City of Johnston
Watershed Assessment
Stormwater Management and Action Plan

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City of Johnston

Watershed Assessment
Stormwater Management and Action Plan

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City of Johnston
Watershed Assessment / Stormwater Management and Action Plan

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Watershed Assessment

Watershed Assessment

Background Information

Purpose and Overview

This document summarizes the information gathered as part of a comprehensive assessment of the watersheds within the City of Johnston. The purpose of this effort was to gain a better understanding of the existing conditions within these watersheds that could have an impact on flooding, streambank stability, water quality and habitat for fish and wildlife. The knowledge gained from this effort is intended to be used to develop a Citywide Stormwater Master Plan which will recommend actions required to mitigate issues identified as part of the Watershed Assessment.

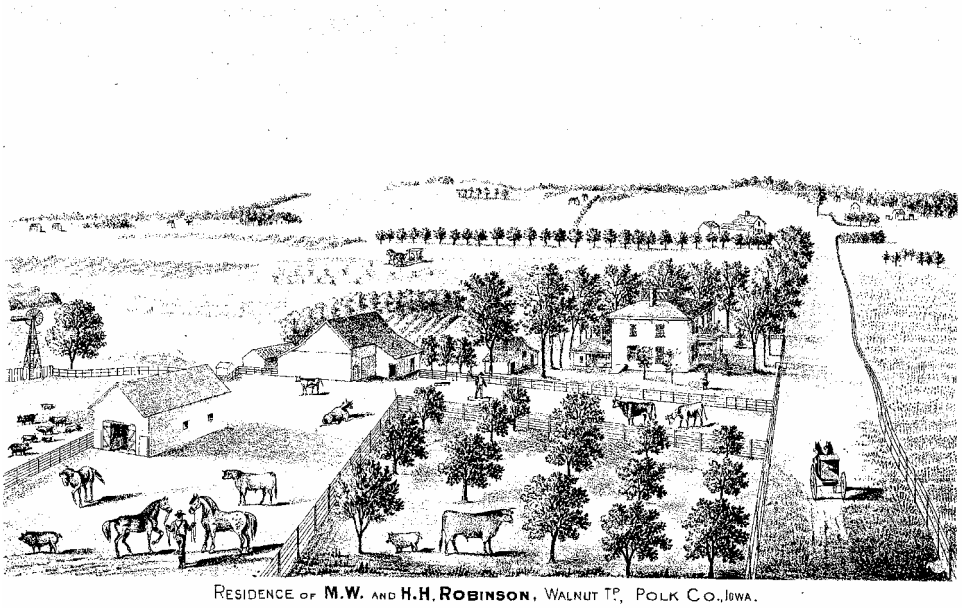
Historical Context

> *"This Township is mostly high rolling prairie, generally first rate soil... Beaver Creek is a very large and beautiful creek affording many favorable sites for mills. The prairie contiguous to it is beautiful, and where there is timber sufficient will invite the attention of the pioneer seeking a location for a farm."*
> *- Samuel W. Durham, Surveyor (October 1847).*

To better understand the condition of the watersheds as they exist today, it is important to understand how they have evolved as they have been affected by agricultural and urban influences. Prior to settlement, the landscape of this area was primarily tall grass prairie, with some scattered areas of timber mainly located in some areas along Beaver Creek and the Des Moines River. In those days, Beaver Creek was considered a large creek by the surveyors, but measured only 30 chain links, or about 20 feet across.

The surveyors only noted three small tributaries to Beaver Creek in this area. One of which is Little Beaver Creek which followed a meandering course near sloughs and some wetlands and was only six to seven feet wide at that time. The other two small streams noted in their surveys measured only two links wide. The course of many of the small urban streams that exist today, were not observed at that time.

Both timbered lands and tall grass prairies had the ability to absorb a large portion of the rainfall that fell on them. The deep root structures of these plants kept the surface soils loose and porous, and acted like a sponge, absorbing much of the water from the surface. Some of the rainfall would evaporate from the surface, and some would infiltrate through the looser soils into the groundwater table. Many of the small streams likely were fed primarily by this groundwater, slowly percolating to the surface and offering a more stable and steady base flow throughout the year. When large storms caused surface runoff, it usually would pass slowly overland, through stable, vegetated swales and overbank areas.

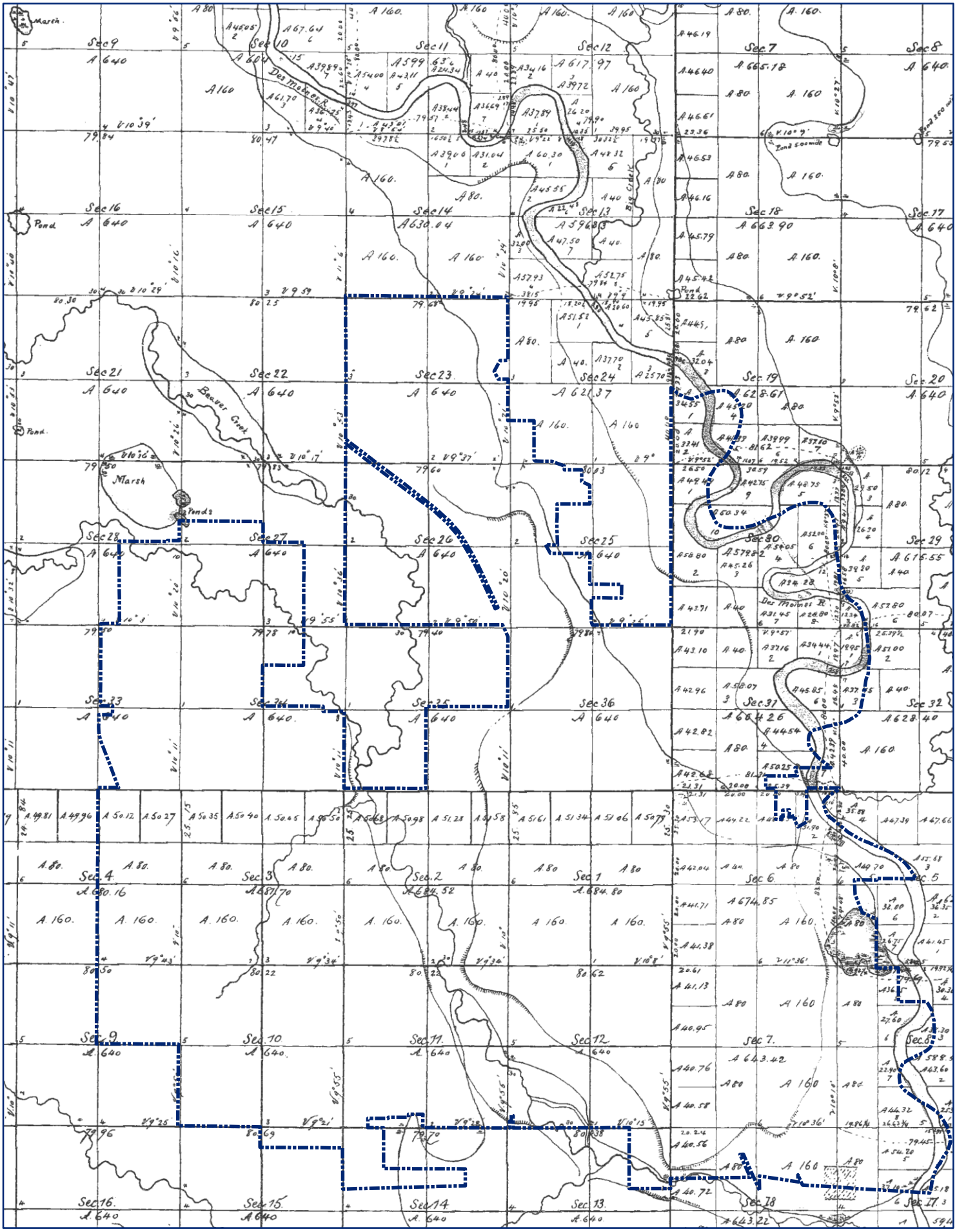


RESIDENCE OF M.W. AND H.H. ROBINSON, WALNUT TP., POLK CO., IOWA.

Image 1

◄ Artist's depiction of Robinson residence circa 1875.

Road at right is Merle Hay Road, and treeline shown in front of the residence in the distance is approximate location of NW 62nd Avenue. Bluffs in the background would be the approximate location of NW Beaver Drive.



Historic Land Survey

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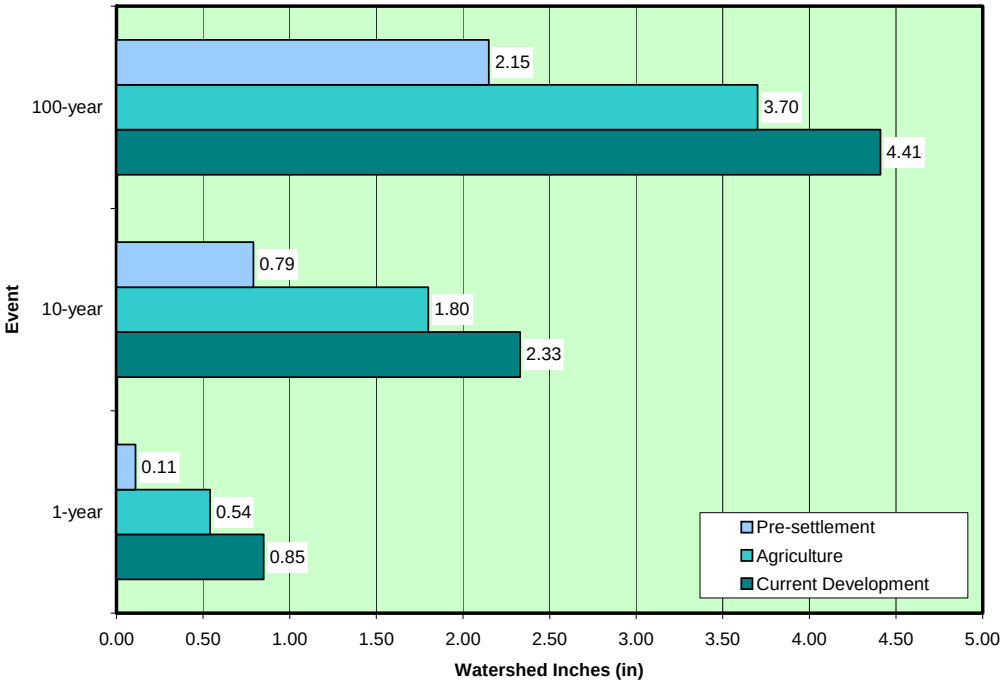
As the area was settled and farmed, the tall grass prairies were lost. Tilled lands would allow more rainwater to runoff the land, and less to be absorbed into the soil. Some drainage paths and small streams were straightened or tiled to accommodate better agricultural production. Rainwater would run off the landscape more often, and more quickly. Isolated grass strips either too wet or steep to farm would start to become new small streams. Once cleared by fire, these areas could start to become overgrown with small brush and trees. Over time, the overgrowth could shade out the tall grasses, leaving the ground largely bare during summer months, and prone to erosion. As more water runs off the land, larger streams (such as Beaver Creek) begin to widen and deepen to be able to pass the flows from larger storm events.

Aerial photo of agricultural area along NW 86th St., north of NW 70th Ave. This area is representative of land cleared and tilled for agriculture, as well as stream corridors that have filled in with trees over the last 50-100 years.

Stormwater Fact:

A watershed-inch is equal to a depth of water of one inch spread over a certain area. This is equal to…
27,156 gallons / acre or
17,380,000 gallons / sq. mile

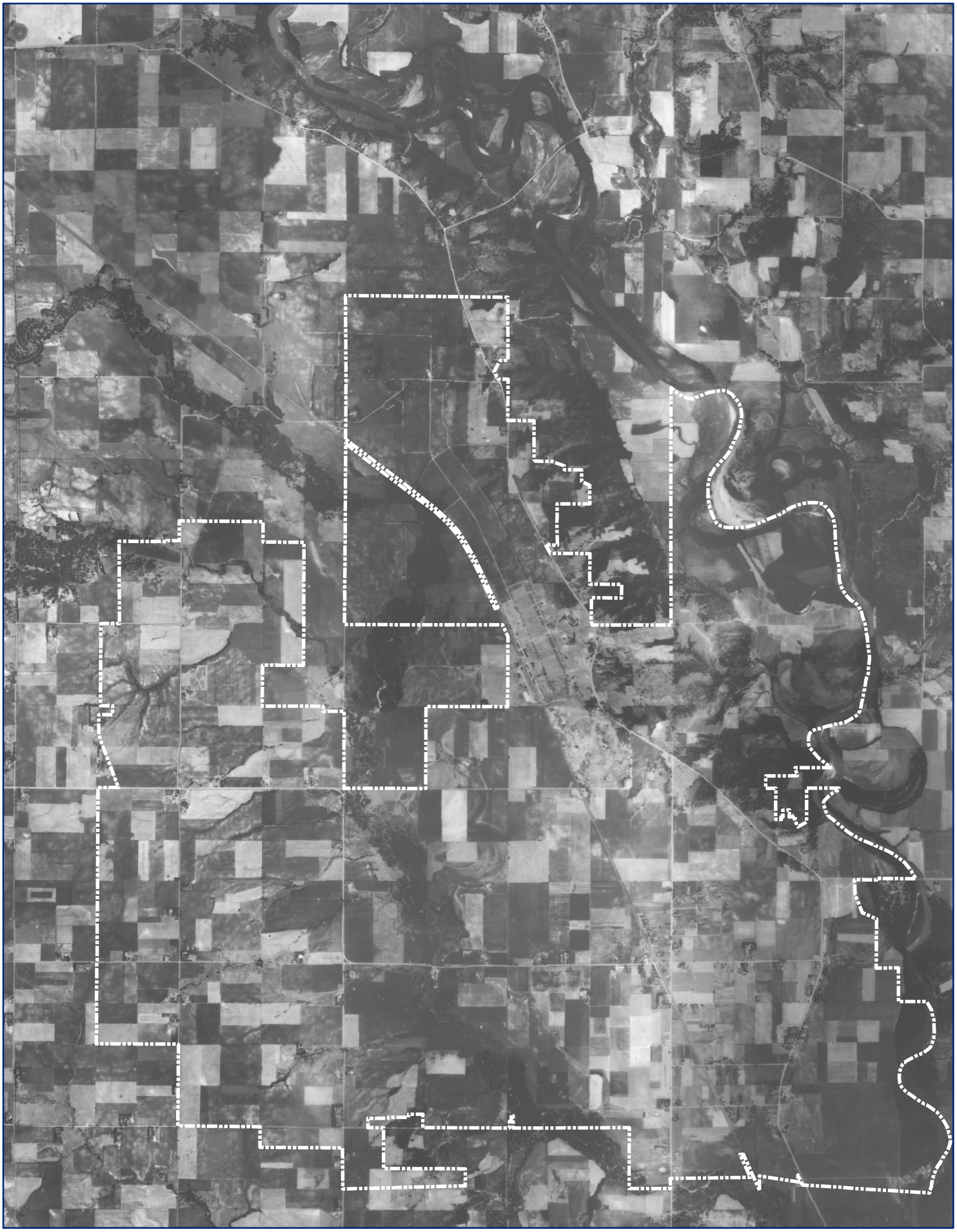


Runoff Depth

Based on typical conditions for the developed watersheds of Johnston, the chart at left reflects the changes in the amount of runoff that would be expected to be observed from different levels of development.

This indicates that as lands are developed into agriculture and then on into urban uses the volume of runoff increases significantly.

1-year, 24-hour storm = 2.34"
10-year, 24-hour storm = 4.27"
100-year, 24-hour storm = 6.61"



1930s Aerial Photograph

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Johnston

Urban growth in this area began primarily during the 1900s, starting with the construction of Camp Dodge and the development of the interurban railroad. Areas near what is now Merle Hay Road and NW 62nd Avenue developed slowly from the early 1900s through the 1960s. More steady growth began after incorporation of the community in 1969, and accelerated with the Green Meadows development in the early 1980s. This more rapid growth continued within areas east of Beaver Creek ever since. Urban development has spread west of Beaver Creek only since the early 1990s.

▶ Aerial photo of portions of developed areas east of Beaver Creek.

Older developed areas (yellow)

Green Meadows (blue)

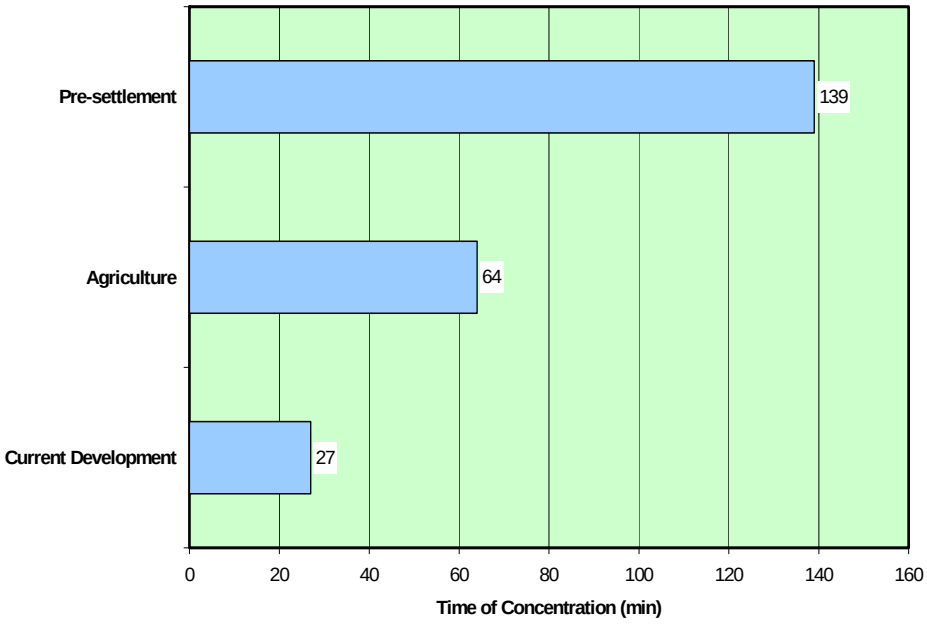
Johnston Commons (green)

Photo 3

Stormwater Fact:

Time of concentration is a measure of how long it takes runoff from the far end of a watershed to reach the outlet (or other point of interest).

It is decreased by shortened flow paths, steeper slopes, smoothing surface conditions or confining water through a narrower channel or pipe.



As grasslands were first tilled and farmed, depressions and swales were drained and straightened allowing the landscape to drain off more quickly.

With urban development, installation of roofs and paved surfaces; as well as flumes and storm sewer systems further increases runoff velocities.

The chart at left reflects the changes in the average time of concentration for the typical developed watersheds in Johnston.

This data indicates that flow times are expected to be reduced by 54% under agricultural conditions, and 81% in urban settings as compared to pre-settlement conditions.

◀ ***Time of Concentration***

1990s Aerial Photograph

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Feet

The construction of the I-35/80 interchange and improvements of NW 86th Street fueled growth west of Beaver Creek. Today most of the land area within the City located east of NW 100th Street, and south of NW 70th Avenue is developed for residential, commercial and civic uses. Construction of paved driveways and streets, and storm sewer systems allows for stormwater runoff to quickly be passed downstream, usually into a series of narrow, deep urban stream corridors.

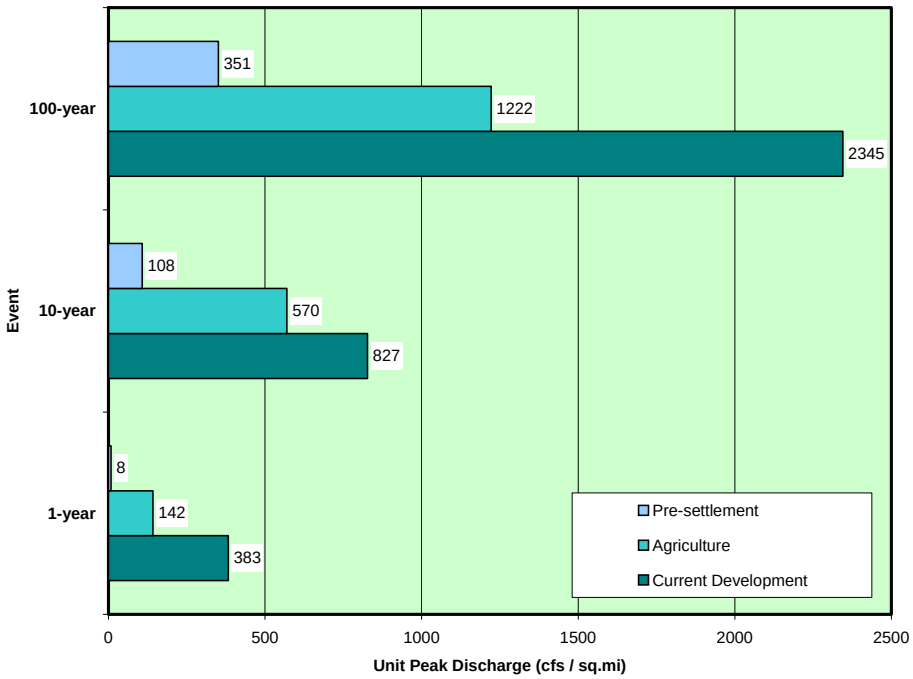
Aerial photo of portions of developed areas west of Beaver Creek.

NW 100th Street (blue)

Windsor Parkway (yellow)

Stormwater Fact:

To compare watersheds of different sizes, unit peak discharge is used and measured in cubic feet per second per square mile. To find an estimate of peak flow for a given watershed, multiply its area (in sq. miles) by the value in the graph below.



Unit Peak Discharge

Unit peak discharge is a measure of how large the "surge" of runoff is during a storm event. This measure is affected by both the volume of runoff generated by a storm, and how quickly it flows downstream.

Installation of "efficient" drainage systems like flumes, storm sewer pipes and narrow drainage ditches speed up the rate which stormwater flows through stream corridors.

This graph is based on developed watersheds within Johnston. An adjustment factor has been applied to current development conditions to account for the effects of storm water detention.

2008 Aerial Photograph

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Johnston

Influences on Watersheds

Hydrology

As land uses change from a natural state to agriculture uses and ultimately to urban development the very nature of the way rainfall is handled by the landscape is altered.

- **Natural landscape – tall grass prairies, wetlands and woodlands.** The deep rooted tall grass prairies that once dominated Iowa's landscapes created the rich deep soils that fuel our state's agricultural industry. These plants and their roots kept the soils loose and porous, allowing much of the annual rainfall to be absorbed directly by plants, or slowly filtered through the soil below into the groundwater. Little direct runoff would have been observed during small storms, and streams were fed primarily by steady sources of clean, fresh groundwater. Runoff during larger storm events was slowly conveyed over a series of swales and broad drainageways to the much narrower receiving streams. Wetlands and pocket marshes in upland and low areas also trapped runoff and reduced flows during larger storm events. In this condition, only about 10% of the annual rainfall would reach the streams by direct runoff and 50% of the rainfall percolated through the soil into the groundwater table.
- **Agricultural uses.** As the prairies were tilled, and wetlands were drained, less rainfall was allowed to infiltrate into the soil below. Straightened ditches and streams and a series of tile networks made it easier for stormwater to runoff the landscape more quickly. Over time this would have led to higher flow rates, flooding and erosion in the larger stream corridors.
- **Mass grading activities for urban development and construction.** Use of large scale grading equipment to move large volumes of earth is often used to accommodate urban development. These grading operations can compact surface and subsurface soil layers, reducing the rate at which rainfall can be absorbed into the soil. Removal of topsoil layers prior to mass grading also removes the amount of organic matter in surface soils, making them less likely to support desired. This increases the need for irrigation and fertilization to support planned trees, shrubs and turf grasses. Saturation of compacted surface soils through irrigation can further increase expected runoff volume.
- **Construction of hard surface elements (roofs, streets and driveways).** Creation of hard surfaces leads to more runoff and higher peak flow rates. In even very small rainfall events, runoff is generated from roof, parking lots and streets. Hard surface areas are often connected together by a series of gutters, flumes and storm pipes reducing the opportunity for infiltration, flow volume reduction and stormwater treatment. Groundwater levels and natural stream baseflow levels decline as less water is able to percolate through the soil.
- **Construction of flumes, storm sewers and defined drainage channels.** In order to prevent local flooding and ponding, a system of flumes, storm sewers and channels is constructed to convey water away from developed areas and into receiving streams. As stormwater is forced into more confined channels, a smaller area is available to convey the same volume of water. Water flows more quickly to accommodate the same volume of water within a smaller area. This leads to increased runoff velocities, peak flow rates and potentially a greater risk of channel erosion.

Proportion of Rainfall Converted into Runoff

	1-year (2.38")	10-year (4.27")	100-year (6.61")
Pre-settlement	4%	18%	33%
Agricultural Development	23%	42%	56%
Urban Development	36%	55%	67%

(Based on typical developed watershed conditions in the City of Johnston, predicted by TR-55 runoff models)

Precipitation

Everyplace on Earth has a unique pattern of snow and rainfall. To better understand the nature of runoff from the landscape in Johnston, it is important to understand these patterns as applied to Central Iowa.

Traditionally stormwater management and design in urban areas has focused on larger storm events (often called minor and major storms) which on average would occur only once every 5 to 100 years. Minor storms (5- to 10-year events) are often studied to design storm sewer systems. Major storms (25- to 100-year events) have often reviewed to size bridges, culverts and stormwater detention systems. It is important to understand the volume and rate of runoff generated by these types of storms to ensure that water can be conveyed in a manner which prevents damage to public and private infrastructure and to reduce the potential for downstream flooding that could be influenced by urban development.

Recently, more attention is being paid to "small storm events", or events that are expected to occur more frequently than once a year on average. A 1-year event (an event which over time would typically be seen about once a year) in Central Iowa is expected to drop 2.34" of rain over a 24-hour period. From the chart at the bottom of this page, it can be seen that 98% of the rain events in Central Iowa are expected to be one of these "small storm events".

As reviewed in the previous sections, development of the landscape into agricultural and urban uses increases the volume and rate of runoff from these smaller storm events, which make up the vast majority of the amount of rainfall that falls in Central Iowa each year. Stormwater control structures designed to control larger storm events often fail to adequately slow runoff from small storm events.

Since small storm events make up such a large percentage of the annual rainfall in this region, it is reasonable to assume that most pollutants are carried off during these events. Even the "first flush" from a half-inch or inch rainfall event will carry away most of the sediments, oils and other pollutants that have been deposited on the landscape. Stormwater management practices designed to capture and treat runoff generated by storms of 1.25" or less are expected to effectively treat runoff from 90% of the rainfall events that occur locally. Installation of these practices enhances downstream water quality by capturing many suspended pollutants and reduces the volume and rate of stormwater runoff from small storm events.

Rainfall Summary for Ames, Iowa (1960-2006)
Adapted from the Iowa Stormwater Management Manual

Rainfall depths less than:	Number of Events Within Category	Cumulative Frequency	Average annual rainfall under depth:	Cumulative % of average annual rainfall
0.10"	1363		2.30"	7%
0.25"	651	33%	5.28"	17%
0.50"	596	62%	10.94"	35%
0.75"	262	75%	15.15"	48%
1.00"	182	85%	19.23"	61%
1.25"	120	91%	22.70"	72%
1.50"	73	94%	25.27"	80%
1.75"	37	96%	26.83"	85%
2.00"	32	98%	28.35"	90%
3.00"	35	99%	30.49"	97%
4.00"	8	99%	31.19"	99%
5.00"	1	99%	31.30"	99%
6.00"	2	100%	31.58"	100%
More than 6.00"	0	100%	31.58"	100%

Stormwater Fact:

Over 90% of the rainfall events in Central Iowa in an average year are less than 1.25" in depth, and 98% are less than 2.34" in depth. These "small storms" also account for around 95% of the annual rainfall volume in Central Iowa.

Pollutants

Urban development, land uses and the activities of daily life create a variety of pollutants that can be easily picked up by stormwater. As the volume of surface runoff increases, more of these substances will be washed into gutters, flumes, and storm sewers and easily transported to nearby streams and rivers. This effect is magnified where impervious surfaces are directly connected together, providing little or no opportunity to capture and treat stormwater runoff to remove these pollutants before it enters the streams. It is important to highlight a few of the common pollutants that can be transported in urban stormwater runoff, and understand their common sources and the impact they have on receiving waters.

Photo 5

◀ Sands and sediments deposited onto streets and parking lots are easily washed into the storm system by heavy snowmelt or the first flush of a rainfall event.

Metals, oils, trash and other debris are also washed through paved gutters and flumes into storm intakes. In this picture, some of this debris has collected inside a manhole, waiting to be washed downstream with the next significant rain event. ▶

Photo 6

Photo 7

◀ Collected sediments are either washed further downstream in larger storm events, or can settle in drainage swales and culverts. In addition to impairing water quality, local flooding can be caused if these structures are partially or completely filled by sediment or other debris.

Pollutant	Source	Impact
Suspended Solids		
Sediments (silt, sands and gravels)	Construction sites, road rights-of-way, eroded stream channels and swales	Sediments can fill natural stream channels leading to local flooding, stream meandering, and diminished habitat. Other pollutants can also become attached to sediment particles and be more easily conveyed to receiving waters.
Leaf and lawn debris	Residential and commercial properties with mowed turf grasses or parking lot island landscaping.	Lawn and leaf debris that is blown onto streets or parking lots can be washed into the streams. Decomposition of these materials can reduce oxygen levels in small streams needed to support fish and other aquatic wildlife.
Pesticides and Herbicides		
Phosphorus and Nitrogen	Landscaped commercial, residential and right of way areas managed with fertilizer and pesticide applications. Some detergents can also contain elevated levels of phosphorus.	Elevated levels of phosphorus can lead to algal blooms in lakes and ponds. Nitrogen can require costly treatment practices to be removed from drinking water sources.
Metals		
Zinc, Copper, Lead, Mercury, Cadmium and others	Cars, corroding metal surfaces, industrial uses and combustion processes.	Some toxic doses can cause cancers and impact the nervous system and kidneys of animals and humans. Some metals can also enhance the growth of algae.
Organic Materials		
Animal and pet waste	Open space areas serving as animal habitat. Lawns, parks or other spaces where pet waste is not collected and disposed of properly.	Bacterial decomposition of pet waste can increase --- and decrease oxygen levels in receiving waters.
Bacteria and viruses	Lawns, roads, illicit sanitary sewer connections / leaks / spills, malfunctioning septic systems.	Pathogens that can spread illness through consumption or by contact. Excessive levels can be difficult to remove in drinking water treatment. Elevated bacterial levels can decrease oxygen levels in receiving waters.
Compost, mulch and landscape debris	Lawns and other landscaped areas.	Increases the level of suspended solids in runoff and can deplete oxygen levels in receiving streams.
Oil, Grease and Hydrocarbons	Parking lots, vehicle maintenance areas, gas stations and illegal dumping into storm sewers	Hydrocarbons can be toxic and pollute both surface and ground water. Oil and grease can destroy habitat and sicken or kill many forms of wildlife that are not considered sensitive.
Thermal pollution		
Warmed stormwater runoff	Runoff from parking lots, streets, and roofs exposed to sunlight.	Elevated water temperatures can reduce the diversity of wildlife in urban streams, as many species of insects, plants and fish are sensitive to elevated water temperatures. Higher temperatures can also increase oxygen demand during summer months, potentially leading to fish kills in polluted waters.

The Watersheds of Johnston

Primary Streams and Watersheds

Stormwater runoff from the City of Johnston and its future growth areas ultimately will reach one of three streams:

North Walnut Creek

Certain portions of the City that lie west of NW 100th Street and south of NW 70th Avenue drain generally southwesterly toward this stream. The watershed for this creek has been developed into residential, industrial and commercial uses over the past 20-30 years and encompasses 13 square miles including portions of Grimes, Urbandale and Johnston. North Walnut Creek is a tributary of Walnut Creek, which additionally includes portions of Waukee, Dallas Center, Clive, West Des Moines, Windsor Heights and Des Moines within its 85 square mile watershed. Walnut Creek drains into the Raccoon River in the southwestern part of the City of Des Moines.

Beaver Creek

Photo 8

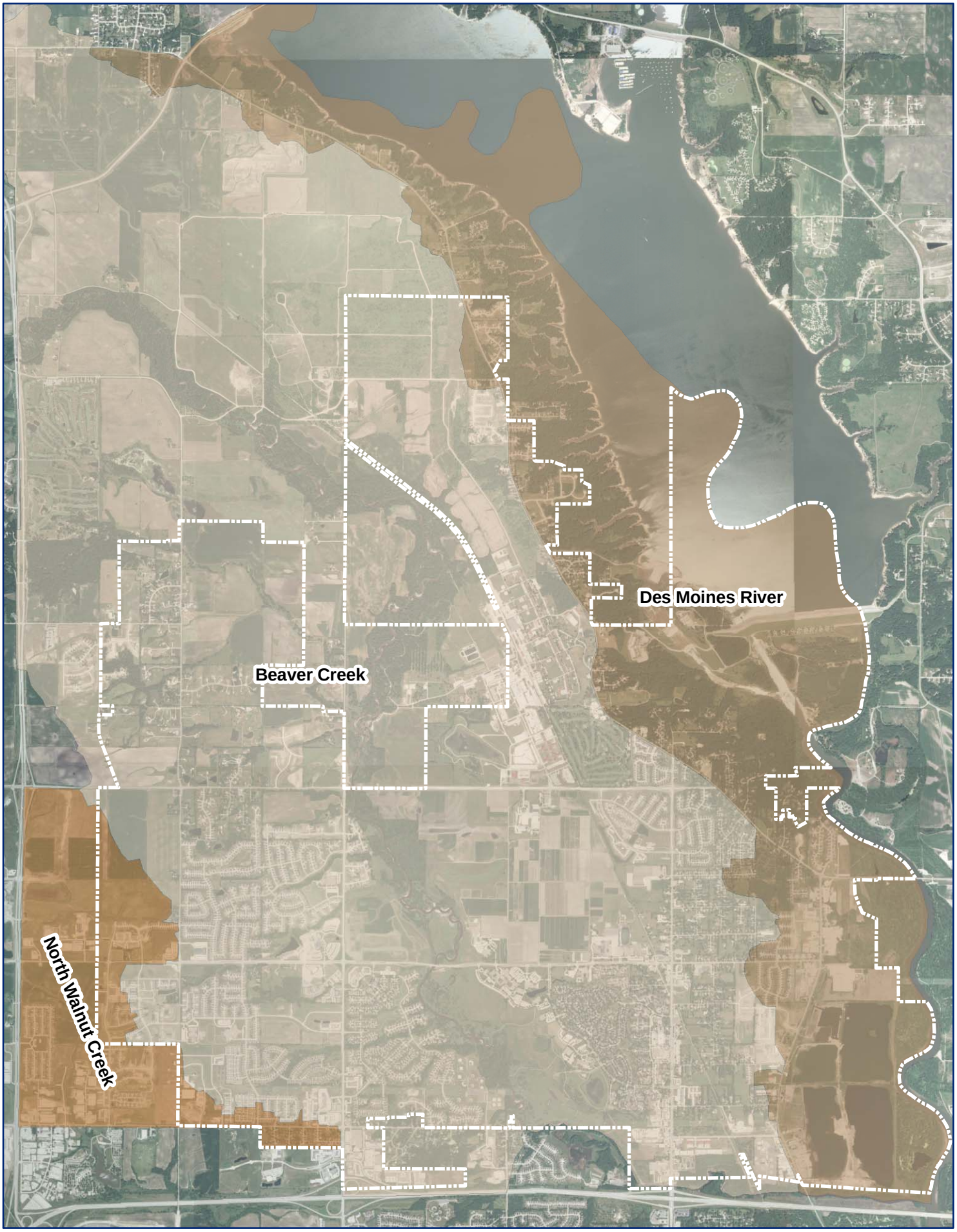
Most of the City falls within the drainage basin of this stream. Beaver Creek begins in southern Webster County running southeasterly to its confluence with the Des Moines River. Included within its watershed are the portions of Webster, Greene, Boone, Dallas and Polk Counties. Agricultural uses make up the vast majority its 372 square mile watershed, although over a dozen small communities also fall within this watershed. Beaver Creek is the State of Iowa's list of impaired waters, and common water quality issues are suspended solids, bacteria and nitrate levels.

