Easter Lake Water Quality Management Plan

With Emphasis on the Impairments of Phosphorus and Sedimentation

Prepared for:

DNR

Polk County Conservation

Polk Soil & Water Conservation District

City of Des Moines

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EXECUTIVE SUMMARY

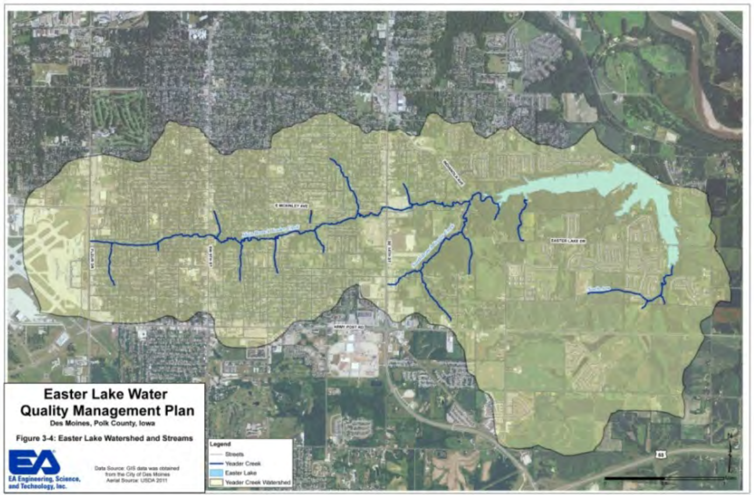
Introduction

Easter Lake, located within Easter Lake Park, has been a great recreational resource for the residents of Des Moines, IA since 1967. However, over the last several years the water quality of the lake has diminished due to increased loads of nutrients and sediment as development has occurred around the lake. Currently, the lake suffers from poor water clarity, algal blooms, high sedimentation rates, low oxygen concentrations, and a poor fishery. In response to these water quality problems, area stakeholders worked together to develop this Easter Lake Water Quality Management Plan (Plan). The planning effort was co-sponsored by the Iowa Department of Natural Resources (IDNR), City of Des Moines, and Polk County Conservation Board PCCB. Other support agencies include; the Iowa Department of Agriculture and Land Stewardship, Polk Soil and Water Conservation District (Polk SWCD), Natural Resources Conservation Service, and the Center for Agricultural and Rural Development. The plan serves as the culmination of existing studies, citizen and stakeholder input, and the consultant's recommendations for structural and non-structural Best Management Practices (BMPs) (referred to as programmatic BMPs) intended to reduce delivery of pollutants to stormwater, reduce stormwater runoff, and renovate Easter Lake. The stakeholders have been working with multiple agencies recently to collect the data needed to complete this Plan. The Plan has been established using three recently completed documents:

1) Iowa State University's Diagnostic Feasibility Study; 2011 – A comprehensive study of Easter Lake's water quality, provides details on key issues and identifies alternatives to reach Water Quality Targets (WQT).
2) Natural Resources Conservation Service (NRCS) Channels and Storm Sewer Outfall Study; 2011 – An erosion and sediment delivery study.
3) NRCS's Planning Level Cost Analysis of Stream Bank and Streambed Stabilization in the Yeader Creek;2011 – A summary report with engineering estimates for design and installation of best management practices (BMPs) needed to reduce sediment delivery to Easter Lake.

The watershed for Easter Lake covers a total of 6,380 acres and originates near the Des Moines International Airport west of Easter Lake (Figure ES-1). There are two main creeks that feed into the lake, Yeader Creek which originates near the airport and a second unnamed waterway which enters Easter Lake from the south, referred to as the 'south-arm' for purposes of this Plan.

Figure ES-1: Easter Lake Location Map



Plan Goals

Goals and objectives have been established in order to achieve the vision of each project stakeholders, which are intended to improve the overall health of the watershed. The Plan will allow the project stakeholders to manage stormwater impacts, reduce sedimentation and runoff, reduce phosphorus loading, stabilize and protect infrastructure in Yeader Creek, and support a more active and healthy fishery in Easter Lake. Below are primary goals of the Plan:

Goal One: Improve water quality throughout the watershed by incorporating management practices and utilization of an information and education effort on water quality.

Goal Two: Reconnect Des Moines metro residents and visitors to the natural amenities of Easter Lake and it surroundings.

Goal Three: Educate the public about water quality and provide awareness of the Easter Lake Water Quality Management Plan.

Goal Four: Achieve a “Full Support” status for the aquatic life use in Easter Lake.

Goal Five: Maintain a “Full Support” status for the aesthetic use.

Public Involvement

A community based planning approach was used in the development of the Plan. Involving the public in the planning process is a very important step to establishing a Plan that is accepted and successfully implemented by the stakeholders of the lake. Public participation and involvement had begun prior to the planning process for establishing the Plan. IDNR, PCCB, and the City had already begun working with an organized council of watershed volunteers, referred to as a ‘Steering Committee’. In addition, a Technical Advisory Team (TAT) had already been formed prior to the Plan kickoff. The TAT and Steering Committee held several meetings prior to plan kickoff. These meetings were focused on the outcomes of two important studies: the Easter Lake Diagnostic/Feasibility Study, and NRCS’s Analysis of Yeader Creek. The Steering Committee was utilized to provide direction and input to the consultant and TAT representatives during plan establishment.

The consultant continued and expanded the public participation that had been established. Following is a general summary of the key public participation events conducted during the development of this Plan.

- **Steering Committee (SC)** – The SC included representatives from neighborhoods, business owners, and various agencies in the project area. During the planning process, the SC met four times including meetings in March, May, June, and October 2012. The primary role of the SC was to provide input from a diverse set of stakeholders that live and work in throughout the watershed.
- **Technical Advisory Team (TAT)** – A technically-based group representing ten different agencies was established during the beginning of the project. The TAT met four times during Plan development and was vital to the establishment of this Plan. The TAT was also responsible for presenting plan elements to the Des Moines City Council and Polk County officials.
- **Open Houses** – One Open House was held on October 4, 2012, and provided an opportunity for the public to provide input on the draft plan and learn about actions planned for the next 10 years in the watershed.
- **Website** – IDNR created a website which was used to share information on the planning process. Information made available included a general background on the

watershed, the original watershed council, information on the watershed plan, maps, photos, and contact information.

Public involvement and input from the SC, TAT, and open houses were used by the project team during establishment of strategies in the Plan.

Plan Elements

The Plan preparation included several key elements that enabled the project team to review existing information, collect field data, screen potential project locations, conceptualize and prioritize projects, and formulate an implementation strategy. Summaries of each significant Plan element are provided below:

Basin Inventory

- Conducted field investigation to verify current conditions the creeks, evaluate detention structures and Easter Lake, and compare conditions to the results of existing studies.
- Completed an inventory to identify critical areas within the watershed with potential to be pollutant sources.

Water Quality and Fisheries Assessment

- Sediment and phosphorus are the pollutants of concern for Easter Lake Watershed listed in the 2005 TMDL.
- Water Quality Standards established by the USEPA and Water Quality Targets established by the State of Iowa were used to set pollutant reduction goals.

Pollutant Sources and Loading Assessment

- Conducted a watershed assessment and literature review to identify potential sources of phosphorus and sediment.
- Both external (watershed) and internal (from the lake) processes contribute to degradation of water quality in Easter Lake
- External sediment and nutrient sources include urbanized, developing, and agriculture land as well as the stream bed and banks.
- Internal sediment sources are limited to shoreline erosion while internal phosphorus loading stems from bottom sediment re-suspension and bottom sediment release.
- Sediment loading to the Lake equals approximately 7,000 tons per year.
- Phosphorus loading to the Lake equals approximately 4,250 pounds per year.

Management Practices (BMPs)

- Conducted a field screening and desktop review multiple sites throughout the watershed to identify potential sites for water quality BMPs, Yeader Creek restoration areas, and in-lake improvements.
- Selected sites in the watershed based upon watershed specific selection criteria to identify the most feasible project types and locations.
- Conceptualized 16 structural projects, including description, cost, water quality benefits, and pollutant load reduction estimates. The projects include restoration of Yeader Creek, water quality demonstration projects throughout the watershed, and in-lake restoration projects
- Established more than 20 programmatic BMP recommendations including expansion of existing programs and consideration of new programs.

Implementation Strategy

- Developed a 10-year implementation strategy to improve water quality in Easter Lake.
- Sediment Load Reduction Target is 23% or approximately 1,600 tons per year.
- Phosphorus Load Reduction Target is 40% or approximately 1,710 pounds per year.

Summary of Implementation Plan and Projected Costs

Improving the water quality of Easter Lake is a complex and challenging effort that will require collaboration of the project sponsors over the next 10 years. This implementation strategy was written using input from the project stakeholders, ISU's DF study, NRCS studies, the public, the summary of conclusions drawn during the planning process, and a review of other available information. The implementation plan was based upon a balance of available resources and the process necessary to achieve the Plan's ultimate goal of removing Easter Lake from the Clean Water Act Section 303(d) list of impaired waters and achieving IDNR's lake restoration goals.

Implementation Strategy

A phased approach has been established that allows for resources to be concentrated on reducing the pollutant load and runoff in the watershed (Phase One) prior to lake restoration and other significant pollution reduction projects being completed in and around Easter Lake (Phase Two). In addition, a strong information and education effort will be utilized to increase the effectiveness of programs and provide information on other activities and their water quality benefits. Phase Three consist of finish work on structural projects and continuation of programmatic BMPs throughout the watershed including continuation of a coordinator to oversee implementation and assist with projects. Costs for projects and programs were estimated based upon costs of similar programs and construction project costs within the Midwest region. Section 7 - Implementation Strategy, in the Plan provides a detailed breakdown of estimated costs, the table below provides a summary of the elements of each phase and the estimated costs for each phase.

Table ES-1: Implementation Strategy Summary

Phase	Years	Focus	Key actions	Projected Cost
One	2012-2014	• Reducing runoff and pollutant sources in the watershed • Information and education • Stream restoration • Lake improvement design	• Financial incentives for water quality BMPs • Installation of bio-infiltration BMPs in watershed • Grade control, stream bank stabilization in Yeader Creek and 'South Arm' • Design and plans for lake improvements	$2,555,000
Two	2015-2018	• Continuing watershed work • Continuing stream restoration • Lake improvement construction	• In-lake improvements and dredging • Aquatic habitat improvements • Watershed BMPs • Information and Education	$5,985,500-$11,280,500
Three	2019-2021	• Continuing watershed work • Easter Lake rehabilitation completion	• Financial incentives for water quality BMPs • Installation of bio-infiltration BMPs in watershed	$1,443,000
TOTAL ESTIMATED COST				**$9,983,500-$15,278,500**

Cost estimates are a forecast of financial resources anticipated to be necessary for both pollution reduction and lake renovation, including aquatic habitat enhancements. Several items related to the aquatic habitat enhancements are not intended to have pollution reduction benefits, but will instead support a sport fishery, which in turn increases recreational benefits and economic development in the region.

Due to the variability in the removal efficiencies of programmatic BMPs (such as residential rain gardens, use of no-phosphorus fertilizers) recommended in this Plan the final total price of the Plan implementation could be adjusted up or down. If the public is active in implementing the pollution control strategies recommended in this Plan, the cost could be significantly reduced. If the public does not actively implement the strategies, it may be necessary to construction additional structural pollutant treatment BMPs which would increase total implementation costs to meet the water quality goals set for Easter Lake. Therefore, a key element in implementation will be the use of an Easter Lake coordinator to encourage the public to implement programmatic BMPs.

SECTION 1 - INTRODUCTION

1.1. Introduction and Purpose

Easter Lake has been providing recreational opportunities for residents and visitors since 1967. The lake is mostly contained within Easter Lake Park located in Des Moines, Iowa; which is managed by the Polk County Conservation Board (PCCB). Over the last several years the water quality of Easter Lake has diminished and the lake currently suffers from poor water clarity, algal blooms, high sedimentation rates, low oxygen concentrations, and a poor fishery.

In response to these water quality problems, area stakeholders have begun working to develop the Easter Lake Water Quality Management Plan (Plan). The planning effort is co-sponsored by the Iowa Department of Natural Resources (IDNR), City of Des Moines, and PCCB. Other support agencies include; the Iowa Department of Agriculture and Land Stewardship, Polk Soil and Water Conservation District (Polk SWCD), Natural Resources Conservation Service, and the Center for Agricultural and Rural Development. A Technical Advisory Team (TAT), including representatives from each agency, was formed to support Plan establishment.

The Plan has been established using three recently completed documents:

1) Iowa State University's Diagnostic Feasibility Study; 2011 (ISU DF Study) – A comprehensive study of Easter Lake's water quality, provides details on key issues and identifies alternatives to reach Water Quality Target's (WQT).
2) Natural Resources Conservation Service Channels and Storm Sewer Outfall Study; 2011 (NRCS 2011) – An erosion and sediment delivery study.
3) NRCS's Planning Level Cost Analysis of Stream bank and Streambed Stabilization in the Yeader Creek; 2011 – A summary report of engineer's estimate for design and installation of best management practices (BMPs) needed to reduce sediment delivery to Easter Lake.

The plan serves as the culmination of existing studies, citizen and stakeholder input, and the consultant's recommendations for structural and non-structural BMPs (referred to as programmatic BMPs) intended to reduce delivery of pollutants to stormwater, reduce stormwater runoff, and renovate Easter Lake. The focus of this Plan is to reduce the sedimentation rate of Easter Lake and to reduce phosphorus loading in order to improve water quality.

Overall, the development of this Plan is guided by interested citizens who formed a Steering Committee (SC) and technical advisors who formed a Technical Advisory Team (TAT). These two groups worked with the project consultant to formulate a strategy to improve the health of the Easter Lake watershed, and improve the water quality in Easter Lake. The following vision statement was created by the Easter Lake Steering Committee.

Easter Lake Vision Statement

Easter Lake will be a sustainable resource that provides diverse outdoor recreational activities for visitors. Public education and community involvement will be the driving force behind improving watershed management techniques and developing a healthy ecosystem.

1.2. Watershed Plan Overview

Easter Lake's water quality issues have been well documented, monitored, and studied over the last 10 years. The watershed is unique in the fact that several differing land uses are present, which included fully urbanized residential, commercial, and industrial properties, mixed with agricultural property. In addition, most of the agricultural property is being planned for development in the near future.

For the purposes of this Plan, sedimentation and phosphorus, as identified in the 2005 Total Maximum Daily Load (TMDL), are the primary focus. The dynamic nature of the land uses in the Easter Lake watershed creates a unique challenge in identifying pollutant load estimates for both sediment and phosphorus. Several sources of information as identified above have been utilized during establishment of this plan. Each source uses a differing pollutant loading estimate for both sediment and phosphorus. The 2005 TMDL lists the existing sediment load as 7,000 tons per year and existing phosphorus load is 4,250 pounds per year.

Additional information gathered during the Easter Lake plan included updated bathymetry of Easter Lake in June 2012. Comparing the capacity of Easter Lake in 2003 to the existing capacity, the average annual sediment loading rate was over 21,000 tons per year over the last decade. The average annual sediment loading rate was 19,800 tons per year from 1967-2003. Bathymetric data can also be highly variable unless the information was conducted by the same personnel using the same protocol. It was not confirmed if the 2003 bathymetric survey was conducted in a similar fashion as the 2012 survey; therefore, the amount of variability and level of accuracy of the bathymetric surveys is unknown.

One explanation for the large difference in the sediment load estimates is that sediment loads based on model results or determined from total suspended solids concentrations and flow tend to be underestimated. This is primarily because gully and streambank erosion are typically underestimated, TSS concentrations do not reflect the true sediment concentration in the stream, and sediment loads from high flow events (e.g. 50 or 100-year events) are not taken into account. In addition, sediment loads were likely much higher during recent wet years during peak urban development around the lake. During this time it is possible for sediment delivery loads to have exceeded 70,000 tons or maybe even 100,000 tons per year and will drive up the average.

Sedimentation rates found during the NRCS study of Yeader Creek in 2010 listed 4,000 tons per year from channel and bank erosion. Gully erosion was found as a minor contributor. The Iowa State University Diagnostic Feasibility Study (ISU DF Study) found numbers that were lower than estimates in the NRCS study. As part of this planning effort, all of the different sources of load data were reviewed and compared. Based upon current observed conditions and review of the data, it was determined that the TMDL pollutant load estimates developed in 2005 provided the best representation of current, or average, loading conditions in the watershed. Therefore, the pollutant load estimates in the 2005 TMDL have been used throughout this Plan to establish pollutant reduction estimates for each project, goal establishment, design criteria, and creation of milestones. Monitoring sediment loads into the lake will be a key factor in verifying or measuring the loading rates throughout the implementation of this plan.

While bacteria have been found in Easter Lake in levels exceeding standards, the focus of the Plan is not on bacteria. Currently a TMDL for Easter Lake focusing on bacteria is does not exist.

1.3. Watershed and Lake Characteristics

Easter Lake is a man-made reservoir located within the city limits of Des Moines in Polk County, Iowa as seen in Figure 1-1: Vicinity Map. The lake was constructed in 1967 on the site of the last operating coal mine in Polk County. The South Town Lake and Development Society, a neighborhood organization, promoted the use of this site as a park rather than its proposed use as a landfill. The lake is largely contained within the borders of Easter Lake Park, which is managed by the Polk County Conservation Board (PCCD). Des Moines City Parks in the watershed include Yeader Creek Park, Jordon Park, and Ewing Park. All of Easter Lake's shoreline is in public ownership (ISU 2011).

Easter Lake suffers from several water quality problems including poor water clarity, summer algal blooms, high sedimentation rates, and low oxygen concentrations in bottom waters during summer stratification. Numerous management practices, including dredging and sediment and retention pond construction, have been implemented to improve water quality throughout the lake's lifespan. Despite these efforts, Easter Lake continues to experience water quality symptoms associated with cultural eutrophication (ISU 2011). Key watershed characteristics are identified below in Table 1-1: Easter Lake Characteristics.

Table 1-1: Easter Lake Characteristics

IDNR Waterbody ID	IA 04-LDM-00490-L
8 Digit Hydrologic Unit Code (HUC)	07100008 (Basin=Des Moines, Subbasin=Lake Red Rock)
12 Digit HUC	071000081507 (Yeader Creek-Des Moines)
Location	Des Moines, Polk County, Iowa
Latitude/Longitude	41-54534 / -93.55538
Designated Uses	Primary Contact Recreation (Class AS)
	Aquatic Life Support (Class B(LW))
Receiving Waterbody	Yeader Creek and unnamed tributary
Maximum Depth* / Mean Depth*	21.2 feet / 8.1 feet
Lake Volume*	1,511 acre-feet
Length of Shoreline	35,300 ft (TMDL)
Watershed Area / Lake Surface Area	6,380 / 178* acres
Watershed / Lake Ratio	37:1
Lake Residence Time	0.28 years (TMDL)
TMDL Pollutants	Phosphorus, Sediment
Impaired Uses	A1 – primary contact recreation & B (LW) – aquatic life

***ISU DF Study 2011**

The watershed originates near the Des Moines International Airport west of Easter Lake. The watershed includes a second unnamed waterway which enters Easter Lake from the south (ISU 2011).

1.4. Demographics and Social Dynamics

Because Easter Lake is located within the city limits of Des Moines, it is easily accessible to the public. The lake is located a short drive from downtown Des Moines. The lake is located in proximity to numerous Interstates (I-35 and I-80), US Highways (US 6, US 65, and US 69), and State Highways (IA 5 and IA 163).

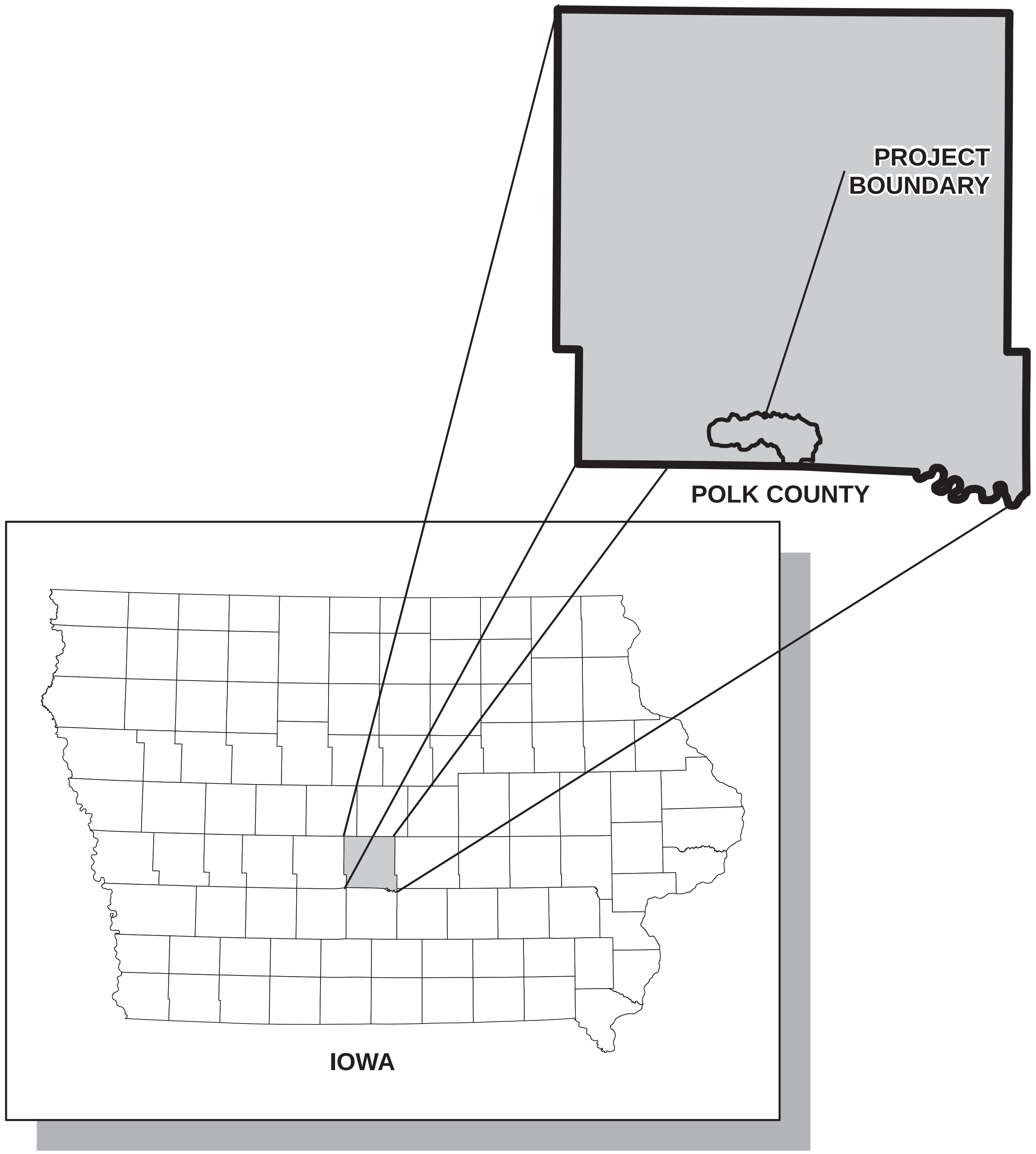
Easter Lake is located in Polk County. Polk County has the largest population in Iowa with an estimated 2009 county population of 429,439 persons (State Data Center of Iowa 2010). The Des Moines-West Des Moines Metropolitan area, which is spread across multiple counties, had an estimated population of 562,906 persons in 2009. Ames (87,214 persons) and Marshalltown (39,259 persons) are other important cities located within 50 miles (80 km) of Easter Lake (ISU 2011). A specific demographic analysis of the Easter Lake watershed was not conducted for this Plan.

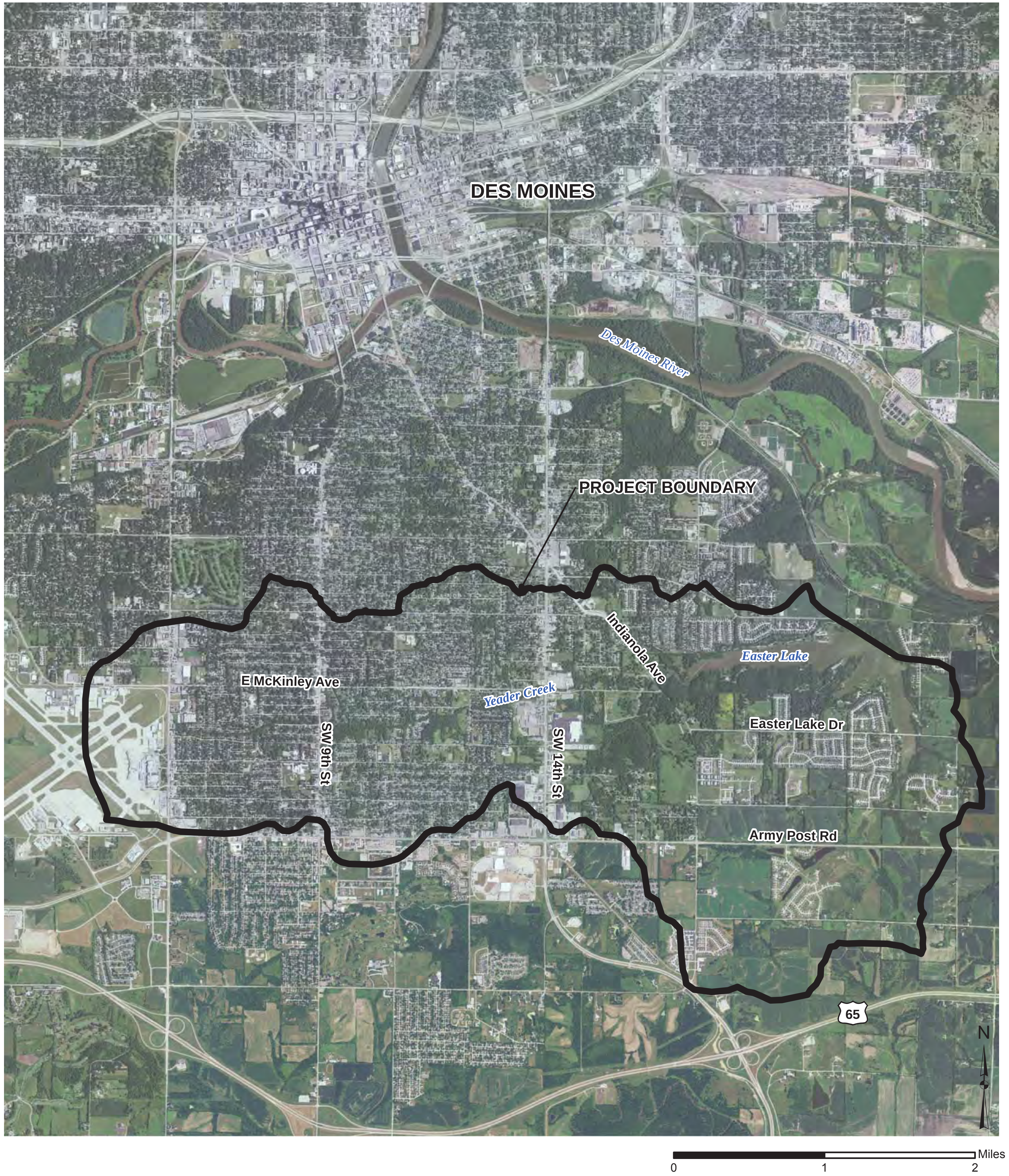
Research was conducted in 2011 during the ISU DF Study on the social dynamics of Easter Lake including interviews and surveys with by five key stakeholder groups: county agency staff and board members, city department staff, state agency representatives, elected officials, and non-profit organizations including neighborhood associations. In addition, 441 surveys were completed, which included 404 by residents. This research confirmed that the lake is a valued resource among both residents of Des Moines and local and state agencies. The majority reported land use rather than lake-based use, including wildlife habitat benefits. Research shows that most respondents have a strong level of understanding of sedimentation problems and are aware of the drainage area that makes up the lake. This includes a strong understanding that Yeader Creek and other tributaries are experiencing stream bank erosion. Among problems negatively impacting Easter Lake, the most frequently mentioned were sediment, erosion, lawn fertilizers, stormwater volume and trash. Respondents also understood that PCCB and IDNR staff would make final decisions about future restoration activities at Easter Lake (Wagner 2011).

