SECTION 10 – IMPLEMENTATION

10.1. Introduction

Reducing the pollutant load into Antelope Creek is a complex and challenging effort that will require the City and LPSNRD to acquire outside financial and technical resources. A cost estimate was established in order to quantify potential financial resources necessary to remove Antelope Creek from the impaired waters list and does not reflect any type of commitment of resources by Basin Plan stakeholders. The Source Loading and Management Model for Windows (WinSLAMM), existing structural BMPs, and historical and current non-structural programs were utilized to develop the cost estimate. The many assumptions used to determine the overall cost are detailed later in this section. Mechanical or ultraviolet (UV) treatment of surface water in Antelope Creek is not included in this estimate and was not considered a practical alternative by the City and NRD. Using these assumptions, a projected cost based on average *E. coli* removal efficiency was developed.

An implementation strategy was written using input from the City, LPSNRD, and public, the summary of conclusions drawn during the planning process, and a review of available information regarding Antelope Creek's water quality.

Based on the above statements, approximately $57 million may be necessary to consistently meet existing regulatory criteria for *E. coli* in Antelope Creek. This estimate far exceeds available funding, therefore it is recommended that the City and LPSNRD implement a phased approach, implementing the most cost effective practices in the early years and continuing to evaluate and implement additional practices over a 40-year period. The project team understands that financial expenditures of this magnitude, to consistently meet the EPA criteria in a recreational stream segment within an urbanized watershed, is somewhat impractical as compared to existing financial resources available. As summarized later, 5-year plan reviews could potentially have large effects on the overall cost estimate based upon the effectiveness of the first phase of project and program implementation. It is also important to note that funding assistance from Federal, state, and local sources are anticipated to ease the financial need by the City and LPSNRD.

Although the goal of this Basin Plan is to remove Antelope Creek from the impaired waters list, the structural and non-structural BMPs recommended have multiple benefits. These include, but are not limited to: reduction of a wide range of other pollutants, reduced stormwater runoff volume, reduced landscape maintenance, increased stream stability, reduced infrastructure cost downstream, recharging groundwater levels, aesthetics, and increasing the overall health of Antelope Creek.

An implementation strategy was written using input from the City, LPSNRD, and public, the summary of conclusions drawn during the planning process, and a review of available information regarding Antelope Creek's water quality. The implementation plan was based upon a balance of available resources and the process necessary to achieve the plan's ultimate goal of removing Antelope Creek from the Clean Water Act Section 303(d) list of impaired waters. The implementation plan lays out efforts that will begin the process of lowering the level of *E. coli* in Antelope Creek to acceptable levels over the next 40 years, in addition to reducing other known contaminants such as sediment and nutrients. This implementation section includes combinations of several strategies that have been discussed in previous sections.

Overall, it is recommended that the Antelope Creek watershed be divided into sub-basins following existing stormwater drainage infrastructure. These sub-basins would be more manageable and allow periods of evaluation and resource gathering.

Input from the project team was used to establish the Antelope Park sub-basin as a priority area for concentrating implementation of structural BMPs over the next 5 years. In addition, non-structural BMPs have been recommended basin-wide. To increase public acceptance of stormwater management practices, several demonstration structural BMPs have been recommended to be implemented across the entire Antelope Creek watershed. It is also recommended that a plan update be completed every 5 years.

For purposes of documenting in-stream water quality and establishing the TMDL, Antelope Creek water quality monitoring is completed every 6 years by NDEQ as part of a statewide basin rotation network. Sampling is completed weekly from May through September. Antelope Creek is scheduled to be sampled again in 2015 by NDEQ at the confluence of Salt Creek and Antelope Creek (2010-2011 sampling point AC-9). *E. coli* results from this location are the basis for the TMDL established in 2007, and will remain the location that will determine if progress is being made towards the goal of reducing bacteria in Antelope Creek. Due to the large size of the

watershed, and diffuse pollutant sources, contamination reductions may be difficult to distinguish over the short-term. A monitoring plan has been detailed in this section.

10.2. Implementation Overview

Due to the cost of implementing the entire plan, a phased approach has been established. This allows the City and LPSNRD to concentrate available resources into one priority sub-basin to be implemented over a short-term period of 5 years, and creates flexibility for implementing additional water quality projects elsewhere in the Antelope Creek watershed as priorities shift. In total eight sub-basins have been identified and are shown in Figure 10-1.

Effectiveness of projects and programs implemented in the priority sub-basin and the Antelope Creek watershed as a whole will be measured through monitoring, surveys, and record keeping. A detailed set of milestones and evaluation criteria are documented later in this section.

An implementation strategy has been established that includes a concentration of resources over the first 5 years into a priority sub-basin, referred to as Antelope Park sub-basin. This sub-basin is Phase One of the 40-year implementation plan and is located in the central portion of Antelope Creek watershed, on the west side of Antelope Creek as shown in Figure 10-2. The Antelope Park sub-basin is considered a priority due to the large amount of public land available, ability to enhance existing sites, and the presence of one of the few remaining open channel tributaries to Antelope Creek. This sub-basin also includes the Lincoln Children's Zoo.

Phase One structural recommendations in the Antelope Park sub-basin are a starting point for working towards the goal of reducing pollutant loading to Antelope Creek. In addition, non-structural BMPs are being recommended to be implemented during Phase One throughout the entire Antelope Creek watershed, as well as the Antelope Park sub-basin. For the Antelope Park sub-basin, an emphasis will be placed on area residents and property owners to implement non-structural BMPs through a more intensive information and education process. Water quality milestones have been established that can be used at specific times to evaluate the effectiveness of the water quality implementation plan.

