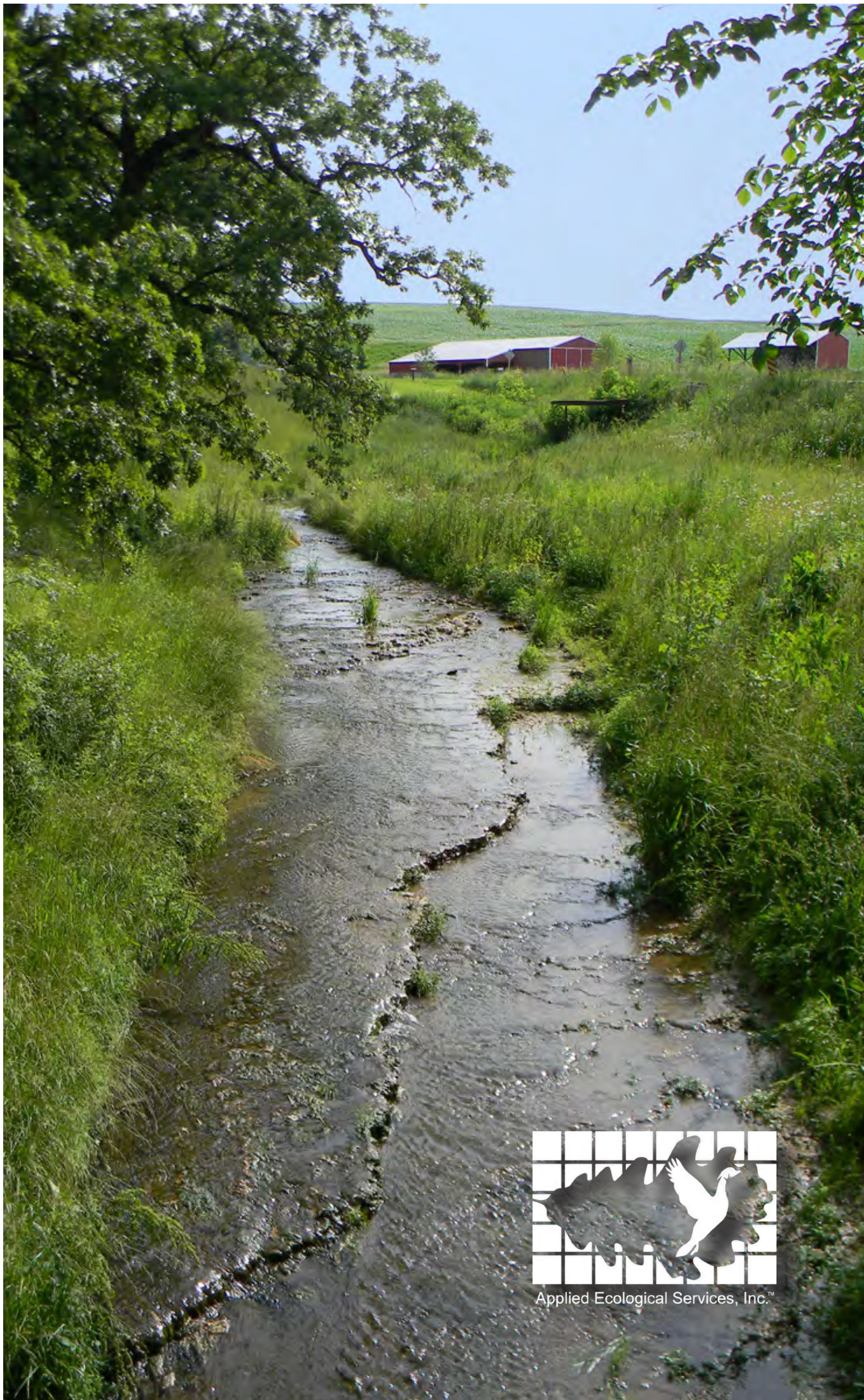
Catfish Creek Watershed Management Plan

A Guide to Protecting and Restoring Watershed Health

Prepared for
City of Dubuque
By Applied Ecological Services, Inc.
December 2014

CATFISH CREEK WATERSHED

FINAL REPORT



Applied Ecological Services, Inc.™

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CATFISH CREEK WATERSHED MANAGEMENT PLAN
Dubuque County, Iowa

A Guide for Protecting and Restoring Watershed Health

FINAL REPORT

DECEMBER 2014
(AES #12-0822)

Prepared by:

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for

CATFISH CREEK WATERSHED

Catfish Creek Watershed Management Authority
with the City of Dubuque as fiscal agent

Funding for this project provided, in part, by the Iowa Economic Development Authority.

ACKNOWLEDGEMENTS

Funding for the Catfish Creek Watershed Management Plan was provided, in part, by the Iowa Economic Development Authority (IEDA). The City of Dubuque is the recipient of the grant. Additional funding was provided by the City of Dubuque, Dubuque County, and Dubuque Soil and Water Conservation District as in-kind matches.

Dean Mattoon (City of Dubuque Engineering Department) and Eric Schmechel (Dubuque County Soil & Water Conservation District) acted as Watershed Administrators for the Catfish Creek Watershed Management Authority (CCWMA) and worked closely with watershed partners and Applied Ecological Services, Inc. (AES) to produce the watershed planning document.

Catfish Creek Watershed Management Authority (CCWMA) is governed by a Board divided among the political subdivisions comprising the watershed. Key partners include the City of Dubuque, Dubuque County, the City of Asbury, the City of Peosta, the City of Centralia, and Dubuque Soil & Water Conservation District. These partners played an important role in providing input on watershed goals & objectives, various planning approaches, and input on potential watershed projects.

Applied Ecological Services, Inc. (AES) conducted analysis, presented at CCWMA meetings, summarized results, and authored the Catfish Creek Watershed Management Plan.

People from the following entities attended and provided input at CCWMA meetings:

Applied Ecological Services, Inc.: Cecily Cunz, Steve Zimmerman
City of Asbury: Curt Kiessling
City of Dubuque: Laura Carstens, Dean Mattoon, Raki Giannakouros, Will Hoyer
City of Peosta: Pat Simon
Dubuque County: Wayne Demmer, Calvin Gatch Jr.
Dubuque Soil & Water Conservation District: Dave Rudin, Eric Schmechel
City of Centralia: Carl Reimer

All photos by Applied Ecological Services unless otherwise noted.

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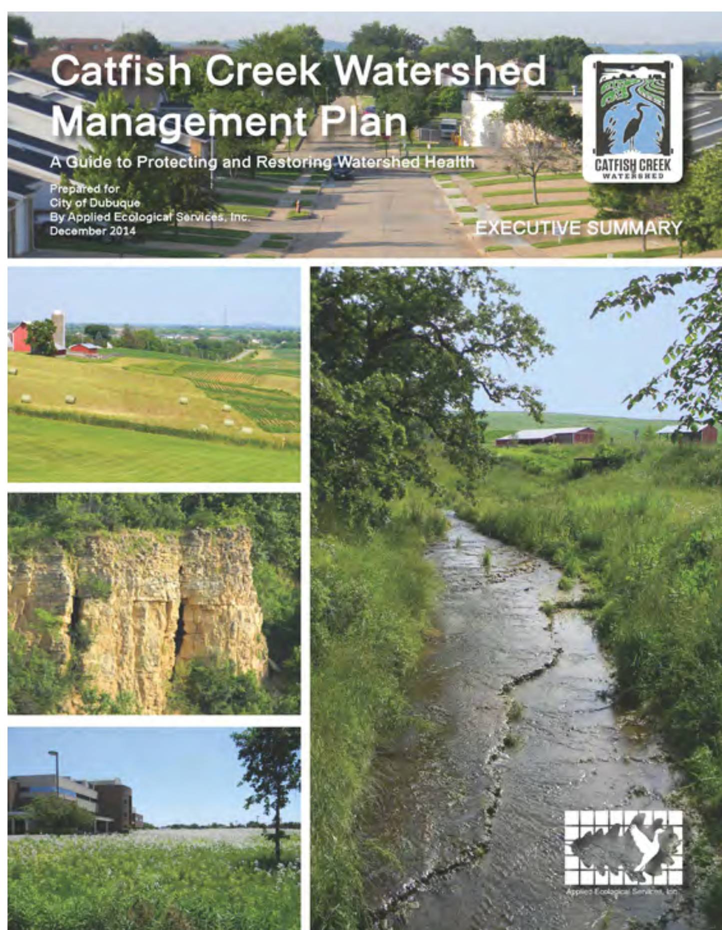

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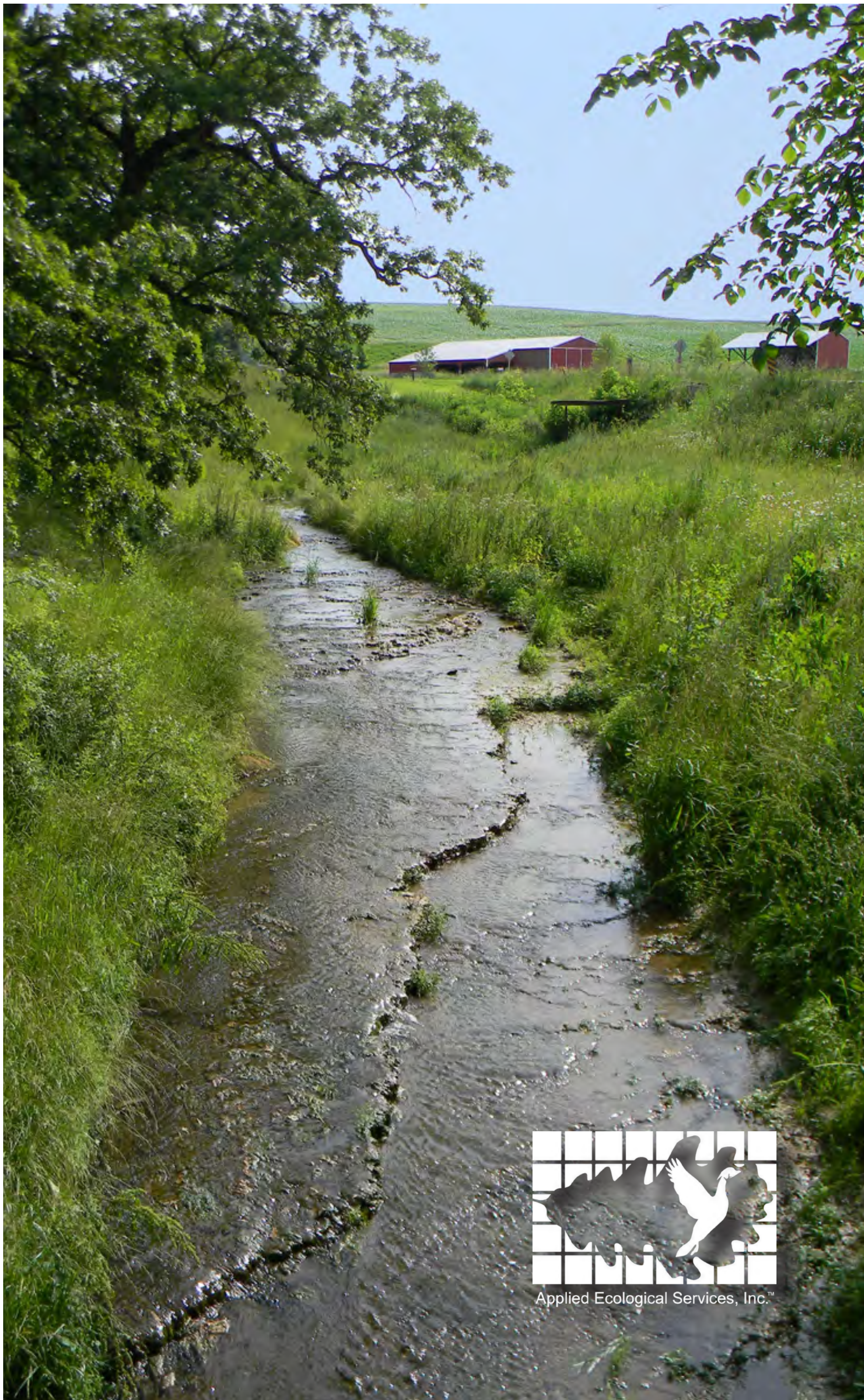
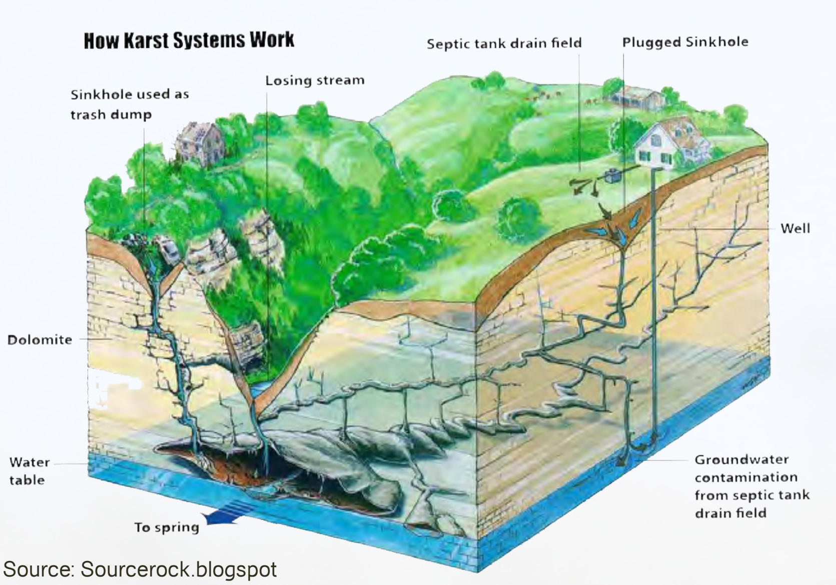
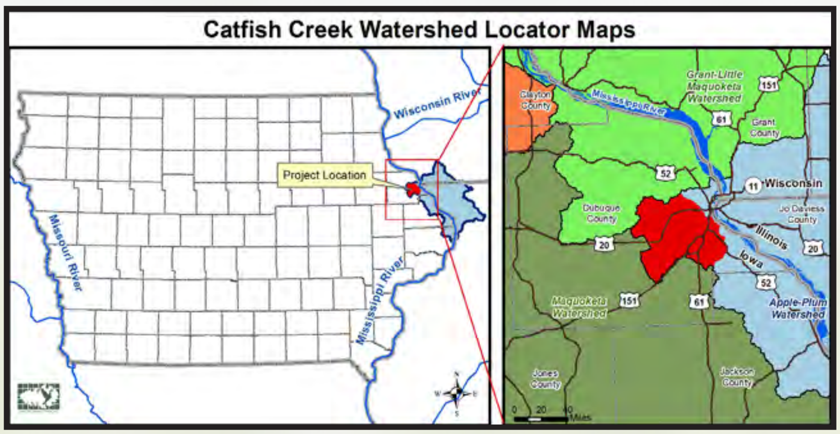
EXECUTIVE SUMMARY



Applied Ecological Services, Inc.



Source: Sourcerock.blogspot

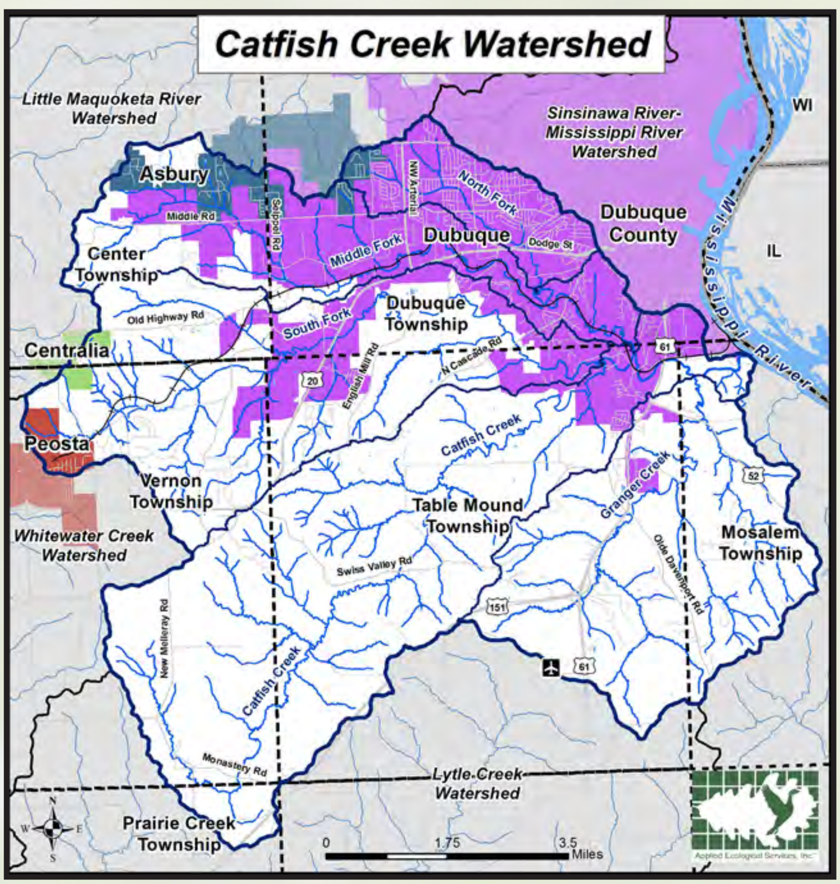


INTRODUCTION

Each of us lives, works, and plays in a watershed. A watershed is best described as an area of land where surface water drains to a common location such as a stream, river, or lake. The source of groundwater recharge to aquifers, streams, and lakes is also considered part of a watershed. Watersheds are complex systems because there is interaction between natural elements such as climate, surface water, groundwater, vegetation, wildlife, and human elements. Human influences generally produce polluted stormwater runoff, increase impervious surfaces, alter stormwater flows, and degrade or fragment natural areas.

Catfish Creek watershed (HUC 10 - #0706000501)) is located along the southwestern half of the City of Dubuque, as well as parts of Asbury, Peosta, and Centralia in Dubuque County, Iowa. Catfish Creek flows generally northeast, beginning near the City of Peosta, and enters the Mississippi River on Dubuque's south side in the Mines of Spain State Recreation Area. There are five smaller watersheds within the Catfish Creek Watershed. These include: North Fork, Middle Fork, South Fork, Granger Creek, and Catfish Creek (main stem). Catfish Creek and its many smaller tributaries account for approximately 196 stream/tributary miles that drain approximately 72 square miles (46,100 acres) of land surface. Much of the watershed remains rural. The five forks of Catfish Creek support a diverse set of plants and animals and are a draw for hunters, anglers and those seeking to enjoy some of Dubuque County's most scenic areas, but they remain threatened by large amounts of soil and nutrients entering the water from both urban and agricultural runoff.

Catfish Creek watershed is located in Dubuque County within portions of seven townships, and four municipalities (see map, left). The entire watershed is located within Dubuque County. Of the four municipalities in the watershed, the City of Dubuque has the largest share of the watershed followed by the City of Asbury, City of Peosta and the City of Centralia.



MISSION

The Catfish Creek Watershed Management Authority (CCWMA) is governed by a Board divided among the political subdivisions comprising the watershed. The Board is dedicated to the preservation, protection, and improvement of Catfish Creek watershed. The CCWMA's mission is to:

"To reduce the risks of flooding and its effects, improve water quality and promote a healthier existence for all living things that call the Catfish Creek Watershed home.

The Catfish Creek Watershed Management Authority is an organization assembled to tackle concerns with water quality and flooding on a watershed level. This means crossing jurisdictional boundaries and working together to solve problems within the entire watershed."

PURPOSE

The overall water quality condition in Catfish Creek watershed is poor. According to IDNR's 2012 Integrated Report, Catfish Creek from the mouth to the confluence with South Fork, Granger Creek, and South Fork are all impaired for either primary or secondary contact due to the presence of indicator bacteria. An unnamed tributary to Catfish Creek (CCT16) is impaired for aquatic life due to organic enrichment/low dissolved oxygen. Catfish Creek upstream of the confluence with South Fork, Middle Fork, and North Fork all have an impairment of a presumptive use (primary contact) due to the presence of indicator bacteria. Additionally, Catfish Creek from Swiss Valley Campground south for about 3 miles is classified as a Class B (CW-1) coldwater aquatic life use stream because it holds an introduced reproducing trout population. This reach is considered partially supported based on biological monitoring conducted in 2001 and 2007.

In 2012, the City of Dubuque and the Catfish Creek Watershed Management Authority (CCWMA) applied for and received Iowa Economic Development Authority (IEDA) funding to undergo a watershed planning effort and produce a comprehensive "Watershed Management Plan" for the Catfish Creek watershed that meets requirements as defined by the United States Environmental Projection Agency (USEPA). Ultimately, the intent of the planning effort is to develop and implement a Watershed Management Plan designed to achieve water quality standards. The City of Dubuque hired Applied Ecological Services, Inc. (AES) in May 2012 to develop the plan.

GOALS

Goal 1: ***Implement watershed educational and stewardship programs and increase communication and coordination among stakeholders.***

Goal 2: ***Manage and mitigate for existing and future structural flood problems.***

Goal 3: ***Protect groundwater quality and quantity and educate stakeholders on the influence of karst topography on groundwater resources.***

Goal 4: ***Protect and manage fish and wildlife habitat.***

Goal 5: ***Improve surface water quality to meet applicable standards.***

Goal 6: ***Manage natural and cultural components of the Green Infrastructure Network.***

Goal 7: ***Encourage agricultural techniques and soil conservation practices that will protect and conserve topsoil and bolster our water resources.***

THE PAST

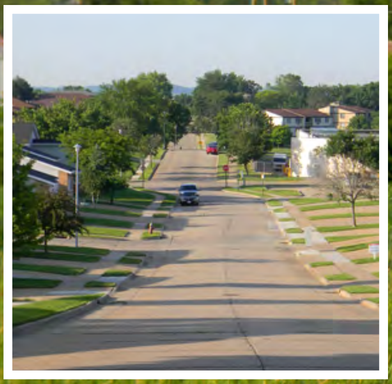
The terrain of the Midwestern United States was created over thousands of years as glaciers advanced and retreated during the Pleistocene Era. Some of these glaciers were a mile thick or more, but the area that is now Catfish Creek watershed lies in a region that was mostly unaffected by the glaciers which covered the rest of Iowa's landscape. Here the carbonate bedrock has been weathered and exposed for longer than the surrounding areas, creating unusual features such as limestone-walled valleys, high bluffs, caves, crevices, and sinkholes, as well as rock formations. This unique geology is known as karst topography. It leaves the region more vulnerable to both surface and groundwater contamination because the system is more permeable than elsewhere. The crevices and sinkholes common in the area allow for less infiltration and pollutant removal than would be found in an area without karst topography and expedited routes for pollutants to contaminate surface and groundwater resources.

The unique geology of the area has also influenced the stream characteristics of Catfish Creek. In some areas, exposed bedrock makes up the bottom of the stream channel. The coldwater portion of the main branch of Catfish Creek (also known as Upper Catfish Creek) is made possible by naturally occurring seeps that keep temperatures cool enough for trout during summer months and provide a warmer environment over winter. This high-quality, cold-water reach is one of only 30 streams in Iowa with a population of naturally reproducing brown trout.

The U.S. public land surveys of Iowa described the majority of Catfish Creek watershed as "timber," "scattering trees," or "part prairie/part timber" with some pockets of "prairie." This mixture of "timber" and "prairie" across the landscape that ecologists now refer to as savanna. A savanna typically consists of scattered trees that have canopies that range from nearly closed to fully open, with a diversified ground cover of mostly grasses and prairie species below.

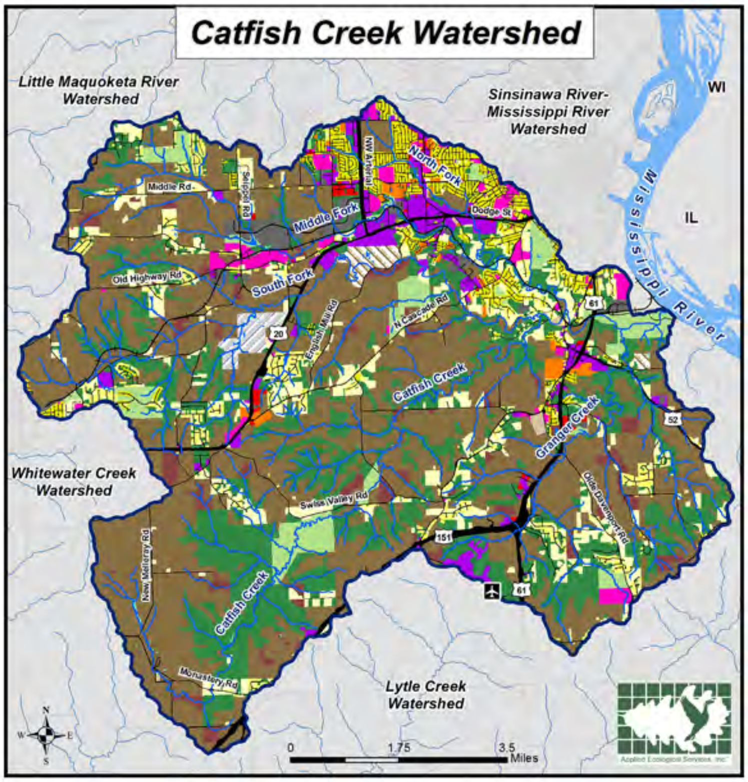
The prairie-savanna landscape was historically maintained and renewed by frequent lightning strike fires, fires ignited by Native Americans, and grazing by bison and elk. Fires ultimately removed dead plant material, exposing the soils to early spring sun, returning nutrients to the soil, and keeping woodlands confined to wetter ravines. Running through the prairie-savanna landscape were the deep valleys surrounding Catfish Creek which were carved by the run-off of melting glaciers long ago, high bluffs, caves, crevices, and sinkholes. During pre-European settlement times most of the water that fell as precipitation was absorbed in upland savanna and prairie communities and within few wetlands that existed along stream corridors.

THE PRESENT

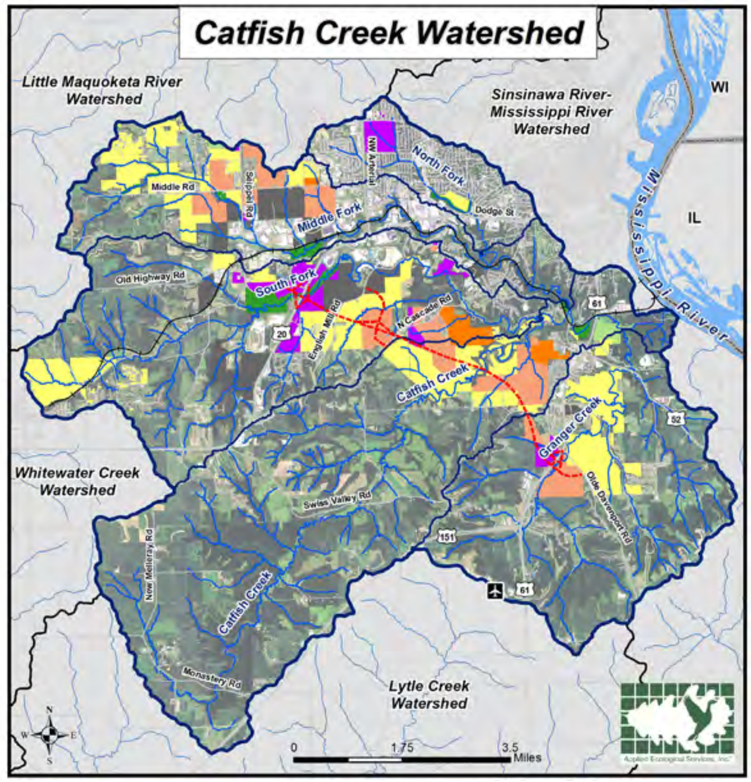


European settlement resulted in drastic changes to the fragile ecological communities. Fires no longer occurred and prairie and floodplains were tilled under or drained for farmland or developed. Row crop farming covered the vast majority of the landscape in the early 1900s, with the outskirts of Dubuque's outward urbanization appearing in the northeastern-most portion of the watershed, but before residential and commercial development seen today. Some of the woodland communities described by early settlers were still present in the late 1930's along the stream channels but farmland replaced most of the savanna and prairie communities. With the advent of farming came significant changes in stormwater runoff.

Today residential and commercial development has replaced some of the farmland in the watershed. Stands of remnant woodlands persist but are fragmented by residential development and farming.



EXISTING 2012 LAND USE/LAND COVER



FUTURE LAND USE/LAND COVER

THE FUTURE

Predicted future land use changes show that the largest loss of current land use/land cover is expected to occur on agricultural land where approximately 6,919.1 acres of the existing 21,590.6 acres (15% decrease) is expected to be converted to mostly residential and industrial land uses. The majority of these changes are expected to occur in the northern half of the watershed within the City of Dubuque and the areas surrounding the Southwest Arterial extension. In addition, existing open space is also expected to decrease from 10,060.4 acres to 9,107.6 acres in the future, a 952.8-acre decrease. However, it is important to note that 111.4 acres of public parks/golf courses are expected to be created.

Land Use

- Ag - Livestock
- Ag - Row Crop
- Cemetery
- Commercial
- Industrial
- Institutional
- Landfill
- Office Space
- Open Space
- Park/Golf Course
- Quarry
- Residential - Multi-Family
- Residential - Mixed
- Residential - High Density (< 1/2 acre)
- Residential - Medium Density (1/2 - 1 acre)
- Residential - Low Density (> 1 acre)
- Transportation
- Water
- Wetland

CHALLENGES & THREATS

Surface Water

- All five branches of Catfish Creek watershed exceed recommended water quality criteria for nitrogen, phosphorus, and sediment.
- Additionally, South Fork, Catfish Creek, and Granger Creek exceed recommended *E.coli* guidelines.

Agricultural Land

- Agricultural land use in the watershed is the single largest contributor of nitrogen (58%), phosphorus (64%), and sediment (57%) to streams, followed by streambank erosion and urban land use.
- 71% of stream reaches in the watershed are at least moderately eroded.
- Where livestock is kept, they are often allowed free access to streambanks, contributing to sediment and phosphorus loading.
- While some farms in the watershed utilize conservation practices, much more prevalent use of these practices needs to be implemented throughout the watershed in order to achieve water quality targets.

Land Use

- The region's karst topography makes the watershed more vulnerable to both surface and groundwater contamination.
- Overall development policy among the watershed communities does not adequately protect green infrastructure.
- Two mulch processing facilities within the watershed drain directly to adjacent streams without additional filtration.

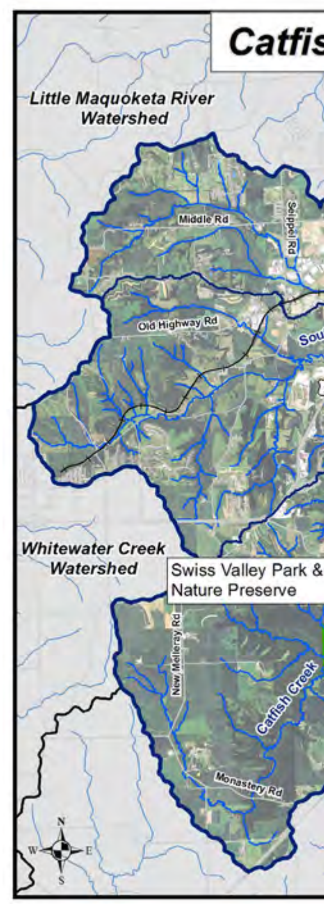
IMPORTANT NATURAL AREAS

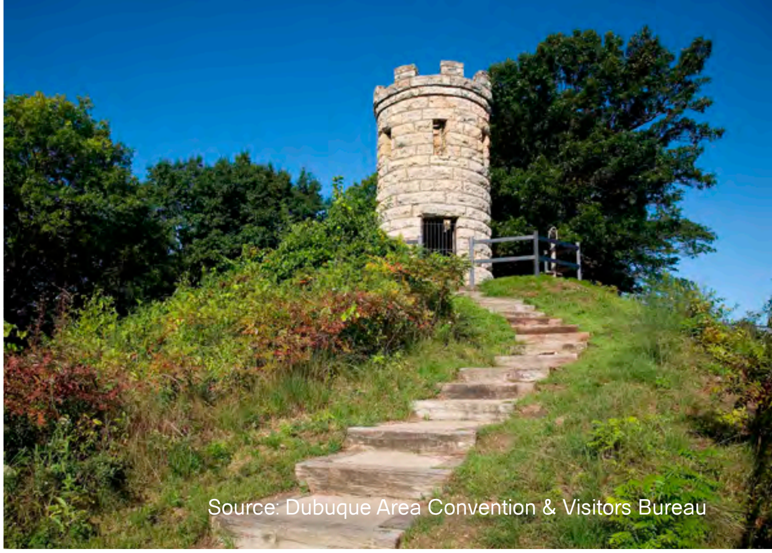
SWISS VALLEY NATURE PRESERVE

Swiss Valley Nature Preserve is a 476-acre site owned by the Dubuque County Conservation Board and located in the southwestern portion of the watershed. The park is home to a large portion of Catfish Creek, as well as remnant woodlands, a restored prairie and the administrative headquarters of the Dubuque County Conservation Board.

The portion of Catfish Creek that winds through the park (also known as Upper Catfish Creek) is made possible by naturally occurring seeps that keep temperatures cool enough for trout during summer months and provide a warmer environment over winter. The Iowa Department of Natural Resources (IDNR) has labeled the Upper Catfish Creek as a cold-water-Class “B” stream from Swiss Valley Park Campgrounds south approximately 3 miles. This high-quality, cold-water reach is one of only 30 streams in Iowa with a population of naturally reproducing brown trout. It is also stocked with trout annually by the Iowa Department of Natural Resources. Work to stabilize 3,000 feet of streambank within the preserve, plant native grasses, and install 35 fish hides to improve habitat along this reach was completed by Dubuque County Conservation Board.

Elsewhere in the preserve, 10 miles of hiking trails, many of which are groomed for cross-country skiing in the winter, work their way through the prairie, savanna, and woodland landscapes. The preserve houses many of the distinct features associated with the Paleozoic Plateau, including an abundance of naturally occurring sinkholes which provide excellent habitat for both common and uncommon species. A remnant woodland remains untouched from pre-settlement times, containing red and white oaks, shagbark hickory, walnut, white ash, elm, and quaking aspen, as well as a mature maple-basswood forest. Many of the trees in this area are more than 200 years old.

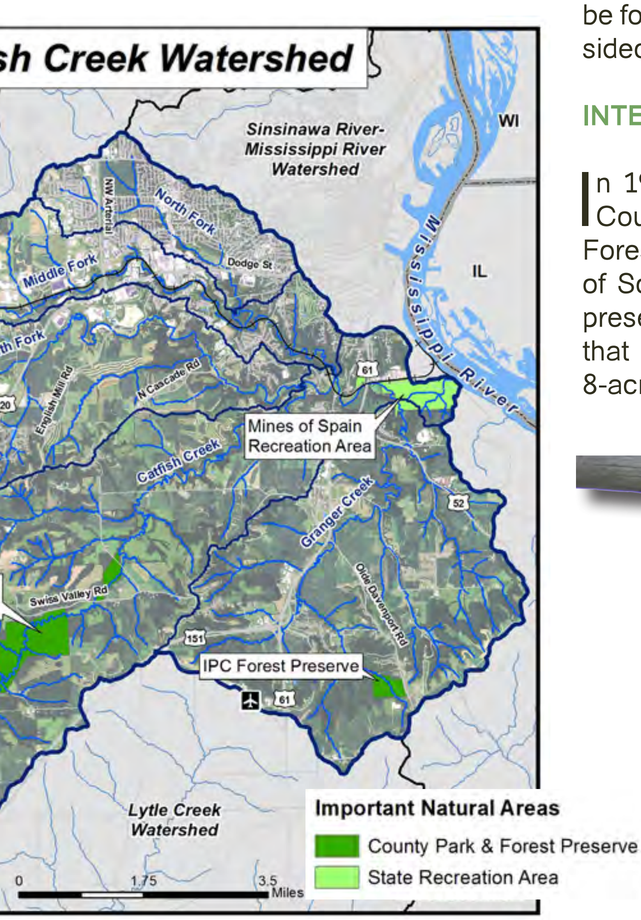




MINES OF SPAIN RECREATION AREA

Mines of Spain Recreation Area consists of 1,300 acres south of the City of Dubuque including the mouth of Catfish Creek and south along the Mississippi River and it is owned by Iowa Department of Natural Resources. Approximately the northern half of this area is designated by IDNR as the Catfish Creek Preserve. Only a 275- acre portion of Mines of Spain Recreation Area/Catfish Creek Preserve falls within the Catfish Creek watershed, but it includes many important natural features.

The preserve is predominantly an oak forest, with paper birch, quaking aspen, maple-basswood forest, juniper groves, and hill prairies also represented. A wide variety of plants can be found within the preserve over the course of the year. Spring flora within the woodlands include jack-in-the-pulpit, spring beauty, hepatica, blood root, wild ginger, false Solomon's seal, pasqueflower, plantain-leaved pussytoes, hoary puccoon, violet wood sorrel, and alumroot. The woodland understory also harbors Indian pipe as well as a number of ferns including such varieties as rattlesnake, maidenhair, ebony spleenwort, lady, silvery glade, fragile, crested wood, spinulose wood, walking, bulblet, and cliffbrake. In summer prairie coreopsis, pale-spiked lobelia, round-headed bush clover, and pale purple coneflower can be found blooming in prairie areas, followed by sky-blue aster, rough blazing star, sideoats grama, big and little bluestem, and Indian grass in the fall.

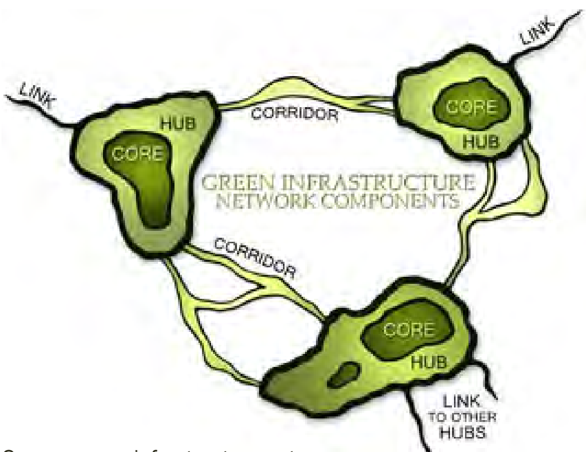


INTERSTATE POWER COMPANY FOREST PRESERVE

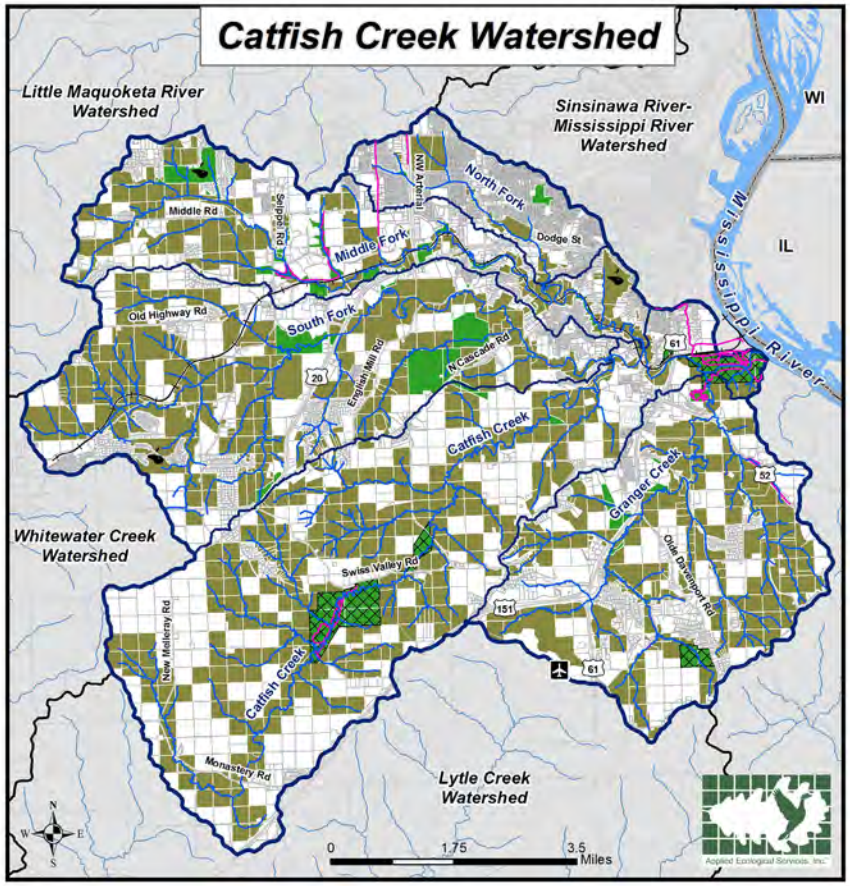
In 1988, Interstate Power Company (IPC) donated 82 acres to the Dubuque County Conservation Board, hence the name Interstate Power Company Forest Preserve. The preserve is located on Olde Davenport Rd. just north of Schueller Heights Rd. IPC still maintains a substation on the site, but the preserve is predominantly a oak woodland with ravines and spring-fed streams that eventually make their way to Granger Creek. Some rolling grassland, an 8-acre restored prairie, and a 1.5-mile trail can also be found on the site.

GREEN INFRASTRUCTURE & YOUR LAND

A Green Infrastructure Network is a connected system of natural areas and other open space that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to wildlife and people. The network (see map, below) is made up of hubs and linking corridors. Hubs generally consist of the largest and least fragmented areas such as Swiss Valley Nature Preserve, Mines of Spain Recreation Area, Interstate Power Company Preserve, large agricultural areas, and golf courses. Corridors are generally formed by the wooded stretches along many of the developed reaches of Catfish Creek and tributaries. Corridors are extremely important because they provide biological conduits between hubs. However, most parcels forming corridors are not ideal green infrastructure until residents and land owners embrace the idea of managing stream corridors or creating backyard habitats.



Source: greeninfrastructure.net



GREEN INFRASTRUCTURE NETWORK

- Existing Recreational Trails
- Important Natural Areas
- Protected Green Infrastructure
- Unprotected Green Infrastructure
- Golf courses

RAIN BARREL

RAIN GARDEN

If a portion of a stream runs through your land, here are some tips to help properly manage your piece of the green infrastructure network:

1. **MANAGE FERTILIZER USE**
   Avoid over fertilizing agricultural fields and lawns adjacent to streams and only use nutrients when soil testing shows that it is necessary.
2. **MANAGE LIVESTOCK ACCESS**
   Where possible, fence streams, create crossings, and/or utilize pasture rotation to manage livestock access to streams and streambanks.
3. **REMOVE NON-NATIVE SPECIES**
   Identify and remove plants that are out of place (see photo guide, right).
4. **PLANT NATIVE VEGETATION**
   Plants adapted to the Midwest climate can help control erosion by stabilizing banks.
5. **A NATURAL, MEANDERING STREAM IS A HAPPY STREAM**
   Work with experts to restore degraded stream reaches.

Source: Appalachian Traveller.

Any property owner can improve green infrastructure. Create a safe place for wildlife by providing a few simple things such as food, water, cover, and a place for wildlife to raise their young. The National Wildlife Federation's Certified Wildlife Habitat® program can help you get started. Golf courses can become certified through the Audubon Cooperative Sanctuary Program.

Creating a rain garden, or a small vegetated depression, to capture water is another way of promoting infiltration while beautifying your yard and providing additional habitat. Disconnecting your roof downspouts and capturing that runoff in rain barrels not only reduces the amount of runoff entering streams, but also serves as a great source of water for irrigating your yard.

STREAM RESTORATION

REMOVE THESE NON-NATIVE AND INVASIVE SPECIES

COMMON REED

BUCKTHORN

Source: Loras.edu.

REED CANARY GRASS

PURPLE LOOSESTRIFE

GARLIC MUSTARD

TEASEL

ACTION RECOMMENDATIONS

The Catfish Creek Watershed-Based Plan includes an "Action Plan" developed to provide stakeholders with recommendations to specifically address plan goals. The Action Plan includes two subsections: programmatic recommendations and site specific recommendations. Programmatic recommendations are general remedial, preventative, and regulatory watershed-wide actions. Site specific recommendations include actual locations where projects can be implemented to improve surface and groundwater quality, green infrastructure, and habitat. Programmatic recommendations and site specific High Priority-Critical Areas are discussed in this section.

POLICY TYPE PROGRAMMATIC RECOMMENDATIONS

Plan Adoption and/or Support & Implementation Policy Recommendations

- Watershed Partners adopt the Catfish Creek Watershed Management Plan and incorporate plan goals, objectives, and recommended actions into comprehensive plans and ordinances.

Green Infrastructure Network Policy Recommendations

- Each municipality incorporates the identified Green Infrastructure Network into comprehensive plans and development review maps.
- Amend municipal comprehensive plans and zoning ordinances to include a Catfish Creek Watershed Protection Overlay that requires Conservation Design or Low Impact standards for all development and redevelopment located on identified Green Infrastructure Network parcels.
- Require Watershed Protection Fees in all municipalities in the form of Development Impact Fees and/or Special Service Area (SSA) taxes for all new and redevelopment to help fund management of green infrastructure components within developments.
- Require developers to protect sensitive natural areas, restore degraded natural areas and streams, then donate all natural areas and naturalized stormwater management systems to a public agency or conservation organization for long term management with dedicated funding.
- Establish incentives for developers who propose sustainable or innovative approaches to preserving green infrastructure and using naturalized stormwater treatment trains.
- Require mitigation for wetlands lost to development to occur within the watershed.

Road Salt Policy Recommendations

- Each municipality/township supplement existing programs with deicing best management practices such as utilizing alternative deicing chemicals, anti-icing or pretreatment, controlling the amount and rate of spreading, controlling the timing of application, utilizing proper application equipment, and educating/training deicing employees.

Lawn Fertilizer Policy Recommendations

- Municipalities/townships create regulations banning phosphorus unless soil testing pre-application proves necessary.

Stormwater Management Facility Policy Recommendations

- *Require new development and redevelopment to use stormwater management facilities that serve multiple functions including storage, water quality benefits, infiltration, and wildlife habitat.*
- *Require reduced runoff volume from new and retrofitted detention basins.*

Native Landscaping/Natural Area Restoration

- Allow native landscaping within local ordinances and ensure local "weed control" ordinances do not discourage or prohibit native landscaping.

OTHER PROGRAMMATIC RECOMMENDATIONS FOUND IN THE PLAN

- Dry & Wet Bottom Detention Basin Design/Retrofits, Establishment, & Maintenance
- Stream & Riparian Area Restoration & Maintenance
- Natural Area Restoration & Native Landscaping
- Conservation & Low Impact Development
- Agricultural Management Practices
- Rainwater Harvesting & Re-use
- Green Infrastructure Planning
- Vegetated Swales (bioswales)
- Septic System Maintenance
- Vegetated Filter Strips
- Wetland Restoration
- Pervious Pavement
- Street Sweeping
- Rain Gardens

HIGH PRIORITY-CRITICAL AREA SITE SPECIFIC PROJECT RECOMMENDATIONS

Detention Basin Retrofits & Maintenance

A number of detention basins can be retrofitted by naturalizing with native vegetation. Naturalized basins improve water quality from developed areas, improve habitat, and require less maintenance. Seven detention basins were identified as High Priority-Critical Areas in the watershed.

Wetland Restoration

Wetland restoration sites are generally associated with large areas that were historically wetland prior to European settlement in the 1830s but were drained for agricultural purposes. Fourteen High Priority-Critical Area wetland restoration sites were identifiied, many of which can be restored by breaking existing drain tiles and planting with native vegetation.

Streambank, Channel, & Riparian Restoration

Fifty-nine stream reaches have been identified as High Priority-Critical Areas because they exhibit highly eroded banks or degraded channel conditions that are a major source of both nutrients and total suspended solids (sediment). Streambank stabilization and channel restoration using bioengineering, as well as adjacent riparian area restoration, will reduce pollutants and improve habitat.

Green Infrastructure Protection Areas

Thirty-five green infrastructure protection areas have been selected in the watershed after careful review of their location within the green infrastructure network and predicted land use changes. Most parcels are undeveloped agricultural land, about half of which are planned for future development. The recommendation is that these parcels be preserved or developed using conservation or low impact development designs.

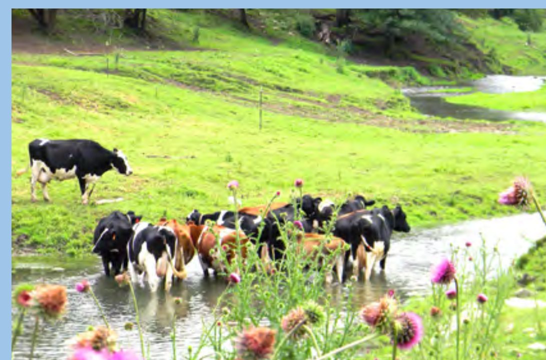
Agricultural Management Practices

Agricultural measures would greatly reduce pollutant loading in the watershed. Recommendations in the plan include conservation tillage (no till) and vegetated swales for cropland and fencing to manage stream access and waste management on livestock operations. Forty-three agricultural areas were identified as High Priority-Critical Areas for potential pollutant reduction based on the results of the watershed inventory.

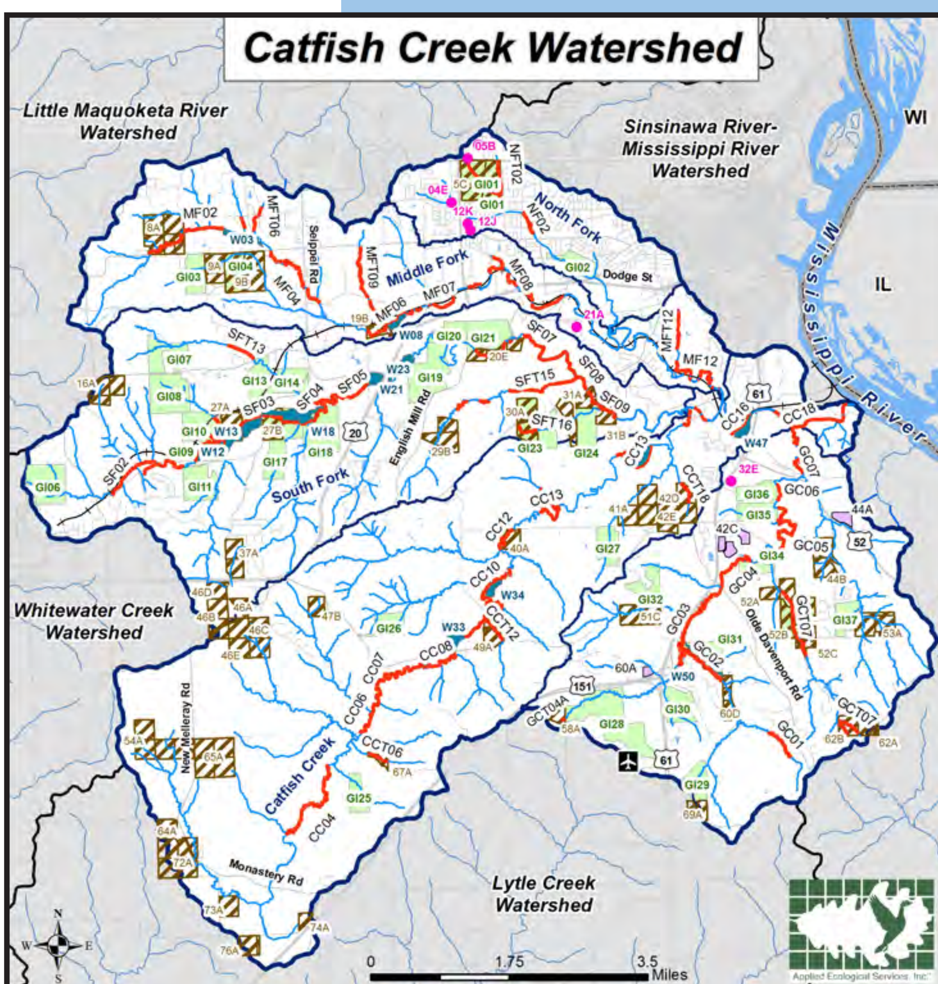
Other Management Measures

As a result of the watershed inventory, three critical areas that fall under the category of "other" management measures were found. They include an area where parking lot BMPs are needed, as well as two mulch processing facilities that drain directly to adjacent streams.

Stabilize and restore degraded streambanks and riparian areas



Fence streams to restrict cattle access and reduce sediment and pollutant loading



Critical Area Types

- Detention Basins
- Wetland Restoration
- Streambank, Channel, & Riparian
- Agricultural Land
- Green Infrastructure Protection Areas
- Other Management Measures

For more information, go to **www.catfishcreekwatershed.org**

How can *you* help Catfish Creek?

Agricultural Community

- ☐ Consult your local Natural Resources Conservation Service (NRCS) office regarding enrollment in conservation programs to help reduce soil erosion, enhance water supplies, improve water quality, increase habitat, and reduce flood damages.

Residents, Land Owners, & Businesses

- ☐ Reduce fertilizer use - only use fertilizer when testing shows it is needed.
- ☐ Use less salt on driveways, parking lots, and sidewalks during winter months.
- ☐ Use native landscaping to decrease watering needs and maintenance.
- ☐ Install rain gardens and use rain barrels to reduce stormwater runoff.
- ☐ Manage your land as part of the green infrastructure network.
- ☐ Attend meetings with decision makers to express concerns about the watershed.
- ☐ Attend watershed education and participation events.
- ☐ Build a sense of community in your neighborhood around Catfish Creek and the watershed.

Municipalities & Townships

- ☐ Adopt the Catfish Creek Watershed Management Plan & inform the public that a plan has been developed.
- ☐ Incorporate watershed plan goals and recommended actions into local comprehensive plans, zoning overlays, codes, and ordinances.
- ☐ Build “demonstration projects,” or large-scale water quality & public education projects, near public facilities.
- ☐ Distribute materials to help residents manage streams and green infrastructure in their backyards.

Catfish Creek Watershed Management Authority

- ☐ Identify “champions” to participate at future Catfish Creek watershed meetings, pursue projects, and to evaluate watershed plan implementation progress.
- ☐ Hire a Watershed Implementation Coordinator to lead plan implementation.

CATFISH CREEK WATERSHED

Watershed Coordinators & CCWMA Administrators:

Dean Mattoon
City of Dubuque

Eric Schmechel
Dubuque Soil & Water Conservation District

Executive Summary Produced by:

Applied Ecological Services, Inc.

All photos by AES unless otherwise noted.

THE CITY OF DUBUQUE *Masterpiece on the Mississippi* · Dubuque County Soil & Water Conservation District · The County of Dubuque · Friends of the Dubuque County Conservation Board, Inc · Keep Dubuque County Clean & Green · United States Environmental Protection Agency · Dubuque County Conservation Board — Something for Everyone · Peosta · City of Asbury · IOWATER Volunteer Water Quality Monitoring · GreenDubuque · IOWA economic development · DNR

1.0 Introduction

1.1 Catfish Creek Watershed Setting

People live, work, and recreate in areas of land known as "Watersheds". A watershed is best described as an area of land where surface water drains to a common location such as a stream, river, or other body of water such as a lake (Figure 1). The source of groundwater recharge to streams, rivers, and lakes is also considered part of a watershed. Despite the simple definition for a watershed, they are complex in

Figure 1. How a Karst watershed system works.

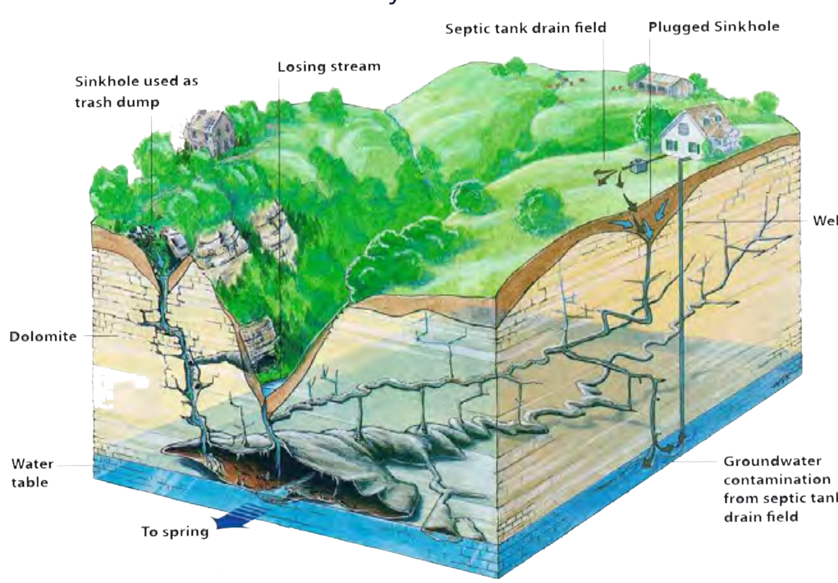
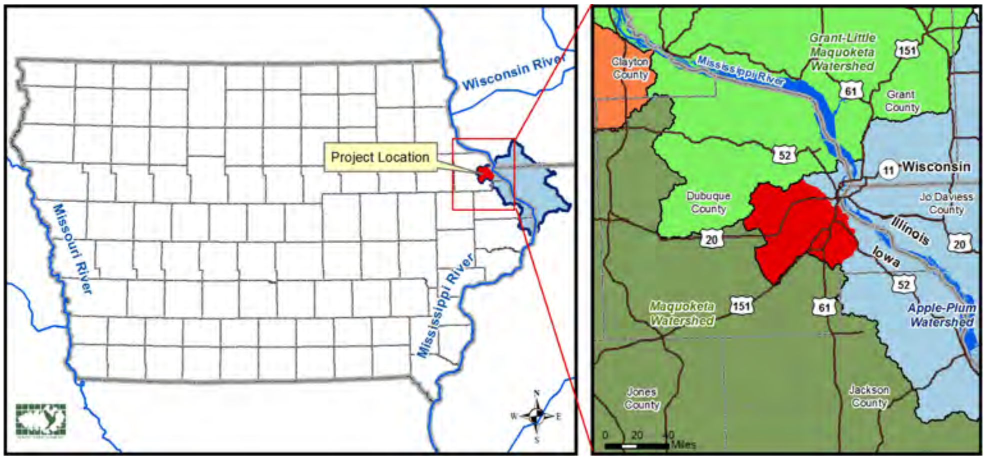


Figure 2. Catfish Creek watershed locator maps.



that there is interaction between natural elements such as climate, surface water, groundwater, vegetation, and wildlife and human elements such as agriculture and urban development that produce polluted stormwater runoff, increase impervious surfaces thereby altering stormwater flows, and degrade or fragment natural areas. Other common names given to watersheds, depending on size, include basins, sub-basins, subwatersheds, and Subwatershed Management Units (SMUs).

Catfish Creek watershed (HUC 10 - #0706000501)) is located along the southwestern half of the City of Dubuque, as well as parts of Asbury, Peosta, and Centralia in Dubuque County, Iowa (Figure 2). Catfish Creek flows southeast, beginning near the City of Peosta, and enters the Mississippi River on Dubuque's south side in the Mines of Spain state park. There are five smaller watersheds within the Catfish Creek Watershed. These include: North Fork, Middle Fork, South Fork, Granger Creek, and Catfish Creek (main stem). Catfish Creek and its many smaller tributaries account for approximately 195.6 stream/tributary miles that drain approximately 72 square miles (46,100 acres) of land surface. Much of the watershed remains rural. The five forks of Catfish Creek support a diverse set of plants and animals and are a draw for hunters, fishers and those seeking to enjoy some of Dubuque County's most scenic areas, but they remain threatened by large amounts of soil and nutrients entering the water from both urban and agricultural runoff.

Pre-European settlement ecological communities in the Catfish Creek watershed and surrounding area were balanced ecosystems with clean water and diverse with plant and wildlife populations. The landscape consisted of forest, oak savanna and open prairie across most of the region, with more densely wooded areas along the steeper slopes adjacent streams and tributaries. The land was largely maintained and shaped by frequent fires ignited by both lightning and the Native Americans that inhabited the area. Herds of bison and elk also helped maintain the ecosystem via large scale grazing. During these times most of the water that fell as precipitation was absorbed in prairie and wooded communities and within the floodplain wetlands that existed along stream and tributary corridors. Ecological conditions changed drastically following European settlement in the early 1800s. Large scale fires no longer occurred and bison and elk were extirpated. Significant portions of wooded communities and nearly all prairie was tilled as farming became the primary land use by the early 1900s.

Depiction of Pre-European prairie & woodland landscape at Mines of Spain

Urbanization within and surrounding Dubuque and the conversion of some farmland to primarily residential and commercial uses followed and continues to this day. Along with the urban area the stream encompasses, the creek meanders through the three significant natural resources within the watershed, Swiss Valley Park, the Swiss Valley Nature Preserve, and the Mines of Spain State Park. Traditional farming and development patterns, as well as general landscape changes, have taken their toll on the environment in Catfish Creek watershed. While some farms practice excellent agricultural land practices such as vegetated swales, contour cropping, and no-till farming, many do not. In some areas, cattle and other livestock are allowed direct and unrestrained access to streambanks, exacerbating erosion and pollutant loading. Where typical residential development has replaced farmland, increased impervious surfaces have greatly reduced the ability of precipitation to infiltrate into the ground and instead have caused stormwater runoff to quickly reach streams and tributaries resulting in downcutting, widening, and bank erosion causing sediment and nutrient loading downstream. Meanwhile, degraded woodland areas and invasive species establishment is causing loss of wildlife habitat and reduced floodplain function. Discharged water from various sources that is not properly filtered is referred to as "non-point source pollution" and is the primary focus of this plan.

According to the Iowa Department of Natural Resources' (DNR's) 305(d) report, a portion of the creek within the park and preserve is classified as a Class B (CW) stream. This section of stream is classified as cold-water and has naturally reproducing trout (one of only 30 streams in Iowa with this capability). The recreational activities in the Catfish Creek watershed are abundant, but threatened. The DNR's 2012 305(b) report shows that for the mouth of Catfish Creek to the confluence of the South Fork and for the South Fork branch, water quality is not supporting for the Designated Use of "Primary Contact Recreation" due to pathogens. The cold-water section, or headwaters, of Catfish Creek's main branch are only partially supporting the Designated Use of "Aquatic Life Support" due to siltation and other habitat alterations.

The Catfish Creek Watershed Management Authority formed in June of 2012. The group's mission statement is "To reduce the risks of flooding and its effects, improve water quality and promote a healthier existence for all living things that call the Catfish Creek Watershed home. The Catfish Creek Watershed Management Authority is an organization assembled to tackle concerns with water quality and flooding on a watershed level. This means crossing jurisdictional boundaries and working together to solve problems within the entire watershed. (CCWMA, 2013)" As part of achieving that mission, the CCWMA decided to move forward with completing a watershed management plan in order to protect and restore the Catfish Creek watershed.

Watershed at a Glance

- Available data shows Catfish Creek to be impaired due to nutrients, sediment, and *E. coli*.
- Catfish Creek and its tributaries account for approximately 72 square miles (46,100 acres) of land surface in Dubuque County, Iowa.
- Oak savanna and prairie were the primary land cover types prior to the 1830s.
- There were 4,784 acres of wetlands prior to European settlement; 99 acres or 2% remain.
- The dominant land use types in 2012 include agricultural row crop/hay, open space, and residential.
- The watershed includes the municipalities of Dubuque, Asbury, Peosta, and Centralia. Dubuque comprises 22% of the watershed.
- The estimated population of the watershed in 2010 is over 56,000 and expected to increase to over 80,000 by 2035.
- A portion of Catfish Creek within Swiss Valley Nature Preserve is designated as a coldwater stream and home to naturally reproducing brown trout, one of only 30 such streams in the state.
- FEMA's 100-year floodplain covers 2,601 acres or 6% of the watershed.
- 29% of streams and tributaries exhibit minimal bank erosion; 71% are moderately to highly eroded.
- There are 88 detention basins. Only 7 (8%) provide "Good" ecological and water quality benefits.
- The use of conservation-type agricultural management practices needs to be increased in the watershed. Forty-three parcels were identified needing implementation of some combination of no-till farming, vegetated swales, fencing to restrict livestock access to streams, and waste management system.

1.2 Project Scope & Purpose

In 2012, the City of Dubuque and the Catfish Creek Watershed Management Authority (CCWMA) applied for and received Iowa Economic Development Authority (IEDA) funding to undergo a watershed planning effort and produce a comprehensive "Watershed Management Plan" for the Catfish Creek watershed that meets requirements as defined by the United States Environmental Projection Agency (USEPA). Ultimately, the intent of the funding is to develop and implement Watershed Management Plans designed to achieve water quality standards. The City of Dubuque hired Applied Ecological Services, Inc. (AES) in May 2012 to develop the plan.

The watershed planning process is a collaborative effort involving voluntary stakeholders with the primary scope to restore impaired waters and protect unimpaired waters by developing an ecologically-based management plan for Catfish Creek watershed that focuses on improving water quality by identifying on-the-ground projects that can improve water quality, protecting green infrastructure, creating protection policies, implementing ecological restoration, and educating the public. Another important outcome is to improve the quality of life for people in the watershed for current and future generations.

The primary purpose of this plan is to spark interest and give stakeholders a better understanding of Catfish Creek watershed to promote and initiate plan recommendations that will accomplish the goals and objectives of this plan. This plan was produced via a comprehensive watershed planning approach that involved input from stakeholders and analysis of complex watershed issues by Applied Ecological Service's watershed planners, ecologists, GIS specialists, and environmental engineers.

CCWMA held regular, public meetings the second half of 2013 and throughout 2014 to guide the watershed planning process by establishing goals and objectives to address watershed issues and to encourage participation of stakeholders to develop planning and support for watershed improvement projects and programs.

Interests, issues, and opportunities identified by CCWMA were addressed and incorporated into the Watershed-Based Plan. The plan acknowledges the importance of managing remaining green infrastructure to meet many of the goals and objectives in the plan and provides scientific and practical rational for protecting appropriate natural resources and green infrastructure from traditional development practices and entering into relationships with public, private, and non-profit entities to manage these properties to maximize watershed benefits. In addition, ideas and recommendations in this plan are designed to be updated through adaptive management that will strengthen the plan over time as additional information becomes available.

1.3 USEPA Watershed Management Plan Requirements

In March 2008, the United States Environmental Protection Agency (USEPA) released watershed protection guidance entitled "Non-point Source Program and Grant Guidelines for States and Territories." The document was created to ensure that Watershed Management Plans and projects make progress towards restoring waters impaired by non-point source pollution. Applied Ecological Services, Inc. consulted USEPA's "Handbook for Developing Watershed Plans to Restore and Protect Our Waters" (USEPA 2008) and Iowa DNR's "Watershed Management Action Plan: DNR Guidebook" (DNR 2009) to create this watershed plan. Having a Watershed Management Plan will allow Catfish Creek watershed stakeholders to access 319 Grant funding for watershed improvement projects recommended in this plan. Under USEPA guidance, "Nine Elements" are required in order for a plan to be considered a Watershed Management Plan.

USEPA Nine Elements

Element A: Identification of the causes and sources or groups of similar sources of pollution that will need to be controlled to achieve the pollutant load reductions estimated in the watershed-based plan;

Element B: Estimate of the pollutant load reductions expected following implementation of the management measures described under Element C below;

Element C: Description of the BMPs (non-point source management measures) that are expected to be implemented to achieve the load reductions estimated under Element B above and an identification of the critical areas in which those measures will be needed to implement

Element D: Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan;

Element E: Public information/education component that will be implemented to enhance public understanding of the project and encourage early and continued participation in selecting, designing, and implementing/maintaining non-point source management measures that will be implemented;

Element F: Schedule for implementing the activities and non-point source management measures the plan; identified in this plan that is reasonably expeditious;

Element G: Description of interim, measurable milestones for determining whether non-point source management measures or other control actions are being implemented;

Element H: Set of environmental or administrative criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards;

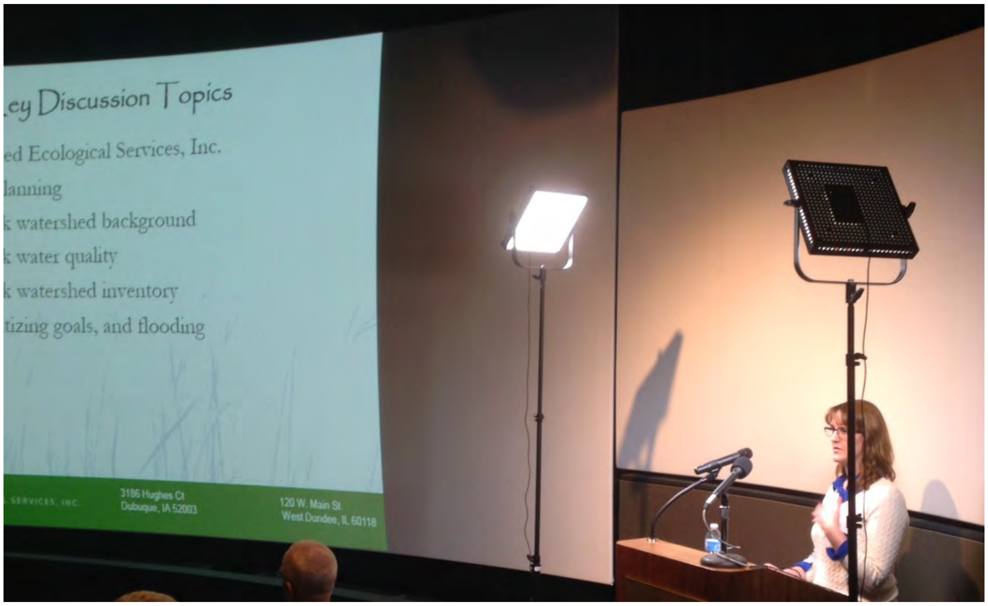
Element I: Monitoring component to evaluate the effectiveness of the implementation efforts over time.

1.4 Planning Process

Watershed Management Authority

The Catfish Creek Watershed Management Authority (CCWMA) first met in July 2013 to kickoff the watershed planning process. At this meeting, Applied Ecological Services, Inc. (AES) provided stakeholders with an overview of the steps involved in the watershed planning process. The CCWMA Watershed Coordinator engaged stakeholders by explaining how their input and participation would benefit the overall outcome of the project. Volunteer stakeholders representing CCWMA met 10 times throughout the planning process. The board consisted of representatives from each municipality in the watershed, Dubuque County, and Dubuque Soil and Water Conservation District.

The CCWMA developed goals and objectives for the watershed and identified problem areas and opportunities. Meetings were initiated by the Watershed Coordinator and generally covered one or more watershed topics. Meetings were devoted to watershed assessment findings, development of goals and objectives, and action plan items. A list of the meetings is summarized in Table 1. Complete meeting minutes are included in Appendix A.



Catfish Creek watershed stakeholder meeting during the Dubuque Low Impact Development Conference.

Table 1. Catfish Creek Watershed Management Authority (CCWMA) meeting schedule.

Date	Agenda	Summary
July 23, 2013	• Watershed Planning Summary	AES summarized to CCWMA "Elements" needed in a USEPA approved watershed plan.
Oct. 22, 2013	• Watershed Field Inventory Results • Detention Basin Discussion • Ag Land Mgmt Discussion • How to get properties in Action Plan	AES summarized the results of the "Watershed Resource Inventory" field investigation. A discussion was held regarding the importance of various restoration practices in the watershed and about potential projects to be included in the plan.
Dec. 3, 2013	• Geology & Soils • Important Natural Areas • Jurisdictions • Demographics • Existing & Future Land Use • Impervious Cover • Green Infrastructure Network	AES presented stakeholders with existing background watershed information including geology, soils, important natural areas, jurisdictions, demographics, land use, impervious cover, and the green infrastructure network.
Feb. 18, 2014	• Impairments • Numeric water quality standards • Chemical & Physical Sampling • Biological Sampling • Pollutant Loading Model • "Hot Spot" SMUs • Goal Topics	AES updated stakeholders on existing water quality data, impairments, and standards as well as explained the pollutant loading model and "hot spot" SMUs. The group also developed a list of goal topics to be presented to stakeholders at the following meeting.
Mar. 11, 2014	• About AES • Watershed Planning • Catfish Creek watershed background • Catfish Creek water quality • Catfish Creek watershed inventory • Goals, prioritizing goals, and flooding	AES presented a large group of watershed stakeholders with a summary of the watershed background, water quality, and inventory, then walked participants through exercises related to prioritizing goals and identifying problem areas/flooding throughout the watershed. Following the meeting, stakeholders voted on goals and identified flood problem areas in the watershed.
Apr. 22, 2014	• CCWMA Mission • Results of goal topic voting • Goals • Objectives	AES presented the CCWMA mission as the mission for the watershed plan as well as the results of the goal topic voting exercise conducted at the previous meeting. The CCWMA then decided on a total of seven goals and drafted preliminary objectives under each goal.
Catfish Creek Festival Apr. 26, 2014	• Chemical and physical sampling demonstration • Macroinvertebrate sampling demonstration • Stream clean-up • Music festival	IOWATER volunteers and CCWMA Administrators led demonstrations of chemical, physical, and macroinvertebrate sampling, stream and riparian area clean-up, and a music festival to promote Catfish Creek watershed.
June 24, 2014	• Action Plan • Programmatic Management Measures • Site Specific Management Measures	AES presented the Action Plan for Catfish Creek, including the Programmatic Management Measures and Site Specific Management Measures.
Sep. 16, 2014	• Executive Summary • Water Quality Monitoring Plan • Report Cards • Information & Education Plan	AES presented the Draft Executive Summary, the water quality monitoring plan, and report cards. Then AES led the CCWMA on a work session to complete the Information & Education Plan
Nov. 12, 2014	• Watershed plan goals • Watershed background • Catfish Creek water quality • Action Plan • Info & Education Plan • Implementation & Monitoring	AES presented the full Draft Catfish Creek Watershed Management Plan at a public hearing to allow for public comments to be addressed in the final plan

1.5 Using the Watershed Management Plan

The information provided in this Watershed Management Plan is prepared so that it can be easily used as a tool by any stakeholder including elected officials, federal/state/county/municipal staff, and the general public to identify and take actions related to watershed issues and opportunities. The pages below summarize what the user can expect to find in each major "Section" of the Watershed-Based Plan.

Section 2.0: Mission, Goals, and Objectives
Section 2.0 of the plan contains the Catfish Creek Watershed Management Authority's (CCWMA) mission and goals/objectives identified by the board and watershed stakeholders. Goal topics generally include protection of education and stewardship, flooding, groundwater quantity and quality, fish and wildlife habitat, surface water quality, green infrastructure network protection, agricultural management reform, and communication and coordination. In addition, "Measurable Objectives" were developed for each goal so that the progress toward meeting each goal can be measured in the future by evaluating information included in Section 9.0: Measuring Plan Progress & Success.

Section 3.0: Watershed Resource Inventory
An inventory of the characteristics, problem, and opportunities in Catfish Creek watershed is examined in Section 3.0. Resulting analysis of the inventory data led to recommended watershed actions that are included in Section 5.0: Management Measures Action Plan. Inventory results also helped identify causes and sources of watershed impairment as required under USEPA's *Element A* and found in Section 4.0.

Section 3.0 includes summaries and analysis of the following inventory topics:

Watershed Resource Inventory Topics *Included* in the Plan

- 3.1 Geology, Climate, Soils
- 3.2 Pre-European Settlement Ecological Communities
- 3.3 Topography, Watershed Boundary, Subwatersheds
- 3.4 Soils
- 3.5 Jurisdictions
- 3.6 Existing Policies
- 3.7 Demographics
- 3.8 Existing & Future Land Use
- 3.9 Transportation Network
- 3.10 Impervious Cover Impacts
- 3.11 Open Space and Green Infrastructure
- 3.12 Natural Areas
- 3.13 Watershed Drainage System
  - Catfish Creek and Tributaries
  - Detention Basins
  - Wetlands & Wetland Restoration
  - Agricultural Land
  - Floodplain and Flood Problem Areas
- 3.14 Groundwater and Community Water

Section 4.0: Water Quality Assessment & Pollutant Loading Analysis
A summary and analysis of available water quality data for the watershed and pollutant modeling assessment is included in its own section because of its importance in the watershed planning process. This section includes a detailed summary of all physical, chemical, and biological data available for Catfish Creek. The pollutant loading assessment identifies pollutant loads from various land cover types. Water quality data combined with pollutant loading data provides information that sets the stage for developing pollutant reduction targets outlined in Section 5.0.

Section 5.0: Causes/Sources of Impairment & Reduction Targets
This section of the plan includes a list of causes and sources of watershed impairment as identified in Section 3.0 that affect Iowa DNR "Designated Uses" for water quality and other watershed features. As required by USEPA, Section 5.0 also addresses all or portions of *Elements A, B, & C* including an identification of the "Critical Areas", pollutant load reduction targets, and estimate of pollutant load reductions following implementation of Critical Area Management Measures identified in Section 6.0.

Section 6.0: Management Measures Action Plan
A "Management Measures Action Plan" is included in Section 6.0. The Action Plan is divided into a Programmatic Action Plan and a Site Specific Action Plan. Programmatic recommendations are described in paragraph format; site specific recommendations are presented in paragraph, figure, and table formats with references to entities that would provide consulting, permitting, or other technical services needed to implement specific measures. The site specific tables also outline project priority, pollutant reduction efficiency, implementation schedule, sources of technical and financial assistance, and cost estimates. This section also contains a watershed-wide summary table of specific information for all recommended site specific management measures combined including "Units," "Cost," and "Estimated Pollutant Load Reduction." This section addresses all or a portion of USEPA *Elements C & D*.

Section 7.0: Information & Education Plan
This section is designed to address USEPA *Element E* by providing an Information & Education component to enhance public understanding and to encourage early and continued participation in selecting, designing, and implementing recommendations provided in the Watershed Management Plan. This is accomplished by providing a matrix that outlines each education objective followed by primary and secondary recommended education activities. For each activity, a target audience, package (vehicle and pathways for reaching

audiences), priority/schedule, lead and supporting agencies, what the expected outcomes or behavior change will be, and estimated costs to implement is provided.

Sections 8.0 & 9.0: Plan Implementation & Measuring Plan Progress & Success
A list of key stakeholders and discussion about forming a Watershed Implementation Committee that forms partnerships to implement watershed improvement projects is included in Section 8.0. Section 9.0 includes two monitoring components: 1) a "Water Quality Monitoring Plan" that includes specific locations and methods where future monitoring programs should focus and a set of water quality "Criteria" that can be used to determine whether pollutant load reduction targets are being achieved over time and 2) "Report Cards" for each plan goal used to measure milestones and to determine if Management Measures are being implemented on schedule, how effective they are at achieving plan goals, and need for adaptive management if milestones are not being met. Sections 8.0 and 9.0 address USEPA *Elements F, G, H, & I*.

Sections 10.0 & 11.0: Literature Cited and Glossary of Terms
Section 10.0 includes a list of literature that is cited throughout the report. The Glossary of Terms (Section 11.0) includes definitions or descriptions for many of the technical words or agencies that the user may find useful when reading or using the document.

Appendix
The Appendix to this report is included on the attached CD. It contains CCWMA meeting minutes (Appendix A), results of the watershed inventory (Appendix B), raw data used to develop the pollutant loading and reduction models (Appendix C), a list of Catfish Creek stakeholders & partners (Appendix D), and a list of potential funding opportunities (Appendix E).

1.6 Prior Studies

Various studies have been completed describing and analyzing conditions within Catfish Creek watershed. Several ecological restoration efforts have also been implemented. This Watershed Management Plan uses existing data to analyze and summarize work that has been completed by others and integrates new data and information. A list of known studies or restoration work is summarized below.

1. *Dubuque County Regional Smart Plan* was adopted by the Dubuque County Board of Supervisors in January of 2013. It was produced by the East Central Intergovernmental Association (ECIA) using a transparent and inclusive public participation process to develop goals, objectives, and policies that reflect the attitudes and opinions of the region.
2. The East Central Intergovernmental Association (ECIA) has produced a series of long range transportation plans known as the Dubuque Metropolitan Area Transportation Study. *Planning for the Future of Transportation: Long Range Transportation Plan 2040* contains a wealth of up-to-date information regarding trends in demographics, transportation, and forecasting for the Dubuque metropolitan area.
3. The Iowa Department of Natural Resources completed their *State Preserves Guide* in 2007. It contains detailed information on the Catfish Creek State Preserve within Mines of Spain Recreation Area including the geology, archaeology, history, and ecology of the site.
4. *Iowa's 2012 Integrated Water Quality Report* includes details regarding the health of its waterbodies. This report describes how Iowa assessed water quality and whether assessed waters meet or do not meet water quality standards specific to each "Designated Use" of a waterbody and includes Catfish Creek.
5. Existing City of Dubuque, Dubuque County, and East Central Intergovernmental Association (ECIA) Geographic Information System (GIS) data for Catfish Creek watershed was obtained and used to analyze various data related to wetlands, soils, land use, demographics, and other relevant information.

2.0 Mission, Goals, & Objectives

2.1 Catfish Creek Watershed Management Authority

The Catfish Creek Watershed Management Authority (CCWMA) is governed by a Board divided among the political subdivisions comprising the watershed. Based upon Watershed demographics (area, population, and value) the Directors of the Board are appointed in the following manner:

1. The City of Dubuque: 3 Directors
2. Dubuque County: 2 Directors
3. The City of Asbury: 1 Director
4. The City of Peosta: 1 Director
5. The City of Centralia: 1 Director
6. Dubuque Soil and Water Conservation District: 1 Director

The Board is dedicated to the preservation, protection, and improvement of Catfish Creek watershed. The CCWMA's mission is to:

"To reduce the risks of flooding and its effects, improve water quality and promote a healthier existence for all living things that call the Catfish Creek Watershed home.

The Catfish Creek Watershed Management Authority is an organization assembled to tackle concerns with water quality and flooding on a watershed level. This means crossing jurisdictional boundaries and working together to solve problems within the entire watershed."

2.2 Goals & Objectives

Watershed stakeholders were first presented with information about the character and quality of watershed resources during meetings prior to developing goals. Based on watershed issues, concerns, and opportunities, eight general goals were identified to be addressed in the watershed plan. Stakeholders were then given the opportunity to vote on goals they felt were most important.

The voting process occurred following the March 11th, 2014 stakeholder meeting. Each stakeholder was given five votes. Each person was allowed to use up to two votes on a single goal topic if he or she felt strongly about it. The voting process helped focus on goals that need to be adequately addressed in the planning process and within this watershed plan report. Tallied votes are as follows:

1. Education and stewardship – 17 votes
2. Flooding – 15 votes
3. Groundwater quantity and quality – 13 votes
4. Fish and wildlife habitat – 12 votes
5. Surface water quality – 11 votes
6. Green infrastructure network – 11 votes
7. Agriculture – 8 votes
8. Communication and coordination – 3 votes

Objectives for each goal were also formulated and are very specific where feasible and designed to be measurable so that future progress toward meeting goals can be assessed. Goals and objectives ultimately lead to the development of action items. The Management Measures Action Plan section of this report is geared toward addressing watershed goals by recommending programmatic and site specific Management Measure actions to address each goal. The goals and objectives are examined in more detail when measuring plan progress and success via milestones and "Report Cards" in Section 9. An exercise was also completed to ensure that the Catfish Creek Watershed Management Plan goals were in consistent with the Dubuque County Regional Smart Plan.

Goal 1: Implement watershed educational and stewardship programs and increase communication and coordination among stakeholders.

Objectives:

1. Increase environmental stewardship and recreational opportunities and encourage stakeholders to participate in watershed plan implementation and restoration campaigns to increase activism in the watershed.
2. Inform public officials on the benefits of conservation, low impact development, and importance of ordinance language changes and encourage these developments and the adoption of the Catfish Creek Watershed-Based Plan.
3. Create targeted educational information for land owners upland and adjacent to tributaries.
4. Develop recommendations and alternatives for fertilizer and road salt.
5. Increase awareness of surface water quality issues among the general public and agricultural community.
6. Educate the public and agricultural community about protecting shallow aquifer water quality and quantity.
7. Encourage amendments of municipal comprehensive plans, codes, and ordinances to include watershed plan goals and objectives where necessary.

Goal 2: Manage and mitigate for existing and future structural flood problems.

Objectives:

1. Implement impervious reduction measures into development that is predicted to occur within Subwatershed Management Units 2-4, 8, 11-15, 23, 24, 30 and 32 which are "Highly Vulnerable" to future development and associated impervious cover.
2. Mitigate for identified structural flood problem areas on a case by case basis where feasible.
3. Limit development in the identified FEMA 100-year floodplain.
4. Provide tax incentives for homeowners or businesses using stormwater infiltration, harvesting, and/or re-use technology.
5. Restore 253 acres of critical area wetland restoration sites along stream corridors.

Goal 3: Protect groundwater quality and quantity and educate stakeholders on the influence of karst topography on groundwater resources.

Objectives:

1. Encourage residents and businesses to install infiltration practices such as rain gardens.
2. Encourage use of Low Impact Development designs within new, redevelopment, and retrofits.
3. Identify target areas where surface water infiltration should be restricted due to groundwater contamination potential.
4. Educate stakeholders about potential groundwater contamination issues and encourage private well testing.

Goal 4: Protect and manage fish and wildlife habitat.

Objectives:

1. Improve habitat in degraded stream reaches using natural design approaches.
2. Include trout-specific habitat improvements in coldwater reaches of Catfish Creek.
3. Increase width and restore riparian buffers along 59 stream reaches identified as critical stream reaches and reconnect to the floodplain where possible.
4. Develop and implement restoration and management plans for all protected natural areas.

Goal 5: Improve surface water quality to meet applicable standards.

Objectives:

1. Stabilize 200,166 linear feet of highly eroded streambanks located along "High Priority-Critical Areas."
2. Restore 200,166 linear feet of riparian buffer along "High Priority-Critical Areas."
3. Restore 253 acres of wetland at "High Priority-Critical Areas."
4. Retrofit 7 "High Priority-Critical Area" detention basins.
5. Implement agricultural best management practices on 2,929 acres identified as "High Priority-Critical Areas."
6. Continue water quality monitoring programs, specifically including Nitrogen, Phosphorus, Total Suspended Solids, and *E.coli*.

Goal 6: Manage natural and cultural components of the Green Infrastructure Network.

Objectives:

1. Include the identified Green Infrastructure Network in all county and municipal comprehensive plans and development review maps.
2. Implement conservation or low impact design standards for applicable "Critical Green Infrastructure Protection Areas" where new or redevelopment occurs.
3. Incorporate natural landscaping into golf courses within the Green Infrastructure Network.
4. Develop and implement restoration and management plans for all protected natural areas.
5. Identify opportunities for additional recreational access, such as bike and pedestrian trails and stream access for fishing, canoeing, and kayaking.
6. Encourage private and agricultural land owners with parcels along streams and tributaries to manage their land for green infrastructure benefits.

Goal 7: Encourage agricultural techniques and soil conservation practices that will protect and conserve topsoil and bolster our water resources.

Objectives:

1. Encourage landowners to utilize existing programs and agencies such as the Natural Resource Conservation Service (NRCS) and the Dubuque Soil and Water Conservation District (SWCD) to install conservation practices that protect soil loss and water quality.
2. Educate landowners and inform landowners of both federal and state cost-share programs, which provide incentives for landowners to enroll in conservation programs and implement conservation practices.
3. Promote the protection of wetlands by utilizing existing agencies, resources, funding, and programs while protecting private property rights.
4. Encourage landowners and farmers to leave adequate buffers between agricultural land and waterways.
5. Encourage landowners and farmers to utilize the most practical conservation practices available for each parcel of land.
6. Educate farmers and agricultural landowners of the economic value of their topsoil and economic and environmental consequences of erosion.
7. Implement agricultural best management practices on 2,929 acres identified as "High Priority-Critical Areas."

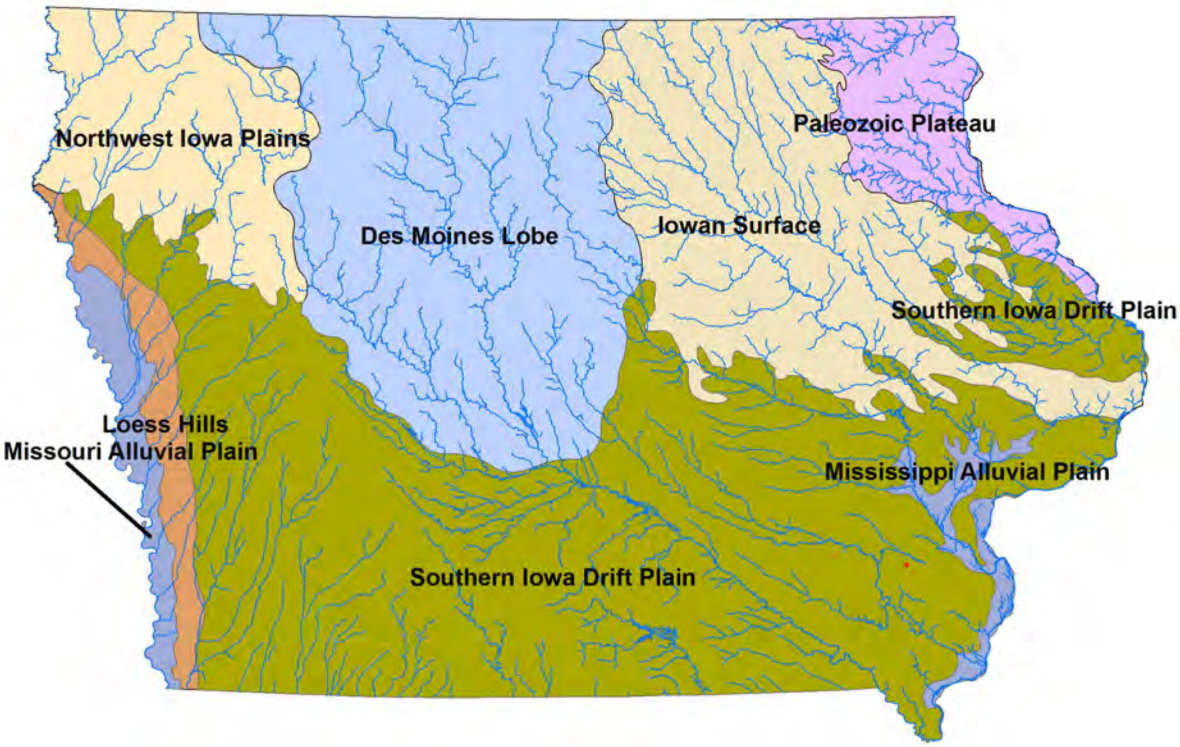
3.0 Watershed Resource Inventory

3.1 Geology, Archaeology, & Climate

Geology

The terrain of the Midwestern United States was created over thousands of years as glaciers advanced and retreated during the Pleistocene Era or "Ice Age." Some of these glaciers were a mile thick or more, but most of the area that is now Catfish Creek watershed lies in an area that was mostly unaffected by the glaciers which covered most of Iowa's landscape. This area is known for its karst topography and is sometimes referred to as the "Switzerland of Iowa." The geology of Catfish Creek dates back to the Paleozoic Era, or about 250 million years ago. Here the carbonate bedrock has been weathered and exposed for longer than the surrounding areas, creating unusual features such as limestone-walled valleys, high bluffs, caves, crevices, and sinkholes, as well as rock formations such as those pictured on the following page. This unique geology is known as karst topography. It leaves the region more vulnerable to both surface and groundwater contamination because the system is more permeable than what is

Figure 3. Landforms of Iowa, based on Prior (1991) and Calvin (1904), with major rivers and streams. Source: Bill Whittaker.



Images, clockwise from near right: "Castle of Galena Limestone," west of Dubuque near ICRR and Catfish Creek, taken in the late 1800's or early 1900's by Samuel Calvin of the University of Iowa; rock outcrop off of English Mill Rd just south of Dubuque; remains of a former quarry at Horseshoe Bluff revealing layers of shallow bedrock; exposed bedrock within Catfish Creek streambed.

found elsewhere. The crevices and sinkholes common in the area allow for less infiltration and pollutant removal than would be found in an area without karst topography and expedited routes for pollutants to contaminate surface and groundwater resources.

Geologically, this area is known as the Paleozoic Plateau (see Figure 3), and it harbors a globally significant area known as algific (cold air) talus (loose rock) slopes. "These slopes' unusual geology keeps them cool on the hottest summer days, so they host many species found nowhere else in Iowa – and, in some cases, nowhere else in the world. (Witt, 2013)" They harbor federally endangered, threatened or candidate species such as the Iowa Pleistocene Snail (*Discus macclintocki*), Northern Monkshood (*Aconitum noveborecense*), and Golden Saxifrage (*Chrysosplenium iowense*). While algific talus slopes occur within the Paleozoic Plateau, it is not known whether they occur within the watershed as these areas are usually not disclosed publically for protection purposes.

Many of the area's scenic bluffs and rock outcrops are a result of the rich geologic history and examples can be found throughout the watershed. As early as 1764, the Mesquakie Indians and later some of the earliest settlers to the area mined the lead ore found in linear deposits within the exposed bluffs in the area where Mines of Spain Recreation Area now lies.

The unique geology of the area has also influenced the stream characteristics of Catfish Creek. In some areas, exposed bedrock makes up the bottom of the stream channel. The coldwater portion of the main branch of Catfish Creek (also known as Upper Catfish Creek) is made possible

by naturally occurring seeps that keep temperatures cool enough for trout during summer months and provide a warmer environment over winter. This high-quality, cold-water reach is one of only 30 streams in Iowa with a population of naturally reproducing brown trout.

Archaeology
Portions of Catfish Creek watershed have shown evidence of hunter-gatherer occupation dating back 8,000 years. These earliest indigenous people were succeeded by mound builders and pottery makers, then farming communities, and eventually

the Mesquakie in the 1700's as they were forced out of the Great Lakes area by the French. "Archaeological sites within the preserve related to these earliest occupations include village and campsites at the mouths of Catfish and Granger Creeks, conical and linear burial mound groups, cemeteries, open-air habitation areas, and specialized activity areas such as hunting and plant food processing locales. Artifacts that have been found include projectile points, end scrapers, drill fragments, bifaces, and ceramics. (IDNR, 2007)"

The Mesquakie village was located at the mouth of Catfish Creek where they mined lead from the bluffs and traded fur with the French, eventually including Julien Dubuque for whom the city was named. As one of the first settlers in the area, Dubuque participated in both fur trading and lead mining, with the permission of the Mesquakie, and was awarded one of the largest land grants from the Spanish government for the "Mines of Spain" in 1796.

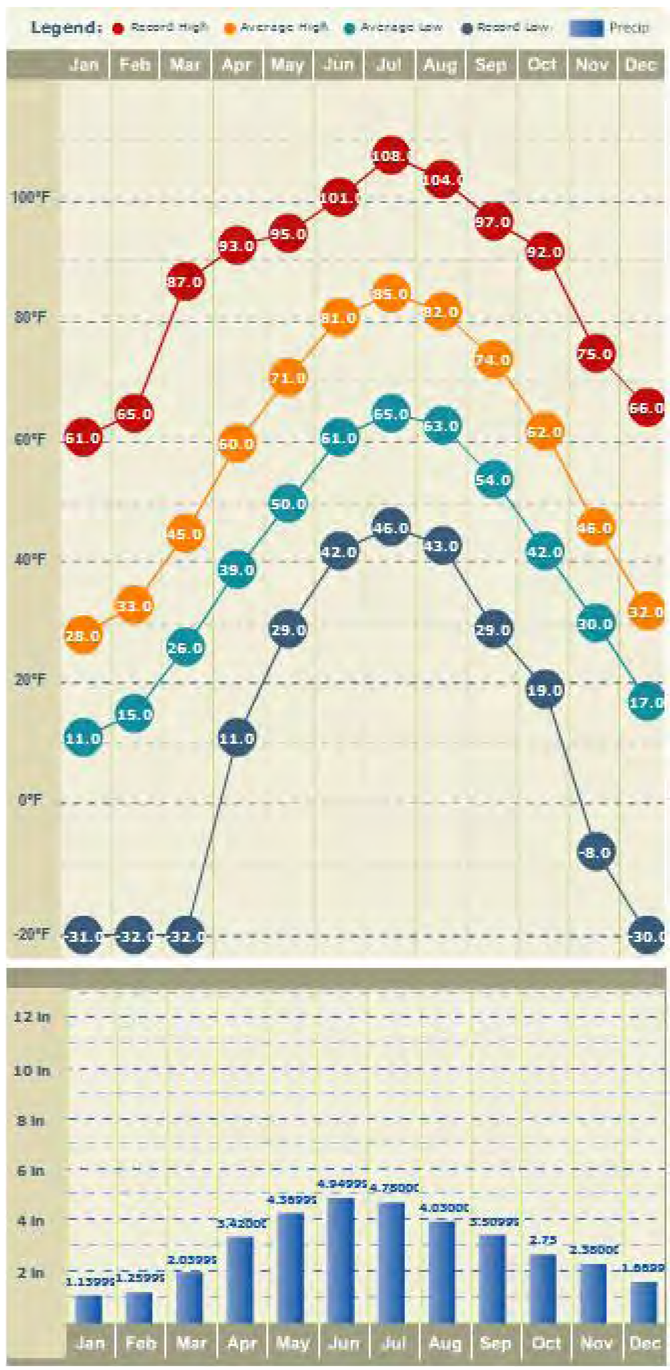
Climate

The climate of northeastern Iowa can be described as temperate with cold winters and warm summers where great variation in temperature, precipitation, and wind can occur on a daily basis. Surges of polar air moving southward or tropical air moving northward cause daily and seasonal temperature fluctuations. The action between these two air masses fosters the development of low-pressure centers that generally move eastward and frequently pass over Iowa, resulting in abundant rainfall. Prevailing winds are generally out of the south, north, or northwest.

The Weather Channel website (www.weather.com) provides an excellent summary of climate statistics including monthly averages and records for many cities in Iowa. Data for Dubuque represents the climate and weather patterns experienced in Catfish Creek watershed (Figure 4). The winter months are cold averaging highs around 31° F while winter lows are around 14° F. Summers are warm with average highs around 83° F and summer lows around 63° F. The highest recorded temperature was 108° F in July 1995 while the lowest temperature was -32° F in January 1996.

Fairly typical for the Midwest, the current climate of Catfish Creek watershed consists of an average rainfall of 35.5 inches and snowfall around 33.7 inches. According to data collected in Dubuque, the most precipitation on average occurs in June (4.95 inches) while January receives the least amount of precipitation with 1.14 inches on average.

Figure 4. Monthly average temperature and precipitation for Dubuque, Iowa. Source: the Weather Channel.



3.2 Pre-European Settlement Landscape to Present Landscape

While there is evidence of prehistoric Native American cultures dating as far back as 8,000 years ago, the last Native American Indian tribe to call the area home was the Mesquakie or Fox Indians. In the early 1700's they settled at the mouth of Catfish Creek, where they traded fur with the French and worked the lead mines in the area now known as the Mines of Spain. In 1788, Julien Dubuque, for whom the city is named, was given the right to mine lead by the Mesquakie and later received a Spanish land grant for the same stretch of land. After Dubuque's death in 1810, the Indians reclaimed their right to the area, but were removed from the land with the signing of the Black Hawk Treaty in 1833. Extensive lead mining ensued at this point and farming and lumbering of the watershed began in the 1850's.

The General Land Office (GLO) conducted the original public land survey of Iowa between 1832 and 1859, mapping and describing natural and man-made features and vegetation communities while creating the "rectangular survey system" for mapping and sale of western public lands of the United States (Anderson, 2008 and Daly & Lutes et. al., 2011). Ecologists know by interpreting survey notes and maps that a complex interaction existed between several ecological communities including prairies, woodlands, savannas, and wetlands prior to European settlement in the 1830s.

The surveyors described the majority of Catfish Creek watershed as "timber," "scattering trees," or "part prairie/part timber" with some pockets of "prairie" (Figure 5). This mixture of "timber" and "prairie" across the landscape was widely described in the mid 1800s as the surveyors and early settlers moved west out of the heavily forested eastern portion of the United States and encountered a much more open environment that ecologists now refer to as savanna. A savanna typically consists of scattered Oak trees that have canopies that range from nearly closed to fully open, with a diversified ground cover of mostly grasses and prairie species below.

The prairie-savanna landscape was maintained and renewed by frequent lightning strike fires, fires ignited by Native Americans, and grazing by bison and elk. Fires ultimately removed dead plant material, exposing the soils to early spring sun, returning nutrients to the soil, and keeping woodlands confined to wetter ravines. Running through the prairie-savanna landscape were the deep valleys surrounding Catfish Creek which were carved by the run-off of melting glaciers long ago, high bluffs, caves, crevices, and sinkholes. During pre-European settlement times most of the water that fell as precipitation was absorbed in upland savanna and prairie communities and within the few wetlands that existed along stream corridors.

European settlement resulted in drastic changes to the fragile ecological communities. Fires no longer occurred and prairie and floodplains were tilled under or drained for farmland or developed. The earliest aerial photographs taken in 1939 (Figure 6) depict Catfish Creek watershed when row crop farming covered the vast majority of the landscape, with the outskirts of Dubuque's outward urbanization appearing in the northeastern-most portion of the watershed, but before residential and commercial development seen today. Some of the woodland communities described by early settlers were still present in the late 1930's along the stream channels but farmland clearly replaced most of the savanna and prairie communities. With the advent of farming came significant changes in stormwater runoff.

Figure 7 shows a 2011 aerial photograph of Catfish Creek watershed. It is clear that residential and commercial development replaced some of the farmland in the watershed. The dark signatures in the southern portions of the watershed reveal stands of remnant woodlands that persist but are fragmented by residential development and farming. Another area of interest is Swiss Valley Nature Preserve, located in the southwestern portion of the watershed. The pale beige signatures of two quarries and a landfill can also be noted.

With degraded ecological conditions comes the opportunity to implement ecological restoration to improve the condition of Catfish Creek watershed. Present day knowledge of how pre-European settlement ecological communities formed and evolved provides a general template for developing present day natural area restoration and management plans. One of the primary goals of this watershed plan is to identify, protect, restore, and manage remaining natural areas.

