessment, site-specific water quality criteria or a use attainability analysis.

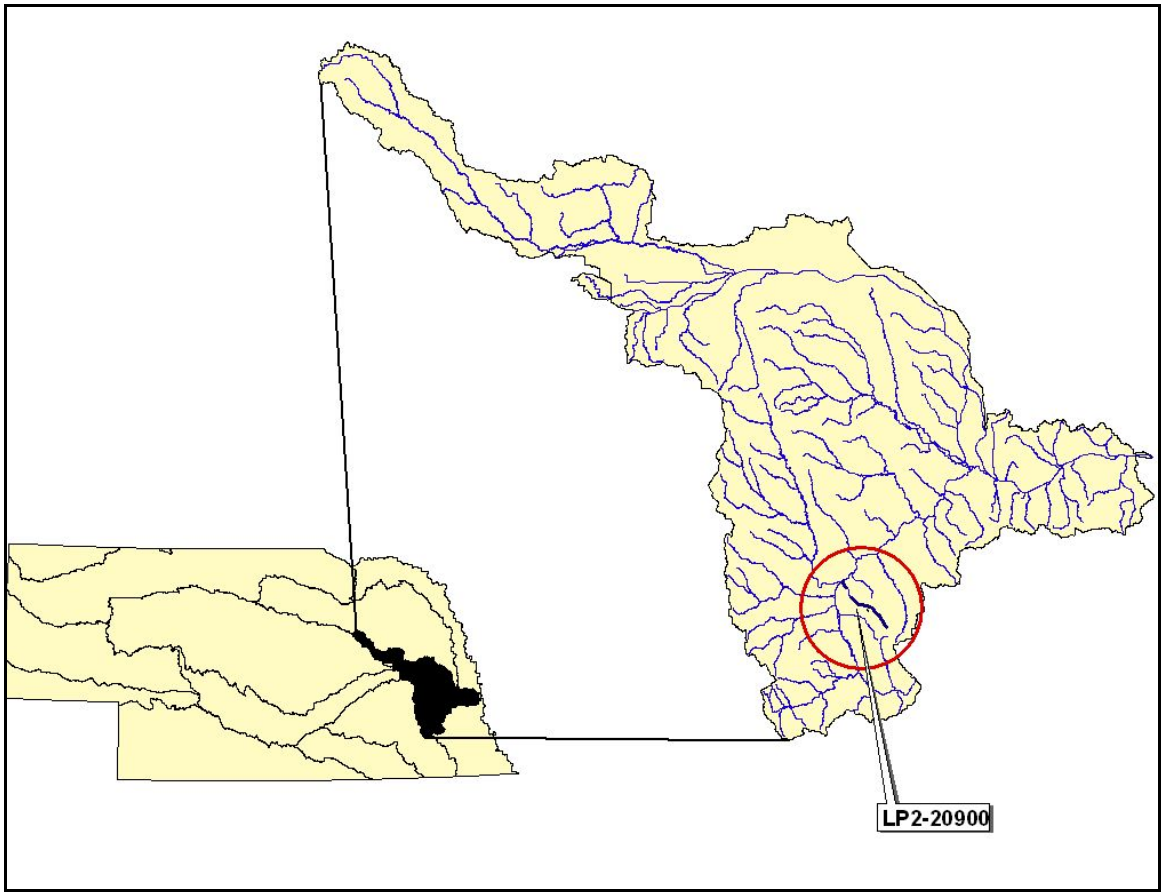
Based on the above, and as required by Section 303(d) of the Clean Water Act and 40 CFR Part 130, TMDLs have been developed for Antelope Creek to address ammonia and *E. coli* bacteria. Therefore, the information contain herein should be considered 2 TMDLs.

1.1 Background Information

Antelope Creek is a tributary of Salt Creek (LP2-20000) with sub-basin 2 of the Lower Platte River Basin. The stream heads in southeast Lancaster County and generally flows northwest (Figure 1.1). Approximately 95% of the Antelope Creek watershed is considered urbanized with the un-urbanized portion being in and around the headwaters region. The stream currently routed underground through a portion of the City of Lincoln and daylights approximately one mile from the confluence with Salt Creek.

Holmes Lake (LP2-L0040) a flood control reservoir, lies five and one-half miles upstream from the mouth and forms a distinct break in the watershed (Figure 1.1b) and associated downstream water quality (Figure 1.1c). In 2003, the Department prepared and received approval of a TMDL for Holmes Lake with the parameters of concern being sediment and nutrients. Along with the TMDL, a community based watershed management plan was completed in 2003 to address pollutants that were causing impairment of Holmes Lake. Implementation of the watershed management plan is currently being taking place.

Figure 1.1 Antelope Creek in the Lower Platte River Basin



Given the physical alteration of water quantity and quality afforded by Holmes Lake, the existence of the approved TMDL and the implementation of the watershed management plan the focus of the Antelope Creek TMDL will be the portion of the stream downstream of the Holmes Lake dam to the confluence with Salt Creek (LP2-20000).