Antelope Creek Baseline Assumptions

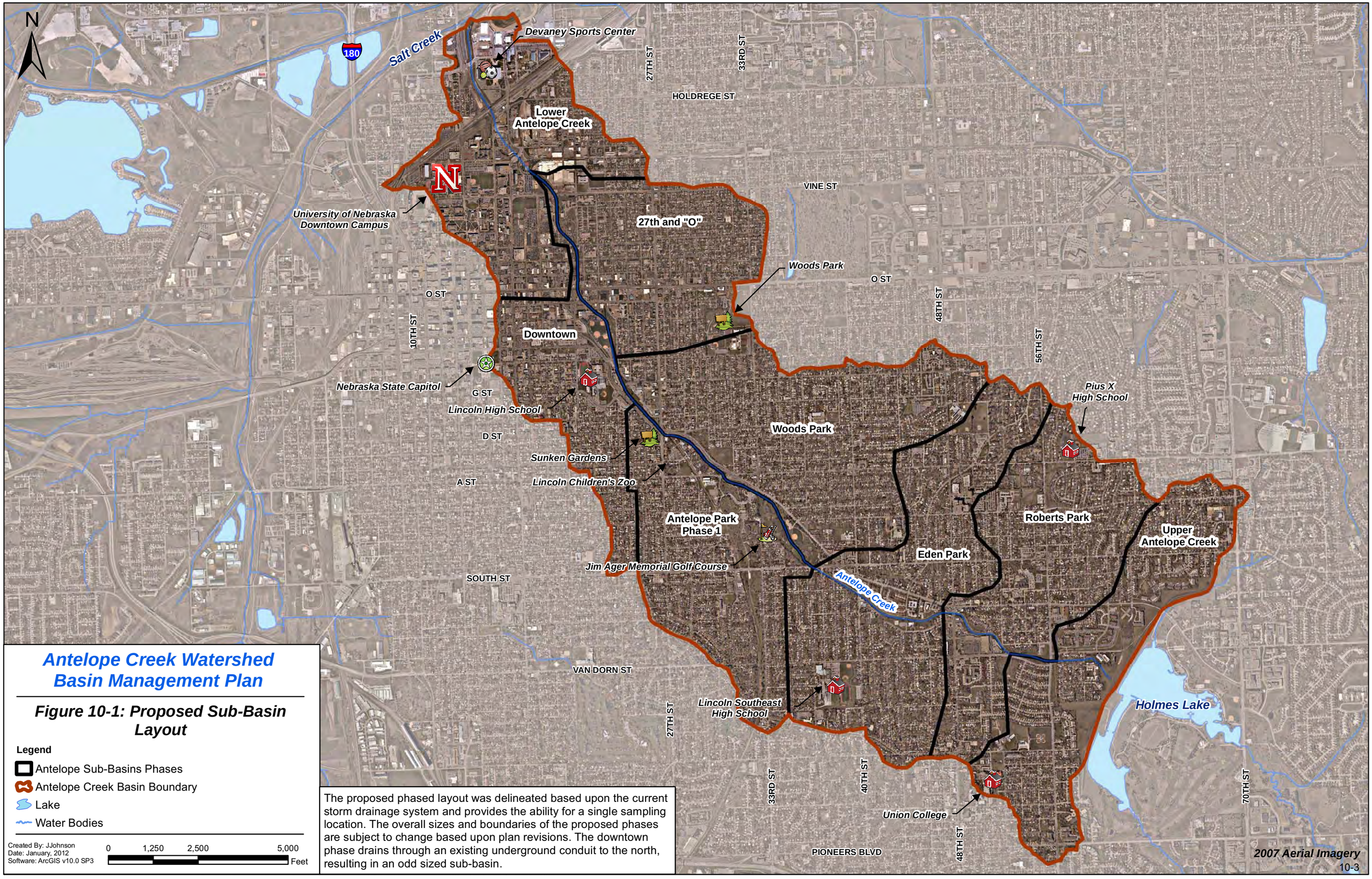
For the purposes of project design and planning, several baseline characteristics of the Antelope Creek watershed have been established and used to create criteria which will be used by the City and LPSNRD as they work towards meeting the goals set in the plan. Information summarized below provides baseline assumptions used to establish the implementation strategy.

- Storm frequencies
- *E. coli* Geometric Mean (May-September 2011)
- Pollutant loading estimates
- Primary pollutants of concern
- Naturally occurring bacteria

Storm Frequency

In order to capture a majority of pollutants and reduce the volume of runoff from frequent rainfall events, structural projects are recommended to be designed up to a 90% rainfall event, which averages 1.25 inches (Lincoln technical Memo, 2012). The City has provided information pertaining to rainfall frequency in Lincoln, as seen in Figure 10-3 below. 90% of rainfall events generally include most of the runoff pollutant discharges by mass which is frequently more than 75% of the annual pollutant discharges. Removing as much of the runoff from this rain event category as practical will most effectively reduce pollutant loading from stormwater runoff into Antelope Creek.

More severe rainfall events are less frequent and produce a greater volume of runoff. However, these storms typically consist of lower concentrations of pollutant discharges than smaller events. Therefore, volume and pollutant load reductions during portions of these large rain events will provide little benefit, and are typically challenging and costly to design and construct. Flows associated with rainfall events greater than the 90% rainfall event are anticipated to contain bacteria concentrations above the TMDL.



Antelope Creek Watershed Basin Management Plan

Figure 10-1: Proposed Sub-Basin Layout

Legend

- Antelope Sub-Basins Phases
- Antelope Creek Basin Boundary
- Lake
- Water Bodies

Created By: JJohnson
Date: January, 2012
Software: ArcGIS v10.0 SP3

0 1,250 2,500 5,000 Feet

The proposed phased layout was delineated based upon the current storm drainage system and provides the ability for a single sampling location. The overall sizes and boundaries of the proposed phases are subject to change based upon plan revisions. The downtown phase drains through an existing underground conduit to the north, resulting in an odd sized sub-basin.