1.5. Lake Usage and Economic Value

Current statewide public-use data are not lake specific (Iowa DNR 2009a); however, rates of lake use in Iowa lakes were estimated in a four year study valuing lake water quality in the state. Survey respondents indicated how many day-trips and multi-day trips they made to Iowa lakes during a calendar year. Easter Lake averaged 116,448 visitors annually from 2002 to 2005, a rate of use higher than the statewide average (CARD 2010).

Although lake-specific activities were not queried in the aforementioned study, historic estimates of lake-specific use were reported in earlier lake classification studies (Bachmann et al. 1980 and 1994). Easter Lake has been used for a variety of recreational purposes throughout its history. In each study, the lake and park were primarily used for picnicking, camping, and other activities prompted by the presence of the lake. Fishing has increased in popularity on Easter Lake from 1979 to 1992. Swimming has decreased dramatically in the lake from 1979 to 1992 which may indicate changes in public perception of water quality. Pleasure boating was also listed as a popular activity in 1992 (ISU 2011).





Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 1-1: Vicinity Map

EA Engineering, Science, and Technology, Inc.

Data Source: GIS data was obtained
from the City of Des Moines
Aerial Source: USDA 2011

1.5.1. Comparison of Use with Other Lakes/Economic Value

Visitors enjoy a variety of outdoor recreation pursuits while visiting Iowa lakes and the benefit to local economies is significant. Easter Lake averaged 116,448 day-use and multi-day use visitors annually from 2002 to 2005 (CARD 2010). These visitors spent $5.69 million annually on a variety of expenditures including supplies, food and lodging as shown in Table 1-2: Spending, Labor Income, and Job Effects of Visitation Estimates.

Table 1-2: Spending, Labor Income, and Job Effects of Visitation Estimates

Category	Spending	Income	Jobs
Supplies	$2,096,441	$242,154	11.1
Eating and drinking	$1,338,320	$382,121	28.5
Gas and car expenses	$661,266	$42,142	1.8
Lodging	$259,408	$75,958	3.6
Shopping and entertainment	$1,332,488	$144,981	6.9
Total	$5,687,923	$887,356	51.9

Source: CARD 2010 / ISU 2011

Easter Lake ranked 5th out of 26 lakes located within 50 miles of Easter Lake based on 2005 single day visitation estimates (CARD 2010). Big Creek Lake, Red Rock Lake, and Lake Ahquabi (in decreasing order) had single day visitation estimates greater than Easter Lake in 2005. Easter Lake single day visitation numbers have grown by 26% from 2002 to 2005 (CARD 2010). A demographic comparison of area lakes is shown below in Table 1-3: Iowa Lake Demographic Comparison.

Table 1-3: Iowa Lake Demographic Comparison

Lake	Average Annual Visitors	Average Annual Spending (millions)	Number of Jobs Supported	Regional Labor Income (millions)
Big Creek Lake	116,531	$19.1	233	$4.8
Three Mile Lake	116,531	$13.0	259	$3.5
Lake Ahquabi	120,022	$8.6	172	$2.3
Don Williams Lake	85,896	$8.3	164	$2.2
Rock Creek Lake	80,301	$6.9	137	$1.8
Hickory Grove Lake	71,123	$6.5	79	$1.6
Springbrook Lake	60,765	$6.0	119	$1.6
Easter Lake	116,448	$5.7	69	$1.4
Arbor Lake	30,264	$3.4	69	$0.9
Red Haw Lake	38,817	$2.3	30	$0.5

Source: CARD 2010 / ISU 2011

1.6. Fisheries Overview

Soon after Easter Lake was completed in 1967, the fishery (lake and watershed) was renovated with rotenone to establish a fishery free of nuisance species. However, even with this effort, bullheads and common carp were recorded in the 1970s and gizzard shad were found in the late 1980s.

Biologists have been concerned with siltation and poor panfish growth since the late 1970s. Several attempts were made to improve the panfishing at Easter Lake. A rearing pond was constructed on site in 1982. This pond was used for rearing largemouth bass to augment the existing bass population. Biologists hoped a stronger bass population, combined with a lake draw down would increase predation on panfish and improve panfish growth rates. Tiger Muskie was also stocked in the 1980s to increase panfish predation.

Unfortunately, the current state of the fishery is surprisingly similar to the 1970s. A quality bass population has been sustained over the course of time; however, the attempts to improve panfish growth rates and size structure at Easter Lake were unsuccessful. Shoreline erosion in the main lake and gully erosion from the tributaries have contributed to the loss of surface acreage, depth and habitat at Easter Lake. The presence of undesirable fish species has nearly eliminated vegetation growth and likely increased turbidity and nutrient re-suspension.

This lake could offer an important urban fishing opportunity for Des Moines Metro residents; however, a thorough renovation of the fishery throughout the watershed will be necessary to eliminate undesirable species. Analysis of the spillway supports that retrofit is necessary to block immigration of undesirable species into the lake. Dredging activities to reclaim lost deeper water habitat are also desired because steep sided lakes tend to support better panfishing in Iowa. Panfish growth rates and body condition should be monitored post lake renovation.

1.7. Goals and Objectives

A series of differing goals and objectives have been created each which guide the overall goal of improving the water quality in Easter Lake. Below are a summary of goals for the IDNR Lake Restoration Program; State of Iowa Water Quality Standards, and a set of Easter Lake specific goals established through public input and feedback from the Steering Committee.

1.7.1. IDNR Lake Restoration Program Goals

For each lake project funded by the Lake Restoration Program the following goals will be achieved:

- Ensure a cost effective, positive return on investment for the citizens of Iowa.
- Ensure a local community commitment to lake and watershed protection.
- Ensure significant improvement in water clarity, safety, and quality of Iowa lakes.
- Result in the removal of the lake from the impaired waters list.

1.7.2. State of Iowa Water Quality Standards

The State of Iowa has established Water Quality Standards (WQS) used to protect and restore surface waters in agreement with the requirements of the Clean Water Act (CWA§319). WQS set goals and criteria to protect water bodies from pollutants based on its classification of designated use. Many factors including the physical, chemical, and biological characteristics of the water body are considered when designated uses for a water body are determined. Also taken into consideration are the use and value of the water body for public water supply and other uses such as recreational, agricultural, industrial, and navigational, as well as for protecting fish and wildlife (ISU 2011).

Under the State water quality classification system, Easter Lake is designated as Class A1, Class B (LW), and Class HH. In short, these designations indicate the lake is used for primary and secondary recreation (e.g., swimming, boating, and fishing) and that it supports aquatic life (ISU 2011).

Also important to restoring and protecting surface waters in Iowa are State Water Quality Targets (WQT). The State Legislation (HF2782) defined WQT for Iowa lake restoration s in 2006 the control of the delivery of phosphorus and sediment from the watershed to a lake mandatory for lake restoration projects utilizing state funding. Water quality targets address water clarity, biota, impairments, and sustainability. Increasing water clarity to 4.5 feet Secchi depth is important relative to the phosphorus reduction necessary to reach this goal. Iowa's WQTs were defined in 2006 by State Legislation – HF2782, and are listed below:

- Clarity – Secchi depth must be at least 4.5 feet, 50% of the time from April to September.
- Biota – A diverse, balanced, and sustainable aquatic community must be maintained.
- Impairment – Water quality impairments must be eliminated.
- Sustainability – The water quality and public use benefit must be sustained for 50 years.

According to the 2011 ISU DF Study, the goal of meeting WQTs for lake restoration projects is to improve water quality to the point that excellent recreation and biological integrity are restored. To support State of Iowa WQTs, restoration needs to consider these additional criteria:

- No agricultural or wastewater discharges causing objectionable or unsafe conditions
- Geometric mean *E. coli* < 126/100mL or single sample <235 organisms/100mL
- pH not <6.5 or >9.0
- Oxygen not <5.0 mg/L
- Temperature <32°C (90°F)
- Unionized ammonia generally <80 µg/L
- No substances causing odor or health risk from eating fish
- Improved fish habitat and fish communities

1.7.3. Easter Lake Watershed Plan Goals and Objectives

Goals and objectives have been established in order to achieve the vision of each project stakeholder and the Steering Committee, which intends to improve the overall health of the watershed. The Plan will allow the project stakeholders to manage stormwater impacts, reduce sedimentation and runoff, stabilize and protect infrastructure in Yeader Creek, and support a more active and healthy fishery in Easter Lake. Below are primary goals and objectives of the Plan:

- Goals—broad based desires, written as statements, of the ultimate result being undertaken
- Objectives—steps or actions performed and assigned to individuals and/or groups, to attain a goal

Goal One: Improve water quality throughout the watershed by incorporating structural and programmatic best management practices providing information and education on water quality and the projects and programs available through this Plan.

Objectives:

- Identify areas in Yeader Creek where structural measures can reduce erosion and stream degradation, stabilize stream banks, and limit the sedimentation rate to Easter Lake.
- Identify and implement best management practices throughout the watershed that reduce pollutant loading, increase water quality of stormwater runoff, and add to the aesthetics of the watershed.
- Perform a restoration of Easter Lake in order to reduce pollutant loading from the shoreline, enhance aquatic habitat, and create more opportunities for sport fishing.

Goal Two: Reconnect Des Moines metro residents and visitors to the natural amenities of Easter Lake and it surroundings

Objective:

- Incorporate native vegetation, use natural materials, and promote conservation as part of each project planned to improve water quality.
- Expand existing trail systems and incorporate trail alignments with planned improvements to Easter Lake, including the west-arm sediment forebay.
- Provide education and outreach opportunities through the natural amenities available at Easter Lake.

Goal Three: Educate the public about water quality and provide awareness of the Easter Lake Water Quality Management Plan.

Objective:

- Public Information and Education—Disseminate information and solicit feedback from the public through open house meetings, newsletters, stakeholder meetings, and a Steering Committee.
- Work to achieve at least a 50% public acceptance rate of programmatic stormwater controls amongst property owners and residents by providing information and education.

Goal Four: Achieve a “Full Support” status for the aquatic life use in Easter Lake.

Objective:

- Decrease phosphorus loading in order to increase the water clarity to 4.5 feet Secchi depth from the 2.5 feet summer average from 2000 to 2007.
- Maintain healthy aquatic habitats that support balanced populations of fish, amphibians/retiles and invertebrates.
- Achieve and maintain lake water quality values for both Chlorophyll α TSI and Secchi TSI of less than 63.

Goal Five: Maintain a “Full Support” status for the aesthetic use.

- Keep the lake and park free of trash and junk.
- Stabilize areas of eroding shoreline.

SECTION 2 - PUBLIC PARTICIPATION AND EDUCATION

2.1. Introduction

Public participation and involvement had begun prior to the planning process for establishing the Plan. IDNR, PCCB, and the City had already begun working with an organized council of watershed volunteers, referred to as a 'watershed council'. In addition, a Technical Advisory Team (TAT) had already been formed prior to the plan kickoff. The TAT and 'watershed council' held several meetings prior to plan kickoff. These meetings were focused on the outcomes of two important studies: the ISU DF Study, and NRCS's Analysis of Yeader Creek.

After the kickoff meeting the 'watershed council' was referred to as the citizens Steering Committee (SC) and was utilized to provide direction and input to the consultant and TAT representatives during Plan establishment. Below is a summary of the TAT, SC, meetings, and outreach efforts.

2.2. Technical Advisory Team

Technical guidance and input from the TAT was vital to establishing the Plan. This group consisted of technical staff representing ten different agencies and departments. The TAT, listed below in Table 2-1: Technical Advisory Team, met four times throughout the planning period; most members also attended Open House events and various other progress meetings. The TAT was responsible for reviewing and commenting on Plan components, providing direction for public involvement and the SC, and adding technical insight to the Plan.

During plan establishment, correspondence with a smaller group of representatives from the TAT occurred on a regular basis. This smaller group was informal and referred to as the 'project team'. This group met two additional times with the consultant during Plan development. Members of the project team are indicated by an asterisk next to their name in Table 2-1 below. George Antoniou (IDNR) served as the primary contact for the TAT, project team, and was the primary contact for the consultants.

Table 2-1: Technical Advisory Team

Name	Representing
Mike Ludwig	City of Des Moines, Community Development
Dan Pritchard*	City of Des Moines, Public Works
Jesse Leckband*	City of Des Moines, Public Works
Dave Miller	City of Des Moines, Public Works
Bill Stowe	City of Des Moines, Public Works
Richard Brown*	City of Des Moines, Parks and Recreation
Teva Dawson	City of Des Moines, Parks and Recreation
Don McLaughlin	City of Des Moines, Parks and Recreation
Don Tripp	City of Des Moines, Parks and Recreation
Jim Gillespie	IDALS / DSC
Vince Sitzmann	IDALS / DSC
Mel Pins	IDNR

Name	Representing
Adam Kiel*	IDNR, 319
Allen Bonini	IDNR, 319/TMDL
Rachel Glaza	IDNR, 319
Steve Hopkins	IDNR, 319
Kate Bason	IDNR, Field Office #5
David Perry	IDNR, Field Office #5
Malia Schepers	IDNR, Field Office #5
George Antoniou*	IDNR, Fisheries
Ben Dodd*	IDNR, Fisheries
Mike McGhee*	IDNR, Fisheries
Randy Schultz	IDNR, Fisheries
Allen Bonini	IDNR, TMDL
Mimi Wagner	ISU, Landscape Architecture
John Downing	ISU, EEOB
Chris Filstrup	ISU, EEOB
Marty Adkins	NRCS
Allen Gehring	NRCS
Paul Miller	NRCS
Wayne Petersen	IDALS-DSC
Kathy Woida	NRCS
Dean Bruscher	PCCD
Loren Lown*	PCCD
Dennis Parker*	PCCD
Cami Rankin	PCCD
Jennifer Welch*	Polk SWCD

***Project Team members**

2.3. Steering Committee

A series of public meetings were held prior to kickoff of this planning effort to inform the public about current research and study results. Watershed landowners and other stakeholders were invited to be a part of the watershed council at these meetings. The watershed council is intended to assist in creation of a management plan that will focus on improving Easter Lake and the associated watershed. The watershed council provided local knowledge and input into the plan and they worked closely with the TAT. The watershed council typically met every other month.

Prior to the kickoff of the Plan, a citizens group was created by IDNR which met on January 19, 2012 at 6 pm at the South Side Library. This council created a vision statement for Easter Lake and established council responsibilities. These responsibilities are highlighted here:

- Work with IDNR and the consultant to develop a widely accepted watershed plan
- Assist with scheduling educational sessions
- Learn about solutions to water quality issues
- Lead or be involved with the public outreach efforts
- Serve as a representative for the watershed

This group continued meeting during the planning process and were referred to as the Steering Committee. In regards to the Plan, their primary role was to gather input from a diverse set of stakeholders that live and work in throughout the watershed and continue their previously determined responsibilities listed above.

The SC included representatives from neighborhoods, business owners, and various agencies in the project area as shown in Table 2-2: Steering Committee. During the planning process, the SC met four times including meetings in March, May, June, and September 2012; brief meeting summaries are provided below. Meeting minutes and sign-in sheets are provided in Appendix A. Ben Dodd (IDNR) served as the primary contact for the SC.

Table 2-2: Steering Committee

Name	Representing
Stan Thompson	Citizen
Karl Schilling	Citizen
Daniel Gregory	Citizen
Peg Schililng	Citizen
Roger Elliott	Citizen
William Kreinbring	Citizen
Dan Hurless	Blank Park Zoo / Citizen
Carl Tarantino	Citizen
Rick Cerwick	DSM Izaak Walton League
Jessie Lowry	Blank Park Zoo
Brian Meyer	Citizen
John Curry	Citizen
Lew Olson	Citizen
Marian Gelb	Citizen
Susan Noland	Citizen

Below is a brief summary of each meeting including topic of discussion and action items.

Steering Committee Meeting #1

Weeks Middle School – 901 East Park Avenue, March 26, 2012 from 6:00 - 7:30 pm

> **Summary**—The first SC meeting included introductions to the project scope, the consultants, and a review of the primary issues facing Easter Lake. This meeting was combined with the TAT. Meeting attendees asked several questions about the consultant's (EA and LakeTech) experience with similar projects. Paul Brakhage of LakeTech described the science behind how watershed pollutants are negatively affecting the lake's water quality.

Steering Committee Meeting #2

Southside Library – 1111 Porter, May 17, 2012 from 6:00 - 7:30 pm

> **Summary**—EA provided a presentation on the structural alternatives being considered for improvement of water quality in the lake, including the west-arm sediment forebay. The committee members were briefed on how this project was being tied with the planned trail expansion around the west arm of the lake. EA also lead a discussion on programmatic BMPs and recorded feedback from SC members on which BMPs they thought would most likely be implemented by residents. Prior to the next meeting, TAT members were planning on touring SC member's yards to look for opportunities for water quality demonstration BMPs.

Steering Committee Meeting #3

South Side Senior Center, 100 Payton Ave, Thursday June 28, 2012 – 6:00 - 7:30 pm

> **Summary**— The third SC meeting focused on demonstration BMPs, and provided an update on which structural alternatives were planned for Yeader Creek, the watershed, and Easter Lake. EA led a discussion focusing on SC member's thoughts on the lake potentially being drained, their thoughts on how urbanization was affecting the park, and how the Easter Lake can connect people in an urban setting back to nature.

Steering Committee Meeting #4

South Side Senior Center, 100 Payton Ave, October 4th, 2012 – 5:30 pm

> **Summary**— The Steering Committee discussed key elements of the draft final plan and reviewed the Open House presentation.

2.4. Open House Events

Citizens and other stakeholders had the opportunity to meet with those working directly on the Plan at an Open House event. The first Open House was held October 4, 2012 at the conclusion of the planning process at the time the draft plan was prepared. The intent of this meeting was to provide a firsthand look at the lake's water quality problems, describe project solutions, and provide an opportunity for citizens to learn about water quality. Below is a brief summary of planned activities for the Open House.

Easter Lake Plan Open House

*South Side Senior Center, 100 Payton Ave, October 4th, 2012 -***Summary**—EA and the project team are providing two 15-minute presentations highlighting the watershed plan. The Open House included informational stations and opportunities for the public to provide feedback.

2.5. Website

IDNR created a website which was used to share information on the planning process. Information made available included a general background on the watershed, the original watershed council, information on the watershed plan, maps, photos, and contact information.

The web location is http://easterlakewatershed.wordpress.com

2.6. Bill Stuffer

The City of Des Moines Public Works Department prepared and delivered a ‘bill stuffer’ on July 19, 2012, with the water bill. The bill stuffer featured a ‘watershed spotlight’ on Easter Lake and Yeader Creek including a summary of the lake, the water quality problems, information about the consultants, SC, and TAT, and purpose of the Plan. Examples of potential restoration measures were included with contact information for the City of Des Moines.

SECTION 3 - BASIN INVENTORY

3.1. Introduction

In order to develop management strategies to improve water quality in Easter Lake and the watershed, it is first necessary to understand the stream, lake, and watershed characteristics. During the summer and fall of 2012, the project team conducted site visits to evaluate the factors potentially affecting water quality. In addition, a desktop review of existing information and field surveys was included.

3.2. Existing Information

3.2.1. Physical Setting

Watershed Size and Boundaries

The watershed for Easter Lake covers a total of 6,380 acres from approximately 26th Street and flows to the east through Yeader Creek, into Easter Lake. Two unnamed creeks from the south and southwest also feed into Easter Lake. The northern edge of the watershed is bordered approximately by Watrous Avenue. Army Post Rd borders the southwestern part of the watershed. The southeastern border of the watershed extends near Highway 5 to the south and State Highway 46 to the east. The watershed includes Easter Lake, a flood control and recreational reservoir located on the eastern end. The watershed is approximately 1.5 miles wide and includes many Neighborhood Associations as seen in Figure 3-1: Neighborhood Associations as well as the following significant landmarks:

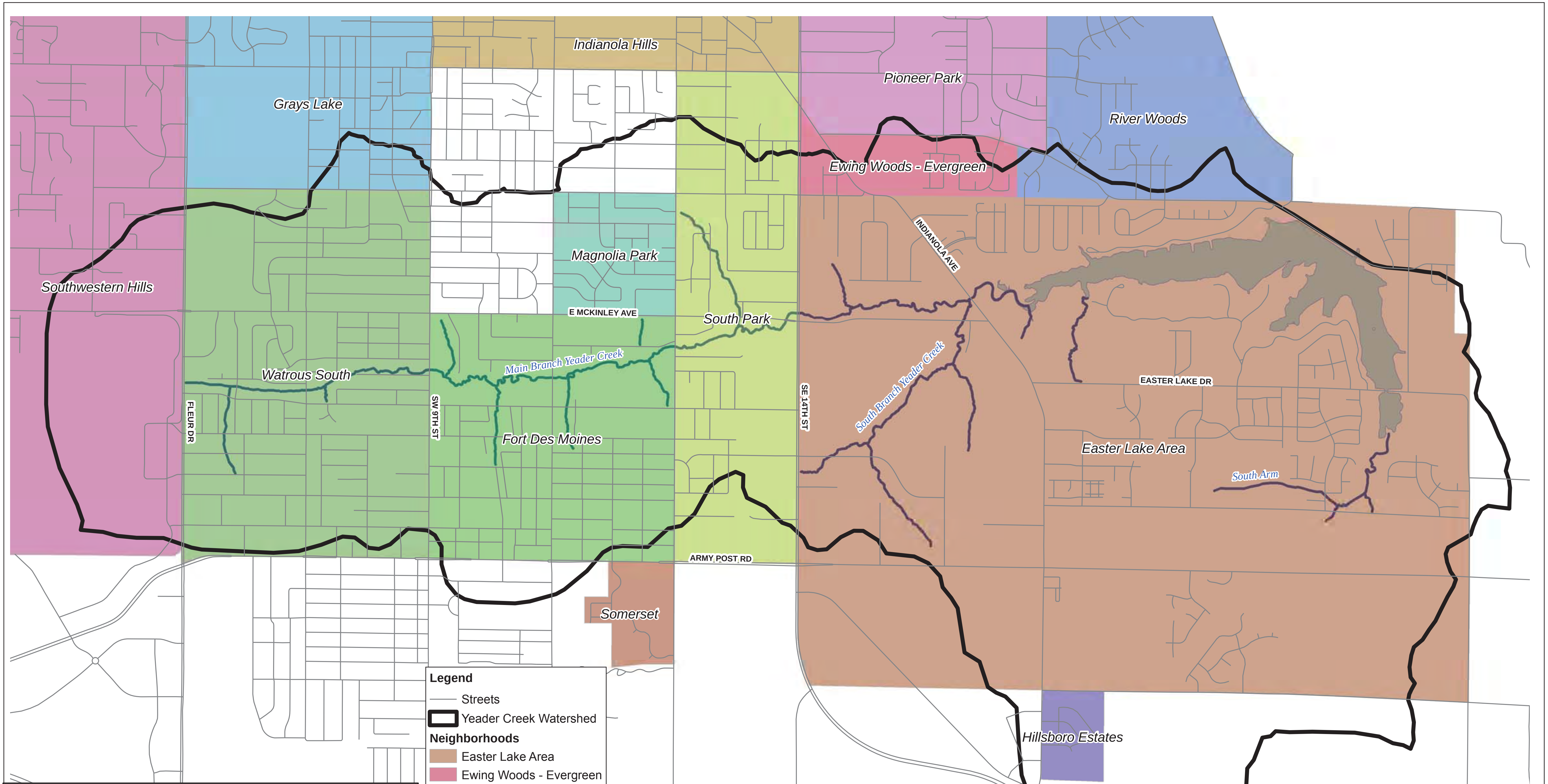
- Des Moines International Airport
- South Side Library
- SE 14th street commercial strip
- Orchard Place School and four elementary schools

The watershed was divided into seven total subbasins. These were used during the implementation process to focus resources in a specific area. Doing so increases the chance of success for particular BMPs. Figure 3-2: Easter Lake Watershed Subbasins shows the layout and names of the subbasins.

In 1988, the City of Des Moines annexed an area to the south of Easter Lake, referred to as the Southeast Annex Area. After this area was incorporated, 98.6% of the Easter Lake watershed was contained within Des Moines city limits. A total of 51.9 acres located to the southeast of the dam are within the city limits of the Allen Township.

Easter Lake

Easter Lake is a constructed impoundment located in Polk County within the city limits of Des Moines. The lake was constructed in 1967 for recreational purposes. Easter Lake has a mean depth of 7.9 feet and a maximum depth of 21.2 feet. Easter Lake has a surface area of 178.2 acres and a volume of 1,397 acre-feet. Easter Lake is fed by the Main Branch and South Branch of Yeader Creek from the west and unnamed creeks from the south and southwest. Easter Lake discharges from a dam at the northeast end to Yeader Creek. The estimated annual average detention time for Easter Lake is 0.28 years based on outflow.