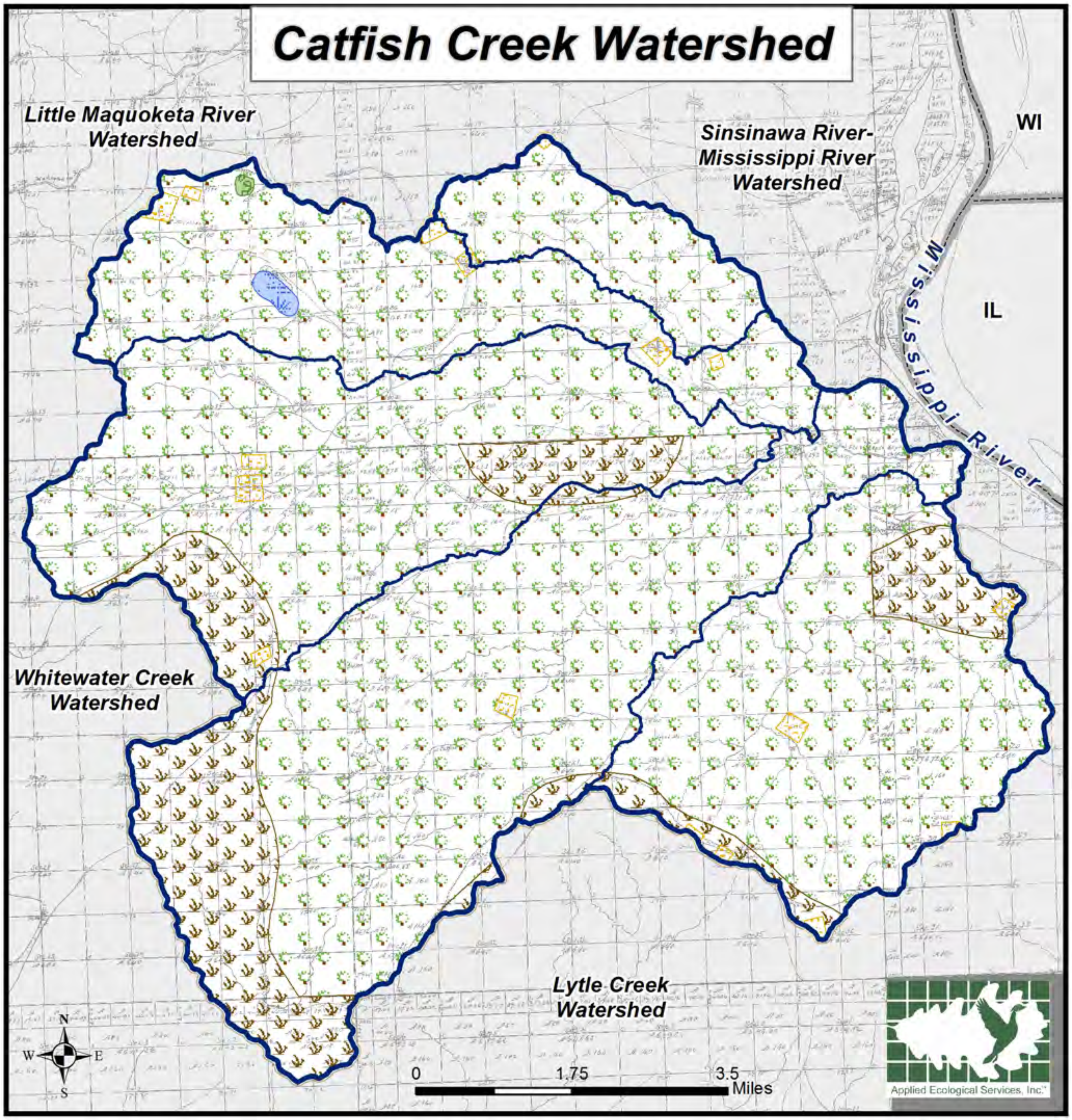


Figure 5: Pre-European Settlement Vegetation (1830's)

Legend

- Roads
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Pre-Eurpopean Settlement Vegetation (1830's)

- Field
- Grove
- Marsh (Wetland)
- Savanna
- Prairie

Data Sources:
IA DNR

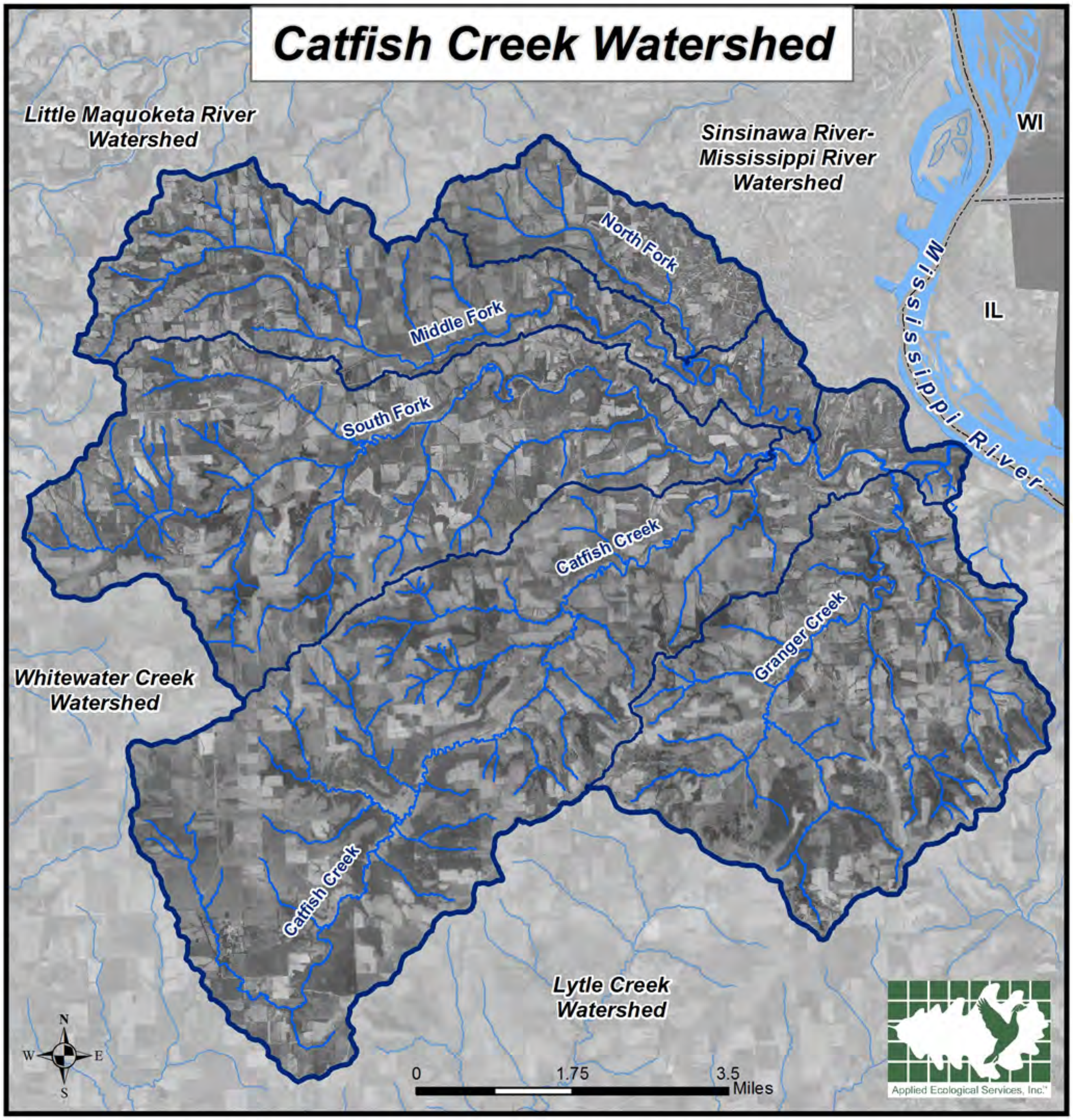


Figure 6: Aerial Photography (1936-1941)

Legend

- Stream & Tributaries
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Data Sources:
IA DNR

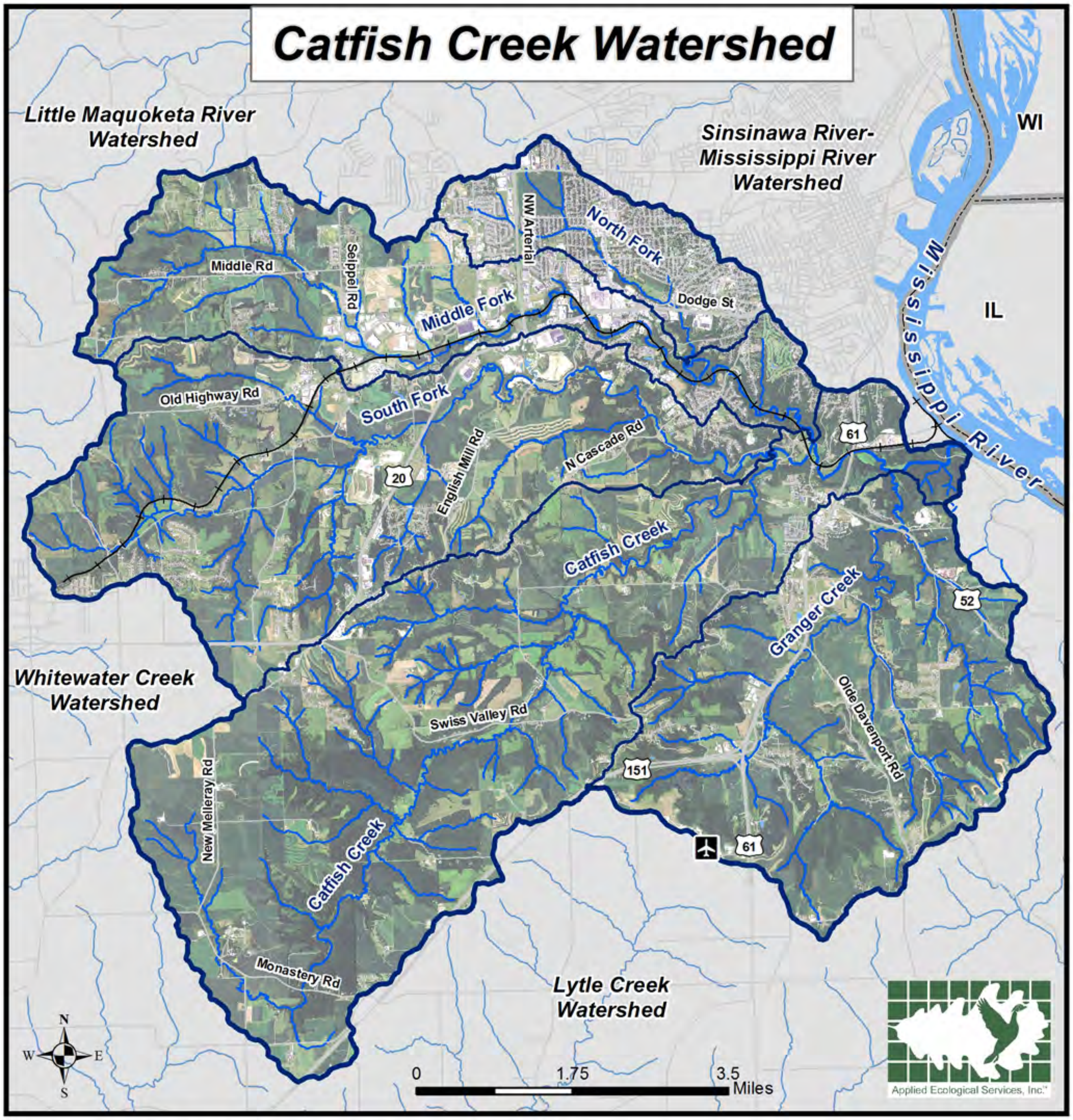
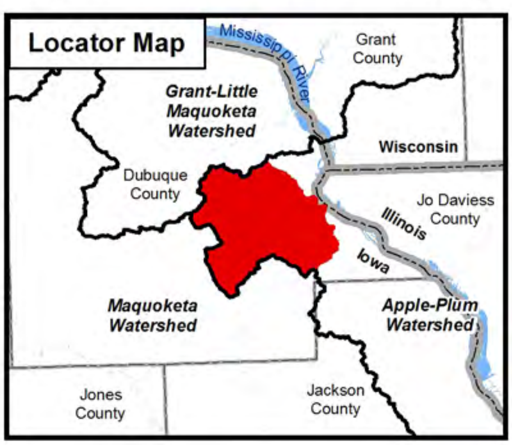


Figure 7: Aerial Photography 2011



Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Data Sources:
NAIP 2011

3.3 Topography, Watershed Boundary, & Subwatershed Management Units

Topography & Watershed Boundary

Much of the topography of Catfish Creek watershed was formed during the Paleozoic Era about 250 million years ago, defining the watershed boundary observed today. Topography refers to elevations of a landscape that describe the configuration of its surface and ultimately defines watershed boundaries. The specifics of watershed planning can not begin until a watershed boundary is clearly defined. The Catfish Creek watershed boundary was defined using the United States Geological Society (USGS) HUC 10 (#0706000501) boundary. The watershed boundary was then input into a GIS model (Arc Hydro) that generated a Digital Elevation Model (DEM) of the watershed (Figure 8). Catfish Creek watershed is 46,100 acres or 72 square miles in size.

Catfish Creek watershed generally drains from west to east before entering the Mississippi River. Elevation within the watershed ranges from a high of 1,178 feet above mean sea level (AMSL) to a low of 594 feet AMSL for a total relief of 584 feet (Figure 8). The highest point is found in the northwest portion of the watershed along Old Highway Rd north of South Fork. Higher elevations also extend along much of the western and southern portions of the watershed. As expected, the lowest elevation occurs where Catfish Creek enters the Mississippi with lower elevations extending along the main stem of Catfish Creek and its tributaries. The DEM depicts the rolling topography of the watershed. Generally, land along the upland areas and within the floodplain of Catfish Creek have slopes ranging from 0-10% while the land along the rolling topography of bluffs, hillsides, and ravines range between 20 to 40% slopes.

Rolling topography viewed from near Asbury Rd in the northwest corner of the watershed.

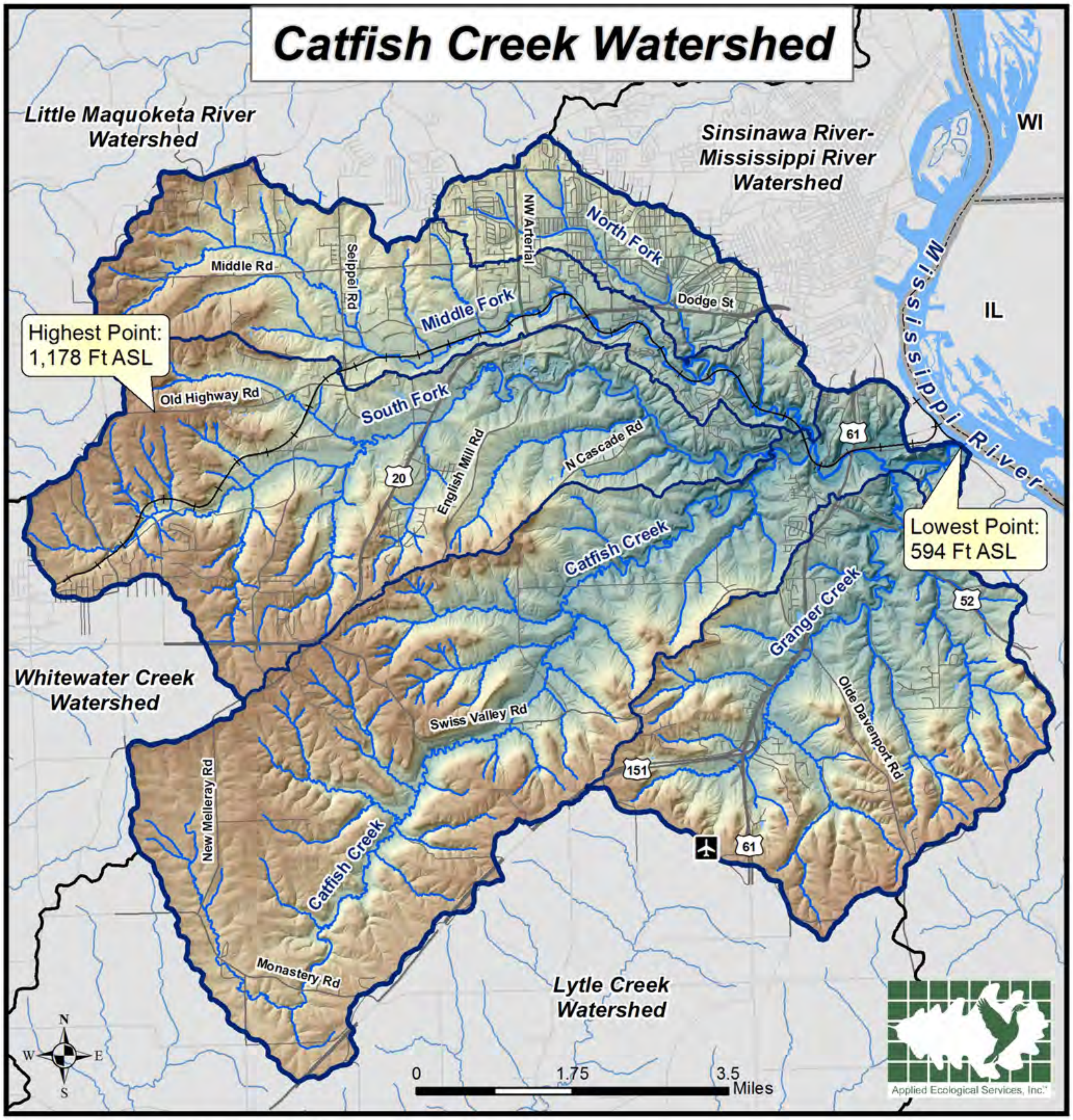
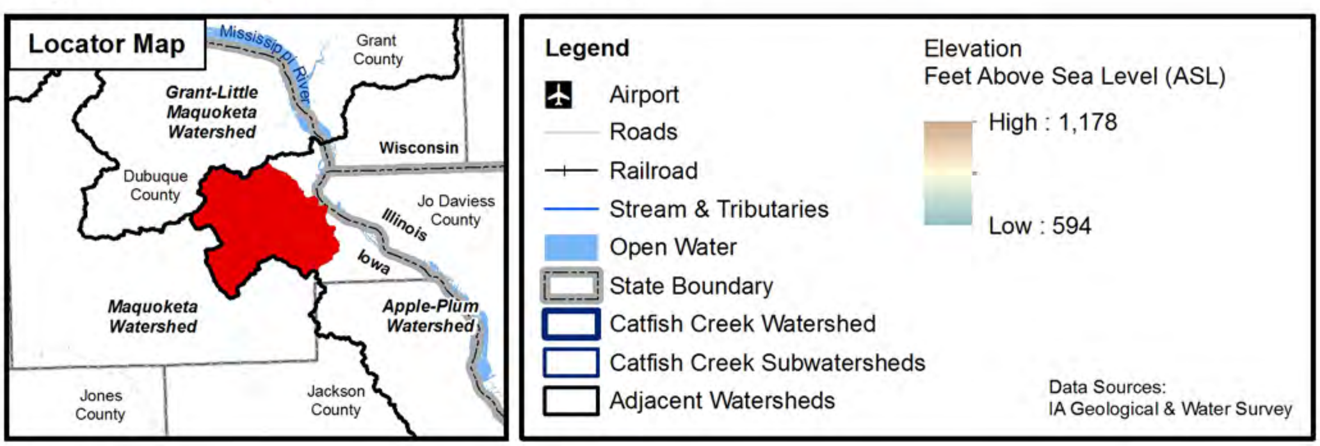


Figure 8: Digital Elevation Model



Subwatershed Management Units (SMUs)

The Center for Watershed Protection (CWP) is a leading watershed planning agency and has defined watershed and subwatershed sizes appropriate to meet watershed planning goals. In 1998, the CWP released the “Rapid Watershed Planning Handbook” (CWP 1998) as a guide to be used by watershed planners when addressing issues within urbanizing watersheds. The CWP defines a watershed as an area of land that drains up to 100 square miles. Broad assessments of conditions such as soils, wetlands, and water quality are generally evaluated at the watershed level and provide some information about overall conditions. Catfish Creek watershed is about 72 square miles and therefore this plan allows for a detailed look at watershed characteristics, problem areas, and management opportunities. However, delineating smaller drainage areas within the larger whole can help determine where pollutants are generated from or the location of site specific problem areas that require immediate attention.

To address issues at a smaller scale, a watershed can be divided into subwatersheds called Subwatershed Management Units (SMUs). Catfish Creek watershed was delineated into 34 SMUs by using the Digital Elevation Model (DEM). Information obtained at the SMU scale allows for detailed analysis and better recommendations for site specific “Management Measures” otherwise known as Best Management Practices (BMPs). Table 2 presents each SMU and size within the watershed. Figure 9 depicts the location of each SMU boundary delineated within the larger Catfish Creek watershed. These subwatersheds range in size from 236 acres to 5,309 acres, but they average approximately 1,349 acres.

Table 2. Subwatershed Management Units and size.

SMU #	Total Acres	Total Square Miles
SMU 1	2,478.6	3.9
SMU 2	2,609.8	4.1
SMU 3	902.2	1.4
SMU 4	2,374.3	3.7
SMU 5	770.2	1.2
SMU 6	2,096.0	3.3
SMU 7	1,026.9	1.6
SMU 8	1,155.8	1.8
SMU 9	774.0	1.2
SMU 10	1,454.5	2.3
SMU 11	584.1	0.9
SMU 12	801.1	1.3
SMU 13	1,456.0	2.3
SMU 14	1,135.2	1.8
SMU 15	879.2	1.4
SMU 16	5,309.2	8.4
SMU 17	1,377.5	2.2
SMU18	822.4	1.3
SMU19	2,006.2	3.1
SMU 20	713.3	1.1
SMU 21	528.2	0.8
SMU 22	1,234.2	1.9
SMU 23	1,930.0	3.0
SMU 24	941.8	1.5
SMU 25	908.7	1.4
SMU 26	236.1	0.4
SMU 27	1,687.0	2.9
SMU 28	1,643.9	2.6
SMU 29	677.6	1.1
SMU 30	905.5	1.4
SMU 31	1,482.9	2.3
SMU 32	862.4	1.3
SMU 33	1,826.1	2.9
SMU 34	281.8	0.4
Totals	**45,872.6**	**72.0**

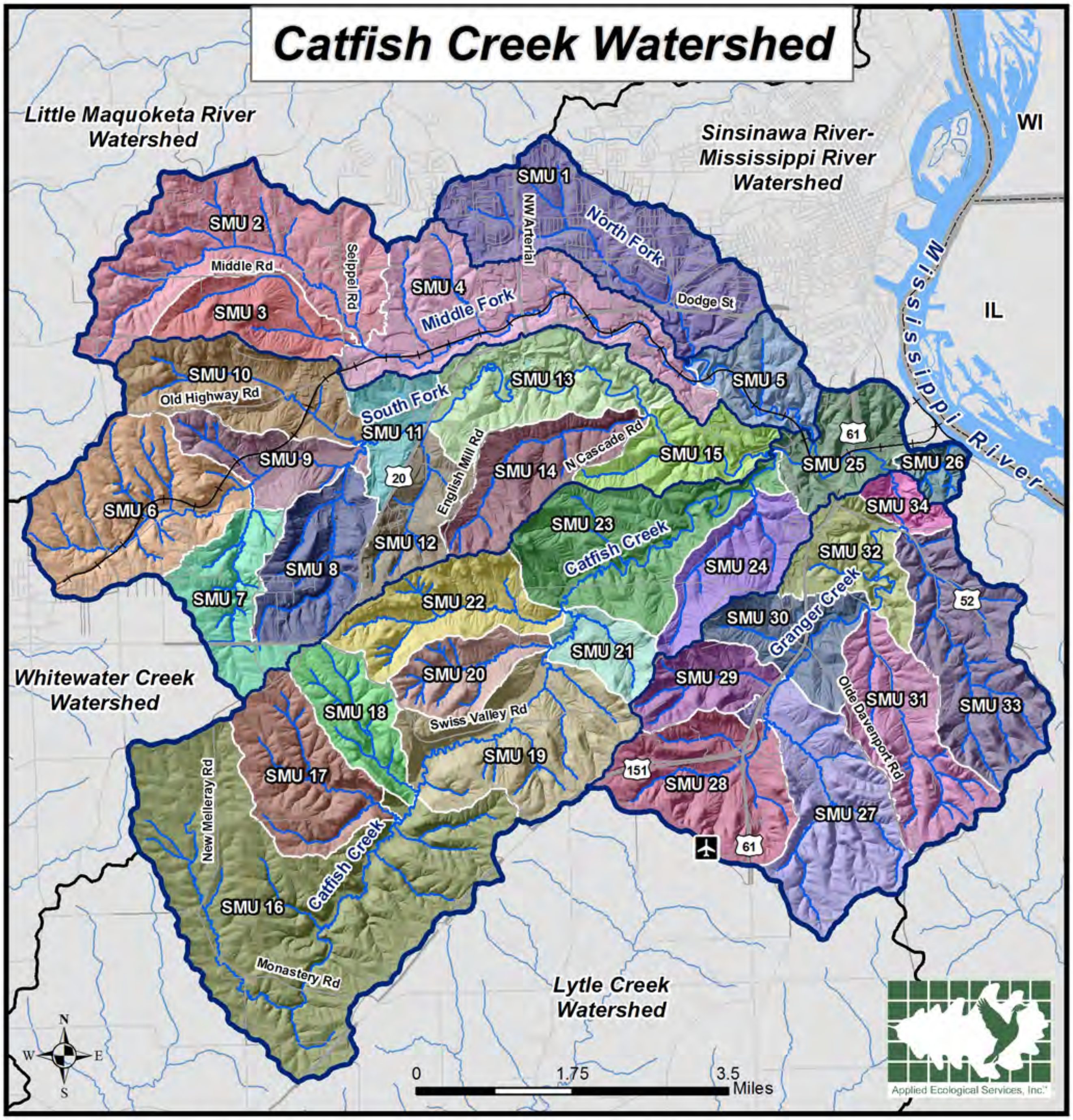


Figure 9: Subwatershed Mangement Units

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Subwatershed Management Units (SMUs)

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34

3.4 Hydric Soils, Soil Erodibility, & Hydrologic Soil Groups

Soils

A combination of physical, biological, and chemical variables such as topography, drainage patterns, climate, and vegetation, have interacted over hundreds of centuries to form the complex variety of soils found in the watershed. Most soils formed under woodland, prairie, and wetland vegetation. The most up to date soils mapping provided by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) was used to summarize the extent of soil types, hydric soils, soil erodibility, and hydrologic soil groups within Catfish Creek watershed (Table 3 & 4; Figures 10-12).

Hydric Soils
Wetland or "Hydric Soils" generally form over poorly drained clay material associated with wet prairies, marshes, and other wetlands and from accumulated organic matter from decomposing surface vegetation. Hydric soils are important because they indicate the presence of existing wetlands or drained wetlands where restoration may be possible. Almost all of the hydric or partially hydric soils in the watershed lie within the floodplain of Catfish Creek and its tributaries.

Historically there were approximately 4,783 acres of wetlands in the watershed. The remaining 41,316 acres are not hydric. According to existing wetland inventories, 1,191 acres or 36% of the pre-European settlement wetlands remain. The location of hydric soils in the watershed is depicted on Figure 10. Existing wetlands and wetland restoration opportunities are discussed in detail in Section 3.13.4.

Soil Erodibility
Soil erosion is the process whereby soil is removed from its original location by flowing water, wave action, wind, and other factors. Sedimentation is the process that deposits eroded soils on other ground surfaces or in bodies of water such as streams and lakes. Soil erosion and sedimentation reduces water quality by increasing total suspended solids (TSS) in the water column and by carrying attached pollutants such as phosphorus, nitrogen, and hydrocarbons. When soils settle in streams and lakes they often blanket rock, cobble, and sandy substrates needed by fish and aquatic macroinvertebrates for habitat, food, and reproduction. Sedimentation is a problem in many stream reaches in the watershed (see Section 3.13.1).

A highly erodible soils map was created by selecting soils with particular attributes such as soil type and the percent slope on which a soil is located (Figure 11). It is important to know the location of highly erodible soils because these areas have the highest potential to degrade water quality during farm tillage and development. Based on mapping, 38,239 acres or 83% of the soils in the watershed are potentially highly erodible. Some of these soils are located in upland areas that are currently stabilized by existing land uses/cover. But others are located on row crop farmland where erosion following annual tilling is a possibility.

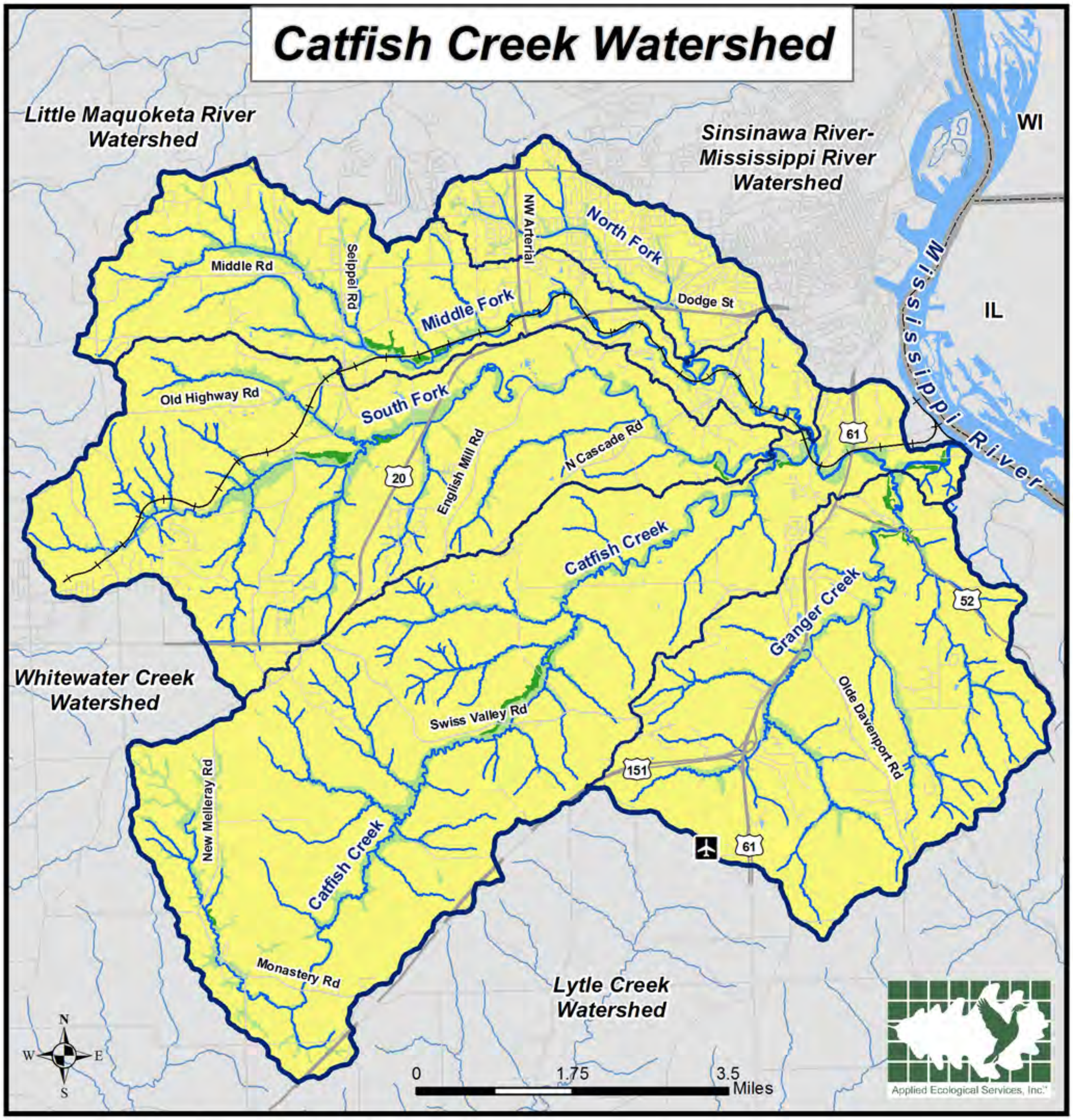
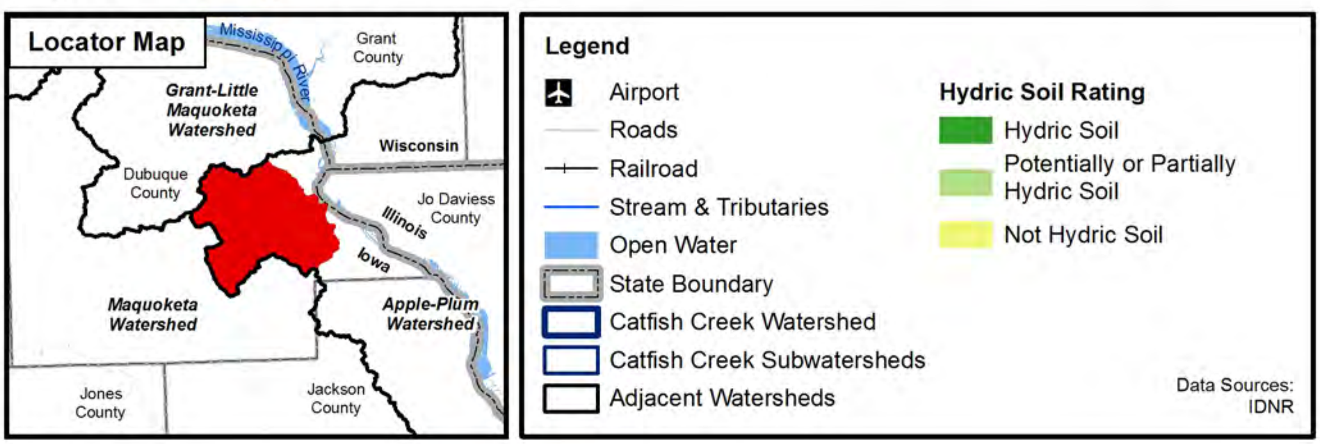


Figure 10: Hydric Soils



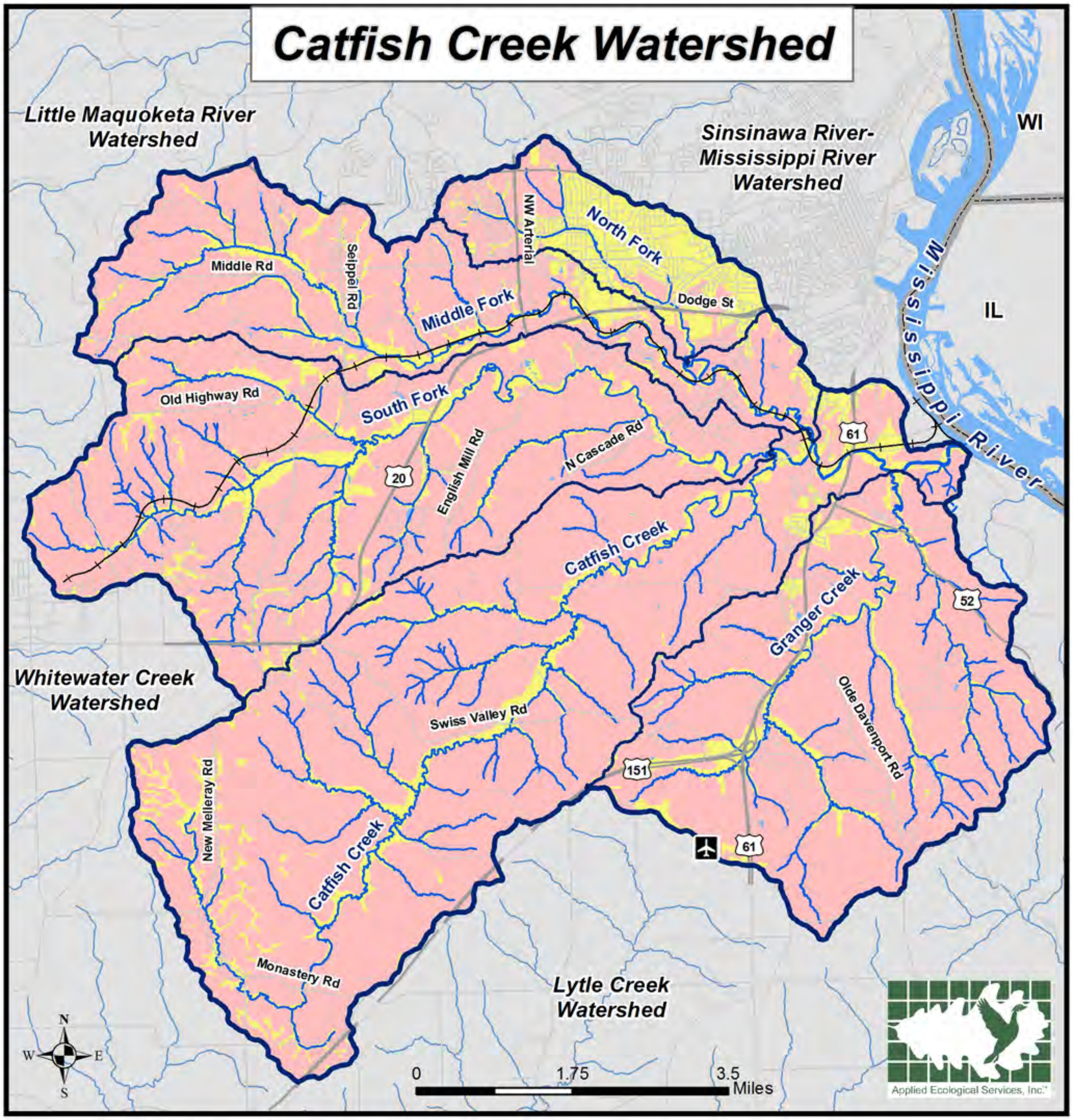
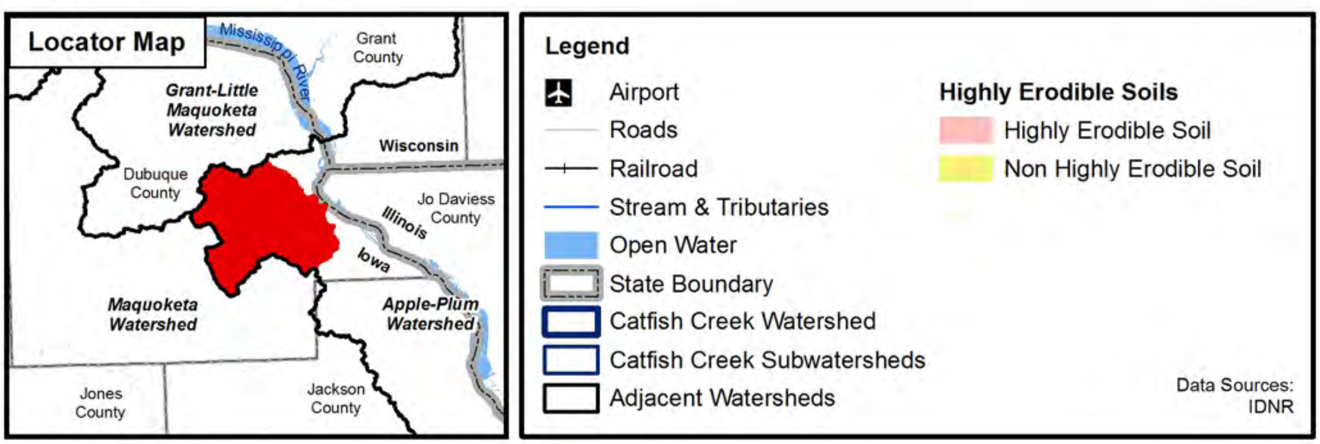


Figure 11: Highly Erodible Soils



Hydrologic Soil Groups
Soils also exhibit different infiltration capabilities and have been classified to fit what are known as "Hydrologic Soil Groups" (HSGs). HSGs are based on a soil's infiltration and transmission (permeability) rates and are used by engineers and planners to estimate stormwater runoff potential. Knowing how a soil will hold water ultimately affects the type and location of recommended infiltration Management Measures such as wetland restorations and detention basins. More importantly however is the link between hydrologic soil groups and groundwater recharge areas. Groundwater recharge is discussed in Section 3.14.

HSG's are classified into four primary categories; A, B, C, and D, and one dual class, B/D. Figure 12 depicts the location of each HSG in the watershed. The HSG categories and their corresponding soil texture, drainage description, runoff potential, infiltration rate, and transmission rate are shown in Table 3 while Table 4 summarizes the acreage and percent of each HSG. Group B soils are dominant throughout the watershed at about 88% coverage and are found throughout the watershed. Group C and unclassified soils make up another 5%, each, of the watershed.

Table 3. Hydrologic Soil Groups and their corresponding attributes.

HSG	Soil Texture	Drainage Description	Runoff Potential	Infiltration Rate	Transmission Rate
A	Sand, Loamy Sand, or Sandy Loam	Well to Excessively Drained	Low	High	High
B	Silt Loam or Loam	Moderately Well to Well Drained	Moderate	Moderate	Moderate
C	Sandy Clay Loam	Somewhat Poorly Drained	High	Low	Low
D	Clay Loam, Silty Clay Loam, Sandy Clay Loam, Silty Clay, or Clay	Poorly Drained	High	Very Low	Very Low

Table 4. Hydrologic Soil Groups including acreage and percent of watershed.

Hydrologic Soil Group	Area (acres)	% of Watershed
A	2.5	< 1%
B	40,738.6	88.4%
B/D	347.4	0.8%
C	2,455.5	5.3%
D	123.2	0.3%
Unclassified	2,432.2	5.3%
Totals	**46,099.5**	**100%**

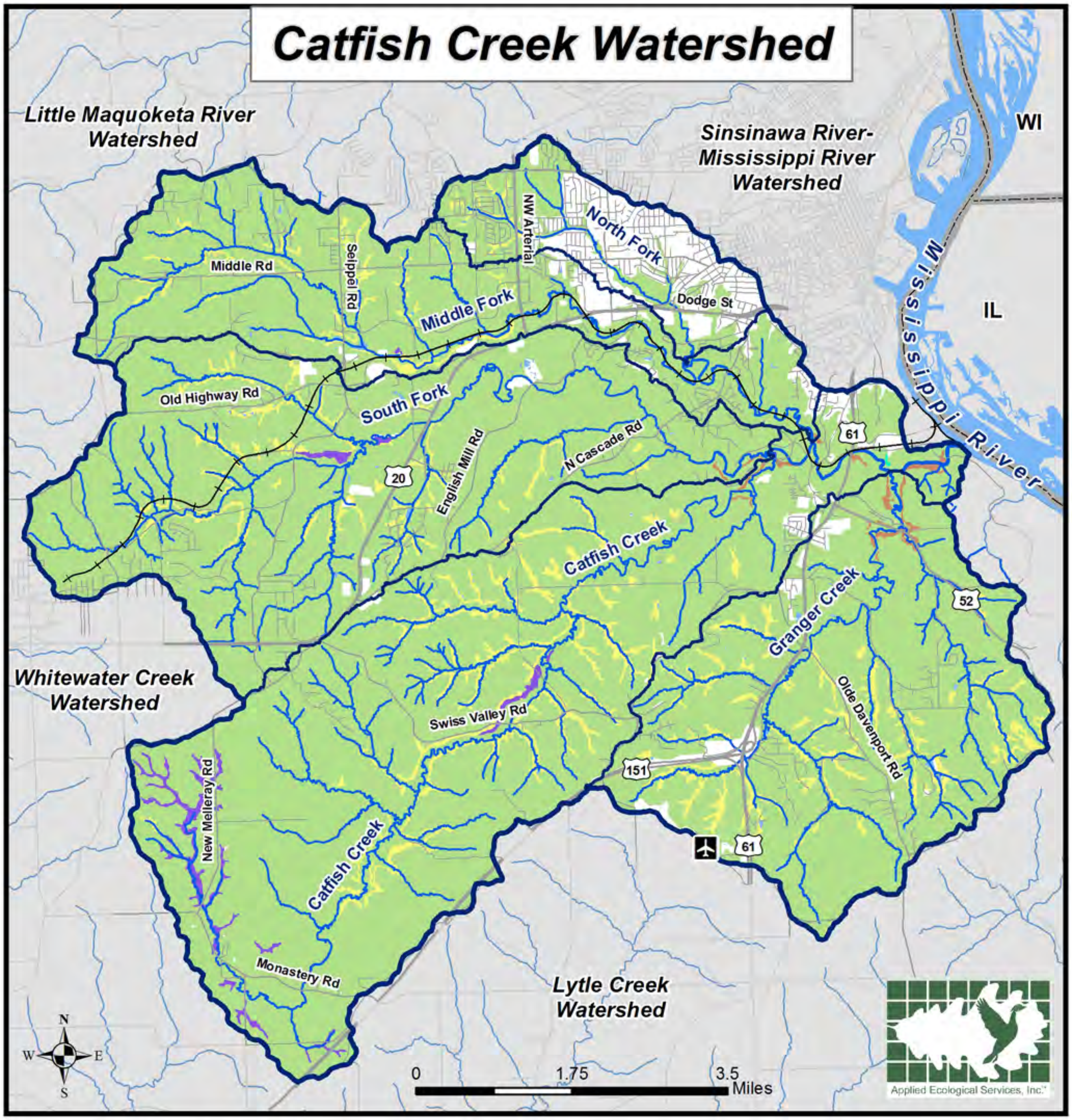
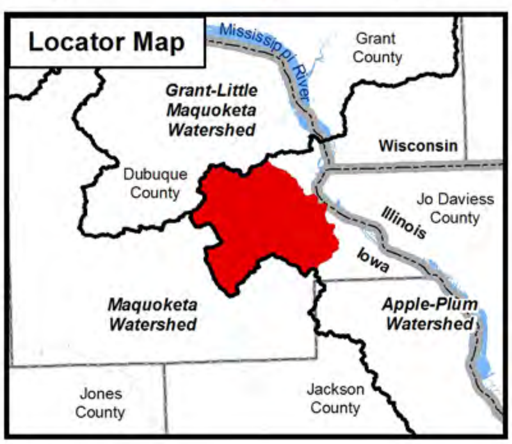


Figure 12: Hydrologic Soil Groups



Legend

	Airport	**Hydrologic Soil Groups**	
	Roads		A
	Railroad		B
	Stream & Tributaries		B/D
	Open Water		C
	State Boundary		D
	Catfish Creek Watershed		Unclassified
	Catfish Creek Subwatersheds		
	Adjacent Watersheds		

Data Sources: IDNR

3.5 Jurisdictions, Roles, & Protections

Catfish Creek watershed is located in Dubuque County with portions of seven townships, and four municipalities (Table 5, Figure 13). The entire watershed is located within Dubuque County. Of the four municipalities in the watershed, the City of Dubuque is the largest (10,234 acres; 22%) followed by the City of Asbury (997 acres; 2%). The City of Peosta and the City of Centralia account for 511 acres or 1% of the watershed. The largest Unincorporated areas are found in Table Mound Township (16,621 acres; 36%) and Vernon Township (8,315 acres; 18%). Unincorporated Mosalem and Center Townships represent another 3,970 acres (9%) and 3,296 acres (7%). In addition, Conservation Areas at Mines of Spain Recreation Area and Swiss Valley Nature Preserve & Park account for another 758 acres or 2% of the watershed. These areas are owned and managed by Iowa Department of Natural Resources (IDNR) and Dubuque County Conservation Board (DCCB) respectively.

Table 5. County, township, unincorporated, and municipal jurisdictions.

Jurisdiction	Area (acres)	% of Watershed
County	46,100	100
Dubuque	46,100	100
Township	46,100	100
Center Township	5,070	11
Dubuque Township	8,763	19
Mosalem Township	4,027	9
Prairie Creek Township	616	1
Table Mound Township	18,690	41
Vernon Township	8,933	19
Washington Township	<1	0
Unincorporated Areas	34,356	74
Unincorporated Center Twp.	3,296	7
Unincorporated Dubuque Twp.	1,537	3
Unincorporated Mosalem Twp.	3,970	9
Unincorporated Prairie Creek Twp.	616	1
Unincorporated Table Mound Twp.	16,621	36
Unincorporated Vernon Twp.	8,315	18
Unincorporated Washington Twp.	<1	0
Municipalities	11,742	25
Asbury	997	2
Centralia	170	0
Dubuque	10,234	22
Peosta	341	1
Conservation Areas	758	2
Mines of Spain Recreation Area	275	1
Swiss Valley Nature Preserve & Park	483	1

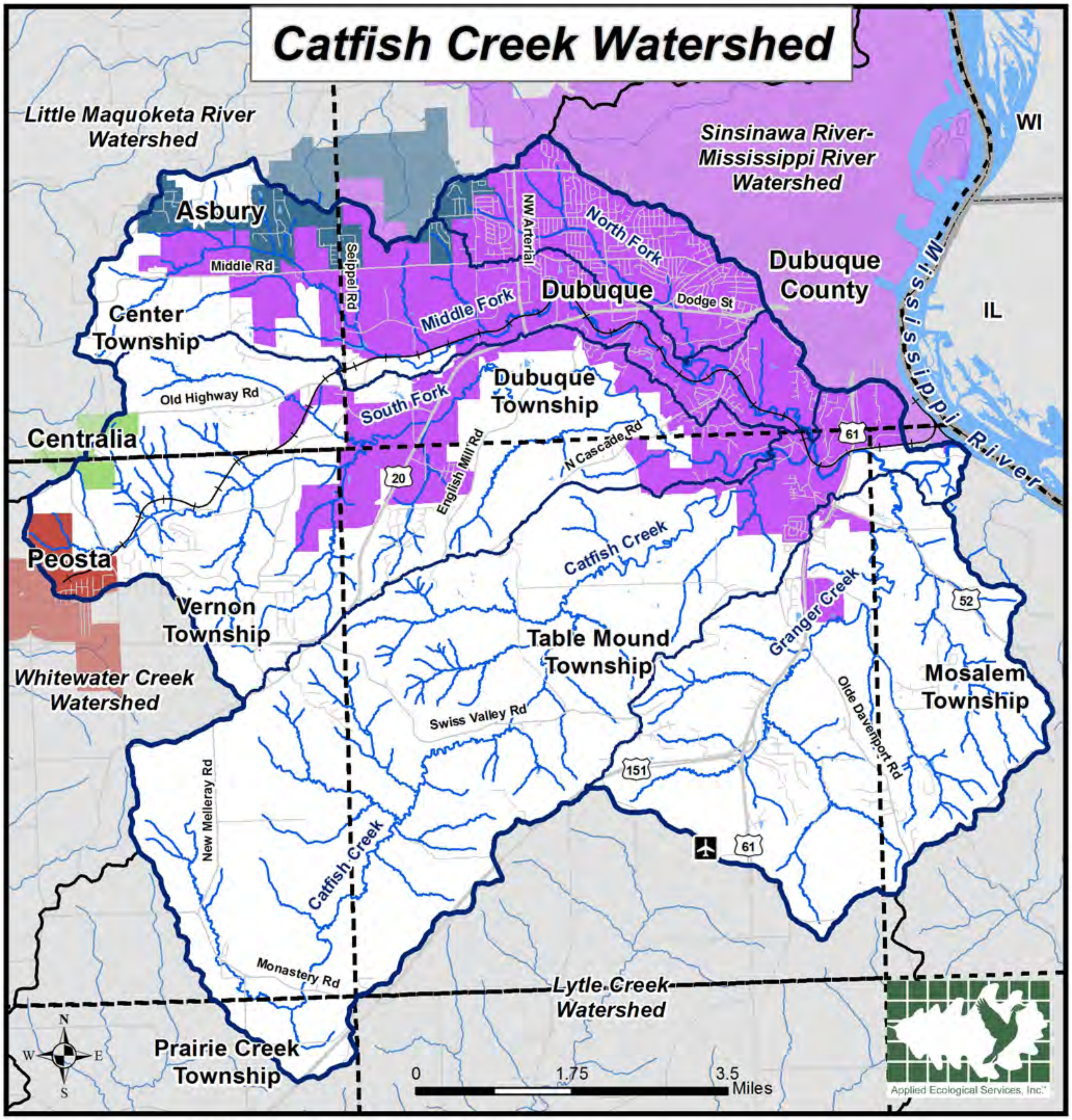
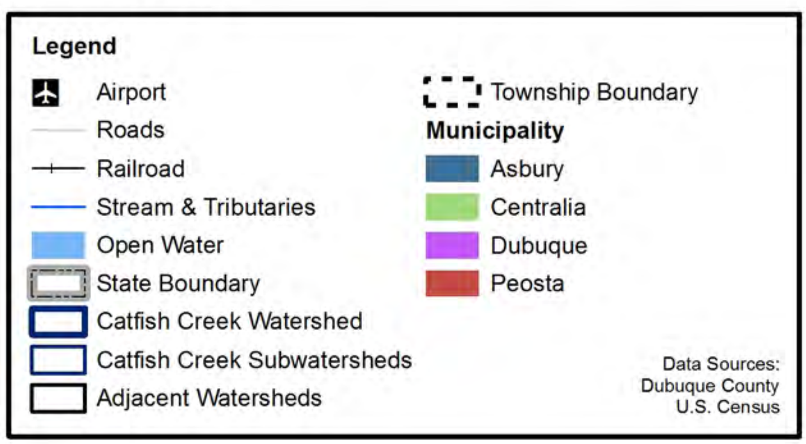


Figure 13: Watershed Jurisdictions



Jurisdictional Roles and Protections

Many types of natural resources throughout the United States are protected to some degree under federal, state, and/or local law. The U.S. Army Corps of Engineers (USACE) and surrounding counties regulate wetlands through Section 404 of the Clean Water Act and county Stormwater Ordinances respectively. The U.S. Fish and Wildlife Service (USFWS), Iowa Department of Natural Resources (IDNR), and Dubuque County Conservation Board (DCCB) protect natural areas and threatened and endangered species. Local municipalities also have ordinances that address other natural resource issues. The IDNR regulates wastewater and stormwater discharges to streams and lakes. Watershed protection in Dubuque County is primarily the responsibility of county and municipal level government.

Land development affecting water resources (rivers, streams, lakes, wetlands, and floodplains) is regulated by the USACE when "Waters of the U.S." are involved. These types of waters include any wetland or stream/river that is hydrologically connected to navigable waters. The USACE primarily regulates filling activities and requires buffers or wetland mitigation for developments that impact jurisdictional wetlands.

Land development in Dubuque County is regulated by the Erosion & Sediment Control and Stormwater Management Ordinance of Dubuque County (adopted March, 2010. Other governments and private entities with watershed jurisdictional or technical advisory roles include the USFWS and IDNR, Dubuque County Conversation Board (DCCB), Dubuque County Boards and the Dubuque Soil and Water Conservation District (SWCD). The USFWS and IDNR play a critical role in natural resource protection, particularly for rare or high quality habitat and threatened and endangered species. They protect and manage land that often contains wetlands, lakes, ponds, and streams. County Boards oversee decisions made by respective county governments and therefore have the power to override or alter policies and regulations. The SWCD provides technical assistance to the public and other regulatory agencies. Although the SWCD has no regulatory authority, they influence watershed protection through soil and sediment control and pre and post-development site inspections.

Municipalities in the watershed may or may not provide additional watershed protection above and beyond existing watershed ordinances under local municipal codes. Municipal codes present opportunities for outlining and requiring recommendations in this plan such as conservation development, Special Service Area (SSA) or watershed protection fees, and natural landscaping.

NPDES Permit Program

The Iowa Department of Natural Resources (IDNR) regulates point source discharges, such as wastewater and stormwater discharges, to streams and lakes by setting effluent limits, and monitoring/reporting on results. IDNR has overseen the National Pollutant Discharge Elimination System (NPDES) program since 1978. The NPDES program was initiated under the federal Clean Water Act to reduce pollutants to the nation's waters. This program requires permits for discharge from publicly owned treatment works (POTWs), discharges from industrial facilities, and discharges of urban runoff.

Under Iowa's NPDES program there are individual and general permits. Individual permits are tailored to a particular facility, while general permits cover multiple facilities that all fall within a specific category, such ones that have the same type of operation or discharge the same type of waste. All NPDES permits limit the amount of pollutants a facility can discharge into waterways (or set effluent limits), set out monitoring and reporting requirements, identify special conditions such as best management practices (BMPs) or additional monitoring, and lay out standard conditions. Permits are generally are set for a five year period, after which the facility must reapply. More detailed information regarding permitted NPDES sites within the watershed can be found in Section 4.1.

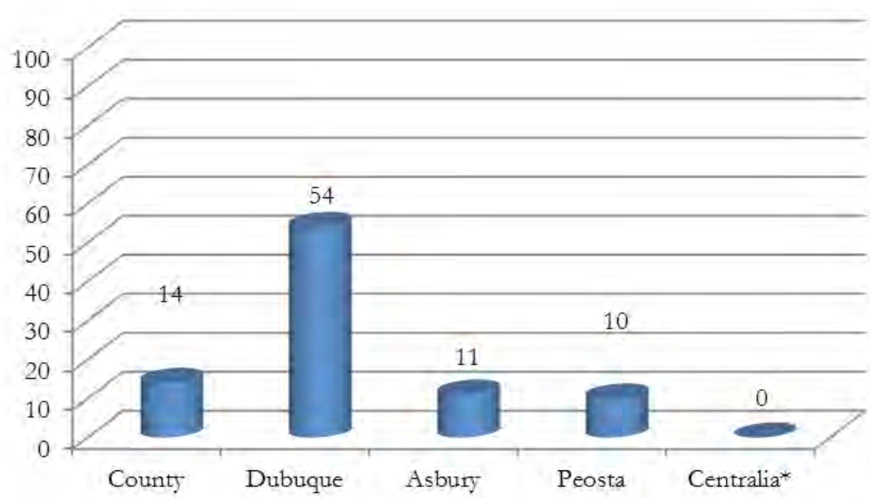
3.6 Existing Policies and Ordinance Review

Protection of natural resources and green infrastructure during future urban growth will be important for the future health of Catfish Creek watershed. To assess how future growth might further impact the watershed, an assessment of county and municipal ordinances was performed to determine how development is controlled within the watershed. In this way, potential improvements to local ordinances can be identified. As part of the assessment, municipal governments were asked to compare their local ordinances against model policies outlined by the Center for Watershed Protection (CWP) in a publication entitled "*Better Site Design: A Handbook for Changing Development Rules in Your Community*" (CWP 1998).

Applied Ecological Services, Inc. (AES) began the assessment process by reviewing municipal ordinances for Dubuque County, Dubuque, Asbury, Peosta, and Centralia. The results of the initial review were then sent to each municipality for review and update if needed. The City of Dubuque provided updates that were then added to AES's original review. The results of the review for each municipality can be found in Appendix C.

CWP's recommended ordinance review process involves assessments of three general categories including "Residential Streets & Parking Lots", "Lot Development" and "Conservation of Natural Areas". Various questions with point totals are examined under each category. The maximum score is 100. CWP also provides general rules based on scores. Scores between 60 and 80 suggest that it may be advisable to reform local development ordinances. Scores less than 60 generally mean that local ordinances are not environmentally friendly and serious reform may be needed. Municipal scores ranged from 10 to 54 with an average score of 22 (Figure 14). Dubuque scored the highest with 54 points followed by Dubuque County with 14, Asbury with 11 points, and Peosta with 10 points. Codes and ordinances for Centralia were unavailable for review during the time of the survey. Although all scores are low, it should be noted that this assessment is meant to be a tool to local communities to help guide development of future ordinances. Various policy recommendations are included in the Action Plan section of the report to address general ordinance deficiencies.

Figure 14. Center for Watershed Protection ordinance review results for local municipalities. * - Centralia's codes and ordinances were unavailable for review at the time of the survey.



3.7 Demographics

The East Central Intergovernmental Association (ECIA) is a regional planning association that supports Cedar, Clinton, Delaware, Dubuque and Jackson Counties in Iowa. The ECIA created 2035 population, dwelling, and employment forecasts as part of the Dubuque Metropolitan Area Transportation Study. ECIA's 2010 to 2035 forecasts of population, dwellings, and employment was used to project how these attributes will impact Catfish Creek watershed (Table 6). ECIA developed these forecasts by generating Transportation Analysis Zone (TAZ) level estimates for population, dwellings, and employment and is depicted on Figures 15-17. It is also important to note that a small portion in the southwest corner of the watershed was not covered by the TAZ data and no equivalent data was available.

The combined population of the watershed is expected to increase from 56,670 in 2010 to 80,039 by 2035, a 41.2% increase. The change in the number of dwellings in the watershed follows this trend and is predicted to increase from 20,800 to 28,424 (36.7% increase). The highest population and dwelling increases are expected in the very center of the watershed in Dubuque and Table Mound Townships, along a central western portion of unincorporated Vernon Township, and between Route 52 and Olde Davenport Rd in Mosalem Township (Figures 15 & 16). Most employment change is predicted along portions of Route 20 in Dubuque, Dubuque Township and Table Mount Township, as well as northeast of Olde Davenport Rd in Table Mound Township (Figure 17).

Table 6. ECIA 2010 data and 2035 forecast data.

Data Category	2010	2035	Change (2010-2035)	Percent Change
Population	56,670	80,039	23,369	+41.2
Dwellings	20,800	28,424	7,624	+36.7
Employment	26,416	33,537	7,121	+27.0

Socioeconomic Status

2010 U.S. Census Bureau information for Dubuque County was summarized in the creation of the Dubuque County Regional Smart Plan. To summarize, the area is comprised of a mostly white population (>94%) with a median household income over $48,000. Approximately 73% of homes are owner-occupied with a median value of those homes at about $131,400. Additionally, 38% of residents 25 and older have a high school diploma and 33% have a college degree (ECIA, 2013).

As part of the Dubuque County Regional Smart Plan, residents were asked to describe their community character. Some of the most common responses included the "small town feel" of the community, a close connection to agriculture, an appreciation for the historic architecture in the area, and recognition of the abundance and uniqueness of the area's natural resources (ECIA, 2013).

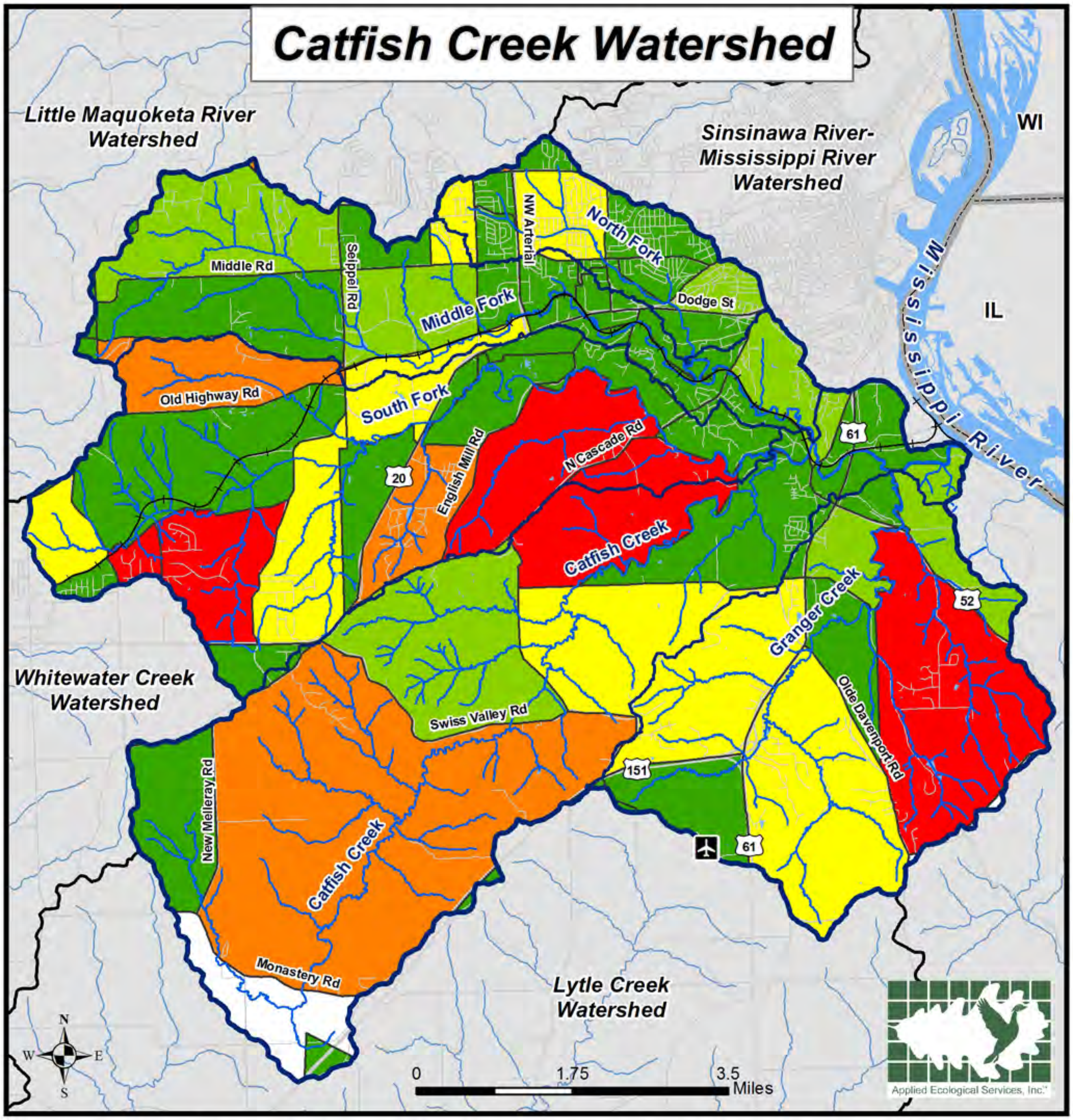
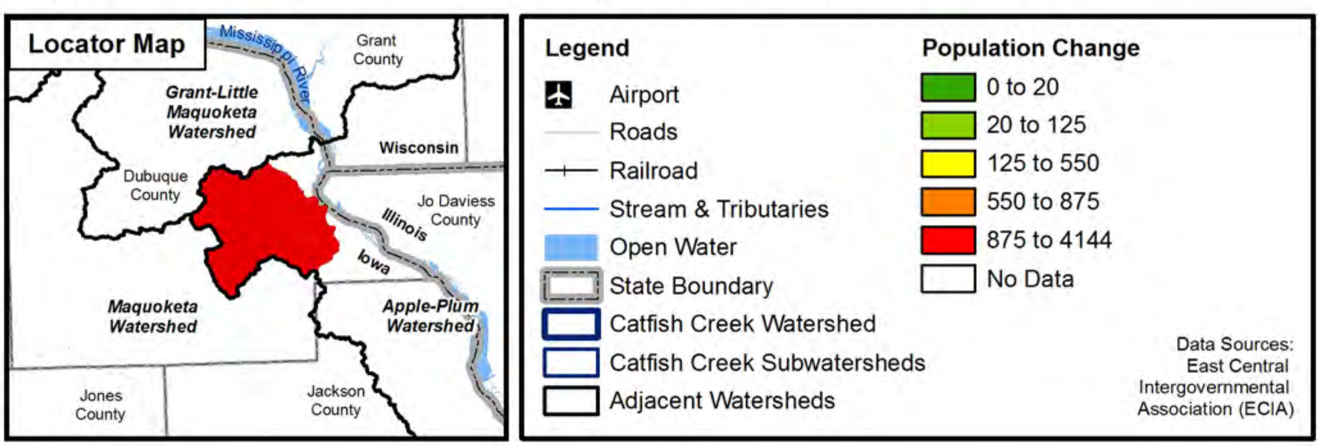


Figure 15: Population Change Year 2010 to 2035



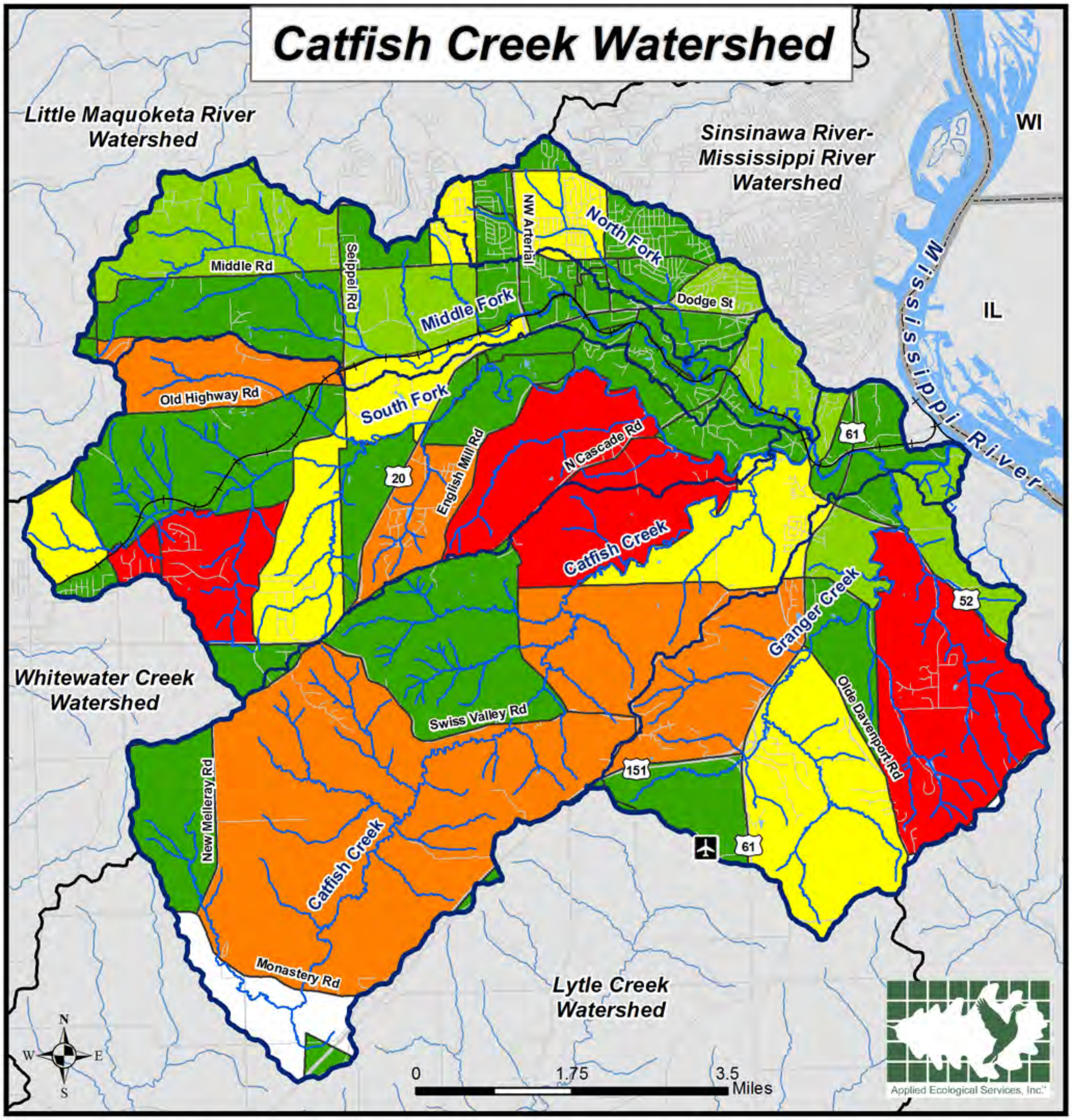


Figure 16: Occupied Dwellings Change Year 2010 to 2035

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Occupied Dwellings Change

- 0 to 10
- 10 to 50
- 50 to 150
- 150 to 300
- 300 to 1370
- No Data

Data Sources: East Central Intergovernmental Association (ECIA)

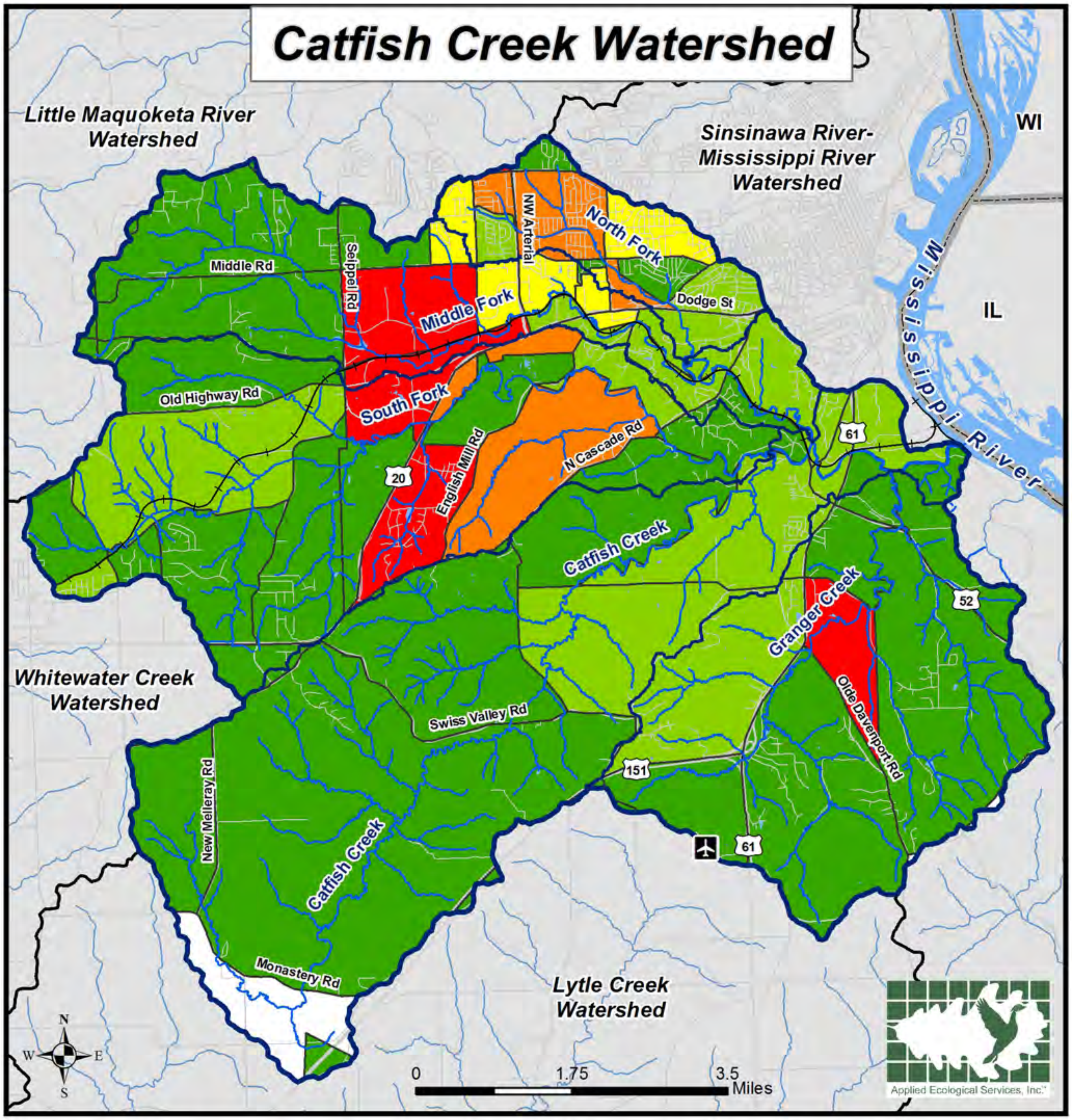


Figure 17: Employment Change Year 2010 to 2035

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Employment Change

- 0 to 30
- 30 to 100
- 100 to 175
- 175 to 375
- 375 to 853
- No Data

Data Sources:
East Central Intergovernmental Association (ECIA)

3.8 Existing & Future Land Use/ Land Cover

2012 Land Use/Land Cover

Highly accurate land use/ land cover data was produced for Catfish Creek watershed using several sources of data. First, East Central Intergovernmental Association (ECIA) 2012 land use data was used as a base layer. 2011 USDA aerial photography of the watershed was also overlaid on existing land use data in GIS so that additional discrepancies could be corrected. In some cases large portions of what is zoned as agriculture are too steep to farm or are unsuitable and much of this land was pulled out as open space; these areas include many of the stream corridors as they tend to be located at the bottom of ravines. Finally, several corrections were made to land use based on field notes taken by AES during the summer of 2013 watershed resource inventory. The 2012 land use/land cover data and map for Catfish Creek watershed is included in Table 7 and depicted on Figure 18.

Agricultural areas are by far the most abundant land use in the watershed at 21,590.6 acres or 46.8 percent. Open space is the next most common land use, constituting 10,060.4 acres (21.8%) of the watershed; this includes primarily land that falls within agricultural parcels, but is generally not farmed (most typically due to terrain). Other common land uses include residential (6,368.6; 13.8%), transportation (2,600.6 acres; 5.6%), park/golf course (1,675.2 acres; 3.6%), and commercial (1,191.8 acres; 2.6%).

Agriculture comprises the most acreage at 21,590.6 acres or 46.8%. Most of this is located in the western and southern portions of the watershed on mostly unincorporated township lands. 94% of agricultural land is used for row crop or hay, while the remaining 6% is dedicated to livestock operation such as dairy farms. Open space is also common at about 10,060.4 acres or 21.8% of the watershed combined. The open space land cover category for this watershed plan is defined as larger tracks of land that showed up on aerial imagery

Table 7. 2012 land use/land cover classifications and acreage.

Land Use	Total Acres	% of Watershed
Agriculture - Livestock	1,231.5	2.7%
Agriculture - Row Crop/Hay	20,359.0	44.2%
Cemetery	67.4	0.1%
Commercial	1,191.8	2.6%
Industrial	756.2	1.6%
Institutional	741.3	1.6%
Landfill	310.8	0.7%
Office	146.1	0.3%
Open Space	10,060.4	21.8%
Park/Golf Course	1,675.2	3.6%
Quarry	273.4	0.6%
Residential - Low Density	3,097.4	6.7%
Residential - Medium Density	1,479.7	3.2%
Residential - High Density	1,456.6	3.2%
Residential - Mixed Use	1.2	0.0%
Residential - Multi-Family	333.7	0.7%
Transportation	2,600.6	5.6%
Water	263.6	0.6%
Wetland	53.5	0.1%
Total	**46,099.5**	**100.0%**

as clearly forested land that typically fell within another land use category (usually agriculture). The bulk of this land is not suitable for most land uses because it consists of steep slopes within the ravines and along the stream corridors. These areas are located throughout the watershed, but predominantly across the southern half of the watershed and often form green infrastructure corridors surrounding stream channels.

Residential land uses combined total 6,368.6 acres of the watershed, or 13.8%. These areas are spread across the watershed, but tend to be concentrated in and around the municipalities of Dubuque, Asbury, and Peosta as well as around US Highways 151 and 61. Although the density of the residential areas differs, roughly half is considered low density residential.

The roads and interstates making up the transportation network are abundant, representing 5.6% of the watershed (or 2,600.6 acres). US Highways 20, 52, 61, and 151 are major arterial roads that serve to connect Dubuque to other parts of the state as well as Illinois. Additionally, major east-west roads include Middle Rd, Old Highway Rd, North Cascade Rd, Swiss Valley Rd, and Monastery Rd; while major north-south roads include New Melleray Rd, Seippel Rd, English Mill Rd, and Olde Davenport Rd.

Parks and golf courses are spread throughout the watershed as well and constitute a total of 1,675.2 acres (3.6%). The largest of these include Dubuque County Conservation Board's Swiss Valley Nature Preserve and Iowa Department of Natural Resources' Mines of Spain Recreation Area as well as several larger municipal and private golf courses.

In addition, total undeveloped land uses such as agricultural lands, open space, park/ golf courses, open water, and wetlands make up 33,643.0 acres or 73.0% of the watershed. Developed land uses account for the remaining 12,456.5 acres or 27.0% of the watershed.

A variety of land use/land covers comprise Catfish Creek watershed

Land Use/Land Cover Definitions:

Agriculture: Land use that includes out-buildings and barns, row & field crops and fallow field farms and pasture, includes dairy and other livestock grazing. Also includes nurseries, greenhouses, orchards, tree farms, and sod farms.

Cemetery: Land use that includes burial grounds and associated chapels and mausoleums.

Commercial: Land use that includes shopping malls and their associated parking, single structure office/ hotels and urban mix (retail trade like lumber yards, department stores, grocery stores, gas stations, restaurants, etc.).

Industrial: Land use that includes industrial, warehousing and wholesale trade, such as mineral extraction, manufacturing and processing, associated parking areas, truck docks, etc.

Institutional: Land use that includes medical facilities, educational facilities, government buildings, religious facilities, and others.

Landfill: Land used for disposal or reclamation where solid waste is buried between layers of dirt and other materials.

Office: Land use that includes office campuses, research parks, and business parks defined as non-manufacturing and characterized by large associated manicured landscape.

Open Space: Natural land cover that includes private and public property that has not been developed for any human purpose.

Park/Golf Course: Recreational open space with greater than 50% manicured turf such as playgrounds and athletic fields. Open space in a mostly natural state that includes public land such as federal, state, county, or other conservation areas and nature preserves. Public or private golf courses, country clubs and driving ranges; including associated buildings and parking.

Quarry: Land use that includes open surface excavation for the extraction of building stone, slate, marble, etc., by drilling, blasting, or cutting.

Residential-Low Density: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes greater than 1 acre.

Residential-Medium Density: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes between 0.5 and 1 acre.

Residential-High Density: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes less than 0.5 acre.

Residential-Mixed Use: Combination of residential, commercial, institutional, or industrial uses, where those functions are physically and functionally integrated, and that provides pedestrian connections.

Residential-Multifamily: Land use that includes multifamily residences. These include duplex and townhouse units, apartment complexes, retirement complexes, mobile home parks, trailer courts, condominiums, and associated parking on lots less than 1/8 acre.

Transportation: Land use that includes railroads, rail rapid transit and associated stations, rail yards, linear transportation such as streets and highways, and airport transportation.

Water: Open water areas including rivers, streams, canals, lakes, ponds, detention basins, and reservoirs.

Wetland: Wetland areas including lagoons/sloughs, marshes, wet prairie, meadows, bogs, etc.

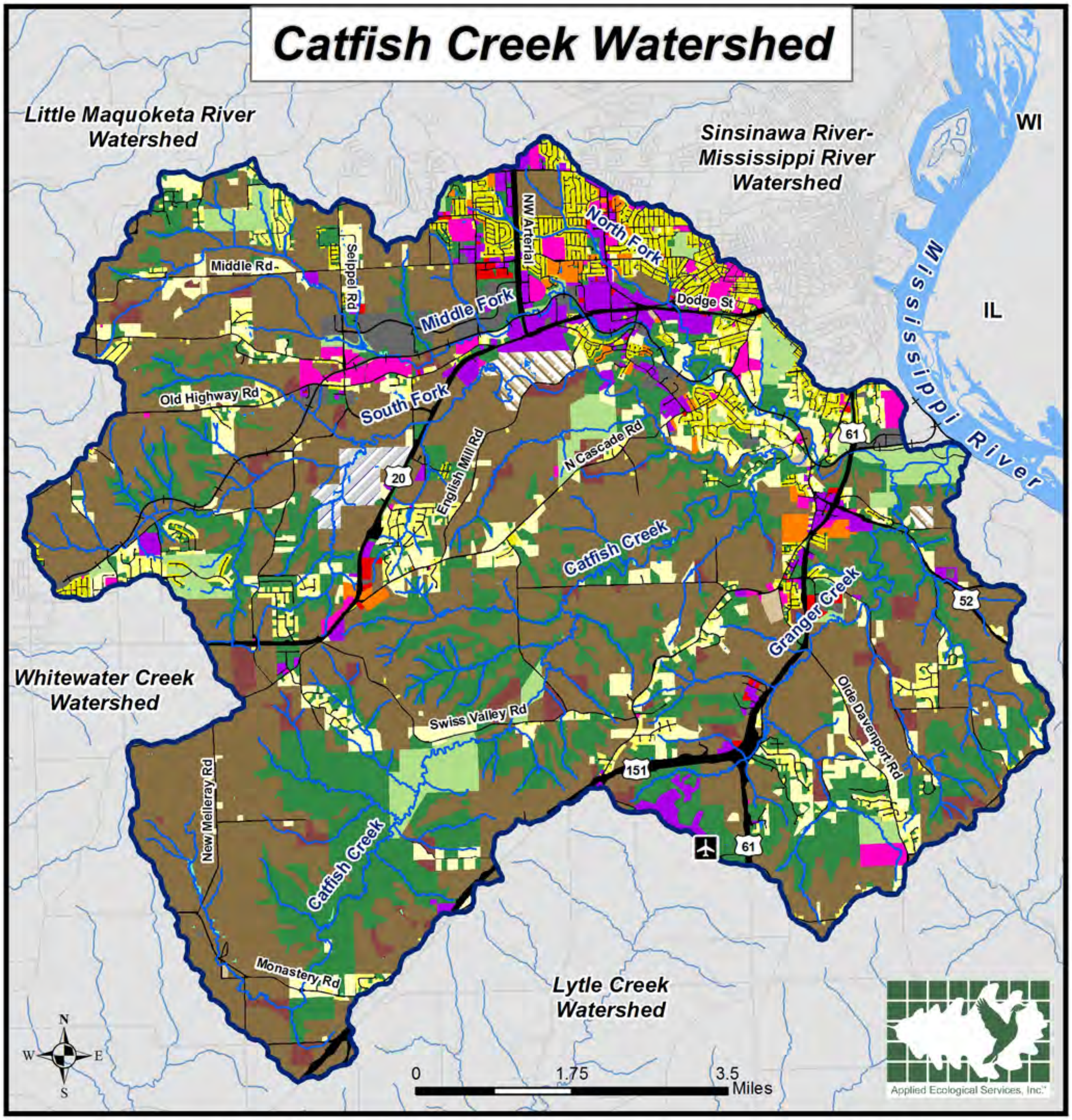
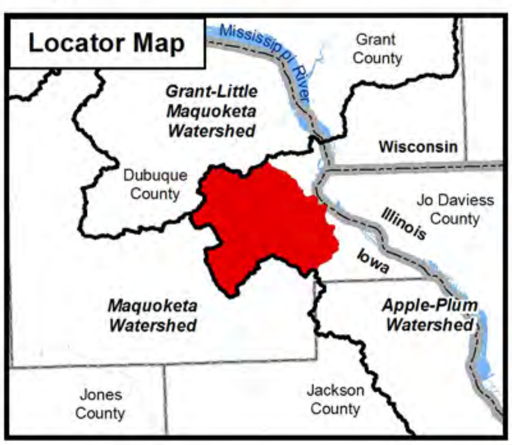
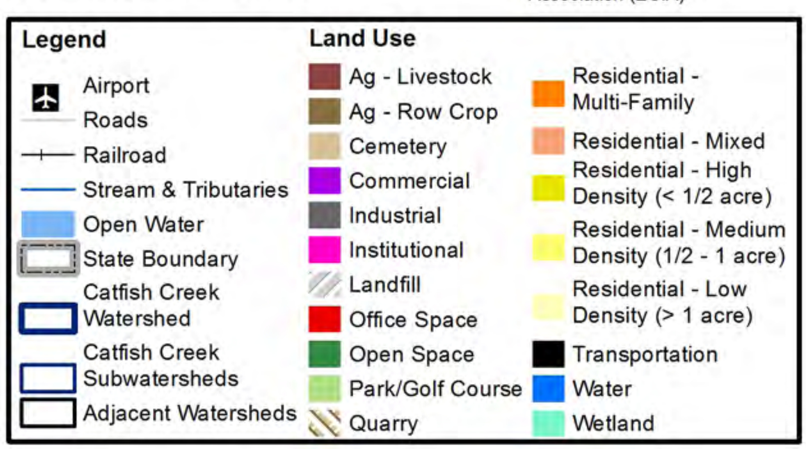


Figure 18: 2012 Land Use/Land Cover

Data Sources:
East Central Inter-governmental Association (ECIA)





Future Land Use/Land Cover Predictions

Information on predicted future land use/land cover for the watershed was obtained primarily from projections created by the ECIA for the Dubuque County Regional Smart Plan and municipal comprehensive plans where available. Available data was analyzed and GIS used to map predicted land use/ land cover changes. The results are summarized in Table 8 and depicted on Figure 19.

Table 8 compares existing land use/land cover acreage to predicted future land use/land cover acreage. The largest loss of a current land use/land cover is expected to occur on agricultural land where approximately 6,919.1 acres of the existing 21,590.6 acres (15.0% decrease) is expected to be converted to mostly residential and industrial land uses. The majority of these changes are expected to occur in the northern half of the watershed within the City of Dubuque and the areas surrounding the Southwest Arterial extension. In addition, it is important to note that existing open space is also expected to decrease from 10,060.4 acres to 9,107.6 acres in the future, a 952.8-acre decrease. However, it is also important to note that 111.4 acres of public parks/golf courses are expected to be created.

By far the most development change occurs where residential land uses will replace primarily farm land and account for over 5,918.7 additional acres in the future. Additionally, commercial and industrial uses are predicted to increase by 1,880 acres.

Table 8. Comparison between 2012 and predicted future land use/land cover statistics.

Land Use/ Land Cover	Current Area (acres)	Current % of Watershed	Predicted Area (acres)	Predicted % of Watershed	Change (acres)	Percent Change
Agriculture – Livestock	1,231.5	2.7%	981.2	2.1%	-250.4	-0.5%
Agriculture - Row Crop/Hay	20,359.0	44.2%	13,690.4	29.7%	-6,668.7	-14.5%
Cemetery	67.4	0.1%	86.1	0.2%	18.7	0.0%
Commercial	1,191.8	2.6%	1,891.9	4.1%	700.1	1.5%
Industrial	756.2	1.6%	1,936.4	4.2%	1,180.2	2.6%
Institutional	741.3	1.6%	703.5	1.5%	-37.8	-0.1%
Landfill	310.8	0.7%	310.8	0.7%	0.0	0.0%
Office	146.1	0.3%	146.1	0.3%	0.0	0.0%
Open Space	10,060.4	21.8%	9,107.6	19.8%	-952.8	-2.1%
Park/Golf Course	1,675.2	3.6%	1,786.6	3.9%	111.4	0.2%
Quarry	273.4	0.6%	273.4	0.6%	0.0	0.0%
Residential	6,368.6	13.8%	12,287.3	26.7%	5,918.7	12.8%
Transportation	2,600.6	5.6%	2,581.1	5.6%	-19.5	0.0%
Water	263.6	0.6%	263.6	0.6%	0.0	0.0%
Wetland	53.5	0.1%	53.5	0.1%	0.0	0.0%

*Road expansion and extension acreage is included in the surrounding land use change where applicable.

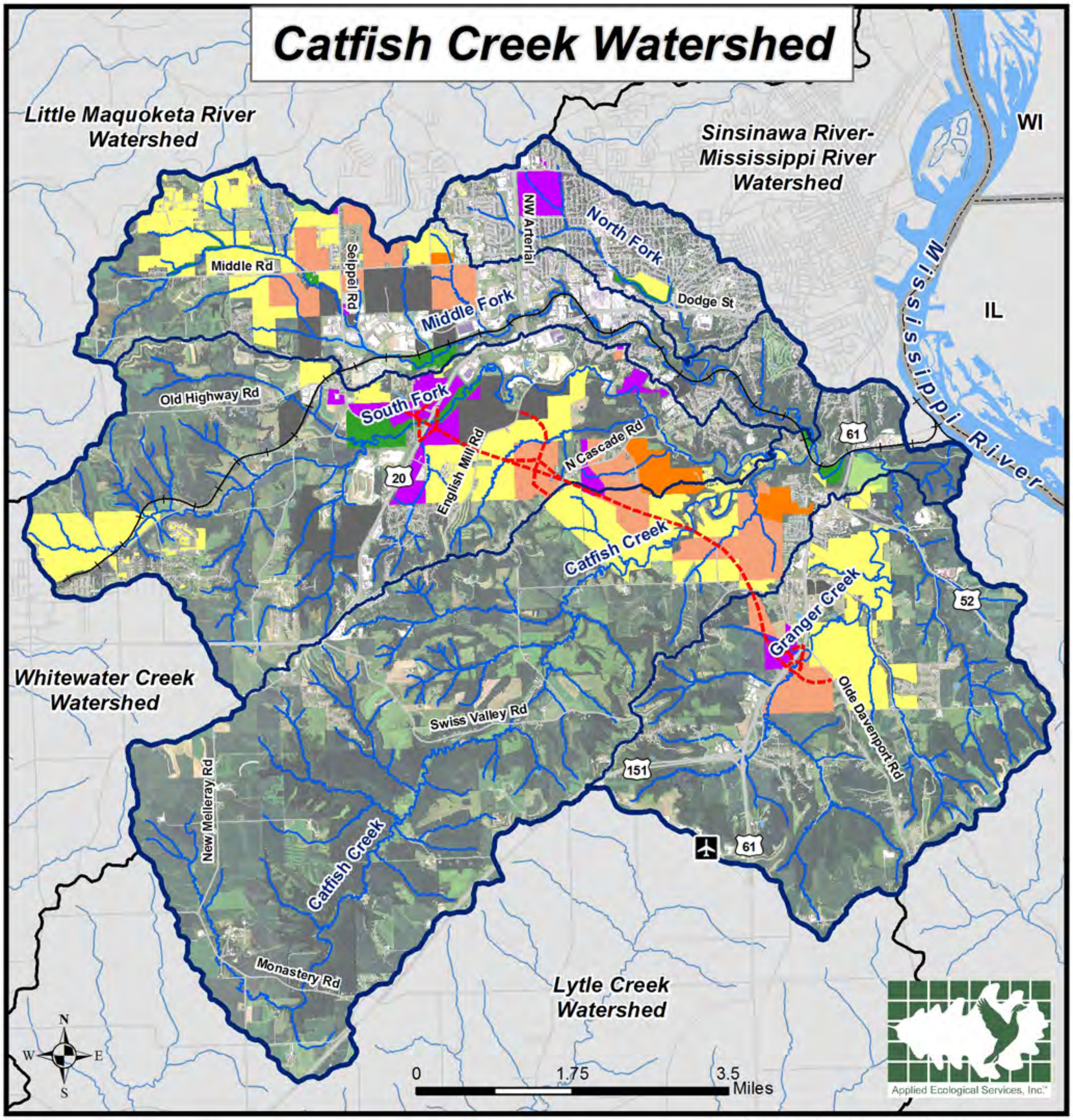
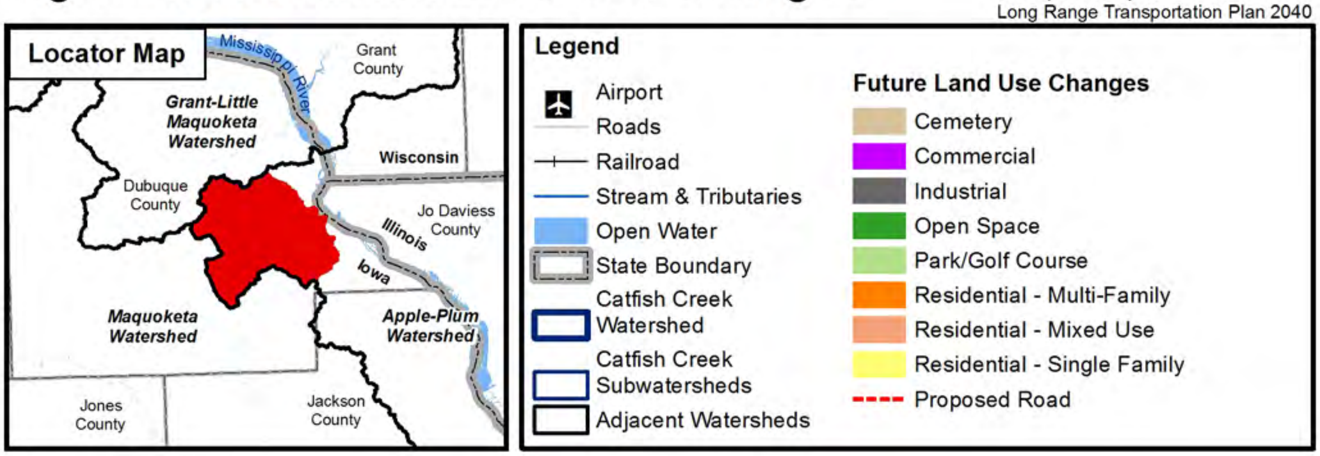


Figure 19: Predicted Land Use Changes

Data Sources: East Central Inter-governmental Association (ECIA)
Dubuque County Smart Plan
Long Range Transportation Plan 2040



Chicago Central and Pacific Railroad near Mines of Spain Recreation Area.

3.9 Transportation Network

Roads

There are 280.8 miles of roads in the watershed. Principal arterial roads, such as highways, make up 70.0 miles and minor arterial roads make up another 39.4 miles. Major collector streets make up 26.1 road miles, while minor collectors and local streets make up the remaining 145.6 miles in the watershed (Figure 20). Five major US Highways, all principal arterial roads, traverse the watershed: US Highways 20, 52, 61, and 151 and Iowa highway 32. US Route 20, also known as Dodge St within Dubuque, is an east-west highway that runs roughly diagonally through the watershed and connects Boston, Massachusetts and Newport, Oregon. US Highway 52 generally runs northwest-southeast, connecting Charleston, South Carolina and Portal, North Dakota. It joins US Highways 61 and 151 on Dubuque's southernmost side. US Highway 61 is a north-south highway that follows portions of Granger Creek before entering Dubuque; it connects New Orleans, Louisiana to Wyoming, Minnesota. US Highway 151 generally takes a southwest-northeast path connecting Interstate 80 in Iowa County, Iowa to Manitowoc, Wisconsin. It runs along the ridge line that forms part of the southern border of the watershed west of the Dubuque Regional Airport and north through Dubuque. Iowa Highway 32, also known as the Northwest Arterial, begins at US Hwy 20 and heads due north across Dubuque.

Construction on the Southwest Arterial, which will connect US Hwy 20 with US Hwys 52, 61, and 151, began in 2010. It is expected to be a four-lane divided highway a little over 6 miles in length and was designed to alleviate freight congestion in downtown Dubuque. In August of 2013 the City of Dubuque transferred jurisdiction of this project to the Iowa Department of Transportation.

Several other major roads are worth mentioning. Major east-west roads include Middle Rd, Old Highway Rd, North Cascade Rd, Swiss Valley Rd, and Monastery Rd. Major north-south roads include New Melleray Rd, Seippel Rd, English Mill Rd, and Olde Davenport Rd.

Railroads

The Chicago Central and Pacific Railroad, owned by Canadian National Railway, runs east-west through the watershed starting in Dubuque and following first part of the main stem of Catfish Creek and then a large portion of Middle Fork then making its way toward Peosta. The railroad extends for almost 12 miles through the watershed and is a freight line.

A tiny portion of the Iowa, Chicago and Eastern Railroad, owned by Canadian Pacific Railway, also runs through the watershed as it travels over the mouth of Catfish Creek. This line is used to transport chemicals, coal, steel, automobiles, and agricultural products.

Airports

The Dubuque Regional Airport was first built in 1948 as the Dubuque Municipal Airport. It is owned by the City of Dubuque and is located seven miles south of downtown. The airport is predominantly used for general aviation, but also offers limited commercial flights to Chicago O'Hare International Airport.

Trails/Bike Paths

Available data on the location of existing trails and bike paths in the watershed reveals a relatively broken network (Figure 20). Approximately 19.5 miles of bike and pedestrian trails currently exist in the watershed. Swiss Valley Nature Preserve, Mines of Spain Recreation Area, and parts of the City of Dubuque have the best trail and bike networks but many opportunities remain, especially along existing road right-of-ways that span most of the watershed. According to Dubuque County Regional Smart Plan, improving safety on existing trails and encouraging compact development in order to reduce travel times are the biggest needs in order to improve bike and pedestrian facilities across the county moving forward. A more expansive system of trails would give the community a unique opportunity to interact with nature and see the benefits of green infrastructure planning, such as that already found within Bergfeld Recreation Area.

Above: Map of existing bike routes near Bergfeld Recreation Area. Below: Bike trails and clearly marked bike routes (overlay) at Bergfeld Recreation Area.