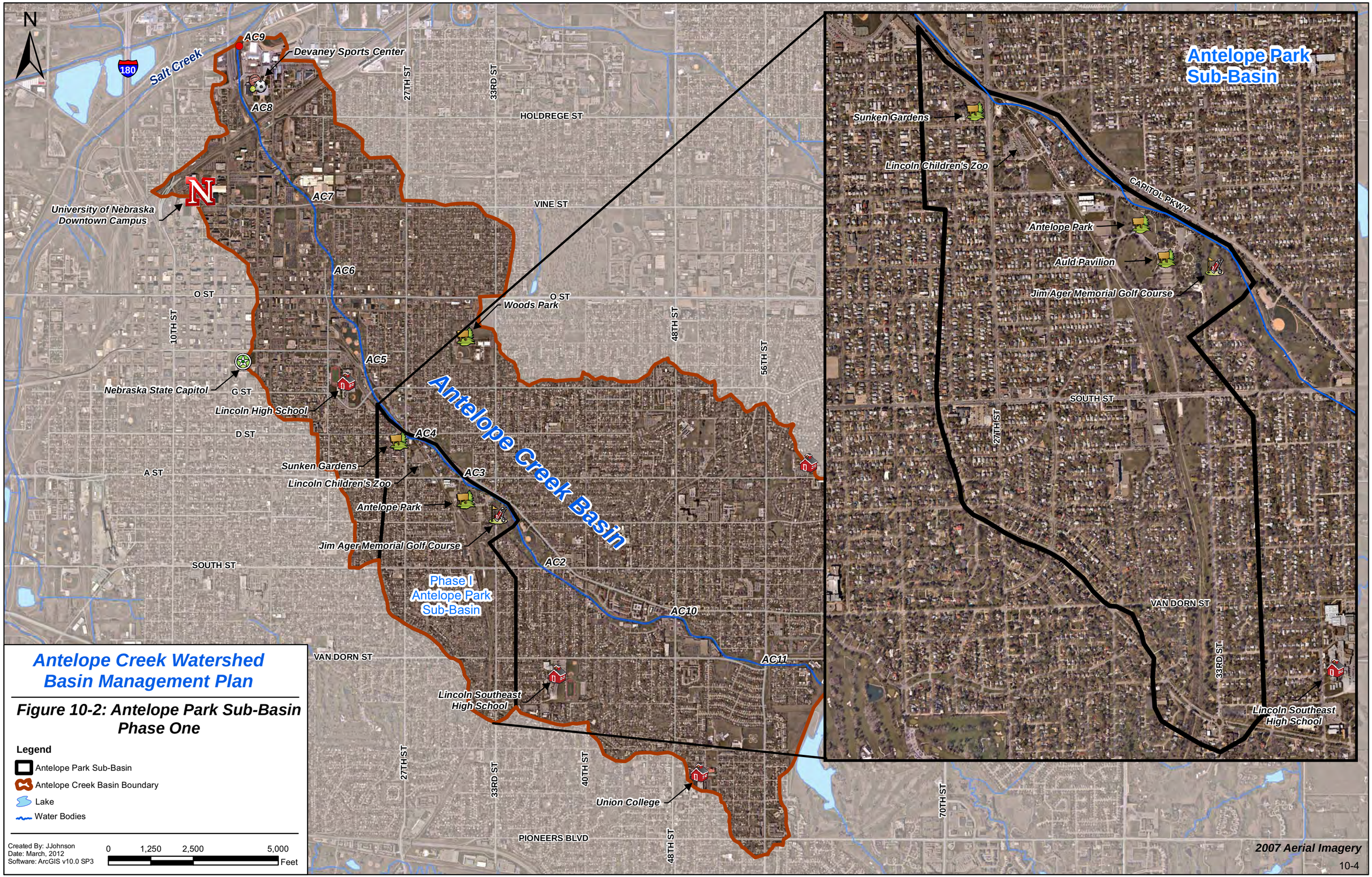
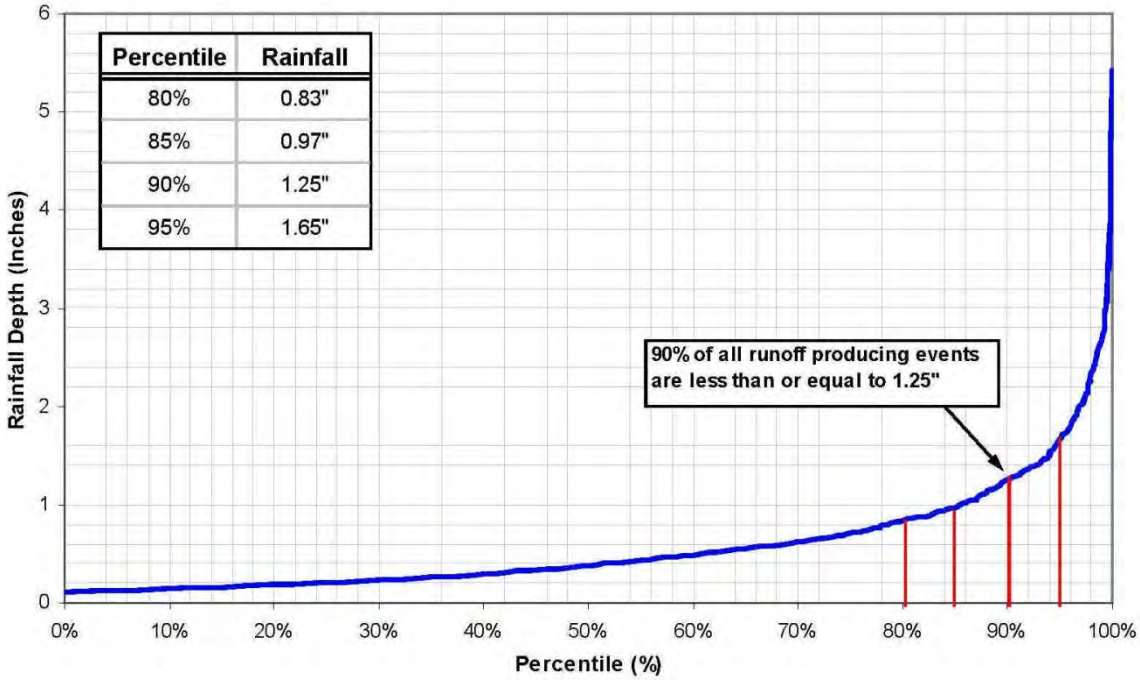

N
Salt Creek
180
AC9
Devaney Sports Center
AC8
27TH ST
33RD ST
HOLDREGE ST
University of Nebraska
Downtown Campus
AC7
VINE ST
AC6
O ST
Woods Park
10TH ST
48TH ST
56TH ST
AC5
Nebraska State Capitol
G ST
Lincoln High School
D ST
AC4
Sunken Gardens
Lincoln Children's Zoo
A ST
AC3
Antelope Park
Jim Ager Memorial Golf Course
Antelope Creek Basin
SOUTH ST
AC2
Phase I
Antelope Park
Sub-Basin
AC10
VAN DORN ST
AC11
Lincoln Southeast
High School
27TH ST
33RD ST
40TH ST
Union College
PIONEERS BLVD
48TH ST
70TH ST
Antelope Park
Sub-Basin
Sunken Gardens
Lincoln Children's Zoo
CAPITOL PKWY
Antelope Park
Auld Pavilion
Jim Ager Memorial Golf Course
SOUTH ST
27TH ST
VAN DORN ST
33RD ST
Lincoln Southeast
High School
Antelope Creek Watershed
Basin Management Plan
Figure 10-2: Antelope Park Sub-Basin
Phase One
Legend
Antelope Park Sub-Basin
Antelope Creek Basin Boundary
Lake
Water Bodies
Created By: JJohnson
Date: March, 2012
Software: ArcGIS v10.0 SP3
0
1,250
2,500
5,000
Feet
2007 Aerial Imagery

Figure 10-3. Rainfall Frequency for Lincoln Municipal Airport



Source: City of Lincoln Technical Memorandum, 2012

E. coli Geometric Mean

Since the NDEQ sampling event in 2004 that determined goals listed in the TMDL, several significant changes have occurred in the Basin Plan area including rehabilitation of Holmes Lake and completion of the Antelope Valley Project. These significant projects address water quality and flooding concerns, respectively. The effects that these significant changes have had on the water quality are unknown. More recently collected data would provide a better representation of existing conditions in the watershed. *E. coli* geometric means as sampled by NDEQ and the project team are shown below in Table 10-1.

Table 10-1. Historic Recreation Season *E. coli* Geometric Means at AC-9

Year	Sampling Entity	Geometric Mean cfu/100 mL
2004	NDEQ	3,433
2009	NDEQ	620
2010 & 2011	EA	1,511

NDEQ's last sampling event for *E. coli* at the confluence with Salt Creek was in 2009 (SLP2ANTLP104). A total of 22 samples were collected weekly between May and September, resulting in a geometric mean of 620 cfu/100 mL.

