# Surface Water Management Plan
## City of Belle Plaine

**October 2018**

**Submitted by:**
Bolton & Menk, Inc.
1960 Premier Drive
Mankato, MN 56001
P: 507-625-4171
F: 507-625-4177
BMI No. M15.112777

# Certification

Surface Water Management Plan

for the

City of Belle Plaine, MN

BMI No. M15.112777

October 2018

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

By: _____

Lanol Leichty
License No. 20846

Date: _____

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# I. Executive Summary

The purpose of this Comprehensive Surface Water Management Plan (SWMP) is to promote, preserve and enhance the natural resources within the City of Belle Plaine. It is the policy of the City to protect water quality and unique and fragile environmentally sensitive land from adverse effects occasioned by poorly sited development or incompatible activities by regulating land disturbances or development activities. The SWMP's purpose is also to control or eliminate storm water pollution along with soil erosion and sedimentation in the City.

The goal of this policy is to minimize conflicts and encourage compatibility between land disturbances and development activities, and water quality and environmentally sensitive lands.

The City will do this by requiring detailed review standards and procedures for land disturbing or development activities proposed for such areas, thereby achieving a balance between urban growth and development and protection of water quality and natural areas.

This SWMP, in conjunction with the the City Ordinances, establishes standards and specifications for conservation practices and planning activities, which minimize storm water pollution, soil erosion and sedimentation.

# II. Summary of Potential Water Resource-Related Problems

The following is a summary of the potential water resource related problems and potential solutions discussed in more detail in this Comprehensive Surface Water Management Plan report.

A. The existing storm sewer piping, ditches and pond network shown in Figure SW-01 is not capable of handling the potential runoff from continued development in the anticipated growth areas around the City.

B. Although there are several alternative methods of accommodating continued growth, the recommended practice is through the construction of upstream detention ponds or detention basins, including infiltration, as a requirement of further developing the outlying growth areas.

C. Regional ponds are recommended for most areas as they are the most easily adapted to unforeseen changes in the upstream development.

D. The construction of upstream regional detention ponds or detention basins will reduce the flows to the downstream system and allow for decreased costs in infrastructure improvements.

E. The proposed pond network is one of a multitude of ways in which the ultimate goal of accommodating continued growth can be accomplished. Revisions will undoubtedly occur as unforeseen developer layouts are presented to the City. Although this plan forms a sound basis for future development, it is important to remain flexible in finding ways to manage runoff while still encouraging the continued development of the City.

F. Detailed dynamic mapping is necessary to coordinate future development by multiple developers. The figures attached at the end of this report are only for illustration purposes. When this report is accepted; GIS compatible files will be provided showing more detailed information including watershed areas, proposed pond areas and storage volumes, estimated flow rates into and out of the proposed ponds for both the existing and developed conditions, proposed interconnecting pipe sizes between ponds, etc. The GIS data will be reviewed and updated as improvements are constructed.

G. Necessary improvements and costs for those improvements must be reviewed and updated. Any determined storm water management charges or area charges to new developments shall be reviewed on an annual basis updated to ensure that changes in land acquisition, construction cost, bonding cost, legal cost, etc. are included in the computed fee.

H. This report is a working document and shall be updated as the outlying areas develop to review the differences between the actual and modeled conditions.

## III. Administrative Information

This submittal is a culmination of many months of research, mapping, land use analysis/planning and hydraulic design. The end product is a detailed design tool that can be used by the City of Belle Plaine in planning growth and infrastructure replacement. This summary report represents only a small part of the total work product created through the master planning process. The City Ordinances were also updated as a result of this process and are the means to implement the recommendations made in this report.

Following the approval of this SWMP and ordinances by the Scott Watershed Management Organization (WMO), the City shall have administrative authority over the approved SWMP and ordinances. The City shall also have the duty to enforce the SWMP and associated ordinances.

The SWMP has the following organization: A description of the existing conditions; general procedures that were used to formulate the SWMP; storm water quantity discussion that includes volume design criteria for the storm water system; storm water quality discussion with quality design criteria for the storm water system; erosion control requirements; information on natural resources protection that includes ravines, bluff, wetlands and groundwater; proposed ponding and system improvements on a watershed basis, including regional infiltration ponds; operations and maintenance; education for City staff, citizens and developers; economic considerations; and summary and recommendations which includes the implementation process.

Minnesota Statute 103B.235, Subd. 2 states that the contents of the SWMP shall:

A. describe existing and proposed physical environment and land use;

B. define drainage areas and the volumes, rates, and paths of storm water runoff;

C. identify areas and elevations for storm water storage adequate to meet performance standards established in the watershed plan;

D. define water quality and water quality protection methods adequate to meet performance standards established in the watershed plan;

E. identify regulated areas; and

F. set forth an implementation program, including a description of official controls and, as appropriate, a capital improvement program.

The items required by Minnesota Statute 103B.235, Subd. 2 are covered in this document. The existing and proposed physical environment and land use are covered in Section 3, Land And Water Resource Inventory. The physical environment is discussed in more detail in Section 9, where each watershed is discussed with regard to the existing and proposed ponding and system improvements. Water quantity controls are covered in Section 5 and water quality protection is covered in Section 6. Regulated areas are discussed in Section 8, and a proposed green corridor will protect sensitive areas from environmental impacts associated with development. Discussion of implementation of the plan recommendations are included in Section 13.

- Minnesota Chapter 8410.0160 outlines the structure of a SWMP

- Meet the requirements for local water management plans as required by MN Statute section 103B.235.
- An executive summary
- A section of water resource related agreements
- A description of the existing and proposed physical environment and land use
- A section on assessment of problems
- A section of the establishment of policies and goals
- A section on corrective actions
- A section on financial considerations
- An implementation program discussing which components of the implementation program the city will prioritize
- A section on the City's amendment procedures

The items required by Minnesota Chapter 8410.0160 are also covered in this document. A purpose statement is included in Section I. Executive Summary Page 1. This section summarizes the policy and goal of the City. Water resource related agreements are covered in Section 2.1, Water Related Agreements. A land and water resource inventory is included in Section 3. Assessment of problems is covered in Section 9, for each watershed. Corrective actions are covered in Ordinance 1103 and in the developer's agreement, which requires a letter of credit to finance corrective actions. Financial considerations are covered in Section 12 and also as part of Section 13.3. Discussion of implementation of the plan recommendations is included in Section 13. A Capital Improvement Plan, which is a process to address projects/concerns with managing surface and groundwater, is discussed in Section 13 of this report. Amendment procedures are covered in this Section and City Ordinance 1103.06, Ordinance Amendments and Land Rezonings.

According to State Statute 103B.235 Subd. 3, Review, after consideration but before adoption by the governing body, the City shall submit its SWMP to the Scott Watershed Management Organization (WMO) for review for consistency with the watershed plan adopted pursuant to section 103B.231. The Scott WMO shall approve or disapprove the plan or parts of the plan. The Scott WMO shall have 60 days to complete its review; provided, however, that the Scott WMO shall, as part of its review, take into account the comments submitted to it by the Metropolitan Council pursuant to subdivision 3a. If the organization fails to complete its review within the prescribed period, the SWMP shall be deemed approved unless an extension is agreed to by the City.

According to State Statute 103B.235 Subd. 3a, Review by Metropolitan Council, concurrently with its submission of its SWMP to the Scott WMO as provided in subdivision 3, the City shall submit its SWMP to the Metropolitan Council for review and comment by the council. The council shall have 45 days to review and comment upon the SWMP or parts of the plan with respect to consistency with the council's comprehensive development guide for the metropolitan area. The council's 45-day review period shall run concurrently with the 60-day review period by the Scott WMO provided in subdivision 3 of State Statute 103B.235. The Metropolitan Council shall submit its comments to the Scott WMO and shall send a copy of its comments to the City. If the Metropolitan Council fails to complete its review and make comments to the Scott WMO within the 45-day period, the Scott WMO shall complete its review as provided in subdivision 3 of State Statute 103B.235.

According to State Statute 103B.235 Subd. 4, Adoption and Implementation, after approval of the SWMP by the Scott WMO, the City shall adopt and implement its plan within 120 days and shall amend its official controls accordingly within 180 days.

According to State Statute 103B.235 Subd. 5, Amendments, to the extent and in the manner required by the Scott WMO, all major amendments to the SWMP shall be submitted to the Scott WMO for review and approval in accordance with the provisions of State Statute 103B.235, subdivisions 3 and 3a for the review of plans. All minor amendments will be reviewed and approved by the City Council.

The City Administrator shall administer and enforce the water resource-related Ordinances under the direction and control of, and subject to the powers expressly reserved to, the City Council. Following approval of the City's Surface Water Management Plan, and/or ordinances, the City shall have administrative authority over the approved Surface Water Management Plan, and/or ordinances. At any time within 15 business days after a decision or determination by the Administrator interpreting or applying these Ordinances, the applicant, permittee or any other person or political subdivision with an interest in the decision or determination, may appeal to the City Council. The Planning Commission, at a regular meeting shall produce advice for the commissioners regarding the appeal. Following the Planning Commission meeting, the City Council shall, at a regular or special meeting, consider and affirm, reverse or remand the decision or determination that is on appeal.

The City places a high priority in improving impaired waters and intends to work with the WMO and other agencies to achieve water quality goals by reducing the impact created by the City. Once a Total Maximum Daily Load (TMDL) has been finalized, the City will create an implementation strategy to achieve the TMDL, including funding mechanisms that will allow the City to carry out the requirements. The City would revise the SWMP and revise the ordinances to be in compliance with the TMDL requirements. The City is committed to implementing TMDL corrective actions.

A. Water Resource Related Agreements

In accordance with the Scott County WMO, the City of Belle Plaine has entered into a Memorandum of Understanding agreement regarding implementation of its Surface Water Management Plan.

The City's zoning ordinance requires developers to enter into a development agreement when new development occurs to ensure that storm water management planning is incorporated.

## IV. Land and Water Resource Inventory

The purpose of this section is to describe the physical aspects of the area that the SWMP covers.

A. Topography

The City of Belle Plaine is located on relatively flat terrace land adjacent to the Minnesota River floodplain. The southern portion of the study area consists of bluff areas that rise above the terrace land into the rolling terrain of southwest Scott County. Elevations within the study area range from 725 near the Minnesota River floodplain to 1,010 along the southern study boundary.

The total hydrological study area includes over 15,000 acres of watershed as shown in Figure SW-02. As can be seen from the figure, the area of the study lies both within and outside of the projected City limits for the year 2040. It is assumed that growth around Belle Plaine will continue to the south and along both the east and west approaches of U.S. Highway 169.

From the ridge on the south side of the City, the majority of the watershed area lying south of U.S. Highway 169 generally migrates from the uplands in the south and flows north. The storm water runoff begins as surface sheet flow that develops into forceful streams directed by steep ravines to the relatively flat area below.

In situations where the soils are either saturated or frozen and when rainfall events are extreme, runoff on the west side of the City generally flows to South Creek, a natural

waterway that begins at the eastern corporate limits at a point approximately 650 feet south of South Street (CSAH 7). The waterway then flows east until it crosses U.S. Highway 169 immediately west of Emma Krumbee's Restaurant. From there, the waterway flows northwesterly in a more pronounced ravine that forms the western barrier of the existing developed part of the City.

Over the last 10 to 20 years, new development has changed the original waterway in the area to the south of U.S. Highway 169 from an intermittent waterway to a series of ponds that are separated by newly constructed roadway crossings with connecting culverts.

B. Soils

There are two major soil associations in the presently developed areas of City of Belle Plaine. The association in the northern region of Belle Plaine is the Hubbard-Estherville-Waukegan-Zimmerman association. This association is defined as level and gently sloping loamy and sandy soils on terraces. This occurs on stratified sand and gravel terraces formed by glacial melt water. While the underlying material has a high capacity for infiltrating storm water, most areas contain a top layer of loamy material (approximately 2 to 3 feet thick) that significantly limits the infiltration of water to the underlying sand and gravel.

The area where the land raises up from the terrace land along the bluffs consists of the Burnsville-Hayden-Kingsley-Sandia association. This association consists of steep and hilly loamy and sandy soils along the bluffs that divide uplands from the bottomland terraces. Erosion is the most common problem along ravines that drain downward through the bluff slopes. Due to the steep grade of these ravines, an increase in runoff rate and volume can significantly increase erosion and decrease the stability of the stream banks in these areas.

Further south, on the relatively undeveloped plateaus above the bluffs, there are two soil associations present: gently sloping and nearly level soils of the Webster-Le Sueur-Clarion-Lester association and the rolling to nearly level soils of the Lester-Webster-Glencoe association.

Figure SW-03 shows the soil hydrology groups in the Belle Plaine area. Areas marked "A/D," "B/D" or "C/D" indicate soils that, when untiled, are D soils, but when tiled, act as A, B or C soils, respectively.

C. Natural Resources

The Minnesota River bluffs and ravines are attractive features of the City of Belle Plaine. The bluffs offer unique views of the river valley and contain some remnants of oak savanna and woodland plant communities that covered the uplands in the City before the era of European settlement. The ravines are still largely wooded, and provide corridors for wildlife movement and recreation, connecting upland areas with the Minnesota River and its floodplain. Although much of the original wetlands outside of the River floodplain but still in the lowlands have been impacted, some areas still support valuable wetland characteristics. There are many large wetland areas in the upland areas. Figure SW-04 shows natural resources areas, including a green corridor to protect existing drainage ways and hydrologic conductivity. Preservation of the green corridors will assist in the proper management for flood routing. Additional information regarding the bluffs and ravines in Belle Plaine can be found in Section 8 of this report.

D. Wetlands

A limited number of wetlands remain in the watershed outside the Minnesota River floodplain. Several more wetlands exist in the uplands to the south of the City. These wetlands play a role in storm water management, and probably provide nesting and feeding habitat for waterfowl and other birds and animals. Figure SW-05 indicates the location of wetlands that are identified by Scott County and the NWI. The Federal Emergency

Management Agency's (FEMA's) Flood Insurance Rate Maps (FIRMs) indicate that there are some flood prone areas of the City. FIRMs can be found at the City offices or online at msc.fema.gov. Figure SW-06 shows the FEMA zones.

E. Land Use and Land Cover

Land use is one of the primary mechanisms that can cause flooding and water quality problems. As prairie and forested areas are converted to agricultural and urban uses, the volume and rate of storm water runoff increases. This increase in storm water runoff can cause significant erosion in steep ravine areas. The conversion of natural land cover also increases the amount of pollutants in storm water runoff such as the levels of pesticides and nutrients from agricultural land use, and trace metal concentrations from urban land use. Pollutant loading analysis has not been included with in this report. This plan estimates the future land use throughout the study area in order to propose improvements in the drainage system. The Minnesota Land Cover Classification System (MLCCS) cover types for the Belle Plaine area are shown on Figure SW-07.

F. Groundwater

The City has a state-approved and locally adopted Source Water Protection Plan. The overall goal of the plan is to prevent contamination of the aquifer and, manage the aquifer cooperatively to assure sustainable water supplies. Portions of the aquifer supplying the system's drinking water have been identified as moderately vulnerable to contamination from typical land use activities. The plan prioritizes creation of awareness and risk management to minimize and avoid future contamination of the aquifer. The recommendations include: manage municipal wells and implement appropriate protections and regulations for private wells, inform the public about groundwater availability and quality through public education, manage aboveground and underground storage tanks, inform the public about shallow disposal wells, collect and manage data to facilitate informed decision making.

## V. General Procedures

The Scope for the SWMP called for the development of a design document to size and locate conceptual future detention basins and other drainage facilities within the City as affected by the future growth areas around the City. Procedures for preparation of the SWMP follow traditional design procedures. By necessity, the SWMP becomes a very technical document. The following summarizes the major activities associated with plan development:

USGS topographic mapping and two-foot aerial contours (as provided by Scott County) were obtained and correlated with the existing storm water data to determine and model the existing drainage patterns. Final design criteria will be based upon site-specific survey information.

Each minor drainage area, flowing to a collection point; such as a manhole at a low intersection, an existing catch basin, or a natural, agricultural low area; was identified and mapped on a master drainage area and topography drawing. Approximately 50 subwatershed collection areas were identified as part of this project.

All subwatersheds were transferred to a GIS compatible computer mapping system. Drainage areas were computed for each subwatershed.

Many factors were considered in this planning/design process including, but not limited to, the following:

- Implementation of recent storm sewer improvements into the future plan to assure that maximum usage and benefit was achieved from prior City investments.
- Incorporation of detention facilities for flood protection and cost-effective pipe or channel sizing wherever open public space or future development permitted such facilities. Such

detention basins can be incorporated into the storm water quality aspects of the plan for water quality enhancement and conformance with future NPDES storm water permitting requirements.

- Combination or rerouting of parts of major watersheds to assure cost effective future storm sewer improvements and to reduce existing flooding problems.
- Diversion of subwatershed areas into detention basins to assist in storm water quality management.

The City's storm water quantity goal is to manage the quantity of runoff so that flows from developed properties do not cause adverse effects downstream or further impair those waters that are already impaired. The impaired waters within the City are shown in Figure SW-08. The City policy is to enforce the City Ordinances to ensure the SWMP's recommendations are being implemented.

Surface runoff, storm sewer and detention basin design is dependent upon the ground cover and the permeability of the soils. Representative runoff coefficients (C factors) for the rational method of storm water modeling and Curve Numbers for the SCS method were computed for each major watershed to reasonably reflect the degree of existing industrial, commercial and residential development. Undeveloped areas were designed using runoff coefficients and curve numbers representative of the proposed land use. See Section 5.4 for more in-depth discussion of runoff rates.

Preliminary basin sizing was based on the Guidelines recommended by the Minnesota Pollution Control Agency (MPCA) "Protecting Water Quality in Urban Areas", William Walker, Jr. in Design Calculations for Wet Detention Ponds (1987) and also in accordance with the recommendations of the Minnesota Board of Water and Soil Resources (BWSR) for wet detention basins and water quality enhancement. It is assumed that all major detention basins in the City shall be developed to assist in water quality enhancement. This will assist the City in obtaining the anticipated future permit as may be needed from the MPCA for NPDES municipal storm water permitting.

A. NPDES Requirements

The NPDES Phase II Stormwater permitting requirements applied to all cities with populations exceeding 10,000 as well as any specifically targeted cities. NPDES Phase I targeted cities with populations exceeding 100,000. To our knowledge, the City of Belle Plaine is not listed as a specially targeted community. However, since the Minnesota River has already received special attention as a cleanup project, and since Scott County has been targeted as a special cleanup area, it appears that the City of Belle Plaine will inevitably be subject to future NPDES requirements.

The federal guidelines call for targeted cities to meet six minimum storm water control measures as follows:

- Public education and outreach
- Public participation and involvement
- Detection and elimination of illegal discharges
- Control of large construction sites runoff
- Post construction storm water management
- Pollution prevention or housekeeping for municipal operations.

MPCA NPDES of Minnesota's storm water discharge permit program is designed to reduce adverse impacts to water quality. The primary targets of acceptable storm water management

plans are urban runoff and construction runoff. This is because urban runoff carries pollutants from cars, lawn fertilizers, pesticide spills and other contaminants into our lakes, wetlands and streams without entering wastewater treatment systems. Construction runoff is often laden with sediment caused by large amounts of unvegetated soil that are loosened by excavation and grading.

The MPCA mandates are intended to regulate these sources of continued environmental degradation. To comply with future NPDES requirements, the Belle Plaine Stormwater Management Plan shall establish measurable goals using a Best Management Practice (BMP) approach and to be able to track performance and progress.

Erosion and sediment control measures shall meet the standard for the General Permit Authorization to Discharge Storm Water Associated With Construction Activity Under the National Pollutant Discharge Elimination System/State Disposal System Permit Program Permit MN R100001 (NPDES General Construction Permit) issued by the Minnesota Pollution Control Agency, August 1 2013, as amended; except where more specific requirements are provided in this Ordinance below.

If land disturbing activity is taking place on a site where the soils are currently disturbed (e.g. a tilled agricultural site that is being developed), areas that will not be disturbed as part of the development and areas that will not be disturbed according to the time frames and slopes specified in the NPDES General Construction permit Part IV.B.2, shall be seeded with temporary or permanent cover before commencing the proposed land disturbing activity.

Where ten (10) or more acres of disturbed soil drain to a common location, a temporary (or permanent) sediment basin must be provided prior to the runoff leaving the site or entering surface waters. The basins must be designed and constructed according to the standards in the NPDES General Construction Permit Part III.C.

The permittee or applicant must ensure final stabilization of the site in accordance with the NPDES General Construction Permit requirements. The site will be considered as having achieved final stabilization following submission of Certificate of Completion by the permittee or applicant, and inspection and approval by the City.

B. Regulation

Several agencies, including the City, have jurisdiction over the floodplain, wetlands and other waters of the U.S. within the City limits. Figure 1 illustrates the City, Minnesota state and federal jurisdiction over water courses.

No person or political subdivision shall commence a land disturbing activity or the development or redevelopment of land, unless specifically exempted, without first obtaining an approved storm water management plan and permit.

C. Exceptions

No permit or storm water management plan is required for the following land disturbing activities:

- Minor land disturbing activities such as home gardens, repairs and maintenance work.
- Construction, installation and maintenance of public utility lines or individual service connections unless the activity disturbs more than one acre.
- Construction of any structure on an individual parcel in a subdivision with a storm water management plan approved by the City, so long as any land disturbing activity complies with the approved plan.