1.1.1 Waterbody Description

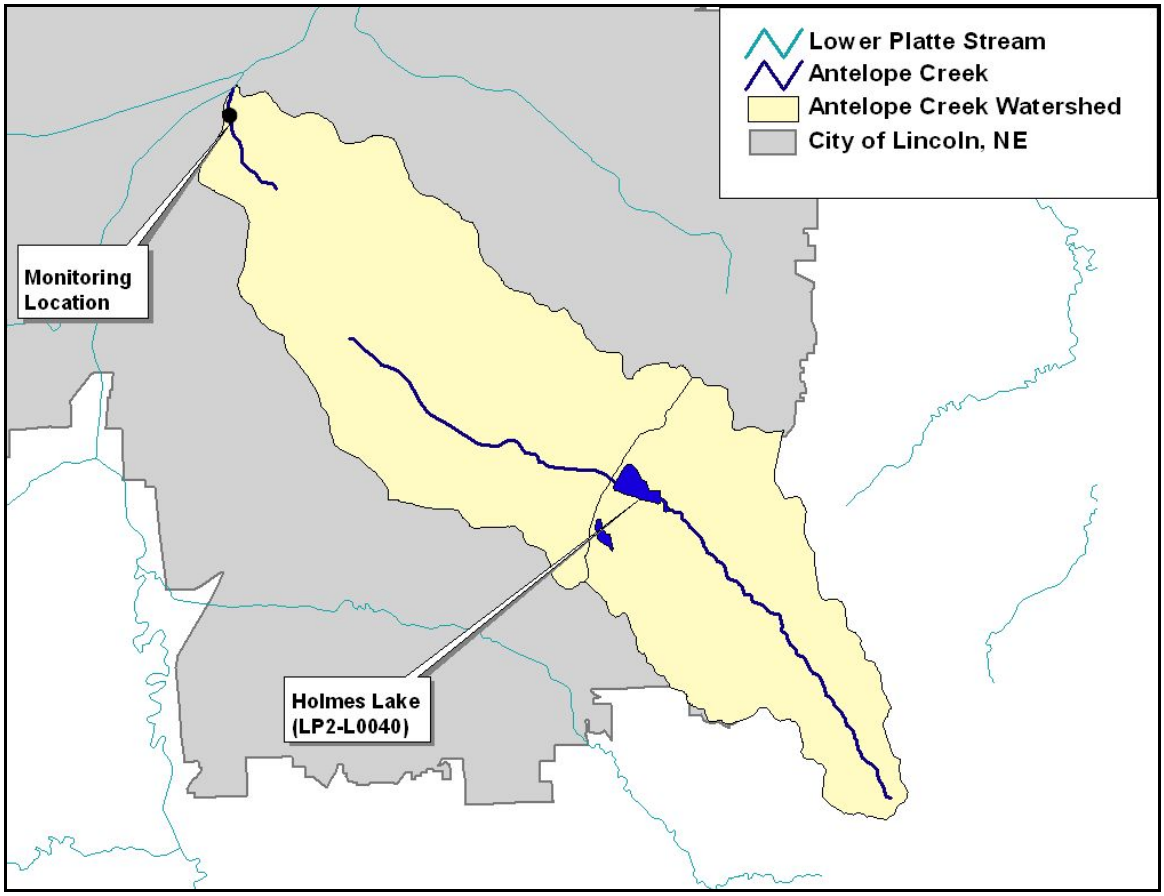
1.1.1.1 Waterbody Name and Stream Identification Number: Antelope Creek: LP2-20900

1.1.1.2 Major River Basin: Missouri

1.1.1.3 Minor River Basin: Lower Platte

1.1.1.4 Hydrologic Unit Code (8 digit): 10200203

Figure 1.1b. Antelope Creek Watershed



1.1.1.5 Assigned Beneficial Uses: Primary contact recreation, warmwater aquatic life – class B, agriculture class A and aesthetics (Title 117 – Nebraska Surface Water Quality Standards).

1.1.1.6 Tributaries: None

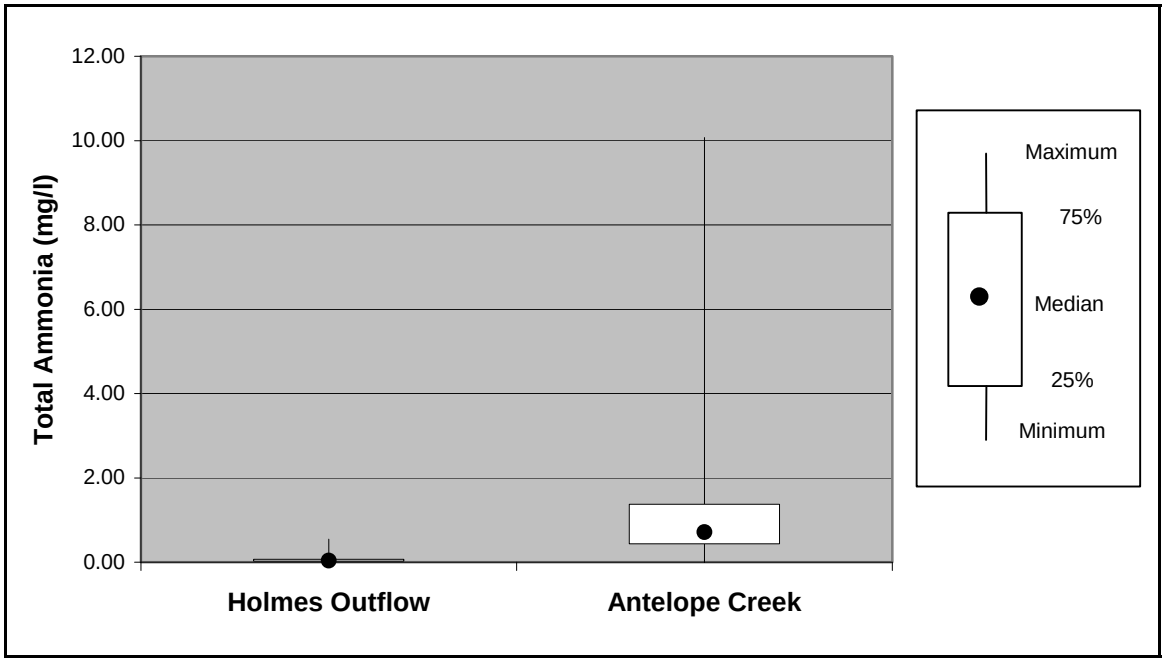
Table 1.1 Physical Description of Antelope Creek

Parameter	Antelope Creek
State	Nebraska
County	Lancaster
Watershed Area	14.2 mi^2
Designated Stream Segments	1
Stream Miles (designated)	8.4 miles

1.1.2 Watershed Characteristics

1.1.2.1 Physical Features: The Antelope Creek watershed encompasses approximately 14.2 mi^2 in southeast Lancaster County. The surface drainage is rapid on the hills and the drainage ways are well defined (NNRC 1973). The aspect is mostly northward through the City of Lincoln proper and towards Salt Creek (LP2-20000).

Figure 1.1c. Ammonia Concentration Comparison: Holmes Lake Outflow and Antelope Creek



Three major soils associations are present in the watershed: the Pawnee-Burchard Wymore-Pawnee and the Sharpsburg-Judson 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 soils of the Sharpsburg-Judson association are deep, nearly level to moderately steep, moderately and well-drained silty soils that formed in loess and colluvium. 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. All 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: A large portion of the Antelope Creek watershed lies within the Lincoln city limits (population 239,213). The municipality is part of Lancaster County, which has shown an approximate 3% growth in the last 10 years.