During sampling conducted in 2010 and 2011 by EA, 18 samples were collected and analyzed at sampling location AC-9 during the recreational season; the same location NDEQ monitored for bacteria in 2009 as part of their 'statewide basin rotation' monitoring network. Samples were collected at this site for confirmation and comparison to the previously collected water quality data and Antelope Creek TMDL criteria. During the 18 sampling events between May and September 2011, the geometric mean was 1,511 cfu/100 mL. Pollutant reduction goals established in the implementation strategy will be based upon the data collected in 2011. Average flows recorded near AC-9 during sampling events were 3.7 cubic feet/second (CFS) or 1,660 gallons/minute, or 2.4 million gallons/day (EA Field Survey, 2012-2011).

Load Reduction Estimates

Pollutant reduction estimates used for the implementation plan are based upon information provided in the two WinSLAMM reports provided by Dr. Pitt. WinSLAMM provides the City and LPSNRD a powerful resource in estimating pollutant reduction levels that could be expected by implementing control strategies for differing land uses

in Lincoln. WinSLAMM can also be used to estimate overall cost of achieving the goal to reduce *E. coli* to the levels listed in the 2007 TMDL.

In order to achieve goals listed in the TMDL results from sampling in 2011, *E. coli* concentration will need to be reduced 93%. The 2007 TMDL is based upon water quality data from 2004 sampling, and calls for a 97% reduction to attain supported status. Due to uncertainty in estimating the nonpoint source load amounts from the Antelope Creek watershed, and the Antelope Park sub-basin, load reduction goals are challenging to quantify. For purposes of planning projects for each sub-basin, it is assumed that a reduction of bacteria concentration by 75-95% per sub-basin will reduce bacteria loading to acceptable levels at AC-9.

Primary Pollutants of Concern

Based upon water quality sampling completed in 2010 and 2011 by EA, *E. coli* was the only constituent of concern identified in the 2007 TMDL that was observed above the applicable water quality standard or TMDL (ammonia was not detected). Based on the 2010 water quality study, the City and LPSNRD have determined that total suspended sediments (TSS) and nutrients should be considered primary pollutants. Therefore, *E. coli,* TSS, and nutrients (phosphorus) will be the focus of pollutant loading reduction estimates and target pollutants for BMPs listed in the implementation strategy.

Naturally Occurring Bacteria

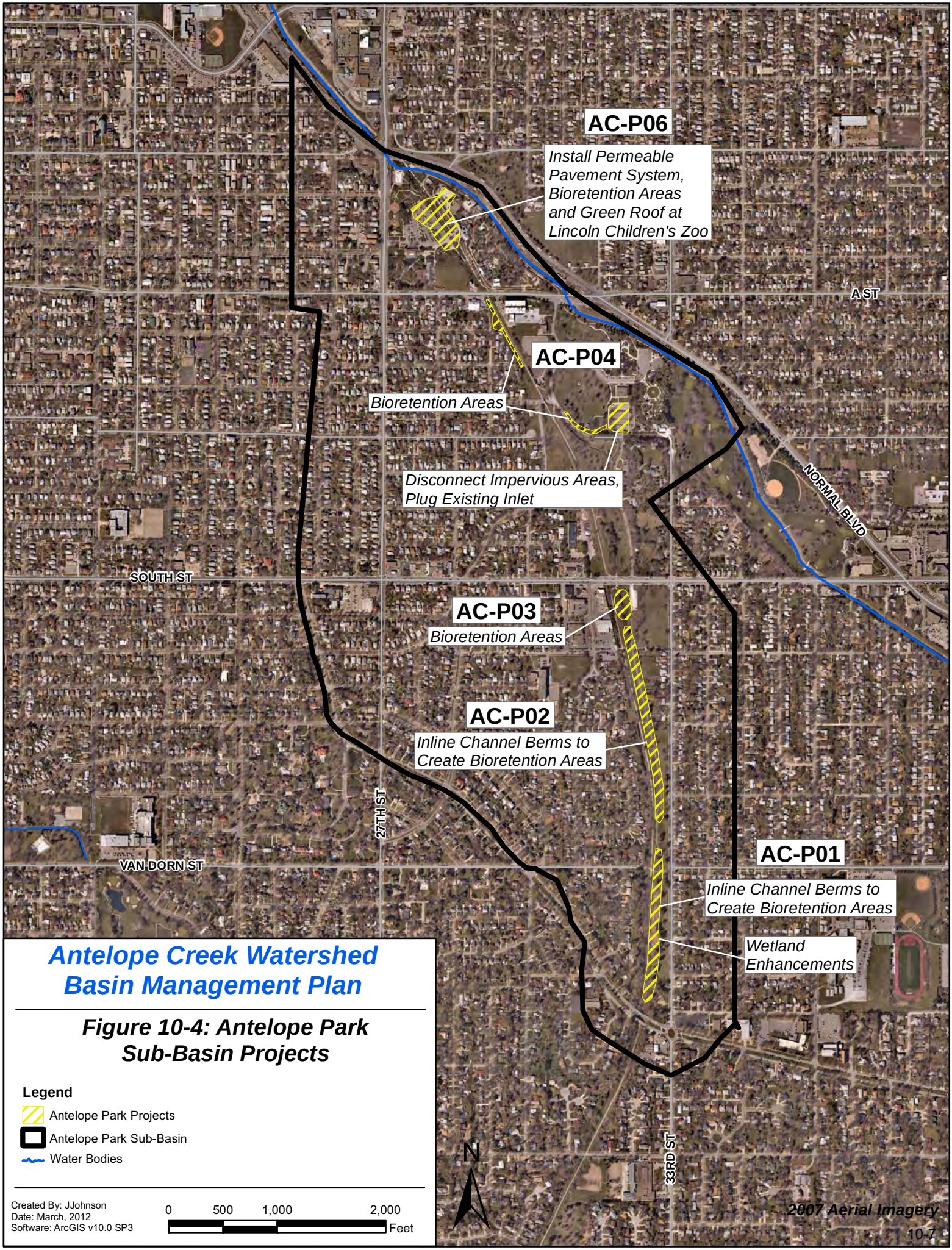
A number of bacteria occur naturally in freshwater streams, and live in the water and sediments. Data currently do not exist to differentiate between anthropogenic (human) and animal sources of *E. coli* bacteria in the Antelope Creek watershed. Therefore, the specific source and quantity of human induced versus naturally occurring bacteria (*e.g.,* wildlife, pets) in the Antelope Creek watershed is unknown. However; sampling in 2010 and 2011 did indicate that concentrations present in Antelope Creek do not represent levels that would indicate an illicit discharge from the sanitary sewer system. Sampling to date indicates a generally ubiquitous distribution of *E. coli* bacteria from below Holmes Lake to the confluence with Salt Creek. No specific drainage inflow or area along Antelope Creek was identified as a primary or major source of the *E. coli* in the watershed. Sampling did not determine the amount of bacteria reaching Antelope Creek from the Antelope Park sub-basin, nor any other sub-basin of Antelope Creek. Although the 2010-2011 sampling did look at low flow *E. coli* contributions from tributaries and at locations throughout the Antelope Creek watershed, the sampling location established for the NDEQ in-stream water quality monitoring network provides the decision point for water quality assessments and TMDL compliance. The historical data from this monitoring point provides *E. coli* levels but no other specific bacteria or specific source tracking information.