- Development or redevelopment of, or construction of a structure on, an individual parcel with a land disturbing activity that does not cause off-site erosion, sedimentation, flooding or other damage, and creates less than 1 acre of cumulative impervious surface.
- Installation of any fence, sign, telephone or electric poles, or other kinds of posts or poles.
- Emergency activity necessary to protect life or prevent substantial harm to persons or property.
- Redevelopment projects are exempt from rate and volume control provisions in the Ordinances. Note: For the purposes of this SWMP if an activity creates more than 1 acre of new or additional impervious surface the activity is considered new development and the exception does not apply to the increased (new) impervious surface.
- Minor wetland impacts that have received a "certificate of exemption or no loss" determination by the City.
- All maintenance, repair, resurfacing and reconditioning activities of existing road, bridge and highway systems, which do not involve land disturbing activities outside of the existing surfaced roadway.
- Land disturbing activities associated with the construction of conservation practices by the Soil and Water Conservation District (SWCD) or the Natural Resources Conservation Services (NRCS) provided that erosion prevention and sediment control practices are used in a manner consistent with the Ordinances.

# VI. Storm Water Quantity

## A. Background

The main purpose of the storm water quantity portion of the SWMP is to serve as a guide for the expansion of the storm drainage system. This chapter identifies opportunities for improving the capacity of the existing system and provides standards for the design of future facilities. The application of these standards will allow for the expansion of the storm drainage system as the City develops while minimizing the cost and inconvenience of local flooding and repair of stream bank damage.

The storm drainage facilities discussed in this study consist of interconnected green corridors (open channels, wetlands, ponds, and piped road crossings with designed emergency overflows (EOFs)). The preliminary design of the storm water drainage system for the Belle Plaine SWMP involved the following aspects:

- Division of the City into subdistricts based upon topographic information and future land use projections;
- Computation of runoff using ultimate land use projections within the study area;
- Selection of a consistent method for conveying runoff;
- Identification of high quality streams and water bodies;
- Utilization of ponding areas for storage, sediment and pollutant trapping and nutrient uptake; and,
- Regulation of peak flows in waterways and ravines to minimize erosion and impacts to stream morphology.

An essential part of the SWMP is the conceptual design of storm water ponding areas. Since the mid-1970s, storm water management authorities have emphasized the use of storm water ponding to control increased rates and volumes of runoff from developing areas. The City currently requires each individual development to analyze and design storm water practices to control runoff. However, this approach will eventually result in a large number of facilities that will be difficult for the City to manage and maintain. Local flooding may still occur under this approach when the entire system is not analyzed on an entire watershed basis.

The Belle Plaine SWMP follows a regional storm water basin approach by consolidating individual basins that would normally be constructed in each subdivision or development, into central facilities within the subdistrict. Basins should be located to provide the most beneficial and cost-effective control of runoff from future development areas. Several individual ponds can be combined into one efficiently designed basin to control runoff for several developments. Regional basins provide a cost-conscious approach to storm water management by providing the following benefits:

- Combining engineering, design and construction cost for individual developments;
- Utilizing naturally occurring depressions and existing topography to minimize excavation costs;
- Reducing total land required for storm water management by providing efficiently designed central facilities in place of several individual facilities;
- Minimizing the cost to manage the system by creating fewer storm water basins;
- Lowering the cost of maintenance and up-keep;
- Providing flexibility in design of larger central facilities to incorporate recreational opportunities, create wildlife habitat areas and improve aesthetic benefits for area residents; and,
- Integrating low areas with upland areas to improve wildlife habitat.

Ponds with oversized outlets reduce the available flow capacity in downstream pipes and tend to empty sooner than desired. This problem can be resolved with the construction of outlet control structures such as orifices and weirs, which are recommended for some ponds. Outlet control structures are designed to reduce the outflow from a pond to a level that is equal to or lower than that in the existing condition. Ponds shall be designed to include a skimmer device, meet Walker design volume criteria and meet and/or exceed MPCA criteria.

Trunk storm sewer conveys runoff from the upper portions of watersheds to the proposed regional pond facilities. Trunk storm sewers are defined as storm sewer pipes that are 24 inches or greater. Storm sewers that convey runoff flows from a regional storm water basin are also considered trunk storm sewers.

B. Design Criteria

1. Precipitation

Storm water runoff is defined as that portion of precipitation, which flows over the ground surface during, and for a short time after, a storm. The quantity of runoff is dependant on the intensity of the storm, the length of storm, the amount of previous rainfall, the type of surface the rain falls onto and the slope of the ground surface.

The intensity of a storm is described by the amount of rainfall that occurs over a given time interval. A specific rainfall amount over a given time interval will statistically occur in a given time span, usually years. This is called a return frequency. A return frequency designates the average time span during which a single storm of a specific magnitude is likely to occur. Thus, the degree of protection afforded by storm sewer

facilities is determined by selecting a return frequency to be used for design based on good economic sense and current engineering practices.

A hydrograph method based on sound hydrologic theory was used to analyze runoff for the design or analysis of flows and water levels. The typical analysis is based on Soil Conservation Service, Technical Release No. 20 (SCS TR-20). The SCS TR-20 methodology is widely accepted among drainage engineers across the United States. However, the SCS procedure is based on a standard rainfall hydrograph that is modified by local parameters (i.e., rainfall, soil type, time to peak flow, etc.). A general hydrology discussion is included in Appendix C.

A SCS 24-hour Type II storm distribution with 100-year intensity was used for the design of ponds and drainage systems. The Type II distribution is the storm event recommended for the upper-Midwest portion of the United States that the Soil Conservation Service has determined from National Weather Bureau data.

For purposes of this report, we chose to analyze the effects of a 6.1-inch rainfall which has a probability of occurring once every 100 years. This is not to say that a 6.1-inch rainfall cannot occur multiple times within the same year; it is just to say that a 6.1-inch rainfall will occur on the average once every 100 years. It is often better to think of the 100-year rainfall as having a 1 percent chance of occurring in any given year.

Analysis of flood levels, storage volumes and flow rates for waterbodies and detention basins shall be based on the range of rainfall and snow melt durations producing the critical flood levels and discharges. The City of Belle Plaine uses a 10-year frequency storm event for storm sewer design, while the greater of the 100-year, 24-hour frequency rainfall event, or the 100-year, 10-day snowmelt event is used for overland drainage and pond storage design. These storm events were selected for the analysis and design of the drainage system for the SWMP. All ponds will be analyzed with a 10-inch, 24-hour rain event in order to determine the emergency over flow (EOF) function as intended.

Storm water detention facilities with peak discharge rates less than 2 cfs/40 acres are typically susceptible to exceeding high water levels during snowmelt conditions. Special consideration of the snowmelt condition becomes more critical for some areas with curve number values less than 70 that typically remain frozen later in the season (such as wooded areas). These areas produce low runoff rates under normal summer conditions. Final basin design must consider snowmelt conditions when sizing outlet structures.

To customize the SCS methodology to fit the typical flows anticipated for Belle Plaine, the peak watershed flows estimated from SCS methods were compared to the flows estimated from the regression equations from “Techniques for Estimating the Magnitude and Frequency of Floods in Minnesota” as generated by the U.S. Geological Survey, Water-Resources Investigations Report 87-4170. Since these equations are extrapolated from actual historical data of river and creek gauging stations in Minnesota, they are considered to be an accurate representation of flows from the agricultural areas in excess of 60 acres in size.

Although the regression equations are considered to be the best representation of the flow generation characteristics in southern Minnesota, they only estimate the peak flow rates for the various probabilities of flooding. Detention storage studies are primarily concerned with flow volumes that are best modeled using SCS methodologies. In our experience in comparing the flows, the SCS peak flow rates are typically higher than that predicted by the regression equations for the same drainage area. Hence, a

tailoring technique has been used to make the two modeling methods report similar results.

The general methodology used to model the existing flows from the larger agricultural watersheds was to calibrate the SCS peak hydrograph flow rates to match the USGS regression equation flows for the same area.

The excess runoff caused by storms greater than that used for design will be accommodated by ponding in low spots in streets for short periods of time and providing outflow through overland drainage routes. This short-term flooding and overland drainage will minimize much of the damage to property that would occur if those facilities were not provided. Provisions shall be made to provide or preserve overland drainage routes for emergency overflows. When possible, storm water pond designs shall include an emergency overflow to provide an outlet one-foot below the lowest opening elevation of any adjacent structure for added safety.

In 2013, the National Weather Service (NWS) released NOAA Atlas 14, Volume 8 which updated the 1961 TP-40 precipitation frequency estimates for Midwestern states. For future development and city projects the Atlas 14 distribution MSE 3 rainfall depths will be used for quantifying stormwater runoff. The Table 1 below shows the difference between the TP-40 and Atlas 14 24-hour rainfall amounts for Belle Plaine:

**Table 1 - Precipitation Frequency Estimates**

| Precipitation Data Source | 2-Year (inches) | 10-Year (inches) | 100-Year (inches) |
|---|---|---|---|
| TP-40 Rainfall | 2.8 | 4.1 | 6.1 |
| Atlas 14 Rainfall | 2.86 | 4.23 | 7.18 |

Table 2 indicates average precipitation data from approximately 1948 through 1986 that was tabulated by the National Climatic Data Center for the Belle Plaine area (ESE 1992). This data indicates that the maximum monthly precipitation totals, maximum storm intensities, and shortest storm durations occur during the month of July for the area. The days for July, the mean residence time for average storm events would be approximately 15 days for the recommended permanent pool volume standard above. This is consistent with the permanent pool volume criteria recommended by the MPCA.

**Table 2 - Average Precipitation Data for Belle Plaine MN – January through June**

| Item | Units | Jan. | Feb. | Mar. | Apr. | May | Jun. |
|---|---|---|---|---|---|---|---|
| Mean Total Precip. | Inches | 0.88 | 0.86 | 1.80 | 2.09 | 3.23 | 3.92 |
| Mean Storm Duration | Hours | 11.05 | 11.30 | 14.61 | 12.18 | 9.61 | 7.91 |
| Mean Storm Events | Number | 2.343 | 2.17 | 3.83 | 4.69 | 6.63 | 6.80 |
| Mean Storm Depth | Inches | 0.225 | 0.27 | 0.43 | 0.41 | 0.45 | 0.53 |
| Mean Storm Intensity | Inch/ Hour | 0.018 | 0.02 | 0.03 | 0.04 | 0.07 | 0.09 |
| Mean Max. Storm Intensity | Inch/ Hour | 0.073 | 0.09 | 0.16 | 0.25 | 0.49 | 0.70 |

**Table 2 (con't) - Average Precipitation Data for Belle Plaine MN – July through December**

| Item | Units | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|
| Mean Total Precip. | Inches | 3.52 | 3.57 | 2.40 | 1.89 | 1.45 | 1.01 |
| Mean Storm Duration | Hours | 6.11 | 7.61 | 8.87 | 10.96 | 12.81 | 11.42 |
| Mean Storm Events | Number | 5.60 | 5.88 | 5.22 | 3.44 | 3.03 | 2.78 |
| Mean Storm Depth | Inches | 0.65 | 0.58 | 0.43 | 0.50 | 0.41 | 0.30 |
| Mean Storm Intensity | Inch/ Hour | 0.13 | 0.11 | 0.07 | 0.05 | 0.03 | 0.02 |
| Mean Max. Storm Intensity | Inch/ Hour | 0.77 | 0.70 | 0.37 | 0.25 | 0.14 | 0.09 |

C. Simplified Hydrologic Yield Method

1. Determining Flood Elevations of Landlocked Basins

Control of building decisions is a major responsibility of local governments. One of the most difficult aspects of this responsibility is making decisions regarding building adjacent to landlocked lakes and ponds.

In the first phases of rural development, development occurs preferentially in higher, well-drained areas. The last-developed areas with many wetlands typically have to maximize land use to be economically feasible, and applicants are often reluctant to keep homes above the run-out elevation of a landlocked area. Because local governments do not have the time or resources to analyze the flood level of each landlocked ponding area, they need a conservative, approximate method that is easy to use.

The following sections describe some examples of approaches to this problem. The City has chosen to use the simplified hydrologic yield method that is based on hydrologic principles, but is simple enough to use for day-to-day development reviews.

2. Full Watershed Yield and Groundwater Simulation

The most complete and scientific approach to the problem is to prepare a long-term watershed yield and groundwater model. Such a model requires the input of meteorological and watershed information, which is then used to determine the total amount of water produced by the watershed (yield). The predicted yield is then input to a groundwater model that simulates the pond's seepage as a function of lake level and climate. If sufficient data on lake levels are available for calibration, this approach can be reasonably accurate. Such models were used by the Federal Emergency Management Agency (FEMA) to determine flood levels of Great Salt Lake, Utah and Devils Lake, North Dakota. In Minnesota this type of model was used by FEMA for Big Marine Lake and Prior Lake. The use of a full yield model is warranted when damages could be high, the water body is large, etc. Since this is generally not the case for most landlocked basins, other methods have been used.

The model described above can be simplified by using "representative" runoff years and by simplifying the land use and groundwater yield models but even at this level, a customized model is too expensive and time-consuming for development review purposes.

3. Back-to-Back 100-Year 24-Hour Rainfall Events

This method is sometimes used because it is simple and does not require calculation of all the other parameters such as seepage to groundwater. It acknowledges the fact that the critical rainfall amount for flooding of landlocked basins is greater than the rainfall from a single one-day storm; a longer-duration event will almost always be critical for a landlocked basin. However, simply doubling the storm rainfall is not a statistically valid way to analyze the problem since the probability of this event occurring is much less than one percent. A simple doubling of the rainfall amount may be difficult to defend if challenged.

4. Ten-Day and Thirty-Day Snowmelt Event or a Thirty-Day Combined Rainfall/Runoff Event

These methods are an improvement over using the one-day storm because they are statistically based and are more representative of long-term flood events. The problem with these methods is that the critical event could be of much longer duration than either ten or thirty days. The critical event could be months or years long. Data on 30-day runoff are relatively scarce, as well.

5. DNR's Ordinary High Water (OHW) Elevation

   The OHW is the elevation at which aquatic vegetation transitions to upland vegetation. While the OHW is used as a management tool by the MDNR (e.g., for shoreland setbacks), even the MDNR does not believe that it should be used for setting building elevations. MDNR staff acknowledges that the OHW is only an indication of past high water; the staff believes that the OHW is often equivalent to approximately the 15-year flood level.

6. No Building Below the Overflow (Runout) Elevation

   This approach to setting building elevations is certainly conservative and will produce safe building decisions, but it may result in very large amounts of land being unbuildable. When this method is used, some freeboard shall be reserved above the overflow (runout) elevation because overflow, if it occurs, will require some additional driving head before the water level stabilizes. Where flow paths are poorly defined, this may be well over a foot of flow depth.

   In some urbanizing communities this policy is viewed as a temporary situation until an outlet can be constructed. However, many basins will have low housing density and relatively high overflow elevations. Under these circumstances, it is unlikely that outlets will ever be provided for most landlocked basins. Nonetheless, this may be acceptable.

7. The Simplified Hydrologic Yield Method

   The City has chosen the simplified hydrologic yield method. The simplified method is derived from watershed yield models completed in the Minneapolis-St. Paul metro region. It uses those studies to make an estimate of the amount of runoff generated during the 100-year annual runoff event. Hence, it is a single-event model, but based on a longer-duration event than the methods discussed earlier. The simplified method calculates the 100-year annual inflow from all parts of the watershed, including the water surface, as shown in Table 3.

| Table 3 - 100-Year Annual Inflow | |
|---|---|
| Impervious Surfaces | 32 inches |
| Turfed Surfaces | 18 inches |
| Water Surfaces | 12 inches |

   Note that these amounts are taken from the Washington County flood insurance study data. Numbers for other communities in the Twin Cities metropolitan area might be slightly different. The “turfed” classification includes vegetated areas that have evapotranspiration and soil storage that is available to plant roots; the value shown is for till (heavier) soils; outwash soils would be slightly different.

   In calculating the flood level, the most conservative assumption would be to neglect outflow and simply use the 100-year inflow from the watershed and assume that it has to be stored in the basin. This produces very high flood levels. However, water does leave the basin. Evaporation from the pond and land surfaces is included in the inflow figures; the greatest missing component is seepage or infiltration from the pond. For a landlocked pond that normally contains water, the inflow and seepage are in long-term equilibrium. Therefore, we know that the long-term average infiltration equals the average inflow from the watershed. According to the simplified method, the average inflow from the watershed to the pond is as shown in Table 4.

| Table 4 - Average Annual Inflow | |
|---|---|
| (equals assumed average outflow) | |
| Impervious Surfaces | 16 inches |
| Turfed Surfaces | 8 inches |
| Water Surfaces | -6 inches |

The runoff from water surfaces is negative because, in the Twin Cities metropolitan area, precipitation is less than average water surface evaporation on an annual basis, so water surfaces cause a reduction in total watershed yield (this is not the case in northern Minnesota).

From a theoretical standpoint, the 100-year storage shall be calculated by subtracting the 100-year seepage from the 100-year watershed yield. Of course, we don't know the seepage under the 100-year high water condition, but we can conservatively substitute the average seepage, which we just noted is equal to the average inflow. The net 100-year annual storage amounts are then as follows:

<u>Net 100-Year Annual Excess</u>

Impervious Surfaces (32-16) = 16 inches Turfed Surfaces (18-8) = 10 inches
Water Surfaces (12-(-6)) = 18 inches

The resulting net runoff volume must be stored above the normal water level of the landlocked water body. It is important to exercise care in setting the assumed normal water level. This is true for any of the methods discussed. Since the water level can fluctuate greatly, it is difficult to determine the correct "normal" water elevation. It is especially difficult for water bodies for which there is little or no water level data. The established normal water level of a landlocked basin must be based on available water level records and topographic maps and shall be carefully reviewed by the permitting jurisdiction. If the OHW is available, it can be used as a guide to the upper level of the "normal" water level.

The typical strategy for use of this method is to apply it, unless the applicant is willing to pay for a more detailed analysis. A more detailed analysis would require calculation of many years of watershed yield numbers. It would also require the placement of observation wells to determine groundwater flow patterns. Based on the groundwater system, a transient groundwater model would be prepared that would be linked to the watershed yield model. Because of the additional expense, permit applicants almost always use the approximate method to determine flood elevations.

The method is based on results of hydrologic models. For example, the 100-year runoff amounts for water and turfed areas are similar to results from the Big Marine Lake Flood Level study for years 1965 and 1975, which had 44.44 inches and 41.68 inches of precipitation, respectively. The average runoff amounts are similar to the average yields determined in the Prior Lake, Big Marine Lake, Minneapolis Chain of Lakes and the Lake Minnetonka watershed yield studies.

The simplified method results in flood elevations that are higher than the 100-year 10-day snowmelt event (assuming the basin does not overflow in the 100-year 10-day snowmelt event), but possibly lower than the overflow elevation.

There are benefits to using the simplified method. Using this method, the permitting jurisdiction has reasonable assurance that buildings will be constructed outside of flood plains without resorting to requiring that buildings be above the overflow elevation. The method is simple; only future land use data and stage/area/storage information is required to determine the 100-year flood elevation. Although data collection is not required, any information about historical water levels is useful.

There are also limitations to the use of the simplified method. It works best with single watersheds that hold water. Dry depressions almost certainly experience seepage that is greater than what is built into the method. Another drawback is that the simplified method uses only the one-year event; the critical event could be of longer duration than one year. In areas with many landlocked ponds, the method can predict overflow from one pond to another; in this case the conservatism of the method can multiply as more upstream areas become tributary. If some of these upstream watersheds contain dry depressions, it could add to the inaccuracy in the flood level determination. Another problem is high seepage areas, especially those with karst hydrology. In one case the observed flood level was 20 feet below the predicted flood level. High seepage areas contain water but exhibit excessive seepage; the simplified method does not take this additional seepage into account. Bank storage is not taken into account in the simplified method. It is possible that a basin's effective storage volume could be much greater at a particular elevation if bank storage was included in the storage volume computation.

8. Example Problem and Comparison with Other Methods

Given a landlocked watershed with a 20-acre pond at about Elevation 1000. The tributary area is 400 acres and the runout (overflow) level is Elevation 1030. The water surface area increases from 20 acres at Elevation 1000 to 50 acres at 1030. The stage-storage curve is zero storage at Elevation 1000 to about 1000 acre-feet at 1030.

The proposed land use in the watershed is low-density residential one-acre lots with approximately 20% impervious surface. Based on average soil conditions and including the pond and impervious areas, the weighted Curve Number would be about 75.

| The land use for the simplified method is: | | |
|---|---|---|
| Water surface | 20 acres x 18 inches of excess runoff | = 30 acre-feet |
| Impervious surface | 80 acres x 16 inches of excess runoff | = 107 acre-feet |
| Turfed surface | 300 acres x 10 inches of excess runoff | = 250 acre-feet |

Total runoff to be stored (yield less assumed seepage) = 387 acre-feet

Results of different runoff calculation methods are described in Table 5.

**Table 5 - Comparison of Flood Level Calculations for Sample Landlocked Pond**

| Method | Runoff | Flood Level | Minimum Building Elevation | Acres of Unbuild-able Land* |
|---|---|---|---|---|
| No building below runout level | Not required to be calculated. Flood level would require about 1054 acre-feet or 31.6 inches of runoff. | 1030+ | 1031+ | 30+ |
| 100-year one-day rainstorm (7.19 inches) | 3.4 inches or 112 acre-feet | 1005 | 1006 | 5 |
| 100-year 10-day rainstorm (10.2 inches) | 5.27 inches or 176 acre-feet | 1007.5 | 1008.5 | 7 |
| 100-year 10-day runoff | 7.2 inches or 240 acre-feet | 1010 | 1011 | 9.2 |
| 30-day runoff event | 9 inches or 300 acre-feet | 1012 | 1013 | 11 |
| Two 100-year 1-day rainstorms (14.4 inches) | 8.76 inches or 291 acre-feet | 1012 | 1013 | 11 |
| Simplified method | 387 acre-feet | 1015 | 1016 | 14 |

* Area of basin below minimum building elevation minus normal lake area.

D. Storm Water Runoff

The Rational Method requires the selection and/or computation of a time of concentration and a runoff coefficient. The time of concentration is the time required for the runoff from a storm to become established and for the flow from the most remote point (in time, not distance) of the drainage area to reach the design point. The time of concentration will vary with the type of surface that the rain falls on and the slope of the surface.