1.1.2.4 Land Uses: Due to the lake and the watershed's location, much of the land use is urban housing, residential acreages and commercial property. In 1992, 56% of the watershed was considered urban (LPSNRD 1992) and the transition for rural/agriculture to urban has remained steady with the current estimate being 95%. Complete "build-out" of the watershed is expected to occur in 15-25 years.

2.0 Ammonia TMDL

2.1 Problem Identification

This section details the extent and nature of the water quality impairments caused by excessive ammonia in Antelope Creek.

2.1.1 Water Quality Criteria Violated and/or Beneficial Uses Impaired

The *Aquatic Life* – Warmwater Class B beneficial use assigned to Antelope Creek is not being met (impaired) due to excessive ammonia.

2.1.2 Data Sources

Ammonia data is collected as part of the Nebraska Ambient Stream Monitoring and Basin Rotation networks. Within the Ambient Stream Network, samples are collected twice per month during April through September. Weekly samples are obtained from Basin Rotation locations. Stream flow information was obtained from actual measurements and extrapolation from the USGS Gage #06803500

2.1.3 Water Quality Assessment

Water quality data assessments were based upon the beneficial use assessment procedures used to identify Category 5/impaired waters for the 2006 Integrated Report. The procedures are based on the application of the "binomial distribution" method that applies a confidence interval to the exceedance rate in an effort to determine the true exceedance of the waterbody versus the data set. A complete description of the water quality data assessment procedures can be found in the *Methodologies for Waterbody Assessments and Development the 2006 Integrated Report for Nebraska*, January 2006.

The details of the assessment process to determine the use support of the Aquatic Life beneficial use can be found in table 2.1.3

Table 2.1.3 Assessment of the Aquatic Life Beneficial Use

Supported	Impaired
≤10% exceedance of acute or chronic water quality criteria	>10% exceedance of acute or chronic criteria

2.1.4 Water Quality Conditions

Ammonia data collected from 2002-2005 where 13 of 64 values exceeded the applicable criteria.

2.1.5 Potential Pollutant Sources

2.1.5.1 Point Sources: Based on NDEQ records and information, two point sources discharge or have the potential to discharge to Antelope Creek. Both are industrial facilities with the characteristics of the effluent being truck wash water and cooling water. Both have been issued a National Pollutant Discharge Elimination System Permit (NPDES) (according to EPA's Permit Compliance System) with neither requiring the control or monitoring of ammonia. Review of these and other facilities, for the pollutant of concern will be conducted during the permit issuance or reissuance process.

The City of Lincoln and the University of Nebraska-Lincoln have been issued MS4 Stormwater permits and are considered point sources and regulated under the NPDES program.

Illicit connections and discharges, combined sewer overflows; sanitary sewer overflows, straight pipes from septic tanks or other on-site wastewater systems can also be sources of ammonia. While these are potential sources, there have not been investigations to determine the nature and extent of these sources contributions to Antelope Creek.

No animal feeding operations that have been issued State of Nebraska permits, required for construction and operation of livestock waste control facilities (LWCF) if the operation has discharged, or has the potential to discharge, livestock waste to waters of the state have been identified in the Antelope Creek watershed.

2.1.5.2 Nonpoint Sources: As stated above, the area covered by the TMDL is that below Holmes Lake. The watershed in this area is entirely within the corporate limits of the City of Lincoln and thus covered under the NPDES-MS4 permit. Based on this, nonpoint sources contributions would be minimal if any.

2.1.5.3 Natural Sources: The anaerobic and aerobic breakdown of organic matter can produce ammonia. Natural sources of organic matter are wildlife and the flora in and along the stream and within the watershed.

2.2 TMDL Endpoint

The endpoint for this TMDL will be based on the numeric criteria associated with the Class B Warmwater Aquatic Life Beneficial Use.

2.2.1 Numeric Water Quality Criteria

Water quality criteria established for the Class B – Warmwater Aquatic Life protection of the beneficial use can be found in Title 117, Chapter 4 and are as follows:

Thirty day average concentrations in mg/l not to exceed the numeric value given by

$$CV = CCC\left(\frac{0.0676}{1=10^{7.688-pH}} + \frac{2.91}{1+10^{pH-7.688}}\right)$$

Where temp is °C and:

CCC = $0.854\left(\text{Minimum of } \{2.85 \text{ or } 1.45*10^{0.028(25\text{-temp})}\}\right)$

During periods when early life stages are present (March through October), or

CCC = $0.854\left(1.45*10^{0.028(25\text{-maximum of temp or } 25\})}\right)$

2.2.2 Selection of Critical Environmental Conditions

The section above establishes two periods that are commonly referred to as “early life stage present” (March through October) and “early life stage absent” (November through February). Implementation of the NPDES program further separates the early life stage present period to account for variability in stream flows and physical (Temperature) and chemical (pH) conditions of waterbodies.

The environmental conditions for this TMDL will be based upon the seasons being used by the NPDES program in the regulation of ammonia. Those seasons are: spring (March-May), summer (June-October) and winter (November-February). The available data, arranged by season is shown in table 2.2.2.

Table 2.2.2 Antelope Creek Ammonia Data and Violations by Season

Period	Season	Number of Observations	Number of Violations	Percentage of Total
Early Life Stage Present	Spring	16	1	8%
	Summer	36	9	69%
Early Life Stage Absent	Winter	12	3	23%

2.2.3 Waterbody Pollutant Loading Capacity

Defining waterbody pollutant loading capacity implies a steady state. The determination of a loading capacity must consider three key variables, stream flow, pH and temperature. Rather than restrict the loading capacity to a single flow, a dynamic approach will be used. That is, loading capacity will be established for the entire hydrograph of each season.

In the development of WLAs where no TMDL is needed, the procedure is to segregate the data into seasons, calculate an ammonia criterion for each paired (pH and temperature) condition and use the median value of the calculated criteria as the design condition. Because the pollutant source is primarily point sources (stormwater) this procedure will be applied.

The load allocation/natural background will also be determined using the established WLA procedures (NDEQ 2001). Similar to pH and temperature, ammonia data will be segregated into seasons and the median value of the data set will be used as the concentration for calculating the LA and background.

The seasonal design conditions are found in table 2.2.3.