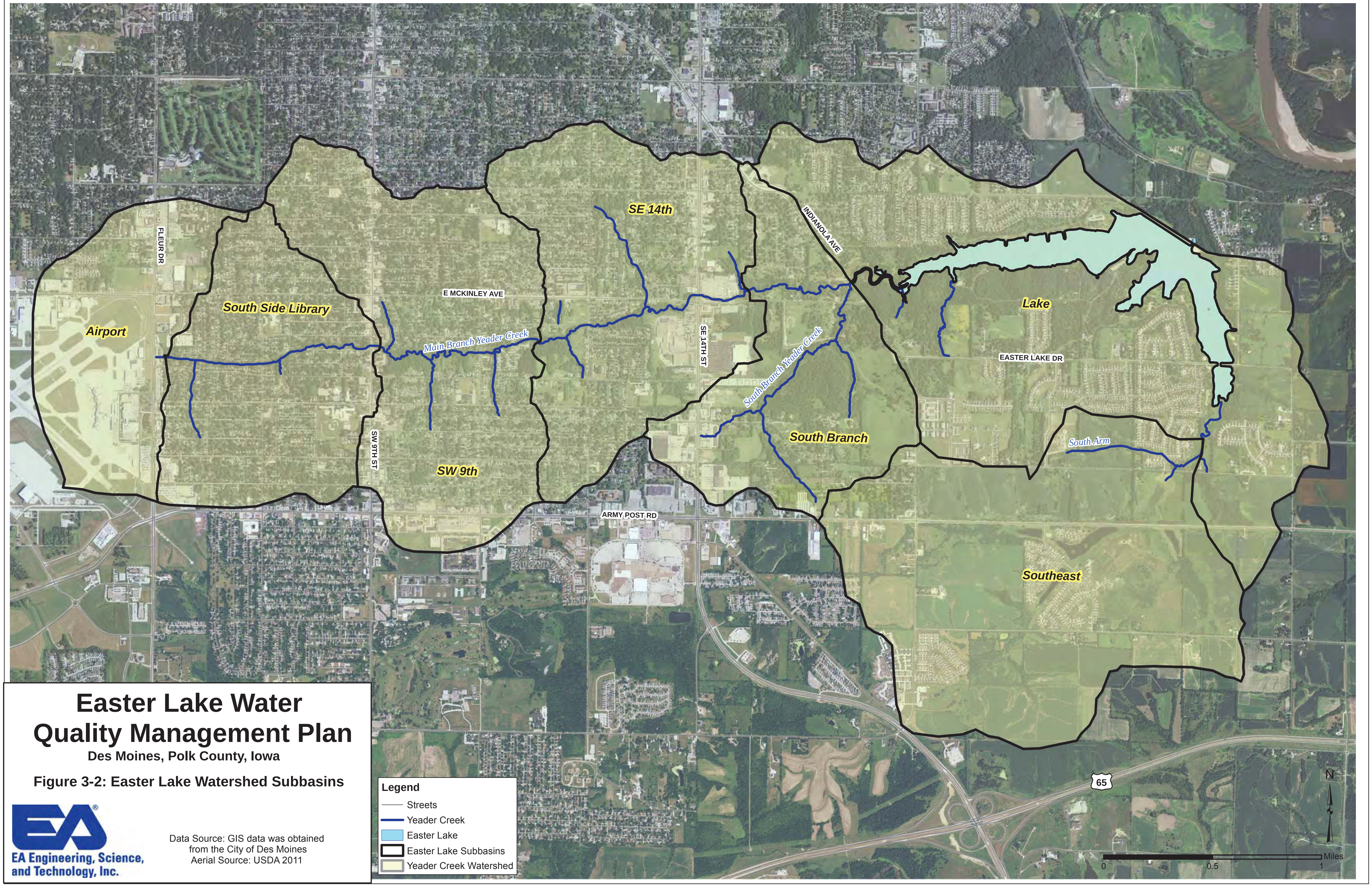
Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 3-1: Neighborhood Associations

Data Source: GIS data was obtained
from the City of Des Moines

EA Engineering, Science,
and Technology, Inc.



Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 3-2: Easter Lake Watershed Subbasins

EA Engineering, Science, and Technology, Inc.

Data Source: GIS data was obtained
from the City of Des Moines
Aerial Source: USDA 2011

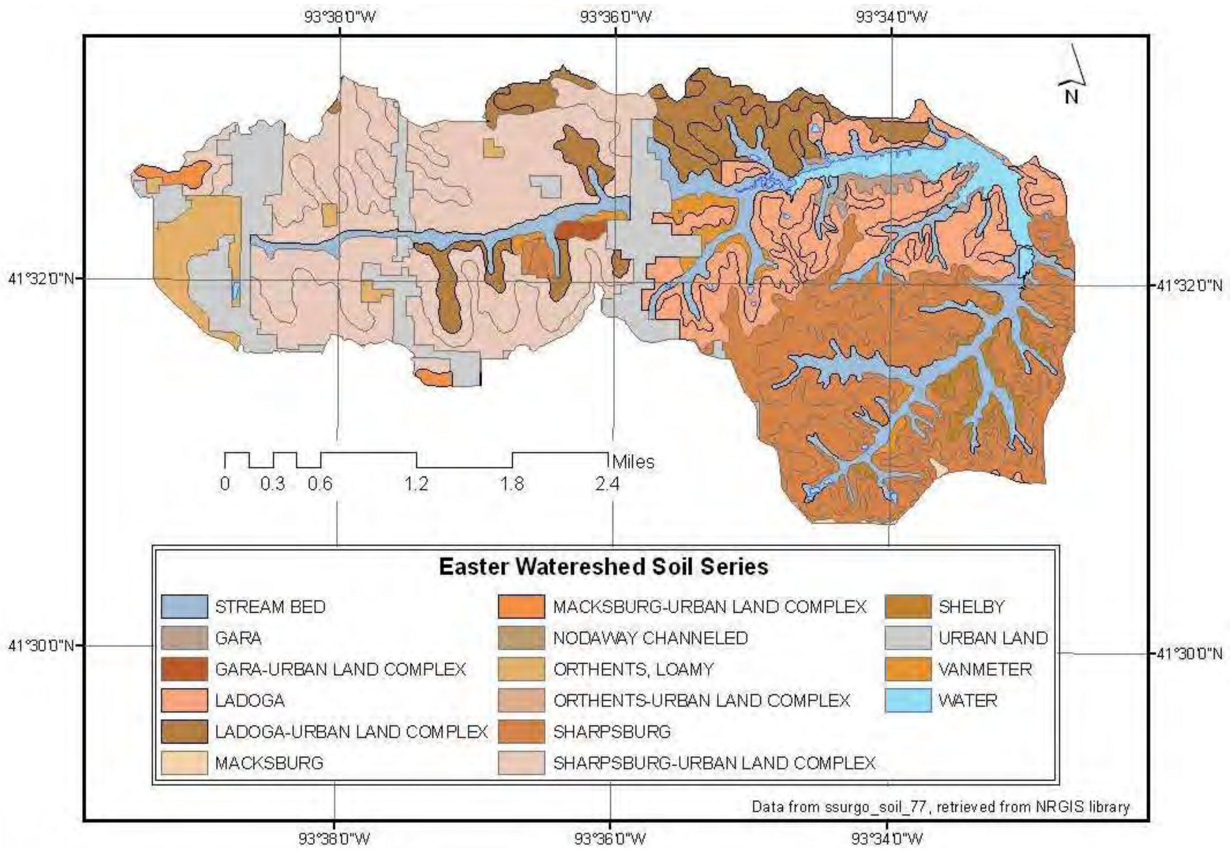
Soils and Topography

The project area is covered by a variety of soil types typical for most areas in Polk County. Due to the existing land uses, the majority of the soils in the watershed are classified as urban soils. Soil types for the area are shown in Figure 3-3: Easter Lake Watershed Soils.

Nearly all of the 17 miles of channel bank along Yeader Creek are composed of fine-grained soils, with the vast majority of banks consisting of loamy soils of the DeForest Formation (Colo-Judson soil series). Some of the tributary banks in both branches consist of loess. In the South Branch, there are about 900 feet of channel with mudstone banks. Many of the banks in Yeader Creek are partially covered with rock and concrete debris that has been dumped over the edge or loosely strewn about, presumably an attempt at bank stabilization by homeowners. Very few reaches – a total of 760 feet of channel – have been protected by constructed rip-rap and a few retaining walls. Easter Lake's streams are shown in Figure 3-4: Easter Lake Watershed and Streams.

Watershed slope is comparatively flat, with most land having slopes < 15%. Most of the land along streams has slopes >15%. Figure 3-5: Easter Lake Watershed Percent (%) Slope shows the project area slopes using a 3 meter Digital Elevation Map for Polk County.

Figure 3-3: Easter Lake Watershed Soils



Data from ssurgo_soil_77, retrieved from NRGIS library

Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

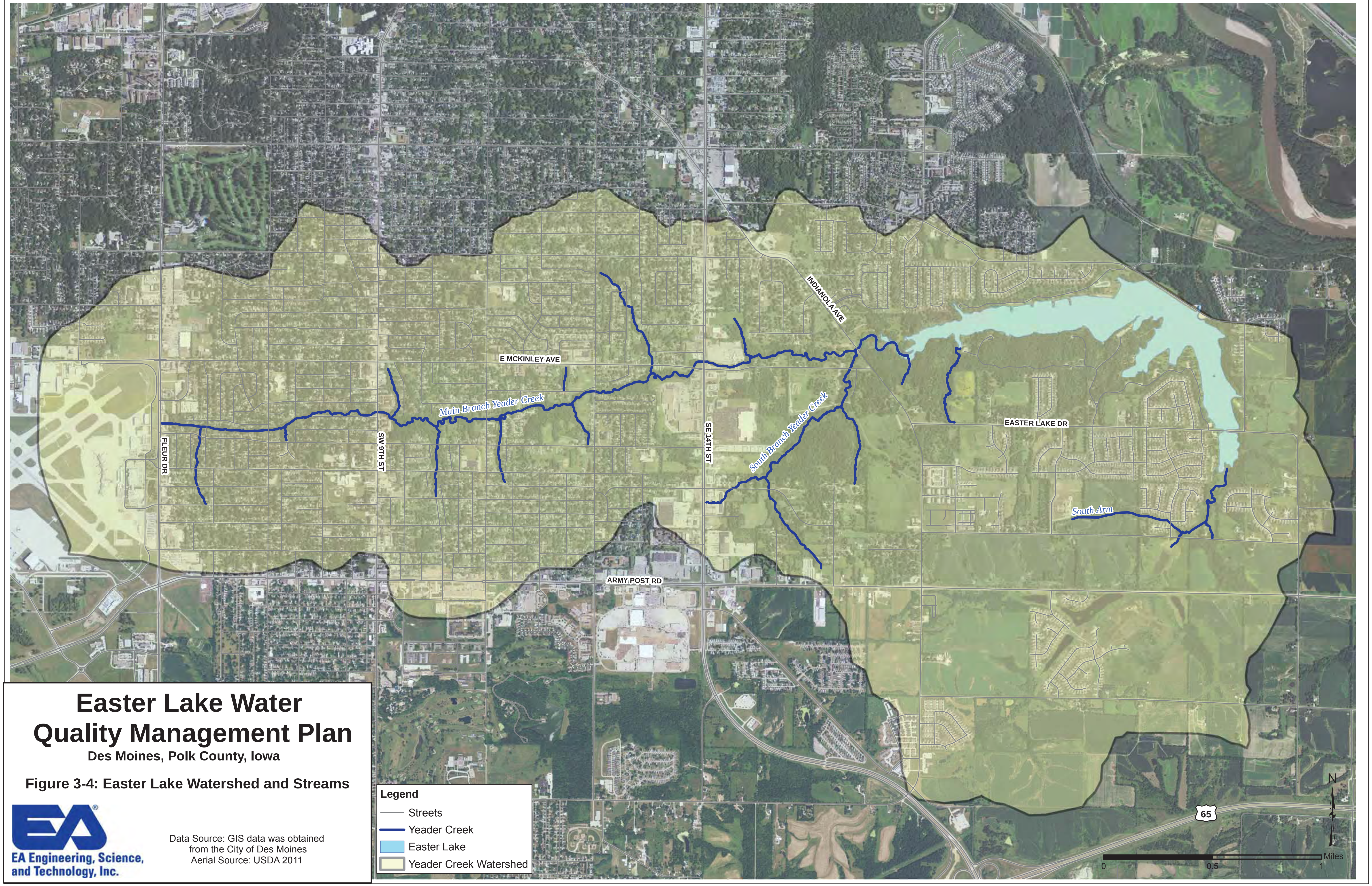


Figure 3-4: Easter Lake Watershed and Streams

Data Source: GIS data was obtained
from the City of Des Moines
Aerial Source: USDA 2011

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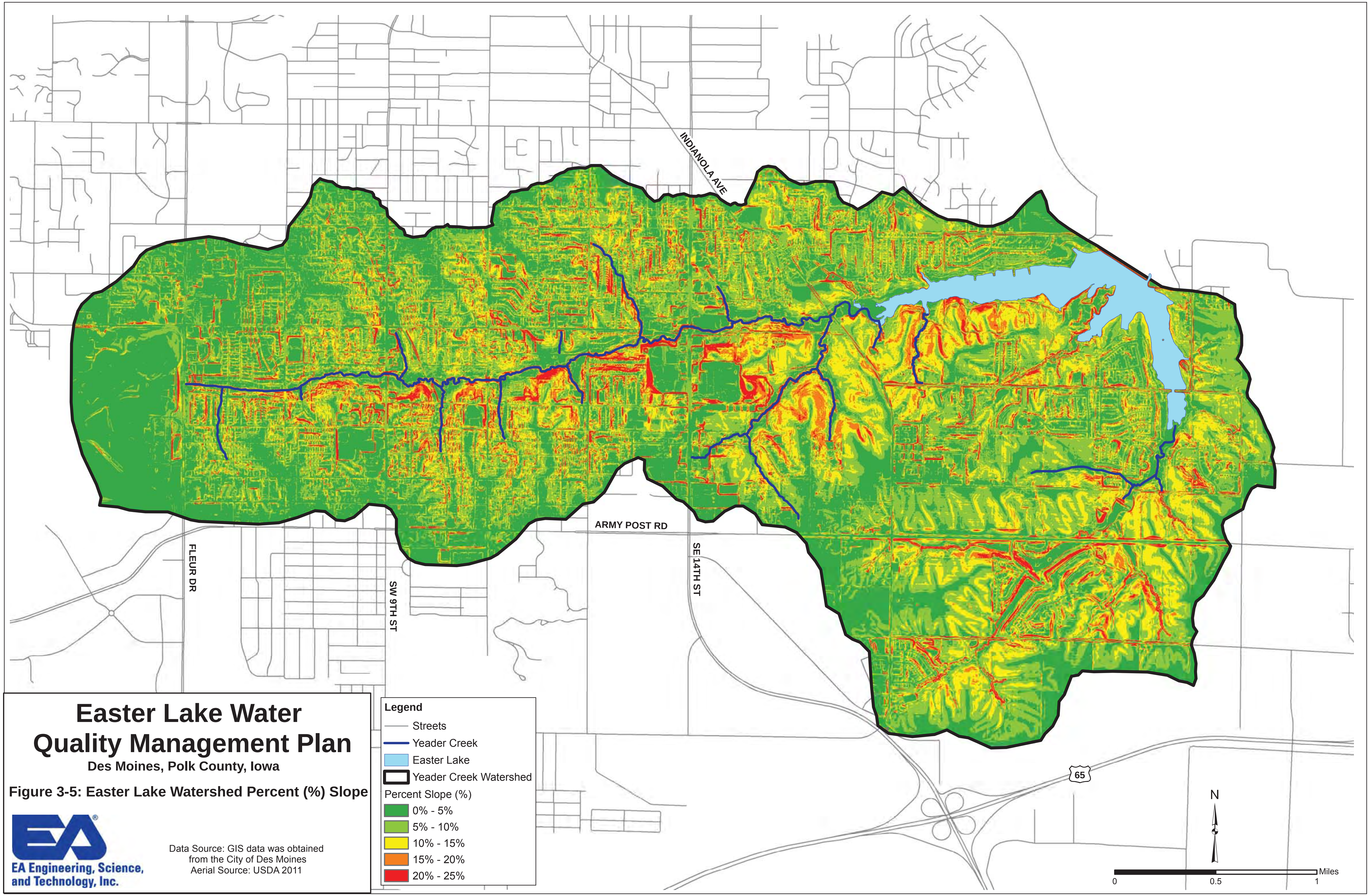
Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 3-5: Easter Lake Watershed Percent (%) Slope



Legend

- Streets
- Yeader Creek
- 🟦 Easter Lake
- ☐ Yeader Creek Watershed

Percent Slope (%)

- 🟩 0% - 5%
- 🟩 5% - 10%
- 🟨 10% - 15%
- 🟧 15% - 20%
- 🟥 20% - 25%

Data Source: GIS data was obtained
from the City of Des Moines
Aerial Source: USDA 2011

EA Engineering, Science,
and Technology, Inc.

3.2.2. Land Use

Land use in the watershed is predominantly urban with residential land composing 17%. Road and commercial industrial land use occupy a combined 27% of the watershed. Row-crops and grazed grasslands occupy 13 and 8% of the watershed. This is according to the 2002 land use and land cover information used in the ISU DF Study. The 2009 land use cover is shown in Figure 3-6: Land Use.

Table 3-1: 2002 Land Use Summary

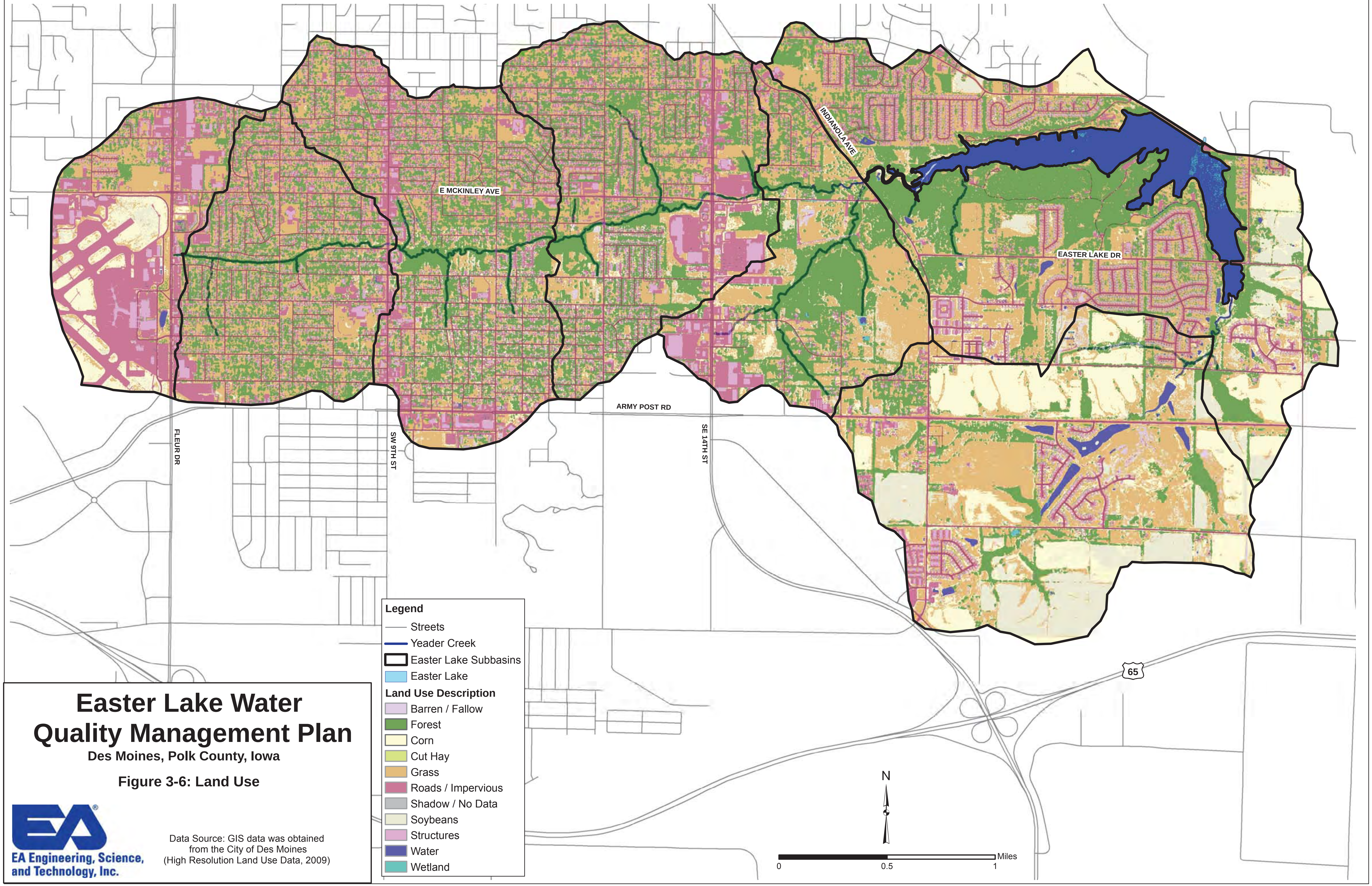
Land use/Land cover	Area (ac)	Percentage
Residential	1133.6	17.4%
Roads	953.5	14.7%
Ungrazed grassland	911.4	14.0%
Forest	891.6	13.7%
Commercial industrial	789.7	12.1%
Grazed grassland	517.6	8.0%
Soybeans	423.4	6.5%
Water	202.7	3.1%
Alfalfa / hay	196.4	3.0%
Corn	190.3	2.9%
Planted grassland	138.8	2.1%
Barren	82.2	1.3%
Wetland	53.8	0.8%
Other row crop	19.8	0.3%

3.2.3. Impervious Surface

The City has information on the quantity of impervious surfaces in the city limits per parcel. This information was used to create Figure 3-7: Impervious Area in Subbasins. The quantity of impervious surface can be an indication of the water quality effects from stormwater runoff. The larger the amount of impervious surface equates to less infiltration of stormwater runoff, more rapid delivery of stormwater to drainage ways, and less vegetation to filter pollutants from stormwater. The subbasin labeled SW 9th has the most impervious totaling 317 acres, or 24% of the total subbasin.

Based on the NRCS study there are 41 total stream crossings in the Yeader Creek watershed include 11 culverts, 15 street bridges, 12 foot bridges, and three fences that cross the stream. About half of the foot-bridges are collapsed and/or partially washed away. The culverts range in diameter from 18 inches to large double-box culverts at NE 14th Street and McKinley Avenue. They are mostly constructed with reinforced concrete, although there are a few corrugated metal pipe culverts as well (NRCS 2011).

An accumulation of sediment was noted at several of the multiple conduit crossings. Primary examples can be viewed at the Yeader Creek crossing with McKinley Avenue and NE 14th Street. The sediment at these locations seems to be fairly well-stabilized with vegetation. As noted later in this report, road crossings in general are not associated with high erosion rates. Stream conduits under road crossings are generally well-protected during installation. Road crossings are usually on an inspection schedule and well maintained (NRCS 2011).



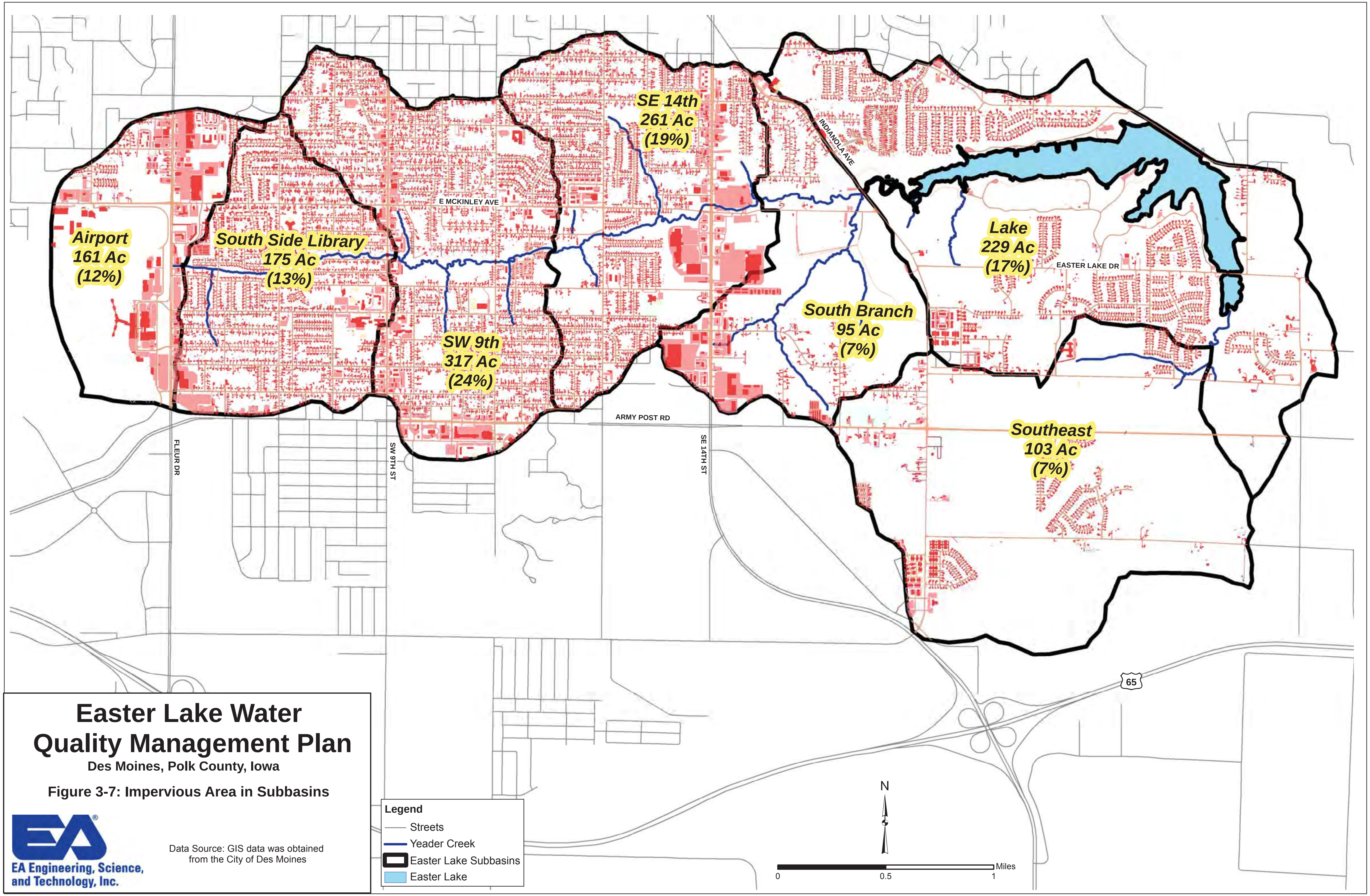
Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 3-6: Land Use

EA Engineering, Science, and Technology, Inc.

Data Source: GIS data was obtained
from the City of Des Moines
(High Resolution Land Use Data, 2009)



Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 3-7: Impervious Area in Subbasins

Data Source: GIS data was obtained from the City of Des Moines

EA Engineering, Science, and Technology, Inc.