A minimum concentration time of fifteen minutes for residential areas and ten minutes for commercial/industrial areas shall be used for design of the trunk storm sewer system. These minimum times shall be considered in the design of lateral systems. As the storm water runoff enters the system, the flow time in the storm sewer is then added to the concentration time and compared to the downstream drainage area concentration time. The maximum of these values is used downstream which results in a longer concentration time and a lower average rainfall intensity as the flow moves downstream from the initial design point.

The percentage of rainfall falling on an area that must be collected by a storm sewer facility is dependent on watershed variables such as soil perviousness, ground slope, vegetation, surface depressions, type of development and antecedent rainfall. These factors are taken into consideration when selecting a runoff coefficient (C) for the Rational Method or a runoff curve number (CN) for use in SCS methodology.

Under ultimate (fully developed) conditions, the values of the coefficient will increase with increases in the amount of impervious surfaces caused by street surfacing, building construction, and grading.

The antecedent moisture condition (AMC) relates to the moisture content of the soil prior to a given storm event. Curve numbers based on land use can be adjusted based on an assumed moisture condition. For purposes of the model, normal antecedent moisture condition (AMC II) was assumed. Curve number values given below can be adjusted for dry conditions (AMC I) or wet conditions (AMC III).

Curve numbers are also dependent on the type of soil in a given drainage area. Soil types are classified into four basic hydrologic groups. Group A soils consist of deep sand and aggregated silts. Group B consists of sandy loams. Group C soils are low in organic content and made up of clay loams and soils high in clay. Group D soils consist of heavy plastic type clay soils. Curve numbers that were assumed in the development of the model were based on the hydrologic soil group for each watershed based on the information contained in the County Soil Survey. Development plans shall consider post-development site soil conditions when choosing runoff curve numbers for final design.

Curve numbers (CN) are given in SCS TR-55. Average CN values for each land use type are used in the design of the storm drainage facilities in undeveloped areas. For the modeling of existing facilities, CN values were determined for each type of development and current zoned land use in each subdistrict.

1. Runoff Rates in Incorporated Areas

   Runoff rates for proposed activities, development or redevelopment within the City of Belle Plaine shall:

   - Not exceed existing runoff rates for the 2-year, 10-year and 100-year critical duration storm events.
   - Not accelerate on or off-site water course erosion, downstream nuisance, flooding or damage as demonstrated by a downstream assessment.
   - All ponds will be analyzed with a 10-inch, 24-hour rain event in order to determine the emergency over flow (EOF) functions as intended.

2. Pre-Settlement Runoff Rate Control

Standard detention basin design procedure calls for ponds to be sized to ensure that the immediate development in the area would not adversely affect the downstream peak flow conditions. Unfortunately, this type of uncoordinated and piecemeal pond development can have significant impacts when considered simultaneously.

Runoff rates for proposed activities in unincorporated areas shall not exceed pre-settlement rates. This guidance addresses two questions with respect to the application of this requirement.

The first question is: *What is required when an area becomes annexed and incorporated?*

When this happens, the Ordinances require control of runoff rates to existing conditions. With incorporation the area is being taken into the City, where with proper planning through the Local Water Plan (LWP) approval process, there is the ability to manage infrastructure and the storm water system commensurate with development since the area is no longer relying on an infrastructure developed to support a largely agricultural setting. Control to pre-settlement conditions is not needed with infrastructure planning. When the area is annexed the existing condition becomes the existing condition for the calculation of existing runoff rates whatever that condition is. For example, if at the time of annexation the land is agricultural, then agricultural is the existing condition for runoff rates. If the land has been developed before annexation using the pre-settlement criteria, then with annexation, this is the existing condition. This means that the storm water system designed to pre-settlement conditions under previous approval cannot be undone as it is now the existing condition. Similarly, if a development created before Scott County Chapter 6 is annexed (which did not require pre-settlement runoff control), the condition without storm water management is the existing condition for rate control calculations.

The second question is: *What about existing developed features such as roads in unincorporated areas? When calculating pre-settlement rates does this apply to these existing features?*

The regulation requires obtaining an approved Stormwater Management Plan or permit prior to land-disturbing activities or the development or redevelopment of land. However, activities that create less than one acre of new impervious surface are exempt from the Ordinance, and activities that meet the definition of redevelopment are exempt from the Ordinance. Thus, volume and rate controls only apply to areas where the land cover changes one acre. Thus, volume and rate controls are applied to the areas of land cover change within new development projects that create more than one acre of new impervious surface. The volume and rate controls do not apply to areas that do not change land cover. An example would be a project to widen a roadway from 36-feet to 100-feet. The original 36-foot width would be considered an existing condition and the pre-settlement rate controls would be applied to the 64 feet of new roadway surface and/or new ROW (Illustration 1).

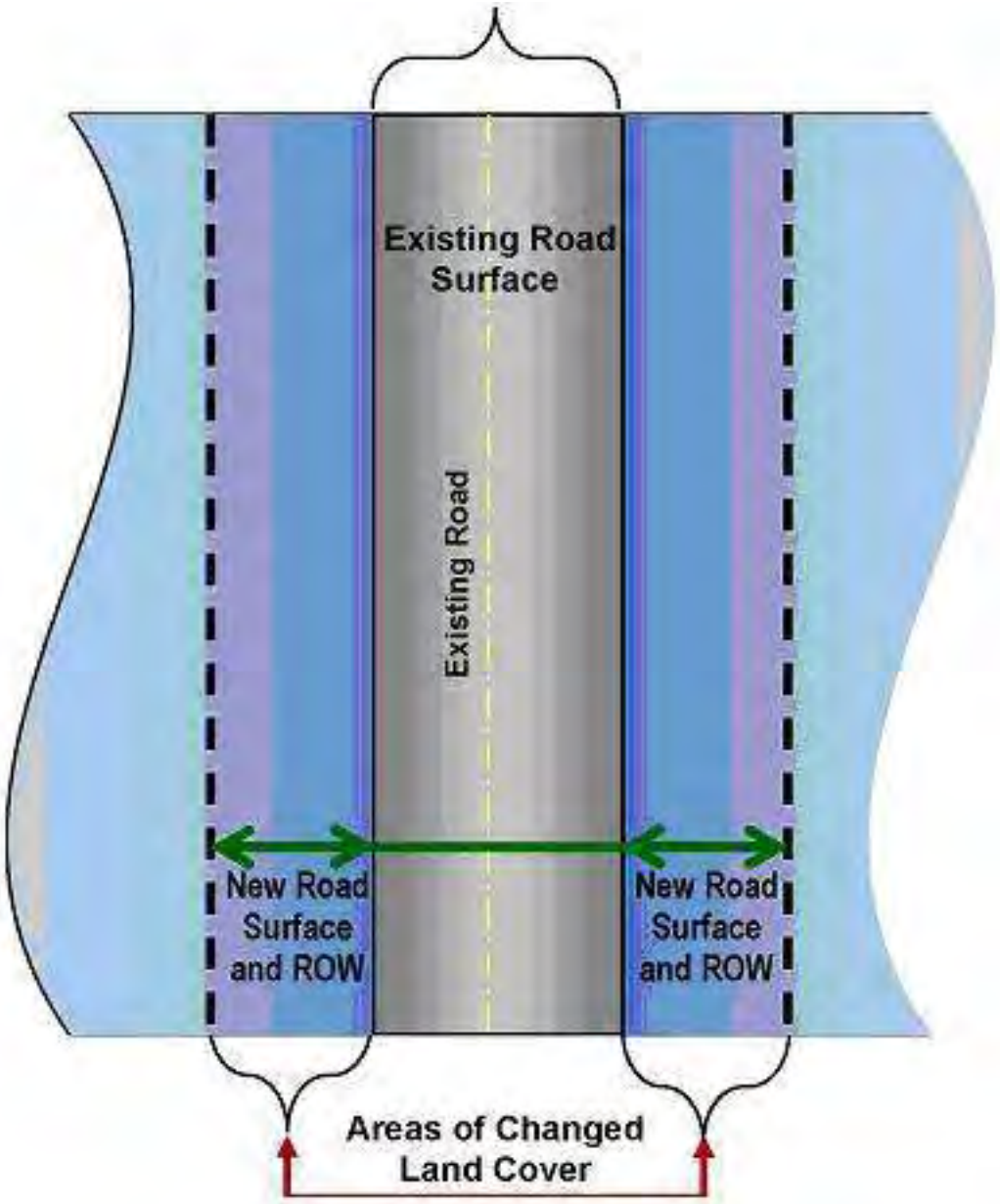



**Illustration 1 - Area of Changed Land Cover**

3. Runoff Rate in Unincorporated Areas

   Runoff rates for the proposed activities in unincorporated areas shall:

   - Not exceed pre-settlement runoff rates for the 2-year, 10-year and 100-year critical duration storm events for land areas currently within unincorporated areas of the Scott WMO (Note: As land is annexed into the City, the land being annexed carries with it the existing condition. Parcels developed after the date of the Scott WMO Rule within unincorporated areas will be regulated using pre-settlement conditions and this would then become the existing condition for the City once the area is annexed. If agricultural land is annexed, agriculture is the existing condition. If roads or streets are present they are part of the existing condition).
   - Use specified curve numbers to analyze pre-settlement conditions.

- For post development runoff, drained hydric soils shall be assumed to revert to an undrained condition unless the applicant demonstrates that publicly owned and maintained drainage facilities will be adequate to maintain the drained condition.
- Not accelerate on or off-site water course erosion, downstream nuisance, flooding or damage as demonstrated by a downstream assessment.

Runoff rates may be restricted to less than the pre-settlement rates when necessary for the public health, safety and general welfare of the City.

4. Storm Water Conveyance Requirements

Storm sewers are the actual conduits used to transport storm water runoff. The capacity of the storm sewer conduit is dependent on the pipe slope, pipe diameter, and the roughness of the inner surface of the pipe. Computations for storm sewer conduit capacity are based on the following Manning's formula:

Q=1.49(A/P)2/3 S1/2 A/n

Where:

Q= Storm sewer conduit capacity in cubic feet per second (cfs)

n= Roughness coefficient

A= Cross-sectional area of conduit

P= Wetted perimeter of conduit

S= Slope of conduit

A roughness coefficient (n) of 0.013 was used for concrete storm sewer pipe, and 0.024 for corrugated metal pipe. These roughness coefficients take into account losses due to bends and manholes in the system as well as the roughness of the inner pipe surface. Only major storm sewer trunks, 30 inches and larger, have been considered in this study.

A trapezoidal cross-section with 4:1 maximum side slopes (4 feet horizontal to 1 foot vertical) was the basis for design wherever existing and proposed open channels are utilized. The same Manning's formula was used to determine channel capacity with the roughness coefficient (n) increased to 0.030. For open channels, P in the equation becomes the wetted perimeter of the channel.

The minimum design capacity of all drainage systems shall accommodate the runoff and velocity of flow from a 10-year storm event, and all drainage systems and facilities shall be designed to withstand the runoff from the critical 100-year event or accumulative antecedent conditions without damage to the system or facility, downstream areas and/or significant risk to public health, safety and welfare unless waived by the City.

Proper design of a storm sewer system requires that all sewer lines be provided with access through manholes for maintenance and repair operations. Spacing of manholes shall be no greater than 400 feet for sewer lines 15 inches or less in diameter and 500 feet for sewer lines 18 inches to 30 inches in diameter. Intervals on larger diameter lines can be increased since the pipes are sufficiently large for a person to physically enter the storm sewer pipe itself for maintenance operations. Regardless of sewer size, manholes shall normally be provided at all junction points and at points of abrupt alignment or grade changes.

Although lateral systems are designed for 10-year storm events, their performance must be analyzed for storms exceeding the design storm. It shall be anticipated that

surcharging of the system will occur when the design storm is exceeded. During surcharging, the system works as a closed conduit and the pipe network becomes pressurized with different pressure heads throughout the system. Low areas that are commonly provided with catch basins become small detention ponds often performing like pressure relief valves (water rushing out in some locations). For this reason, it is extremely important to ensure that these low areas have an acceptable overland drainage route with proper transfer capacity.

Ponding on streets must meet all of the requirements of the 100-year design criteria as a minimum. For safety reasons, the maximum depth shall not exceed two feet at the deepest point and the lowest exposed building elevation shall be at least one foot above the high water overflow level. The high water overflow level for temporary street ponding is defined as the elevation to which water rises before overflowing through adjacent overland routes.

Any new residential, commercial, industrial and other habitable structures shall be constructed with the following low floor elevation: Elevation of the lowest opening of a structure shall be a minimum of 2 feet above the Emergency Overflow, or 1 foot above the HWL of the nearby pond or waterbody, whichever is higher. When possible, storm water pond designs shall include an emergency overflow (EOF) to provide an outlet 2 feet below the lowest floor elevation of any adjacent structure for added safety. The EOF shall be analyzed using a with a 10-inch, 24-hour rain event in order to determine the emergency over flow (EOF) functions as the design intent. The Overland flow routes shall be incorporated into the design for ponds and maintained during development. The City may require additional freeboard for landlocked areas or ponds where emergency overflows cannot be provided. The lowest exposed floor or opening elevation of structures that are adjacent to ponds shall be indicated on the site grading plan to ensure adequate freeboard. The area of a pond's HWL plus 1 foot of freeboard shall be contained entirely within an outlot that is owned and maintained by the City.

All storm sewer facilities, especially those conveying large quantities of water at high velocities, shall be designed with efficient hydraulic characteristics. Manholes and other structures at points of transition should be designed and constructed to provide gradual changes in alignment and grade. Pond outlet control structures shall be designed to allow water movement in natural flow line patterns, minimize turbulence, provide good self-cleaning characteristics, and prevent damage from erosion.

Intake structures shall be liberally provided at all low points where storm water collects and at points where overland flow is to be intercepted. Inlet structures are of special importance, since it is a poor investment to have an expensive storm sewer line flowing partially full while property is being flooded due to inadequate inlet capacity. Inlets shall be placed and located to eliminate overland flow in excess of 1,000 feet on streets or a combination of streets and swales and 600 feet on collector and arterial streets. Additionally, inlet grates must have the capacity to collect the drainage from the 10-year storm event. This may require multiple catch basins or the use of special high capacity grates at some locations. Intake grates and openings shall be of self-cleaning design to minimize capacity reduction when clogged with twigs, leaves and other debris.

The following recommendations must be considered when designing storm sewers:

- Inlet and outlet pipes of storm water ponds shall be extended to the normal water level whenever possible.
- Outlets with velocities less than 4 fps that project flows downstream into a

channel in a direction at less than 30 degrees from the normal channel axis generally do not require energy dissipaters or stilling basins but do require riprap protection.

- Where an energy dissipater is used, it shall be sized to provide an average outlet velocity of less than 6 fps, unless riprap is also used. In the latter case, the average outlet velocity shall not exceed 8 fps.
- Where outlet velocities exceed 8 fps, the design shall be based on the unique site conditions present. Submergence of the outlet or installation of a stilling basin approved by the City shall be required when excessive outlet velocities are experienced.
- Riprap shall be provided at all storm sewer outlets to drainage channels and natural streams. Riprap shall be placed on a suitably graded filter material over geotextile fabric to ensure that soil particles do not migrate through the riprap and reduce its stability. Riprap shall be placed to a thickness of at least 2.5 times the mean rock diameter so as to ensure that it will not be undermined or rendered ineffective by displacement. If riprap is used as protection for overland drainage routes, grouting may be recommended.
- Overland drainage routes where velocities exceed 8 fps shall be reviewed and approved by the City. Permanent turf reinforcement mats must be provided if velocities exceed 7 fps.

Where inlet capacity does not allow for total run off capture, the street and storm sewer design shall account for overland routing into the detention pond(s). Since the storm sewer is designed for a 10-year storm event and the storm water management system is designed for a 100-year storm event, street designs shall require routing by-pass flows into the ponding system.

Open channels are recommended where flows and small grade differences prohibit the economical construction of an underground conduit and in areas where an open channel type drainage will enhance the aesthetic or wildlife qualities of an area. A green corridor designed to protect existing open drainageways is shown on Figure SW-04. A minimum slope of 1.0% shall be maintained in unlined open channels and overland drainage routes in developed areas whenever possible. Slopes of less than 1.0% are difficult to construct and maintain and can create problems with pocketing of water without an underdrain system. (Side slopes shall be a maximum of 4:1 (horizontal to vertical) with gentler slopes being very desirable.)

Rock riprap must be provided at all points of juncture between two open channels and where storm sewer pipes discharge into a channel. The design velocity of an open channel shall be sufficiently low to prevent erosion of the bottom. Riprap or permanent turf reinforcement mats shall be provided in areas where high velocities cannot be avoided. Periodic cleaning of an open channel is required to ensure that the design capacity is maintained. Therefore, all channels must be designed to allow easy access for equipment including a 12 feet wide maintenance path with 15% maximum grade at storm sewer outfalls, road crossings and connections to other channels or streams.

Both storm drainage facilities and sanitary sewer lines should be designed to take advantage of natural draws and usually follow a ravine, creek or gully. As more area develops in the City, the total runoff in natural drainageways will increase, and correspondingly the water level may rise. In certain areas, water could enter the sanitary sewer system, causing capacity problems and added costs for treatment of storm water.

For this reason, sanitary sewer manholes that could be subject to temporary inundation shall be equipped with watertight castings and added precautions shall be taken in construction of these manholes to prevent the entrance of storm water.

Sanitary manholes located near ponding areas shall be raised above the 100-year high water level and the adjacent areas filled when access is required at all times. (If access is not required, watertight castings shall be installed.) Future storm drainage construction shall include provisions for improving the water tightness of nearby sanitary sewer manholes. All newly constructed sanitary manholes in the vicinity of ponding areas and open channels described in this report shall be waterproof.

5. Storm Water Basin Requirements

A number of methods have been developed to determine the expected maximum rate of runoff for an area under a certain design storm. The wet ponds were sized with permanent "dead-pool" storage volumes as calculated based on the criteria recommended by William Walker, Jr. in *Design Calculations for Wet Detention Ponds* (1987) (i.e., the volume equivalent to the runoff produced from a 2.5-inch rainfall event under a fully developed condition, plus additional volume based on the percentage of future impervious area). This design provides for 85-95 percent removal of suspended solids and 40-70 percent removal of total phosphorus.

Incorporating ponding areas as recommended in the SWMP is important to maintaining stability of creeks and natural corridors. Ponding areas provide the necessary storage required to retain high intensity storm water runoff peaks and reduce the possibility of flooding downstream. The storage requirements established for each pond must be maintained to prevent flooding of property. The discharge flow rates computed for each ponding area must also be maintained to ensure that the storage volume provided is used and downstream flows are not exceeded. The peak flows indicated in the plan for proposed basins occur at the high water level, usually under pressurized conditions.

The smaller wet ponds are intended to treat the runoff through sedimentation, infiltration, and to dampen the discharge flow into ravine(s) en route to the larger, downstream regional infiltration ponds. The wet ponds are also intended to control runoff rates so that they do not exceed existing runoff rates for the 2-year, 10-year and 100-year critical duration storm events; and do not accelerate on or off-site water course erosion, downstream nuisance, flooding or damage.

Permanent sedimentation and water quality ponds shall be designed to the Wet Pond Design Standards in the NPDES General Construction Permit, the pond requirements of City Ordinance 1109 and provide:

- Water quality features consistent with NURP criteria and best management practices.
- A permanent wet pool with dead storage of at least 1800 cubic feet of storage below the outlet pipe for each acre that drains to the basin. The basin's permanent volume must reach a minimum depth of at least 3 feet and must have no depth greater than 10 feet. The basin must be configured such that scour or resuspension of solids is minimized. Pond outlets shall be designed to prevent short circuiting of the flow from pond inlets to the outlet. Basin outlets must have energy dissipation.
- A normal water elevation above the OHW of adjacent waterbodies, or normal water level (NWL) where an OHW is not established.
- An outlet skimmer to prevent migration of floatables and oils for at least the 1-year storm event.

- An outlet structure to control 2-year, 10-year and 100-year critical storm events to runoff rates specified in Section 5.4 of this SWMP.
- An identified overflow spillway and downstream route sufficiently stabilized to convey a 100-year critical storm event.
- Access for future maintenance.

Any new residential, commercial, industrial and other habitable structures shall be constructed with the following low floor elevation: Elevation of the lowest opening of a structure shall be a minimum of 2 feet above the Emergency Overflow, or 1 foot above the HWL of the nearby pond or waterbody, whichever is higher. The area of a pond's HWL plus 1 foot of freeboard shall be contained entirely within an outlot that is owned and maintained by the City.

When possible, storm water pond designs shall include an emergency overflow to provide an outlet 2 feet below the lowest floor elevation of any adjacent structure for added safety. Overland flow routes shall be incorporated into the design for ponds and maintained during development. The City may require additional freeboard for landlocked areas or ponds where emergency overflows cannot be provided. The lowest exposed floor or opening elevation of structures that are adjacent to ponds shall be indicated on the site grading plan to ensure adequate freeboard.

E. Regional Detention

Regional detention basins shall be utilized to manage peak flow rates and runoff volumes, and meet water quality objectives when feasible. On-site detention basins, volume control facilities, and permanent sedimentation and water quality ponds are allowed when regional basins are not in place or feasible, or would not otherwise meet requirements for the protection of downstream areas.

For the most part, Belle Plaine and the surrounding area consist of sandy porous soils. A large percentage of the soils found within the study area were classified as hydrologic type A and/or B, which are known to have very good to moderate water wicking capabilities. Figure SW-03 shows the soils hydrology for the area.

Where possible, regional basins are proposed to be large, shallow, dry basins that will take full advantage of the natural permeability of the soils. Given that heavy sedimentation can decrease the infiltration rates, most of the recommended regional dry basins are proposed to be placed downstream from smaller wet detention basins.

The regional dry basins shall follow infiltration requirements from the NPDES General Construction Permit and City Ordinance 1109:

The design must explicitly address the use of best management practices to limit the loss of pervious area, and limit runoff volume increases from impervious areas to the extent feasible considering site-specific conditions.