Table 2.2.3 Antelope Creek Design Conditions

Season	Design Criteria	Design Background Ammonia Concentration
Spring	3.087 mg/l	0.73 mg/l
Summer	2.323 mg/l	0.61 mg/l
Winter	6.261 mg/l	0.84 mg/l

The stream loading capacity will be determined by:

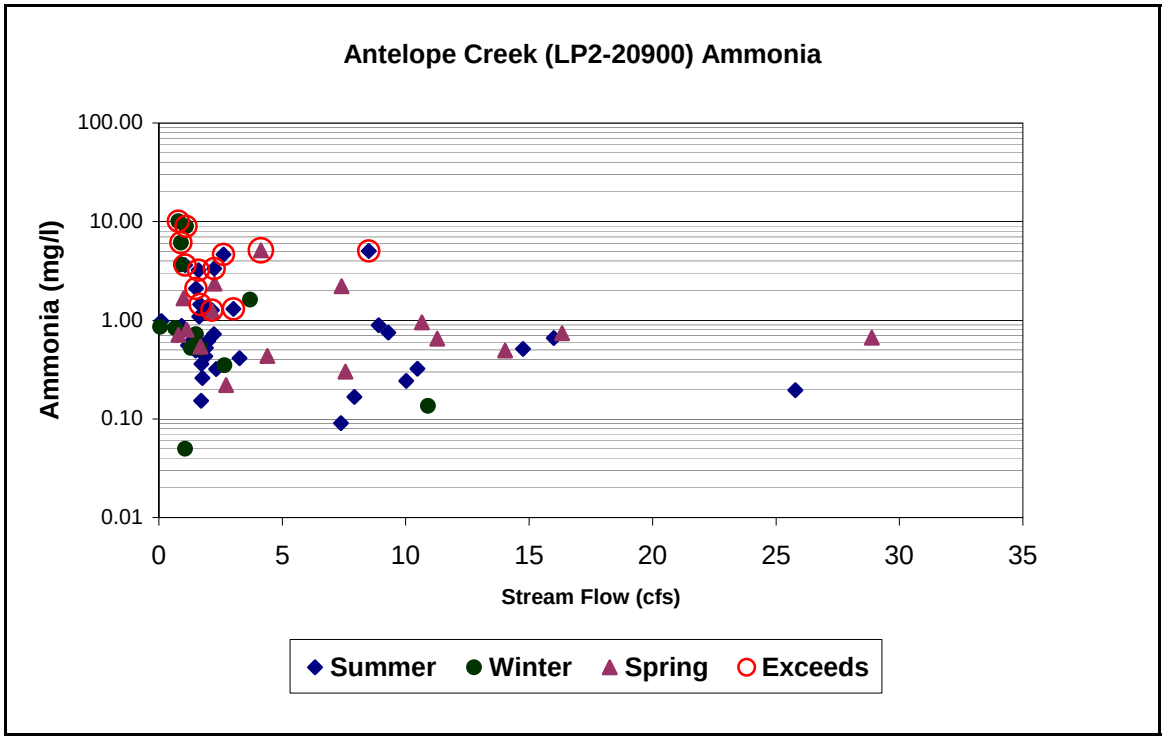
$$LC_i = Q_i * C_x * C$$

Where:
LC_i = load allocations at the i^{th} flow
Q_i = stream flow at the i^{th} flow
C_x = seasonal ammonia criteria
C = conversion factor

2.3 Existing Pollutant Conditions

It is important to identify the existing pollutant conditions to assists in source identification and implementation of controls. Figure 2.3 presents the available ammonia data in relationship to flow and season.

Figure 2.3 Antelope Creek Ammonia Data



2.4 Pollutant Allocations

A TMDL is defined as:

$$TMDL = Loading\ Capacity = WLA + LA + Background + MOS$$

As stated above, the loading capacity is based upon flow position in the hydrograph and is defined by:

$$LC_i = Q_i * C_x * C$$

Where:
LC_i = loading capacity at the i^{th} flow
Q_i = stream flow at the i^{th} flow
C_x = seasonal ammonia criteria
C = conversion factor

The flow hydrograph (0-100th Percentile) used in the ammonia TMDL is provided in Table 2.4.

To achieve the desired loading capacities requires the following allocations:

2.4.1 Load Allocation/Natural Background

Because the watershed is covered under an MS4 permit and source of pollutants is predominantly a point source, the load allocation and background will not be separated. The LA will be calculated by:

$$LA_i = Q_i * C_s * C$$

Where:
LA_i = load allocations at the i^{th} flow
Q_i = stream flow at the i^{th} flow
C_s = seasonal median ammonia concentration
C = conversion factor

2.5 Antelope Creek Annual Hydrograph: 0-100th Percentile

Percentile	Flow Value (cfs)
0	0.6
10	1.5
20	1.8
30	2.1
40	2.4
50	2.9
60	3.5
70	4.3
80	5.9
90	10
100	522

2.4.2 Wasteload Allocation

The wasteload allocation will be the difference between the loading capacity and the LA/background and will be determined by:

$$WLA_i = LC_i - LA_i$$

Where:
WLA_i= wasteload allocation at the i^{th} flow
LC_i = loading capacity at the i^{th} flow
LA_i = load allocations at the i^{th} flow

The seasonal TMDLs are illustrated in Figures 2.4a-c.