Little Beaver Creek is a primary tributary to Beaver Creek. It originates in Grimes, flowing east under Highway 141 toward Beaver Creek. It too has a large agricultural influence, but much of its 13 square mile watershed has been developed over the past two decades. The City of Grimes outfall from its wastewater treatment facility discharges to this stream.

Des Moines River

Photo 9

The Des Moines River Basin is the largest watershed in the State of Iowa. At its confluence with Beaver Creek, its watershed contains over 6,200 square miles, mostly developed into agricultural uses. Saylorville Lake was constructed to the northeast of Johnston and is used primarily for flood control on the river and recreational uses. Des Moines Water Works studies indicate that the lake offers opportunities for settlement and treatment of runoff. Elevated levels of bacteria and nitrates at their intake at MLK Parkway in Des Moines usually correspond to times when a larger proportion of water in the river is from the Beaver Creek watershed. During one such event in April 2007, it was estimated that over 60% of the flow at the 2nd Avenue gauging station in Des Moines came from Beaver Creek. Areas north and east of Beaver Drive in the City of Johnston generally drain directly to either Saylorville Lake or the Des Moines River. The Des Moines River eventually reaches the Mississippi River, where its watershed area has increased to 14,467 square miles, or an area approximately ¼ of the entire land area within State of Iowa.



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Large Scale Watershed Map

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Feet

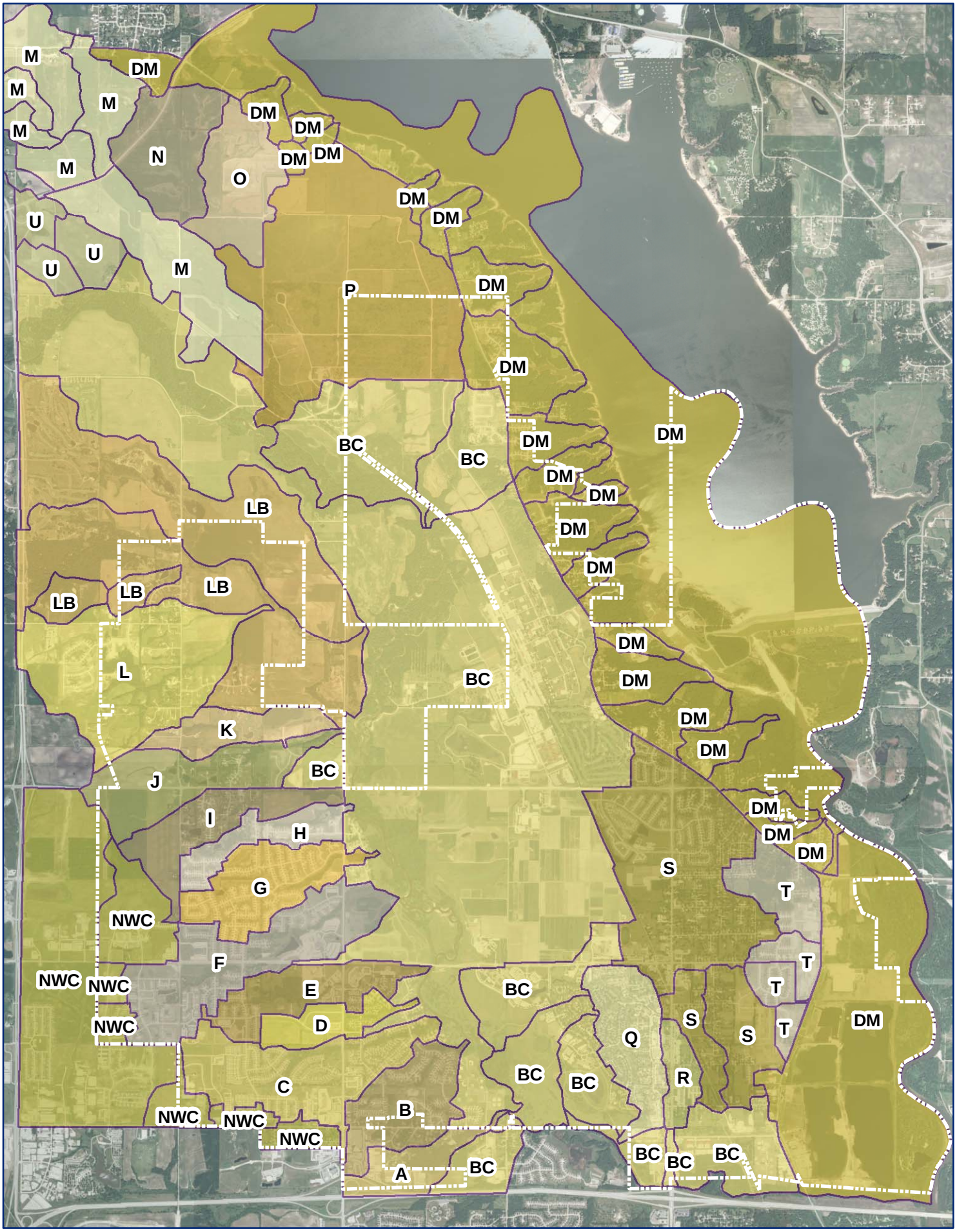
Johnston

Secondary Streams and Sub-watersheds

The City of Johnston can be divided into dozens of smaller drainage areas, or sub-watersheds made up of small streams and local storm sewer networks. A more detailed review of the characteristics and issues identified as part of this assessment are included in the following sections of this report.

	Sub-watershed Name	Drainage Area	Impervious Area %
A	Birchwood	120 acres	26%
B	South Greenmeadows West	229 acres	27%
C	Greenwood / Chambery	380 acres	45%
D	Windsor	106 acres	23%
E	South NW 62nd	201 acres	37%
F	North NW 62nd	422 acres	28%
G	Newgate	246 acres	32%
H	Wooded Point	132 acres	30%
I	South NW 70th	205 acres	8%
J	Central NW 70th	281 acres	7%
K	North NW 70th	140 acres	12%
L	NW 100th / 107th	576 acres	11%
M	Saylorville Road 1	813 acres	2%
N	Saylorville Road 2	252 acres	2%
O	Saylorville Road 3	236 acres	1%
P	North Camp Dodge	1000 acres	1%
Q	Green Meadows	218 acres	44%
R	South Merle Hay	53 acres	49%
S	Central Drainage District	933 acres	36%
T	Beaver Drive	273 acres	31%
U	Highway 141	185 acres	2%
BC	Beaver Creek Floodplain	5253 acres*	15%
DM	Des Moines River Floodplain	4916 acres*	5%
LB	Little Beaver Creek	1497 acres*	5%
NWC	North Walnut Creek	1131 acres*	25%

* Area within planning boundary as shown on map.



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Small Scale Watershed Map

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Citywide Overview

Stormwater "Character Districts"

As part of the development of this assessment, a number of areas within the City with common characteristics related to stormwater were identified. Areas within these "Character Districts" can be grouped together to describe a common list of qualities and the issues that arise from them.

Walnut Creek District

This district includes the extreme southwestern part of the City that lies within the North Walnut Creek basin. The land in this area is gently rolling, with open grassed drainageways free of tree cover. The path of these streams has been straightened by grading for both agricultural and development uses. Primary concerns in this area are preventing an increase of storm water runoff volume as additional development occurs, and the presence of pollutants which are typically carried in runoff from agricultural and urban developed areas. ▶

Photo 10

Western Hills District

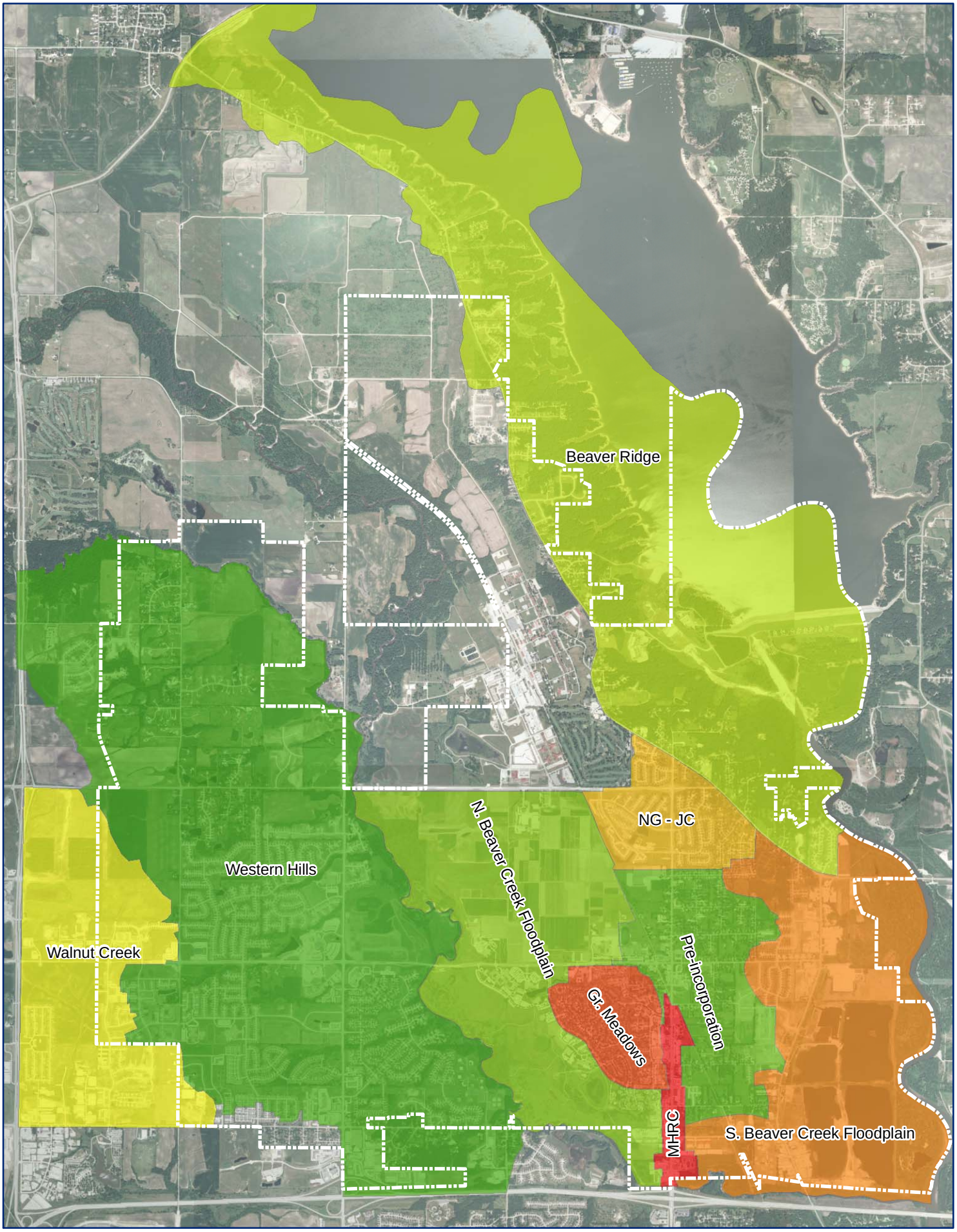
Photo 11

◀

This district makes up the narrow steep watersheds feeding into small urban streams which drain west toward Beaver Creek. The slopes in this area and amount of hard surfaces (roofs, drives, streets, parking lots, etc.) allow rainfall from almost any storm event to be quickly conveyed via gutters, flumes and storm sewers to these small urban streams.

Little area within these watersheds has typically been devoted to stormwater detention, and those that do exist usually have not been installed with outlet controls designed to manage small storm events. Water levels rise and fall rapidly during even small storm events, leading to common streambank erosion, and extremely degraded habitat conditions. There is little opportunity to capture and remove sediments and pollutants present in rainfall runoff before it can be quickly conveyed through these small streams to Beaver Creek. ▶

Photo 12



Character District Map

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Johnston

Northern Beaver Creek Floodplain District

Photo 13

◀

This wide and flat floodplain is primarily used for agricultural uses and recreation. Most areas appear to sheet drain toward the creek, or follow a twisting path along small swales or historic creek meanders before reaching the stream. Key issues along this corridor are the potential for flooding during wet years, protection of jurisdictional wetlands, streambank erosion (especially along portions of Beaver Creek) and continued proper management of agricultural areas to prevent soil loss and nutrient delivery to the creek.

Southern Beaver Creek Floodplain District

Commercial and industrial development has encroached into the floodplain in this area. Although protected by a levee system, this area including outdoor storage areas, concrete and asphalt batch plants and a gravel pit are prone to flooding. Additional flood protection of this area is not possible without increasing the flood risk of other areas upstream. Key issues include stormwater pollution related to outdoor material storage and batch plant operations and the need to drain flooded areas east of Beaver Drive more quickly after a flood event has passed. ▶

Photo 14

Green Meadows District

Photo 15

◀

This residential area was one of the first planned communities in the State of Iowa. Most of this residential community drains to a two-mile long network of concrete flumes. These flumes were originally intended to allow for efficient drainage and to allow for a clean edge along a mowed park greenbelt through the community. After nearly three decades of use, the network has become a maintenance problem for the City Parks Department, with areas prone to sedimentation, ponding and scour. There is also little opportunity to reduce runoff by allowing rainfall to infiltrate into the sandy soils below, or to capture suspended sediments and dissolved pollutants.

Merle Hay Road Corridor District

Commercial properties line Merle Hay Road from just north of NW 62nd Street to the corporate boundary at Beaver Creek. Most of these properties have roofs, drives and parking areas that drain to the storm sewer system along Merle Hay Road. Some of these properties have small detention basins intended to address runoff from large flood events. Most have not been designed with management practices focused on providing water quality or limiting flows from smaller storm events. Many of these sites have flumes or pipes that create directly connected impervious area (DCIA) where water can run from roofs, drives and roads directly into the storm system with no opportunity for runoff volume reduction or treatment. The biggest concerns in this district are quick and easy conveyance of trash, debris and other pollutants through the storm system to receiving waters; and increased rates of runoff during both small and large storm events.

Photo 16

Pre-incorporation District

Photo 17

This area was developed into acreages and larger residential lots, with a network of streets without curb and gutter. Areas north of NW 62nd Street within this district typically do have a network of storm sewers that aid in the drainage of narrow shallow roadside ditches. The southern part of this district generally lacks storm sewer, and rainfall runoff meanders through a series of roadside ditches and depressions and generally soaks into the sandy soils common in this area during smaller storm events. During larger storms, runoff will eventually work its way to a 72" storm sewer trunk line that parallels a recreational trail built on the old Interurban rail grade. Currently, the biggest challenges within this area are a series of small nuisance and conveyance issues and small pockets of shallow flooding. There are opportunities for infill and redevelopment in some areas of this district. A future challenge within this area is providing for development without altering the natural hydrology yet still providing for the safe conveyance of stormwater.

North Glenn – Johnston Commons District ►

Photo 18

This residential area has developed on the moderate slopes on the southwest side of Beaver Drive. These neighborhoods developed with curb and gutter streets and a storm sewer network that drains to a straight graded swale running east to west under Merle Hay Road. Eventually drainage from this area reaches a concrete flume running along the east side of the Johnston High School campus until it reaches a large intake structure at the upper end of the 72" storm sewer which follows the old interurban grade. Areas west of Merle Hay Road have been developed with stormwater detention ponds intended to address runoff from large flood events. Key issues in this district is ongoing maintenance issues along the swale along the southern edge of the North Glenn neighborhood, and rapid flows observed within the concrete flume during large rainfall events.

Beaver Ridge District ►

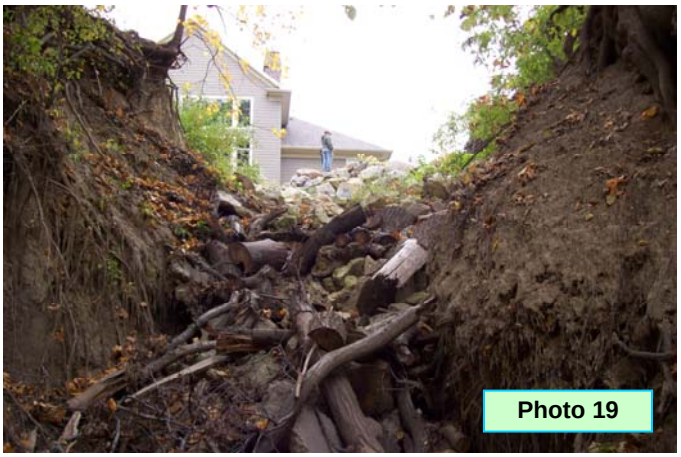


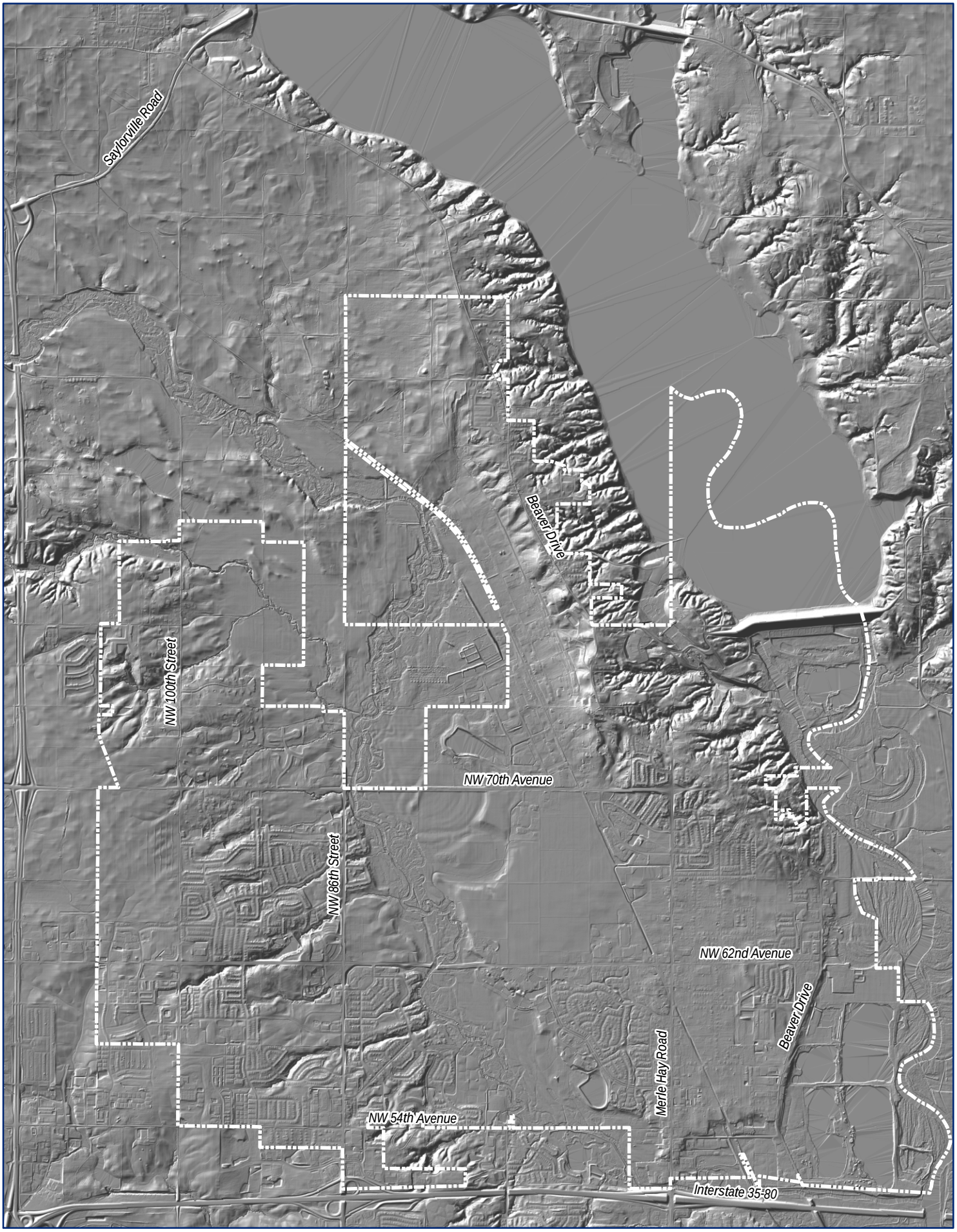
Photo 19

North of NW 66th Avenue, the terrain on the east side of Beaver Drive is made up of timbered tall bluffs and narrow, steep ravines. Large lot residential properties have developed in this area. Some erosion and conveyance issues have developed in the ravines downstream of outlets from some of these developments. Key issues in this area are addressing unstable storm outlets, preserving sensitive slopes and wooded areas, and managing erosion and sediment within the ravines leading to Saylorville Lake.

Photo 20

◄ *Future North Development Area*

Although not yet within the City limits, and not designated as a character district as part of this study, it is important to understand the unique features of the area north of Camp Dodge along Saylorville Road. Primarily developed into agricultural uses, the grade is generally flat to gently rolling. Most drainageways are broad, unchannelized paths, usually protected by grass buffer strips. Most of these strips have been kept relatively clear of trees and other brush, allowing sunlight levels that sustain these deep rooted grasses which reduce the potential for erosion.



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Hillshade 1-meter LIDAR

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Feet

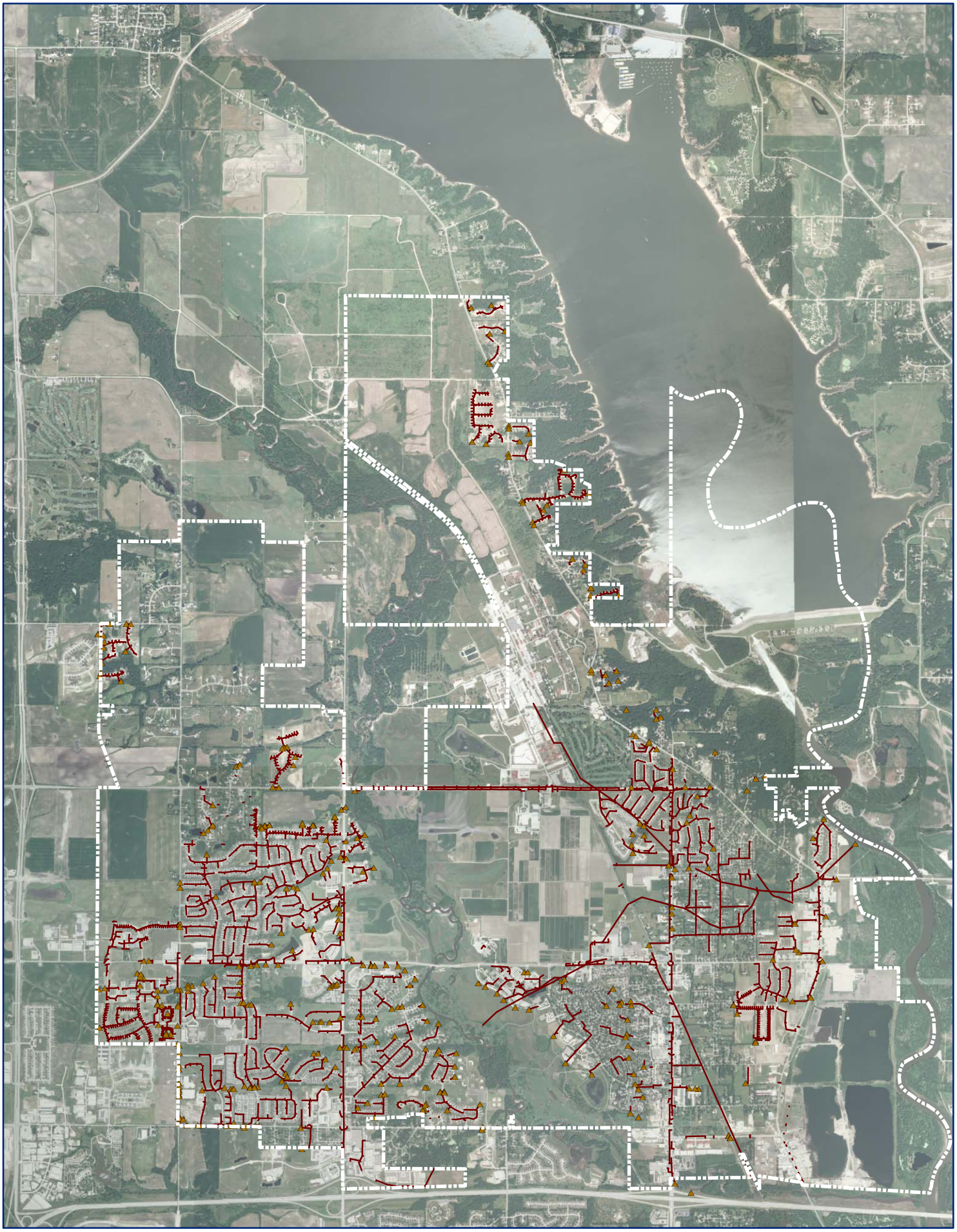
Existing Storm Sewer Infrastructure

Most of the storm sewer infrastructure within the City is relatively new, and designed with proper capacity to convey typical storm events (10-yr storm or less). The largest issue identified as part of this assessment is the potential damage to the system that could be caused by erosion downstream of storm sewer outfalls, either near downcutting stream channels or downstream of storm outlets discharging near the top of a steep grade. Some outfalls may require additional protection or other enhancements to address these issues. Some other issues regarding the system are important to highlight:

- Older developed portions of the City located east of Merle Hay Road are designed with rural street sections with shallow ditches, or with undersized storm sewers. Most of these areas have soils with good infiltration capability, but there are some areas that do not have adequate paths for large storm conveyance or are prone to standing water during periods of wet weather. As redevelopment occurs in some of these areas, a balance will need to maintained to preserve the natural hydrology of the area, while providing for safe conveyance of large storms.
- Areas immediately north of Dewey Park have reportedly experienced high flows from adjacent agricultural areas and street flooding during large events. It is believed that the storm sewer from this area discharges to the old Camp Dodge tile outlet which drains to the Des Moines River. This line may be surcharged during large events, not allowing these areas to be effectively drained.

- Erosion at the inlet of a corrugated metal culvert at the intersection of NW 54th Avenue and NW 100th Street is undercutting the edge of the pavement (see photo at right).

- Downstream of a 36” pipe outlet at the top of this slope, storm flow has washed away large revetment stone and fabric underlay designed to stabilize this portion of a steep channel, formed after installation of the pipe.



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Storm Sewer Network

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Feet

Johnston

Flooding and Floodplain Development Issues

With the City being bisected by Beaver Creek, and being so close to its confluence with the Des Moines River, flooding and related issues are a significant concern. The most recent large flood events occurred in the late spring and early summers of 2008 and 1993. These flood events, along with available FEMA maps provide a baseline record to determine which properties within the City are most affected by the possibility of flooding.

With the 2008 floods, the City was able to use LIDAR topographic information, and flood crest information from the USGS to determine which properties were most likely to be affected during that event. The recent release of higher quality LIDAR information from the State of Iowa will make it likely that this process can be repeated even more effectively in the future.

The floodplain area of Beaver Creek has largely been managed effectively as development has occurred. As development spread to the west side of Beaver Creek during the 1990s, the floodplain corridor has largely been reserved from development. The floodplain itself has been reserved for open spaces, parks, and agricultural uses. Some residential lots have been platted near the floodplain in the Green Meadows West and Augustine developments, but no structures have been allowed to be constructed within the flood fringe areas.

Map Legend (For all Floodplain Development Maps)

Area within 100-year Floodplain – according to current FIRM maps:
These areas have a chance of being flooded in a given year of 1% or more. Some individual structures that have flood protection provisions, or were elevated above the flood elevation by fill may have been removed from this zone by a Letter of Map Amendment, which may not be reflected on the current FEMA Flood Insurance Rate Maps (FIRM).

Area within 500-year Floodplain – according to current FIRM maps:
These areas have a chance of being flooded in a given year of between 0.2% and 1%. Some individual structures that have flood protection provisions, or were elevated above the flood elevation by fill may have been removed from this zone by a Letter of Map Amendment, which may not be reflected on the current FEMA Flood Insurance Rate Maps (FIRM).

Structures within Flood Zones:
These structures either have been impacted by recent flood events, or are indicated to have the potential to be impacted according to the current flood rate maps. (These are not indicated on the Citywide map, but are shown on the local inset maps that follow)

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Floodplain Development

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Feet

Johnston

There are some commercial properties along Merle Hay Road near Beaver Creek which have been impacted by flooding, usually requiring some degree of protection (sandbagging, etc.) during large flood events. Along Johnston Drive, there were storage units and a commercial building that were affected by the 2008 flood event as well.

The properties within the City that are most often affected by flooding, are those located near the confluence of Beaver Creek and the Des Moines River. These properties are located along Beaver Drive, just north of the interstate and south of the alignment of Johnston Drive. These properties are protected by a system of levees along Beaver Creek, but these levees are not effective at preventing flooding of these areas during the largest flood events.

Photo 24

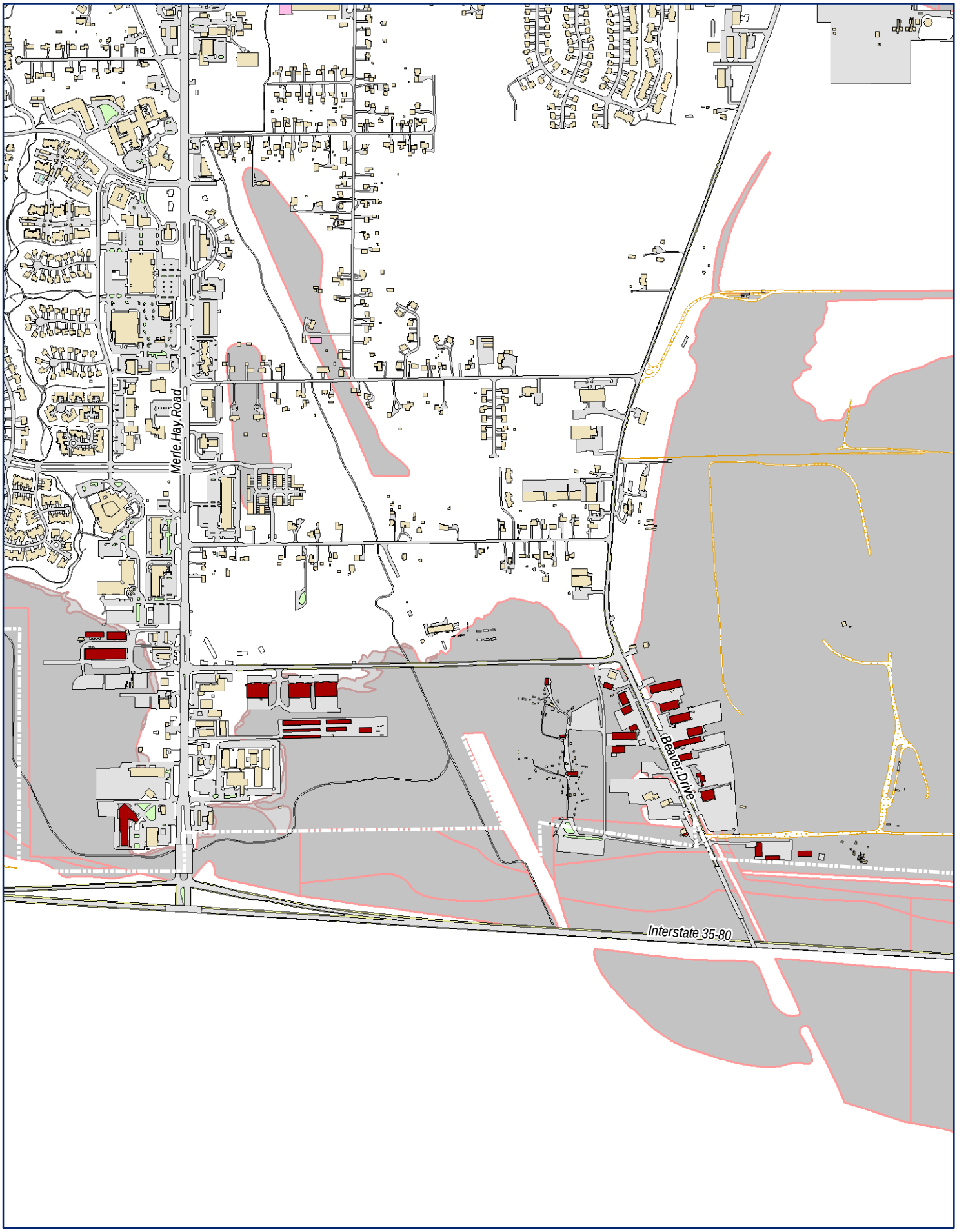
Photo 25

Levees west of Beaver Drive are lower than those on the east side of Beaver Drive. Floodwaters will often enter these areas first and will eventually will overtop Beaver Drive and flood the areas on the east side of the road. The levee system cannot be improved to protect these areas, as there are concerns that this could raise expected upstream flood elevations that could lead to residential properties being compromised.

The 2008 flood event impacted commercial buildings and flooded outdoor storage areas for sand, gravel and asphalt millings. Some of these materials and other site equipment were washed away with the floodwaters. After the flood event had passed, it took weeks to get water levels to fall to a level where access was available to all buildings and work sites within the flooded area.

There is a system of pipes with the levee that were intended to allow this area to drain out after a flood event had passed. These pipes were constructed with flapgates at the outlet for flood prevention. Their ability to drain this area is limited, as they were set at an elevation that is too high to drain lower areas which provide access to a number of buildings and sites around the gravel pit area. The City is currently reviewing a plan with the Iowa Department of Transportation to install a new storm outlet for this area, controlled by a sluice gate, which would allow it to be more quickly drained after a flooding has receded.

Photo 26



Floodplain Development - Lower Beaver Inset

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0 250 500 1,000 1,500 2,000 Feet

Johnston

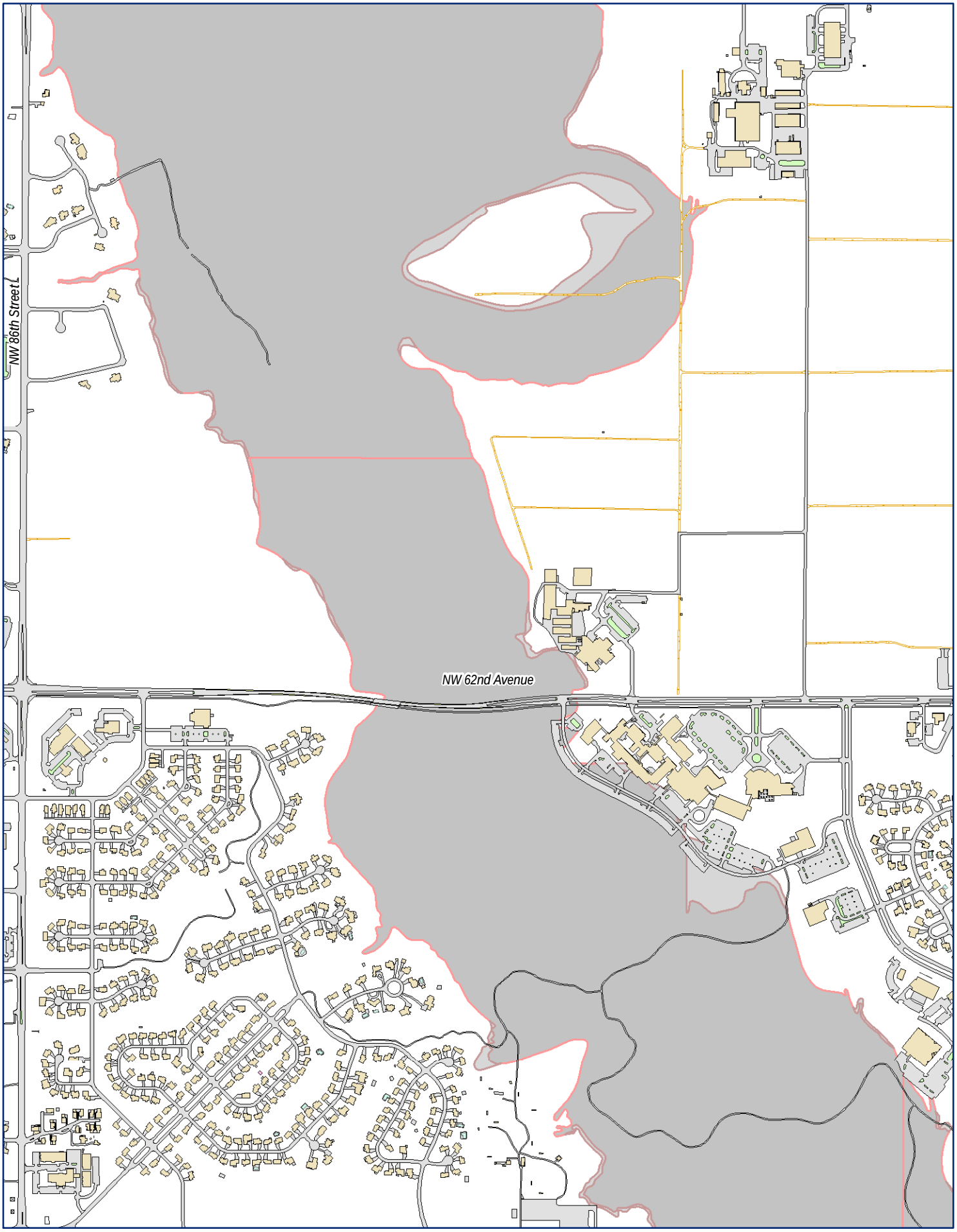
Some structures within the Green Meadows and Green Meadows West (blue dash outline in photo) developments have been constructed relatively close to, but outside of the areas designated with flood risk. Some of these properties could be impacted by extremely rare flood events (larger than a 500-year flood event). Improvements to raise levees downstream to protect areas along Beaver Drive are not possible due to concerns that upstream flood elevations along this corridor could be raised, putting existing homes and businesses at risk.