10.3. Phased Implementation Strategy

Due to the size of the Antelope Creek watershed, a total of eight sub-basins are anticipated to be used to implement projects and programs over the life of the Basin Plan. A general approach for the additional sub-basins is described later in this section.

A phased approach to implementing a water quality management plan in a watershed of this size can provide a strong chance of success. The proposed approach could allow the City and LPSNRD to meet the EPA's Nine Element requirements for the 319 grant program while allowing for flexibility during the implementation of the Plan to implement projects outside of priority zones. A phased implementation approach also allows for grant applications and funding allocation to follow a methodical stepped approach over a period of years.

A phased implementation strategy will provide the City and LPSNRD a focused approach to begin working towards improved water quality in Antelope Creek. The Antelope Park sub-basin selected by the project team consists of the area around Antelope Park, including Lincoln Children's Zoo. The Antelope Park sub-basin is shown in Figure 10-4.


AC-P06
Install Permeable Pavement System, Bioretention Areas and Green Roof at Lincoln Children's Zoo
A ST
AC-P04
Bioretention Areas
Disconnect Impervious Areas, Plug Existing Inlet
NORMAL BLVD
SOUTH ST
AC-P03
Bioretention Areas
AC-P02
Inline Channel Berms to Create Bioretention Areas
27TH ST
VAN DORN ST
AC-P01
Inline Channel Berms to Create Bioretention Areas
Wetland Enhancements
33RD ST
N
2007 Aerial Imagery
Antelope Creek Watershed Basin Management Plan
Figure 10-4: Antelope Park Sub-Basin Projects
Legend
Antelope Park Projects
Antelope Park Sub-Basin
Water Bodies
Created By: JJohnson
Date: March, 2012
Software: ArcGIS v10.0 SP3
0
500
1,000
2,000
Feet

10.3.1 Phase One

Antelope Park Sub-Basin Description

Antelope Park sub-basin consists of 52.5% residential land use, 16.0% park/recreation/open spaces, and 25.8% 'other'; which includes mostly streets. A land use breakdown is provided in Table 10-2. This sub-basin represents a total of approximately 12.7% of the total 4,932 acre Antelope Creek watershed. Efforts in the sub-basin focus on structural enhancements along a tributary that flows south to north through Antelope Park and reaches Antelope Creek near the Lincoln Children's Zoo.

Table 10-2. Antelope Park Sub-basin Land Use Breakdown

Land Use	Area (ac)	Area (%)
Single Family Residential	283.6	45.1%
Multiple Family Residential	46.2	7.4%
Commercial	11.0	1.8%
Industrial	0.8	0.1%
Public/Quasi-Public	20.1	3.2%
Transportation	4.1	0.7%
Park/Recreation/Open Space	100.7	16.0%
Other (Streets)	161.9	25.8%
Total	628.3	100%

Source: City Planning Department, 2011

Antelope Park Sub-basin Structural Improvements

The City of Lincoln has recently made improvements to portions of the tributary in the sub-basin including bank stabilization, creation of a detention pond, and wetland improvements. Recommended structural improvements outlined below include both new projects and enhancements to existing projects to provide increased water quality benefits. Details for each of these projects are provided in SECTION 8 - MANAGEMENT PRACTICES–RECOMMENDED PROJECTS/PROGRAMS. All of the proposed structural improvements are located on publicly owned property, and are listed in Table 10-3 and are graphically displayed in Figure 10-3.

Table 10-3. Antelope Park Sub-basin Water Quality Improvements

Project Number/Name	Description	Cost Estimate	Prioritization Rank
P01: Antelope Park: Van Dorn St to Sheridan Blvd	Channel and Wetland Enhancements	$125,000	200
P02: Antelope Park: South St to Van Dorn St	Channel Enhancements	$125,000	240
P03: Antelope Park: SW of 33rd and South St	Bioretention Areas	$125,000	260
P04: Antelope Park: A Street to South Street	Disconnect parking lot, address erosion in meandering stream	$250,000	180
P06: Lincoln Children's Zoo	Green roof, permeable pavement, bioretention	$425,000	300
	TOTAL	**$1,050,000**	**--**

Non-structural Best Management Practices

In addition to structural improvements in the Antelope Park sub-basin, the implementation of non-structural BMPs will be instituted throughout the entire Antelope Creek watershed. A full list of non-structural BMP recommendations was detailed in SECTION 8 - MANAGEMENT PRACTICES–RECOMMENDED PROJECTS/PROGRAMS.

The following five non-structural BMP recommendations would be the responsibility of the City and/or LPSNRD to implement using their resources. These five have been listed based on their efficacy to reduce key pollutants from stormwater in the short-term.

1) Retrofitting older bridges and overpasses crossing Antelope Creek to limit bird activity
2) Sanitary Sewer Line Inspection Program Expansion
3) Dry Weather Storm Drainage Screening
4) Enforcement of existing pet waste ordinances
5) Supplying and maintaining additional pet waste containers

Picture 38: Several bridges over Antelope Creek currently support bird roosting and nesting habitat

Non-structural BMPs listed below would be for residents and property owners to implement through programs offered by the City and/or LPSNRD. These non-structural options have been listed for their efficacy to reduce key contaminants, including *E. coli,* TSS, and nutrients. Each is a new or expanded program and is further detailed in SECTION 8 - MANAGEMENT PRACTICES–RECOMMENDED PROJECTS/PROGRAMS.

1) Low/No-phosphorus fertilizer program
2) Rooftop disconnection incentive program
3) Rain garden program
4) Rain barrel program

Basin-wide Information and Education

A significant information and education campaign will be necessary to encourage property owners and residents to begin making changes in everyday routines in order for non-structural BMPs to be successful. The City and LPSNRD can use their websites, news articles, neighborhood association meetings/newsletters, and other traditional mechanisms to inform residents and property owners about the opportunity to improve the health of their watershed. Prior to project implementation, surveys can be used to gather information about existing property management strategies, number of direct connections on properties, number of pets, type of fertilizer used, etc. The City and LPSNRD can then follow-up after implementation to evaluate the effectiveness of each strategy within the Antelope Creek watershed.

Antelope Park Sub-basin Information and Education Emphasis

Emphasis will be placed on notifying property owners and residents within the priority Antelope Park sub-basin. Additional efforts, beyond what is used for the entire watershed, could include letters to homeowners, bill stuffers, presentations to neighborhood associations in the area, or visits by City and LPSNRD staff. Residents and property owners in the Antelope Park sub-basin could be offered additional benefits such as:

- Low/No-phosphorus fertilizer at no or reduced cost
- Additional incentives for installation of rain gardens and rain barrels
- Materials needed to disconnect downspouts at reduced or no cost

Due to the high level of uncertainty in the non-point source reduction estimates and the unknown level of existing *E. coli* bacteria originating from the Antelope Park sub-basin, it is assumed that a combination of structural BMPs and a strong emphasis on non-structural BMPs will have a significant effect in reducing *E. coli* bacteria in Antelope Creek.