Figure 2.4a Spring TMDL

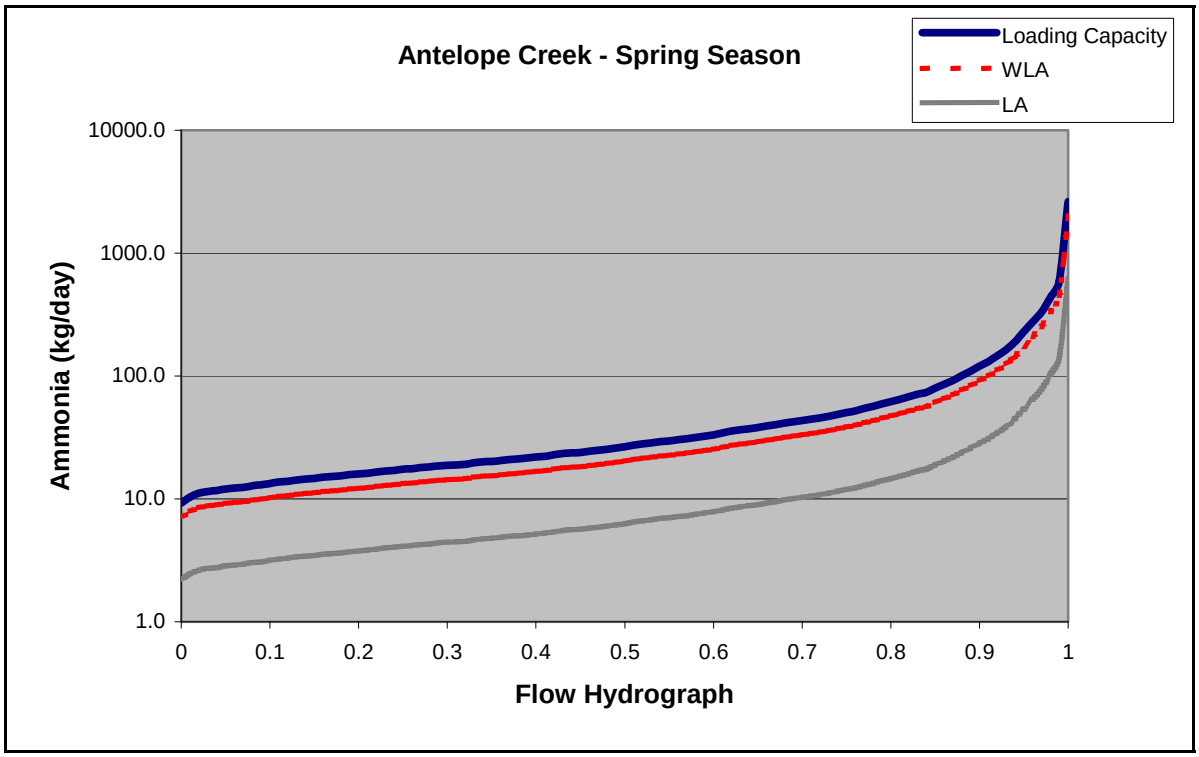
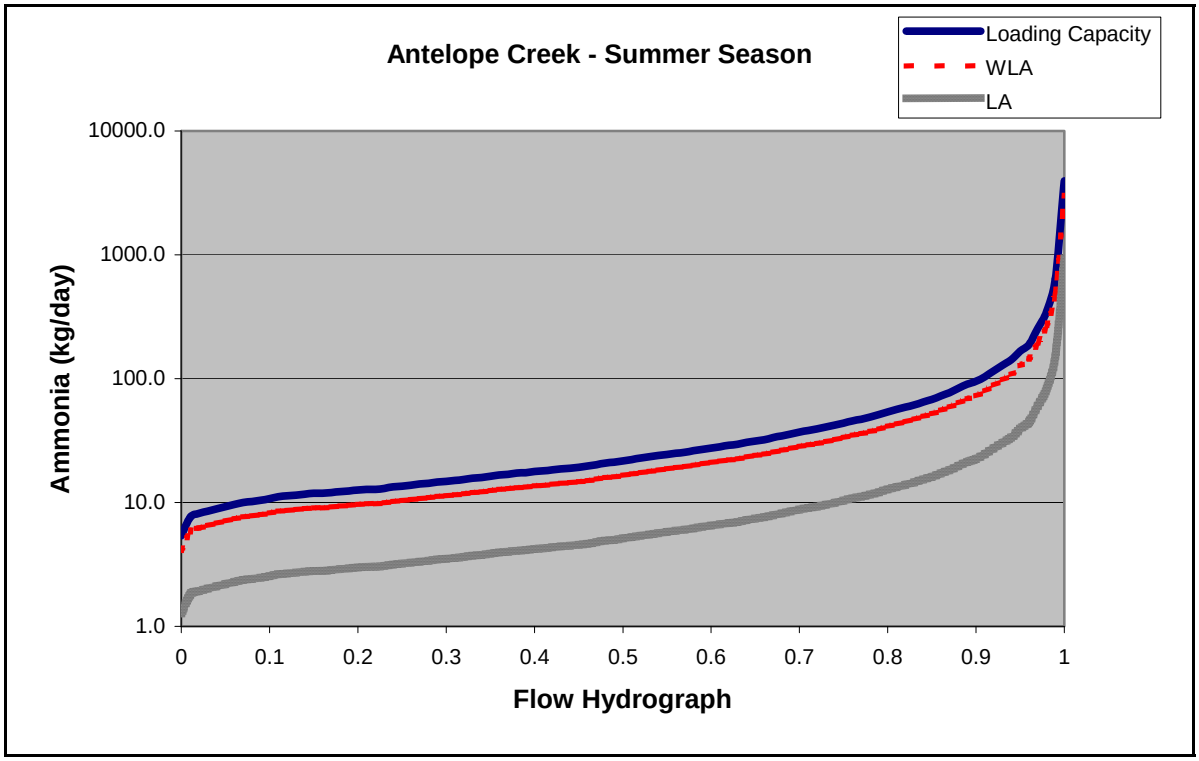
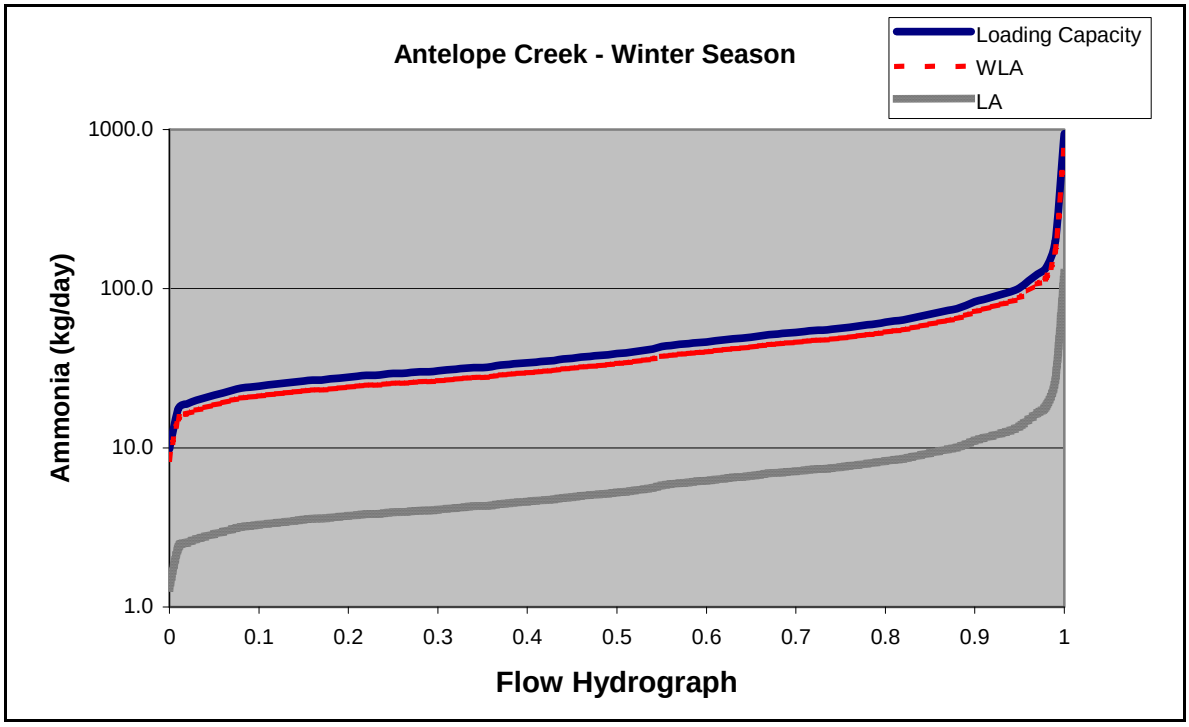