Unstable Cut Banks

Evidence of Past Stream Meanders

Meander Section Being Lost

▲ The photo above looks south along the Beaver Creek floodplain, near NW 62nd Avenue (bridge in photo).
The meandering nature of the stream can be seen in detail.
Tall, vertical banks are present throughout this area, many of which are actively moving.
Surface vegetation gives indications of where the stream bed used to be many years ago.
A meandered section is being lost where bank erosion is occurring between channel bends.



Floodplain Development - NW 62nd Ave. Inset

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Feet

Johnston

Stormwater Hotspots

Photo 28

Hotspots are locations or land uses which have the potential to allow much higher amounts of a particular pollutant to be washed off the site, or infiltrated into the groundwater during rain events. To protect the water quality of streams and aquifers, it is important to identify and locate such uses and develop management plans to reduce or prevent the release of such pollutants.

Residential and Commercial Lawns and Landscaped Areas

Lawns and landscaped areas (especially those managed with irrigation and fertilizer/pesticide applications) can generate significant levels of suspended solids (lawn clippings, washed off mulch), phosphorous and nitrogen from fertilizer applications, and bacteria from pet waste and the decomposition of mowed or trimmed landscaping materials. Pollution levels can be highest where these clippings or waste are easily blown or washed onto paved surfaces where they can be washed into the storm sewer system.

Active Construction Sites

Construction sites can generate tons of sediment per acre each year. This sediment typically other pollutants such as pesticides, oils and other hazardous chemicals to easily bind with suspended particles and be easily carried to receiving waters. Pollution levels can be highest where appropriate sediment and erosion controls are not implemented, where stabilization by seeding or sodding is delayed, or where off-site tracking occurs.

Large Commercial and Industrial Parking Lots ●

Stormwater runoff form large parking lots can contain chemicals leaked from car and truck engines and exhaust, oil and grease, and metals such as lead, zinc and copper. Pollution levels can be highest where paved parking surfaces directly drain to paved flumes or storm sewers, allowing for minimal opportunity for these pollutants to be captured and removed from runoff before leaving the site.

Outdoor Storage Areas ●

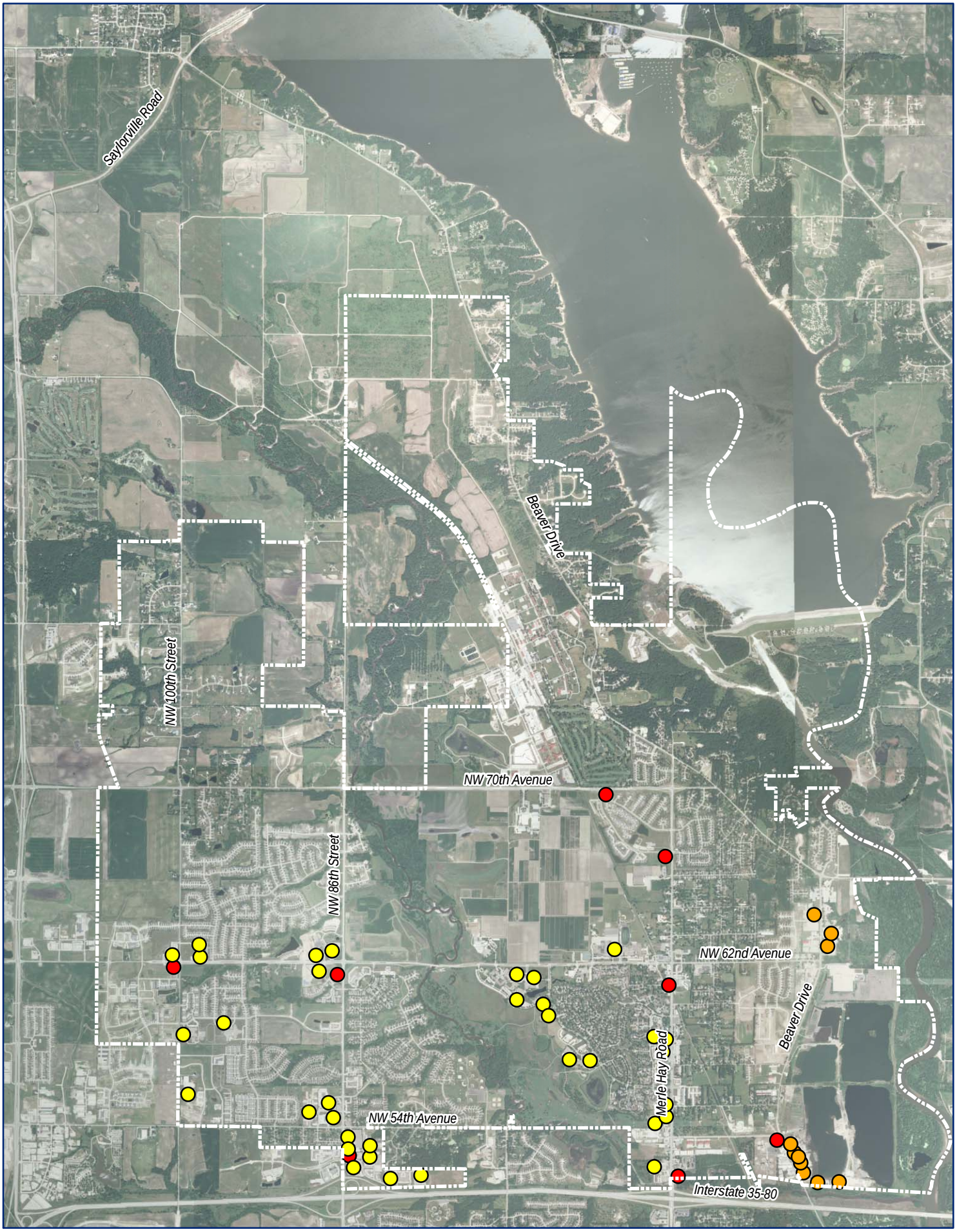
Photo 29

Outdoor material storage will expose uncovered stored chemicals, sands, gravels, and other materials to rainfall. Significant amounts of these materials can be washed across parking or access areas into the adjacent storm sewers, ditches or receiving waters. Pollution levels can be highest where materials are left uncovered and not effectively contained or managed to prevent washoff during rainfall events.

Gas Stations ●

Photo 30

Fuels, oil, grease and various metals can be significant in runoff from these sites. Fuels can pollute both surface runoff and also infiltrate and pollute groundwater. Pollution levels can be reduced by providing pre-treatment of stormwater runoff in a system designed to remove suspended fuels, oil and grease. These systems should be employed before stormwater runoff is discharged to either other BMPs (especially infiltration practices such as bioretention, raingardens, etc.) or the storm sewer network.



Hotspot Location Map

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Johnston

Existing Detention Facilities

As part of the scope of this study, detailed site visits were completed for 62 detention facilities within the City. Nearly all of basins reviewed were small management practices intended to address runoff from large storm events for an individual site, or a group of small sites within a common development. During these visits, photographs were taken and detailed site sketches prepared. One goal of this review was to identify any specific construction, pollution or maintenance issues that may need to be considered as part of the overall stormwater management program for the City. Another goal was to look for common issues and trends that could have a larger impact on the watersheds of the City.

Overview of Structural Detention Controls Employed

Based on a review of available design calculations and information gathered during site visits, all of the basins reviewed appear to be intended to address primarily large, infrequent storm events to prevent the surcharge of the local storm sewer network and prevent flooding. Very few of the facilities reviewed had any type of best management practices (BMPs) incorporated into the final construction to address water quality or control runoff from small storm events. Only two of the 62 basins visited had any kind of multi-stage outlet control.

Multi-stage outlet control devices allow for a slow draw down of captured rainwater during smaller storm events, while having second or third stages that allow water to be release more quickly during larger rain events. This slow drawdown of smaller events reduces the rapid rise and fall of water levels in urban streams, reducing erosion and providing a more steady base flow between storm events. It also allows enough time for suspended pollutants to settle out or be absorbed within the treatment area before they can be washed into the receiving stream. In addition to the lack of multi-stage control, most of the basins visited appeared to be lacking orifice plates or other control devices that were designed to control flow rates during the larger storm events the basins were actually designed to address.

Another structural concern is how water is intended to pass through many of these basins:

- **Passive detention** systems route water directly from hard surfaces to the storm sewer network without allowing any kind of flow surface flow within the basin itself. This type of construction relies on a restriction in the pipe (small orifice or pipe, etc.) to cause water to back up, causing ponding in stormwater basins during large events.
    - **The intent:** To keep the basins relatively dry and easy to maintain between large rain events.
    - **Water quality impact:** Runoff has little or no opportunity to pass over landscaped areas where water can be treated and pollutants captured before leaving the site. In most cases, small storms pass easily through the pipe network and never enter the detention area. If the specified restriction was not installed, even large storms can be allowed to easily pass into the storm network.

Photo 31

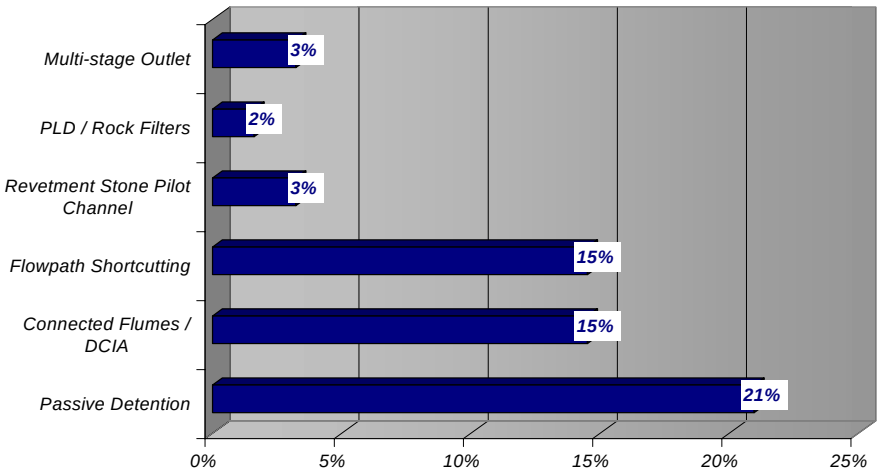
- **Low Flow Flumes and/or Directly Connected Impervious Areas (DCIA).** Basins are often constructed with a pilot channel or other means that allows runoff to pass to the outlet entirely over paved surfaces.
    - **The intent:** To allow turf-grasses bottoms to remain dry and easy to mow and to prevent ponding or standing water in channels with little slope.
    - **Water quality impact:** No opportunity is provided for the reduction of runoff volumes by infiltration, or to capture or treat runoff before it leaves the site. Sediment, landscape debris and trash can easily be transported downstream. Often, these flumes become a maintenance issue themselves, prone to settlement, cracking and edge scour. Ponding can occur in low slope areas, providing prime habitat for mosquito breeding; along with the growth of algae and moss.

Photo 32

- **Flowpath Shortcutting.** Basins sometimes are constructed with their inlets and outlets located very close together, allowing runoff to leave the site without passing through a large part of the detention facility.
    - **The intent:** Usually a function of site utility layout and grading. Some designs could be planned this way to keep larger portions of the basins dry and easier to maintain.
    - **Water quality impact:** Especially during smaller storm events, water runs quickly in and out of the basin, and pollutants cannot be effectively captured before they leave the site.

Photo 33

These types of design practices have been employed in 50% of the basins observed. The largest concern is how runoff from small storms is addressed in these measures. With even the smallest storms, runoff will be generated from these sites. Since their outlets are not designed to slowly release such events, small storm runoff passes through these systems virtually without restriction, contributing to the rapid rise and fall that is likely observed in each urban stream during smaller storm events. By contrast, less than 10% of the detention sites visited employed either best management practices designed to capture, treat and infiltrate runoff from small storm events, or to gradually release runoff from such events.



Types of Stormwater Basins Reviewed

There were a variety of practices within the City that have been used to manage stormwater.

Photo 34

- **Dry bottom detention basins with managed turf lawn cover** are the most common practice employed throughout the city (39%).
  - **The intent:** To provide stormwater volume (or quantity) storage for large storm events while providing an attractive, useable open space landscaped area.
  - **Water quality impact:** Under the guidelines of the Iowa Stormwater Management Manual, these systems are not allowed to be considered for water quality treatment, as their design usually allows for little ability to capture and treat runoff from small storm event. Turf grasses often cannot be sustained in areas that are routinely wet for extended periods after rainfall events. Infiltration is usually hampered by subsurface soils that have been compacted by large grading equipment during construction, and insufficient amounts of topsoil are often replaced prior to final seeding or sodding. Lawn clippings, leaf debris, fertilizers and pesticides can easily be washed from these areas into the receiving storm sewer or stream.

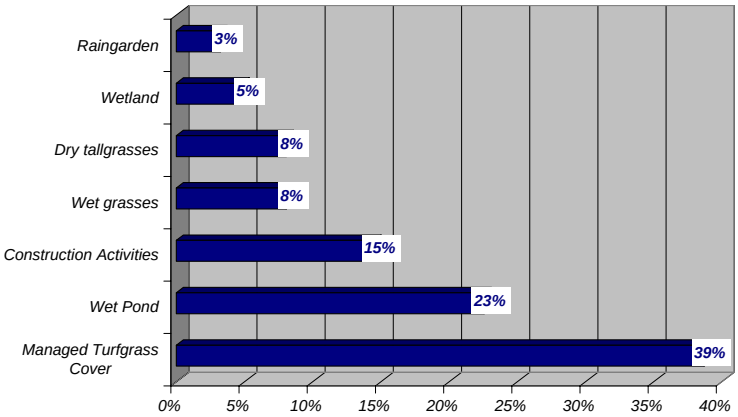
- **Wet ponds** can be employed as an aesthetic landscape feature and also provide for water quality treatment. They make up almost one-quarter of the sites observed as part of this assessment.
  - **The intent:** Usually intended to provide stormwater quantity storage for large storm event in an area that can be accented by boulders, waterfalls, fountains or other landscape features.
  - **Water quality impact:** These systems can be quite effective if paired with areas or devices intended to provide a level of pre-treatment of runoff before it can enter these areas. Pre-treatment systems can intercept trash, lawn and landscape debris and heavier sediments before they can be washed into the pond. Wet ponds are more effective when designed with enough pool storage to capture and treat runoff from small storms, and a multi-stage outlet is provided to slowly release runoff from these events over a 24-hour period. The water quality benefits of these areas are severely limited when these design elements are lacking. None of the 14 wet ponds observed employed any of the water quality design features highlighted in the new Iowa Stormwater Management Manual to any effective level.

Photo 35

- **Bioretention areas and raingardens** can be dry or wet systems that employ combinations of native deep-rooted plants, loosely compacted (sometimes enhanced) soils, and subsurface drainage to enhance the treatment and infiltration potential of open spaces to capture and treat runoff from smaller storm events. Combined these practices have been employed in about 20% of the sites that were reviewed by this assessment.
  - **The intent:** These are typically designed as landscape features within depressional open spaces using native grasses and flowers capable of absorbing larger amounts of water and providing for improved soil structure and infiltration. These can be coupled with practices to provide stormwater quantity storage for large storm events.
  - **Water quality impact:** These areas have a much higher ability to capture and treat runoff, especially from small storms. They can be quite effective at the removal of suspended sediments, metals, bacteria, oils and grease.

Photo 36

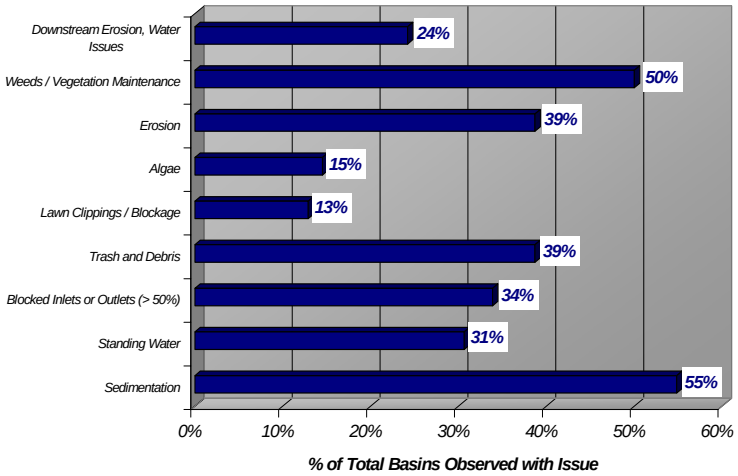
It should be noted that nine of the 62 sites (15%) reviewed as part of this study were in some state of construction at the time of review, which did not allow them to be properly categorized at this time.



Common Maintenance Issues Observed

The way stormwater management areas are maintained and operated can be just as important as their design when reviewing potential impairments to water quality or proper flood management. Common issues observed were:

- **Minor or major amounts of sediment deposition** washed from site areas into the basins.
- **Erosion** near inlets to the basin, along the flowpath through the basin, or scour along the sides or ends of flumes.
- **Weeds or other vegetation management issues** making it difficult to identify and remove collected debris, sediment or other pollutants.
- **Presence of trash and debris**, such as bottles, cans, other litter and large landscape debris.
- **Inlets or Outlets significantly blocked or buried** causing them not to work as designed.
- **Standing Water** in the bottom of the basins or near blocked outlets.
- **Downstream erosion or other water conveyance issues** either in the form of undercut outlet structures, channel erosion and incision and concentration of flows through downstream agricultural or open space areas.
- **Algae** growth either in wet ponds or areas with significant standing water.
- **Inlet or Outlets blocked by lawn or other small landscape debris** which indicate large amount of these could have been passed into the receiving system during other storm events.



These issues indicate that many existing facilities are poorly maintained and require attention to function as originally intended.

Detailed Assessments

Urban Small Stream Corridors

As part of this study, field assessments were conducted of 25 miles of urban streams using the Iowa Department of Natural Resources' RASCAL protocol (Rapid Assessment of Stream Conditions along Length). This involved two person teams walking each corridor with a digital camera and a handheld GPS device to locate and document observed conditions.

In many areas of the country, water quality and management issues have taken on greater importance when a vital natural resource that was easily recognized by the public became impaired. In Maryland and Delaware, the quality of the water in Chesapeake Bay was impaired to the level that it created a dead zone, killing fish and other aquatic wildlife; drastically impairing the fishing industry. In Minnesota, tainted runoff began to impact their network of wetlands, streams and lakes which were a vital natural resource for public recreation and tourism.

In Iowa, we have lacked that one thing that clearly identifies the result of how stormwater has historically been managed in our state. Through shielded from view from most of the public, urban streams may best indicate the outcome of the water quality issues in our urban areas.

Too numerous to list in great detail, a list of common issues were observed:

- **Excessive streambank and channel erosion.** Unstable streambanks can pose a safety hazard, and deliver considerable sediment loads downstream as the erosion continues. Eventually they can undercut large trees, recreational trails, public utility lines and structures; and potentially even endanger private building structures and public streets.
- **Large trash, debris and log-jams.** Large trash and debris such as car parts, construction waste and other items can be a source of metal and other chemical pollution. Undercut large trees, dumped timber and large yard waste can create large jams which can impede flows during large events. This can create flooding issues upstream and magnify the potential for bank scour in the immediate area.
- **Threatened, undermined, exposed or damaged public and private improvements.** Storm sewer outfalls, sanitary manholes, trunk sewers and other utilities can be exposed and dislocated by erosion. In some cases, manholes once buried to the rim had been exposed by as much as 8-10 feet. Eventually the integrity of these utilities could become compromised leading to large spills and additional utility damage.
- **Overgrown, unmanaged timbered areas some with invasive species.** Overgrown timbered areas prevent sunlight from reaching the surface to a point where deep-rooted erosion resistant grasses and flowers can't be maintained. The banks in these areas are usually completely without protection from the erosive force of running water. Thick brush and undergrowth also can make it difficult to access the stream corridors to monitor known impairments or conduct necessary maintenance before a larger issue is created.
- **Impaired or greatly diminished habitat for a balanced array of wildlife.** The habitat in many urban streams is severely degraded, only allowing for the most hearty and invasive species to thrive. As habitat for competition and predators is lost, the least sensitive species (like mosquitoes) tend to flourish.

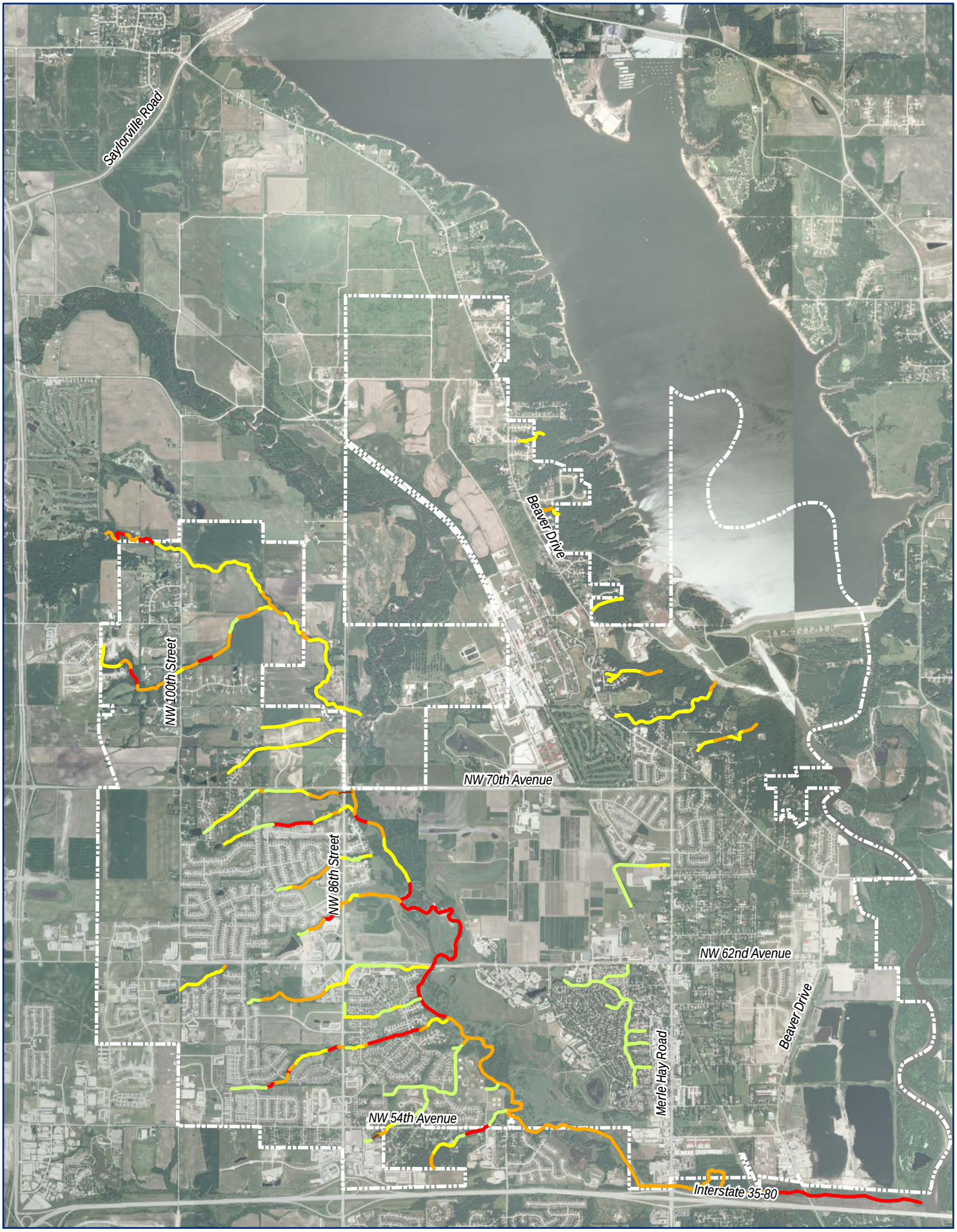
Map Legend

Stable: Banks are protected by natural vegetation and are not showing signs of lateral erosion.

Moderately Stable: Banks are mostly protected by natural vegetation; the bank is showing some signs of minor erosion.

Moderately Unstable: Natural vegetation is not protecting major portions of the stream, outside banks are showing signs of erosion, some signs of tress and/or vegetation falling into stream.

Unstable: Some straight reaches & inside bends are actively eroding, as well as outside bends. Trees, vegetation have fallen into stream and little natural vegetation is protecting the banks.



RASCAL Streambank Stability Rating

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0 1,000 2,000 4,000 6,000 8,000 Feet

Johnston

Excessive Streambank and Channel Erosion

Photo 38

◄ Channel downcutting extending into a tallgrass area from a large wooded ravine downstream. Overtime, this downcutting will work its way upstream, like a zipper, cutting a deeper and wider channel capable of conveying larger flows.

Photo 39

◄ The large tree to the left is being undercut by the adjacent stream. Overtime the root structure will not be able to hold the tree, and it will fall over into the stream, potentially creating a log jam or damaging other trees or property nearby.

► Channel incision is occurring here, downstream of a commercial development with on-site detention. Larger volumes and flowrates from both small and large storms slowly scour away at the edges of this narrow channel. The roots exposed at the side indicate recent erosion, likely from repeated scour from a series of small storm events.

Photo 40

The eroded bank to the right has a nearly vertical face and is around 20 feet tall. Trees at the top of the slope are being undercut, and their roots are hanging free. The sides of the slope are relatively clean, and the elevation difference between the toe of the slope to the flowline of the stream indicates some of this erosion likely occurred quite rapidly during a large rain event.

Downcutting has created a waterfall about 9 feet in height in this area. This area is at the downstream end of an area known as “aggredation” where sediment has been deposited in the natural channel over time from agricultural or land development activities. This creates a large dam where the stream channel will meander and change courses frequently (perhaps with even a single rain event). An older chute-like stream channel with a very steep grade was slowly being diverted to this downcut streambed in this location. This downcutting is likely to continue upstream over time. Eventually it could impact residential rear yard areas and accessory structures located upstream.

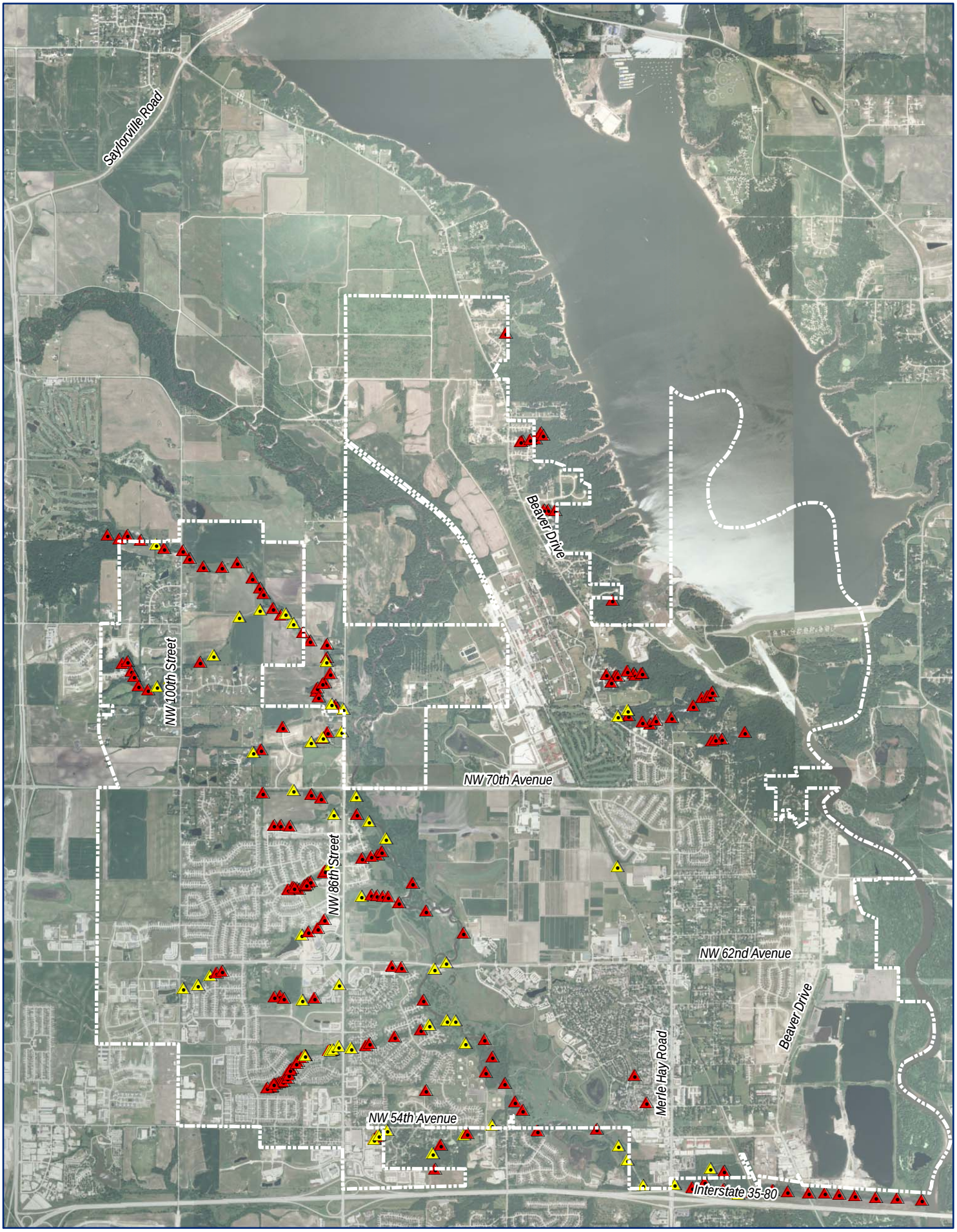
◄ At this location, clear groundwater seeps out through cracks in eroded shale in the wall of a deeply incised creekbed.

► A tall steep bank (10-12 feet high) is seen here where small trees above are being undercut. Their roots can be seen dangling from the top of the slope.

Map Legend

Area of Moderately Severe Erosion:
Alternating bends and outer banks eroded with cut bank heights of at least 6 feet, or both banks eroded with cut bank heights of at least 3 feet.

Area of Severe Erosion:
Alternating bends and outer banks eroded with cut bank heights of at least 10 feet, or both banks eroded with cut bank heights of at least 6 feet.



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Streambank Erosion

0 1,000 2,000 4,000 6,000 8,000 Feet

Johnston

Large trash, debris and log-jams

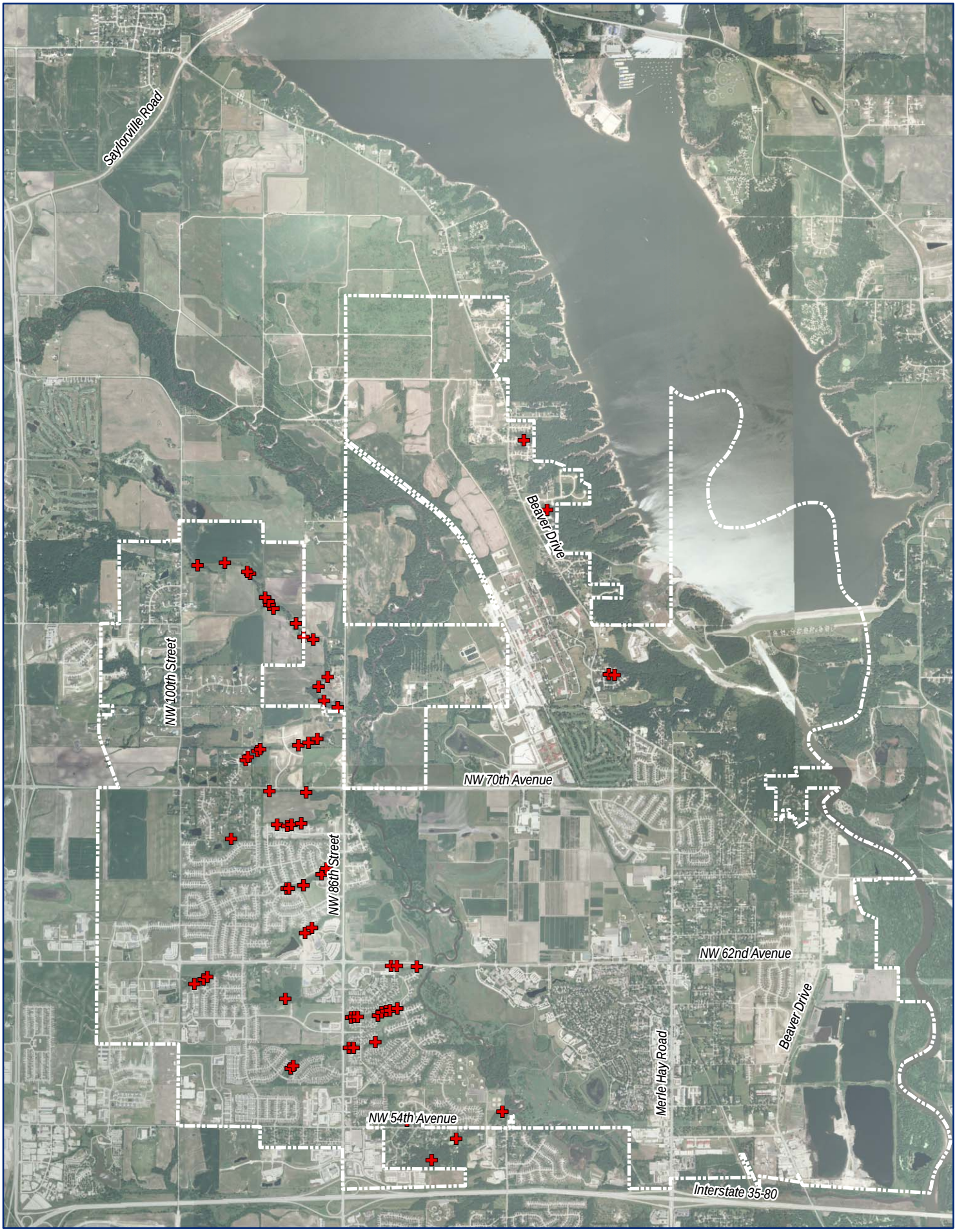
Large woody debris has become trapped around small trees in this area, creating small dams. This is allowing the stream to meander and establish a new drainage path through this area. ▶

Large dead trees have created a 5 foot tall dam in this location, in a stream running parallel to Newgate Drive. ▶

◀ This stream, which runs through Green Meadows West; is deep, narrow and overgrown. It is filled with log jams, undercut trees, and other large debris such as the sink shown.