- At a minimum, volume control practices shall provide a reduction in site runoff discharge volume of at least 1 inch of runoff from all new impervious surfaces.
- Volume controls shall be greater than 1-inch from new impervious surfaces if necessary to mitigate downstream impacts in accordance with City Ordinance 1109.
- When using infiltration for volume control, infiltration volumes and facility sizes shall be calculated using the appropriate hydrological soil group classification and saturated infiltration rate from the Minnesota Stormwater Manual, and shall be capable of infiltrating the required volume within 48 hours. Documented site-specific infiltration or

hydraulic conductivity measurements completed by a licensed soil scientist or engineer may be used in place of the Manual values.

The proposed ultimate network makes every attempt to utilize the natural drainage routes. One advantage of incorporating large, dry regional basins is the multi-functional uses for these areas. Although buildings would be prohibited in the direct detention area, the open spaces may be used for walking trails, parks, soccer fields and much more. For a large majority of the time, the basins will be relatively dry and the park type use is similar to the way many river cities have parks in river flood plains.

Similarly, the regional basins and green corridor may be designed to reduce the quantity of trunk storm sewer pipe that would be required for inflowing and outflowing storm water transport. When considering the proposed basins, please keep in mind that the actual design of the regional pond or basin does need to be symmetrical depression to hold water, but could easily be designed as a non-uniform meandering waterway creating a more natural appearance while maintaining the design intent and saving the length of interconnecting piping. Further consideration shall be given to future development in order to maintain viable and safe flood routing.

F. Alternative BMPs

Alternative BMPs may be approved instead of permanent sedimentation and water quality ponds if it is found that the water quality performance of the proposed alternative BMPs is equivalent to that of a permanent sedimentation and water quality pond designed according to the criteria set forth for permanent sedimentation and water quality ponds (i.e., 80% TSS removal).

G. Downstream Assessment

A procedure for an assessment of the potential for adverse impacts downstream of site improvements, and corrective actions in proportion to the proposed project input, is required. At a minimum an assessment must consist of:

- Potential impacts to areas surrounding landlocked lakes or ponds, or lakes or ponds with inadequate outlets.
- Potential impact to public or private structures or infrastructure located near potential flood prone areas with corrective actions that mitigate in proportion to the impact.
- Potential impacts to downstream infrastructure, public and private structures, and erosion along the drainage path and downstream public waters, with corrective actions that mitigate in proportion to the impact.
- Potential impacts to wetlands with exceptional vegetative diversity, with corrective actions that mitigate in proportion to the impact.

Left unmanaged, development and the creation of impervious surfaces and drainage networks increase peak runoff rates and total runoff volumes. These increases can adversely impact downstream areas. Some of these impacts include increased frequency and magnitude of flooding, overtopping on roads and driveways, erosion, stream bank instability, and damage to public and private improvements and infrastructure.

This SWMP and the Ordinances address a portion of the change with requirements to manage peak runoff rates. However, because creation of impervious surfaces and installation of drainage systems increases the total volume of runoff, changes the timing of flows, and makes the system more efficient, these requirements do not address all of the potential adverse impacts of development.

The City has decided to assess impacts and needs as development occurs. As shown in Illustration 2, the Scott WMO Rules allow either approach. Individual developments shall assess downstream impacts and needs of the individual projects as described below.

It is important to put bounds on the assessment so it is proportional to the size of the development. The City has therefore incorporated a requirement to limit the assessed area to a drainage area equal to 10 times the proposed development area.

If existing or potential problems are found, they need to be mitigated in proportion to the proposed project's impacts. This does not mean making the new development pay to fix other's problems. However, knowing whether or not there are existing problems will help the City make informed decisions concerning whether necessary infrastructure is in place to support the development.

The City has three downstream assessment processes to determine:

- Problems and impacts to areas surrounding landlocked basins (Illustration 3);
- Problems and impacts to public and private improvements, infrastructure and erosion (Illustration 4); and,
- Stormwater impacts to wetlands with exceptional vegetative diversity (Illustration 5).
- With respect to the following assessment of existing erosion and erosion potential, the City suggests using information and methods for the assessment:
- Highly erodible soil types [listing available from the Soil and Water Conservation District (SCWD)]
- Bank stability and bank protection methods, summarized in Table 6 below, from U.S. EPA, 1999: Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Chapter 5).
- The scope of the land or receiving watercourse: Watercourse slopes exceeding two percent (2%) would be susceptible to erosion.
- Hydraulic/Hydrologic modelings/calculations to assess whether velocities could increase by five percent (5%) or more from existing to proposed conditions. In most cases the calculation of velocity using available Manning's equation with software should be sufficient.

**Table 6 - Summary of U.S. EPA Bank Stability and Bank Protection Assessment Methods**

| Habitat Parameter | Condition Category | | | |
|---|---|---|---|---|
| | **Optimal** | **Condition Sub optimal** | **Marginal** | **Poor** |
| **Bank Stability** (score each bank)<br><br>Note: determine left or right side by facing downstream (high and low gradient) | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected | Moderately stable, infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Unstable; many eroded areas; "raw", unvegetated, areas are frequent along straight sections and bends; obvious bank sloughing; 60%-100% of bank has erosion scars. |
| SCORE ___(LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___(RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

| Table 6 - Summary of U.S. EPA Bank Stability and Bank Protection Assessment Methods | | | | |
|---|---|---|---|---|
| **Habitat Parameter** | **Condition Category** | | | |
| | **Optimal** | **Condition Sub optimal** | **Marginal** | **Poor** |
| | | | | |
| **Vegetative Protection** (score each bank)<br><br>Note: determine left or right side by facing downstream Score each bank<br><br>(high and low gradient) | More than 90% of the stream bank surfaces and immediate **riparian** zones covered by native vegetation, including trees, understory shrubs, or non-woody plants; vegetative disruption through grazing or mowing is minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream vegetation very high, vegetation has been removed to 5 centimeters or less in average stubble height. |
| SCORE ___(LB) | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE ___(RB) | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

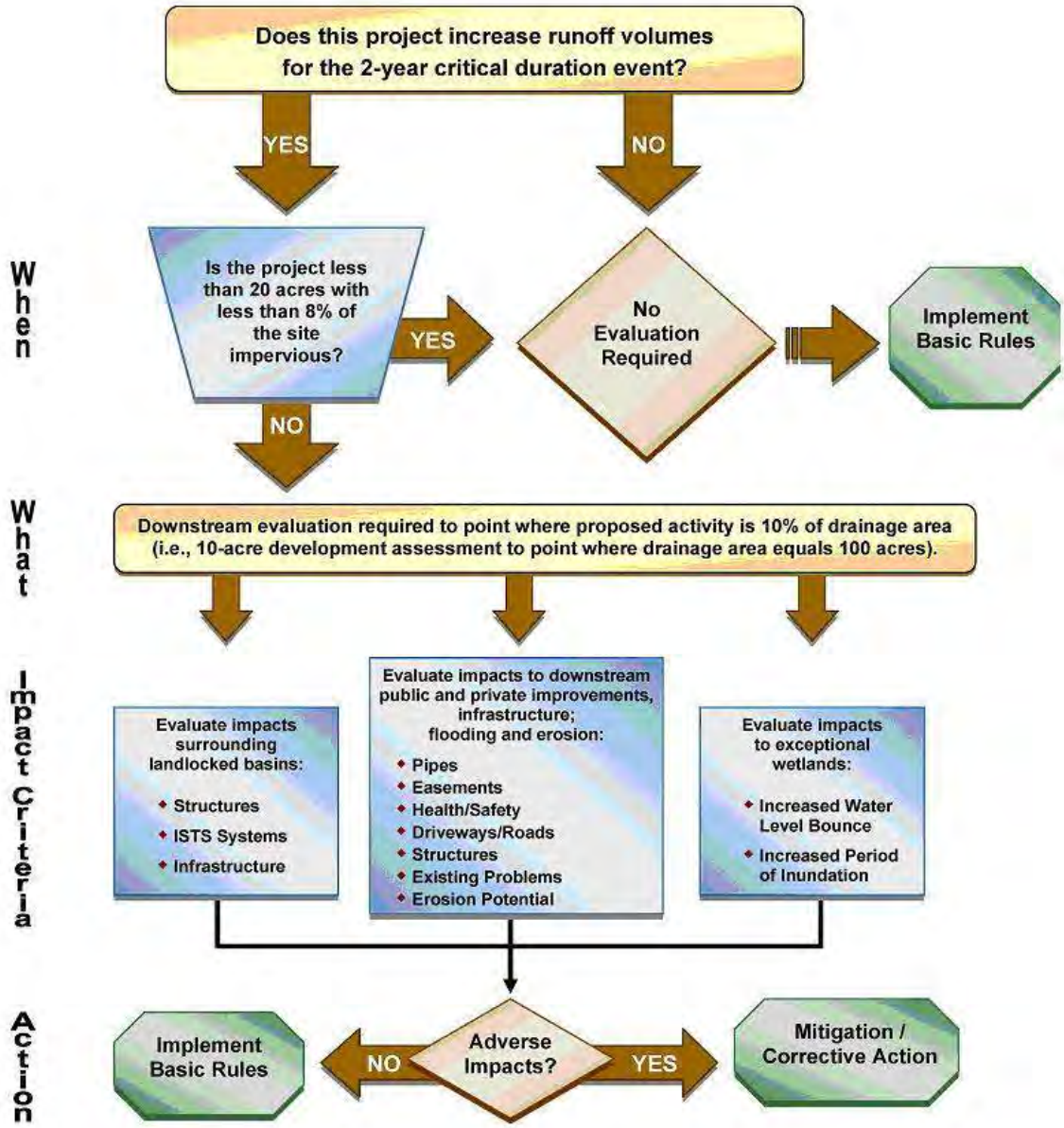



**Illustration 2 - Downstream Assessment**

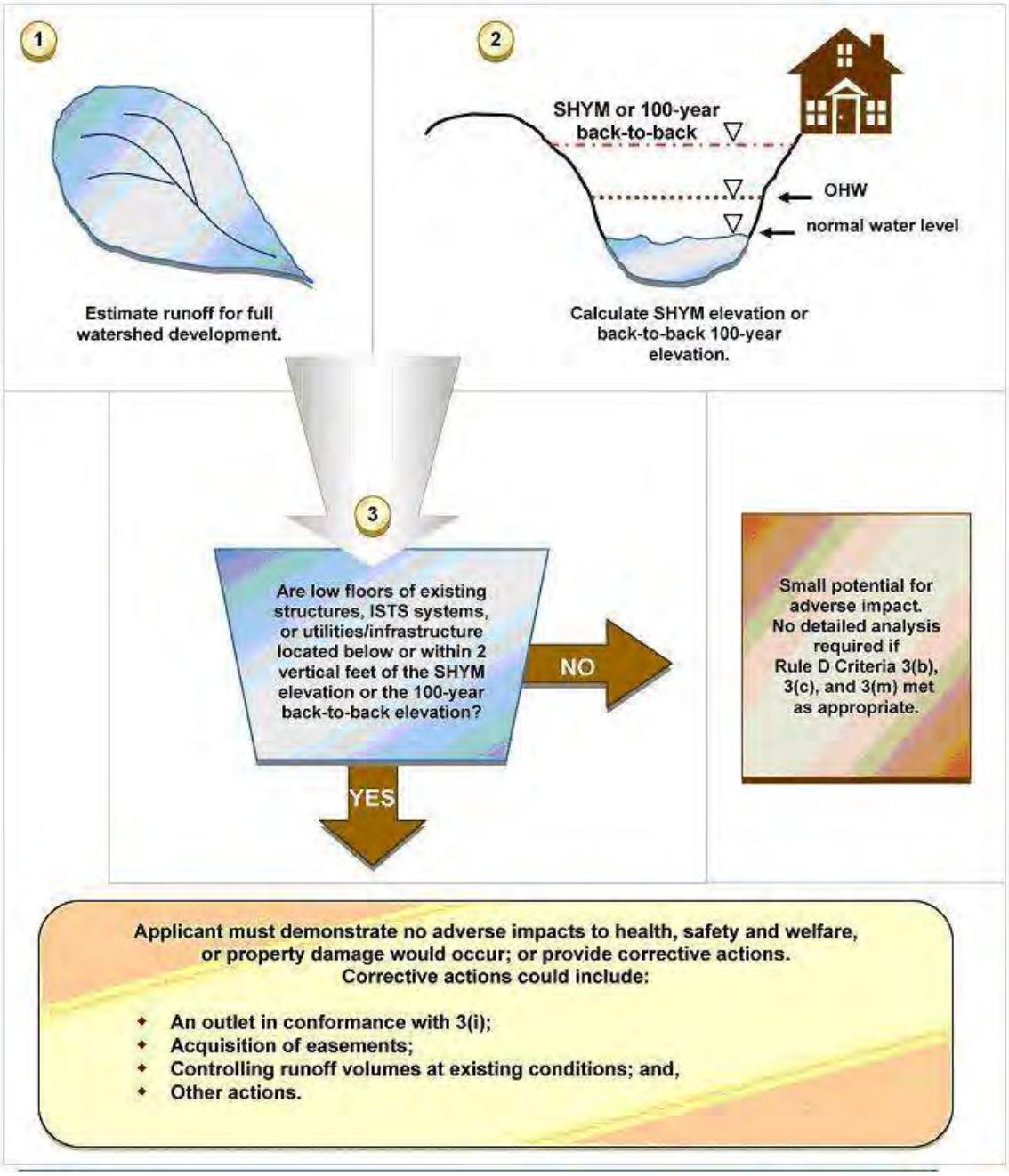



**Illustration 3 - Problems and Impacts to Areas Surrounding Landlocked Basins**

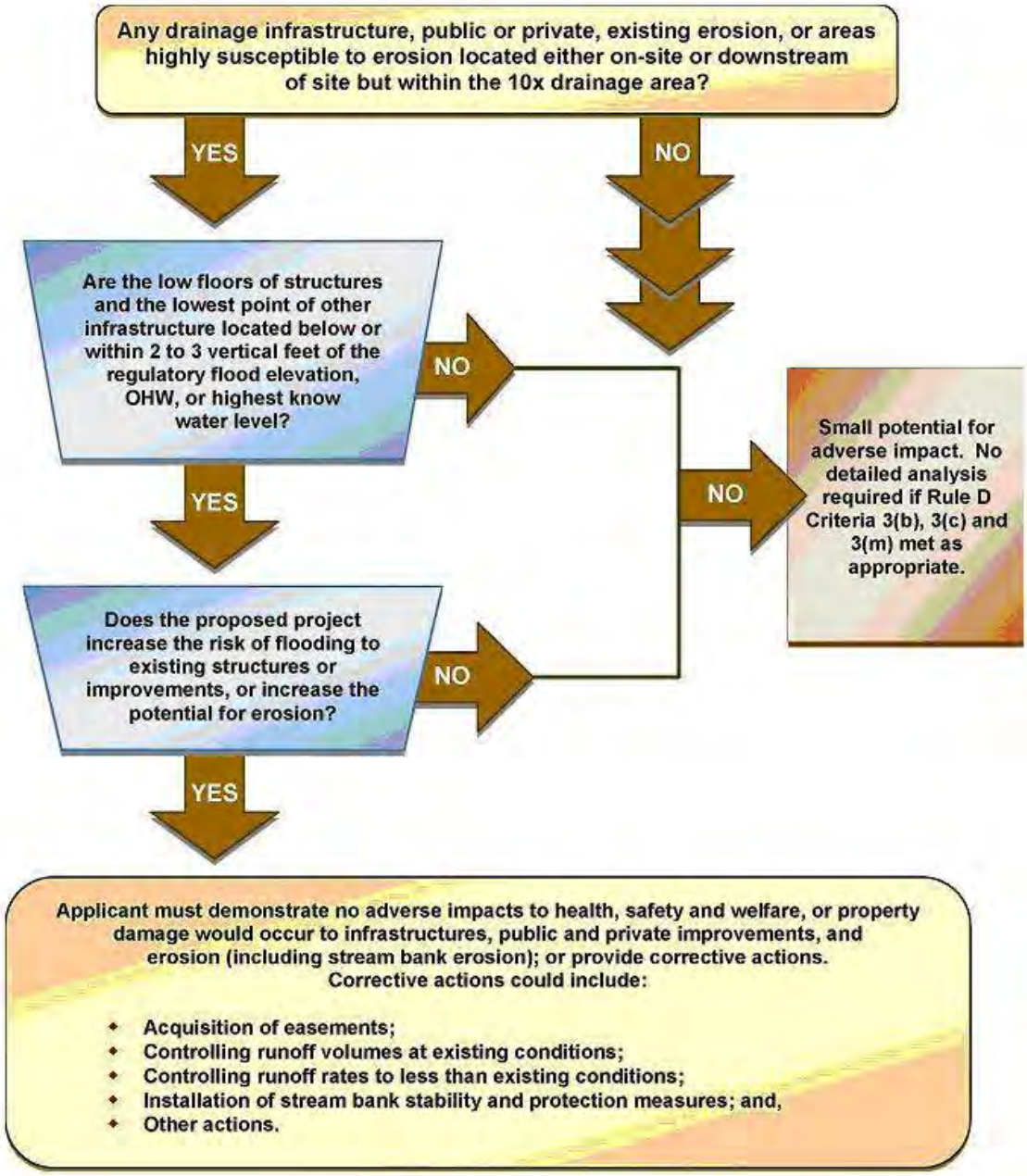



**Illustration 4 - Problems and Impacts to Public and Private Improvements, Infrastructure and Erosion**

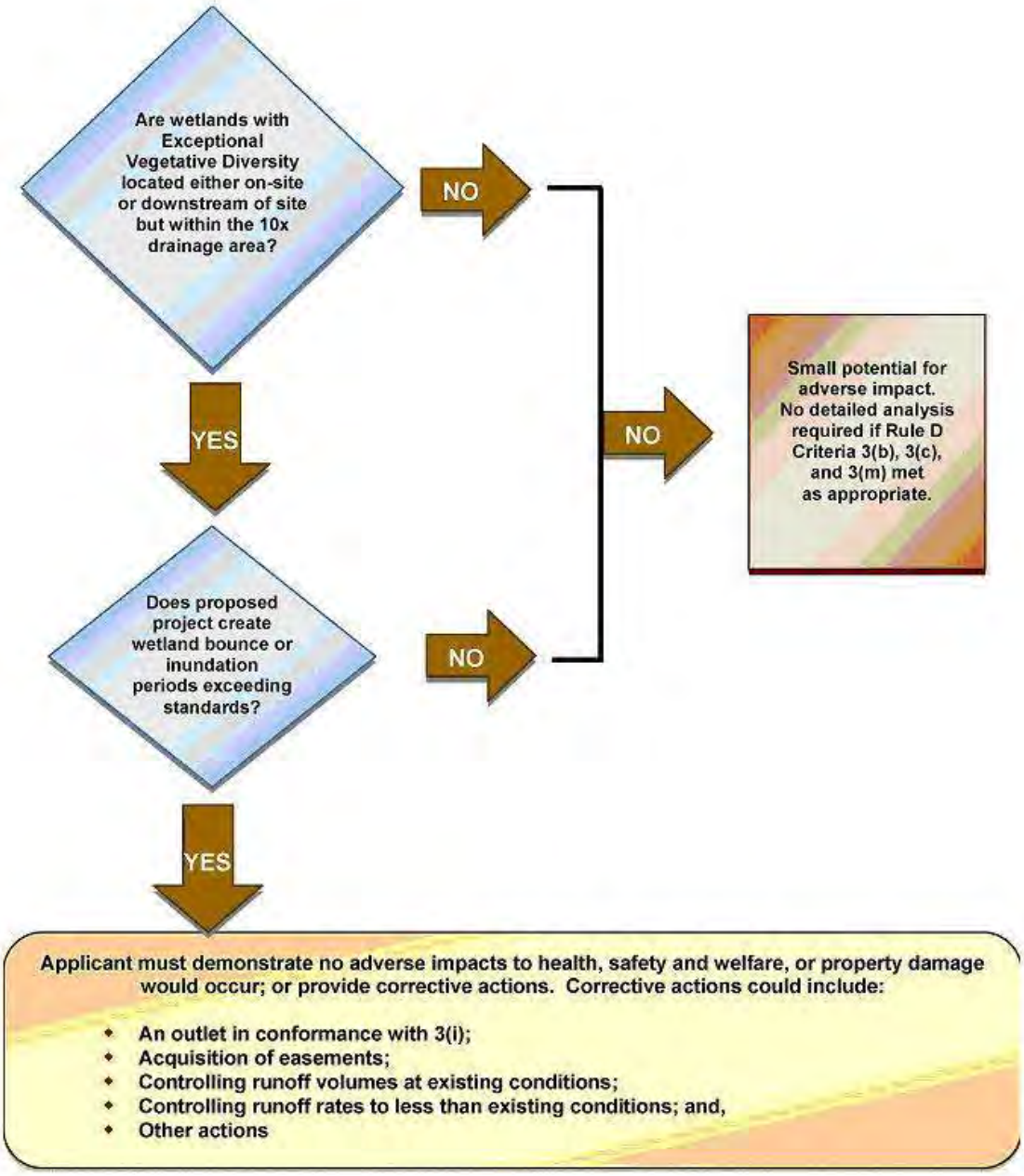



**Illustration 5 - Stormwater Impacts to Wetlands With Exceptional Vegetative Diversity**

Adverse impacts to existing public and private structure varies depending on whether or not the structure is already located in a flood prone area. Elevation of the lowest opening of a structure shall be a minimum of 2 feet above the Emergency Overflow, or 1 foot above the HWL of the nearby pond or waterbody, whichever is higher. If the structure is already below the flood level, the development shall be expected to not make it worse, but would not be expected to remove it from flooding. Similarly, if the structure is located above the flood level, but below the 1 to 3 foot required freeboard, the development shall not make it worse, but is not expected to improve the situation. If the existing structure is located above the flood level and the 1 to 3 feet of freeboard, the development shall not cause the freeboard to drop below the required amount.