Figure 2.4b Summer TMDL



2.4c Winter TMDL



2.4.3 Load Reductions to Meet Water Quality Criteria:

It is important to report the reductions necessary to meet the water quality criteria. The necessary reductions were determined based upon the 2002-2005 data, which is considered representative information. The targeted reductions found in Table 2.4.3 provide water quality managers with a quantitative endpoint by which implementation planning can be carried out.

Table 2.4.3 Targeted Reductions to Meet Water Quality Criteria

Season	% Reduction
Spring	50%
Summer	75%
Winter	55%

2.4.4 Margin of Safety

A margin of safety (MOS) must be incorporated into TMDLs in an attempt to account for uncertainty in the data, analysis or targeted allocations. The MOS can either be explicit or implicit and for this TMDL are as follows:

- Implementation of controls will target the stormwater as a whole rather than just the monitoring data where violations are noted. This action will reduce the pollutant load as a whole.
- Antelope Creek was assessed as being impaired based on 13 of 61 values exceeding the applicable criteria. When less than ten of the measurements exceed the applicable criteria the waterbody will be assessed as supported. The reductions stated in section 2.4.3 will only result in one value that still exceeds the criteria.

3.0 *E. coli* TMDL

3.1 Problem Identification

Segment LP2-20900 was included on Category 5 of the 2006 Integrated Report as having an impaired primary contact recreation beneficial use with the parameter of concern being *E. coli* bacteria. This section deals with the extent and nature of the water quality impairments caused by excessive *E. coli* bacteria in the Antelope Creek.

3.1.1 Water Quality Criteria Violated and/or Beneficial Uses Impaired

The Primary Contact Recreation beneficial use has been deemed impaired on the above-identified segments. The Primary Contact Recreation beneficial use applies to surface waters which are used or have the potential to be used for primary contact recreation that includes activities where the body may come into prolonged or intimate contact with the water such that water may be accidentally ingested or sensitive body organs (e.g. eyes, ears, nose) may be exposed (NDEQ 2002c).

3.1.2 Data Sources

The Nebraska Department of Environmental Quality (NDEQ) monitors surface waters based upon a rotating basin scheme, whereby monitoring is limited to two or three river basins each year with all 13 basins being (partially) examined in a five year period. Under the auspice of the rotating basin plan, data was collected from Lower Platte River basin in 2004. Data collected in 2004 included stream flow (volume) information and will be used for this TMDL. Stream flow data used to extrapolate the hydrograph was obtained from the United States Geological Survey who operates a monitoring gage on Salt Creek at Lincoln - #06803500.

3.1.3 Water Quality Assessment

Water quality data assessments were based upon the beneficial use assessment procedures used to identify Category 5/impaired waters for the 2006 Integrated Report. The procedures are based on the application of the "binomial distribution" method that applies a confidence interval to the exceedance rate in an effort to determine the true exceedance of the waterbody versus the data set. A complete description of the water quality data assessment procedures can be found in the *Methodologies for Waterbody Assessments and Development the 2006 Integrated Report for Nebraska*, December 2005.

The details of the assessment process to determine the use support of the Primary Contact Recreation beneficial use can be found in table 3.1.3

Table 3.1.3 Assessment of the Primary Contact Recreation Beneficial Use Using Fecal Coliform and *E. coli* Bacteria Data

Parameter	Season Geometric Mean	Single Sample Maximum	Supported	Impaired
Fecal coliform	≤200/100 ml	No more that 10% of Samples >400/100 ml	Season geometric mean ≤200/100 ml or ≤10% of samples exceed 400/100ml	Season geometric mean >200/100 ml and/or >10% of samples exceed 400/100ml
E. coli	≤126/100 ml		Season geometric mean ≤126/100 ml	Season geometric mean >126/100 ml

3.1.4 Water Quality Conditions

E. coli data collected during the 2004 recreation season (May through September) was assessed to determine the beneficial use support for primary contact recreation. Table 3.1.4 presents this information.

Table 3.1.4 Antelope Creek: 2004 *E. coli* Data and Assessments – Category 5 Waterbodies

Segment	Site Location	Number of Samples	Season Geometric Mean (#/100 ml)
LP2-20900	Antelope Creek at Lincoln	20	3,433

3.1.5 Potential Pollutant Sources

3.1.5.1 Point Sources: As stated in section 2.1.5.1, two point sources discharge or have the potential to discharge to Antelope Creek. Both are industrial facilities with the characteristics of the effluent being truck wash water and cooling water. Both have been issued a National Pollutant Discharge Elimination System Permit (NPDES) (according to EPA's Permit Compliance System) with neither requiring the control or monitoring of *E. coli* bacteria. Review of these and other facilities, for the pollutant of concern will be conducted during the permit issuance or reissuance process.