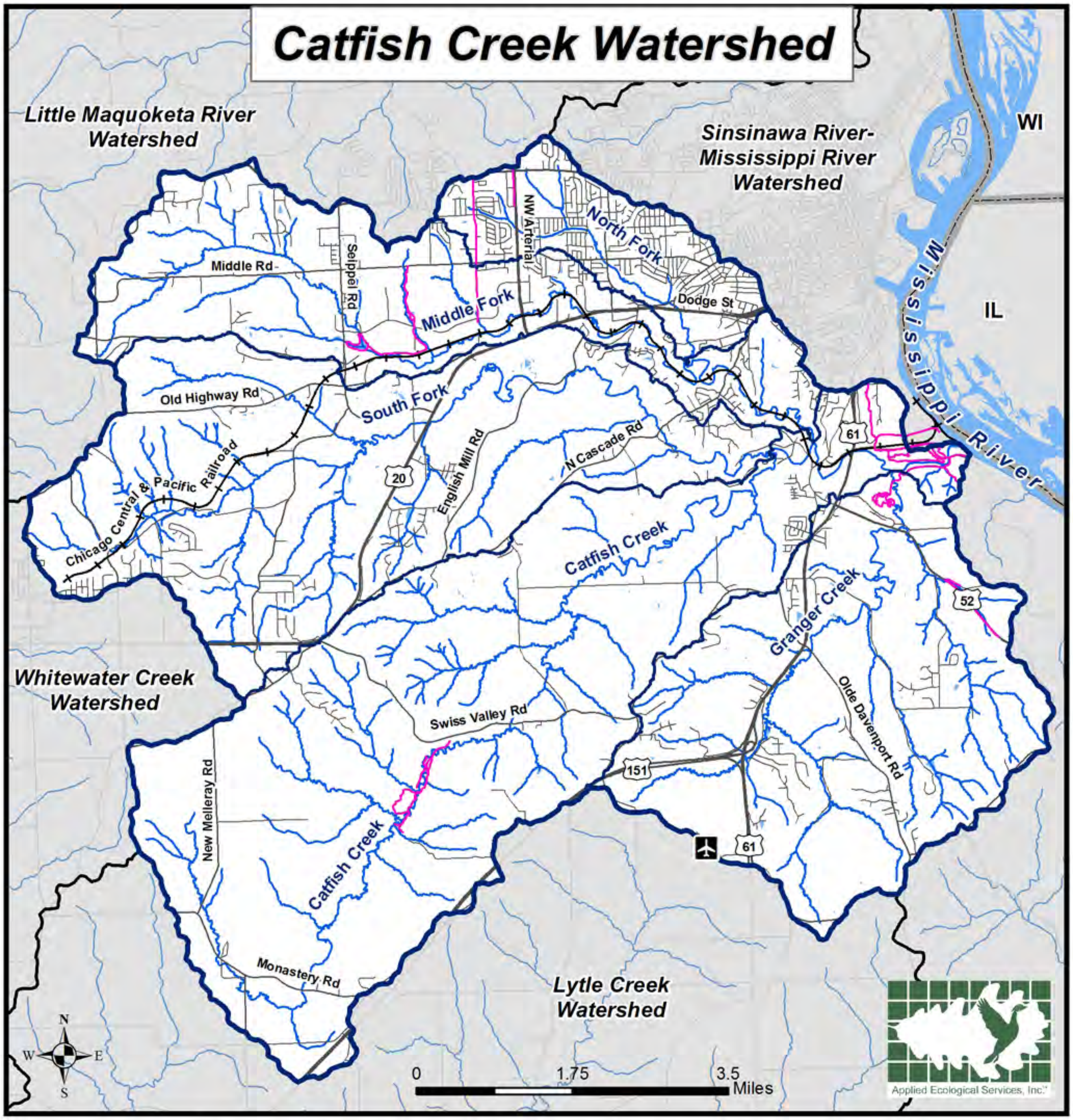


Figure 20: Existing Transportation Network

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds
- Existing Recreational Trails

Data Sources:
City of Dupage
Mines of Spain

3.10 Impervious Cover Impacts

Impervious cover is defined as surfaces of an urban landscape that prevent infiltration of precipitation (Scheuler 1994). Imperviousness is an indicator used to measure the impacts of urban land uses on water quality, hydrology and flows, flooding/depressional storage, and habitat related to streams (Figure 21). Based on studies and other background data, Scheuler (1994) and the Center for Watershed Protection (CWP) developed an Impervious Cover Model used to classify streams within subwatersheds into three quality categories: Sensitive, Impacted, and Non-Supporting (Table 9). In general, Sensitive subwatersheds have less than 10% impervious cover, stable channels, good habitat, good water quality, and diverse biological communities whereas streams in Non-Supporting subwatersheds generally have greater than 25% impervious cover, highly degraded channels, degraded habitat, poor water quality, and poor-quality biological communities. In addition, runoff over impervious surfaces collects pollutants and warms the water before it enters a stream resulting in a shift from sensitive species to ones that are more tolerant of pollution and hydrologic stress.

Figure 21. Relationship between impervious surfaces, evapotransporation, & infiltration. Source: The Federal Interagency Stream Restoration Working Group, 1998 (Rev. 2001).

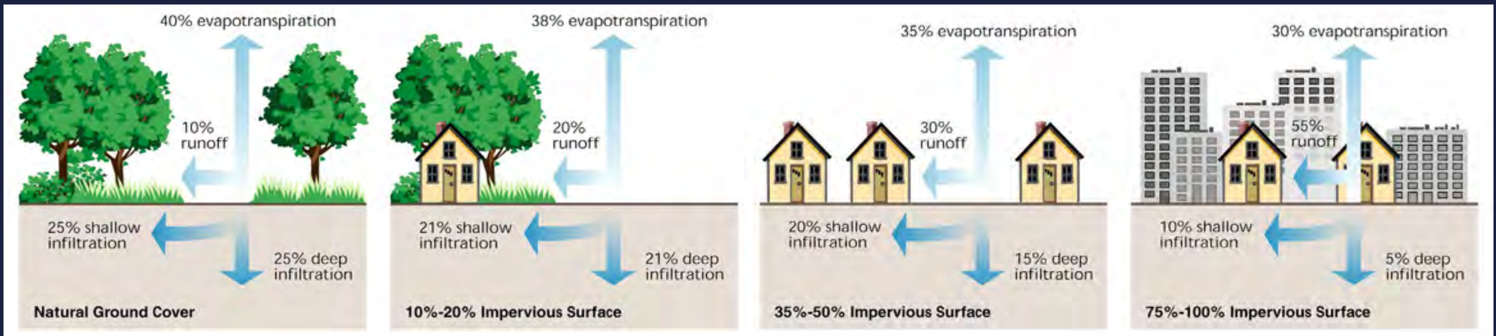


Table 9. Impervious category & corresponding stream condition via the Impervious Cover Model.

Category	% Impervious	Stream Condition within Subwatershed
Sensitive	<10%	Stable stream channels, excellent habitat, good water quality, and diverse biological communities
Impacted	>10% but <25%	Somewhat degraded stream channels, altered habitat, decreasing water quality, and fair-quality biological communities.
Non-Supporting	>25%	Highly degraded stream channels, degraded habitat, poor water quality, and poor-quality biological communities.

Sensitive Stream

Impacted Stream

Non-Supporting Stream

Water Quality Impacts

Imperviousness affects water quality in streams and lakes by increasing pollutant loads and water temperature. Impervious surfaces accumulate pollutants from the atmosphere, vehicles, roof surfaces, lawns and other diverse sources. During a storm event, pollutants such as nutrients (nitrogen and phosphorus), metals, oil/grease, and bacteria are delivered to streams and lakes. According to monitoring and modeling studies, increased imperviousness is directly related to increased urban pollutant loads (Schueler 1994). Furthermore, impervious surfaces can increase stormwater runoff temperature as much as 12 degrees compared to vegetated areas (Galli, 1990). According to Iowa Department of Natural Resources (IDNR), water temperatures in coldwater streams must not exceed 75°F during hot summer months and warmwater streams should not exceed 90°F (or 32°C) (IDNR 2004, 2010).

Hydrology and Flow Impacts

Higher impervious cover translates to greater runoff volumes thereby changing hydrology and flows in streams. If unmitigated, high runoff volumes can result in higher floodplain elevations (Schueler 1994). In fact, studies have shown that even relatively low percentages of imperviousness (5% to 10%) can cause peak discharge rates to increase by a factor of 5 to 10, even for small storm events. Impervious areas come in two forms: 1) disconnected and 2) directly connected. Disconnected impervious areas are represented primarily by rooftops, so long as the rooftop runoff does not get funneled to impervious driveways or a stormsewer system. Significant portions of runoff from disconnected surfaces usually infiltrate into soils more readily than directly connected impervious areas such as parking lots that typically end up as stormwater runoff directed to a stormsewer system that discharges directly to a waterbody.

Flooding and Depressional Storage Impacts

Flooding is an obvious consequence of increased flows resulting from increased impervious cover. As stated above, increased impervious cover leads to higher water levels, greater runoff volumes, and high floodplain elevations. Higher floodplain elevations usually result in more flood problem areas. Furthermore, as development increases, wetlands and other open space decrease. A loss of these areas results in increased flows because wetlands and open space typically soak up rainfall and release it slowly via groundwater discharge to streams and lakes. Detention basins can and do minimize flooding in highly impervious areas by regulating the discharge rate of stormwater runoff, but detention basins do not reduce the overall increase in runoff volume.

Habitat Impacts

A threshold in habitat quality exists at approximately 10% to 15% imperviousness (Booth and Reinelt 1993). When a stream receives more severe and frequent runoff volumes compared to historical conditions, channel dimensions often respond through the process of erosion by widening, downcutting, or both, thereby enlarging the channel to handle the increased flow. Channel instability leads to a cycle of streambank erosion and sedimentation resulting in physical habitat degradation (Schueler 1994). Streambank erosion is one of the leading causes of sediment suspension and deposition in streams leading to turbid conditions that may result in undesirable changes to aquatic life (Waters 1995). Sediment deposition alters habitat for aquatic plants and animals by filling interstitial spaces in substrates important to benthic macroinvertebrates and some fish species. Physical habitat degradation also occurs when high and frequent flows result in loss of riffle-pool complexes.

2012 Impervious Cover Estimate & Future Vulnerability

In 1998, the Center for Watershed Protection (CWP) published the Rapid Watershed Planning Handbook. This document introduced rapid assessment methodologies for watershed planning. The CWP released the Watershed Vulnerability Analysis as a refinement of the techniques used in the Rapid Watershed Planning Handbook (Zielinski 2002). The vulnerability analysis focuses on existing and predicted impervious cover as the driving forces impacting potential stream quality within a watershed. It incorporates the Impervious Cover Model described at the beginning of this subsection to classify Subwatershed Management Units (SMUs). SMUs are defined and examined in more detail in Section 3.3.

AES used a modified Vulnerability Analysis to compare each SMU's vulnerability to predicted land use changes across Catfish Creek watershed. Three steps were used to generate a vulnerability ranking of each SMU. The results were used to make and rank recommendations in the Action Plan related to curbing the negative effects of predicted land use changes on the watershed. The three steps are listed below and described in detail on the following pages:

> *Step 1:* Existing impervious cover classification of SMUs based on 2012 land use/land cover
>
> *Step 2:* Predicted future impervious cover classification of SMUs based on predicted land use/land cover changes
>
> *Step 3*: Vulnerability Ranking of SMUs based on changes in impervious cover and classification

Step 1: Existing Impervious Cover Classification

Step 1 in the Vulnerability Analysis is an existing classification of each SMU based on 2012 land use/land cover and measured impervious cover. 2012 impervious cover was calculated by assigning an impervious cover percentage for each land use/land cover category based upon the United States Department of Agriculture's (USDA) Technical Release 55 (TR55) (USDA 1986). Highly developed land such as commercial/retail for example is estimated to have over 70% impervious cover while a typical medium density residential development exhibits around 25% impervious cover. Open space areas such as forest preserves generally have less than 5% impervious cover. GIS analysis was used to estimate the percent impervious cover for each SMU in the watershed using 2012 land use/land cover data. Each SMU then received an initial classification (Sensitive, Impacted, or Non-Supporting) based on percent of existing impervious cover (Table 10; Figure 22).

To summarize, twenty-two SMUs (SMUs 2, 3, 6, 7, 9, 10, 14, 16-24, 26, 27, 29, 31, 33, and 34) were classified as Sensitive, nine as Impacted (SMUs 5, 8, 11-13, 15, 28, 30, and 32), and three as Non-Supporting (SMUs 1, 4, and 25) based on 2012 impervious cover estimates. The Sensitive SMUs include mostly agricultural land and open space surrounding ravines to the south and west, but also cover Swiss Valley Nature Preserve and Mines of Spain Recreation Area. Most of the Impacted SMUs are located in the central portion of watershed where medium and low density residential development and some commercial areas are common. All of the Non-Supporting SMUs are associated with highly impervious commercial, industrial, and high density residential development in portions of the City of Dubuque.

Table 10. 2012 & predicted future impervious cover by Subwatershed Management Unit.

SMU #	Step 1: Existing Impervious %	Existing (2012) Impervious Classification	Step 2: Predicted Impervious %	Predicted Impervious Classification	Percent Change	Step 3: Vulnerability
1	43.4%	Non-Supporting	49.5%	Non-Supporting	6.0%	Medium
2	9.7%	Sensitive	23.3%	Impacted	13.7%	High
3	8.7%	Sensitive	23.2%	Impacted	14.5%	High
4	40.8%	Non-Supporting	53.1%	Non-Supporting	12.2%	High
5	20.1%	Impacted	21.7%	Impacted	1.6%	Low
6	8.9%	Sensitive	13.4%	Impacted	4.5%	Medium
7	7.3%	Sensitive	7.3%	Sensitive	0.0%	Low
8	13.3%	Impacted	31.6%	Non-Supporting	18.3%	High
9	5.9%	Sensitive	7.3%	Sensitive	1.5%	Low
10	9.6%	Sensitive	12.7%	Impacted	3.1%	Medium
11	15.5%	Impacted	39.3%	Non-Supporting	23.8%	High
12	21.1%	Impacted	36.6%	Non-Supporting	15.5%	High
13	17.3%	Impacted	42.1%	Non-Supporting	24.8%	High
14	4.3%	Sensitive	18.4%	Impacted	14.1%	High
15	12.9%	Impacted	33.1%	Non-Supporting	20.2%	High
16	3.3%	Sensitive	3.3%	Sensitive	0.0%	Low
17	1.2%	Sensitive	1.2%	Sensitive	0.0%	Low
18	5.4%	Sensitive	5.4%	Sensitive	0.0%	Low
19	4.2%	Sensitive	4.2%	Sensitive	0.0%	Low
20	0.4%	Sensitive	0.4%	Sensitive	0.0%	Low
21	1.5%	Sensitive	1.5%	Sensitive	0.0%	Low
22	5.1%	Sensitive	5.1%	Sensitive	0.0%	Low
23	2.1%	Sensitive	15.0%	Impacted	12.9%	High
24	9.6%	Sensitive	31.2%	Non-Supporting	21.6%	High
25	30.4%	Non-Supporting	31.6%	Non-Supporting	1.2%	Low
26	4.9%	Sensitive	4.9%	Sensitive	0.0%	Low
27	9.9%	Sensitive	12.0%	Impacted	2.1%	Medium
28	21.1%	Impacted	21.1%	Impacted	0.0%	Low
29	7.9%	Sensitive	8.6%	Sensitive	0.7%	Low
30	12.9%	Impacted	33.2%	Non-Supporting	20.3%	High
31	5.7%	Sensitive	10.3%	Impacted	4.6%	Medium
32	21.5%	Impacted	32.6%	Non-Supporting	11.1%	High
33	6.1%	Sensitive	6.1%	Sensitive	0.0%	Low
34	4.5%	Sensitive	6.0%	Sensitive	1.5%	Low

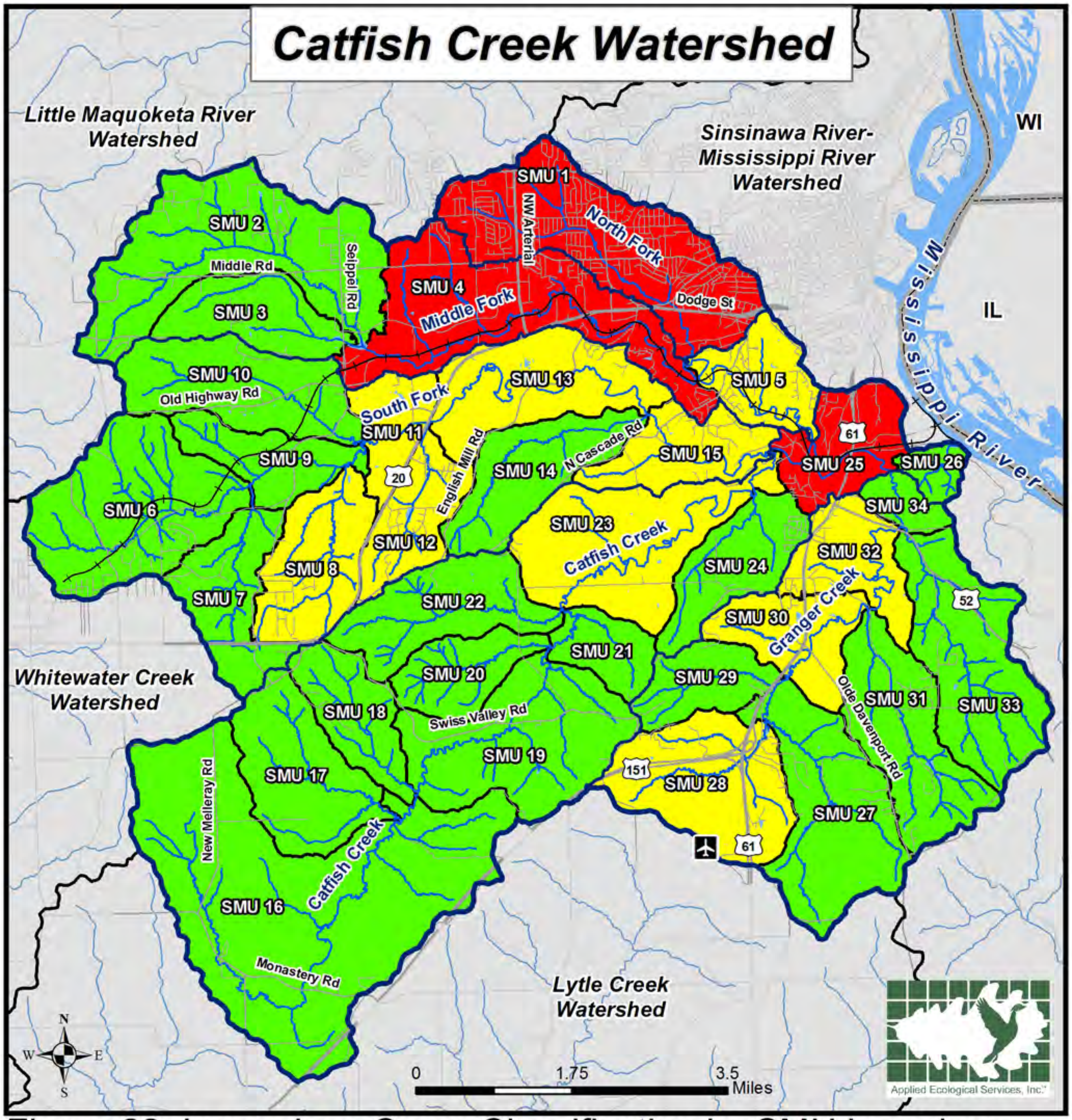


Figure 22: Impervious Cover Classification by SMU based on LandUse/Land Cover

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

2012 Impervious Cover by SMU

- Sensitive (0 to 10% Impervious)
- Impacted (10 to 25% Impervious)
- Non-Supporting (25 to 100% Impervious)

Step 2: Predicted Future Impervious Cover Classification

Predicted future impervious cover was evaluated in Step 2 of the vulnerability analysis by classifying each SMU as Sensitive, Impacted, or Non-Supporting based on predicted land use changes. Table 10 and Figure 23 summarize and depict predicted future impervious cover classifications for each SMU. This step identifies Sensitive and Impacted SMUs that are most vulnerable to future development pressure. SMUs 2, 3, 6, 10, 14, 23, 27 and 31 all changed from Sensitive to Impacted, reflecting those SMUs that are predominantly agriculture land or other open space predicted to experience a significant increase in impervious cover. SMUs 8, 11-13, 15, 30 and 32 all changed from Impacted to Non-Supporting. These changes are attributed to predicted extended commercial/retail/office and residential development in the central and northern portions of the watershed.

Step 3: Vulnerability Ranking

The vulnerability of each SMU to predicted future land use changes was determined by considering the following questions:

1. Will the SMU classification change?
2. Does the impervious cover of the SMU experience change greater than 10%?
3. What is the absolute change in impervious cover from existing to predicted conditions?

Vulnerability to future development for each SMU was categorized as Low, Medium, or High:

Low = no change in classification; <2% change in impervious cover
Medium = classification change and/or 2-10% change in impervious cover
High = classification change and >10% change in impervious cover

The vulnerability analysis resulted in 13 High, 5 Medium, and 16 Low ranked SMUs (Table 10; Figure 24). SMUs 2-4, 8, 11-15, 23, 24, 30 and 32 are ranked as highly vulnerable to future problems associated with impervious cover because each is expected to change classification and will undergo a greater than 10% change in impervious cover. Potential causes of increased impervious cover are due to the outward expansion of existing development both in areas where development already exists and into areas that are currently dominated by agricultural land uses.

SMUs 1, 6, 10, 27, and 31 are ranked as moderately vulnerable to predicted land use changes. SMU 1 did not experience a classification change, but did see a 6% change in impervious cover. SMUs 6, 10, 27, and 31 are expected to change classification from Sensitive to Impacted, but all see less than 5% change in impervious cover. Predicted residential development in areas that are currently agricultural will most affect SMUs 6 and 31 while commercial/retail development is expected to affect SMU 1. The remaining SMUs are not vulnerable to predicted future land use changes.

The results of this analysis clearly point to the potential negative impacts of traditional residential and commercial/retail development. It will be important to consider developing these areas using Conservation/Low Impact Design standards that incorporate the most effective and reliable Stormwater Treatment Train practices whereby stormwater is routed through various Management Measures prior to being released from the development site.

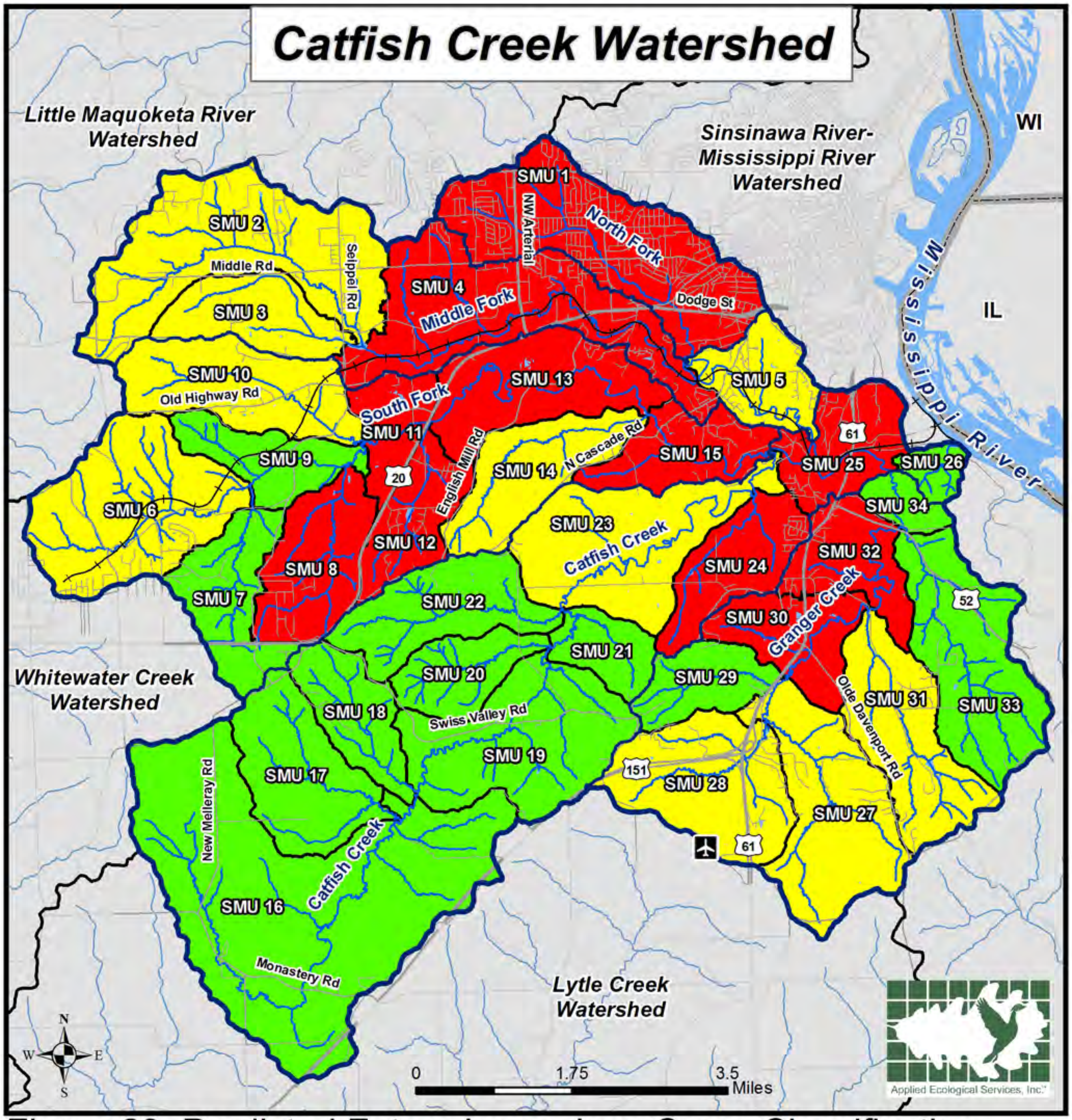
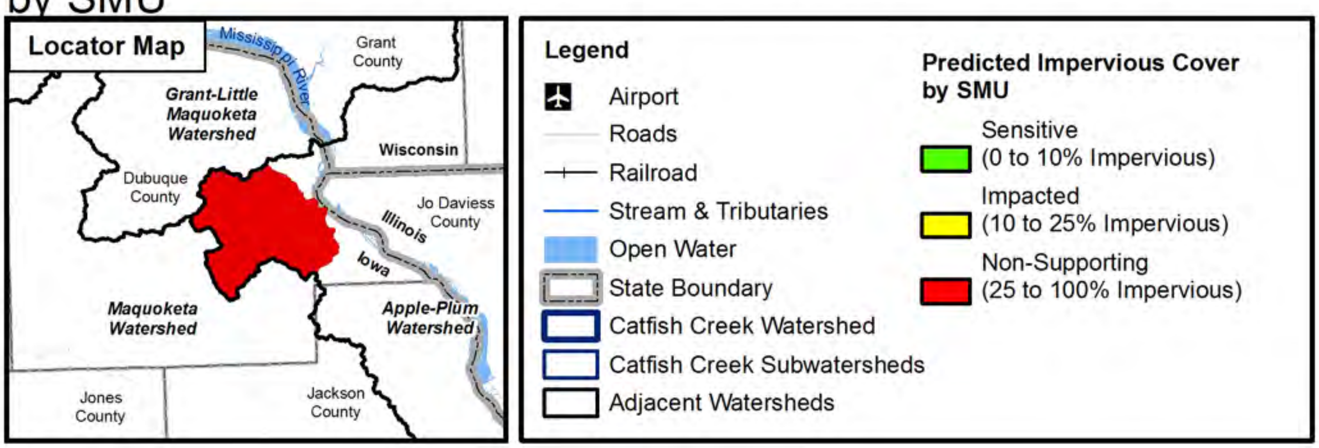


Figure 23: Predicted Future Impervious Cover Classification by SMU



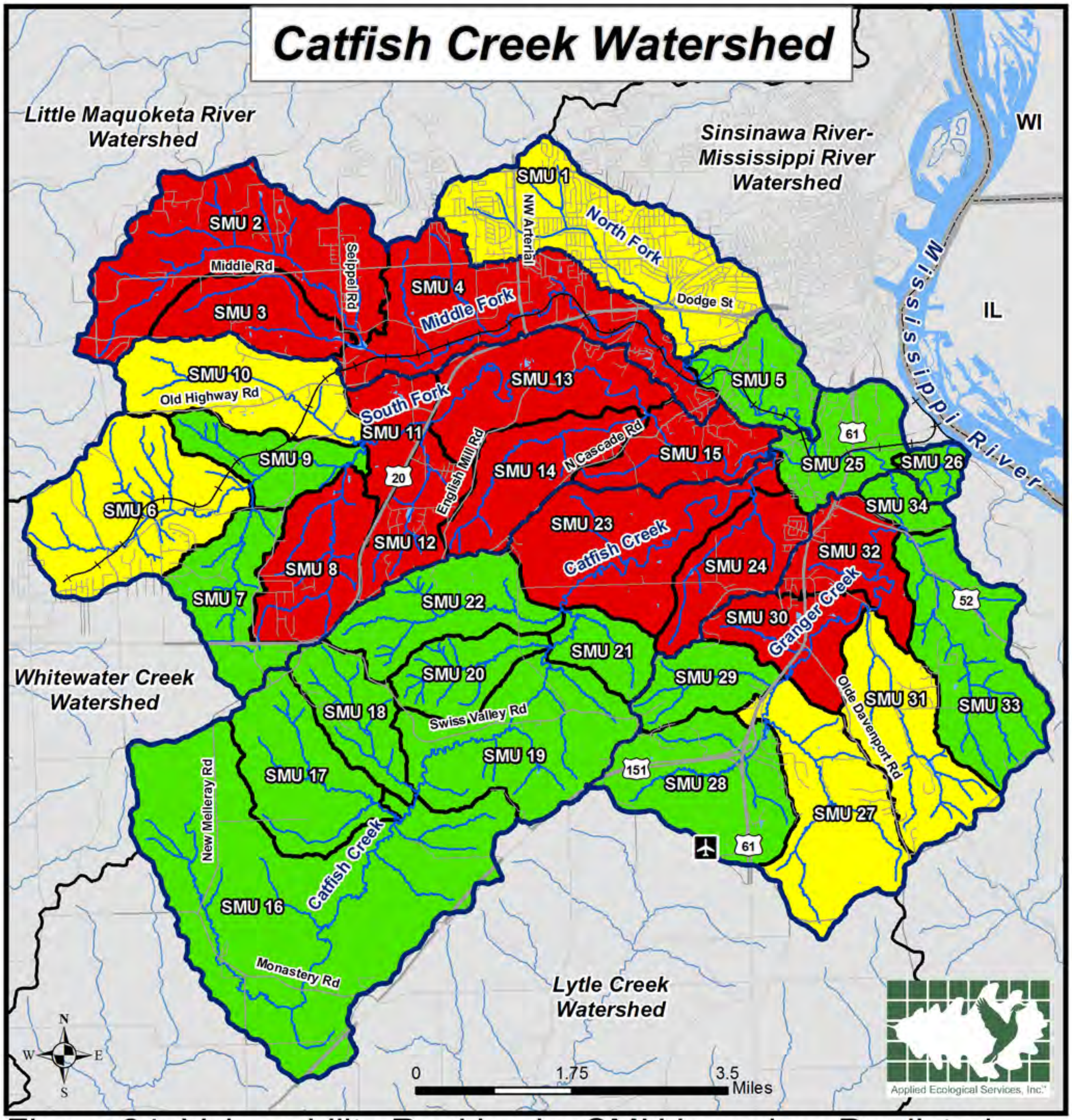
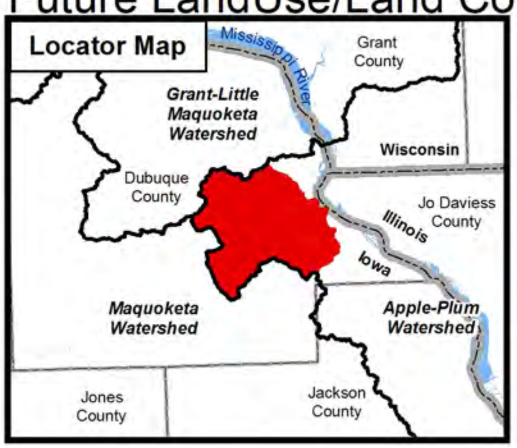
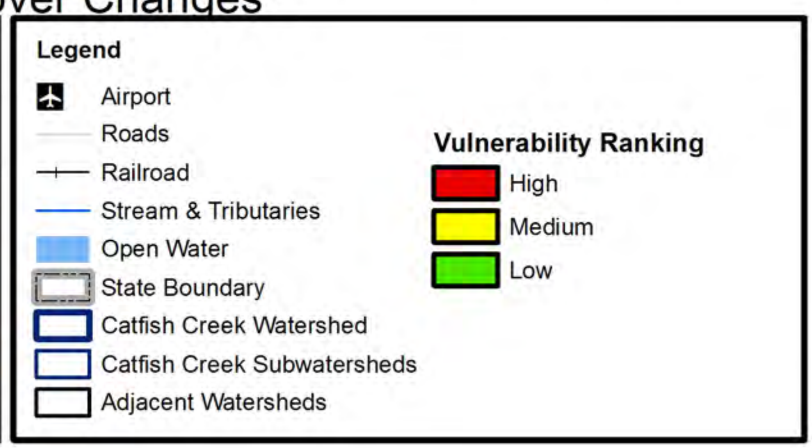


Figure 24: Vulnerability Ranking by SMU based on Predicted Future LandUse/Land Cover Changes





The negative effects of "Traditional Development" are well documented. As additional residential and other development occurs within Wind Point watershed, it will be extremely important to consider development alternatives such as "conservation development" and "low impact development".

Conservation Development Design

Conservation design facilitates development density needs while preserving the most valuable natural features and ecological functions of a site. It does this by reducing lot size, especially lot width thereby reducing the amount of roads and infrastructure (Figure 25). The open space is typically preserved or restored natural areas that are integrated with newer natural stormwater features and recreational trails. The open space allows the residents to feel like they have larger lots because most of the lots adjoin the open space system.

Such flexibility is intended to retain or increase the development rights of the property owner and the number of occupancy units permitted by the underlying zoning designation, while encouraging environmentally responsible development. Conservation design is most appropriate in areas having natural and open space resources to be protected and preserved such as floodplains, groundwater recharge areas, wetlands, woodlands, streams, wildlife habitat, etc. It can also be used to preserve and integrate agricultural uses into the land pattern. The approach first takes into account the natural landscape and ecology of a development site rather than determining design features on the basis of pre-established density criteria. The general steps included below are generally followed when designing the layout of a development site:

Step 1: Identify and analysis of existing site conditions including: all natural resources, conservation areas, potential restoration areas, natural drainage systems and their connections, physical features, and scenic areas.

Step 2: Delineation of preservation areas.

Step 3: Design of the lots and transportation system.

Figure 25. Traditional vs. Conservation Development Design (Elkhorn, WI).

Prairie Crossing Conservation Development in Grayslake, Illinois

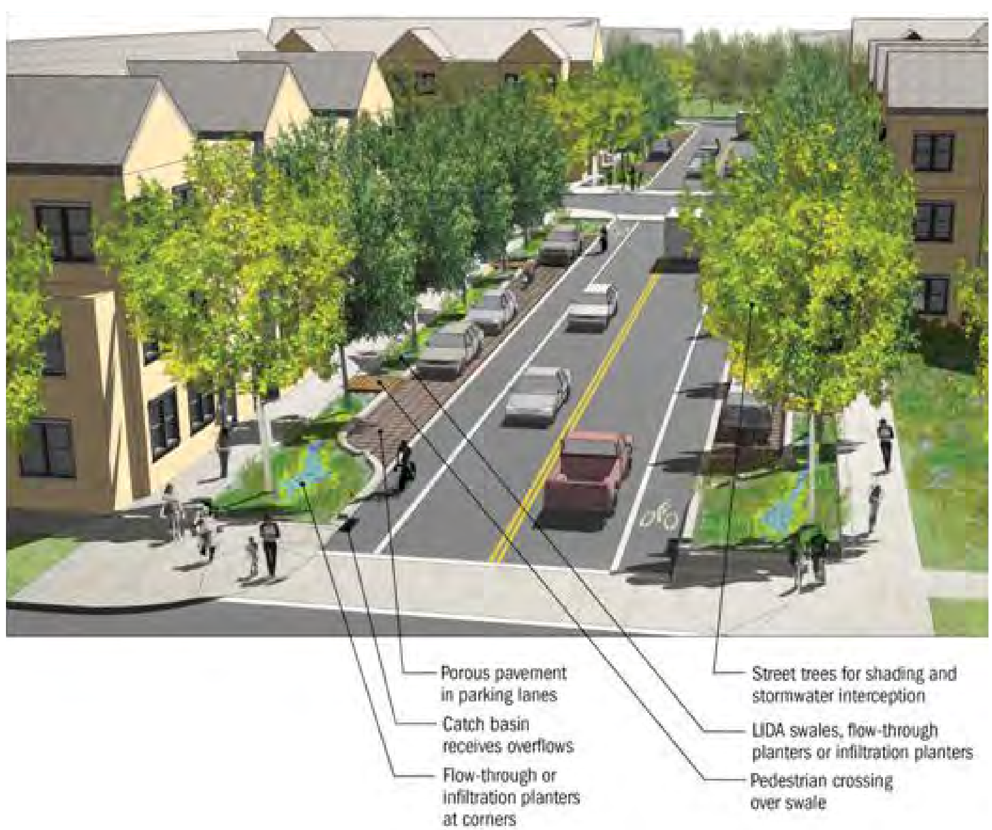
Low Impact Development (LID)

Low impact development (LID) focuses on the hydrologic impact of development and tries to maintain pre-development hydrologic systems, treating water as close to the source as possible. LID principals can be incorporated into development or stormwater ordinances and used in new development or retrofitting existing developments. Green infrastructure systems are created to mimic natural processes that promote water infiltration, native plant evapotranspiration, and stormwater reuse.

Low impact development seeks to keep stormwater out of pipes and instead keep the entire infrastructure more natural and above ground. Solutions start at the lot scale such as rain gardens and overflows to swales adjacent to roads. Larger impervious areas, such as a commercial development may utilize constructed wetlands for stormwater storage while adding value to the area by enhancing aesthetics, site interest and the ecology.

Dubuque County Soil & Water Conservation District (DCSWCD) details many agricultural and urban conservation practices that could be implemented in the watershed. The Noteworthy section below is a partial list of possible Management Measure practices, as described by DCSWCD on their website.

Above: **Figure 26.** Example of stormwater treatment train within a Conservation or Low Impact Development. Right: **Figure 27.** Greener Streetscape using LID practices. "*Greening the Code*" Washington County, OR



Dubuque County SWCD Recommended Management Measure Practices

Terrace: Break long slopes into shorter ones. They usually follow the contour. As water makes it way down a hill, terraces serve as small dams to intercept water and guide it to an outlet.

Grassed Waterway: A natural drainage way is graded and shaped to form a smooth, bowl-shaped channel. This area is seeded to sod-forming grasses. Runoff water that flows down the drainage way flows across the grass rather than tearing away soil and forming a larger gully. An outlet is often installed at the base of the drainage way to stabilize the waterway and prevent a new gully from forming.

Manure Storage Structure: The type of manure storage structure you would use depends upon your livestock operation, animal waste management system and planned field application. Several options exist including an earthen storage pond, above or below ground tank, pit underneath a confinement facility or a sheltered concrete slab area. Manure can be pumped, scraped and hauled, pushed or flushed into your storage structure. The structure's purpose is to safely contain the manure and keep nutrient loss and pollution of downstream water bodies to a minimum by preventing runoff.

Grade Stabilization Structure: A dam, embankment or other structure built across a grassed waterway or existing gully controls and reduces water flow. The structure drops water from one stabilized grade to another and prevents overfall gullies from advancing up a slope.

Contour Farming: Crop row ridges built by tilling and planting on the contour create hundreds of small dams. These ridges or dams slow water flow and increase infiltration which reduces erosion.

Planned Grazing System: Pasture is divided into two or more pastures or paddocks with fencing. Cattle or moved from paddock to paddock on a pre-arranged schedule based on forage availability and livestock nutrition needs.

Streambank Stabilization: Streambank Stabilization is used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries. It is used to prevent the loss land or damage to land uses, or other facilities adjacent to the banks, including the protection of known historical, archeological, and traditional cultural properties.

Rain Gardens: Rain gardens are depressional areas landscaped with perennial flowers and native vegetation that soak up rainwater. They are strategically located to capture runoff from impervious surfaces, such as roofs and streets.

Native Landscaping: Native plantings are beautiful additions to any urban landscaped. When established, native landscapes are low maintenance areas that provide great habitat for insects and birds adapted to Iowa. Their deep root system increase soil organic matter, builds soil quality, and helps retain and infiltrate storm water.

Pervious Paving: Pervious paving allows water to infiltrate into layers of limestone placed below the paving and then into the soil and groundwater below. By infiltrating most of the storm water on-site, the amount of water and pollution flowing into storm sewers, rivers and streams is reduced. This helps protect water quality, maintains more stable base flows to streams, reduces flood peaks, and reduces stream bank erosion. With infiltration, groundwater is recharged and streams are replenished with cool, clean groundwater in a more natural way.

Bioswales: Bioswales are storm water runoff conveyance systems that provide an alternative to storm sewers. They can absorb flows or carry runoff from heavy rains to storm sewer inlets or directly to surface waters. Bioswales improve water quality by infiltrating the first flush of storm water runoff and filtering the large storm flows they convey.

Constructed Wetland: A constructed shallow water ecosystem designed to simulate natural wetlands.

Green Roofs: Green roofs, also known as vegetated roof covers, eco-roofs or nature roofs, are multi-beneficial structural components that help to mitigate the effects of urbanization on water quality by filtering, absorbing or detaining rainfall. They are constructed of a lightweight soil media, underlain by a drainage layer, and a high quality impermeable membrane that protects the building structure. The soil is planted with a specialized mix of plants that can thrive in the harsh, dry, high temperature conditions of the roof and tolerate short periods of inundation from storm events.

Economics of Conservation Developments and Low Impact Development

Both conservation developments and low impact development (LID) are not only environmentally sound choices, but economical ones for both developers and municipalities. Conservation design can produce some of its biggest cost savings in infrastructure costs such as site preparation, stormwater management, site paving, and sidewalks (Conservation Research Institute, 2005). According to a study conducted by AES, the average savings created by choosing conservation development over more traditional footprints is 24% (Table 11) (AES, 2007). Not only do lots in conservation developments typically cost less to install, but they also "carry a price premium … and sell more quickly than lots in conventional subdivisions (Mohamed, 2006)." Another study conducted in Concord, Massachusetts found that over an eight year period, a cluster development with protected open space had a 2.6% higher annual appreciation rate over "residential properties with significantly larger private yards, but without the associated open-space (Lacy, 1990)."

While low impact development covers a range of stormwater practices, it has some of the same cost benefits as conservation design. Typically LID practices "can cost less to install, have lower operations and maintenance costs, and provide more cost-effective stormwater management and water-quality services than conventional stormwater controls (ECONorthwest, 2007)." Similarly to conservation design, cost savings from utilizing LID practices can be found as a reduction in the amount of drainage infrastructure and land disturbance required; additionally, property values can be increased by 12 - 16% (UNH Stormwater Center, 2011).

There is also evidence that combining both conservation and low impact development practices through holistic site design can create deeper cost savings for developers as well as increased ecosystem benefits – particularly by combining clustered site designing and naturalized stormwater management systems (Conservation Research Institute, 2005). Not only do conservation and low impact development practices provide a more economical possibility for developers and municipalities, but they can improve water quality, habitat, and property values in the watershed.

Table 11. Savings of Conservation Development over Traditional Subdivision Design for ten Midwestern conservation development projects.

Savings of Conservation Development over Traditional Subdivision Design (P=Project)

Positive numbers are savings of Conservation Development over Traditional.
Negative numbers are costs of Conservation Development over Traditional.

Project:	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Average
ITEM											
Grading	-$214,740	$257,832	$1,813,726	$2,215,025	$1,856,206	$1,862,988	$796,705	$291,957	$302,497	$2,852,312	51.00%
Roadway	$84,702	$18,754	-$16,477	-$130,230	$1,464,599	$1,187,386	$205,168	$9,231	-$9,963	$801,484	18.00%
Storm Sewer	$181,611	$31,220	$6,648	$89,676	$974,689	$547,184	$210,289	$65,501	$110,021	$678,302	40.00%
Sanitary Sewer	$41,614	-$4,365	$0	-$203,064	$850,962	$224,776	$72,436	-$15,502	$5,960	$423,458	6.00%
Water	$44,483	-$4,671	-$63,680	-$215,881	$905,157	$240,064	$76,815	-$16,257	$5,973	$451,084	5.00%
Ecological	-$56,500	-$74,857	-$277,472	-$400,321	-$407,131	-$625,084	-$160,341	-$93,954	-$264,513	-$380,992	-154.00%
Amenities	$17,572	-$16,202	-$94,399	-$226,216	$552,667	$221,666	$7,825	-$15,749	-$39,274	$266,982	6.00%
Contingencies	$132,055	$51,928	$342,087	$282,247	$1,549,287	$914,745	$302,225	$56,307	$27,675	$1,273,157	24.00%
Total Savings	$660,277	$259,639	$1,710,433	$1,411,235	$7,746,436	$4,573,725	$1,511,124	$281,534	$138,377	$6,365,787	
Total Percent Savings	**19.00%**	**20.00%**	**33.00%**	**15.00%**	**43.00%**	**32.00%**	**25.00%**	**15.00%**	**4.00%**	**37.00%**	**24.30%***
Cost Savings Per Lot	**$8,725.00**	**$6,978.00**	**$147,012.00**	**$29,012.00**	**$7,904.00**	**$20,077.00**	**$7,346.00**	**$4,078.00**	**$4,959.00**	**$67,676.00**	**$30,376.70**

* Total Savings Percentage is *not* the percentage savings of all individual Items added together, because dollar-values of Items are different.
Visit www.appliedeco.com for more detailed info.

3.11 Open Space Inventory, Prioritization, & Green Infrastructure Network

A major component of watershed planning includes an examination of open space to determine how it best fits into a "Green Infrastructure Network". Green infrastructure is best defined as an interconnected network of natural areas and other open space that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife (Benedict 2006). Natural features such as stream corridors, wetlands, floodplain, woodlands, and grassland are the primary components of green infrastructure. Working lands such as farms and partially developed areas including parks, ball fields, golf courses, school grounds, detention basins, large residential parcels, and any residential lot that includes a stream corridor are also considered components of a Green Infrastructure Network. A three step process was used to create a parcel-based Green Infrastructure Network for Long Run Creek watershed:

Step 1: All parcels of land in the watershed were categorized as open space, partially open space, or developed.

Step 2: All open and partially open parcels were prioritized based on a set of criteria important to green infrastructure.

Step 3: Prioritized open and partially open parcels were configured to form a Green Infrastructure Network.

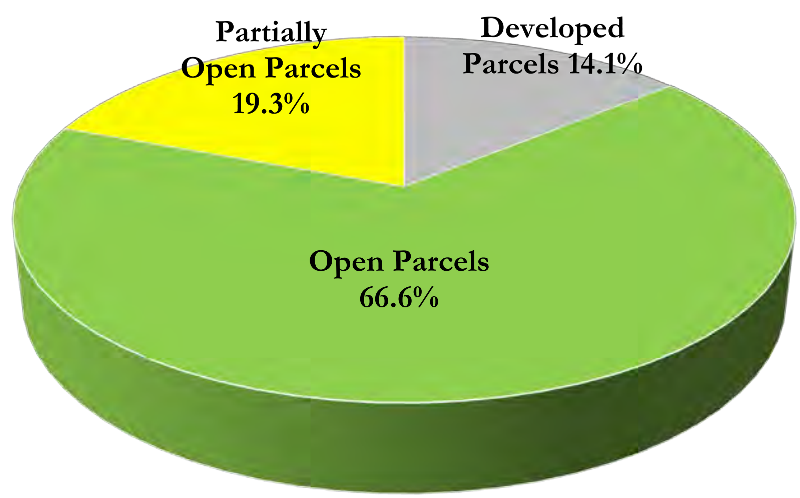
For this watershed plan, an "open space" parcel is generally defined as any parcel that is not developed such as a nature preserve or agricultural field. "Partially open" parcels have been developed to some extent, but the parcels still offer potential green infrastructure opportunities. Examples of partially open parcels include school grounds and residential lots generally greater than two to three acres with minimal development. Parcels that are mostly built out such as commercial/retail areas and roads are considered "developed". Public versus private and protected versus unprotected status of open and partially open space parcels are other important green infrastructure attributes that are discussed in more detail below.

Open, Partially Open, & Developed Parcels

Step 1 in creating a Green Infrastructure Network was completed by categorizing all parcels in the watershed as "open", "partially open", or "developed."

Figures 28 and 29 summarize and depict Step 1 results used to develop the Green Infrastructure Network. Open space parcels comprise approximately 28,961 acres or 66.6% of the watershed. Parcels range from less than 1 acre to 276 acres with a 16.5-acre average. Partially open parcels make up another 8,400 acres or 19.3% of the watershed. These parcels range from less than 1 acre to 167 acres with an 8.9-acre average. Developed parcels account for the remaining 6,103 acres or 14.1% of the watershed. Most open and partially open parcels are located on agricultural land, Swiss Valley Nature Preserve, Mines of Spain Recreation Area, golf courses, and larger residential lots.

Figure 28. Distribution of open, partially open, and developed parcels.



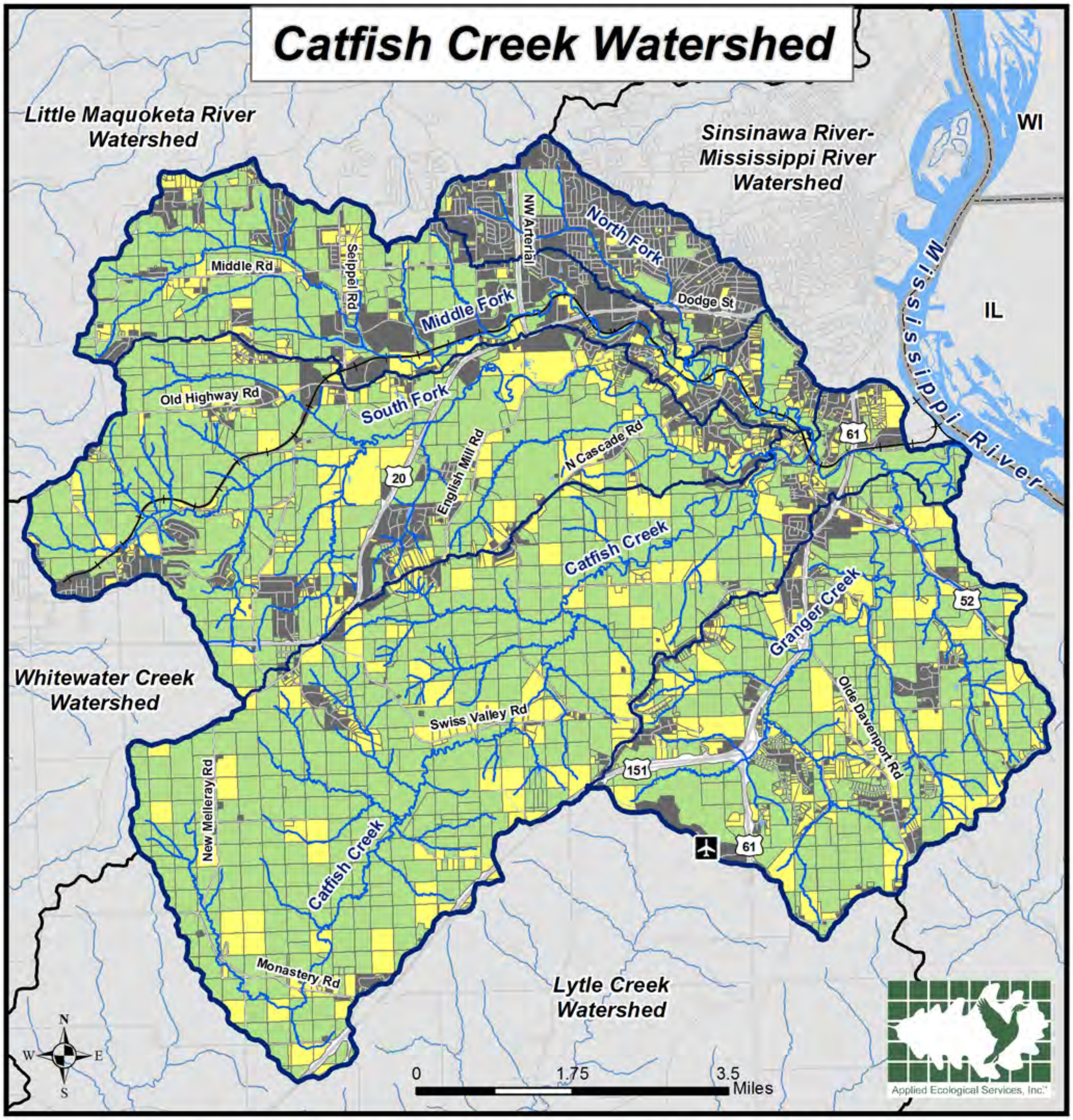
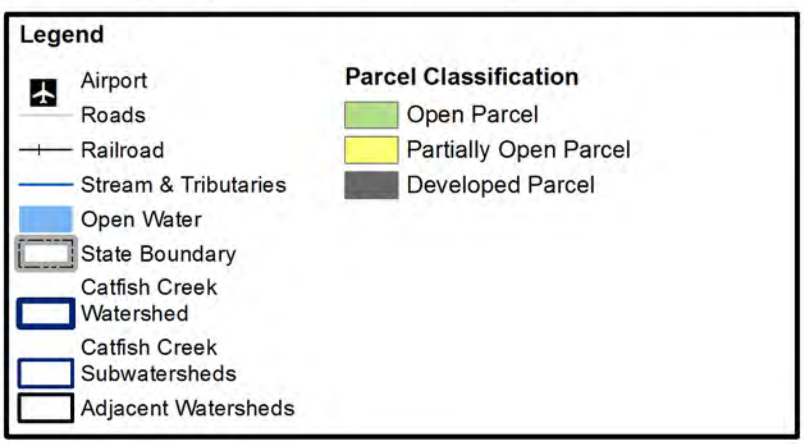


Figure 29: 2012 Open, Partially Open, & Developed Parcels



Public/Private Ownership of Open and Partially Open Parcels

The public or private ownership of each open and partially open parcel was determined from available parcel data. Developed parcels are not included in this summary. Publicly owned parcels include those owned by state, county, township, or municipal government, and school districts. Public open and partially open parcels account for 6% and <1% of the open and partially open acreage respectively (Figures 30 & 32). Private ownership types include homeowners/ business associations, commercial, residential, agricultural, golf clubs, etc. Private open parcels comprise 71.7% of the open and partially open acreage whereas private partially open parcels comprise 21.8%. Public open and partially open parcels are owned by IDNR, conservation boards, municipalities, and townships.

Protected Status of Open and Partially Open Parcels

Preservation of open space is critical to maintaining and expanding green infrastructure and is an important component of sustaining water quality, hydrological processes, ecological function, and the general quality of life for both wildlife and people. Without preservation, open space can be converted to other less desirable land uses in the future. Protected open and partially open parcels account for about 6% of the open and partially open parcel acreage in the watershed while unprotected open and partially open parcels account for the remaining 94% (Figures 31 & 33). Most protected open or partially open parcels are owned by state, county, township, homeowner association, or municipal government.

The most critical unprotected open and partially open parcels include the undeveloped agricultural areas in the southern and western portions of the watershed. Many of these areas are currently open space connected or adjacent to other green infrastructure. Future development that incorporates conservation design and/or Stormwater Treatment Train systems will be extremely important in these areas to improve water quality and reduce stormwater runoff volume to an already stressed Catfish Creek.

Figure 30. Distribution of private and public open and partially open parcels.

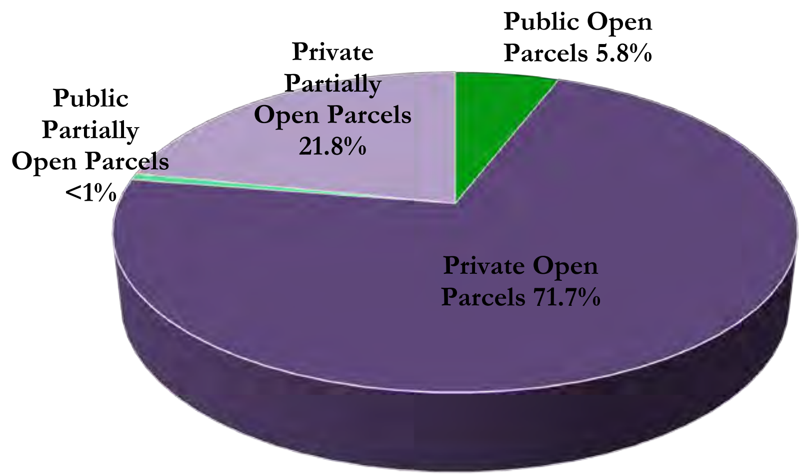
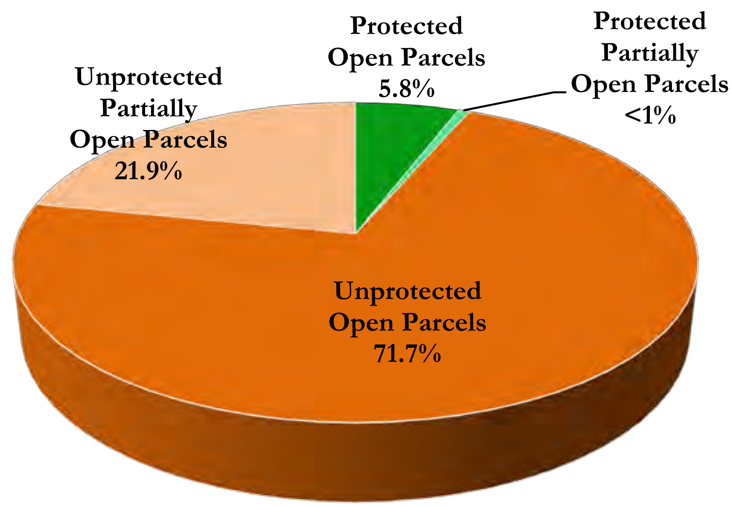


Figure 31. Distribution of protected and unprotected open and partially open parcels.



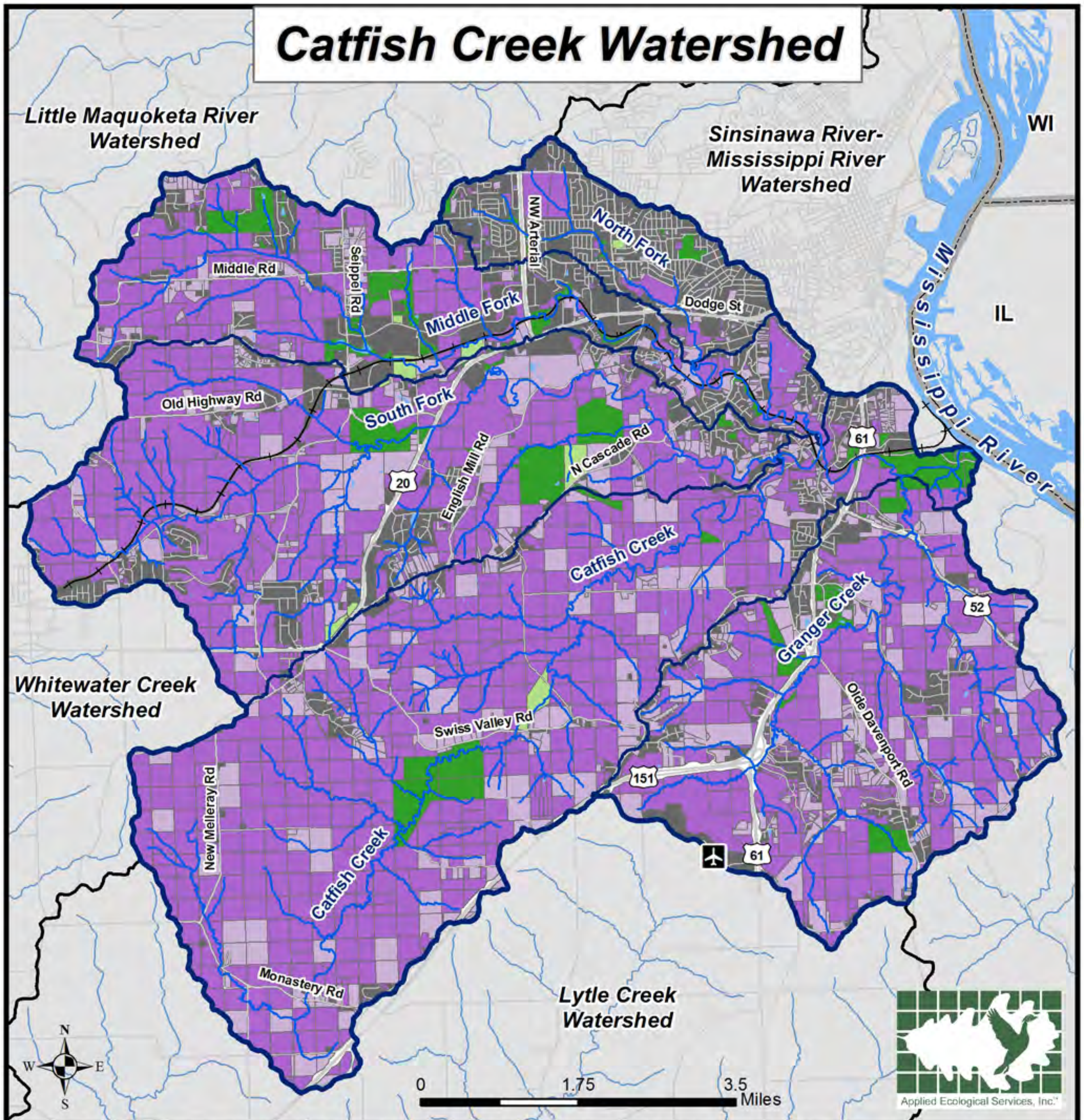
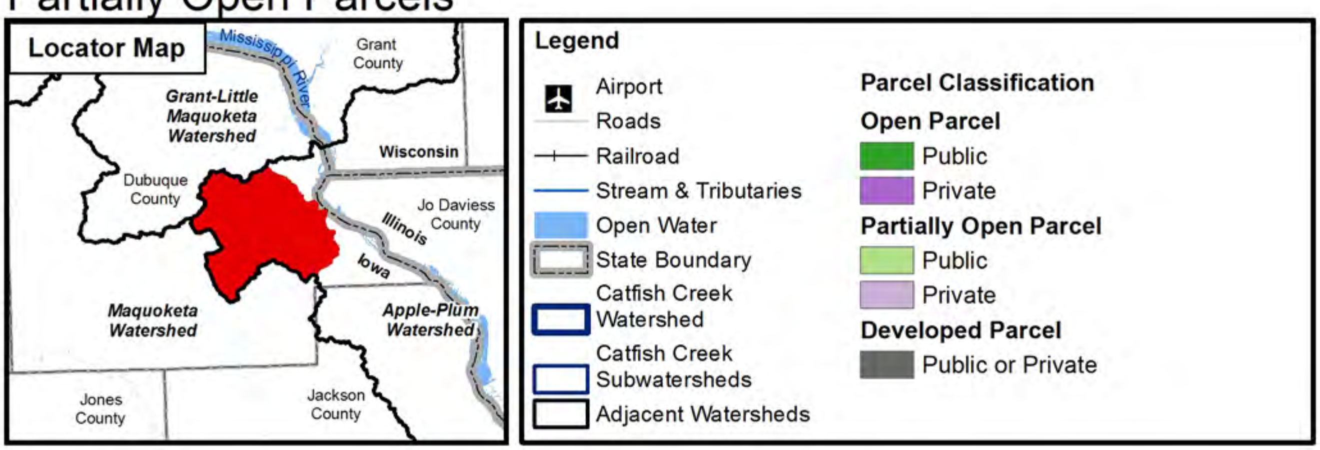


Figure 32: Public versus Private Ownership of Open and Partially Open Parcels



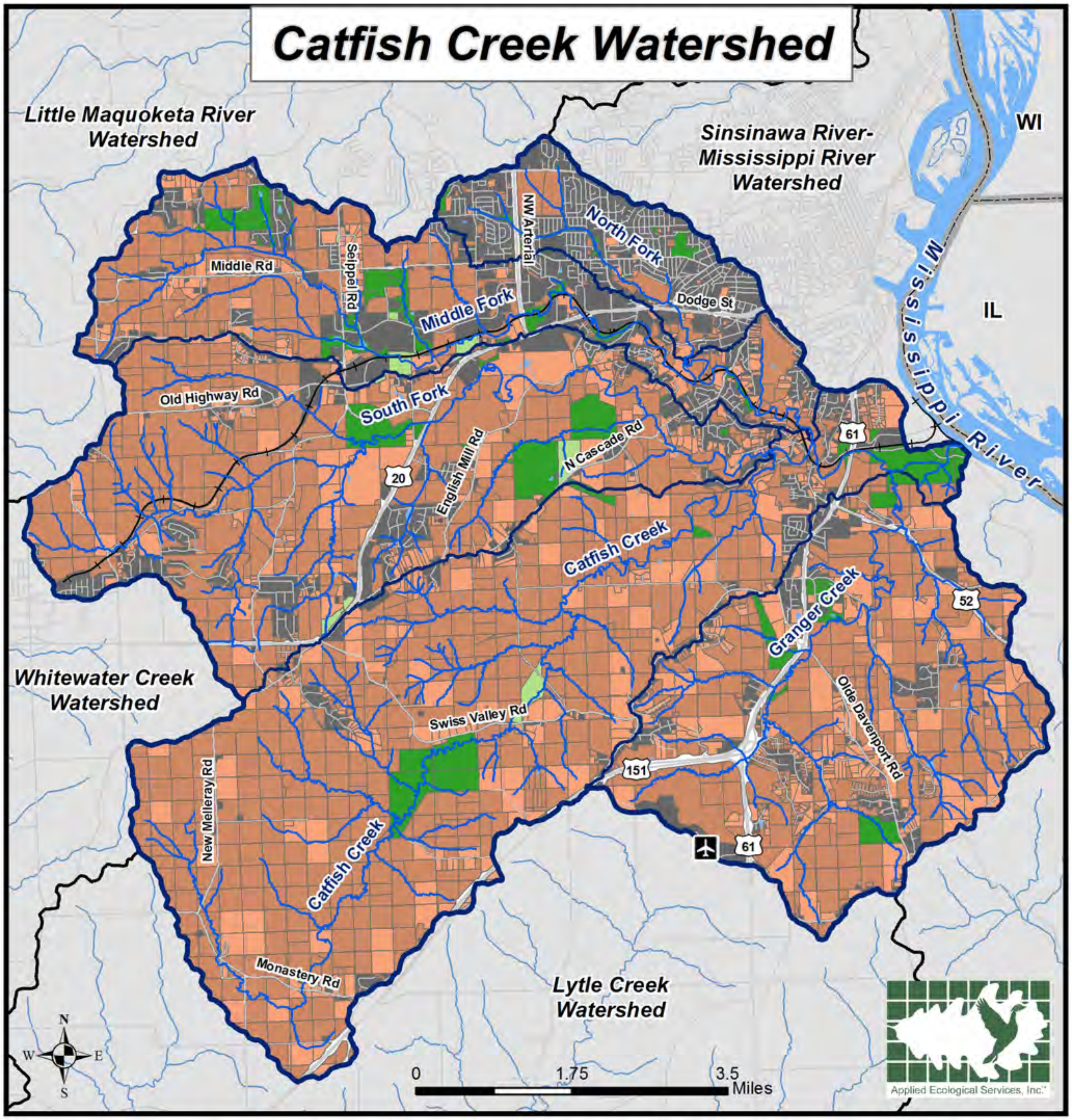
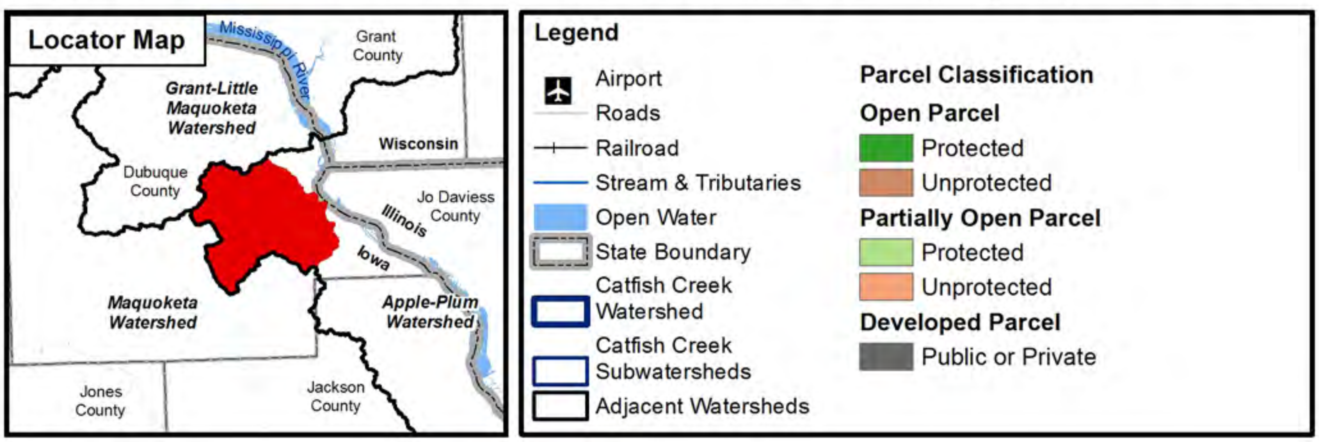


Figure 33: Protection Status of Open & Partially Open Parcels



Open Space Parcel Prioritization

Step 2 in creating a Green Infrastructure Network for Catfish Creek watershed was completed by prioritizing open and partially open parcels. For this step, 10 prioritization criteria important to green infrastructure were examined via a GIS analysis (Table 12). If an open or partially open parcel met a criterion it received one point. If the parcel did not meet that criterion, it did not receive a point. This process was repeated for each open and partially open parcel and for all criteria. The prioritization process was not completed for developed parcels. The total points received for each parcel were aggregated to determine parcel importance within the Green Infrastructure Network-parcels with the highest number of points are more important to green infrastructure than parcels that met fewer criteria.

The combined possible total of points any one parcel can accumulate is 10 (10 of 10 total criteria met). The highest total value received by a parcel in the weighting process was 8 (having met 8 of the 10 criteria). After completion of the prioritization, parcels were categorized as "High Priority", "Medium Priority", or "Low Priority" based on point totals. Parcels meeting 5-8 of the criteria are designated High Priority for inclusion into the Green Infrastructure Network while parcels meeting 3-4 criteria are designated Medium Priority. Parcels with a combined value of 0-2 are categorized as Low Priority but are not necessarily excluded from the Green Infrastructure Network based on their location or position as linking parcels.

Figure 34 depicts the results of the parcel prioritization. High Priority green infrastructure parcels tend to correlate most strongly with floodplain areas surrounding Catfish Creek and its tributaries, as well as areas with trails, the coldwater sections of Catfish Creek, and susceptible groundwater capture zones. For the most part they include agricultural land, publically held lands, and nature preserves. Many of the Medium Priority parcels abut High Priority parcels or intersect a stream, floodplain, or headwater. Low Priority parcels are found in areas further from streams, tributaries, or floodplain areas.

Table 12. Criteria used to prioritize parcels for a Green Infrastructure Network.

Green Infrastructure Criteria
1. Open or partially open parcels that intersect FEMA 100-year floodplain
2. Open or partially open parcels within 0.25-miles of any headwater stream
3. Open or partially open parcels that intersect a wetland
4. Open or partially open parcels within susceptible or highly susceptible groundwater capture zones
5. Open or partially open parcels that are within 150 feet of a stream or significant open water
6. Open or partially open parcels in a "Highly or Moderately Vulnerable" Land Use/Land Cover SMU
7. Open or partially open parcels adjacent to or including private or public protected open space
8. Open or partially open parcels draining to the cold water section of Catfish Creek
9. Open or partially open parcels that intersect existing trails
10. Open or partially open parcels that include or intersect an "Important Natural Area"

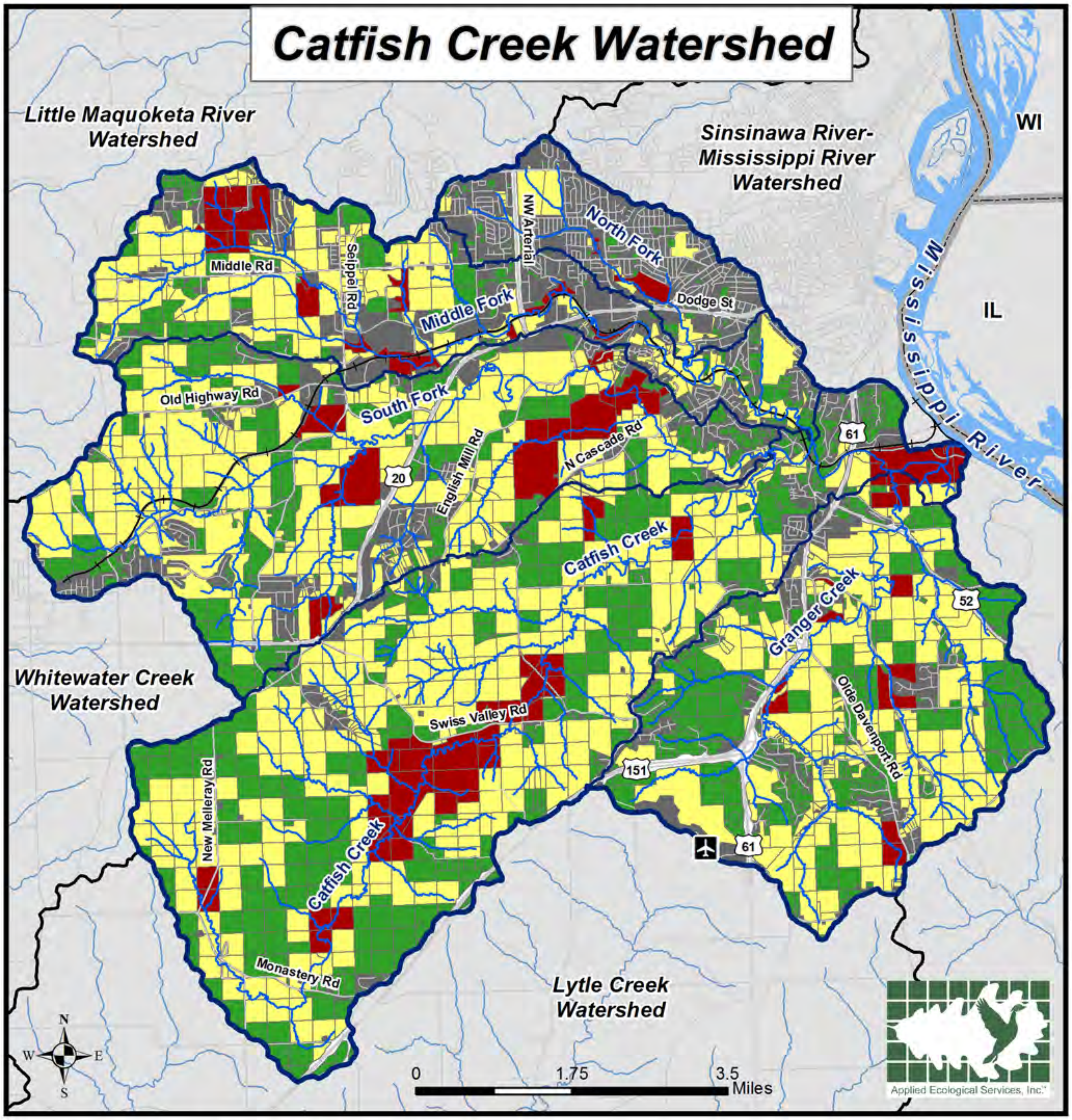


Figure 34: Parcel Prioritization

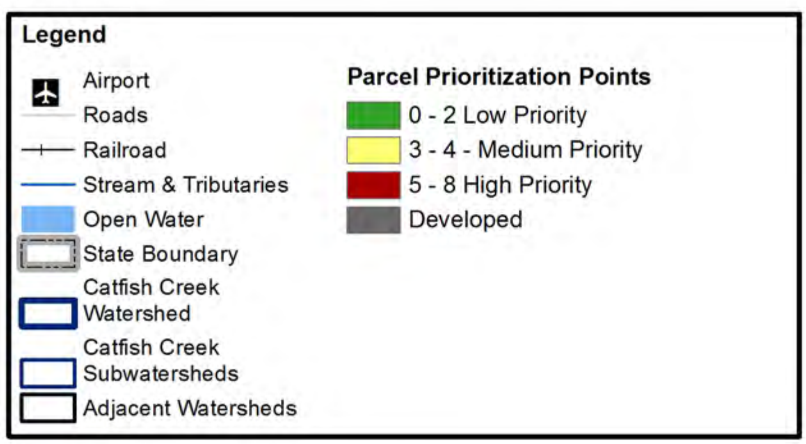
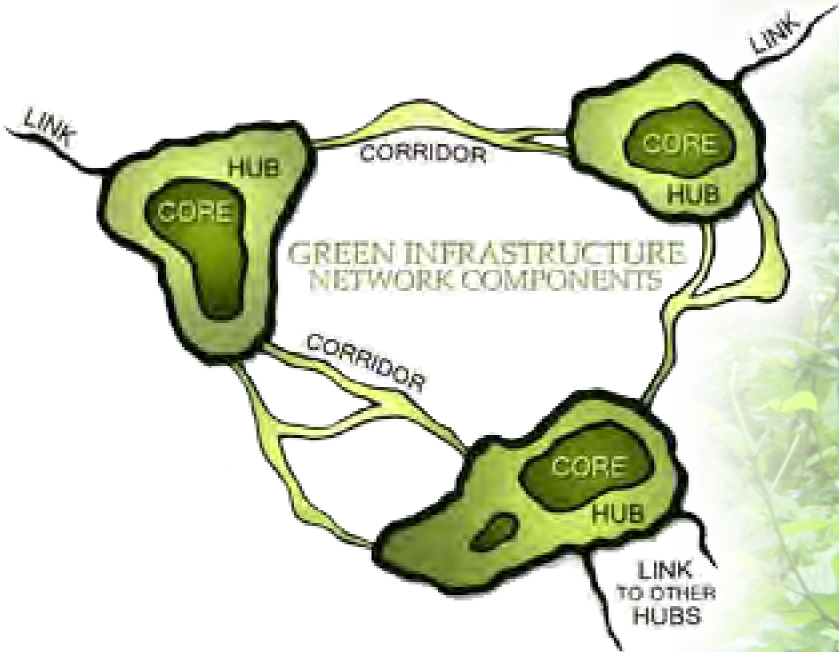


Figure 35. (Below) Green Infrastructure components. Source: greeninfrastructure.net. Image (right): Wildlife utilize the green infrastructure network, traveling along corridors from hub to hub.



Green Infrastructure Network

The final st ep (Step 3) in creating a green infrastructure network for Catfish Creek watershed involves laying out the network by incorporating; 1) prioritized open space results from Steps 1 & 2, 2) information gathered during the watershed resource field inventory conducted by AES in summer 2013, and 3) stakeholder recommendations. County and regional wide green infrastructure plans generally focus on natural features such as stream corridors, wetlands, floodplain, buffers, and other natural components. The green infrastructure network created for Catfish Creek watershed captures all the natural components and other green infrastructure such as recreational parks, large residential lots, golf courses, and appropriate cropland at the parcel level. Parcel level green infrastructure planning is important because land purchases, acquisitions, and land use changes almost always occur at the parcel level.

The green infrastructure network for Catfish Creek watershed is illustrated on Figure 36. It is comprised of approximately 23,069 acres in total. Parcels within the network range in size from less than 1 acre to 276 acres, with an average parcel size of 22 acres. Only 2,166 acres, or 9%, of the green infrastructure network is considered protected. The remaining 20,903 acres (91%) is currently unprotected.

Perhaps the most important aspect of green infrastructure planning is that it helps communities identify and prioritize conservation opportunities and plan development in ways that optimize the use of land to meet the needs of people and nature (Benedict 2006). Green infrastructure planning provides a framework for future growth that identifies areas not suitable for development, areas suitable for development but that should incorporate conservation design standards, and areas that do not affect green infrastructure.

A Green Infrastructure Network is a connected system of *Hubs* and linking *Corridors* (Figure 35). Hubs generally consist of the largest and least fragmented areas such as Swiss Valley Nature Preserve, Mines of Spain Recreation Area, and publically owned parcels. Corridors are generally formed by private/ unprotected parcels along stream and tributaries as well as headwater areas to those streams and tributaries. Corridors are extremely important because they provide biological conduits between hubs. However, most parcels forming corridors are not ideal green infrastructure until farmers, businesses, and residents embrace the idea of naturalizing stream corridors. While trails exist within larger hubs and along some corridors within the network, many opportunities exist to expand trails to the rest of the watershed. The Action Plan section of this report contains recommendations for protecting and expanding the green infrastructure network.

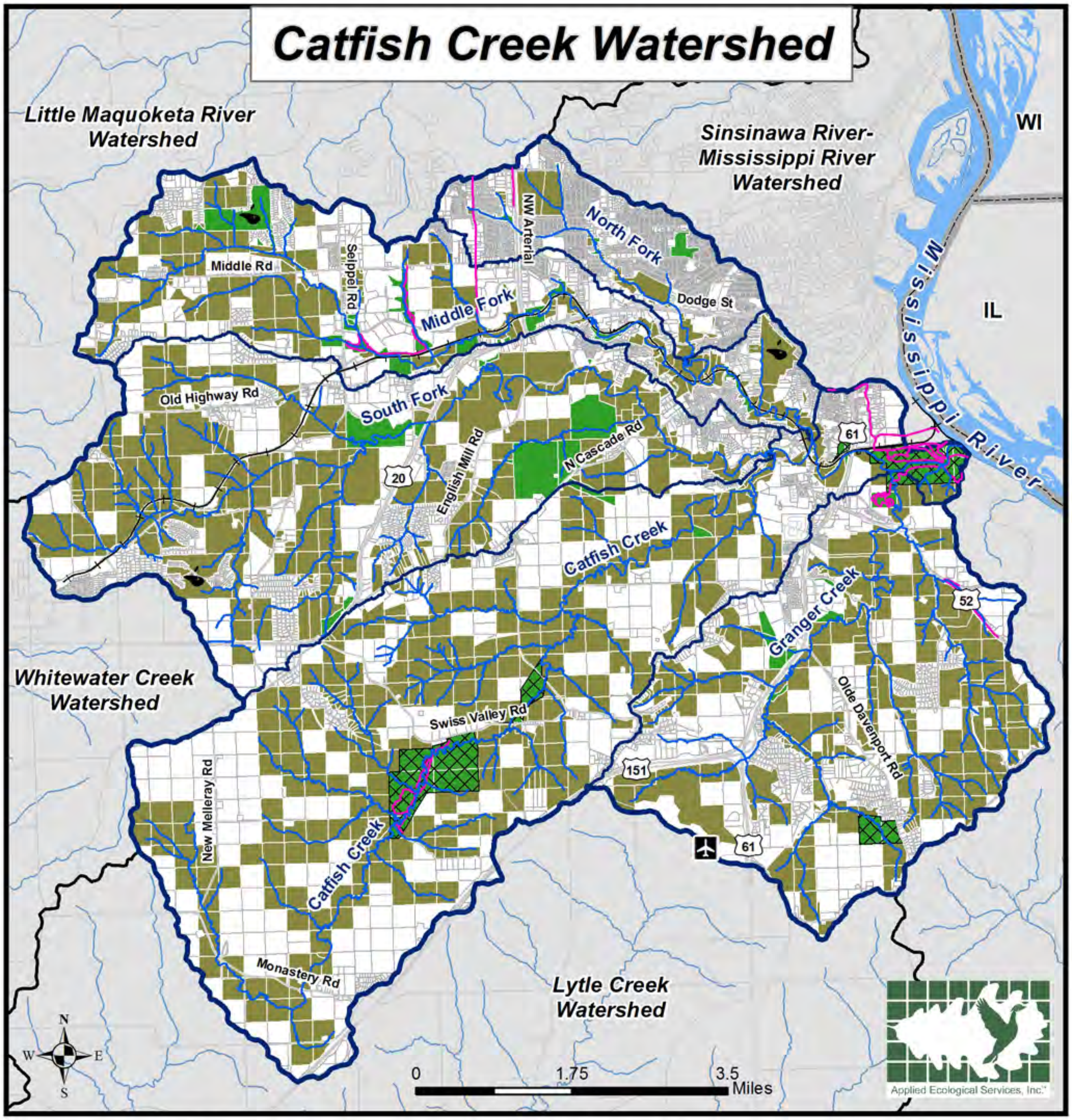
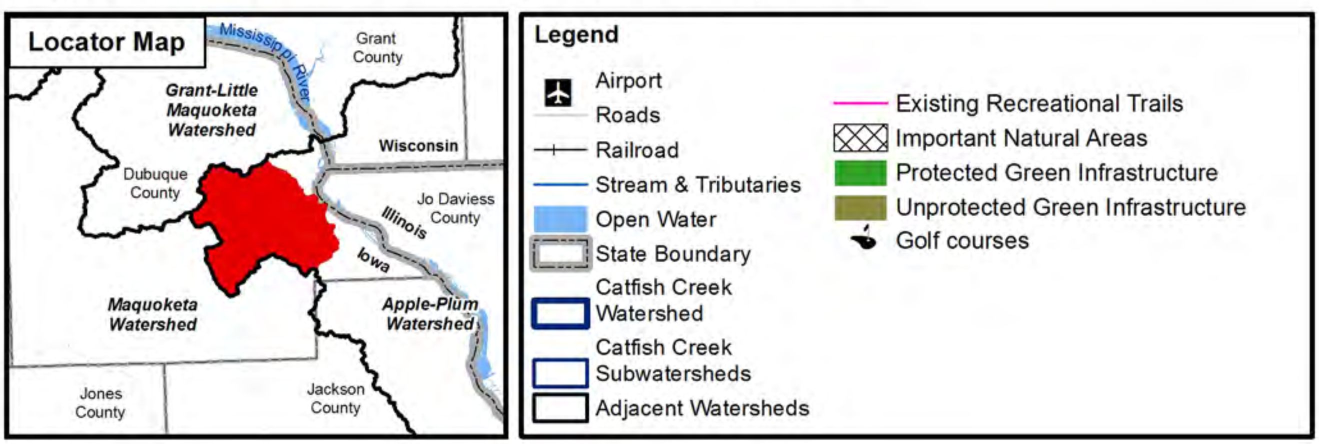


Figure 36: Green Infrastructure Network



3.12 Important Natural Areas

For this watershed plan, "Important Natural Areas" include protected woodlands, prairie, and wetland within forest preserves and nature preserves (Table 13; Figure 37). Many of these areas often provide high quality habitat and may harbor uncommon or even threatened and endangered (T&E) species. These areas also provide large greenway hubs that serve as the largest and least fragmented natural areas, support native species, maintain natural ecological processes, and contribute to the health of quality of life for communities and people. Several "Important Natural Areas" are located in the watershed including one state preserve, one nature preserve, and one forest preserve.

Table 13. Important natural area summary data.

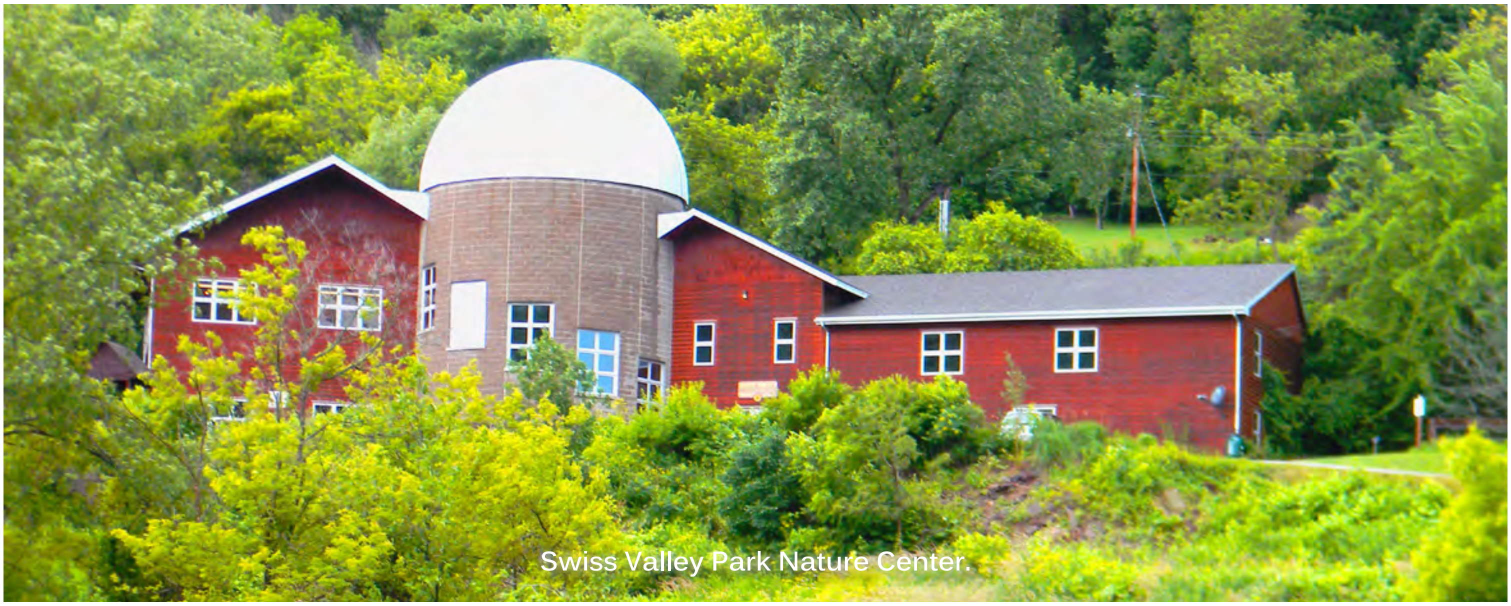
Natural Area	Size (acres)	Description
Iowa Department of Natural Resources		
Mines of Spain Recreation Area/ Catfish Creek State Preserve	275 ac	Mines of Spain Recreation Area is approximately 1,300 acres with roughly the northern half designated as Catfish Creek State Preserve. Only about 275 acres of the Preserve and Recreation Area fall within the watershed, characterized by vertical bedrock outcrops and steep slopes. An oak forest, dominated by red and white oak makes up much of the site with bur oak groves found on the highest hilltops and ridges with the steepest slopes supporting maple-basswood forest, juniper groves, and hill prairies.
Dubuque County Conservation Board		
Swiss Valley Nature Preserve & Park	483 ac	A relic forest including red and white oaks, shagbark hickory, walnut, white ash, elms, and quaking aspen as well as a maple and basswood forest including silver maples and giant sycamore trees can all be found at the preserve. A restored oak savanna can also be observed within the floodplain area of the creek. Naturally occurring sinkholes are found throughout the preserve. The stretch of Catfish Creek that runs through the preserve supports trout fishing.
Interstate Power Company Forest Preserve	82 ac	Predominantly a dense woodland area containing deep ravines and spring-fed streams, this area also includes an 8-acre restored prairie and about 15 acres of grassland. A 1.5 mile trail also winds through the preserve.

Swiss Valley Nature Preserve & Park

Swiss Valley Nature Preserve is a 476-acre site owned by the Dubuque County Conservation Board and located in the southwestern portion of the watershed (Table 13; Figure 37). The park is home to a large portion of Catfish Creek, as well as relic woodlands, a restored prairie and the administrative headquarters of the Dubuque County Conservation Board.

The portion of Catfish Creek that winds through the park is part of the coldwater section of the main stem and is stocked with trout annually by the Iowa Department of Natural Resources. Work to stabilize 3,000 feet of streambank within the preserve, plant native grasses, and install 35 fish hides to improve habitat along this reach was completed by Dubuque County Conservation Board. 10 miles of hiking trails, many of which are groomed for cross-country skiing in the winter, work their way through the prairie, savanna, and woodland landscapes. The preserve houses many of the distinct features associated with the Paleozoic Plateau, including an abundance of naturally occurring sinkholes which provide excellent habitat for both common and uncommon species. A remnant woodland remains left untouched from pre-settlement times, containing red and white oaks, shagbark hickory, walnut, white ash, elm, and quaking aspen, as well as a mature maple-basswood forest. Many of the trees in this area are in more than 200 years old (DCCB, 2013).

Swiss Valley Park is located one mile northeast of the preserve and includes an additional 62 acres of camping and recreational opportunities. The coldwater section of Catfish Creek also continues through this property as well.


Swiss Valley Park Nature Center.


Scenic woodland at Swiss Valley Nature Preserve.


Fishing along Catfish Creek at Swiss Valley Nature Preserve.

Clockwise from left: *Northern entrance to Mines of Spain Recreation Area; Indian pipe (*Monotropa uniflora*) - Source: O18; The Julien Dubuque monument; A bike path along the deeply dissected main stem of Catfish Creek within Mines of Spain Recreation Area/ Catfish Creek Preserve; Woodland at Interstate Power Company Forest Preserve (source: J. Orvis); and restored prairie at Interstate Power Company Forest Preserve.*

Mines of Spain Recreation Area & Catfish Creek Preserve

Mines of Spain Recreation Area consists of 1,300 acres south of the City of Dubuque including the mouth of Catfish Creek and south along the Mississippi River and it is owned by Iowa Department of Natural Resources. Approximately the northern half of this area is designated by IDNR as the Catfish Creek Preserve. Only a 275- acre portion of Mines of Spain Recreation Area/Catfish Creek Preserve falls within the Catfish Creek watershed, but it includes many important natural features.

The preserve is predominantly an oak forest, with paper birch, quaking aspen, maple-basswood forest, juniper groves, and hill prairies also represented. A wide variety of plants can be found within the preserve over the course of the year. Spring flora include jack-in-the-pulpit, spring beauty, hepatica, blood root, wild ginger, false Solomon's seal, pasqueflower, plantain-leaved pussytoes, hoary puccoon, violet wood sorrel, and alumroot. The woodland understory harbors Indian pipe as well as a number of ferns including such varieties as rattlesnake, maidenhair, ebony spleenwort, lady, silvery glade, fragile, crested wood, spinulose wood, walking, bulblet, and cliffbrake. In summer prairie coreopsis, pale-spiked lobelia, round-headed bush clover, and pale purple coneflower can be found blooming, followed by sky-blue aster, rough blazing star, sideoats grama, big and little bluestem, and Indian grass in the fall (IDNR, 2007).

The preserve also contains excellent examples of the geology of the Paleozoic Plateau and unique historic and cultural sites. Outcrops of Galena dolomite over 450 million years old, 200-foot bluffs bordering the Mississippi River, and narrow ridges create a distinct topography within the preserve. Both the mouth of the main stem of Catfish Creek and its confluence with Granger Creek fall within this part of the Catfish Creek Preserve and display deeply dissected stream channels created by the flow of vast amounts of glacial meltwater long ago. Ravines, seeps, caves, and vertical crevices can also be found within the preserve. Archaeologically, there is evidence that the preserve has been occupied for about 8,000 years, including village and campsites occupations located at the mouths of Catfish and Granger Creeks (IDNR, 2007). The Julien Dubuque monument can also be found here, bearing the inscription "Julien Dubuque, Miner of Mines of Spain, Founder of Our City, Died March 24, 1810." From the monument beautiful views of the Mississippi River and the City of Dubuque can be found, as well as the mouth of Catfish Creek immediately to the south.

Interstate Power Company Forest Preserve

In 1988, Interstate Power Company (IPC) donated 82 acres to the Dubuque County Conservation Board, hence the name Interstate Power Company Forest Preserve. The preserve is located on Olde Davenport Rd just north of Schueller Heights Rd. IPC still maintains a substation on the site, but the preserve is predominantly degraded oak woodland with ravines and spring-fed streams that eventually make their way to Granger Creek. Some rolling grassland, an 8-acre restored prairie, and a 1.5-mile trail can also be found on the site.

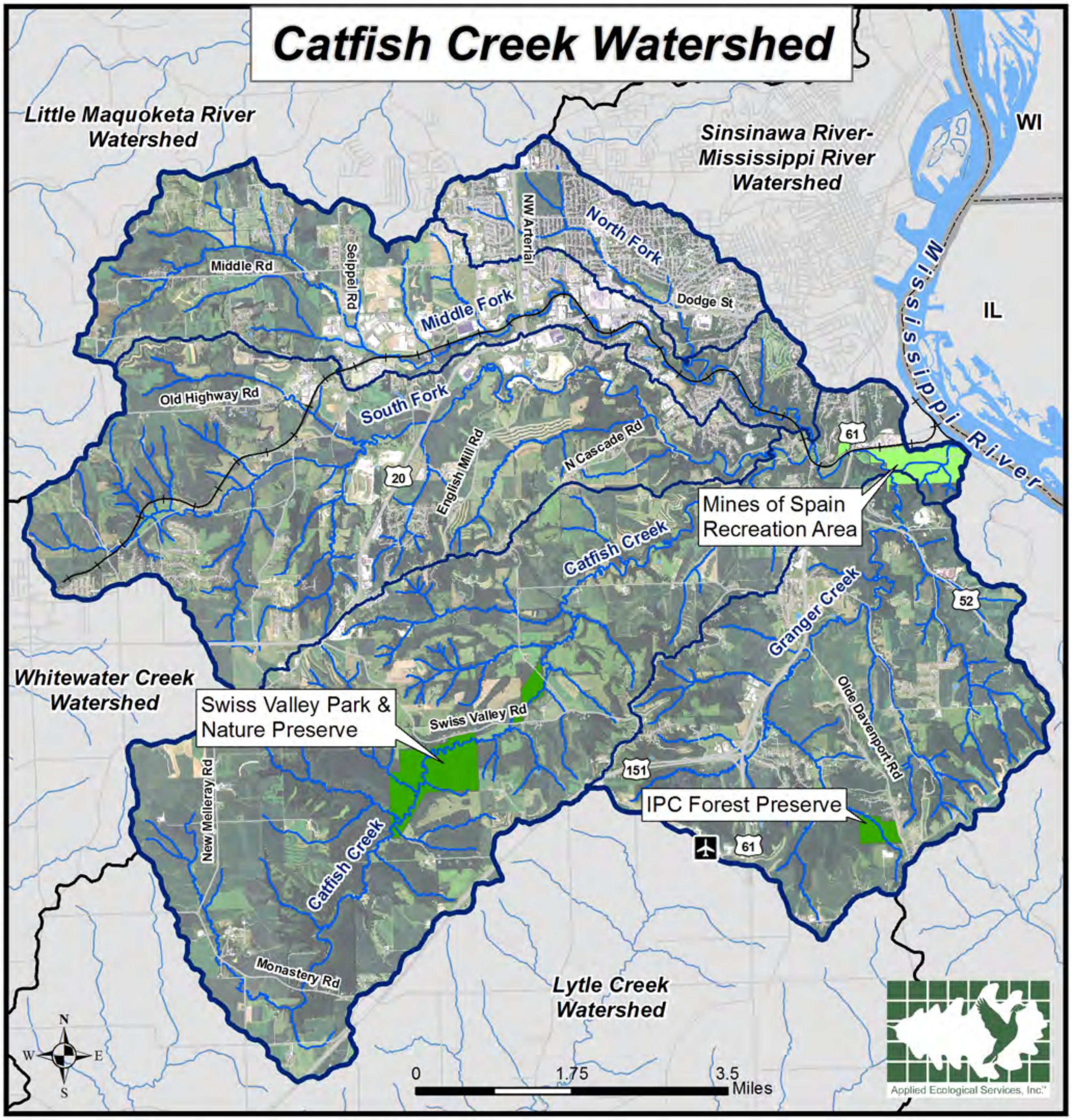
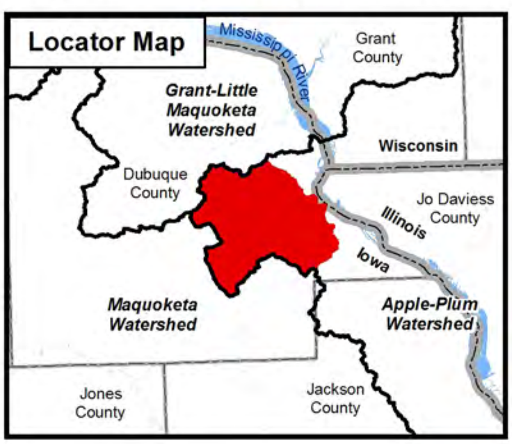


Figure 37: Important Natural Areas



Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Important Natural Areas

- County Park & Forest Preserve
- State Recreation Area

Data Sources:

3.13 Watershed Drainage System

3.13.1 Streams & Tributaries

The five main branches, including North Fork, Middle Fork, South Fork, Catfish Creek, and Granger Creek are the primary streams draining Catfish Creek watershed. Sixty-three (63) tributary streams are also found throughout the watershed (Table 14; Figure 38). The main branches alone account for 63.7 linear miles in length while the tributaries account for another 131.9 linear miles.

Table 14. Summary of stream and tributary reaches and lengths.