Map Legend

+ *Location of Log-jam, Rubble or Other Large Debris*



Log Jams and Debris

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0 1,000 2,000 4,000 6,000 8,000 Feet

Johnston

Here are examples of storm sewer outlets that have been impacted by channel erosion. The one to the right is a 30" RCP flared end section, whose footing has been undermined and is now located about six feet above the downstream channel. This outlet leads to a steep, overgrown incised channel cut about nine feet deep and only being about 10 feet wide at the top. ▶

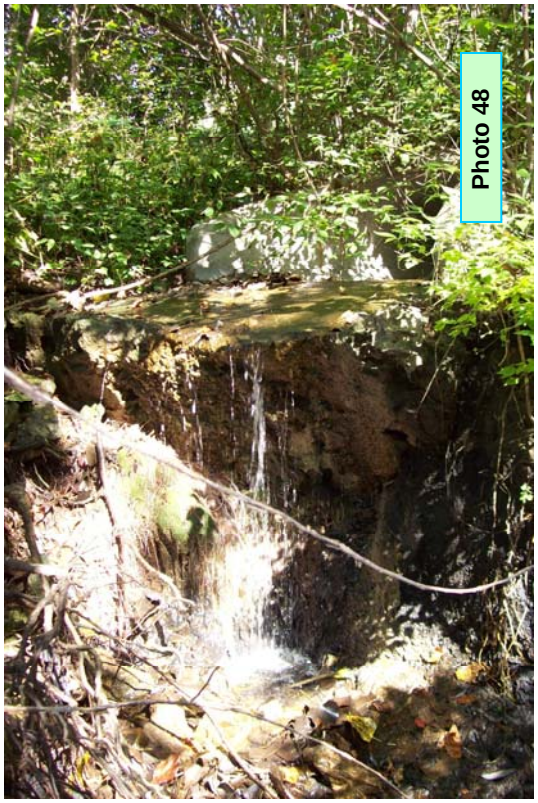


Photo 48

Below is a storm outlet whose footing has been broken off and is undercut by about four feet by the stream running from right to left by the pipe. Eventually this end section could be completely displaced by the passing stream flows.
▼

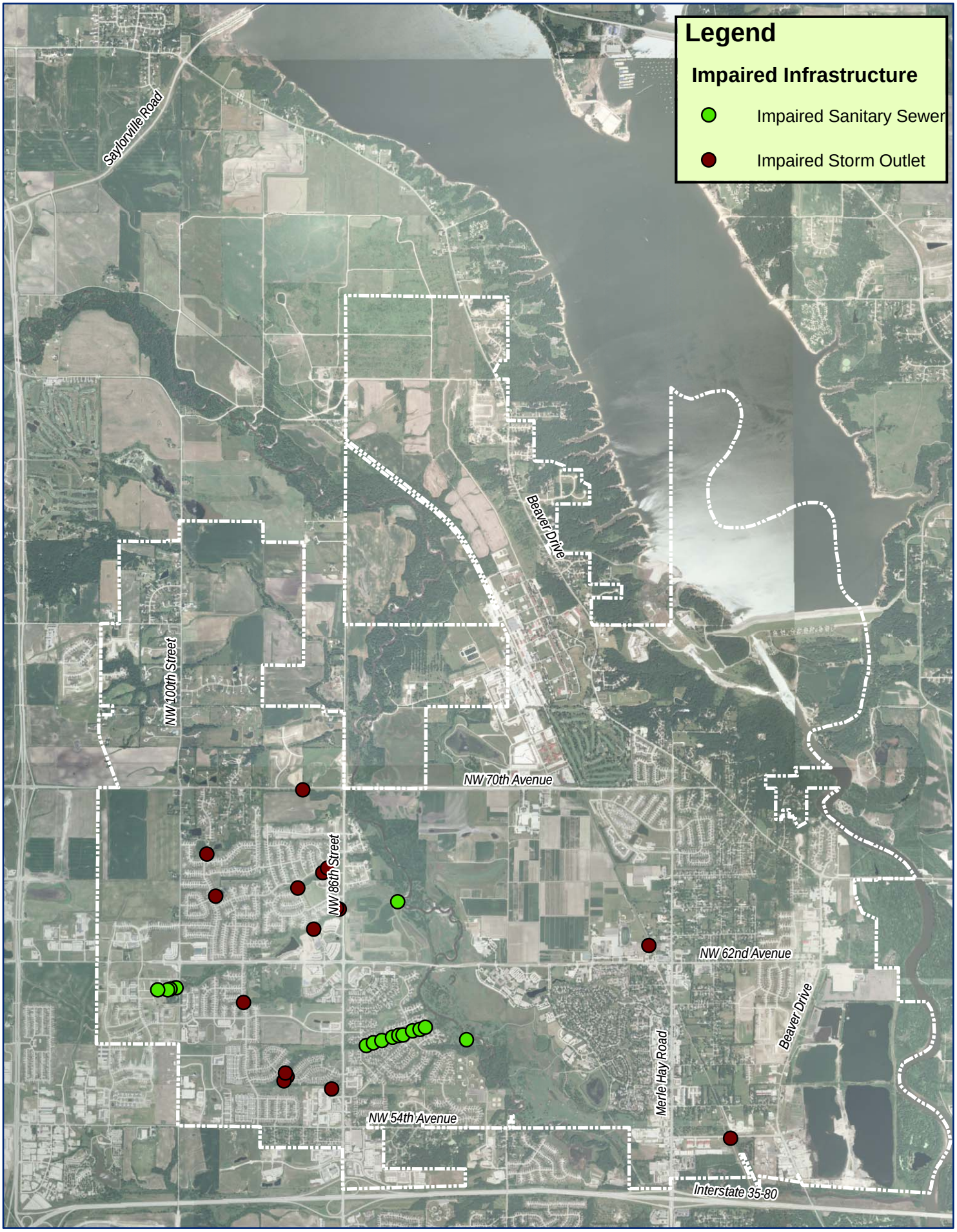
Photo 49

A large sanitary sewer, once protected by revetment stone has been exposed by scour from increased flow volume from both small and large storm events. This sanitary sewer provides service to almost all developed areas west of Beaver Creek.
▼

Photo 50

Photo 51

The sanitary manhole to the right is located within the Green Meadows West development and has been exposed nearly eight feet from the rim to the creek below. Other exposed manholes along this corridor were observed, exposed 4-6 feet in height. ▶



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Impaired Infrastructure

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Overgrown, unmanaged timbered areas some with invasive species

This area is overgrown, preventing sunlight from reaching the surface. Only small weeds are able to surface on the floor of the ravine. The stream itself is only visible from a few feet away for many of the spring and summer months. Dumping and debris cannot easily be witnessed, and ongoing erosion issues are not able to be identified before they become a larger issue.

Impaired or greatly diminished habitat for a balanced array of wildlife

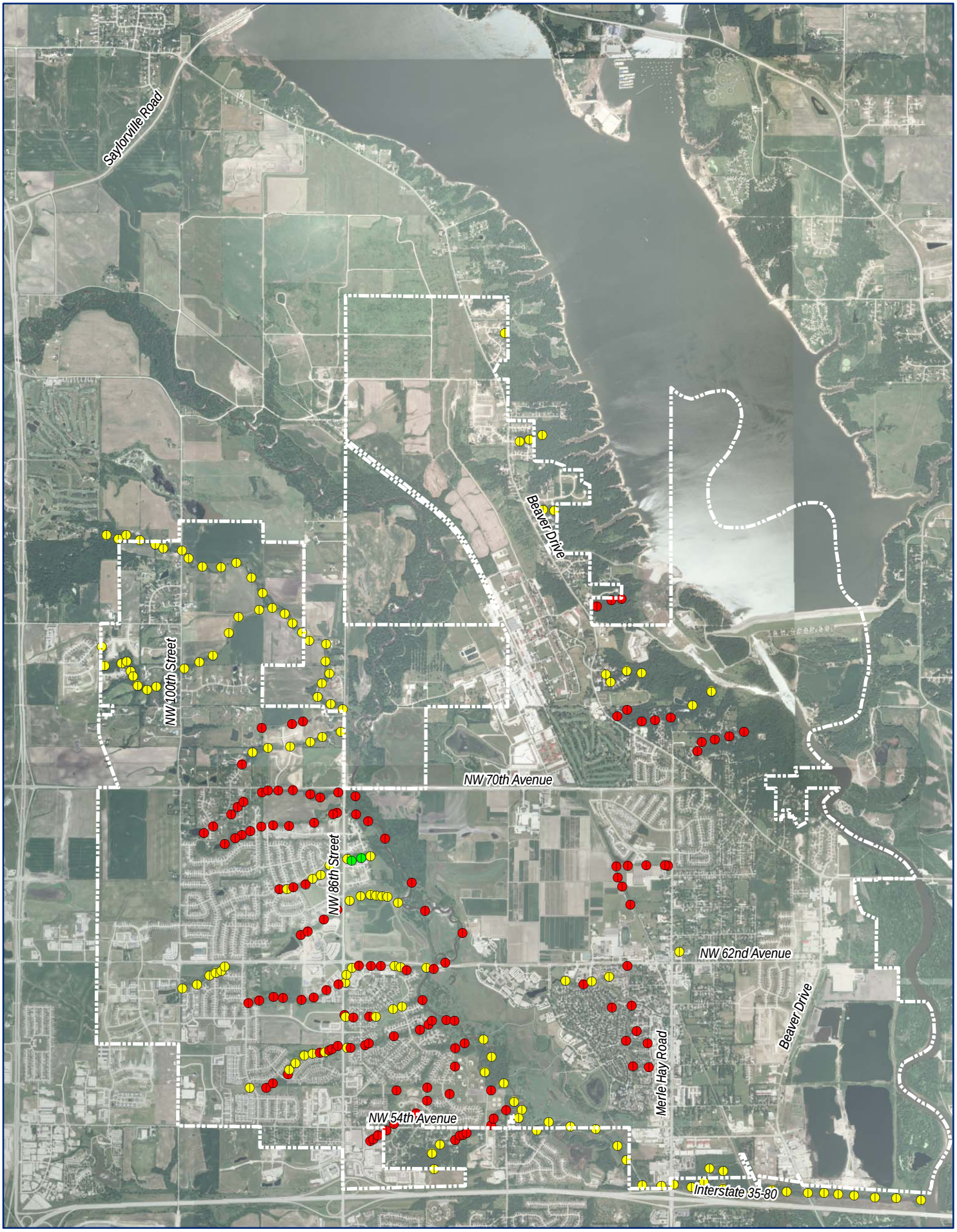
The lack of a riffle and pool system in this stream, offers little opportunity for fish and other aquatic species to thrive.

Map Legend

Good to 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 or no examples 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.



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Habitat Quality

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Johnston

Little Beaver and Beaver Creek Corridors

Little Beaver Creek

As part of this study, a detailed evaluation of Little Beaver Creek has been completed from the eastern edge of the Beaver Creek golf course (approximately ½ mile east of Highway 141) to its confluence with Beaver Creek. Most of its 13 square mile watershed is made up of agriculture and open space areas, but upland areas include portions of the City of Grimes primarily developed into residential uses, as well as scattered rural residential developments. The stream has widened throughout agricultural and urban development, as the early land surveyors had noted it only being 4-6 feet wide. Today, the stream is 20-30 feet wide in most locations, having a very shallow base flow typically.

Through the study corridor, the stream is typically moderately stable, with scattered locations where bank stability is either moderately unstable to unstable. There are two noticeable areas of heavier bank erosion.

The first is located immediately east of Beaver Creek Golf Course, where stream banks are eroded, most likely due to steeper side slopes along the adjacent valley and heavier tree canopy cover. This tree cover can inhibit the development of erosion resistant deep rooted grasses and plants along the banks of the stream. Trees are being undercut by erosion. ▶

Photo 54

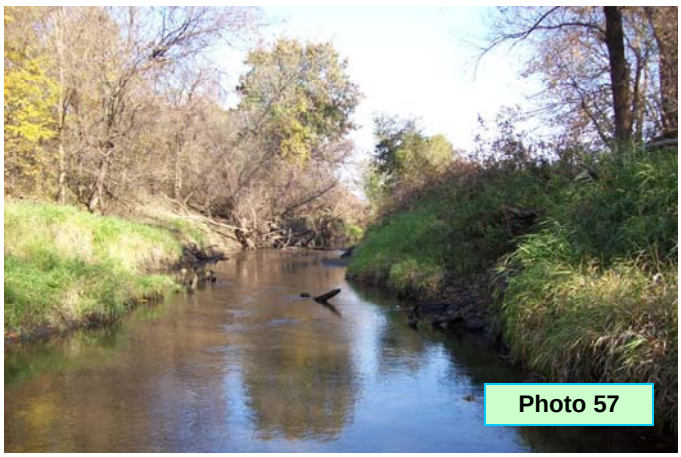
Photo 55

◀

The second is the outside of sharp bend upstream of NW 86th Street. The stream is actively widening at this location. There is a six foot tall vertical bank, is exposed and lacks vegetation of any kind. An area like this is subject to minor erosion during small rain events, and potentially to major erosion (bank movement of a few feet) during larger flood events.

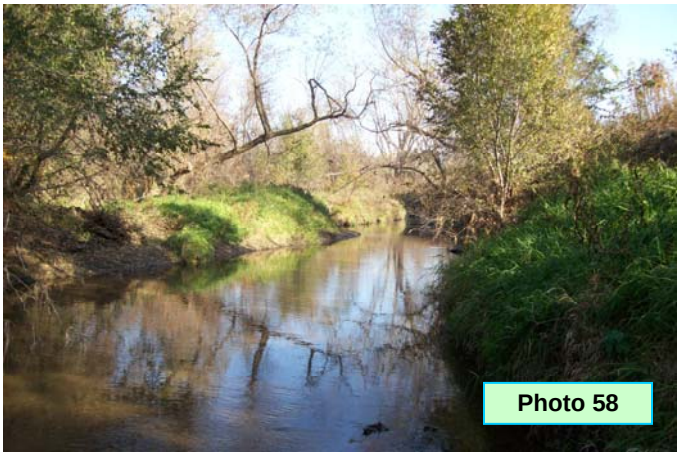
Some other features of note: Here is an example of a riffle/pool system. Large stones form a dam in the creek, creating a deeper pond of water upstream providing better habitat for fish and a more diverse array of wildlife. These systems occur naturally in streams that have not been impacted by agricultural or urban development, and function as a means to reduce the overall slope of the stream channel by creating a system of step pools. This lowers the speed of flow in the stream and reduces the potential for erosion. ▶

Photo 56



◀ Most of the steam corridor resembles sections like this. The banks in this section are moderately stable. There is tree cover along the stream, but enough sunlight reaches the surface to allow deep rooted grasses and flowers to grow. These plants are more resistant to erosion and help to stabilize the streambank.

Continued management of tree and shrub growth along the streambank will be necessary to make sure that these grasses do not become too shaded to survive. Some woody debris is buried in the sediment in the channel bottom, providing habitat for frogs, turtles and other species. The amount of debris is not excessive; not causing large log jams to form. ▶



Beaver Creek

Detailed investigation of the conditions along Beaver Creek was limited to areas within the City located outside of the perimeter of the Camp Dodge military installation. Review of aerial photos, LIDAR topography and other information available indicate that many of the conditions within the National Guard facility are likely to be similar to those in other areas of the City.

The existing conditions of this stream are influenced greatly by the large agricultural area in the watershed. As the prairies were settled and developed into farms, hydrology of the entire watershed was altered. Less rainfall is allowed to infiltrate into the soil, creating more direct runoff to be generated. The banks of the stream were eroded and widened over time to accommodate these larger stormwater flows. A stream measured at 20 feet across by the original surveyors now measures 60 to 100 feet wide. ▶

Photo 59

The stream meanders greatly through this area, and likely did so even prior to settlement. Agricultural effects can accelerate this process however, by delivering larger amounts of sediment into the stream. This larger sands and gravels in this sediment can settle out in the inside bends of the stream, where the velocity of flow is lower. As these build up, it narrows the width of the stream and pushes the water flow toward the outside bank. This narrow and fast flow begins to eat away at the outside bank. Overtime the outside bends of two sections of the stream can meet, creating a new, shorter flowpath. This process is repeated; wherever conditions exist that allow the process to begin. ▶

Photo 60

Photo 61

◀

There are a few specific conditions along this section of stream that should be highlighted. Many areas of the stream have dense tree cover, which inhibits the establishment of erosion resistant grasses. The photo the left, taken is of the west bank, just south of NW 70th Avenue. This section of the stream is relatively straight, but some minor scour can be observed along the banks and some trees are being undercut by erosion.

Near the Augustine development, the stream has eroded into a tall bluff along an outside bend. The erosion is not encroaching into private property at this point, but the slope is around 20 feet from its ledge to the water below. A large tree has fallen into the stream at this location. ▶

Photo 62

Photo 63

◀

Within the Pioneer research farm property (beginning about ½ mile north of NW 62nd Avenue) the stream has a series of sharp bends. Debris collects in some of the scour points along some of the outer bends of the stream.

▶

Recent flood events have significantly moved the streambanks along this reach. Two years ago a site walk was conducted to investigate the proper location for a bike trail near this location. At that time, there was 15 feet of land between the fence in this picture and the bank of the creek. At the time this photo was taken in November 2008 the bank is about 2-5 feet beyond the fence in this location, and the fence was suspended above the water. This area was revisited during the spring of 2009 and the creek had washed out 20 feet beyond the fence, and approximately 100 feet of the fence had fallen into the creek. A sanitary sewer trunk line, running parallel to the creek in this area, is now only separated by about 50 feet from the new edge of the stream in this location.

Photo 64

Photo 65

◀

Just north of NW 62nd Avenue, the outer bends are scoured in several locations, this one with a shear bank of 12-15 feet. One of the bends has moved closer to the right-of-way of the roadway, to the point that it will need to be addressed if plans are pursued to widen the roadway to a four lane boulevard and construct a new bridge at this location.

◀ Downstream of NW 62nd Street, the west bank has been eroded away near a couple of homes within the Green Meadows West development. A large tree fell into the stream at this location during 2008, which extended across almost the entire width of the stream.

Large debris and trees can collect near the knick points along the outer bends of the stream. A recreational trail can be seen in this photo only a few feet away form the bare outer bend of the east bank of the creek in this location. ▶

◀ There is evidence of beavers along this section of stream. They used to help keep tree cover manageable along the streambanks in the historic landscape.

Minor grading in this area was conducted to address an area of standing water near a recreational trail. Flood events during 2008 routed overbank flows from Beaver Creek through this area, yielding this significant erosion. ▶

◀

Some portions of the banks downstream of Merle Hay Road are relatively stable. Ground cover is more established, as tree cover has been removed and limited by construction and maintenance of the Interstate 35/80 right-of-way corridor. Some of the banks have been stabilized with revetment stone, partially buried with tallgrass vegetation established in the gaps between stones.

A large box culvert conveys drainage from commercial developed areas within the cities of Des Moines and Urbandale, located on the southern side of the interstate. Some scour is noticeable on the bank, just downstream of the outlet. ▶

Photo 72

◄

This is the ultimate outlet from the 72" storm sewer which drains most of the older developed areas of the City which are located along and to the east of Merle Hay Road.

Large trees and other debris had collected along the piers of the interurban recreational trail bridge, which connects the cities of Johnston and Des Moines. This debris can dam up flows during flood events and increase the drag forces on the piers. ►

Photo 73

Photo 74

◄

These culverts with flapgates were constructed through the levee system east of Beaver Drive to allow the area protected by the levee to drain out more quickly when the levee is bypassed and the area is flooded. They were located too high to effectively drain all of the areas needed for access around the gravel pit and concrete batch plant areas.

◀ The south bank of Beaver Creek, downstream of Beaver Drive has become severely eroded along the interstate right-of-way. The fence along the roadway is now suspended above the stream in this location.

An aerial photo taken in November of 2006, shows the same section of stream, where the fence is visible and about 10-20 feet appears to separate the fence from the streambank at this location. ▶

Fence

◀ The confluence of Beaver Creek with the Des Moines River, with the I-35/80 Bridge seen downstream in the background.

Conditions Affecting Development

Introduction

To guide future planning efforts, it is important to identify and map sensitive areas that are either resources to be preserved or site conditions that exist that are adverse to development. Preserving wetlands, stream corridors and quality open spaces provide access for maintenance, habitat for wildlife and temper increases in stormwater runoff. Known soil conditions may indicate the presence of shallow groundwater tables, steep slopes or other areas that may be more susceptible to erosion. These features will be discussed in more detail in the following sections.

Jurisdictional Wetlands

Wetlands are areas which have a certain combination of certain types of soils, water levels and wildlife. These areas can be protected by Federal Law under regulations administered by the U.S. Army Corps of Engineers. Wetlands are protected from impact by development activities under these rules for a variety of conditions. Before impacting these areas, reports must be reviewed and approved by the Corps that identify which areas are protected wetlands and how these areas are to be protected, or replaced (mitigated) if they are affected.

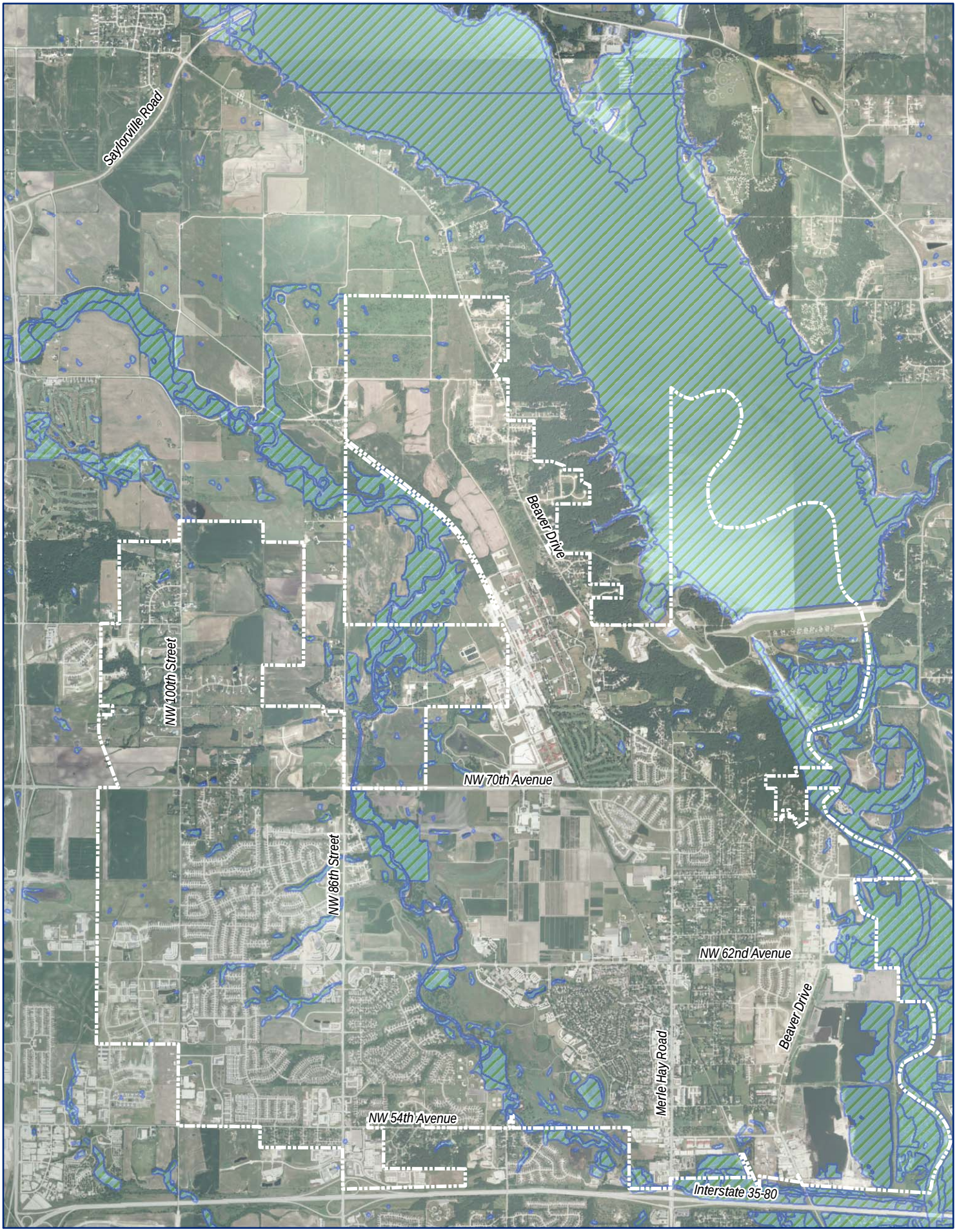
Wetlands are a valuable natural resource, providing the following benefits:

- **Stormwater runoff volume and flowrate reduction.** Wetlands can collect and store stormwater runoff, slowing the rate which it is released into receiving waters. This reduces the potential for downstream erosion and can help reduce the impacts of flooding.
- **Improved downstream water quality.** Wetlands can trap sediments and other pollutants, either through settlement by ponding or absorption by plants. Water can be filtered and slowly allowed to infiltrate into subsurface groundwater. Historically many small streams would have been provided a clean steady base flow in this manner.
- **Quality wildlife habitat.** Healthy, balanced wetlands can be home to a wide array of plants, insects, fish and other animals.

For all these reasons, wetlands are vital resources that need to be protected from sedimentation, dewatering or site grading activities to the greatest extent possible.

Map Legend

Areas classified as wetlands by the National Wetlands Inventory maintained by the United States Fish and Wildlife Service. Wetlands shown may include both jurisdictional and non-jurisdictional wetlands that have already been identified. Detailed site wetland determination and delineation studies are required to determine if other wetlands are present at a given site, or to determine whether site wetlands are jurisdictional (regulated and usually requiring mitigation if impacted) or non-jurisdictional (mitigation may not be required).



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Wetlands

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Feet

Johnston

Soil Conditions

Soil properties should be a key consideration when planning future development within the city. Countywide soil survey maps offer a great deal of information on the general properties of soils common in Iowa, including their benefits and liabilities with respect to land development activities. The presence of shallow water tables, steep slopes, or soils prone to erosion may require special planning, construction methods or other limitations.

Photo 78

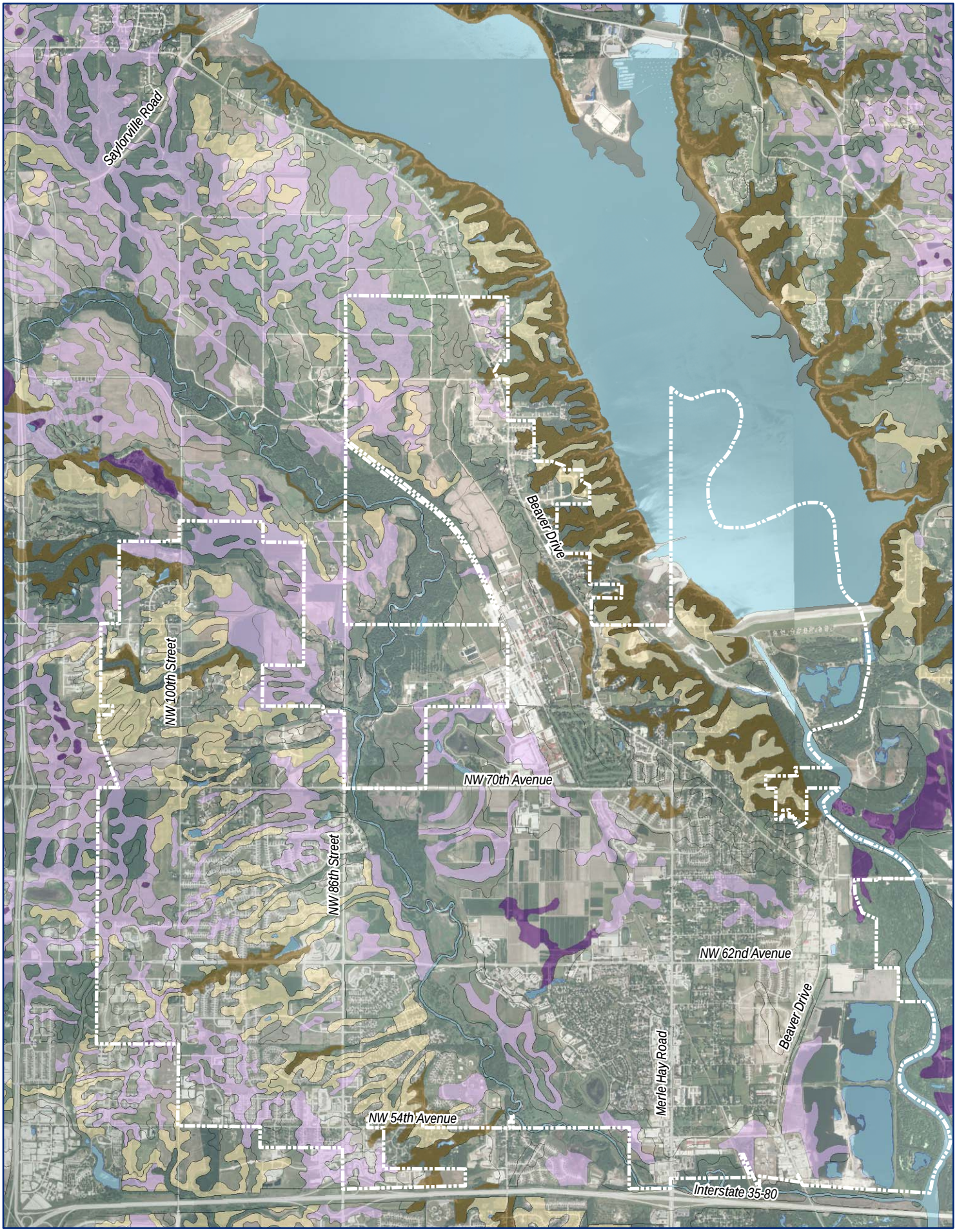
Map Legend

Fully hydric soils:
These soils often have a shallow water table and are often located near swales, depressions and flood plains. Special construction practices are often required to safely construct improvements such as streets, utilities and structures in these areas. These soils may also indicate the presence of jurisdictional wetlands. Development should be limited as much as possible in these areas.

Depressional, fully hydric soils:
These areas often exist in shallow depressions and are often prone to seasonal shallow flooding. Many of these areas are located along flood plains or were once part of prairie pothole wetlands that were common in Iowa prior to agricultural development. These areas should be reserved from development and are candidates to be reestablished as wetlands.

Steep Slopes (14% or greater):
It is extremely difficult to prevent erosion and re-establish stable vegetation on steep slopes disturbed by construction activities. Exposed slopes can be prone to gully erosion and slope failures potentially causing downstream siltation, erosion and flooding. Structures constructed near the top of steep slopes can be impacted if sufficient separation is not maintained from the base of the structure to the toe of the slope. Construction in these areas can also harm the scenic character of these areas, especially if they are established with quality woodlands or native prairie flowers and grasses. These issues need to be addressed before allowing development on or near these slopes.

Moderate Slopes (5 to 14%) Prone to Erosion:
Some soils are more prone to erosion when disturbed than others. Preventing erosion and sediment loss and re-establishing vegetation on these areas when graded may require more effort than normal. Proper pollution planning and vegetation management will be needed in these areas.



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Soil Conditions

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Feet

Johnston

Quality Open Spaces

Reviewing other valuable natural and historic resources can provide a framework for a network of high quality open spaces. This can offer opportunities to integrate watershed management needs into the planning of future parks, trails and other reserved areas.

Map Legend

Quality Wooded Areas:
Well managed treed areas, especially those with mature native trees provide important habitat for a variety of birds, insects and animals. Wooded areas reduce rainfall runoff and protect surface soils from erosion caused by rainfall.

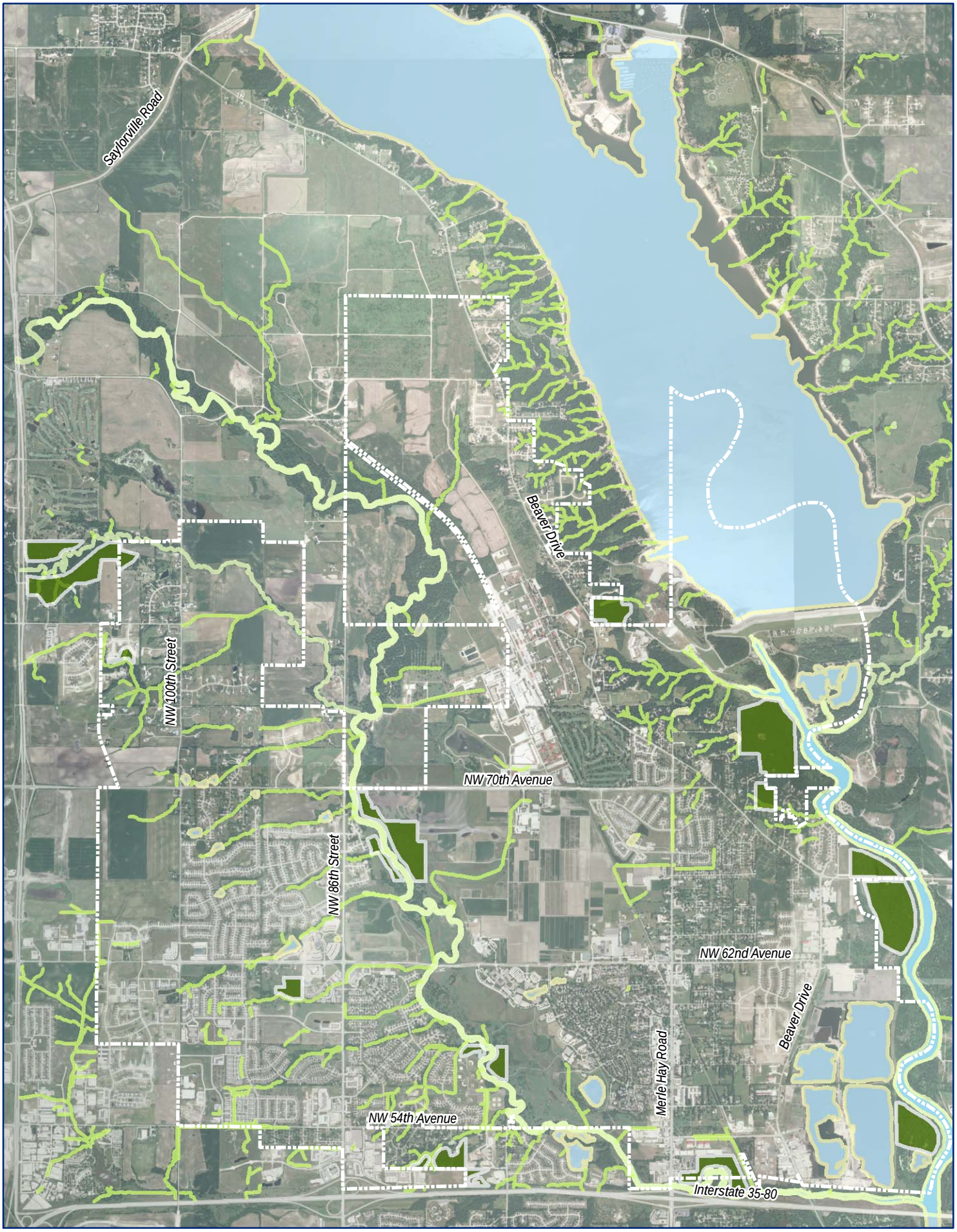
Prairie Remnants:
Existing prairies can prevent erosion, absorb pollutants and reduce stormwater runoff. They also provide a valuable seedbank for native flowers and grasses that can help to add diversity to any native planted areas constructed nearby. They also provide important habitat to a wide variety of species.

Stream Corridors:
Maintaining a healthy buffer along both small and large streams offer the following benefits:

- Absorption and filtration of stormwater runoff.
- Establishment and protection of wildlife habitat.
- Reduced streamflow velocities and streambank erosion.
- Provision for safe storage and conveyance of large storm runoff
- Moderation of downstream flooding.

NA

Archeological Sites::
Many sites with historic and prehistoric value have been identified within the City of Johnston. The value of these sites can be lost forever if disturbed through land development, erosion or demolition.