The City of Lincoln and the University of Nebraska-Lincoln have been issued MS4 Stormwater permits and are considered point sources and regulated under the NPDES program.

Illicit connections and discharges, combined sewer overflows; sanitary sewer overflows, straight pipes from septic tanks or other on-site wastewater systems can also be sources of *E. coli* bacteria. While these are potential sources, there have not been investigations to determine the nature and extent of these sources contributions to Antelope Creek.

No animal feeding operations that have been issued State of Nebraska permits, required for construction and operation of livestock waste control facilities (LWCF) if the operation has discharged, or has the potential to discharge, livestock waste to waters of the state have been identified in the Antelope Creek watershed.

3.1.5.2 Nonpoint Sources: As stated above, the area covered by the TMDL is that below Holmes Lake. The watershed in this area is entirely within the corporate limits of the City of Lincoln and thus covered under the NPDES-MS4 permit. Based on this, nonpoint sources contributions would be minimal if any.

3.1.5.3 Natural Sources: The primary natural source of *E. coli* is wildlife.

3.2 TMDL Endpoint

The endpoint for these TMDLs will be based on the numeric criteria associated with the Primary Contact Recreation beneficial use.

3.2.1 Numeric Water Quality Criteria

Water quality criteria established for the protection of the Primary Contact Recreation beneficial use can be found in Title 117, Chapter 4 and are as follows:

These criteria apply during the recreational period of May 1 through September 30.

E. coli
E. coli bacteria shall not exceed a geometric mean of 126/100 ml. For increased confidence of the criteria, the geometric mean should be based on a minimum of five samples taken within a 30-day period. This does not preclude fecal coliform limitations based on effluent guidelines. Single sample minimum allowable densities shall not exceed the following criteria.

235/100 ml at designated bathing beaches
298/100 ml at moderately used recreational waters
406/100 ml at lightly used recreation al waters
576/100 ml at infrequently used recreational waters

The November 16, 2004 Federal Register (Volume 69, No. 220) contained information regarding the final rule for "Water Quality Standards for Costal and Great Lakes Recreational Waters". This rule includes a discussion on the use of the single season maximum (SSM). Specifically:

"EPA expects that the single season maximum values would be used for making beach notification and closure decisions. EPA recognizes however that States and Territories also use criteria in their water quality standards for other purposes under the Clean Water Act in order to protect and improve water quality. Other than in the beach notification and closure decision context, the geometric mean is the more relevant value for ensuring that appropriate actions are taken to protect and improve water quality because it is a more reliable measure, being less subject to random variation and more directly linked to the underlying studies on which the 1986 criteria were based.

Given this discussion and recommendation regarding the use of single season maximum in TMDLs and waterbody assessments, these TMDLs will focus on meeting the *E. coli* recreation season geometric mean of 126/100 ml.

3.2.2 Selection of Critical Environmental Conditions

The water quality criteria associated with the Primary Contact Recreation beneficial use only applies from May 1 through September 30. Therefore, the critical conditions for these TMDLs will be those occurring from May 1 through September 30.

3.2.3 Waterbody Pollutant Loading Capacity

Defining waterbody pollutant loading capacity implies a steady state. The TMDL recognizes loadings are dynamic and can vary with stream flow. As well, the above section indicates a wide range of environmental conditions that must be accounted for.

The method chosen to account for the variation in flow is based upon a load duration (TMDL) curve. TMDL curves are initiated by the development a stream's hydrograph using the long-term gage information. The flow information (curve) is then translated into a load curve by multiplying the flow values by the water quality standard (WQS) and a conversion factor (C). The acceptable "load" is then plotted graphically.

Therefore, the loading capacity for each of the segments will be defined by:

Loading capacity = WQS * Flow * C

3.3 Pollutant Source Assessment

For this TMDL the source loading is based upon the position of the monitoring data points in relation to the boundary established on the TMDL curve between point source and nonpoint source influences. This process for selecting the load point is described in the document entitled Nebraska's Approach for Developing TMDLs for Streams Using the Load Duration Curve Methodology (NDEQ 2002).

3.3.1 Existing Pollutant Conditions

The existing pollutant conditions are shown in the TMDL curve Figure 3.3.1. The points plotted above the acceptable loading indicate a deviance from the water quality criteria.

3.3.2 Deviation from Acceptable Pollutant Loading Capacity

Table 3.3.2 describes the deviation from the acceptable water quality standards based upon the 2004 *E. coli* monitoring information.