Phase One Cost and Load Reduction Estimates

Phase One costs are generally anticipated to include the installation of recommended structural and non-structural BMPs within the Antelope Park sub-basin, as well as basin-wide implementation of non-structural programs, 5-year

review, and monitoring. The estimated cost of each of these components is summarized in Table 10-4. Cost estimates for maintenance is not included. *E. coli* reductions for Phase One are estimated in two ways: reduction within the Antelope Park sub-basin, and reduction at AC-9 sampling location near the confluence with Salt Creek. The estimated *E. coli* reductions for each individual structural BMP were calculated using WinSLAMM.

Due to uncertainty of the existing bacteria contributors in each sub-basin, and uncertainty of the level of implementation, a wide range in reduction estimates exist. For example, if 75% of the bacteria load derives from bird droppings under bridges, and wildlife control measures remove the majority of birds from roosting, the bacteria pollutant load reduction could be upwards of 75%. The *E. coli* reduction estimates for the six structural BMPs are listed below in Table 10-4. If each project is implemented within the Antelope Park sub-basin a total reduction of 6% has been estimated using WinSLAMM. This equates to approximately 1% reduction at AC-9 (see Figure 10-2).

Basin-wide non-structural programs are expected to reduce *E. coli* throughout the Antelope Creek watershed by 15-40%. Assuming a fair contribution of implementation across the entire watershed, the Antelope Park sub-basin would then also experience a similar reduction of 15-40%. Emphasizing the same non-structural programs using a more stringent education and outreach strategy within the Antelope Park sub-basin is expected to achieve an additional 10-50% reduction of *E. coli* in the Antelope Park sub-basin. Combining both the basin-wide and the more stringent Antelope Park sub-basin non-structural programs results in an *E. coli* reduction of 25-90% within the sub-basin. These non-structural programs result in an additional 1-7% reduction at AC-9.

Overall, total reduction estimates for the Antelope Park sub-basin, including structural BMPs, total 31-96%. Combining the estimates for the entire watershed with the reduction estimates from the Antelope Park sub-basin results in a total estimated reduction at AC-9 of 17-46%.

Table 10-4. Cost and Load Reduction Estimates

Basin Plan Watershed	Project Cost	*E. coli* reduction (within Sub-basin)	*E. coli* reduction (at AC-9)
Phase One: Structural BMPs			
P01: Antelope Park: Van Dorn St to Sheridan Blvd	$125,000	2%	<1%
P02: Antelope Park: South St to Van Dorn St	$125,000	3%	<1%
P03: Antelope Park: SW of 33rd and South St	$125,000	1%	<1%
P04: Antelope Park: A Street to South Street	$250,000	<1%	<1%
P06: Lincoln Children's Zoo	$425,000	<1%	<1%
Sub-total	**$1.1 million**	**6%**	**1%**
Phase One: Non-Structural BMPs	**$550,000**	**25-90%**	**16-45%**
Phase One: Review, Monitoring, plan revision	$50,000	NA	NA
Grand Total	**$1.7 million**	**31-96%**	**17-46%**

Non-structural cost estimates were calculated based on experience the City has gained from implementation of several existing programs. Cost estimates include staff time, printing, mailing, etc. The following general assumptions were used:

- Low/no-phosphorus fertilizer $35/bag, purchase 250 bags per year for distribution
- Equipment cost for residential downspout disconnections to re-route runoff to vegetated areas
- Cost to produce newsletters, letters, stamps, billboards, TV ads, press releases, etc.
- Annual clean-out of sediment around bridges and overpasses
- Low-cost bridge retrofits including netting, bird spikes
- Installation of 2,000 square feet of residential rain gardens per year at $10/square foot
- Installation of 20 rain barrels per year at $200 per rain barrel
- Annual dry weather screening of Antelope Creek with limited sampling

10.4. Plan Revisions and Additional Phases

In order to effectively plan for a series of ongoing capital improvements, an adaptive management strategy has been developed that will include plan revisions and review approximately every 5 years. Additional phases and plan revisions will be based upon availability of new technologies and evaluation of performance of BMPs as part of Phase One. This timeline was selected to allow for implementing and evaluating the effectiveness of projects listed in the Antelope Park sub-basin. Projects which were not implemented over the first 5-year period might be considered priorities for the next phase.

The size of each additional sub-basin for future phases of implementation has been determined by the area deemed to be manageable in limiting pollutants over a 5-year period, and the potential high cost and large scope of the problem. Each sub-basin should average 670 acres, but total size may vary depending upon land use and land available for BMPs. Full sub-basin delineation was not completed as part of this plan. Sub-basins will be delineated during the plan update based upon a review of the effectiveness of the strategies listed for Phase One.

10.5. Structural Demonstration Projects (Basin-wide)

Several project opportunities, identified throughout the entire Antelope Creek watershed during site selection and project screening, are listed in further detail in SECTION 8 - MANAGEMENT PRACTICES–RECOMMENDED PROJECTS/PROGRAMS. The intent of locating projects outside of the priority sub-basin is to allow the City and LPSNRD flexibility to implement additional structural projects to serve as demonstration sites. These pilot projects will allow the city to gain valuable experience in how stormwater controls function locally, and allow the City and LPSNRD to more effectively place additional controls in the Antelope Creek watershed based upon lessons learned. These projects may become priority structural projects as additional sub-basins are identified as new priorities during future phase development. In total, 13 projects have been identified basin-wide, including demonstrative projects and the priority-sub basin improvements.

10.6. Other Opportunities

Opportunities for water quality projects during future redevelopment activities (green roof, parking lot redevelopment, etc.) should also be considered by the City and LPSNRD. In many situations, the City and LPSNRD could consider offering cost-share or becoming a grant sponsor to create a partnership with a private entity. Several planned redevelopment activities exist in the watershed, including Innovation Campus and areas recently removed from the floodplain after completion of The Antelope Valley project. The City and LPSNRD should consider identifying other water quality improvements as opportunities are presented.

10.7. Implementation Schedule and Milestones

Project milestones have been established to identify anticipated times in which key components of the Phase One implementation plan are to be started. As the implementation process unfolds, the City and LPSNRD can use these milestones to determine their progress at that time. Milestones have been established for each year of Phase One and include significant actions. The first year of phase two has also been included, as seen in Table 10-5. Milestones for non-structural BMPs are representative of a basin-wide effort for Phase One.