3.2.4. Stream Adjacent Land Use

For the watershed as a whole, 43% of all channel banks lie adjacent to residential property, while roughly 26% are adjacent to woodland and 24% to grass/meadow. Six percent of the total channel length is bordered by commercial property and less than 1% by row crop. The predominant type of property on Yeader Creek is residential and includes single-family dwellings, apartment buildings, and backyards. In the South Branch, half of the channel banks are located in woodland. Grass/meadow consists of areas of mowed grass such as parks and large private lots and acreages, as well as small areas of tall grass, pasture, and meadow.

For this study, “riparian buffer” was defined as an area of deep-rooted vegetation paralleling the edge of the stream bank, including native and non-native trees, shrubs, tall grasses, and forbs. Buffers greater than 60 feet wide are found almost exclusively in the woodland land use type.

3.2.5. Storm Drainage System

The storm drainage system largely consists of typical curb and gutter within the urbanized subbasins. The agricultural portion of the watershed contributes sheet flow into surface drainage tributaries in a mostly undeveloped subbasin. Yeader Creek includes a main branch and a south branch, both which drain into Easter Lake. A third channel, referred to the ‘south arm’, also flows into Easter Lake in the southeast portion of the watershed. Figure 3-8: Storm Drain System shows the layout of the current storm drainage system.

The system includes approximately 109 miles of storm drain pipe across the watershed. The majority of the system’s storm drain pipe is in generally good condition and primarily made up of 15- inch (38%), 18-inch (13%), and 24-inch (10%) reinforced concrete pipe. The Easter Lake watershed contains roughly 2,714 storm drain inlets that collect flows discharging to approximately 160 outfalls. The outfalls vary in size from 2-inch foundation drains to an 8 foot wide box culvert.

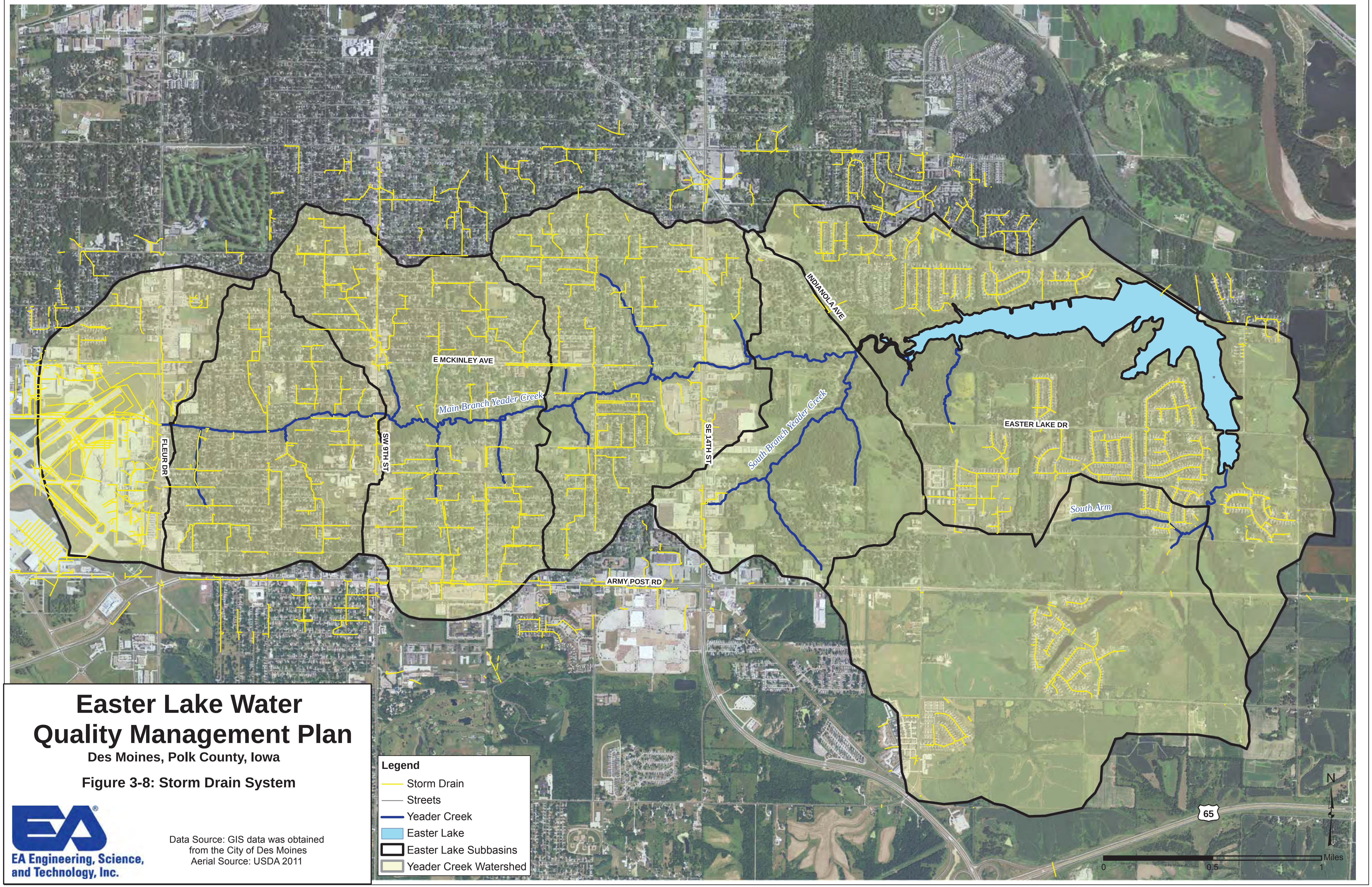
Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 3-8: Storm Drain System

EA Engineering, Science, and Technology, Inc.

Data Source: GIS data was obtained
from the City of Des Moines
Aerial Source: USDA 2011

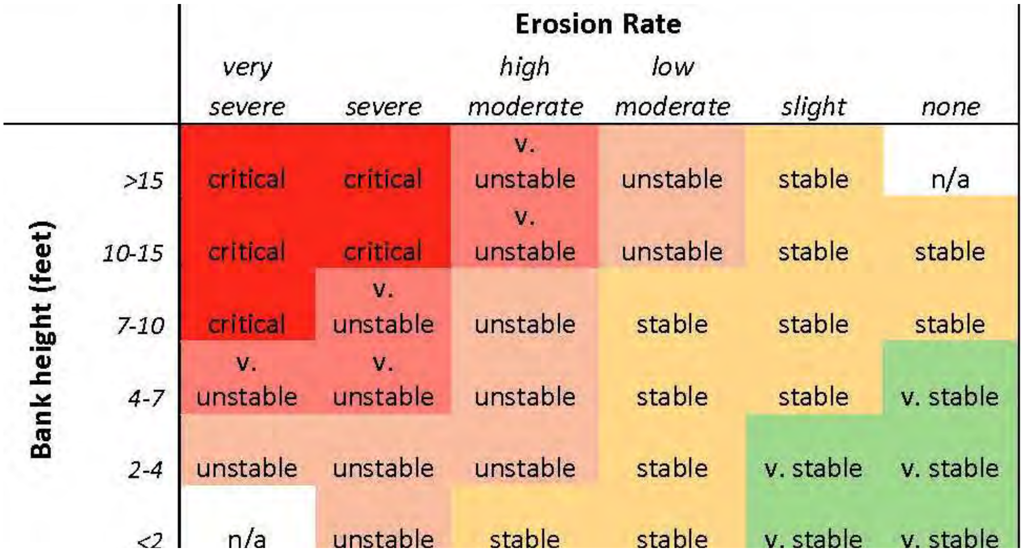


3.2.6. NRCS Stream Assessment

Stream bank erosion rates were assessed by NRCS in 2010. Banks were identified as “high bank” and “low bank.” By distinguishing the banks in this manner—rather than as “right” and “left”— the channel was able to be divided into longer reaches instead of starting a new reach at every meander bend, where the cut bank (which is typically taller) switches sides. Where the banks on both sides were of equal height, the one with a higher erosion rate was designated as the “high bank.”

The height of the channel bank together with its rate of erosion were used to determine the bank stability rating for each of the 220 reaches, as delineated in Table 3-2: Criteria for Assigning Bank Stability Rating. Based on these criteria, 54% of the “high banks” along Yeader Creek are in unstable, very unstable, or critical condition. On the other hand, only 16% of the “low banks” along Yeader Creek are unstable, very unstable, or critical.

Table 3-2: Criteria for Assigning Bank Stability Rating



	Erosion Rate					
Bank height (feet)	*very severe*	*severe*	*high moderate*	*low moderate*	*slight*	*none*
>15	critical	critical	v. unstable	unstable	stable	n/a
10-15	critical	critical	v. unstable	unstable	stable	stable
7-10	critical	v. unstable	unstable	stable	stable	stable
4-7	v. unstable	v. unstable	unstable	stable	stable	v. stable
2-4	unstable	unstable	unstable	stable	v. stable	v. stable
<2	n/a	unstable	stable	stable	v. stable	v. stable

Source: NRCS 2010

The percentages translate to roughly 10,000 feet of very unstable bank and 2,100 feet of critical bank along Yeader Creek.

Nearly half of the critical banks (980 feet) are disproportionately in the South Branch, which has only about one-quarter of the total channel length. All of the very unstable and critical banks in the South Branch occur between Diehl Road and the Soap Box racetrack. Bank heights along this section approach 20 feet as a result of the severe down cutting that has occurred over the past several years. This has led to extensive undermining and collapse of the banks.

Gullies are defined here as ephemeral, actively eroding, concentrated flow paths. Compared to channel bank erosion, gully erosion along Yeader Creek is relatively minor in scope.

The stream assessment data was analyzed to determine the impact of storm sewer discharge on stream banks immediately downstream of the outfalls. All stream reaches that began or ended within 30 feet of outfalls (18 inches in diameter or larger) were included in the subset. The NRCS’s assessment concluded that there was no correlation between higher bank erosion rates and close proximity to outfalls (NRCS 2011).

In addition to proximity to infrastructure, several other watershed and stream characteristics were assessed to determine their potential association with accelerated bank erosion. As expected, one characteristic that is associated with high rates of bank erosion is a high degree of channel sinuosity. More than half of the banks on reaches with well-developed or extreme sinuosity are experiencing high-moderate to very severe erosion, compared to less than one quarter of banks on less sinuous reaches.

Another attribute that shows some correlation with bank erosion was adjacent land use. Fifty-five percent of the very severely eroding banks along Yeader Creek are located adjacent to commercial property, which makes up only 6% of the total adjacent land use. Also, 42% of banks adjacent to commercial property are eroding at a high-moderate rate or worse, compared to 32% of banks in residential property and grass/meadow alike. However, the woodland land use type has the highest percentage (45%) of banks eroding at a high-moderate rate or worse.

According to the NRCS study, most watersheds have a direct correlation between the degree of bank erosion and the width of the riparian buffer occurring along the bank edge. In this urban watershed; however, the reaches with a narrow buffer or no buffer actually exhibit lower rates of bank erosion than other reaches. The most likely explanation for this is that most reaches with narrow or nonexistent buffers occur in residential and/or commercial areas, often along the straighter stream reaches and where landowners have made some effort to protect the banks. Conversely, most reaches with buffers greater than 30 feet wide occur in wooded areas away from homes and businesses, where the channels typically exhibit greater sinuosity and where very little has been done to protect the banks.

3.2.7. Shoreline Assessment by IDNR

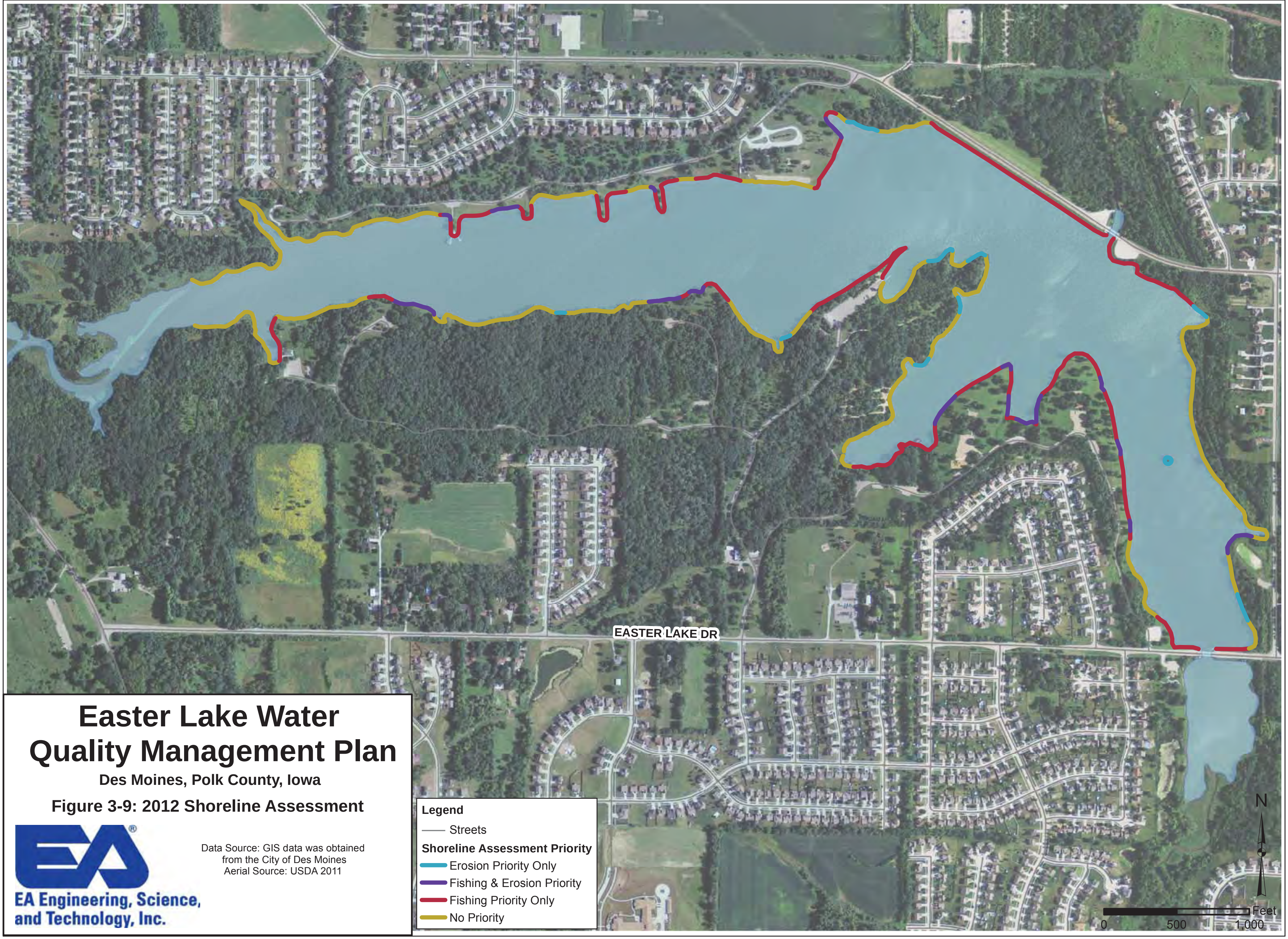
In order to characterize the shoreline for Easter Lake, a set of criteria were developed by EA. These criteria were used by IDNR in August of 2012 to rapidly assess and characterize the shoreline. These criteria are not part of any standard assessment and have been developed by EA. Data collected is intended only to assist EA with identification and prioritization of shoreline lake improvements as part of the Easter Lake Water Quality Management Plan.

Below displays the criteria used during the rapid assessment. IDNR recorded the shoreline priority by the following:

- Erosion Priority Only
- Fishing and Erosion Priority
- Fishing Priority Only
- No Priority

Table 3-3: EA's Shoreline Rapid Assessment Criteria

Rating	Criteria	Description
1	Excellent	Healthy and functional shoreline, no improvements necessary
2	Fair	Somewhat healthy and functional, minor improvements may include: • Creating grass buffer • Wildlife control • Restriction of foot access
3	Poor	Significant degradation present, erosion present, shallow water and algae growth. Improvements necessary might include: • Creating grass buffer / establish vegetation • Wildlife control • Restriction of foot access • Minor Shoreline reshaping • Excavation to deepen lake near shoreline
4	Critical	Severe degradation, erosion present, contributing sediment to lake, limited or no vegetation present, shallow water and algae growth. Improvements might include: • Creating grass buffer / establish vegetation • Wildlife control • Restriction of foot access • Major Shoreline reshaping • Shoreline protection • Excavation to deepen lake near shoreline • Rip-rap, turf reinforcement mat, etc.



Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 3-9: 2012 Shoreline Assessment

Data Source: GIS data was obtained
from the City of Des Moines
Aerial Source: USDA 2011

EA Engineering, Science, and Technology, Inc.

3.3. Historical Management Studies

Easter Lake was constructed in 1967 and has a long history of management activities. The lake has been stocked with sport fish, such as channel catfish in 1971 and walleye beginning in 1981, throughout its history. Grass carp were introduced in 1989 for aquatic weed control. The lake has been treated with chemicals, rotenone in 1974 and Fintrol C in 1978, to control fish populations. Sediment removal operations and retention and sediment pond construction have occurred in the 1990s and 2000s. Management efforts were implemented in 2000 to reduce pollution originating from DSM airport. Table 3-4: Historic Management Practices highlights significant management practices since construction in 1965.

Table 3-4: Historic Management Practices

Date	Description
1965	Easter Lake Construction
1965	Dam and spillway construction begins
1971	Channel catfish stocking
1974	Jetty and ramp construction
1974	Chemical treatment with Rotenone
1974	Lake drained
1975	Shoreline control measures implemented
1978	Chemical treatment with Fintrol C
1979	Water sampling
1981	Walleye stocking begins
1981	Water drawn down by 11 feet
1989	Grass carp introduced
1990	Water sampling
1997	Retention pond construction
2000	Pollution prevention plan for DSM Airport implemented
2001	Sediment pond construction
2002	Fish kill
2004	Sediment pond construction

Source: NRCS 2011

3.4. Plans and Resources

Several recent studies were completed ahead of the development of this Plan. Each is summarized below:

Easter Lake Diagnostic/Feasibility Study

Iowa State University Limnology Laboratory completed this study in 2011 for IDNR. This study focuses on the issues behind the lake's deteriorating water quality. Main elements of the ISU DF study include detailed monitoring data and analysis, suggested solutions for pollution reduction, discussion of actions to reach water quality goals, and cost estimates. This study was used throughout this watershed Plan as a resource. The ISU DF study included a social dynamics assessment completed in January 2011.

Condition of Channels and Storm Sewer Outfalls – Yeader Creek Watershed – Des Moines, Iowa

To support the planning level cost analysis study the NRCS completed an erosion and sediment delivery study of the Main and South Branches of Yeader Creek in August 2010.

Planning Level Cost Analysis of Streambank and Streambed Stabilization – Yeader Creek Watershed – Des Moines, Iowa

The NRCS completed this study for IDNR in October 2011 to provide information on channel erosion as the primary source of sediment to Easter Lake. This study provided site specific cost estimates for grade control sites and streambank erosion.

Total Maximum Daily Loads for Nutrients and Siltation – Easter Lake – Polk County, Iowa

IDNR completed a TMDL for Easter Lake in 2005. The TMDL was used as a resource for pollutant source load identification, pollutant reduction goal establishment, and general resource.

SECTION 4 - WATER QUALITY AND FISHERIES ASSESSMENT

4.1. Introduction

Easter Lake has water quality problems due to high sediment and phosphorus loads originating in its predominantly urban watershed, especially the Yeader Creek watershed. Runoff from the watershed contributes sediment and phosphorus to the water and may lead to higher algal biomass, reduced water transparency, and greater suspended solids concentrations in the near-term. Over time, accumulated sediments in the lake basin can cause a variety of water quality problems that are common to shallow lakes. Eventually, lake basins can fill to the point that they are no longer useful for open-water recreation.

Sediment and phosphorus from watershed runoff continues to impact Easter Lake despite the collective efforts of state and local agency officials, scientists, and concerned citizens to improve lake water quality. In addition, Easter Lake lacks a diverse, balanced, and sustainable aquatic community. Poor water quality continues to impact popular sport fish (e.g., crappie and other panfish) despite extensive fisheries management. Easter Lake falls short in nearly all criteria of Iowa DNR water quality standards. Poor water quality reduces the economic impact of this important natural resource to the community.

This section summarizes the comprehensive assessment of water quality and the existing fishery in Easter Lake. Information in this section is summarized based upon data gathered in ISU's DF study completed in 2011. This section provides information on other impairments other than sedimentation and phosphorus.

4.2. Water Quality Criteria

Water Quality Standards (WQS) establish by EPA and Water Quality Targets (WQT) establish by Iowa are both used to protect and restore surface waters.

4.2.1. Water Quality Standards

WQS were created in agreement with the requirements of the Clean Water Act Section 319. WQS set goals and criteria to protect a given water body from pollutants based on its classification or designated use. Many factors including the physical, chemical, and biological characteristics of the water body are considered when designated uses for a water body are determined. Also taken into consideration are the use and value of the water body for public water supply and other uses such as recreational, agricultural, industrial, and navigational, as well as for protecting fish and wildlife.

Under the State water quality classification system, Easter Lake is designated as Class A1, Class B (LW), and Class HH. These designations indicate the lake is used for primary and secondary recreation (e.g., swimming, boating, and fishing) and that it can support aquatic life. More detailed technical descriptions of individual classifications are provided below:

Surface Water Classification Descriptions For Easter Lake Designated Uses

(Iowa Administrative Code (IAC), 567-61.3(455B)

Class "A1"

> Waters in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreational canoeing.

Class “B (LW)”

> Artificial and natural impoundments with hydraulic retention times and other physical and chemical characteristics suitable to maintain a balanced community normally associated with lake-like conditions.

Class “HH”

> Waters in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

WQT are defined in Iowa Administrative Code (IAC 7/10/02) for a variety of important water quality parameters including temperature, pH, dissolved oxygen, and bacteria for each designated use. These criteria are taken from IAC 61.3(2) and are applicable to all surface waters including general use and designated use waters, at all places and at all times for the uses described in 61.3(1)“a.” of Iowa Code.

- Waters shall be free from substances attributable to point source wastewater discharges that will settle to form sludge deposits.
- Waters shall be free from floating debris, oil, grease, scum, and other floating materials attributable to wastewater discharges or agricultural practices in amounts sufficient to create a nuisance.
- Waters shall be free from materials attributable to wastewater discharges or agricultural practices producing objectionable color, odor, or other aesthetically objectionable conditions.
- Waters shall be free from substances attributable to wastewater discharges or agricultural practices in concentrations or combinations which are acutely toxic to human, animal, or plant life.
- Waters shall be free from substances attributable to wastewater discharges or agricultural practices in quantities which would produce undesirable or nuisance aquatic life.
- The turbidity of the receiving water shall not be increased by more than 25 Nephelometric turbidity units by any point source discharge.
- Acceptable levels of total dissolved solids (TDS) and constituent cations and anions will be established on a site-specific basis. The implementation approach for establishing the site-specific levels may be found in the “Supporting Document for Iowa Water Quality Management Plans,” Chapter IV, July 1976, as revised on June 16, 2004.
- The *Escherichia coli (E. coli)* content of water which enters a sinkhole or losing stream segment, regardless of the water body’s designated use, shall not exceed a Geometric Mean value of 126 organisms/100 ml or a sample maximum value of 235 organisms/100 ml. No new wastewater discharges will be allowed on watercourses which directly or indirectly enter sinkholes or losing stream segments.

4.2.2. Water Quality Targets

Also important to restoring and/protecting surface waters in Iowa are State WQT. WQT for restoration of Iowa lakes were defined in 2006 by State Legislation (HF2782) and make the control of the delivery of phosphorus and sediment from the watershed to a lake mandatory for lake restoration projects utilizing state funding. Water quality targets address water clarity, biota, impairments, and sustainability.

Water Quality Targets

(Defined in 2006 by State Legislation – HF2782)

- **Clarity:** Secchi depth must be at least 4.5 feet, 50% of the time from April to September.
- **Biota:** A diverse, balanced, and sustainable aquatic community must be maintained.
- **Impairment:** Water quality impairments must be eliminated.
- **Sustainability:** The water quality and public use benefit must be sustained for 50 years.

The WQT of increased water clarity to 4.5 feet Secchi depth is important relative to needed reduction in phosphorus loading to reach this goal.

4.2.3. Summary of Water Quality Criteria

The goal of meeting WQT for lake restoration projects is to improve water quality to the point that excellent recreation and biological integrity are restored. To support State of Iowa WQT, restoration needs to consider these additional criteria:

- No agricultural or wastewater discharges causing objectionable or unsafe conditions
- Geometric mean *E. coli* < 126 colonies/100mL or single sample <235 colonies/100mL
- pH not <6.5 or >9.0
- Oxygen not <5.0 mg/L
- Temperature <32°C (90°F)
- Unionized ammonia generally <80 µg/L
- No substances causing odor or health risk from eating fish
- Improved fish habitat and fish communities

The Federal Clean Water Act requires the IDNR to develop a TMDL for waters that have been identified on the state’s 303(d) list as impaired by a pollutant. Easter Lake has been identified as impaired by nutrients and accumulation of sediment. The purpose of these TMDLs for Easter Lake is to calculate the maximum allowable nutrient and sediment loads that the lake can receive and still meet water quality standards (TMDL 2005)

This document consists of TMDLs for nutrients and siltation designed to provide Easter Lake water quality that fully supports its designated uses. Phosphorus, which is related through the Trophic State Index (TSI) to chlorophyll and Secchi depth, is targeted to address the nutrient impairment. Sediment delivery is targeted to address the siltation impairment (TMDL 2005).

4.3. Data Availability and Assessment

The primary sources of data provided in this section are Iowa State University (ISU) and Iowa Department of Natural Resources (IDNR). Data summarization and assessments were conducted by ISU and summarized in the ISU DF study. The reservoir growing season is defined as being from May through September. These are typically the months that produce the greatest pollutant loadings and the poorest water quality conditions in Easter Lake.

4.4. In-Lake Water Quality Summary

In-lake water quality is summarized using the water quality data gathered during the ISU DF study. Historical water quality variables for Easter Lake from 2000 to 2007 data are based on annual summer averages. Table 4-1: In-lake Water Quality Summary includes the calculated average, median, minimum, and maximum values for mixed zone samples collected at four lake monitoring sites (L 001, L 002, L 003, and L 004) from October 2007 to August 2009. TN:TP descriptive statistics cannot be calculated directly from those describing total nitrogen and total phosphorus.