Figure 3.3.1 *E. coli* TMDL Curve for LP2-20900

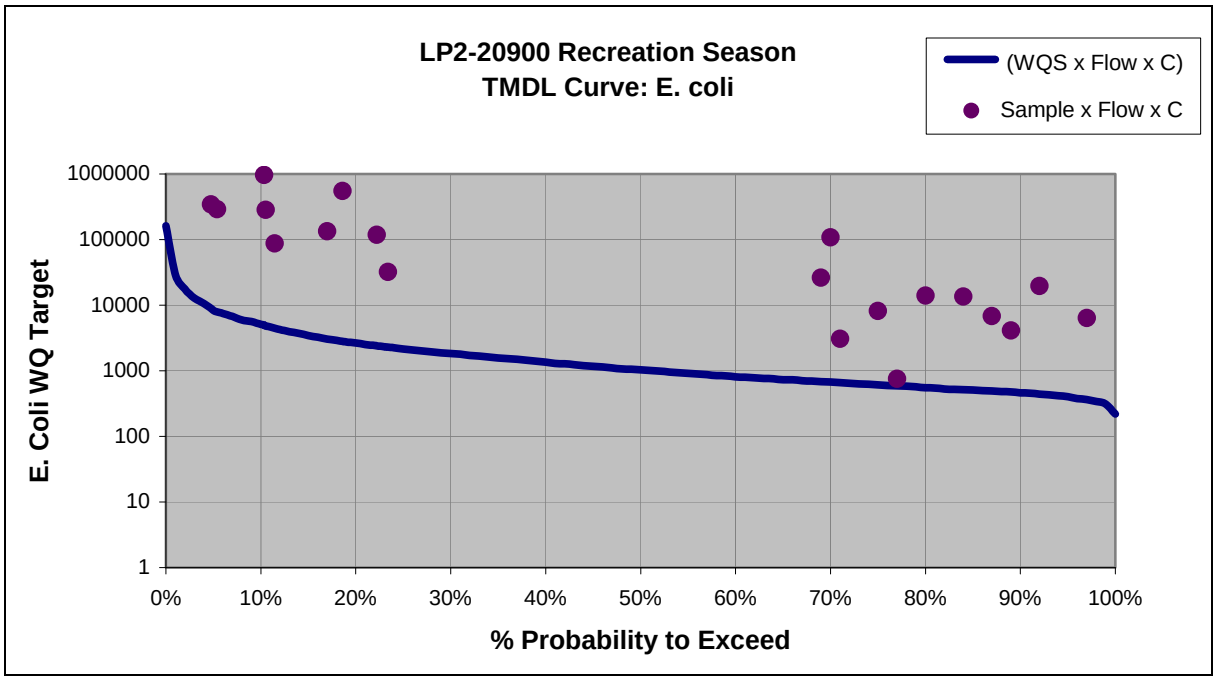


Table 3.3.2 Deviation From the Applicable Water Quality Criteria

Segment	Observed Season Geometric Mean (#/100 ml)	#/100 ml Above WQS
LP2-20900	3,433	3,307

3.4 Pollutant Allocation

A TMDL is defined as:

TMDL = Loading Capacity = WLA + LA + Background + MOS

By regulation, a TMDL requires a loading capacity value for the pollutant of concern. In the case of *E. coli*, a "load" (flow rate x concentration x time) could be calculated, but the approach may not be appropriate for expressing this non-conservative parameter. Therefore, for the purposes of these TMDLs, a loading capacity will not be "calculated" but will be expressed as the water quality standard. Because the water quality is expressed as a concentration, the LC will not equal the WLA + the LA.

The flow hydrograph (0-100th Percentile) used in the *E. coli* TMDL is provided in Table 3.4.

To achieve the desired loading capacities requires the following allocations

3.4 Antelope Creek Recreation Season Hydrograph: 0-100th Percentile

Percentile	Flow Value (cfs)
0	0.7
10	1.5
20	1.8
30	2.2
40	2.6
50	3.4
60	4.4
70	5.9
80	8.6
90	16.6
100	522

3.4.1 Wasteload Allocations

Title 117 does not allow for the application of a mixing zone for the initial assimilation of effluents in order to meet the criteria associated with the recreation beneficial use. Because of this, the water quality criteria are applied to the “end-of-pipe” concentrations and are applicable at all stream flows >7q10. Therefore, the *E. coli* wasteload allocation established by this TMDL will be a monthly geometric mean 126/100 ml.

3.4.2 Load Allocations

The load allocations assigned to these TMDLs will be based upon the stream flow volume and will be defined as:

$$LA_i = Q_i*126/100\ ml*C$$

Where:
LA_i = load allocations at the i^{th} flow
Q_i = stream flow at the i^{th} flow
126/100 ml = applicable/target water quality criteria for *E. coli* from Title 117
C = conversion factor

3.4.2.1 Load Reduction to Meet Water Quality Criteria: It is important to report the reductions necessary to meet the water quality criteria. In order for Antelope Creek to attain supported status, the *E coli* densities must be reduced by 97% from the observed 2004 conditions. The targeted reductions provide water quality managers with a quantitative endpoint by which implementation planning can be carried out. The reductions stated also include the margin of safety described below

3.4.3 Margin of Safety

A margin of safety (MOS) must be incorporated into TMDLs in an attempt to account for uncertainty in the data, analysis or targeted allocations. The MOS can either be explicit or implicit and for this TMDL is as follows:

- To account for uncertainty in the nonpoint source load reduction, the targeted reductions will be set at 90% of the water quality target (126/100 ml). Specifically the reductions shall be applied to meet a seasonal geometric mean of ≤113/100 ml.

4.0 Implementation Plan

Because the watershed below Holmes Lake is subject to coverage of the MS4 permits, implementation will lie solely within the NPDES program.

Facilities discharging stormwater under the authority of a NPDES permit are required to implement the minimum control measures and thus all permits will be consistent with applicable regulations.

Rather than apply numeric limitations on individual stormwater outfalls, the strategy will be to initially allow the municipalities sufficient opportunity to comply with the NPDES requirements; either voluntarily or under the authority of an NPDES permit. In the future, should additional monitoring data indicate the minimum control measures are inadequate or have not been incorporated; consideration will be given to application of wasteload allocations for the outfalls in the area of concern.

MS4 permits have been issued to the City of Lincoln and the University of Nebraska-Lincoln. During review and reissuance of these permit, the NDEQ must incorporate the WLAs established in the TMDL. Incorporation of the WLAs in to the TMDL will be consistent with EPA guidance, specifically; the November 22, 2002 memorandum from Robert Wayland and James Hanlon (http://www.epa.gov/owow/tmdl/policy.html).

4.1 Reasonable Assurance

The NDEQ is responsible for the issuance of NPDES or state operating permits for industrial and municipal wastewater discharges, regulated stormwater discharges. Issued permits must be consistent with or more stringent then the wasteload allocations set forth by these TMDLs, as explained in the above cited EPA guidance. As well, the issued permits must include measurable goals to reduce the discharge of pollutants set forth by the TMDL. Compliance with the permit may require the WLA be addressed through post construction BMPs or other measurable goals.

5.0 Future Monitoring

Future monitoring of Antelope Creek will be completed through the ambient stream program for ammonia and through the basin rotation program for *E. coli* bacteria. Streams sites in the ambient program are monitored twice monthly from April through September and once monthly from October through March.

In 2009, basin rotation monitoring will once again be conducted in the Lower Platte Basin. Stream sites are monitored weekly from May through September.

Recently, analytical techniques have been introduced that may provide a greater level of confidence in the identification of pollutant sources. These techniques include microbial source tracking and specialized sampling the targets human wastewater. As the science progresses the application of these analytical techniques may become a valuable tool for source identification and pollutant reduction.

6.0 Public Participation

The availability of the TMDLs in draft form was published in the Lincoln Journal-Star with the public comment period running from approximately May 14, 2007 to June 18, 2007. These TMDLs were also made available to the public on the NDEQ's Internet site and interested stakeholders were informed via email of the availability of the draft TMDLs. No comments were received during the public participation period.

7.0 References

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