Stream or Tributary Name	Abbreviation	Number of Reaches	Stream Length (Ft)	Stream Length (Mi)
Catfish Creek	CC	18	115,628.2	21.9
Catfish Creek Tributary 1	CCT01	1	6,733.5	1.3
Catfish Creek Tributary 2	CCT02	1	2,914.6	0.6
Catfish Creek Tributary 3	CCT03	1	5,047.2	1.0
Catfish Creek Tributary 4	CCT04	1	6,667.2	1.3
Catfish Creek Tributary 5	CCT05	1	6,845.0	1.3
Catfish Creek Tributary 6	CCT06	1	11,974.6	2.3
Catfish Creek Tributary 7	CCT07	1	32,041.6	6.1
Catfish Creek Tributary 8	CCT08	1	26,877.7	5.1
Catfish Creek Tributary 9	CCT09	1	3,081.5	0.6
Catfish Creek Tributary 10	CCT10	1	4,686.7	0.9
Catfish Creek Tributary 11	CCT11	1	8,500.1	1.6
Catfish Creek Tributary 12	CCT12	1	6,894.9	1.3
Catfish Creek Tributary 13	CCT13	1	6,992.4	1.3
Catfish Creek Tributary 14	CCT14	1	30,901.9	5.9
Catfish Creek Tributary 15	CCT15	1	7,487.3	1.4
Catfish Creek Tributary 16	CCT16	1	34,866.8	6.6
Catfish Creek Tributary 17	CCT17	1	9,377.6	1.8
Catfish Creek Tributary 18	CCT18	1	18,402.4	3.5
Catfish Creek Tributary 19	CCT19	1	3,225.5	0.6
Catfish Creek Tributary 20	CCT20	1	3,079.9	0.6
Granger Creek	GC	7	49,232.5	9.3
Granger Creek Tributary 1	GCT01	1	12,049.6	2.3
Granger Creek Tributary 2	GCT02	1	3,382.1	0.6
Granger Creek Tributary 3	GCT03	1	2,991.6	0.6
Granger Creek Tributary 4	GCT04	2	28,192.9	5.3
Granger Creek Tributary 5	GCT05	1	18,555.7	3.5
Granger Creek Tributary 6	GCT06	1	7,596.9	1.4
Granger Creek Tributary 7	GCT07	1	38,991.1	7.4
Granger Creek Tributary 8	GCT08	1	5,014.2	0.9

Stream or Tributary Name	Abbreviation	Number of Reaches	Stream Length Assessed (Ft)	Stream Length Assessed (Mi)
Granger Creek Tributary 9	GCT09	1	56,636.3	10.7
Middle Fork Catfish Creek	MF	12	76,896.0	14.6
Middle Fork Catfish Creek Tributary 1	MFT01	1	3,803.6	0.7
Middle Fork Catfish Creek Tributary 2	MFT02	1	1,494.5	0.3
Middle Fork Catfish Creek Tributary 3	MFT03	1	6,027.0	1.1
Middle Fork Catfish Creek Tributary 4	MFT04	1	6,505.8	1.2
Middle Fork Catfish Creek Tributary 5	MFT05	1	4,063.7	0.8
Middle Fork Catfish Creek Tributary 6	MFT06	1	2,757.4	0.5
Middle Fork Catfish Creek Tributary 7	MFT07	1	5,318.5	1.0
Middle Fork Catfish Creek Tributary 8	MFT08	1	7,526.5	1.4
Tributary to MFT08	MFT08A	1	11,964.3	2.3
Middle Fork Catfish Creek Tributary 9	MFT09	1	7,969.9	1.5
Middle Fork Catfish Creek Tributary 10	MFT10	1	10,249.5	1.9
Middle Fork Catfish Creek Tributary 11	MFT11	1	1,393.0	0.3
Middle Fork Catfish Creek Tributary 12	MFT12	1	4,756.1	0.9
North Fork Catfish Creek	NF	4	21,157.2	4.0
North Fork Catfish Creek Tributary 1	NFT01	1	1,747.9	0.3
North Fork Catfish Creek Tributary 2	NFT02	1	7,608.9	1.4
Catfish Creek North Branch	NFT03	1	1,801.1	0.3
South Fork Catfish Creek	SF	9	73,196.9	13.9
Fork Branch	SFFB01	1	27,283.7	5.2
South Fork Catfish Creek Tributary 1	SFT01	1	2,932.9	0.6
South Fork Catfish Creek Tributary 2	SFT02	1	5,220.2	1.0
South Fork Catfish Creek Tributary 3	SFT03	1	2,968.9	0.6
South Fork Catfish Creek Tributary 4	SFT04	1	10,988.9	2.1
South Fork Catfish Creek Tributary 5	SFT05	1	2,988.3	0.6
South Fork Catfish Creek Tributary 6	SFT06	1	4,565.9	0.9
South Fork Catfish Creek Tributary 7	SFT07	1	11,871.1	2.2
South Fork Catfish Creek Tributary 8	SFT08	1	1,277.4	0.2
South Fork Catfish Creek Tributary 9	SFT09	1	2,792.5	0.5
South Fork Catfish Creek Tributary 10	SFT10	1	9,933.7	1.9
South Fork Catfish Creek Tributary 11	SFT11	1	1,745.6	0.3
South Fork Catfish Creek Tributary 12	SFT12	1	37,195.8	7.0
South Fork Catfish Creek Tributary 13	SFT13	1	24,302.0	4.6
South Fork Catfish Creek Tributary 14	SFT14	1	22,348.2	4.2
South Fork Catfish Creek Tributary 15	SFT15	1	26,044.7	4.9
South Fork Catfish Creek Tributary 16	SFT16	1	7,107.4	1.3
Totals		**113**	**1,032,674.3**	**195.6**

Catfish Creek

Catfish Creek is the main branch within the watershed; South Fork, Middle Fork, and Granger Creek all outlet directly to Catfish Creek while North Fork outlets to Middle Fork. Catfish Creek begins in agricultural fields in Vernon Township near N Cascade and New Melleray Rds in the southwestern portion of the watershed and flows south-southeast for approximately four miles before changing course and flowing northeast. At this point the cover changes from predominantly agriculture to fairly dense woodland as it flows through private lands and eventually through Swiss Valley Nature Preserve and Park. After leaving the campground, Catfish Creek continues its way through additional agricultural land and some less accessible areas before being joined from the north by South Fork and then Middle Fork. From there it follows the wider floodplain through this section, as does the railroad, before entering Mines of Spain Recreation Area and being joined by Granger Creek from the south. This last stretch before Catfish Creek joins the Mississippi River contains the deepest and oldest geology as the floodplain here was carved predominantly by meltwater from the last glaciation. In addition to South Fork, Middle Fork, and Granger Creek, Catfish Creek is fed by twenty other tributary streams of ranging from 0.6 to 6.6 miles in length and varying characteristics before it reaches the Mississippi.

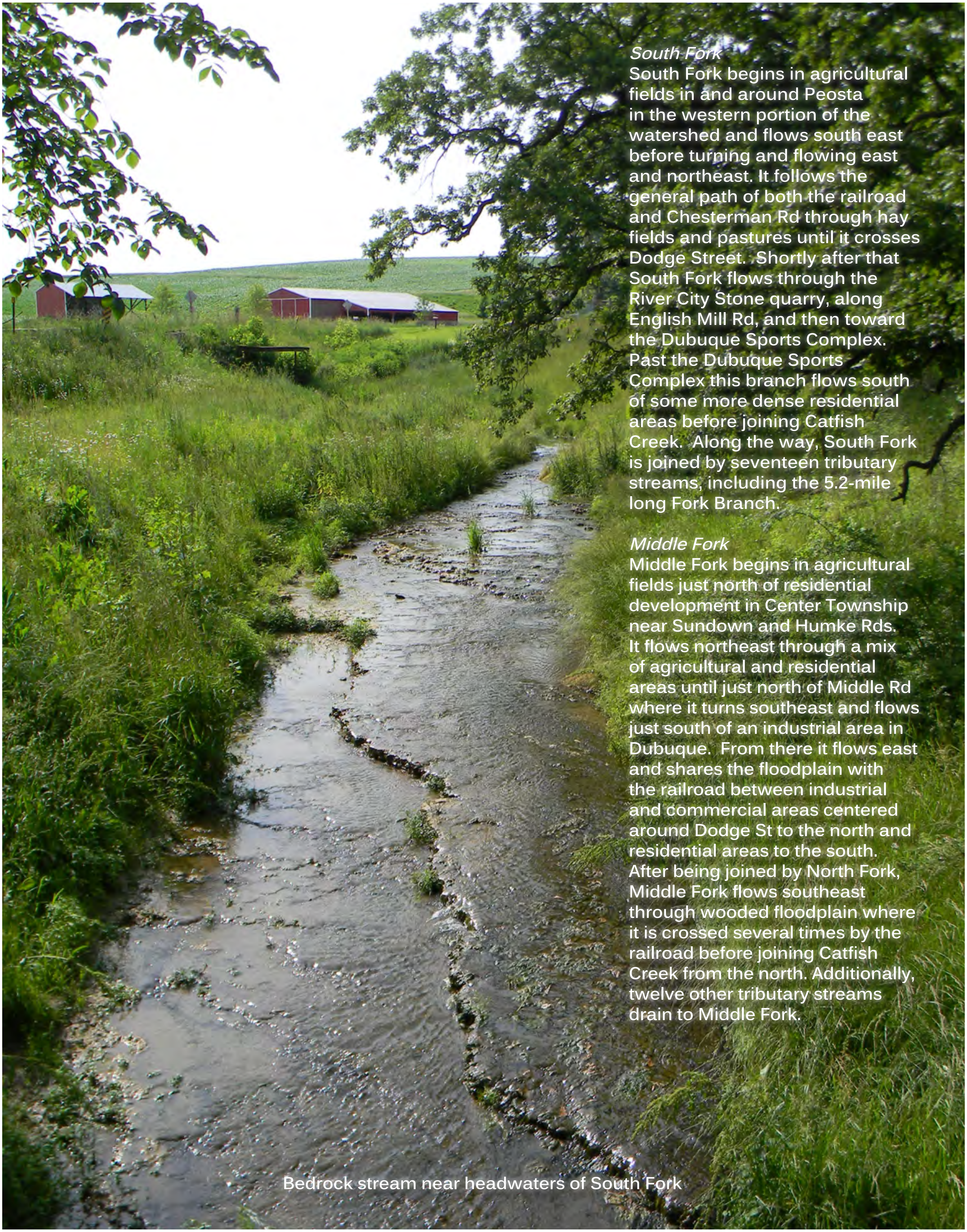
Catfish Creek Reach 15 (CC15) between South Fork and Middle Fork

South Fork

South Fork begins in agricultural fields in and around Peosta in the western portion of the watershed and flows south east before turning and flowing east and northeast. It follows the general path of both the railroad and Chesterman Rd through hay fields and pastures until it crosses Dodge Street. Shortly after that South Fork flows through the River City Stone quarry, along English Mill Rd, and then toward the Dubuque Sports Complex. Past the Dubuque Sports Complex this branch flows south of some more dense residential areas before joining Catfish Creek. Along the way, South Fork is joined by seventeen tributary streams, including the 5.2-mile long Fork Branch.

Middle Fork

Middle Fork begins in agricultural fields just north of residential development in Center Township near Sundown and Humke Rds. It flows northeast through a mix of agricultural and residential areas until just north of Middle Rd where it turns southeast and flows just south of an industrial area in Dubuque. From there it flows east and shares the floodplain with the railroad between industrial and commercial areas centered around Dodge St to the north and residential areas to the south. After being joined by North Fork, Middle Fork flows southeast through wooded floodplain where it is crossed several times by the railroad before joining Catfish Creek from the north. Additionally, twelve other tributary streams drain to Middle Fork.



Bedrock stream near headwaters of South Fork

North Fork

North Fork Catfish Creek, the smallest and most urbanized of the branches, begins as a detention basin in a residential neighborhood near the intersection of Radford and Saratoga Rd on the eastern outskirts of Asbury. It makes its way east and southeast through dense residential and commercial development in Dubuque. Generally, the stream has been confined to channels of varying sizes through this development. North of Dodge St it flows south of an smaller agricultural field before crossing under Dodge St and through a heavily wooded area before outletting to Middle Fork. North Fork is fed by three tributary streams, all of which drain from north to south.

Granger Creek

Granger Creek begins in a wooded area surrounded by agriculture and low density residential development in Mosalem Township near the intersection of Olde Davenport and Laudeville Roads. It flows northwest through additional woodland, pastures, and low density residential areas until it nears Route 61, at which point it flows northeast just south of Route 61 along agricultural land. It continues to the south of the Dubuque Technology Park and then through a more densely wooded area to the south of Route 52. Granger Creek flows northward under Route 52 and then through more woodland until it enters Mines of Spain Recreation Area. Shortly thereafter it joins Catfish Creek. Granger is fed by nine tributary streams, three of which are longer than 5 miles.

North Fork Reach 1

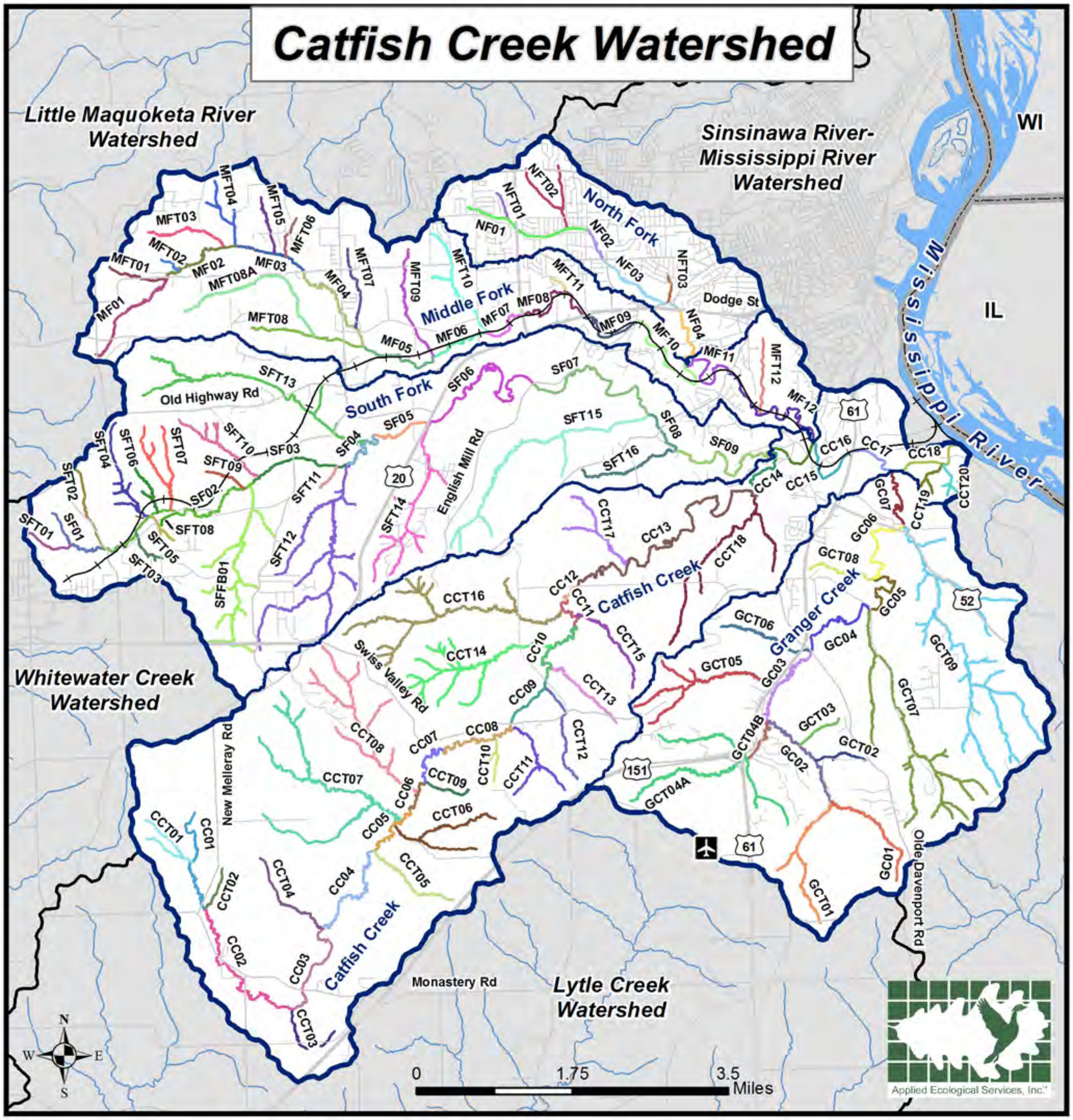


Figure 38: Stream Reaches

Legend

- Airport
- Roads
- Railroad
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds
- CC01 Stream Reach

Data Sources:

Since 2008, the City of Dubuque, Dubuque Soil and Water Conservation District (SWCD), the University of Dubuque, and local citizens have been collecting IOWATER data along the five main branches within Catfish Creek watershed. They used the Rapid Assessment of Stream Corridor Along Length, or RASCAL protocol in order to catalogue stream conditions roughly every 500-800 feet. The RASCAL data was then aggregated into "Stream Reaches" based on stretches of similar conditions (Table 14; Figure 38). Reaches are defined as stream segments having similar hydraulic, geomorphic, riparian condition, and/or adjacent land use characteristics. Methodology included walking portions of the stream and tributary reaches, collecting measurements, taking photos, and noting channel, streambank, and riparian corridor conditions on RASCAL data sheets or on Stream Inventory/BMP Data Forms. Because of the sheer number of stream and tributary miles, most data collection was concentrated along the main branches, with additional tributary data collected as time and available personnel allowed.

The characteristics of roughly every 500 feet or so along the main branches was inventoried, including levels of erosion, stream habitat condition, details regarding the riparian areas, debris jams, etc. This data was then aggregated into larger reaches according to similar characteristics for the purpose of summarizing data, identifying critical areas, and making further recommendations. Within any of the reaches, there is the potential to have isolated areas that do not correlate to the general reach conditions, such as a 500 foot section of extreme erosion within a larger reach that generally exhibits little to no erosion. Wherever possible these isolated projects will be called out within the Site Specific Project Recommendations (Section 6.2).

Numerous municipal stormwater point discharges, bridges, dams, and debris and log jams were also encountered during the inventory and inventoried as points of interest.

Catfish Creek

Catfish Creek (Reach Code CC) stretches 21.9 miles and was divided into 18 distinct "Stream Reaches" beginning at the headwaters in agricultural fields in Vernon Township and ending at the Mississippi River (Table 14; Figure 38).

Catfish Creek Reach 1 (CC01) begins in an agricultural area in Vernon Township southeast of Peosta and ends just past the junction of Monastery Rd and New Melleray Rd. Catfish Creek Reach 2 (CC02) extends from the end of Reach 1 to the junction of Catfish Creek Tributary 3; they are 1.6 miles and 2.4 miles long, respectively. Neither of these reaches was inventoried as part of the RASCAL data collection.

Catfish Creek Reach 3 (CC03) extends between tributaries 3 and 4 (CCT03 and CCT04) and exhibits low amounts of erosion and excellent stream habitat. The dominant riparian cover for this reach is trees


Catfish Creek Reach 3

and the riparian buffer ranges from 30-60 feet wide. Catfish Creek Reach 4 continues to the next tributary (CCT05) and exhibits moderate signs of erosion, excellent stream habitat and similar riparian widths, but is dominated by pasture land.

Catfish Creek Reaches 5, 6, 7, and 8 (CC05, CC06, CC07, and CC08) continue through woodland and the Swiss Valley Nature Preserve. These reaches are generally low to moderately eroded and all have excellent stream habitat conditions. Some channel alterations have been made including previous streambank stabilization projects within Swiss Valley Nature Preserve. Riparian buffer widths are greater than 60 feet, with the exception of Reach 07 which has 30-60 feet of buffer on either bank. Riparian cover along all of these reaches is a mix of Conservation Reserve Program (CRP) grass and trees.

Catfish Creek Reach 7

Catfish Creek Reach 9 (CC09) extends through the Swiss Valley Park between Swiss Valley and Whitetop Roads. It consists of moderate levels of erosion, excellent stream habitat and smaller riparian buffers of trees because of its proximity to the campground facilities.

Isolated pocket of high erosion within Swiss Valley Park, Catfish Creek Reach 9

Catfish Creek Reaches 10, 11, and 12 (CC10, CC11, and CC12) lie between Whitetop Rd and Oakland Farms Rd and all exhibit fairly high levels of erosion. Here the condition of in-stream habitat is average to poor and buffer widths range between 30-60 feet and greater than 60 feet. Riparian cover along these reaches in include CRP grass, pasture, and trees.

Reach 13 (CC13) of Catfish Creek is the longest reach of Catfish Creek at over 4 miles in length, but flows through private agricultural land where access is a problem. No RASCAL data was available for this reach.

Catfish Creek Reach 14 (CC14) extends from Tributary 18 (CCT18) to the confluence with South Fork. It displays moderate levels of erosion and average stream habitat quality. The riparian cover consists of trees along both banks at a width of 30-60 feet along the left bank and greater than 60 feet on the right bank. Reach 15 (CC15) extends from the confluence with South Fork to the confluence with Middle Fork and exhibits the same characteristics as Reach 14, but its riparian cover is made of both trees and grass. Reach 16 (CC16) continues to Route 61 and is also moderately eroded with average stream habitat, but has a riparian buffer of trees that is less than 30 feet in width and flows generally within a few hundred feet of the railroad tracks.

Catfish Creek Reaches 17 and 18 (CC17 and CC18) extend from Route 61 to the confluence with Granger Creek and from the confluence with Granger to the Mississippi River, respectively. These last two reaches both exhibit high levels of erosion and average stream habitat conditions with trees as the predominantly riparian cover. Reach 17 has a 30-60 foot buffer, while Reach 18 has a buffer of at least 60 feet on either bank. Most of Reach 17 and all of Reach 18 fall within Mines of Spain Recreation Area.

South Fork

South Fork (Reach Code SF) stretches 13.9 miles and was divided into 9 stream reaches beginning at the headwaters in agricultural fields in Vernon Township and ending at its confluence with Catfish Creek (Table 14; Figure 38).

South Fork Reach 1 (SF01) begins in agricultural fields in Peosta and flows south east to SFT02 near Cox Springs Rd. This reach was not assessed. South Fork Reaches 2 and 3 (SF02 and SF03) flow to either side of Chesterman Rd with SF02 ending where it joins Fork Branch (SFFB01) and SF03 ending at SFT12. Both reaches exhibit moderate erosion and excellent stream habitat and riparian cover types for the two include grass, pasture, and trees. The riparian width of SF02 is 30-60 feet, while the riparian width of SF03 is generally less than 30 feet.

South Fork's Reaches 4 and 5 (SF04 and SF05) flow south of agricultural land and north of the Dubuque Metro Landfill and end at Route 20. Reach SF04 is highly eroded and has average stream habitat while SF05 is only moderately eroded with excellent stream habitat conditions. Riparian widths for both reaches are generally 30-60 feet wide and consist of a mix of grass, trees, and pasture.

Reaches 6 and 7 of the South Fork (SF06 and SF07) extend between Route 20 and the South Fork's junction with SFT15 and are divided by English Mill Rd. These reaches are dominated by agriculture and the River City Stone quarry and riparian cover includes a mix of grass, trees, and pasture. Both have excellent stream habitat. Reach SF06 exhibits low levels or erosion while Reach SF07 is moderately eroded.

South Fork Reaches 8 and 9 (SF08 and SF09) are the last two reaches of South Fork. Reach 8 extends to SFT16 and Reach 9 flows from there to the confluence with Catfish Creek. These reaches are predominantly wooded with some open grass areas and generally have a 30-60 foot riparian buffer width. Both are moderately eroded; Reach 08 has excellent stream habitat while Reach 09 has average stream habitat conditions.

South Fork Reach 1

Middle Fork

Middle Fork (Reach Code MF) stretches 14.6 miles and was divided into 12 reaches beginning in agricultural fields just north of residential development in Center Township near Sundown and Humke Rds and ending at its confluence with Catfish Creek (Table 14; Figure 38).

Middle Fork Reach 1 (MF01) extends from the headwaters to Middle Road and was not assessed via the RASCAL data collection. Middle Fork Reach 2 (MF02) winds through agricultural fields to MFT04, is moderately eroded and has average stream habitat. The riparian cover is predominantly trees and is 30-60 feet wide.

Middle Fork Reach 3 (MF03) extends back to Middle Road through more agricultural fields with a narrow tree buffer less than 30 feet wide. This reach has average stream habitat and low amounts of erosion.

Middle Fork Reach 4 (MF04) flows from Middle Road to a detention basin within the Bergfeld Recreation Area through an industrial area. It is moderately eroded with excellent stream habitat and a 30-60 foot riparian buffer of grass. Middle Fork Reach 5 (MF05) flows from the detention basin to MFT09 and Reaches 6 and 7 (MF06 and MF07) extend from MFT09 to NW Arterial, divided by MFT10. These three reaches all flow to the south the industrial area and adjacent to the railroad tracks. All exhibit average stream habitat with trees as the dominant riparian cover. Reaches 5 and 6 have narrow buffers of less than 30 feet, while Reach 7 has a 30-60 foot buffer. Reach 5 exhibits low levels of erosion while Reaches 6 and 7 are moderately eroded.

Middle Fork Reaches 8 and 9 (MF08 and MF09) extend from NW Arterial to Cedar Cross Rd, divided by Dodge St. These reaches flow between commercial and residential areas and lie adjacent to the railroad tracks. Both reaches are moderately eroded and have average stream habitat with at least a 60 foot buffer of trees on either bank.

The last three reaches of Middle Fork, Reaches 10 (MF10), 11 (MF11), and 12 (MF12), continue along the floodplain adjacent to the railroad tracks until Middle Fork joins Catfish Creek. Reach 10 ends at the confluence with North Fork and Reach 11 ends at Fremont Ave. These reaches all have average stream habitat and low levels of erosion. The riparian buffers within these reaches consist predominantly of trees and range from 30 to 60 feet or greater in size. Reaches 10 and 12 have been altered previously.


Middle Fork Reach 3


Middle Fork Reach 11

North Fork

North Fork (Reach Code NF) stretches 4.0 miles and was divided into 4 stream reaches. It begins as a detention basin in a residential neighborhood near the intersection of Radford and Saratoga Rd. on the eastern outskirts of Asbury and ends at its confluence with Middle Fork (Table 14; Figure 38).

North Fork Reach 1 (NF01) extends to Key Way Dr. through dense residential development. The stream channel here has been confined by that development and is moderately eroded with average stream habitat conditions. The riparian buffer is 30 feet or less in width and consists mostly of trees. A portion of this reach between Key Way Dr. and NW Arterial has been restored. North Fork Reach 2 (NF02) extends to Pennsylvania Ave. and is highly eroded, but has excellent stream habitat conditions. Riparian buffers here are in the same conditions as those of Reach 1.

North Fork Reach 3 (NF03) flows from Pennsylvania Ave. to Dodge St. The right bank of this reach is bordered by commercial development with a 30 foot or less buffer of trees while the left bank opens up to an agricultural field and has a buffer of at least 60 feet. Reach 3 exhibits low erosion and has average stream habitat. North Fork Reach 4 (NF04) continues to the confluence with Middle Fork. It is moderately eroded and also has average stream habitat conditions. Here the riparian corridor is 30-60 feet wide and dominated by trees.


North Fork Reach 1

Granger Creek

Granger Creek (Reach Code GC) stretches 9.3 miles and was divided into 7 stream reaches. It begins in a wooded area surrounded by agriculture and low density residential development in Mosalem Township near the intersection of Olde Davenport and Laudeville Roads and ends at the confluence with Catfish Creek (Table 14; Figure 38). Granger Creek Reaches 1 and 2 (GC01 and GC02) extend from the headwaters to Hidden Valley Rd and then from there to where it is joined by GCT04 east of Route 61. No RASCAL data was collected along these two reaches.

Granger Creek Reach 3 (GC03) extends from GCT04 to Olde Davenport Rd. and is confined between Route 61 and agricultural land to the east. It exhibits moderate levels of erosion and has a 30-60 foot riparian buffer of trees and CRP grass.

Granger Creek Reach 4 (GC04), 5 (GC05), and 6 (GC06) all flow through cropland areas. Reach 4 extends from Olde Davenport Rd to Lake Eleanor Rd, Reach 5 flows to the junction with GCT08, and Reach 6 ends just past Route 52. Most buffers within these reaches are greater than 60 feet wide and consist of a mix of CRP grass and trees.

Reaches 4 and 6 exhibit low levels of erosion, while Reach 5 is moderately eroded, however all of these reaches have isolated pockets of excessive erosion. Reach 4 has excellent stream habitat conditions, while Reaches 5 and 6 are only average.

Reach 7 is the last reach of Granger Creek (GC07) and it extends from just north or Route 52 to the confluence with Catfish Creek within Mines of Spain Recreation Area. This reach is highly eroded and has average stream habitat conditions. The riparian buffer consists of trees and is generally greater than 60 feet wide.

Excessive erosion along one bank of Granger Creek Reach 5

Tributary Streams
Sixty-three (63) tributary streams are found in the watershed (Table 14; Figure 38). Twenty (20) of these tributaries flow directly into Catfish Creek, 17 flow to South Fork, 12 drain to Middle Fork, 3 flow to North Fork, and the remaining 9 flow to Granger Creek. A brief description of each tributary stream is included below.

Catfish Creek Tributary 1 (CCT01):
This tributary flows for a total of 1.3 southeast along two branches consisting of drainage swales within cropland west of Bakey Rd and New Melleray Rd on its way to Catfish Creek Reach 1.

Catfish Creek Tributary 2 (CCT02):
This 0.6 mile tributary flows southwest though a partially channelized drainage ditch within cropland just east of New Melleray Rd prior to joining Catfish Creek Reach 2.

Catfish Creek Tributary 3 (CCT03):
Catfish Creek Tributary 3 begins northwest of Route 151 and Prairie Creek Rd and flows southwest and then north for 1.0 miles through cropland and woodland areas before entering Catfish Creek Reach 3.

Catfish Creek Tributary 4 (CCT04):
This tributary flows southeast west of New Melleray Rd. It begins as swales in cropland, but most of the reach flows through a woodland corridor before joining Catfish Creek Reach 4. The tributary is 1.3 miles long.

Catfish Creek Tributary 5 (CCT05):
Tributary 5 begins near Route 151 and flows northwest for 1.3 miles before entering Catfish Creek Reach 5. This tributary dominated by a woodland corridor.

Catfish Creek Tributary 6 (CCT06):
This tributary consists of two branches totaling 2.3 mile in length. Both branches begin in agricultural land west of Route 151 and north of Nolan Ln and flow roughly westward through grass and woodland areas before joining Catfish Creek Reach 5 within Swiss Valley Nature Preserve.

Catfish Creek Tributary 7 (CCT07):
Catfish Creek Tributary 7 consists of several branches for a total of 6.1 miles in length and is the second largest tributary to Catfish Creek. The northern branches begin in croplanc south west of Cascade and New Melleray Roads and flow south and east, while the southern branch begins near Bakey Rd and flows east before they all join Catfish Creek Reach 5. These branches flow through a mix of cropland and wooded areas.

Catfish Creek Tributary 8 (CCT08):
Another long and brachiated tributary, Catfish Creek Tributary 8 begins just south of the junction of N Cascade and Swiss Valley Roads and flows generally south to Catfish Creek Reach 6. It flows from cropland and pasture areas near the headwaters and just east of a low density residential development though woodland.

Catfish Creek Tributary 9 (CCT09):
Tributary 9 is 0.6 miles in length and flows westward from just went of Hendricks Ln to Catfish Creek Reach 7. Most of this tributary falls within woodlands within Swiss Valley Nature Preserve.

Catfish Creek Tributary 10 (CCT10):
This tributary begins adjacent to the headwaters of Tributary 9, but flows northward through two branches toward Catfish Creek Reach 8. It is approximately 0.9 miles in total length and flows predominantly through woodlands immediately east of Swiss Valley Nature Preserve.

Catfish Creek Tributary 11 (CCT11):
Catfish Creek Tributary 11 has two branches beginning just east of Hendricks Ln and just west of Route 151 for a total of 1.6 miles. Both branches begin in cropland at the headwaters, then flow northward through woodland and through a low density residential area before joining Catfish Creek Reach 8 just south of Swiss Valley Rd.

Catfish Creek Tributary 12 (CCT12):
Tributary 12 begins in cropland north of Route 151 and west of Military Rd and flows north through crop and woodland areas. It flows through a culvert under Swiss Valley Rd and through pasture before entering Catfish Creek Tributary 9 within Swiss Valley Park and totals 1.3 miles in length. The last portion of this reach is highly eroded due to unchecked cattle access to streambanks within the pastureland.

Catfish Creek Tributary 13 (CCT13):
Tributary 13 flows northwest for 1.3 miles, originating in a detention basin or pond within a low density residential area south of Swiss Valley Rd. It flows through mostly cropland with some woodland cover before joining Catfish Creek Tributary 10. Part of this tributary within the agricultural land has been channelized.

Catfish Creek Tributary 14 (CCT14):
This is a very brachiated tributary that flows generally from west to east for a total of 5.6 miles. It lies between Swiss Valley Rd and Whitetop Rd through agricultural land with varying widths of woodland surrounding much of the stream. It crosses Whitetop Rd via a culvert to join Catfish Creek Reach 10 from the west.

Catfish Creek Tributary 15 (CCT15):
Catfish Creek Tributary 15 flows generally north and east for 1.4 miles from a low density residential development west of Old Hwy 151 to join Catfish Creek Reach 11. Most of this tributary falls within a wooded corridor, except for the headwaters adjacent the residential area.

Catfish Creek Tributary 16 (CCT16):
Catfish Creek Tributary 16 is the longest tributary to Catfish Creek at 6.6 miles in length and is comprised of several branches. Generally the tributary flows from west to east to join Catfish Creek at Reach 11. While most of the tributary is surrounded by a mix of crop and


Catfish Creek Tributary 17

woodland areas, the headwaters of several branches begin in commercial areas and high and medium density residential areas near N Cascade Rd and Route 20.

Catfish Creek Tributary 17 (CCT17): Tributary 17 flows south east for 1.8 miles along two branches to Catfish Creek Reach 13. This reach is dominated by pasture land and agricultural areas and lies between N Cascade Rd and Oakland Farms Rd.

Catfish Creek Tributary 18 (CCT18): Joining Catfish Creek Reach 14 near the end of Mason Rd, Tributary 18 flows north for 3.5 miles across three branches through predominantly cropland areas with some low and high density residential areas nearby.

Catfish Creek Tributary 19 (CCT19) and 20 (CCT20): Tributary 19 and 20 both lie within Mines of Spain Recreation area and flow north for 0.6 miles each before joining Catfish Creek Reach 18. Both tributaries are in heavily wooded areas.

South Fork Tributary 1 (SFT01): South Fork Tributary 1 begins near Sundown Rd south of Old Highway Rd in the western-most portion of the watershed and flows southeast and east to join South Fork Reach 1. It is 0.6 miles long and flows through cropland.

South Fork Tributary 2 (SFT02): South Fork Tributary 2 also flows through cropland for a total of 1.0 miles, beginning near Old Highway Rd and flowing east of and along Cox Springs Rd before joining South Fork at Reach 2

South Fork Tributary 3 (SFT03): Tributary 3 begins near Thunder Hills Rd and flows northwest for 0.6 miles to join South Fork Reach 2. This reach flows through low density residential and wooded land.

South Fork Tributary 4 (SFT04): Tributary 4 flows generally south beginning in cropland south of the intersection of Sundown and Old Highway Roads. It extends for 2.1 miles through agricultural and wooded land before joining South Fork Reach 2.

South Fork Tributary 5 (SFT05): Beginning in woodland south of Chesterman Rd, Tributary 5 flows northwest for a total of 0.6 miles to join South Fork Reach 2.

South Fork Tributary 6 (SFT06) and South Fork Tributary 7 (SFTO7): Tributaries 6 and 7 both begin south of Old Highway Rd and flow south for 0.9 and 2.2 miles, respectively, before joining South Fork Reach 2 north of Chesterman Rd. Both tributaries flow through woodlands surrounded by cropland.

South Fork Tributary 8 (SFT08): Tributary 8 is a short, 0.2-mile tributary that flows along Chesterman Rd eastward through partially wooded land.

South Fork Tributary 9 (SFT09): South Fork Tributary 9 is a short, 0.5

mile tributary that flows southeast through a mix of woodland and cropland to join South Fork Reach 2 from the north.

South Fork, Fork Branch Tributary (SFFB01): Fork Branch Tributary is a long and brachiated tributary that begins near Route 20 and Cottingham Rd and flows predominantly north for a total of 5.2 miles. Most of this tributary flows extends through woodland, with agricultural areas and Thunder Hills golf course surrounding the headwaters of some of the tributary branches. It joins South Fork Reach 3 between Tributaries 9 and 10, but from the south.

South Fork Tributary 10 (SFT10): Tributary 10 flows southeast for 1.9 miles, beginning near Old Highway Rd and flowing through woodland before joining South Fork Reach 3 south of the railroad tracks.

South Fork Tributary 11 (SFT11): South Fork Tributary 11 is a 0.3 mile tributary that lies between Cottingham Rd and the Dubuque Metro Landfill. It flows northeast through mostly agricultural land, with some landfill property comprising its headwaters, before joining South Fork Reach 3.

South Fork Tributary 12 (SFT12): At 7.0 miles in length, Tributary 12 is the longest and probably the most brachiated of South Fork's tributaries. It lies predominantly north and west of Route 20. Headwater areas generally include low and high density residential uses and most of the branches flow through woodland areas. The final downstream portion of Tributary 12 is channelized along the west edge of the Dubuque Metro Landfill before joining South Fork at Reach 4.

South Fork Tributary 13 (SFT13): Tributary 13 total 4.6 miles in length and flows east from east of Sundown R between Humke and Old Highway Roads. It flows under Old Highway Rd, the railroad tracks, and Cottingham Rd before joining South Fork Reach 4 north of the Dubuque Metro Landfill. Land cover surrounding this tributary includes woodland, cropland, and some pockets of low density residential and commercial areas.

South Fork Tributary 14 (SFT14): Beginning north of Cascade Rd and east of Route 20, South Fork Tributary 14 flows generally north through low density residential, industrial, woodland, and cropland areas. It totals 4.2 miles in length and is channelized along the east side of Route 20 for the last portion before joining South Fork at Reach 6.

South Fork Tributary 15 (SFT15): Extending from north of Cascade Rd and east of English Mill Rd, Tributary 15 flows first northeast through cropland and then east through cropland and woodland areas. It joins South Fork Reach 8 and is 4.9 miles in length.

South Fork Tributary 16 (SFT16): The last tributary to South Fork is Tributary 16. It flows east from south of Cascade Rd to join South Fork Reach 9, extending through cropland and woodland areas for a total of 1.3 miles.

Middle Fork Tributary 1 (MFT01): Middle Fork Tributary 1 begins between Sundown and Middle Roads for 0.7 miles before flowing east to join Middle Fork Reach 1; it is comprised of a mix of crop, woodland, and low density residential areas.

Middle Fork Tributary 2 (MFT02): Middle Fork Tributary 2 is 0.3 miles in length and flows southeast through agriculture and woodland areas before joining Middle Fork Reach 2.

Middle Fork Tributary 3 (MFT03): Tributary 3 begins in agricultural land near Sundown Rd and extends east for 1.1 miles to join Middle Fork Reach 2. This tributary flows through a wooded corridor surrounded by cropland.


South Fork Tributary 15

Middle Fork Tributary 4 (MFT04): Beginning north of and flowing south through Meadows Golf Course, Middle Fork Tributary 4 totals 1.2 miles in length. In addition to the golf course, this tributary also flows through cropland before joining Middle Fork Reach 3.

Middle Fork Tributary 5 (MFT05): Middle Fork Tributary 5 begins in a detention basin on the northeastern portion of Meadows Golf Course and flows south for a total of 0.8 miles through the golf course and a residential area before joining Middle Fork Reach 3.

Middle Fork Tributary 6 (MFT06): Tributary 6 extends for 0.5 miles south through mostly low density residential land east of Torrey Pines Rd before joining Middle Fork at Reach 3.

Middle Fork Tributary 7 (MFT07): Tributary 7 begins in a residential area north of Middle Rd and flows south for 1.0 miles to south of Chavenelle Rd to join Middle Fork Reach 4. Over its course, Tributary 7 flows through an orchard, a high density residential area, and a commercial development.

Middle Fork Tributary 8 (MFT08): Middle Fork Tributary 8 begins near Humke Rd and B M R Ln and flows east 1.4 miles to join Middle Fork Reach 5. Along the way it also picks up a rather large tributary stream, Middle Fork Tributary 8A (MFT08A), of 2.3 miles in length. Both of these streams extend predominantly through cropland areas as well as some private lands.

Middle Fork Tributary 9 and 10 (MFT09 and MFT10): Tributary 9 and 10 both begin north of Middle Rd and flow south through agricultural and industrial lands to join Middle Fork at Reaches 6 and 7, respectively, south of the railroad. Tributary 9 is 1.5 miles in length and Tributary 10 is 1.9 miles in length.

Middle Fork Tributary 11 (MFT011): Middle Fork Tributary 11 begin south of Welu Dr and flows southeast through woodland at Welu Park for 0.3 miles to join Middle Fork Reach 8.

Middle Fork Tributary 12 (MFT012): Tributary 12 is the last tributary to Middle Fork. It begins at the Dubuque Golf & Country Club and flows south between the golf course and a residential area off Wartburg Place for 0.9 miles to join Middle Fork Reach 12 south of the railroad tracks. Other than a small portion within the golf course, this tributary flows through woodland.

North Fork Tributary 1 (NFT01): North Fork Tributary 1 begins southeast of Asbury Court and west of NW Arterial. It flows south for 0.3 miles adjacent to both residential and commercial areas before joining North Fork Reach 1

North Fork Tributary 2 (NFT02): Tributary 2 is located east of NW Arterial and predominantly south of Asbury Rd. It flows along two branches through a farm field before reaching a residential area near Hillcrest Rd. It flows for a total of 1.4 miles before joining North Fork Reach 1.

North Fork Tributary 3 (NFT03): North Fork Tributary 3, the last of the tributaries along North Fork, flows south for 0.3 miles through a residential area before joining North Fork Reach 3 near the junction of University Ave and Dodge St.

Granger Creek Tributary 1 (GCT01): Granger Creek Tributary 1 begins east of the Dubuque Regional Airport and flows generally northward from north of Laudeville Rd to Granger Creek Reach 2. It extends for a total of 2.3 miles in length through wooded and low density residential areas.

Granger Creek Tributary 2 (GCT02): Tributary 2 flows west adjacent to Hidden Valley Rd for approximately 0.6 miles before joining Granger Creek Reach 2 and falls almost entirely within a low density residential area.

Granger Creek Tributary 3 (GCT03): Granger Creek Tributary 3 flows southwest for 0.6 miles through agricultural land west of Olde Davenport Rd to join Granger Creek Reach 2.

Granger Creek Tributary 4 (GCT04): Tributary 4 is divided into two reaches. Tributary 4 Reach A (GCT04A) consists of three branches that total 4.6 miles in length and all join at the top of Tributary 4 Reach B (GCT04B). The north branch of Reach A begins southeast of Amy Dr and flows through low density residential areas and under the junction of Route 151 and 61. The middle and longest branch flows east through crop and woodland areas south of Route 151. The south branch flows north, also through crop and woodland areas, just east of Route 61. Tributary 4 Reach B flows northward adjacent to Elmwood Ln and Dr through a low density residential area. It extends 0.7 miles before joining Granger Creek Reach 3.

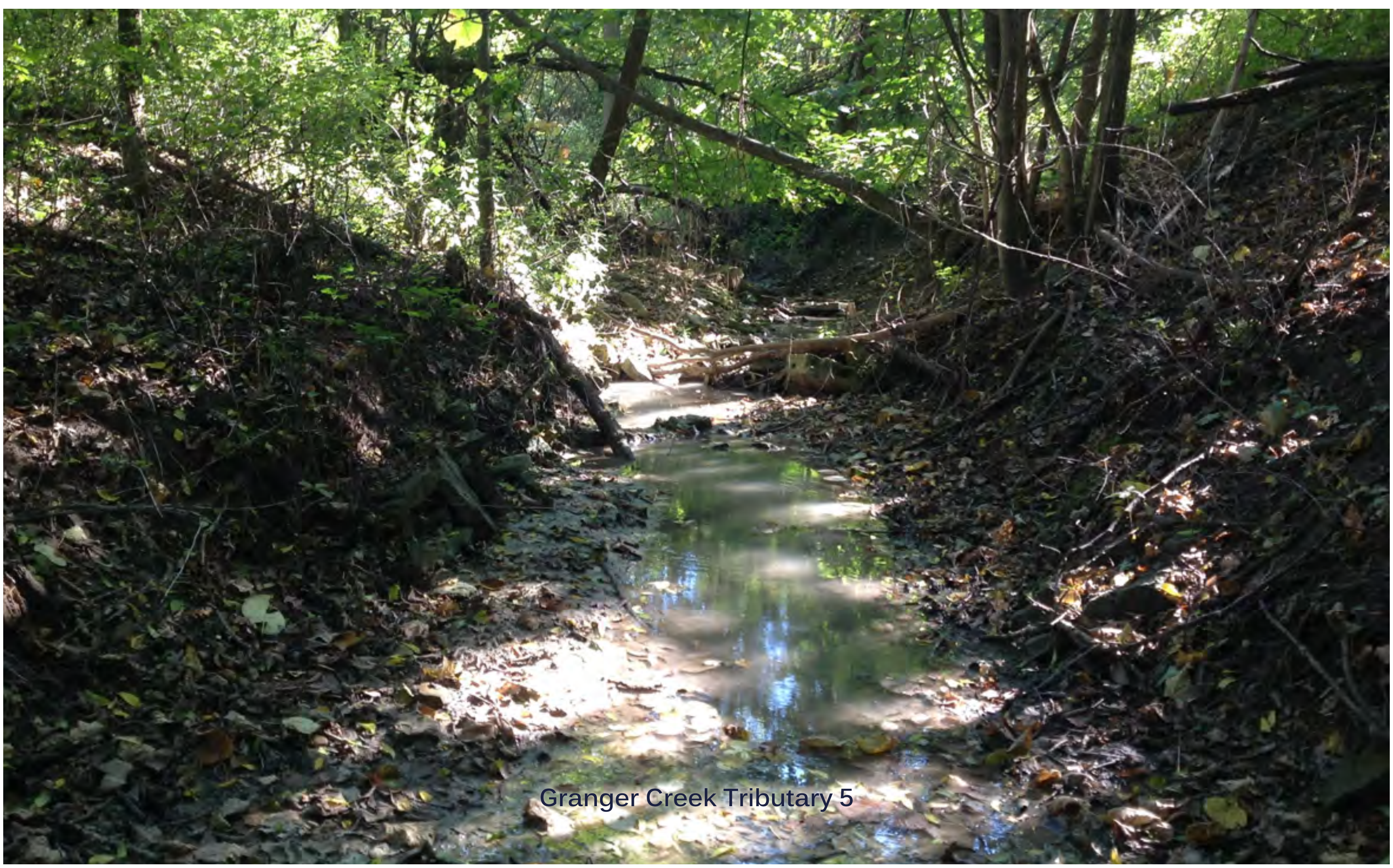
Granger Creek Tributary 5 (GCT05): Granger Creek Tributary 5 is a 3.5-mile long, brachiated tributary that flows east from east of Military Dr to join Granger Creek Reach 3. Generally, the headwaters of its branches fall within low density residential areas and then extend through wood and cropland areas.

Granger Creek Tributary 6 (GCT06): Tributary 6 begins near low density residential developments east of Military Rd and flows east across agricultural. It flows under Rt 151 and ends at Olde Davenport Rd before joining Granger Creek Reach 4. Tributary 6 is 1.4 miles in length.

Granger Creek Tributary 7 (GCT07): Granger Creek Tributary 7 is a long and brachiated tributary that begins in cropland near Schueller Heights Rd. It follows Lake Eleanor Rd through low density residential, pasture and cropland areas for a total of 7.4 miles.

Granger Creek Tributary 8 (GCT08): Beginning north of Cedar Point Ct behind a low density residential neighborhood, Tributary 8 flows for 0.9 miles east through woodland to join Granger Creek Reach 6.

Granger Creek Tributary 9 (GCT09): At 10.7 miles in total length, Granger Creek Tributary 9 is the longest and most brachiated tributary to Granger Creek. It covers much of the eastern-most portion of the watershed and lies west of and along Route 52. It flows through a mix of crop, woodland, and low density residential areas.


Granger Creek Tributary 5

Streambank Erosion
RASCAL data was collected for approximately 56.7 miles of streams and tributaries within Catfish Creek watershed. Unnatural streambank erosion generally results following an instability in flow rate or volume in the stream channel, human alteration such as channelization, or change in streambank vegetation. Resulting sediment accumulation and transportation downstream can cause significant water quality problems. Streambank erosion is moderate on average throughout the watershed and is a reflection of increased stormwater runoff and impervious cover. Watershed pollutant loading data (see Section 4.4) indicates that streambank erosion is one of the leading causes of sedimentation.

The location and severity of streambank erosion in the watershed is summarized in Table 15 and depicted on Figure 39. Approximately 29% (16.3 linear miles) of the total assessed stream and tributary length exhibits no or low bank erosion. Moderate erosion, or erosion occurring on one or alternate banks, is occurring along 59% (33.3 linear miles) of streambanks. Highly eroded streambanks, including reaches with excessive erosion along both banks, account for 12% (7.1 linear miles) of the total assessed stream length. Most highly eroded reaches are considered “Critical Areas” because they are actively contributing significant sediment loads downstream.

All or portions of all highly eroded and some moderately eroded streambanks provide excellent opportunities for streambank stabilization projects. The Action Plan section of this report addresses and prioritizes opportunities for reducing streambank erosion.

Photos: Excessive erosion along Catfish Creek Reach 12 (top) and South Fork Reach 4 (bottom).

Table 15. Summary of stream and tributary bank erosion for reaches assessed via RASCAL data.

Stream or Tributary Name	Abbreviation	Stream Length Assessed	None or Low Erosion		Moderate Erosion		High Erosion	
		(miles)	(miles)	(%)	(miles)	(%)	(miles)	(%)
Catfish Creek	CC	13.7	3.2	23.3%	7.3	53.7%	3.1	23.0%
South Fork	SF	12.8	2.9	22.2%	9.0	70.3%	1.0	7.5%
Middle Fork	MF	13.0	6.6	50.8%	6.4	49.2%	0	0%
North Fork	NF	4.0	1.2	29.4%	2.3	58.3%	.5	12.3%
Granger Creek	GC	6.0	2.4	40.5%	2.6	42.3%	1.0	17.1%
Granger Creek Trib 4B	GCT04B	0.7	0	0%	0.7	100%	0	0%
North Fork Trib 2	NFT02	1.4	0	0%	0	0%	1.4	100%
South Fork Trib 15	SFT15	4.9	0	0%	4.9	100%	0	0%
Totals		**56.7**	**16.3**	**28.8%**	**33.3**	**58.7%**	**7.1**	**12.5%**

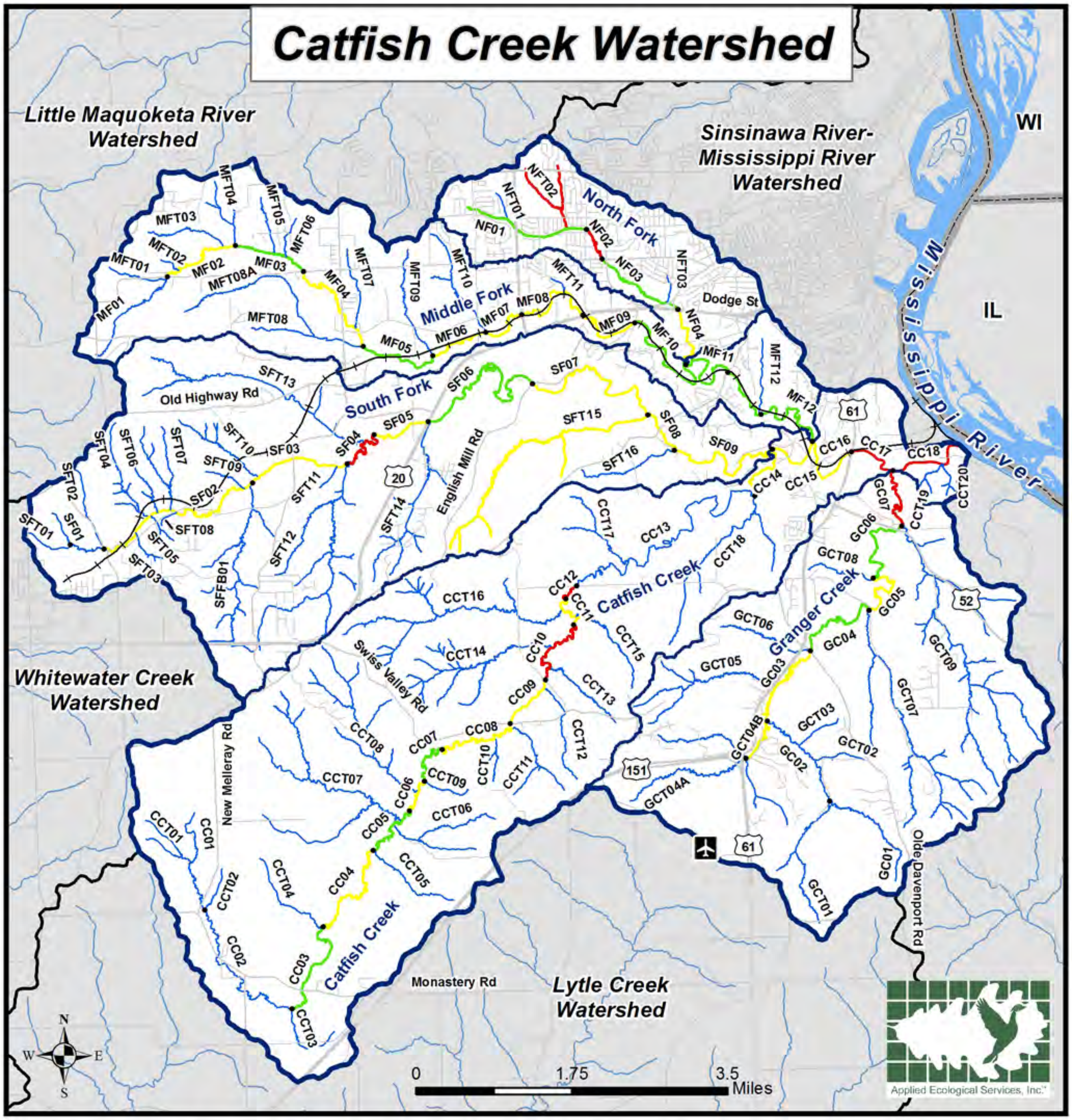


Figure 39: Degree of Streambank Erosion

Legend

- Airport
- Roads
- Railroad
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds
- • Stream Reach End Point

Degree of Streambank Erosion

- Low
- Moderate
- High
- No data

Data Sources:

In-Stream Habitat Condition

Stream habitat condition is closely related to biological diversity and is an integral part of the overall health of a stream or tributary. In-stream habitat was assessed as part of the overall RASCAL stream assessments ongoing since 2008. According to the RASCAL assessment form, examples of in-stream habitat include such findings as logs, backwater pools, riffles, aquatic vegetation, whether fish are present, etc. Ranking was determined as follows:

- Excellent – many examples of in-stream habitat exist; aquatic species (insects and fish) are present. This type of segment appears significantly better than other segments surveyed.
- Average – Some examples of in-stream habitat are present
- Poor – Very few to no example of in-stream habitat exist in stream segment. Few fish or aquatic insects are present. This type of segment appears worse than other segments surveyed.

The condition and location of in-stream habitat in the watershed is summarized in Table 16 and Figure 40. Approximately 49%, or 27.9 linear miles, of the in-stream habitat was assessed as being in "Excellent" condition and generally include upstream portions of Catfish Creek, South Fork, and Granger Creek. Roughly half, or 50% (28.5 linear miles), of stream and tributary length were assessed as having "Average" in-stream habitat condition. This includes most of Middle Fork and North Fork as well as downstream portions of the remaining branches. The last 1% (0.3 linear miles) of stream habitat is in "Poor" condition and found along one reach of Catfish Creek (CC12). Fortunately, ecological restoration helps improve in-stream habitat conditions. The Action Plan lists and prioritizes opportunities for improving in-stream habitat as part of the recommended Streambank and Channel Restorations.

Table 16. Summary of stream and tributary in-stream habitat condition for reaches assessed via RASCAL data.

Stream or Tributary Name	Abbreviation	Stream Length Assessed	Excellent Condition		Average Condition		Poor Condition	
		(miles)	(miles)	(%)	(miles)	(%)	(miles)	(%)
Catfish Creek	CC	13.7	7.4	54.5%	6.0	43.6%	0.3	1.9%
South Fork	SF	12.8	10.1	78.5%	2.8	21.5%	0	0%
Middle Fork	MF	13.0	1.5	11.6%	11.5	88.4%	0	0%
North Fork	NF	4.0	.5	12.3%	3.5	87.7%	0	0%
Granger Creek	GC	6.0	2.7	45.4%	3.3	54.6%	0	0%
Granger Creek Trib 4B	GCT04B	0.7	0.7	100%	0	0%	0	0%
North Fork Trib 2	NFT02	1.4	0	0%	1.4	100%	0	0%
South Fork Trib 15	SFT15	4.9	4.9	100%	0	0%	0	0%
Totals		**56.7**	**27.9**	**49.2%**	**28.5**	**50.3%**	**0.3**	**0.5%**

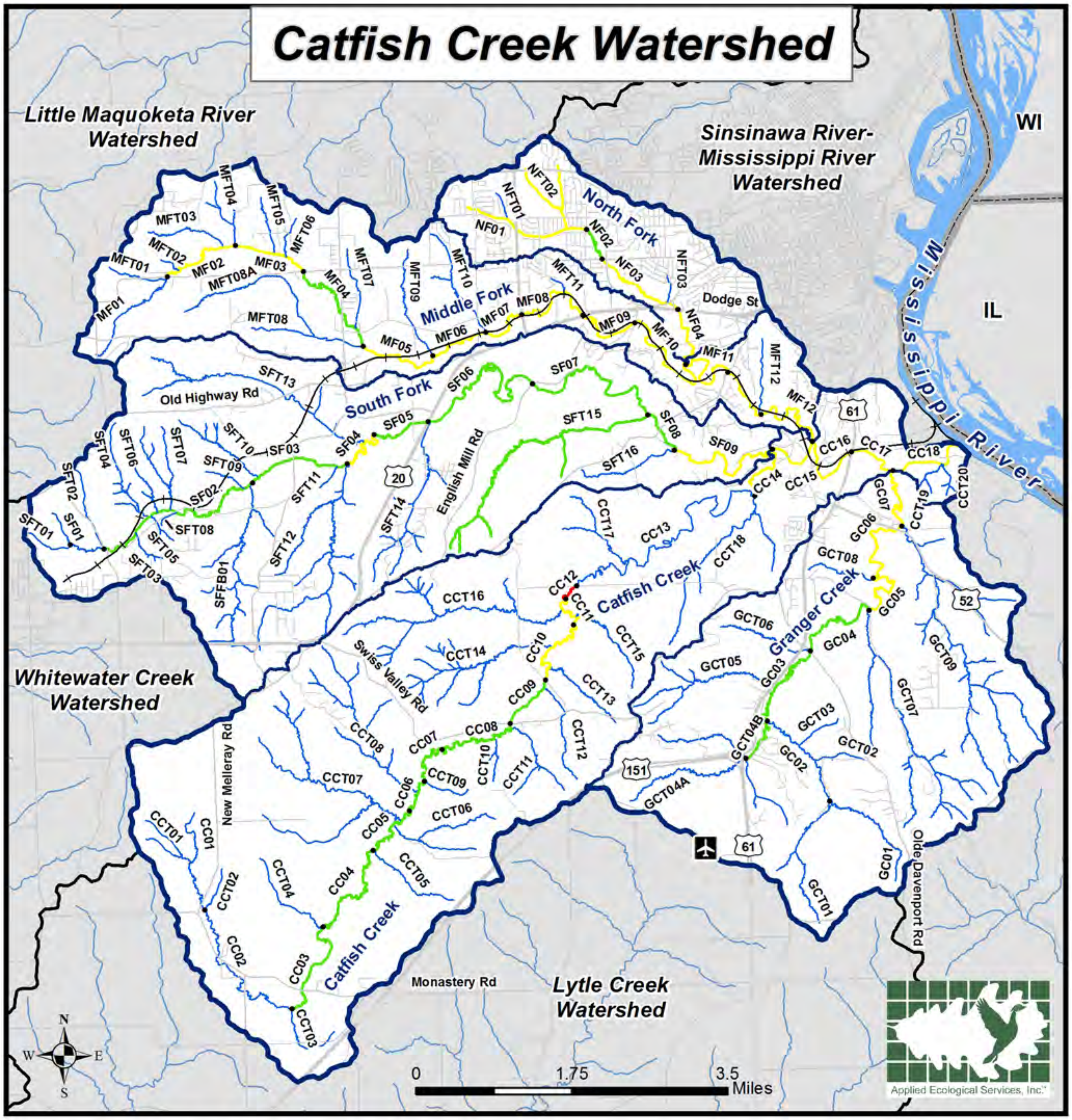
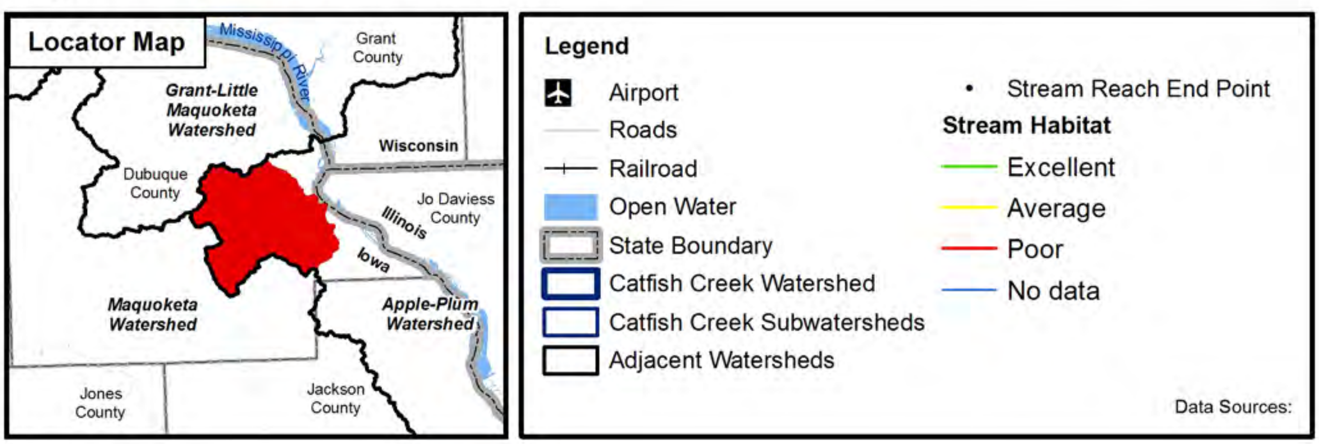


Figure 40: Stream Habitat



Riparian Area Width

Riparian areas buffer streams by filtering pollutants, providing beneficial wildlife habitat, and connecting green infrastructure. Generally speaking, the wider a riparian buffer is the more vegetation is present to filter pollutants from adjacent land uses, with a 30 foot buffer being the minimum recommendation for the benefit of water quality.

Riparian areas along streams and tributaries were assessed during the RASCAL data collection as to general width and cover types. Buffers were assessed as being either less than 30 feet wide, 30-60 feet wide, or greater than 60 feet wide.


Example of narrow riparian buffers along Middle Fork.

The location and average width of riparian areas in the watershed is summarized in Table 17 and Figure 41. Approximately 31%, or 17.5 linear miles, of the riparian areas are have a riparian buffer that is greater than 60 feet wide and are most often located along sections of both Catfish and Granger Creeks. Another 46% (25.8 linear miles) of riparian area buffers average between 30 and 60 feet wide. Twenty-three percent, or 13.3 linear miles, of stream and tributary riparian area buffers are less than 30 feet wide. Installation of native buffers of at least 30 feet in width will benefit overall water quality along those reaches. The Action Plan lists and prioritizes opportunities for improving riparian areas.

Table 17. Summary of stream and tributary average riparian buffer width.

Stream or Tributary Name	Abbreviation	Stream Length Assessed	>60 feet		30-60 feet		<30 feet	
		(miles)	(miles)	(%)	(miles)	(%)	(miles)	(%)
Catfish Creek	CC	13.7	5.1	37.2%	7.7	56.0%	0.9	6.8%
South Fork	SF	12.8	0	0%	6.5	51.0%	6.3	49.0%
Middle Fork	MF	13.0	3.3	25.4%	7.0	53.6%	2.7	20.9%
North Fork	NF	4.0	0	0%	2.0	50.2%	2.0	49.8%
Granger Creek	GC	6.0	3.5	57.7%	2.6	42.3%	0	0%
Granger Creek Trib 4B	GCT04B	0.7	0.7	100%	0	0%	0	0%
North Fork Trib 2	NFT02	1.4	0	0%	0	0%	1.4	100%
South Fork Trib 15	SFT15	4.9	4.9	100%	0	0%	0	0%
Totals		**56.7**	**17.5**	**30.9%**	**25.8**	**45.6%**	**13.3**	**23.5%**

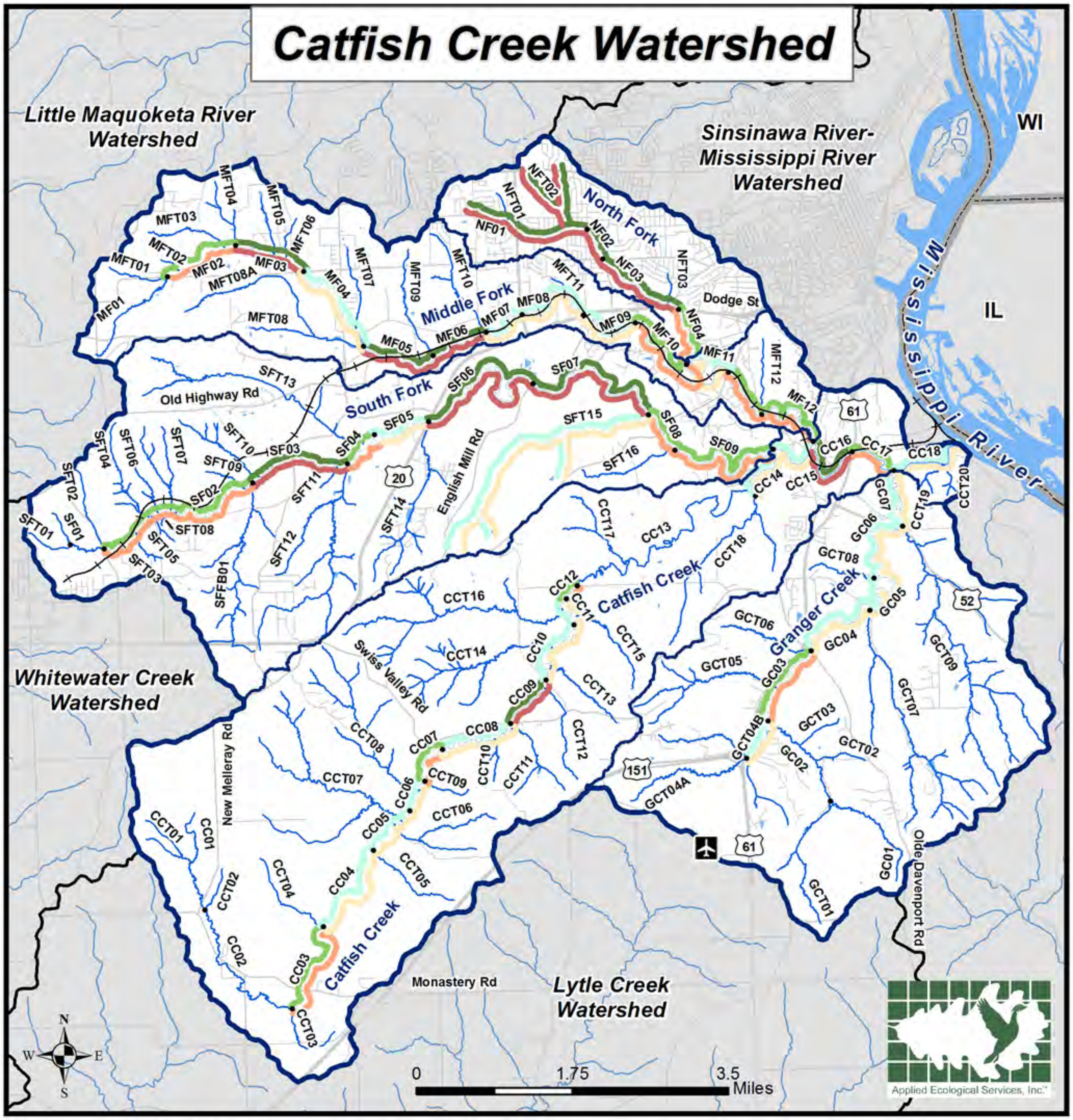
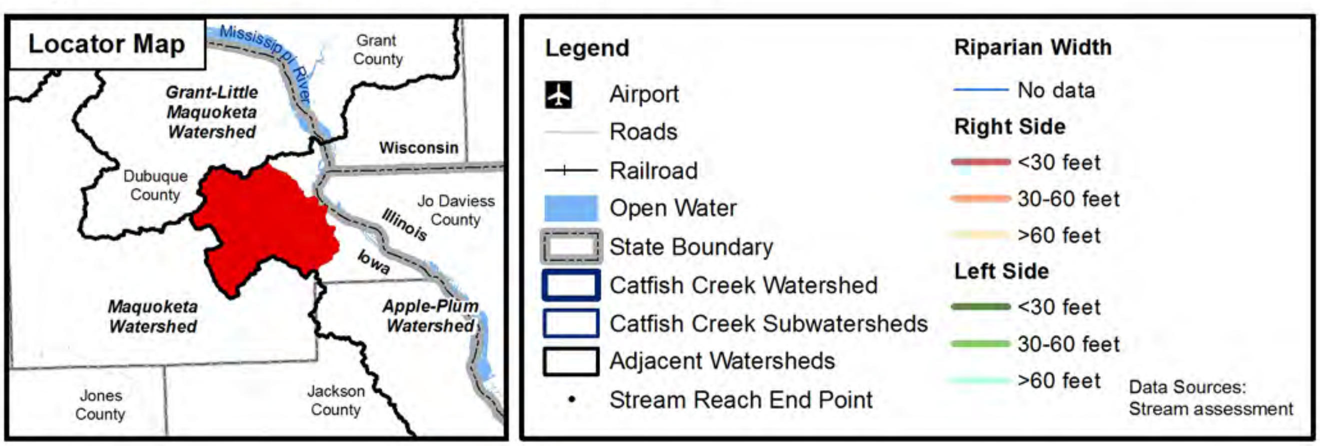


Figure 41: Width of Riparian Area



3.13.2 Detention Basins

The drainage system in Catfish Creek watershed consists of farmland sheet flow, channels, and ditches as well as runoff from developed areas. Planners and engineers quickly realized the benefits of storing stormwater runoff in detention basins near development. A detention basin is a human-made structure for the temporary storage of stormwater runoff with a controlled release rate. Detention basins can also provide excellent wildlife habitat and improve water quality if designed with the proper configuration, slopes, and water depths then planted with native prairie and wetland vegetation. Today, detention basins capture runoff from much of the most urbanized areas of the watershed making the quality and quantity of water leaving these basins critically important to the health of Catfish Creek.


Typical rock-lined dry detention behind Pizza Ranch near Radford and Saratoga Rd in Dubuque.

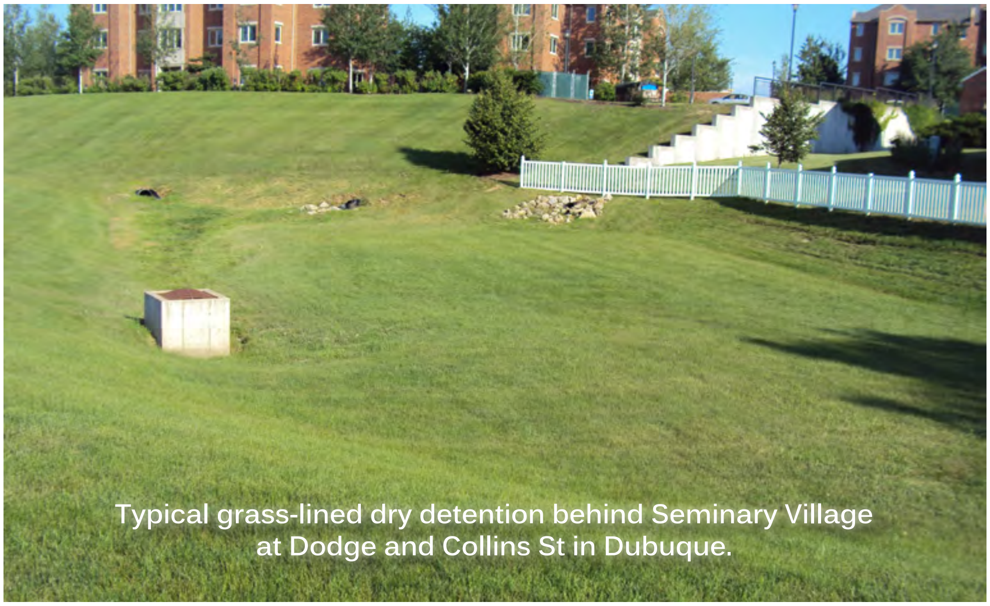
Detention basins can be designed and constructed as wet bottom, wetland bottom, or dry bottom and planted with various types of natural or manicured vegetation. Wet and wetland bottom basins typically hold water that is controlled by the elevation of the outlet structure. Wet bottom basins are usually greater than 3 feet deep and do not have emergent vegetation throughout whereas wetland bottom detention basins are shallow enough to be dominated by emergent wetland plants. These designs promote water quality treatment and support wildlife when they include sufficient buffers and less steep slopes along basin edges. Dry bottom basins are designed to drain completely after temporarily storing stormwater following rain events. They can be lined, planted to turf grasses, or naturalized with native species.

Catfish Creek watershed has 88 known detention basins (Figure X). Applied Ecological Services, Inc. completed a basic assessment of each detention basin in summer 2013. Assessment methodology included a visit to each site and collection of data relevant to existing conditions. Detailed notes were recorded related to existing ecological/water quality improvement condition and potential retrofit Management Measures for eventual inclusion into the Action Plan section of this report. Results of the inventory and detailed summaries of each detention basin can be found in Appendix B.

Fifty-four (54) dry bottom basins, 19 wet bottom basins, and 14 wetland bottom basins were inventoried (Figure 42). The overwhelming majority of basins are located within the City of Dubuque and Asbury. Of the 88 detention basins, one was not assessed for water quality purposes due to inaccessibility. Water quality was assessed based on design, plant cover within and surrounding basins, and the existing condition of each basin. Only 7 basins (8%) likely provide “Good” ecological and water quality benefits while 21 basins (24%) likely provide “Average” benefits. The remaining 59 basins (67%) likely provide “Poor” ecological and water quality benefits because most were designed simply to meet stormwater storage volume requirements.

Designs that also improve water quality and wildlife habitat were not necessarily considered because they were not required under local regulations until recently. Dubuque County’s Stormwater Management ordinance contains detailed examples and standardized specifications, but was adopted in 2010, after most development in the watershed had already occurred. Dubuque County now requires that Best Management Practices (BMPs) be part of permitted developments to protect the County’s lakes, streams, wetlands and quality of life by reducing the negative impacts of sediment, rainfall, melting snow and other water runoff.

Although every detention basin is unique, dry bottom detention basins are the most common type found in the watershed and they generally come in two different varieties. The first variety consists of a small, rock-lined basin often with a manhole at the bottom (see image, above). Many of these basins are also overrun with weeds or debris. These are most commonly found in the heavily urbanized portions of the watershed and near existing commercial and industrial development. The other common form of dry detention basin consists of a swale or depression planted with turf grass and containing a large concrete structure at one end (see image, right). These are typically found in or near residential development. Neither of these types provides much by way of water quality benefits, wildlife habitat, or infiltration to replenish groundwater.



Typical grass-lined dry detention behind Seminary Village at Dodge and Collins St in Dubuque.

Dry bottom basins lined with rock or planted with turf grass hold water for shorter periods following rain events and infiltrate less water compared to dry bottom basins naturalized with deep rooted vegetation. In addition, many of the dry bottom basins are constructed with manholes or outlet drains flush with the bottom of the basin. In these cases, polluted stormwater runoff following smaller rain events travels directly through the basin without being stored, treated, or infiltrated. These designs should be avoided in the future. Many of the dry bottom basins in the watershed present excellent retrofit opportunities and would serve to pre-treat stormwater runoff and increase infiltration rates. Most dry bottom basins are relatively easy to naturalize with native plantings once any rock has been removed from channel bottoms and concrete structures and drains can be manipulated to store and infiltrate water as desired.

Wet and wetland bottom detention basins can also be found in the watershed and often are located adjacent to streams and tributaries. Although these basins vary in type, one design tends to be fairly common. Typically these basins have been created near newer development, both residential and commercial, that was constructed along a ridgeline. Subsequently detention servicing these areas was built by creating a berm at one end of the top of the nearest ravine or draw draining to a stream. This method of creating detention also means that these basins are often situated at the headwaters of various tributaries within the watershed, making them crucial for pre-treatment purposes. These basins tend to be naturalized more often than the dry bottom basins found in the watershed because of how they were created, but many still could benefit from the installation of native buffers and/or an emergent shelf as well as routine maintenance.

Naturalized basin created with a berm at one end of a draw near NW Arterial and Chavenelle Rd.

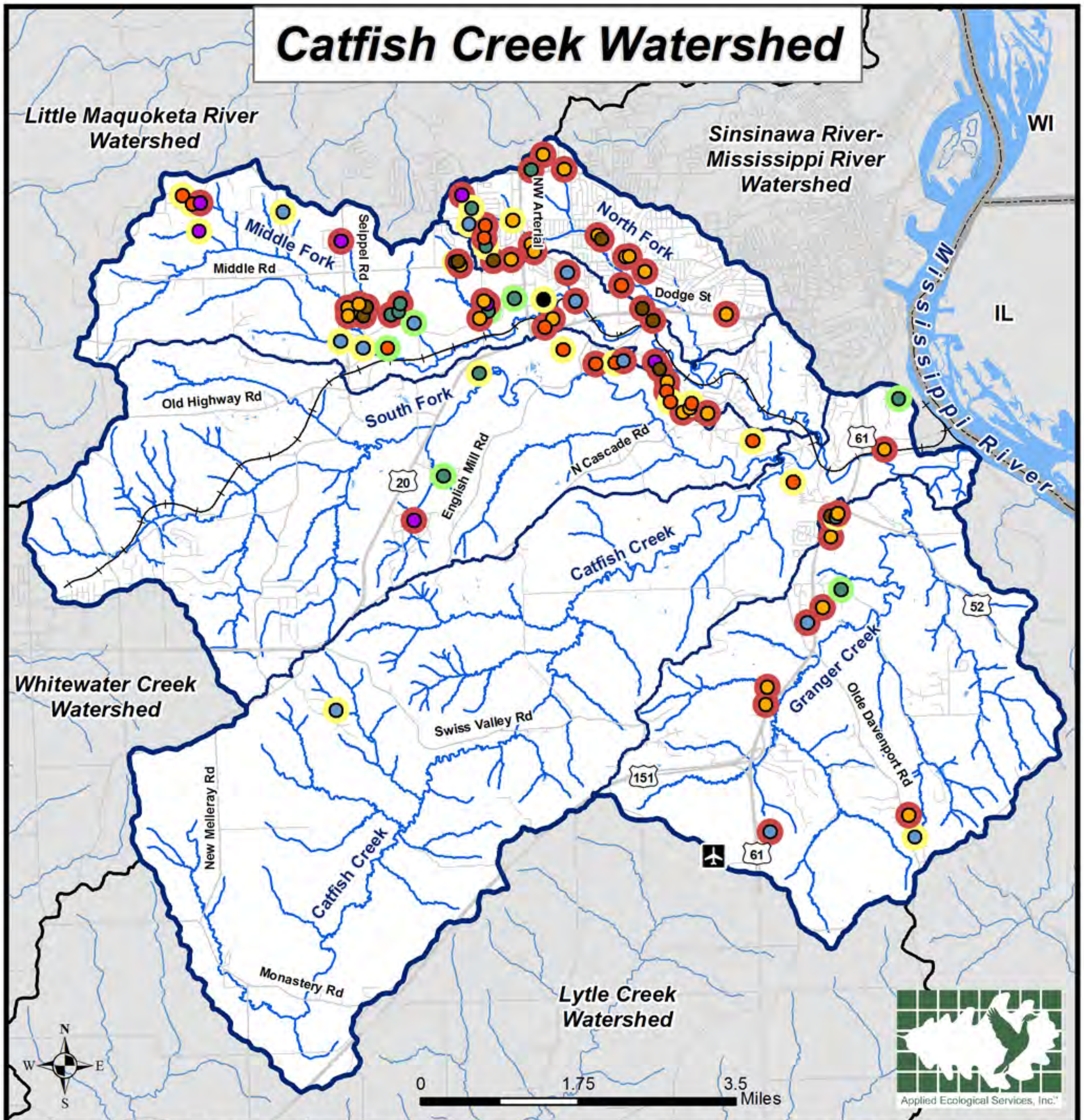
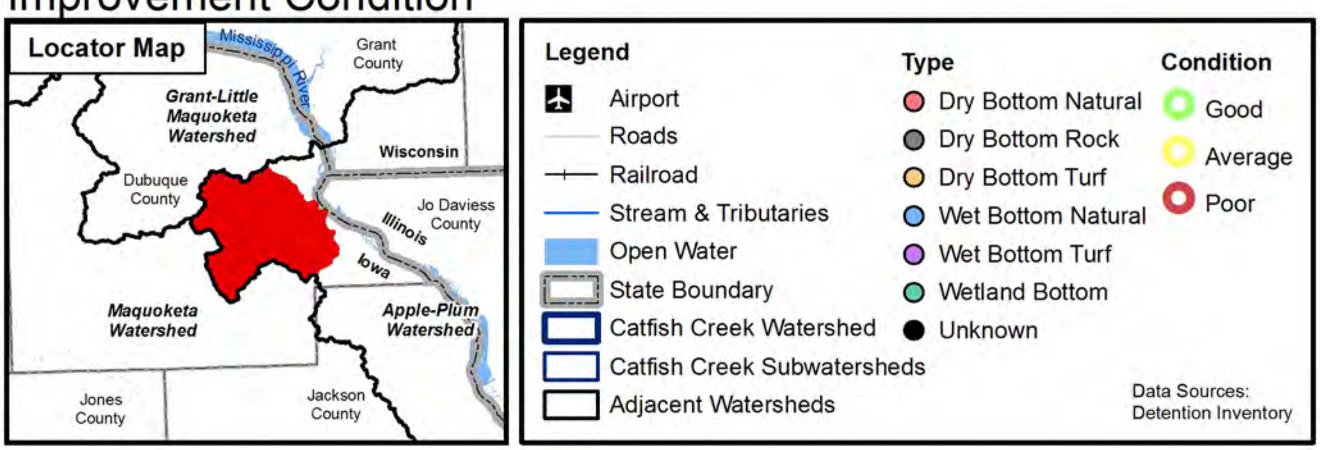


Figure 42: Detention Basin Locations & Ecological/Water Quality Improvement Condition



3.13.3 Agricultural Land

Agricultural land uses dominate much of the watershed outside of the City of Dubuque and include row crops, hay, pasture, and livestock uses. While Iowa is known for its food production, how this land is managed can have a significant effect on water quality. According to the Environmental Protection Agency's (EPA's) National Water Quality Inventory for 2000, "agricultural nonpoint source (NPS) pollution was the leading source of water quality impacts on surveyed rivers and lakes... Agricultural activities that cause NPS pollution include poorly located or managed animal feeding operations; overgrazing; plowing too often or at the wrong time; and improper, excessive or poorly timed application of pesticides, irrigation water and fertilizer. (EPA, 2013)" According to the pollutant modeling conducted by AES, agricultural land uses are the leading source of both nutrients and sediment in the watershed.

Environmental Working Group published a paper entitled "Murky Waters: Farm Pollution Stalls Cleanup of Iowa Streams," in 2012. The paper clearly identifies nutrient loading from agriculture and the lack of regulation of agricultural runoff as the largest impediment to cleaning up Iowa's streams. Currently, programs aimed at reducing agricultural nutrient loading are entirely voluntary and educational in nature and are generally underfunded. Regardless, curbing "particularly risky practices such as planting crops right up to stream banks or allowing livestock unmanaged access to streams" are detrimental to watershed health and need to be remedied. The paper also recommends reducing soil loss, better management of fertilizer and manure applications, and increased nutrient uptake through the use of constructed wetlands, filter strips, and riparian areas (Cox, 2012).

Summarizing agricultural land across the watershed can be difficult because not only do crops change from year to year on some fields, but each farm has unique agricultural practices and equipment at their disposal. The United States Department of Agriculture's (USDA's) National Agricultural Statistics Service produces a yearly, crop-specific inventory of land across the United States based on satellite imagery and the spectral signatures of various land cover types. The 2009 Iowa Cropland Data Layer was used as a snapshot of cropland for the watershed (Table 18; Figure 43). In 2009, pasture/hay was the single largest agricultural cover type at 14,211.3 acres, or 64.3% of the watershed. Corn (3,591.0 acres; 16.3%) and soybeans (1,872.2 acres; 8.5%), both representing row crops, were the second and third largest shares of agricultural cover types in the watershed with pasture/grass (1,223.6 acres; 5.5%) and alfalfa (749.4 acres; 3.4%) rounding out the predominant types.

Table 18. USDA 2009 Iowa Cropland Data for cropland cover types.

Cropland Type	Acres	Percent of Total Cropland
Corn	3,591.0	16.3%
Soybeans	1,872.2	8.5%
Spring Wheat	0.8	0.0%
Winter Wheat	6.2	0.0%
Oats	199.9	0.9%
Alfalfa	749.4	3.4%
Other Hays	230.9	1.0%
Dry Beans	0.8	0.0%
Potatoes	1.5	0.0%
Pasture/Grass	1,223.6	5.5%
NLCD - Pasture/Hay	14,211.3	64.3%
Total Cropland	**22,087.6**	**100.0%**

Photos: Examples of terrace farming (far left, top), no-till farming (far left, bottom), and contour cropping (below) within Catfish Creek watershed.

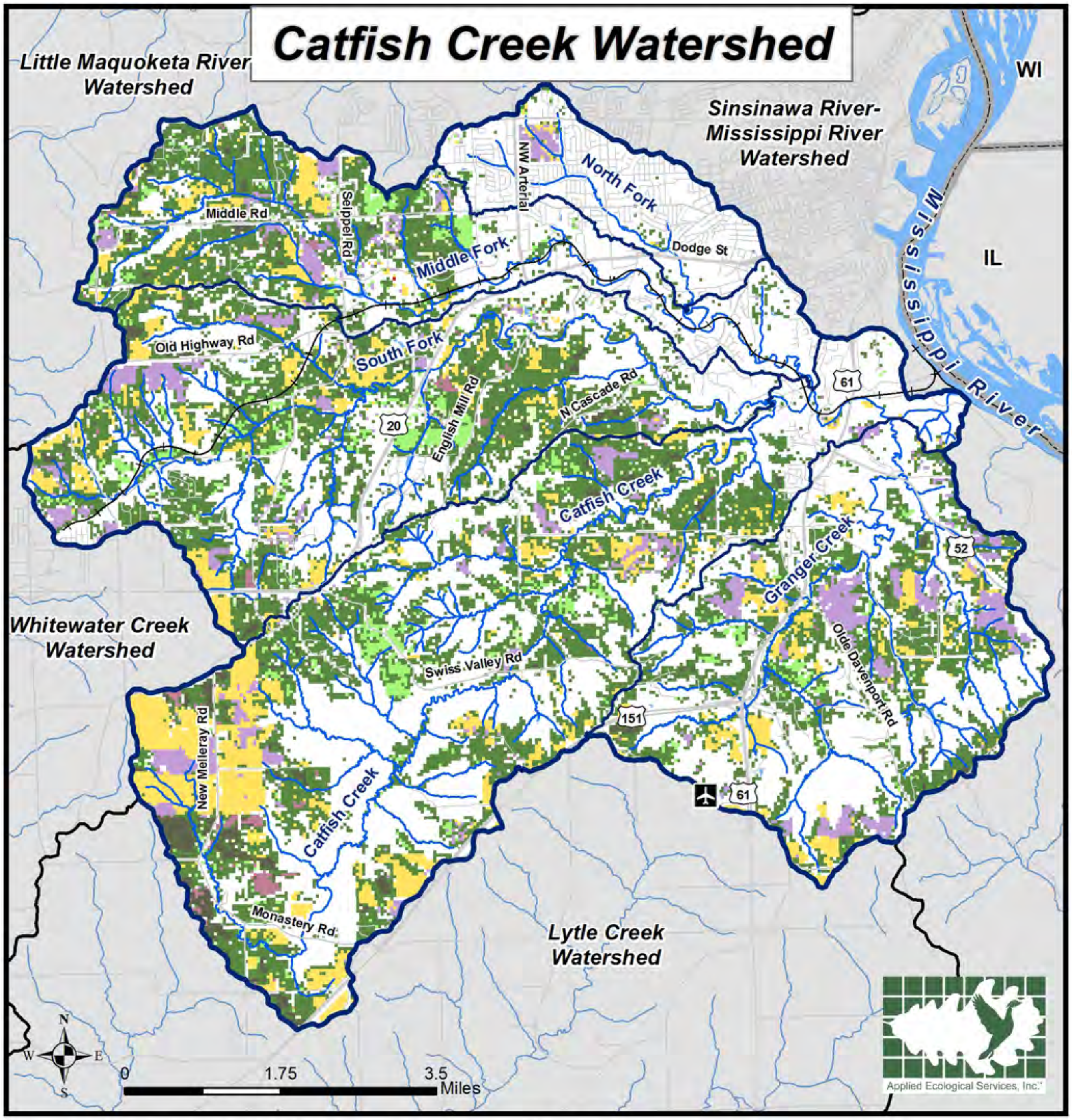
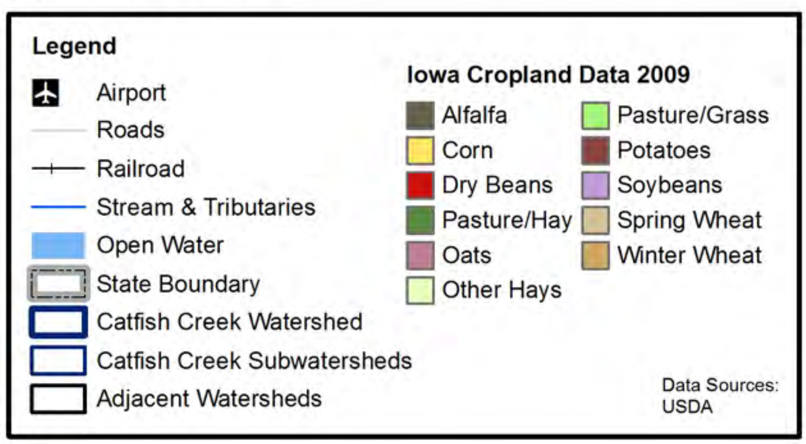


Figure 43: 2009 Iowa Cropland Data



In summer 2013, Applied Ecological Services, Inc. (AES) completed a windshield survey of agricultural land within Catfish Creek watershed. This included map notations of existing conservation practices (such as terrace farming, vegetated swales, contour cropping, no-till farming, etc.) as well as general agricultural land cover types (such as row crop, hay, or pasture). Areas where additional conservation practices could be implemented were also noted. Once back in the office, the map notations were then aligned with available parcel data through GIS. In total, 84 agricultural parcels were later identified that needed some type of additional conservation practices. Results of the agricultural land inventory can be found in Appendix B.

Many agricultural parcels within the watershed are already utilizing appropriate conservation practices, including terrace farming, contour cropping, vegetated swales, and

Swales or other in-field practices needed in agricultural land northwest of Military Rd and Key West Dr

Swales or other in-field practices needed in agricultural land near intersection of Cottingham and Cascade Roads no-till farming, in order to reduce nutrient and sediment loading to streams. Most farmers understand the inherent value in reducing soil and nutrient losses on their farms and consider it good business practice to do so. For those parcels where conservation practices appeared to be lacking, potential recommendations were noted. These recommendations most commonly included the need for additional in-field vegetated swales or other targeted agricultural best management practices (Figure 44). Thirty-nine (39) parcels (46%) were identified as needing vegetated swales or a combination of vegetated swales and additional conservation practices such as contour cropping or no-till farming.

The watershed also includes a number of dairy and other livestock operations. In some cases it was apparent that livestock were allowed free access to streams and streambanks and instances of heavily eroded and muddy banks were not uncommon in these areas. Unmanaged cattle access to streams can lead to large increases in total kjeldahl nitrogen, total phosphorus, ammonium, total suspended solids, turbidity, and *E. coli.* over summer and fall months (Vidon, 2008). Forty-two (42) parcels (50%) were identified in which cattle access management was necessary and approximately half of those parcels will also benefit from some level of streambank stabilization as well.

In addition, 2 parcels were identified as priority protection areas in the northern, urbanized portion of the watershed and 1 parcel could benefit from the addition of both vegetated swales and cattle access restrictions.

Management of livestock access to streams needed off of Oakland Farms Rd (top), Lake Eleanor Rd (middle), and along Catfish Creek along Reach 12 (bottom).

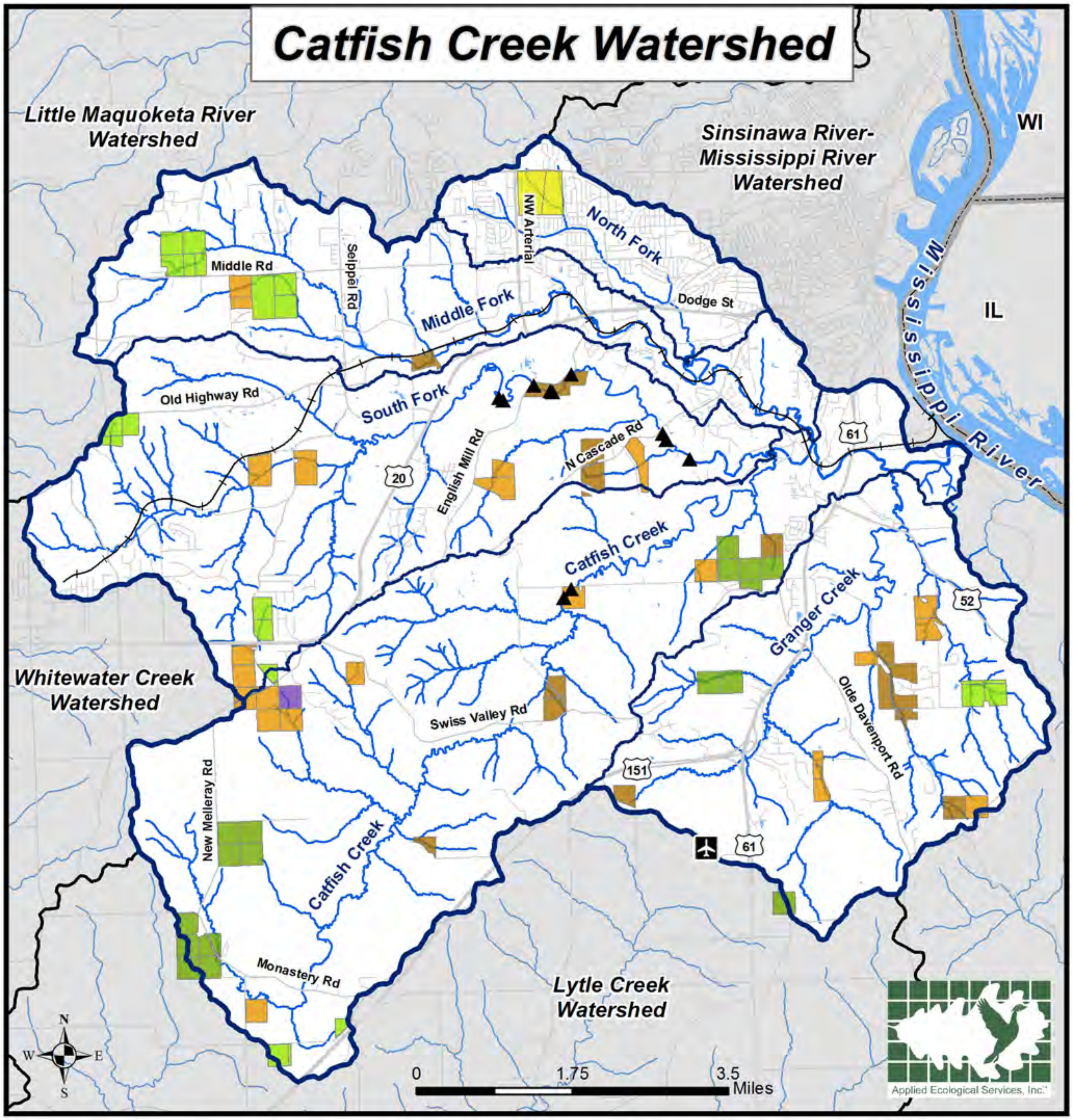


Figure 44: Agricultural Management Practice Conditions

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Conditions by type

- Needs Vegetated Swales
- Needs Swales and Other BMP
- Needs Swales and Restrict Cattle Access
- Priority Protection Area
- Restrict Cattle Access
- Restrict Cattle Access and Stabilize Streams
- Animal Crossing

3.13.4 Wetlands & Potential Wetland Restoration Sites

A diverse network of wetlands remained intact in Catfish Creek watershed until European settlers began to alter significant portions of the watershed's natural hydrology and wetland processes. Where it was feasible, sedge meadow, wet prairie, and marsh communities commonly found in floodplain areas were drained, streams channelized, and existing vegetation cleared to farm the rich soils. There were approximately 4,784 acres of wetlands in the watershed prior to European settlement based on the most up to date hydric soils mapping provided by the USDA Natural Resources Conservation Service (NRCS). According to existing wetland inventories, about 99 acres or 2% of the pre-European settlement wetlands remain (Figure 45).

Functional wetlands do more for water quality improvement and flood reduction than any other natural resource. In addition, intact wetlands typically provide habitat for a wide variety of plant and animal species. They also provide groundwater recharge, filter sediments and nutrients, and slowly discharge to streams thereby maintaining water levels in streams during drought periods. General wetland information and mapping is available for Catfish Creek watershed via the United States Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI).

Little data exists about the quality of existing wetlands within the watershed. According to what data is available and data collected during the field inventory, most existing wetlands are of low quality and typically dominated by invasive or opportunistic plants.

Floodplain wetland adjacent to Catfish Creek within Swiss Valley Nature Preserve.

Wetland Protection

Wetlands connected to "Waters of the United States" are protected in Dubuque County by the U.S. Army Corps of Engineers (USACE) - Rock Island District via section 404 of the Clean Water Act. The USACE will generally require an Individual Permit (IP) for modifications to high quality wetlands although most high quality wetlands are generally considered unmitigatable. In rare cases where mitigation is allowed, as much as a 5:1 mitigation ratio is required. Additionally, high quality wetlands located within developed areas require a 100-foot buffer to aid in protection. Mitigation for impacts to low quality wetlands is set at a 1.5:1 ratio.

The USACE does not have jurisdiction over "Isolated Wetlands". Counties and municipalities have jurisdiction over isolated wetlands via countywide ordinances. However, these ordinances do not prevent the net loss of isolated wetlands. It is recommended that local Municipalities and Counties pass local ordinances to protect isolated wetlands.

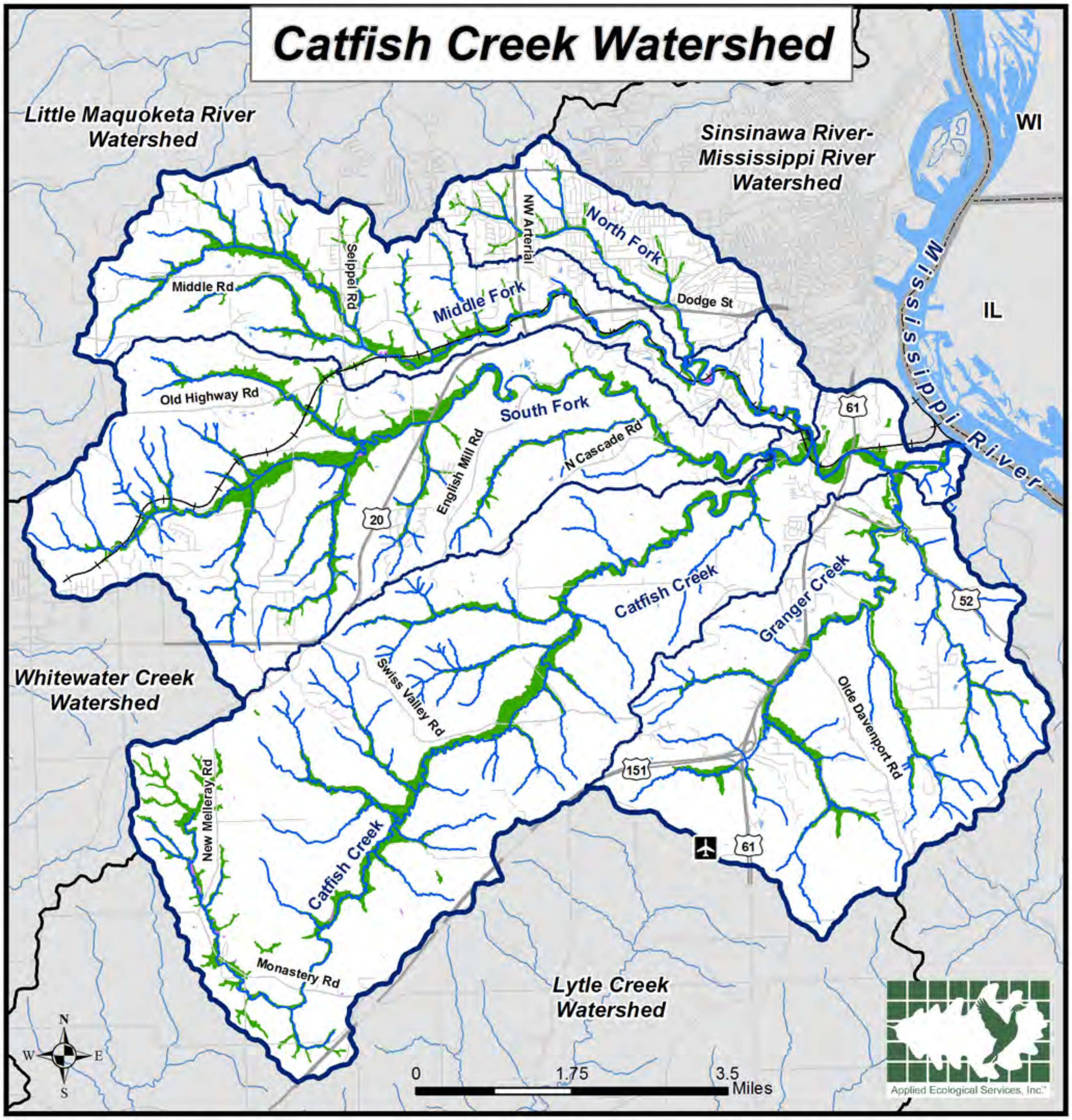


Figure 45: Pre-European Wetlands & Existing Wetlands

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds
- Existing Wetlands
- Pre-European Wetland/Hydric Soil

Data Sources:
National Wetlands Inventory
IDNR

Potential Wetland Restoration Sites

Wetland restoration projects are among the most beneficial in the context of improving watershed health. Wetlands are vitally important because they improve basic environmental functions such as storing floodwaters, increasing biodiversity, creating green infrastructure, and improving water quality. The wetland restoration process involves returning hydrology (water) and vegetation to soils that once supported wetlands but no longer do because of human impacts such as tile and ditch draining and/or filling. Potential wetland restoration sites were identified using a Geographic Information Systems (GIS) exercise whereby sites were selected that include at least 2 acres of drained hydric soils located on an open or partially open parcel where no wetlands currently exist.