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Quality Open Spaces

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Johnston

Summary of the Management Plan

Overview of the Stormwater Management Plan

The purpose of this document is to develop and describe the vision for stormwater management within the City of Johnston. The goal of this plan is to develop a framework for handling stormwater issues in a developing urban area that protects existing resources, addresses existing impairments and mitigates the effects of additional future development.

Lessons Learned from the Watershed Assessment

The benefits of the citywide watershed assessment program will only be realized if the lessons learned become part of how stormwater is managed from this point forward within the City of Johnston. For this reason, it is important to highlight some of the observed issues:

- **Traditional methods of stormwater management have failed to prevent urban stream deterioration in recently developed areas.** Many of the issues related to water quality, habitat loss and streambank erosion have occurred in areas west of Beaver Creek that have largely developed since 1993. Many of these areas included on-site stormwater detention basins that were intended to control flooding that could be caused by large, infrequent storm events. These basins were developed with little means to address the effects of increased frequency and volume of runoff from smaller storms.

- **There are several key areas where prompt action is necessary to prevent damage to public and private infrastructure.** Certain sections of smaller urban streams and portions of Beaver Creek require improvements to protect adjacent sewers, streets and other private and public infrastructure from damage.

- **Installed practices often have design issues that limit their effectiveness to protect against channel erosion or manage water quality requirements.** Passive detention systems, connected impervious areas and flowpath shortcutting amplify the effects of small storm runoff. Practices that treat stormwater as a waste product and get it off the site as soon as possible have created a series of unintended consequences.

- **Better planning for access and maintenance is needed.** Stormwater management areas have typically been constructed on private property. In single family residential areas these basins are often left in backyards with little or no provision for maintenance access. Homeowners are often not equipped to deal with the on-going maintenance requirements of these facilities.

- **Stream corridors need maintenance and buffer protection.** Many urban stream corridors need removal of trees, underbrush and debris. Bank stabilization, grade control and habitat improvements are needed as well.

- **There are few practices within the City that have been designed to address water quality issues.** To date, few practices have been installed that seek to capture and treat runoff to remove sediments and other pollutants that are commonly found in urban runoff.

- **Flooding impacts to infrastructure are largely limited to lower areas of Beaver Creek.** These areas are primarily north of Interstate 35/80, from near Merle Hay Road to the confluence with the Des Moines River. Additional flood protection of these areas may not be possible without increasing the risk to upstream properties, but means to relieve flooding more quickly after large events may be possible.

Applying the Experience

Developing Principles and Objectives to Guide Stormwater Management

The first step in addressing the lessons learned through the watershed assessment process is to develop a series and principles and objectives that will guide the overall vision of how the City wants to address ongoing stormwater issues in a more sustainable manner. From these objectives, plans and policies will be generated ultimately leading to projects to be constructed and ordinances to be implemented.

Extended discussions with City staff and the Stormwater Steering Committee led to the development of these key principles and objectives:

- ***Follow a conservation design ethic, to protect high quality natural areas and open spaces.***
- ***Treat stormwater as a resource to be conserved, rather than a waste product to be disposed of.***
- ***Encourage the use of effective, sustainable, attractive and safe best management practices (BMPs) to improve the quality and reduce the volume of stormwater runoff.***
- ***In developing or redeveloping areas, promote better site design methods to reduce impervious surfaces, reduce the volume and impact of grading activities and employ BMPs to mimic pre-settlement hydrology to the greatest extent possible.***
- ***Locate water quality and quantity controls so that they are accessible and maintainable.***
- ***Consider long-term operation and maintenance of proposed stormwater management facilities as part of site design.***
- ***Encourage sound engineering practices in the design and construction of stormwater management facilities as early in the design process as possible to ensure flexibility.***
- ***Develop a funding source dedicated to stormwater management improvements.***
- ***Develop public education programs, informational handouts and encourage dialog on the importance of stormwater management techniques.***

These principles and objectives are intended to be the foundation of the planning and policy directives discussed throughout the remainder of this management plan.

Photo 82

Photo 83

Setting the Balance: The Vision for Stormwater Management

One of the largest questions to be answered with this plan is how to implement new methods of stormwater management. This ultimately will be accomplished through the combined efforts of site level development practices and larger scale practices that are likely to be constructed by the City as public improvement projects. Publicly owned stormwater improvements will likely be integrated into a green network of parks and trails; developed for the protection of wetlands, streams and buffers.

- **Site level – development scale practices.** These practices will usually be included as part of plans for an individual development (ranging in size from less than an acre to as much as 80 acres). The goal of these practices will be as follows:

    - **Address water quality treatment requirements to intercept pollutants typical for the proposed land use.** This means as part of site development, practices will be installed that capture and treat runoff from a 1.25", 24-hour storm event (Water Quality Volume). Approximately 95% of the rainfall events in Central Iowa are of this depth or less, and almost 80% of the annual rainfall volume is generated by storms in this category. By effective management of these storms (and the "first flush" of larger events), many of the pollutants of concerned will be removed from rainfall runoff before it can leave the site area.

    - **Protect downstream receiving waters from further habitat loss, channel erosion and streambank degradation.** As part of site development, practices will be implemented that allow for extended detention of the Channel Protection Volume (generated by a 1-year, 24-hour event of 2.38"). This means capturing the runoff volume from a storm of this nature, and slowly releasing it over a period of no less than 24-hours. This reduces the rapid "bounce" effect common in many urban streams that leads to a large portion of rapid downcutting and streambank erosion.

    - **Provide on-site stormwater detention to limit runoff peak flow rates from minor storms (more frequent than a 10-year recurrence interval).** At the site development level, provide stormwater detention practices with multi-stage outlets that control the outflow from these events to pre-settlement levels (meadow in good condition). This is intended to prevent the surcharge of downstream culverts and storm sewers and allow for the safe conveyance of these events from the site area. This will also reduce the possibility of overbank flooding from these minor storms.

    - **For larger storm events (10-year to 100-year recurrence intervals), provide a safe path of conveyance from the outlet point of the site to the location of a regional stormwater management area.** To protect private and public improvements from flood damage, a clear path must be established that is capable of safely conveying larger storms from the site area to a planned or constructed regional stormwater facility, likely to be located within a proposed city park or greenbelt. If no safe path exists, additional detention may be required as needed to prevent potential flood damage.

Storm Event (24-hr, Type II rainfall distribution)	Site Level Requirements
Water Quality Event (1.25")	*Apply site appropriate BMPs to capture and treat runoff from all rainfall events of this size or smaller.*
Channel Protection Event (1-year; 2.38")	*Provide Extended Detention (ED) to capture runoff from this event, and release slowly over 24-48 hours.*
Overbank Flood Protection (>1-year to 10-year)	*Provide detention storage to limit peak discharge rates to those similar to pre-settlement hydrology (meadow in good condition, extended Tc).*
Extreme Flood Protection (>10-year to 100-year)	*Developed flows are allowed to be released provided that a safe path of conveyance is available to a planned or constructed regional detention facility. Additional detention may be required.*
Refer to the Iowa Stormwater Management Manual for more information	

- **Regional level – larger scale practices located in City owned parks or greenbelts.** These practices will usually be included as part of plans for overall watershed management, meeting the flood control needs for multiple development properties. The goal of these practices will be as follows:

    - **Provide additional water quality improvements.** Incorporate additional practices that focus on additional pretreatment and protection for constructed water features and amenities. These will provide additional water quality enhancements above and beyond the Water Quality Volume requirements that should be met at the site development level.

    - **Provide safe and stable conveyance of stormwater runoff from the site outlets to the regional facility.** Site level practices should reduce the possibility of erosion and streambank degradation, but proper design and maintenance is needed to keep flow velocities low while conveying both small and large storm events.

    - **For larger storm events (10-year to 100-year recurrence intervals), regional facilities shall provide temporary storage for larger storm events.** Peak flow rates after full development of the watershed shall be limited to pre-settlement levels (meadow in good condition) for these events. This is intended to protect downstream areas and larger receiving streams from flooding during these rare, but large storm events.

    - **Use collected stormwater as a resource to develop aesthetic enhancements and amenities.** Constructed wetlands, lakes and other features can provide many opportunities for recreation, adding value to the local neighborhoods.

    - **Provide a means of access for maintenance and operation.** Constructed trails and buffer easements can provide a means to provide routine maintenance and upkeep near stormwater management areas. By locating larger site level practices adjacent to the open space network, better access may be available for privately maintained facilities as well.

Storm Event (24-hr, Type II rainfall distribution)	Regional Level Requirements
Water Quality Event (1.25")	*Requirements met at site level. Provide additional treatment measures such as enhanced swales, streams and wetlands as appropriate.*
Channel Protection Event (1-year; 2.38")	*Requirements to be met at site level.*
Overbank Flood Protection (>1-year to 10-year)	*Provide detention storage to limit peak discharge rates to those similar to pre-settlement hydrology (meadow in good condition, extended Tc).*
Extreme Flood Protection (>10-year to 100-year)	*Provide detention storage to limit peak discharge rates to those similar to pre-settlement hydrology (meadow in good condition, extended Tc).*
Refer to the Iowa Stormwater Management Manual for more information	

Photo 84

Photo 85

Addressing Stormwater at the Development Level

The proposed new stormwater balance requires a change in philosophy when approaching site development design. Historically, storm water was typically addressed in the latter stages of site design (develop a plan, calculate detention requirements and then try to get the basin to fit in to a remaining open space on the site).

Stormwater management and design must be incorporated early in the planning process, by reviewing site topography and other constraints that were identified as part of the watershed assessment. The focus of design needs to be using the following toolbox of management techniques to mitigate the effects of site development and better reflect how water would runoff the site in a natural state.

Source Reduction

The most effective technique of storm water management is reducing the amount of stormwater runoff from being generated from new development, rather than trying to capture or manage the runoff after it has already been created. This can be accomplished in many ways:

- **Minimizing the area disturbed during site construction** reduces the potential for soil compaction and the loss of deeper topsoil and existing vegetation. Keeping natural site soils improves rainfall absorption. Reducing the disturbed area also reduces the area prone to soil erosion (reduces costs for construction site management, maintenance and pollution prevention).

- **Minimizing site grading activities** by aligning the site to work with the natural landscape. Excessive cuts or fills through mass grading activities can greatly compact soils, lessening the potential for infiltration and absorption of rainfall and leading to increased stormwater runoff.

- **Minimizing the impervious area** allows for more of the site area to be used to intercept, treat and infiltrate rainfall before it can leave the site area. This can be accomplished by choosing more efficient site layouts, reducing areas dedicated for paved parking lots and drives and reducing building footprint areas by increased use of multi-story structures.

- **Soil decompaction** through surface or deep tilling lessens the effect of mass grading activities on site soils, allowing runoff to percolate into the soil at a rate more similar to that that would have been expected prior to site development.

- **Proper installation of topsoil respread and other soil amendments** to leave porous, nutrient rich soils at the surface with sufficient depth to support planned vegetation. Topsoil with at least 5% organic matter content is desired. These soils and their supported vegetation create a “sponge” effect which absorb and use more rainfall naturally. This can also reduce the long-term requirements for irrigation and fertilization.

- **Green roofs** can be installed on many new and existing structures, allowing a matrix of soil and plants to capture and use more the rain falling onto a building structure.

- **Porous pavement applications** allow for rainfall to infiltrate into a subsurface rock base to be stored temporarily or to infiltrate into the ground where site soils allow. Successfully installed and maintained applications can greatly reduce the volume and rate that rainwater moves off of paved parking and drive areas. ▶

Photo 86

Pretreatment

Many of the structural practices proposed to capture, treat and reduce stormwater runoff need effective means of pretreatment. Measures to capture sediments and other pollutants need to be employed in a location where they can be removed before they enter a higher quality practice downstream. This helps the removal efficiency and long term performance of these practices, by preventing them from becoming quickly clogged with heavier pollutant loads. Some methods of pre-treatment that can be employed are:

- **Grass swales, buffers and filter strips** slow runoff velocities and can often effectively capture sediments, metals, and hydrocarbons. These can be in the form of narrow buffers (i.e. along parking areas where sheet flow enters a treatment practice) or longer linear swales (i.e. directed runoff from a downspout or storm outlet can be slowly conveyed over 20 to 75 feet before entering another method of treatment). ▶

Photo 87

- **Forebays** are depressions constructed at pipe outlets or other points of entry to larger management practices that slow outlet velocities and allow heavier sediments and other pollutants to settle out. These measures can be shallow (6" or less) or deeper (3-4 feet) depending on the application, site area, and downstream practice to be protected. A hard bottom is often encouraged to allow for ongoing sediment removal without heavy disturbance to the bottom of the structure. These often can be constructed to reduce soil erosion at pipe outlets or other points of concentrated flows. ▶

Photo 88

- **Subsurface mechanical systems** can effectively remove trash, debris, oils, grease and sediments that are suspended in urban runoff. These come in a variety of sizes, shapes and designs depending on the characteristics of the watershed being treated and the specific pollutants of interest. (Example: A system which removes fuels, oils and other hydrocarbons could be employed where runoff is collected from a gas station, before it is discharged to another practice where receiving streams or groundwater could be contaminated). ▶

Photo 89

Source controls

Once runoff has been created, the next most effective method of reducing its impact is through installation of smaller, distributed practices located close to the source of the created runoff. Such controls can be smaller, less intrusive and be much more efficient at treatment and pollutant removal, since each practice is capturing a much smaller volume of water. This also allows for storm water to be treated through a series of controls, meaning that should one practice fail due to improper maintenance or construction that water may still be treated successfully by several other controls on the same site.

- **Rainwater harvesting** by installing rainbarrels, cisterns or other collection devices can store and collect runoff from roofs and other hard surface areas that can be used for irrigation, decorative features and other non-potable uses of water. ▶

Photo 90

Photo 91

- **Infiltration planter boxes and gardens** can be installed to collect rainwater and use it for small formal landscape elements. ◀

- **Raingardens** can collect and store runoff from hard surface areas in small depressions (usually 9" deep or less) landscaped with plants and flowers appropriate for the given soils and water conditions. These are typically designed to allow collected water to percolate into the natural soils below within 24-48 hours after a storm event. ▶

Photo 92

- **Bioretention areas** are similar to raingardens in appearance, but feature engineered soils and usually a perforated tile underdrain to enhance infiltration and prevent extended periods of standing water after rainfall events. ◀

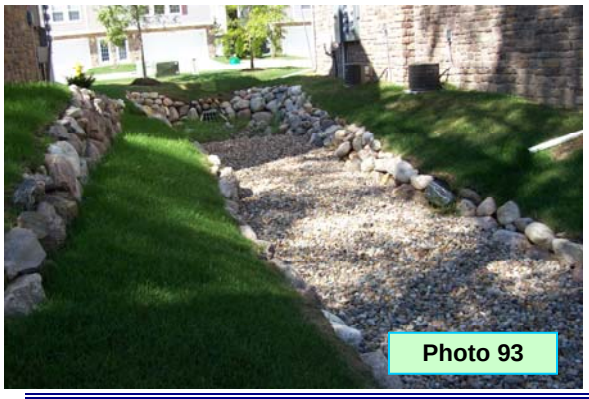

Photo 93

- **Porous landscape detention** allows runoff to percolate through layers of landscape rock, pea gravel or clean stone to either a perforated subdrain or subsoils with higher infiltration rates. The rock medium allows for the filtration of runoff, and provides a medium where pollutants can be captured and broken down by natural processes before they can leave the site area. The voids in the stone layer allow water to be "detained" and slowly released into the subdrain or infiltrated into site sub-soils.

Conveyance

Rainfall runoff should be conveyed in a manner that protects existing and proposed infrastructure from flooding, yet extends the time it takes for rainfall to leave a site during and after a rain event. Use of open surface conveyance is preferred over traditional methods such as storm sewers and concrete flumes, although these practices will certainly still be needed in some locations. Facilities should be designed to convey design events without significant erosion, and subdrains may be necessary in some areas where subsoil infiltration capability is limited or where a permanent pool or standing water is not desired.

- **Grass swales** can effectively convey both small and large storm events, and can provide water quality treatment if properly designed. Most are designed with a bottom width of 2 to 8 feet, with side slopes of less than 3:1 (no steeper than 6:1 preferred). Check dams, riffle dams or drop structures may be needed to control flow velocities and to prevent erosion, downcutting and filter rainfall runoff.

- **Rock or gravel lined swale** are similar to grass swales, but lack permanent vegetation in the bottom of the swale. This reduces the ability of the practice to filter and absorb runoff by plants, but these practices can be installed with elements similar to porous landscape detention allowing for runoff capture, storage and infiltration. ▶

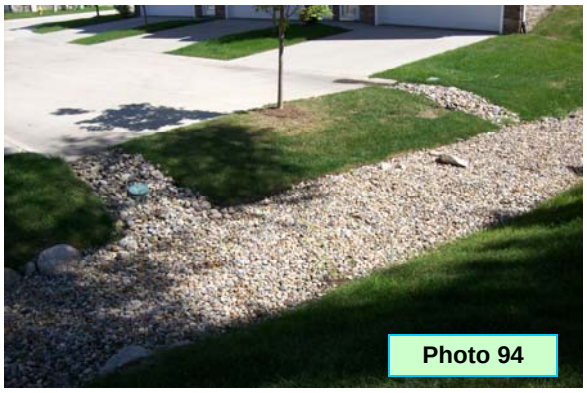

Photo 94

Photo 95

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- **Wet swales or small perennial streams** convey water from both small and large events while maintaining wet surface soils or a constant baseflow of surface water. This often occurs where the receiving area is large, or includes areas which are heavily irrigated or have subsurface tiles or other foundation drain discharges which route groundwater to the surface. Pretreatment or other source controls may be necessary upstream to manage smaller storm events to prevent channel erosion.

- **Traditional storm sewer systems** convey water runoff through a series of subsurface pipes and structures. Typically these systems are designed to convey minor storm events (5 to 10 year recurrence interval) without surcharge. Larger storms are usually allowed to be conveyed at the surface, provided there is a path to safely convey such events (up to a 100 year recurrence) without significant erosion, damage to property or impairment of access. These systems quickly and efficiently convey water during both small and large storms; allowing pollutants to easily pass through to downstream areas. Erosion at pipe outlets due to high outflow velocities needs to be addressed.

Outlet controls

Practices near where runoff exits the site are often needed to address remaining water quality treatment requirements and manage medium to large storm events. The purpose of these facilities is to achieve full compliance with site water quality requirements, protect downstream receiving channels from erosion and adequately protect downstream structures and property from flooding. Many elements already listed as options for pretreatment, source control, and conveyance may be appropriate as outlet controls, depending on the makeup of the upstream watershed area. The following additional practices are also acceptable as outlet controls, provided they are combined with appropriate means for pretreatment of surface runoff.

- **Constructed stormwater wetlands** can often be effectively employed in areas with high groundwater elevations, or areas with fully hydric soils. They feature a mix of shallow marshes, wet grasses and open water that sustain a balanced array of wildlife. They have a need for a relatively constant inflow of water, so they require either a large enough drainage area to support them, or inflow of other sources of water such as lawn irrigation or discharge from foundation subdrains or intercepted subsurface tile lines. These practices are good at removing suspended sediments, phosphorous, bacteria and hydrocarbons. Forebays with provisions for maintenance access are necessary as part of effective design to provide an area where trash, debris and sediment can be collected and removed without disturbing large portions of the wetland after vegetation has been established. ▶

Photo 96

Photo 97

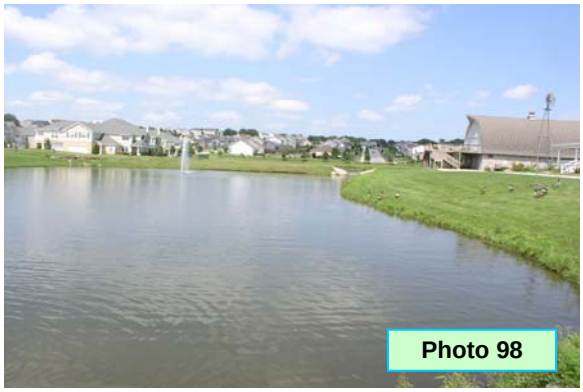
Photo 98

Photo 99

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- **Wet stormwater ponds** can be designed as aesthetic landscape features, while providing water quality and quantity management. These facilities have a permanent pool of water that often can be deep enough to support fish, amphibians and other wildlife that help to control water born insects. Forebays and other pretreatment practices should be employed that filter and prevent trash, debris and other pollutants from being directly discharged to the pond.

◀

- **Dry stormwater detention areas** are larger depressions, often established with turf or native grasses used primarily for temporary storage of larger storm events. Their ability to treat and remove pollutants present in urban runoff is limited so their storage volume is not typically considered to meet requirements for capturing and treating the water quality event.

- **Multi-stage outlet structures** are essential to effectively managing runoff from both small and large storm events. Lower stages with smaller openings restrict flows from more frequent small storms, allowing captured runoff to be released over a longer period of time, allowing proper pollutant capture and settlement to occur. Upper stages allow larger release rates, but are only used during very large storm events and can limit peak flow rates to desired levels. ▶

Photo 100

Photo 101

◀

- **Level spreaders** can be employed to convert concentrated point discharges into shallow sheet flow, where runoff runs slowly in wide, shallow flows where it can be effectively be treated by other practices (such as a grass buffer strip). This can mitigate localized erosion and channelization that can occur in a field or stream when post development flows have typically been released at one focal point, rather than a broad flat area prior to development.

Project Staging, Construction and Maintenance

Much of the time, the failure of a chosen practice to meet design goals can be directly related to damage or lack of protection of the facility during construction or improper maintenance after its installation. When choosing a BMP for a given site, designers should consider the following:

- **Prepare and follow the site Stormwater Pollution Prevention Plan (SWPPP).** Required by law, regardless of how post-construction water quality is being addressed at a given site. The sequence of events should clearly identify the order of construction of the project, when BMPs are to be installed and how they are to be maintained or protected during the construction period.

- **Protection of the BMP area.** The installation area should be protected from excessive compaction or sedimentation during construction.

- **Delay final construction until final landscaping.** If site constraints make it too difficult to provide adequate protection for the BMP during construction, it may be necessary to plan to re-excavate the area using smaller construction equipment near the end of the project, when most of the upstream site area has been stabilized. Compacted soils and accumulated sediments can be removed and placed with higher quality or engineered soils that meet the design requirements of the planned BMP. Final landscaping of the practice can also occur during this period.

- **Establishment and maintenance.** Plans should address how desired trees, shrubs, flowers and grasses are to be established and how they are to be maintained. For native planting areas, short-term plans (first 3 to 5 years) are necessary to control invasive plants, weeds and brush to get the landscaping to a more sustainable long-range period where less maintenance is expected to be required.

The Green Network: Regional Stormwater Management

Site level practices as prescribed should address water quality and channel protection by effectively managing small to medium size storm events. A sound program needs to be established to collect and convey stormwater within the green network in a manner that is stable, safe and adds value to the City's system of parks, trails and open spaces.

Entrance pretreatment

Before runoff can enter the green conveyance network, methods of pretreatment are necessary to address runoff from untreated public streets and assure that pollutants are not being discharged from individual development sites. Providing accessible locations where pollutants can be collected and removed can prevent sedimentation and pollution of downstream channels that can lead to habitat loss and channel erosion. Similar to site development, the following BMPs could provide effective methods of pretreatment:

- **Grass swales, buffers and filter strips**
- **Forebays**
- **Subsurface mechanical systems**

Enhanced stream corridors

As part of the overall stormwater management plan, significant stream corridors have been developed that can be made part of the green open space network. These corridors can be divided into three categories:

Photo 102

- **Type I streams** (such as Beaver Creek, Little Beaver Creek and the Des Moines River) have established flood plains, established baseflows and watershed areas of a much larger scale than most other urban streams. Proper buffer protection and management and shoreline protection are key concerns for these streams. ▶

Photo 103

- **Type II streams** do not usually have established flood plains, but often have established baseflows in urban areas. These streams often have watersheds of 40 – 2000 acres and likely will require ongoing maintenance to prevent larger erosion issues from being created as development occurs. Such issues are difficult to be handled by either a private homeowner or an association of local property owners.

◀

Photo 104

- **Type III streams** may or may not have established baseflows and usually have watershed areas of less than 80 acres. These corridors should be protected or enhanced through the site development process, but likely could be maintained by a private entity as long as maintenance access is available through appropriate building setbacks and required easements. Public or private ownership of these watercourses could be considered on a case by case basis at the site development stage. ▶

Stream buffer establishment and maintenance

It is necessary to establish buffers along these stream corridors to provide for ongoing maintenance, prevent streambank erosion and protect or enhance existing wildlife habitat. Different types of buffers need to be established for the different levels of streams:

- **Type I streams** need buffers focused on protecting the existing floodplain area from development. Selective tree clearing and removal can help streambank stability by allowing erosion resistant deep rooted grasses and flowers to be established. Existing wetlands can be protected and new wetlands established in low lying areas and depressions. Access paths should be established by mowed vegetated paths or by constructed recreational trails.

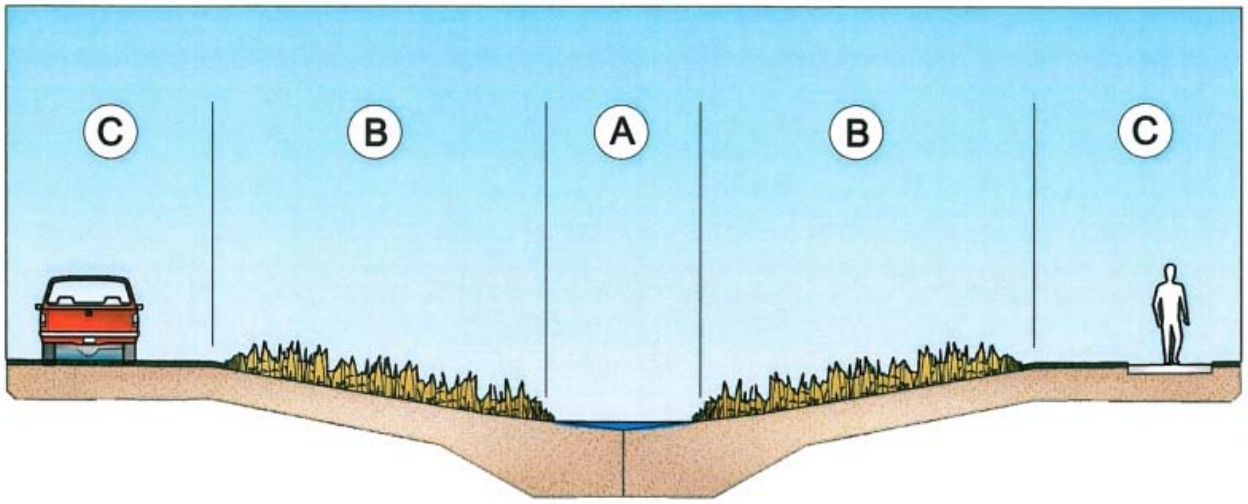
- **Type II streams** can be divided into two categories:
    - **Channelized stream corridors with some level of existing erosion** need to have buffers that protect against additional erosion, while allowing for corrective action to be taken at a future date. Reserved buffers should be wide enough to grade back steep slope areas from the existing stream flowline at grades of no steeper than 3:1 (6:1 preferred); while allowing for at least 20' on either side for maintenance access.

    - **Less defined streams and swales** (usually through undeveloped agricultural areas) need to have buffers to respect the existing topography near the flowpath. Where flow paths are less defined and shallow, the buffer may need to widen to convey design flows more slowly over a wider, shallower flow path (without requiring the stream to be channelized). The buffer will likely be composed of three elements:
        - A flow section, established with taller wet grasses that may only be maintained during extended dry periods.
        - A transitional section (varies with conveyance needs, but at least 20 feet wide on both sides of the stream) of shorter native grasses and flowers that can be more routinely maintained to provide a more attractive edge to the buffer.
        - An access path (15-20 feet wide on both sides of the stream) for ongoing maintenance. One side could be a lawn or short native grass mix that could be mowed on a weekly or bi-weekly basis. The other could be a paved recreational trail.

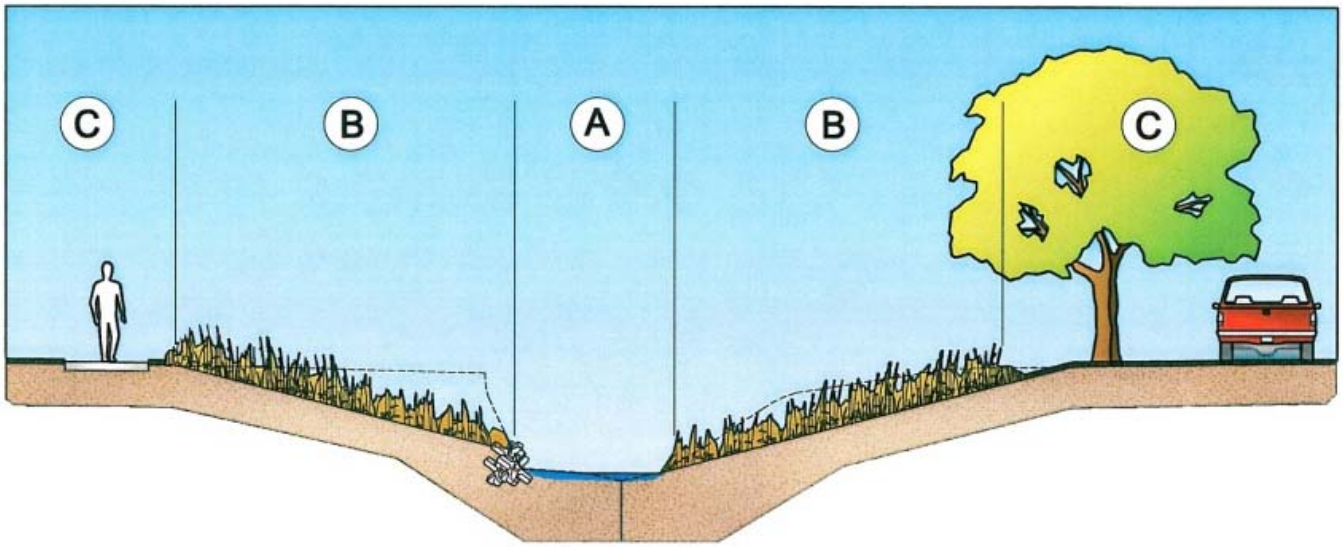
    Low head stream crossings or other points of access may be required to allow for maintenance vehicles to easily cross from one side of the stream to the other.

- **Type III streams** may have narrow buffers designed to convey stormwater from a smaller watershed area in a non-erosive manner. They should be established with erosion resistant deep rooted plants and flowers, with a width to allow for proper conveyance of the 100-year storm event plus a 20 foot strip on one side for maintenance access. Where located outside of publicly owned lands, easements should be established to protect the entire width of the buffer.

Less-defined Channel Cross-section Elements (Type II streams)
(not to scale)



Channelized Cross-section Elements (Type I and II streams)
(not to scale)



Stream Buffer Protection Guidelines – Class I and II streams

		A Flow Section	B Transitional Section	C Access Path
Purpose		Bottom of swale or creek expected to be seasonally or constantly wet. Bottom edges (toes) of defined streambanks included.	Buffer width necessary to maintain or repair slopes to a stable grade of 3:1 or flatter (6:1 preferred). Safely convey minor storms and smaller flood events.	To provide rights for access and a clear path for maintenance equipment to reach the stream corridor to evaluate its condition, remove brush and debris as necessary and address erosion issues as they occur. Safely convey larger flood events.
Conveyance Requirement		This section should convey the peak rate of flow from a 1-year, 24-hour storm event.	The peak rate of flow from a 25-year, 24-hour storm event should be contained within this section.	The peak rate of flow from a 100-year, 24-hour storm event should be contained within this section.
Vegetation		Wet tolerant, deep-rooted native grasses and sedges. Portions of streambed may be free of vegetation.	Erosion resistant native grasses and forbs tolerant of a variety of moisture conditions. Growth of trees and brush should be controlled to allow adequate sunlight to reach surface.	Maintain a clean edge against transitional section. Promote shorter varieties of native grasses or turf lawn applications along access paths and trails. Taller native varieties should be kept at least 10' off the edge of paved trails.
Stream Type	**Access Provisions**	**Minimum Width for Each Section**		
Type I	Paved trail (one side), clear grass path (other side)	defined by existing channel	No less than 50' each side, but wider as needed to establish minimum 3:1 slopes and meet conveyance requirement.	Maintain a clear 20' path (both sides) and meet conveyance requirement.
Type II (channelized)	Paved trail (one side), clear grass path (other side)	defined by existing channel	No less than 20' each side, but wider as needed to establish minimum 3:1 slopes and meet conveyance requirement.	Provide at least a 20' clear path (both sides) and meet conveyance requirement.
Type II (less defined)	Paved trail (one side), clear grass path (other side)	At least 10' wide, but wider as needed to meet conveyance requirements.	No less than 20' each side, but wider as needed meet conveyance requirement.	Provide at least a 15-20' clear path (both sides) and meet conveyance requirement.

Water Features That Also Provide Regional Stormwater Management

Management of larger rainfall events will occur in facilities that may be several acres in surface area. These facilities can be developed into lakes, ponds, naturalized areas and constructed wetlands to provide effective methods of stormwater detention inside an aesthetic landscape water feature within the park system. These features should include the following:

- **Forebays or other pretreatment** to collect sediments, trash and other pollutants at accessible locations before they can be washed into the larger facility.

Photo 105

- **Surface and subsurface habitat improvements** to promote a more diverse array of fish and other wildlife that can act as predators to invasive and nuisance species. ▶

Photo 106

- **A mix of natural and formal landscapes** providing the habitat diversity and erosion protection of tallgrass prairies and wetlands, but allowing for more active recreation and access to the water in desirable locations.

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Photo 107

- **An aquatic safety bench around all deep water areas** to support shallow water shoreline vegetation and to prevent park users from falling into deep water if falling from the edge. ▶

Photo 108

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- **Public visibility and access** to encourage use of the facility and allow for ongoing maintenance and operation.

Map Index
Proposed Improvement Projects

A	*Water Quality Basin West of NW 86th Street*
B	*Green Meadows West Central Tributary Repair*
C	*Beaver Creek Shoreline Repair Near Augustine*
D	*Beaver Creek Shoreline Repair Near Future Recreation Trail Within Pioneer Property*
E	*Beaver Creek Shoreline Repair North of NW 62nd Avenue*
F	*Beaver Creek Shoreline Repair South of NW 62nd Avenue*
G	*North Glenn Channel Improvements and Bioretention*
H	*Green Meadows Flume Removal and Bioretention Network*
J	*Newgate Drive Stream Stabilization and Water Quality Basin*
K	*Augustine Stream Outlet Stabilization Near Future Recreational Trail*
L	*Improvements Downstream of Bright Trust*

Map Legend

Proposed Open Space "Green Network":
The connected series of public and private open spaces which provide access to urban stream corridors for operation and maintance, habitat for wildlife and opportunities for recreation.

Flood Map Overlay:
Areas designated by current FEMA FIRM maps as being inundated by the 100-year or 500-year flood events.

Camp Dodge Military Installation

Current City of Johnston Corporate Limits

RD *Proposed Regional Stormwater Detention Area:*
A constructed lake or wet pond designed with habitat improvements and aesthetic features, having a dual purpose of providing detention storage for extremely large flood events.

WT *Proposed Constructed Water Quality Wetland:*
Areas with flat topography and fully hydric site soils that appear to be ideal sites for constructed wetland systems.