H. Landlocked Basins

Landlocked water basins may be provided with outlets if an outcome based analysis and resource oriented management review regarding downstream impacts is completed that demonstrates that:

- A hydrologic regime is maintained that complies with other rules.
- Dead storage is provided to retain the fully developed future conditions water volume, above the highest anticipated groundwater elevation to the extent possible while preventing damage to property adjacent to the basin (i.e., outlet is not lower than the future conditions; SHYM elevation, or 100-year back-to-back elevation) (see Illustration 6).
- The outlet does not create adverse downstream flooding or water quality conditions, or materially affect stability of downstream watercourses according to this SWMP and the Ordinances;
- Proposed development tributary to the landlocked basin has incorporated runoff volume control practices to the extent practical.
- There is a demonstrated need for an outlet to protect existing structures and infrastructure.
- The outlet design is part of an approved comprehensive local water management plan.

The need for an outlet could be demonstrated through the documentation of existing problems, such as high water levels affecting existing homes, or creating safety issues for roads.

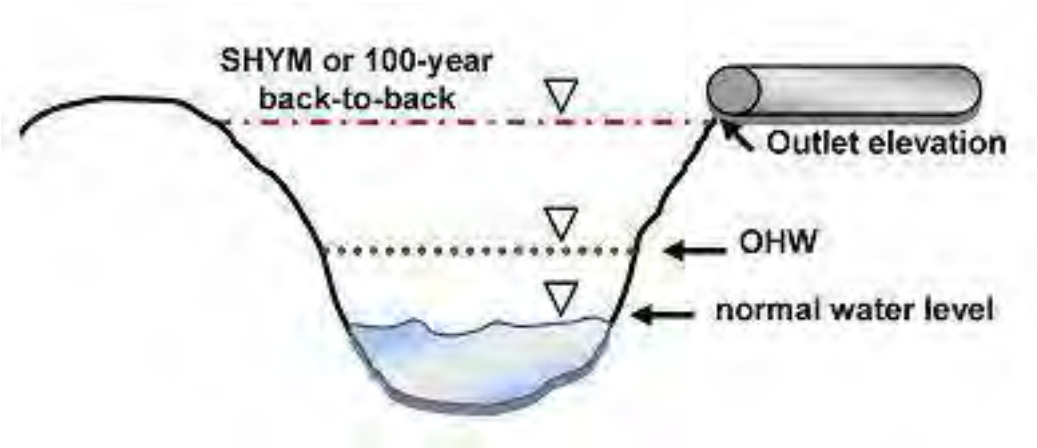



**Illustration 6 - Outlet Elevation**

I. Volume Control

Development and redevelopment that creates one (1.0) or more acre of impervious surfaces must incorporate runoff volume control practices into the design in accordance with the NPDES General Construction Permit No: MN R100001 (as amended).

The design must explicitly address the use of BMPs to limit the loss of pervious area, and limit runoff volume increases from impervious areas to the extent feasible considering site-specific conditions. At a minimum volume control practices shall provide a reduction in site runoff discharge volume of at least 1-inch of runoff from all new impervious surfaces. Volume controls shall be greater than 1-inch from new impervious surfaces if necessary to mitigate downstream impacts in accordance with the downstream assessment.

If the proposed action increases runoff volumes, is not being completed under this approved SWMP where infrastructure needs have already been addressed, and if it is not an Environmentally Sensitive Subdivision; then runoff volume management is required. The level of management, however, is dependent on analysis of adverse impacts completed for the downstream assessment criteria in Ordinance 1109.08 Subd. 5 (14).

If downstream assessment shows little potential for adverse impacts, special mitigation actions will not be required, and the potential for cumulative impacts is addressed with a requirement to control 1-inch of runoff from newly created impervious surfaces. Where adverse impacts are identified, mitigation/corrective actions are required in proportion to the impact in addition to the 1-inch volume control.

The following list includes major parameters that must be included into the final design of the quantity portion of storm water facilities. Site-specific details must be considered at the time of final design.

- Consult with City Staff and the SWMP for planned peak discharge rates at the proposed pond locations in relation to the overall ultimate drainage system plan.
- Model 100-year, 24-hour storm event to calculate the High Water Level (HWL) of the Pond.
- Model a multi-stage outlet for maximum peak discharge reduction for the 2 and 10 year events.
- Check pond outlet capacity to insure 10-day snowmelt event does not exceed 100-year HWL.
- Maintain a minimum of two feet above the 100-year HWL for the lowest floor elevations of structures adjacent to the basins.
- Any new residential, commercial, industrial and other habitable structures shall be constructed with the following low floor elevation: Elevation of the lowest opening of a structure shall be a minimum of 2 feet above the Emergency Overflow, or 1 foot above the HWL of the nearby pond or waterbody, whichever is higher.
- The area of a pond's HWL plus 1 foot of freeboard shall be contained entirely within an outlot that is owned and maintained by the City.
- Limit the maximum side slopes leading to the normal water level to 4:1.
- Provide a minimum aquatic bench of 10 feet at a 10:1 slope below the normal water level.
- Provide a minimum maintenance bench of 10 feet at a 10:1 slope above the normal water level if side slopes adjacent to the basin are steeper than 5:1.
- Design erosion control or energy dissipators at pond inlets and the outfalls of basin outlet pipes or weirs.
- Provide a clear approach and trash rack at the basin outlet.
- Check that the proposed pond elevation will provide for the outlet of possible upstream landlocked areas.
- Provide a 12-ft wide maintenance access at a maximum grade of 15% to the normal water level of all basins. Access must be provided to the basin outlet structure, all inlets to the basin, and to the first cell of a multi-cell basin.
- Include other design parameters as required by regulatory agencies.

- Basin design must include the method and schedule for stabilizing adjacent slopes and consideration of wetland plantings around the perimeter.
- Provide overflow routes for added protection against flooding and local erosion.

## VII. Storm Water Quality

A. Background

The storm water quality goal of the Belle Plaine SWMP is to protect and improve the water quality of the City's wetlands and waterways for existing and future generations by meeting or exceeding State and Federal requirements and providing an efficient level of runoff treatment for future development areas. The only completely effective way to achieve this goal is to prevent undesirable sediments, nutrients and pollutants from entering the storm drainage system. Presently, complete interception for water treatment at the point of discharge into the drainage system is neither practical nor economically feasible. The City's policy is to enforce the City's Ordinances to ensure that the SWMP's recommendations are being implemented.

The four main reasons for degradation of water quality are:

- Erosion and sedimentation;
- Solids and associated chemicals (including sodium chloride or salt) from erosion and street sanding;
- Composted organic matter such as leaves and grass clippings; and,
- Fertilizers and other chemicals from farming practices, impervious surfaces, and lawn care.

Recognition of the problem sources and the implementation of reasonable control measures can minimize the degradation of water quality in the City. Storm water ponding areas used for rate control can be an essential part of reducing the amount of pollutants being transported downstream. Water quality ponds, commonly known as wet ponds, provide locations where ponding allows sediments and many pollutants to settle out and be effectively removed from storm water runoff.

The Belle Plaine SWMP utilizes the regional storm water approach by locating large storm water facilities to serve 20 to 80-acre drainage areas. Small wet ponds are recommended upstream, with dry regional infiltration ponds downstream. The green corridor also helps protect existing drainageways. The regional approach provides more efficient maintenance requirements by centralizing pond areas in fewer locations. This approach also provides cost effective design, land acquisition and construction expenditures for development by proposing pond facilities in locations that take advantage of natural terrain and provide the most efficient benefit for runoff water quality treatment.

B. Water Quality and Land Use

Although pollutant concentrations may not vary greatly between land uses, pollutant loadings are a function of both runoff volume and concentration. The volume of runoff is directly related to the amount of impervious surface from a particular land use. For example, if Area A has twice the runoff due to higher impervious land cover as Area B with the same pollutant concentration, Area A will have twice the pollutant loading. This illustrates the major difference in water quality between residential and commercial type land uses.

C. Storm Water Pollutant Removal

Permanent sedimentation and water quality ponds are the most effective means of removing sediment and the pollutants associated with it such as trace metals and nutrients. The removal of pollutants such as heavy metals can be estimated based on the removal efficiency of total suspended solids. The removal of water quality constituents such as total Kjeldahl nitrogen, zinc, lead and total phosphorus can also be associated with the removal of total suspended solids. The percent removal of these pollutants is based on the detention time that runoff is held in the basin. Settling column studies have shown that the majority of urban sediments that can be removed, settle out within the first six to eight hours of detention. However, longer detention times are needed to remove fine sediments and establish ideal settling conditions.

Pollutant removal rates are based on detention time within a water quality pond. The removal rates asymptotically approach their maximum level after 50 hours of detention time, with the largest percentage of removal in the first 12 hours. Therefore, a pond that is designed to retain all runoff from a tributary area for periods in excess of 12 hours will provide a majority of the available water quality treatment properties from storm water detention.

What must be determined is the level of protection that is appropriate to downstream water bodies. This is determined by choosing a storm event that is retained in excess of 12 hours of detention time for maximum treatment levels. Once this event is determined, storm water facilities can be designed with permanent pool volumes equal to the upstream runoff from this event. Figure 11 illustrates the relationship between pollutant removal and detention time.

D. Permanent Sediment

Permanent sedimentation and water quality ponds are an essential part of a storm drainage system. These areas provide locations where ponding caused by restricted flow can be allowed; thereby minimizing flood damage and stream bank failure. The effective use of storm water basins enables the installation of outflow sewers with reduced capacities. The design storm duration is effectively increased over the total time required to fill and empty the ponding reservoirs.

Equally as important is the use of pond areas to:

- Improve water quality;
- Return storm water to the groundwater table; and,
- Increase water amenities in developments for aesthetic, recreational and wildlife purposes.

Storm water quality is improved by allowing nutrients and sediments carried by runoff to settle below the pond normal water level and allow fringe vegetation to assimilate additional pollutants. The restriction of outflow rates from pond areas promotes groundwater recharge by increasing the detention time and allowing the runoff to infiltrate. Amenity aspects are maximized by careful planning in the initial development of an area to incorporate pond areas into recreational areas, parks and trail systems.

E. Design Criteria

Pond design characteristics are critical in achieving the maximum pollutant removal efficiencies. The criteria listed below shall be used in the design of water quality aspects for future storm water ponds.

1. Ponds designed to improve water quality shall be designed with water quality features consistent with NURP (William Walker, Jr. in Design Calculations for Wet Detention

Ponds -1987) criteria and best management practices and a permanent wet pool with dead storage of at least the runoff from a 2.5-inch storm event, plus additional volume based on the percentage of future impervious area.

2. Pond design must maximize detention time by preventing short circuiting. This can be accomplished by maximizing the distance between inflow pipes and the pond outlet with a minimum length to width ratio of 3:1.

3. Maintenance access to the pond must be provided for dredging sediment material from the pond.

4. Meet and/or exceed NPDES General Construction Permit pond design criteria.

## VIII. Erosion Control

The City recognizes that it is essential to promote, preserve and enhance the quality of the City's water resources, and to protect those resources from adverse effects caused by changes in land use. To protect water quality in the City, erosion control measures are essential in limiting the loading of sediment, phosphorus and other pollutants and minimizing the need for future restoration programs. The City's policy is to enforce the City Ordinances to ensure that the SWMP's recommendations are being implemented.

Steps important to limiting the impacts from land use include the use of BMPs for construction and conservation practices to reduce the degradation of downstream water resources.

A. Best Management Practices for Construction

The implementation of erosion control is most important during the construction phase of development when erosion rates can be 10 to 100 times the rate of undisturbed areas. In areas of the City where extensive development is taking place, storm water discharging to streams and wetlands frequently contains substantial quantities of solids and other pollutants. Even with extensive erosion control practices, sediment and airborne particulates enter the surface waters of the City.

Table 7 indicates the standard storm water BMPs that must be considered during the preparation of all development grading plans that are submitted to the City for review. Grading plans shall indicate the location of the proposed BMPs and provide a detail plate for the design and installation of the practice (when deemed applicable by the City).

Information indicating when the BMP is to be installed or completed must also be placed on the grading plan to avoid disagreement between contractors, inspectors and City Staff. In addition to the BMP listed in Table 7, City Staff may require additional practices based on the specific conditions of a particular grading site. The MPCA's Urban BMP Handbook provides information on many more BMPs that are available.

**Table 7 - Construction BMPs**

| Practice | Intended Result |
|---|---|
| Temporary Sediment Basins | Limit sedimentation rate during construction |
| Seeding Requirement/Schedule | Stabilize soils soon after grading completion |
| Storm Sewer Inlet Protection | Prevent sediment from entering storm sewer |
| Filter Fabric Fence Placement | Limit sediment in overland flow |
| Fit Development to Existing Terrain | Limit changes in grade and drainage |
| Limit Area of Disturbance | Reduce the amount of exposed soils |
| Phasing of Earth Work | Limit amount of soil exposed at one time |
| Stabilized Vehicle Exit | Reduce amount of mud tracking onto streets |

Even with the best and most expensive solids removal system, contamination of ponds and lakes will occur unless careful attention is given during the development phase and continued use of the land. Developers must utilize BMPs to minimize erosion during home construction in addition to the mass grading phase. Property owners must use care in the development of their yards and sodding of bare areas. Debris is frequently raked from lawn areas before and after sodding and left in the street gutters which, if not cleaned up, will be washed into the storm sewer, eventually reaching ponding areas.

Seeding and mulching is the most effective method of controlling erosion at the point of inception. The establishment of turf and disk anchoring of mulch stabilizes the soil to help prevent erosion from occurring. Disturbed areas shall be seeded as soon as grading is completed or if disturbed areas will be left for long periods of time. The Minnesota Department of Transportation Specification book provides a detailed description of seed mixtures and placement guidelines.

Temporary rock construction entrances provide an area where mud from vehicle tires can be removed. This prevents tracking of mud onto local streets where it can enter the storm sewer system and be transported to downstream water bodies. A major portion of soil that is tracked onto streets occurs during the construction phase of development. Once the foundation or basement of structures is constructed and backfilled, a gravel base shall be placed in the driveway location to provide a stable access to the site.

After development is complete, streets must be kept clean by conscientious effort from citizens to avoid littering or poor housekeeping practices, and by frequent street sweeping to remove sand, dirt, and litter before it washes into the storm sewer system. Chemicals such as sodium chloride must be minimized in ice control programs on streets and highways. Citizens must also make judicious use of fertilizers, which wash into ponds, streams and rivers and cause degradation of the water quality. Street sweeping by the City is prioritized based on tree cover, if the area drains directly to a surface water or receives treatment in a municipal stormwater pond, and the volume of sand used in those area. The City's goal is to sweep all streets in spring in fall, but may sweep more or less based on these priorities.

It is important that an inspection program and enforcement procedures be developed for erosion control on construction sites. The MPCA reviews and enforces erosion control for construction sites disturbing one acre or greater through the NPDES program. However, a limited number of MPCA staff members are responsible for the entire state and are not likely to field inspect a particular site unless a violation is reported. The protection of local water resources is best served through regular site erosion control inspections.

The City requires that grading permit applications address the manner in which soil erosion and sedimentation will be minimized during site development. Conformance with erosion control plans shall be field checked for conformance during the early phases of mass grading and periodically until turf has been established on the site.

All development shall conform to the natural limitations presented by the topography and soil in order to create the best potential for preventing sod erosion. All land disturbing activities, whether requiring a permit under the Ordinances or otherwise, shall be undertaken in conformance with best management practices and in compliance with the standards and criteria in the Ordinances. Land disturbing activities shall be planned and conducted to minimize the extent of disturbed area, runoff velocities and erosion potential, and to reduce and delay runoff volumes. Erosion and runoff controls, consistent with Best Management Practices (BMPs), shall be properly installed before commencing land disturbing activities, shall be sufficient to retain sediment on-site, and shall not be removed without approval. Erosion and runoff controls shall be regularly inspected and maintained. Temporary vegetation shall be installed over the disturbed areas promptly if the land disturbing activity

ceases or is suspended, and upon completion. Pipe outlets must be provided with temporary or permanent energy dissipation.

Slopes over thirty (30) percent in grade shall not be used as a building site. Development on slopes with a grade between twenty (20) percent and thirty (30) percent shall be carefully reviewed to insure adequate measures have been taken to prevent erosion, sedimentation and structural damage.

Erosion and siltation control measures, as approved by the City Engineer, shall be coordinated with the different stages of development. Appropriate control measures shall be installed prior to development when necessary to control erosion.

Land shall be developed in increments of workable size such that adequate erosion and siltation controls can be provided as construction progresses. The smallest practical area of land shall be exposed at any one period of time and no exposure shall exceed sixty-five (65) days unless extended by the City Council.

Where the topsoil is removed, sufficient arable soil shall be set aside for re-spreading over the disturbed area or new topsoil shall be brought in. The topsoil shall be restored to a depth of four (4) inches and shall be of a quality at least equal to the sod quality prior to development.

When development density, topographic features, and soil and vegetation conditions are not sufficient to adequately handle runoff using natural features and vegetation, various types of constructed facilities such as diversions, settling basins, skimming devices, dikes, watercourses and ponds may be used. Preference shall be given to designs using surface drainage, vegetation and infiltration rather than buried pipes and man-made materials and facilities.

When possible, existing natural watercourses and vegetated soil surfaces shall be used to convey, store, filter and retain runoff before discharge into public waters or a storm water conveyance system. When possible, runoff from roof gutter systems shall discharge onto lawns or other pervious surfaces to promote infiltration.

Use of fertilizer and pesticides in the shoreland protection zone shall be done so as to minimize runoff into public waters by the use of earth material, vegetation, or both.

Public and private properties adjacent to the development site shall be protected from the effects of erosion, sedimentation, flooding or other damage. Any violations of this provision must be corrected by the owner to the satisfaction of the City within five (5) days of receiving notification of such. If the violation is not remedied within the time period specified, the City may correct the problem and assess the costs incurred to the property owner.

Whenever the City determines that any land disturbing activity has become a hazard to any person, or endangers the property of another, adversely affects water quality or any waterbody, increases flooding, or otherwise violates these Ordinances, the owner of the land upon which the land disturbing activity is located, or other person or agent in control of such land, upon receipt of written notice from the City, shall within the time period specified therein repair or eliminate such condition. The owner of the land upon which a land disturbing activity is located shall be responsible for the cleanup and any damages from sediment that has eroded from such land. The City may require the owner to obtain a permit from the City under these Ordinances before undertaking any repairs or restoration.

Implementation of regional storm water basin approach – Regional storm water facilities can reduce discharge rates for large drainage areas when properly designed and located in a watershed.

Buffer Areas – The establishment of buffer areas along existing and future drainage ways and streams provide filtration of sediments and pollutants in storm water runoff and stabilize stream banks against erosion and stream meandering.

Top Soil- A minimum of four inches of top soil shall be placed over disturbed areas to aid in the establishment of vegetative cover for soil stabilization.

Preservation of Existing Wetlands – Existing wetlands provide natural water quality ponding for storm water runoff. Wetland impacts shall be mitigated to provide replacement of water quality functions.

Location of Development – Areas with existing steep slopes or areas of highly erodible soils shall be preserved to the greatest extent possible. These areas shall be identified for protection.

Sedimentation Ponds – Areas with moderate to highly erodible soils may require permanent on-site sedimentation ponds prior to discharging runoff to downstream regional storm water facilities. Proposed development within areas containing highly erosive soil units shall include permanent BMPs to minimize chronic erosion problems. Additional conservation practices may be required at the discretion of City Staff.

Stream Banks – An on-going program shall be developed to field identify stream bank stablization problem areas based on information collected on the geology of the stream bed, soil conditions and anticipated land use. The Scott County Soil and Water Conservation District (SWCD) can provide assistance in this area and may have funds available to complete stream bank stability projects.

B. Waivers

Ordinance Section 1109.08 Subd. 9 covers criteria for environmentally sensitive development, and states that the volume control requirement for environmentally sensitive developments may be waived.

The Ordinance states that on-site runoff rate and water quality control design criteria of the Rules may be waived if a City has an approved local water management plan that provides for off-site storm water facilities capable of meeting the requirements of the Rule.

The Ordinance states that design criteria for the 100-year actual storm may be waived for limited use, low maintenance road crossings.

C. Maintenance

As stated in Ordinance Section 1109.08 Subd. 10, all storm water management structures and facilities shall be maintained in perpetuity to assure that the structures and facilities function as originally designed. The responsibility for maintenance shall be assumed by the City with jurisdiction over the structures and facilities.

D. Easements

As stated in Ordinance Section 1109.08 Subd. 7 (9), applicants shall establish, in a form acceptable to the City, temporary and perpetual easements, or dedicated outlots, for ponding, flowage and drainage purposes over hydrologic features such as waterbodies and storm water basins. The easements, or outlots, shall include the right of reasonable access for inspection, monitoring, maintenance and enforcement purposes.

E. Covenants

The City may require that the land be subjected to restrictive covenants or a conservation easement, in form acceptable to the City, to prevent the future expansion of impervious surface and the loss of infiltration capacity. Covenants are covered under Ordinance Section 1109.08 Subd. 7 (10).

F. Exceptions

As stated in Ordinance Section 1109.08 Subd. 11, no permit or storm water management plan shall be required for the following land disturbing activities:

- Minor land disturbing activities such as home gardens, repairs and maintenance work.
- Construction, installation and maintenance of individual sewage treatment systems.
- Construction, installation and maintenance of public utility lines or individual service connections unless the activity disturbs more than one acre.
- Construction of any structure on an individual parcel in a subdivision with a storm water management plan approved by the City, so long as any land disturbing activity complies with the approved plan.
- Development or redevelopment of, or construction of a structure on, an individual parcel with a land disturbing activity that does not cause off-site erosion, sedimentation, flooding or other damage, and creates less than 1 acre of cumulative impervious surface.
- Installation of any fence, sign, telephone or electric poles, or other kinds of posts or poles.
- Emergency activity necessary to protect life or prevent substantial harm to persons or property.
- Redevelopment projects are exempt from rate and volume control provisions. Note: for the purposes of this SWMP and the Ordinances, if an activity creates more than 1 acre of new or additional impervious surface the activity is considered new development and the exception does not apply to the increased (new) impervious surface.