The GIS exercise resulted in 56 potential wetland restoration sites. These sites were chosen based on size, location, and existing condition. A careful review of hydric and potentially hydric soil locations against 2011 aerial photography, floodplain, open space inventory results, existing land use, and level of site disturbance was completed. Of the 4,784 acres of pre-European settlement wetlands, approximately 470 acres were determined to be potentially feasible wetland restoration sites (Table 19; Figure 46). Most of the potentially feasible sites are located on large blocks of undeveloped land such as agricultural fields or pasture land and were often found within the floodplain. Where agriculture dominates the floodplain, agricultural production is jeopardized by potential flooding and the land is not being used effectively for floodplain storage during heavy rain events. When these areas are restored as wetlands, they serve to improve water quality, flood storage, and habitat. Most of the sites that were eliminated were found in areas where either the existing conditions were generally undisturbed woodland or the proximity of existing development simply would not allow for wetland restoration. It is important to note that a feasibility study beyond the scope of this project will need to be completed prior to the planning and implementation of any potential wetland restoration.

Wetland restoration recommendations are included and prioritized in the Action Plan section of this report. Municipalities should strongly consider requiring "Conservation Design" that incorporates wetland restoration on parcels slated for future development. Another potential option is to restore wetlands as part of a wetland mitigation bank. In this case, wetlands are restored on private land and must meet certain performance criteria before they become "fully certified". Following certification, developers are able to buy wetland mitigation credits from the wetland bank for wetland impacts occurring elsewhere in the watershed. A fully certified acre of restored wetland can sell between $40 and $100 thousand dollars. Although this may seem like an enormous expense to a developer, it is often cheaper than going through a long permitting process to impact wetlands and provide mitigation on the development site. Typically, larger sites have greater potential for wetland mitigation. Within Catfish Creek, there are eight sites that are at least 18 acres in size - these would be the most appropriate sites on which to research mitigation banking possibilities.

Table 19. AES ID number, size, and existing condition of potential wetland restoration sites.

AES ID#	Acres	Existing Condition/Location
W01	4.9	Located on private agricultural land south of Meadows Golf Club between Middle Fork and MFT03
W02	9.2	Located on private agricultural land north of Middle Rd and just south of Middle Fork and Meadows Golf Club
W03	13.2	Located on private agricultural land north of Sand Wedge Ct and south of Middle Fork
W04	6.5	Located on private agricultural land south of Meadows Golf Club, between Middle Fork and Torrey Pines Dr
W05	3.9	Located on private agricultural land south of Spyglass Dr and north of Middle Fork
W06	5.0	Located on private agricultural land south of Whistle Wind Ln and west of Seippel Rd along the east bank of MFT08A
W07	5.8	Located on private agricultural land south of Hormel Foods and the railroad tracks and north of Middle Fork Reach 5
W08	10.2	Located on private agricultural land between Old Highway Rd and Middle Fork Reach 6
W09	4.2	Located on private agricultural land south of the railroad tracks and north of Middle Fork Reach 6
W10	3.7	Located on private agricultural land south of AY Mcdonald Manufacturing and the railroad tracks and north of Middle Fork Reach 7
W11	5.3	Located on private agricultural land east of Kelly Ln and Rockdale Methodist Cemetary, between the railroad tracks and the last reach of Middle Fork
W12	24.0	Located on private agricultural land north of Chesterman Rd between South Fork Reach 2 and SFFB01
W13	18.8	Located on private agricultural land north of Chesterman Rd, west of Cottingham Rd and south of South Fork Reach 3
W14	5.8	Located on private agricultural land north of South Fork Reach 3 and south of Mc Clain Ln
W15	19.8	Located on private agricultural land north of Chesterman Rd, west of Cottingham Rd and south of South Fork Reach 3
W16	2.6	Located on private agricultural land north of South Fork Reach 3 and south of Mc Clain Ln immediately west of Cottingham Rd
W17	25.7	Located on private agricultural land south and east of Cottingham Rd near Doreen Ln
W18	20.9	Located on private agricultural land south and east of Cottingham Rd adjacent South Fork Reach 4
W19	7.5	Located on private agricultural land along norht bank of SFT13 just west of Cottingham Rd
W20	4.7	Located on private agricultural land along norht bank of SFT13 just east of Cottingham Rd
W21	14.5	Located on private agricultural land immediately west of Route 20 and east of Cousins Rd between Seippel Rd and South Fork Reach 5
W22	5.5	Located on private agricultural land immediately east of Route 20 along the north end of SFT14
W23	18.9	Located on private agricultural land immediately east of Route 20 and west of the upstream end of South Fork Reach 6
W24	5.9	Located on private agricultural land southeast of the Menards on Route 20 and along the east bank of South Fork Reach 6
W25	6.2	Located on private agricultural land adjacent South Fork Reach Reach 6 southwest of River City Stone quarry
W26	7.8	Located on private agricultural land east of Nightengale Ln and north of South Fork Reach 7
W27	2.5	Located on private agricultural land east of South Fork Reach 8 between Cascade and Miners Rds
W28	6.8	Located on private agricultural land north of South Fork Reach 9 immediately south of Richards Rd
W29	4.3	Located on private agricultural land adjacent existing wetlands northwest of Monastery and New Melleray Rds along Catfish Creek Reach 1
W30	3.1	Located just east of the junction of Monastery and New Melleray Rds along the east bank of Catfish Creek Reach 2 on private agricultural land
W31	6.7	Located on private agricultural land south of Catfish Creek Reach 2 and east of Mc Andrews Rd

AES ID#	Acres	Existing Condition/Location
W32	5.4	Located on private agricultural land south of Prairie Creek Rd along both banks of Catfish Creek Tributary 3
W33	29.0	Located on private agricultural land just north of Swiss Valley Nature Preserve along west bank of Catfish Creek Reach 9
W34	10.9	Located on private agricultural land along Catfish Creek Reach 10 immediately east of its junction with CCT14
W35	5.8	Located on private agricultural land along Catfish Creek Reach 10 just south of and east of its junction with CCT15
W36	4.5	Located on private agricultural land along north bank of CCT16 west of Whitetop Rd
W37	9.1	Located on private agricultural land along west bank of Catfish Creek Reach 12 south of Oakland Farms Rd
W38	9.4	Located on private agricultural land along west bank of Catfish Creek Reach 13 immediately north of Oakland Farms Rd
W39	4.9	Located on private agricultural land along west bank of Catfish Creek Reach 13 north of Perry Construction
W40	3.6	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13
W41	2.6	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13
W42	2.0	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13
W43	8.2	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13
W44	3.7	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13
W45	12.6	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13
W46	9.0	Located on private agricultural land between Catfish Creek Reach 16 and the railroad tracks
W47	15.8	Located on private agricultural land between Catfish Creek Reach 16 and Route 61/52
W48	8.5	Located on private agricultural land along both banks of Granger Creek Tributary 4A east of Route 61
W49	5.7	Located on private agricultural land between GCT02 and GCT03 west of the bend in Hidden Valley Rd
W50	18.5	Located on private agricultural land north of Granger Creek Reach 2 and west of GCT03
W51	2.6	Located on private agricultural land east of Granger Creek Reach 3 and Route 61
W52	3.5	Located on private agricultural land northwest of Tamarack business park and north of Granger Creek Tributary 5
W53	2.2	Located on private agricultural land just north of Tamarack business park and north of Granger Creek Tributary 5
W54	2.9	Located on private agricultural land south of the junction of Route 61 and Olde Davenport Rd
W55	3.6	Located on private agricultural land along north bank of Granger Creek Reach 4 near the Dubuque Techonology Park
W56	2.2	Located on private agricultural land along south bank of Granger Creek Reach 5 north and east of Lake Eleanor Rd

Note: A feasibility study will need to be completed prior to the planning and restoration of any potential wetland restoration.

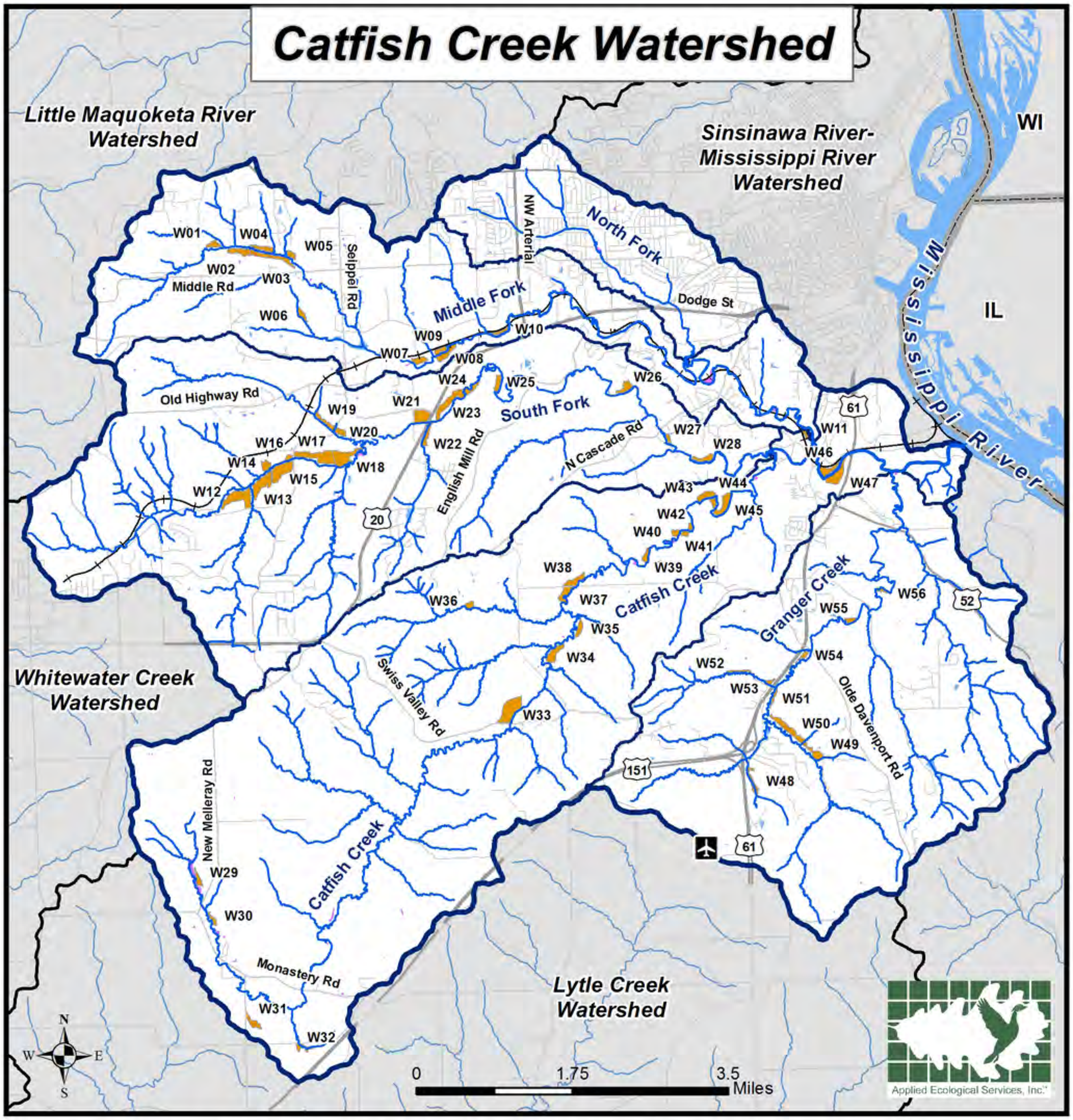


Figure 46: Potential Wetland Restoration Sites

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds
- Existing Wetlands
- Potential Wetland Restoration Site

Data Sources:
National Wetlands Inventory

3.13.5 Floodplain & Flood Problem Areas

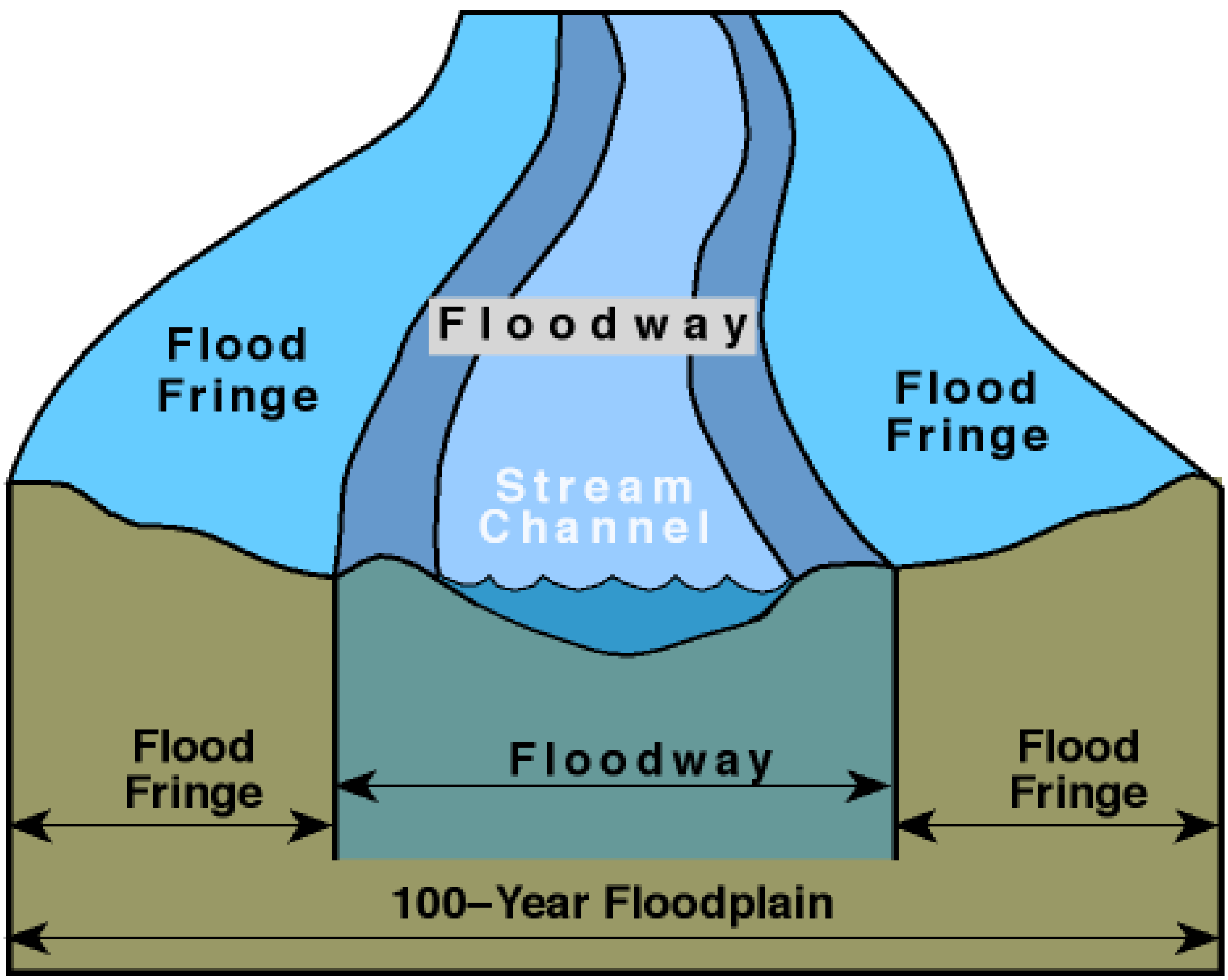
FEMA 100-Year Floodplain

Functional floodplains along stream and river corridors perform a variety of green infrastructure benefits such as flood storage, water quality improvement, passive recreation, and wildlife habitat. The most important function however is the capacity of the floodplain to hold water following significant rain events to minimize flooding downstream. The 100-year floodplain is defined by the Federal Emergency Management Agency (FEMA) as the area that would be inundated during a flood event that has a one percent chance of occurring in any given year (100-year flood). 100-year floods can and do occur more frequently, however the 100-year flood has become the accepted national standard for floodplain regulatory and flood insurance purposes and was developed in part to guide floodplain development to lessen the damaging effects of floods.

The 100-year floodplain also includes the floodway. The floodway is the portion of the stream or river channel that comprises the adjacent land areas that must be reserved to discharge the 100-year flood without increasing the water surface. Figure 47 depicts the 100-year floodplain and floodway in relation to a hypothetical stream channel.

As expected the mapped floodplain in the watershed closely follows Catfish Creek and its tributaries. Figure 48 depicts the 100-year floodplain which occupies 2,601 acres or about 6% of the watershed. The most extensive floodplain areas are associated with the lower reaches of Catfish Creek near Mines of Spain, reaches of Catfish Creek adjacent to the Swiss Valley Campground, and sections of South Fork near Route 20.

Figure 47. 100-year floodplain and floodway depiction.



Documented Flood Problem Areas

For this report, a Flood Problem Area (FPA) is defined as a location where documented flooding can or does cause structural damage or other problems such as flooding roads. Information about the location and condition of documented FPAs was obtained during the Catfish Creek watershed stakeholder meeting held at the Dubuque Low Impact Development Conference in March of 2014. Five documented FPAs were identified in Catfish Creek watershed (Figure 48). Information about each FPA is included in Table 20.

All five of the flood problem areas that were documented within Catfish Creek watershed appear to be the result of roadway elevations being located within the floodplain. Potential mitigation measures include elevating roadways, resizing culverts, and creating potential flood storage projects upstream of problem areas.

Table 20. Documented Flood Problem Areas.

Flood Problem Area #	Type of Flooding	Location/Description	Potential Mitigation Measures
1	Overbank-Roads	Middle Rd near Jonquil Terrace	Raise elevation of Middle Rd and/or increase culvert size where road crosses Middle Fork
2	Overbank-Roads	Cottingham Rd at South Fork Reach 3	Raise elevation of Cottingham Rd and/or increase culvert size where road crosses South Fork
3	Overbank-Roads	Cottingham Rd at South Fork Tributary 13	Raise elevation of Cottingham Rd and/or increase culvert size where road crosses South Fork Tributary 13
4	Overbank-Roads	Cascade Rd at South Fork Reach 8	Raise the elevation of Cascade Rd and/or increase culvert size where South Fork passes under Cascade Rd
5	Overbank-Roads	Swiss Valley Campground Road at Catfish Creek Reach 9	Raise the elevation of the campground road and install sufficiently sized culvert where Catfish Creek crosses the road

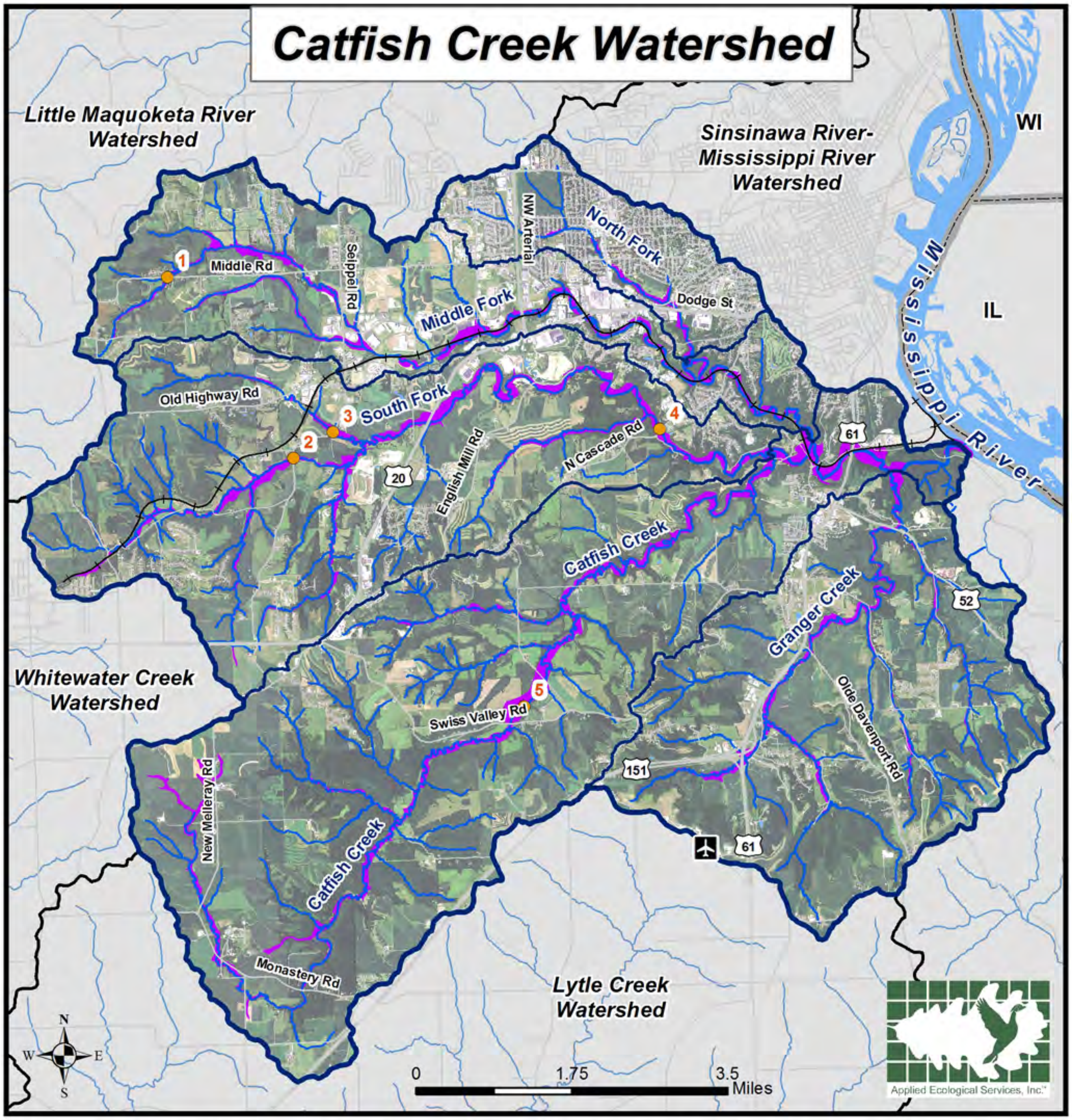


Figure 48: FEMA 100-Year Floodplain & Flood Problem Areas

Legend

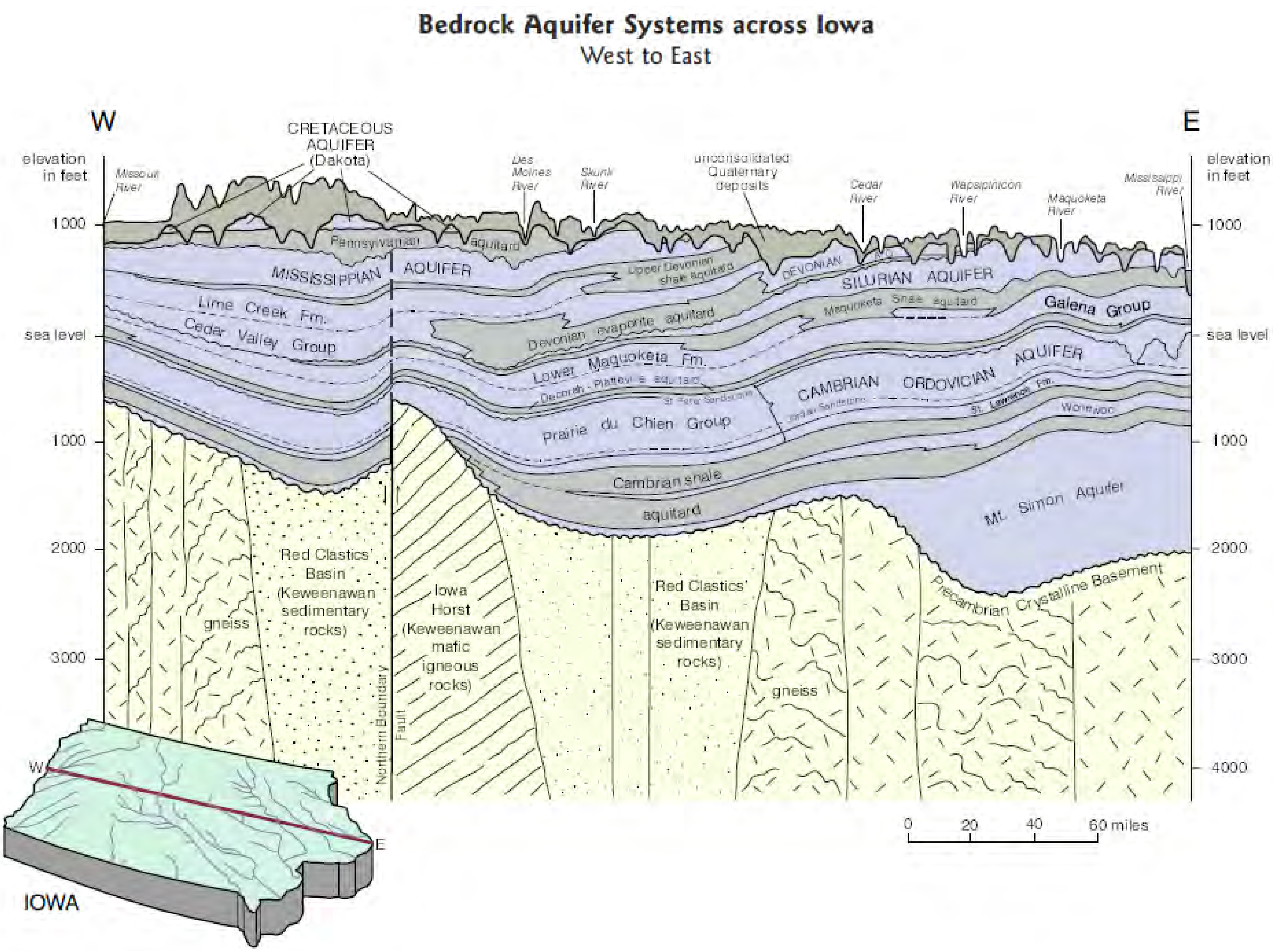
- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds
- Documented Flood Problem Areas
- FEMA 100-Year Floodplain

Data Sources:
NAIP 2011

3.14 Groundwater & Community Water Supply

Groundwater Aquifers
Groundwater is water that saturates small spaces between sand, gravel, silt, clay particles, or crevices in underground rocks. Groundwater is found in aquifers underground or layers of water-bearing bedrock, glacial material, or buried sediments that provide readily available quantities of water to wells, springs, or streams. Groundwater sources available within the watershed are found in various hydrogeologic units (Figure 49) including Cambrian-Ordovician, Ordovician, and Silurian. Dominant geologic materials found within these units consist of sandstone and dolomite within the Cambrian-Ordovician unit; dolomite, limestone, and sandstone within the Ordovician unit; and dolomite within the Silurian unit (Prior, 2003). These bedrock aquifers are tapped and used by residences, farms, or entire communities.

Figure 49. Bedrock aquifer systems across Iowa – West to East. Source: Prior, 2003.

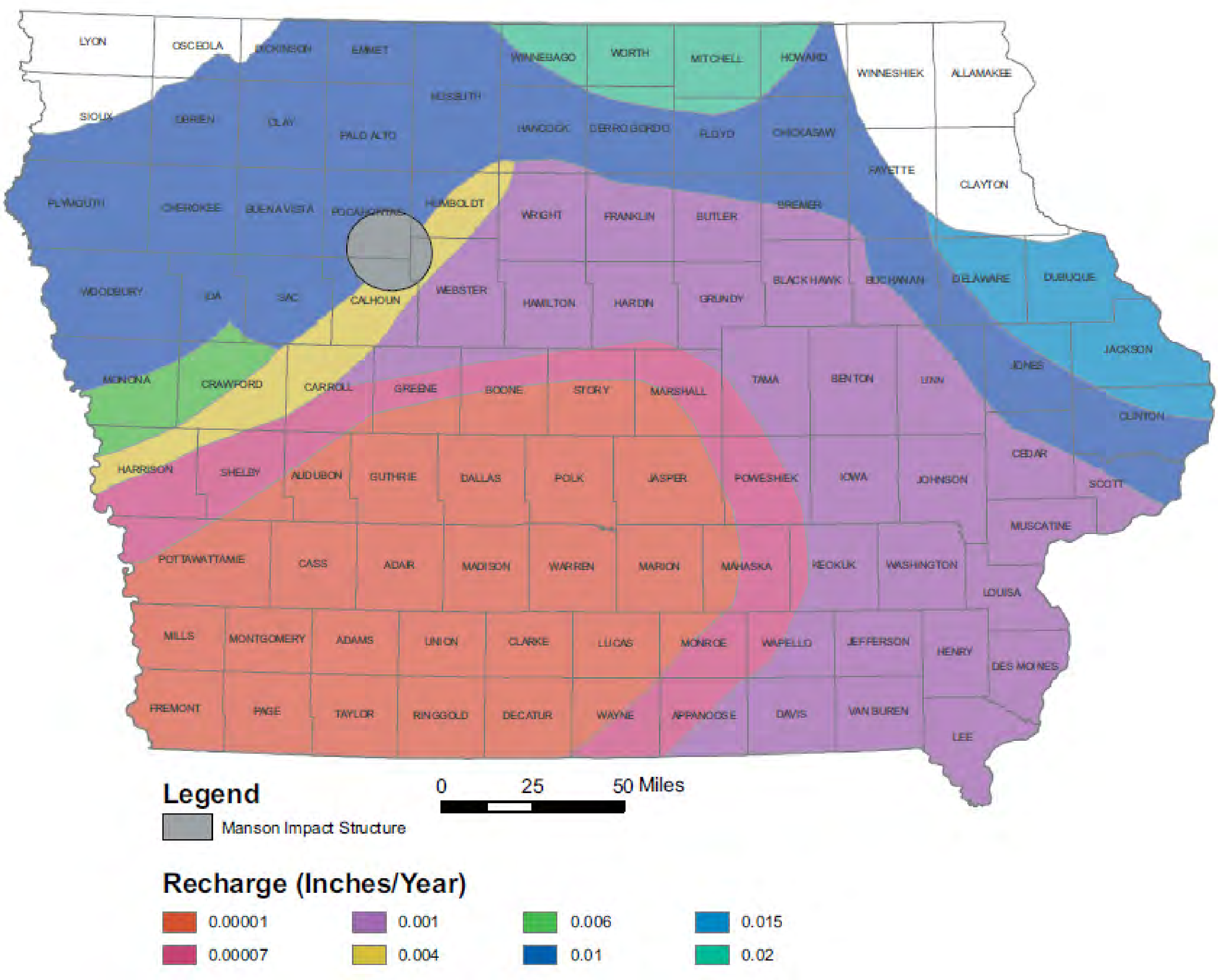


Cambrian-Ordovician Recharge and Drawdown

While the Cambrian-Ordovician aquifer is not the only aquifer relied on for groundwater usage within the watershed, it is by far the most prevalent. The Iowa Department of Natural Resources through the Iowa Geological and Water Survey conducted a study modeling groundwater availability of the Cambrian-Ordovician aquifer within Iowa in 2009.

As part of the study, calibrated recharge distribution was calculated based on historic water levels across sample wells. Groundwater aquifer recharge is the process by which precipitation reaches and re-supplies the groundwater aquifers. The model suggests that the Cambrian-Ordovician aquifer in the area of Catfish Creek watershed generally has a better recharge rate than much of the rest of the state (Figure 50). This is mostly due to thinner or more pervious confining beds comprising the upper

Figure 50. Net recharge or leakage into the Cambrian-Ordovician aquifer. Source: Gannon, 2009.

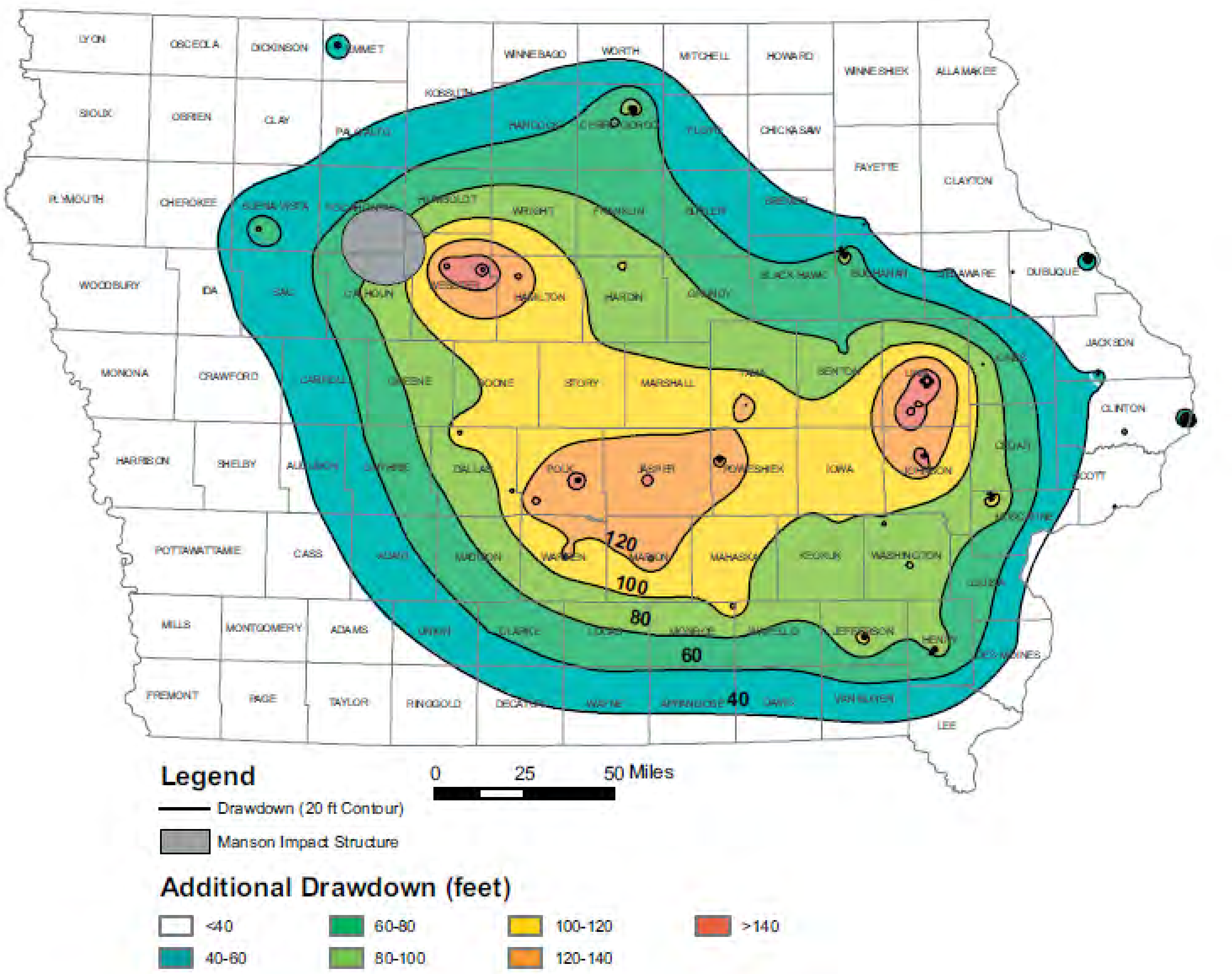


most bedrock surface within the watershed (Gannon, 2009).

The study also went on to model how future water use might affect groundwater availability across the aquifer utilizing several scenarios, including low, medium, and high water usage rates. Figure 51 depicts the simulated additional drawdown that can be expected between 2009 and 2029 based on medium future water-use.

While the area surrounding Catfish Creek watershed does not seem to be facing immediate danger of water shortage, enhanced groundwater infiltration and reductions in the amount of impervious surfaces play important roles in protecting groundwater resources in the future.

Figure 51. Predicted (simulated) additional drawdown of the Cambrian-Ordovician aquifer in feet from 2009 to 2029 for medium future water use (50% growth in pumping rates). Source: Gannon, 2009.



Community Water Supply
Groundwater is an essential resource within Catfish Creek watershed as underlying aquifers provide the drinking water supply for many people. The City of Dubuque's drinking water supply comes predominantly from wells located outside of the watershed. Regardless, a total of 34 public water supply wells, including one for the City of Asbury, are located within Catfish Creek watershed (Table 21; Figure 53).

Table 21. Public water supply (PWS) wells within Catfish Creek watershed.

PWS ID	PWS Name	Pop. Served	Aquifer	Susceptibility Ranking
3100600	Table Mound Park	600	Cambrian-Ordovician	Susceptible
3100608	Lost Canyon Mobile Home Park	97	Ordovician	Low Susceptibility
3100629	Ace Mobile Home Park	60	Ordovician	Susceptible
3100675	Broadview Trailer Court	54	Ordovician	Low Susceptibility
3100724	Elk Lodge #297	60	Ordovician (abv St. Peter)	Low Susceptibility
3100899	Corporation of New Melleray	192	Cambrian-Ordovician	Low Susceptibility
3102001	Asbury	2200	Cambrian-Ordovician	Low Susceptibility
3122301	Country Hills Water Corporation	41	Ordovician	Low Susceptibility
3126013	Dubuque Regional Airport	420	Ordovician	Low Susceptibility
3126301	Barrington Lakes Water Commission	333	Ordovician (abv St. Peter)	Slightly Susceptible
3126302	Twin Ridge Corporation	130	Ordovician (abv St. Peter)	Susceptible
3126304	Hickory Acres	114	Cambrian-Ordovician	Low Susceptibility
3126306	Lore Oaks Homeowners Association	71	Cambrian-Ordovician	Susceptible
3126308	Regency West Subdivision	46	Cambrian-Ordovician	Slightly Susceptible
3126315	Vernon Water Company	25	Cambrian-Ordovician	Low Susceptibility
3126345	Shagbark Estates	38	Cambrian-Ordovician	Slightly Susceptible
3126594	Saint Joseph's School & Parish	225	Ordovician (abv St. Peter)	Low Susceptibility
3126603	Super 20 Mobile Home Park	238	Ordovician	Low Susceptibility
3126887	Sun Down Ski Resort	685	Ordovician (abv St. Peter)	Low Susceptibility
3170301	Briarwood Estates	60	Ordovician (abv St. Peter)	Low Susceptibility
3170302	Burds Green Acres Subdivision	300	Ordovician (abv St. Peter)	Low Susceptibility
3170303	Thunder Ridge Estates	50	Cambrian-Ordovician	Low Susceptibility
3170335	Thunder Hills Home & Utility Association	300	Ordovician	Low Susceptibility
3126211	Budde's	75	Ordovician	Highly Susceptible
3126401	Mines Of Spain - Eb Lyons Nature Center	35	Ordovician	Highly Susceptible
3100648	Riley Development	30	Ordovician	Susceptible
3126203	Rhodys	35	Ordovician	Highly Susceptible
3126205	Ioco Truck Stop	912	Ordovician	Low Susceptibility
3126208	Dubuque Sports Complex	400	Ordovician	Highly Susceptible
3126209	Truck Country of Iowa	55	Ordovician (abv St. Peter)	Susceptible
3126941	Swiss Valley Nature Center	363	Silurian	Highly Susceptible
3126942	Swiss Valley Park	183	Ordovician (abv St. Peter)	Susceptible
3151201	Airline Inn	53	Ordovician (abv St. Peter)	Highly Susceptible
3126410	Hoot Owl Hollow Campground	25	Ordovician	Highly Susceptible

Groundwater Susceptibility Rating

The Iowa Geological Survey and Iowa Department of Natural Resources delineated source water protection areas for each groundwater-based public water supply system. In order to accomplish this they utilized geologic and hydrogeological information to determine capture zones where the data was available; in other cases, fixed radii were used to determine capture zones. Once the capture zones were delineated, a rating of how susceptible each is to contamination from surface sources was determined based on the thickness of the confining layer above the aquifer (IDNR, 2006).

Capture zones and their susceptibility rating are depicted in Table 21 and Figure 52. Approximately 20.5%, or 7 of the 34 source water protection areas within the watershed, were rated as being Highly Susceptible to contamination. For each of these areas, the confining layer above the aquifer was less than 25 feet thick. These areas are spread across the center of the watershed. Another 20.5% (7 source water protection areas) were shown to be Susceptible, with confining layers between 25 and 50 feet thick and were similarly distributed across the watershed. Three of the capture zones (9%) had confining bedrock thicknesses between 50 and 100 feet thick, rating as Slightly Susceptible. The remaining 50% of source water protection areas (17) were rated as having Low Susceptibility with confining bedrock thicknesses greater than 100 feet and generally include the western and southern portions of the watershed.

Susceptible and highly susceptible groundwater capture zones were used to help prioritize parcels within the Green Infrastructure Network (Section 3.11).

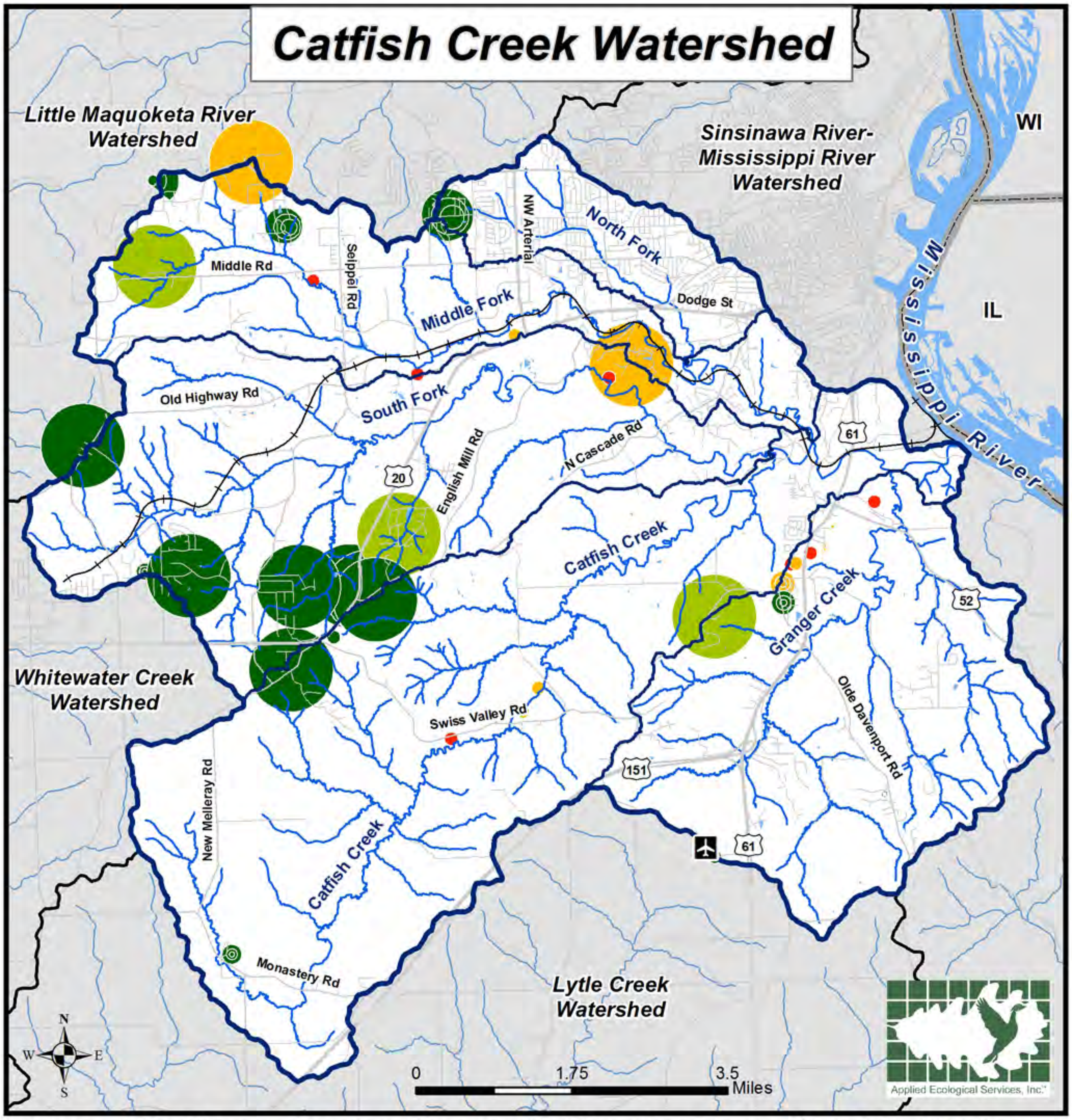
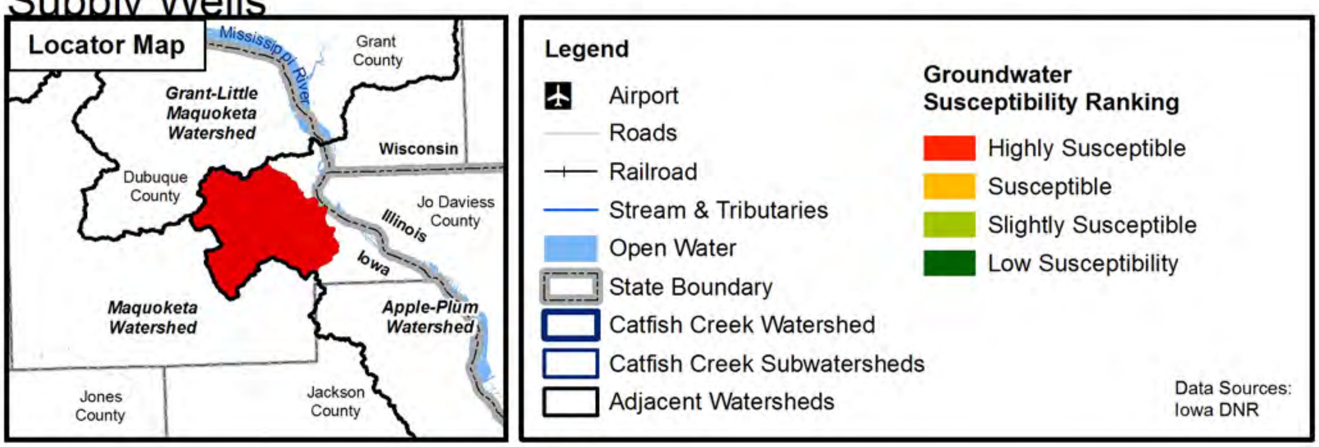


Figure 52: Groundwater Susceptibility Ranking of Public Water Supply Wells



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4.0 Water Quality Assessment & Pollutant Loading Analysis

4.0 Water Quality Assessment & Pollutant Loading Analysis

Catfish Creek is comprised of five branches and numerous smaller tributaries. The main branches alone – Catfish Creek, South Fork, Middle Fork, North Fork, and Granger Creek, account for 63.7 linear miles in length while the tributaries account for another 131.9 linear miles. Generally speaking, the major branches flow roughly southwest to northeast and South Fork, Middle Fork, North Fork, and Granger Creek all join Catfish Creek before it enters the Mississippi River.

4.1 Point and Nonpoint Source Pollutants

Point Source Pollutants

Water quality can be adversely affected by both point and nonpoint source pollutants. Point sources are identified as any discharge that comes from a pipe or permitted outfall, such as municipal and industrial discharges. Municipal and industrial discharges to Catfish Creek and tributaries are regulated by Iowa's stormwater runoff permits. There is one municipal permit that falls within the watershed for the Dubuque Water Pollution Control Plant, however it discharges directly to the Mississippi River, not Catfish Creek. There is one stormwater for the City of Asbury, as well as several industrial and semi-public permits.

City of Dubuque MS4 Program

A good portion of the Catfish Creek watershed falls within the City of Dubuque and is covered under the City's MS4 (Municipal Separate Storm Sewer Systems) permit. This is an important regulatory requirement. The City's Stormwater Management Plan includes minimum control measures to track and enforce such policies as construction site storm water runoff control, post construction stormwater management, public education, public involvement and participation, illicit discharge detection and elimination, and pollution prevention/good housekeeping.

NPDES Permit Program
Section 402 of the federal Clean Water Act established the National Pollutant Discharge Elimination System. This program regulates point source discharges of pollutants into United States waters and sets specific limits on discharges from point sources, establishes monitoring and reporting requirements, and establishes exceptions. The permitting program is designed to prevent storm water runoff from washing harmful pollutants into local surface waters such as streams, rivers, lakes or coastal waters. It also allows for the USEPA to authorize states to assume many of the permitting, administrative and enforcement responsibilities of the program (EPA, 2012).

The Iowa Department of Natural Resources (IDNR) regulates point source discharges, such as wastewater and stormwater discharges, to streams and lakes by setting effluent limits, and monitoring/reporting on results. IDNR has overseen the National Pollutant Discharge Elimination System (NPDES) program since 1978. The NPDES program was initiated under the federal Clean Water Act to reduce pollutants to the nation's waters. This program requires permits for discharge from publicly owned treatment works (POTWs), discharges from industrial facilities, and discharges of urban runoff.

Under Iowa's NPDES program there are individual and general permits. Individual permits are tailored to a particular facility, while general permits cover multiple facilities that all fall within a specific category, such as ones that have the same type of operation or discharge the same type of waste. All NPDES permits limit the amount of pollutants a facility can discharge into waterways (or set effluent limits), set out monitoring and reporting requirements, identify special conditions such as best management practices (BMPs) or additional monitoring, and lay out standard conditions. Permits are generally set for a five year period, after which the facility must reapply.

NPDES Permit Sites
There are a total of 15 NPDES permit sites within the watershed. One of those is a municipal permit for the Dubuque Waters and Resource Recovery Center, but this POTW discharges directly to the Mississippi River and not to Catfish Creek. The remaining include one stormwater permit for the City of Asbury, five industrial permits, and eight semi-public permits (Table 22).

Table 22. Active NPDES facilities within Catfish Creek watershed.

EPA ID	Facility Name	City Name	Permit Type	Class
0064751	U.S. Army Reserve Center Stp	Dubuque	SEMI-PUBLIC	MINOR
0065994	Dubuque Regional Airport	Dubuque	SEMI-PUBLIC	MINOR
0063991	Hickory Acres	Dubuque	SEMI-PUBLIC	MINOR
0073334	Super 20 Mobile Home Park	Dubuque	SEMI-PUBLIC	MINOR
0061298	Twin Ridge Corp	Dubuque	SEMI-PUBLIC	MINOR
0063827	Lost Canyon Mobile Home Park	Peosta	SEMI-PUBLIC	MINOR
0064009	Verde Water Co.-table Mound #1-well #2	Dubuque	SEMI-PUBLIC	MINOR
0075477	Iowa Dot Maintenance Garage-Dubuque	Dubuque	INDUSTRIAL	MINOR
0044458	Water Pollution Control Plant	Dubuque	MUNICIPAL	MAJOR
0076821	Edwards Cast Stone Company	Dubuque	INDUSTRIAL	MINOR
0001210	BP Products Dubuque Terminal	Peosta	INDUSTRIAL	MINOR
0069540	Arctic Glacier Premium Ice	Dubuque	INDUSTRIAL	MINOR
0063860	A.Y. Mcdonald Mfg. Co.	Dubuque	INDUSTRIAL	MINOR
0074608	The Meadows Of Dubuque Golf Course Stp	Dubuque	SEMI-PUBLIC	MINOR
0078905	Asbury, City Of Ms4	Asbury	STORMWATER	MINOR

Source: Iowa Department of Natural Resources.

Nonpoint Source Pollutants
Nonpoint source pollutants are pollutants that enter a waterway from a source other than a pipe or permitted outfall. Historically these pollutants are the most difficult to control because tracking them back to their source is difficult. Nonpoint source pollutants can include, but are not limited to, illicit discharges into waterways, excess nutrients (such as nitrogen and phosphorus), oils and chemicals washed off of roadways (such as chlorides from deicing agents), and/or excess sediment (from construction or streambank erosion). Most nonpoint source pollutants are monitored through physical-chemical water quality testing.

4.2 Water Quality Report, Designated Use, & Impairments for Catfish Creek

The Federal Clean Water Act requires Iowa and all other states to submit to the United States Environmental Protection Agency (USEPA) a biannual report of the quality of the state's surface and groundwater resources and an updated Section 303 (d) list. *Iowa's 2012 Integrated Report* was compiled by the Iowa Department of Natural Resources (IDNR) and is the most recent of these reports. These reports must also describe how Iowa assessed water quality and whether assessed waters meet or do not meet water quality standards specific to each "Designated Use" of a stream or lake as defined in Iowa Administrative Code 567 Chapter 61. Categorizing water bodies according to what they are used for, such as recreation or supporting aquatic life, helps states determine what level of protection each water body necessitates. When a waterbody is determined through biological and/or physical-chemical sampling to be impaired for its designated use, IDNR must list potential causes and sources for impairment in the 303 (d) impaired waters list.
IDNR utilizes a "presumed" use rule in designating Use Assessment and Attainability. This assumes that primary contact recreational use (Class A1) and an ability to support and maintain a large variety of aquatic life (Class B (WW-1)) are applicable to every stream or river in the state unless water quality assessments demonstrate otherwise. IDNR's full list of water quality standards and use designations is detailed in Table 23.

Iowa also utilizes an anti-degradation policy as a component of protecting waters. This policy is aimed at ensuring that existing uses (Tier 1), high quality waters (Tier 2), and outstanding national resource waters (Tier 3) are prevented from being degraded by identifying them by Tier and then following specific steps to protect them. No waterbodies within Catfish Creek watershed have been classified as outstanding national resource waters.

The overall water quality condition in Catfish Creek watershed is poor. According to IDNR's 2012 Integrated Report, Catfish Creek from the mouth to the confluence with South Fork, Granger Creek, and South Fork are all impaired due for either primary or secondary contact due to the presence of indicator bacteria. An unnamed tributary to Catfish Creek (CCT16)

Table 23. Iowa Department of Natural Resources water quality standards and Use Designations.

Class	Use Designation	Use Description
Class A1	Primary contact recreational use	The water's recreation uses involve full body immersion with prolonged and direct contact with the water, such as swimming and water skiing.
Class A2	Secondary contact recreational use	Water recreation uses involve incidental or accidental contact with the water, where the probability of ingesting water is minimal, such as fishing and shoreline activities.
Class A3	Children's recreational use	Water recreation uses where children's activities are common, like wading or playing in the water. These waters are commonly located in urban or residential areas where the banks are defined and there is visible evidence of flow.
Class B (WW-1)	Warmwater 1	Typically large interior and border rivers and the lower segments of medium-size tributary streams capable of supporting and maintaining a wide variety of aquatic life, including game fish.
Class B (WW-2)	Warmwater 2	Typically smaller, perennially flowing streams capable of supporting and maintaining a resident aquatic community, but lack the flow and habitat necessary to fully support and sustain game fish populations.
Class B (WW-3)	Warmwater 3	Intermittent stream with non-flowing perennial pools capable of supporting and maintaining a resident aquatic community in harsher conditions. These waters lack the flow and habitat necessary to fully support and sustain a game fish population.
Class B (CW-1)	Coldwater 1	Waters in which the temperature and flow are suitable for the maintenance of a variety of cold water species, including reproducing and non-reproducing populations of trout (*Salmonidae* family) and associated aquatic communities.
Class B (CW-2)	Coldwater 2	Waters that include small, channeled streams, headwaters, and spring runs that possess natural cold water attributes of temperature and flow. These waters usually do not support consistent populations of trout (*Salmonidae* family), but may support associated vertebrate and invertebrate organisms.

Source: Iowa Department of Natural Resources.

is impaired for aquatic life due to organic enrichment/low dissolved oxygen. Catfish Creek upstream of the confluence with South Fork, Middle Fork, and North Fork all of have an impairment of a presumptive use (primary contact) due to the presence of indicator bacteria. Table 24 includes a summary of Classes and Designated Use Impairments for Catfish Creek and its tributaries. Additionally, Catfish Creek from the headwaters downstream for 5.3 miles is classified as a Class B (CW-1) coldwater aquatic life use stream because it holds an introduced reproducing trout population. This reach is considered partially supported based on biological monitoring conducted in 2001 and 2007.

Table 24. Designated Use Impairments for Catfish Creek and tributaries.

Waterbody Name	Segment Class	Location Description	Impaired Use	Use Support	Cause/ Stressor	Integrated Report Category
Catfish Creek	Class A1, Class B (WW-1), Class HH	mouth to confluence with South Fork Catfish Cr.	Primary Contact	Not supporting	Indicator Bacteria	5a
Catfish Creek	Class A1, Class B (WW-2)	from S. Fk. Catfish C. to south line of S9 T88N RdE	Primary Contact	Not supporting	Indicator Bacteria	5p
Unnamed tributary to Catfish Creek (CCT16)	General Use	from confluence with unnamed trib in SW ¼, S7, T88N, R02E, Dubuque Co. upstream for 750 feet to the outfall of Super 20 MHP WWTP in SW1/4, S7, T88N, R02E, Dubuque Co.)	Aquatic Life	Not supporting	Organic Enrichment/ Low DO	5a
Granger Creek	Class A1, Class A2, Class B (WW-2)	mouth to county road bridge crossing in S24 T88N R2E	Secondary Contact	Not supporting	Indicator Bacteria	5a
Middle Fork Catfish Creek	Class A1, Class B (WW-2)	mouth to west line of S30 T89N R2E	Primary Contact	Not supporting	Indicator Bacteria	5p
Middle Fork Catfish Creek	Class A1, Class B (WW-1)	from Seippel Rd to headwaters in SW 1/4 S27 T89N R1E	Primary Contact	Not supporting	Indicator Bacteria	5p
North Fork Catfish Creek	Class A1, Class B (WW-2)	mouth to Hwy 20 bridge crossing in S27 T89N R2E	Primary Contact	Not supporting	Indicator Bacteria	5p
North Fork Catfish Creek	Class A1, Class B (WW-1)	from Hwy 20 bridge in Dubuque to headwaters in NW 1/4 S20 T89N R2E	Primary Contact	Not supporting	Indicator Bacteria	5p
South Fork Catfish Creek	Class A1, Class B (WW-2)	mouth to confluence with unnamed tributary in SW 1/4 S3 T88N R1E	Primary Contact	Not supporting	Indicator Bacteria	5a

Source: Iowa's 2012 Integrated Report – Category 5: EPA-approved Section 303(d) impaired waters

4.3 Water Quality Monitoring

In Iowa, chemical, physical and biological water quality sampling is conducted both through statewide sampling as well as Iowa's volunteer monitoring program – IOWATER. None of the statewide Ambient Water Monitoring sites fall within Catfish Creek watershed, but IOWATER volunteer monitoring has been active for many years within the watershed. IOWATER sampling has collected data on transparency, pH, nitrite nitrogen, nitrate nitrogen, dissolved oxygen, phosphate, chloride, water temperature, and benthic macroinvertebrate sampling. While any one sample alone does not necessarily provide an accurate portrayal of water quality for a stream, many samples taken over a period of time can together depict the average water quality of that waterbody (IDNR, 2013).

While many years of IOWATER sampling data is available, this watershed plan utilizes the most recent data collected since 2010 in order to assess the most accurate representation of the current conditions of Catfish Creek and its tributaries. Table 25 lists all known chemical, physical, and biological data sites, dates, and parameters sampled in the watershed from 2010 to early 2013 while Figure 53 displays the location of each sample site where the data was collected. In general, the most recent data is analyzed and averaged so that recommendations and management strategies are based on the most current depiction of the water quality and biological conditions. Additionally, a project summary and locations from a 2014 research project at Loras College was included at the end of the planning process, even though the final report for that project will not be completed until May of 2015. Full sampling data and the report will be available through Loras College at that time.

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Table 25. List of most recent chemical and biological water quality sample sites.

Site ID	Source	Location	Date(s)	Water Quality and other Parameters
CC-E1	IOWATER	Catfish Creek at Swiss Valley campground	6/12/12, 6/27/12, 7/5/12, 8/1/12, 8/8/12,8/14/12, 1/8/13, 4/9/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
CC-E2	IOWATER	Catfish Creek at Creek Wood Rd, just before confluence with South Fork	1/5/2010, 4/20/10, 7/2/10, 10/6/10, 1/4/11, 1/20/11, 4/6/11, 6/14/11, 10/18/11, 1/4/12, 6/12/12, 6/27/12, 7/5/12, 8/1/12, 1/8/13, 2/26/13, 4/9/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
CC-H1	IOWATER	Catfish Creek at Monastery Rd	6/12/12, 6/27/12, 7/5/12, 8/1/12, 1/8/13, 4/9/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
CC-M1	IOWATER	Catfish Creek at Oakland Farms Rd	6/27/12, 1/9/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp.
CC-T1	IOWATER	Catfish Creek at mouth, just upstream of confluence with Mississippi River	6/12/12, 6/27/12, 7/5/12, 8/1/12, 8/17/12, 12/11/12	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
GC-H1	IOWATER	Granger Creek east of junction of Route 61 and 151, at junction of GCT04A and GCT04B	6/13/12, 6/27/12, 7/6/12, 7/30/12, 12/11/12, 1/8/13, 2/26/13, 4/8/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
GC-M1	IOWATER	Granger Creek just northeast and downstream of Lake Eleanor Rd	6/13/12, 6/28/12, 7/6/12, 7/30/12, 8/8/12, 12/11/12, 1/8/13, 2/26/13, 4/8/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
GC-T1	IOWATER	Granger Creek about 1,000 feet north of Route 52	6/13/12, 6/28/12, 7/6/12, 7/30/12, 12/11/12, 1/8/13, 4/8/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
MF-E1	IOWATER	Middle Fork just west of Seippel Rd	1/6/2010, 4/15/10, 7/9/10, 10/4/10, 1/4/11, 1/20/11, 4/6/11, 6/14/11, 8/15/11, 10/18/11, 1/3/12, 6/7/12, 6/19/12, 7/6/12, 7/31/12, 1/8/12, 2/26/13, 4/22/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
MF-E2	IOWATER	Middle Fork at Freemont Rd	1/15/2010, 4/20/10, 7/9/10, 10/5/10, 1/4/11, 1/20/11, 4/6/11, 6/13/11, 10/18/11, 1/4/12, 6/7/12, 6/19/12, 7/6/12, 7/31/12, 8/10/12, 1/9/13, 4/22/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
MF-H1	IOWATER	Middle Fork at Joanquil Terrace and Middle Rd	6/7/12, 6/19/12, 7/6/12, 7/31/12, 1/8/13, 2/26/13, 4/22/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
MF-M1	IOWATER	Middle Fork behind AY Mcdonald Manufacturing	1/6/2010, 4/15/10, 7/9/10, 10/5/10, 1/4/11, 1/20/11, 4/6/11, 6/14/11, 8/16/11, 10/18/11, 1/3/12, 6/19/12, 7/6/12, 7/31/12, 12/14/12, 1/8/13, 4/22/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
MF-T1	IOWATER	Middle Fork at confluence with Catfish Creek, between Southern Ave and Old Mill Rd	6/7/12, 6/19/12, 7/6/12, 7/31/12, 1/9/13, 4/22/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
NF-E1	IOWATER	North Fork at Rosemont St	1/13/2010, 4/15/10, 7/8/10, 10/4/10, 1/20/11, 4/5/11, 6/13/11, 6/21/11, 7/13/11, 10/18/11, 1/4/12, 6/6/12, 6/18/12, 7/6/12, 7/31/12, 1/9/13, 2/26/13, 4/23/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
NF-E2	IOWATER	North Fork just south of Dodge St	1/13/2010, 4/12/10, 7/8/10, 10/4/10, 1/4/11, 1/20/11, 4/5/11, 6/13/11, 7/15/11, 10/18/11, 6/6/12, 6/18/12, 7/6/12, 7/31/12, 1/9/13, 4/23/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
NF-H1	IOWATER	North Fork at Teddy Bear Park off High Cloud Dr	6/6/12, 6/18/12, 7/6/12, 7/31/12, 1/8/13, 4/23/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp.
NF-M1	IOWATER	North Fork northwest of junction of Pennsylvania Ave and John F Kennedy Rd	4/16/10, 7/8/10, 10/4/10, 1/4/11, 1/20/11, 4/5/11, 6/13/11, 6/16/11, 7/13/11, 10/18/11, 1/5/12, 6/6/12, 6/18/12, 7/6/12, 7/31/12, 8/10/12, 1/9/13, 4/23/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
NF-T1	IOWATER	North Fork at Brunskill Rd, just upstream of confluence with Middle Fork	6/6/12, 6/19/12, 7/6/12, 7/31/12, 1/9/13, 4/23/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
SF-E1	IOWATER	South Fork just west of Cottingham Rd	6/11/12, 6/25/12, 7/5/12, 8/1/12, 12/12/12, 1/8/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
SF-E2	IOWATER	South Fork at the Dubuque Sports Complex off Nightengale Ln	6/11/12, 6/25/12, 7/5/12, 8/1/12, 8/8/12, 12/12/12, 1/8/13, 2/26/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
SF-H1	IOWATER	South Fork north of Chesterman Rd before confluence with SFT03	6/11/12, 6/25/12, 7/5/12, 8/1/12, 12/19/12, 1/8/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
SF-M1	IOWATER	South Fork at Cousins Rd, west of Route 20	1/6/2010, 4/20/10, 7/2/10, 10/5/10, 1/4/11, 1/20/11, 4/6/11, 6/14/11, 8/11/11, 10/18/11, 1/3/12, 6/7/12, 6/11/12, 6/25/12, 7/5/12, 8/1/12, 1/8/13	Transparency, pH, NO2, NO3, DO, Phosphate, Chloride, Water Temp., IBI
SF-T1	IOWATER	South Fork off Miller Rd about 1,500 feet from confluence with Catfish Creek	1/5/2010, 4/20/10, 7/2/10, 10/5/10, 1/4/11, 1/20/11, 4/6/11, 6/14/11, 8/16/11, 1/4/12, 6/11/12, 6/25/12, 7/5/12, 8/1/12, 12/12/12, 1/8/13, 2/26/13	*E. coli.*, TN, TP

Site ID	Source	Location	Date(s)	Water Quality and other Parameters
WQ-1	QAPP	Catfish Creek at mouth, just upstream of confluence with Mississippi River	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-2	QAPP	Granger Creek at Route 52, south of road	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-3	QAPP	Granger Creek just northeast and downstream of Lake Eleanor Rd	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10	*E. coli*., TN, TP
WQ-4	QAPP	Granger Creek at Olde Davenport Rd	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-5	QAPP	Catfish Creek at Creek Wood Rd, just before confluence with South Fork	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-6	QAPP	Middle Fork at Freemont Rd	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-7	QAPP	North Fork at Brunskill Rd, just upstream of confluence with Middle Fork	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-8	QAPP	South Fork at confluence with SFT15, northwest of Cascade Rd	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-9	QAPP	North Fork southeast of junction of Pennsylvania Ave and John F Kennedy Rd	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-10	QAPP	South Fork at English Mill Rd	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-11	QAPP	North Fork at Rosemont St	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-12	QAPP	Middle Fork at Radford Rd	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-13	QAPP	Catfish Creek at Oakland Farms Rd	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-14	QAPP	South Fork just west of Route 20	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-15	QAPP	Middle Fork at Middle Rd, east of Whistle Wind Ln	5/12/10, 5/26/10, 6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10, 9/13/10, 9/30/10, 10/27/10	*E. coli*., TN, TP
WQ-16	QAPP	South Fork about 1,800 feet west and upstream of Cousins Rd	6/9/10, 6/24/10, 7/1/10, 7/15/10, 7/26/10, 8/9/10	*E. coli*., TN, TP
MF-UP	Fitzpatrick	Middle Fork northwest of Knob Hill Dr	5/29/14, 5/30/14, 7/7/14, 7/8/14, 7/29/14, 7/30/14, 9/22/14	Temp., NO2, NO3, phosphates, turbidity, DO, ammonia, FIBI
MF-DN	Fitzpatrick	Middle Fork east of north end of Candlewick Ct	5/29/14, 5/30/14, 7/7/14, 7/8/14, 7/29/14, 7/30/14, 9/22/14	Temp., NO2, NO3, phosphates, turbidity, DO, ammonia, FIBI
SF-UP	Fitzpatrick	South Fork at Cottingham Rd	4/18/14, 4/19/14, 5/27/14, 5/28/14, 6/25/14, 6/26/14, 7/23/14, 7/24/14, 8/19/14	Temp., NO2, NO3, phosphates, turbidity, DO, ammonia, FIBI
SF-DN	Fitzpatrick	South Fork at Cousins Rd	4/18/14, 4/19/14, 5/27/14, 5/28/14, 6/25/14, 6/26/14, 7/23/14, 7/24/14, 8/19/14	Temp., NO2, NO3, phosphates, turbidity, DO, ammonia, FIBI
CC-UP	Fitzpatrick	Catfish Creek at Whitetop Rd	4/17/14, 4/18/14, 5/22/14, 5/23/14, 6/16/14, 6/17/14, 7/9/14, 7/10/14, 8/4/14, 8/5/14, 8/19/14	Temp., NO2, NO3, phosphates, turbidity, DO, ammonia, FIBI
CC-DN	Fitzpatrick	Catfish Creek at Oakfield Farms Rd	4/17/14, 4/18/14, 5/22/14, 5/23/14, 6/16/14, 6/17/14, 7/9/14, 7/10/14, 8/4/14, 8/5/14, 9/22/14	Temp., NO2, NO3, phosphates, turbidity, DO, ammonia, FIBI
GC-UP	Fitzpatrick	Granger Creek east of Route 61 between Elmwood Dr and Olde Davenport Rd	4/18/14, 4/19/14, 5/23/14, 5/24/14, 6/5/14, 6/6/14, 7/15/14, 7/16/14, 8/19/14	Temp., NO2, NO3, phosphates, turbidity, DO, ammonia, FIBI
GC-DN	Fitzpatrick	Granger Creek just northeast and downstream of Lake Eleanor Rd	4/18/14, 4/19/14, 5/23/14, 5/24/14, 6/5/14, 6/6/14, 7/15/14, 7/16/14, 8/19/14	Temp., NO2, NO3, phosphates, turbidity, DO, ammonia, FIBI
		KEY:	NO2 = nitrite nitrogen	TSS = total suspended solids
		DO = dissolved oxygen	NO3 = nitrate nitrogen	pH=acid/base scale
		TN = total nitrogen	TP = total phosphorus	IBI = Index of Biotic Integrity

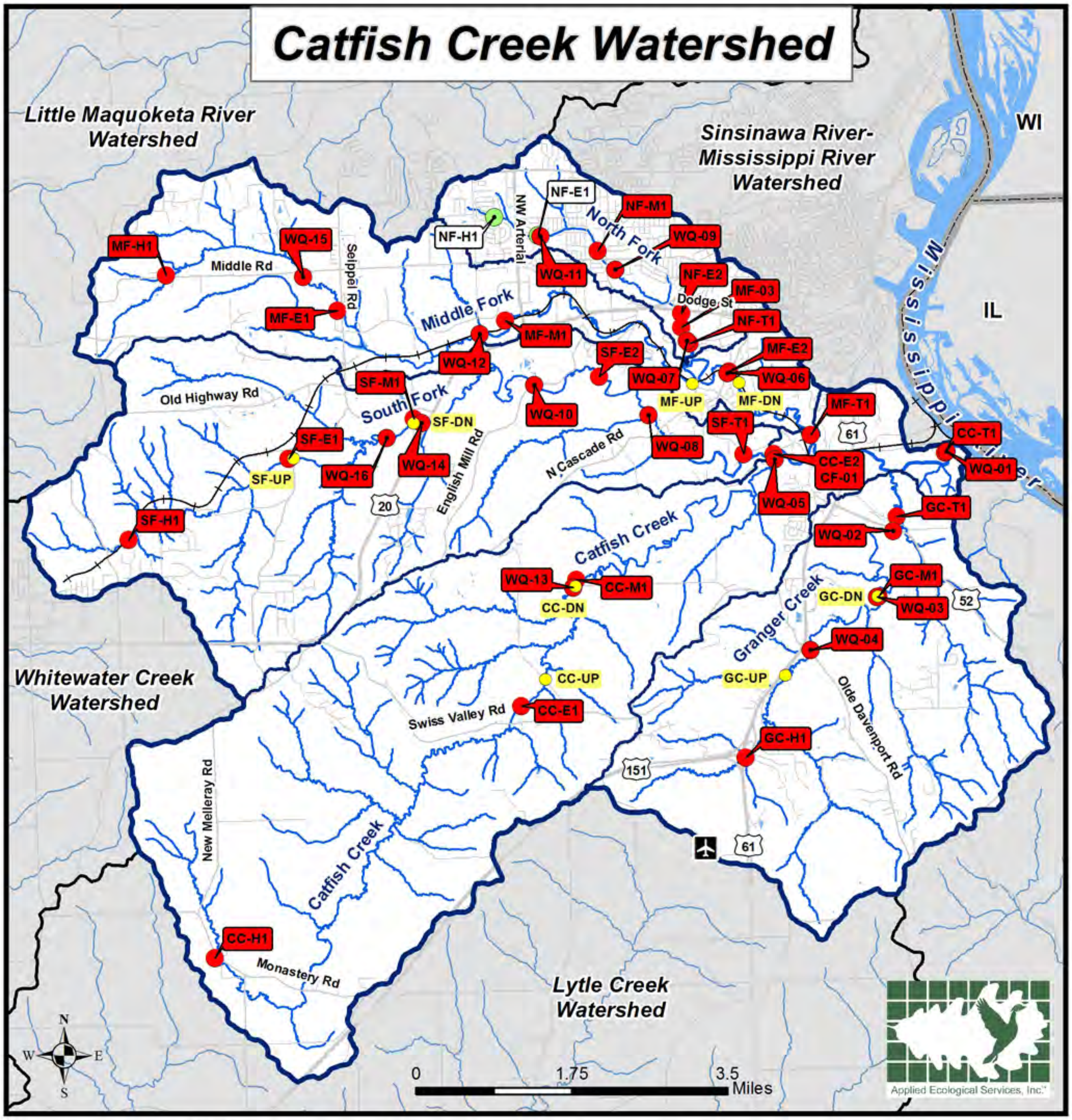
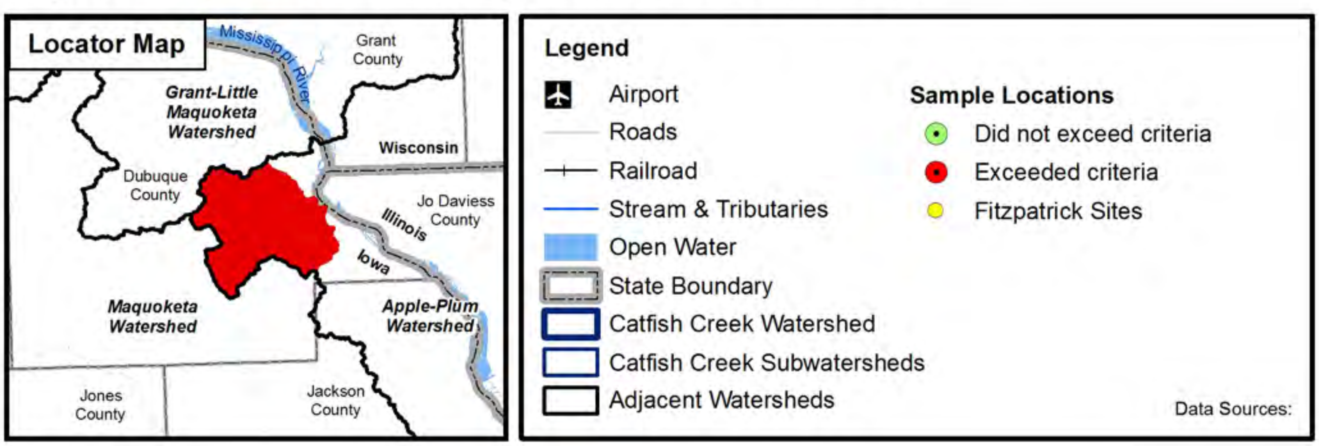


Figure 53: Water Quality Sample Locations



Numeric Water Quality Standards

USEPA has tasked states to establish *numeric* water quality standards for nutrients (phosphorus and nitrogen) in lakes and streams. To date, Iowa has not developed *numeric* standards for nitrogen, phosphorus, chlorides, turbidity, or total suspended solids in streams. *Numeric* criteria have been proposed by USEPA for nutrients based on a reference stream method for the Driftless Area of Ecoregion VII which includes Catfish Creek watershed and the USEPA has also established general national guidelines for other criteria. The USGS has published a document outlining recommended *numeric* criteria for sediment in streams for Ecoregion VII. These reference criteria are used in this report to assess the quality of Catfish Creek and tributaries to develop pollution reduction targets and measure future successes, even though Iowa has not adopted these criteria as standards.

Image: *Testing dissolved oxygen levels on Catfish Creek during Catfish Creek Festival.*

Chemical and Physical Water Quality Monitoring

Chemical and physical sampling conducted in the watershed demonstrates that the overall condition of Catfish Creek watershed is poor. According to IDNR's 2012 Integrated Report, each of the main branches of Catfish Creek is currently impaired due to the presence of indicator bacteria (*Escherichia coli* or *E. coli*). Chemical and physical sampling also points to potential impairments for phosphorus, nitrogen, and total suspended solids within the watershed.

Table 26 summarizes the IOWATER water quality sample results for Catfish Creek and its tributaries from 2010 to early 2013; sample results for each criterion at each site were averaged from available data. The table also provides statistical and numerical guidelines for the various criteria. Iowa provides numeric guidelines within its administrative code for temperature, dissolved oxygen, and pH within Section 567 Chapter 61. Iowa has not yet derived their own guidelines for the remaining criteria so appropriate regional or national standards were utilized. Criteria for nitrogen, phosphorus, chlorides, turbidity, and *E.coli* reference general guidelines set forth by the relevant ecoregion or proposed state guidelines where applicable. The United States Geological Survey provided the reference conditions for total suspended solids.

In addition to the IOWATER data a QAPP, or quality assurance project plan, was conducted by the City of Dubuque and Dubuque Soil & Water Conservation District in order to make an initial assessment of water quality for Catfish Creek and its tributaries. The results of the QAPP are included in Table 27 and demonstrate why all five branches were listed as impaired due to *E. coli*.

Table 26. IOWATER water quality sample results for Sites CC-E1 – SF-M1. Temperature is shown as a maximum value while all other testing results are displayed as an average of all available testing data from 2008 to 2012. Sites for each branch are listed from headwater to mouth. The site labeled "T1" for each of the branches is the point furthest downstream before entering the next waterbody.

Parameter	Statistical, Numerical, or General Use Guidelines	Site CC-H1	Site CC-E1	Site CC-M1	Site CC-E2	Site CC-T1	Site GC-H1	Site GC-M1	Site GC-T1	Site MF-H1	Site MF-E1	Site MF-M1	Site MF-E2	Site MF-T1	Site NF-H1	Site NF-E1	Site NF-M1	Site NF-E2	Site NF-T1	Site SF-H1	Site SF-E1	Site SF-M1	Site SF-E2	Site SF-T1
Stream Name		Catfish Creek					Granger Creek			Middle Fork					North Fork					South Fork				
Turbidity (converted from cm)	<3.38 NTU*	AVG 17	12	<10	12	19	17	15	<10	12	14	12	10	10	<10	<10	11	<10	<10	14	19	17	13	10
pH	>6.5 or <9.0**	AVG 8.4	8.6	9	8.4	8.4	8.6	8.8	8.4	8.7	8.3	8.3	8.6	9	8.3	8.6	8.6	8.3	8.8	8.7	9	8.6	8.9	8.8
Nitrite + Nitrate NO2 + NO3	<1.73 mg/L*	AVG 7	2.89	2	3.12	1.2	1.59	0.88	1.29	3.83	1.21	0.88	0.8	1	1.67	0.23	0.77	0.33	1.2	8.33	4.2	2.5	1.86	2.26
Dissolved Oxygen (DO)	>5.0 mg/l**	AVG 8	10	12	9.8	7.6	10	8.3	11.1	10.7	11.1	10.5	11.25	11.6	12	10.6	9.18	9.6	9	10.3	11.5	10.5	11.4	11.5
Total Phosphorus (TP)	<0.070 mg/L*	AVG 0.082	0.047	0.033	0.036	0.13	0.053	0.043	0.042	0.079	0.044	0.065	0.073	0.033	0.022	0.039	0.238	0.08	0.052	0.026	0.013	0.063	0.057	0.038
Chlorides	Chronic Toxicity <389 mg/L***	AVG <33	<33	<33	<33	<33	86.1	47.5	47.6	66.8	64.7	114.4	190.3	93.6	236	290.1	291.9	287.6	230.2	45	40.2	49.3	70.6	59.2
Temp (F)	<86° F**	MAX 84°	83°	80°	84°	84°	80°	85°	80°	74°	74°	79°	78°	85°	70°	80°	79°	76°	76°	79°	80°	82°	82°	87°

-Cells highlighted in red exceed recommended statistical, numerical, or General Use guidelines
* Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion VII (USEPA 2000)
** Iowa Water Quality Standards, IAC 567 Chapter 61 (IAC, 2012)
*** Revising Criteria for Chloride, Sulfate, and Total Dissolved Solids (IDNR, 2009)

Table 27. QAPP water quality monitoring results. Temperature is shown as a maximum value while all other testing results are displayed as an average of all available testing data from May to October 2010. Sites for each branch are listed from headwater to mouth. The last site listed for each of the branches is the point furthest downstream before entering the next waterbody.

Parameter	Statistical, Numerical, or General Use Guidelines	Site WQ-13	Site WQ-5	Site WQ-1	Site WQ-4	Site WQ-3	Site WQ-2	Site WQ-15	Site WQ-12	Site WQ-6	Site WQ-11	Site WQ-9	Site WQ-7	Site WQ-16	Site WQ-14	Site WQ-10	Site WQ-8
		Catfish Creek			Granger Creek			Middle Fork			North Fork			South Fork			
E. coli	126 org/100 mL*	AVG 5168.3	9975.5	6416.4	3893	4938.9	2145	4414.5	7436.4	5652.4	3872.9	2366.4	1747.3	5605	7618.2	6024.5	8628.2
Total Nitrogen (TN)	<1.73 mg/L**	AVG 1.33	3.67	2.45	2.6	2.21	2.27	2.4	1.14	0.84	0.75	1.61	1.05	1.36	4.06	3.55	3.08
Total Phosphorus (TP)	<0.070 mg/L**	AVG 0.226	0.292	0.194	0.119	0.141	0.14	0.142	0.191	0.176	0.098	0.09	0.078	0.202	0.175	0.195	0.168

-Cells highlighted in red exceed recommended statistical, numerical, or General Use guidelines
* Iowa Surface Water Quality Standards Implementation (IDNR, 2010)
** Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion VII (USEPA 2000)

Table 28. Baseflow and rain event water quality monitoring results from City of Dubuque, August 1 and 22, 2013.

Parameter	Statistical, Numerical, or General Use Guidelines	Site CC-E1	Site CC-T1	Site GC-T1	Site MF-T1	Site NF-T1	Site SF-T1
		Catfish Creek		Granger Creek	Middle Fork	North Fork	South Fork
Total Suspended Solids	Baseflow <11.5 mg/L*	AVG 2	10	4	8	5	6
Nitrate	Baseflow <1.73 mg/L**	AVG 5.00	2.00	2.00	2.00	2.00	2.00
Total Phosphorus (TP)	Baseflow <0.070 mg/L**	AVG 0.000	0.000	0.065	0.033	0.000	0.065
Total Suspended Solids	0.6" Rain Event <11.5 mg/L*	AVG 50	135	302	32	14	162
Nitrate	0.6" Rain Event <1.73 mg/L**	AVG 5	0.00	1.00	0.00	0	1
Total Phosphorus (TP)	0.6" Rain Event <0.070 mg/L**	AVG 0.360	0.510	0.450	0.440	0.400	0.660

-Cells highlighted in red exceed recommended statistical, numerical, or General Use guidelines
– Nitrate standard is depicted as NO2 + NO3, but NO2 contribution negligible relative to NO3
* Present and Reference Concentrations and Yields of Suspended Sediment in Streams in the Great Lakes Region and Adjacent Areas (USGS 2006)
** Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion VII (USEPA 2000)

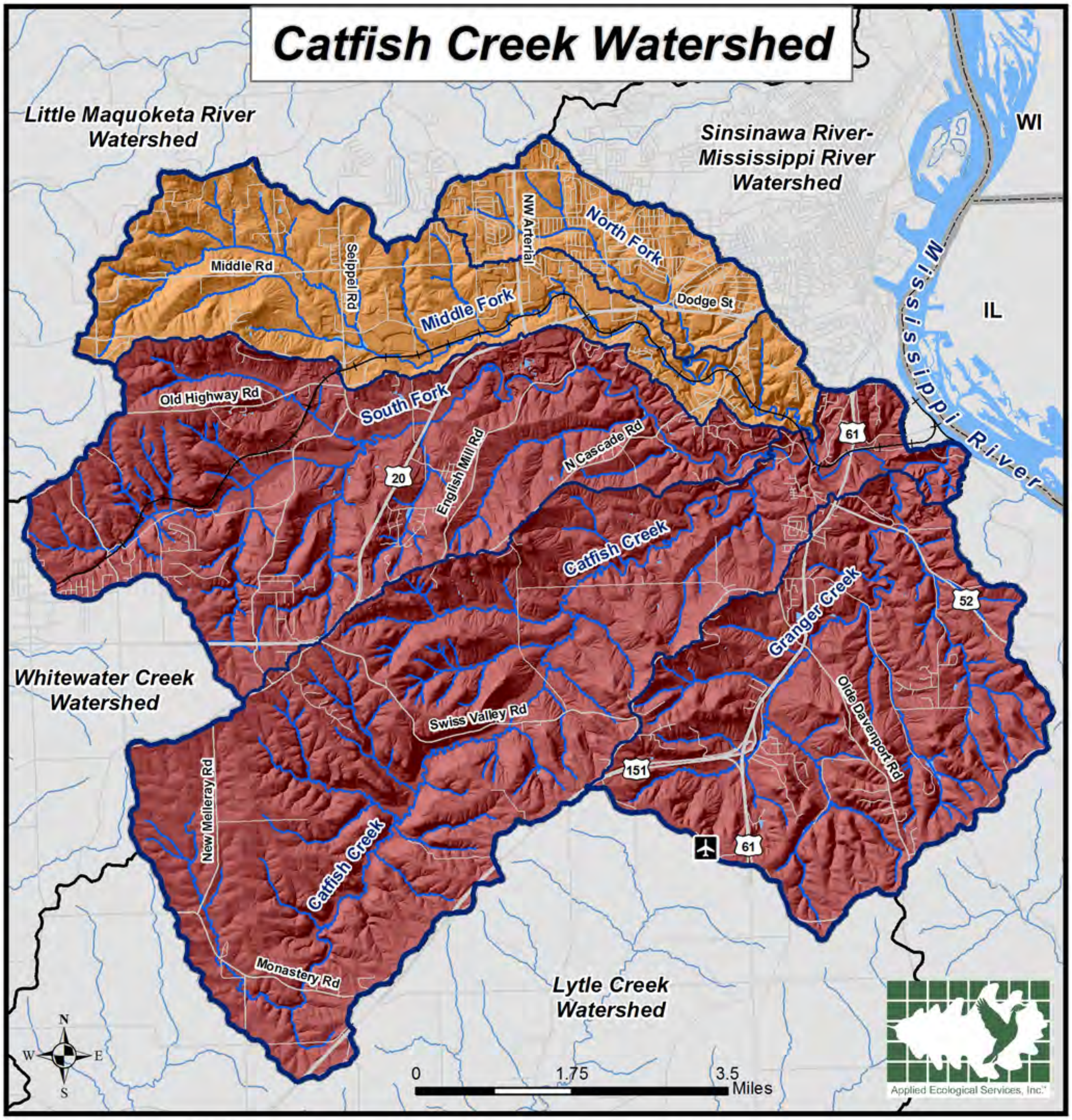
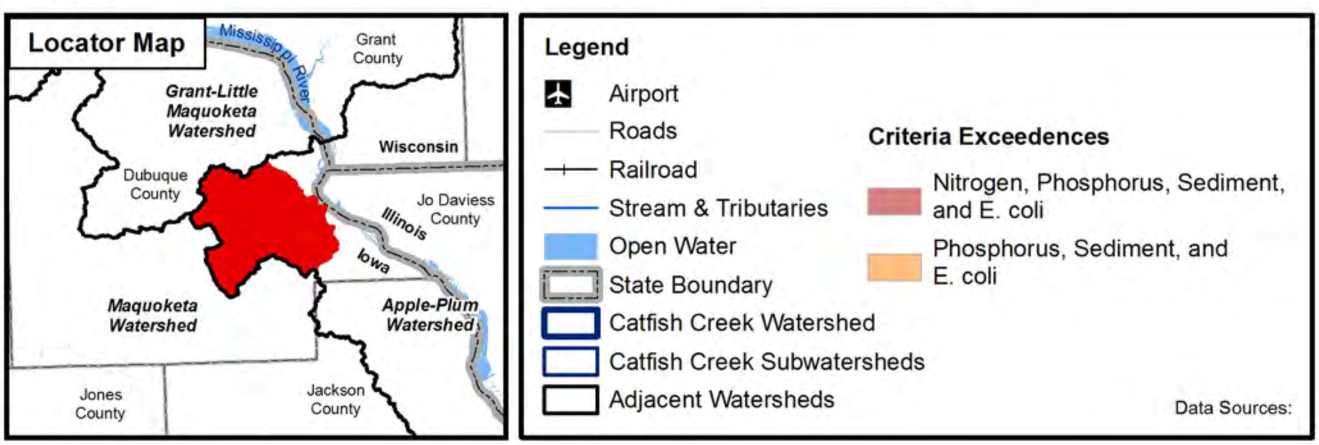


Figure 54: Water Quality Criteria Exceedences



The IOWATER water quality sampling covered five sites on each of the tributaries, except for Granger Creek which had three. The QAPP water quality sampling covered three sites on each branch, except for South Fork which had four. Together this data can be used to summarize the water quality of each of the five branches. The water quality sampling data supports the impairment status of each of the branches.

According to the chemical and physical sampling results (Tables 26, 27, and 28; Figure 54), Catfish Creek and each of the branches have exceeded the numerical or statistical guidelines for both phosphorus and *E. coli*. Catfish Creek, Granger Creek, and South Fork exceed the guideline for nitrogen. North Fork is also approaching the numerical standard for chronic chloride toxicity at every sampling point along its length.

Turbidity and total suspended solids both measure the amount of solids (such as soils or algae) that are suspended in water. Turbidity in the IOWATER sampling data was first measured as transparency using a turbidity tube in the field, then approximating the equivalent in NTUs. Because of a lack of sensitivity in turbidity tube readings versus actual turbidity measurements it is difficult to approximate the lowest values below 10 NTUs. The IOWATER data shows that Catfish Creek, Middle Fork, and South Fork exceed the ambient water quality statistical guidelines for turbidity.

Another way of accessing the amount of solids that are suspended in a stream is to measure total suspended solids. Both turbidity and total suspended solids are highly correlated to rain events. When heavy rain events occur, they “flush” pollutants and particularly sediment into streams. Taking water quality samples within 24 hours of a heavy rain event can capture the amount of sediments that are being “flushed” into streams during these events and before they’ve had a chance to settle out. Water quality samples were taken by the City of Dubuque during baseflow and within 24 hours following a rain event for Catfish Creek and each of the branches (Table 28). This sampling shows that both sediment and phosphorus (which is tied to those sediments) exceed criteria on every branch post rain event.

Nutrients such as phosphorus and nitrogen, both exceeding recommended criteria for the Catfish Creek, are a necessary component of plant growth and are therefore included in many fertilizers. Unfortunately, both have adverse effects on water quality, with phosphorus being particularly detrimental to aquatic systems in excess quantities. These nutrients can result from fertilizer applications, either in an agricultural setting or by applicators or residents, or from livestock allowed direct access to streams. Either way, the excess nutrients not absorbed by plants are then washed into waterways. Excess nutrients can cause algal blooms, accelerated plant growth, decreasing oxygen levels, and can lead to fish kills.

The ability to control erosion and excess sediment, and thereby total suspended solids, in waterways can be linked to the control of how both development and farming are handled. The construction process generally involves significant land disturbance and ecosystem destruction. The grading of sites, removal of vegetation, rerouting of natural drainage systems, and the addition of impervious surfaces, such as roads and parking lots, all interfere with water quality both in the short and long term. Removing vegetation and trees near the stream or floodplain removes the stability of the soil and increases bank erosion and sedimentation to nearby waterways. Converting open land to farming also disturbs soils as does the process of farming itself, although there are methods of farming (such as no-till) that can be utilized in order to minimize the amount of erosion and sediment loss off of fields. Alteration of natural drainage patterns can also significantly reduce the ability of the ecosystem to compensate for such increase in contaminants and sedimentation. High suspended sediment levels are problematic when light penetration is reduced, oxygen levels decrease, fish and macroinvertebrate gills are clogged, visual needs of aquatic organisms is reduced, and when sediment settles out in streams and lakes.

E. coli is used as an indicator that a waterbody is contaminated by sewage which could carry other possible pathogens such as bacteria, viruses, and protozoans. While potential pathogens are too numerous to test for individually, the USEPA recommends *E. coli* testing "as the best indicator of health risk from water contact in recreational waters (USEPA, 2012)." Not only does the presence of excessive *E. coli* counts suggest there is a possible health risk in recreational contact with those waters, but the bacteria "can also cause cloudy water, unpleasant odors, and an increased oxygen demand (USEPA, 2012)."

Finally, excess chlorides are also a concern for North Fork. While chronic chloride toxicity guidelines have not been exceeded, North Fork is consistently testing high for chlorides. A common practice in snowy states such as Iowa, the application of road salts and deicers is used as a means to protect public safety on roadways. Typical deicers contain chlorides that do not breakdown naturally and can affect the reproduction of fish and other aquatic animals. Waters with a high salinity also are denser, sinking to the bottom of water bodies and impairing water circulation and effecting oxygen levels. As deicers are spread along roadways, those chemicals are also harmful to the vegetation, particularly trees, along those roads.

To summarize, the water quality site CC-T1/WQ-1 provides a final snapshot of water quality for all of Catfish Creek watershed prior to joining the Mississippi River. Based on averages of all available sampling data for CC-T1/WQ-1, exceedences exist for total nitrogen, total phosphorus, *E. coli*, total suspended solids, and turbidity based on recommended USEPA, USGS, and Iowa numeric criteria. Total nitrogen at this site is 2.45 mg/L (the standard is <1.73 mg/L); total phosphorus is 0.194 mg/L (the standard is <0.070 mg/L); *E. coli* is 6416.4 org/100mL (the standard is 126 org/100mL); total suspended solids post rain event are 135 mg/L (the standard is 11.5 mg/L); and average turbidity is 19 NTU (the standard is <3.38 NTU). These water quality results form the basis for calculating watershed-wide reduction targets for achieving water quality standards for Catfish Creek. Section 5.3 of this report includes detailed information related to developing pollutant load reduction/ impairment targets for Catfish Creek and addressing "Critical Areas" to reach these targets.

Biological Water Quality Monitoring
IOWATER volunteers have also conducted biological monitoring across all of the branches of Catfish Creek. This monitoring includes collecting and identifying aquatic benthic macroinvertebrates (aquatic insects that live in bottom substrates). Each species is assigned a value based on how much pollution it can typically tolerate. The types of species found and the number of each can then be used to calculate a Benthic Macroinvertebrate Index of Biotic Integrity (IBI) value in order to estimate a streams overall health (IDNR, 2012). IDNR created a simplified rating system in order to differentiate between good, fair, and poor IBI scores and it is included in Table 29.

Table 29. Scoring Criteria for IOWATER Index of Biotic Integrity (IBI) for benthic macroinvertebrates.

Score	Rating	Fish Community Attributes
> 2.25	Good	Scores greater than 2.25 indicate a good benthic macroinvertebrate population and are likely dominated by benthic macroinvertebrates in the high quality tolerance group. Benthic macroinvertebrates in the low and middle quality tolerance group are likely to be present, but in smaller numbers.
1.76 - 2.25	Fair	IBI scores ranging from 1.76 to 2.25 would indicate a fair benthic mancroinvertebrate population and are likely dominated by benthic macroinvertebrates in the middle quality tolerance group. These sites may also have low and high quality benthic macroinvertebrates present.
< 1.75	Poor	Scores below 1.75 indicate a poor benthic macroinvertebrate population and are likely dominated by benthic macroinvertebrates in the low quality tolerance group. High and middle quality benthic macroinvertebrates may be present, but in small numbers.

The biological water quality monitoring results within Catfish Creek generally agree with the results of the chemical and physical monitoring – water quality needs to be improved within the watershed. IOWATER conducted a total of 97 biological water quality surveys across most of the sampling locations on Catfish Creek and its tributaries between 2010 and 2012. The dates and results of these surveys are detailed in Table 30. Across the 21 sites, 9 of them had an average IBI score that was rated "Poor," while 12 were rated as "Fair." While a handful of individual samples were rated "Good," none of the sample sites was rated "Good" on average. Existing biological data does not point to any clear trends or obvious causes for the low IBI scores for Catfish Creek. Factors contributing to these low rankings could include any combination of the following: the pollutants identified in the physical-chemical surveys, stream habitat changes, and/or riparian vegetation changes.


Biological water quality testing demonstration on Catfish Creek during Catfish Creek Festival.

Table 30. Index of Biotic Integrity (IBI) scores for benthic macroinvertebrates at IOWATER survey sites, 2010-2012. Scores shown as average of all available scores for each site.

Site	Dates	IBI Score	IBI Rating
CC-E1	7/11/12, 8/20/12	1.77	Fair
CC-E2	4/8/10, 7/2/10, 10/6/10, 6/14/11, 7/15/11, 1/4/12, 7/11/12, 8/21/12	1.83	Fair
CC-H1	7/12/12, 8/22/12	1.82	Fair
CC-T1	7/12/2012	1.10	Poor
GC-H1	7/17/12, 8/20/12	1.58	Poor
GC-M1	7/13/12, 8/21/12	1.62	Poor
GC-T1	7/17/12, 8/20/12	1.73	Poor
MF-E1	4/15/10, 7/9/10, 10/4/10, 6/14/00, 8/8/11, 1/3/12, 7/18/12, 8/23/12	2.09	Fair
MF-E2	4/20/10, 7/9/10, 10/5/10, 6/13/11, 10/18/11, 7/18/12, 8/23/12	1.90	Fair
MF-H1	7/18/12, 8/23/12	1.51	Poor
MF-M1	4/15/10, 7/9/10, 10/5/10, 6/14/11, 8/16/11, 10/18/11, 1/3/12, 7/18/12, 8/22/12	2.17	Fair
MF-T1	7/18/12, 8/27/12	1.38	Poor
NF-E1	4/15/10, 7/8/10, 10/4/10, 6/13/11, 7/13/11, 10/18/11, 1/4/12, 7/19/12, 8/24/12	1.63	Poor
NF-E2	4/6/10, 7/5/10, 9/23/10, 6/13/11, 7/11/11, 10/12/11, 12/14/11, 7/19/12, 8/23/12	1.83	Fair
NF-M1	4/8/10, 7/5/10, 10/4/10, 6/13/11, 7/13/11, 1/5/12, 7/19/12, 8/24/12	1.70	Poor
NF-T1	7/19/12, 8/24/12	1.87	Fair
SF-E1	7/12/12, 8/23/12	1.21	Poor
SF-E2	7/12/12, 8/21/12	1.84	Fair
SF-H1	7/12/12, 8/21/12	2.05	Fair
SF-M1	4/20/10, 7/2/10, 10/5/10, 6/14/11, 8/11/11, 10/18/11, 7/12/12	2.05	Fair
SF-T1	4/20/10, 7/2/10, 10/5/10, 6/14/11, 8/16/11, 1/4/12, 7/17/12, 8/22/12	2.08	Fair

Additional biological water quality data was obtained through a research project conducted by Amanda Fitzpatrick of Loras College's Biological Research department. The project was designed to study the "Effects of Farming Practices on Fish Species Richness in the Five Watersheds of Catfish Creek." The study included documenting water temp, nitrates, nitrites, phosphates, dissolved oxygen, and ammonia as well as fish sampling results for one upstream and one downstream site for a farm where the crop field and/or pasture land occurred within 10 meters of the creek bank. Data was collected from March through November of 2014 across all branches except for North Fork due to access issues. Research, sampling, and identification were conducted with assistance from Dan Kirby, Mark Winn, Melvin Bowler, and Scott Gritters all with IDNR.

As part of the monitoring for this project, 8 sample sites were monitored for the physical and chemical properties mentioned several times over the course of the project and biological surveys were conducted at each site.

Results of the biological sampling were analyzed following the Fish Index of Biotic Integrity (FIBI) as outlined in the Biological Assessment of Iowa's Wadeable Stream guide produced by the Iowa Department of Natural Resources (2004). FIBI scores are rated from 0 to 100, with scores breaking down as follows: 71-100 – Excellent, 51-70 – Good, 26-50 – Fair, and 0-25 – Poor. The results show that, on average, Middle Fork was rated as fair while South Fork, Catfish Creek, and Granger Creek rated as Good biological condition according the characteristics of fish assemblage.

The full report and sampling data will be available in May of 2015 through Loras College.

4.4 Pollutant Loading Analysis

The USEPA modeling tool called STEPL (Spreadsheet Tool to Estimate Pollutant Loads) was used to estimate the existing nonpoint source load of nutrients (nitrogen & phosphorus) and sediment from Catfish Creek watershed and by individual Subwatershed Management Unit (SMU). The model uses land use/cover category types, precipitation, soils information, existing best management practices, and other data input information. The model outputs average annual pollutant load for each of the land use/cover types. The results of this analysis were used to estimate the total watershed load for nitrogen, phosphorus, and sediment and to identify and map pollutant load "Hot Spot" SMUs. It is important to note that STEPL is not a calibrated model; it also does not estimate E. coli loading which is significantly more complicated and beyond the scope of this watershed plan.

The results of the STEPL model run at the watershed scale indicates that Catfish Creek watershed produces 298,802 lbs/yr of nitrogen, 13,690 lbs/yr of phosphorus, and 58,993 tons/yr of sediment (Table 31; Figure 55).

Cropland contributes the highest nutrient (nitrogen and phosphorus) and sediment loading in Catfish Creek watershed (Table 31). Annual nitrogen and phosphorus loading from cropland is estimated at 172,079 lbs/yr and 52,854 lbs/yr, respectively. This accounts for about 58% of the total annual load for nitrogen and 64% of the total annual load for phosphorus. Annual sediment loading from cropland is estimated at 33,797 tons/yr, accounting for approximately 57% of the total annual load for sediment. Cropland is expected to be a significant pollutant contributor since it makes up nearly half of the watershed and involves both nutrient application and soil disturbance.

Table 31. Estimated existing (2013) annual pollutant load by source at the watershed scale.