Table 10-5. Phase One Implementation Schedule and Milestones

Milestone	2012	2013	2014	2015	2016	2017	2018
Establishment of priority Non-structural BMP programs		X					
319 Non-point Source Grant Application for Structural and Non-structural BMPs	X	X	X	X	X	X	X
Antelope Park Sub-basin Improvements		X	X	X	X	X	
Begin Update of Basin Plan					X		
Phase Two Implementation Begins							X
NDEQ Statewide Basin Rotation Monitoring Network				X			
Monitoring and Evaluation		X	X	X	X	X	X

10.8. Monitoring Milestones and Schedule

Water quality monitoring will be completed at the confluence with Salt Creek (AC-9) in order to assess in-stream water quality relative to established water quality standards. This location will also serve as the point of compliance for the TMDL. In-stream sampling to support establishment of the TMDL for Antelope Creek, completed in 2007, has been conducted by NDEQ on a rotating statewide basin schedule; the last event occurred in 2009. According to NDEQ, the next scheduled monitoring that includes Antelope Creek will be weekly starting May to September in 2015. This site, referred to as AC-9 in this plan, is the only site directly relevant to potential changes in the TMDL. The City could consider partnering with other local agencies, such as the LPSNRD or University of Nebraska–Lincoln (UNL), to sample Antelope Creek more often. This information could serve multiple purposes, such as research on BMPs or evaluation of the success of BMPs.

In order for water quality data collected by a third-party entity to be used to update the TMDL, approval must first be granted by NDEQ. This could be completed through a quality assurance performance plan approving procedures of the third party entity prior to data collection. Information collected by third party agencies that is not approved by NDEQ could still be utilized for purposes of watershed planning, monitoring, and evaluation by the City and LPSNRD.

10.8.1 Sampling at AC-9 – Confluence with Salt Creek

Sampling at the confluence to Salt Creek will provide an outlook on the *E. coli* reduction progress as projects and programs are implemented. This location is the ultimate compliance location for water quality sampling and the TMDL. This data can be compared to the water quality sampling completed in the past as well as information in relation to the TMDL. AC-9 provides a picture of the whole Antelope Creek watershed with most sub-basin contributions (see Figure 10-2: Antelope Creek Park Sub-Basin Phase One). Sampling at AC-9 will not allow the City and LPSNRD to understand pollutant load reductions from an individual BMP or load reductions from any individual sub-basin. Sampling at the confluence will determine the total percent reduction basin-wide and if the TMDL is being met. Data collection through the recreational season, May to September, will provide comparable data in relation to the TMDL.

Water quality indicators to be sampled in the future should include *E. coli*, TSS, and Total Phosphorus, in addition to general water quality parameters such as conductivity, pH, temperature, and flow. These physical parameters will be helpful in understanding the overall Antelope Creek water quality. The use of analysis of tracer analytes in water samples taken at AC-9 for the purpose of screening illicit discharges is not recommended. Below are recommendations for sampling Antelope Creek at the confluence of Salt Creek:

- Perform weekly sampling for *E. coli* from May 1 to September 30th to calculate the geometric mean, and evaluate whether the TMDL is being met.

- Perform monthly sampling for TSS, Total Phosphorus, conductivity, pH, temperature, and flow during the same time period.
- The City and/or LPSNRD should consider coordination with NDEQ to arrange sampling at AC-9 on an annual basis in order to evaluate progress over the entire watershed.

10.8.2 Sub-basin Sampling

Sampling at the outlet(s) of each sub-basin will not provide information relevant to achieving goals listed in the TMDL due to the key location being at the confluence with Salt Creek. However, monitoring of individual sub-basins or at each individual structural BMP will provide information on percent removals of a given BMP. This information can be used to analyze the design of the BMP and can be compared to the anticipated performance based upon WinSLAMM data to proof the application. Documenting outflow from the sub-basin is critical to determining potential contaminant reductions due to volume reduction of runoff; which should directly reduce the loading of pollutants to Antelope Creek.

Picture 39: EA staff conducts sediment sampling

The following is a recommended water sampling protocol for sampling each sub-basin during its active Phase:

- Sample up to six events that produce measurable runoff from the sub-basin. Selected runoff events should be during rainfall events with less than 1.25 inches of rain.
- Sample between May and September.
- Each event should be sampled for *E. coli,* TSS and phosphorous. Other parameters such as conductivity, pH, temperature, and flow should also be documented.

Establishment of the sampling locations for each sub basin is dependent upon the characteristics of the sub-basin, number of projects being completed, and the number of outlets to Antelope Creek. Specific sampling locations have not been identified and would need to be located prior to monitoring activity. In most sub-basins, several outlets to Antelope Creek exist. Overall, measurement of progress towards meeting goals in the TMDL should be gathered at AC-9.

10.9. Evaluative Criteria

The basis for identifying progress towards program and project success will be measured through several evaluation criteria. Criteria have been split into short term and long term, and include evaluation of structural and non-structural BMPs. The evaluation criteria include data collection through water quality monitoring and record keeping as well as gathering information from property owners and residents.

Short-term information will allow the City and LPSNRD to establish a baseline for existing in-stream conditions in Antelope Creek, and present behaviors of property owners and residents. In-stream monitoring on an annual or bi-annual basis will allow the City and LPSNRD to understand pre-project physical and chemical conditions of the creek.

It is important to gather information from property owners and residents across the entire Antelope Creek watershed, with an emphasis on the Antelope Park sub-basin over the first 5-year period. This could be completed through online and phone surveys, request for information to be submitted to a website, and information gathered at neighborhood association meetings.

Over the long-term, information will be collected on how property owners change their everyday habits to improve the health of their watershed. This information can be collected in a similar fashion. Efforts should again be concentrated into the Antelope Park sub-basin.

To evaluate progress of structural BMPs, the City will keep records of each improvement, the water quality benefits, and other details such as how well native vegetation was established, how well the BMP appeared to be functioning, and pictures of each BMP.

A separate website specific to implementation of the Basin Plan is recommended. Creating an opportunity to view ongoing implementation of projects in the Antelope Creek watershed will allow the public to provide feedback, learn about the benefits of stormwater BMPs, and know what is being planned in the future in the Antelope Creek watershed. This website could also feature locations of known stormwater BMPs in Antelope Creek, how many rain

gardens or rain barrels have been installed, allow residents to post pictures of their projects, and quantify the number of improvements made by residents and property owners (*i.e.,* number of disconnections, rain gardens, rain barrels, etc.).

Water quality monitoring data gathered at AC-9 will be used to evaluate progress towards reducing *E. coli* and other pollutants in Antelope Creek. The Section 303(d) listing for bacteria in Antelope Creek was based on data collection from AC-9. This site will also provide the basis for evaluating progress towards reducing *E. coli* and other pollutants in Antelope Creek. Data collected annually will be assessed bi-annually by NDEQ to evaluate beneficial use support and water quality trends.

10.10. Resource Needs

Cost estimating structural and non-structural BMPs for an urbanized watershed with non-point sources is a highly challenging endeavor, particularly with *E. coli* bacteria as the constituent of concern. Promoting a high level of participation by residents and property owners throughout the watershed through non-structural programs is expected to decrease the cost significantly. Findings of this Basin Plan show that non-structural BMPs will likely have the greatest impact in reducing *E. coli*, TSS, and nutrients throughout the watershed using source controls.