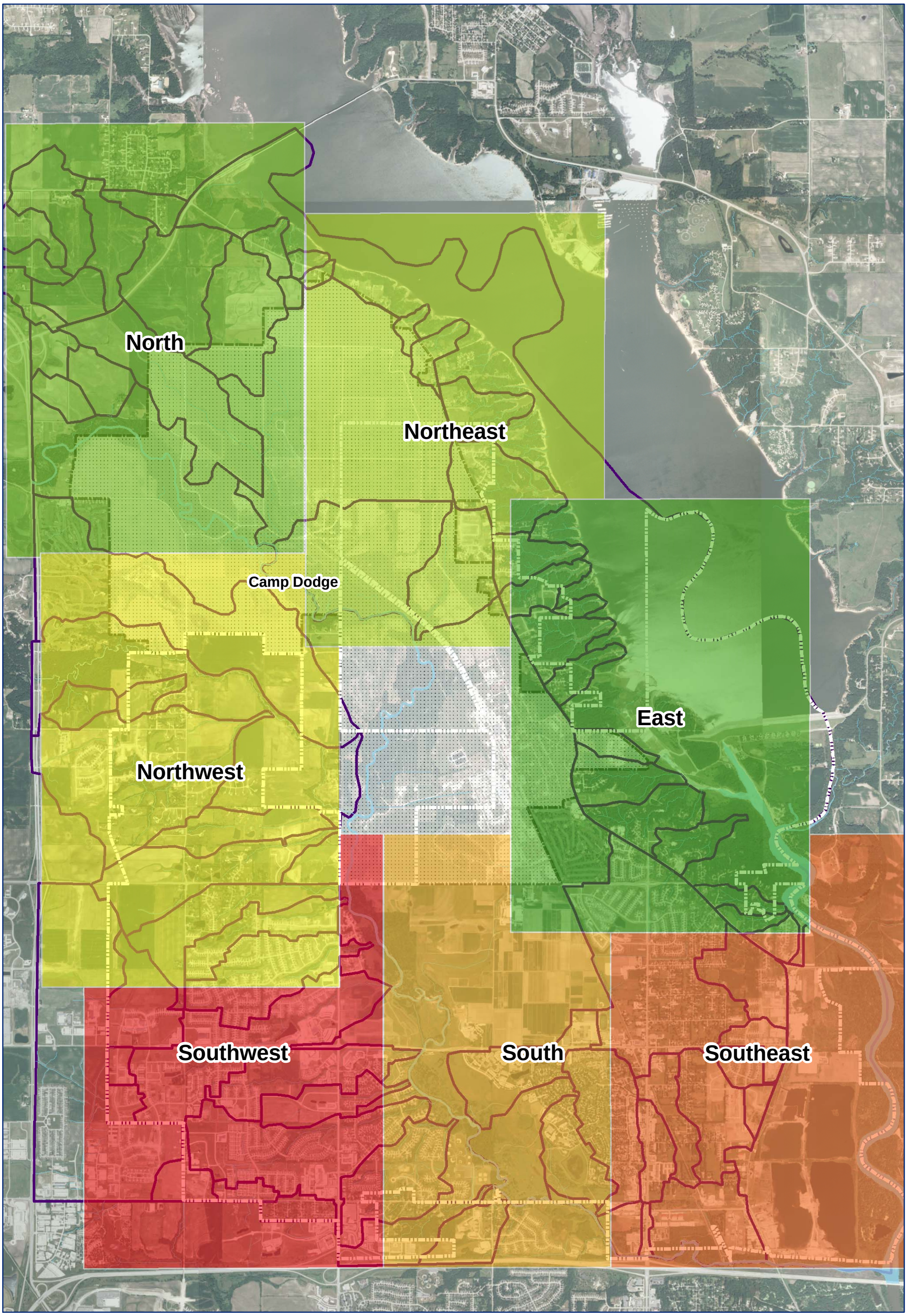
WQ *Proposed Water Quality Basin:*
Areas that could be constructed as forebays, wet pond storage or other means to capture and treat runoff from small storm events, to reduce the potential for downstream erosion or pollution transmission. Usually these can be located where there is sufficient room to grade a basin along an urban stream corridor just upstream of a road crossing.

Type II Stream Corridors

Type III Stream Corridors

Watershed Boundary

Linear Capital Improvement Project Area
(see preceding page for project delineations)



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Stormwater Master Plan Map Index

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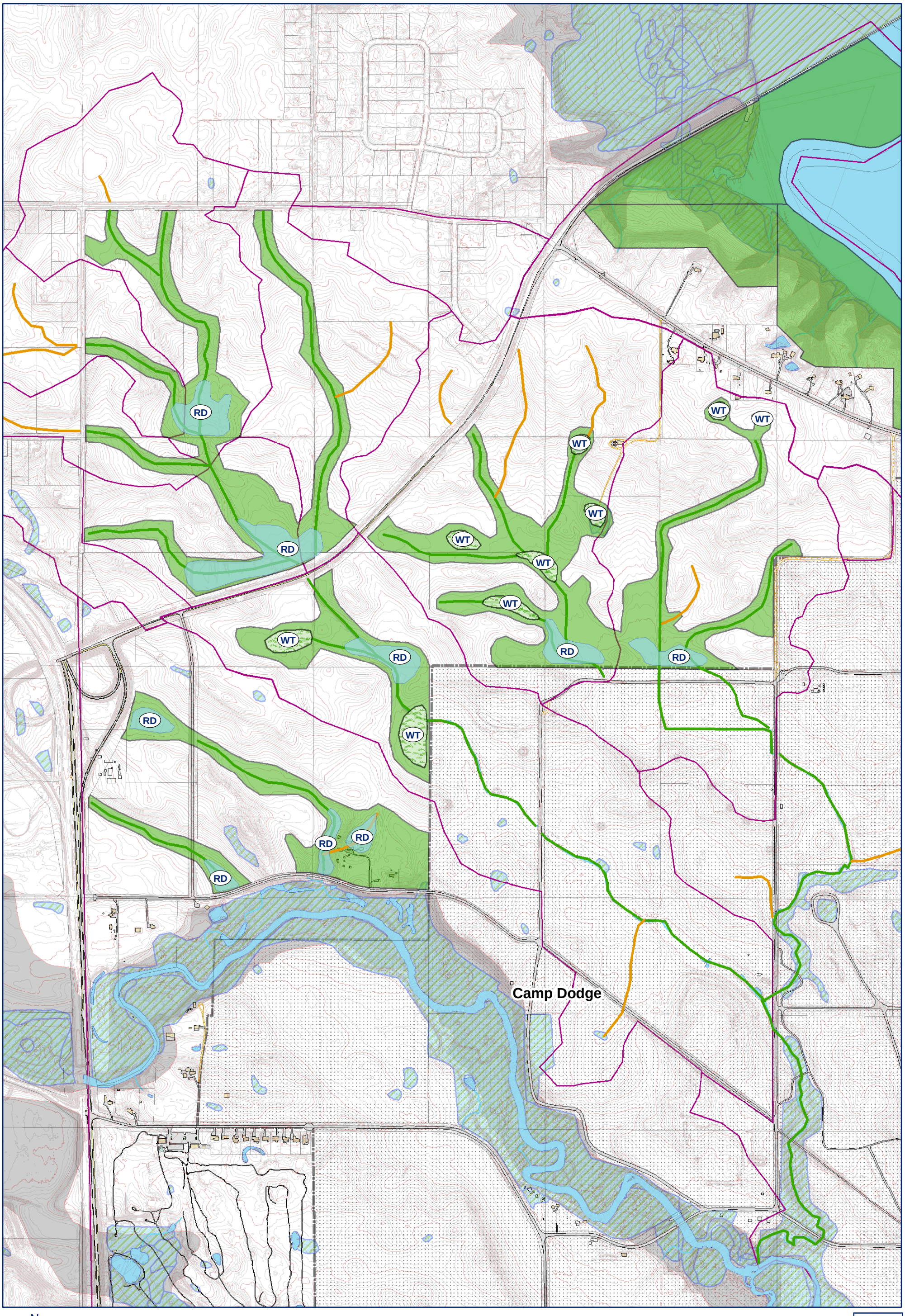

North Area Storm Water Management Plan

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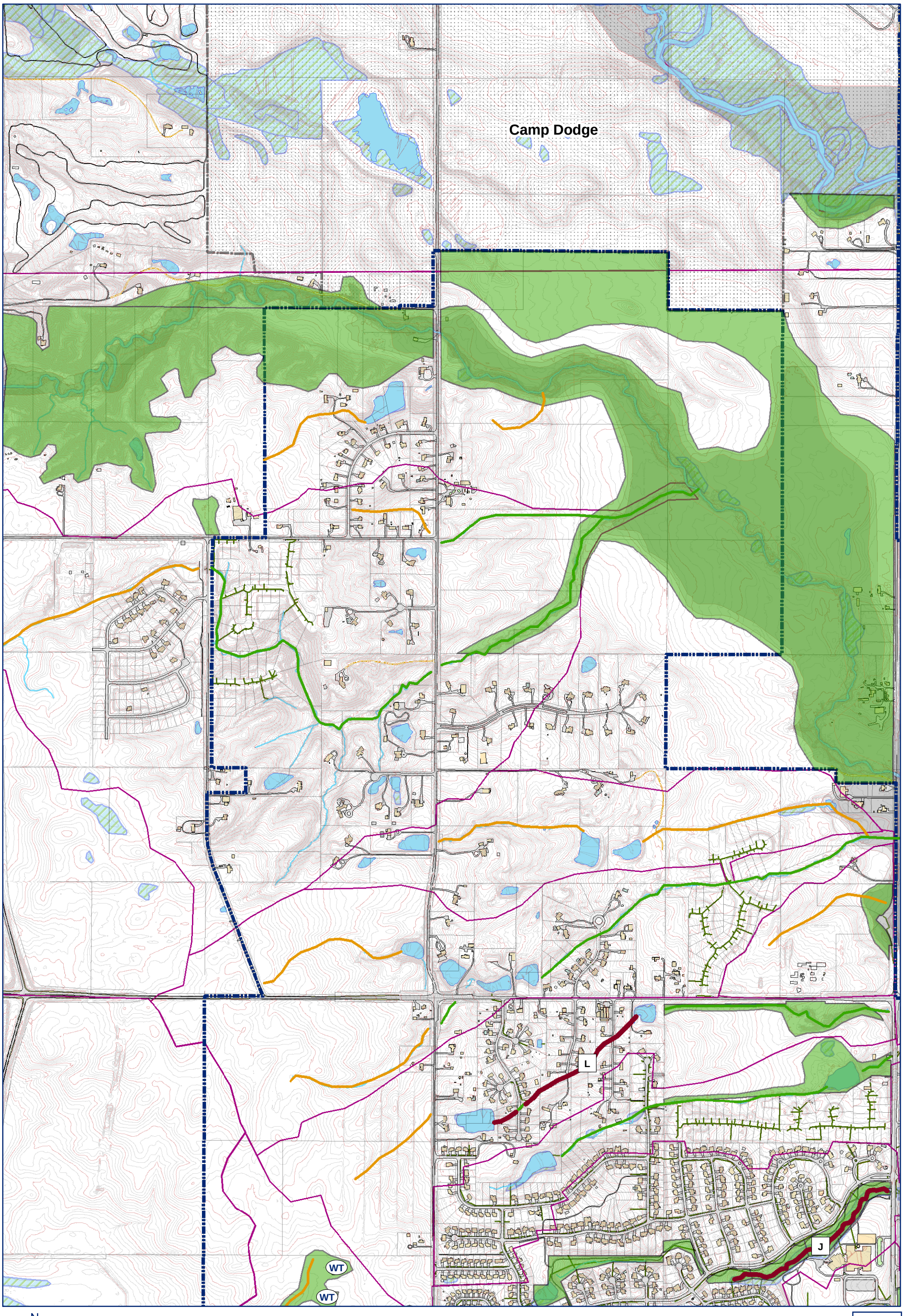

Northwest Area Storm Water Management Plan

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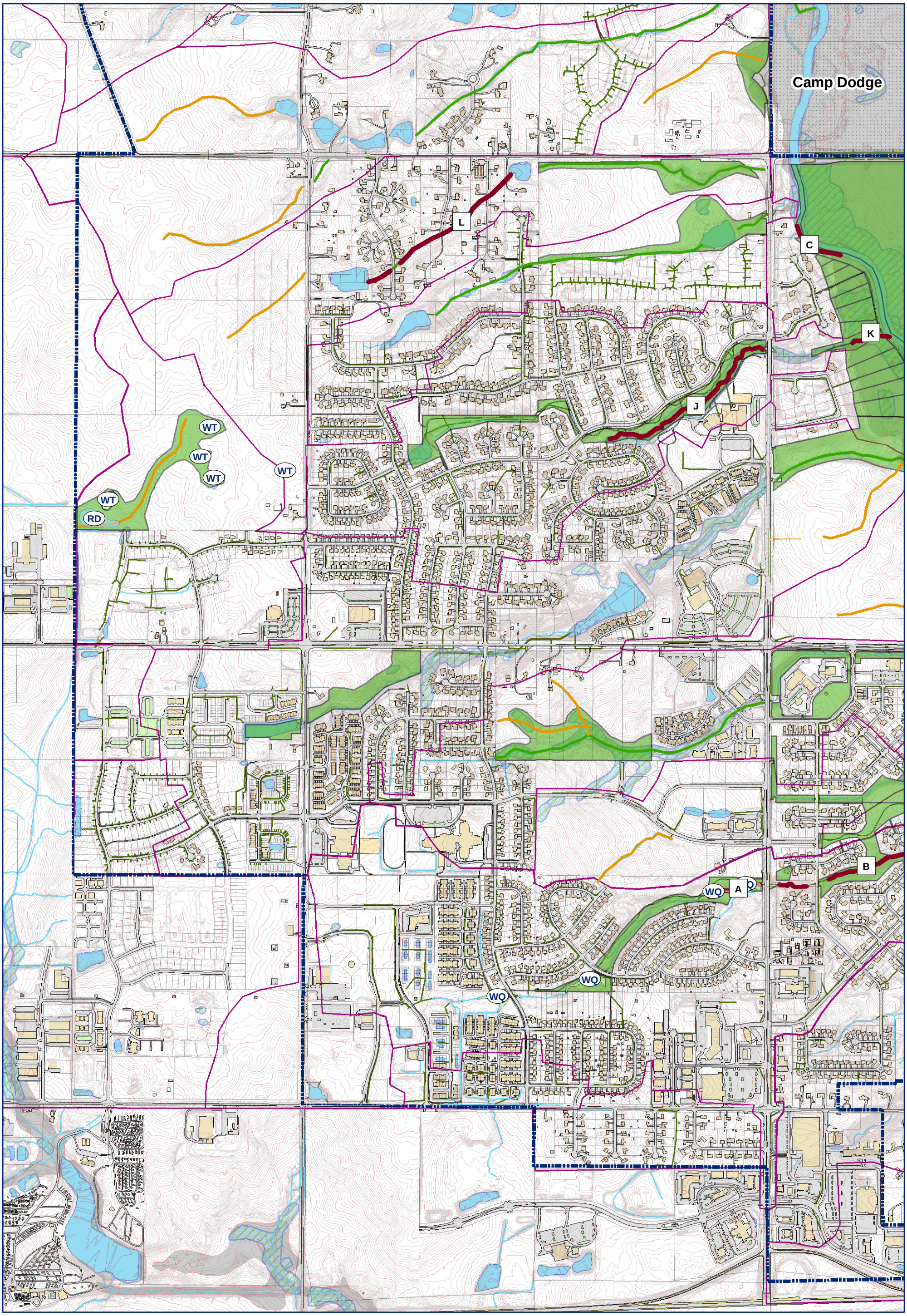

Southwest Area Storm Water Management Plan

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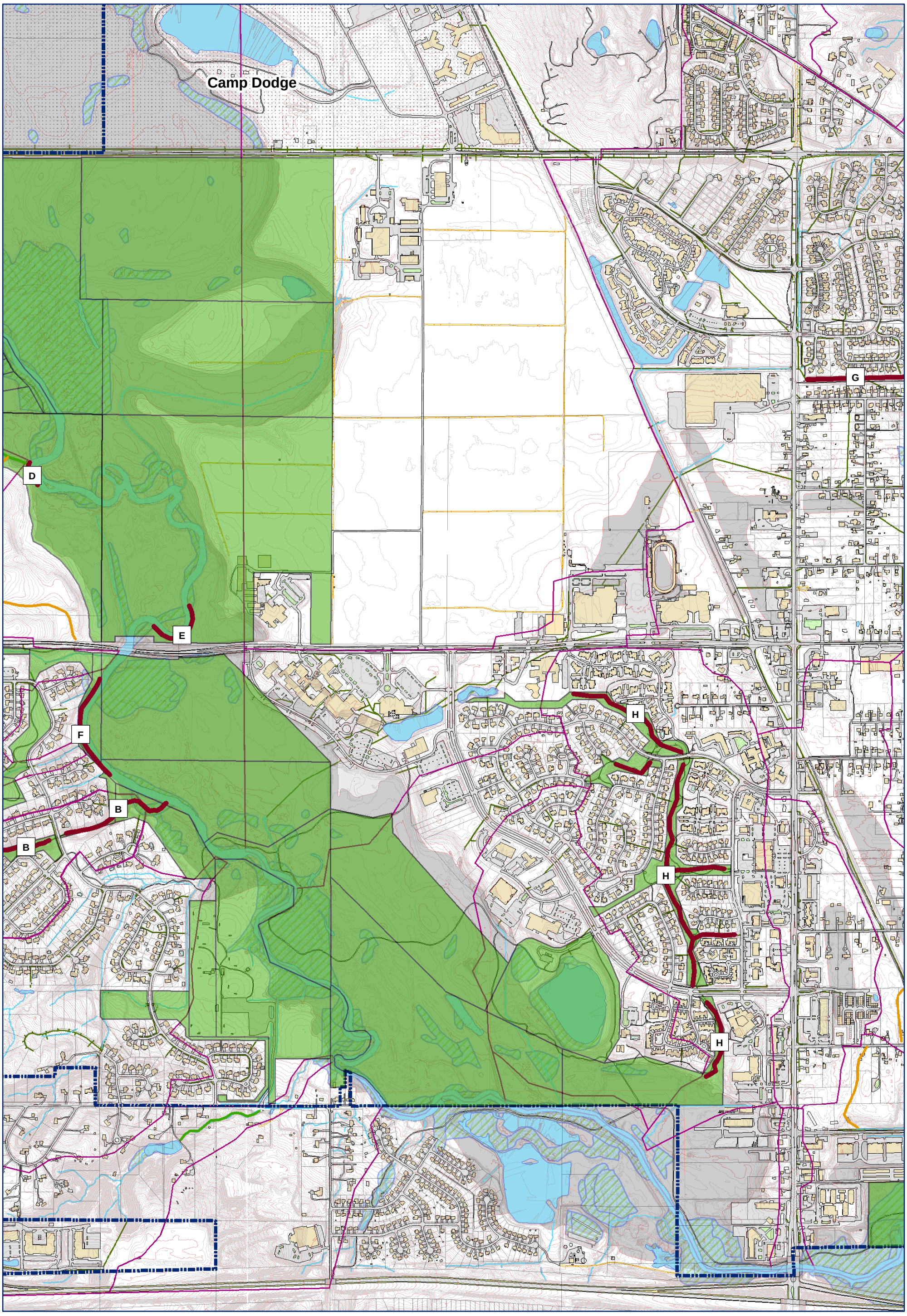

South Area Storm Water Management Plan

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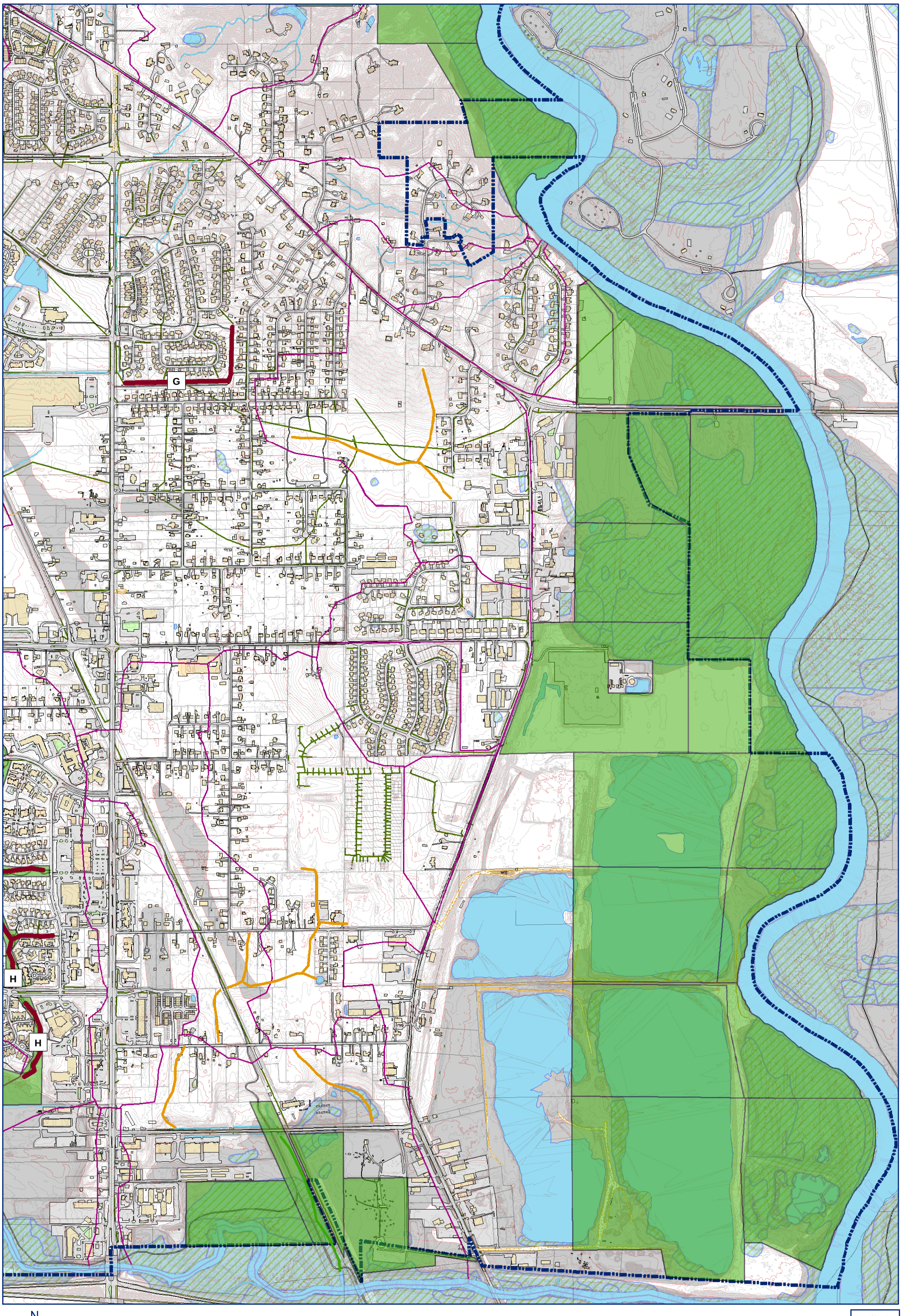

Southeast Area Storm Water Management Plan

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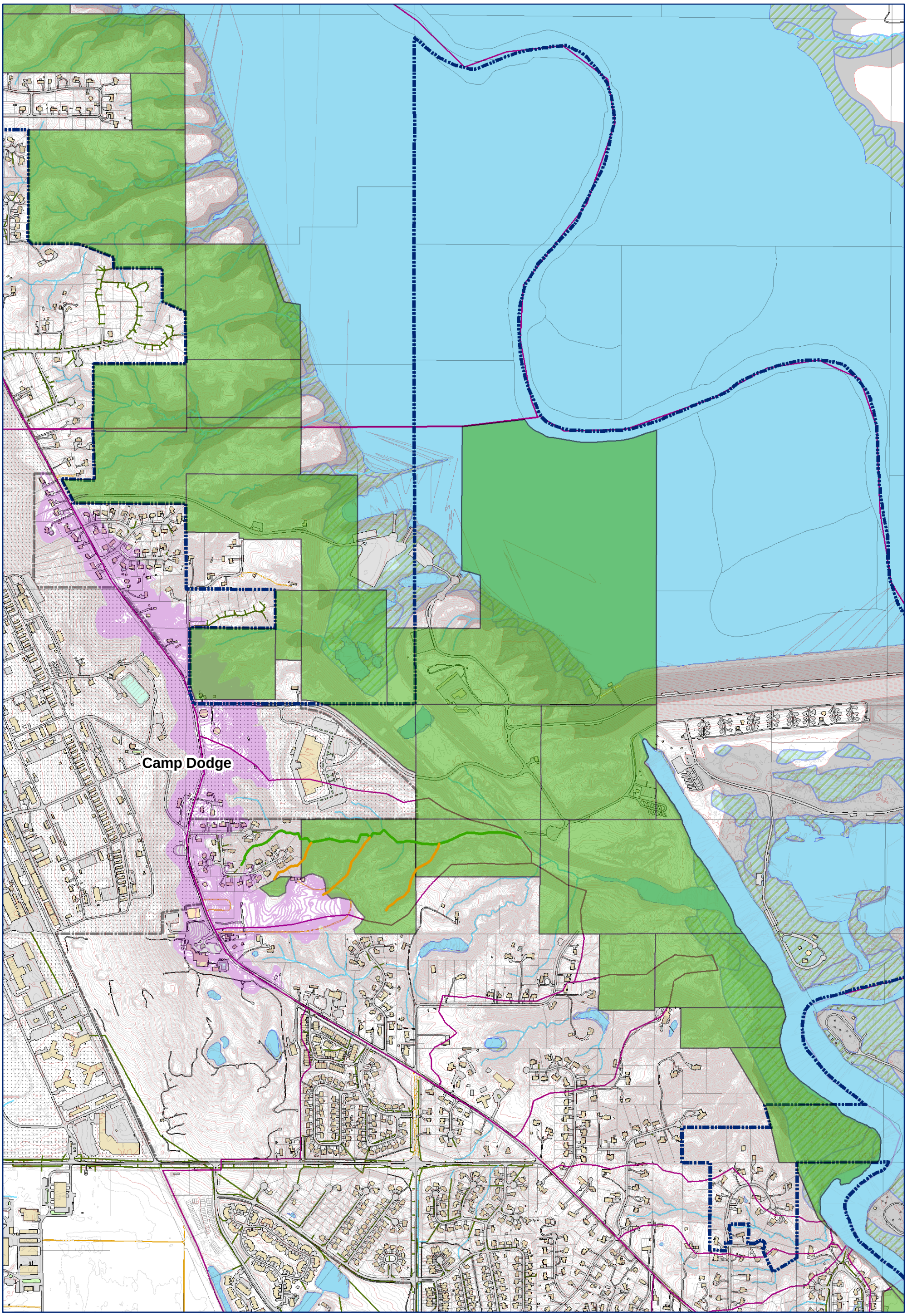

East Area Storm Water Management Plan

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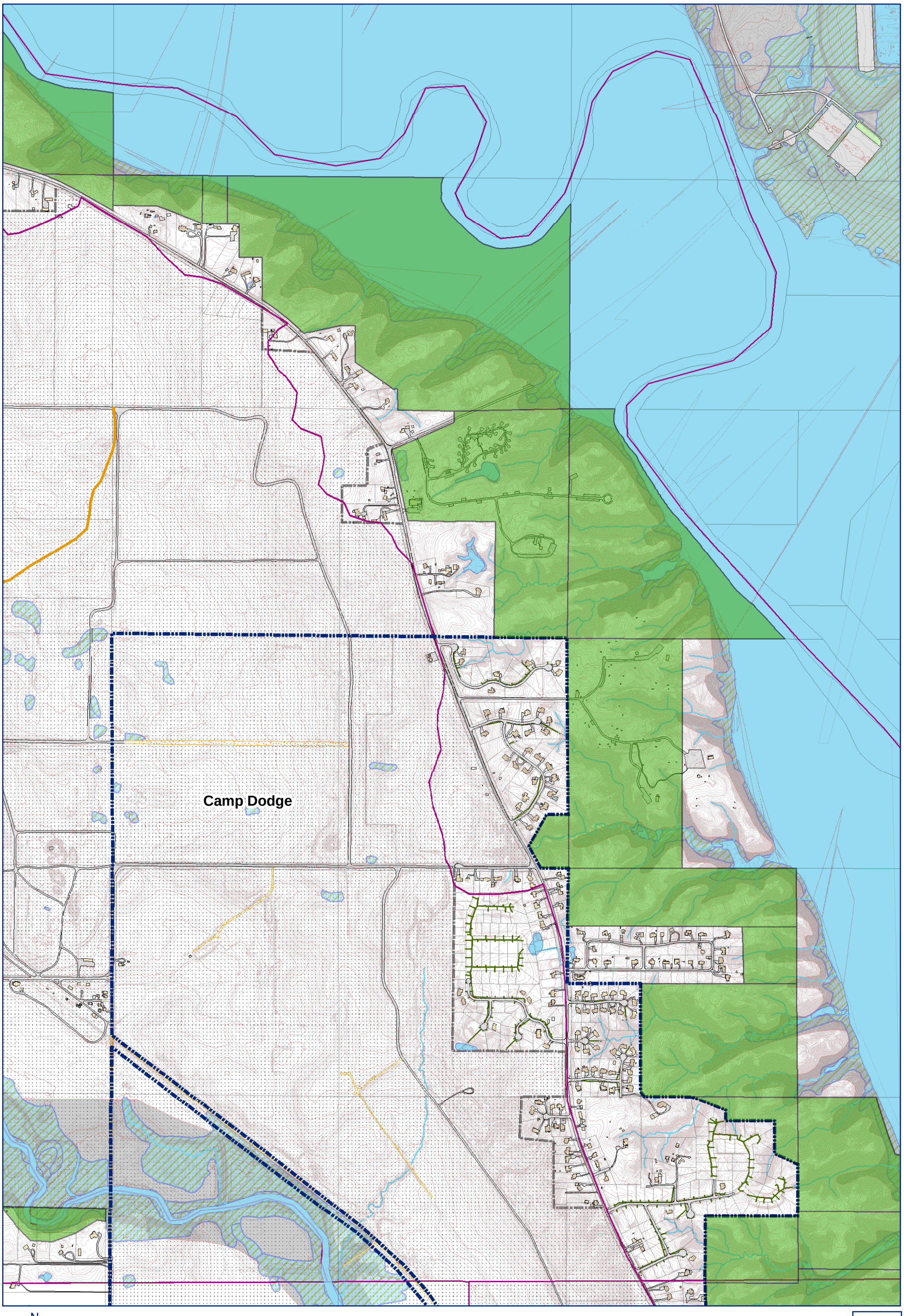

Northeast Area Storm Water Management Plan

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Citywide Watershed Action Plan

Citywide Watershed Action Plan

Watershed Action Plan

Overview of Impairments Identified by Watershed Assessment

Throughout the citywide watershed assessment process, over 80 locations were identified that were in need of some level of improvement or repair that could warrant consideration as City funded project. It was realized very early that funding sources would not be available to address all of the identified issues using City funds.

There was a need to narrow the list of projects to a more select group that could be reviewed in more detail. Problem areas were evaluated by a set of preliminary screening criteria, such as the potential danger posed to public and private infrastructure, expectations for additional damage without action, provisions for access, and the general scale of cost. Problem areas that did not threaten existing improvements, affected only a few property owners or had poor access from existing roads were most likely to be set aside from further consideration.

Just over twenty projects warranted further evaluation with City staff. The initial criteria were reviewed in more detail, along with new parameters that considered the overall watershed benefits and characteristics, habitat improvements, connectivity with other practices and the educational value of the project.

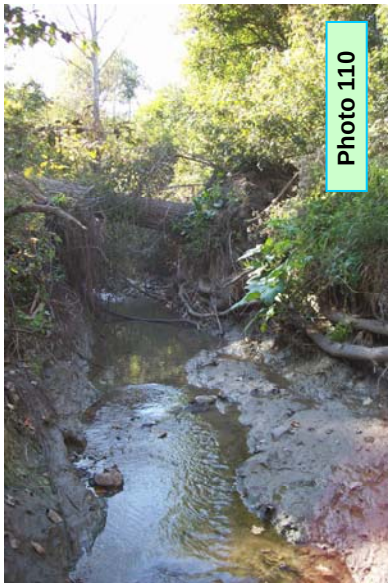
From this evaluation, nine projects were identified and presented to the steering committee. The purpose of the initial review was to identify projects that could be eligible for a watershed improvement grant, but the understanding was that most of these projects were considered strong candidates for inclusion in the City's long term capital improvements plan.

Potential Capital Improvement Projects

The following nine projects were reviewed at the December 2008 meeting of the steering committee:

- **Green Meadows West**
  Central Tributary Channel Repairs
  (Estimated Cost $1,800,000)

This corridor extends approximately 3,600 feet from NW 86th Street to Beaver Creek, through Green Meadows West. The stream corridor runs in land owned by the Green Meadows West Homeowner's Association, but several single family dwellings are located close to this stream. This channel is extremely down cut with eroded banks, with heavy debris. Several sanitary sewer manholes have been exposed through the corridor, and the conditions are likely to continue to degrade without intervention due to high-velocity flows and exposed steep side slopes. ▶



- **Green Meadows – Flume Removal and Bioretention Network** *($1,075,000)*

Photo 111

Green Meadows was constructed with a network of 9,450 feet of concrete flumes, which drain City streets and storm sewers toward Beaver Creek. Over time this network has become difficult for the City Parks Department to maintain, and has required routine removal of leaves, debris as well as pavement and scour erosion repairs. The existing network also impairs the quality of storm water runoff, by eliminating the possibility of infiltration and reducing opportunities for treatment and pollutant capture. In virtually any rainfall event, water will runoff of paved areas very quickly, and carries oils, sediments, nutrients and bacteria to the receiving waters. ◀

- **North Glenn – Drainageway and Bioretention Improvements** *($250,000)*

The North Glenn neighborhood drains to a long grassed channel that runs parallel to a City bike trail. Since its construction maintenance of this stream channel has been difficult. The channel is very flat and constantly has standing water. It also will rise quickly with large storm events. Several attempts have been made to improve the channel through minor regrading, work funded through neighborhood grants, and other efforts. Water flow from this area is also impeded by accumulated sediment on the downstream side of the Merle Hay Road box culvert, which has been cleaned several times in the past. ▶

Photo 112

- **Green Meadows West – Central Tributary Water Quality Basin West of NW 86th Street** *($925,000)*

Photo 113

At approximately 300 feet west of NW 86th Street, severe downcutting is in progress, including a free drop of approximately 9 feet. Without intervention, this erosion will continue to work its way east, potentially impacting residential back yards and accessory structures located along the creek, currently located 200 feet to the west. This location is also the last opportunity to control flow rates to the impaired stream that runs through the Green Meadows West subdivision.
(see previous page)
◀

- **Beaver Creek Shoreline Stabilization**
  Augustine *($2,000,000)*

Severe bank erosion exists along the northern edge of the Augustine subdivision on the west bank of Beaver Creek. This bank was already tall, but appears to have been impacted by flood events in 2008. The radius of the bend is not as sharp as some others along the corridor, so erosion does not appear as rapid, but the height of the slope is over 20 feet at its highest and public safety and the stability of privately owned land and trees is a concern. ▶

Photo 114

- **Beaver Creek Shoreline Stabilization**
  Near Future Recreational Trail Within Pioneer Property *($290,000)*

Photo 115

Severe bank erosion exists along a sharp bend near a chain link fence within Pioneer owned land. This location is near a planned recreational trail which will connect the Augustine subdivision to NW 62nd Avenue. This bank is about 10 feet tall and has impacted a fence and is within 50 feet of a trunk sanitary sewer. The erosion at this bend is extremely active, as there was approximately 15 feet of land on the east side of the fence when City staff walked this area in 2006. The erosion has since moved about 30 feet beyond the fence, leaving 100 feet of the fence in the stream. ◀

- **Beaver Creek Shoreline Stabilization**
  North of NW 62nd Avenue *($345,000)*

Severe bank erosion exists along a sharp bend on the east side of Beaver Creek. This erosion has moved several feet to the southeast with this year's flooding and over time could affect the road right of way. Future improvements plans in this area call for widening of NW 62nd Street, to add a set of westbound lanes constructed north of the existing roadway and bridge. The slope grading for this alignment is projected to fall within the eroded creek channel at this location. Any improvements at this location need to consider the ultimate construction of the roadway through this area. ▶

Photo 116

- **Beaver Creek Shoreline Stabilization South of NW 62nd Avenue** *($575,000)*

Severe bank erosion exists along residential uses on the west side of Beaver Creek. This erosion has moved the bank west a few feet into private yards this year, and has undermined a few trees along the corridor. No structures appear to be in immediate danger, but property loss will likely continue during large flood events. ▶

Photo 117

- **Newgate Drive Stream Corridor Restoration** *($1,150,000)*

Photo 118

The stream corridor along the south side of Newgate Drive is generally classified as moderately unstable, with steep slopes and heavy wooded debris. A number of storm outlets have been undercut by excessive erosion over time. The corridor lacks a natural system of riffles and pools and sustains little quality habitat along its length, effectively acting as only a large urban storm sewer. Newgate Drive floods periodically near its low point, either from backwater from the stream or an undersized outlet storm pipe. ◀

Project	Estimated Construction Cost in 2010 dollars (includes Design and Administration)
Green Meadows West Central Tributary Channel Repairs	$ 1,800,000
Green Meadows Flume Removal and Bioretention Network	$ 1,075,000
North Glenn Drainageway & Bioretention Improvements	$ 250,000
Green Meadows West Central Tributary Water Quality Basin	$ 925,000
Beaver Creek Shoreline Stabilization Augustine	$ 2,000,000
Beaver Creek Shoreline Stabilization Near Future Rec. Trail Within Pioneer Property	$ 290,000
Beaver Creek Shoreline Stabilization North of NW 62nd Avenue	$ 345,000
Beaver Creek Shoreline Stabilization South of NW 62nd Avenue	$ 575,000
Newgate Drive Stream Corridor Restoration	$ 1,150,000
Total for These Projects	$ 8,410,000

Additionally, other projects considered by City staff may warrant inclusion in the near term capital improvements program.