STEPL Source	N Load (lbs/yr)	% of Total Load	P Load (lbs/yr)	% of Total Load	Sediment (tons/yr)	% of Total Load
Urban	79,066	26.5%	12667	15.4%	1,836	3.1%
Cropland	172,079	57.6%	52854	64.3%	33,797	57.3%
Pastureland	6,553	2.2%	1007	1.2%	520	0.9%
Forest & Grassland	2,434	0.8%	1100	1.3%	319	0.5%
Feedlots	2,081	0.7%	416	0.5%	0	0.0%
Water/Wetland	1,030	0.3%	406	0.5%	297	0.5%
Streambank Erosion	35,559	11.9%	13,690	16.7%	22,224	37.7%
Total	298,802	100%	82,140	100%	58,993	100%

Urban land uses contribute the second highest load of nitrogen (79,066 lbs/yr: 27%) and the third highest load of phosphorus (12,667 lbs/yr: 15%) and sediment (1,836 tons/yr: 3%). Streambank erosion contributes the second highest phosphorus load (13,690 lbs/yr: 17%) and second highest sediment load (22,224 tons/yr: 38%) to Catfish Creek and also contributes significantly to nitrogen loading (35,559 lbs/yr: 12%). As expected, the STEPL model suggests that very few of the modeled pollutants originate from pastureland, forest/ grassland/ and water/wetland. Complete STEPL Model results can be found in Appendix D.

The results of the STEPL model were also analyzed for nonpoint source pollutant loads at the Subwatershed Management Unit (SMU) scale. This allows for a more refined breakdown of nonpoint pollutant sources and leads to the identification of pollutant load "Hot Spots." Hot Spot SMUs were selected by examining pollutant load concentration (load/acre) for each pollutant. Next, pollutant concentrations exceeding the 75% quartile and 50% quartile were calculated resulting in "High Concentration" and "Moderate Concentration" nonpoint source pollutant load Hot Spot SMUs. Any SMU exhibiting pollutant load concentrations below the 50% quartile contribute "Low Concentration" of pollutants relative to other SMUs. Table 32 and Figure 56 depict and summarize the results of the SMU scale pollutant loading analysis. Five of the 34 SMUs comprising Catfish Creek watershed are considered "High Concentration" pollutant load Hot Spots for nitrogen, phosphorus, and sediment based on STEPL modeling. Twelve SMUs are considered "Moderate Concentration" pollutant load Hot Spots for various combinations of nitrogen, phosphorus, and sediment. The remaining seventeen SMUs contribute "Low Concentrations" based on modeling.

Figure 55. Estimated percent contributions to existing (2013) pollutant load by STEPL source.

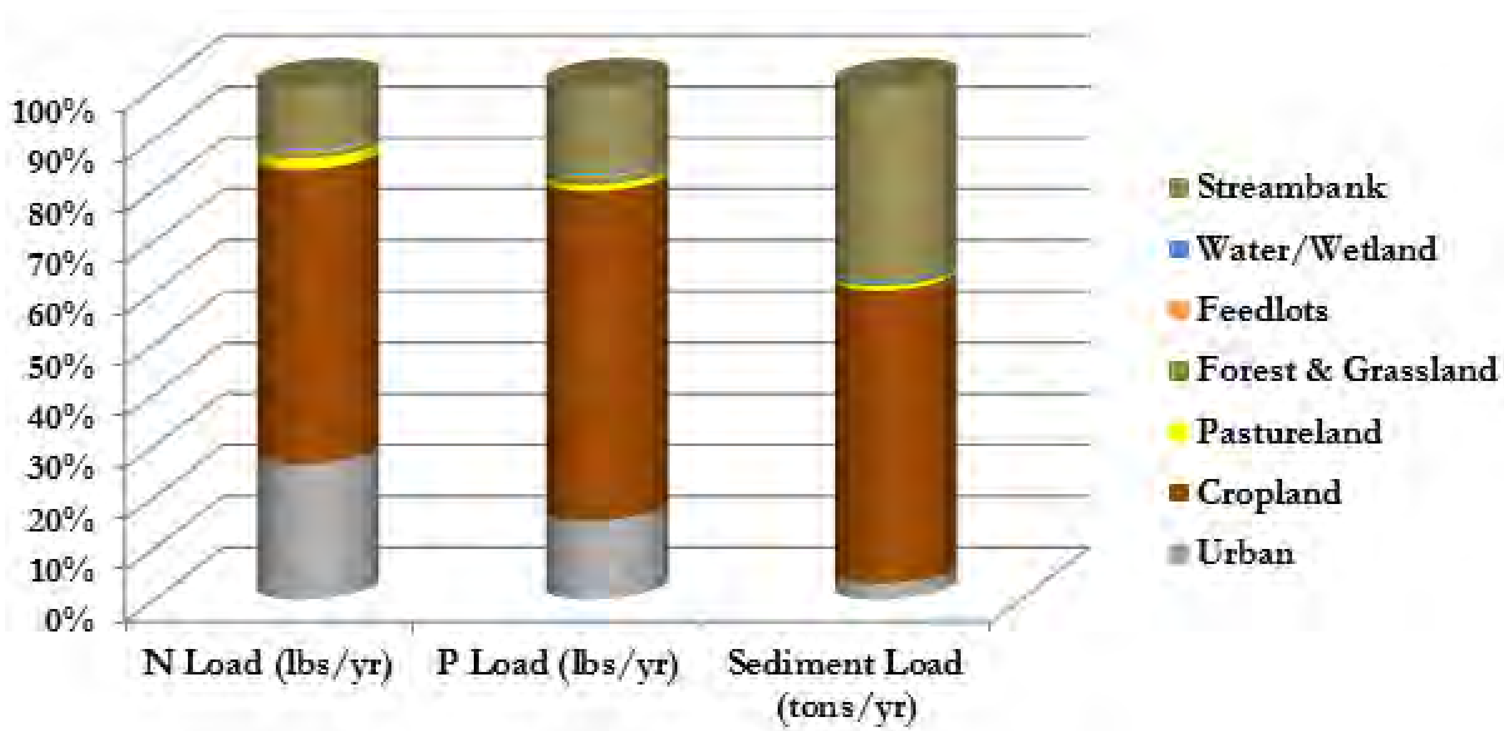


Table 32. Pollutant load "Hot Spot" SMUs.

Hot Spot SMU	Size (acres)	N Load (lb/yr)	N Load (lb/yr)/ acre	P Load (lb/yr)	P Load (lb/yr)/ acre	Sediment Load (t/yr)	Sediment Load (t/yr)/ acre
High Concentration Hot Spot SMUs							
SMU 9	774	7,089	9.2	2,168	2.8	2,007	2.6
SMU 11	584	5,734	9.8	1,636	2.8	1,463	2.5
SMU 21	528	4,465	8.5	1,479	2.8	1,483	2.8
SMU 26	236	3,830	16.2	1,376	5.8	2,098	8.9
SMU 34	282	3,602	12.8	1,230	4.4	1,672	5.9
Moderate Concentration Hot Spot SMUs							
SMU 1	2,479	19,773	8.0	4,738	1.9	4,337	1.7
SMU 2	2,610	18,180	7.0	5,158	2.0	3,577	1.4
SMU 3	902	7,126	7.9	2,040	2.3	1,205	1.3
SMU 4	2,374	17,001	7.2	3,977	1.7	2,717	1.1
SMU 6	2,096	14,782	7.1	4,299	2.1	2,902	1.4
SMU 14	1,135	8,334	7.3	2,442	2.2	1,728	1.5
SMU 15	879	6,431	7.3	1,901	2.2	1,768	2.0
SMU 16	5,393	36,563	6.8	10,366	1.9	6,323	1.2
SMU 19	2,006	12,467	6.2	3,677	1.8	3,128	1.6
SMU 23	1,930	12,700	6.6	3,922	2.0	2,854	1.5
SMU 24	942	6,468	6.9	1,835	1.9	1,090	1.2
SMU 25	909	6,378	7.0	1,655	1.8	1,637	1.8

High Concentration Hot Spot SMUs exceed the 75% quartile: N=7.3 lbs/yr/acre, P=2.2 lbs/yr/acre, Sediment= 1.7 t/yr/acre
Moderate Concentration Hot Spot SMUs exceed the 50% quartile: N=6.6 lbs/yr/acre, P=1.8 lbs/yr/acre, Sediment= 1.2 t/yr/acre

A brief summary of "High Concentration" pollutant loading Hot Spots follows:

- SMU 9 comprises 774 acres. Nonpoint source pollutants in this SMU originate from a combination of cropland areas and moderate to severe streambank erosion. Eroded sediment also carries with it attached nitrogen and phosphorus.
- Pollutants coming from SMU 11 (584 acres) originate primarily from cropland, industrial, residential, and moderately to highly eroded streambanks.
- SMU 21 (528 acres) contributes pollutants at high concentrations originating from cropland areas and highly eroded streambanks.
- SMU 26 is one of the smallest subwatersheds (236 acres) and although it is made up almost entirely of open space it has severely eroded banks throughout.
- SMU 34 is another small subwatershed (282 acres) with pollutants originating from cropland and industrial areas as well as severely eroded streambanks.

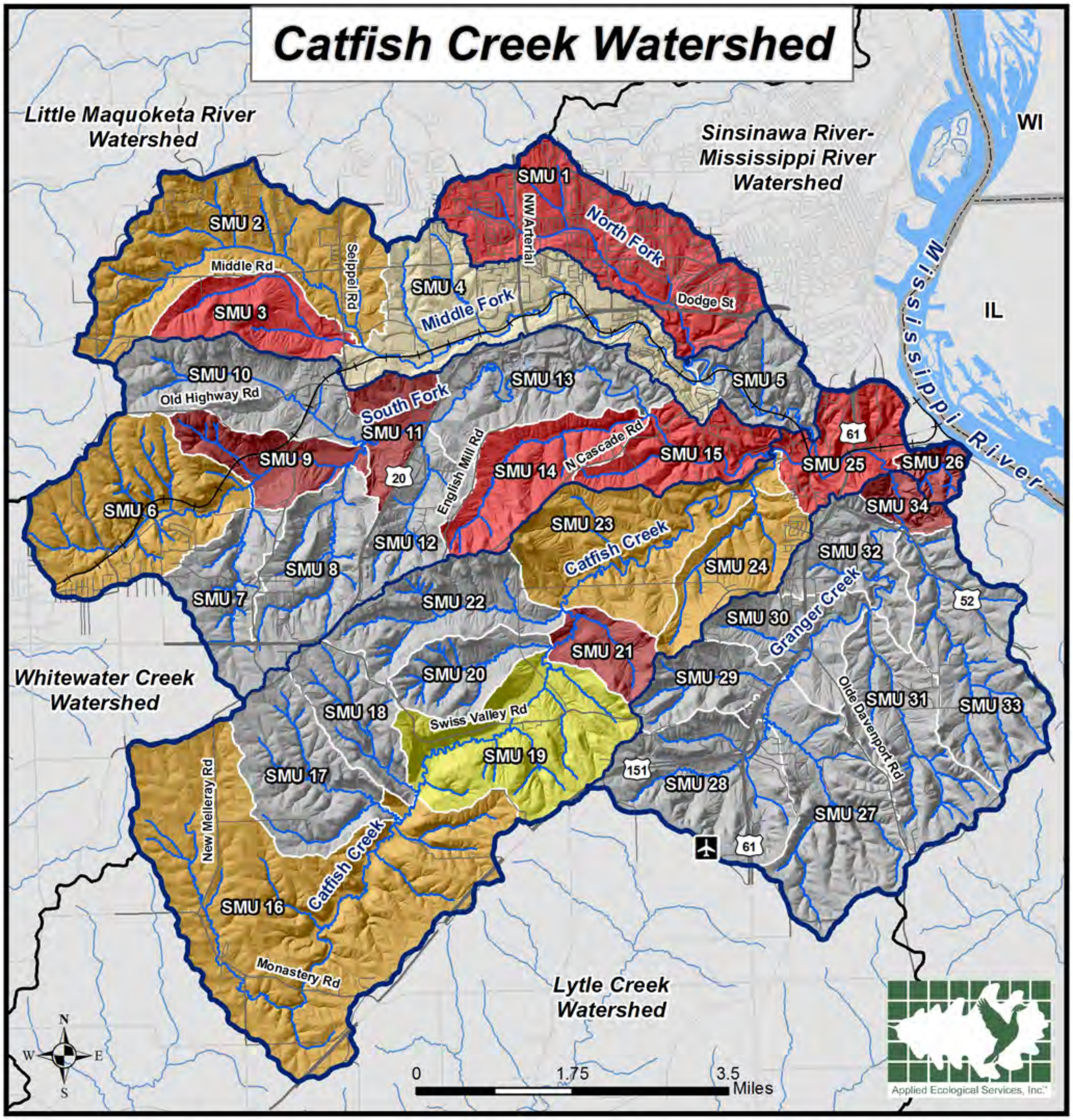


Figure 56: Nonpoint Source Pollutant Loading "Hot Spot" SMUs

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Pollutant Load Hot Spot SMUs

- High Concentration - Nitrogen, Phosphorus, Sediment Loading
- High to Moderatate Concentration - Nitrogen, Phosphorus, Sediment Loading
- Moderate Concentration - Nitrogen, Phosphorus, Sediment Loading
- Moderate Concentration - Phosphorus, Sediment Loading
- Moderate Concentration - Nitrogen
- Low Concentration

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5.0 Causes/Sources of Impairment & Reduction Targets

5.1 Causes & Sources of Impairment

According to Iowa's most recent 2012 *Integrated Water Quality Report and Section 303(d) List*, all or part of Catfish Creek, South Fork, Middle Fork, North Fork, and Granger Creek are considered "Not supporting" for the "Primary Contact" Designated Use due to indicator bacteria. Additionally, Tributary CCT16 is considered "Not supporting" for the "Aquatic Life" Designated Use due to organic enrichment/low dissolved oxygen. Recent water quality sampling data also suggests impairment due to nutrient and sediment loading resulting from farming activities, streambank erosion, and channel modification.

There are also non-water quality related impairments in the watershed such as habitat degradation, loss of open space, hydrologic and flow changes, reduced groundwater infiltration, and structural flood damage. Many different causes and sources are related to these impairments.

Table 33 summarizes all *known* or *potential* causes and sources of watershed impairment as documented by Iowa DNR, items identified via Applied Ecological Service's watershed resource inventory, and input from Catfish Creek Watershed Management Authority stakeholders who met during the planning process to discuss impairments.

Table 33. *Known* and *potential* causes and sources of watershed impairment.

Impairment	Cause of Impairment	Known or Potential Source of Impairment
Catfish Creek		
Water Quality: Aquatic Life	Nutrients- *known impairment*: (Phosphorus & Nitrogen)	Streambank erosion; Agricultural row crop runoff; Livestock in or with access to streams; Residential, Ag, and commercial lawn fertilizer; Failing septic systems; Inadequate policy; Level of landowner education; Livestock operations (manure); Tree service and mulch operations (leachate)
Water Quality: Aquatic Life	Sediment- *known impairment* (Total Suspended Solids/ turbidity)	Streambank erosion; Construction sites & utility corridor work; Existing & future urban runoff; Agricultural row crop runoff
Water Quality: Aquatic Life	Chlorides (salinity)- *potential impairment*	Deicing operations on roads & other pavement; Inadequate policy; Level of public education
Water Quality: Aquatic Life	Organic enrichment/low dissolved oxygen- *known impairment*	Heated stormwater runoff from urban areas; Lack of natural riffles in stream reaches; Tree service and mulch operations (leachate)
Water Quality: Primary and Secondary Contact	Indicator Bacteria *known impairment*	Agricultural row crop runoff; Livestock in or with access to streams; Failing septic systems;
Habitat Degradation	Invasive/non-native plant species in riparian and other natural areas- *known impairment*	Spread from existing and introduced populations; Level of public education
Habitat Degradation	Loss and fragmentation of open space/natural habitat due to development *known impairment*	Inadequate protection policy; Lack of land acquisition funds; Pre-existing land development agreements; Traditional development design; Streambank, channel, and riparian area modification; Lack of appropriate land management; Lack of restoration and maintenance funds; Wetland loss
Hydrologic and Flow Changes in Catfish Creek	Impervious surfaces- *known impairment*	Existing & future urban runoff; Wetland loss
Structural Flood Damage	Encroachment in 100-year floodplain- *known impairment*	Poor detention basin design & function; Existing and future urban impervious surfaces; Channelized streams; Wetland loss; Debris jams in streams; Agricultural drain tiles

5.2 Critical Areas, Management Measures & Estimated Impairment Reductions

For this watershed plan a "Critical Area" is best described as a location in the watershed where existing of potential future causes and sources of an impairment or existing function are significantly worse than other areas of the watershed. Six Critical Area types were identified in Catfish Creek watershed and include: 1) highly degraded stream reaches and riparian areas; 2) poorly designed/functional detention basins or detention needs; 3) drained wetlands; 4) large agricultural areas; 5) green infrastructure protection areas; and 6) other management measures. Short descriptions of each Critical Area type are included below. Table 34 includes summaries of the current condition at each Critical Area (by type) and recommended Management Measures with estimated nutrient and sediment load reductions expected. The list of Critical Areas is derived from a comprehensive list of measures found in the Action Plan section of this report. Figure 57 maps the location of each Critical Area.

Pollutant load reduction is evaluated for the majority of the Critical Area Management Measures based on efficiency calculations developed for the USEPA's Region 5 Model. This model uses "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual" (MDEQ 1999) to provide estimates nutrient and sediment load reductions from the implementation of *agricultural* Management Measures. Estimate of nutrient and sediment load reduction from implementation of *urban* Management Measures is based on efficiency calculations developed by Illinois EPA. Illinois EPA pollutant load reduction worksheets for each Critical Area Management Measure are located in Appendix D.

Critical Streambank, Channel, and Riparian Reaches
Critical stream reaches are those with highly eroded streambanks and/or highly degraded channel conditions that are a major source of total suspended solids (sediment) carrying attached phosphorus and nitrogen. Streambank erosion is a critical problem in the watershed not only because there are many eroded streambanks, but because where streambanks are eroded they are severely eroded with very steep and often unstable banks. Streambank stabilization using bioengineering and installation of artificial riffles in Critical Area stream reaches will greatly reduce sediment and nutrient transport downstream while improving habitat and increasing oxygen levels. Fifty-nine (59) stream reaches totaling 200,166 linear feet were identified as Critical Areas. Section 3.13.1 includes a complete summary of streams and tributaries in the watershed. All stream reaches that have been designated as critical area projects have been broken out by parcel ownership so as to aid in implementation.

Critical Detention Basins
Critical detention basins are generally defined as existing basins that provide poor ecological and water quality benefits in areas where these attributes are needed. Seven (7) detention basins meet the criteria of a Critical Area based of their location, function, and size. Many of the Critical Area detention basin retrofit recommendations are located in highly visible locations that would also serve as an educational opportunity. The most common recommendation is to naturalize basins with native vegetation that are currently turf grass or rock-lined to provide better water quality improvement, greater infiltration of water, and wildlife habitat. A summary of the detention basins in the watershed is included in Section 3.13.2.

Critical Wetland Restoration Sites
Critical wetlands restoration sites are generally associated with large areas that where historically wetland prior to European settlement in the 1830s but were drained most often for agricultural purposes. Many of these historic wetlands can be restored by breaking existing drain tiles and planting with native vegetation. Wetland restorations are among the most recommended projects to improve water quality, reduce flooding, and improve wildlife habitat. They also can reduce fecal coliforms by an average of 92% when installed between a field and a stream (Wolfson, 2010). Critical Area status was assigned based on location, size, and restoration potential. There are 14 critical wetland restoration areas totaling 253 acres. A detailed summary of the extent of drained wetlands and potential wetland restoration opportunities in the watershed is included in Section 3.13.4.

Critical Agricultural Land
It is well documented that agricultural land is a significant contributor of nutrients and sediment in watersheds. According to modeling, agricultural areas contribute between 58% and 64% of the nutrient load and 57% of the

sediment load in the watershed. There are currently 21,590.6 acres of agricultural land used for row crops/hay production and livestock in Catfish Creek watershed. Forty-three (43) agricultural areas totaling 2,929 acres were identified as Critical Areas based on the results of the watershed inventory. While some good conservation-type agricultural practices were observed throughout the watershed, the extent of use of those practices needs to be increased significantly given the amount of nutrient and sediment loading was modelled as coming off of that agricultural land. Critical agricultural lands are those for which application of agricultural measures would reduce pollutant loading significantly. Practices recommended in this plan include conservation tillage (no till) for crop land, vegetated swales, fencing to restrict livestock access, and waste (manure) management on livestock operations. Fencing has also been shown to reduce E. coli loading 37-46% (Texas, 2011); vegetated swales reduce fecal coliform by 74% (Wolfson, 2010); and manure management systems reduce varying amounts of pathogens between 90-99% depending on the type of system/treatment utilized (Sobsey, 2001). A detailed summary of agricultural land and management practices in the watershed is included in Section 3.13.3.

Critical Green Infrastructure Protection Areas

Information obtained from predicted future land use data and green infrastructure sections of this plan led to identification of 35 critical green infrastructure protection areas totaling 3,350 acres.
Most of the green infrastructure protection areas are essentially undeveloped parcels located on existing agricultural land. The implementation of conservation or low impact development designs on parcels that will be developed or acquiring and protecting those that come up for sale in these areas could provide extensive watershed benefits.

Other Management Measures

As a result of the watershed inventory conducted by AES, three critical areas that fall under the category of "other" management measures were found. They include an area where parking lot BMPs are needed (42C), as well as two mulch processing facilities (44A and 60A).

Parking lot BMPs are needed at Dubuque Technology Park across 17 existing parking lot islands. Retrofitting these islands as vegetated depressions and installing curb cuts would improve infiltration and water quality.

Two sites were identified where detention is needed to improve water quality runoff from existing mulch processing and storage facilities. Over time, mulch piles begin to decompose, releasing a dark brown organic liquid. This liquid, or leachate, may contain high levels of tannins, organic acids, and other contaminants. Due to its potentially acidic nature, leachate from wood material can degrade the quality of nearby water sources by reducing the pH, mobilizing metals within the soil, lowering the level of dissolved oxygen in surface water, and may also contain nutrients and organic material. This in turn can kill fish and other aquatic organisms, and impair wildlife habitats (PA Department of Environmental Protection, 2003).

Table 34. Critical Areas, existing conditions, recommended Management Measures, & estimated nutrient and sediment load reductions.

Critical Area	Existing Condition/ Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
			TSS (t/yr)	TP (lbs/yr)	TN (lbs/ yr)
Stream Reaches					
Catfish Creek Reaches 3-4 (CC03-04)	4,721 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	488	488	975
Catfish Creek Reach 4 (CC04)	4,153 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	413	413	826
Catfish Creek Reaches 5-8 (CC05-08)	11,116 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	935	935	1,871
Catfish Creek Reach 8 (CC08)	3,433 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	357	357	714
Catfish Creek Reaches 9-10 (CC09-10)	2,793 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	192	192	385
Catfish Creek Reach 10 (CC10)	4,992 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	855	855	1,711
Catfish Creek Reaches 11-12 (CC11-12)	2,395 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	535	535	1,070
Catfish Creek Reach 13A (CC13-A)	2,410 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	516	516	1,032

Critical Area	Existing Condition/ Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
			TSS (t/yr)	TP (lbs/yr)	TN (lbs/ yr)
Catfish Creek Reach 13B (CC13-B)	5,142 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	1,574	1,574	3,147
Catfish Creek Reaches 14-15 (CC14-15)	2,514 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	438	438	875
Catfish Creek Reach 16 (CC16)	2,751 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	505	505	1,010
Catfish Creek Reaches 17-18, Granger Creek Reach 7 (CC17-18, GC07)	7,262 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	2,644	2,644	5,289
Catfish Creek Tributary 17 (CCT17)	2,865 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	614	614	1,227
Catfish Creek Tributary 18 (CCT18)	1,000 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	184	184	367
Granger Creek Reaches 2-3, Granger Creek Tributary 4B (GC02-03, GCT04B)	7,886 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	679	679	1,357
Granger Creek Reach 3 (GC03)	3,329 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	286	286	573

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Granger Creek Reaches 3-4 (GC03-04)	5,782 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	807	807	1,614
Granger Creek Reaches 5-6 (GC05-06)	8,186 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	639	639	1,278
Granger Creek Reach 7 (GC07)	3,580 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	893	759	1,518
Granger Creek Tributary 7A (GCT07-A)	2,730 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	543	543	1,086
Granger Creek Tributary 7B (GCT07-B)	618 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	123	123	246
Granger Creek Tributary 7C (GCT07-C)	4,398 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	875	875	1,749
Middle Fork Reaches 2-3 (MF02-03)	2,915 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	281	281	562
Middle Fork Reach 2A (MF02-A)	2,841 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	190	190	380
Middle Fork Reach 2B (MF02-B)	1,302 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	90	90	179

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			TSS (t/yr)	TP (lbs/yr)	TN (lbs/ yr)
Middle Fork Reach 4A (MF04-A)	1,306 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	90	90	180
Middle Fork Reach 4B (MF04-B)	3,502 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	375	375	750
Middle Fork Reach 4C (MF04-C)	1,654 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	202	202	405
Middle Fork Reaches 5-6 (MF05-06)	3,660 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	402	402	805
Middle Fork Reach 6 (MF06)	1,217 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	192	192	384
Middle Fork Reaches 6-7 (MF06-07)	2,095 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	183	183	365
Middle Fork Reach 8 (MF08)	1,394 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	181	181	363
Middle Fork Reach 8, Middle Fork Tributary 11 (MF08, MFT11)	3,899 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	611	611	1,223
Middle Fork Reach 9A (MF09-A)	2,536 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	303	303	606

Critical Area	Existing Condition/ Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
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Middle Fork Reach 9B (MF09-B)	1,535 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	200	200	399
Middle Fork Reach 12 (MF12)	3,847 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	644	644	1,287
Middle Fork Tributary 5 (MFT05)	846 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	91	91	181
Middle Fork Tributary 6 (MFT06)	1,927 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	111	111	221
Middle Fork Tributary 9 (MFT09)	6,326 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	1,065	1,065	2,129
Middle Fork Tributary 12 (MFT12)	1,140 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	98	98	196
North Fork Reach 2A (NF02-A)	528 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	90	76	153
North Fork Reach 2B (NF02-B)	1,421 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	242	206	411
North Fork Tributary 2 (NFT02)	6,253 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	2,151	1,828	3,656

Critical Area	Existing Condition/ Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
			TSS (t/yr)	TP (lbs/yr)	TN (lbs/ yr)
South Fork Reaches 2-3 (SF02-03)	4,687 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	455	455	911
South Fork Reach 2A (SF02-A)	4,153 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	286	286	572
South Fork Reaches 2B, South Fork Tributary 8 (SF02-B, SFT08)	3,755 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	180	180	560
South Fork Reach 3A (SF03-A)	1,436 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	122	104	208
South Fork Reach 3B (SF03-B)	2,941 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	507	431	862
South Fork Reaches 3-4 (SF03-04)	3,103 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	938	798	1,595
South Fork Reaches 4-5 (SF04-05)	5,507 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	2,186	1,858	3,716
South Fork Reach 7A (SF07-A)	3,157 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	423	423	845

Critical Area	Existing Condition/ Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
			TSS (t/yr)	TP (lbs/yr)	TN (lbs/ yr)
South Fork Reach 7B (SF07-B)	3,239 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	396	396	793
South Fork Reaches 7-8, South Fork Tributary 15 (SF07-08, SFT15)	6,766 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	776	776	1,553
South Fork Reaches 8-9 (SF08-09)	3,133 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	479	479	959
South Fork Tributary 9 (SFT09)	1,346 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	129	129	257
South Fork Tributary 10 (SFT10)	1,843 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	282	282	564
South Fork Tributary 15 (SFT15)	5,488 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	157	157	315
South Fork Tributary 16 (SFT16)	1,727 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	529	529	1,057
South Fork, Fork Branch 1 (SFFB01)	1,685 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	516	516	1,032

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Detention Basins					
4E	Dry Bottom Detention - turf; dry bottom online regional detention area, dry area mowed; natural areas dominated by invasive species	Design and implement a project to remove invasives along tribs, plant dry areas to prairie, and maintain for three years to establish	7	22	74
5A	Dry Bottom Detention - turf; services church parking lot to south, large drop outlet on east side, sheet flows from parking lot	Design and implement a project install a native prairie vegetation outside of ballfield area and maintain for three years to establish	4	4	15
5B	Wetland Bottom Detention; at headwaters of trib, services Sams Club to north, whole basin mowed down even through wet areas	Design and implement project to install a native prairie buffer, plant emegents along shoreline, and maintain for three years to establish	8	10	71
12J	Dry Bottom Detention - turf; shallow basin w/flush manhole	Design and implement to install a native prairie buffer, naturalize basins, install educational signage/trails, and maintain for three years to establish	3	3	11
12K	Dry Bottom Detention - turf; shallow basin and surrounding area being mowed	Design and implement to install a native prairie buffer, naturalize basins, install educational signage/trails, and maintain for three years to establish	3	5	17
21A	Wet Bottom Detention - turf; steep sloped basin, no emergent plants, water appears to be dyed, algae abundant	Design and implement project to regrade shoreline to accommodate emergents, install a native prairie buffer, plant emegents along shoreline, and maintain for three years to establish	4	11	36
32E	Dry Bottom Detention - turf; drainage swale through center, appears to drain commercial area to west and portion of trailer park and highway, outlet is corrugated pipe that could be retrofitted as detention outlet	Design and implement a project to alter outlet for detention purposes, excavate areas adjacent to swale for additional storage, install a native prairie buffer, plant emegents along shoreline, and maintain for three years to establish	11	13	46

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			TSS (t/yr)	TP (lbs/yr)	TN (lbs/yr)
Drained Wetlands					
W03	13.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	9	39
W08	10.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	2	12
W12	24.0 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	5	11	42
W13	18.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	4	24
W15	19.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	5	32
W17	25.7 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	6	35
W18	20.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	5	27
W21	14.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	5	32
W23	18.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	4	23
W33	29.0 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	6	8	50
W34	10.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	6	34
W45	12.6 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	4	18
W47	15.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	8	13	73
W50	18.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	6	36

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Agricultural Land					
8A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	1,218	1,277	2,503
9A	Agricultural land in row crop production with cattle; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	461	917	1,866
9B	Agricultural land in row crop production with in-field vegetated filter strips and buffers visibly lacking	Utilize no-till soil conservation practice, install vegetated filter strips, and buffers on private agricultural land	1,236	1,297	2,542
16A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	658	678	1,329
19B	Agricultural land and dairy farm; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	257	849	4,213
20E	Agricultural land with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	489	1,258	4,584
27A	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	456	909	1,858
27B	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	481	870	1,136
29B	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	612	1,228	2,494
30A	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	671	1,374	2,969
31A	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	393	757	1,376
31B	Agricultural land in row crop production with livestock; livestock allowed free access to streams	Utilize waste management system and fencing to restrict livestock access on private agricultural land	512	896	3,817

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37A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	574	589	1,154
40A	Agricultural land with cattle and horses; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	322	793	2,747
41A	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	326	739	2,413
42D	Agricultural land and dairy farm; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	341	995	4,346
42E	Some in-field swales present, but insufficient for topography	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	1,321	1,388	2,720
44B	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	619	1,158	1,741
46A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	201	200	392
46B	Agricultural land in row crop production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	604	1,566	5,724
46C	Agricultural land in row crop production with livestock; in-field vegetated filter strips visibly lacking; livestock allowed free access to streams	Utilize no-till soil conservation practice, install vegetated filter strips, waste management system, and fencing to restrict livestock access on private agricultural land	720	785	1,512
46D	Agricultural land in row crop production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	284	523	821
46E	Agricultural land in row crop production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	885	1,677	2,557

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47B	Agricultural land in row crop/hay production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	277	510	809
49A	Agricultural land with cattle; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	537	1,053	1,989
51C	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	690	712	1,395
52A	Agricultural land in row crop/hay production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	215	404	712
52B	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	939	1,898	3,790
52C	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	172	412	1,407
53A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	759	785	1,538
54A	Confined animal feedlot - pigs	Utilize waste management system on private agricultural land	0	649	2,673
58A	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	265	966	5,179
60D	Agricultural land in row crop/hay production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	381	694	976
62A	Agricultural land and dairy farm; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	322	1,065	5,270
62B	Agricultural land and dairy farm; cattle allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	339	786	2,434

Critical Area	Existing Condition/Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
			TSS (t/yr)	TP (lbs/yr)	TN (lbs/ yr)
64A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	347	351	688
65A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	1,211	1,270	2,489
67A	Agricultural land with horses/pasture; horses allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	183	325	449
69A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	334	338	662
72A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	1,195	1,252	2,454
73A	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	333	982	4,334
74A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	158	156	306
76A	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	364	369	723
Green Infrastructure Protection Areas					
GI01	Two parcels totaling 160.1 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI02	68.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI03	78.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI04	79.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI06	138 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		

Critical Area	Existing Condition/Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
			TSS (t/yr)	TP (lbs/yr)	TN (lbs/ yr)
GI07	103.9 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI08	152.7 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI09	70.6 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI10	80.1 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI11	113.9 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI13	73.2 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI14	89.6 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI15	60.5 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI16	63.0 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI17	74.3 acres currently in agricultural production with woodland areas and part of landfill operations	Once landfill is closed, create public open space amenity by naturalizing area	Pollutant reduction cannot be assessed via modeling		
GI18	166.9 acres of landfill and related uses	Once landfill is closed, create public open space amenity by naturalizing area	Pollutant reduction cannot be assessed via modeling		
GI19	179.7 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI20	66.6 acres in agricultural production and quarry	Once quarry operations cease, convert to public open water feature and naturalize where possible	Pollutant reduction cannot be assessed via modeling		
GI21	123.2 acres of stone quarry and related uses	Once quarry operations cease, convert to public open water feature and naturalize where possible	Pollutant reduction cannot be assessed via modeling		
GI22	88.3 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI23	67.2 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI24	79.9 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		

Critical Area	Existing Condition/Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
			TSS (t/yr)	TP (lbs/yr)	TN (lbs/ yr)
GI25	66.4 acres of woodland areas and possible hay field	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI26	72.4 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI27	78.5 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI28	275.7 acres of woodland areas and agricultural production	Preserve as open space and protect parcel from future development; protect and manage ecological components of the site	Pollutant reduction cannot be assessed via modeling		
GI29	66 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI30	86.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI31	82.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI32	72.4 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI33	103.3 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI34	60.9 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI35	69.4 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI36	69.3 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
GI37	66.6 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling		
Other Management Measures					
42C	Many of parking lot areas sheet flow directly into adjacent ravines	Design and install project to retrofit 17 existing parking lot islands as depressions w/curb cuts and planted w/vegetation (not necessarily natives)	37	46	336

Critical Area	Existing Condition/Description	Recommended Critical Area Management Measure	Nutrient & Sediment Load Reduction		
			TSS (t/yr)	TP (lbs/yr)	TN (lbs/yr)
44A	Mulch company in old quarry; site visited during rain event and runoff from mulch piles flows through paved area and into trib to Granger; could be nutrient hot spot; has not detention	Design and implement a project to create settling-type detention basin to remove nutrients and runoff prior to release from site	10	13	55
60A	Mulch producing business; water sheet flows from mulch piles to swale that flows to tributary	Design and implement a project to create wetland detention on site that captures and treats runoff prior to discharging from site	4	5	19

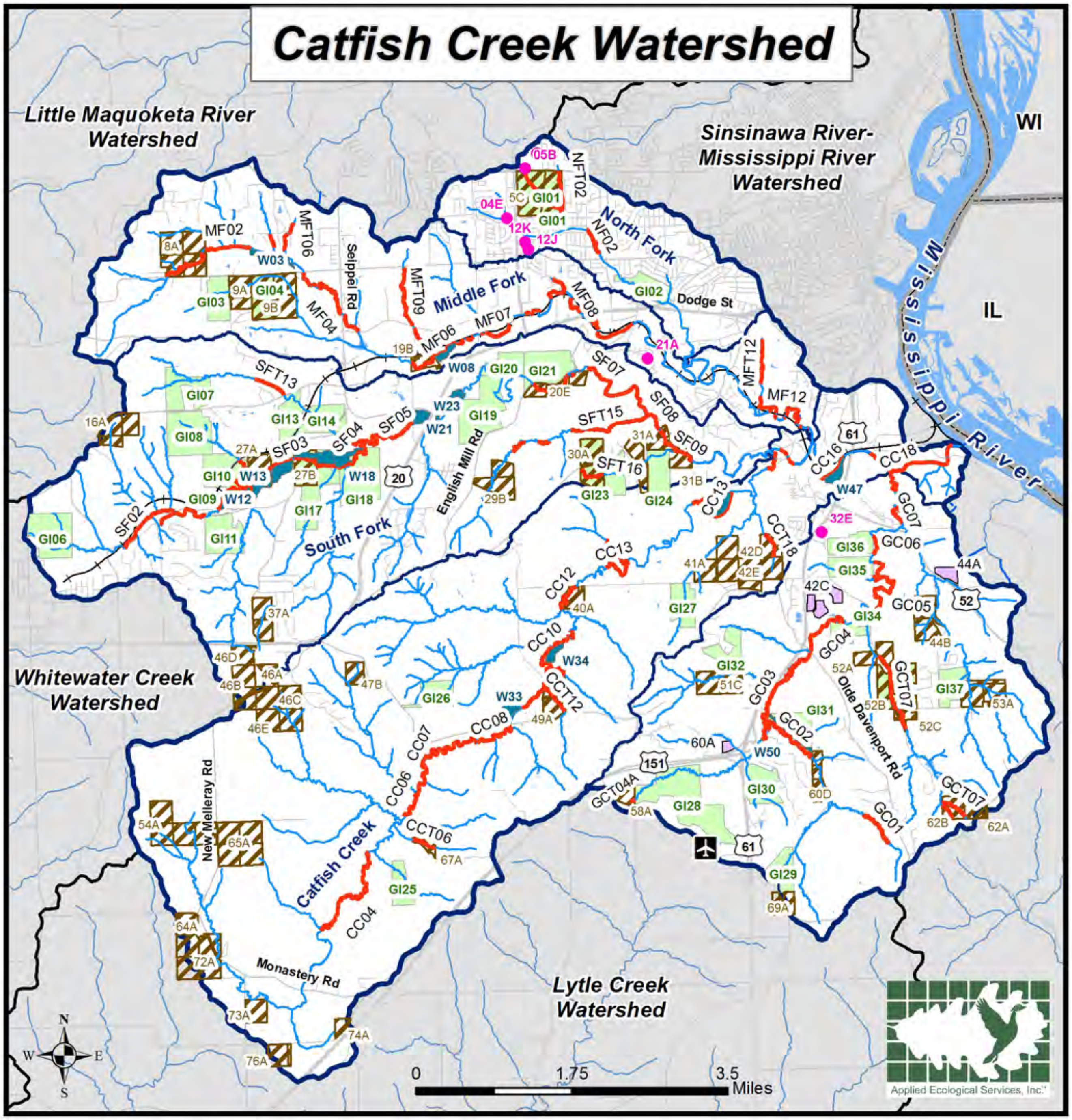
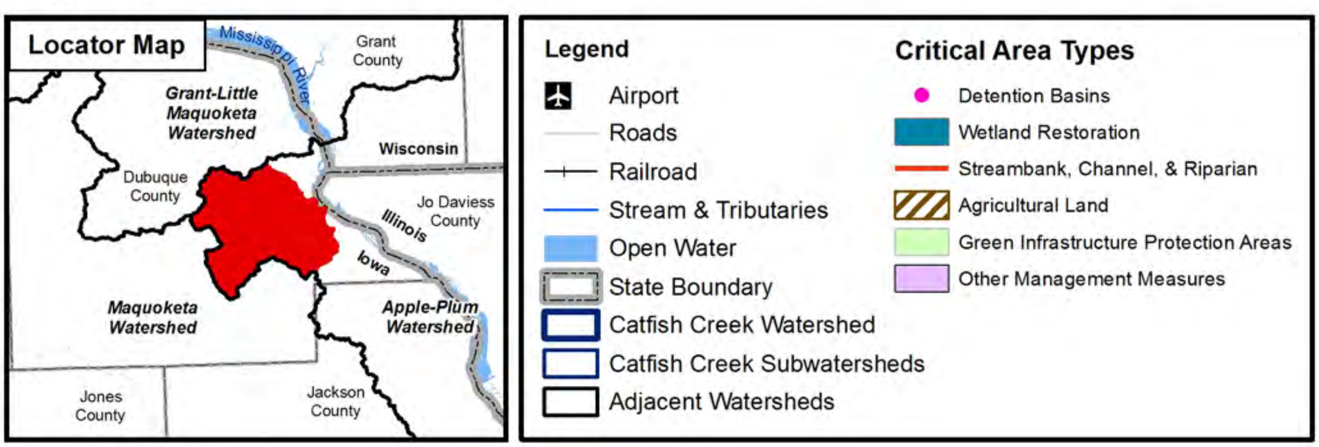


Fig. 57: Critical Areas



5.3 Watershed Impairment Reduction Targets

Establishing "Impairment Reduction Targets" is important because these targets provide a means to measure how implementation of Management Measures at Critical Areas is expected to reduce watershed impairments over time. Table 35 summarizes the basis for *known* impairments and reduction targets. Reduction targets listed in Table 35 are based on documented information, modeling results and/or water quality standards and criteria set by Iowa (2010), USEPA (2000), and USGS (2006). It is important to note that the assumption is made that percent decrease in sample concentration (mg/l) needed correlates to the percent reduction in annual load (lbs/yr or tons/yr) for phosphorus, nitrogen, and sediment reduction targets. In addition, Table 35 summarizes the load reduction of phosphorus, nitrogen, and total suspended solids (sediment) expected from addressing Critical Areas.

Watershed-Wide Reduction Targets for Phosphorus, Nitrogen, and Suspended Solids

Watershed-wide nitrogen, phosphorus, and sediment reduction targets could be attained by addressing Critical Areas alone according to the pollutant reduction calculations. Addressing all Critical Areas will remove 55,220 tons/yr of sediment, 69,393 lbs/yr of phosphorus, and 162,484 lbs/yr of nitrogen.

E. coli reductions cannot be measured through modeling however *E. Coli* reductions will come as a result of implementing projects such as wetland restoration, fencing, vegetated swales, and waste management systems. Wetland restorations or construction can reduce fecal coliforms by an average of 92% when installed between a field and a stream (Wolfson, 2010). Fencing has also been shown to reduce *E. coli* loading 37-46% (Texas, 2011); vegetated swales reduce fecal coliform by 74% (Wolfson, 2010); and waste (manure) management systems reduce varying amounts of pathogens between 90-99% depending on the type of system/treatment utilized (Sobsey, 2001). Given that a 98% reduction in *E. coli* loading is needed in order attain the target reduction, the target reduction for *E. coli* will not be met by addressing Critical Areas alone.

Additional watershed-wide reduction targets were established for habitat degradation, hydrologic flow changes, and structural flood problems. Habitat degradation and hydrologic flow change targets could be met by implementing riparian area restoration and by restoring wetlands. Each of the five structural flood problem areas can be addressed on a case by case basis to meet targets.

Table 35. Basis for *known* impairments, reduction targets, & impairment reduction for pollutants from Critical Areas.

Impairment: Cause of Impairment	Basis for Impairment	Reduction Target	Reduction from Critical Area	Target Attainable?
Watershed-Wide Reduction Targets				
Aquatic Life: Phosphorus in Catfish Creek	82,140 lbs/yr of phosphorus loading based on STEPL model & wastewater treatment plant loading; 0.194 mg/l total phosphorus in Catfish Creek water quality samples	**>63.9% or 52,487 lbs/yr reduction in phosphorus** loading to achieve 0.070 mg/l total phosphorus USEPA numeric criteria for streams in Ecoregion VII	31,159 lbs/yr or 38% reduction from critical stream reaches	
			71 lbs/yr or <1% reduction from critical riparian areas	
			179 lbs/yr or <1% reduction from critical wetland restorations	
			220 lbs/yr or <1% reduction from critical detention basin retrofits	
			37,700 lbs/yr or 46% reduction from critical agricultural land	
			64 lbs/yr or <1% from other management measures	
TOTAL			**69,393 lbs/yr or 84% total phosphorus reduction from all Critical Areas**	Yes
Aquatic Life: Nitrogen in Catfish Creek	298,802 lbs/yr of total nitrogen loading based on STEPL model & wastewater treatment plant loading; 2.45 mg/l total nitrogen in Catfish Creek water quality samples	**>29.4% or 87,848 lbs/yr reduction in nitrogen** loading to achieve 1.73 mg/l nitrite + nitrate nitrogen USEPA numeric criteria for streams in Ecoregion VII	62,517 lbs/yr or 21% reduction from critical stream reaches	
			687 lbs/yr or <1% reduction from critical riparian areas	
			945 lbs/yr or <1% reduction from critical wetland restorations	
			834 lbs/yr or <1% reduction from critical detention basin retrofits	
			97,091 lbs/yr or 32% reduction from critical agricultural land	
			410 lbs/yr or <1% from other management measures	
TOTAL			**162,484 lbs/yr or 54% total nitrogen reduction from all Critical Areas**	Yes
Aquatic Life: Total suspended solids (sediment) in Catfish Creek	58,993 tons/yr of sediment loading based on STEPL model & wastewater treatment plant loading; 135 mg/l total suspended solids in Catfish Creek water quality samples	**>91.5% or 53,979 tons/yr reduction in sediment** loading to achieve 11.5 mg/l total suspended solids based on USGS numeric criteria in Great Lakes Region and Adjacent Areas	32,227 lbs/yr or 55% reduction from critical stream reaches	
			44 lbs/yr or <1% reduction from critical riparian areas	
			115 lbs/yr or <1% reduction from critical wetland restorations	
			119 lbs/yr or <1% reduction from critical detention basin retrofits	
			22,662 lbs/yr or 38% reduction from critical agricultural land	
			51 lbs/yr or <1% from other management measures	
TOTAL			**55,220 tons/yr or 94% sediment reduction from all Critical Areas**	Yes

Impairment: Cause of Impairment	Basis for Impairment	Reduction Target	Reduction from Critical Area	Target Attainable?
Primary Contact: Indicator Bacteria	6416 org/100mL *E. coli* in Catfish Creek water quality samples	**>98.0% or 6,288 org/ 100 mL reduction in *E. coli*** loading to achieve 126 org/100mL based on Iowa Surface Water Quality Standards Implementation	Pollutant reduction cannot be assessed via modeling, but *E. coli* and pathogen reductions will occur by implementing wetland restorations, fencing, and agricultural waste management systems	No
Habitat Degradation: Invasive/non-native plant species in riparian areas	Many riparian areas are currently in poor condition	**154,901 linear feet or 15%** of riparian areas ecologically restored	204,417 linear feet or 20% of riparian areas restored at critical riparian areas	Yes
Habitat Degradation: Hydrologic and flow changes in Catfish Creek	4,685 acres (98%) of wetlands lost since pre-settlement	**14 critical wetlands restored** accounting for 253 acres	253 critical wetland acres restored	Yes
Structural Flood Damage: Structures in 100-year floodplain	5 structural flood problem areas	**5 or 100%** structural flood problem areas addressed	Not Applicable	Yes

6.0 Management Measures Action Plan

Earlier sections of this plan summarized Catfish Creek watershed's characteristics and identified causes and sources of watershed impairment. This section includes an "Action Plan" developed to provide stakeholders with recommended "Management Measures" (Best Management Practices) to specifically address plan goals at general and site specific scales. The Action Plan is divided into two subsections:

- *Programmatic Measures :* general remedial, preventive, and policy watershed-wide Management Measures that can be applied across the watershed by various stakeholders.
- *Site Specific Measures:* actual locations where Management Measure projects can be implemented to improve surface and groundwater quality, green infrastructure, and flooding.

The recommended programmatic and site specific Management Measures provide a solid foundation for protecting and improving watershed conditions but should be updated as projects are completed or other opportunities arise. Lead implementation stakeholders are encouraged to organize partnerships with key stakeholders and develop various funding arrangements to help delegate and implement the recommended actions. The key stakeholders in the watershed are listed in Table 36. Detailed descriptions and responsibilities of each stakeholder is found in Appendix E.

Table 36. Key Catfish Creek watershed stakeholders/partners.

Key Watershed Stakeholder/Partner	Acronym/Abbreviation
Catfish Creek Watershed Management Authority	CCWMA
Center Township	Center
City of Asbury	Asbury
City of Centralia	Centralia
City of Dubuque	Dubuque
City of Peosta	Peosta
Dubuque County	County
Dubuque County Conservation Board	DCCB
Dubuque Soil and Water Conservation District	SWCD
Dubuque Township	Dubuque Twp
East Central Intergovernmental Association	ECIA
Environmental Stewardship Advisory Commission	ESAC
Golf Courses	GC
Green Dubuque	Green
Iowa Department of Agriculture and Land Stewardship	IDALS
Iowa Department of Natural Resources	IDNR
Iowa Department of Transportation	IDOT
Iowa's Volunteer Water Quality Monitoring Program	IOWATER
Mosalem Township	Mosalem
Prairie Creek Township	Prairie Creek
Table Mound Township	Table Mound
US Fish & Wildlife Service	USFWS
Vernon Township	Vernon
Washington Township	Washington

6.1 Programmatic Management Measures Action Plan

Numerous types of programmatic Management Measures are recommended to address watershed objectives for each plan goal. The following pages include recommended measures that are applicable throughout the watershed and information needed to facilitate implementation of specific actions. A brief summary of the general programmatic measure types is included below:

Policy: Local, state, and federal government can help prevent watershed impairments in various ways through policy but specifically by adopting the Catfish Creek Watershed Management Plan, implementing green infrastructure policy, requiring conservation or low impact developments, protecting groundwater, reducing road salt usage and lawn fertilizers, requiring natural detention basins, and allowing use of native vegetation/landscaping.

Non-Structural: This includes a broad group of practices that prevent impairment through maintenance and management of Management Measures or programs that are ongoing in nature and designed to control pollutants at their source. Such programs include many of the agricultural programs available to farmers, the Audubon Cooperative Sanctuary Program (ACSP) for golf courses, and street sweeping.

Structural: This includes a broad group of practices that prevent impairment via installation of in-the-ground measures. This plan focuses on implementation of naturalized stormwater measures/retrofits, permeable paving, vegetated filter strips/buffers, natural area restoration, wetland restoration, and use of rainwater harvesting devices.

Educational: Outreach is important to educate the public related to environmental impacts of daily activities and to build support for watershed planning and projects. Topics typically addressed include land management, pet waste management, lawn fertilizer use, environmentally-friendly housekeeping, etc.

6.1.1 Policy Recommendations

Various recommendations are made throughout this report related to how local governments can improve the condition of Catfish Creek watershed through policy. Policy recommendations focus on improving watershed conditions by preserving green infrastructure, utilizing appropriate agricultural land management programs, minimizing road salt usage, minimizing lawn fertilizer application, sustainable management of stormwater, and allowances for native landscaping. To be successful, the Catfish Creek Watershed Management Plan would need to be adopted by local governments and local plans and ordinances would need to be updated with recommendations. The process of creating and implementing policy changes can be complex and time consuming. And, although there are numerous possible policy recommendations for the watershed, the following policy recommendations are considered the most important and highest priority for adoption.

Plan Adoption & Implementation Policy Recommendations

- Watershed Partners adopt the Catfish Creek Watershed Management Plan and incorporate plan goals, objectives, and recommended actions into comprehensive plans and ordinances.

Green Infrastructure Network Policy Recommendations

- Each municipality incorporates the identified Green Infrastructure Network into comprehensive plans and development review maps.

- Amend municipal comprehensive plans and zoning ordinances to include a Catfish Creek Watershed Protection Overlay that requires Conservation Design or Low Impact standards for all development and redevelopment located on identified Green Infrastructure Network parcels. The Conservation Subdivision portion of the City of Dubuque Unified Development Code adopted October 19, 2009 can be used as a minimum standard/guideline.

- Require Watershed Protection Fees in all municipalities in the form of Development Impact Fees and/or Special Service Area (SSA) taxes for all new and redevelopment to help fund management of green infrastructure components within developments.

- Require developers to protect sensitive natural areas, restore degraded natural areas and streams, then donate all natural areas and naturalized stormwater management systems to a public agency or conservation organization for long term management with dedicated funding. It is not recommended that these features be handed over to HOA's to manage.

- Establish incentives for developers who propose sustainable or innovative approaches to preserving green infrastructure and using naturalized stormwater treatment trains.

- Require mitigation for wetlands lost to development to occur within the watershed.

Road Salt Policy Recommendations

- Each municipality/township supplement existing programs with deicing best management practices such as utilizing alternative deicing chemicals, anti-icing or pretreatment, controlling the amount and rate of spreading, controlling the timing of application, utilizing proper application equipment, and educating/ training deicing employees. See the USEPA's Source Water Protection Practices Bulletin entitled "Managing Highway Deicing to Prevent Contamination of Drinking Water," available at http://www.epa.gov/safewater/sourcewater/pubs/fs_swpp_deicinghighway.pdf.

Lawn Fertilizer Policy Recommendations

- Municipalities/townships create regulations banning phosphorus unless soil testing pre-application proves necessary.

Stormwater Management Facility Policy Recommendations

- Require new development and redevelopment to use stormwater management facilities that serve multiple functions including storage, water quality benefits, infiltration, and wildlife habitat.

- Require reduced runoff volume from new and retrofitted detention basins.

Native Landscaping/Natural Area Restoration

- Allow native landscaping within local ordinances.

- Ensure local "weed control" ordinances do not discourage or prohibit native landscaping.

- Include requirements for short and long term management with performance standards for restored natural areas and stormwater features within new and redevelopment.

6.1.2 Dry & Wet Bottom Detention Basin Design/ Retrofits, Establishment, & Maintenance

Detention basins are best described as human made depressions for the temporary storage of stormwater runoff with controlled release following a rain event. There are over 88 detention basins in Catfish Creek watershed and most are associated with residential and commercial development. Many of the existing dry bottom basins are designed as either small, rock-lined basins with a manhole at the bottom or a swale or depression planted with turf grass and containing a large concrete structure at one end. These attributes do not promote good infiltration, water quality improvement, or wildlife habitat capabilities. Most existing wet bottom basins have been created near newer development, both residential and commercial, that was constructed along a ridgeline. Subsequently detention servicing these areas was built by creating a berm at one end of the top of the nearest ravine or draw draining to a stream.

Studies conducted by several credible entities over the past two decades reveal the benefits of detention basins that serve multiple functions. According to USEPA, properly designed dry bottom infiltration basins reduce total suspended solids (sediment) by 75%, total phosphorus by 65%, and total nitrogen by 60%. Wet bottom basins designed to have wetland characteristics reduce total suspended solids (sediment) by 77.5%, total phosphorus by 44% and total nitrogen by 20%.

Detention Basin Recommendations
Future detention basin design within the watershed should consist of naturalized basins that serve multiple functions including appropriate water storage, water quality improvement, natural aesthetics, and wildlife habitat. Figure 60 illustrates how naturalized detention basins could

Figure 58. Naturalized dry bottom infiltration basin design.

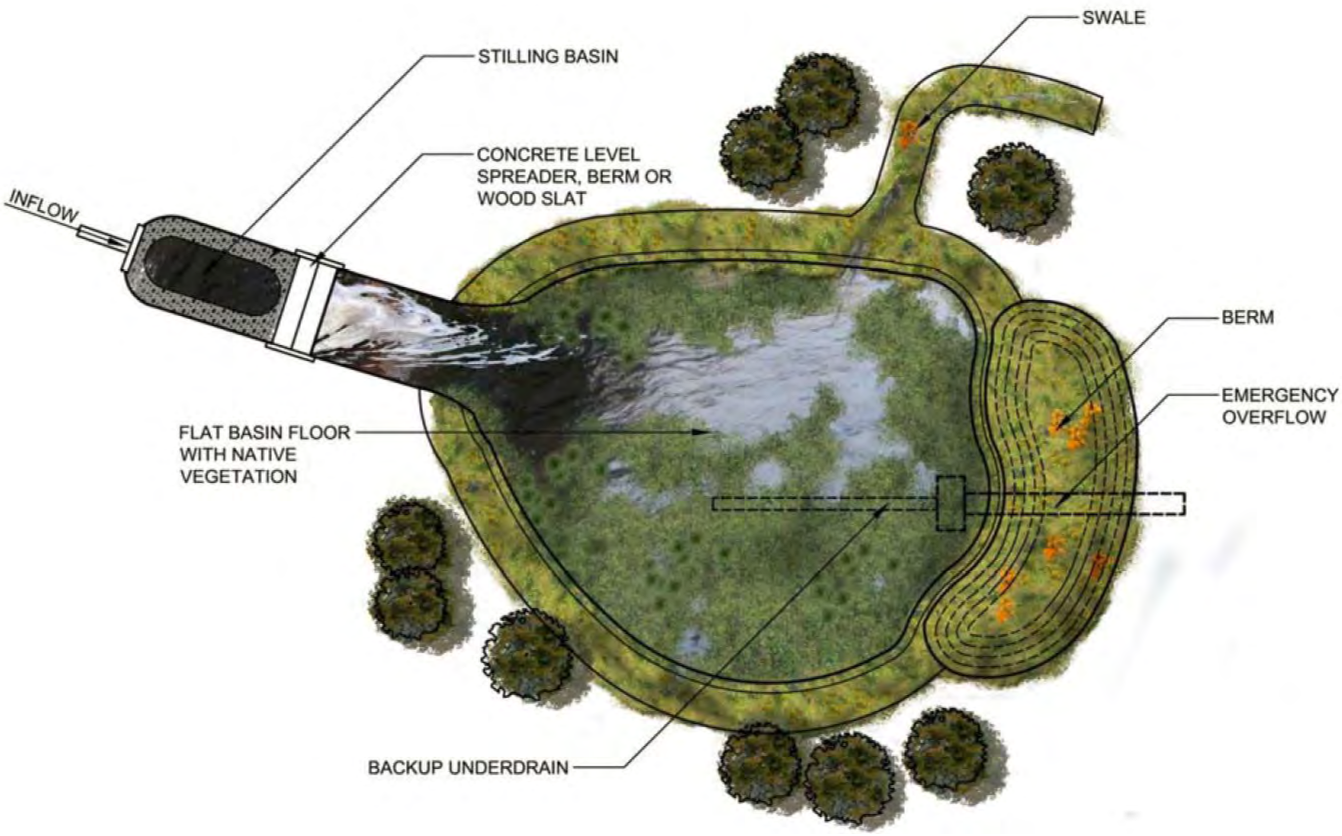


Figure 59. Naturalized wet bottom detention basin design.

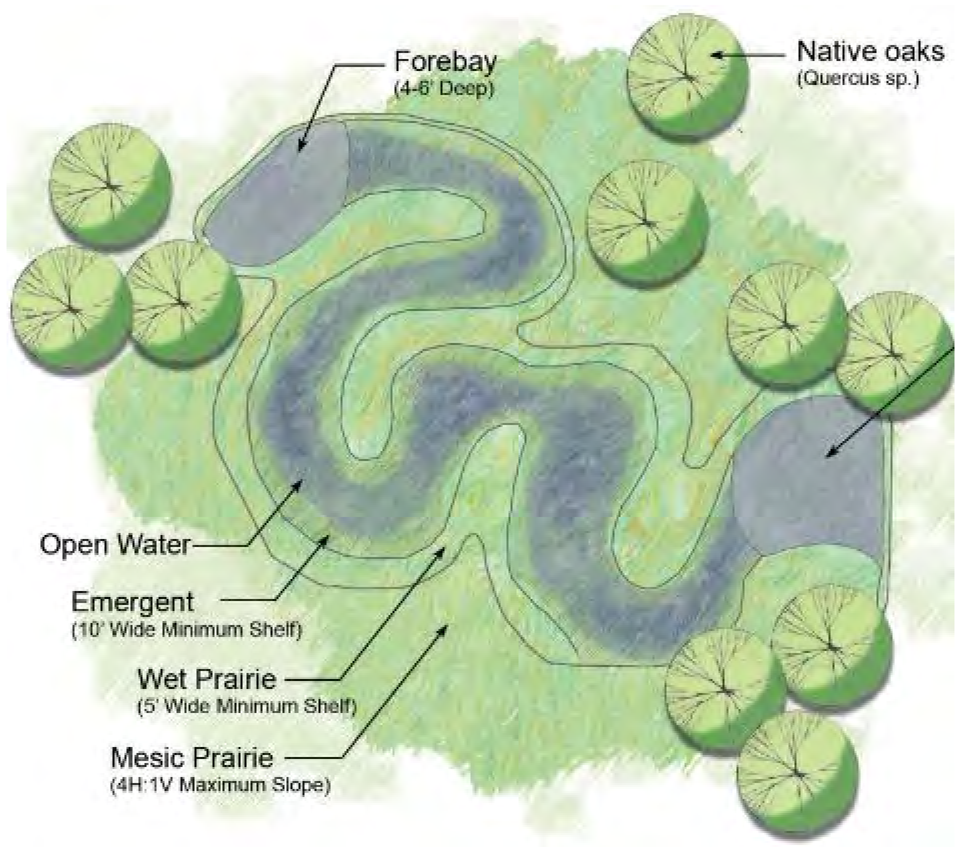
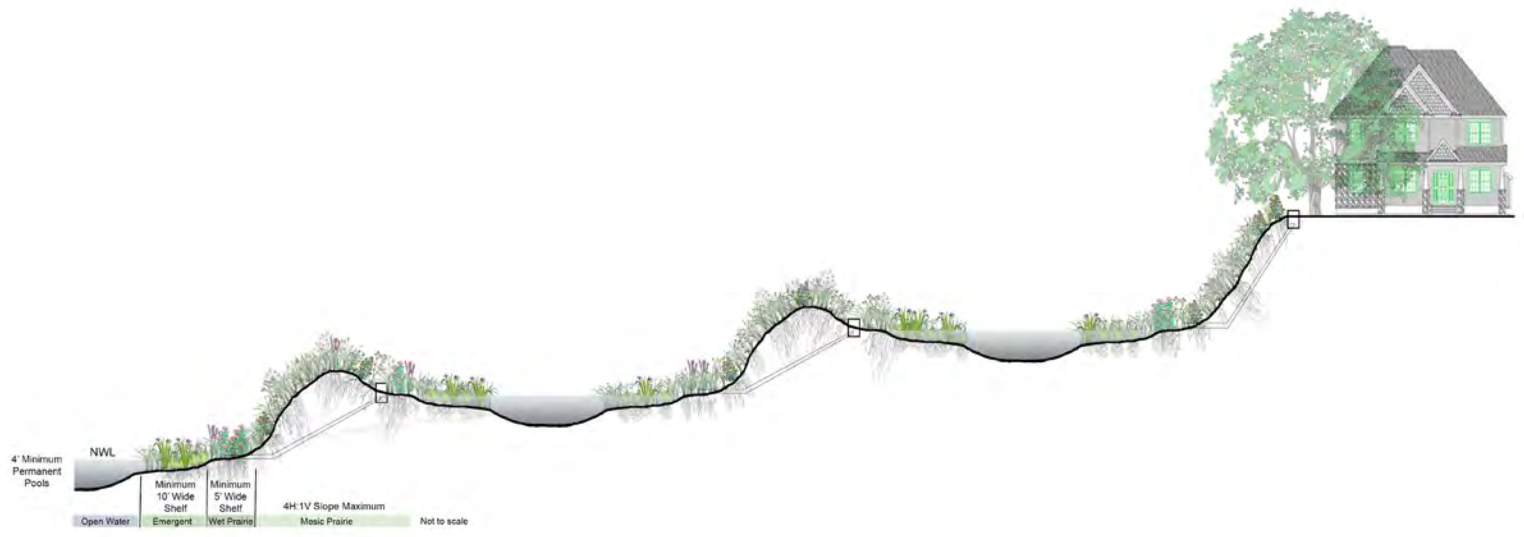


Figure 60. Series of terraced, naturalized wet detention basins proceeding down ravine.



be constructed within a typical ravine in Catfish Creek watershed. In this example, the development is located on a ridgeline. From this ridgeline, stormwater could be treated in naturalized roadside swales then piped down to a series of naturalized wetland detention ponds where additional sediment and nutrient could be removed prior to water being released to the nearest stream. This series of naturalized detention basins would also result in improved wildlife habitat and overall more functional green infrastructure. There are also a large number of opportunities to retrofit existing dry or wet bottom detention basins by incorporating minor engineering changes and naturalizing with native vegetation. Site specific retrofit opportunities are identified in the Site Specific Action Plan. Location, design, establishment, and long term maintenance recommendations for detention basins is included below.

<u>Detention Location Recommendations</u>

- In many cases, naturalized detention basins can be located within ravines and adjacent to other existing green infrastructure in an attempt to aesthetically fit and blend into the landscape.
- Basins should not be constructed in any average to high quality ecological community.
- Outlets from detentions should not enter sensitive ecological areas.

<u>Detention Design Recommendations</u>

- Where feasible, one appropriately sized detention basin should be constructed across multiple development sites rather than constructing several smaller basins. This will create better recreational opportunities and make management easier.
- Side slopes should be planted to native prairie vegetation and stabilized with erosion control blanket. Native oak trees (*Quercus sp.*) and other fire-tolerant species should be the only tree species planted on the side slopes. This will make fire management easier.
- A minimum 5-foot wide shelf planted to native wet prairie vegetation and stabilized with erosion control blanket should be constructed above the normal water level. This area should be designed to inundate after every 0.5 inch rain event or greater.
- A minimum 10-foot wide shelf planted with native emergent plants should extend from the normal water level to 2 feet below normal water level.
- Permanent pools in wet and wetland bottom basins should be at least 4 feet deep.

<u>Short Term (3 Years) Native Vegetation Establishment Recommendations</u>

In most cases, the developer or owner should be responsible for implementing short term management of detention basins and other natural areas to meet a set of performance standards. Generally speaking, three years of management is needed to establish native plant communities within detention basins. Measures needed include mowing during the first two growing seasons following seeding to reduce annual and biennial weeds. Spot herbiciding is also required to eliminate problematic non-native/invasive species such as thistle, reed canary grass, common reed, purple loosestrife, and emerging cottonwood, willow, buckthorn, and box elder

Table 37. Three-year vegetation establishment schedule for naturalized detention basins.

Year 1 Establishment Recommendations
Mow prairie areas to a height of 6-12 inches in May, July, and September.
Spot herbicide non-native/invasive species throughout site in late May and again in August/September. Target thistle, reed canary grass, common reed, purple loosestrife, and all emerging woody saplings.
Check for clogging and erosion control at inlet and outlet structures during every site visit.
Year 2 Establishment Recommendations
Mow prairie areas to a height of 12 inches in June and August.
Spot herbicide non-native/invasive species throughout site in May and again in August/September. Target thistle, reed canary grass, common reed, purple loosestrife, and all emerging woody saplings.
Plant additional emergent plugs if needed and reseed any failed areas in fall.
Check for clogging and erosion control at inlet and outlet structures during every site visit.
Year 3 Establishment Recommendations
Spot herbicide non-native/invasive species throughout site in May and again in August/September. Target thistle, reed canary grass, common reed, purple loosestrife, and all emerging woody saplings.
Check for clogging and erosion control at inlet and outlet structures during every site visit.

saplings. In addition, the inlet and outlet structures should be checked for erosion and clogging during every site visit. Table 37 includes a three year schedule appropriate to establish native plantings around naturalized detention basins.

Long Term (3 Years +) Native Vegetation Maintenance Recommendations

Long term management of most detention basins associated with development should be the responsibility of the homeowner or business association or local municipality. Often, these groups lack the knowledge and funding to implement long term management of natural areas resulting in the decline of these areas over time. Future developers should be encouraged to donate naturalized detention basins and other natural areas to a local municipality or conservation organization for long term management who receive funding via a Special Service Area (SSA) tax or other means. Table 38 includes a cyclical long term schedule appropriate to maintain native vegetation around detention basins following the initial three year establishment period.

Table 38. Three year cyclical long term maintenance schedule for naturalized detention basins.

Year 1 of 3 Year Maintenance Cycle
Conduct controlled burn in early spring. Mow to height of 12 inches in November if burning is restricted.
Spot herbicide problematic non-native/invasive species throughout site in mid-August. Specifically target thistle, reed canary grass, common reed, and emerging woody saplings such as willow, cottonwood, buckthorn, and box elder.
Check for clogging and erosion control at inlet and outlet structures during every site visit.
Year 2 of 3 Year Maintenance Cycle
Spot herbicide problematic non-native/invasive species throughout site in August. Specifically target thistle, reed canary grass, common reed, and emerging woody saplings such as willow, cottonwood, buckthorn, and box elder.
Mow prairie areas to a height of 6-12 inches in November.
Check for clogging and erosion control at inlet and outlet structures during every site visit.
Year 3 of 3 Year Maintenance Cycle
Spot herbicide problematic non-native/invasive species in August. Specifically target thistle, reed canary grass, common reed, and emerging woody saplings. Cutting & herbiciding stumps of some woody saplings may also be needed.
Check for clogging and erosion control at inlet and outlet structures during every site visit.

Rain garden at Swiss Valley Nature Preserve

6.1.3 Rain Gardens

Rain gardens have become a popular new way of creating a perennial garden that cleans and infiltrates stormwater runoff from rooftops and sump pump discharges. A rain garden is a small shallow depression that is typically planted with deep rooted native wetland vegetation. These small gardens can be installed in a variety of locations but work best when located in existing depressional areas or near gutters and sump pump outlets. Not only do rain gardens clean and infiltrate water, they also provide food and shelter for many birds, butterflies, and insects.

Rain Garden Recommendations
Education programs in the watershed should focus on teaching residents and businesses the beneficial uses of rain gardens. Local governments in the watershed should also install demonstration rain gardens as a way for the general public to better understand their application. Local governments and Dubuque Soil and Water Conservation District (SWCD) could hold rain garden training seminars and potentially provide partial funding to residents and businesses that install gardens.

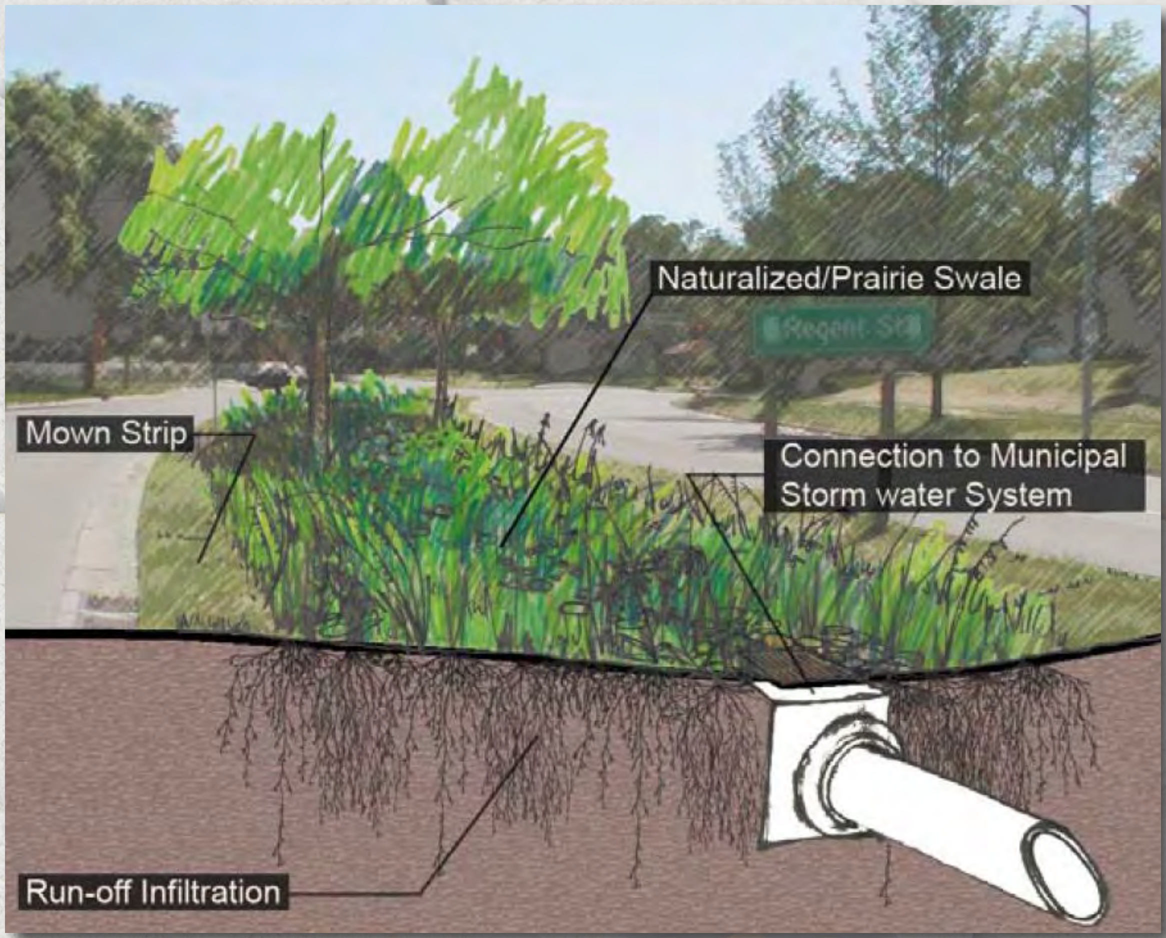
6.1.4 Vegetated Swales (Bioswales)

Vegetated swales, also known as bioswales, are designed to convey water and can be modified slightly to capture and treat stormwater for the watershed. Vegetated swales are designed to remove suspended solids and other pollutants from stormwater running through the length of the swale. The type of vegetation can dramatically affect the functionality of the swale. Turf grass is not recommended because it removes less suspended solids than native plants. In addition, vegetated swales can add aesthetic features along a roadway or trail. They can be planted with wetland plants (preferably native) or a mixture of rocks and plant materials can be used to provide interest.

Swales can be designed as either wet or dry swales. Dry swales include an underdrain system that allows filtered water to move quickly through the stormwater treatment train. Wet swales retain water in small wetland like basins along the swale. Wet swales act as shallow, narrow wetland treatment systems and are often used in areas with poor soil infiltration or high water tables.

Water quality is improved by filtration through engineered soils in dry swales and through sediment accumulation and biological systems in wet swales. According to USEPA, vegetated swales reduce total suspended solids (sediment) by 65%, total phosphorus by 25%, and total nitrogen by 10%.

Right: Dry vegetated swale rendering. Overlay: One type of pervious pavement.



Vegetated Swale Recommendations

Vegetated swales should be used to replace pipes or curbs in new and redevelopment where feasible. Swales can easily be integrated into various urban fabrics with curb cuts for water to access them from roadways, or they can be added between existing lots or in the grassy parkways between roads and sidewalks. Typically swales are used in lower density settings where infiltration might be maximized. Dry swales should be used for smaller development areas with small drainages. Wet swales should be used along larger roadways, small parking areas, and commercial developments.

6.1.5 Pervious Pavement

Pervious pavement is also referred to as porous or permeable pavement. Areas that are paved with pervious pavement produce less stormwater runoff than conventionally paved areas. These areas allow for infiltration of the water by allowing water that falls on the surface to flow to a storage gallery through holes in the pavement. As a great local example of the use of pervious pavement, the Dubuque County Conservation Board installed a porous asphalt driveway and a permeable paver sidewalk at the Swiss Valley Nature Center.

Traditionally, the quantity and quality of water running off paved surfaces, together with buildings, are the primary reason stormwater treatment is needed. Pervious pavement reduces runoff rates and volumes and can be used in almost every capacity in which traditional asphalt, concrete, or pavers are used.

Pervious pavement captures first flush rainfall events and allows water to percolate into the ground. Pervious pavement allows for the treatment of stormwater through soil biology and chemistry as the water slowly infiltrates. Groundwater and aquifers are recharged and water that might otherwise go directly into streams will slowly infiltrate, reducing flooding and peak flow rates entering drainage channels. Studies documented by the USEPA show that properly designed and maintained pervious pavement can reduce total suspended solids (sediment) by 90%, total phosphorus by 65%, and total nitrogen by 85%.

Pervious Pavement Recommendations

Future development and redevelopment in Catfish Creek watershed should consider the use of pervious pavement. Permeable pavement can be used in a variety of settings including parking lots, parking aprons, private roads, fire lanes, residential driveways, sidewalks, and bike paths.

Left: Filter strip along municipal building in Algonquin, Illinois; Right: Native landscaping near residential home. Source: Mike Halverson.

6.1.6 Vegetated Filter Strips

Vegetated filter strips are shallowly sloped vegetated surfaces that remove suspended sediment, and nutrients from sheet flow stormwater that runs across the surface. This Management Measure is often referred to as a buffer strip. The type of vegetation can dramatically affect the functionality of the filter strip. Filter strips can either be planted or can be comprised of existing vegetation. Turf grass is not recommended as it removes less total suspended solids than filter strips planted with native vegetation.

Filter strips are more effective the wider they are because the amount of time water has for interception/ interaction with the plants and soil within the filter strip is increased. When installed and functioning properly, the USEPA has documented that filter strips can reduce total suspended solids (sediment) by 73%, total phosphorus by 45%, and total nitrogen by 40%.

Vegetated Filter Strip Recommendations
Vegetated filter strips work in a variety of locations. Vegetated filter strips in rural and urban areas should be installed along streams, lakes, or ponds. Additionally, they can be used adjacent to buildings and parking lots that sheet drain. The water would then pass through the vegetated filter strip and into a waterway, such as a vegetated swale, stream, lake, pond, or other stormwater feature.

6.1.7 Natural Area Restoration & Native Landscaping

Natural area restoration and native landscaping are essentially one in the same but at different scales. Natural area restoration involves transforming a degraded natural area into one that exhibits better ecological health and is typically done on larger sites such as nature/forest preserves. Native landscaping is done at smaller scales around homes or businesses and is often formal in appearance. Both require the use of native plants to create environments that mimic historic landscapes such as prairie, woodland, and wetland. Native plants are defied as indigenous, terrestrial or aquatic plant species that evolved naturally in an ecosystem. The use of native plants in natural areas or native landscaping is well documented. They adapt well to environmental conditions, reduce erosion, improve water quality, promote water infiltration, do not require fertilizer, provide wildlife food and habitat, and have minimal maintenance costs.

Several environmental agencies support the use of native plants including Iowa Department of Natural Resources (IDNR), Dubuque County Conservation Board (DCCB), Dubuque Soil and Water Conservation District (DSWCD), U.S. Department of Agriculture (USDA), Natural Resource Conservation Program (NRCS), and National Wildlife Federation (NWF).

Natural Area Restoration/Native Landscaping Recommendations
Large residential lots with existing natural components such as prairie, oak woodlands, and wetlands as well as golf courses provide many of the best opportunities for natural area restoration and native landscaping at a larger scale. Homeowners interested in restoring natural areas or implementing native landscaping can find guidance through the agencies listed above or by contacting a local ecological consulting company. Backyard habitats can be certified through the National Wildlife Federation's Certified Wildlife Habitat program.

There are three golf courses in the watershed that comprise nearly 450 acres. Each course is situated either along a tributary stream or at the headwaters of one and all of them fall within the identified Green Infrastructure Network.

However, most courses could improve their function as green infrastructure by implementing natural area restoration into existing designs. The Audubon Cooperative Sanctuary Program (ACSP) is an education and certification program that helps golf courses protect the environment by providing guidance for outreach and education, resource management, water quality and conservation, and wildlife habitat management. A golf course becomes certified under the program when implementing and documenting recommended environmental management practices. Annual program membership fees are $200.

6.1.8 Wetland Restoration

Nearly 4,685 acres or 98% of the historic wetlands in Catfish Creek watershed have been lost to farming and development practices since European settlement in the 1830s. Wetlands are essential for water quality improvement and flood reduction in any watershed and also provide habitat for a wide variety of plant and animal species.

Approximately 470 acres of drained wetland was discovered in areas of the watershed were wetland restoration might be possible but many of these areas are located on land that is currently in agricultural production adjacent to stream channels. The wetland restoration process involves returning hydrology (water) and vegetation to soils that once supported wetlands. The USEPA estimates that wetland restoration projects can reduce suspended solids (sediment) by 77.5%, total phosphorus by 44%, and total nitrogen by 20%. Additionally, wetlands (even constructed wetlands) as an edge of field practice or ones that drain agricultural fields can reduce fecal coliforms by 92% on average (Wolfson, 2010).

Wetland Restoration Recommendations

Municipalities should strongly consider requiring “Conservation Design” that incorporates wetland restoration on parcels slated for future development. Another potential option is to restore wetlands as part of a wetland mitigation bank where wetlands are restored and become “fully certified.” Then, developers are able to buy wetland mitigation credits from the wetland bank for wetland impacts occurring elsewhere in the watershed. Wetland banks may provide an opportunity for polluters elsewhere in the watershed to buy “water quality trading credits.” Currently, there are no existing wetland mitigation banks in the area, but the Catfish Creek Watershed Management Authority has expressed interest in pursuing a wetland mitigation bank within the watershed. The Site Specific Action Plan section of this report identified sites where wetland restoration might be feasible.

Wetland restoration at Carrington Reserve Conservation Development in West Dundee, Illinois

Top: Routine street sweeping is an effective Management Measure. Source: USGS.
Bottom: Stream restoration project in Barrington, IL.

6.1.9 Street Sweeping

Street sweeping is often overlooked as a Management Measure option to reduce pollutant loading in watersheds. With 2,600 acres of roads accounting for about 5% of the watershed, municipal street sweeping programs could significantly reduce non-point source pollutants from urban areas in Catfish Creek watershed. Street sweeping works because pollutants such as sediment, trash, road salt, oils, nutrients, and metals that would otherwise wash into stormsewers and streams following rain events are gathered and disposed of properly. The USEPA and Center for Watershed Protection report similar pollutant removal efficiencies for street sweeping; weekly street sweeping can remove between 9% and 16% of sediment and between 3% and 6% of nitrogen and phosphorus.

Street Sweeping Recommendations
It is likely that some if not all of the municipalities in the watershed implement street sweeping to some degree. The frequency of street sweeping is a matter of time and budget and should be determined by each municipality. Weekly street sweeping would provide the best results but bi-weekly sweeping is cited as being sufficient in most cases.

6.1.10 Stream & Riparian Area Restoration & Maintenance

Streambank erosion and channelization is a leading problem in Catfish Creek Watershed. Stream surveys reveal that about 12% (7.1 linear miles) of streams in the watershed are highly eroded and another 59% (33.3 linear miles) are moderately eroded. Pollutant modeling indicates that nearly 22,224 tons/yr of sediment or 38% of sediment loading comes from eroded streambanks. In addition, riparian areas adjacent to streams are suffering as 24% are less than 30 feet in width and most of these areas are dominated by non-native and invasive species.

Stream and riparian area restoration is one of the best Management Measures that can be implemented to improve degraded stream and riparian area conditions. This work involves improvements to a stream channel using artificial pool-riffle complexes, streambank stabilization using a combination of bioengineering with native vegetation and hard armoring with rock if need, and adjacent riparian area improvements via removal of non-native vegetation and replacement with native species. These practices are typically done together as a way to improve water quality by reducing sediment transport, increasing oxygen, and improving habitat. The USEPA reports that as much as 90% of sediment, phosphorus, and nitrogen can be reduced following stream restoration. The downside to stream restoration is that it is technical and expensive. Stream restoration projects include detailed construction plans, often complicated permitting, and construction that must be done by a qualified contractor.

With so many individual landowners with parcels intersecting Catfish Creek and its tributaries, routine maintenance of stream systems is challenging. In many cases, landowners simply do not have the knowledge or are not physically capable of maintaining streams on their property. Stream maintenance includes an ongoing program to remove blockages caused by accumulated sediment, fallen trees, etc. and is a cost effective way to prevent flooding and streambank erosion.

Stream & Riparian Area Recommendations
There are many opportunities to implement stream and riparian area restoration in the watershed. These opportunities are identified in the Site Specific Action Plan. The American Fisheries Society has created a short document called "Stream Obstruction Removal Guidelines" which is meant to clarify the appropriate ways to maintain obstructions in streams to preserve fish habitat.

6.1.11 Septic System Maintenance

Septic systems are common in unincorporated areas of Catfish Creek watershed. When septic systems are not maintained and fail they can contribute high levels of nutrients and bacteria to the surrounding environment. Literature sources from USEPA indicate a general septic system failure rate of between 2% and 5%.

Septic System Recommendations
Septic owner should be compliant with the Dubuque County Private Sewage Disposal Systems ordinance and have routine inspections and sampling completed at least every six months. Septic owners should contact the Dubuque County Health Department who will inspect septic systems to ensure that they are designed and operating properly. In addition, the United States Environmental Protection Agency (USEPA) provides an excellent guide for septic system owners called "A Homeowner's Guide to Septic Systems" (USEPA 2005). The guide explains how septic systems work, why and how they should be maintained, and what makes a system fail.

6.1.12 Agricultural Management Practices

The single largest land use category in Catfish Creek watershed is agriculture, representing nearly 47% of the landscape; this gives agricultural land management practices a crucial role in helping to improve water quality watershed-wide. Pollutant loading estimates using USEPA's STEPL model point to agricultural land as the single largest contributor of nitrogen, phosphorus, and sediment in runoff. Fortunately, there are numerous agricultural measures and funding sources that can be used by farmers. Many recommended programs are offered through the Dubuque Soil and Water Conservation District (SWCD), U.S. Department of Agriculture (USDA) Natural Resource Conservation Program (NRCS), and Farm Service Agency (FSA).

Environmental Quality Incentive Program (EQIP)
The NRCS's Environmental Quality Incentive Program (EQIP) is a voluntary conservation program that provides financial assistance to individuals/entities to address soil, water, air, plant, animal and other related natural resource concerns on their land. EQIP offers financial and technical help to assist participants install or implement structural and management practices on eligible agricultural land.

Driftless Area Landscape Conservation Initiative (DALCI)
The NRCS's Driftless Area Landscape Conservation Initiative (DALCI) is a voluntary program aimed at helping producers and landowners within the Driftless Area to improve, protect and restore habitat for unique fish and wildlife species found in the region. The Driftless Area, including all of Catfish Creek watershed, stretches over parts of Iowa, Illinois, Wisconsin, and Minnesota. Funds for this program come through EQIP and target the reduction of erosion and sediment in streams. DALCI encourages the use of practices such as access control, fencing, prescribed grazing, conservation cover, heavy use area protection, and stream protection.

Several management practices are aimed at managin livestock access to streams in order to reduce erosion and sediment loading. Access Control and/or Fencing are practices that involve either temporary or permanent exclusion of animals or vehicles from a sensitive area such as streambanks. Stream Crossings are another management practice that can help control streambank erosion by creating stabilized areas

for both animal and vehicle traffic across streams. Heavy Use Area Protection is a practice that involves stabilizing land in areas that are heavily impacted by livestock, such as outdoor paddocks or near feeding troughs, so as to control erosion and soil disturbance. Access control, fencing, stream crossings, and heavy use area protection also help reduce pathogens, such as *E. coli* from entering waterways. All of these practices are available through both the EQIP and DALCI programs.

Conservation Tillage (no till) is a land management option within the EQIP program and is the leading recommendation for farmers in Catfish Creek watershed (see Site Specific Action Plan). With conservation tillage, the land is left undisturbed from harvest through planting, preserving a canopy of crop residue on the surface to protect the soil from erosion. Along with soil conservation benefits, high fuel prices are driving a switch to conservation tillage for many farmers. Eliminating tillage passes reduces both fuel and labor expenses. $15/ac is offered to farmers through the NRCS's EQIP program.

Wetland Reserve Program (WRP)
The Wetlands Reserve Program (WRP) is a voluntary program offering farmers the opportunity to protect, restore, enhance, and protect wetlands on their property. The NRCS provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection. Landowners who choose to participate in WRP may sell a conservation easement or enter into a cost-share restoration agreement with NRCS to restore and protect wetlands. The program offers landowners three options: permanent easements, 30-year easements, and restoration cost-share agreements of a minimum 10-year duration. Landowners and NRCS then develop a plan for the restoration and maintenance of the wetland. As a requirement of the program, landowners voluntarily limit future use of the land, yet retain private ownership.

Grassland Reserve Program (GRP)
The Grassland Reserve Program (GRP) is a voluntary conservation program that emphasizes support for working grazing operations, enhancement of plant and animal biodiversity, and protection of

Conservation Tillage (no till) farming. Source: farmprogress.com.

Above: Grass waterway on highly erodible agricultural land . Source: NRCS. Left: Access Control or Fencing. Source: NRCS.

grassland under threat of conversion to other uses. Participating farmers voluntarily limit future development and cropping uses of the land while retaining the right to conduct common grazing practices and operations related to the production of forage and seeding, subject to certain restrictions during nesting seasons of bird species that are in significant decline or are protected under Federal or State law. A grazing management plan is required for participants.

Agricultural Conservation Easement Program (ACEP)
The Agricultural Conservation Easement Program is a voluntary program that provides financial and technical assistance to help conserve agricultural lands and wetlands and their associated benefits through Agricultural Land Easements. ACEP is a new program designed to consolidate the WRP, GRP, and Farm and Ranch Land Protection Program.

Land eligible for agricultural easements includes cropland, rangeland, grassland, pastureland, and nonindustrial private forest land, while farmed or converted wetland that can be successfully and cost-effectively restored is eligible for wetland reserve easements. These programs require agricultural land easement or wetland reserve restoration easement plans to protect the land over the long-term.

Conservation Reserve Program (CRP)
The Conservation Reserve Program (CRP) is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species such as native prairie grasses that will improve environmental health and quality. Contracts for land enrolled in CRP are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

Wildlife Habitat Incentive Program (WHIP)
The Wildlife Habitat Incentive Program (WHIP) is a voluntary program for landowners who want to develop and improve wildlife habitat primarily on private lands. It provides both technical assistance and cost share payments to help native fish and wildlife species, reduce impacts of invasive species, and improve aquatic wildlife habitat.

Participants work with NRCS to prepare a wildlife habitat development plan in consultation with the local conservation district. The plan describes the participant's goals for improving wildlife habitat, includes a list of practices and a schedule for installing them, and details the steps necessary to maintain the habitat for the life of the agreement. NRCS and the participant enter into a cost-share agreement for wildlife habitat development that lasts from 5 to 10 years.

Waste (Manure) Management
The agricultural industry, livestock production within the agricultural industry is a producer of waste materials that need management. These wastes include primarily manure from livestock. The NRCS has produced the “Agricultural Waste Management Field Handbook (AWMFH)” to provide specific guidance for planning, designing, and managing systems where agricultural wastes are involved. It can help assist agricultural producers in organizing a comprehensive plan that results in the integration of waste management into overall farm operations. Material in this handbook covers a wide range of activities from incorporating available manure nutrients into crop nutrient budgets to proper disposal of waste materials that do not lend themselves to resource recycling.

6.1.13 Rainwater Harvesting & Re-use

Water harvesting and re-use using rain barrels and cisterns are important options to decrease the amount of stormwater runoff in a watershed. It is a simple, economical solution that can be done by any homeowner or business. On most homes and buildings, the water from roofs flows into downspouts and then onto streets, parking areas, or into stormsewers. Disconnecting the downspouts and using either rain barrels or cisterns or re-use later can reduce the flood levels in local streams.

Water re-use differs based on the type of storage and water treatment. A rain barrel is typically attached to a downspout and collects water for irrigation purposes. In many areas, residential irrigation can account for almost 50 percent of residential water consumption. Re-using water is a great way of minimizing water use and lowering water bills.

A cistern also stores water from rooftop runoff to be used later. However a cistern is often larger, sealed, and the water can be filtered for a wider variety of uses. With appropriate sanitation treatments, water from cisterns can even be reused for toilets, housecleaning, showers, hand washing, and dish washing. Cistern water, without any sanitation, can be used for lawn and garden watering, irrigation, car washing, and window cleaning.


Rain barrel at Swiss Valley Nature Center

The primary purpose of rain barrels and cisterns is water storage. Rain barrels typically store 55 gallons each. Cisterns can store greater amounts. Rain barrels and cisterns also reduce water demand in the summer months by reducing the potable water used for irrigation or other household uses.

Rainwater Harvesting & Reuse Recommendations
Education programs in the watershed should focus on teaching residents and businesses the beneficial uses of rain barrels and cisterns. Local governments in the watershed should aim to install demonstration rain barrels as a way for the public to better engage in their use around residential homes. Local governments and conservation organizations such as the Catfish Creek Watershed Management Authority (CCWMA), Dubuque County Conservation Board, and Dubuque Soil and Water Conservation District (SWCD) should sponsor programs where residents and businesses can purchase rain barrels.

6.1.14 Conservation & Low Impact Development

Conservation design facilitates development density needs while preserving the most valuable natural features and ecological functions of a site. It does this by reducing lot size, especially lot width thereby reducing the amount of roads and infrastructure (Figure 61). The open space is typically preserved or restored natural areas that are integrated with newer natural stormwater features and recreational trails. The open space allows the residents to feel like they have larger lots because most of the lots adjoin the open space system. Conservation design is also known as cluster or open space design.

Low impact development (LID) focuses on the hydrologic impact of development and tries to maintain pre-development hydrologic systems, treating water as close to the source as possible. LID principals can be incorporated into development or stormwater ordinances and used in new development or retrofitting existing developments. Green infrastructure systems are created to mimic natural processes that promote water infiltration, native plant evapotranspiration, and stormwater reuse.

Conservation /Low Impact Development Recommendations
Both Conservation Design and Low Impact Development are already encouraged under the Dubuque County Smart Plan. There are several opportunities to implement Conservation/Low Impact Design into future development sites in the watershed. These opportunities are identified in the Site Specific Action Plan. The general steps included below are generally followed when designing the layout of a development site using conservation or low impact design:

Step 1: Identify all natural resources, conservation areas, open space areas, physical features, and scenic areas and preserve and protect these areas from any negative impacts generated as a result of the development.

Step 2: Locate building sites to take advantage of open space and scenic views by requiring smaller lot sizes or cluster housing as well as to protect the development rights of the property owner and the number of occupancy units permitted by the underlying zoning of the property.

Step 3: Design the transportation system to provide access to building sites and to allow movement throughout the site and onto adjoining lands; roads should not traverse sensitive natural areas.

Step 4: Prepare engineering plans which indicate how each building site can be served by essential public utilities.

Figure 61. Conservation/Low Impact development design.

6.1.15 Green Infrastructure Planning

A green infrastructure network provides communities with a tool to identify and prioritize land use or conservation opportunities and plan development that benefits both people and nature by providing a framework for future growth that identifies areas not suitable for development, areas suitable for development but that should incorporate conservation or low impact design standards, and areas that do not affect green infrastructure. The municipalities in the watershed, Dubuque County Conservation Board, and IDNR can use green infrastructure plans for trail routing, open space linkages, and natural area restoration decisions. Residents can use green infrastructure recommendations to reduce runoff from their properties and to see how their properties fit into the larger network. A Green Infrastructure Network for the watershed was developed in Section 3.11.

Green Infrastructure Network *implementation* has several actions:

- Protect specific unprotected green infrastructure parcels through acquisition, regulation, and/or incentives.
- Incorporate conservation or low impact design standards on green infrastructure parcels where development is planned.
- Limit future subdivision of green infrastructure parcels.
- Implement long term management of green infrastructure.

Green Infrastructure Recommendations
A Green Infrastructure Network can only be realized by coordinated planning efforts of local municipalities, park districts, developers, and private land owners. Stakeholders should follow the recommended process below to initiate and implement the Green Infrastructure Network for Catfish Creek watershed.

1. Include all green infrastructure parcels in updated community comprehensive plans and development review maps.
2. Create zoning overlay and update development ordinances to require conservation development/low impact design on all green infrastructure parcels.
3. Require Development Impact Fees and/or Special Service Area taxes for all new development to help fund future management of green infrastructure.
4. Identify important unprotected green infrastructure parcels not suited for development then protect and implement long term management.
5. Work with private land owners along stream/tributary corridors to manage their land for green infrastructure benefits.
6. Use the Green Infrastructure Network to identify new trails and trail connections.

6.2 Site Specific Management Measures Action Plan

Site Specific Management Measure (Best Management Practice [BMP]) recommendations made in this section of the report are backed by findings from the watershed field inventory, overall watershed resource inventory, and input from stakeholders. In general, the recommendations address sites where watershed problems and opportunities can best be addressed to achieve watershed goals and objectives. The Site Specific Management Measures Action Plan is organized by the jurisdiction in which recommendations are located making it easy for users to identify the location of project sites and corresponding project details. It is important to note that project implementation is voluntary and there is no penalty or reduction in future grant opportunities for not following recommendations. Site Specific Management Measures were identified within the following jurisdictional boundaries and are included in the Action Plan:

- *Asbury*
- *Center Township*
- *Centralia*
- *Center Township*
- *Dubuque*
- *Dubuque County*
- *Dubuque Township*
- *Mosalem Township*
- *Peosta*
- *Prairie Creek Township*
- *Table Mound Township*
- *Vernon Township*

Management Measure categories in the Site Specific Management Measures Action Plan include:

- *Detention Basin Retrofits & Maintenance*
- *Wetland Restoration*
- *Streambank, Channel, & Riparian Restoration*
- *Green Infrastructure Protection Areas*
- *Agricultural Management Practices*
- *Other Management Measures*

Descriptions and location maps for each Management Measure category follow. Table 41 includes useful project details such as site ID#, Location, Units (size/length), Owner, Existing Condition, Management Measure Recommendation, Pollutant Load Reduction Efficiency, Priority, Responsible Entity, Sources of Technical Assistance, Cost Estimate, and Implementation Schedule.

Project importance, technical and financial needs, cost, feasibility, and ownership type were taken into consideration when prioritizing and scheduling Management Measures for implementation. High, Medium, or Low Priority was assigned to each recommendation. "Critical Areas" as discussed in Section 5.2 are all High Priority and highlighted in red on project category maps and the Action Plan table. For this watershed plan a "Critical Area" is best described as a location in the watershed where existing of potential future causes and sources of an impairment or existing function are significantly worse than other areas of the watershed. Implementation schedule varies greatly with each project. Maintenance projects are ongoing.

The Site Specific Management Measures Action Plan is designed to be used in one of two ways.

Method 1: The user should find the respective jurisdictional boundary (listed alphabetically in Table 41) then identify the Management Measure category of interest within that boundary. A Site ID# can be found in the first column under each recommendation that corresponds to the Site ID# on a map (Figures 62-67) associated with each category.

Method 2: The user should go to the page(s) summarizing the Management Measure category of interest then locate the corresponding map and Site ID# of the site specific recommendations for that category. Next, the user should go to Table 41 and locate the jurisdiction where the project is located then project category and Site ID# for details about the project.

Pollutant Load Reduction Estimates

Where applicable, pollutant load reductions and/or estimates for total suspended solids (TSS), nitrogen (TN), and phosphorus (TP) were evaluated for each recommended Management Measure based on efficiency calculations developed for the USEPA's Region 5 Model. This model uses "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual" (MDEQ, 1999) to provide estimates of sediment and nutrient load reductions from the implementation of *agricultural* Measures. Estimate of sediment and nutrient load reduction from implementation of *urban* Measures is based on efficiency calculations developed by Illinois EPA.

Estimates of pollutant load reduction using the Region 5 Model are measured in weight/year (tons/yr for total suspended solids and lbs/yr for nitrogen and phosphorus). The model was generally used to calculate weight of pollutant reductions for all recommended High Priority-Critical Areas where calculation of such data is applicable. In summary, pollutant reductions were calculated for 24 detention basin retrofit, creation, & maintenance projects, 35 wetland restoration projects, 59 streambank, channel, & riparian restoration projects, and 43 agricultural management projects. Spreadsheets used to determine pollutant load reductions can be found in Appendix D.

Estimated *percent* removal of total suspended solids, nitrogen, and phosphorus for projects where calculation of pollutant weight reduction is beyond the scope of this project are shown below. The percent removal efficiencies were based on various Management Measures included in the Region 5 Model as shown in Table 39.

The Region 5 Model pollutant removal efficiencies for Management Measures do not include calculations for the removal of pathogens. While pathogens are a major source of pollution within Catfish Creek watershed, tracking the causes and sources of pathogens is an emerging field of study and still rather cost-prohibitive. While bacterial source tracking is important, it is beyond the scope of this watershed plan.

Generally, potential sources of fecal bacteria are grouped into three major categories: human, livestock, or wildlife (EPA, 2002). "EPA estimates that one dairy cow can produce about 120 pounds of wet manure in a day, with 80 percent being water (EPA, 2008). On the other hand, humans account for 3 to 6 pounds per day, and a goose averages about 0.34 pounds of wet droppings per day. (Wolfson, 2010)" Other potential sources of pathogens include failing septic systems and municipal waste water treatment plans.

Research is still ongoing in determining how various Management Measures contribute to reductions in pathogens, but studies have been conducted regarding wetland filtration and fencing. Results from a study published by the University of California demonstrated that filtering agricultural runoff through relatively small wetlands can reduce *E. coli* from irrigated pastures by 73% on average per irrigation event (Knox, 2007). Research also shows that fencing streams to control livestock access to waterways can reduce *E. coli* by 37 to 46%, reduce sediment loads by 82%, and total phosphorus levels by 76% (Texas AgriLife, 2011).

Table 39. Region 5 Model percent pollutant removal efficiencies for various Management Measures.

Management Measures	TSS	TN	TP
Vegetated Filter Strips	73%	40%	45%
Wet Pond/Detention	60%	35%	45%
Wetland Detention	77.5%	20%	44%
Dry Detention	57.5%	30%	26%
Infiltration Basin	75%	60%	65%
Streambank/Lake Shoreline Stabilization	90%	90%	90%
Weekly Street Sweeping	16%	6%	6%
Porous Pavement	90%	85%	65%
Manure Waste Management	na	80%	90%
Fencing*	82%	na	76%

Note: Streambank/lake shoreline stabilization pollutant removal is based on bank height and lateral recession rates.
* Fencing was calculated using the Region 5 Model as an edge of field practice with pollutant reduction values based on values determined in "Reducing Bacteria with Best Management Practices for Livestock. Fence: NRCS Code 382." - Texas AgriLife, 2011.