Table 4-1: In-lake Water Quality Summary

Parameter	1979	1990	2000	2001	2002	2003	2004	2005	2006	2007
Secchi disk depth	1.0 m	0.7 m	0.6 m	1.0 m	0.6 m	0.9 m	0.9 m	0.6 m	0.7 m	0.7 m
	3.3 ft	2.3 ft	2.0 ft	3.3 ft	2.0 ft	3.0 ft	3.0 ft	2.0 ft	2.3 ft	2.3 ft
Temperature(°C)	-	-	24.5	25.1	28.0	25.3	23.7	27.0	26.2	26.7
Dissolved oxygen (mg/L)	9.1	-	7.4	12.4	8.3	9.0	10.5	11.8	6.2	8.3
Dissolved oxygen (% saturation)	-	-	89	149	108	111	125	150	76	104
Specific conductivity (µS/cm)	362	-	326	461	417	426	430	381	478	431
Turbidity (NTU)	8	-	29	18	33	20	19	30	20	15
Chlorophyll α (µg/L)	28	44	15	26	57	23	31	126	27	25
Total phosphorus as P (µg L^{-1})	55	101	106	88	76	59	50	74	58	59
SRP as P (µg/L)	-	-	-	-	1	3	3	1	1	1
Total nitrogen as N (mg L^{-1})	0.5	1.6	1.1	1.3	1.0	1.3	1.3	1.4	0.9	0.9
(Phenate) Ammonia nitrogen (NH3 + NH4 +) as N(µg/L)	0	0	-	-	-	-	47	35	53	48
(Phenate) Ammonia nitrogen (NH3) as N (unionized; µg/L)	-	-	-	-	-	-	4.6	2.8	3.7	4.1
Nitrate + Nitrite (NO3 + NO2) as N (mg/L)	0.1	0.0	3.0	0.4	0.1	0.4	0.2	0.2	0.1	0.2
TN:TP ratio (by weight)	-	-	25	15	14	23	25	20	16	16
pH	-	-	7.5	8.2	8.4	8.3	8.4	8.5	8.1	8.3
Silica as Si (mg/L)	-	-	-	3.2	2.6	2.5	4.2	-	-	
Dissolved organic carbon (mg/L)	-	-	-	9.3	7.8	3.8	5.4	4.7	4.1	

Parameter	1979	1990	2000	2001	2002	2003	2004	2005	2006	2007
Inorganic suspended solids (mg/L)	30	7	7	6	6	8	8	8	6	
Volatile suspended solids (mg/L)	-	4	7	11	6	7	12	5	5	
Total suspended solids (mg/L)	41	11	13	16	13	15	20	13	11	
Carlson trophic state index (Secchi)	-	68	60	67	62	62	68	65	64	
Carlson trophic state index (Chl α)	-	57	63	70	61	64	78	63	62	
Carlson trophic state index (TSI)	-	71	69	67	63	61	66	63	63	

4.4.1. Temperature and Stratification

Easter Lake displayed strong thermal stratification during the ISU DF study. The water column began to stratify in June 2008 and July 2009. Autumn overturn occurred in late-August/early-September during 2008. Based on these observations, Easter Lake was classified as dimictic, meaning that the lake mixed twice per year (once in spring and once in autumn), stratified during the summer, and inversely stratified during the winter.

4.4.2. pH and Conductivity

Hydrogen ion concentration was strongly influenced by high decomposition rates during periods of thermal stratification in Easter Lake. The lowest pH values (<7.1) were observed in bottom waters (i.e. hypolimnion) during summer stratification in 2008 and 2009. The highest pH values (>8.7) occurred during late-autumn/early-winter following autumn overturn. The pH values observed in the deep waters of Easter Lake were lower than values commonly seen in Iowa lakes.

Similar to pH, electrical conductivity was influenced by thermal stratification and high decomposition rates during summer stratification. Conductivity values were greatest during the onset of spring mixing and lowest in the upper waters (epilimnion) during summer stratification.

4.4.3. Turbidity and Total Suspended Solids

Organic and inorganic solids that are suspended in the water can create problems for aquatic life as well as decrease the aesthetic qualities of a lake or reservoir. In situ turbidity values were greatest in bottom waters (i.e. hypolimnion) during summer stratification. Turbidity values were generally greater in winter and spring than summer and autumn. Turbidity values were often less than average turbidity values reported from all Iowa lakes from 2000 to 2007 (45 NTU).

High concentrations of total suspended sediments (TSS) and inorganic suspended sediments (ISS) were observed throughout the study. Elevated TSS and ISS concentrations were observed throughout the water column during June 2008 which demonstrated the potential influence of large sediment inflow events on lake water quality. Elevated TSS and ISS concentrations were also observed during late-winter/early-spring of 2009. Lake-wide average TSS and ISS each ranged from 0 to 93 mg/L during completion of the ISU DF Study.

also observed during late-winter/early-spring of 2009. Lake-wide average TSS and ISS each ranged from 0 to 93 mg/L during completion of the ISU DF Study.

Lake-wide average volatile suspended solids (VSS) concentrations averaged 5.5 mg/L (range of 0 to 16 mg/L) during the ISU DF study. High VSS concentrations were observed during the summer of 2008 with peak concentrations (>11 mg/L) resulting from organic matter decomposition in the hypolimnion. Elevated VSS concentrations were also observed during the 2008-2009 winter and likely resulted from decomposition of surface sediment organic matter.

4.4.4. Algae

The production of algae is controlled primarily by water temperature, light availability, and nutrient availability. In addition to degrading aesthetics, dense growths of algae can lead to the depletion of dissolved oxygen. Chlorophyll concentrations are used as an indicator of algal biomass. This test is inclusive of all types of algae. Mixed zone chlorophyll α concentrations averaged 18 µg/L throughout Easter Lake during the ISU DF study with maximum concentrations of 61 µg/L. From 2001 to 2007, annual summer average chlorophyll α concentrations varied from 15 to 126 µg/L (median of 27 µg/L) in the mixed zone. At the primary sampling station, chlorophyll α concentrations peaked in the euphotic zone during autumn overturn (September 2008) following nutrient replenishment in the upper water column from the nutrient-rich bottom waters.

4.4.5. Water Transparency

The transparency of water can limit or promote the production of certain species of algae, fish, and aquatic plants. The depth to which light will penetrate in a lake or reservoir is dependent upon several factors. The two main influences on light penetration are algae and suspended sediment. Water transparency is measured by using a Secchi disk.

Lake-wide average Secchi disk transparency varied from 0.2 to 1.9 m (0.7 to 6.2 ft) and averaged 0.7 m (2.4 ft) during the ISU DF study. Summer average Secchi disk transparency from 2000 to 2007 averaged 0.8 m (2.5 ft) for Easter Lake. This value was lower than the average summer Secchi disk transparency values from 2000 to 2007 for all Iowa lakes (1.2 m; 3.9 ft).

4.4.6. Nutrients

Phosphorus and nitrogen are the two nutrients most critical for the production of algae in lakes and reservoirs. High concentrations of these nutrients can stimulate the production of excessive amounts of algae commonly known as algal blooms. Total phosphorus is comprised of both dissolved phosphorus and particulate phosphorus. Dissolved phosphorus is readily available for uptake by biological organisms while particulate phosphorus must be converted to the dissolved phase before utilization can take place. While total phosphorus indicates the amount of phosphorus that is “potentially available” to biological organisms, the amount of dissolved phosphorus plays a more important role in determining current productivity. Since particulate phosphorus is bound to soil particles, high nutrient concentrations can be associated with high sediment loads and/or high concentrations of suspended sediment.

Lake-wide average total phosphorus (TP) concentrations from the mixed zone averaged 61 µg/L and reached maximum concentrations of 139 µg/L during the ISU DF study. Average TP concentrations were lower than average TP concentrations reported for all Iowa lakes from 2000 to 2007 (110 µg/L), although maximum concentrations were higher. The greatest TP concentrations occurred during the summer of 2008 with concentrations >300 µg/L observed in the hypolimnion. High hypolimnetic concentrations likely resulted from watershed inputs during rain events or decomposition of surface sediment organic matter and internal loading of TP from the sediments. Mixed zone average soluble reactive phosphorus (SRP) concentrations averaged 3 µg/L in Easter Lake and were lowest during summer stratification. SRP concentrations were much less than average concentrations from all Iowa lakes from 2000 to 2007 (16 µg/L) and indicated that much of the phosphorus in Easter Lake was in the particulate state. Similar to TP concentrations, SRP concentrations were greatest in the hypolimnion during summer 2008.

Total nitrogen (TN) and nitrite + nitrate (NO_2 + NO_3) concentrations in the mixed zone averaged 1.0 and 0.3 mg/L throughout the lake during the ISU DF study. NO_2 + NO_3 concentrations in the mixed zone were depleted and approached 0 mg/L during late-summer/early-autumn. These concentrations indicated that nitrogen primarily occurred in the particulate state in Easter Lake. TN concentrations were greatest in the hypolimnion during the summer of 2008 (>1.6 mg/L) whereas NO_2 + NO_3 were greatest during spring overturn in 2008 and decreased throughout the summer growing period.

Lake-wide ammonia + ammonium (NHx) concentrations in the mixed zone averaged 88 mg/L with maximum concentrations reaching 383 mg/L. Seasonally, maximum NHx concentrations (>1,000 mg/L) were observed in the hypolimnion during the summer of 2008. These high concentrations likely resulted from the mineralization of organic matter into ammonia + ammonium during thermal stratification.

During the ISU DF study, lake-wide average total nitrogen-to-total phosphorus (TN:TP) ratios averaged 19 in the mixed zone. Lake-wide average TN:TP ratios in the mixed zone reached a minimum ratio of 6.8, which was slightly less than the Redfield ratio (~7 by mass). TN:TP ratios were greatest during spring overturn and decreased throughout the summer growing period. Lake-wide average TN:TP ratios in the mixed zone were lowest during late-summer/early-autumn in Easter Lake. Decreasing TN:TP ratios in summer likely favored N-fixing Cyanobacteria as the growing season progressed.

Lake-wide average dissolved organic carbon (DOC) concentrations were 4.1 mg/L in the mixed zone. DOC concentrations peaked (>5 mg/L) in the hypolimnion during summer and likely originated from decomposed organic matter. High DOC concentrations occurred during autumn overturn in 2008 and spring overturn in 2009. Elevated DOC concentrations during mixing periods may have been caused by increased primary productivity fueled by increased nutrient availability in the photic zone.

4.4.7. Dissolved Oxygen

For aquatic life, one of the most important constituents dissolved in water is oxygen. Sources of dissolved oxygen to a lake or reservoir include flowing water, transfer from the atmosphere, and production by plants. Oxygen is consumed or removed from these systems through chemical and biological processes causing oxygen demands. The amount of dissolved oxygen water can hold is dependent upon water temperature. Warmer water has less capacity to hold dissolved oxygen than cooler water.

Oxygen concentrations were adequate and typically over-saturated during winter and the two mixing periods in Easter Lake. However, oxygen concentrations were quickly depleted in bottom waters during thermal stratification which resulted in a hypoxic hypolimnion. The lowest oxygen concentrations (<2 mg/L; <20% saturation) occurred during July and August of 2008 and June and July of 2009. Hypoxia was more severe and of longer duration in 2009 compared to 2008.

4.4.8. Metals

The influx of heavy metals can be a concern for reservoirs that have urban watersheds. Contamination from heavy metals can cause both short-term and long-term concerns for human health and aquatic life. Metal and chemical pollutants at Easter Lake were analyzed in water samples in 2001 and 2002 respectively and sediment samples in 2004 as part of the Iowa

Lakes Survey. Metal and chemical pollutants were also analyzed in fish tissue collected at Easter Lake in 2005.

Sediment samples were collected and analyzed for various metals and pesticides during the 2004 Iowa Lakes Survey. Total arsenic (4.6 mg/kg sediment), total barium (210 mg/kg sediment), total chromium (18 mg/kg sediment), total lead (20 mg/kg sediment), total nickel (24 mg/kg sediment), and total zinc (69 mg/kg sediment) concentrations were above quantification limits in sediments. Total antimony, total beryllium, total cadmium, total mercury, total selenium, total silver, and total thallium concentrations were below method quantification limits. Sediment samples were also analyzed for various pollutants including polychlorinated biphenyls, chlorinated hydrocarbon insecticides, organophosphate insecticides, nitrogen containing herbicides, and acid herbicides. All pollutants were below method quantification limits.

Water samples were collected and analyzed for nitrogen-containing herbicides in 2001 and metals in 2002. With the exception of barium (0.10 mg/L), metal concentrations in water were below quantification limits. Several nitrogen-containing herbicides, including Atrazine (0.66 µg/L), Desethyl Atrazine (0.17 µg/L), Dimethenamid (0.27 µg/L), and Metolachlor (0.18 µg/L), were reported above quantification limits.

4.4.9. Bacteria

Microorganisms are ever present in all terrestrial and aquatic ecosystems. While many types are beneficial, functioning as agents for chemical decomposition, as food sources for larger animals, and as essential components for the nutrient cycle, they can also cause illness if ingested by humans. Waste from warm-blooded animals is a source for many types of bacteria found in waterbodies. Fecal coliform and *E. coli* bacteria are used as indicators for more serious types of organisms being present. Unfortunately, most types of bacteria originate from a multitude of sources (sanitary wastewater, stormwater, livestock and wildlife) making it difficult to differentiate between individual contributions.

Water samples were collected from lake sampling sites (October – November 2007, April – November 2008, and March – August 2009), the beach sampling site (November 2007, April – November 2008, and March – August 2009), tributary sampling sites (October – November 2007, February – December 2008, and January – August 2009), and storm drain sampling sites (May – June 2008; and March, June and August 2009) and analyzed for presence and abundance of total coliform and *E. coli* bacteria. A total of 22 samples were collected from each of the lake sites; the beach was sampled 21 times. Tributary sites were sampled 29 times and water samples collected when flow was present. Storm drains were sampled 7 times following rain events and water samples collected when flow was present.

A total of four lake sampling sites were used to collect data for the DF Study. Site L 002 showed the greatest bacterial contamination and had a geometric means of 1,161 and 44 colonies per 100 mL for total coliforms and *E. coli* respectively. Lake sites L 001, L 003, and L 004 were similar to each other and had concentrations at approximately half that of site L 002. The beach site also saw relatively low concentrations with geometric means of 578 and 9 colonies per 100 mL for total coliforms and *E. coli* respectively.

The tributary sites had a wider range of total coliform and *E. coli* concentrations than the lake sites. The lowest total coliform and *E. coli* concentrations were observed at the outflow of the lake (site S1). Tributary sites S5 and S6 had the greatest total coliform concentrations with geometric means >2,200 colonies/100 mL for each site, whereas tributary sites S8, S9, and S10 had the greatest *E. coli* concentrations with geometric means >400 colonies per 100 mL for each site.

Storm drain sampling sites displayed the greatest bacterial concentrations of all sampling sites. Each storm drain site had geometric means of >2,419 colonies/100 mL. *E. coli* concentrations ranged from geometric means of 405 colonies/100 mL (site D2) to 1,303 colonies/100 mL.

4.4.10. Sediment

Sedimentation is the sinking of particles (silt, algae, dead organisms) through the water column and their deposition on the bottom of the lake. In addition to the loss of useable lake area for recreation, sedimentation can affect water temperatures, water transparency, nutrient levels, and habitat. Sediment loading in urban drainages can increase significantly during land development. Decreasing the transport of eroded soil into the lake is critical to restoring Easter Lake to a healthy, functioning system and to slow a return to current degraded lake conditions, post-restoration. Preventative measures in the watershed are therefore necessary to slow the input of new sediments and nutrients into the lake.

Although several management practices addressing this issue have been implemented in the past, the ISU DF study indicated that significant sediment and phosphorus loading reductions using additional watershed management practices are required. Potential engineering modifications to improve water quality downstream could include targeted stream stabilization/protection and dredging existing detention ponds in the Southern watershed. Additionally, public education and participation in watershed management practices to reduce phosphorus runoff from the landscape will be required to achieve the 44% reduction in total phosphorus loads required to meet the State Water Quality Target.

4.4.11. Easter Lake Assessment

At the time of Iowa's 1994 lake classification survey, Easter Lake was classified as eutrophic but water quality conditions had degraded (Bachmann et al. 1994). Total phosphorus and total nitrogen concentrations in the mixed zone averaged 101 mg/L (N=9) and 1.6 mg/L (N=9). Average chlorophyll α concentrations increased to 44 mg/L (N=9). Secchi disk transparency had decreased to 0.7 m (N=3). Fish kills continued to be rare to absent. In addition to the concerns and management practices suggested in the initial lake classification survey, the report also recommended reducing pesticide and fertilizer application in the urban watershed to reduce pollutant concentrations in the lake. Water quality monitoring at Easter Lake continued as part of the Iowa Lakes Survey in 2000-2007.

Water clarity at Easter Lake is below the WQT of 4.5 feet Secchi depth due to water quality degradation. Management options for Easter Lake are relatively limited compared to other Iowa lakes because of the lake's primarily urban watershed. Restoration alternatives considered target both watershed and in-lake processes contributing to poor water quality. Because water quality problems are largely watershed driven, implementing watershed restoration activities prior to executing in-lake restoration activities is recommended.

4.4.12. Fish Tissue

Fish tissue samples were collected by the Iowa DNR at Easter Lake during September 2005. Channel catfish and largemouth bass tissues were analyzed for pesticides and heavy metals by the University of Iowa Hygienic Laboratory. Chlordane and three Chlordane isomers were above quantification limits in channel catfish. DDE, total mercury, and total selenium were above quantification limits in channel catfish and largemouth bass. Largemouth bass had much greater concentrations of total mercury (0.1720 mg/kg) and total selenium (1.6000 mg/kg) compared to channel catfish.

SECTION 5 - POLLUTANT SOURCES AND LOADING ASSESSMENT

5.1. Introduction

Pollutants that contribute to reduced water quality originate from both natural and man-made processes and activities that occur in the watershed and within the lake itself. As stormwater flows across roads, rooftops, and other surfaces, pollutants are picked up and then discharged to streams and lakes. According to the 2005 TMDL, Easter Lake is experiencing excessive nutrients and siltation. Therefore, sediment and phosphorus are the key pollutants of concern. While this Plan focuses on impairments of the 2005 TMDL, other damaging pollutants such as bacteria, nitrogen, and oil and grease can also be addressed by the recommended alternatives.

Both external (watershed) and internal (lake) processes contribute phosphorus and sediment to Easter Lake. External sediment and nutrient sources include urbanized, developing, and agriculture land as well as the stream bed and banks. Internal sediment sources are limited to shoreline erosion while internal phosphorus loading stems from bottom sediment re-suspension and bottom sediment release. This section provides a discussion of these sources and estimates their contribution to the overall load delivered to the lake. Source estimation was accomplished using empirical data, modeling, literature, and information provided by professionals.

Several varying sources of information are available and provide different pollutant load estimates for both phosphorus and sedimentation. Therefore, the pollutant load estimates in the 2005 TMDL have been used throughout this plan to establish pollutant reduction estimates for each project, goal establishment, design criteria, and creation of milestones. Monitoring sediment loads into the lake will be a key factor in verifying or measuring the loading rates throughout the implementation of this plan. This section provides a summary of the information available in existing studies and provides an overview of the varying pollutant sources and load estimates.

One tool used to provide loading information from the agricultural portion of the watershed was the Spreadsheet Tool for Estimating Pollutant Load (STEPL). STEPL is a model approved by the EPA that calculates nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs).

This section provides a summary of information on pollutant sources and estimated loading from the 2011 ISU DF Study, 2005 TMDL, and from the STEPL model. Phosphorus attached to sediment was not included in the STEPL modeling, and was therefore not estimated. Although there were multiple sources for loading information, the 2005 TMDL regulatory rates were used within this plan as the target reduction levels.

The point source wasteload allocations were not factored into nonpoint external loading estimates in the watershed. Pollutant reduction strategies in this plan are non-regulatory and are intended to provide the City with management options above and beyond any existing actions identified in the City’s MS4.

The 2005 TMDL includes discussion on two regulated storm water discharges within the watershed. The lake and most of the lake watershed are located within the corporate limits of the City of Des Moines. As discussed in Section 3, the City is authorized to discharge from a MS4 under Iowa NPDES Permit #77-27-0-07. The Des Moines International Airport also discharges stormwater under a NPDES permit.

The existing annual average total phosphorus load from the regulated sources is estimated to be 4,130 pounds per year with the wasteload allocation for these sources is 2,200 pounds per year. The existing sediment load from the point sources is estimated to be 3,030 tons per year. The sediment wasteload allocation is 2,100 tons per year (TMDL 2005).

5.2. External Pollutant Sources

Pollutant loads from the watershed, also called external loads, are dependent on the land use, human and animal activities, and soil types that are present in the watershed. The primary land uses include large residential areas, industrial/commercial areas, airport parking lots, city streets, park area/open space, and open water areas, such as wetlands, ponds, and the lake itself. External loading was divided up into the following major areas:

- Urbanized
- Developing
- Agriculture
- Channels
- Riparian Areas

5.2.1. Urbanized

Numerous studies conducted since the late 1970s show stormwater runoff from urban areas can be a significant source of pollution. Table 5-1: Common Urban Runoff Pollutant Sources identifies a variety of pollutants and sources often found in urban settings such as solids, nutrients, pathogens, dissolved oxygen demands, metals, and oils. *E. coli* is another common pollutant found in stormwater runoff, and is used to indicate the presence of fecal contamination. As mentioned earlier, because Easter Lake is experiencing excessive nutrients and siltation, the focus is on sediment and phosphorus.

Table 5-1: Common Urban Runoff Pollutant Sources

Pollutant Category Source	Solids	Nutrients	Pathogens	Dissolved Oxygen Demands	Metals	Oils	Synthetic Organics
Soil erosion	X	X		X	X		
Cleared vegetation	X	X		X			
Fertilizers		X	X	X			
Human waste	X	X	X	X			
Animal waste	X	X	X	X			
Vehicle fuels and fluids	X			X	X	X	X
Fuel combustion						X	
Vehicle wear	X			X	X		
Industrial and	X	X		X	X	X	X
Industrial processes	X	X		X	X	X	X
Paints and preservatives					X	X	X
Pesticides				X	X	X	X
Stormwater facilities without proper maintenance	X	X	X	X	X	X	X

Adapted from: Horner, R.R., J.J. Skupien, E.H. Livingston and H.E. Shaver. 1994. Fundamentals of Urban Runoff Management: Technical and Intuitional Issues. Washington, DC: Terrene Institute and EPA.

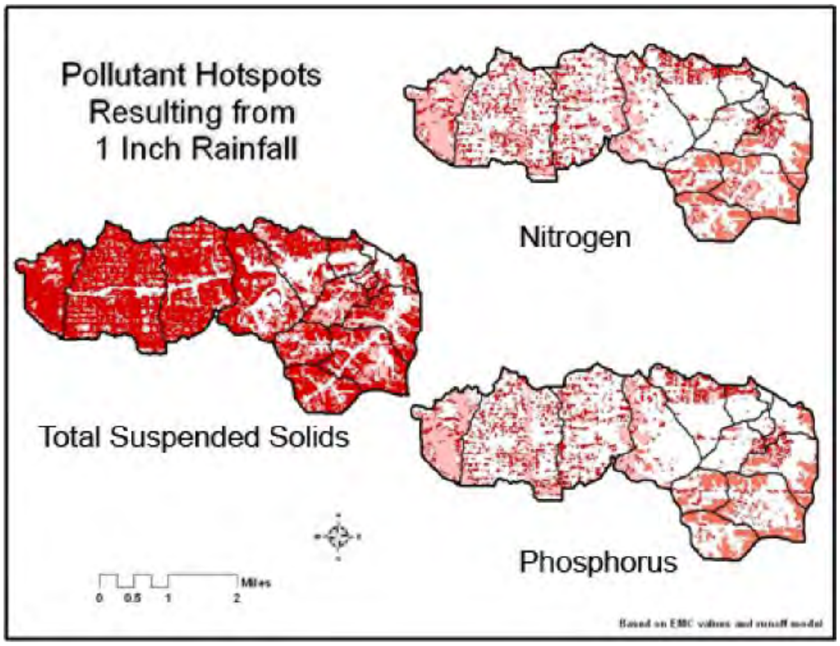
Watershed characteristics were used in the ISU DF study to model pollutant hotspots using event mean concentration (EMC) models. EMC is a metric that estimates the mass of pollutants discharged from certain land use types by runoff in a single storm event. Runoff models indicated that hotspots typically coincided with urban land uses. Roads and residential land use had the greatest runoff rates followed by industrial and commercial land use. Total suspended solids (TSS), phosphorus, and nitrogen hotspots were located throughout the watershed and are shown below in Figure 5-1: Pollutant Hotspots.

Phosphorus hotspots were associated with urban land uses in the watershed and with agricultural land uses in the south of the lake (ISU 2011). Urban land use consists of 44.2 percent of the watershed (2,877 acres). Sediment and phosphorus from within the watershed is grouped into the following sources:

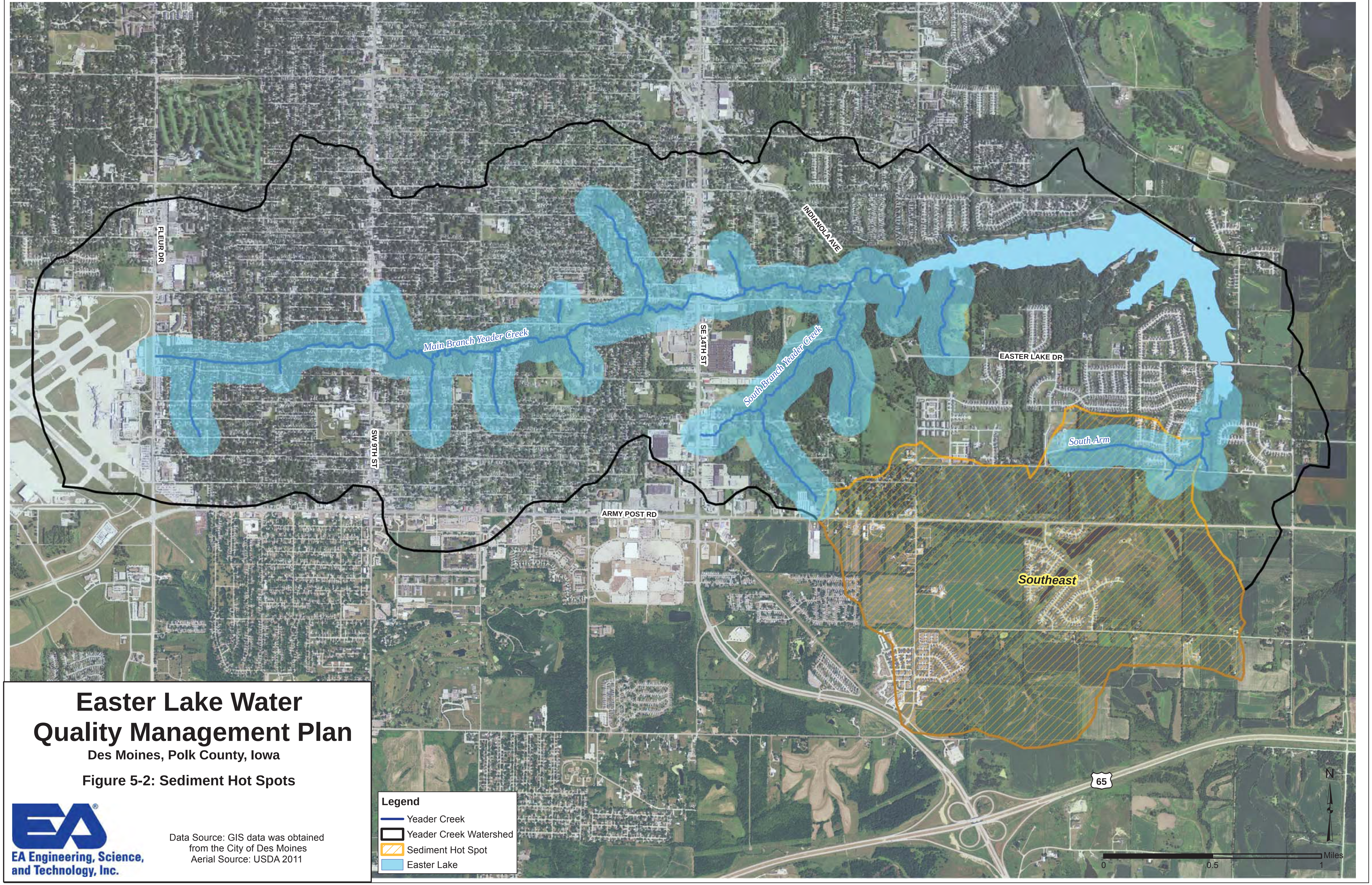
- Pet waste
- Fertilizers
- Yards waste
- Wind-blown sediment (streets and other paved surfaces)
- Riparian Areas

Sedimentation hotspots are shown in Figure 5-2: Sediment Hot Spots. This map displays areas around Yeader Creek, which is considered by the NRCS study as a primary source for sediment to Easter Lake. In addition, the Southeast Subbasin is highlighted. Development and agricultural uses in this area provide increased sediment loads to the lake. The potential for urban development to continue in this part of Des Moines is very good, thus creating a significant potential for very high sediment loads into Easter Lake in the near future. The Southeast Subbasin is listed as a high priority for future management actions later in the plan.