- **Storm Sewer Improvements Downstream of Bright Trust**

Photo 119

◀

A small tributary runs through a series of agricultural ponds and narrow swales downstream of the Bright Trust. This drainageway runs from the east side of NW 100th Street to the northeast until it reaches the south side of the NW 70th Avenue right of way, which it then parallels until it reaches Beaver Creek. These ponds and swales were not designed to convey urban runoff from the Bright Trust, and upgrades and maintenance of these facilities may be required to support additional development.

- **Augustine Tributary Channel Stabilization Near Future Trail Crossing**

  As part of the construction of the Augustine subdivision in 2005, the developer made significant improvements to grade back unstable slopes and install toe protection armor to stabilize sections of this stream running between proposed residential lots. A section of the stream between these improvements and its outlet to Beaver Creek was not addressed by these improvements. In order to prevent streambank erosion from impacting a proposed recreational trail after it has been constructed, additional improvements may be necessary. ▶

Photo 120

Project	Estimated Construction Cost in 2010 dollars (includes Design and Administration)
Bright Trust Storm Sewer	$ 360,000
Augustine Outlet Stabilization	$ 135,000
Total for These Projects	$ 495,000

There are also other long term costs that have yet to be programmed into the capital improvements plan, but shifts in development trends or other priorities could require inclusion of additional costs for new projects or maintenance.

- **Storm Sewer Utility Extensions to the Pre-incorporation District**

Redevelopment plans for this area, or the need to provide higher level utility and street infrastructure could require funds to be provided for storm sewer construction along existing ROW corridors, currently built with rural cross-sections without storm sewer systems. Higher intensity development of this area may make a more formal storm sewer system necessary. ▶

Photo 121

- **Other Repairs or Enhancements to Stream Corridors**

Photo 122

◀

The current capital improvement plan only addresses a small fraction of the erosion and maintenance issues witnessed within the City of Johnston's urban stream corridors. These issues have been formed primarily over the last two decades, and are very dynamic in nature. Less prominent erosion issues today can become significantly worse due to a variety of factors. Ongoing observation of known issues will be required and additional maintenance or improvements proposed should stream stability issues become markedly worse in certain areas that are not currently scheduled for repairs.

- **Construction of Regional Stormwater Management Controls in Developing Areas**

The phasing of stormwater controls programmed for developing areas is largely unknown at this time. When significant development begins in certain areas, such as the northern development corridor near Saylorville Road, significant funds will be required to establish the green network of streams, wetlands, ponds and lakes.

Means of Funding Identified Improvement Needs

The identified projects represent nearly $9 million (in 2010 construction value) that primarily have not been included in the City's near or long term capital improvements program. Several of these projects warrant prompt action to prevent damage to private property and public utilities. Addressing these impairments within the existing financial structure of the City represents a significant challenge. There are several options for providing funding for these projects:

- **City General Funds**

  In order to address the high priority projects identified within this report within the current City funding structure, general obligation bonds would likely need to be issued for financing. City staff has completed an analysis which shows that inclusion of these projects would likely increase the City's debt service levy by about $0.50 per year over the next five years, which is the length of the City's CIP financial planning model. This would push the debt service levy above $4.00 in FY 2014-2015, exceeding the previously established goal of at or below $3.75. It is possible that delays in other City projects or programs would need to be considered or property tax rates increased to fund these projects within the existing financing structure of the CIP.

- **Federal and State Funded Grants**

  There are several grant programs that target projects related to watershed improvements, storm water treatment or conveyance. There is a competitive application process for these grants, but it is possible to fund some of these projects in this manner. Most grants have a maximum award amount and require the City to provide some level of matching funds towards the design and construction of a project under consideration for funding.

  For smaller projects, City general funds could be used to meet these matching requirements. However, for larger scale projects, it will be difficult to provide matching funds or make up the difference between the maximum award and the overall cost of design and construction. Grants also are one-time sources of funds related to project construction, and typically do not address how to provide long-term operation and maintenance expenses.

- **Creation of a Storm Water Utility**

  The City could consider adopting an ordinance which would create a storm water utility. Similar to utilities established for funding water and sanitary sewer projects, such a utility develops a revenue stream by charging a monthly fee to "users" to construct, operate and maintain storm water related improvements. The utility would need to be established as a separate fund which would be dedicated solely to address storm water related issues.

  Such a system offers a stable, dedicated funding stream that could be used for the improvement and maintenance needs identified as part of the watershed assessment. Utility funds can also be used as collateral to leverage funding sources for larger construction projects, such as loans and grants. Forty-five cities within the State of Iowa have established such a utility, including the communities of Des Moines, Clive, Ankeny, West Des Moines, Waukee and Norwalk. The concept of a storm water utility is further detailed over the following five pages to provide a more detailed explanation of the complexities of such a utility, since this would be a new concept for the City.

- **Loans and Revenue Bonds**

  Implementation of a storm water utility could make it easier to finance larger scale projects. This would allow them to be constructed earlier than if utility funds were collected and saved over a period of years to pay for improvements directly from the fund. A steady, established utility fee can be barrowed against and paid back over a period of time from collected revenues. Usually such bonds or loans are over an extended period of time (i.e.20 years) and typically at a relatively low interest rate (3-5% per year). This increases the overall cost of the project in the long term, but the effect of this is tempered somewhat by avoiding potential inflation in construction costs that would be encountered by delaying projects for several years.

Basics of a Storm Water Utility

Should the City adopt an ordinance which establishes a storm water utility, it could begin collecting user fees from generators of storm water throughout the City. Functionally this is usually done by adding the fee as separate line items to individual water bills. A storm water "user" is typically defined as any property that has been improved with hard surfaces such as buildings, parking lots, sidewalks, trails and driveways that generate the majority of storm water runoff in an urban environment.

Cities with utilizes have established fees in a variety of ways:

- **Charge a flat rate fee for all users.** All "users" are charged a flat monthly fee regardless of the size of their property, or the amount of hard surfaces built upon it.

- **Charge a fee based on the size of a given user, with a factor related to development intensity.** Larger parcels pay higher fees and multipliers are applied for land uses with more hard surfaces (such as commercial and industrial uses). This method accounts for the size of the "user" but will treat sites within a similar land use essentially the same, regardless of the actual amount of hard surfaces constructed on their sites.

- **Charge a fee based on the impervious area of a given user.** A set fee can be established for a certain base unit of hard surface area. Available GIS hard surface data, site plan and building permits can be reviewed to determine the number of units that each user will be charged for. Theoretically this method most directly ties the amount of storm water a user generates to the fee that will be charged, but if can be burdensome to calculate and update the amount of hard surfaces on all parcels within the City, especially those in residential areas.

- **Charge flat rate fees for residential users, but base fees for higher intensity uses on their impervious areas.** Many cities that have established a utility have used a variation of this method. It still closely ties the fee paid by users to the amount of storm water they are expected to generate, but it establishes a flat rate for residential properties meaning that it is unnecessary to calculate the hard surface area for each of the over 5,000 residential properties within the limits of the City. An average impervious area is typically established for single family parcels within the City, based on a significant sample of actual residential properties. The average hard surface area for a typical single family lot is called an ERU (equivalent residential unit). The amount of hard surfaces on commercial and industrial users are reviewed and converted to an equivalent number of ERUs. For example, if an ERU is established as 4,000 square feet of hard surfaces; then a commercial property with 40,000 square feet of impervious areas would be assigned 10 ERUs. Each type of user is assigned a fee they will be charged for each ERU.

These options for fee structure were discussed extensively with City staff and were reviewed with the Stormwater Steering Committee at their March 2009 meeting. The consensus of both groups was that the final option would be the preferred option to pursue, as it ties the generation of storm water runoff to the fees being charged, but would be easier to implement by not requiring assessments of actual hard surface areas on all residential properties throughout the City. This method also provides incentive to review design options as part of new construction and retrofits that reduce the footprint of impervious areas, thereby reducing the burden on the storm water network as a whole.

The Steering Committee has also expressed interest into incorporating a system of grants or credits as incentive to property owners to manage stormwater more effectively. Fee reductions or other credits could be based on a variety of things such as installation of a series of BMPs on a site that meet certain design criteria, construction of stormwater retrofits on existing sites, open space conservation or dedication; and other special circumstances. A grant program could also be considered to assist property owners in the design or construction of practices that achieve targeted stormwater treatment goals. Credits or grants (as well as the means to implement and monitor such programs) should be discussed in greater detail as part of any future discussion regarding establishment of a storm water utility.

Establishing a Fee Structure

Calculating an Equivalent Residential Unit (ERU)

Pursuing the preferred option to establish fees based on ERUs, it was first necessary to evaluate the impervious areas of a sampling of single family residential lots. City GIS data was used to calculate the hard surface areas of a variety of residential lots in wide range of lot widths and densities. Over 200 residential properties were reviewed, having an average impervious area of 4,200 square feet. This evaluation included several large lot residential properties which had much larger impervious footprints than smaller, more typical suburban lots.

Many other Iowa communities have established ERUs between 2,500 and 3,200 SF. Taking this into consideration, it is recommended to establish an ERU as 4,000 square feet of impervious area. It should be noted that using a smaller value for an ERU increases the number of ERUs for each commercial and industrial properties. If a smaller value for an ERU was chosen, it would raise the monthly fees that would be charged to every higher intensity user.

Evaluating Citywide Total of ERUs

Single family residential units, townhomes and apartments are proposed to be categorized as residential units for the purpose of storm water utility rate calculation. Based on available water billing data and current building permits, the breakdown of the number of residential users in the spring of 2009 are as follows:

Single Family Residential	**4,600**
Townhomes	**787**
Apartments	**340**
Total Residential ERUs	**5,727**

Over 350 commercial and industrial properties were reviewed to determine their impervious areas. All properties that receive water bills were included in this review. Public facilities, schools and churches were also included in this evaluation. An ERU value was calculated for each of these higher intensity users. Based on an ERU of 4,000 square feet, just over 4,300 ERUs of impervious area were located on these types of properties when mapped as part of the Polk County GIS system in 2006. Combining residential and higher intensity users, it is estimated that approximately 10,000 ERUs were located within the City limits during the period of evaluation.

For future revenue analysis, it is assumed that the total number of ERUs will remain steady through fiscal year 2011, and will grow at a linear rate of 2% beyond 2011 (an average additional 18 acres of hard surfaces developed each year). This is likely to be a conservative assumption, applied to avoid overestimating the long-term growth potential of the utility fund.

Assessment of Financial Need

As mentioned previously, there is a need to generate over $9 million to fund capital improvement projects related to storm water. Many of these projects need immediate attention to prevent damage to infrastructure or property. Not all of these projects can be constructed immediately, and as they are delayed inflation in design, administration and construction costs of 4% per year have been assumed.

As the City begins to take ownership of more open space areas, and pursue construction of storm water improvements, it will be necessary to dedicate funds for ongoing operation and maintenance (O & M). As part of this analysis, it is assumed that 10% of collected revenue in the first year of the utility would be dedicated to O & M, rising to 20% by the third year. This leaves the remaining funds to be applied to new construction projects.

Discussions with the steering committee and City staff also reviewed the possibility of using utility funds to absorb some of the existing costs associated with storm system maintenance and NPDES permit compliance. The 2008 annual report to the DNR identified the annual cost to the City for such services as $376,000. Given the large number of projects identified, a much higher utility fee would be needed to fully absorb these costs. It was also stressed as a priority that a new fee should be used to provide a higher level of service to the residents of the City, rather than being used to shift existing costs from the general fund to another source.

Some cities have also allowed application of credits or sponsored grants to encourage water quality retrofits or improvements. Iowa City, for example, dedicates $25,000 annually to a fund that offers design and financial assistance to residential and commercial property owners looking to add raingardens or other water quality improvements to their properties. For the purpose of this budget analysis, it is assumed that such credits might be considered as an option, and $10,000 has been dedicated to such efforts through the first five years of the utility, assumed to be increased to $25,000 per year in years six through ten.

From this study, it has also been realized that many issues can develop or change greatly over a short period of time. For this reason, it is assumed that 10% of each year's revenue will be dedicated to unprogrammed capital improvement projects focused on larger repair or maintenance issues. These funds could be saved if not needed, or applied to identified projects to allow them to be constructed in a more timely manner; or applied to other projects that were identified but were not included in this storm water capital improvements plan due to lack of available funds.

Given these parameters, the following staging of projects to be funded by the storm water utility is proposed to address the needs identified within this study (assuming utility collection would begin in fiscal year 2011):

Construction Year	Project	Cost to Utility (2011-2020)
Payments for Financed Improvements		***$ 3,127,000***
2011	Green Meadows West – Water Quality Basin	$ 599,000
2011	Beaver Creek – South of NW 62nd Avenue	$ 372,000
2011-12	Green Meadows West Channel Restoration	$ 1,074,000
2013	Beaver Creek - Augustine	$ 1,082,000
Programmed Improvements Paid by Direct Utility Funds		***$ 2,165,000***
2012	Bright Property Downstream Improvements	$ 324,000
2012	Augustine Stream Outlet Repair	$ 146,000
2012	North Glenn Channel Improvements	$ 135,000
2012	Beaver Creek – Near Rec. Trail, Pioneer Property	$ 78,000
2013	Green Meadows Flume Removal – Phase 2	$ 448,000
2014	Beaver Creek – North of NW 62nd Avenue	$ 256,000
2020	Newgate Drive Channel Improvements – Phase 1	$ 777,000
Expected Operation and Maintenance Budget		***$ 1,461,000***
Retrofit Credit or Grant Program		***$ 175,000***
Unprogrammed Capital Improvement Projects		***$ 785,000***
Total Funding Needs (2011-2020)		***$ 7,713,000***
Estimated Revenue Generated (2011-2020)		***$ 7,848,000***

It should be noted that the four projects listed to be financed need urgent attention, but are extremely costly. There will be insufficient funds built up in the utility reserve to pay directly for these improvements. Federal or state loans, leveraged against utility revenues will be necessary to complete these projects this early in the program. Many of these types of loans can offer terms of 20 years with low interest rates, so the finance interest cost is likely balanced when compared against inflation related to construction delay or additional stream degradation.

With this program, it is also assumed that other sources of funding will pay for all or portions of several projects:

- **Green Meadows Flume Removal – Phase 1 (2010).** Anticipated to be paid by $375,000 in general funds and $300,000 in grants. It is anticipated that project construction could precede adoption of the storm water utility and collection of adequate revenue to pay for design and construction.

- **Beaver Creek Shoreline Repair Near Future Trail (2012).** The streambank has moved 40 feet to the west over the past two years and is now in the general vicinity of a sanitary sewer trunk main on the west side of the creek. It may not be possible to wait for establishment of a storm water utility to repair this issue. There may be a temporary solution provided by slope grading in this area, which would need to be monitored closely for continued erosion. Additional $72,500 for toe armor protection is programmed into this proposed capital improvements budget in 2012.

- **North Glenn Improvements (2012).** It is hoped that half of the project cost would be paid by a watershed improvement or other type of grant. The remainder is noted as paid by the utility.

- **Beaver Creek Shoreline Repair North of NW 62nd Avenue (2013).** This project is expected to be completed as part of widening the roadway to a boulevard cross-section in this area. Twenty percent of the cost of this project is assumed to be absorbed within the grading portion of the funding of the road project itself. The remainder is noted as paid by the utility.

Calculation of Required Fees to Cover Expenses

With the projects as selected and scheduled, and the assumptions of other sources of funding listed above, a fee of $6.00 per ERU will be necessary to generate enough revenue over a ten year period to cover these expenses. Such a fee would be expected to generate $7.8 million over this period, yielding an account balance of approximately $136,000 in 2020 (minimum anticipated balance of $11,000 in 2014. Balances will need to fluctuate greatly from year to year to save up for larger construction projects in later years.

During the second ten year period (2021-2030) about $4 million is required to continue to make annual payments for the projects financed and constructed between 2011 and 2013. The second phase of the Newgate Drive Stream Corridor Project is anticipated to be constructed around 2022. It is expected that most of the remaining funds generated by the utility will go towards construction of the green infrastructure network in the northern development corridor, near Highway 415. Remaining funds could be applied to other water quality and improvement projects that could become required by future changes in water quality regulations or modifications to the City's MS4 permit requirements.

Construction Year	Project	Cost to Utility (2021-2030)
	Payments for Financed Improvements	***$ 3,967,000***
	Programmed Improvements Paid by Direct Utility Funds	***$ 547,000***
	Expected Operation and Maintenance Budget	***$ 1,858,000***
	Retrofit Credit or Grant Program	***$ 340,000***
	Unprogrammed Capital Improvement Projects	***$ 2,376,000***
	Total Funding Needs (2011-2020)	***$ 9,088,000***
	Estimated Revenue Generated (2011-2020)	***$ 9,288,000***

Steps to Implement a Storm Water Utility

It is recommended that the first step in implementing a public utility is raising public awareness of the issues surrounding storm water within the City of Johnston, and the financial need that has developed. The public needs to understand the urgency surrounding some of these issues and the need to take action. The citizens also need to be assured that with this additional fee, comes a higher level of service and improvements to their community that are both visible and quantifiable. It needs to be clear how the improvements proposed add value to the community as a whole.

It is important to gain acceptance of both residents and local businesses. Large businesses will pay much higher monthly fees than individual residential users. The system of assessing the fees needs to appear fair and equitable.

A draft ordinance can be created, influenced by other ordinance employed or proposed by other communities from around the state and across the nation. The ordinance would follow the typical public hearing procedures, to be adopted and become part of the City code.

Close cooperation will be necessary between City departments, to address billing issues and conflicts. GIS map information, county assessor information and approved site plans can be used as resources to develop ERU calculations for higher-intensity uses.

Conclusion and Final Recommendations

● Short term goal ● Long term goal

In final review of the proposed Stormwater Master Plan and Watershed Action Plan, the principles and objectives set forth by City staff and the Stormwater Steering Committee can be achieved by the following:

- ***Follow a conservation design ethic, to protect high quality natural areas and open spaces.***
  - *Use design guidance documents and the developed master plan to work with developers, engineers and planners to include stormwater management at the beginning of the design process.*
  - *Develop a sensitive areas ordinance to preserve high quality natural areas, sensitive sites and open space corridors.*
  - *Over time, construct the proposed green network of storm water improvements in developing areas.*

- ***Treat stormwater as a resource to be conserved, rather than a waste product to be disposed of.***
  - *Construct aesthetic and high quality landscape features such as lakes, ponds and constructed wetlands to provide water quality treatment and enhanced habitat within areas open to public recreation.*

- ***Encourage the use of effective, sustainable, attractive and safe best management practices (BMPs) to improve the quality and reduce the volume of stormwater runoff.***
  - *Review and update City ordinances as necessary.*
  - *Apply site appropriate BMPs at the site level and as part of City infrastructure projects to address Water Quality management needs.*

- ***In developing or redeveloping areas, promote better site design methods to reduce impervious surfaces, reduce the volume and impact of grading activities and employ BMPs to mimic pre-settlement hydrology to the greatest extent possible.***
  - *Apply site appropriate BMPs at the site level and as part of City infrastructure projects to address Water Quality management needs.*

- ***Locate water quality and quantity controls so that they are accessible and maintainable.***
  - *Locate regional management controls within a City owned green network, with appropriate access for maintenance vehicles. Where possible, locate site level controls near public streets, parking lots or adjacent to the green network so private maintenance can be conducted more easily.*

- ***Consider long-term operation and maintenance of proposed stormwater management facilities as part of site design.***
  - *Review guidance information in this document, technical review guidance and the Iowa Stormwater Management Manual for additional information.*

- ***Encourage sound engineering practices in the design and construction of stormwater management facilities as early in the design process as possible to ensure flexibility.***
  - *Use design guidance documents and the developed master plan to work with developers, engineers and planners to include stormwater management at the beginning of the design process.*
  - *Make sure that stormwater management is a key topic discussed at early planning and pre-application meetings.*

- ***Develop a funding source dedicated to stormwater management improvements.***
  - *Develop and enact an ordinance forming a Storm Water Utility.*

- ***Develop public education programs, informational handouts and encourage dialog on the importance of stormwater management techniques.***
  - *Use information gathered as part of this effort, to build on existing educational efforts to make citizens, designers and political representatives aware of the issues regarding stormwater management within the community.*

Technical Guidance Documents

Technical Guidance Documents

Background and Purpose

Previous sections of the Watershed Assessment and Stormwater Management Plan have detailed the impairments and stream conditions identified throughout the City. Many of these issues have been greatly influenced by the traditional methods of stormwater management that have been employed in these watersheds.

To review this relationship, six existing stormwater management sites from areas around the City were selected as a representative sample for further technical review of their original design. The six sites were chosen to represent a diverse selection of sizes and land uses. The original design of each facility was completed using the modified rational method, primarily focused on controlling runoff during a 100-year storm event. While this method has been historically an accepted standard for use in this area, concerns have been developing for several years that this method fails to address the effects of small storms, may underestimate the storage requirements for large storms by underestimating runoff rates and volumes; and focuses on very intense, short duration storm events.

To review the potential of these concerns, the site data from the original studies was used to create a runoff model (using TR-55 software as per the Iowa Stormwater Management Manual) that could be routed through the basins as they were originally designed. This model looks at a longer duration storm with more total rainfall volume (usually a 24-hour event). A summary of the results of this analysis can be seen below:

Condition	2-year peak (cfs)	5-year peak (cfs)	25-year peak (cfs)	100-year peak (cfs)	Original Study*
Commercial #1	*26.3 acres*	*32% imperv.*	*Dev. CN = 73*	*Tc = 15 min.*	
Developed to Basin	24.8	40.9	79.3	119.6	
Basin Release	14.3	18.3	23.4	39.7	26
Pre-settlement	2.0	6.3	20.8	39.3	
Commercial #2	*12.6 acres*	*75% imperv.*	*Dev. CN = 89*	*Tc = 15 min.*	
Developed to Basin	28.8	39.0	60.2	80.6	
Basin Release	4.9	5.8	7.3	25.7	8.8
Pre-settlement	1.0	3.2	10.6	20.0	
Commercial #3	*3.8 acres*	*70% imperv.*	*Dev. CN = 87*	*Tc = 10 min.*	
Developed to Basin	9.0	12.5	19.7	26.7	
Basin Release	3.8	4.6	5.8	15.2	3.7
Pre-settlement	0.6	2.0	6.3	11.3	
Commercial #4	*2.7 acres*	*74% imperv.*	*Dev. CN = 88*	*Tc = 8 min.*	
Developed to Basin	7.3	9.9	15.4	20.7	
Basin Release	1.7	2.0	2.4	13.3	2.6
Pre-settlement	0.3	1.0	3.4	6.3	
Single Family #1	*14.6 acres*	*38% imperv.*	*Dev. CN = 75*	*Tc = 15 min.*	
Developed to Basin	15.8	25.2	47.2	70.0	
Basin Release	7.9	9.4	32.1	64.1	11.4
Pre-settlement	1.3	4.3	14.2	26.6	
Single Family #2	*23.5 acres*	*38% imperv.*	*Dev. CN = 75*	*Tc = 15 min.*	
Developed to Basin	25.4	40.6	76.1	112.7	
Basin Release	12.5	15.4	67.7	109.7	18.4
Pre-settlement	1.9	6.0	19.8	37.2	

* Allowable 100-year release rate calculated as per original drainage study.

Notes:

(1) Time of concentration was assumed in each of the original studies to be 15 minutes. For the purposes of this analysis, this was assumed to be correct, except for the two smallest commercial sites, where adjustments were made.

(2) To fairly compare between the methods, no adjustment was made to account for soil compaction as part of site development, which would further increase runoff volume to the basin.

The following conclusions can be drawn from this analysis:

- **The basins (as designed) fail to adequately control frequently occurring, small storm events.** Release rates expected from each basin from a 2-year, 24-hour event are 5 to 7 times higher than pre-settlement peak rates. Though not shown in the previous summary, the proportion of increase is even higher for smaller events, such as the Water Quality event (1.25") or the 1-year storm event (for which an approximate increase of 20 times pre-settlement rate is expected).

- **They lack storage to handle runoff volume for the longer duration storm.** When the basins are full, they will overtop and most of the ability to control outflow is lost. For the purpose of this study, each basin was assumed to have a broad-crested weir of uniform width at the crest of the basin which allows flow out to downstream properties or roadways. All four of the commercial basins studied were able to contain the 25-year event before overtopping. The two residential basins failed to contain any event larger than a 10-year, 24-hour storm. When this overtopping is accounted for, the new model predicts these basins will release runoff much more rapidly than previously stated.

- **The commercial basins provide better control for intermediate events than either small or very large storms.** These basins control the 10- to 50-year events better than either the very large or small storms, as most of the release rates reviewed were near pre-settlement levels. However, even in these cases release rates were actually below pre-settlement rates only 50% of the time.

- **The shortfalls observed are made more dramatic when runoff curve numbers are adjusted to account for soil compaction.** A second model was developed to account for the effects of mass grading and soil compaction. Under this model, commercial basins are expected to contain up to the 10- or 25-year storm events, while neither of the residential basins are expected to contain the 5-year event without overtopping. The effects on small storm runoff are further magnified as well.

Sub-watershed Hydrology

A similar TR-55 model analysis has been completed at a sub-watershed level. The purpose of this study is not to develop detailed flow rates to be used for stormwater facility design, but to identify approximate flow rates, volumes, trends and changes within the watersheds of the City. Within the scope of this effort, it is impossible to analyze the effect of every detention basin within a given sub-watershed. Many areas of the City have developed without any means of stormwater detention. Based on this fact, coupled with results of the analysis of existing detention facilities, the sub-watershed model for each area has been developed without an adjustment for stormwater detention. These models demonstrate the following:

- **Runoff volume increases dramatically during development.** The proportion of rainfall that is converted to runoff rises with the conversion of land into agriculture, and then even more dramatically as land uses become urban in nature. The amount of change is much more significant during smaller storm events, where very little runoff would have been developed under pre-settlement conditions. The urban landscape is expected to generate more runoff volume from a 1-year event (2.38") than the pre-settlement landscape would have generated during a 10-year event (4.27").

- **The increase in peak rate of flow expected is more dramatic than the increase in volume.** Higher runoff volumes combined with shorter times of travel mean a larger volume of water is reaching the outlet of the basin in a narrower period of time (more water, more quickly equals higher rates of flow). Again, the change is most dramatic for smaller storm events. Existing stormwater detention may reduce some of this effect, but not to desired levels. Based on the location of detention basins throughout the watershed, the areas they cover and general expectations of their performance, correction factors for detention can be applied to the output values listed from the stormwater model (may reduce values listed on chart by 20% for 1-year event, 40% for 10-year event and 10% for 100-year event).

- **Both the detention and watershed analyses highlight the need for a change in stormwater management criteria.** These studies support the adoption of the Iowa Stormwater Management Manual as a design standard. The following set of technical guidance documents have been developed to aid design and review personnel in the effort to design better stormwater management facilities.

Storm Event = 1-year, 24-hour **Rainfall Depth (inches) = 2.38**

		Pre-settlement Conditions				Agricultural Development						Current Developed Conditions					
Watershed Sub-area	Drainage Area	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	% increase in runoff volume (pre-settlement)	% increase in peak flow rate (pre-settlement)	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	% increase in runoff volume (pre-settlement)	% increase in peak flow rate (pre-settlement)
	acres	cubic feet	watershed inches	%	cubic feet per second	cubic feet	watershed inches	%	cubic feet per second	%	%	cubic feet	watershed inches	%	cubic feet per second	%	%
A Birchwood	120	46,000	0.11	4%	1.9	80,000	0.18	8%	6	74%	216%	160,000	0.37	15%	36	248%	1795%
B South Green Meadows West	229	89,000	0.11	4%	3.5	447,000	0.54	23%	68	402%	1843%	564,000	0.68	29%	149	534%	4157%
C Greenwood / Chambery	380	146,000	0.11	4%	5.7	748,000	0.54	23%	76	412%	1233%	1,430,000	1.04	44%	324	879%	5584%
D Windsor	106	41,000	0.11	4%	1.5	207,000	0.54	23%	32	405%	2033%	410,000	1.07	45%	110	900%	7233%
E South NW 62nd	201	77,000	0.11	4%	2.8	392,000	0.54	23%	60	409%	2043%	634,000	0.87	37%	140	723%	4900%
F North NW 62nd	422	162,000	0.11	4%	5.7	835,000	0.55	23%	90	415%	1479%	1,302,000	0.85	36%	230	704%	3935%
G Newgate	246	95,000	0.11	4%	3.1	488,000	0.55	23%	67	414%	2061%	766,000	0.86	36%	183	706%	5803%
H Wooded Point	132	51,000	0.11	4%	1.7	257,000	0.54	23%	39	404%	2194%	418,000	0.87	37%	117	720%	6782%
I South NW 70th	205	79,000	0.11	4%	2.6	403,000	0.54	23%	51	410%	1862%	348,000	0.47	20%	41	341%	1477%
J Central NW 70th	281	109,000	0.11	4%	3.4	550,000	0.54	23%	58	405%	1606%	550,000	0.54	23%	58	405%	1606%
K North NW 70th	140	54,000	0.11	4%	1.8	273,000	0.54	23%	42	406%	2233%	141,000	0.28	12%	15	161%	733%
L NW 100th / 107th	576	222,000	0.11	4%	6.7	1,140,000	0.55	23%	122	414%	1721%	1,123,000	0.54	23%	172	406%	2467%
M Saylorville Road 1	813	313,000	0.11	4%	8.2	1,600,000	0.54	23%	119	411%	1351%	1,599,000	0.54	23%	119	411%	1351%
N Saylorville Road 2	252	97,000	0.11	4%	3.5	496,000	0.54	23%	71	411%	1929%	496,000	0.54	23%	71	411%	1929%
O Saylorville Road 3	236	91,000	0.11	4%	3.2	461,000	0.54	23%	61	407%	1806%	461,000	0.54	23%	61	407%	1806%
P North Camp Dodge	1000	385,000	0.11	4%	10.5	1,967,000	0.54	23%	168	411%	1500%	1,967,000	0.54	23%	168	411%	1500%
Q Green Meadows	218	84,000	0.11	4%	2.8	429,000	0.54	23%	40	411%	1329%	527,000	0.67	28%	119	527%	4150%
R South Merle Hay	53	20,000	0.10	4%	0.7	104,000	0.54	23%	11	420%	1471%	142,000	0.74	31%	48	610%	6757%
S Central Drainage District	933	360,000	0.11	4%	8.8	1,832,000	0.54	23%	92	409%	945%	2,568,000	0.76	32%	323	613%	3570%
T Beaver Drive	273	106,000	0.11	4%	3.6	537,000	0.54	23%	50	407%	1289%	903,000	0.91	38%	280	752%	7678%
U Highway 141	185	71,000	0.11	4%	2.6	362,000	0.54	23%	42	410%	1515%	362,000	0.54	23%	42	410%	1515%

Storm Event = 5-year, 24-hour **Rainfall Depth (inches) = 3.64**

		Pre-settlement Conditions				Agricultural Development						Current Developed Conditions					
Watershed Sub-area	Drainage Area	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	% increase in runoff volume (pre-settlement)	% increase in peak flow rate (pre-settlement)	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	% increase in runoff volume (pre-settlement)	% increase in peak flow rate (pre-settlement)
	acres	cubic feet	watershed inches	%	cubic feet per second	cubic feet	watershed inches	%	cubic feet per second	%	%	cubic feet	watershed inches	%	cubic feet per second	%	%
A Birchwood	120	222,000	0.51	14%	18	297,000	0.68	19%	39	34%	117%	453,000	1.04	29%	134	104%	644%
B South Green Meadows West	229	425,000	0.51	14%	31	1,102,000	1.33	36%	196	159%	532%	1,299,000	1.56	43%	369	206%	1090%
C Greenwood / Chambery	380	699,000	0.51	14%	50	1,845,000	1.34	37%	217	164%	334%	2,873,000	2.08	57%	664	311%	1228%
D Windsor	106	196,000	0.51	14%	12	510,000	1.33	36%	91	160%	658%	810,000	2.11	58%	221	313%	1742%
E South NW 62nd	201	372,000	0.51	14%	22	967,000	1.33	36%	172	160%	682%	1,346,000	1.84	51%	309	262%	1305%
F North NW 62nd	422	778,000	0.51	14%	44	2,060,000	1.34	37%	258	165%	486%	2,767,000	1.81	50%	513	256%	1066%
G Newgate	246	456,000	0.51	14%	22	1,204,000	1.35	37%	191	164%	768%	1,628,000	1.82	50%	404	257%	1736%
H Wooded Point	132	243,000	0.51	14%	13	635,000	1.33	36%	113	161%	769%	889,000	1.86	51%	256	266%	1869%
I South NW 70th	205	378,000	0.51	14%	18	995,000	1.34	37%	146	163%	711%	903,000	1.21	33%	129	139%	617%
J Central NW 70th	281	521,000	0.51	14%	23	1,357,000	1.33	37%	166	160%	622%	1,357,000	1.33	37%	166	160%	622%
K North NW 70th	140	258,000	0.51	14%	13	674,000	1.33	36%	120	161%	823%	442,000	0.87	24%	69	71%	431%
L NW 100th / 107th	576	1,063,000	0.51	14%	45	2,812,000	1.34	37%	353	165%	684%	2,772,000	1.33	36%	492	161%	993%
M Saylorville Road 1	813	1,501,000	0.51	14%	48	3,947,000	1.34	37%	340	163%	608%	3,947,000	1.34	37%	340	163%	608%
N Saylorville Road 2	252	466,000	0.51	14%	27	1,223,000	1.34	37%	205	162%	659%	1,223,000	1.34	37%	205	162%	659%
O Saylorville Road 3	236	435,000	0.51	14%	25	1,137,000	1.33	36%	175	161%	600%	1,137,000	1.33	36%	175	161%	600%
P North Camp Dodge	1000	1,846,000	0.51	14%	63	4,855,000	1.34	37%	482	163%	665%	4,855,000	1.34	37%	482	163%	665%
Q Green Meadows	218	403,000	0.51	14%	21	1,058,000	1.34	37%	114	163%	443%	1,215,000	1.54	42%	297	201%	1314%
R South Merle Hay	53	98,000	0.51	14%	4.8	256,000	1.33	37%	31	161%	546%	314,000	1.63	45%	112	220%	2233%
S Central Drainage District	933	1,725,000	0.51	14%	49	4,521,000	1.33	37%	255	162%	420%	5,675,000	1.68	46%	771	229%	1473%
T Beaver Drive	273	506,000	0.51	14%	27	1,325,000	1.34	37%	143	162%	430%	1,882,000	1.90	52%	601	272%	2126%
U Highway 141	185	341,000	0.51	14%	21	893,000	1.33	37%	122	162%	481%	893,000	1.33	37%	122	162%	481%