Watershed-Wide Summary of Action Recommendations

All Site Specific Management Measures, Education Plan (Section 7.0) Monitoring Plan (Section 9.0) recommendation information is condensed by Category in Table 40. This information provides a watershed-wide summary of the “Total Units” (size/length), “Total Cost”, and “Total Estimate of Pollutant Load Reduction” if all the recommendations in the Site Specific Management Measures Action Plan, Education Plan, and Monitoring Plan are implemented. Key points include:

- 10,620 acres of ecological and riparian buffer restoration with a total cost of $9,174,640.
- 205,167 linear feet of streambank stabilization and restoration costing $72,479,392.
- 273 acres of yearly maintenance related to detention basins and streams costing $205,000/year.
- 55,220 tons/year of Total Suspended Solids (TSS) would potentially be reduced each year exceeding 53,979 tons/year Reduction Target identified in Section 5.3.
- 162,484 pounds/year of Nitrogen (TN) would potentially be reduced each year exceeding 87,848 pounds/year Reduction Target identified in Section 5.3.
- 69,393 pounds/year of Phosphorus (TP) would potentially be reduced each year, exceeding the 52,487 pounds/year Reduction Target identified in Section 5.3.
- Education programs will cost more than $26,000 to implement with an additional $7,000-10,000 annually to maintain programs (see Section 7.0).
- A monitoring plan will cost $15,000 for installation of each real-time monitor (see Section 9.1).

Table 40. Watershed-wide summary of Management Measures recommended for implementation.

Management Measure Category	Total Units (size/length)	Total Cost	Estimated Load Reduction		
			TSS (t/yr)	TN (lbs/yr)	TP (lbs/yr)
Detention Basin Retrofits & Maintenance*					
Retrofits (prairie buffers, emergent plantings, etc.)	37.7 acres	$503,419	119	834	220
Maintenance (burning, mowing, invasives, brushing, etc.)	37.7 acres	$42,000/yr	na	na	na
Wetland Restoration	397.9 acres	$6,694,105	115	945	179
Streambank, Channel, & Riparian Restoration*					
Streambank & Channel Restoration	205,167 lf	$72,479,392	32,229	62,517	31,159
Riparian Areas	240 acres	$1,977,116	44	687	71
Maintenance (burning, invasive control, brushing, etc.)	240 acres	$163,000/yr	na	na	na
Green Infrastructure Protection Areas**	3,646 acres	na	na	na	na
Agricultural Management Practices*					
Conservation Tillage (no till) and Filter Strips Farming	2,708 acres	na	10,643	39,137	19,786
Waste (manure) Management	1,664 acres	na	na	57,954	6,619
*Fencing****	1,508 acres	na	12,019	na	11,295
Other Management Measures**					
Bioswales	0.4 acres	$15,000	na	na	na
Rain Gardens	0.4 acres	$35,000	na	na	na
Native prairie, bioswales, and rain garden retrofit	10.4 acres	$50,000	na	na	na
Rough Area Retrofits at 2 Golf Courses	296 acres	$275,000	na	na	na
Parking lot BMP	36 acres	$50,000	37	336	46
Stabilization of eroded gullies	1.2 acres	$100,000	na	na	na
Natural area restoration	73 acres	$400,000	na	na	na
Naturalized detention basin at 2 mulch processing sites	0.5 acres	$40,000	14	74	18
Install terrace system and drainage	0.7 acres	$500,000	na	na	na
Information/Education Plan	Entire Plan	>$26,000 + $10,000/yr	na	na	na
Water Quality Monitoring Plan	Entire Plan	$15K	na	na	na
TOTALS	**10,620.2 acres**	**$9,174,640**	**55,220 tons/yr**	**162,484 lbs/yr**	**69,393 lbs/yr**
	272.7 acres maintenance	**$205,000/yr**			
	205,167 lf	**$72,479,392**			
	Other	**$1,465,000**			
	Education	**>$26,000 + $10,000/yr**			
	Monitoring	**$15,000**			

* Pollutant load reduction calculated for applicable High Priority-Critical projects only.
** Pollutant load reductions were not or could not be calculated using STEPL or other modeling.
*** Pollutant load reductions for fencing were approximated through STEPL as edge-of-field practices using pollutant reduction percentages for fencing as determined by Texas AgriLIFE Extension, 2011

6.2.1 Detention Basin Retrofits & Maintenance Recommendations

A number of detention basin retrofit projects were identified in Catfish Creek watershed where the watershed is already developed and detention basins are currently in place. Most detention basins provide little in the way of water quality improvement, infiltration capability, and wildlife habitat. In the future it is recommended that new standards for detention basins become requirements in local and county development ordinances (see Section 6.1.2). Applied Ecological Services, Inc. (AES) conducted an inventory of 88 detention basins in summer of 2013. The results of the detention basin inventory are summarized in Section 3.13.2. Detailed field investigation datasheets and maps can be found in Appendix B.

The condition of detention basins in the watershed varies. Fifty-four (54) dry bottom basins, 19 wet bottom basins, and 14 wetland bottom basins were assessed. Of the 88 basins, 7 basins (8%) likely provide "Good" ecological and water quality benefits while 21 basins (24%) likely provide "Average" benefits. The remaining 59 basins (67%) likely provide "Poor" ecological and water quality benefits because most were designed simply to meet stormwater storage volume requirements.

All recommended detention basin retrofits and/or maintenance recommendations are shown on Figure 62 by priority. Details about each recommendation can be found in the Action Plan Table (Table 41) within the appropriate jurisdictional boundary. All of the High priority recommendations are considered "Critical Areas." Many of these are areas that present a good opportunity for a demonstration project and/or would provide improved water quality benefit. Medium priority is generally assigned to smaller private basins and those with fewer problems or maintenance needs. In addition, there are many low priority detention basins for which recommendations would improve water quality, but on such a small scale as to not warrant a project.

Critical Area detention basin retrofit opportunity at Haas Park

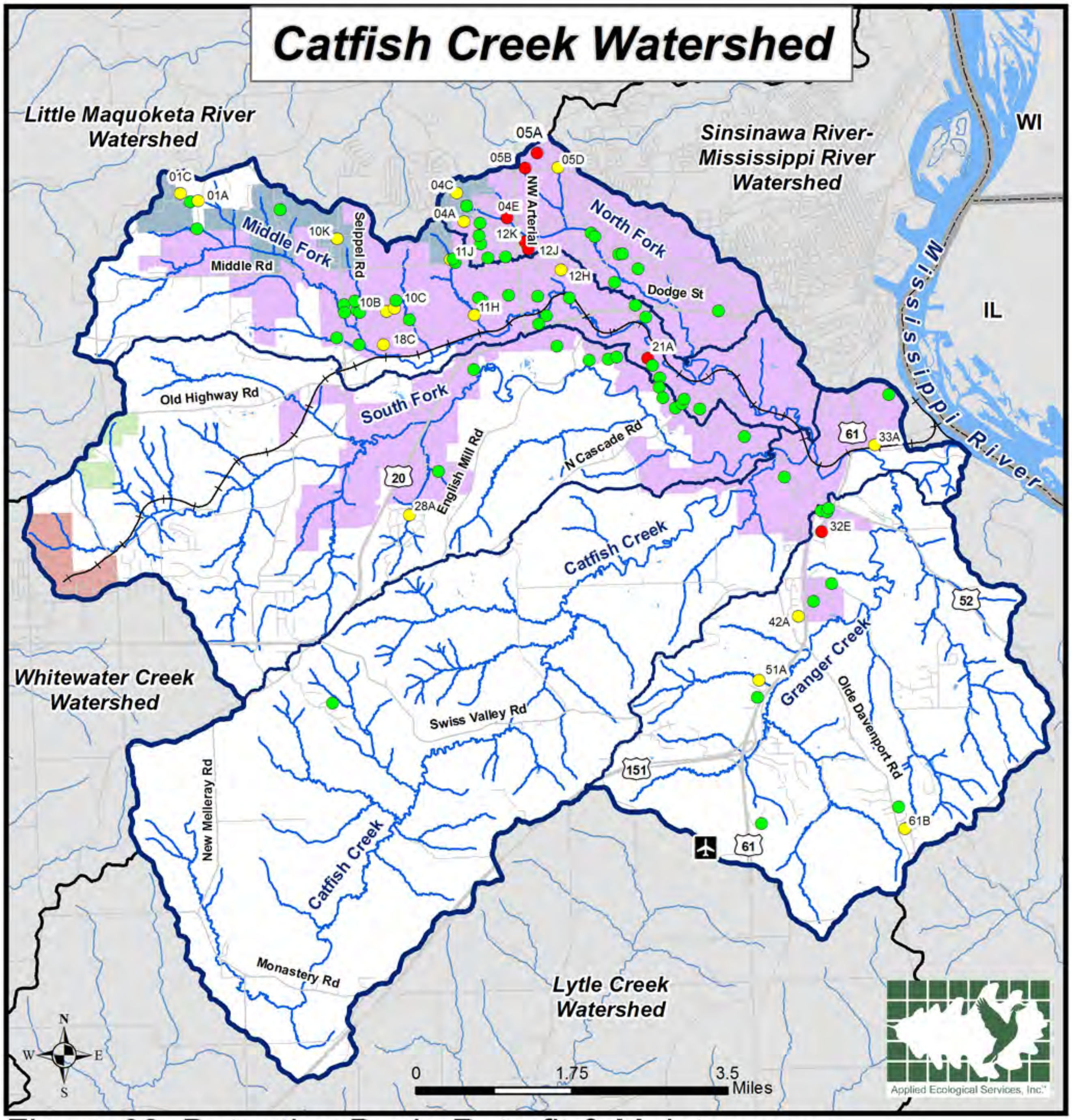
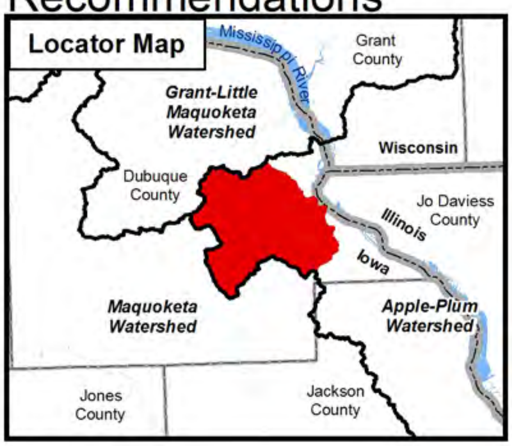


Figure 62: Detention Basin Retrofit & Maintenance Recommendations



Legend	
Airport	
Roads	
Railroad	
Stream & Tributaries	
Open Water	
State Boundary	
Catfish Creek Watershed	
Catfish Creek Subwatersheds	
Adjacent Watersheds	

PRIORITY
- High/Critical Area
- Medium
- Low

Municipality
- Asbury
- Centralia
- Dubuque
- Peosta

6.2.2 Wetland Restoration Recommendations

Wetland restoration is the process of bringing back historic wetlands in areas where they have been drained. This section does not include enhancement and maintenance for existing wetlands. Restoration can be important for mitigation purposes or done simply to benefit basic environmental functions that historic wetlands once served. Improvement in water quality is the greatest benefit provided by wetland restoration. Other benefits include reducing flood volumes/rates and improved habitat to increase plant and wildlife biodiversity. They also can reduce fecal coliforms by an average of 92% when installed or restored between a field and a stream (Wolfson, 2010).

The wetland restoration process is generally the same for all sites. First a study must be completed to determine if restoration at the site is actually feasible. If it is, a design plan is developed, permits obtained, then the project is implemented by breaking existing drain tiles and/or regrading soils to attain proper hydrology to support wetland hydrology and vegetation. Planting with native species is the next step followed by short and long term maintenance and monitoring to ensure establishment.

Wetland restoration sites were identified in Section 3.13.4 using a GIS exercise and specific criteria determined to be essential for restoration of a functional and beneficial wetland. The analysis resulted in 56 potential sites meeting these criteria.

Figure 63 includes the location of wetland restoration sites by site priority and site ID#. The site ID#s match those used in Section 3.13.4. Details about each recommendation can be found in the Action Plan Table (Table 41) within the appropriate jurisdictional boundary. In general, large sites on agricultural land, sites on public land, and sites within the identified Green Infrastructure Network are higher priority than smaller sites and those on private land.

Example wetland restoration at AES wetland mitigation site

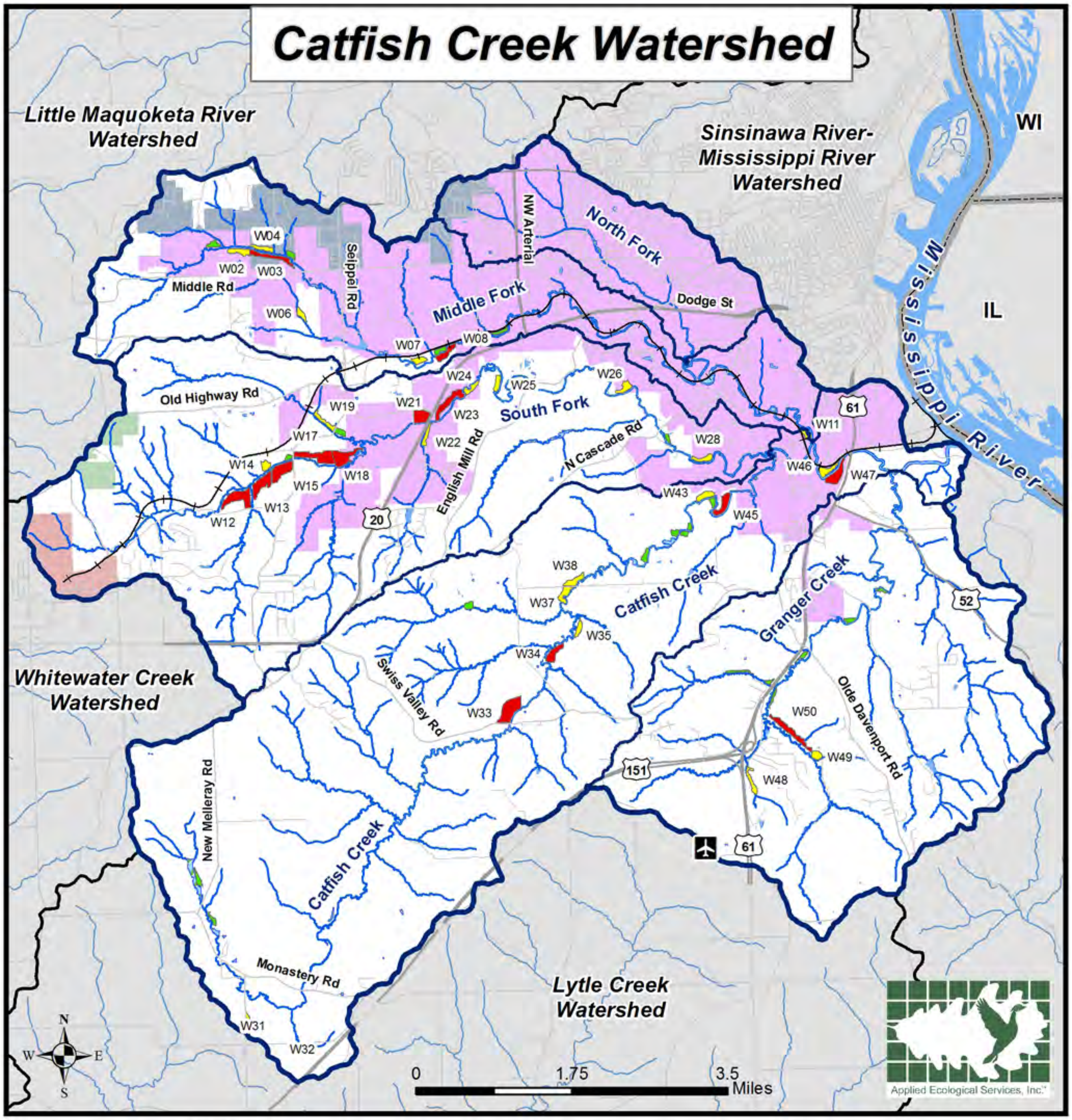
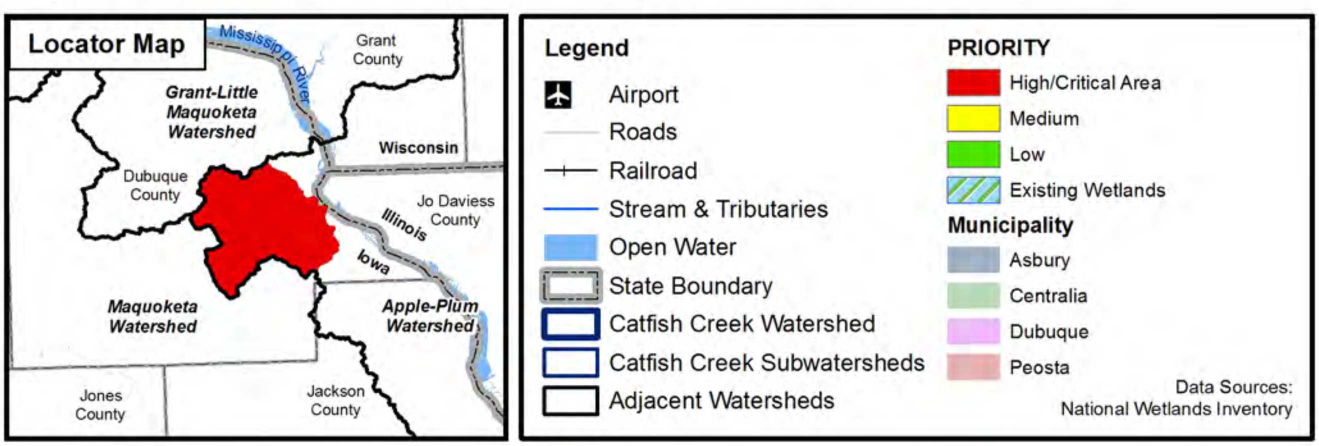


Figure 63: Wetland Restoration Recommendations



6.2.3 Streambank, Channel, and Riparian Restoration & Maintenance Recommendations

Since 2008, the City of Dubuque, Dubuque County Soil and Water Conservation District (SWCD), the University of Dubuque, and local citizens have been collecting IOWATER data along the five main branches within Catfish Creek watershed. They used the Rapid Assessment of Stream Corridor Along Length, or RASCAL protocol in order to catalogue stream conditions roughly every 500-800 feet. The RASCAL data was then aggregated into "Stream Reaches" based on stretches of similar conditions. A total of forty-six (46) stream reaches and 56.7 linear miles of stream along the main branches and tributaries of Catfish Creek were assessed. The RASCAL data, combined with consultation with the City of Dubuque and Dubuque County SWCD, was used to determine potential project locations for improving streambank, channel, and riparian conditions and maintaining these reaches long term. The results of the RASCAL data collection are summarized in Section 3.13.1.

The condition of stream reaches in the watershed varies. According to the RASCAL assessments, 29% of stream and tributary length is exhibiting little to no erosion; 59% is moderately eroded; and 12% is heavily eroded.

Most stream restoration projects include at least one of the following three water quality and habitat improvement components; 1) removal of existing invasive vegetation including trees and shrubs from the streambanks followed by; 2) stabilized streambanks using bioengineering, regrading of banks, and installation of native vegetation; and 3) restored riffles/grade controls in the stream channel to simulate conditions found in naturally meandering streams.

Riparian area restoration and/or maintenance projects generally focus on converting degraded ecological communities into higher quality communities that function to store and filter stormwater while also providing excellent wildlife habitat. The restoration process usually includes removal of invasive trees, shrubs, and

herbaceous vegetation such as turf grass followed by planting with native vegetation. Short and long term maintenance then follows and is critically important in the development process and to maintain restored conditions.

Figure 64 shows the location of all potential streambank/channel restoration projects by reach ID# and priority while Table 41 lists project details about each recommendation within the appropriate jurisdictional boundary. Potential streambank and channel restoration projects on public land and reaches exhibiting severe problems on private land are generally assigned as higher priority for implementation. Medium priority was assigned to stream reaches with moderate levels of erosion – these are reaches where restoration efforts are needed, but are not as critical or urgent as High Priority projects. Low priority was generally assigned to stream reaches exhibiting only minor problems.

Potential stream project (right) along Granger Creek Reach 5 and example AES stream restoration in Barrington, IL (inset, left).

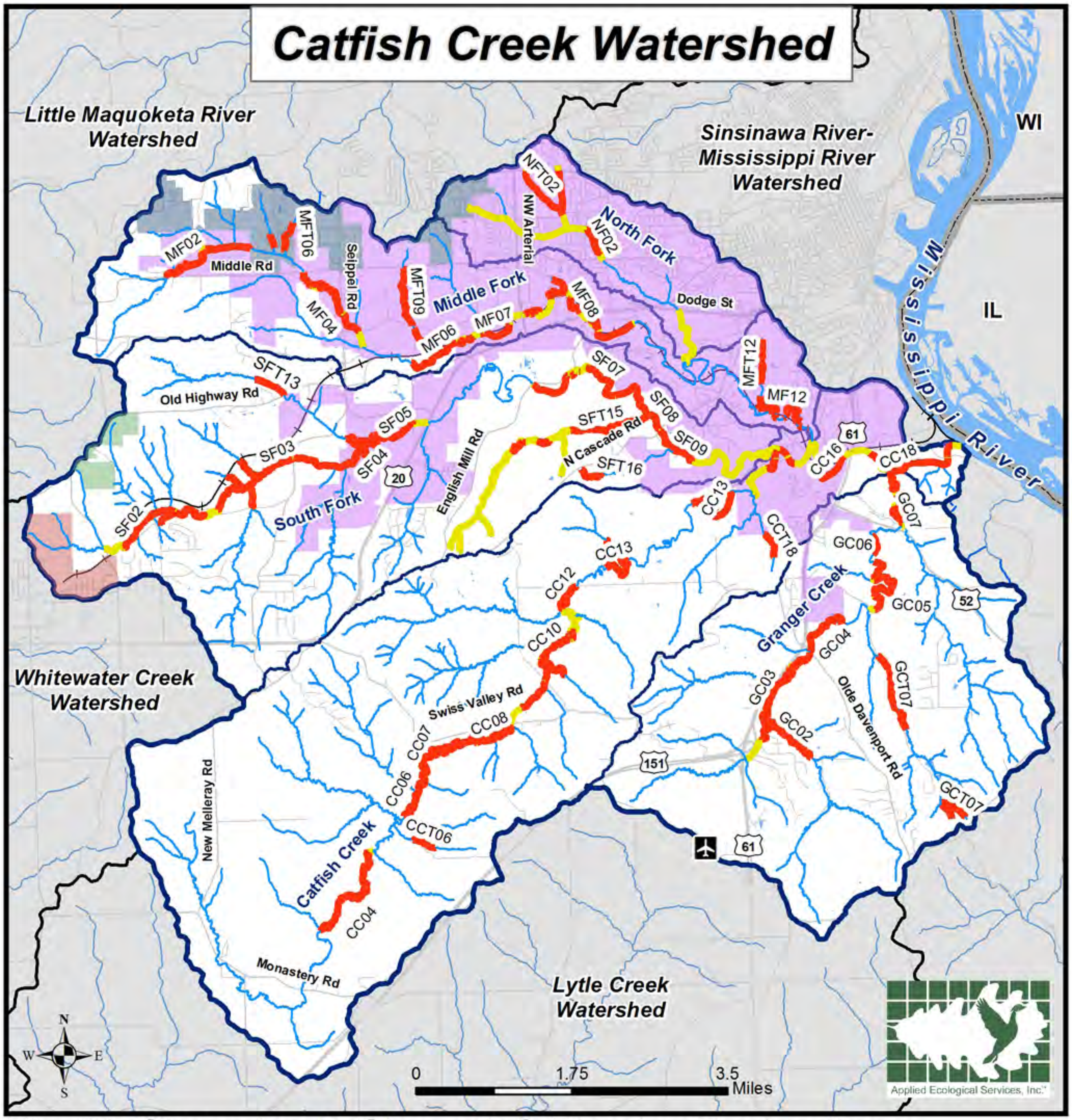
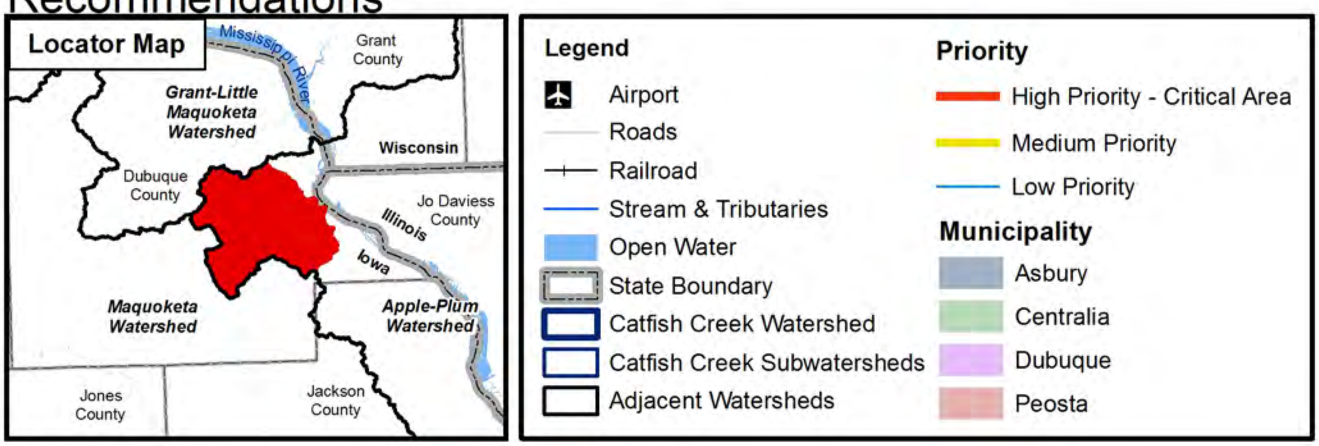


Fig. 64: Streambank, Channel, & Riparian Restoration Recommendations



6.2.4 Green Infrastructure Protection Area Recommendations

Green Infrastructure Protection Areas are best described as large, unprotected parcels of land that are currently undeveloped with no plans for future development or similar parcels where future development is planned. The significance is that these parcels are situated in environmentally sensitive or important green infrastructure areas where protecting and restoring or developing using "Conservation Design" or "Low Impact" standards would best benefit watershed conditions. Information obtained from predicted future land use data and location of large undeveloped and unprotected parcels within the Green Infrastructure Network led to identification of 35 green infrastructure protection areas totaling 3,350 acres.

Most of the Green Infrastructure Protection areas are undeveloped parcels located on existing agricultural and just less than half of these are predicted to be developed in the future. Two of the protection areas are privately held golf courses.

Figure 65 shows the location of all 35 Green Infrastructure Protection Areas by site ID# while Table 41 includes action recommendations for each. All 35 sites are considered High Priority-Critical Areas. Cost estimates and schedules for implementing recommendations for these areas is not included due to the difficulty in determining how or if each site will be protected or developed. In addition, pollutant reduction estimates cannot be determined for these areas.

Green Infrastructure Protection Area 1 near headwaters of North Fork

Aerial view of Green Infrastructure Protection Areas 7 (top) and 8 (bottom), north and south, respectively, of Old Highway Rd in western portion of South Fork. Source: Google.

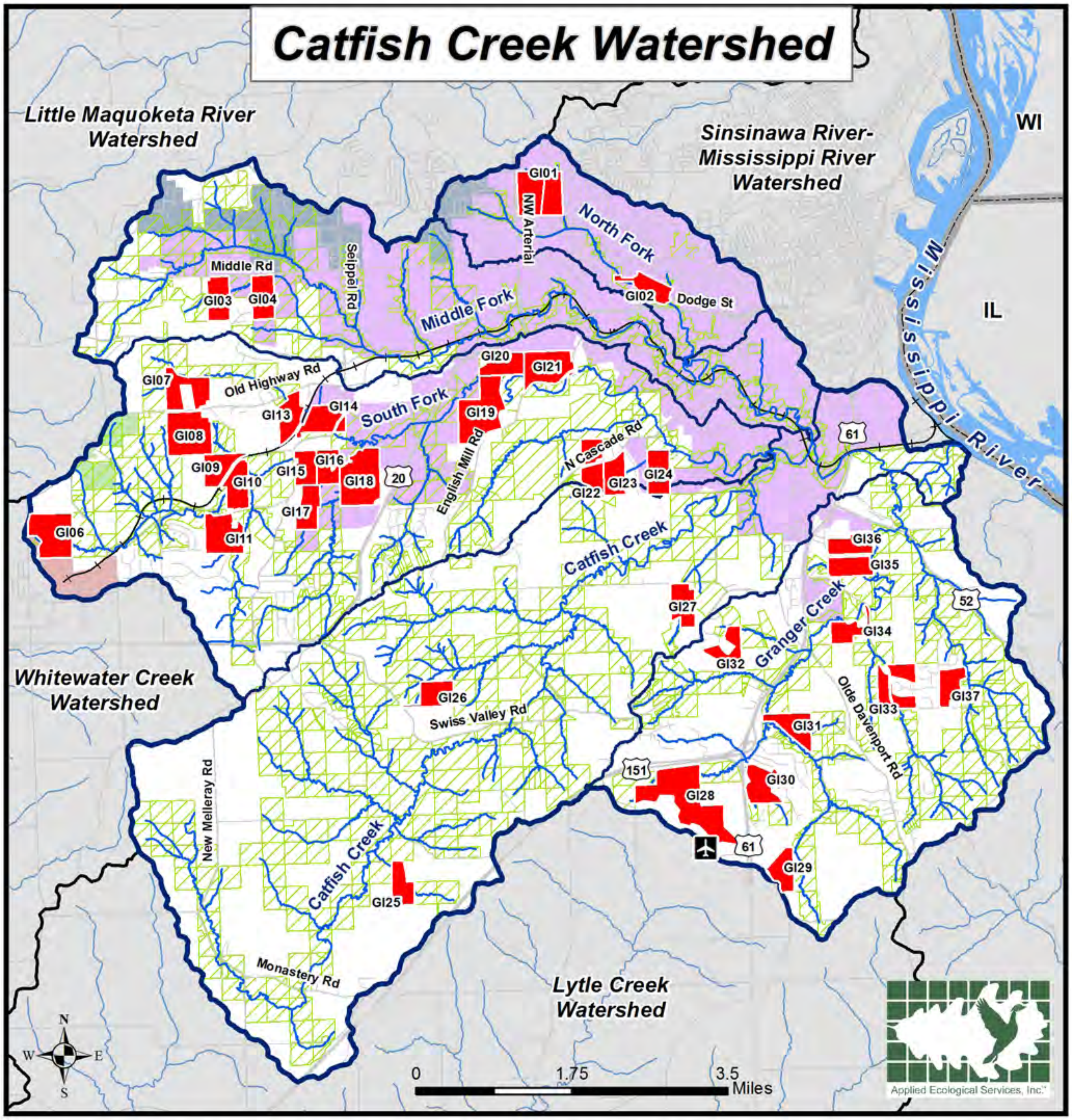
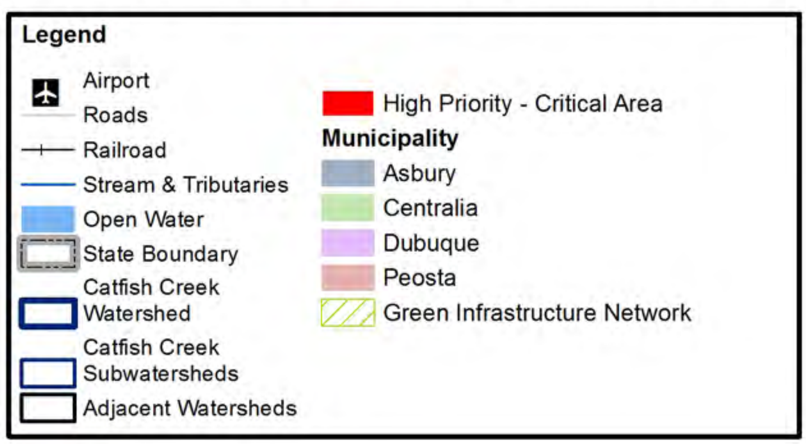


Figure 65: Green Infrastructure Protection Area Recommendations



6.2.5 Agricultural Management Practices Recommendations

Agricultural land uses dominate much of the watershed outside of the City of Dubuque and include row crops, hay, pasture, and livestock uses. While Iowa is known for its food production, how this land is managed can have a significant effect on water quality. According to the Environmental Protection Agency's (EPA's) National Water Quality Inventory for 2000, "agricultural nonpoint source (NPS) pollution was the leading source of water quality impacts on surveyed rivers and lakes... Agricultural activities that cause NPS pollution include poorly located or managed animal feeding operations; overgrazing; plowing too often or at the wrong time; and improper, excessive or poorly timed application of pesticides, irrigation water and fertilizer. (EPA, 2013)" Agricultural land and management practices are discussed in detail in Section 3.13.3; results of the agricultural field inventory can be found in Appendix B.

Agricultural land can be a significant contributor of nutrients and sediment to local streams when practices such as filter strips, grass swales, "Conservation Tillage" (no till) farming, waste (manure) management, and fencing to restrict livestock access to streams are not in place. Observations made during Applied Ecological Service's, field inventory in summer 2013 indicate that practices such as grassed swales, no-till, and terrace farming are in place in some areas of the watershed, but are needed to be implemented more commonly throughout the watershed while practices such as manure management and fencing need to be implemented as well. Pollutant load modeling estimates show that agricultural land uses in Catfish Creek watershed contribute between 58% and 65% of the nutrient load and about 58% of the sediment load. These pollutant load contributions are significant. The use of conservation tillage and swales on larger fields, managing manure on select livestock operations, and fencing streams to reduce livestock access could potentially reduce phosphorus, nitrogen and sediment loading in the watershed.

Forty-three (43) agricultural areas, including 28 livestock operations, totaling 3,024 acres were identified as High Priority-Critical Areas for potential nutrient and sediment reduction based on existing conditions, location in the watershed, and potential for improving water quality. If agricultural management practices are used in these critical areas pollutant loading could be reduced by 37,700 lbs/yr of phosphorus, by 97,091 lbs/yr of nitrogen loading, and by 22,662 tons/yr of sediment loading.

Practices recommended in this plan include conservation tillage (no till) for crop land, vegetated swales, fencing to restrict livestock access, and waste (manure) management on livestock operations. Fencing has also been shown to reduce *E. coli* loading 37-46% (Texas, 2011); vegetated swales reduce fecal coliform by 74% (Wolfson, 2010); and manure management systems reduce varying amounts of pathogens between 90-99% depending on the type of system/treatment utilized (Sobsey, 2001).

Figure 66 shows the location of all 43 sites by ID# while Table 41 includes action recommendations for each. Note: cost estimates for implementing agricultural practices are not included because the costs can differ greatly from field to field and on a farmer's available equipment.

Example of no-till farming and in-field filter strips in Catfish Creek watershed.

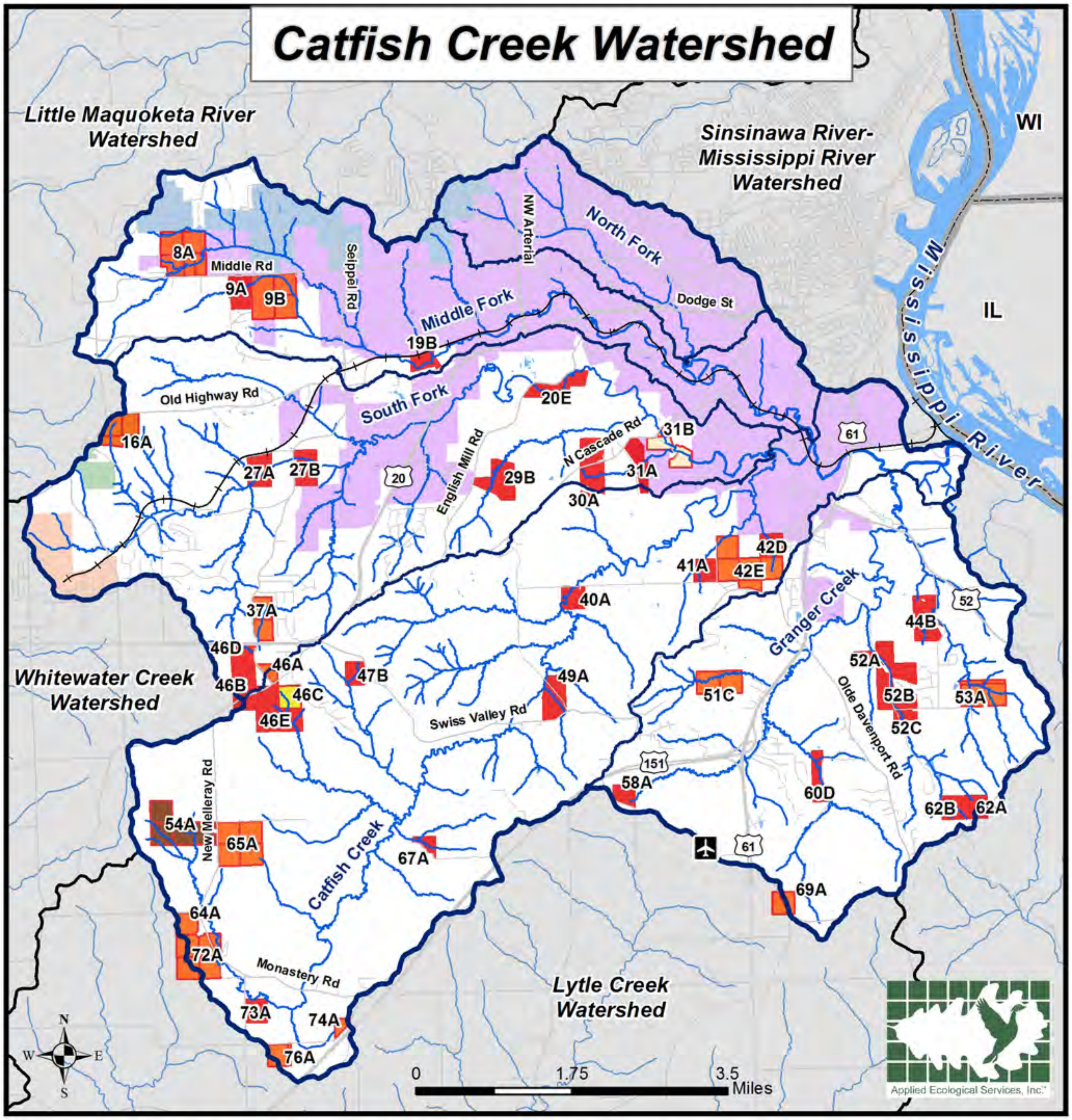
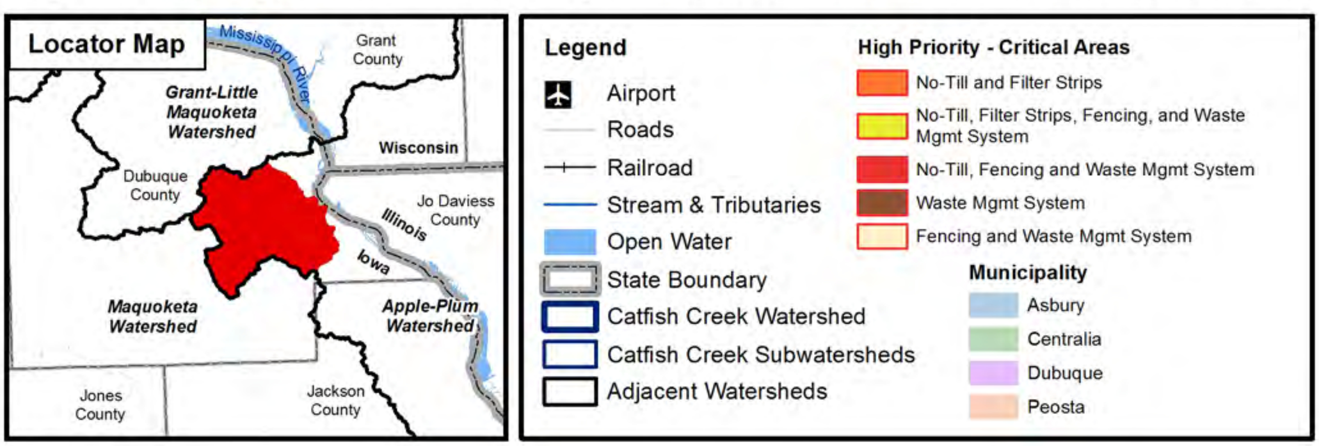


Figure 66: Agricultural Management Practices Recommendations



6.2.6 Other Management Measures

While completing the general inventory of Catfish Creek watershed, Applied Ecological Services, Inc. (AES) noted potential Management Measure projects that fit under miscellaneous other categories. Figure 67 shows the location of "Other Management Measure" recommendations by ID# while Table 41 lists details about each recommendation within the appropriate jurisdictional boundary. Additionally, the five Flood Problem Areas identified in Section 3.13.5 are considered other management measures.

Potential projects include:

1. Rain garden opportunity at Eleanor Roosevelt Middle School.
2. Natural Area Restoration at Flora Park.
3. Stabilization of 2 eroded gullies at commercial development - Cedar Cross Rd and Hughes Ct.
4. Native prairie, bioswales, and rain garden opportunities at Valentine Park.
5. Rough and pond naturalization opportunities at Dubuque Golf Country Club.
6. Rain garden opportunity Table Mound School.
7. Bioswale opportunity along south side of Julien Dubuque Dr, east of Inland Ln.
8. Rough and pond naturalization opportunities at Thunder Hills Country Club.
9. Parking lot BMP opportunities at Dubuque Technology Park.
10. Naturalized detention basin opportunity at Dubuque Mulch Co. mulch processing site.
11. Naturalized detention basin opportunity at Bill Miller & Sons Logging mulch processing site.
12. Rain garden opportunity at along Wildlife Ridge south of Turkey Valley Ln.
13. Woodland restoration opportunity at Interstate Power Company Forest Preserve.
14. Installation of a terrace system and drainage at Finnin Ford in Dubuque.

Clockwise from upper right: Parking lot BMP opportunity at Dubuque Technology Park; woodland restoration opportunity at Interstate Power Company Forest Preserve; and rain garden opportunity at Eleanor Roosevelt Middle School.

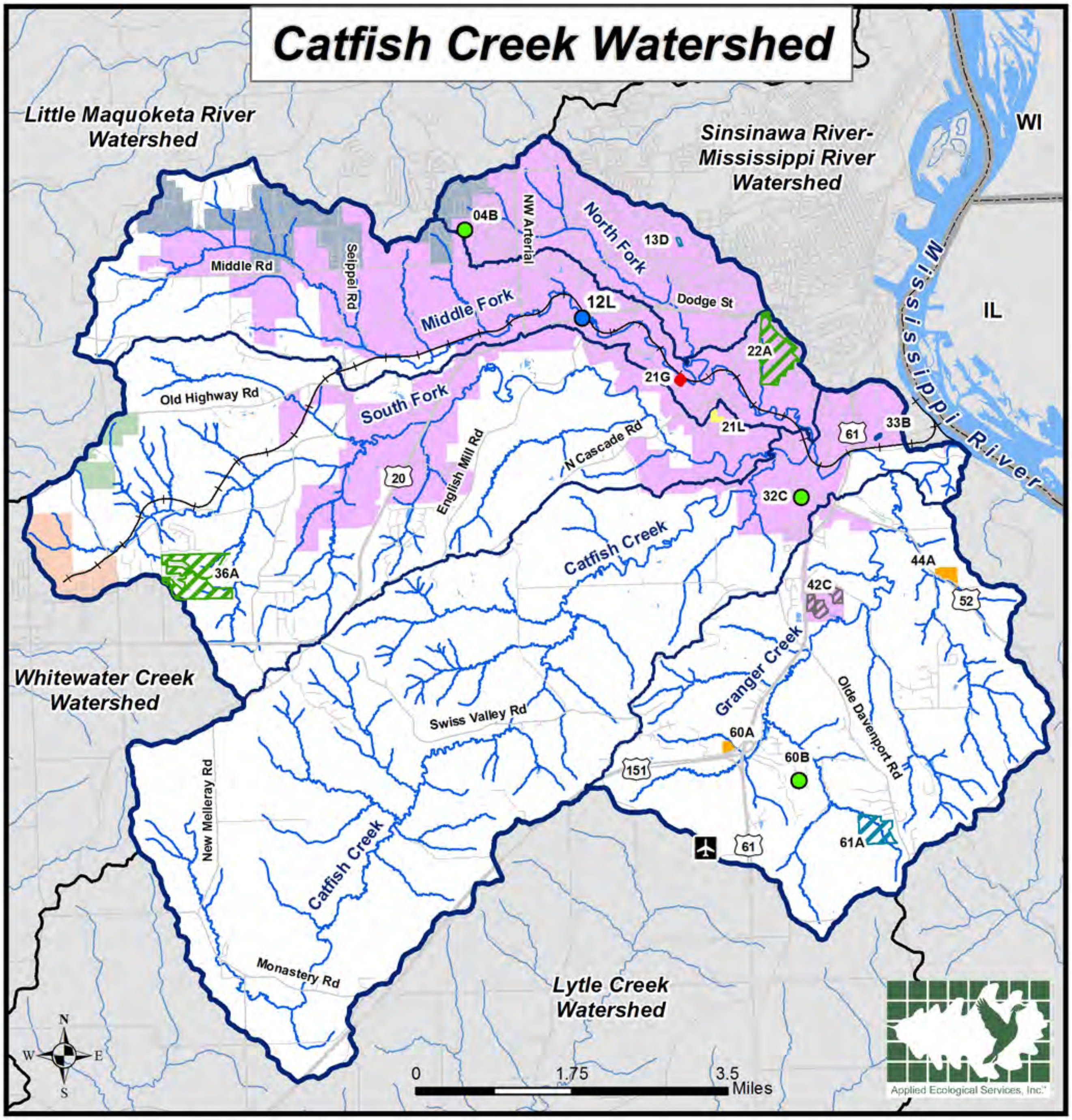
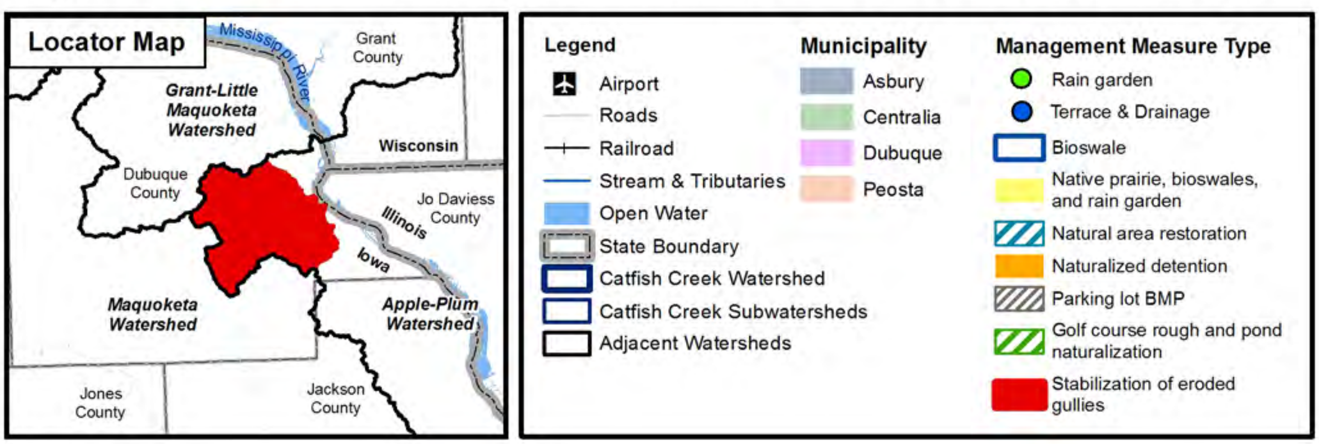



Figure 67: Other Management Measure Recommendations



6.2.7 Site Specific Management Measures Action Plan Table

Table 41. Site Specific Management Measures Action Plan.

ASBURY													
ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
DETENTION BASIN RETROFITS & MAINTENANCE (See Figure 62)													
Technical and Financial Assistance Needs: Technical assistance needed to implement detention basin retrofits is relatively low while financial assistance needs are moderate. Private landowners will require the greatest assistance.													
10K	Northwest of junction of Seippel Rd and Pawnee Ln	0.8	City of Asbury (Public)	Wet Bottom Detention - turf; typical grass lined detention servicing adjacent subdivision	Design and implement project to install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	2.0	7	24	Medium	City of Asbury	Ecological Consultant/ Contractor	$12,000 to design & install prairie buffer & emergent plants; $1,000/ yr maintenance for 3 year establishment period	10-20 years
11J	North of Pennsylvania along tributary MFT10	1.5	City of Asbury (Public)	Wetland Bottom Detention; online detention consisting of invasive species (mostly RCG) side slopes mostly old field veg.	Design and implement project to remove invasives, install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	6.0	19	65	Medium	City of Asbury	Ecological Consultant/ Contractor	$22,000 to design & install prairie buffer & emergent plants; $2,000/ yr maintenance for 3 year establishment period	10-20 years
1C	Just east of end of Tuscany Ridge Dr	0.1	City of Asbury (Public)	Dry Bottom Detention - natural; detention built into draw, stormsewer currently not connected, eroded channel entering from west	Design and implement a project to retrofit basin with step-down system for swale using native vegetation	0.2	1	2	Medium	City of Asbury	General Contractor, Ecological Consultant/ Contractor	$145,000 to design & install step-down detention system in swale using native vegetation; $1,000/yr maintenance for 3 year establishment period	10-20 years
4C	Behind mulit-family housing along Grand Meadow Dr	1.3	City of Asbury (Public)	Wet Bottom Detention - turf; pond surrounded by newer multi-family residential, very little water quality benefit	Design and implement project to install a native prairie vegetation buffer and plant emergents along shoreline, and maintain for three years to establish	6.0	9	30	Medium	City of Asbury	Ecological Consultant/ Contractor	$20,100 to design & install prairie buffer & emergent plants; $2,000/ yr maintenance for 3 year establishment period	10-20 years
STREAMBANK, CHANNEL, & RIPARIAN RESTORATION & MAINTENANCE RECOMMENDATIONS (See Figure 64)													
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.													
MFT05	See Figure 64 for project location	846	City of Asbury	846 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	91	91	181	High/ Critical Area	City of Asbury	USACE, Consultant, IDNR, NRCS	$305 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $8 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
MFT06	See Figure 64 for project location	1,927	City of Asbury	1,927 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	111	111	221	High/ Critical Area	City of Asbury	USACE, Consultant, IDNR, NRCS	$700 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $18 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
WETLAND RESTORATION RECOMMENDATIONS (See Figure 63)													
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.													
W03	Located on private agricultural land north of Sand Wedge Ct and south of Middle Fork	13.2	Owner (private)	13.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	9	39	High/ Critical Area	Owner, Asbury	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$198,000 to design and implement wetland restoration	1-10 years
W04	Located on private agricultural land south of Meadows Golf Club, between Middle Fork and Torrey Pines Dr	6.5	Owner (private)	6.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	6	22	Medium	Owner, Asbury	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$129,000 to design and implement wetland restoration	10-20 years
W05	Located on private agricultural land south of Spyglass Dr and north of Middle Fork	3.9	Owner (private)	3.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	2	9	Low	Owner, Asbury	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$78,000 to design and implement wetland restoration	10-20 years

CENTER TOWNSHIP

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
DETENTION BASIN RETROFITS & MAINTENANCE (See Figure 62)													
Technical and Financial Assistance Needs: Technical assistance needed to implement detention basin retrofits is relatively low while financial assistance needs are moderate. Private landowners will require the greatest assistance.													
1A	Southwest of junction of Hidden Meadows Dr and Budd Rd	0.8	County (Public)	Wet Bottom Detention; newly created basin recently seeded to turf, swale on west side severely eroded, no restrictor, has concrete over-spill	Design and implement project to regrade toe, install check dams in swale, install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	0.3	1	3	Medium	County	Ecological Consultant/ Contractor	$20,500 to design & install prairie buffer, check dams in swale, & emergent plants; $1,000/year maintenance for 3 year establishment period	10-20 years
GREEN INFRASTRUCTURE PROTECTION AREAS (See Figure 65)													
Technical and Financial Assistance Needs: Technical assistance needed to protect open space or implement conservation/low impact development is high because of land, design/permitting, and construction costs.													
GI03	South of Middle Rd and west of Seippel Rd	78.8	Private agricultural land	78.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI07	North of Old Highway Rd and west of Clear View Heights, near headwaters of SFT13	103.9	Private agricultural land	103.9 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI08	South of Old Highway Rd and west of Clear View Heights	152.7	Private agricultural land	152.7 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI14	East of railroad tracks at junction of Cottingham and Seippel Rds	89.6	Private agricultural land	89.6 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
WETLAND RESTORATION RECOMMENDATIONS (See Figure 63)													
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.													
W06	Located on private agricultural land south of Whistle Wind Ln and west of Seippel Rd along the east bank of MFT08A	5.0	Owner (private)	5.0 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	5	32	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$101,000 to design and implement wetland restoration	10-20 years
W19	Located on private agricultural land along norht bank of SFT13 just west of Cottingham Rd	7.5	Owner (private)	7.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	4	22	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$150,000 to design and implement wetland restoration	10-20 years
W20	Located on private agricultural land along norht bank of SFT13 just east of Cottingham Rd	4.7	Owner (private)	4.7 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	16	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$94,000 to design and implement wetland restoration	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
OTHER MANAGEMENT MEASURES (See Figure 67)													
Technical and Financial Assistance Needs: Technical assistance and financial assistance needed to implement these projects varies depending on complexity.													
FPA #3	Cottingham Rd at South Fork Tributary 13	N/A	Center Twnshp (public)	Overbank-Roads	Raise elevation of Cottingham Rd and/or increase culvert size where road crosses South Fork Tributary 13	Pollutant reduction cannot be assessed via modeling			Medium	DOT, Center Twnshp	Engineer, USACE	N/A	10-20 years

CENTRALIA

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
AGRICULTURAL MANAGEMENT PRACTICES (See Figure 66)													
Technical and Financial Assistance Needs: Technical assistance needed to implement farm management practices is relatively low because the NRCS provides much of this information and provides matching funds.													
16A	Private agricultural land southeast of Sundown and Old Highway Rd	77.7	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	658	678	1,329	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years

DUBUQUE

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
AGRICULTURAL MANAGEMENT PRACTICES (See Figure 66)													
Technical and Financial Assistance Needs: Technical assistance needed to implement farm management practices is relatively low because the NRCS provides much of this information and provides matching funds.													
31A	Private agricultural land east of Edval Ln and south of N Cascade Rd	48.1	Private agricultural land	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	393	757	1,376	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
8A	Private agricultural land north of Middle Rd and just east of Jonquil Rd	157.0	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	1,218	1,277	2,503	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
9A	Private agricultural land south of intersection of Middle Rd and Dreamway Dr	57.5	Private agricultural land	Agricultural land in row crop production with cattle; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	461	917	1,866	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
9B	Private agricultural land southwest of junction of Middle Rd and Whistle Wind Ln	159.7	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips and buffers visibly lacking	Utilize no-till soil conservation practice, install vegetated filter strips, and buffers on private agricultural land	1,236	1,297	2,542	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
DETENTION BASIN RETROFITS & MAINTENANCE (See Figure 62)													
Technical and Financial Assistance Needs: Technical assistance needed to implement detention basin retrofits is relatively low while financial assistance needs are moderate. Private landowners will require the greatest assistance.													
10B	West of Innovation Dr at Green Industrial Supply	0.1	Business (Private)	Wetland Bottom Detention; newly constructed and planted basin, looks to be planted w/turf	Design and implement project to install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	4.0	5	23	Medium	Business	Ecological Consultant/ Contractor	$2,000 to design & install prairie buffer & emergent plants; $1,000/ yr maintenance for 3 year establishment period	10-20 years
10C	East of Innovation Dr at IWI Motor Parts	0.6	Business (Private)	Wetland Bottom Detention; long linear swale detention planted to turf w/opportunistic wetland plants growing	Design and implement project to install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	3.0	4	17	Medium	Business	Ecological Consultant/ Contractor	$8,500 to design & install prairie buffer & emergent plants; $1,000/ yr maintenance for 3 year establishment period	10-20 years
11H	In front of Budweiser at Chavenelle and Radford Rd	0.9	Business (Private)	Dry Bottom Detention - turf; deep depressional basin adjacent to stream	Design and implement project to install a native prairie buffer, naturalize basin, and maintain for three years to establish	8.0	11	45	Medium	Business	Ecological Consultant/ Contractor	$9,000 to design & install prairie buffer; $1,000/yr maintenance for 3 year establishment period	10-20 years
12H	East of Riley Dr and south of Pennsylvania Ave	1.1	Owner (private)	Wet Bottom Detention - natural; between 2 multi-family developments, detention has drop structure on south end, some erosion along toe, pond is fenced	Design and implement project to regrade toe, install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	7.0	9	31	Medium	Owner	Ecological Consultant/ Contractor	$70,000 to regrade eroded toe; $16,000 to design & install prairie buffer & emergent plants; $2,000/ yr maintenance for 3 year establishment period	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
12J	Northeast corner of Haas Park	0.1	Dubuque (Public)	Dry Bottom Detention - turf; shallow basin w/flush manhole	Design and implement to install a native prairie buffer, naturalize basins, install educational signage/ trails, and maintain for three years to establish	3.0	3	11	High/ Critical Area	Dubuque	Ecological Consultant/ Contractor	$100,000 to install paved trails and signage throughout park; $2,000 to design & install prairie buffer; $1,000/ yr maintenance for 3 year establishment period	1-10 years
12K	North end of Haas Park at base of hill	0.1	Dubuque (Public)	Dry Bottom Detention - turf; shallow basin and surrounding area being mowed	Design and implement to install a native prairie buffer, naturalize basins, install educational signage/ trails, and maintain for three years to establish	3.0	5	17	High/ Critical Area	Dubuque	Ecological Consultant/ Contractor	combined with 12K	1-10 years
18C	Behind 7500 Chavenelle Rd	0.4	Business (Private)	Dry Bottom Detention - natural; appears to be planted w/ prairie and wetland species	Maintain in current condition	8.0	11	48	Medium	Business	Ecological Consultant/ Contractor	$1,000/year maintenance	10-20 years
21A	Cedar Lake west of Lake Ridge Dr and northeast of Cedar Cross Rd	2.4	Owner (private)	Wet Bottom Detention - turf; steep sloped basin, no emergent plants, water appears to be dyed, algae abundant	Design and implement project to regrade shoreline to accommodate emergents, install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	4.0	11	36	High/ Critical Area	Owner	Ecological Consultant/ Contractor	$150,000 to regrade eroded toe; $36,000 to design & install prairie buffer & emergent plants; $2,000/yr maintenance for 3 year establishment period	1-10 years
33A	East of Marjo Hills Access Rd at APC and south of Julien Dubuque Dr	0.2	Business (Private)	Dry Bottom Detention - turf; swale-like basin between road and building, all mowed	Design and implement a project to install native prairie buffer, naturalize swale, and maintain for three years to establish	4.0	5	22	Medium	Business	Ecological Consultant/ Contractor	$6,500 to design & install prairie buffer and naturalize swale; $1,000/yr maintenance for 3 year establishment period	10-20 years
4A	Detention at north end of Eleanor Roosevelt Middle School	1.1	School (Public)	Wet Bottom Detetion - natural; detention services school, runoff enters via swale	Design and implement a project to replant side slopes, naturalize swales, and maintain for three years to establish	10.0	14	50	Medium	School	Ecological Consultant/ Contractor	$16,570 to design & install prairie buffer & emergent plants; $2,000/yr maintenance for 3 year establishment period	10-20 years
4E	Behind Teddy Bear Park and between NW Arterial and Camelot Dr	7.4	Dubuque (Public)	Dry Bottom Detention - turf; dry bottom online regional detention area, dry area mowed; natural areas dominated by invasive species	Design and implement a project to remove invasives along tribs, plant dry areas to prairie, and maintain for three years to establish	7.0	22	74	High/ Critical Area	Dubuque	Ecological Consultant/ Contractor	$37,000 for brush removal; $77,600 to design & install prairie buffer; $5,000/yr maintenance for 3 year establishment period	1-10 years
5A	Behind Resurrection School off of Asbury Rd and Welter	1.3	School (Private)	Dry Bottom Detention - turf; services church parking lot to south, large drop outlet on east side, sheet flows from parking lot	Design and implement a project install a native prairie vegetation outside of ballfield area and maintain for three years to establish	4.0	4	15	High/ Critical Area	School	Ecological Consultant/ Contractor	$13,500 to design & install prairie buffer; $2,000/yr maintenance for 3 year establishment period	1-10 years
5B	Northwest corner of Asbury Rd and Welter	0.4	Business (Private)	Wetland Bottom Detention; at headwaters of trib, services Sams Club to north, whole basin mowed down even through wet areas	Design and implement project to install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	8.0	10	71	High/ Critical Area	Business	Ecological Consultant/ Contractor	$6,500 to design & install prairie buffer & emergent plants; $1,000/yr maintenance for 3 year establishment period	1-10 years
5D	North of Asbury Rd and east of Matthew John Dr	0.9	Dubuque (Public)	Dry Bottom Detention - turf; services subdivision to north and west, weltand swale from inlet to outlet	Design and implement a project to install native prairie buffer, naturalize swale, and maintain for three years to establish	5.0	14	46	Medium	Dubuque	Ecological Consultant/ Contractor	$14,000 to design & install prairie buffer and naturalize swale; $2,000/yr maintenance for 3 year establishment period	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
GREEN INFRASTRUCTURE PROTECTION AREAS (See Figure 65)													
Technical and Financial Assistance Needs: Technical assistance needed to protect open space or implement conservation/low impact development is high because of land, design/permitting, and construction costs.													
GI01	Southeast of intersection of NW Arterial and Asbury Rd	160.1	Private agricultural land/Developer	Two parcels totaling 160.1 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI02	South of Ridgeway Ave and north of Dodge St.	68.8	Private agricultural land	68.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI04	South of Middle Rd and west of Seippel Rd	79.8	Private agricultural land	79.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI13	South of Old Highway Rd and west of railroad along SFT13	73.2	Private agricultural land	73.2 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI17	East of Cottingham Rd along SFT12	74.3	Dubuque Metro Area Solid Waste Agency	74.3 acres currently in agricultural production with woodland areas and part of landfill operations	Once landfill is closed, create public open space amenity by naturalizing area	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Dubuque Metro Area Solid Waste Agency	Ecological Consultant; Landscape Architect	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI18	West of junction of Route 20 and Barrington Dr	166.9	Dubuque Metro Area Solid Waste Agency	166.9 acres of landfill and related uses	Once landfill is closed, create public open space amenity by naturalizing area	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Dubuque Metro Area Solid Waste Agency	Ecological Consultant; Landscape Architect	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI24	South of Cascade Rd and east of Edval Ln	79.7	Private agricultural land/Developer	79.9 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
OTHER MANAGEMENT MEASURES (See Figure 67)													
Technical and Financial Assistance Needs: Technical assistance and financial assistance needed to implement these projects varies depending on complexity.													
4B	Depression at north end of school building off of Radford Rd	N/A	Eleanor Roosevelt Middle School	Depressional area on north end of school w/manhole flush w/bottom	Design and implement a project to raise manhole and create demonstration rain garden	Pollutant reduction cannot be assessed via modeling			Medium	School	Dubuque, Ecological Consultant/ Landscape Architect	$10,000 to design and implement rain garden	1-10 years
12L	Finnin Ford at Dodge St (Rt. 20) east of Menard Ct	0.7 acres	Finnin Ford (Private)	Fill was dumped to make parking lot. Unstable soils and piled rubble.	Design and implement a project to install terracing system and drainage	Pollutant reduction cannot be assessed via modeling			Medium	Business	Dubuque, Ecological Consultant/ Landscape Architect	$500,000 to design and implement a project to install terraces and drainage	1-10 years
13D	Partial remnant oak woodland in draw at northwest end of park including rain gardens	2 acres	Dubuque (Public)	Partially remnant mesic woodland in draw w/pin oak, ash, sycamore, locust, cottonwood; understory is mowed turf; swale at bottom w/2 rain garden/check dam features	Design and implement a project to naturalize draw and add additional check dams naturalize upper slopes (retain picnic areas)	Pollutant reduction cannot be assessed via modeling			Medium	Dubuque	Ecological Consultant; Engineer	$50,000 to design and implement project to naturalize draw, upper slopes, and add additional check dams	1-10 years
21G	Just east of commerical development at Cedar Cross Rd and Hughes Ct	1 acre	Developer (Private)	Area where detention is supposed to be consists of 2 gullies down steep slope; 1 is partially stabilized w/rip rap; other has no protection	Design and implement a project to stabilize gullies and create additional detention when development resumes	Pollutant reduction cannot be assessed via modeling			Medium	Developer	Engineer	$100,000 to design and implement a project to stabilize gullies	When development resumes
21L	In Valentine Park off of Valentine Dr between June and Cody Drives	10.4 acres	Dubuque (Public)	Park w/ ball fields, track and play ground on southern half, northern half has parking area and many sloped areas all planted to turf w/ parkway trees; path surrounds entire park	Replant northern half of slopes to prairie to reduce mowing/ maintenance costs; bioswales could be cut into perimeter of parking lot w/curb cuts; existing parking islands could be converted to depressed rain gardens w/ curb cuts and educational signage installed	Pollutant reduction cannot be assessed via modeling			Medium	Dubuque	Ecological Consultant; Engineer	$50,000 to naturalize unused slopes, convert parking lot curbs to bioswales, convert parking islands to rain gardens, and install signage	1-10 years
22A	South of Dodge St between Fremont and N Grandview Ave	131.9 acres	Dubuque Golf & Country Club	131.9 acres of manicured and mowed golf course	Opportunity to enroll in Audubon Cooperative Sanctuary Program (ACSP) and establish low stature prairie buffers in roughs and around pond features.	Pollutant reduction cannot be assessed via modeling			Medium	Dubuque Golf & Country Club	Ecological Consultant	$100,000 to naturalize rough and pond features	1-10 years
32C	Off of Tower Dr and near Jaeger Dr	N/A	Table Mound School	4 downspouts drain to linear turf area along front of school; secondary opportunity on west side but not as visible	Good project opportunity to install rain garden along building front; good demonstration/education location	Pollutant reduction cannot be assessed via modeling			Medium	School	Engineer; Landscape Architect	$10,000 to design and implement rain garden	1-10 years
33B	Along south side of Julien Dubuque Dr, east of Inland Ln	0.4 acres	APC	Stormwater swale along APC @ Julien Dubuque Dr. with mowed turf and small eroded channel	Good opportunity to naturalize swale and install check dams	Pollutant reduction cannot be assessed via modeling			Low	Business	Ecological Consultant	$15,000 to naturalize swale and install check dams	1-10 years
42C	Along Digital Dr off of Route 61	N/A	Businesses (private)	Many of parking lot areas sheet flow directly into adjacent ravines	Design and install project to retrofit 17 existing parking lot islands as depressions w/curb cuts and planted w/vegetation (not necessarily natives)	37	46	336	High/ Critical Area	Businesses	Engineer	$50,000 to design and retrofit existing parking lot islands as naturalized detentions and add curb cuts	1-10 years
FPA #1	Middle Rd near Jonquil Terrace	N/A	Dubuque (Public)	Overbank-Roads	Raise elevation of Middle Rd and/ or increase culvert size where road crosses Middle Fork	Pollutant reduction cannot be assessed via modeling			Medium	DOT, Dubuque	Engineer, USACE	N/A	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
STREAMBANK, CHANNEL, & RIPARIAN RESTORATION & MAINTENANCE RECOMMENDATIONS (See Figure 64)													
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.													
CC14-15	See Figure 64 for project location	2,514	Private agricultural land	2,514 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	438	438	875	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$905 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $23 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
CC16	See Figure 64 for project location	2,751	Private agricultural land	2,751 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	505	505	1,010	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$990 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $25 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
MF01	Just south of Middle Rd between Rocky Hill Ln and Joanquil Terrace	750	Residential (Private)	750 lf of moderately eroded stream and approximately 5 acres of slope stabilization	Design, permit, and implement project to do tree clearing, sediment removal, and bank shaping as necessary	N/A	N/A	N/A	Medium Priority	Owner, Dubuque	USACE, Ecological Consultant	$200 K to design, permit, and implement project to clear trees, remove sediment, and bank shaping	If and when funding is available over the next 20+ years
MF02-03	See Figure 64 for project location	2,915	Private agricultural land	2,915 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	281	281	562	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $27 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
MF02-A	See Figure 64 for project location	2,841	Private agricultural land	2,841 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	190	190	380	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $26 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
MF02-B	See Figure 64 for project location	1,302	Private agricultural land	1,302 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	90	90	179	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$469 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $12 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
MF04-A	See Figure 64 for project location	1,306	Private agricultural land	1,306 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	90	90	180	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$470 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $12 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
MF04-B	See Figure 64 for project location	3,502	Developer (private)	3,502 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	375	375	750	High/ Critical Area	Developer, Dubuque	USACE, Consultant, IDNR, NRCS	$1.3 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $32 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
MF04-C	See Figure 64 for project location	1,654	Dubuque (public)	1,654 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	202	202	405	High/ Critical Area	Dubuque	USACE, Consultant, IDNR, NRCS	$596 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $15 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
MF06-07	See Figure 64 for project location	2,095	Private agricultural land	2,095 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	183	183	365	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$754 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $19 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
MF08	See Figure 64 for project location	1,394	Private agricultural land	1,394 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	181	181	363	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$502 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $13 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
MF08, MFT11	See Figure 64 for project location	3,899	Dubuque (public)	3,899 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	611	611	1,223	High/ Critical Area	Dubuque	USACE, Consultant, IDNR, NRCS	$1.4 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $36 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
MF09-A	See Figure 64 for project location	2,536	Dubuque (public)	2,536 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	303	303	606	High/ Critical Area	Dubuque	USACE, Consultant, IDNR, NRCS	$913 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $23 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
MF09-B	See Figure 64 for project location	1,535	Business (private)	1,535 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	200	200	399	High/ Critical Area	Business, Dubuque	USACE, Consultant, IDNR, NRCS	$553 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $14 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
MF12	See Figure 64 for project location	3,847	Private agricultural land	3,847 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	644	644	1,287	High/ Critical Area	Dubuque	USACE, Consultant, IDNR, NRCS	$1.4 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $35 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
MFT09	See Figure 64 for project location	6,326	Dubuque (public)	6,326 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	1,065	1,065	2,129	High/ Critical Area	Dubuque	USACE, Consultant, IDNR, NRCS	$2.2 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $58 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
MFT12	See Figure 64 for project location	1,140	Private agricultural land	1,140 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	98	98	196	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$410 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $10 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
NF02-A	See Figure 64 for project location	528	Church (private)	528 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	90	76	153	High/ Critical Area	Church, Dubuque	USACE, Consultant, IDNR, NRCS	$190 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $5 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
NF02-B	See Figure 64 for project location	1,421	Dubuque (public)	1,421 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	242	206	411	High/ Critical Area	Dubuque	USACE, Consultant, IDNR, NRCS	$512 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $13 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
NFT02	See Figure 64 for project location	6,253	Business (private)	6,253 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	2,151	1,828	3,656	High/ Critical Area	Business, Dubuque	USACE, Consultant, IDNR, NRCS	$2.2 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $57 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
SF03-A	See Figure 64 for project location	1,436	Private agricultural land	1,436 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	122	104	208	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$517 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $13 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
SF03-B	See Figure 64 for project location	2,941	Private agricultural land	2,941 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	507	431	862	High/ Critical Area	Owner, Dubuque	USACE, Consultant, IDNR, NRCS	$1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $27 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
SF03-04	See Figure 64 for project location	3,103	Dubuque Metro Landfill	3,103 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	938	798	1,595	High/ Critical Area	Dubuque Metro Landfill, Dubuque	USACE, Consultant, IDNR, NRCS	$1.1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $28 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
SF04-05	See Figure 64 for project location	5,507	Dubuque Industrial Center	5,507 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	2,186	1,858	3,716	High/ Critical Area	Dubuque Industrial Center, Dubuque	USACE, Consultant, IDNR, NRCS	$1.9 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $51 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
SF07-B	See Figure 64 for project location	3,239	Businesses (private)	3,239 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	396	396	793	High/ Critical Area	Business, Dubuque	USACE, Consultant, IDNR, NRCS	$1.2 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $30 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
SF07-08, SFT15	See Figure 64 for project location	6,766	Private agricultural land	6,766 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	776	776	1,553	High/ Critical Area	Owner, Dubuque, Dubuque County	USACE, Consultant, IDNR, NRCS	$2.3 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $62 K to restore riparian buffer; $5 K/yr maintenance	If and when funding is available over the next 20+ years
SF08-09	See Figure 64 for project location	3,133	Private agricultural land	3,133 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	479	479	959	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $29 K to restore riparian buffer; $3 K/yr maintenance	If and when funding is available over the next 20+ years
WETLAND RESTORATION RECOMMENDATIONS (See Figure 63)													
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.													
W01	Located on private agricultural land south of Meadows Golf Club between Middle Fork and MFT03	4.9	Owner (private)	4.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	1	7	Low	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$98,000 to design and implement wetland restoration	10-20 years
W02	Located on private agricultural land north of Middle Rd and just south of Middle Fork and Meadows Golf Club	9.2	Owner (private)	9.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	6	35	Medium	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$185,000 to design and implement wetland restoration	10-20 years
W10	Located on private agricultural land south of AY Mcdonald Manufacturing and the railroad tracks and north of Middle Fork Reach 7	3.7	Owner (private)	3.7 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	10	11	44	Low	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$74,000 to design and implement wetland restoration	10-20 years
W11	Located on private agricultural land east of Kelly Ln and Rockdale Methodist Cemetary, between the railroad tracks and the last reach of Middle Fork	5.3	Owner (private)	5.3 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	8	28	Medium	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$106,000 to design and implement wetland restoration	10-20 years
W18	Located on private agricultural land south and east of Cottingham Rd adjacent South Fork Reach 4	20.9	Owner (private)	20.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	5	27	High/ Critical Area	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$314,000 to design and implement wetland restoration	1-10 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/yr)					
W21	Located on private agricultural land immediately west of Route 20 and east of Cousins Rd between Seippel Rd and South Fork Reach 5	14.5	Owner (private)	14.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	5	32	High/ Critical Area	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$217,000 to design and implement wetland restoration	1-10 years
W22	Located on private agricultural land immediately east of Route 20 along the north end of SFT14	5.5	Owner (private)	5.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	5	6	38	Medium	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$109,000 to design and implement wetland restoration	10-20 years
W23	Located on private agricultural land immediately east of Route 20 and west of the upstream end of South Fork Reach 6	18.9	Owner (private)	18.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	4	23	High/ Critical Area	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$283,000 to design and implement wetland restoration	1-10 years
W24	Located on private agricultural land southeast of the Menards on Route 20 and along the east bank of South Fork Reach 6	5.9	Owner (private)	5.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	2	12	Medium	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$119,000 to design and implement wetland restoration	10-20 years
W26	Located on private agricultural land east of Nightengale Ln and north of South Fork Reach 7	7.8	Owner (private)	7.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	17	Medium	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$156,000 to design and implement wetland restoration	10-20 years
W28	Located on private agricultural land north of South Fork Reach 9 immediately south of Richards Rd	6.8	Owner (private)	6.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	4	11	Medium	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$135,000 to design and implement wetland restoration	10-20 years
W46	Located on private agricultural land between Catfish Creek Reach 16 and the railroad tracks	9.0	Owner (private)	9.0 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	5	7	22	Medium	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$180,000 to design and implement wetland restoration	10-20 years
W47	Located on private agricultural land between Catfish Creek Reach 16 and Route 61/52	15.8	Owner (private)	15.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	8	13	73	High/ Critical Area	Owner, Dubuque	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$237,000 to design and implement wetland restoration	1-10 years

DUBUQUE COUNTY

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
OTHER MANAGEMENT MEASURES (See Figure 67)													
Technical and Financial Assistance Needs: Technical assistance and financial assistance needed to implement these projects varies depending on complexity.													
61A	West of Olde Davenport Rd at junction with Schueller Heights Rd	70.5 acres	Dubuque County Conservation Board	Site has restored prairie on east end along Olde Davenport Rd; slopes along trib. comprised of degraded oak woodland with mature burr, red, and white oak; some hickory; understory is degraded w/various second growth trees and shrubs	Design and implement a project to brush invasive species from understory and re-seed understory as necessary	Pollutant reduction cannot be assessed via modeling			Medium	Dubuque County Conservation Board	Ecological Consultant	$350,000 to restore woodland	1-10 years
FPA #5	Swiss Valley Campground Road at Catfish Creek Reach 9	N/A	Dubuque County Conservation Board	Overbank-Roads	Raise the elevation of the campground road and install sufficiently sized culvert where Catfish Creek crosses the road	Pollutant reduction cannot be assessed via modeling			Medium	DOT, Dubuque County	Engineer, USACE	N/A	10-20 years

DUBUQUE TOWNSHIP

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
AGRICULTURAL MANAGEMENT PRACTICES (See Figure 66)													
Technical and Financial Assistance Needs: Technical assistance needed to implement farm management practices is relatively low because the NRCS provides much of this information and provides matching funds.													
19B	Private agricultural land/dairy between Old Highway Rd and railroad tracks along Middle Fork Reach 5	29.5	Private agricultural land	Agricultural land and dairy farm; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	257	849	4,213	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
20E	Private agricultural land south of English Mill Rd and River City Stone quarry	61.7	Private agricultural land	Agricultural land with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	489	1,258	4,584	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
GREEN INFRASTRUCTURE PROTECTION AREAS (See Figure 65)													
Technical and Financial Assistance Needs: Technical assistance needed to protect open space or implement conservation/low impact development is high because of land, design/permitting, and construction costs.													
GI19	West of English Mill Rd	179.7	Private agricultural land	179.7 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/ SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI20	South of Route 20 and north of English Mill Rd	66.6	River City Stone	66.6 acres in agricultural production and quarry	Once quarry operations cease, convert to public open water feature and naturalize where possible	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	River City Stone	Ecological Consultant; Landscape Architect	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI21	South of Route 20 and north of English Mill Rd	123.2	River City Stone	123.2 acres of stone quarry and related uses	Once quarry operations cease, convert to public open water feature and naturalize where possible	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	River City Stone	Ecological Consultant; Landscape Architect	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
STREAMBANK, CHANNEL, & RIPARIAN RESTORATION & MAINTENANCE RECOMMENDATIONS (See Figure 64)													
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.													
CC05-08	See Figure 64 for project location	11,116	Dubuque County Conservation Board	11,116 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	935	935	1,871	High/ Critical Area	Dubuque County Conservation Board	USACE, Consultant, IDNR, NRCS	$3.8 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $102 K to restore riparian buffer; $7 K/yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
CC10	See Figure 64 for project location	4,992	Private agricultural land	4,992 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	855	855	1,711	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.7 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $46 K to restore riparian buffer; $3 K/yr maintenance	If and when funding is available over the next 20+ years
CC11-12	See Figure 64 for project location	2,395	Private agricultural land	2,395 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	535	535	1,070	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$862 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $22 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
MF05-06	See Figure 64 for project location	3,660	Private agricultural land	3,660 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	402	402	805	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.3 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $35 K to restore riparian buffer; $3 K/yr maintenance	If and when funding is available over the next 20+ years
MF06	See Figure 64 for project location	1,217	State of Iowa (public)	1,217 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	192	192	384	High/ Critical Area	State of Iowa	USACE, Consultant, IDNR, NRCS	$438 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $11 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
SF07-A	See Figure 64 for project location	3,157	Private agricultural land	3,157 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	423	423	845	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $29 K to restore riparian buffer; $3 K/yr maintenance	If and when funding is available over the next 20+ years
SFT15	See Figure 64 for project location	5,488	Dubuque (public)	5,488 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	157	157	315	High/ Critical Area	Dubuque	USACE, Consultant, IDNR, NRCS	$1.9 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $50 K to restore riparian buffer; $3 K/yr maintenance	If and when funding is available over the next 20+ years
SF07-08, SFT15	See Figure 64 for project location	6,766	Private agricultural land	6,766 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	776	776	1,553	High/ Critical Area	Owner, Dubuque, Dubuque County	USACE, Consultant, IDNR, NRCS	$2.3 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $62 K to restore riparian buffer; $5 K/yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
WETLAND RESTORATION RECOMMENDATIONS (See Figure 63)													
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.													
W07	Located on private agricultural land south of Hormel Foods and the railroad tracks and north of Middle Fork Reach 5	5.8	Owner (private)	5.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	2	13	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$116,000 to design and implement wetland restoration	10-20 years
W08	Located on private agricultural land between Old Highway Rd and Middle Fork Reach 6	10.2	Owner (private)	10.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	2	12	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$153,000 to design and implement wetland restoration	1-10 years
W09	Located on private agricultural land south of the railroad tracks and north of Middle Fork Reach 6	4.2	Owner (private)	4.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	17	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$85,000 to design and implement wetland restoration	10-20 years
W25	Located on private agricultural land adjacent South Fork Reach Reach 6 southwest of River City Stone quarry; parcel is slated for future development	6.2	Owner (private)	6.2 acres of drained wetlands on private agricultural land	Incorporate wetland restoration into future Conservation Development plans by using areas as wetland detention & mitigation	2	2	14	Medium	Future developer/ Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$124,000 to design and implement wetland restoration	10-20 years
OTHER MANAGEMENT MEASURES (See Figure 67)													
Technical and Financial Assistance Needs: Technical assistance and financial assistance needed to implement these projects varies depending on complexity.													
FPA #4	Cascade Rd at South Fork Reach 8	N/A	Dubuque Twnshp (Public)	Overbank-Roads	Raise the elevation of Cascade Rd and/or increase culvert size where South Fork passes under Cascade Rd	Pollutant reduction cannot be assessed via modeling			Medium	DOT, Dubuque Twnshp	Engineer, USACE	N/A	10-20 years

MOSALEM TOWNSHIP

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
AGRICULTURAL MANAGEMENT PRACTICES (See Figure 66)													
Technical and Financial Assistance Needs: Technical assistance needed to implement farm management practices is relatively low because the NRCS provides much of this information and provides matching funds.													
44B	Private agricultural land west of Kemp Rd and south of Route 52	80.6	Private agricultural land	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	619	1,158	1,741	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
52B	Several agricultural parcels along Lake Eleanor Rd and north of Kane Rd	129.7	Private agricultural land	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	939	1,898	3,790	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
52C	Private agricultural land southeast of Lake Eleanor and Kane Rds	18.7	Private agricultural land	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	172	412	1,407	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
53A	Private agricultural land northeast of Kemp and Kane Rds	91.4	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	759	785	1,538	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
62A	Private agricultural land north of Schueller Heights Rd and east of Decker	38.3	Private agricultural land	Agricultural land and dairy farm; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	322	1,065	5,270	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
62B	Private agricultural land north of Schueller Heights and Decker Rd	40.5	Private agricultural land	Agricultural land and dairy farm; cattle allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	339	786	2,434	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
DETENTION BASIN RETROFITS & MAINTENANCE (See Figure 62)													
Technical and Financial Assistance Needs: Technical assistance needed to implement detention basin retrofits is relatively low while financial assistance needs are moderate. Private landowners will require the greatest assistance.													
61B	South of Harvest Ln and east of Olde Davenport Rd	1.2	Owner (private)	Wet Bottom Detention - natural; at headwaters of trib in subdivision created via berm in draw, mostly overland flow directed toward pond, border dominated by RCG	Design and implement project to install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	2.0	6	22	Medium	Owner	Ecological Consultant/ Contractor	$18,000 to design & install prairie buffer & emergent plants; $2,000/yr maintenance for 3 year establishment period	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
GREEN INFRASTRUCTURE PROTECTION AREAS (See Figure 65)													
Technical and Financial Assistance Needs: Technical assistance needed to protect open space or implement conservation/low impact development is high because of land, design/permitting, and construction costs.													
GI33	Along Lake Eleanor Rd north of Kane Rd	103.3	Private agricultural land	103.3 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI37	North or Kane Rd and east of Kemp Rd	66.6	Private agricultural land	66.6 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
OTHER MANAGEMENT MEASURES (See Figure 67)													
Technical and Financial Assistance Needs: Technical assistance and financial assistance needed to implement these projects varies depending on complexity.													
44A	East off of Route 52 immediately north of Olde Massey Rd	N/A	Dubuque Mulch Co.	Mulch company in old quarry; site visited during rain event and runoff from mulch piles flows through paved area and into trib to Granger; could be nutrient hot spot; has no detention	Design and implement a project to create settling-type detention basin to remove nutrients and runoff prior to release from site	10	13	55	High/ Critical Area	Dubuque Mulch Co.	Engineer	$20,000 to design and install a detention basin	1-10 years
61A	West of Olde Davenport Rd at junction with Schueller Heights Rd	70.5 acres	Dubuque County Conservation Board	Site has restored prairie on east end along Olde Davenport Rd; slopes along trib. comprised of degraded oak woodland with mature burr, red, and white oak; some hickory; understory is degraded w/various second growth trees and shrubs	Design and implement a project to brush invasive species from understory and re-seed understory as necessary	Pollutant reduction cannot be assessed via modeling			Medium	Dubuque County Conservation Board	Ecological Consultant	$350,000 to restore woodland	1-10 years
STREAMBANK, CHANNEL, & RIPARIAN RESTORATION & MAINTENANCE RECOMMENDATIONS (See Figure 64)													
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.													
CC17-18, GC07	See Figure 64 for project location	7,262	State of Iowa (public)	7,262 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	2,644	2,644	5,289	High/ Critical Area	State of Iowa	USACE, Consultant, IDNR, NRCS	$2.5 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $67 K to restore riparian buffer; $5 K/yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
GC05-06	See Figure 64 for project location	8,186	Private agricultural land	8,186 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	639	639	1,278	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$2.8 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $75 K to restore riparian buffer; $5 K/ yr maintenance	If and when funding is available over the next 20+ years
GC07	See Figure 64 for project location	3,580	Developer (private)	3,580 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	893	759	1,518	High/ Critical Area	Developer, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.3 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $33 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
GCT07-A	See Figure 64 for project location	2,730	Private agricultural land	2,730 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	543	543	1,086	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.3 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $33 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
GCT07-B	See Figure 64 for project location	618	Private agricultural land	618 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	123	123	246	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.3 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $33 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
GCT07-C	See Figure 64 for project location	4,398	Private agricultural land	4,398 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	875	875	1,749	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.3 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $33 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
WETLAND RESTORATION RECOMMENDATIONS (See Figure 63)													
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.													
W56	Located on private agricultural land along south bank of Granger Creek Reach 5 north and east of Lake Eleanor Rd	2.2	Owner (private)	2.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	7	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$44,000 to design and implement wetland restoration	10-20 years

PEOSTA

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
GREEN INFRASTRUCTURE PROTECTION AREAS (See Figure 65)													
Technical and Financial Assistance Needs: Technical assistance needed to protect open space or implement conservation/low impact development is high because of land, design/permitting, and construction costs.													
GI06	East of Sundown Rd near headwaters of South Fork	138.0	Private agricultural land	138 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development

PRAIRIE CREEK TOWNSHIP

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
AGRICULTURAL MANAGEMENT PRACTICES (See Figure 66)													
Technical and Financial Assistance Needs: Technical assistance needed to implement farm management practices is relatively low because the NRCS provides much of this information and provides matching funds.													
73A	Private agricultural land east of Mc Andrews Rd and south of Monastery Rd	39.8	Private agricultural land	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	333	982	4,334	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
74A	Private agricultural land north west of Prairie Creek Rd at Route 151	15.3	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	158	156	306	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
76A	Private agricultural land south of Prairie Creek Rd and west of Route 151	39.5	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	364	369	723	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
WETLAND RESTORATION RECOMMENDATIONS (See Figure 63)													
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.													
W31	Located on private agricultural land south of Catfish Creek Reach 2 and east of Mc Andrews Rd	6.7	Owner (private)	6.7 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	4	24	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$134,000 to design and implement wetland restoration	10-20 years
W32	Located on private agricultural land south of Prairie Creek Rd along both banks of Catfish Creek Tributary 3	5.4	Owner (private)	5.4 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	4	22	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$107,000 to design and implement wetland restoration	10-20 years

TABLE MOUND TOWNSHIP

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
AGRICULTURAL MANAGEMENT PRACTICES (See Figure 66)													
Technical and Financial Assistance Needs: Technical assistance needed to implement farm management practices is relatively low because the NRCS provides much of this information and provides matching funds.													
29B	Private agricultural land east of English Mill Rd along SFT15	79.6	Private agricultural land	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	612	1,228	2,494	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
30A	Private agricultural land to either side of N Cascade Rd at Westercamp Dr	88.3	Private agricultural land	Agricultural land in row crop/ hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	671	1,374	2,969	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
31B	Private agricultural land at end of Edval Ln	64.8	Private agricultural land	Agricultural land in row crop production with livestock; livestock allowed free access to streams	Utilize waste management system and fencing to restrict livestock access on private agricultural land	512	896	3,817	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
40A	Private agricultural land south of Oakland Farms Rd at Catfish Creek Reach 12	38.2	Private agricultural land	Agricultural land with cattle and horses; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	322	793	2,747	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
41A	Private agricultural land northwest of Oakland Farms Rd and Knepper Ln	38.8	Private agricultural land	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	326	739	2,413	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
42D	Private agricultural land west of Key West Dr and Oregon St, behind residential area	40.8	Private agricultural land	Agricultural land and dairy farm; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	341	995	4,346	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
42E	Several agricultural parcels east of Knepper Ln and north of Military Rd	172.2	Private agricultural land	Some in-field swales present, but insufficient for topography	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	1,321	1,388	2,720	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
47B	Private agricultural land southeast of intersection of Route 20 and Swiss Valley Rd near headwaters of CCT08	32.2	Private agricultural land	Agricultural land in row crop/ hay production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	277	510	809	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
49A	Private agricultural land located west of junction of Swiss Valley and Whitetop Rds	68.5	Private agricultural land	Agricultural land with cattle; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	537	1,053	1,989	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
51C	Private agricultural land west of Route 61 behind Tamarack Rd business Park	82.1	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	690	712	1,395	High/ Critical Area	Owner/Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
52A	Private agricultural land west of Lake Eleanor Rd along Granger Creek Tributary 7	24.2	Private agricultural land	Agricultural land in row crop/hay production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	215	404	712	High/ Critical Area	Owner/Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
58A	Private agricultural land south and east of Route 151 and Jecklin Ln	30.6	Private agricultural land	Agricultural land in row crop/hay with livestock; livestock allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	265	966	5,179	High/ Critical Area	Owner/Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
60D	Private agricultural land west of Hidden Valley Rd along Granger Creek Reach 2	46.4	Private agricultural land	Agricultural land in row crop/hay production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	381	694	976	High/ Critical Area	Owner/Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
67A	Private agricultural land at west end of Nolan Ln	20.1	Private agricultural land	Agricultural land with horses/ pasture; horses allowed free access to streams, streams heavily eroded as a result	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	183	325	449	High/ Critical Area	Owner/Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
69A	Private agricultural land along either side of Airview Ln north of junction with Laudeville Rd	35.8	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	334	338	662	High/ Critical Area	Owner/Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
DETENTION BASIN RETROFITS & MAINTENANCE (See Figure 62)													
Technical and Financial Assistance Needs: Technical assistance needed to implement detention basin retrofits is relatively low while financial assistance needs are moderate. Private landowners will require the greatest assistance.													
28A	Barrington Lake south of Barrington Dr between Woodview and Lakeview Dr	7.5	Owner (private)	Wet Bottom Detention - turf; large pond also serves as detention for subdivision, beach at south end, used for recreation, some erosion along toe	Design and implement project to install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	7	21	74	Medium	Owner	Ecological Consultant/ Contractor	$113,000 to design & install prairie buffer & emergent plants; $5,000/ yr maintenance for 3 year establishment period	10-20 years
32E	Between Noonan St and Cascade Dr just east of Route 61	1.8	Owner (public?)	Dry Bottom Detention - turf; drainage swale through center, appears to drain commercial area to west and portion of trailer park and highway, outlet is corrugated pipe that could be retrofitted as detention outlet	Design and implement a project to alter outlet for detention purposes, excavate areas adjacent to swale for additional storage, install a native prairie buffer, plant emergents along shoreline, and maintain for three years to establish	11	13	46	High/ Critical Area	Owner	General Contractor, Ecological Consultant/ Contractor	$100,000 to design & install additional storage, prairie buffer, plant emergents along shoreline,; $2,000/ year maintenance	1-10 years
42A	South of Janelle Ct and east of Route 61	5.1	Owner (private)	Wet Bottom Detention - natural; probably a farm pond serving as detention w/cattle access, appears to serve subdivision to northwest; weedy	Restrict cattle access to some degree	4	13	43	Medium	Owner	NRCS	N/A	10-20 years
51A	North of Silverwood off of Tamarack Dr	0.8	Business (Private)	Dry Bottom Detention - turf; long linear basin w/large PVC pipe draining to it, outlet is on east end w/ small wetland pocket dominated by cattail near outlet	Design and implement a project to plant swale as bioswale w/natives and maintain for three years to establish	3	2	19	Medium	Business	Ecological Consultant/ Contractor	$8,000 to design & install naturalized swale; $1,000/ yr maintenance for 3 year establishment period	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
GREEN INFRASTRUCTURE PROTECTION AREAS (See Figure 65)													
Technical and Financial Assistance Needs: Technical assistance needed to protect open space or implement conservation/low impact development is high because of land, design/permitting, and construction costs.													
GI22	North and south of Cascade Rd west of Westercamp Dr	88.3	Private agricultural land	88.3 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI23	South of Cascade Rd and west of Edval Ln	67.2	Private agricultural land	67.2 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI25	West of Route 151 and Nolan Ln	66.4	Private agricultural land	66.4 acres of woodland areas and possible hay field	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI26	North and east of Swiss Valley Rd and west of Swiss Valley Campground	72.4	Private agricultural land	72.4 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI27	South of Oakland Farms Rd along CCT18	78.5	Private agricultural land	78.5 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI28	Southeast of Routes 151 and 61, adjacent to Dubuque Regional Airport	275.7	Dubuque	275.7 acres of woodland areas and agricultural production	Preserve as open space and protect parcel from future development; protect and manage ecological components of the site	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Dubuque	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI29	North of Laudeville Rd and east of Airview Dr	66.0	Private agricultural land	66 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/ farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
GI30	Southeast of junction of Routes 151 and 61 south of Silver Oaks Dr	86.8	Private agricultural land/ Developer	86.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI31	East of Route 61 at junction of Routes 151 and 61	82.8	Private agricultural land	82.8 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI32	East of Katie Cove near junction of Katie Cove and Military Rd	72.4	Private agricultural land/ Developer	72.4 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI34	West of Lake Eleanor Rd southeast of Dubuque Technology Park	60.9	Private agricultural land	60.9 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI35	Northeast of Dubuque Technology Park between Route 52 and Lake Eleanor Rd	69.4	Private agricultural land	69.4 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI36	Northeast of Dubuque Technology Park between Route 52 and Lake Eleanor Rd	69.3	Private agricultural land	69.3 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/ open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
OTHER MANAGEMENT MEASURES (See Figure 67)													
Technical and Financial Assistance Needs: Technical assistance and financial assistance needed to implement these projects varies depending on complexity.													
60A	Northeast of the junction of Route 61 and 151	N/A	Bill Miller & Sons Logging Inc	Mulch producing business; water sheet flows from mulch piles to swale that flows to tributary	Design and implement a project to create wetland detention on site that captures and treats runoff prior to discharging from site	4	5	19	High/ Critical Area	Bill Miller & Sons Logging Inc	Engineer	$20,000 to design and install a detention basin	1-10 years
60B	At southeast end of Wildlife Ridge south of junction with Turkey Valley Ln	0.3 acres	HOA/ Residents	Depressed area w/inlet and outlet pipe, but no detention; small redoed channel from inlet to outlet, outlet area very wet; 1 large white oak in basin	Design and implement a project to manipulate outlet and stabilize eroded channel, then convert to rain garden-like feature	Pollutant reduction cannot be assessed via modeling			Low	HOA/ Residents	Engineer; Landscape Architect	$15,000 to design and implement rain garden	1-10 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
STREAMBANK, CHANNEL, & RIPARIAN RESTORATION & MAINTENANCE RECOMMENDATIONS (See Figure 64)													
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.													
CC08	See Figure 64 for project location	3,433	Private agricultural land	3,433 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	357	357	714	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.2 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $32 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
CC09-10	See Figure 64 for project location	2,793	Dubuque County	2,793 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	192	192	385	High/ Critical Area	Dubuque County	USACE, Consultant, IDNR, NRCS	$1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $26 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
CC13-A	See Figure 64 for project location	2,410	Private agricultural land	2,410 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	516	516	1,032	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$870 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $22 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
CC13-B	See Figure 64 for project location	5,142	Private agricultural land	5,142 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	1,574	1,574	3,147	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.8 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $47 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
CCT17	See Figure 64 for project location	2,865	Private agricultural land	2,865 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	614	614	1,227	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $26 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
CCT18	See Figure 64 for project location	1,000	Private agricultural land	1,000 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	184	184	367	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$360 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $9 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
GC02-03, GCT04B	See Figure 64 for project location	7,886	Private agricultural land	7,886 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	679	679	1,357	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$2.7 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $72 K to restore riparian buffer; $5 K/ yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
GC03	See Figure 64 for project location	3,329	Private agricultural land, Dubuque (public)	3,329 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	286	286	573	High/ Critical Area	Owner, Dubuque, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.2 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $31 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
GC03-04	See Figure 64 for project location	5,782	Private agricultural land	5,782 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	807	807	1,614	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$2 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $53 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
SFT16	See Figure 64 for project location	1,727	Private agricultural land	1,727 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	529	529	1,057	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$360 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $9 K to restore riparian buffer; $2 K/yr maintenance	If and when funding is available over the next 20+ years
CC03,04	See Figure 64 for project location	4,721	Developer (private)	4,721 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	488	488	975	High/ Critical Area	Developer, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.7 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $43 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
CC04	See Figure 64 for project location	4,153	Private agricultural land	4,153 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	413	413	826	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.5 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $38 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
SF08-09	See Figure 64 for project location	3,133	Private agricultural land	3,133 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	479	479	959	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.1 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $29 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
WETLAND RESTORATION RECOMMENDATIONS (See Figure 63)													
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.													
W27	Located on private agricultural land east of South Fork Reach 8 between Cascade and Miners Rds	2.5	Owner (private)	2.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	2	7	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$50,000 to design and implement wetland restoration	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
W33	Located on private agricultural land just north of Swiss Valley Nature Preserve along west bank of Catfish Creek Reach 9	29.0	Owner (private)	29.0 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	6	8	50	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$435,000 to design and implement wetland restoration	1-10 years
W34	Located on private agricultural land along Catfish Creek Reach 10 immediately east of its junction with CCT14	10.9	Owner (private)	10.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	6	34	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$164,000 to design and implement wetland restoration	1-10 years
W35	Located on private agricultural land along Catfish Creek Reach 10 just south of and east of its junction with CCT15	5.8	Owner (private)	5.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	17	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$117,000 to design and implement wetland restoration	10-20 years
W36	Located on private agricultural land along north bank of CCT16 west of Whitetop Rd	4.5	Owner (private)	4.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	1	5	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$90,000 to design and implement wetland restoration	10-20 years
W37	Located on private agricultural land along west bank of Catfish Creek Reach 12 south of Oakland Farms Rd	9.1	Owner (private)	9.1 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	2	12	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$182,000 to design and implement wetland restoration	10-20 years
W38	Located on private agricultural land along west bank of Catfish Creek Reach 13 immediately north of Oakland Farms Rd	9.4	Owner (private)	9.4 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	5	6	39	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$188,000 to design and implement wetland restoration	10-20 years
W39	Located on private agricultural land along west bank of Catfish Creek Reach 13 north of Perry Construction	4.9	Owner (private)	4.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	15	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$98,000 to design and implement wetland restoration	10-20 years
W40	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13	3.6	Owner (private)	3.6 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	17	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$73,000 to design and implement wetland restoration	10-20 years
W41	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13	2.6	Owner (private)	2.6 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	2	12	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$52,000 to design and implement wetland restoration	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
W42	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13	2.0	Owner (private)	2.0 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	2	15	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$40,000 to design and implement wetland restoration	10-20 years
W43	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13	8.2	Owner (private)	8.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	16	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$165,000 to design and implement wetland restoration	10-20 years
W44	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13	3.7	Owner (private)	3.7 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	2	11	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$73,000 to design and implement wetland restoration	10-20 years
W45	One of six sites located on private agricultural land along either bank of the northwestern potion of Catfish Creek Reach 13	12.6	Owner (private)	12.6 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	4	18	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$190,000 to design and implement wetland restoration	1-10 years
W48	Located on private agricultural land along both banks of Granger Creek Tributary 4A east of Route 61	8.5	Owner (private)	8.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	6	10	50	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$170,000 to design and implement wetland restoration	10-20 years
W49	Located on private agricultural land between GCT02 and GCT03 west of the bend in Hidden Valley Rd	5.7	Owner (private)	5.7 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	1	5	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$113,000 to design and implement wetland restoration	10-20 years
W50	Located on private agricultural land north of Granger Creek Reach 2 and west of GCT03	18.5	Owner (private)	18.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	6	36	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$277,000 to design and implement wetland restoration	1-10 years
W51	Located on private agricultural land east of Granger Creek Reach 3 and Route 61	2.6	Owner (private)	2.6 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	17	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$53,000 to design and implement wetland restoration	10-20 years
W52	Located on private agricultural land northwest of Tamarack business park and north of Granger Creek Tributary 5	3.5	Owner (private)	3.5 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	5	8	42	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$70,000 to design and implement wetland restoration	10-20 years
W53	Located on private agricultural land just north of Tamarack business park and north of Granger Creek Tributary 5	2.2	Owner (private)	2.2 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	2	14	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$44,000 to design and implement wetland restoration	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
W54	Located on private agricultural land south of the junction of Route 61 and Olde Davenport Rd	2.9	Owner (private)	2.9 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	16	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$58,000 to design and implement wetland restoration	10-20 years
W55	Located on private agricultural land along north bank of Granger Creek Reach 4 near the Dubuque Techonology Park	3.6	Owner (private)	3.6 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	4	16	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$71,000 to design and implement wetland restoration	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
AGRICULTURAL MANAGEMENT PRACTICES (See Figure 66)													
Technical and Financial Assistance Needs: Technical assistance needed to implement farm management practices is relatively low because the NRCS provides much of this information and provides matching funds.													
27A	Private agricultural land northwest of Cottingham and Chesterman Rds	56.9	Private agricultural land	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	456	909	1,858	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
27B	Private agricultural land west of Cottingham Rd at junction with Mc Clain Ln	60.5	Private agricultural land	Agricultural land with livestock; cattle allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	481	870	1,136	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
37A	Private agricultural land east of Cottingham Rd and north of Route 20	66.5	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	574	589	1,154	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
46A	Private agricultural land located at northeast corner of Cottingham and Cascade Rds	20.0	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	201	200	392	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
46B	Two agricultural parcels north and south of Cascade Rd west of Cottingham Rd	78.4	Private agricultural land	Agricultural land in row crop production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	604	1,566	5,724	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
46C	Private agricultural parcel west of Royal Wood Dr and south of Cascade Rd	41.1	Private agricultural land	Agricultural land in row crop production with livestock; in-field vegetated filter strips visibly lacking; livestock allowed free access to streams	Utilize no-till soil conservation practice, install vegetated filter strips, waste management system, and fencing to restrict livestock access on private agricultural land	720	785	1,512	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
46D	Private agricultural land south of Route 20 and west of Cotthingham Rd	33.2	Private agricultural land	Agricultural land in row crop production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	284	523	821	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
46E	Three agricultural parcels south of Cascade Rd and west of Royal Wood Dr	121.3	Private agricultural land	Agricultural land in row crop production with livestock; livestock allowed free access to streams	Utilize no-till soil conservation practice, waste management system, and fencing to restrict livestock access on private agricultural land	885	1,677	2,557	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
54A	Private agricultural land south of N Cascade Rd and west of New Melleray Rd	156.3	Private agricultural land	Confined animal feedlot - pigs	Utilize waste management system on private agricultural land	0	649	2,673	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years
64A	Private agricultural land southwest of junction of Monastery and New Melleray Rds	37.5	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	347	351	688	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/ buy-in occurs over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
65A	Private agricultural land southeast of New Melleray Rd and Bakey Ln	156.0	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	1,211	1,270	2,489	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
72A	Private agricultural land west of Monastery Rd and the new Melleray Abbey	153.7	Private agricultural land	Agricultural land in row crop production with in-field vegetated filter strips visibly lacking	Utilize no-till soil conservation practice and install vegetated filter strips on private agricultural land	1,195	1,252	2,454	High/ Critical Area	Owner/ Farmer (private)	NRCS, Dubuque SWCD	Not Applicable	As owner education/buy-in occurs over the next 20+ years
GREEN INFRASTRUCTURE PROTECTION AREAS (See Figure 65)													
Technical and Financial Assistance Needs: Technical assistance needed to protect open space or implement conservation/low impact development is high because of land, design/permitting, and construction costs.													
GI09	Northwest of railroad along SFT09	70.6	Private agricultural land	70.6 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI10	Southeast of railroad along SFT09 and SF02	80.1	Private agricultural land	80.1 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI11	South of Chesterman Rd and west of Cottingham Rd	113.9	Private agricultural land	113.9 acres currently in agricultural production and woodland areas	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI15	South and east of Cottingham Rd along SF03	60.5	Private agricultural land	60.5 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development
GI16	South and east of Cottingham Rd along SF03	63.0	Private agricultural land	63.0 acres currently in agricultural production	Acquire, naturalize, and protect parcel as natural area/open space or incorporate conservation design standards in future development plans	Pollutant reduction cannot be assessed via modeling			High/ Critical Area	Private owner/farmer	Dubuque County; Dubuque County Conservation Society; NRCS/SWCD; Ecological Consultant	The cost for acquiring & protecting parcels cannot be determined	If/when parcels become available for purchase or development

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
OTHER MANAGEMENT MEASURES (See Figure 67)													
Technical and Financial Assistance Needs: Technical assistance and financial assistance needed to implement these projects varies depending on complexity.													
36A	East of Thunder Hills Rd, between Thunder Ridge Dr and Thunder Hills Dr	164.5 acres	Thunder Hills Golf & Country Club	164.5 acres of manicured and mowed golf course	Opportunity to enroll in Audubon Cooperative Sanctuary Program (ACSP) and establish low stature prairie buffers in roughs and around pond features.	Pollutant reduction cannot be assessed via modeling			Medium	Thunder Hills Golf & Country Club	Ecological Consultant	$175,000 to naturalize rough and pond features	1-10 years
FPA #2	Cottingham Rd at South Fork Reach 3	N/A	Vernon Twnshp (Public)	Overbank-Roads	Raise elevation of Cottingham Rd and/or increase culvert size where road crosses South Fork	Pollutant reduction cannot be assessed via modeling			Medium	DOT, Vernon Twnshp	Engineer, USACE	N/A	10-20 years
STREAMBANK, CHANNEL, & RIPARIAN RESTORATION & MAINTENANCE RECOMMENDATIONS (See Figure 64)													
Technical and Financial Assistance Needs: Stream restorations are complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration. The project becomes more complex in areas that flow through several governing bodies or multiple private residences. Technical and financial assistance associated with stream maintenance is generally low for minor tasks such as removing debris.													
SF02-03	See Figure 64 for project location	4,687	Private agricultural land	4,687 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	455	455	911	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.7 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $43 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
SF02-A	See Figure 64 for project location	4,153	Private agricultural land	4,153 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	286	286	572	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.5 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $38 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
SF02-B, SFT08	See Figure 64 for project location	3,755	Developer (private)	3,755 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	180	180	560	High/ Critical Area	Developer, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.4 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $34 K to restore riparian buffer; $3 K/ yr maintenance	If and when funding is available over the next 20+ years
SFT09	See Figure 64 for project location	1,346	Private agricultural land	1,346 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	129	129	257	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$485 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $12 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
SFT10	See Figure 64 for project location	1,843	Private agricultural land	1,843 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	282	282	564	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$663 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $17 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years
SFFB01	See Figure 64 for project location	1,685	Private agricultural land	1,685 lf of stream with severely eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	516	516	1,032	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$607 K to design, permit, and implement a project to stabilize and restore eroded streambanks; $15 K to restore riparian buffer; $2 K/ yr maintenance	If and when funding is available over the next 20+ years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
CC03,04	See Figure 64 for project location	4,721	Developer (private)	4,721 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	488	488	975	High/ Critical Area	Developer, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.7 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $43 K to restore riparian buffer; $3 K/yr maintenance	If and when funding is available over the next 20+ years
CC04	See Figure 64 for project location	4,153	Private agricultural land	4,153 lf of stream with moderately eroded streambanks	Design, permit, and implement project to selectively stabilize eroded areas using bioengineering techniques, or hard-armoring where necessary, and restore 25 ft buffer by removing invasive species and planting native vegetation	413	413	826	High/ Critical Area	Owner, Dubuque County	USACE, Consultant, IDNR, NRCS	$1.5 M to design, permit, and implement a project to stabilize and restore eroded streambanks; $38 K to restore riparian buffer; $3 K/yr maintenance	If and when funding is available over the next 20+ years
WETLAND RESTORATION RECOMMENDATIONS (See Figure 63)													
Technical and Financial Assistance Needs: Wetland restoration projects are typically complex and require high technical and financial assistance needs to protect land, design, construct, monitor, and maintain the restoration.													
W12	Located on private agricultural land north of Chesterman Rd between South Fork Reach 2 and SFFB01	24.0	Owner (private)	24.0 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	5	11	42	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$361,000 to design and implement wetland restoration	1-10 years
W13	Located on private agricultural land north of Chesterman Rd, west of Cottingham Rd and south of South Fork Reach 3	18.8	Owner (private)	18.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	3	4	24	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$282,000 to design and implement wetland restoration	1-10 years
W14	Located on private agricultural land north of South Fork Reach 3 and south of Mc Clain Ln	5.8	Owner (private)	5.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	17	Medium	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$116,000 to design and implement wetland restoration	10-20 years
W15	Located on private agricultural land north of Chesterman Rd, west of Cottingham Rd and south of South Fork Reach 3	19.8	Owner (private)	19.8 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	5	32	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$296,000 to design and implement wetland restoration	1-10 years
W16	Located on private agricultural land north of South Fork Reach 3 and south of Mc Clain Ln immediately west of Cottingham Rd	2.6	Owner (private)	2.6 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	1	2	10	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$51,000 to design and implement wetland restoration	10-20 years

ID#	Location	Units (acres/ linear feet)	Owner (public or private)	Existing Condition	Management Measure Recommendation	Pollutant Reduction Efficiency			Priority	Responsible Entity	Sources of Technical Assistance	Cost Estimate	Implementation Schedule (Years)
						TSS (tons/yr)	TP (lbs/yr)	TN (lbs/ yr)					
W17	Located on private agricultural land south and east of Cottingham Rd near Doreen Ln	25.7	Owner (private)	25.7 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	4	6	35	High/ Critical Area	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$385,000 to design and implement wetland restoration	1-10 years
W29	Located on private agricultural land adjacent existing wetlands northwest of Monastery and New Melleray Rds along Catfish Creek Reach 1	4.3	Owner (private)	4.3 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	15	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$86,000 to design and implement wetland restoration	10-20 years
W30	Located just east of the junction of Monastery and New Melleray Rds along the east bank of Catfish Creek Reach 2 on private agricultural land	3.1	Owner (private)	3.1 acres of drained wetlands on private agricultural land	Restore hydrology by breaking drain tiles if necessary and revegetate with native vegetation	2	3	20	Low	Owner, Dubuque County	Dubuque; Engineer; Ecological Consultant; USACE; SWCD; IDNR	$62,000 to design and implement wetland restoration	10-20 years

7.0 Information & Education Plan

The health of the Catfish Creek watershed faces challenges and threats from poor land management practices, streambank erosion, invasive species, land use changes, and problematic flooding. At the root of these challenges and threats is that key audiences lack the necessary knowledge and tools to make informed decisions and adopt positive behaviors to mitigate such threats and challenges. Since a significant amount of Catfish Creek watershed is held as private property, any efforts to improve water quality must include significant education and outreach efforts to those landowners and key stakeholders.