Figure 5-1: Pollutant Hotspots



Source: ISU 2011



Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 5-2: Sediment Hot Spots

EA Engineering, Science, and Technology, Inc.

Data Source: GIS data was obtained
from the City of Des Moines
Aerial Source: USDA 2011

Pet Waste

While pet waste is generally recognized as a source of phosphorus that finds its way into lakes and streams through urban storm systems, it is difficult to find studies relating to its relative impact on water quality. According to the North Carolina Cooperative Extension Service dog manure is approximately 10% phosphate. In a study conducted to evaluate the impacts of various urban sources of nutrients on water quality of Four Mile Run near Washington, D.C, the Environmental Services Division of the Northern Virginia Regional Commission estimated that a population of 11,400 dogs in the area generated 5,000 pounds of solid waste every day or 1,000 tons per year over a 20 square mile area. Assuming the waste was 15% dry matter, by using the above information from North Carolina and Virginia, it can be calculated that the average dog is responsible for approximately 2.6 pounds of phosphate per year. Where the animal “deposits” his annual phosphorus contribution is of significant importance to the water quality of Easter Lake. Proper pet sanitation must not be overlooked when seeking means to reduce phosphorus contributions from urban runoff. In watersheds with phosphorus fertilizer restrictions, pet waste was the main source of phosphorus to lawns (ISU 2011)

Proper disposal of pet waste can help reduce nutrient and bacteria loading to receiving streams. Based on several different scenarios, pets contribute 23-33% of phosphorus inputs to household budgets. Estimations for the amount of pet waste generated in the Easter Lake Watershed are below.

1. Estimates on the number of dogs in the watershed were based on the number of registered pets in zip codes 50315 and 50320, which encompass an area slightly larger than the watershed boundary. It was estimated that 8,357 dogs are housed in these two zip codes.
2. The amount of waste generated per dog was taken from literature provided on the following web site: www.rosehulman.edu/hugginjs/population.htm. The average waste generated by each dog per day was estimated at about 2 lbs. For the calculations 1 pound per day for dogs was used.
3. Based on 8,357 dogs at 1 pound per day for 365 days, the amount generated was 3,050,300 pounds, or approximately 1,525 tons, annually. This is an estimate of the quantity of waste produced in the watershed, not an estimate of what is delivered to the lake.
4. Assuming the pet waste is 15% dry matter and contains 10% phosphorus, approximately 45,750 pounds or 23 tons annually of phosphorus are generated from dogs within these two zip codes.

In addition to pet waste, other urban animals including birds, especially Canada geese, raccoons, deer, turkey, etc. can also contribute to the phosphorus loading. For the purposes of this plan, these loads were not calculated, but can be an important source, especially due to proximity to the lake shores.

Nutrient-Rich Fertilizers

Lawns are an important source of nutrients to receiving waters. Lawns have been identified as the largest source of total and dissolved phosphorus transported to lakes via urban runoff. Therefore, BMPs regarding lawn maintenance, such as fertilizer application, watering, and removing yard waste, are critical to reducing nutrient loading to receiving waters in urban watersheds.

Fertilizer management practices and policies can reduce nitrogen and phosphorus in stormwater runoff. Several studies have documented decreased phosphorus loading in watersheds following municipal policies restricting application of phosphorus-bearing fertilizers. These studies have predicted 25-50% phosphorus loading reductions to stormwater within years of fertilizer restrictions. However, phosphorus losses from lawns typically varied from <1 to 18% of fertilizer application rates. BMPs could include the following: 1) restricting application of phosphorus containing fertilizers, 2) applying phosphorus fertilizers when needed based on soil test results, 3) restricting phosphorus fertilizer applications before storms, 4) water after phosphorus fertilizer application to accelerate dissolution into soils, 5) ban fertilizer application on impervious surfaces, and 6) application of slow-release nitrogen fertilizers only (ISU 2011)

Do to the difficulty of estimating the usage of phosphorus containing fertilizer across the watershed, the phosphorus loading rate associated with fertilizer was not calculated.

Yard Waste

Removing yard waste, including lawn clippings and leaves, can also reduce phosphorus loading from lawns. Waschbusch et al. (1999) found that >25% of total phosphorus on lawns was associated with yard waste. Lawn clipping removal can export 20-75% of fertilizer input from watersheds and remove 2-13 pounds of phosphorus per acre per year in temperate climates. Leaves can also contribute significant amounts of phosphorus to urban runoff (Dorney 1986). Daniels et al. (2010) stated that preventing losses of lawn clippings and fertilizers from impervious surfaces is the single-most important practice for reducing short-term nutrient runoff (ISU 2011).

It is difficult to estimate the effect yard waste has on water quality. Because of this, the phosphorus loading rate associated with yard waste was not calculated.

Paved surfaces

Concrete, asphalt, and other paved surfaces collect many pollutants overtime. Rain events wash these pollutants to the nearest storm drainage structure and stream. If left untreated, these flows can have concentrated levels of nutrients and sediment. In a hypothetical city, street runoff following a storm contained 4,000× more solids, 1,000 × more bacteria, 150× more phosphorus, and 40× more nitrogen than secondary plant effluent. In 12 US cities, street surfaces contained 1,400 pounds per curb mile of solids, 99×10^9 pounds per curb mile of total coliforms, 1.1 pounds per curb mile of phosphorus, and 2.2 pounds per curb mile of nitrogen (ISU 2011)

It is difficult to determine how quickly sediment and other pollutants accumulate on paved surfaces, and also how effective rain events are at washing these pollutants into the storm drainage system. Because of these uncertainties, the sediment and phosphorus loading rates were not calculated. The loading rates could be reduced by “disconnecting” them from the storm drainage system. By allowing these areas to be naturally filtered through grass or other BMPs, the amount of nutrients and sediment can be reduced.

Street sweeping can help reduce pollutant loading from streets to receiving waters. In 12 US cities, street surfaces contained 1,400 pounds per curb mile of solids, 99×10^9 pounds per curb mile of total coliforms, and 1.1 pounds per curb mile of phosphorus. Removal efficiencies for street sweeping operations depend on sweeper types and sweeping frequency. Mechanical sweepers removed 14-55% of total solids and 9-40% of total phosphorus when operated at weekly intervals. Vacuum-assisted sweepers increased removal efficiencies to 15-98% of total solids and 14-74% of total phosphorus. Simulated street sweeper removal efficiencies increased from 25 to 80% for suspended solids, 5 to 50% for total phosphorus, and 5 to 50% for fecal coliform bacteria when changing from mechanical sweepers to dry vacuum sweepers. When swept daily, load removals increased to 20% for suspended solids, 7% for total phosphorus, and 4% for fecal coliform bacteria at a removal efficiency of 76 (ISU 2011).

Although street sweeping can be cost-effective, this usually refers to gross pollutants captured, leaving nutrients and finer particles on the pavement to wash off in the next rain event. One study suggests that street sweeping may increase contaminant runoff potential by mobilizing fine particles. Another disability to street sweeping is performance. A single parked car results in three to four car lengths left uncleaned. In addition, it is difficult to evaluate the effectiveness of street sweeping based on captured sediment and trash (ISU 2011).

Total Loading Rates for Urbanized Areas

The model STEPL was used to approximate loading rates for sediment and phosphorus due to the many difficulties associated with estimating these rates within urban land uses.

According to STEPL, approximately 0.14 tons per acre per year of sediment is transported from urban areas. With 2,877 acres of urban area, approximately 404 tons of sediment is produced.

STEPL also shows that 0.95 pounds per acre per year of phosphorus is transported from urban areas. With 2,877 acres of urban area, approximately 2,743 pounds of phosphorus is produced.

5.2.2. Agriculture Land (Cropland)

With the bulk of the Southeast subbasin in some form of agricultural production, the majority of these loads most likely stem from row crops. Soil erosion rates can be highly variable given soil types, land slopes, land management, tilling practices, and rainfall intensity/duration. Heavy spring rains when vegetation is lacking produce higher sediment and nutrient loads than when crop canopy has been established. Phosphorus loading tends to increase as sediment loads increase, however, fertilizer amounts, timing of application, and proximity to drainage ways can all significantly influence phosphorus loss from fields.

The southeast area of the watershed was surveyed in June of 2012 by IDNR in order to update the amount of cropland within the watershed. This survey resulted in approximately 1,498 acres being classified as cropland. Using this updated cropland acreage; STEPL was used to calculate the loading rate for sediment and phosphorus. It was assumed that once sediment and phosphorus left the field, it was delivered to the lake.

Eight existing detention ponds, along with three proposed detention ponds are shown in the southeast area of the watershed on Figure 5-3: Southeast Detention Basins. Detention ponds are useful for intercepting materials originating from upland sources and traveling via streams. Detention ponds have been shown to reduce phosphorus loading from urban watersheds. Their phosphorus removal efficiencies can be increased greatly by planting aquatic vegetation during construction. Detention ponds were previously constructed from 1998 to 2005. Currently, 8 detention ponds varying in surface area from 0.59 – 8.71 acres are located in the Southern watershed. Although these ponds appear to be functioning, sediment and phosphorus removal efficiencies could be improved by dredging (ISU 2011).

The existing ponds were used to provide an additional estimate on the sedimentation rate by the cropland nearby. Table 5-2: Summary of Detention Pond Sedimentation Rates summarizes information provided on the existing detention ponds. According to the estimated rates, the surrounding cropland produces sediment at a rate of 3,094 tons/year.

Table 5-2: Summary of Detention Pond Sedimentation Rates

Structure ID No.	Year Constructed	Estimated Sedimentation Volume (Cu. Yd.)	Sedimentation Rate (tons/year)
1	2005	643	87
3	1998	10,220	694
4	1998	3,666	249
5	1998	14,118	958
8	1998	5,846	397
9	2005	3,260	443
9a	2005	295	40
10	2005	1,667	226
		Total	**3,094**

Source: EA 2012

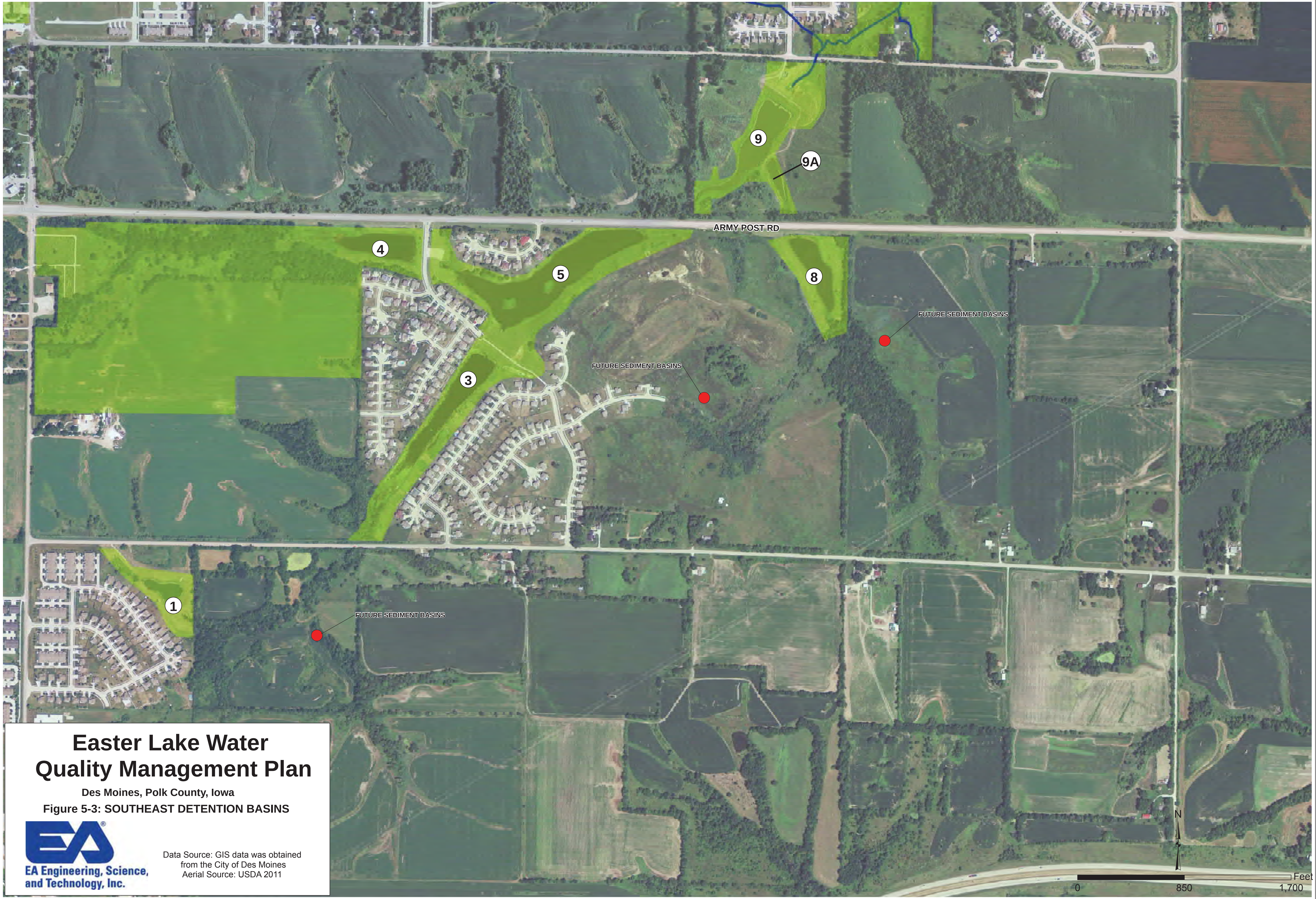
According to STEPL, approximately 1.99 tons per acre of sediment and 2.93 pounds per acre of phosphorus are produced by cropland annually. With 1,498 acres of cropland in this subbasin, total annual sediment and phosphorus loads produced were estimated to be 775 tons and 1,683 pounds respectively.

5.2.3. Developing

A majority of the agricultural ground is owned by developers and is anticipated to be developed in the near future. Significant residential and commercial development will increase urban storm water contributions in the watershed. Also, construction activities related to urban development have the potential to increase external sediment loads. Poor implementation and enforcement of erosion control measures at development sites can greatly increase the amount of sediment loading from developing sites beyond current or average conditions. Established and maintained storm water controls are expected to significantly reduce both temporary construction-related erosion and long-term future sediment and phosphorus delivery to the lake. (2005 TMDL)

In order to estimate the loading rates of sediment and phosphorus from the undeveloped portion of the watershed in the southeast subbasin, STEPL was run to provide a scenario showing conditions during urban development. This developing cropland was assumed to be bare soil, and modeled as such, with no BMPs to show the worst case scenario.

According to STEPL, approximately 13.30 tons/ac of sediment and 16.4 pounds per acre of phosphorus are produced by developing land annually. With 1,498 acres of potential development area in the southeast subbasin, total annual sediment and phosphorus loads were estimated to be 19,900 tons and 12.3 tons respectively. This results in a significant increase when compared to the cropland. Implementing the proper storm water controls is a major factor in controlling sediment transport from developing areas. This information emphasizes the importance of stormwater management in the southeast subbasin when development activities continue.



Easter Lake Water Quality Management Plan

Des Moines, Polk County, Iowa

Figure 5-3: SOUTHEAST DETENTION BASINS

EA Engineering, Science, and Technology, Inc.

Data Source: GIS data was obtained
from the City of Des Moines
Aerial Source: USDA 2011

5.2.4. Channel erosion

Channel erosion is believed to be significant based on observed stream bank conditions and sediment deposition in the upper section of the lake. The Yeader Creek Erosion and Sediment Delivery Study provided estimates for sediment loading rates for erosion conditions in 2011. Assuming a sediment delivery rate of 95%, channel bank erosion is contributing roughly 3,000 tons of sediment from the Main Branch and roughly 1,000 tons of sediment from the South Branch to Easter Lake each year. Gully erosion is minor, contributing less than 150 tons of sediment to the lake each year. In all, 4,150 tons per year of sediment from channel erosion is generated. While the primary load from channel erosion is sediment, phosphorus can also be included.

5.2.5. Riparian Area (Woodland Areas)

Riparian areas are currently contributing an abnormal amount of sediment to Easter Lake due to water quality issues deriving from the presence of invasive species such as honeysuckle. During the non-growing season the understory of the riparian woodlands around Easter Lake and the lower portion of Yeader Creek, are vulnerable to erosion and runoff due to a lack of ground cover. It is difficult to estimate the effect the riparian area has on water quality. Because of this, the sediment and phosphorus loading rates associated with the riparian areas was not calculated. Riparian areas also contribute bacteria due to the presence of wildlife.

According to STEPL, approximately 0.04 tons/ac of sediment and 0.14 pounds per acre of phosphorus are transported to Easter Lake annually. With 891 acres of woodland area in this subbasin, total annual sediment and phosphorus loads to Easter Lake were estimated to be 36 tons and 125 pounds respectively.

EA estimated the pollutant reduction from removing bush honeysuckle and re-establishing native vegetation using the universal soil loss equation (USLE) and an estimated phosphorus load on the creek per ton of soil. A silty clay loam soil type, an average ground slope of 5 percent, and an average flow length of 400 feet to the creek were assumed in the USLE calculations. Based on the USLE and the stated assumptions, annual soil loss will be reduced from 2.4 tons/ac/year to 0.7 tons/ac/year by removing bush honeysuckle and re-establishing native vegetation. The phosphorus that the soil contributes to creek is estimated to be 0.08 pounds of phosphorus per ton of soil. Using this estimate, the phosphorus load will be reduced from 0.2 lbs/ac/year to 0.06 lbs/ac/year by removing bush honeysuckle and re-establishing native vegetation.

5.3. Internal Pollutant Sources

Pollutant loads from within the lake are categorized as internal loads. Internal pollutant loads can result from the re-suspension of lake-bottom sediment, decay of dead organisms such as fish and aquatic plants, and from the shoreline. Sediment re-suspension occurs naturally in lakes due to wind and wave action, but can be increased due to other factors, such as power boating, jet skis, and bottom feeding fish (e.g., carp and bullhead). Internal loading was divided up into the following major sources:

- Internal lake phosphorus loading
- Shoreline
- Lake bottom re-suspension

5.3.1. Internal Lake Phosphorus Loading

The release of phosphorus from bottom sediment is a complicated process that varies significantly from year to year. An estimation of internal phosphorus loads in Easter Lake was performed by LakeTech Inc. using two methods. Both methods relied on water quality data collected during 2008 and 2009 as part of the ISU DF study. First, internal phosphorus contributions under stratified conditions were determined from epilimnetic & hypolimnetic phosphorus concentrations. Loads were calculated using hypolimnetic volumes determined from thermal stratification depths and bathymetric data. Secondly, an internal phosphorus release rate of 3 mg P/m2/day, specific for Easter Lake, was applied to the hypolimnetic surface area (LakeTech, 2012). Both methodologies produced comparable results given the natural variation in internal loading. However, neither method accounted for phosphorus release from oxidized bottom sediment or re-suspended sediment, therefore making the estimates conservative.

The estimated average summer stratified load calculated from water quality data for 2008 and 2009 was 325 and 45 pounds respectively. Calculations for 2008 and 2009 using release rates measured on Easter Lake sediments produced phosphorus loads of 256 and 132 pounds respectively. Based on Iowa State University's average annual external phosphorus loading estimate of 3,920 pounds per year, internal loads comprised anywhere from one percent of the total load in 2009 to eight percent of the total load in 2008. The median value (291 pounds per year) for worse-case case conditions (2008) was used.

While the internal load comprised less than 10 percent of the total annual load to Easter Lake, the timing of that load can play a critical role in algal production. Internal loads in Easter Lake are generated through the summer and late summer months when rainfall and runoff is less. During dry weather periods, internal loads can become the primary phosphorus source for the lake, thus being the driver behind algal production. In addition to load timing, nutrient release from bottom sediments is in the dissolved form, which is readily useable by algae (LakeTech 2012).

5.3.2. Shoreline

Shoreline erosion in the main lake has contributed to the loss of surface acreage, depth, and habitat at Easter Lake (ISU 2011). The shoreline is 100% publically owned and currently contributes to sedimentation in certain areas. Shoreline erosion is compounded by recreational use and foot traffic, waterfowl, and a lack of aquatic vegetation.

The sedimentation basins in the Southeast subbasin are also publically owned, however in certain areas these public setbacks have been managed by private residents. These shorelines also currently contribute to sediment loads due to insufficient management, a lack of vegetation, and waterfowl use. Privately owned parcels adjacent to the public setbacks generally have manicured lawns up to the basin's edge. These create two problems: increased runoff and phosphorus to the lake; provide sites for waterfowl to inhabit near the water's edge. Reducing the access to the waterfront would both reduce runoff as well as pollutant loading directly into the lake.

The amount of sediment and phosphorus transported to the lake from the Easter Lake shorelines and detention structure shorelines was not estimated.

5.3.3. Lake Bottom Re-suspension

Among the potential mechanisms of internal loading is re-suspension of bottom sediments from bottom feeding rough fish such as carp. The presence of undesirable fish species has nearly eliminated vegetation growth and likely increased turbidity and nutrient re-suspension.

Wind-driven waves and currents, and boat propellers are another potential mechanism for internal loading. Intensification of activities such as power boating and jet skis can add to lake turbulence and increase re-suspension of settled solids and internal phosphorus loading. Significant internal loading may also occur during turnover events when accumulated phosphorus-laden sediment is disturbed (2005 TMDL).

Easter Lake has also accumulated large amounts of sediment at the lake bottom over time. This increases the ability for phosphorus to mix into the water column. It is difficult to estimate the effect that lake bottom re-suspension has on water quality. Because of this, the sediment and phosphorus loading rates associated with lake bottom re-suspension was not calculated.

In order to limit re-suspension of bottom sediments, nutrients, and limit shoreline erosion, Easter Lake should continue to be managed as a no-wake lake.

5.4. Load Reduction Targets

Table 5-3: External and Internal Loads of Sediment and Phosphorus summarize the external and internal loads for sediment and phosphorus. Although there were multiple sources for loading information, the 2005 TMDL regulatory rates were used within this plan as the target reduction levels.

It should be stressed that the goal of this plan is to meet a desired state of water quality in the lake. While the loadings and loading reductions provide the numeric path to reach this desired state, there are no guarantees that the desired state will be achieved. As with any long-term plan, an extensive monitoring program is needed to evaluate progress in meeting goals. If goals are not met in a reasonable period of time, adjustments should be made to the plan.

These goals will be met by implementing a diverse set of non-structural (programmatic) and structural BMPs. These BMPs and their reduction levels are discussed in Section 6.

Table 5-3: External and Internal Loads of Sediment and Phosphorus (2005 TMDL)

Pollutant Source	External	Internal	Total Load	Load Reduction	% Load Reduction
Sediment (tons/year)	7,000	NC	7,000	1,600	23%
Phosphorus (pounds/year)	4,250	291	4,540	1,710	40%

***NC=Not Calculated**

5.4.1. Sediment

Since sediment loads are the result of periodic intensive and/or high volume precipitation events they are highly variable and hard to estimate. Additionally, non-point source controls are typically designed for smaller events. While the sediment TMDL is expressed as an annual average load, the actual load for any given year will most like fall below or exceed the annual average target. Two sets of bathymetric data were used to show how variable the average external loading rates to Easter Lake can be:

- Easter Lake bathymetric data from 1967 to 2003: 19,800 tons/yr. This estimate was reported in the 2005 TMDL, and does not include the two dredging events and is therefore a conservative estimate. This estimate is not adjusted based on the build out of the watershed during this time period.
- Easter Lake bathymetric data from 2003 to 2012: 21,807 tons/yr. This estimate does not include the dredging event during this time period and is therefore a conservative estimate. This estimate includes the large deposition of sediment from development in the southeast subbasin.

A sub-division located in the southeast subbasin started construction between 2001 and 2002. This sub-division was abandoned by the contractor and resulted in a large amount of sediment to be transported into detention basins and Easter Lake in the following years. Because of this and differences in surveying methods and accuracy, the numbers for the sedimentation rate for Easter Lake are higher than expected.

Based on the 2005 TMDL, the current external and internal sediment load is approximately 7,000 tons/yr. Of this load, 3,900 tons/year (56%) resulted from channel erosion and 3,100 tons/year (44%) originates from the watershed. In order to meet the TMDL, the total sediment load would need to be reduced to 5,400 tons/year or by 23%. The targeted load of 5,400 tons/year will result less than one third of the original lake volume within a 100-year design life.

5.4.2. Phosphorus

As with sediment loads, external phosphorus loads are also storm event, driven making them highly variable. As opposed to sediment, nutrients in urban runoff can be in the dissolved phase making them more difficult to control and quantify. The total external phosphorus load to Easter Lake was estimated at 3,920 pounds per year during the ISU DF study. This TP load is similar to that reported in the 2005 TMDL (4,250 pounds per year) as calculated in 2004 by Iowa DNR.