## IX. Natural Resources Protection

The Minnesota River bluffs and ravines are attractive features of the City of Belle Plaine. The bluffs offer unique views of the river valley, and contain some remnants of oak savanna and woodland plant communities that covered the uplands in the City before the era of European settlement. The ravines are still largely wooded, and provide corridors for wildlife movement and recreation, connecting upland areas with the Minnesota River and its floodplain. Although much of the original wetlands outside of the river floodplain but still in the lowlands have been impacted, some areas still support valuable wetland characteristics. There are many large wetland areas in the upland areas. It is the City's goal to protect its valuable natural resources, including ravines, bluff areas, and wetlands. It is the City's policy to enforce the City Ordinances to ensure that the SWMP's recommendations are being implemented.

The green corridors identify high priority areas for preservation, restoration and establishment and establishing them is a planned action. This will be achieved by acquiring easements or rights of first refusal for the areas delineated as green corridors as those properties are developed

The City's Comprehensive Plan shall be used to guide development within the City by providing policies and objectives to support development while at the same time protecting and managing the City's natural resources. As discussed in the City's Comprehensive Plan and in the Minnesota Stormwater Manual, low impact development and better site design will lessen the environmental impacts on the City's natural resources, and the City will encourage use of low impact development and better site design. This is discussed in more detail in Section 9 of this report.

During the initial preparation phase of the SWMP, a study of the existing features of the Belle Plaine area was completed. An evaluation of the bluff areas, ravines and wetlands provided

information on the level of protection and recommended management strategies that will be needed to preserve these areas during future development. Natural resources are shown on Figure SW-04.

A. Ravine Areas

Two major ravines are located within the SWMP study area. A description of these areas and recommended management practices area are indicated below.

1. South Creek Ravine

The South Creek Ravine runs along the western edge of Belle Plaine. The creek runs intermittently in this ravine, along a good channel with stable banks that includes some pool and riffle areas.

Much of the South Creek ravine is covered by a high, dense canopy of tree species typical of the Maple-Basswood forest community. Dominant tree species include basswoods, sugar maples, northern red oaks, bur oaks, green ash, and quaking aspens in cut-over areas. On drier slopes, red and bur oaks dominate. The understory in these areas includes saplings of the canopy trees, as well as buckthorn, currants, and a variety of herbaceous plants and vine. A list of species identified during a field inventory of the ravine conducted for the 1998 version of the SWMP (Bonestroo, Rosene, Anderlik & Associates, 1998) is included in Table 8.

**Table 8 - Plant Species Inventory – Ravine Areas**

| | |
|---|---|
| **Canopy** | **Ground layer (forest) cont.** |
| Basswood (Tilia americana) | Motherwort (Leonurus cardiaca) |
| Sugar maple (Acer saccharum) | Giant ragwood (Ambrosia trifida) |
| Boxelder (Acer negundo) | Plantain (Plantago major) |
| Slippery elm (Ulmus rubra) | |
| Red oak (Quercus rubra) | **Ground layer (old field, prairie and wetland openings)** |
| Bur oak (Quercus macrocarpa) | Smooth brome grass (Bromus inermis) |
| Green ash (Fraxinus pennsylvanica) | Kentucky blue grass (Poa praetensis) |
| Cottonwood (Populus deltoides) | Reed canary grass (Phalaris arundinacea) |
| Quaking aspen (Populus tremuloides) | Tall goldenrod (Solidago altissima) |
| | White clover (Meliotis alba) |
| **Subcanopy/Understory** | Yellow clover (Meliotis officinalis) |
| Buckthorn (Rhamnus cathartica) | Woodland sunflower (Helianthus divaricatus) |
| Black cherry (Prunus serotina) | Bergamot (Monarda fistula) |
| Staghorn sumac (Rhus typhina) | Yellow cone flower (Ratibida pinnata) |
| Black raspberry (Rubus occidentalis) | Daisy fleabane (Erigeron annuus) |
| Currants (Ribes sp.) | Prairie phlox (Phlox pilosa) |
| | Hoary vervain (Verbena stricta) |
| **Ground layer (forest)** | Tall buttercup (Ranunculus acris) |
| False Soloman's seal (Smilacina racemosa) | Meadow parsnip (Thaspium trifoliatum) |
| Pennsylvania sedge (Carex pennsylvanica) | Yarrow (Achillea millefolium) |
| Wood nettle (Laportea Canadensis) | Sulphur cinquefoil |
| Stinging nettles (Urtica dioica) | Common milkweed (Asclepias syriaca) |
| Wild grape (Vitis riparia) | Thimbleweed (Anemone virginiana) |
| Moon seed vine (Menispermum canadense) | Prairie dock (Silphium terebinthinaceum) |
| Common mallows (Malva neglecta) | Dark green bulrush (Scirpus atrovirens) |
| Sweet cicely (Osmorhiza claytonii) | Cattails (Typha sp.) |
| Virginia creeper (Parthenocissus inermis) | Willows (Salix sp.) |
| Violets (Viola papilionacea) | |

The forest community is probably similar to the vegetation that was in the ravine before European settlement began in the area during the 1800s. While upland areas around Belle Plaine were covered with oak woodlands, savannas, and prairies that were maintained by regular fires, ravine areas were protected from burning, and supported Maple-Basswood or other forest communities. Cutting, grazing and invasion by exotic species such as buckthorn and honeysuckle have reduced the diversity of the forest since pre-settlement times, but it still provides valuable wildlife habitat and the potential for recreation, storm water management, and other passive uses.

At the upper end of the ravine, openings in the tree canopy include areas of old field and prairie vegetation. Wetland species are interspersed here, in low areas and near the edges of the bluffs.

This mixture of vegetation types is valuable for supporting wildlife, and offers potential for recreation and nature study. The area is easily accessible to schools in Belle Plaine, as well as city residents.

The following recommendations for consideration are provided to assist the City in managing the South Creek ravine area:

- Maintain existing watershed runoff rates for the 1, 10 and 100-year storm events to preserve the morphology of the streambed, prevent bank failures, and protect the existing vegetation.
- Work with adjacent landowners to ensure appropriate public access to the ravine, and to include signage that identifies private property.
- Encourage use of the ravine by school and community groups interested in nature study. School or community groups could complete occasional clean-ups in the ravine, clear exotic species such as buckthorn, or complete plantings of native forest and prairie species.

2. Brewery Creek Ravine

This ravine runs along the eastern edge of Belle Plaine. Brewery Creek is a continuous stream through this area, with a rocky channel upstream, and broader meanders as it enters the Minnesota River floodplain. This lower portion of the ravine, near the railroad tracks, is broad and flat. The creek meanders through large monotypic stands of reed canary grass in this area. The ruin of an old stone brewery is accessible from trails that lead from city streets into this portion of the ravine.

South of this area, the ravine becomes steeper. Banks are particularly steep on the west side, and do not offer good access for trails. The bank on the east side is flatter, and existing trails and fences in this area indicate current use for trails, as well as private land ownership. Some trails in this area have been developed steeply perpendicular to the creek along the bank, and are causing erosion on banks sloping to the creek.

The vegetation in the ravine area is dominated by Maple-Basswood forest, with species similar to those found in the South Creek ravine.

The following recommendations for consideration are provided to assist the City in managing the Brewery Creek ravine area:

- Maintain existing watershed runoff rates for the 1, 10 and 100-year storm events to preserve the morphology of the streambed, prevent bank failures, and protect the existing vegetation.
- Provide signage for trails at the north end of the ravine, and interpretive information about the Creek, plants and animals in the ravine area.

- Work with landowners on the east bank of the creek, to determine if a public trail is appropriate and acceptable in this area. The City could negotiate trail easements along the corridor if this is agreeable to landowners. Trails should be run parallel to the creek.
- Protect hillside slopes along the western side of the ravine to prevent erosion of slopes. Identify and map existing erosion areas and stabilize as needed.
- Preserve as much of the native forest and understory community along the ravine as possible, particularly in steep slope areas, to prevent erosion. Work with adjacent landowners on both sides of the creek to encourage them to maintain the forest canopy and understory.
- Work with the property owner, county historical society and local history interests to determine the future of the historic brewery, which is on private property. The site offers possibilities for interpretation, a picnic area, or other passive use. This will require an access agreement with the property owner.
- Integrate scenic trails with existing trail system.

3. Bluff Areas

a) Bluff Protection

Bluffs can be found to the south and east of the City. Since the City is expanding in those directions, bluff protection shall be addressed. The City has developed local bluff protection requirements. The City, at a minimum, requires the following:

- Prohibit soil disturbance in the Bluff Preservation Areas that have been identified on the map in the City's Ordinance 1109 and verified through site surveys, and prohibit all activities that would result in disturbances or destabilization of the Bluff Face.
- The minimum erosion and sediment control BMPs include site stabilization and slope restoration measures needed to ensure the proposed activity shall not result in:
    - Adverse impact to adjacent and/or downstream properties or water bodies;
    - Unstable slope conditions; and,
    - Degradation of water quality due to erosion, sedimentation, flooding and other damage.
- Preservation of existing hydrology and drainage patterns. Land disturbing activities shall not result in any new water discharge points along the bluff.

  It also specifies minimum standards. These standards are graphically displayed below, along with definitions.

| | |
|---|---|
| Bluff | A topographic feature such as a hill, cliff, or embankment in which the average grade of any portion of the slope is 30 percent or greater and there is at least a 25-foot rise in elevation. |
| Bluff Impact Zone | A 25-foot zone from the top of a bluff. |
| Bluff Face | The area between the toe of the bluff and top of the bluff. |

| | |
|---|---|
| Bluff Overlay District | The Overlay District designated by Ordinance 1109: "Bluff Overlay Districts of the City of Belle Plaine." |
| Bluff, Toe of | The point at the lower part of the bluff where the average slope levels off to 18 percent or less. |
| Bluff, Top of | The point where there is a clearly identifiable break in the land from steeper land below the break to a gentler slope above the break. If a break is not apparent, the top of the bluff is determined to be the higher point of a 50-foot segment with an average slope exceeding 18 percent. |

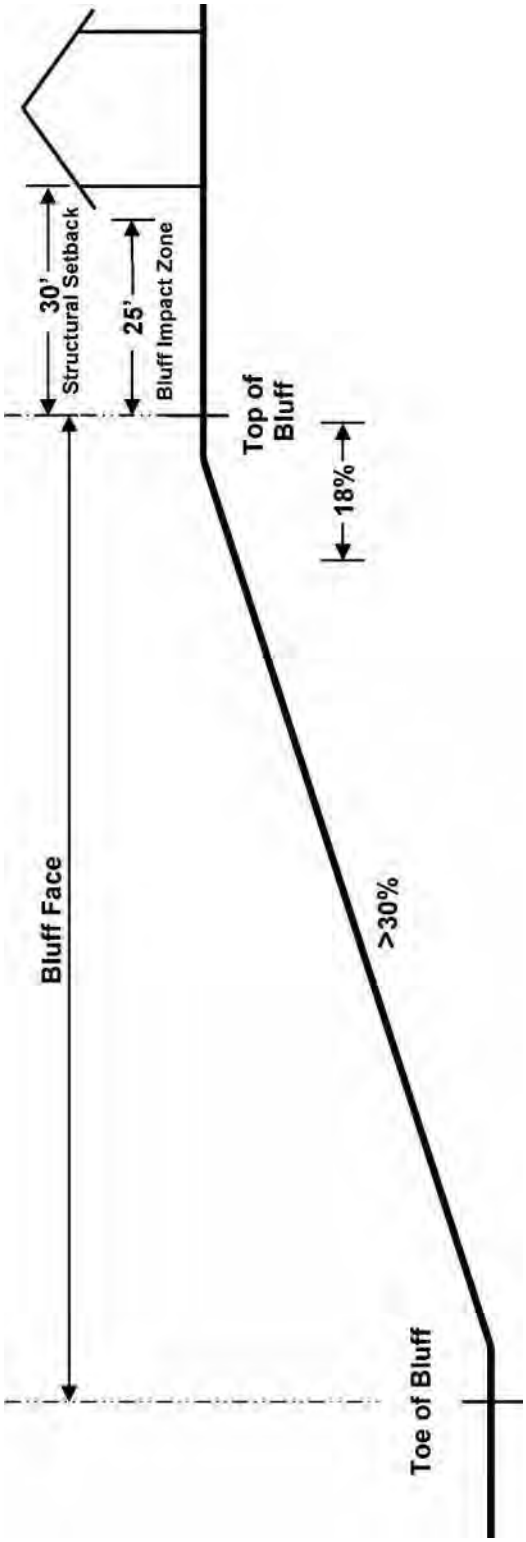



**Illustration 7 - Bluff Definitions**

The bluffs along the Minnesota River Valley south of Highway 169 in Belle Plaine offer attractive views of the valley, as well as home and business sites. The soils on the bluffs are extremely sandy and prone to erosion. The bluffs are a part of the ecology of the river corridor, and provide upland wildlife habitat and feeding and resting areas for species that migrate along the Minnesota River corridor.

Before settlement of the area by Europeans in the 1800s, the bluffs area was probably covered by oak woodlands, oak savanna, and prairie openings, with Maple-Basswood forest in sheltered ravine areas. The bluffs were probably regularly burned by prairie fires, set by lightning or native peoples to drive game animals or maintain desired habitat for game species. Farming, grazing and residential development have changed these plant communities extensively in the Belle Plaine area. While some groups of oaks remain, most of the ground and understory species have been replaced by lawns, or greatly simplified by grazing or cropping.

City Ordinance 1109.06 includes requirements and guidance intended to protect bluff areas. The Ordinance:

- Regulates construction and land uses along the bluff, to prevent erosion.
- Encourages landowners to retain native vegetation buffers, and to plant species native to the area, to protect and improve wildlife habitat and maintain the historic ecological role and appearance of the blufflands along the river. The existing housing developments along bluffs have addressed retention of native vegetation in one of two ways: platting of the property in an outlot and deeding that to the City or through a conservation easement.

4. Wetlands

The preservation, restoration, and enhancement of shoreland and wetland environments in their natural state shall be encouraged. To the extent possible, all wetlands shall be retained in their natural state to serve as natural water ecosystems and also as wildlife habitat. Mitigation of unavoidable wetland disturbances by replacing functions and values in the same major subwatershed is required. The rules and regulations applicable to wetlands and set forth by the Minnesota Wetland Conservation Act and Minnesota Clean Water Act have been incorporated into City Ordinance 1109.04. All wetlands within the City and the projected growth areas have been identified by Scott County. The City is it's own local governmental unit and will administer the Minnesota Wetlands Conservation Act.

The following guidance on the Wetlands Rule provides examples of applying the buffer averaging and road construction provisions of the Rule. The Rule sets average and minimum buffer widths based on functional assessment of the vegetative diversity of the wetland. Illustration 8 provides an example of the general approach for setting buffer widths and setbacks for a wetland with exceptional vegetative diversity. Note that the structure setback in this case is less than the buffer width. However, structures cannot be placed in the buffer. Buffer averaging can be used, as shown in Illustration 9, where needed to reduce the buffer to a minimum of 25 feet in specific areas to allow structures up to the setback. However, additional buffer width would be needed in other areas to obtain an average buffer width of 65 feet.

Buffers need to be recorded as a conservation easement, or included in a dedicated outlot.

Averaging can also be used to facilitate the placement of roads as shown in Illustration 10.

In other cases, such as where wetlands are so close together that even the minimum buffer widths do not allow a road, provisions are included in the rules allowing roads in buffers provided adverse impacts on the function of the buffer have been avoided or minimized to the extent practical. Illustration 11 provides an example. In this case

where the wetlands are 70 feet apart, the 25-foot minimum buffer on both wetlands would consume 50 feet, leaving 20 feet for a road. A road could still be placed between the wetlands per the rules if required to comply with subdivision approval and if impacts have been avoided or minimized to the extent possible. Avoidance means investigating and using other alternatives if feasible. Minimizing can be achieved by using a low impact design/narrower road cross section and/or aligning the road to have the smallest area impact on the buffer.