Shaded Watersheds are Mostly Urbanized

Storm Event = 10-year, 24-hour **Rainfall Depth (inches) = 4.27**

		Pre-settlement Conditions				Agricultural Development						Current Developed Conditions					
Watershed Sub-area	Drainage Area	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	% increase in runoff volume (pre-settlement)	% increase in peak flow rate (pre-settlement)	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	% increase in runoff volume (pre-settlement)	% increase in peak flow rate (pre-settlement)
	acres	cubic feet	watershed inches	%	cubic feet per second	cubic feet	watershed inches	%	cubic feet per second	%	%	cubic feet	watershed inches	%	cubic feet per second	%	%
A Birchwood	120	345,000	0.79	19%	32	440,000	1.01	24%	64	28%	100%	630,000	1.45	34%	193	83%	503%
B South Green Meadows West	229	661,000	0.80	19%	54	1,481,000	1.78	42%	269	124%	398%	1,714,000	2.06	48%	492	159%	811%
C Greenwood / Chambery	380	1,087,000	0.79	18%	88	2,479,000	1.80	42%	300	128%	241%	3,646,000	2.64	62%	844	235%	859%
D Windsor	106	304,000	0.79	19%	21	685,000	1.78	42%	125	125%	495%	1,023,000	2.66	62%	278	237%	1224%
E South NW 62nd	201	577,000	0.79	19%	38	1,300,000	1.78	42%	263	125%	592%	1,736,000	2.38	56%	401	201%	955%
F North NW 62nd	422	1,208,000	0.79	18%	76	2,769,000	1.81	42%	356	129%	368%	3,568,000	2.33	55%	665	195%	775%
G Newgate	246	708,000	0.79	19%	38	1,617,000	1.81	42%	236	128%	521%	2,099,000	2.35	55%	524	196%	1279%
H Wooded Point	132	378,000	0.79	18%	23	853,000	1.78	42%	155	126%	574%	1,146,000	2.39	56%	332	203%	1343%
I South NW 70th	205	587,000	0.79	18%	31	1,337,000	1.80	42%	201	128%	548%	1,230,000	1.65	39%	182	110%	487%
J Central NW 70th	281	809,000	0.79	19%	40	1,823,000	1.79	42%	229	125%	473%	1,823,000	1.79	42%	229	125%	473%
K North NW 70th	140	401,000	0.79	18%	23	905,000	1.78	42%	164	126%	613%	630,000	1.24	29%	106	57%	361%
L NW 100th / 107th	576	1,651,000	0.79	18%	75	3,779,000	1.81	42%	487	129%	549%	3,724,000	1.78	42%	677	126%	803%
M Saylorville Road 1	813	2,332,000	0.79	19%	78	5,304,000	1.80	42%	471	127%	504%	5,304,000	1.80	42%	471	127%	504%
N Saylorville Road 2	252	724,000	0.79	19%	47	1,644,000	1.80	42%	282	127%	500%	1,644,000	1.80	42%	282	127%	500%
O Saylorville Road 3	236	676,000	0.79	18%	43	1,528,000	1.78	42%	241	126%	460%	1,528,000	1.78	42%	241	126%	460%
P North Camp Dodge	1000	2,868,000	0.79	19%	105	6,524,000	1.80	42%	666	127%	534%	6,524,000	1.80	42%	666	127%	534%
Q Green Meadows	218	626,000	0.79	19%	35	1,422,000	1.80	42%	158	127%	351%	1,603,000	2.03	47%	397	156%	1034%
R South Merle Hay	53	153,000	0.80	19%	8.1	344,000	1.79	42%	43	125%	431%	410,000	2.13	50%	146	168%	1702%
S Central Drainage District	933	2,680,000	0.79	19%	80	6,074,000	1.79	42%	352	127%	340%	7,400,000	2.18	51%	1017	176%	1171%
T Beaver Drive	273	786,000	0.79	19%	46	1,781,000	1.80	42%	197	127%	328%	2,414,000	2.44	57%	772	207%	1578%
U Highway 141	185	529,000	0.79	18%	37	1,199,000	1.79	42%	168	127%	354%	1,199,000	1.79	42%	168	127%	354%

Storm Event = 100-year, 24-hour **Rainfall Depth (inches) = 6.61**

		Pre-settlement Conditions				Agricultural Development						Current Developed Conditions					
Watershed Sub-area	Drainage Area	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	% increase in runoff volume (pre-settlement)	% increase in peak flow rate (pre-settlement)	Runoff Volume	Runoff Volume	% of rainfall converted to runoff	Peak flow rate	% increase in runoff volume (pre-settlement)	% increase in peak flow rate (pre-settlement)
	acres	cubic feet	watershed inches	%	cubic feet per second	cubic feet	watershed inches	%	cubic feet per second	%	%	cubic feet	watershed inches	%	cubic feet per second	%	%
A Birchwood	120	936,000	2.15	33%	107	1,097,000	2.52	38%	185	17%	73%	1,393,000	3.20	48%	443	49%	314%
B South Green Meadows West	229	1,794,000	2.16	33%	181	3,052,000	3.67	56%	569	70%	214%	3,399,000	4.09	62%	984	89%	444%
C Greenwood / Chambery	380	2,950,000	2.14	32%	293	5,110,000	3.70	56%	640	73%	118%	6,662,000	4.83	73%	1527	126%	421%
D Windsor	106	827,000	2.15	33%	69	1,413,000	3.67	56%	263	71%	281%	1,849,000	4.81	73%	495	124%	617%
E South NW 62nd	201	1,567,000	2.15	32%	123	2,679,000	3.67	56%	499	71%	306%	3,283,000	4.50	68%	757	110%	515%
F North NW 62nd	422	3,281,000	2.14	32%	248	5,706,000	3.72	56%	759	74%	206%	6,746,000	4.40	67%	1257	106%	407%
G Newgate	246	1,923,000	2.15	33%	120	3,334,000	3.73	56%	558	73%	365%	3,968,000	4.44	67%	989	106%	724%
H Wooded Point	132	1,026,000	2.14	32%	74	1,759,000	3.67	56%	328	71%	343%	2,167,000	4.52	68%	624	111%	743%
I South NW 70th	205	1,595,000	2.14	32%	99	2,756,000	3.70	56%	427	73%	331%	2,604,000	3.50	53%	402	63%	306%
J Central NW 70th	281	2,196,000	2.15	33%	126	3,758,000	3.68	56%	488	71%	287%	3,758,000	3.68	56%	488	71%	287%
K North NW 70th	140	1,089,000	2.14	32%	74	1,866,000	3.67	56%	348	71%	370%	1,461,000	2.87	43%	267	34%	261%
L NW 100th / 107th	576	4,483,000	2.14	32%	237	7,789,000	3.73	56%	1036	74%	337%	7,676,000	3.67	56%	1430	71%	503%
M Saylorville Road 1	813	6,332,000	2.15	32%	238	10,932,000	3.70	56%	1008	73%	324%	10,932,000	3.70	56%	1008	73%	324%
N Saylorville Road 2	252	1,965,000	2.15	32%	154	3,388,000	3.70	56%	598	72%	288%	3,388,000	3.70	56%	598	72%	288%
O Saylorville Road 3	236	1,835,000	2.14	32%	139	3,150,000	3.68	56%	511	72%	268%	3,150,000	3.68	56%	511	72%	268%
P North Camp Dodge	1000	7,787,000	2.15	32%	323	13,446,000	3.70	56%	1424	73%	341%	13,446,000	3.70	56%	1424	73%	341%
Q Green Meadows	218	1,700,000	2.15	33%	113	2,931,000	3.70	56%	336	72%	197%	3,179,000	4.02	61%	795	87%	604%
R South Merle Hay	53	414,000	2.15	33%	26	709,000	3.69	56%	92	71%	254%	793,000	4.12	62%	281	92%	981%
S Central Drainage District	933	7,275,000	2.15	32%	239	12,520,000	3.70	56%	758	72%	217%	14,322,000	4.23	64%	1987	97%	731%
T Beaver Drive	273	2,135,000	2.15	33%	147	3,671,000	3.70	56%	421	72%	186%	4,511,000	4.55	69%	1427	111%	871%
U Highway 141	185	1,437,000	2.14	32%	123	2,472,000	3.68	56%	356	72%	189%	2,472,000	3.68	56%	356	72%	189%

Shaded Watersheds are Mostly Urbanized

General Information

Iowa Stormwater Management Manual Reference: Section 2A-1

These technical guidance documents are intended to work with the Iowa Stormwater Management Manual (ISWMM) to help developers, designers, City staff and officials to understand how the requirements within the Manual relate to achieving the City's overall stormwater management goals. It is recommended that all individuals that play a role in the development or review of site development plans within the City become familiar with these guidance documents and the ISWMM.

Section 2A-1 covers broad topics related to the design of management facilities to address both stormwater quality and quantity. Many of these issues are also addressed within the City's Watershed Assessment and Stormwater Management Plan.

The following sections of the ISWMM offer more detailed preliminary design guidance that should be reviewed and considered as early in the site development process as possible:

Section 2A-2 – Planning and Design Principles
Section 2A-3 – Stormwater Regulations and Permitting
Section 2A-4 – Stormwater Management Criteria
Section 2A-5 – Project Drainage Report

Project Drainage Report

Iowa Stormwater Management Manual Reference: Section 2A-5

To provide a through and efficient review of the management program for a given development site, a project drainage report shall be presented at the time of initial submittal and shall identify all of the following items:

☐	Cover sheet with project name, location and name of firm preparing calculations
☐	Professional Engineer's signed and sealed certification
☐	Table of Contents (clearly identify individual elements of included calculations)
☐	City of Johnston Summary Data Sheet (included on next page)
☐	Brief Narrative Sections that Refer to Location of Included Calculations (Refer to Section 2A-5C)
☐	Pre-settlement conditions and runoff analysis (meadow in good condition:CN=58 and pre-settlement Tc) [similar elements to Section 2A-5C.1.e]
☐	Existing conditions and runoff analysis (current land uses) [similar to C.1.e]
☐	Contributing off-site drainage [C.1.c]
☐	Floodways, floodplains and wetlands [C.1.d]
☐	Post-development conditions and runoff analysis [similar to C.2]
☐	Stormwater Conveyance Design [C.3]
☐	Stormwater Management Design [C.4] (include Small Storm Management BMP design)
☐	Permits [C.5]
☐	References [C.6]
☐	Appendix [C.7] (Clearly identify each subcategory in the table of contents)
☐	Drawings [C.7.a]
☐	Impervious area (in SF and % of area) for each sub-area and site total
☐	Curve number (runoff coefficient) calculations for sub-areas and site total
☐	Time of concentration calculations (pre-settlement, existing and developed for each sub-area and site total)
☐	Runoff Hydrograph Determination Information (see tech guidance for Section 2C-7)
☐	Calculations for WQv (based on the watershed sub-area of the BMP used for treatment)
☐	Calculations for CPv
☐	Calculations for storm sewer, intake and culvert design
☐	Peak discharge calculations (see Section 2B-1 for requirements)
☐	Detention basin design (see tech guidance for Section 2C-10)

For each development site complete the attached Summary Data Sheet
Attach a separate Summary Data Sheet for each stormwater detention area

Storm Water Summary Data Sheet

Project Name: _____

Location: _____

Site Sub-watershed: _____

Date: _____

City of Johnston Watershed Designation: _____

Watershed Characteristic Summary

	Off-site area within watershed			Site development area within watershed		
	Pre-settlement	Existing	Developed	Pre-settlement	Existing	**Developed**
Size (acres)						
Impervious area (acres)						
Impervious area (%)						
Time of concentration (Tc)						
NRCS Curve Number (CN)	58			58		
Runoff Peak Rate (cfs)						
1-year						
2-year						
5-year						
10-year						
25-year						
50-year						
100-year						

Detention Basin Summary

	Required	Provided
Water Quality Volume Storage		
CPv Release Rate		
CPv Storage Provided		
CPv Water Surface Elevation		
10-year Release Rate		
10-year Storage Provided		
10-year Water Surface Elevation		
100-year Release Rate		
100-year Storage Provided		
100-year Water Surface Elevation		

Unified Sizing Criteria

Iowa Stormwater Management Manual Reference: Section 2B-1

Introduction

The sections that follow describe in more detail, the methods of performing stormwater design calculations in conformance with the Iowa Stormwater Management Manual, and special design requirements as per the City of Johnston.

Standards set by the City are intended to address the issues related to stormwater runoff quality and quantity that have been identified as part of the City of Johnston Watershed Assessment and Stormwater Management Plan. Without special exemption by City staff, stormwater calculations for all development sites should identify post-development conformance with the following design requirements:

1. **Capture and treat the Water Quality Volume [WQv]**, or the runoff that is expected to be generated from a given site after development from a 1.25" rainfall event (reference Small Storm Hydrology Section).

2. **Provide extended detention of the 1-year, 24-hour storm event [Channel Protection Volume – CPv]** (with a drawdown time of 24- to 48-hours) to reduce rapid fluctuations of flows in urban stream corridors that lead to erosive velocities and unstable streambanks.

3. **Restrict post-development peak discharge rates for the 5- and 10-year, 24-hour storm events to pre-settlement levels [Overbank Flood Protection – Qp]** (based on a land use of meadow in good condition – NRCS CN=58 and pre-settlement travel times for stormwater flows)..

4. **Provide safe conveyance of larger, rare storm events (25-, 50- and 100-year; 24-hour storm events) [Extreme flood protection – Qf] to planned or constructed downstream regional detention facilities or urban stream corridors.** These events shall be released in a safe and non-erosive manner from a site (through an outlet pipe or properly designed emergency spillway) and it must be demonstrated that there are adequate flow paths (via easements, rights-of-way, etc.) to convey these developed storm flows to the receiving facility or stream corridor without significant risk to public or private property. If this cannot be demonstrated, additional stormwater detention may be required.

Rainfall and Runoff Analysis

Iowa Stormwater Management Manual Reference: Section 2C-2

Preferred Design Assumptions

Johnston is located within Climate Section 05, as shown in Figure 1 or Section 2C-2. Rainfall values used for stormwater design analysis should be taken from values from this section listed in Table 2 of this section.

Addressing Small Storm Hydrology:

Note that as per Table 1 of Section 2C-2, 90% of the rainfall events that typically occur in Central Iowa have been of 1.25" depth or less. Without proper planning and installation of appropriate best management practices (BMPs) that address these types of events, runoff from these storms will go largely unmanaged, leading to more frequent storm discharges and greater runoff volumes being released to urban stream corridors. Refer to the Small Storm Hydrology Section for more information.

Rainfall Depths, Intensities for Frequently Used Storm Durations

Duration	1-year	2-year	5-year	10-year	25-year	50-year	100-year
(minutes)	Intensity (inches/hour)						
5	3.48	4.20	5.28	6.12	7.44	8.40	9.48
10	3.00	3.66	4.56	5.40	6.48	7.38	8.34
15	2.56	3.16	3.92	4.60	5.56	6.32	7.12
20	2.29	2.83	3.51	4.12	4.98	5.66	6.38
25	2.03	2.49	3.11	3.64	4.40	5.00	5.64
30	1.76	2.16	2.70	3.16	3.82	4.34	4.90
35	1.65	2.03	2.54	2.97	3.59	4.08	4.60
40	1.55	1.90	2.37	2.78	3.35	3.81	4.30
45	1.44	1.77	2.21	2.59	3.12	3.55	4.01
50	1.33	1.63	2.04	2.39	2.89	3.29	3.71
55	1.23	1.50	1.88	2.20	2.65	3.02	3.41
60	1.12	1.37	1.71	2.01	2.42	2.76	3.11
90	0.91	1.11	1.38	1.63	1.96	2.23	2.51
120	0.69	0.85	1.06	1.24	1.50	1.70	1.92

Duration	1-year	2-year	5-year	10-year	25-year	50-year	100-year
(hours)	Rainfall depth (inches)						
1	1.12	1.37	1.71	2.01	2.42	2.76	3.11
6	1.79	2.18	2.73	3.20	3.86	4.40	4.96
24	2.38	2.91	3.64	4.27	5.15	5.87	6.61

Note: Data from 5-minute intervals is linearly interpolated from Table 2 values.

Time of Concentration

Iowa Stormwater Management Manual Reference: Section 2C-3

Preferred Design Assumptions

The following values are recommended for use in completing calculations for time of concentration within the City of Johnston. Provided design calculations shall provide a detailed explanation and evidence supporting any variation from these recommended values:

Existing conditions for large areas of undeveloped agricultural lands or pre-settlement analysis:

To better quantify the effect of retention of rainfall on large areas of undeveloped landscapes, use the NRCS lag method as described in **Section 2C-3E "Estimating time of concentration (NRCS lag method)" [Equations 5 and 6]**. Note that the value for "Y" in the equation given is average watershed land slope, not slope along the stream length. Slope data from county soil surveys or LIDAR topographic information can often be used to compute this value.

Be aware of the limitations of this method as listed in note 2d of this section.

Existing and proposed conditions near or within urbanized areas:

Use the NRCS velocity method as described in Section 2C-3D. Apply the following additional information:

- **Sheet flow.** Sheet flow is very shallow, uniform flow that usually occurs along the upper edges of a watershed. It only occurs until water reaches a point where flow will concentrate in a small depression or swale. It should never be measured past the point where contours indicate flow will begin to funnel to a common path. Follow the following guidelines for sheet flow calculation:
    - **Flow Length (maximum values – stop at point of concentration)**
        - **Pre-development conditions:** No greater than 100 feet total.
        - **Post-development conditions:** No greater than 50 feet of lawn, grass or wooded area unless specific practices are installed that encourage sheet flow conditions (level spreader, etc.) Total including paved surfaces no greater than 100 feet.
    - **Roughness coefficient.** Use selected values below from Table 1.

Surface Description	n
Pavement	0.011
Cultivated agriculture	0.17
Prairie grasses	0.15
Turf grass lawns	0.24
Woods	0.40

    - **P_2.** The 2-year, 24-hour rainfall event for Johnston, Iowa is 2.91".

- **Shallow concentrated flow.** Use the following equations to calculate flow velocity:

  Unpaved areas: $V = 16.1345 * \sqrt{(S)}$
  Paved areas: $V = 20.3282 * \sqrt{(S)}$

- **Channel flow.** Use Equation 4 based on channel cross-section properties and surface conditions.

  Refer to Table 2 for values of "n" for this equation.
  Include with submitted calculations details on the assumed cross-section and surface conditions used to select value of "n".

Rational Method

Iowa Stormwater Management Manual Reference: Section 2C-4

Preferred Design Assumptions

The rational method is not the preferred calculation method for developing storm water design flows within the City of Johnston. In projects involving storm water management and detention design, the TR-20 or TR-55 methods are required to be used to develop more detailed hydrographs for stage-storage routing and outlet design. Design flow information generated from these calculations can best be applied to smaller sub-watersheds within the development area, based on weighted proportion (by product of area and curve number) of the sub-area as compared to the larger watershed review area.

In projects that flow routing is not required, the rational method may be used to generate peak flow runoff values for storm sewer design, provided the conditions of Section 2C-4B and 4C are met. A few of the key constraints are highlighted:

- **Carefully select a value for "C".** A 20% increase or decrease in the value of C has the effect of changing a 5-year recurrence interval to a 15-year or 2-year interval respectively.
- **Use the method only for small watersheds.** Apply to drainage areas of less than 160 acres.
- **Take caution in selecting Tc in large hard surface areas.** Runoff from a portion of the drainage area that is highly impervious may result in a larger peak discharge than would occur if the entire area is considered. It may be necessary to ignore contributions from large open spaces that would extend Tc and actually lower the calculated values for peak flow rate.
- **Be aware of all limitations of the method listed in Section 2C-4C and determine if any apply.**

Runoff Coefficient Selection:

Select appropriate values from Table 1 of Section 2C-4, with the following provisions:

- **Hydrologic Soil Groups.** Refer to county soil survey data with the following conditions:

Unless influenced otherwise by county soils data, use Group B for undeveloped areas and areas where developed has occurred without mass grading activities.

Use Group C for developed areas where mass grading has occurred, unless methods to decompact surface soils after construction are specified.

- **Land Use Selection.** In new development areas where proportions of hard surfaces can be determined, calculate "C" by weighted average using lawn values (75% or more grass) for open spaces and appropriate value for type of hard surface. Use value for appropriate soil group.

Runoff Coefficients "C" for 5-year storm events

Percent Impervious Area	Soil Group B	Soil Group C
20%	0.29	0.37
40%	0.43	0.49
60%	0.57	0.61
80%	0.71	0.73

Rainfall Intensity:

Use appropriate values from "Rainfall and Runoff Analysis" section for calculated time of concentration.

NRCS TR-55 Methodology

Iowa Stormwater Management Manual Reference: Section 2C-5

Preferred Design Assumptions

TR-55 is the required design method for projects involving storm water management and detention basin routing within the City of Johnston. The TR-20 program is also acceptable, (being the basis for calculations for TR-55) but includes additional calculation features for stream and basin routing, and allows for a larger number of subwatersheds to be analyzed.

Rainfall: Use Type II distribution, based on 24-hour rainfall depths for storm recurrence interval of interest.

Curve Number (CN): For storms of a 2-year recurrence interval and larger, use Curve Numbers selected from Tables 2, 3 and 4 of Section 2C-5. (Refer to Small Storm Hydrology Section for required adjustments to curve numbers for smaller, more frequent events).

- **Pre-settlement Condition Analysis.** Use Soil Group B, Meadow in good condition for analysis (CN=58).
- **Existing and Developed Condition Analysis.** Select by appropriate cover type. Use appropriate soil group, as per county soil survey data. Unless influenced otherwise by county soils data, use Group B for undeveloped areas and areas where developed has occurred without mass grading activities. Use Group C for developed areas where mass grading has occurred, unless methods to decompact surface soils after construction are specified.
    - **Agricultural Development.** Select by appropriate cover type. Use good conditions for analysis, unless clear reasons for using fair or poor conditions can be documented.
        - **Off-site detention and conveyance analysis:** When reviewing off-site agricultural areas to determine flows to be allowed to "pass-through" on-site detention areas, care must be given to not over-estimate CN to allow a larger release rate from the detention facility. It is also important not to under-estimate CN while designing for proper conveyance of said flows either through or around the site work area. For row crops and seed grains, use curve numbers no larger than those for contoured land w/ crop residue (C+CR) in good condition, unless clear reasons for using other conditions can be documented.
    - **Urbanized Areas.** Select by appropriate cover type. In development areas where proportions of hard surfaces can be determined, calculate CN by weighted average using "Open Space in good condition" for open spaces and "Paved parking lots, roofs and driveways" (CN=98) for hard surface areas. (See chart below).

Weighed Curve Numbers By Percent Impervious Area for Urbanized Areas

Percent Impervious Area	Soil Group B	Soil Group C
0 %	61	74
10 %	65	76
20%	68	79
30%	72	81
40%	76	84
50%	80	86
60%	83	88
70%	87	91
80%	91	93
90%	94	96
100 %	98	98

Note: Use these values for storm events of a 2-year recurrence or greater.

Small Storm Hydrology

Iowa Stormwater Management Manual Reference: Section 2C-6

Preferred Design Assumptions

Management practices that address runoff from smaller storms will either capture and infiltrate (or filter) runoff from such events, or release runoff much more slowly than under previous design methods (slow drawdown over 24 to 48 hour period). This section provides guidance information for completing calculations that address smaller storm events.

Water Quality Volume: For Central Iowa, 90% of rainfall events are smaller than or equal to 1.25" in rainfall depth. The chart below contains values for the Water Quality Volume (WQv – volume to be captured and treated by selected BMPs to remove 80% of the annual total suspended solids (TSS) load) and adjusted NRCS Curve Numbers (CN) adapted from Equations 1, 2 and 3 of Section 2C-6.

1. Multiply WQv value from the table by total development site area (or subarea) to determine site WQv requirements.

2. Use the adjusted values for CN for any TR-55 (or TR-20) modeling of runoff from the 1.25" rainfall event.

Water Quality Treatment Volume and Adjusted NRCS Curve Numbers for Small Storms

Percent Impervious Area	Rv	WQv (per acre) (CF)	Adjusted CN 1.25" event	Adjusted CN 1-year event
0%	--	--	73	59
10%	0.140	635	80	68
20%	0.230	1044	85	74
30%	0.320	1452	88	79
40%	0.410	1860	90	83
50%	0.500	2269	93	87
60%	0.590	2677	94	90
70%	0.680	3086	96	92
80%	0.770	3494	97	95
90%	0.860	3902	98	97
100 %	0.950	4311	99	99

Channel Protection Volume: The procedure listed in Section 2C-6C is used to determine the initial estimate of the Channel Protection Volume (CPv) or the extended detention volume required to capture and slowly release runoff from the 1-year, 24-hour storm event. This type of management reduces the flashy nature of runoff from urban development sites during small storm events, reducing the potential for erosion in downstream urban stream corridors.

Note the following items when applying the step-by-step procedure for estimating CPv:

1. Calculate the NRCS curve number and time of concentration for a given watershed or subwatershed based on previous sections.

2. The 1-year, 24-hour storm depth in Johnston, Iowa is 2.91 inches.

3. When reviewing the output from a TR-55 (or TR-20) analysis, know the following:

   a. If the software used to run the analysis provides total runoff volume in cubic feet, the runoff volume in inches can be calculated as below:

      Q_a = Runoff Volume (cf) x 12 (in/ft) / [43,560 (sf / ac) x Watershed Area (ac)]

   b. The unit peak discharge can be calculated as below:

      q_u = Peak discharge (cfs) / [Watershed Area (sq. mi) x Qa (inches)]

4. Draw a line up from q_u in Figure 1, then over to the left to find the ratio (qo / qi).

5. Solve for the peak release rate from the extended detention basin during a 1-year event. For this equation, Q_i is the Peak discharge from the TR-55 model output (in cfs).

6. Solve for the estimated ratio of extended detention storage required compared to the runoff volume from the study area during the storm event.

7. Solve for the estimated extended detention storage volume required. This is an estimate for initial basin sizing to be used for preliminary site design. Software packages may give results for runoff volume in either inches or cubic feet. Note the required conversions for desired volume measurement.

8. When a preliminary site design has been developed that accommodates the storage above, solve for the preliminary size of the control outlet. Note that q_o comes from Step 5, and h_o depends on the design of the basin and the depth of storage required to achieve the required extended detention volume.

9. A perforated riser pipe may be required in lieu of an orifice of 4-inches in diameter or smaller (or other means applied to prevent clogging of the basin outlet).

10. Use preliminary basin design to develop stage-storage-discharge relationships for flow routing. Then perform an actual reservoir routing calculation (see Section 2C-10) to verify that the initial design means the release peak rate requirements (from step 5) and an extended drawdown of the basin can be observed (24- to 48-hour drawdown).

Runoff Hydrograph Determination

Iowa Stormwater Management Manual Reference: Section 2C-7

Introduction

Given the variety of available software packages capable of performing calculations consistent with TR-55 methodology, it is assumed that designers will rarely use techniques to manually develop runoff hydrographs in the methods described. The designer should be familiar with the basis of such calculations, and the following information should be clearly indicated in storm water drainage reports:

1. **Rainfall depths for reviewed storms** (1-, 2-, 5-, 10-, 25-, 50- and 100-year events) consistent with prescribed values for Johnston, Iowa. Models for 24-hour storms should indicate that a Type-II rainfall distribution was used.

2. **Drainage maps** identifying watershed (and subwatersheds) areas. Flow paths and land uses for both pre- and post-development conditions should be identified.

3. **Details of calculations of time of concentration**, consistent with preferred design assumptions.

4. **Details of selected curve numbers**, as the basis of their selection consistent with preferred design assumptions.

5. For models with multiple sub-areas, where hydrographs are to be combined with or routed through downstream areas or basins; provide a flow **chart or schematic plan or map that identifies how separate hydrographs have been routed or combined**.

6. For hydrograph routing through a detention basin, pond or outlet structure, refer to Section 2C-10.

Detention Storage Design

Iowa Stormwater Management Manual Reference: Section 2C-9

Introduction

This supplement is intended to provide guidance related to Section 2C-9, to achieve better designed, constructed and maintained management practices related to storm water detention.

Discouraged Design Practices

The following design practices reduce the ability of stormwater detention systems to address runoff quality and quantity from small storm events. Storm water management practices should be designed to avoid these types of practices:

1. **Passive detention systems.** These systems direct captured runoff through the storm sewer network to the outlet from the site. At that point, a restriction is placed, such as an orifice plate, which causes water to surcharge and back up out of an intake into a surface depression for temporary storage during large storm events. This design method allows runoff from smaller storm events to leave the site directly, without the opportunity to remove suspended pollutants and debris.

2. **Low flow flumes and directly connected impervious areas.** These systems prevent infiltration of storm water runoff and reduce or eliminate the possibility of providing water quality treatment or small storm management. Virtually any storm event will direct surface runoff from paved areas to the receiving storm sewer system or stream.

3. **Flow path shortcutting.** When runoff enters a basin or treatment practices at nearly the same point where it outlets from the practice, the opportunity for absorption, infiltration or treatment of storm water runoff is severely reduced. For this reason, it is recommended that storm water runoff enter a basin or other treatment practice as far from the outlet as possible. Pipe outlets, flumes or other points of concentrated stormwater flows should enter a treatment practice or basin at a distance from the outlet of no less than twice the width of the practice (a pipe entering a 15' wide bioretention cell should be located no closer than 30' from the point where water would leave the treatment area).

Approved Detention Storage Design Methods

Of the alternatives listed in Section 2C-9, only the NRCS TR-55 Method is approved for storm water detention design within the City of Johnston. The formula listed in Table 1 of Section 2C-9 should only be used to obtain a preliminary estimate of required storage. Final storage volume requirements should be based on stage-storage routing of developed hydrographs through a proposed basin and outlet design.

Note: LID methodology (as described in Section 2C-8) may also be applied for projects that use a comprehensive system of practices to address both water quantity and quality and mimic pre-settlement hydrology.

Channel and Storage (Reservoir) Routing

Iowa Stormwater Management Manual Reference: Section 2C-10

Introduction

Given the variety of available software packages capable of performing calculations consistent with the routing methods described within this section, it is assumed that designers will rarely use techniques to manually perform these calculations as described within this section. The designer should be familiar with the basis of such calculations, and the following information should be clearly indicated in storm water drainage reports:

Channel Routing:

1. Clearly identify the **channel length, slope** (along channel length) **and Manning roughness coefficient** (n) used for design. Document surface conditions considered for selection of "n" and identify length and elevation used for slope calculation on drainage map.

2. Provide a **sketch showing the assumed cross-section of the channel** (triangular, rectangular, trapezoidal, etc.) with bottom width and side slopes clearly labeled.

Reservoir Routing: For detention design analysis, a stage-storage hydrograph routing is required for the 1-, 2-, 5-, 10-, 25-, 50- and 100-year events to verify that after development, a given site does not violate peak release rate restriction requirements for these storms. Additional routing of the WQv event may be required if selected practices intended to meet the Water Quality Volume requirements for a given area have inadequate capacity to retain the required volume and therefore use extended detention (slow release through a surface inlet) to allow settling of suspended pollutants and treatment to occur.

1. **Inflow hydrograph** (numeric or graphic) through the duration of the storm event. Maximum time steps of 6-minutes (2-minutes preferred).

2. **Stage-storage volume relationship** of the reservoir area. No less than one foot intervals.

3. **Stage-discharge relationship of basin outlet.** Calculations should identify all stages of outflow design (riser pipe, orifice, weir, discharge pipe, etc.) and include characteristics of each (elevation, size, etc.) that match plan dimensions. Calculations should include either detailed calculations of flow through each outlet stage, or graphical representation of stage-discharge relationship from calculation output from used software package.

4. **Energy loss coefficients** for weir and orifice conditions.

5. **Target peak discharge allowed** from the reservoir (for each event to be considered – WQv; 1-, 2-, 5-, 10-. 25-. 50-, and 100-year events).

6. **Outflow hydrograph** from routing output identifying flow rate (in cfs) versus time, the peak flow rate, time of occurrence in relation to the rainfall event. For analyses involving the four key design events identified in this report (WQv, 1-year, 10-year and 100-year) provide a numeric or graphic representation of the entire outlet hydrograph through the duration of the storm event. For other events reviewed (2-, 5-, 25-, and 50-year events) a summary sheet that identifies the peak flow rate and time of occurrence will be sufficient.

7. **A graph of storage volume or elevation versus time** for the key design events. Review drawdown for extended detention of small storms. (24-to 48-hour drawdown after storm event)

8. **Identify maximum storage volume and water surface elevation for each event reviewed.**

Inlet Sediment Forebays

Iowa Stormwater Management Manual Reference: Section 2C-11

Introduction

Sediment forebays are essential to long-term maintenance and performance of proposed stormwater management BMPs. A forebay is an area near a concentrated point of discharge to a certain BMP, where stormwater flows can be slowed to an extent where heavier sediments and debris can be captured before they enter the BMP itself.

These should be located in areas where they can be accessed for maintenance and sediment (and debris) removal. This helps reduce the amount of heavy pollutants that enter a proposed treatment practice (pollutants that could clog or otherwise negatively affect the performance or appearance of those practices).

Key design considerations:

1. Sediment forebays should be sized for 0.10 – 0.25 inches of runoff per impervious acre within the watershed upstream of the forebay. **A typical sizing criterion is 10% of the WQv to be treated**.

2. **Forebays are often separated from the BMP they protect by a physical barrier** of some type (berm, spillway, gabion or revetment stone wall, etc.) that forces water entering the BMP to pool temporarily near the entrance to the facility, reducing velocities and allowing suspended materials to settle out.

3. **Forebays should be located where they can be directly accessed for maintenance.** Provide clear paths from adjacent streets to the facility that can accommodate expected maintenance equipment (trucks, small excavators, etc.). In some cases this may require a hard surface access path.

4. **A hardened bottom surface** should be considered to help avoid over-excavation during cleanout operations.

5. **Plan for sediment cleanout at least every 3-5 years (for stabilized watershed)**, or when 6-12 inches of sediment have accumulated, which ever occurs first.

Detention Basin Outlet Structures

Iowa Stormwater Management Manual Reference: Section 2C-12

As per the reservoir routing design guidance section, Calculations should identify all stages of outflow design (riser pipe, orifice, weir, discharge pipe, etc.) and include characteristics of each (elevation, size, etc.) that match plan dimensions.

Calculations should include either detailed calculations of flow through each outlet stage, or graphical representation of stage-discharge relationship from calculation output from used software package. Methods to calculate release rates through a variety of types of storm outlets are included in Section 2C-12.

Photo Key and Resources

Resources

Books

Andreas Atlas Company (1970). *A.T. Andreas' Illustrated Historical Atlas of Iowa, 1875.* Iowa City, Iowa: State Historical Society.

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Petersen, W. (2007) *Photo of porous asphalt surface at Trinity at Luther Park campus, Des Moines, Iowa*.

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Photography Credits

Photographs and Images Not Shown on Citywide Photo Index Map

Image 1:	*A.T. Andreas' Illustrated Historical Atlas of Iowa*.
Photo 2 – 4:	City of Johnston Aerial Photographs (November 2006).
Photo 11:	City of Johnston Aerial Photograph (November 2006).
Photo 16:	City of Johnston Aerial Photograph (November 2006).
Photo 23:	City of Johnston Aerial Photograph (November 2006).
Photo 24:	City of Johnston Aerial Photograph (November 2006).
Photo 27:	City of Johnston Aerial Photograph (November 2006).
Photo 79 – 80:	City of Johnston Aerial Photograph (November 2006).
Photo 85:	Vintage Lake at Prairie Trail: Ankeny, Iowa. Nilles Associates.
Photo 86:	Pervious asphalt. Trinity at Luther Park: Des Moines, Iowa. Wayne Petersen, IDALS.
Photo 88:	Forebay. Precedence at Prairie Trail: Ankeny, Iowa. Nilles Associates.
Photo 89:	Vortech Unit Installation. Ankeny, Iowa: Nilles Associates.
Photo 90:	Rainbarrel. Simplyrainbarrels.com.
Photo 96 – 97:	Constructed Wetland. Precedence at Prairie Trail: Ankeny, Iowa. Nilles Associates.
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Photo 108:	Precedence at Prairie Trail and Vintage Lake: Ankeny, Iowa. Courtesy DRA Properties.

(All other photographs courtesy City of Johnston or Nilles Associates, Inc.)

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Citywide Photo Index Map

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