According to the TMDL, the current phosphorus rate must be reduced to 2,540 pounds per year. The nutrient TMDL was developed based on the annual phosphorus loading that will result in attainment of TSI targets for the growing season (May through September). To meet this goal, an average annual load reduction of 1,710 pounds per year, or 40% is required.

SECTION 6 - MANAGEMENT PRACTICES

6.1. Introduction and Purpose

Over the last three years Easter Lake, Yeader Creek, and its tributaries has been studied to determine pollutant sources, quantify source loadings, and evaluate loading reduction strategies for targeted pollutants. Now with the problems identified, the focus turns to management practices that will be most effective in reducing the pollutant load and increasing water quality, as well as actions for renovating Easter Lake.

As outlined in Section 5 – Pollutant Sources and Loading Assessment, sediment and phosphorus are the primary pollutants of concern for Easter Lake based upon the 2005 TMDL. Projects and programs that reduce sediment and phosphorus will also lower other pollutants of concern such as *E. coli*, Nitrogen, and pollutants typically found in urban stormwater runoff. Pollutant sources contributing to sediment and nutrients do appear to be non-point sources deriving from erosion of creek, shoreline erosion, internal loading of nutrients, and sediments and nutrients from the surrounding watershed. Therefore there is no single repair or structural project at a point source for achieving goals listed in the TMDL.

Based upon field inventories, Yeader Creek is highly vulnerable to continued degradation and erosion with few structural improvements in place to stabilize the channel, banks, or reduce down cutting from its tributaries. Compounding this issue is the highly urbanized nature of the watershed with relatively little open space available for large scale structural solutions such as wet ponds. Retrofitting of existing streets, parking lots, and other infrastructure can also be complicated by utilities in the right-of-way. Due to these circumstances, structural BMPs described in this section are intended to reduce pollutant loading to Yeader Creek, thus reducing loading to Easter Lake. Structural projects can serve a secondary benefit by serving as demonstration projects for public outreach and education when placed in highly visible and publically owned properties such as parks, library, or schools.

The methodology for selecting structural BMP sites throughout the watershed was based heavily on the existing NRCS studies and ISU DF study. EA utilized these resources to begin site inventories and screening of projects in order to recommend projects at the most vulnerable locations. This section identifies structural and programmatic BMP and alternatives available for reducing pollutant loading. This section also generally outlines potential pollution reduction quantities for each listed management practice.

- Structural projects – These projects are intended to focus on load reduction goals for specific types of land uses within localized areas including Yeader Creek and its tributaries.
- Non-structural programs – These programmatic BMPs are basin-wide recommendations and encourage property owners to adopt management solutions to reduce non-point pollutant loads. These programs include small scale structural BMPs, such as residential rain gardens.

The implementation strategy described later in Section 7, includes several of the structural projects and a programmatic BMPs listed in this section and splits management activities into three phases covering the 10-year life of the plan. Programs and projects listed in the implementation strategy are actions above and beyond actions listed in the current City's MS4 permit. Implementation strategies provided in this plan are specific to address nonpoint source impairments documented in the 2005 TMDL for Easter Lake.

An adaptive management approach has been proposed in order to allow the project sponsors an opportunity to evaluate programs and projects as they are implemented through monitoring, described later in Section 8 - Monitoring. This approach will allow project sponsors an opportunity to make changes to future projects, add other projects as opportunities arise, and make changes to programmatic BMPs. The plan review will include an evaluation of what has been completed thus far, how effective it was, and what the next actions might be to further improve water quality. Evaluation criteria used to determine project and program effectiveness, as well as water quality monitoring criteria, are outlined later in Section 8 - Monitoring.

6.1.1. Management Practice Categories

Due to the geographical uniqueness of the watershed, management practices have been separated into four key categories. The majority of the watershed consists of urbanized land uses; however, the majority of the southeast subbasin is currently used for agriculture. The southeast subbasin is also a prime target for future development as several of the land parcels are currently owned by private developers, but leased to agricultural producers. Due to the presence of this dynamic, the potential for a significant sediment and nutrient load is present if development is to reconvene. During development of the Plan very little development was taking place. The four primary management practice categories included in this plan are summarized below.

Watershed Areas

For the purpose of this plan, the ‘watershed’ includes management practices that are not specifically for stream restoration, Easter Lake, or programmatic or policy based. Watershed management practices generally include infiltration BMPs and source controls such as pet waste pick-up or use of no-phosphorus fertilizers. According to the 2005 TMDL for Easter Lake, BMPs to reduce external nutrient delivery, particularly phosphorus, should be emphasized in the watershed. Some of the recommendations in the 2005 TMDL are highlighted below:

- Nutrient management on production agriculture ground to achieve the optimum soil test category. This soil test category is the most profitable for producers to sustain in the long term.
- Incorporate or subsurface apply phosphorus (manure and commercial fertilizer) while controlling soil erosion. Incorporation will physically separate the phosphorus from surface runoff.
- Continue encouraging the adoption of reduced tillage systems, specifically no till and strip tillage.
- Initiate a fall-seeded cover crop incentive program. Target low residue producing crops (e.g. soybeans) or low residue crops after harvest (e.g. corn silage fields). This practice increases residue cover on the soil surface and improves water infiltration.
- With much of the watershed already devoted to urban land uses and future anticipated development, BMPs for controlling nutrient delivery associated with urban runoff are of particular importance in the Easter Lake watershed. These practices include:
    - Addition of landscape diversity to reduce runoff volume and/or velocity through the strategic location of filter strips, rain gardens and grass waterways, etc.
    - Installation of terraces, ponds, or other erosion and water control structures at appropriate locations within the watershed to control erosion and reduce delivery of sediment and phosphorus to the lake.
    - Use of low or no-phosphorus fertilizers on residential and commercial lawns.
    - Use of appropriate erosion controls on construction sites to reduce delivery of sediment and phosphorus to the lake.

The TMDL discussed overland sheet and rill erosion control activities, including the maintenance and installation of structures. Suggested controls are:

- Agricultural management practices that will increase crop residue such as no-till farming.
- Construction of terraces and grassed waterways.
- Installation of buffer strips along stream corridors.
- Implementation of enforcement of erosion control measures at development sites.

In-lake Alternatives

According to the TMDL, internal loading can be controlled through fish management to control rough fish (e.g., carp) and dredging to remove nutrients from the lake system. The City's existing efforts to control runoff through construction of detention structures through implementation of the Southeast Annex Area Comprehensive Storm Water Study and Master Plan helps reduce loading. In addition, the City of Des Moines' NPDES MS4 permit requires development of a Storm Water Pollution Prevention and Management Program (SWMP). The SWMP includes requirements for implementation of BMPs including controls to reduce pollutants in discharges from municipal application of fertilizers and operation of a public environmental information and education program to inform the public about the proper use of fertilizers. Implementation activities listed in this Plan are above and beyond actions the City is currently implementing as part of the City's MS4 permit.

In-lake improvement projects will reduce the influx of sediment and nutrients into the lake, protect the shoreline from erosion; enhance aquatic habitat, and deepening of the lake. In order to avoid issues with nutrient suspension in the future, maintain Easter Lake as a 'No Wake' lake and do not allow power boating.

Yeader Creek and the 'South Arm'

According to the TMDL, channel erosion has been identified as a significant sediment source. Channel contributions should be identified and stream bank restoration work done. Areas of severe channel erosion should be identified and targeted for restoration activities. The TMDL suggest the following controls:

- Installation of structures to reduce peak flows during runoff events.
- Installation of stream bank protection measures such as vegetation and graded rock.
- Stabilization of stream banks by shaping and removing overhangs.

Creek segments include the main branch of Yeader Creek, the south branch of Yeader Creek, and an unnamed drainage way that flows to Easter Lake referred to as the 'South Arm'. Each waterway has been targeted for structural projects to stabilize stream banks and the channel, reduce erosion at outfalls, and reduce sediment contributions to stormwater and base flows.

Non-structural Source Controls and Programs (Programmatic BMPs)

Stormwater BMPs that focus on management of pollutants at their source by minimizing exposure to runoff, rather than treating runoff in structural BMPs. These projects are recommended to be implemented throughout the entire basin for the life of this plan and beyond. For the purposes of this Plan, some small scale structural practices, such as residential rain gardens, are recommended to be implemented similar to existing programs, such as Rainscaping Iowa. Non-structural programs also include regulatory actions and establishment of policies aimed to promote actions to reduce pollutant runoff.

6.2. Management Practice Overview

This section includes a comprehensive listing of project alternatives and/or programs that will assist project stakeholders in reaching water quality goals. Many of these programs and projects will require a strong information and education component in order to change current habits of property owners and watershed residents. As shown below, Rainscaping Iowa, an existing program administered statewide is highlighted as a mechanism to be utilized for several important water quality projects. This program is administered locally by Polk SWCD. Projects listed below include a mix of non-structural solutions, small scale structural alternatives, and also a listing of larger scale structural alternatives. This list is intended to be a comprehensive resource summary of BMPs to be available to project sponsors when working to achieve water quality goals. This section includes some general recommendations, policy changes, and suggestions for ordinances to be considered. Practices and programs suggested for priority implementation, or those which have been included as part of a detailed project, are summarized in Section 7 – Implementation Strategy.

6.3. Rainscaping Iowa

Rainscaping Iowa is a statewide educational campaign that promotes urban stormwater management practices to protect water quality and reduce runoff with the help of its partners. The ultimate goal of the program is to build awareness and behavioral change that will result in the improvement and protection of water resources in Iowa (Rainscaping Iowa 2012).

Rainscaping Iowa recognizes several water quality BMPs and promotes that people adopt the practice that suits them depending upon the conditions of the project. Information listed below summarizes each of the practices currently recognized on the Rainscaping Iowa website (www.rainscapingiowa.org).

Through utilization of Rainscaping Iowa practices, water quality projects can be implemented throughout the watershed. Residents and property owners should be given financial incentives to participate and implement water quality BMPs (e.g. 50/50 cost share). Incentives could be increased for property owners that conduct a Rainscaping Iowa water edit of the property, which allows property owners to learn how much water is generated and runs off their property. The following describes several of the water quality practices used as part of Rainscaping Iowa.

6.3.1. Bioretention Cells

Bioretention captures and infiltrates stormwater runoff from impervious surfaces to reduce water pollution and reduce stream flows. Bioretention cells have an engineered and constructed subgrade to ensure adequate percolation and infiltration of captured runoff. Bioretention cells can be used in most settings including parking lots and residential areas where soils don't adequately percolate. They use plants that can tolerate a wide range of moisture conditions. Native plants are encouraged because they are deep rooted, maintain soil quality, and provide percolation of rainwater. A limiting factor for placement of a bioretention cell may be the lack of an outlet for the subdrain. An outlet is necessary to ensure proper drainage. The subdrain often outlets into the storm sewer or can discharge down gradient of the bioretention cell.

6.3.2. Bioswales

Bioswales are vegetated paths installed as an alternative to underground storm sewers. The bioswale is engineered so runoff from frequent, small rains infiltrate into the soil below. When larger storms occur, bioswales slow the flow of runoff while using above ground vegetative to filter and clean the runoff before it ends up in the local stream.

6.3.3. Green Roofs

A green roof incorporates vegetation, soil or other growing medium, a drainage layer all over a waterproof membrane as an alternative to an impervious roof surface. A green roof will eliminate 50% to 80% of roof runoff. The soil and vegetation absorb precipitation and release what is not used by plants over several hours rather than the rapid runoff associated with impervious roofs. Runoff volumes from frequent, small precipitation events are eliminated and runoff from larger events is reduced.

A green roof provides air quality and aesthetic benefits. They reduce the heat island effect in heavily populated urban areas. Green rooftops also improve the energy efficiency of buildings, especially for air conditioning when HVAC units are located on the roof as is often the case in large commercial or institutional buildings. The ambient air temperatures at green roof sites are significantly lower than at impervious roof surface sites. There are two main types of green roof systems, extensive or intensive, depending on the plant material and planned uses for the roof area.

Extensive green roofs are usually not accessible and are characterized by lower weight, lower installation cost, lower plant diversity, and minimal maintenance requirements. Modular systems that consist of a flat of sedum rooted in growing media can be installed.

Intensive green roofs are often accessible and are characterized by deeper soil and greater weight, higher installation costs, increased plant diversity, and have more maintenance requirements. Intensive roof systems often provide green space for leisure activities in an ultra-urban setting.

6.3.4. Native Landscaping

Plants, native to Iowa, enhance the landscapes' ability to manage stormwater. It features hardy plants and grasses with deep root systems, creating open space and allowing rainfall to percolate into the soil below. Native plants should be strategically placed in the landscape to enhance infiltration of stormwater.

Native plants are adapted to the Iowa climate and are tolerant of weather extremes, they create a diverse habitat that attract birds, butterflies, and other wildlife and most importantly don't require fertilizer and pesticides to survive.

Many of the infiltration based stormwater management practices use native plants. Natives can replace large expanses of turf grass in parks, yards, and corporate campuses. After establishment, native landscaping is less expensive to maintain than mowed turf grass areas.

6.3.5. Native Turf

Native turf features a blend of low-growing native grasses that provide a lawn-like appearance. Native turf provides deep, fibrous root systems that will help build and maintain soil quality. Mowing of native turf plantings could be eliminated, and the height of the vegetation would stay in the 8 to 18-inch range. Or, mowing could be done on a limited basis, keeping the natives more like a traditional turf grass.

Native turf grasses are warm-season plants, which mean they respond to the increased sunlight as days grow longer and hotter. Therefore, native turf will not break dormancy and green up as early in the growing season as cool season turf grass lawns. However, they will be green and growing during the long, hot days of summer when non-native cool season turf often goes dormant in response to the hot, dry conditions. Native turf will not need fertilization or watering after the root systems are established.

6.3.6. Permeable Pavement Systems

Roads, parking lots, and driveways account for over 60% of impervious surfaces in urban areas. Consequently, pavement is the largest generator of stormwater runoff. Pervious pavement allows water to infiltrate into layers of rock placed below the pavement and then into surrounding soils. A perforated drain pipe is installed in the rock chamber. If surrounding soils won't allow water to percolate, water will move to the drain pipe and be slowly discharged. The movement of water through the rock and soil aids in filtering pollutants, maintains stable stream flows, and can reduce flood potential. There are multiple types of permeable pavement such as:

- Permeable paver blocks
- Porous asphalt
- Pervious concrete
- Grass paved systems
- Gravel paved systems

6.3.7. Rain Gardens

Bioretention features, often referred to as ‘rain gardens, are a type of structural BMP commonly used for stormwater quality improvement in urban areas. When properly designed and maintained, they can offer highly efficient reduction of phosphorus, as well as other pollutants. According to Rainscaping Iowa, a rule of thumb for sizing rain gardens is to use 10% of the impervious area (i.e. roof) to determine the size of the rain garden. Rain garden are usually sized to temporarily pond runoff generated by a 1.25 inch rain. Ponded water should infiltrate into the soil within 24 hours. Soils can be amended with sand and compost if topsoil quality is questionable. Plants with deep roots are encouraged to help maintain soil quality and good percolation rates.

6.3.8. Rainwater Harvesting

Rain water harvesting at a small scale is commonly done by a ‘rain barrel’. Rain barrels typically are 55-gallons in size and consist of materials that can either be purchased or put together by a homeowner or at a retail store. Rain barrels can reduce the total quantity of runoff into streams, thus reducing the total pollutant load. More importantly, rain barrels and rainwater harvesting can benefit property owners through water conservation.

It is an easy and fairly inexpensive practice for urban property owners to install with the purchase or making of a rain barrel and connecting them to downspouts. When it rains water is stored in the rain barrel for watering yards and gardens. The downside to rain barrels is that they do not manage a significant amount of runoff but they are an important way to get started in water harvesting and conservation practices.

> *“Soil quality restoration can be completed on any existing yard, making this one of the easiest water quality actions to implement”.*

6.3.9. Soil Quality Restoration

Healthy soil is the key to preventing polluted runoff. As buildings and houses are built top soil is removed and the remaining sub-soil is compacted by all the grading and construction activity. The owner is left with heavily compacted subsoils, usually with high clay content and little organic matter after construction is complete. Soil quality restoration is so simple - start by reducing soil compaction and increasing organic matter content with the addition of compost. Soil quality restoration can be completed on any existing yard, making this one of the easiest water quality actions to implement. In addition to reduced pollutant loading to Easter Lake, homeowners also benefit by having a more attractive lawn.

Lawns with good soil quality have a positive impact on water quality by reducing the need for watering, and minimize the need for fertilizers and pesticides. Yards with poor, compacted soil contribute to water quality problems due to their inability to infiltrate and absorb water or make it available to turfgrass. Compacted soil also requires more fertilizers and pesticides, both of which could end up in runoff and eventually adding to pollution in our local creek and streams.

6.3.10. Stream Corridor / Shoreline Stabilization

Stream corridors and the flood plain buffers along each side of the stream serve as multi-purpose green infrastructure, providing area needed to stabilize and maintain stream channels, allowing for the installation and maintenance of infrastructure, and offering community enhancing amenities such as trails.

Once streams banks are allowed to erode they can be difficult and costly to repair, especially in an urban setting, where streams are fragmented by residential lot ownership making it difficult to get full cooperation for a project that treats the stream as a “system."

Stream channel stabilization is a complex undertaking involving a comprehensive survey and engineering design for successful stabilization. However, there are some basic aspects involved in stream corridor stabilization. Down cutting must first be stabilized; eroding banks need to be peeled back to a stable slope and re-vegetated. Once those two steps are complete protecting the lower part of the bank is recommended by preventing erosion at the toe (bottom) of the slope.

6.3.11. Additional Water Quality Technologies

Several other technologies are available to reduce pollutant loading to Easter Lake. These include Silva cells, vegetated box filter, curb-cut biosales, and retrofitted storm drain inlets, among others. During the project planning phase project sponsors should evaluate the availability of other new technologies, or consider a combination of BMPs commonly called a ‘treatment train’.

6.4. Additional Best Management Practices

In addition to the above mentioned practices, the following water quality practices and/or programs are available to improve water quality throughout the watershed.

6.4.1. Vegetative Invasive Species Removal

Several invasive vegetated species, including bush honeysuckle, oriental bittersweet, garlic mustard, reeds canary grass, and purple loosestrife have created a dense cover under the woodlands surrounding Easter Lake. The most problematic in the watershed are the bush honeysuckle and oriental bittersweet. Dense vegetation limits the diversity of plants growing in the area which leads to barren soil during the non-growing season. This leads to a sediment pollutant source adjacent to the surface water, suffocates wildlife habitat, and limits the availability of woodland acres to visitors of Easter Lake.

In order to control honeysuckle and other invasive species, remove dense stands of vegetation using tree sheering, drum mowing, spraying, and man power to physically pull out vegetation. Furthermore, promote replacement of invasive vegetation stands by seeding native species.

6.4.2. Pet Waste Disposal Cans

Currently pet waste containers are not present in parks and public use areas in the watershed, except for the disposal system at the Ewing Dog Park.

To support efforts towards reducing the sources of phosphorus in the watershed, install and maintain several pet waste containers along parks and recreational areas. Signs explaining the importance of picking up pet waste at each container would likely increase usage of the containers. Assistance from local partners to help with maintenance of pet waste containers, such as neighborhood associations, might be considered.

6.4.3. Pet Waste Ordinances

The City of Des Moines currently has an ordinance to regulate removal of animal waste immediately after excrement or droppings are deposited by any animal on public or private property. These ordinances include the possibility of penalties.

To increase compliance with existing pet waste ordinances notify residents through bill stuffers, letters, news articles, and other means, about the water quality benefits of picking up pet waste and the potential enforcement actions available to the City for those not complying with local pet waste ordinances.

6.4.4. Sanitary Sewer Line Inspection Program

The City of Des Moines Department of Public Works is responsible for maintaining the City's nearly 900 miles of sanitary sewer. The City regularly inspects and makes repairs to existing infrastructure.

In order to limit potential sources of bacteria and other nutrients from faulty sewer lines, target programs to inspect sanitary sewer lines in the Easter Lake watershed using a T.V. camera. Inspections will ensure the condition of the sewer lines are sufficient and limit potential for leaks in the system.

6.4.5. Dry Weather Storm Drainage Screening Program

The City of Des Moines Department of Public Works regularly conducts dry weather sampling throughout the city. Dry weather storm drain screening includes locating flows in storm drains during periods in which precipitation has not occurred for a given amount of time. Screening activities may or may not include sampling. During low flow periods, pollutants tend to be more concentrated and are more identifiable. Therefore, sampling dry weather flows can provide valuable information for identifying illicit discharges from illegal connections, leaks in sanitary sewer lines, and domestic water supply lines. Indicators such as color, turbidity, and odor can be simple indicators as to non-stormwater runoff. Tracking the source of the flows can further delineate the origin, and also the potential discharge location. Following established programs and manuals such as the Illicit Discharge Detection and Elimination guidance manual by USEPA can aid in developing a dry weather screening program.

In an effort to improve water quality in Easter Lake consider increasing the frequency of dry weather screening inspections in Yeader Creek and other drainage ways leading to the lake.

6.4.6. Long Grass Maintenance Areas

Maintenance of open spaces and grassed areas around Easter Lake and the confluence of Yeader Creek and Easter Lake are shared responsibilities for PCCD (Easter Lake Park) and the City of Des Moines (Ewing Park). Increasing the extent of long grass maintenance areas adjacent to the lake, and throughout the watershed, can have positive water impacts, in addition to helping control the use of these areas by waterfowl. Long grass areas can also include native species which have naturally replaced turf grasses over time.

To increase filtration of pollutants in stormwater, discourage geese gathering, and increase native grass species consider the establishment of buffer zones through the use of long grass maintenance areas. In addition, create buffer zones to all applicable drainage ways, along Yeader

Creek and the ‘south arm, park areas, and other sensitive areas. A buffer zone is recommended to be 30 feet wide but may vary due to steepness, severity of erosion, and management goals.

Figure 6-1: Mowed Shorelines

6.4.7. No-phosphorus Fertilizers Program and Soil Testing

Nutrients are essential to support plant growth, especially nitrogen, phosphorus, and potassium. Fertilizers, pesticides, animal waste, and detergents commonly include nutrients. Phosphorus is one of two pollutants (sediment) listed as a parameter of concern in the Easter Lake TMDL. Excessive phosphorus loading into Easter Lake is a leading contributor to algae growth, with lowers water quality and causes several of the issues discussed in detail in this Plan.

In order to lower the phosphorus loading into Easter Lake establish a no-phosphorus fertilizer program that will encourage residents, property owners, and lawn care providers to use no-phosphorus fertilizers. Provide education and outreach on how nutrients in fertilizer can negatively affect water quality by contributing to excessive algae growth. Utilize financial incentives for residents, property owners, and lawn care providers to encourage a change in practice from traditional fertilizers to no-phosphorus fertilizers.

The Easter Lake Steering Committee has identified providing education to local businesses and lawn care providers about the water quality issues at Easter Lake as a priority action during implementation. This can be a key activity of the Easter Lake implementation coordinator.

As part of the no-phosphorus program, include information on soil testing lawns prior to applying fertilizer and offer education and outreach or incentives to lawn care providers to promote soil testing as an option to customers. Provide flyers and other information to lawn care providers to share with their customers that explain the benefits of soil testing and how that can lower their expense and benefit water quality.

6.4.8. Urban Wildlife Management

Bird droppings below bridges, underpasses, and on shorelines can be a significant source of *E. coli,* as well as phosphorus in all types of watersheds. Several methods are available to either control the wildlife population or discourage wildlife from using sensitive areas.

To limit bird activity under bridges and overpasses, retrofit older bridges and overpasses crossing Yeader Creek and other waterways to modify habitat to reduce feeding, watering, roosting, and nesting sites for birds. Future bridges or overpasses over waterways contributing to Easer Lake should be designed in a manner that reduces habitat suitable for nesting and perching of pigeons and other birds. Other visible perching sites, such as light posts, could be considered for placing mechanisms to discourage perching.

Discourage waterfowl from shorelines through establishing tall grass buffer zones with controlled access areas around Easter Lake and the existing detention structures located in the Southeast Subbasin (Three Lakes Estates).

Consider the use of a trained dog to control nuisance Canadian geese around Easter Lake and lower portions of Yeader Creek within Ewing Park and Easter Lake Park.

6.4.9. Rooftop and Parking Lot Disconnection Incentive Programs

Several businesses and homes currently have downspouts moving water directly from a rooftop to an impervious surface where stormwater runoff travels untreated directly into waterways draining to Easter Lake. The roof on a residential home is often the biggest generator of rainwater runoff and can send 7,500 gallons of water down the driveway in one year (Rainscaping Iowa Handout 2012).

To support efforts to limit the quantity of stormwater and pollutant loading, encourage property owners and residents to disconnect runoff from impervious surfaces with financial incentives. Disconnections can be low-cost solutions that if implemented over a large area could have a strong impact on pollutant reduction to Easter Lake.

Establish an incentive program for property owners to disconnect downspouts and roof drains from spilling onto impervious surfaces. Support the program with a considerable educational campaign using bill stuffers, billboards, press releases, social media, news articles, information on the project and project stakeholder’s websites, and other means. Disconnection of rooftop runoff on properties where adequate vegetative cover is available is important.

To support efforts to limit the quantity of stormwater and limit pollutant loading, identify locations in the watershed area where parking lot drainage to storm drain inlets could be disconnected. Directing flow of stormwater from parking lots onto vegetated surfaces, swales, rain gardens, or other BMPs, could have a considerable positive impact on water quality. Converting impervious areas to pervious areas using pervious pavement systems can have similar effects. Work with property owners to encourage disconnection of parking lots and other large impervious surfaces from the storm drain system.

6.5. Large Scale Structural BMPs

Planning, design, and construction of large scale BMPs will be the responsibility of project sponsors including the City of Des Moines, PCCB, PSCD, and IDNR. Several structural projects for stream restoration, in-lake improvements, and watershed projects have been sited and detailed in Section 7 – Implementation Strategy. The practices below are available as other opportunities for water quality projects present themselves. Planning and siting of additional BMPs will occur throughout the life of this Plan, and beyond, especially as development continues in the Southeast Subbasin.

6.5.1. Extended Detention Basin

An extended detention basin (EDB) is a sedimentation basin designed to detain stormwater for many hours after storm runoff ends. This BMP is similar to a detention basin used for flood control, however; the EDB uses a much smaller outlet that extends the emptying time of the more frequently occurring runoff events to facilitate pollutant removal. The EDB's 40-hour drain time for the water quality capture volume (WQCV) is recommended to remove a significant portion of total suspended solids (TSS). Soluble pollutant removal is enhanced by providing a small wetland marsh or "micropool" at the outlet to promote biological uptake. The basins are sometimes called "dry ponds" because they are designed not to have a significant permanent pool of water remaining between storm runoff events.