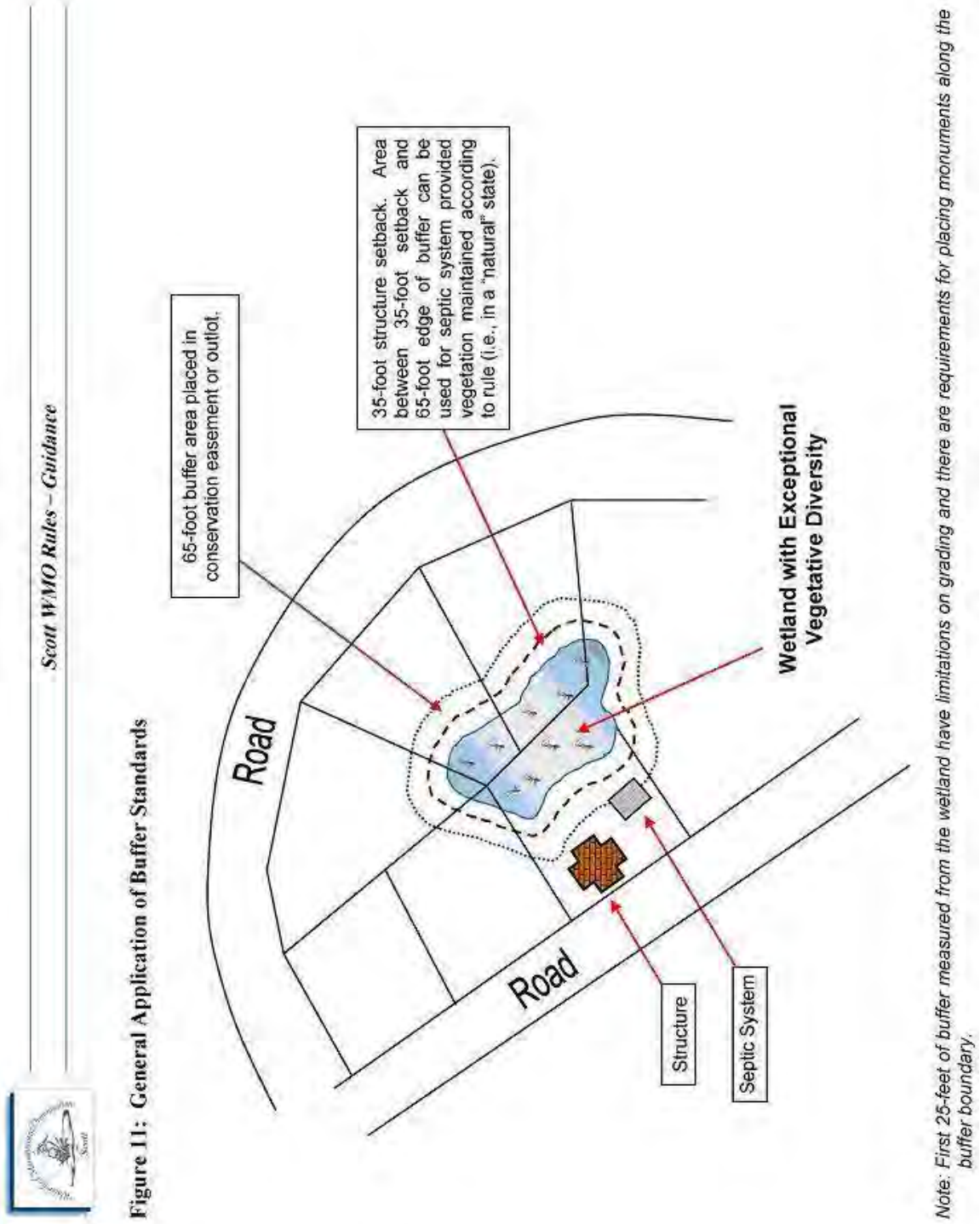



**Illustration 8 - General Application of Buffer Standards**

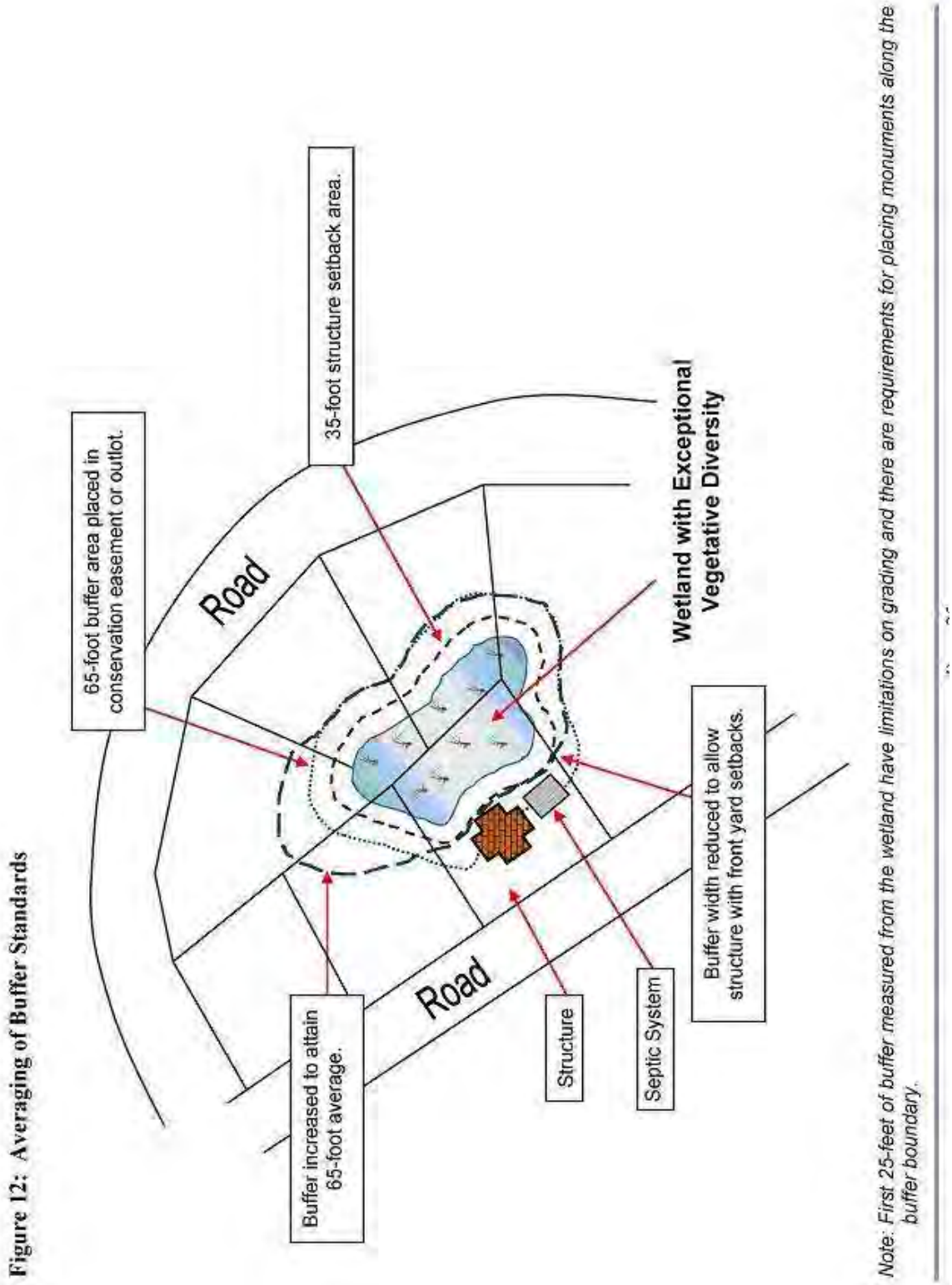
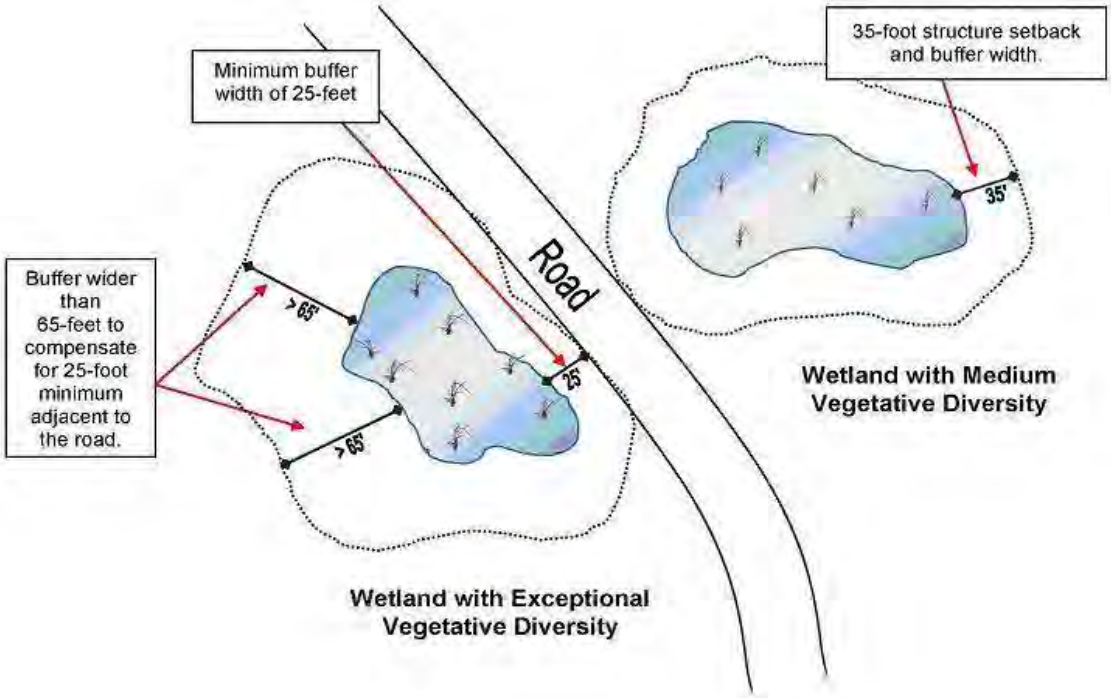



**Illustration 9 - Averaging of Buffer Standards**

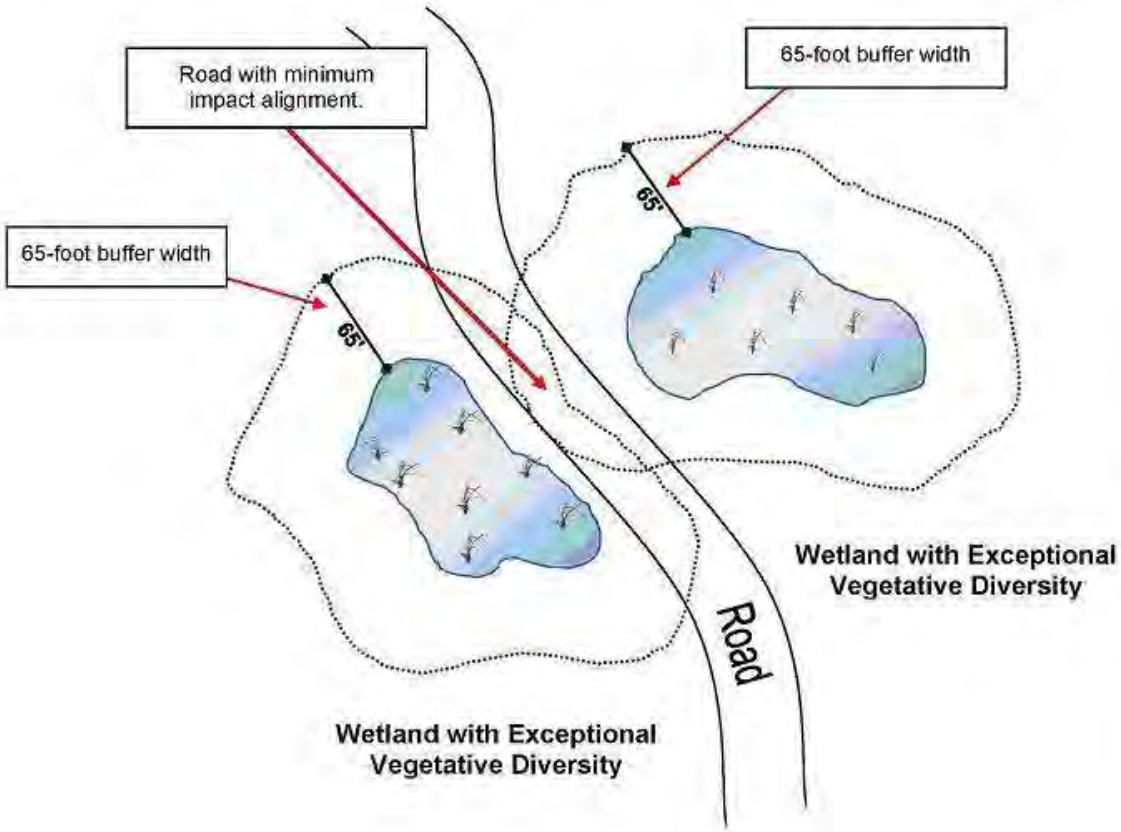
**Figure 13: Application of Buffer Standards for Roads between Wetlands**
***(Note Averaging to get an average width of 65-feet.)***




*Note: First 25-feet of buffer measured from the wetland have limitations on grading and there are requirements for placing monuments along the buffer boundary.*

**Illustration 10 - Application of Buffer Standards for Roads between Wetlands**

**Figure 14: Application of Buffer Standard for Road between Closely Spaced Wetlands**




*Note: Placement, maintenance, repair or replacement of public roads, and utility and drainage systems are allowed if required to comply with any subdivision approval or building permit so long as any adverse impacts on the function of the buffer have been avoided or minimized to the extent practical.*

**Illustration 11 - Application of Buffer Standards for Roads between Closely Spaced Wetlands**

A limited number of wetlands remain in the watershed outside the Minnesota River floodplain. Several more wetlands exist in the uplands to the south of the City. These wetlands play a role in storm water management, and probably provide nesting and feeding habitat for waterfowl and other birds and animals. Figure SW-05 indicates the location of wetlands that are identified by Scott County and the NWI.

Wetland management recommendations:

- Occasional controlled burns (every 3-4 years) would help to control the spread of

reed canary grass, and may help to diversify the forbs in the wetland. Fall burns may be preferred, to avoid affecting nesting waterfowl, and to encourage forb growth.

- For wetlands with low plant diversity, seeding of native plant species could provide some diversity in vegetation for the area.
- Work with surrounding landowners to preserve upland vegetation, especially trees, to increase the habitat value of the wetland.

5. Groundwater

Groundwater is the primary source of potable water for the residents of the City. Because of this, it is the goal of the City to protect its groundwater resources to provide clean and ample drinking water for the City's residents. The City has a Wellhead Protection Plan. A Wellhead Protection Area (WHPA) was delineated through this Wellhead Protection Plan. It is the policy of the City to:

a) Support identification and reduction of groundwater contamination from both point and nonpoint sources.

b) Require that all ISTS on a property be removed once sanitary sewer service is available to the property.

c) Continue to support programs that promote efficient administration of groundwater pollution programs.

d) To target high priority water bodies for water quality projects: including working with those waters listed as "impaired" by the MPCA for listing under Section 303(d) of the Clean Water Act. These include waters listed for excess nutrients and fecal coliform bacteria where failing ISTS systems and contaminated groundwater contribute to the impairment.

e) Not allow constructed infiltration practices within the Wellhead Protection Area, within 400 feet of a community water system or within 100 feet of a private well.

f) Encourage water conservation by enforcing a watering restriction (no watering between 9 am and 5 pm daily).

The City requires all ISTS on a property be removed once sanitary sewer service is available to the property. If sanitary sewer service is not available to the property, the City shall require all known non-compliant ISTS in the 10-year capture area of Wellhead Protection Area (WHPA) to be upgraded to conform with Minnesota Rule 7080 within 3 years of establishment of this Ordinance.

An exception may be granted by the City where non-compliant systems will be provided with municipal sewer service within 5 years. However, in no case should noncompliant systems remain in violation for more than 5 years from the date of establishment of Ordinance 1109 or 5 years of establishment of a WHPA.

## X. Proposed Ponding and System Improvements

The purpose of this section is to examine land use changes in relation to adjoining land uses, site accessibility, storm water management systems availability, and consistency with the City's Comprehensive Plan and policies. The City's growth areas have been delineated into watersheds and recommendations have been made for mitigating the impacts due to the development of each watershed. In general, the anticipated land use change in the City's growth areas would be from agricultural to residential or commercial. Later discussion in this section covers the storm water system improvements necessary to accommodate that land use change. The City's Comprehensive

Plan shall be used to guide development within the City by providing policies and objectives to support development and provide site access while at the same time protecting and managing the City's natural resources, which includes water resources. As discussed in the City's Comprehensive Plan and in the Minnesota Stormwater Manual, low impact development and better site design will lessen the environmental impacts on the City's natural resources. Low impact development/better site design includes placement of housing units in a manner that preserves significant natural resources, compatible land use patterns that relate to the City's environmental features, reducing and disconnecting impervious surfaces to lessen storm water runoff, and guiding land use development by promoting area-wide identification of environmentally sensitive natural resource areas. The environmentally sensitive areas will be protected by the proposed green corridor shown on Figure SW-04.

As noted previously, several factors were considered in developing the proposed future storm plan for the City of Belle Plaine. Because of the intricacies of the recommended improvements, this summary report will not discuss every detail of the recommended improvements. However, we wish to highlight several key design features and recommendations.

During the analysis of the watershed area south of U.S. Highway 169, it was evident that this uncoordinated and piecemeal scenario has resulted in a composite system that does not properly manage continued development drainage from the uplands to the south. From our analysis, the existing pond system and future storm sewer stub lines will function properly for smaller rainfall events. However, the larger rainfall events will need to be managed to prevent damage to the presently developed downstream properties by constructing emergency spillway channels, larger interconnecting conveyance or diversion piping and/or increased pond storage volume.

Basins should be generally located in strategic low areas that lie around the perimeter and upstream of the community to allow for future development (generally residential). They are intended to serve as both protection of existing developments from upstream agricultural runoff and water quality enhancement.

Key design criteria have been documented in greater detail in the design computations. Upstream basins have been sized to accommodate ultimate watershed development and have been preliminarily sited to fit natural low areas. In most cases, the location and shape of the basins can be modified to fit future development provided that the controlling design conditions are maintained (storage volume, maximum elevation, MPCA and BWSR requirements).

Of course, if ultimate development characteristics of the watershed change significantly, detention basin design and interconnected storm sewers will need to be modified accordingly.

Preliminary sighting of detention basins is based on available open space and hydraulic requirements. Cursory consideration has been given to land use, development potential, boundary lines, etc. Many of the recommended detention sites are already prone to flooding and would require substantial fill for development.

Unfortunately, in the older, more densely developed portions of the community, such as the originally platted areas north of U.S. Highway 169, open space for detention basin development is extremely limited. Throughout most of this drainage area new detention basins would require site clearing of previously developed properties.

Consequently, in these highly developed areas, drainage needs will need to be satisfied through the construction of major storm sewer interceptors. Where appropriate and feasible the City will consider and encourage use of green storm water best management practices that maximize infiltration for redevelopment.

The following is a brief description of the various major watershed areas studied.

A. General

The City of Belle Plaine was divided into watershed districts as shown in Figure SW-02. The watershed districts are further broken down to Study Areas as shown on Figure SW-09. The criteria and method for defining an appropriate watershed is based on the information in the USGS contour map. Watersheds were delineated by using the contours to outline an area that drains to a point. The watersheds were broken down to feed a water body such as a ditch, stream or wetland. If the ditch or stream had forks, the watershed was broken down to the area feeding each fork. The land use and land cover were taken into consideration; keeping land use and land cover homogeneous within the watershed if possible. In general, the watersheds should be somewhere between 50 to 500 acres; trying to balance between having large watersheds and being too general, or having small watersheds and getting bogged down in too many details. The storage volume and outflow rate of a pond are attributes that are important to preserve for each ponding area in order to successfully maintain the integrity of the storm drainage system. Pond areas and water levels may change in the final design of the ponding area in order to best suit the proposed development, but care must be exercised so that the outflow rates do no impede the performance of the downstream drainage facilities.

B. Brewery Creek

Brewery Creek district is located to the southeast of the City. Brewery Creek district drains toward the downtown area through a series of natural and constructed channel sections. A natural creek section flows north from Highway 169, past an abandoned stone brewery and crosses the railroad tracks before entering the Minnesota River. The central portion of Brewery Creek between Highway 169 and Goshen Boulevard has been reconstructed to improve drainage through this flat portion of the watershed. East of Goshen Boulevard, Brewery Creek becomes very steep along two branches or ravines. Most of the district is currently under agricultural land use.

As development occurs along Brewery Creek, the City shall continue to obtain easements or outlots to provide a natural buffer and possibly a trail system along the entire length of the creek.

All storm sewer outlets shall be checked regularly for dry weather flows that could indicate illicit connections to the storm sewer from the future development areas.

Brewery Creek, from Highway 169 to the Minnesota River, was added to the 2018 draft list of impaired waters. It was listed for impairments due to aquatic macroinvertebrate bioassessments, fishes bioassessments and E. coli bacteria. The City looks forward to working with the MPCA and Scott County in the TMDL study planning process.

C. South Creek

South Creek flows down a central ravine through the bluffs along the golf course. The creek then flows through four recently constructed storm water ponds near Loredo Avenue and Highway 169. South Creek then extends along a natural corridor down to the Minnesota River at the existing railroad crossing.

D. Robert Creek

Robert Creek runs from the uplands down through the bluffs, on the west side of Belle Plaine. This watershed includes the property planned for a future school site. The school site grading plans will determine the direction that the storm water will ultimately flow. The outlet for the souther portion of the property will likely need to be routed along Oak Creset Trail down the steep road grade to Robert Creek.

The area south of Highway 169 in this watershed currently outlets through field drain tile to Robert Creek. When development occurs in this area, the drain tile will likely need to be replaced with storm sewer pipe along the same alignment as the existing drain tile.

Significant rate reduction in the southwestern portion of this watershed is needed before development can take place in the lower portions of the district. When development occurs in this area, the survey information shall be included in this model. Adequate energy dissipation will be needed at the outlets to Robert Creek to prevent erosion within the streambed.

Robert Creek, from the City's sewage ponds to approximately one-half mile south of Highway 169, was added to the 2018 draft list of impaired waters. It was listed for impairments due to aquatic macroinvertebrate bioassessments, fishes bioassessments, total suspended solids and E. coli bacteria. The City looks forward to working with the MPCA and Scott County in the TMDL study planning process.

E. Minnesota River

This watershed has several separate drainageways to the Minnesota River. A storm water improvement is proposed at the crossing of an existing deep ravine and Forest Street. Erosion problems are occurring down stream of this crossing due to steep grades. The construction of a control structure at the crossing location can provide temporary storage of runoff from smaller (and more frequently occurring) rain events. Final design of this structure shall target the one to two year storm event for maximum storage before utilizing the full capacity of the culvert crossing.

Adequate energy dissipation will be needed at the base of the slopes along the northern portion of these watersheds to prevent erosion.

F. Area 110

Area 110 is south of County State Aid Highway No. 7 (CSAH 7) and east of the present City limits. This area is more accurately described as straddling the line between Sections 8 and 9 of Belle Plaine Township. Area 110 exists as a large upland plateau that falls to the northeast toward a central ravine. The ravine collects the storm water runoff from approximately 190 acres and delivers the flow to an existing culvert crossing CSAH 7. The soil characteristics of this area are best described as a sandy-clay loam.

If developed, we recommend placing a pond immediately upstream of the collection ravine. The developable upland area (Subcatchment 111) to be served by this proposed new pond is approximately 155 acres in size. This proposed new pond is strategically located to naturally intercept the runoff from the upper plateau.

The downstream benefits of the recommended Area 110 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The runoff velocities can be more easily controlled in the steep ravine to reduce erosion.
- The downstream flooding along CSAH 7 can be controlled.

G. Area 120

Area 120 is located immediately south of CSAH 7 and northwest of Area 110. This 485 acre watershed is best described as draining the majority of Section 8, Belle Plaine Township. The area is a highland plateau in the southern portion which surface drains to the northern lowlands as directed by ravines. Area 120 presently has no piped outfall to the north. It appears that the present runoff generally flows toward CSAH 7 and naturally ponds in a large farmed low area that may be tiled. As this area becomes developed, the natural ponding is anticipated to become insufficient, resulting in long term flooding in the area immediately south of CSAH 7 as well as the eventual overtopping of the roadway. Farmers Ridge

development has been constructed (2004) with in the catchment and provides local storm water management on site.

A two-tier system is proposed to manage storm water runoff associated with continued development in this area. The upper plateau area is proposed to be separated into 4 new subareas (Subcatchment Nos. 121, 122, 123 and 124). These areas are proposed to be served by the small wet detention ponds as described earlier (in Section 6). Similar to the proposed pond in Area 110, the small wet detention ponds are also strategically placed to naturally intercept runoff immediately prior to discharging into a ravine. A large dry regional detention pond is proposed as the secondary system and is proposed to be located in the present farmed lowlands of Area 120.

The new regional pond is proposed to promote groundwater infiltration and have a culvert discharge as a backup feature for times where the ground is frozen or to accommodate more extreme rainfall events.

In order to lessen the possibility of flooding of the existing pond system between Laredo Avenue and Kittson Boulevard, we propose to construct a new centerline culvert crossing Kittson Boulevard at its lowest point. This is proposed to hydraulically connect the pond east of Lindsey Lane (Pond 8) to Area 120. This precautionary measure will allow ponded storm water to overflow to the east into the Area 120 regional pond. This relief allows additional protection against property damage caused by extreme rainfall events.

The downstream benefits of the recommended Area 120 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The runoff velocities can be more easily controlled in the steep ravine to reduce erosion.
- The downstream flooding and ponding along CSAH 7 can better be controlled.
- Proposed pond location makes use of existing local depression.

H. Area 130

Area 130 is approximately 245 acres in size and is located immediately southwest of Kittson Boulevard. Similar to the previous areas, Area 130 has an upland plateau in the south which surface flows through rolling terrain toward the northwest. Farmers Ridge development has been constructed (2004) with in the catchment and provides local storm water management on site. Runoff flows through several smaller, less defined swales in contrast to the deeper ravine systems found in Areas 120 and 110. The Area 130 is currently either farmed or has open space with wooded steeper slopes.

The most probable development in Area 130 is anticipated to be in the relatively flat upland terrain. This upper area of approximately 115 acres has been called Subcatchment 131 for analysis purposes. A localized wet detention basin is proposed to dampen and treat the flows from this area. This basin is proposed to be located immediately upstream from the steep eastern ditch of CSAH 5. The discharge route follows the existing flow pattern with an ultimate outlet into Pond 10.

The southern portion of Area 130 is best described as rolling terrain that continues to deliver runoff to the north. No regional pond is proposed for this area, because the area is better suited for a secondary wet detention basin. As this area develops, it is recommended that the tandem basin network be considered in the overall design to ensure that the composite post-development flow conditions are relatively similar to the pre-development conditions.

The downstream benefits of the recommended Area 130 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The runoff velocities can be more easily controlled in the steep ravine to reduce erosion.
- The large regional pond option offers a greater benefit than up-sizing the current storm sewer system and/or creating alternative flow route.