The cost estimates provided in WinSLAMM do not take into account the percentage of reduction anticipated to be achieved over the life of the Plan by less expensive non-structural BMPs. The summary provided in the section below provides a forecast of potential resources necessary to achieve pollution reduction of *E. coli* using a larger balance of structural BMPs then currently listed in the implementation plan.

Evaluation of BMPs implemented as part of Phase One will occur after the first 5 years of the Basin Plan. As part of an adaptive management strategy, these results will determine the next level of effort and resources necessary to continue working towards the plan goal. In the event additional structural BMPs are necessary to reach plan goals, a scenario has been provided that will allow the City and LPSNRD to forecast additional resources that may be necessary. WinSLAMM identifies curb-cut biofilters as the most effective structural BMP of those evaluated in removing *E. coli* from stormwater runoff, therefore curb-cut biofilters are included in this scenario.

The following assumptions have been made to create a scenario to assist with long term planning and resource needs for the life of the Plan:

- Antelope Park priority sub-basin would need an additional 60% reduction in *E. coli* concentration after Phase One.
- Further reduction could not be achieved from non-structural BMPs, such as public education and outreach within the Antelope Park sub-basin.
- Additional reductions needed would be achieved through construction of additional structural BMPs.
- To estimate additional structural costs and project Basin Plan resource needs, 40% curb-cut biofilters were assumed to be constructed within the Antelope Park priority sub-basin as part of future phases.
- Using WinSLAMM, 40% curb-cut biofilters in residential land use areas are estimated to reduce the amount of *E. coli* by approximately 57%.
- Continued basin-wide non-structural programs are expected to reduce *E. coli* throughout the Antelope Creek watershed by 16% beyond Phase One.
- Through the structural BMPs installed in the Antelope Park sub-basin in Phase One (1% *E. coli* reduction), and the additional curb-cut biofilters considered for installation in this sub-basin as part of this scenario (7% *E. coli* reduction), a total additional reduction in *E. coli* of 8% at AC-9 is anticipated.
- With Phase One and additional structural BMPs combined, an estimated reduction of 24% at AC-9 is estimated.

With seven sub-basins remaining, each would need an average 10% reduction to meet the TMDL goal. Since the basin-wide non-structural programs are assumed to be already implemented at this stage, the additional 69% reduction in *E. coli* is assumed to come from other structural BMPs. Multiplying the cost of implementing Phase One and the additional structural practices necessary by seven, excluding the onetime cost of implementing the basin-wide non-structural BMPs, will give an idea of the total cost of implementing this strategy over the next 40 years and reaching the TMDL *E. coli* concentration goal at AC-9. The estimated *E. coli* reductions are summarized in Table 10-6.

Table 10-6. Basin Plan Total Cost Estimates

	Implementation Cost	*E. coli* reduction In Antelope Park sub-basin(s)	*E. coli* reduction At AC09
Phase One (2012-2017)			
Basin wide non-structural	$600,000	25%	16%
Antelope Park sub-basin 1(structural	$1.1 million	6%	1%
Sub-totals	**$1.7 million**	**31%**	**17%**
Phase 2 (2017-2021)	$6.0 million	57%	7%
Phase One and Two Totals	**$7.7 million**	**88%**	**24%**
Phase 3-8			Each will be 10%
Total Estimated Cost of remaining Sub-basins (Sub-basin 1 X (7), excluding basin-wide non-structural)	$49.7 million		65-70%
Estimated Grand Total	**$57 million**	**88%**	**89-94%**

Funding

Funding availability will be a primary driver in the implementation process. This Basin Plan has been written in a manner to be consistent with requirements of EPA's Nonpoint Source Management Program funding provided to NDEQ on an annual basis. Several other potential funding sources are available and are summarized below:

City of Lincoln, Nebraska

1) Public Works and Utilities Department Storm Water Bond Funding – provides funding for design and construction of urban drainage projects, stream rehabilitation and waterway work, comprehensive watershed master plan projects, water quality projects, and basin master planning.

Lower Platte South Natural Resources District

1) Water Quality BMP Cost-Share Program – assist land owners with the implementation of BMPs aimed at improving the quality of surface waters within the District. This program could support programs created through this Basin Plan.
2) Annual Inter-local Agreement with the City – provides cost share to support planned watershed improvement activities as a co-sponsor with the City of Lincoln. Potentially support implementation of demonstration projects and programs to improve water quality in Antelope Creek.

US Environmental Protection Agency (EPA)

1) Section 319 Nonpoint Source Management Program – provides financial assistance for the prevention and abatement of nonpoint source water pollution. Potentially support implementation of projects and programs in the Basin plan including BMPs.
2) Assessment and Watershed Protection Program Grants – provide resources to stakeholders to develop and implement effective, comprehensive programs for watershed protection, restoration, and management.
3) Water Quality Cooperative Agreements – provides grants to state water pollution control agencies including stormwater control.

USDA Natural Resources Conservation Service (NRCS)

1) Landscape Planning – supports watershed rehabilitation, planning, and operations.
2) NRCS Conservation Programs – supports programs that reduce soil erosion and improve water quality.

Nebraska Environmental Trust

1) Environmental Project Fund – provides local governments and organizations funding to conserve, enhance, and restore the natural environment. This funding source possibly will provide assistance to implement BMPs and educational components of water quality projects.

Technical Assistance/Agency Coordination

Implementation of the management strategies and recommendations in the Basin Plan will be a primary responsibility of the City of Lincoln Public Works and Utilities Department, Watershed management. Efforts will be coordinated with the Lower Platte South Natural Resources District, University of Nebraska-Lincoln, NDEQ, and other City Departments including Planning, Parks and Recreation, and Engineering Services. A summary of coordinated responsibilities is listed below:

- **Lower Platte South LPSNRD** – Co-sponsor of projects and programs listed in this plan, providing funding assistance and cost-share for BMPs. Assist in evaluation and monitoring the performance of BMPs.
- **City of Lincoln Planning Department** – Incorporation of water quality elements and city-wide recommendations into the 2040 Comprehensive Plan.
- **City of Lincoln Parks and Recreation Department** – Coordination in implementation of non-structural and structural activities onto parks property. Assistance in public education and outreach through installation of signage and informative panels on park property.
- **City of Lincoln Engineering Services** – Consideration of policy changes, establishment of bio-swales, coordination with activities in the public right-of-way.
- **University of Nebraska-Lincoln** – Incorporation of stormwater source control activities into planned construction and redevelopment activities on UNL's City Campus and Innovation Campus. Provide opportunities for studies on BMP effectiveness, water quality monitoring, wildlife control studies, and other research or educational efforts.
- **NDEQ** – Technical assistance with monitoring, funding assistance, and public information and education activities.