An extended detention basin can also be designed to provide Full Spectrum Detention. In this case, the EDB is sized for 100-year peak reduction and the excess urban runoff volume (EURV) is used instead of the WQCV. The EURV is designed with a drain time of approximately 72 hours.

Widespread use of Full Spectrum Detention is anticipated to reduce impacts on major drainage ways by reducing post-development peak discharges to better resemble pre-development peaks.

EDBs are well suited for watersheds of 5 to 640 impervious acres. Smaller watersheds can result in an orifice size small enough to increase the potential for clogging. Larger watersheds and watersheds with base flows can complicate the design and reduce the level of treatment provided. EBDs are also well suited where flood detention is incorporated into the same basin. The depth of groundwater should be investigated. Groundwater depth should be 2 or more feet below the bottom of the basin in order to keep this area dry and maintainable.

Benefits

- The relatively simple design can make EDBs less expensive to construct than other BMPs, especially for larger basins,
- Maintenance requirements are straightforward,
- The facility can be designed for multiple uses.

Limitations

- Ponding time and depths may generate safety concerns,
- Best suited for tributary areas of 5 impervious acres or more. EDBs are not recommended for sites less than 2 impervious acres.
- Although ponds do not require more total area compared to other BMPs, they typically require a relatively large continuous area.

6.5.2. Retention Pond

A retention pond, sometimes called a "wet pond," has a permanent pool of water with capacity above the permanent pool designed to capture and slowly release the WQCV over 12 hours. The permanent pool is replaced, in part, with stormwater during each runoff event so stormwater runoff mixes with the permanent pool water. This allows for a reduced residence time compared to that of the EDB. The 12- hour drain time helps to both better replicate pre-development flows for frequent events and reduce the potential for short circuiting treatment in smaller ponds. Retention ponds can be very effective in removing suspended solids, organic matter and metals through sedimentation, as well as removing soluble pollutants like dissolved metals and nutrients through biological processes. Retention ponds can also be designed to provide Full Spectrum Detention. Widespread use of full spectrum detention is anticipated to reduce impacts on major drainage ways by reducing post-development peak discharges to better resemble predevelopment peaks.

Retention ponds require groundwater or a dry-weather base flow if the permanent pool elevation is to be maintained year-round. The designer should consider the overall water budget to ensure that the base flow will exceed evaporation, evapotranspiration, and seepage losses (unless the pond is lined). High exfiltration rates can initially make it difficult to maintain a permanent pool in a new pond, but the bottom can eventually seal with fine sediment and become relatively impermeable over time. However, it is best to seal the bottom and the sides of a permanent pool if the pool is located on permeable soils and to leave the areas above the permanent pool unsealed to promote infiltration of the stormwater detained in the surcharge WQCV.

Studies show that retention ponds can cause an increase in temperature from influent to effluent. Retention ponds are discouraged upstream of receiving waters that are sensitive to increases in temperature (e.g., fish spawning or hatchery areas).

Use caution when placing this BMP in a basin where development will not be completed for an extended period, or where the potential for a chemical spill is higher than typical. When these conditions exist, it is critical to provide adequate containment and/or pretreatment of flows. In developing watersheds, frequent maintenance of the forebay may be necessary.

Benefits

- Creates wildlife and aquatic habitat,
- Provides recreation, aesthetics, and open space opportunities,
- Can increase adjacent property values,
- Cost-effective BMP for larger tributary watersheds.

Limitations

- Safety concerns associated with open water,
- Requires physical supply of water,
- Sediment, floating litter, and algae blooms can be difficult to remove or control,
- Ponds can attract water fowl which can add to the nutrients and bacteria leaving the pond,
- Ponds increase water temperature.

6.5.3. Constructed Wetland Pond

A constructed wetland pond is a shallow retention pond designed to permit the growth of wetland plants such as rushes, willows, and cattails. Constructed wetlands slow runoff and allow time for sedimentation, filtering, and biological uptake. Constructed wetlands ponds differ from "natural" wetlands, as they are artificial and are built to enhance stormwater quality. Do not use existing or natural wetlands to treat stormwater runoff. Stormwater should be treated prior to entering natural or existing wetlands and other environmentally sensitive areas. Allowing untreated stormwater to flow into existing wetlands will overload and degrade the quality of the wetland. Sometimes, small wetlands that exist along ephemeral drainage ways can be enlarged and incorporated into the constructed wetland system. Such actions, however, require the approval of federal and state regulators.

Regulations intended to protect natural wetlands recognize a separate classification of wetlands, constructed for water quality treatment. Such wetlands generally are not allowed to be used to mitigate the loss of natural wetlands but are allowed to be disturbed by maintenance activities. Therefore, the legal and regulatory status of maintaining a wetland constructed for the primary purpose of water quality enhancement is separate from the disturbance of a natural wetland.

Nevertheless, any activity that disturbs a constructed wetland should be cleared through the U.S. Army Corps of Engineers to ensure it is covered by some form of an individual, general, or nationwide 404 permit.

A constructed wetland pond requires a positive net influx of water to maintain vegetation and microorganisms. This can be supplied by groundwater or a perennial stream. An ephemeral stream will not provide adequate water to support this BMP. A constructed wetland pond is best used as a follow-up BMP in a watershed, although it can serve as a stand-alone facility. Algae blooms may be reduced when BMPs that are effective in removing nutrients are placed upstream. Constructed wetland ponds can also be designed for flood control in addition to capture and treatment of the WQCV. Although this BMP can provide an aesthetic onsite amenity, constructed wetland ponds designed to treat stormwater can also become large algae producers. The owner should maintain realistic expectations.

Benefits

- Creates wildlife and aquatic habitat,
- Provides open space opportunities,
- Cost effective BMP for larger tributary watersheds.

Limitations

- Requires physical supply of water to be impounded,
- Ponding depth can pose safety concerns requiring additional considerations for public safety during design and construction,
- Sediment, floating litter, and algae blooms can be difficult to remove or control,
- Ponds can attract water fowl which can add to the nutrients leaving the pond.

6.5.4. Constructed Wetland Channel

A constructed wetland channel is a conveyance BMP that is built, in part, to enhance stormwater quality. Constructed wetland channels use dense vegetation to slow down runoff and allow time for both biological uptake and settling of sediment. Constructed wetlands differ from natural wetlands, as they are artificial and are built to enhance stormwater quality. Do not use existing or natural wetlands to treat stormwater runoff. Stormwater should be treated prior to entering natural or existing wetlands and other environmentally sensitive areas. Allowing untreated stormwater to flow into existing wetlands will overload and degrade the quality of the wetland. Sometimes, small wetlands that exist along ephemeral drainage ways may be enlarged and incorporated into the constructed wetland system. Such action, however, requires the approval of federal and state regulators.

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Constructed wetland channels provide conveyance of stormwater similar to a grass swale; however, this BMP is appropriate when a base flow can be anticipated. A constructed wetland channel requires a net influx of water to maintain vegetation and microorganisms. This can be supplied by groundwater or a perennial stream. An ephemeral stream may not provide adequate water. In addition to water supply, loamy soils are needed in the wetland bottom to permit plants to take root. Wetland channels also require a near-zero longitudinal slope; drop structures can be used to create and maintain a flat grade.

A constructed wetland channel can be used in the following two ways:

- It can be established in a completely man-made channel providing conveyance and water quality enhancement,
- It can be located in a treatment train configuration, downstream of a stormwater detention facility (water quality and/or flood control) where a large portion of the sediment load has been removed upstream. This allows the wetland channel to benefit from the long duration of outlet flow and reduced maintenance requirements associated with pretreatment.

Benefits

- Wetland channels provide natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal,
- Provides effective follow-up treatment to onsite and source control BMPs that rely upon settling of larger sediment particles.

Limitations

- Requires a continuous base flow,
- Without proper design, salts and other floatables can accumulate and be flushed out during larger storms,
- Safety concerns associated with open water.

6.5.5. Underground BMPs

Underground stormwater BMPs include proprietary and non-proprietary devices installed below ground that provide stormwater quality treatment via sedimentation, screening, filtration, hydrodynamic separation, and other physical and chemical processes. Conceptually, underground BMPs can be categorized based on their fundamental treatment approach and dominant unit processes. Some underground BMPs combine multiple unit processes to act as a treatment train. While performance data for underground flood-control detention is lacking, this description provides general knowledge of the BMP for determining when the use of underground BMPs may be considered for water quality. When surface BMPs are found to be infeasible, underground BMPs may be the only available strategy for satisfying regulatory water quality requirements, especially in highly built-up urban areas where water quality measures must be implemented as a part of a retrofit to meet regulatory requirements. Underground BMPs should not be considered for standalone treatment when surface-based BMPs are practicable. For most areas of new urban development or significant redevelopment, it is feasible and desirable to provide the required WQCV on the surface. It is incumbent on the design engineer to demonstrate that surface-based BMPs such as permeable pavements, rain gardens, extended detention basins and others have been thoroughly evaluated and found to be infeasible before an underground system is proposed. Surface-based BMPs provide numerous environmental benefits including infiltration, evapotranspiration, groundwater recharge, aquatic habitat, mitigation of "heat island effect", and other benefits associated with vegetation for those that are planted.

The most common sites for underground BMPs are "ultra urban" environments with significant space constraints. These could include downtown lot-line-to-lot-line development projects, transportation corridors, or small (less than 0.5 acre) redevelopment sites in urban areas. Important site features that must be considered include the following:

- Depth to Groundwater: Due to the potentially large displacement caused by an underground vault, if there is seasonally high groundwater, buoyancy can be a problem. Vaults can be sealed to prevent infiltration of groundwater into the underground system and these systems can be anchored to resist uplift. If seasonally high groundwater is expected near the bottom of an underground system, the engineer should evaluate the potential for infiltration of groundwater and uplift forces and adjust the design accordingly,
- Proximity to Public Spaces: As material accumulates in an underground system, there is potential for anoxic conditions and associated odor problems,
- Gravity versus Pumped Discharge: The ability to drain to the receiving storm drainage system via gravity is an important consideration. In some cases it may be necessary to pump discharge from an underground system; however, a gravity outfall is always recommended if possible and some communities may not allow pumped systems. If a pumped system must be used, there should be redundancy in pumps, as well as a contingency plan in the event that a power outage disables pumps. Additionally, maintenance of the pump system should be identified as part of the water quality BMP in the maintenance plan. When BMP maintenance records are required by the MS4 permit holder, pump system maintenance records should also be included,
- Access: Equipment must be able to access all portions of the underground BMP, typically at multiple locations, to perform maintenance. As the size of the underground system increases, so must the number of access points,
- Traffic Loading: Due to space constraints, in some situations, underground BMPs may be located in a right-of-way or other location where there may be traffic loadings. Many underground BMPs are or can be constructed for HS-20 traffic loading. Take additional measures when necessary to ensure that the BMP is designed for the anticipated loading,
- Potential for Flooding of Adjacent Structures or Property: For underground BMPs, it is important that the hydraulic grade line be analyzed to evaluate the potential for backwater in the storm drainage system. In addition, some types of underground BMPs, such as catch basin inserts, have the potential to clog and cause flooding if not frequently maintained.

Benefits

- Underground BMPs may be designed to provide pre-treatment and/or WQCV in space-constrained situations,
- There are many alternative configurations for proprietary and nonproprietary devices,
- Treatment train applications can be designed using different unit processes in series,
- Some underground BMPs, designed specifically for certain target pollutants, can be used to address a TMDL,
- Many underground devices can be effective for settling of particulates in stormwater runoff and gross solids removal.

Limitations

- Performance data for underground BMPs in the Des Moines area are limited,
- Maintenance is essential and must be performed frequently,
- Inspection and maintenance can require traffic control, confined space entry, or specialized equipment,
- Devices that do not provide WQCV do not qualify for standalone treatment,
- Gravity outfall may not be feasible in some situations,
- Many do not provide volume reduction benefits,
- Potential for anoxic conditions and odor problems.

6.6. In-lake Improvements

Several in-lake improvements have been identified as both water quality improvement projects and aquatic habitat enhancements. Several of these projects are intended to improve the recreational opportunities, mainly fishing, once the lake restoration is complete.

6.6.1. In-lake Sediment Forebays

According to ISU's DF Study, utilizing different arms of the lake as sediment detention basins is another means of minimizing the potential for materials to enter the main basin of Easter Lake. The west arm detention basin could be created by constructing a fishing jetty whereas the southern arm detention basin could be created using the existing constriction at Easter Lake Drive. Each of these project alternatives are listed in Section 7 – Implementation Strategy. The ISU DF Study further discussed that in order to achieve phosphorus reductions to the lake by 50%, these structural practices will need to be complimented by a strong effort in the watershed through habitual changes of property owners and residents in how they manage their properties. The timing of west-arm forebay will be coordinated with the planned trail expansion being sponsored by PCCB.

6.6.2. In-lake Treatment (Aeration and Alum)

Aeration and phosphorus inactivation are two management techniques that can address hypolimnetic phosphorus loading. Given the minimal amount of internal loading, neither alternative would be cost effective for Easter Lake. The low hydraulic residence time and high sediment loads from the watershed may make inactivation techniques, such as alum, less effective (LakeTech 2012).

Both the amount of nutrients entering a system and the timing of those loads are important in algal production. Measured internal phosphorus release rates, estimated total internal loads, high reservoir flushing rates, and high sediment loading would make treatments such as aeration and aluminum sulfate less cost effective. Two processes can increase phosphorus release from bottom sediments. First, anoxia near the reservoirs bottom sediment-water interface will promote phosphorus release. Secondly, draining/drying and re-filling will result in high concentrations of dissolved phosphorus and some metals in the lakes water column. If internal loads become a significant portion of the overall load, in-lake measures such as aeration or alum should be considered. If Easter Lake is lowered for renovation, post project phosphorus concentrations should be closely monitored (LakeTech 2012).

6.6.3. Wetland Enhancement/Creation

Opportunities are available to enhance wetlands in several areas at the confluence of Yeader Creek and the lake. Wetland enhancements would be beneficial to water clarity, phosphorus reductions, and benefits associated with fish renovation. Enhancement of existing wetlands as part of the west-arm sediment forebay, from Indianola Avenue into the lake, should be considered. In addition, this area services as a location for bird watching, fishing, hiking, and will be visible from the trail-way bridge planned to be constructed across the west-arm sediment forebay. Secondary benefits of wetland enhancements include aesthetics, wildlife habitat, and restoration of the ecosystems natural functionality.

6.6.4. Fish Renovation

Fisheries renovation and restoration would help decrease internal sediment and nutrient re-suspension and restore healthy ecosystem functions including riparian and littoral vegetation. The Iowa DNR suggested a complete renovation of the lake and its watershed during establishment of the ISU DF study. In-lake restoration components include increasing the vertical drop on the outlet structure to prevent undesirable species from entering the lake, shoreline stabilization, and creating in-lake fish habitat.

Easter Lake lacks a diverse, balanced, and sustainable aquatic community. Poor water quality continues to impact popular sport fish, such as crappie and other panfish, despite extensive fisheries management. The presence of undesirable fish species has nearly eliminated vegetation growth and likely increased turbidity and nutrient re-suspension (ISU 2011). The lake could offer an important urban fishing opportunity for Des Moines Metro residents, and visitors, but a thorough renovation of the fishery throughout the watershed, including detention structures located in the Southeast Subbasin, would be necessary.

In-lake restoration activities outlined later in Section 7 – Implementation Strategy, are based upon recommendations in the ISU DF study and further analysis by the consultant. Fish renovation activities are comprehensive, and include several other alternatives such as targeted dredging, installation of aquatic habitat features, etc. Fish renovation activities include more than physical removal of trash fish, and stocking with game fish. Overall, fish renovation activities are important to restoring the biological functioning of the system.

6.6.5. Shoreline Stabilization

As reservoirs age, they tend to get larger in size and lose depth. In part, this is due to natural bank erosion processes. Physical factors such as bank height, prevailing winds, the distance waves have to generate (fetch), and the amount of vegetation on the banks and in the water can dictate the extent of shoreline erosion. Reservoirs found in city parks, such as Easter Lake, tend to have manicured lawns up to the water’s edge, which facilitates erosion. The bank stabilization practices recommended for Easter Lake are based on reconnaissance surveys and the cost effectiveness of the practices available (LakeTech 2012).

Shoreline erosion in the main lake and gully erosion from the tributaries have contributed to the loss of surface acreage, depth and habitat at Easter Lake (ISU 2011). IDNR conducted a rapid shoreline assessment of Easter Lake in August 2012. This assessment was intended to select areas as an erosion priority only, a fishing access priority only, and both a fishing access and erosion priority. The results from IDNR’s rapid assessment are shown in Section 3.

A combination of rip rap (hard armor) and tall grass management or tall grass buffers are recommended for stabilization of shoreline. Locations of these shoreline stabilization methods will be determined during the design phase of the in lake restoration projects discussed in Section 7 of this Plan. If necessary, smaller areas can be mowed for lake access. Waterfowl can have an impact on lake nutrient loads and land based recreation. Both practices recommended for shoreline stabilization will also help deter waterfowl migration between the lake and park (LakeTech 2012).

Severe shoreline erosion is present also at the detention structures in the Southeast Subbasin near the Three Lakes Subdivision. Shoreline erosion is occurring around each detention structure due to a lack of vegetation, waterfowl use, and inadequate maintenance; in addition to the islands constructed as part of structure number X. Shoreline stabilization activities are detailed in Section 7 – Implementation Strategy. Project sponsors are also encouraged to improve shoreline stabilization around the Three Lakes Estates sub-division by establishing a vegetated buffer, increasing slope at the shoreline to promote wetland vegetative growth, and hindering use of the area by nuisance waterfowl.

6.6.6. Outlet Structure Retrofitting

To support the fisheries renovation, a modification would be required to the Easter Lake outlet structure to increase the vertical drop to prevent undesirable species from entering the lake. IDNR has completed similar retrofits to outlet structures at other state lakes. The intent is to modify the existing outlet to create an approximate 9-foot drop that will disallow fish to jump and travel upstream into the lake. This is the preferred strategy of IDNR.

A second option includes installation of a fish screen such as Aqua Sierra's Wedge-Wire Hydro Diversion Screens, or a similar type technology. A fish screening technology would be a less costly option and should be considered as an alternative to a more structural alternative. For the purposes of this plan, cost-estimates for a fish screen technology were not evaluated.

A detailed project description for retrofitting the outlet structure can be found in Section 7 – Implementation Strategy.

6.6.7. Sediment Management - Targeted Dredging

Removal of sediment in targeted areas can help improve water quality (Carter Lake 2008). The following is a summary of water quality benefits resulting from targeting dredging:

- Increased depth in shallow areas will reduce sediment re-suspension and increase water clarity
- Targeted dredging will improve fish habitat, thereby increasing the water quality benefits obtained with the fisheries renovation.
- Targeted dredging will also increase the efficiency and longevity of any future alum applications.

While direct benefits of targeted dredging may not be apparent, it enhances the performance of a number of other water quality improvements, making this alternative a vital component of the overall plan (Carter Lake 2008).

Sediment management through dredging operations and retention and sediment pond construction has occurred previously in 1990s and 2000s (ISU 2011). Total volume of sediment removed during past dredging operations is unknown. IDNR Fisheries personnel would like to consider dredging to reclaim lost deeper water habitat because steep sided lakes tend to support better fishing habitat.

To the extent possible, the area of bottom sediments exposed during renovation activities should be minimized. Additionally, increasing lake depths beyond 3.5 meters will increase the hypolimnetic surface area and internal phosphorus loads. Regardless of the techniques used, the lake should be closely monitored and corrective actions should be taken if these problems occur (LakeTech 2012).

In addition to targeted dredging of the lake, dredging of the eight existing detention structures in the Southeast Subbasin is also recommended. Specific information on quantities and cost for dredging these structures is also available in Section 7 – Implementation.

6.6.8. Sediment Management - Whole Lake Dredging

Whole lake dredging is not cost effective and was not fully evaluated in the ISU DF study. During plan development, the consultant team research internal phosphorus loading assessments and provided recommendations. One key recommendation was to perform targeted mechanical dredging in order to minimize the area of bottom sediments exposed during renovation (LakeTech 2012).

6.7. Regulatory and Policy Based Water Quality Alternatives

Several actions to support water quality initiatives will begin with decisions of key stakeholders to enforce existing regulations, create new policies, and possibly create new land use regulations. This section describes management practices that are based upon regulation and policy.

6.7.1. Incorporation of Water Quality Elements into Flood Control Projects / Retrofitting

Incorporation of water quality elements into flood control projects should be considered in the Easter Lake watershed. Examples include the use of extended dry cells, native vegetation, bioswales, and other available technologies what will allow for infiltration, filtration, or natural treatment of pollutants.

Retrofitting of existing flood control structures throughout the City to enhance water quality benefits could be a large scale, cost effective treatment option. Several commercial sites throughout the Easter Lake watershed currently have dry detention basins to manage runoff during rainfall events. The dry cells are typically designed to temporarily detain stormwater and allow outflow at a specified rate that will not cause flooding downstream. Existing dry cells can be retrofitted with amended soils and outlet structure modifications to capture and infiltrate the small rain events. Retrofit of these cells could have a significant effect on pollutant loads in a watershed, by reducing total runoff volumes and the pollutant load it carries, and trapping sediment from stormwater.

6.7.2. No-Wake Boating Policy

Easter Lake is currently a no-wake lake. This policy should be continued in order to limit re-suspension of nutrients in the lake, limit erosion of shorelines, and help protect the investment being placed into Easter Lake's renovation.

6.7.3. Overlay Districts

Overlay districts, such as historic districts, airport noise and height districts, are commonly used by municipalities. In these areas, development must meet higher design standards and often has a special review board. Conservation overlay districts have also been used to address environmentally related land use activities such as restrictions for agricultural producers in a wellhead protection area. These types of overlay districts could be used to regulate land use activities potentially harmful to water quality. Examples might include requirements for disconnection of rooftop runoff to impervious areas, use of no-phosphorus fertilizers, or others.

6.7.4. Snow and Ice Management

Water quality considerations for snow and ice management include avoidance of pilling snow in areas where snow melt can flow into Easter Lake. Snow melt can carry many pollutants, especially trash and sediment. Consideration should be given to both where the City piles snow, and where property owners pile snow. Avoid piling snow near stormwater drains. The City's snow removal management strategies might consider orienting snow dump sites such that snowmelt is directed through an appropriate BMP before entering a waterway.

6.7.5. Yeader Creek Drainage Way Buffer Requirements

Buffer zones are designated transitional areas around a stream, lake, or wetland left in a natural, usually vegetated state so as to protect the waterbody from runoff pollution. The City should evaluate and place vegetated buffers where possible in the right-of-way areas along all existing streams and creeks.

6.7.6. Stormwater Ordinance / Enforcement

As development occurs in the Easter Lake watershed, especially the southeast subbasin, actively enforce existing construction stormwater runoff regulations. Consider incentives for developers in the south-east subbasin that encourage stormwater BMPs above the minimum required by local regulation.

6.7.7. Detention Cell Buffer & Maintenance

The six existing detention cells and three planned structures as seen in Figure 5-3: Southeast Detention Basins were constructed to serve the purpose of reducing the impact of stormwater runoff into Easter Lake in accordance with the City's stormwater discharge criteria (SE Annex Study 1994). Changes in land use and development patterns around this area have increased the quantity of runoff, which can limit the effective life span of each structure. The City should manage each structure in order to maximize water quality benefits. The following are examples of management strategies to improve water quality:

- Establish a vegetated buffer around each existing detention cell to limit shoreline erosion, limit waterfowl use, and stabilize shorelines.
- Manage the right-of-way around each detention structure for accessibility of equipment used for future sediment removal.
- Disallow any residential type structures, such as boat docks, sheds, or patios, etc. in public access areas around detention structures.
- Perform a detailed bathymetric survey of each detention cell to further understand the remaining life span of each structure and provide data for a maintenance plan for each structure. Bathymetric surveys should be completed using GPS level survey equipment with data collected 50-100 feet between transects. Data should be collected at the conservation pool around the entire perimeter of each structure. For technical assistance, contact IDNR for bathymetric survey protocol.
- Consider aquatic habitat improvements during sediment removal, such as steepening shorelines to limit algae growth.

6.7.8. Additional or Miscellaneous Projects

This Plan identifies 16 main structural control projects to help achieve water quality goals in Easter Lake. However, any water quality based project in the watershed will increase the probability of meeting long term water quality goals. The stakeholders should consider additional projects located within the watershed as the opportunity arises. These types of projects could include the following:

- Hydrodynamic separators on direct outfalls to Easter Lake
- Additional storm water detention structures within the watershed (besides those in the Southeast Annex Stormwater Study)
- Retrofit existing quantity control structures to include water quality benefits
- Review all construction projects within the watershed to possibly incorporate water quality features
- Large scale parking lot rain gardens or bio-swales
- Disconnection of large impervious surface drainage from the stormwater drainage system to infiltration BMPs

6.8. Summary

In order to develop an effective water quality management plan, it is essential to identify sources of pollutants in a watershed and then evaluate BMPs that can be utilized to reduce pollutant loads and improve water quality conditions throughout the watershed. Management strategies should include a variety of practices in order to comprehensively reduce pollutant loading. This section provides a large variety of both structural and programmatic BMPs available to key stakeholders to improve Easter Lake's water quality. According to the ISU DF study, restoration will produce major benefits both to the environment of the state of Iowa and Iowa's citizens, residents, and visitors. The following are restoration benefits for Easter Lake:

- Water quality will improve to the point that excellent recreation and biological integrity will be restored
- No discharges in the watershed should yield objectionable or unsafe conditions
- Geometric mean *E. coli* and fecal coliforms should be substantially reduced
- pH should decline in mid-summer and no-longer exceed criteria during phytoplankton blooms
- Deep waters should maintain adequate oxygen conditions
- Temperatures should be cooler due to decreased radiative and biochemical heating
- Unionized ammonia concentrations should always be low, promoting quality growth of fish and other fauna
- Odor should be reduced in the lake and fish should smell fresher and be healthier
- Total phosphorus concentrations should approach much lower values that promote ecosystem health and sustainability
- Fish growth and habitat should be substantially improved
- Water transparency should approach the 4.5 feet mark
- The social and economic value of the lake will be improved
    - Normally, Iowa's restored lakes show great increases in visitation; these rates are often double pre-restoration levels
    - Economic benefits to Iowa and the community are substantially enhanced. Recent research in Iowa shows that such water quality improvement increases:
    - The value of the lake to all Iowans, and enhanced local economic benefits of an improved recreational amenity.

The following section, Implementation Strategy, lays out a road map for project stakeholders to begin construction of water quality improvement projects, establish programs that will engage property owners to take action to help reduce pollutant loading, and actions that will most effectively improve Easter Lake's water quality.