This Information & Education Plan (I&E Plan) recommends campaigns that are designed to enhance understanding of the issues, problems, and opportunities within the Catfish Creek watershed. The intention is to promote general acceptance and stakeholder participation in selecting, designing, and implementing recommended Management Measures to improve watershed conditions. The first step in understanding the issues, problems, and opportunities within Catfish Creek watershed is to gain a better perspective of how the watershed evolved over time into what exists today.

Municipal staffs, elected officials and other key stakeholders will have tools at their disposal to establish watershed-based practices and engrain them into their respective activities and procedures. Developers will follow guidelines that consider watershed health; and residents in the Catfish Creek watershed will be actively involved in protecting and restoring Catfish Creek and its tributaries. They will become aware of the creek's location and needs and adopt specific behaviors to improve its health. Through these changes in behaviors, the threats and challenges in the watershed will decrease, water quality will


CATFISH CREEK
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improve and the overall health of the watershed will improve.

Due to the current conditions of water quality within the watershed, it is imperative that the Management Measure recommendations are closely linked with watershed information and education programs. Thorough public information and stakeholder education efforts will ultimately inspire local residents and community members to adopt recommended behaviors. The cumulative actions of individuals and communities watershed-wide can accomplish the goals of the watershed plan. Watershed health is of primary importance for the people of Catfish Creek watershed. When people begin to understand the issues related to water quality and natural resource protection, they begin to change their behaviors and activities, thereby improving the overall health of the watershed.

Many of the stakeholders in the Catfish Creek watershed have been active in the creation and leadership of the Catfish Creek Watershed Management Authority (CCWMA). Key stakeholders include the City of Dubuque, Dubuque County, the City of Asbury, the City of Peosta, the City of Centralia, and Dubuque Soil and Water Conservation District. The CCWMA is actively engaging the public in watershed activities such as: educational seminars, watershed outings, rain garden demonstration area, stream clean up days, and extensive public education programs. The watershed planning process for Catfish Creek began in 2012 with the establishment of the CCWMA. The planning process has allowed watershed partnerships to form that will help with implementing the watershed plan and initiating projects.

Recommended Information & Education Campaigns

A successful I&E Plan first raises awareness among stakeholders of watershed issues, problems, and opportunities. The second step is to provide stakeholders with information on alternatives to implement to address the issues, problems, and opportunities. This I&E Plan includes the following components as referenced in USEPA's "*Handbook for Developing Watershed Plans to Restore and Protect Our Waters*" (USEPA 2008):

- Define I&E goals and objectives.
- Identify and analyze the target audiences.
- Create the messages for each audience.
- Package the message to various audiences.
- Distribute the message.
- Evaluate the I&E program.

Goals and Objectives

Development of an effective I&E Plan begins by defining I&E goals and objectives. Goals were established for the Catfish Creek watershed based on stakeholder participation, voting, and responses during the March 11th Low Impact Development Conference stakeholder meeting. The goals and objectives were then refined during the planning process. Objectives assigned to each goal are intended to be measurable where appropriate so that future progress can be assessed. The following goals refer to communications goals and objectives (objectives unrelated to communications have been left out of this section).

Far left: Sign identifying Catfish Creek watershed at Key Way Dr. in Dubuque.
Below: Informational watershed sign at Swiss Valley Nature Center.

Goal 1: Implement watershed educational and stewardship programs and increase communication and coordination among stakeholders.

Objectives:

1. Increase environmental stewardship and recreational opportunities and encourage stakeholders to participate in watershed plan implementation and restoration campaigns to increase activism in the watershed.
2. Inform public officials on the benefits of conservation, low impact development, and importance of ordinance language changes and encourage these developments and the adoption of the Catfish Creek Watershed Management Plan.
3. Create targeted educational information for land owners upland and adjacent to tributaries.
4. Develop recommendations and alternatives for fertilizer and road salt.
5. Increase awareness of surface water quality issues among the general public and agricultural community.
6. Educate the public and agricultural community about protecting shallow aquifer water quality and quantity.
7. Encourage amendments of municipal comprehensive plans, codes, and ordinances to include watershed plan goals and objectives where necessary.

Goal 3: Protect groundwater quality and quantity and educate stakeholders on the influence of karst topography on groundwater resources.

Objectives:

1. Encourage residents and businesses to install infiltration practices such as rain gardens.
2. Encourage use of Low Impact Development designs within new, redevelopment, and retrofits.
4. Educate stakeholders about potential groundwater contamination issues and encourage private well testing.

Goal 7: Encourage agricultural techniques and soil conservation practices that will protect and conserve topsoil and bolster our water resources.

Objectives:

1. Encourage landowners to utilize existing programs and agencies such as the Natural Resource Conservation Service (NRCS) and the Dubuque Soil and Water Conservation District (SWCD) to install conservation practices that protect soil loss and water quality.
2. Educate landowners and inform landowners of both federal and state cost-share programs, which provide incentives for landowners to enroll in conservation programs and implement conservation practices.
3. Promote the protection of wetlands by utilizing existing agencies, resources, funding, and programs while protecting private property rights.
4. Encourage landowners and farmers to leave adequate buffers between agricultural land and waterways.
5. Encourage landowners and farmers to utilize the most practical conservation practices available for each parcel of land.
6. Educate farmers and agricultural landowners of the economic value of their topsoil and economic and environmental consequences of erosion.

Target Audiences

The recommended target audience for each education campaign is selected based on the ability to attain objectives. The target audience is a group of people with a common denominator who are intended to be reached by a particular message. The target audience of the watershed includes people of all demographics, locations, occupations, and watershed roles. There can be multiple target audiences depending on which topic is being presented. The overall umbrella target audiences selected to meet watershed goals and objectives include riparian landowners, homeowners, general public, local government, elected officials, homeowner and business associations, and schools.

Public Input

Creating and distributing a message for each audience is done via campaigns that address education goal objectives.
The I&E Plan objectives for the Catfish Creek watershed were determined through stakeholder meetings. An I&E Plan matrix (Table 42) was developed as a tool to help implement the I&E Plan. Not only does the matrix include recommended education campaigns, it also includes columns for 1) “Target Audience”, 2) “Communications Vehicles”, 3) “Schedule”, 4) “Lead & Supporting Organizations”, 5) “Outcomes/ Behavior Change”, and 6) “Estimated Cost.”

Evaluation

The I&E Plan should be evaluated regularly to provide feedback regarding the effectiveness of the outreach campaigns. Evaluation conducted early on in the effort will help determine campaigns that are successful and those that are not. Based on the evaluation, information, money, and time can be saved by focusing on the campaigns that work. Those that do not work should be ended and/or refined. Section 9.0 of this plan contains a “Report Card” with milestones related to watershed education that can be used to evaluate I&E Plan implementation efforts.

Table 42. Information and Education Plan Matrix.

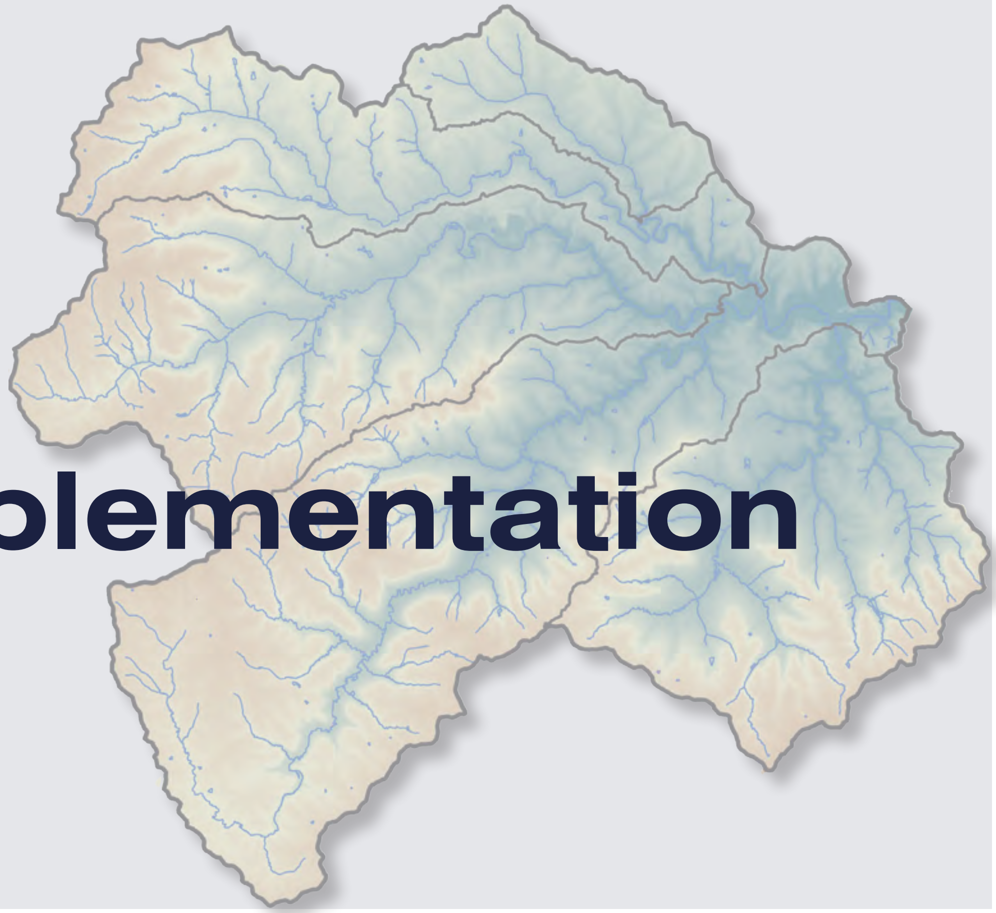
Education Action of Campaign	Target Audience	Communications Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Behavior Change	Estimated Cost
Adopt-a-Stream	Private owners and public facilities	Media blitz, word of mouth	Ongoing	CCWMA (One Mississippi)	Create awareness, activism, and ownership regarding streams and tributaries and their health in the watershed	**$1,440 + $2,160/ yr + $70 per sign** (40 hours initial set up of program; 5 hs/mo for 1 hr workshop + cost of signage)
Water testing	all stakeholders	IOWATER program - training provided by state	Ongoing	City of Dubuque, IOWATER	awareness, additional monitoring sites	**$864** (24 hours/ year)
Educate elected officials about the completed plan and 1) Encourage them to adopt the Pike River Watershed-Based Plan and 2) Encourage amendments of municipal comprehensive plans, codes and ordinances to include watershed plan goals and objectives.	Elected Officials in Dubuque County, City of Dubuque, City of Asbury, City of Peosta, and City of Centralia and residents of the communities	Meetings with heads of government (mayor, chairperson, president, and county administrators), special mailing, and presentations to elected officials.	Immediately following completion of plan	CCWMA	Within two years each municipality and county board of elected officials adopts the Plan.	**$720** (20 hours)
Tour of watershed and BMPs	Elected officials and residents	LID conference, Contractor Workshop, Social Media, Newsletter	Immediately following completion of plan	CCWMA Administrators	Create awareness	**$500**
CCWMA informational DVDs	residents, schools, elected officials, volunteer groups	Informational DVDs that can be used, distributed by CCWMA in order to educate residents on wide range of topics	Ongoing	CCWMA (Local universities and schools)	Creates awareness, promotes projects	**$2 per DVD**

Education Action of Campaign	Target Audience	Communications Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Behavior Change	Estimated Cost
Annual recognition	active volunteers, all stakeholders	Annual public recognition and award for active participation in any volunteer programs in watershed	Annually	CCWMA	Create awareness of various programs in watershed	**$360/yr** (10 hours/yr)
Habitat/Green Infrastructure Educational Seminars - Beekeepers, Certified Wildlife Habitat, etc.	residents, homeowners, landowners	Seminar or presentations on programs available on how residents and owners can extend the Green Infrastructure Network in their backyard	Annually	CCWMA (BeeKeepers, National Wildlife Federation)	Create awareness	**$2,000**
Watershed Kiosks	Residents and tourists	Swiss valley and Mines of Spain nature centers	Ongoing	CCWMA administrators	Create awareness	**$15,000**
River Paddles	Residents and tourists	Media blitz	Annually	CCWMA administrators	Create awareness	**$400**
Fishing Derby	Residents and tourists	Media blitz	Annually	CCWMA administrators, fly fishers	Create awareness	**$400**
Catfish Creek Festival	Residents and tourists	Media blitz	Annually	CCWMA administrators	Create awareness	**$500**
Educate professional landscapers about green practices in landscaping	Professional Landscapers	Hold a workshop featuring experts in native plant landscaping and best management practices, such as bioswales and rain gardens.	Offer every 2-3 years	CCWMA, Ecological Consultant	Professional landscapers will report that they are building more BMPs for their clients	Fees pay for costs of workshop.

Education Action of Campaign	Target Audience	Communications Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Behavior Change	Estimated Cost
Provide schools with information about the Catfish Creek watershed as a means to support outdoor curriculum within the watershed's green infrastructure	Schools, students	Support and expand reach of water education programs to help integrate basic watershed planning and education into existing elementary, middle, and high school science curriculum. Offer free presentations to teachers and student groups. Provide schools with copies of the Catfish Creek watershed Executive Summary to educate students about the role of watershed planning, importance of green infrastructure and actions they can take at home to improve overall watershed conditions.	Annual program	CCWMA (Schools)	Students in the Catfish Creek watershed will understand the environment in which they live and realize the importance of maintaining a healthy place for people and nature to live in harmony and understand actions they and their family members can take to protect water quality. What is learned will be passed on to parents and future generations.	**$1,440 setup + $360/ presentation + $300** (40 hours set up + 10 hr/ presentation + 200 copies of Executive Summary)
Educate farmland owners and renters about the plan and recommended actions, particularly the Critical Area projects. Encourage and support farmland owners and renters to implement recommended actions within the watershed plan.	Owners and renters of farmland identified for Critical Area projects in the plan.	Meetings of farmland owners and renters (available funding for projects, purchase of development rights, buffers and their impact on water quality, role of wetlands). Tour of completed projects.	Immediately following completion of plan	CCWMA, DSWCD (NRCS)	Increase level of awareness of critical area project types and locations for agricultural projects in the watershed and increase level of participation in implementing agricultural project recommendations	**$360/yr** (10 hours/ yr)

Education Action of Campaign	Target Audience	Communications Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Behavior Change	Estimated Cost
Host NRCS presentations geared at improving water quality	Agricultural landowners and farmers	Hold seminar on appropriate NRCS programs, potential funding and types of projects that should be implemented in the watershed	Immediately following completion of plan	CCWMA, NRCS, DSWCD	Increase level of awareness of NRCS programs and how they relate to agricultural projects in the watershed and increase level of participation in implementing agricultural project recommendations	$3,000

8.0 Plan Implementation



8.1 Plan Implementation Roles and Coordination/ Responsibilities

Identification of responsible entities for implementation of Management Measure recommendations was first mentioned in the Action Plan section of this report. These entities are key stakeholders that will be responsible in some way for sharing the responsibility required to implement the Watershed Management Plan. However, no single stakeholder has the financial or technical resources to implement the plan alone. Rather, it will require working together and using the strengths of individual stakeholders to successfully implement this plan. Key stakeholders are listed in Table 43. Appendix E includes additional information about each stakeholder and possible roles.

There are several important first steps that the Catfish Creek Watershed Management Authority (CCWMA) and partners will need to accomplish prior to plan implementation.

1. Watershed partners are encouraged to adopt and/or support (via a resolution) the Catfish Creek Watershed Management Plan.
2. The partners will need to recruit "champions" within each municipality and other stakeholder groups to form a Watershed Implementation Committee that actively implements the Watershed Management Plan and conducts progress evaluations.
3. The watershed partners may also need to hire and fund a Watershed Implementation Coordinator or find an employee internally to follow through on plan implementation.

Table 43. Key Catfish Creek watershed stakeholders/partners.

Key Watershed Stakeholder/Partner	Acronym/Abbreviation
Catfish Creek Watershed Management Authority	CCWMA
Center Township	Center
City of Asbury	Asbury
City of Centralia	Centralia
City of Dubuque	Dubuque
City of Peosta	Peosta
Dubuque County	County
Dubuque County Conservation Board	DCCB
Dubuque Soil and Water Conservation District	SWCD
Dubuque Township	Dubuque Twp
East Central Intergovernmental Association	ECIA
Environmental Stewardship Advisory Commission	ESAC
Golf Courses	GC
Green Dubuque	Green
Iowa Department of Agriculture and Land Stewardship	IDALS
Iowa Department of Natural Resources	IDNR
Iowa Department of Transportation	IDOT
Iowa's Volunteer Water Quality Monitoring Program	IOWATER
Mosalem Township	Mosalem
Prairie Creek Township	Prairie Creek
Table Mound Township	Table Mound
US Fish & Wildlife Service	USFWS
Vernon Township	Vernon
Washington Township	Washington

8.2 Implementation Schedule

The Watershed Implementation Committee should try to meet at least quarterly each year to guide the implementation of the Catfish Creek Watershed Management Plan. The development of an implementation schedule is important in the watershed planning process because it provides a timeline for when each recommended Management Measure should be implemented in relation to others. High Priority Critical Area projects, for example, are generally scheduled for implementation in the short term where possible. A schedule also helps organize project implementation evenly over a given time period, allowing reasonable time availability for developing funding sources and opportunities.

For this plan, each "Site Specific Management Measure" recommendation located in the Management Measures Action Plan (see Section 6.0) contains a column with a recommended "Implementation Schedule" based on a short term time frame of 1-10 years, 10-20 years for a medium term, and 20+ years for long term projects. Other recommendations such as maintenance activities have ongoing or as needed schedules. Some projects that are high priority could be recommended for long term implementation based on selected practices, available funds, technical assistance needs, and time frame. In addition, the "Information & Education" plan (see Section 7.0) is designed to be completed over three phases spanning five years. Finally, the "Monitoring Plan" is designed to be conducted and evaluated every five years to determine if progress is being made toward achieving plan goals and objectives.

8.3 Funding Sources

Opportunities to secure funds for watershed improvement projects are widespread due to the variety and diversity of Management Measure recommendations found in the Action Plan. Public and private organizations that administer various conservation and environmental programs are often eager to form partnerships and leverage funds for land preservation, restoration, and environmental education. In this way, funds invested by partners in Catfish Creek watershed can be doubled or tripled, although actual dollar amounts are difficult to measure. A list of potential funding programs and opportunities is included in Appendix F. The list was developed by Applied Ecological Services, Inc. (AES) through involvement in other watershed and ecological studies.

Funds generally fall into two relatively distinct categories. The first includes existing grant programs, funded by a public agency or by other sources. These funds are granted following an application process. The Iowa Watershed Improvement Review Board grant is an example: an applicant will submit a grant application to the program, and, if the proposed project meets the required criteria and if the funds appropriated have not been exhausted, a grant may be awarded.

The second category, one that can provide greater leverage, might be called "money to be found." The key to this money is to recognize that any given project may have multiple benefits. It is important to note and explore all of the potential project benefits from the perspective of potential partners and to then engage those partners. Partners may wish to become involved because they believe the project will achieve their objectives, even if they have little interest in the specific objectives of the Watershed Management Plan.

It is not uncommon for an exciting and innovative project to attract funds that can be allocated at the discretion of project partners. When representatives of interested organizations gather to talk about a proposed project, they are often willing to commit discretionary funds simply because the proposed project is attractive, is a priority, is a networking opportunity, or will help the agency achieve its mission. In this way, a new partnership is assembled.

Leveraging and Partnerships

It is critically important to recognize that no one program has been identified that will simply match the overall investment of the Catfish Creek watershed partners in implementing the Watershed Management Plan. Rather, partnerships are most likely to be developed in the context of individual and specific land preservation, restoration, or education projects that are recommended in the Plan. Partners attracted to one acquisition may not have an interest in another located elsewhere for jurisdictional, programmatic, or fiscal reasons.

Almost any land or water quality improvement project ultimately requires the support of those who live nearby if it is to be successful over the long term. Local neighborhood associations, homeowner associations, and similar groups interested in protecting water resources, open space, preventing development, or protecting wildlife habitat and scenic vistas, make the best partners for specific projects. Those organizations ought to be contacted in the context of specific individual projects.

It is equally important to note that the development of partnerships that will leverage funding or goodwill can be, and typically is, a time-consuming process. In many cases, it takes more time and effort to develop partnerships that will leverage support for a project than it does to negotiate with the landowners for use or acquisition of the property. Each protection or restoration project will be different; each will raise different ecological, political and financial issues, and each will in all likelihood attract different partners. It is also likely that the process will not be fully replicable. That is, each jurisdiction or partner will have a different process and different requirements.

In short, a key task in leveraging additional funds is to assign responsibility to specific staff or for developing relationships with individual agencies and organizations, recognizing that the funding opportunities might not be readily apparent. With some exceptions, it will not be adequate simply to write a proposal or submit an application; more often, funding will follow a concerted effort to seek out and engage specific partners for specific projects, fitting those projects to the interests of the agencies and organizations. Successful partnerships are almost always the result of one or two enthusiastic individuals or "champions" who believe that engagement in this process is in the interests of their agency. There is an old adage in private fundraising: people give to other people, not to causes. The same thing is true with partnerships using public funds.

Partnerships are also possible, and probably necessary, that will leverage assets other than money. By entering into partnerships with some agencies, organizations, or even neighborhood groups, a stakeholder will leverage valuable goodwill, and relationships that have the potential to lead to funds and other support, including political support, from secondary sources.

9.0 Measuring Plan Progress & Success

A monitoring plan and evaluation component is an essential step in the watershed planning process to evaluate plan implementation progress over time. This watershed plan includes two monitoring/ evaluation components:

1. The "**Water Quality Monitoring Plan**" includes methods and locations where monitoring should occur and a set of criteria (indicators & targets) used to determine whether impairment reduction targets and other watershed improvement objectives are being achieved over time.

2. "**Report Cards**" for each plan goal were developed that include interim, measurable milestones linked to evaluation criteria that can be evaluated by the planning committee over time.

9.1 Water Quality Monitoring Plan & Evaluation Criteria

Available water quality data collected within Catfish Creek watershed is summarized in Section 4.2. The most recent chemical water quality data for Catfish Creek was collected from 2010 to 2013 and was included as part of the IOWATER data collection. Other recent data includes a QAPP conducted by the City of Dubuque and Dubuque Soil & Water Conservation District. The overall water quality condition in Catfish Creek watershed is poor. According to IDNR's 2012 Integrated Report, Catfish Creek from the mouth to the confluence with South Fork, Granger Creek, and South Fork are all impaired due for either primary or secondary contact due to the presence of indicator bacteria. An unnamed tributary to Catfish Creek (CCT16) is impaired for aquatic life due to organic enrichment/low dissolved oxygen. Catfish Creek upstream of the confluence with South Fork, Middle Fork, and North Fork all of have an impairment of a presumptive use (primary contact) due to the presence of indicator bacteria. Additionally, Catfish Creek from the headwaters downstream for 5.3 miles is classified as a Class B (CW-1) coldwater aquatic life use stream because it holds an introduced and naturally reproducing trout population. This reach is considered partially supported based on biological monitoring conducted in 2001 and 2007.

According to the chemical and physical sampling results, Catfish Creek and each of the branches have exceeded the numerical or statistical guidelines for both phosphorus and E. coli. Catfish Creek, Granger Creek, and South Fork exceed the guideline for nitrogen. North Fork is also approaching the numerical standard for chronic chloride toxicity at every sampling point along its length.

The following monitoring plan recommendations should be implemented to measure changes in watershed impairments related primarily to water quality. Water quality monitoring is performed by first collecting physical, chemical, biological, and/or social indicator data. This data is then compared to criteria (indicators & targets) related to established water quality objectives.

The water quality monitoring plan is designed to; 1) capture snapshots of water quality within Catfish Creek and its tributaries through time; 2) assess changes in water quality following implementation of Management Measures, and 3) assess the public's social behavior related to water quality issues. **It is important that all future monitoring be completed using protocol and methods set out by the IOWATER Program of IDNR with their Quality Assurance Project Plan (QAPP).** IDNR's *Quality Assurance Project Plan for IOWATER* can be found at http://www.iowadnr.gov/Portals/idnr/uploads/watermonitoring/iowater/Publications/QAPP_IOWATER2010.pdf

Monitoring Plan Implementation
Procedures by which physical, chemical, and biological monitoring data should be collected in the watershed, recommended monitoring locations, monitoring entity, monitoring frequency, and expected costs are outlined in Table 44. Figure 68 includes the location of all existing and new recommended monitoring locations. Note: monitoring locations related to individual Management Measures are not described as this monitoring will come later when projects are implemented.

Physical and Chemical Monitoring Methods & Recommendations
Physical and chemical monitoring of water can be time consuming and expensive depending on the complexity of the monitoring program. Usually the budget and/or personnel available for monitoring limit the amount of data that can be collected. Therefore, a monitoring program should be developed to maximize the usable data given the available funding and personnel. Any monitoring program should be flexible and subject to change to collect additional information or use newer equipment or technology when available.

Many different parameters can be included in physical monitoring of water quality in streams and seeps. Measurements of temperature, pH, conductivity, dissolved oxygen, and turbidity should be collected in the field for any monitoring done on Catfish Creek or tributaries using portable instruments. The measurements can then be recorded on data sheets in the field or the units can be taken back to the lab and the data downloaded. Additionally, at least one real-time monitor should be installed on Catfish Creek, with additional streams added as funding allows.

Table 44. Recommended water quality and biological monitoring programs/locations.

Waterbody/ Location	Monitoring Entity/Program	Monitoring Location (See Figure 68)	Monitoring Frequency	Parameters Tested	Cost to Implement
Existing Recommended Monitoring Programs					
Catfish Creek	City of Dubuque/ IOWATER	At Creek Wood Rd just before confluence with South Fork; Just upstream of confluence with Mississippi (CCC and CCW)	Monthly - quarterly	Physical; Chemical; Biological	Not Applicable
Granger Creek	City of Dubuque/ IOWATER	About 1,000 feet north of Route 52 (GC)	Monthly - quarterly	Physical; Chemical; Biological	Not Applicable
Middle Fork	City of Dubuque/ IOWATER	At confluence with Catfish Creek, between Southern Ave and Old Mill R (MF)	Monthly - quarterly	Physical; Chemical; Biological	Not Applicable
North Fork	City of Dubuque/ IOWATER	At Brunskill Rd, just upstream of confluence with Middle Fork (NF)	Monthly - quarterly	Physical; Chemical; Biological	Not Applicable
South Fork	City of Dubuque/ IOWATER	Off Miller Rd about 1,500 feet from confluence with Catfish Creek (SF)	Monthly - quarterly	Physical; Chemical; Biological	Not Applicable
New Recommended Monitoring Programs					
Catfish Creek	Installation of one real time monitor	One location on Catfish Creek, with possibility of adding additional streams as budget allows	Continuous	Physical, Chemical	$15,000 per unit
Individual Management Measures	Stakeholder in cooperation with Environmental Consultants	Varies: Specific to each measure	Pre and post project	Physical, Chemical, and Biological	$5,000 for each measure

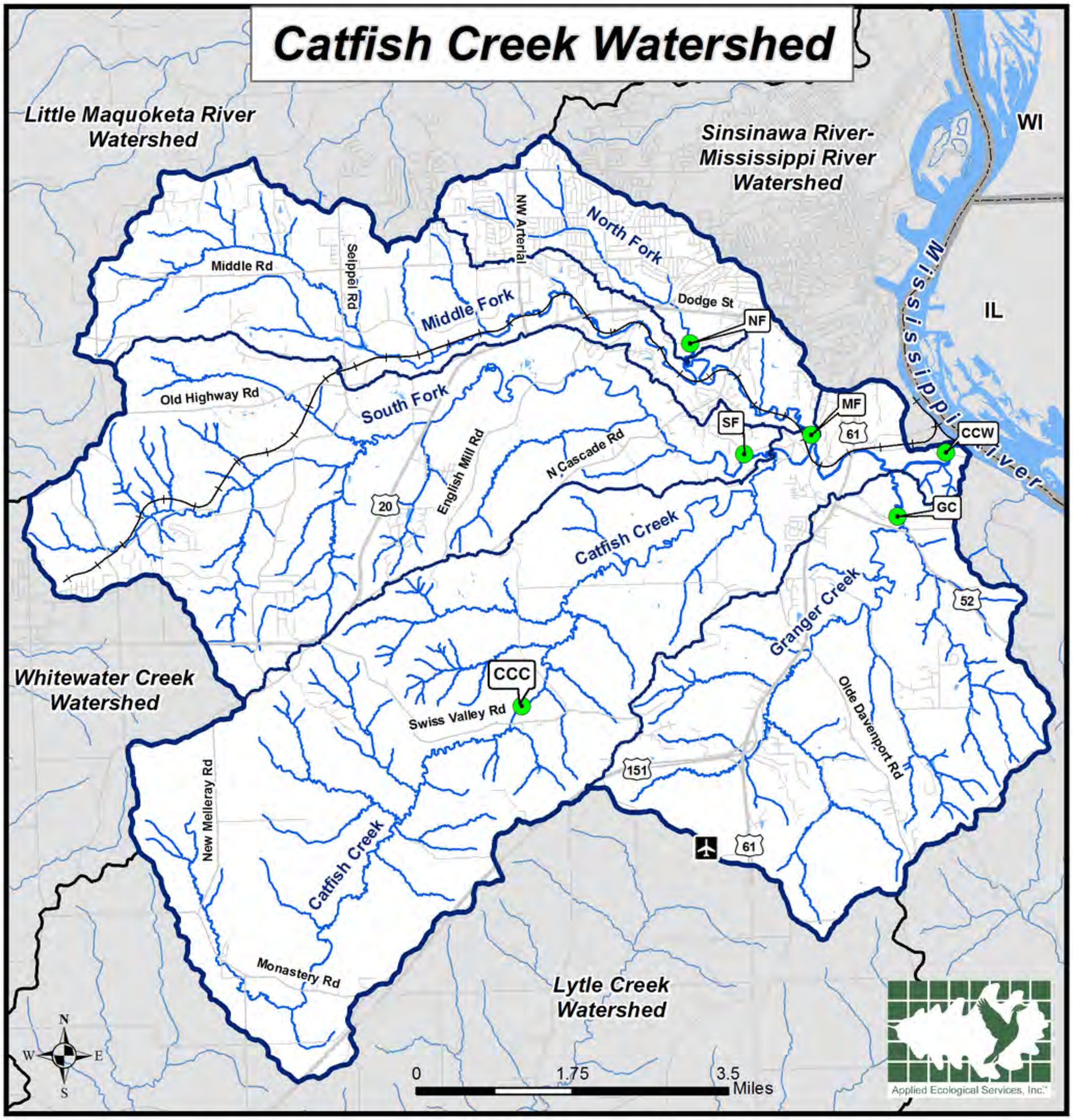


Figure 68: Recommended Water Quality Monitoring Locations

Legend

- Airport
- Roads
- Railroad
- Stream & Tributaries
- Open Water
- State Boundary
- Catfish Creek Watershed
- Catfish Creek Subwatersheds
- Adjacent Watersheds

Recommendations

- Monitoring Location

Data Sources:

It is crucial to collect representative water samples using careful handling procedures. Unrepresentative samples or samples contaminated during collection or handling are often useless. The collected samples should be submitted for analysis to a laboratory certified by the National Environmental Laboratory Accreditation Conference (NELAC). Alternatively, money can be saved by having one of the CCWMA partners analyze samples using a municipal water treatment plant lab once it has the proper certification. Generally, the laboratory will work closely with the monitoring entity to assure that the samples are collected in the proper containers with preservatives for the parameter of interest. The laboratory usually provides the containers, ice chests for transport, labels, and chain-of-custody forms to the client as part of their service.

Currently, the City of Dubuque will be conducting chemical, physical, and biological sampling on all of the branches of Catfish Creek on a monthly to quarterly basis. Chemical tests will include total nitrogen, total phosphorus, total suspended solids, and *E. coli* and will be analyzed using the certified lab of the Dubuque Water & Resource Recovery Center. Additionally, in-field testing for pH, conductivity, dissolved oxygen, temperature, and transparency will also be conducted. Physical monitoring will include a stream assessment form.

Table 45. Physical & chemical stream monitoring parameters, collection, and handling procedures.

Parameter	Statistical, Numerical, or General Use Guideline	Container	Volume	Preservative	Max. Hold Time
Physical Parameters Measured in Field					
pH	>6.5 or <9.0	These parameters are measured in the field			
Conductivity	<1,667 µmhos/cm				
Dissolved Oxygen	>5.0 mg/l				
Temperature	<90 F				
Transparency	<16.6 inches				
Chemical & Physical Parameters Analyzed in Lab					
Total Suspended Solids	<11.5 mg/L	Plastic	32 oz	Cool 4° C	7 days
Total Nitrogen	<1.73 mg/L	Plastic	4 oz	Cool 4° C 20% Sulfuric Acid	28 days
Total Phosphorus	<0.070 mg/L	Plastic	4 oz	Cool 4° C 20% Sulfuric Acid	28 days
E. coli	<126 org/100mL	Plastic	32 oz	Cool 4° C	6 hours

Biological Monitoring Methods and Recommendations

IOWATER volunteers have also conducted biological monitoring across all of the branches of Catfish Creek. This monitoring includes collecting and identifying aquatic benthic macroinvertebrates (aquatic insects that live in bottom substrates). Each species is assigned a value based on how much pollution it can typically tolerate. The types of species found and the number of each can then be used to calculate a Benthic Macroinvertebrate Index of Biotic Integrity (IBI) value in order to estimate a streams overall health (IDNR, 2012). IDNR created a simplified rating system in order to differentiate between good, fair, and poor IBI scores and it is included in Table 46. More detailed information on biological monitoring can be found in Section 4.3.

Each summer, biological monitoring in the form of a Benthic Macroinvertebrate IBI will be conducted by the City of Dubuque at each of the monitoring sites as well.

The only ongoing analysis of IBI values is included as part of the IOWATER program. Where possible however, fish sampling and calculation of IBI values should be built into future stream restoration projects.

Habitat Monitoring Methods and Recommendations

Stream habitat assessments comprise a major component of physical water quality monitoring. Many habitat assessment methods are available for assessing streams such as the RASCAL method that is currently being used by IOWATER volunteers. While this method does a thorough job of assessing stream conditions, it is very time consuming. For more routine monitoring, a more simplified version of a stream assessment is recommended.

Figure 69 depicts an example of a more simplified stream assessment form that can be completed in less than five minutes at each location and gathers appropriate information such as degree of channelization and erosion, sinuosity, number of debris jams, the quality of riparian habitat, etc. It also has room to note possible future BMPs that can be implemented to improve stream and habitat conditions. The City of Dubuque will be completing such a stream assessment form when performing water quality sampling at each of the five branches.

Table 46. Scoring Criteria for IOWATER Index of Biotic Integrity (IBI) for benthic macroinvertebrates.

Score	Rating	Macroinvertebrate Community Attributes
> 2.25	Good	Scores greater than 2.25 indicate a good benthic macroinvertebrate population and are likely dominated by benthic macroinvertebrates in the high quality tolerance group. Benthic macroinvertebrates in the low and middle quality tolerance group are likely to be present, but in smaller numbers.
1.76 - 2.25	Fair	IBI scores ranging from 1.76 to 2.25 would indicate a fair benthic mancroinvertebrate population and are likely dominated by benthic macroinvertebrates in the middle quality tolerance group. These sites may also have low and high quality benthic macroinvertebrates present.
< 1.75	Poor	Scores below 1.75 indicate a poor benthic macroinvertebrate population and are likely dominated by benthic macroinvertebrates in the low quality tolerance group. High and middle quality benthic macroinvertebrates may be present, but in small numbers.

Macroinvertebrate sampling on Catfish Creek.

Figure 69. Example stream inventory sheet.

CATFISH CREEK WATERSHED STREAM INVENTORY/BMP FORM

STREAM NAME:________________________________REACH ID:________________ DATE:_________

REACH BOUNDARIES:____OWNER:_______________

MAP/AES#________ PHOTOS_______ APPROX. LENGTH (ft):_______ INVESTIGATOR: ________

CHANNEL CONDITIONS:

CHANNELIZATION: NONE_____ LOW____ MODERATE____HIGH_______

SPOILS PILES ON BANKS (Left / Right / Both)

CHANNEL SINUOSITY: NONE____ LOW____ MODERATE____ HIGH____

POOL/RIFFLE DEVELOPMENT: NONE____ LOW____ MODERATE____ HIGH____

DEGREE OF BANK EROSION (circle most appropriate):

NONE	LOW	MODERATE	HIGH
Stable; less than 5% of banks affected.	Moderately stable; 5-33% banks have areas of erosion.	Moderately unstable; 33-66% of banks have areas of erosion.	Unstable; 66-100% of banks highly eroded.

MEAN BANK HEIGHT & CHANNEL WIDTH (facing downstream):

LEFT BANK HEIGHT (FT)		MEAN CHANNEL WIDTH		RIGHT BANK HEIGHT (FT)	

DEBRIS JAMS: INSTREAM/OVERBANK: LOW _____ MODERATE _____ HIGH _____

SEDIMENT ACCUMULATION: LOW _____ MODERATE _____HIGH _____

RIPARIAN VEGETATION COVER (facing downstream):

BRIEFLY DESCRIBE RIPARIAN AREA: ____

____

____

____

OVERALL ECO CONDITION OF RIPARIAN AREA: GOOD:______AVERAGE:______POOR:_______

BMP RECOMMENDATIONS:

- ☐ Invasive Species Removal (Riparian)
- ☐ Artificial Riffles/Pools
- ☐ Bioengineered Bank Armoring
- ☐ Soil Lifts
- ☐ Native Seeding/Plug Planting
- ☐ Native Tree/Shrub Planting
- ☐ Regrade/Reslope Stream Banks
- ☐ Hard Bank Armoring (ie Gabions)
- ☐ Maintenance (ie debris clearing)

BMP DETAILS: ____

____

____

____

____

BMP PRIORITY: CRITICAL AREA______ HIGH______ MEDIUM_____ LOW______

Explain Priority: ____

____

____

Social Indicators of Water Quality
Quantifying social indicators of success in a watershed planning initiative is difficult. It is subjective to a large degree and complaints about poor conditions are often heard rather than compliments on improvements. The Great Lakes Regional Water Program (GLRWP) is a leading organization that addresses water quality research, education, and outreach in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. Their work on the social indicators of water quality is directly applicable to Catfish Creek. They define social indicators as standards of comparison that describe the context, capacity, skills, knowledge, values, beliefs, and behaviors of individuals, households, organizations, and communities at various geographic scales. The GLRWP suggests that social indicators used in water quality management plans and outreach efforts are effective for several reasons including:

- Help watershed committee evaluate projects related to education and outreach;
- Help support improvement of water quality projects by identifying why certain groups install Management Measures while other groups do not;
- Measure changes that take place within grant and project timelines;
- Help watershed committee with information on policy, demographics, and other social factors that may impact water quality;
- Measure outcomes of water quality programs not currently examined.

GLRWP has developed a Social Indicators Data Management and Analysis Tool (SIDMA) to assist watershed stakeholders with consistent measures of social change by organizing, analyzing, and visualizing social indicators related to non-point source (NPS) management efforts. Detailed information about GLRWP's social indicator tool can be found at: http://35.8.121.111/si/Home.aspx.

Figure 70. Steps to measure social indicators. Source: GLRWP.

To summarize, the SIDMA tool uses a seven step process to measure social indicators as shown in Figure 70.

Several potential social indicators could be evaluated by the CCWMA using different strategies to assess changes in water quality. For example, surveys, public meetings, and establishment of interest groups can give an indication of the public feelings about the water quality in the watershed. It is important to involve the public in the water quality improvement process at an early stage through public meetings delineating the plans for improvement and how it is going to be monitored. Table 47 includes a list of potential social indicators and measures that can be used by the watershed committee to evaluate the social changes related to water quality issues.

Monitoring social indicators in the watershed will be the responsibility of the CCWMA. On-line internet surveys are among the most popular method to gauge social behavior. A survey should be developed that identifies residents' perceptions of water quality problems and protection strategies. Citizens that respond to the survey should be given a chance to donate a small amount of money ($1 for example) to a

Table 47. Social indicators and measures to understand behavior toward watershed issues.

Social Indicator	Measure
Media Coverage	• # of radio broadcasts related to watershed protection • # of newspaper articles related to watershed protection • # of press releases relate to watershed protection • # of social media posts related to watershed protection
Resident Awareness	• # of residents who are aware a watershed plan exists • % of residents who know where water from their property drains • # of residents who attend municipal meetings • # of residents participating in Geocaching within the watershed • # of residents attending “Volunteer Days” and workshops • # of HOAs that manage natural areas appropriately • # of informational flyers distributed per given time period
Watershed Management Activities	• # of watershed signage along roads • # of schools helping implement the watershed monitoring plan • # of residents that perform ecological restoration on their properties • # of stream miles cleaned up per year • # of Green Infrastructure Parcels protected during development • # of linear feet or miles of trails created or maintained each year • # of watershed partners who adopt the watershed management plan

non-profit environmental group. Then thank you letters should be sent to those that responded, while those that did not respond should be sent a second survey. The results of the survey can be used to develop appropriate media, citizen awareness, and watershed management activities to improve social behavior.

Water Quality Evaluation Criteria

Water quality criteria (expressed as measurable indicators & targets) have been developed so that water quality objectives can be evaluated over time. The criteria are designed to be compared against data gathered from the Monitoring Plan and other data then analyzed to determine the success of the watershed plan in terms of protecting and improving water quality. These criteria also support an adaptive management approach by providing ways to reevaluate the implementation process if adequate progress is not being made toward achieving water quality objectives.

Section 2 of this plan includes a water quality goal (Goal 5) with six objectives. Criteria are selected for each water quality objective to determine whether components of the water quality goal are being met (Table 48). Criteria are based on water quality criteria, data analysis, reference conditions, literature values, and/or expert examination. Criteria are also designed to address potential or known sources of water quality impairment identified in Section 5.0. Future evaluation of the criteria will allow the CCWMA to gage plan implementation success or determine if there is a need for adaptive management. Note: evaluation criteria are included for the water quality goal only; criteria for other plan goals are examined within the appropriate progress evaluation “Report Cards” in Subsection 9.2.

Table 48. Set of criteria related to the water quality goal and objectives.

GOAL 5: Improve Surface Water Quality to Meet Applicable Standards.	
Water Quality Objective	Criteria: Indicators and Targets
1) Stabilize 200,166 linear feet of highly eroded streambanks located along "High Priority-Critical Areas."	• *Number of Restored Streambank Reaches*: At least 50% of 59 (200,166 lf) "High Priority-Critical Area" stream reaches restored. • *Chemical & Physical Water Quality Standards*: <11.5 mg/l TSS, <0.070 mg/l TP, and <1.73 mg/l TN in stream water quality samples. • *Biotic Indexes*: Macroinvertebrate communities achieve at least "Fair" resource quality based on IOWATER Index of Biotic Integrity (IBI). • *Social Indicator*: >50% of surveyed residents know that streambank erosion is a problem in the watershed and support streambank stabilization efforts.
2) Restore 200,166 linear feet of riparian buffer along "High Priority-Critical Areas."	• *Number of Riparian Restorations*: At least 50% of 59 (200,166 lf) "High Priority-Critical Area" stream riparian buffers restored. • *Chemical & Physical Water Quality Standards*: <11.5 mg/l TSS, <0.070 mg/l TP, and <1.73 mg/l TN in stream water quality samples. • *Social Indicator*: >50% of surveyed residents know importance of restoring riparian areas.
3) Restore 253 acres of wetland at "High Priority-Critical Areas."	• *Number of Wetland Restorations*: All 250+ acres (14 locations) of critical area wetland restoration is completed. • *Social Indicator*: >50% of surveyed residents know the importance of wetlands and support wetland restoration projects.
4) Retrofit 7 "High Priority-Critical Area" detention basins.	• *# of Detention Basin Retrofits*: All 7 "High Priority-Critical Area" detention basins retrofitted. • *Social Indicator*: >50% of surveyed stakeholders understand the water quality and habitat benefits created by retrofitting detention basins with native vegetation.
5) Implement agricultural best management practices on 2,929 acres identified as "High Priority-Critical Areas."	• *# of Parcels*: All 2,929 acres (43 locations) identified as "High Priority-Critical Area" agricultural land implements agricultural management practices. • *Chemical & Physical Water Quality Standards*: <126 org/100 mL in stream water quality samples. • *Social Indicator*: >75% of farmers know the importance of management measures for reducing pollutants to streams/tributaries.
6) Continue water quality monitoring program, specifically including Nitrogen, Phosphorus, Total Suspended Solids, and *E. coli*.	• *Social Indicator*: >75% of surveyed residents understand why continuous water quality monitoring is important and why it should continue in the future.

9.2 Goal Milestones/ Implementation & Progress Evaluation "Report Cards"

Milestones are essential when determining if Management Measures are being implemented and how effective they are at achieving plan goals over given time periods. Tracking milestones allows for adaptive management whereby periodic plan updates and changes can be made if milestones are not being met.

Watersheds are complex systems with varying degrees of interaction and interconnection between physical, chemical, biological, hydrological, habitat, and social characteristics. Criteria that reflect these characteristics may be used as a measure of watershed health. Goals and objectives in the watershed plan determine which criteria should be monitored to evaluate the success of the watershed plan.

A successful watershed plan involves volunteer stakeholder participation to get projects completed, and must include a feedback mechanism to measure progress toward meeting goals. Watershed "Report Cards," developed specifically for each goal in this plan, provide this information.

Each Report Card provides:

- Summaries of current conditions for each goal to set the stage for what efforts are needed
- Most important performance criteria related to goal objectives (see Section 2.0)
- Milestones for various time frames
- Monitoring needs and efforts required to evaluate milestones
- Remedial actions to take if milestones are not met
- Notes section

Report Cards were developed for each of the seven plan goals and are located at the end of this section. The milestones are based on "Short Term" (1-10 years; 2015-2025), "Medium Term" (10-20 years; 2025-2035), and "Long Term" (20+ years; 2035+) objectives. Grades for each milestone term should be calculated using the following scale: 80%-100% of milestones met = A; 60%-79% of milestones met = B; 40%-59% of milestones met = C; and < 40% of milestones met = failed.

Report Cards should be used to identify and track plan implementation to ensure that progress is being made towards achieving the plan goals and to make corrections as necessary.

Lack of progress could be demonstrated in factors such as monitoring that shows no improvement, new environmental problems, lack of technical assistance, or lack of funds. In these cases the Report Card user should explain why other factors resulted in milestones not being met in the notes section of the Report Card.

Early on in the plan implementation process, the Catfish Creek Watershed Management Authority (CCWMA) should assign or hire a Watershed Implementation Coordinator to update the committee on plan implementation progress by way of the Report Cards. If needed, adaptive management should be implemented accordingly by referencing the adaptive management recommendations on each Report Card then developing a strategy to either change the milestone(s) or decide how to implement projects or actions to achieve the milestone(s).

Report Cards can be evaluated at any time. However, it is recommended that they be evaluated every five years to determine if sufficient progress is being made toward achieving milestones or if adaptive management is needed.

Goal 1 Report Card

Implement watershed educational and stewardship programs and increase communication and coordination among stakeholders.

Current Condition:

- The Catfish Creek Watershed Management Authority (CCWMA) promotes a healthy watershed.
- A limited number of watershed stakeholders are currently pursuing grant funds to implement watershed improvement projects. The City of Dubuque and Dubuque Soil and Water Conservation District are the leading entities pursing grant money and implementing watershed improvement projects.
- A number of practices and projects will require multi-jurisdictional and public-private participation/cooperation.
- Municipal decision-makers will need to work collectively to develop productive multijurisdictional partnerships related to funding, grant proposals, cost sharing ideas, and green infrastructure/open space protection.

Criteria/Targets to Meet Goal Objectives:

- All four municipalities and Dubuque County adopt the Catfish Creek Watershed Management Plan.
- At least one public official from each municipality supports the Watershed Management Plan.
- Educational information is provided to at least 50% of land owners adjacent to tributaries.
- Number of entities using alternatives to fertilizer and road salt.
- One workshop is held every five years to build awareness among the public and agricultural community about surface and groundwater issues.
- All four municipalities and Dubuque County amend comp plans, codes, and ordinances to include watershed plan recommendations.

Goal/Objective Milestones:

		Grade
1-10 Yrs: (Short)	1. All four municipalities and Dubuque County adopt the Catfish Creek Watershed Management Plan. 2. At least one public official from each municipality is educated and supports the Management Plan. 3. Educational information is disseminated to at least 25% of land owners adjacent to critical tributaries. 4. CCWMA leads effort to identify at least one potential supplement to existing fertilizer and road salt application programs. 5. At least two workshops are held to build awareness about surface and groundwater issues. 6. Two of four municipalities and Dubuque County amend comprehensive plans/codes/ordinances.	
10-20 Yrs: (Medium)	1. At least one public official from each municipality is educated and supports the Management Plan. 2. Educational information is disseminated to an additional 25% of land owners adjacent to critical tributaries. 3. At least one alternative to both fertilizer and road salt is used in the watershed. 4. At least two workshops are held to build awareness about surface and groundwater issues. 5. Remaining two municipalities amend comprehensive plans/codes/ordinances.	
20+ Yrs: (Long)	1. At least one public official from each municipality is educated and supports the Management Plan. 2. At least two alternatives to fertilizer and road salt are widely used in the watershed. 3. At least two workshops are held to build awareness about surface and groundwater issues.	

Monitoring Needs/Efforts:

1. Track number of entities that adopt the Catfish Creek Watershed Management Plan.
2. Document number of public officials that support the Watershed Management Plan.
3. Distribute survey to land owners adjacent to tributaries to measure effectiveness of educational information.
4. Track entities that use alternatives to fertilizer and road salt.
5. Keep attendance records related to surface and groundwater awareness workshops.
6. Track changes made to any comprehensive plans/codes/ordinances that support the Watershed Management Plan.

Remedial Actions:

1. Meet with entities that do not adopt or make changes to ordinances supporting the Watershed Management Plan.
2. Identify potential public officials that could be elected who support the Watershed Management Plan.
3. Meet individually with key land owners adjacent to tributaries and provide personalized support for Plan implementation.
4. Consider codes/ordinances related to use or alternatives to fertilizer and road salt.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 2 Report Card

Manage and mitigate for existing and future structural flood problems.

Current Condition:

- Five documented Flood Problem Areas (FPAs) were identified. FPA #1 is overbank/road flooding at Middle Rd. near Jonquil Terrace. FPA #2 is overbank/road flooding at Cottingham Rd. FPA #3 is overbank/road flooding at Cottingham Rd. at South Fork Tributary 13. FPA #4 is overbank/road flooding at Cascade Rd. at South Fork Reach 8. FPA #5 is overbank/road flooding at Swiss Valley Campground Rd. at Catfish Creek Reach 9.
- FEMA's 100-year floodplain occupies 2,601 acres or 6% of the watershed along the five primary streams.

Criteria/Targets to Meet Goal Objectives:

- 100% of new development that occurs within SMU's 2-4, 8, 11-15, 23, 24, 30 & 32 incorporates runoff reduction measures.
- All 5 (100%) Flood Problem Areas are mitigated for.
- Limited development is allowed within FEMA's 100-year floodplain.
- At least 200 homeowners or businesses receive tax incentives for using stormwater infiltration, harvesting/reuse technology.
- All 250+ acres of critical area wetland restoration is completed.

Goal/Objective Milestones:

		Grade
1-10 Yrs: (Short)	1. At least 50% of new development within SMU's 2-4, 8, 11-15, 23, 24, 30 & 32 reduces stomwater runoff. 2. At least 2 of 5 Flood Problem Areas are addressed. 3. Limited development occurs within FEMA's 100-year floodplain and is mitigated for. 4. At least 50 homeowners or businesses use stormwater infiltration, harvesting/reuse technology. 5. Restore at least 50 acres of wetland at critical area wetland restoration sites.	
10-20 Yrs: (Medium)	1. At least 75% of new development in SMU's 2-4, 8, 11-15, 23, 24, 30 & 32 reduces stomwater runoff. 2. Remaining 3 Flood Problem Areas are addressed. 3. All four 4 structural Flood Problem Areas are addressed. 4. Limited development occurs within FEMA's 100-year floodplain and is mitigated for. 5. At least 50 homeowners or business use stormwater infiltration, harvesting/reuse technology. 6. Restore at least 50 acres of wetland at critical area wetland restoration sites.	
20+ Yrs: (Long)	1. 100% of new development in SMU's 2-4, 8, 11-15, 23, 24, 30 & 32 reduces stomwater runoff. 2. No new development occurs within FEMA's 100-year floodplain. 3. At least 50 homeowners or businesses use stormwater infiltration, harvesting/reuse technology. 4. Restore at least 100+ acres of wetland at critical area wetland restoration sites.	

Monitoring Needs/Efforts:

- Track number of new developments that incorporate stormwater runoff reduction measures.
- Track number of Flood Problem Areas that area addressed.
- Track number of new developments that are allowed within FEMA's 100-year floodplain and mitigation measures used.
- Track number of homeowners or businesses that use stormwater infiltration, harvesting/reuse technology.

Remedial Actions:

- Meet with municipalities to discuss codes/ordinances related to runoff reduction measures.
- Conduct follow-up visits to Flood Problem Area sites during flood events to determine if additional remedial work is needed.
- Meet with municipalities to discuss policies related to development within FEMA's 100-year floodplain.
- Meet with municipalities to encourage tax incentives for using stormwater infiltration, harvesting, or reuse technology.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 3 Report Card

Protect groundwater quality and quantity and educate stakeholders on the influence of karst topography on groundwater resources.

Current Conditions:

- The geology includes carbonate bedrock that has been weathered and exposed for longer than the surrounding areas, creating unusual features such as limestone-walled valleys, high bluffs, caves, and crevices known as karst topography.
- Tapped aquifers beneath the watershed include the Cambrian-Ordovician, Ordovician, and Silurian units.
- Aquifer recharge in the study area is generally higher than most of the state of Iowa.
- Water shortage is not expected to be significant in the near future however, 7 of 34 source water protection areas are rated as being highly susceptible to contamination.

Criteria/Targets to Meet Goal Objectives:

- At least 200 homeowners or businesses install stormwater infiltration measures.
- All (100%) of new development in sensitive recharge areas incorporate Low Impact Development designs.
- State of Iowa and/or local communities conduct study to determine areas that greatest groundwater contamination potential.
- All (100%) stakeholders located within high groundwater contamination areas are educated about groundwater contamination.

Goal/Objective Milestones:

	Milestones	Grade
1-10 Yrs: (Short)	1. At least 50 homeowners or businesses install stormwater infiltration measures. 2. At least 50% of development in sensitive recharge areas incorporate Low Impact Development designs. 3. State of Iowa and/or local communities conduct groundwater contamination potential study.	
10-20 Yrs: (Medium)	1. At least 50 homeowners or businesses install stormwater infiltration measures. 2. At least 75% of development in sensitive recharge areas incorporate Low Impact Development designs. 3. At least 50% large land owners located within high groundwater contamination areas are educated about groundwater contamination.	
20+ Yrs: (Long)	1. At least 100 homeowners or businesses install stormwater infiltration measures. 2. All (100%) of development in sensitive recharge areas incorporate Low Impact Development designs. 3. All (100% large land owners located within high groundwater contamination areas are educated about groundwater contamination.	

Monitoring Needs/Efforts:

- Track number of homeowners or businesses that install stormwater infiltration measures.
- Track number of new developments that incorporate Low Impact Development.
- Track number of large land owners that were sent material or educated in other ways regarding groundwater contamination.

Remedial Actions:

- Meet with municipalities to encourage tax incentives for using stormwater infiltration measures.
- Meet with municipalities to discuss development codes/ordinances related to stormwater infiltration requirements.
- Meet with municipalities to discuss policies related to development within FEMA's 100-year floodplain.
- Contact State of Iowa regarding potential to conduct a detailed groundwater contamination area map.
- Meet individually and educate large land owners within groundwater contamination areas.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 4 Report Card

Protect and manage fish and wildlife habitat.

Current Condition:

- Ecological communities were balanced ecosystems with clean water and diverse with plant and wildlife populations among prairies, savannas, and wetlands prior to European settlement in the 1830s.
- Following European settlement, fires rarely occurred, prairies were tilled for farmland or developed, wetlands were drained, and several streams were channelized.
- Invasive species establishment is causing loss of wildlife habitat and reduced floodplain function.
- Important Natural Areas in the watershed include Mines of Spain, Swiss Valley Nature Preserve, and Interstate Power Company Forest Preserve.
- A portion of the Catfish Creek within Swiss Valley Nature Preserve is a Class B stream; it is considered cold-water and has naturally reproducing trout.

Criteria/Targets to Meet Goal Objectives:

- All (100%) of stream restoration projects include at least minimal fish habitat designs.
- All (100%) of stream restoration projects in coldwater reaches include detailed fish habitat designs.
- Riparian buffers along 59 critical area stream reaches are enhanced for wildlife, pollutant filtering, and floodplain purposes.
- Detailed ecological management plans are developed and implemented at all three existing Important Natural Areas.

Goal Milestones: | **Grade**

		Grade
1-10 Yrs: (Short)	1. All (100%) of stream restoration projects include at least minimal fish habitat designs. 2. All (100%) of stream restoration projects in coldwater reaches include detailed fish habitat designs. 3. At least 5 riparian buffers along critical stream reaches are enhanced. 4. Detailed ecological management plans are developed for all three Important Natural Areas.	
10-20 Yrs: (Medium)	1. All (100%) of stream restoration projects include at least minimal fish habitat designs. 2. All (100%) of stream restoration projects in coldwater reaches include detailed fish habitat designs. 3. At least 10 riparian buffers along critical stream reaches are enhanced. 4. Ecological management plans are implemented at all three Important Natural Areas.	
20+ Yrs: (Long)	1. All (100%) of stream restoration projects include at least minimal fish habitat designs. 2. All (100%) of stream restoration projects in coldwater reaches include detailed fish habitat designs. 3. At least 20+ riparian buffers along critical stream reaches are enhanced. 4. Ecological management plans are reassessed and updated for all three Important Natural Areas.	

Monitoring Needs/Efforts:

- Track all stream restoration projects and review for inclusion of fish habitat designs.
- Track number of riparian buffer projects implemented each year that include ecological benefits.
- Track management plan status and implementation progress at all three Important Natural Areas.

Remedial Actions:

- Request that CCWMA review all stream restoration project designs related to fish habitat prior to permitting and implementation.
- Work with agencies such as Dubuque County Soil and Water Conservation District to find funding for riparian buffer projects.
- Appropriate entities prepare budgets for creating and implementing ecological management plans.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 5 Report Card

Improve surface water quality to meet applicable standards.

Current Conditions:

- According to Iowa DNR's (2012 Integrated Report), Catfish Creek and all of its branches are "Not Supporting" for *Primary Contact*. Recent data suggests additional impairment via high total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS).
- The majority of pollutants are originating from agricultural uses and streambank erosion.
- Biological data suggests that Catfish Creek is impaired, ranking as either a "Fair" or "Poor" quality aquatic resource.

Criteria/Targets to Meet Goal Objectives:

- At least 50% of 59 (200,166 lf) "High Priority-Critical Area" stream reaches & riparian buffers restored.
- All 250+ acres (14 locations) of critical area wetland restoration is completed.
- All 7 "High Priority-Critical Area" detention basins retrofitted.
- All 2,929 acres (43 locations) identified as "High Priority-Critical Area" agricultural land implements agricultural management practices.
- A future water quality monitoring plan is developed and implemented.

Goal/Objective Milestones:

	Milestones	Grade
1-10 Yrs: (Short)	1. At least 5 critical area stream reaches/riparian buffers are restored. 2. At least 50 acres of wetland at critical area wetland restoration sites is restored. 3. At least 2 of 7 critical detention basins are retrofitted. 4. At least 20 of 43 critical area agricultural land reforms are implemented. 5. A water quality monitoring plan is implemented based on Section 9.1 of this plan.	
10-20 Yrs: (Medium)	1. At least 5 critical area stream reaches/riparian buffers are restored. 2. At least 50 acres of wetland at critical area wetland restoration sites is restored. 3. At least 2 of 7 critical detention basins are retrofitted. 4. At least 20 of 43 critical area agricultural land reforms are implemented. 5. A water quality monitoring plan is implemented based on Section 9.1 of this plan.	
20+ Yrs: (Long)	1. At least 10 critical area stream reaches/riparian buffers are restored. 2. At least 100+ acres of wetland at critical area wetland restoration sites is restored. 3. At least 3 of 7 critical detention basins are retrofitted. 4. All remaining critical area agricultural land reforms are implemented. 5. A water quality monitoring plan is implemented based on Section 9.1 of this plan.	

Monitoring Needs/Efforts:

- Track stream, channel, and riparian area restoration projects.
- Track wetland restoration project implementation and success.
- Track detention basin retrofit project implementation and success.
- Track sites/acres of agricultural land that implements recommended land management measures.
- Monitor water quality via the "Monitoring Plan" in this Section 9.1 of this report.

Remedial Actions:

- Locate EPA 319 grants that are being submitted for recommended stream, riparian, buffer, wetland, and detention basin projects and determine success rate.
- Dubuque County SWCD contact farmers to provide assistance with agricultural management measures.
- Locate potential funds to implement the "Monitoring Plan".

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 6 Report Card

Manage natural and cultural components of the Green Infrastructure Network.

Current Condition:

- Ecological communities were balanced ecosystems with clean water and diverse with plant and wildlife populations among prairies, savannas, and wetlands prior to European settlement in the 1830s.
- Following European settlement, fires rarely occurred, prairies were tilled for farmland or developed, wetlands were drained, and several streams were channelized.
- In 2012, agricultural areas were most common (21,591 ac; 47%) followed by open space (10,060 ac; 22%) and residential areas (6,368 ac; 21.8%)
- The largest change of a land use/land cover is predicted to occur on agricultural land (-6,919 ac; -15%) in the next 30 years.
- Important Natural Areas in the watershed include Mines of Spain, Swiss Valley Nature Preserve, and Interstate Power Company Forest Preserve.
- A portion of the Catfish Creek within Swiss Valley Nature Preserve is a Class B stream; it is considered cold-water and has naturally reproducing trout.

Criteria/Targets to Meet Goal Objectives:

- All four municipalities and Dubuque County adopt the Catfish Creek Watershed Management Plan.
- 100% of developments on "Critical Green Infrastructure Protection Areas" use Conservation/Low Impact Design.
- All golf courses within the Green Infrastructure Network incorporate natural landscaping.
- At least 3.0 miles of new trails, two new fishing access points, and two new canoe/kayak access points.
- >50% of land owners along streams/tributaries take steps to manage land for green infrastructure benefits.

Goal/Objective Milestones:

	Milestones	Grade
1-10 Yrs: (Short)	1. All four municipalities and Dubuque County adopt the Catfish Creek Watershed Management Plan. 2. >50% of developments on "Critical Green Infrastructure Protection Areas" follow recommendations. 3. All golf courses develop plans for incorporating natural landscaping in rough areas. 4. A plan is developed that identifies 3.0 miles of new trails, two fishing access points, and two canoe/kayak access points. 5. Surveys show >10% of residents along streams/tributaries take steps to manage land for GI.	
10-20 Yrs: (Medium)	1. >75% of developments on "Critical Green Infrastructure Protection Areas" follow plan. 2. All golf courses begin to install natural landscaping in at least 25% of rough areas. 3. 1.0 mile of new trails, one fishing access point, and one canoe/kayak access point is created. 4. Surveys show that >25% of residents along streams/tributaries take steps to manage land for GI.	
20+ Yrs: (Long)	1. 100% of developments on "Critical Green Infrastructure Protection Area" follow plan recommendations. 2. All golf courses begin to install natural landscaping in at least 50% of rough areas. 3. 1.0 mile of new trails, one fishing access point, and one canoe/kayak access point is created. 4. Surveys show that at least 50% of residents along streams/tributaries take steps to manage land for GI.	

Monitoring Needs/Efforts:

- Track number of entities that incorporate Green Infrastructure Network into Comp Plans and development reviews.
- Track developments on "Critical Green Infrastructure Protection Areas" that incorporate Conservation/Low Impact Design.
- Track number and type of natural landscaping incorporated at golf courses.
- Track miles of new trails, fishing access, and canoe/kayak access created in the watershed.
- Conduct surveys of residents along streams/tributaries asking about their understanding of watershed issues practices used.

Remedial Actions:

- Meet with municipalities/county to back the Green Infrastructure Network in Comp Plans and development reviews.
- Investigate via FOIA reasons/decisions that were made for developments that did not incorporate GI recommendations.
- Meet with golf course representatives to discuss possible low cost natural landscaping options.
- Meet with representatives of both public and private land to discuss recreational options.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

Goal 7 Report Card

Encourage agricultural techniques and soil conservation practices that will protect and conserve topsoil and bolster our water resources.

Current Condition:

- Agricultural land comprises nearly half of the watershed at 21,590 acres.
- The health of the watershed faces challenges and threats from agricultural land which if not managed properly can increase nutrient loading. The pollutant loading model suggests that cropland is the leading cause of nitrogen, phosphorus, and sediment loading in the watershed. At the root of these challenges and threats is that key audiences may lack the necessary knowledge, tools, and funding to make informed decisions and adopt positive behaviors to mitigate such threats and challenges. Since a significant amount of the watershed is held as private agricultural property, any efforts to improve water quality or increase groundwater recharge will need to include significant education, outreach, and funding efforts to the agricultural community.
- As survey of agricultural areas identified 84 parcels that could be improved with agricultural management measures.

Criteria/Targets to Meet Goal Objectives:

- At least 50% of High Priority-Critical Area agricultural landowners utilize existing NRCS or SWCD programs to install recommended conservation practices.
- At least one agricultural related workshop dedicated to cost-share programs is held every 5 years.
- At least one workshop dedicated to implementation of critical area agricultural projects is held every 5 years.
- All (100%) of 2,929 acres of High Priority-Critical Area agricultural management areas implement recommended agricultural management practices.

Goal/Objective Milestones: **Grade**

1-10 Yrs: (Short)	1. At least 10% of High Priority-Critical Area agricultural landowners utilize existing NRCS or SWCD programs to install recommended conservation practices. 2. Two agricultural related workshops dedicated to cost-share programs are held. 3. Two workshops dedicated to implementation of critical area agricultural projects are held. 4. At least 25% (732 acres) implement recommended agricultural management practices.	
10-20 Yrs: (Medium)	1. At least 25% of High Priority-Critical Area agricultural landowners utilize existing NRCS or SWCD programs to install recommended conservation practices. 2. Two agricultural related workshops dedicated to cost-share programs are held. 3. Two workshops dedicated to implementation of critical area agricultural projects are held. 4. At least 25% (732 acres) implement recommended agricultural management practices.	
20+ Yrs: (Long)	1. At least 50% of High Priority-Critical Area agricultural landowners utilize existing NRCS or SWCD programs to install recommended conservation practices. 2. Two agricultural related workshops dedicated to cost-share programs are held. 3. Two workshops dedicated to implementation of critical area agricultural projects are held. 4. Remaining 50% (1,464 acres) implement recommended agricultural management practices.	

Monitoring Needs/Efforts:

- Track number of critical area agricultural workshops held every 10 years.
- Track number of NRCS workshops held every 10 years.
- Track number of agricultural landowners participating in NRCS cost-share programs.
- Track number of agricultural land owners/parcels where recommended agricultural management practices are implemented.

Remedial Actions:

- CCWMA work with NRCS and SWCD to raise funds for and/or sponsor agricultural related workshops.
- CCWMA work with NRCS and SWCD to increase participation in existing programs.
- NRCS and/or SWCD approach land owners individually to offer assistance with implementing management practices.

Notes:

Grade Evaluation: 80%-100% met = A; 60%-79% met = B; 40%-59% met = C; and < 40% = failed.

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11.0 Glossary of Terms

100-year floodplain: A 100-year flood is a flood that has a 1-percent chance of being equaled or exceeded in any given year. A base flood may also be referred to as a 100-year storm and the area inundated during the base flood is called the 100-year floodplain.

303(d) Impaired Waters: The Federal Clean Water Act requires states to submit a list of impaired waters to the USEPA for review and approval using water quality assessment data from the Section 305(b) Water Quality Report. States are then required to develop total maximum daily load analyses (TMDLs) for waterbodies on the 303(d) list.

305(b): The Iowa 305(b) report is a water quality assessment of the state's surface and groundwater resources that is compiled by the IDNR as a report to the USEPA as required under Section 305(b) of the Clean Water Act.

ADID wetlands: Wetlands that were identified through the Advanced Identification (ADID) process. Completed in 1992, the ADID process sought to identify wetlands that should be protected because of their high functional value. The three primary functions evaluated were:

1. Ecological value based on wildlife habitat quality and plant species diversity;
2. Hydrologic functions such as stormwater storage value and/or shoreline/bank stabilization value; and
3. Water quality values such as sediment/toxicant retention and/or nutrient removal/transformation function.

Applied Ecological Services Inc. (AES): A broad-based ecological consulting, contracting, and restoration firm that was founded in 1978. The company consists of consulting ecologists, engineers, landscape architects, planners, and contracting staff. The mission of AES is to bring wise ecological decisions to all land use activities.

Aquatic habitat: Structures such as stream substrate, woody debris, aquatic vegetation, and overhanging vegetation that is important to the survival of fish and macroinvertebrates.

Aquifer: A layer of permeable rock, sand, or gravel through which ground water flows, containing enough water to supply wells and springs.

Base flow: The flow that a perennially flowing stream reduces to during the dry season. It is often supported by groundwater seepage into the channel.

Bedrock stream: A stream in which there is little to no sediment or soil covering the bedrock over which it flows.

Bedrock: The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Best Management Practices (BMPs): See **Management Measures**

Biodiversity: The variety of organisms (plants, animals and other life forms) that includes the totality of genes, species and ecosystems in a region.

Bioengineering (or Soil Bioengineering): Techniques for stabilizing eroding or slumping stream banks that rely on the use of plants and plant materials such as live willow posts, brush layering, coconut logs and other “greener” or “softer” techniques. This is in contrast to techniques that rely on creating “hard” edges with riprap, concrete and sheet piling (metal and plastic).

Bio-infiltration: Excavated depressional areas where stormwater runoff is directed and allowed to infiltrate back into groundwater rather than allowing to runoff. Infiltration areas are planted with appropriate vegetation.

Center for Watershed Protection (CWP): Non-profit 501(c)3 corporation founded in 1992 that provides local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation’s most precious natural resources such as streams, lakes and rivers.

Channelized stream: A stream that has been artificially straightened, deepened, or widened to accommodate increased stormwater flows, to increase the amount of adjacent land that can be developed or used for urban development, agriculture or for navigation purposes.

Clean Water Act (CWA): The CWA is the basic framework for federal water pollution control and has been amended in subsequent years to focus on controlling toxics and improving water quality in areas where compliance with nationwide minimum discharge standards is insufficient to meet the CWA’s water quality goals.

Coldwater stream: Streams in which maximum summer temperatures are typically below 75 degrees Fahrenheit and a flow of at least 0.3 cubic feet per second. Typically these streams are fed predominantly by springs and seeps.

Conservation development: A development designed to protect open space and natural resources for people and wildlife while at the same time allowing building to continue. Conservation design developments sometimes designate half or more of the buildable land area as undivided permanent open space.

Conservation easement: The transfer of land use rights without the transfer of land ownership. Conservation easements can be attractive to property owners who do not want to sell their land now, but would support perpetual protection from further development. Conservation easements can be donated or purchased.

Debris jam: Natural and man-made debris in a stream channel including leaves, logs, lumber, trash and sediment.

Designated Use: Appropriate uses are identified by taking into consideration the use and value of the water body for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes. In designating uses for a water body, States and Tribes examine the suitability of a water body for the uses based on the physical, chemical, and biological characteristics of the water body, its geographical setting and scenic qualities, and economic considerations.

Detention basin: A man-made structure for the temporary storage of stormwater runoff with controlled release during or immediately following a storm.

Digital Elevation Model (DEM): Regularly spaced grid of elevation points used to produce elevation maps.

Discharge (streamflow): The volume of water passing through a channel during a given time, usually measured in cubic feet per second.

Dissolved oxygen (DO): The amount of oxygen in water, usually measured in milligrams/liter.

Downcutting: The action of a stream to deepen itself, often as a result of channelization.

Dubuque County Conservation Board (DCCB): The Dubuque

County Conservation Board consists of five County residents who are appointed by the Dubuque County Board of Supervisors and given, by terms of the State Code of Iowa, the responsibility "...to acquire, develop, maintain, and make available to the inhabitants of the County [and its visitors] public parks, preserves, parkways, playgrounds, recreation centers, county forests, wildlife and other conservation areas, and to promote and preserve the health and welfare of the people, to encourage the orderly development and conservation of natural resources, and to cultivate good citizenship by providing adequate programs of public recreation."

Dubuque County Soil & Water Conservation District (DCSWCD): The Dubuque Soil & Water Conservation District helps guide the soil and water conservation programs in the county, and has the opportunity to influence state and national conservation programs. Conservation Districts establish conservation priorities, resolve soil loss complaints, establish acceptable soil loss limits, publish annual reports, approve soil conservation plans, and assist in the management of district funds and personnel.

East Central Intergovernmental Association (ECIA): East Central Intergovernmental Association is committed to working with member governments, their citizens, and others to empower eastern Iowa communities and enhance the quality of life in Cedar, Clinton, Delaware, Dubuque and Jackson Counties. Through ECIA membership, local governments share resources they could not afford individually. The services and programs provided by ECIA cover six broad categories: Community Development, Economic Development, Housing Assistance, Employment and Training, Transit, and Transportation and Planning.

Ecology: The scientific study between living organisms and their interactions with their natural or developed environment, other organisms, and their abiotic environment.

Ecosystem: An ecological community together with its environment, functioning as a unit.

Erosion: Displacement of soil particles on the land surface due to water or wind action.

European settlement: A period in the early 1800s when European settlers moved across the United States in search of better lives. During this movement, much of the historical communities were altered for farming and other types of development.

Eutrophic: A waterbody having a high level of biological productivity. A typical eutrophic waterbody either has many aquatic plants and is clear or has few plants and is less clear. Both situations have potential to support many fish and wildlife.

Federal Emergency Management Agency (FEMA): Government agency within the Department of Homeland Security that responds to, plans for, recovers from, and mitigates against disasters/ emergencies, both natural and man-made.

Fee-in-lieu: Defined by the USACE and EPA as a payment "to a natural resource management entity for implementation of either specific or general wetland or other aquatic resource development projects" for projects that "do not typically provide compensatory mitigation in advance of project impacts."

Fen: Peat-forming wetlands that receive nutrients from sources other than precipitation: usually from upslope sources through drainage from surrounding mineral soils and from groundwater movement. Fens are characterized by their water chemistry which is neutral or alkaline with relatively high dissolved mineral levels.

Filter strip: A long narrow portion of vegetation used to retard water flow and collect sediment for the protection of watercourses, reservoirs or adjacent properties.

Flash hydrology/flooding: A quickly rising and falling overflow of water in stream channels that is usually the result of increased amounts of impervious surface in the watershed.

Flood problem area (FPA): One or more buildings, roads or other infrastructure in one location that are repeatedly damaged by flooding.

Floodplain (100-year): Land adjoining the channel of a river, stream, watercourse, lake or wetland that has been or may be inundated by floodwater during periods of high water that exceed normal bank-full elevations. The 100-year floodplain has a probability of 1% chance per year of being flooded.

Floodproofing: Any combination of structural and non-structural additions, changes or adjustments to structures or property which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and contents.

Floodway: The floodway is the portion of the stream or river channel that includes the adjacent land areas that must be reserved to discharge the 100-year flood without increasing the water surface.

Flow Regime: The pattern of flow variability for a particular river or region.

Geographic Information System (GIS): A computer-based approach to interpreting maps and images and applying them to problem-solving.

Geology: The scientific study of the structure of the Earth or another planet, especially its rocks, soil, and minerals, and its history and origins.

Global Positioning System (GPS): Satellite mapping system that enables locators and mapping to be created via satellite.

Green infrastructure network: An interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks and other conservation lands, farms, and forests of conservation value; and wilderness and other open spaces that support native species, maintain natural ecological processes, sustain air and water resources and contribute to the health and quality of life.

Greenways: A protected linear open space area that is either landscaped or left in its natural condition. It may follow a natural feature of the landscape such as a river or stream, or it may occur along an unused railway line or some other right of way. Greenways also provide wildlife corridors and recreational trails.

Groundwater recharge: Primary mechanism for aquifer replenishment which ensures future sources of groundwater for commercial and residential use.

Headwaters: Upper reaches of streams and tributaries in a watershed.

HUC Code: A hydrologic unit code (HUC) that refers to the division and subdivision of U.S. watersheds. The hydrologic units are arranged or nested within each other, from the largest geographic area (regions) to the smallest geographic area (cataloging units).

Hydraulic and Hydrologic modeling: Engineering analysis that predicts expected flood flows and flood elevations based on land characteristics and rainfall events.

Hydraulic structures: Low head dams, weirs, bridges, levees, and any other structures along the course of the river.

Hydric soil: Soil units that are wet frequently enough to periodically produce anaerobic conditions, thereby influencing the species composition or growth, or both, of plants on those soils.

Hydrologic Soil Groups (HSG): Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. A's generally have the smallest runoff potential and D's the greatest.

Hydrology: The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hydrophytic vegetation: Plant life growing in water, soil or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content; one of the indicators of a wetland.

Impervious Cover Model: Simple urban stream classification model based on impervious cover and stream quality. The classification system contains three stream categories, based on the percentage of impervious cover that predicts the existing and future quality of streams based on the measurable change in impervious cover. The three categories include sensitive, impacted, and non-supporting.

Impervious cover/surface: An area covered with solid material or that is compacted to the point where water cannot infiltrate underlying soils (e.g. parking lots, roads, houses, patios, swimming pools, tennis courts, etc.). Stormwater runoff velocity and volume can increase in areas covered by impervious surfaces.

Incised channel: A stream that has degraded and cut its bed into the valley bottom; indicates accelerated and often destructive erosion.

Index of Biotic Integrity (IBI): An index used to evaluate the heath of a stream based on the macroinvertebrate community present. Used to rate water quality using macroinvertebrate taxa tolerance to organic pollution in streams.

Infiltration: Portion of rainfall or surface runoff that moves downward into the subsurface soil.

Invasive vegetation/plant: Plant species that are not native to an area and tend to out-compete native species and dominate an area (e.g. European buckthorn or garlic mustard).

Iowa Department of Natural Resources (IDNR): A government agency established to manage, protect and sustain Iowa's natural and cultural resources; provide resource-compatible recreational opportunities and to promote natural resource-related issues for the public's safety and education.

Iowa Department of Transportation (IDOT): The Iowa Department of Transportation focuses primarily on the state's policies, goals and objectives for Iowa's transportation system and provides an overview of the department's direction for the future.

Karst topography: Karst topography is any area where the terrain has been dissolved by the physical and chemical weathering of the bedrock. These areas are composed of carbonate rocks, such as dolomite and limestone, or have a high concentration of evaporites, such as salt and gypsum, because these materials tend to be highly soluble in water. This high solubility causes the parent material to be highly susceptible to chemical weathering (UWEC, 2006).

Low Impact Development: Comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds.

Macroinvertebrate (aquatic): Invertebrates that can be seen by the unaided eye (macro). Most benthic invertebrates in flowing water are aquatic insects or the aquatic stage of insects, such as stonefly nymphs, mayfly nymphs, caddisfly larvae, dragonfly nymphs and midge larvae. They also include such things as clams and worms. The presence of benthic macroinvertebrates that are intolerant of pollutants is a good indicator of good water quality.

Management Measures: Also known as Best Management Practices (BMPs) are non-structural practices such as site planning and design aimed to reduce stormwater runoff and avoid adverse development impacts - or structural practices that are designed to store or treat stormwater runoff to mitigate flood damage and reduce pollution. Some BMPs used in urban areas may include stormwater detention ponds, restored wetlands, vegetative filter strips, porous pavement, silt fences and biotechnical streambank stabilization.

Marsh: An area of soft, wet, low-lying land, characterized by grassy vegetation and often forming a transition zone between water and land.

Meander (stream): A sinuous channel form in flatter river grades formed by the erosion on one side of the channel (pools) and deposition on the other (point bars).

Mitigation: Measures taken to eliminate or minimize damage from development activities, such as construction in wetlands or Regulatory Floodplain filling, by replacement of the resource.

Moraine (terminal): A ridge-like accumulation of till and other types of drift that was produced at the outer margin or farthest advance, of a retracting glacier.

Municipal Separate Stormwater Systems (MS4's): A system that transports or holds stormwater, such as catch basins, curbs, gutters, ditches, man-made channels, pipes, tunnels, and or/ storm drains before discharging into local waterbodies.

National Pollutant Discharge Elimination System (NPDES Phase II): Clean Water Act law requiring smaller communities and public entities that own and operate a Municipal Separate Storm Sewer System (MS4) to apply and obtain an NPDES permit for stormwater discharges. Permittees at a minimum must develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable. The stormwater management program must include these six minimum control measures:

1. Public education and outreach on stormwater impacts
2. Public involvement/ participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment
6. Pollution prevention/good housekeeping for municipal operations.

National Wetland Inventory (NWI): U.S. Fish and Wildlife Service study that provides information on the characteristics, extent, and status of U.S. wetlands and deepwater habitats and other wildlife habitats.

Native Landscaping: A landscape that contains plants or plant communities that are indigenous to a particular region.

Native vegetation/plants: Plant species that have historically been found in an area.

Natural community/area: an assemblage of plants and animals interacting with one another in a particular ecosystem.

Nitrogen: A colorless, odorless unreactive gas that forms about 78% of the earth's atmosphere. The availability of nitrogen in soil is important for ecosystem processes.

No-net-loss: A policy for wetland protection to stem the tide of continued wetland losses. The policy has generated requirements for wetland mitigation so that permitted losses due to filling and other alterations are replaced and the net quality wetland acreage remains the same.

Nonpoint source pollution (NPS pollution): Refers to pollutants that accumulate in waterbodies from a variety of sources including runoff from the land, impervious surfaces, the drainage system and deposition of air pollutants.

Nutrients: Substances needed for the growth of aquatic plants and animals such as phosphorous and nitrogen. The addition of too many nutrients (such as from sewage dumping and over fertilization) will cause problems in the aquatic ecosystem through excess algae growth and other nuisance vegetation.

Open space parcel: Any parcel of land that is not developed and is often set aside for conservation or recreation purposes.

Paleozoic Era: The geologic time period lasting from roughly 541,000,000 to 252,170,000 million years ago and the earliest of the geologic eras.

Partially open parcel: Parcels that have been developed to some extent, but still offer some opportunities for open space and Best Management Practice (BMP) implementation.

Phosphorus: A nonmetallic element that occurs widely in many combined forms especially as inorganic phosphates in minerals, soils, natural waters, bones, and teeth and as organic phosphates in all living cells.

Pleistocene Era: The geologic time period lasting from roughly 2,588,000 to 11,700 years ago and covering the world's most recent glacial period.

Point source pollution: Refers to discharges from a single source such as an outfall pipe conveying wastewater from an industrial plant or wastewater treatment facility.

Policy: A high-level overall plan embracing the general goals and acceptable procedures especially of a governmental body.

Pollutant load: The amount of any pollutant deposited into waterbodies from point source discharges, combined sewer overflows, and/or stormwater runoff.

Pool: A location in an active stream channel usually located on the outside bends of meanders, where the water is deepest and has reduced current velocities.

Prairie: A type of grassland characterized by low annual moisture and rich black soil characteristics.

Preventative measures: Actions that reduce the likelihood that new watershed problems such as flooding or pollution will arise, or that those existing problems will worsen. Preventative techniques generally target new development in the watershed and are geared toward protecting existing resources and preventing degradation.

Programmatic Action: A series of steps to be carried out or goals to be accomplished.

Rain gage station: Point along a stream where the amount of water flowing in an open channel is measured. The USGS makes most streamflow measurements by current meter. A current meter is an instrument used to measure the velocity of flowing water. By placing a current meter at a point in a stream and counting the number of revolutions of the rotor during a measured interval of time, the velocity of water at that point is determined.

Rainwater Harvesting: The accumulation and storing of rainwater for reuse before it reaches an aquifer.

Regulatory floodplain: Regulatory Floodplains may be either riverine or non-riverine depressional areas. Projecting the base flood elevation onto the best available topography delineates floodplain boundaries. A floodprone area is Regulatory Floodplain if it meets any of the following descriptions:

1. Any riverine area inundated by the base flood where there is at least 640 acres of tributary drainage area.
2. Any non-riverine area with a storage volume of 0.75 acre-foot or more when inundated by the base flood.
3. Any area indicated as a Special Flood Hazard Area on the FEMA Flood Insurance Rate Map expected to be inundated by the base flood located using best available topography.

Regulatory floodway: The channel, including on-stream lakes, and that portion of the Regulatory Floodplain adjacent to a stream or channel as designated by the Iowa Department of Natural Resources-Office of Water Resources, which is needed to store and convey the existing and anticipated future 100-year frequency flood discharge with no more than a 0.1 foot increase in stage due to the loss of flood conveyance or storage, and no more than a 10% increase in velocities. Where interpretation is needed to determine the exact location of the Regulatory Floodway boundary, the IDNR-OWR should be contacted for the interpretation.

Remnant: a small fragmented portion of the former dominant vegetation or landscape which once covered the area before being cleared for human land use.

Retrofit: Refers to modification to improve problems with existing stormwater control structures such as detention basins and conveyance systems such as ditches and stormsewers. These structures were originally designed to improve drainage and reduce flood risk, but they can also be retrofitted to improve water quality.

Ridge: A line connecting the highest points along a landscape and separating drainage basins or small-scale drainage systems from one another.

Riffle: Shallow rapids, usually located at the crossover in a meander of the active channel.

Riparian: Referring to the riverside or riverine environment next to the stream channel, e.g., riparian, or streamside, vegetation.

Runoff: The portion of rain or snow that does not percolate into the ground and is discharged into streams by flowing over the ground instead.

Savanna: A type of woodland characterized by open spacing between its trees and by intervening grassland.

Sediment: Soil particles that have been transported from their natural location by wind or water action.

Sedimentation: The process that deposits soils, debris and other materials either on other ground surfaces or in bodies of water or watercourses.

Seep: A moist or wet place where groundwater reaches the earth's surface from an underground aquifer.

Sinkhole: A hole or depression in the ground formed when the surface layer collapses. In karst topography sinkholes are typically formed when carbonate rock below ground is dissolved away.

Socioeconomics: Field of study that examines social and economic factors to better understand how the combination of both influences something.

Special Service Area (SSA) Tax: Special taxing districts in municipalities that are established by ordinance, often at the request of developers of new housing subdivisions, in order to pass on the costs of the streets, landscaping, water lines, and sewer systems to homeowners who reside within.

Stakeholders: Individuals, organizations, or enterprises that have an interest or a share in a project. (see also Watershed Stakeholders).

Stormsewershed: An area of land whose stormwater drains into a common storm sewer system.

Stormwater management: A set of actions taken to control stormwater runoff with the objectives of providing controlled surface drainage, flood control and pollutant reduction in runoff.

Stormwater Treatment Train: An alternative approach to managing stormwater that uses a series of natural Best Management Practices (BMPs) that are sized, engineered, and ecologically designed for low maintenance. The STT mimics the natural hydrologic cycle by basically creating a landscape design that slowly moves water through natural features that infiltrate, evaporate, filter and clean stormwater. STT elements include rooftop treatments, vegetated swales, parking-lot treatments, landscaping that utilizes stormwater, and open space systems such as parks and rights-of-way.

Stream corridor: The area of land that runs parallel to a stream.

Stream monitoring: Chemical, biological and physical monitoring used to identify the causes and sources of pollution in the river and to determine the needs for reduction in pollutant loads, streambank stabilization, debris removal and habitat improvement.

Stream reach: A stream segment having fairly homogenous hydraulic, geomorphic and riparian cover and land use characteristics (such as all ditched agriculture or all natural and wooded).

Streambank stabilization: Techniques used for stabilizing eroding streambanks.

Substrate (stream): The composition of the bottom of a stream such as clay, silt or sand.

Subwatershed Management Unit (SMU): Small unit of a watershed or subwatershed that is delineated and used in watershed planning efforts because the effects of impervious cover are easily measured, there is less chance for confounding pollutant sources, boundaries have fewer political jurisdictions, and monitoring/mapping assessments can be done in a relatively short amount of time.

Subwatershed: Any drainage basin within a larger drainage basin or watershed.

Swale: A vegetated channel, ditch or low-lying or depressional tract of land that is periodically inundated by conveying stormwater from one point to another. Swales are often used in natural drainage systems instead of stormsewers.

Threatened and Endangered Species (T&E): An "endangered" species is one that is in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered in the foreseeable future.

Till: A heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders deposited directly by and underneath a glacier without stratification.

Topography: The relative elevations of a landscape describing the configuration of its surface. Study and depiction (such as charts or maps) of the distribution, relative positions, and elevations of natural and man-made features of a particular landscape.

Total Maximum Daily Load (TMDL): A TMDL is the highest amount of a particular pollutant discharge a waterbody can handle safely per day.

Total suspended solids (TSS): The organic and inorganic material suspended in the water column and greater than 0.45 micron in size.

Treatment Train: Several Management Measures/Best Management Practices (BMPs) used together to improve water quality, infiltration and reduce sedimentation.

Trophic State Index (TSI): Trophic State is a measure of the degree of plant material in a body of water. It is usually measured using one of several indices (TSI) of algal weight (biomass): water transparency (Secchi Depth), algal chlorophyll, and total phosphorus.

Turbidity: Refers to the clarity of the water, which is a function of how much material including sediment is suspended in the water.

United States Army Corps of Engineers (USACE): Federal group of civilian and military engineers and scientists that provide services to the nation including planning, designing, building and operating water resources and other Civil Works projects. These also include navigation, flood control, environmental protection, and disaster response.

United States Environmental Protection Agency Section 319 (Section 319): Section 319 of the Clean Water Act encourages and funds nonpoint source pollution control projects (any indirect pollution, like runoff, stormwater discharge, road salt, sediment, etc.) or NPS reduction at the source.

United States Geological Survey (USGS): Government agency established in 1879 with the responsibility to serve the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

Urban runoff: Water from rain or snow events that runs over surfaces such as streets, lawns, parking lots and directly into storm sewers before entering the river rather than infiltrating the land upon which it falls.

USDA TR55 Document: A single event rainfall-runoff hydrologic model designed for small watersheds and developed by the USDA, NRCS, and EPA.

Vegetated buffer: An area of vegetated land to be left open adjacent to drainageways, wetlands, lakes, ponds or other such surface waters for the purpose of eliminating or minimizing adverse impacts to such areas from adjacent land areas.

Vegetated swale: An open channel drainageway used along residential streets and highways to convey stormwater and filter pollutants in lieu of conventional storm sewers.

Velocity (of water in a stream): The distance that water can travel in a given direction during a period of time expressed in feet per second.

Wastewater Treatment: Process that modifies wastewater characteristics such as its biological oxygen demand (BOD), chemical oxygen demand (COD), pH, etc. in order to meet effluent or water discharge standards.

Water Chemistry: The nature of dissolved materials (e.g. chlorides or phosphates) in water.

Waters of the United States (WOUS): For the purpose of this Ordinance the term Waters of the United States refers to those water bodies and wetland areas that are under the U. S. Army Corps of Engineers jurisdiction.

Watershed Management Plan: A document that provides assessment and management information for geographically defined watershed, including the analysis, actions, participants, and resources related to development and implementation of the plan.

Watershed partner(s): Key watershed stakeholders who take an active role in the watershed management planning process and implementing the watershed plan.

Watershed Vulnerability Analysis: Rapid planning tool for application to watersheds and subwatersheds that estimates future and impervious cover and provides guidance on factors that might alter the initial classification or diagnosis of a watershed or subwatershed.

Watershed: An area confined by topographic divides that drains to a given stream or river. The land area above a given point on a waterbody (river, stream, lake, wetland) that contributes runoff to that point is considered the watershed.

Wet meadow/sedge meadow: A type of wetland away from stream or river influence with water made available by general drainage and consisting of non-woody vegetation growing in saturated or occasionally flooded soils.

Wetland: A wetland is considered a subset of the definition of the Waters of the United States. Wetlands are land that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, under normal conditions, a prevalence of vegetation adapted for life in saturated soil conditions (known as hydrophytic vegetation). A wetland is identified based upon the three attributes: 1) hydrology, 2) hydric soils and 3) hydrophytic vegetation.