I. Area 140

Area 140 is approximately 370 acres in size and is located southwest of CSAH 5. This area includes some residential development around the Valley View Golf Course and is farmed in most of the remaining area. There is a fairly large wetland/depression in the southwest quarter of Section 18, Belle Plaine Township. This depression drains to the northeast to an existing pond and then to the north to where the channel crosses CSAH 5 in the southeast quarter of Section 7 through a 72-inch Corrugated Metal Pipe (CMP) culvert. This culvert is considered to be the primary outlet to Area 140.

When considering potential development of this area, we believe that the area is best served by a sub-regional pond in the southeastern area limits. This sub-regional pond would be incorporated into the existing pond/bounce area directly south of the 72-inch culvert.

The upper 100-acre area, hereinafter labeled Area 141, is proposed to use the existing depression as a pond/basin prior delivering controlled flow through the existing drainage channel. The remaining lower area (golf course), hereinafter labeled Area 140, is proposed to be served by the existing pond/bounce area located on golf course property immediately south of the existing 72-inch CMP culvert crossing CSAH 5.

Some parts of Area 140 may be developed in clusters where a regional pond may not be warranted. In this possibility, small, localized ponds may be the best solution. However, as described above, these smaller ponds shall be reviewed as part of the comprehensive system during the design phase to ensure that the cumulative effect of these smaller ponds does not cause an increase in the downstream flows rather than the desired flow control.

The downstream benefits of the recommended Area 140 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The existing downstream properties and storm water system would have reduced flooding potential.
- The large upland detention pond option offers a greater benefit than up-sizing the current storm sewer system and/or creating an alternative flow route.

J. Area 150

Area 150 is located immediately west of Area 140 and east of CSAH 3. This area is approximately 140 acres in size and is similar to Area 140 as it also consists of sparse residential development around the Valley View Golf Course with the remaining area being farmed. Similar to the previous areas, Area 150 slopes from the uplands in the south to the lowlands in the north and runoff flows in this general direction through ravines and/or ditches. This area ultimately drains to the south end of Heritage Acres 2nd Addition where a shallow depression and catch basin collects and transports the discharge into the existing pond system between O'Brien Parkway and Laredo Avenue (Ponds 4 & 5). The primary discharge route is by way of storm sewer along Ash Street. The Ash Street storm sewer system is inadequate to handle the larger storm events and street flooding may occur.

To accommodate continued growth in this area, it is proposed to locate a regional pond in the north central portion of Area 150 with in an existing depression. The proposed regional pond will intercept the existing storm water runoff at the area's northern limit. This proposed regional pond would discharge to the existing storm sewer along Ash Street. The increase in pond storage volume will benefit the down stream developments by reducing the possibility of overtopping while regulating discharge to a manageable rate that coincides with the available capacity of the existing storm sewer system along Ash Street.

The downstream benefits of the recommended Area 150 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The existing downstream properties and storm water system would have reduced flooding potential.
- The regional pond option offers a greater benefit than up-sizing the current storm sewer system.

K. Area 160

Area 160 is approximately 125 acres in size and is located east and adjacent to CSAH 3. Storm water runoff flows toward a central main ravine which falls in the northerly direction to a relatively flat sandy terrain at its outlet. The existing discharge from Area 160 is collected by existing storm sewer stubs with catch basins along the western edge of Wildflower Ridge.

There are existing storm water detention ponds located along the northern region of Area 160. The relatively flat area in the southernmost portion of the area may be subject to relatively dense development. If so, a smaller localized development pond(s) would be required to properly manage the fully developed flows from the area. Any new localized development pond(s) shall be carefully reviewed to ensure that the discharge rate is considered in tandem with the existing pond system and ultimately the existing storm sewer system capacity. Emergency overflow routing shall also be carefully reviewed.

The downstream benefits of the recommended Area 160 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The existing downstream properties and storm water system would have reduced flooding potential.
- Incorporating the existing storm water management pond system offers a greater benefit than up-sizing the current storm sewer system and/or constructing a large regional pond.

L. Area 170

Area 170 is the adjacent to and west of CSAH 3. This area is approximately 375 acres in size and encompasses all of the northeast quarter of Section 13, Belle Plaine Township. There is a large, flat upper plateau in the southeast portion of the watershed which drains to the northern lowlands through four separate major ravines whish have several smaller tributaries. Storm water runoff collects in the northern portion of the catchment within a depression prior to being discharged to the north of the east-west township road in Section 12, which separates Area 170 from Area 180.

When this area develops, a two-stage system is proposed to treat and regulate the flow. The upland plateau is proposed to be separated into smaller subwatershed Nos. 171 and 172. Each of these subwatersheds is proposed to have a small wet detention pond based as a

pretreatment system prior to being discharged into a ravine. In the second stage of the proposed storm water management system, a large dry regional detention basin, capable of handling flows from the entire area is proposed in the lowland.

The downstream benefits of the recommended Area 170 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The runoff velocities can be more easily controlled in the steep ravine to reduce erosion.
- The downstream flooding and water ponding along CSAH 3 can better be controlled.
- Pond location makes use of area in which water ponds naturally.

M. Area 180

Area 180 is located to the south of T.H.169 and west of CSAH 3. This area is approximately 170 acres in size and is comprised of relatively flat sandy terrain, which generally falls toward the northeast. The area contains the Chatfield on the Green subdivision. Area 180 flows into Area 190 through a 24-inch culvert. The majority of the storm water runoff leaves area 180 by exfiltration and/or through a private tile system. After an extreme rainfall or snow melt event, stored water will overtop CSAH 3 and flow through the system of outlet culverts crossing T.H. 169.

As this area develops, the potential for overtopping CSAH 3 will also increase. A dry regional pond is proposed in the low lands that occupy the west central portion of the catchment to assist in managing the additional runoff from continued growth and development in this area. The regional pond is proposed to be discharged to the northwest of T.H. 169 and into the proposed Pond 1 improvements. Pond 1 is located southwest of the intersection of Meridian Street and South Street. Regional Pond 180 is proposed to outlet through the existing 24-inch culvert crossing T.H. 169.

The downstream benefits of the recommended Area 180 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with an outlet constructed to discharge north of T.H.169 offers better flow management for future development for the entire western watershed.
- Area 180 regional pond reduces the probability of overtopping CSAH 3 and/or T.H. 169.

N. Area 190

Subcatchment 190 is approximately 327 acres in size and is located to the north of T.H. 169 and west of Meridian Street. This area is presently partially farmed and partially developed (Southern Oaks 2nd Addition and Oak Village). This area is also a relatively flat sandy terrain, which drains to the northeast and terminates in an existing depression at the culvert outlet southwest of the intersection of South Street and Meridian Street (Pond 1).

Since there is no outlet culvert for upstream Area 180, runoff from the upstream areas only enters Area 190 after extreme single rainfalls, heavy snowmelt, or unrelenting repeated smaller rainfalls where overtopping of CSAH 3 occurs.

When this area develops, a dry regional pond as proposed would provide storm water management functions as well as act as a surge basin for the existing up stream pond network.

The downstream benefits of the recommended Area 190 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- Enlarging the existing depression south of South Street in order to create a large regional pond makes efficient use of current conditions while providing storm water management functions for Area 190.
- The large regional pond acts as a surge basin in larger storm events, which helps the proposed adjacent southern area pond network operate more efficiently.

O. Area 240

Area 240 is approximately 35 acres in size and is located to the north of T.H.169 and south of South Street. This area is presently partially farmed and partially developed (Southern Oaks 1st Addition). This area is relatively flat sandy terrain, which drains to the center of the catchment and then to the north.

To manage runoff from future development within the area, localized development ponds are proposed as required. The discharge from Area 240 is proposed to flow to the north of South Street and into Robert Creek.

The downstream benefits of the recommended Area 240 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The use of a smaller development pond(s) reduces the footage of storm sewer pipe in order to route storm water run off to a regional pond.

P. Area 250

Area 250 consists of approximately 124 acres of farmland. This area is located to the west of Oakcrest Trail and is bordered by Robert Creek to the west. The area is relatively flat sandy terrain, which drains to the west into Robert Creek.

When Area 250 develops, multiple sub-regional ponds are proposed to provide storm water management. The use of multiple ponds rather than single regional pond is because of the numerous discharge locations along Robert Creek. The multiple pond system allows existing flow routing to be maintained.

The downstream benefits of the recommended Area 250 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- Multiple detention basins along Robert Creek will help to ensure improved quality of the storm water runoff in a cost effective manner.

Q. Area 260

Area 260 consists of approximately 38 acres of farmland. This area is located to the north of T.H.169. This area is relatively flat sandy terrain, which drains southeast to Pond 1 in Area 190.

It is proposed to manage storm water run off from future development by means of localized development ponds as required. These ponds are proposed to discharge directly into Robert Creek.

The downstream benefits of the recommended Area 260 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The use of a development pond(s) reduces the footage of storm sewer pipe required while allowing phased construction.

R. Area 270

Area 270 is approximately 200 acres and is presently farmed. The area is located to the south of T.H.169 and is bordered by Robert Creek to the west. This area is comprised of highland bluffs in the east that slopes to the west and north. The area has numerous discharge locations into Robert Creek along its western border.

Area 270 is proposed to incorporate a combination of ponds that are best suited to utilize the natural topography. Smaller localized development detention pond(s) and larger sub-regional pond(s) are proposed for storm water management functions for Area 270. The proposed multiple pond system ensures that existing flow routing will be maintained.

The downstream benefits of the recommended Area 270 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- Multiple detention basins along Robert Creek will help to ensure improved quality of the storm water runoff in a cost effective manner.
- By utilizing the natural topography in the storm water management design, an economical and efficient system may be implemented.

S. Area 280

Area 280 is in the northeast part of the city and is nestled within existing development. More specifically, this area is located to the north of Main Street, south of Deer Creek Parkway and to the east of Laredo Street. Area 280 is approximately 68 acres in size and presently drains to the north and into Brewery Creek that outlets into the Minnesota River. The area predominantly exists as idle open space awaiting development. The existing storm sewer network near and around the area is not designed to handle this additional acreage.

Should this area develop, it is proposed to construct a sub-regional wet pond in the northern region to intercept runoff prior to out letting into the ravine outfall. The subregional pond could be designed to dampen the developed runoff. In addition, it may be prudent to over design this pond to allow the current overloaded, adjacent existing storm sewer to be diverted into the area. The subregional pond is proposed to discharge to the north of Deer Creek Parkway and outlet into the ravine.

The downstream benefits of the recommended Area 280 pond system are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The regional pond offers storm water management functions for the entire Area 280.
- The storm water management system in Area 280 may alleviate the current load on the existing undersized storm sewer system.

T. Area 500

Area 500 is located southeast of T.H. 169, south of Co. Rd. 64 and north of CSAH 7. The watershed is approximately 218 acres in size and presently drains to the north to the southern ditch of Co. Rd. 64 where two existing culverts discharge water to the north. The terrain is

relatively flat with a variety of soils scattered throughout. The area is currently farmed and part of the interchange construction.

As this area develops, a regional pond is proposed to handle the additional runoff. This pond is proposed to be located immediately upstream of the existing culverts crossing the eastern extension of Main Street. This area has been zoned for industrial/commercial land use, which may warrant either an enlarged regional pond or the use of coordinated small on-site wet detention ponds as part of the individual developments. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified.

The anticipated storm water run off from each individual parcel (commercial/industrial) shall be evaluated for on site storage requirements on a case-by-case basis, because of the wide variety of potential occupants.

The benefits of these recommended Area 500 improvements are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The recommended regional pond would function as a storm water management tool for the entire catchment prior to being discharged to the north of C.R.64.

U. Area 510

Area 510 is located southeast of T.H.169, south of Co. Rd. 64 and north of CSAH 7. This area presently flows to the east. The terrain is relatively flat with a variety of soils scattered throughout. The catchment is currently in row crop production.

In the developed stage, the Area 510 is proposed to manage storm water runoff with the use of a regional pond(s) to be constructed as an extension of the culvert depressions that currently exist. This area has been zoned for residential/ industrial/commercial land use, which may warrant either an enlarged regional pond or the use of coordinated small on-site wet detention ponds as part of the individual developments. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with an outlet constructed to discharge to the east offers storm water management for future development.
- Allows storm water to be discharged from Area 120 by creating a positive outfall for the Eastern Watershed.

V. Area 520

Area 520 is located west of Meridian Avenue and north of Mahoney State Wildlife Management Area. This area presently flows to the northwest, into Robert Creek. The terrain is relatively flat with large area of hydric soils and wetlands centrally located. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 520 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the centrally located wetland occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required.

In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to discharge to the wetland, and ultimately to Robert Creek, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

W. Area 530

Area 530 is located east of Meridian Avenue and north of Mahoney State Wildlife Management Area. This area presently flows to the west, through Area 520 and into Robert Creek. The terrain is relatively flat with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and wetland on the west side of this area, as well as smaller wetlands scattered throughout. The large wetland on the west side of the area is hydraulically connected to the large wetland in Area 520, but is physically divided by Meridian Road. Most of the catchment is currently in row crop production with the exception of a wooded parcel east of the large wetland complex.

In the developed stage, it is proposed to manage Area 530 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the centrally located wetland occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to discharge to the wetland, and ultimately to Robert Creek, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

X. Area 540

Area 540 is located west of Hickory Boulevard and north of Highway 19. This area presently flows to the east, through Area 570 and into County Ditch No. 3. The terrain is relatively flat with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and wetland on the south side of this area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production and/or occupied by the large wetland complex.

In the developed stage, it is proposed to manage Area 540 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the centrally located wetland occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately

evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to discharge to the wetland, and ultimately to County Ditch No. 3, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

Y. Area 550

Area 550 is located north of Highway 19. This area presently flows to the north, through Area 540 into County Ditch No. 3. The terrain is relatively flat with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and wetland on in the center of this area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production with wooded parcels throughout.

In the developed stage, it is proposed to manage Area 550 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the centrally located wetland occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional pond with outlet constructed to discharge to the wetland in Area 540/550, and ultimately to County Ditch No. 3, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

Z. Area 560

Area 560 is located north of Highway 19 and west of Hickory Boulevard. This area presently flows to the north, through Areas 540 and 570 into County Ditch No. 3. The terrain is relatively flat with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and wetland on the south side of this area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 560 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the large wetland complex occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.

- The large sub-regional pond with outlet constructed to discharge to the wetland in Area 540, and ultimately to County Ditch No. 3, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

AA. Area 570

Area 570 is located east of Hickory Boulevard. This area presently flows to the east, into County Ditch No. 3. Areas 540, 550, 560, and 575 drain into County Ditch No. 3 through Area 570. The terrain is relatively flat with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and wetland on the east side of this area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 570 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the large wetland complex occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to ultimately discharge to County Ditch No. 3, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

BB. Area 575

Area 575 is located east of Hickory Boulevard, north of Highway 19 and contains Michel State Wildlife Management Area. This area presently flows to the north, through Area 570 into County Ditch No. 3. The terrain is relatively flat with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils (soil type D) and wetland in the center of this area, as well as smaller wetlands scattered throughout. The catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 575 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the large wetland complex occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to ultimately discharge to County Ditch No. 10, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

CC. Area 580

Area 580 is located east of Hickory Boulevard and west of Union Hill Boulevard. This area presently flows to the east, through Area 590 into County Ditch No. 10. Areas 600 and 610 flow into Area 580. The terrain is rolling hills, with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and wetland on the north side of this area and one in the center of the area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 580 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the centrally located wetland occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to ultimately discharge to County Ditch No. 10, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

DD. Area 590

Area 590 is located east of Hickory Boulevard and west of Union Hill Boulevard. This area presently flows to the east, into County Ditch No. 10. Areas 580, 600 and 610 flow into Area 590. The terrain is relatively flat with a variety of wetlands and hydric soils scattered throughout. There are large areas of hydric soils and wetlands on the east side and south side of this area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 590 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the large wetland complex occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to ultimately discharge to County Ditch No. 10, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

EE. Area 600

Area 600 is west of Union Hill Boulevard. This area presently flows to the west, through Area 580 and into County Ditch No. 10. The terrain is relatively flat with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and

wetland on the south side of this area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 600 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the large wetland complex occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with outlet constructed to discharge to Area 580, and ultimately to County Ditch No. 10, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

FF. Area 603

Area 603 is east of Union Hill Boulevard. This area presently flows to the west, through Areas 600 and 580 and into County Ditch No. 10. The terrain is relatively flat with a variety of soils scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 603 storm water runoff with the use of a regional pond at the southwest side of the area. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with outlet constructed to discharge to Area 600, then Area 580, and ultimately to County Ditch No. 10, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

GG. Area 605

Area 605 is east of Union Hill Boulevard. This area presently flows to the west, through Areas 600 and 580 and into County Ditch No. 10. The terrain is relatively flat with a variety of soils scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 605 storm water runoff with the use of a regional pond at the west side of the area. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with outlet constructed to discharge to Area 600, then Area 580, and ultimately to County Ditch No. 10, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

HH. Area 608

Area 608 is east of Union Hill Boulevard. This area presently flows to the west, through Areas 600 and 580 and into County Ditch No. 10. The terrain is relatively flat with a variety of soils scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 608 storm water runoff with the use of a regional pond at the west side of the area. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with outlet constructed to discharge to Area 600, then Area 580, and ultimately to County Ditch No. 10, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

II. Area 610

Area 610 is located southwest of Union Hill Boulevard. This area presently flows to the south, through Area 580 and into County Ditch No. 10. The terrain is relatively flat, with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and wetland on the south side of this area and one on the north side of the area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 610 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the large wetland complex occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to discharge to the wetlands and ultimately discharge to County Ditch No. 10, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

JJ. Area 620

Union Hill Boulevard runs through Area 620. The majority of Area 620 is to the north of Union Hill Boulevard. This area presently flows to the south, through Areas 670, 690, 700 and into the Minnesota River. The terrain is generally steeply sloped with a variety of wetlands and hydric soils scattered throughout. There is a large wooded ravine area in the central northern part of the area. Most of the catchment is currently either in row crop production or is wooded ravine.

In the developed stage, it is proposed to manage Area 620 storm water runoff with the use of a sub-regional pond at the south end of the area, before the water runs through the ravine; as well as the use of coordinated small on-site wet detention ponds as part of the individual

developments. Direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional pond with outlet constructed to discharge to the ravine, and ultimately to the Minnesota River, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

KK. Area 630

Area 630 is northeast of Union Hill Boulevard and south of 228th St West. This area presently flows to the north, through Areas 650, 680, 690, 700 and into the Minnesota River. The terrain is generally steeply sloped with a variety of wetlands and hydric soils scattered throughout. There is a large area of hydric soils and wetland in the center of this area, as well as smaller wetlands scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 630 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the large wetland complex occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to discharge to the wetlands and ultimately discharge to the Minnesota River, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

LL. Area 635

Area 635 is south of 228th St West. This area presently flows to the north, through Areas 630, 650, 680, 690, 700 and ultimately into the Minnesota River. The terrain is generally sloped with a variety of soils scattered throughout. There is a wetland area in the central eastern part of the area. Most of the catchment is currently either in row crop production.

In the developed stage, it is proposed to manage Area 635 storm water runoff with the use of either subregional ponds and/or coordinated small on-site wet detention ponds as part of the individual developments: because the large wetland complex occupies the catchment's natural drainage collection point, numerous ponds will be required to treat the development's storm water run. The direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional pond with outlet constructed to discharge to Area 630, and ultimately to the Minnesota River, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

MM. Area 640

Area 640 is south of 228th St West. This area presently flows to the north, through Areas 650, 680, 690, 700 and into the Minnesota River. The terrain is generally sloped with a variety of soils scattered throughout. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 640 storm water runoff with the use of a regional pond at the southwest side of the area. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with outlet constructed to discharge to Area 650, and ultimately to the Minnesota River, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

NN. Area 650

Area 650 is north of 228th St West. This area presently flows to the northwest, through Areas 680, 690, 700 and into the Minnesota River. The terrain is generally steeply sloped with a few wetlands and hydric soils in the southwest corner. There is a large ravine area on the northwest side of this area. Most of the catchment is currently in row crop production or is wooded ravine.

In the developed stage, it is proposed to manage Area 650 storm water runoff with the use of three sub-regional ponds: one in the east, one in the south, and one in the north; as well as the use of coordinated small on-site wet detention ponds as part of the individual developments. Direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of these recommended locations are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to discharge to the ravine and ultimately discharge to the Minnesota River, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

OO. Area 660

Area 660 is south of 225th St West. This area presently flows to the north, through Areas 670, 690, 700 and into the Minnesota River. The terrain is generally steeply sloped with a

variety of soils scattered throughout. About half of the catchment is currently in row crop production, while the other half is wooded ravine.

In the developed stage, it is proposed to manage Area 660 storm water runoff with the use of a regional pond at the north side of the area. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with outlet constructed to discharge to Area 670, and ultimately to the Minnesota River, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

PP. Area 670

Area 670 is north of 225th St West. This area presently flows to the northwest, through Areas 690 and 700 and into the Minnesota River. The terrain is generally sloped with a variety of soils scattered throughout. About two thirds of the catchment is currently in row crop production, while the other third is wooded ravine.

In the developed stage, it is proposed to manage Area 670 storm water runoff with the use of a regional pond at the west side of the area. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with outlet constructed to discharge to Area 690, and ultimately to the Minnesota River, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

QQ. Area 680

Area 680 is southeast of Highway 169. This area presently flows to the southwest, through Areas 690 and 700 and into the Minnesota River. The terrain is generally flat with a variety of soils scattered throughout. There is a wetland on the north side of the catchment. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 680 storm water runoff with the use of a regional pond at the southwest side of the area. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large regional pond with outlet constructed to discharge to Area 690, and ultimately to the Minnesota River, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

RR. Area 690

Area 690 is southeast of Highway 169. This area presently flows to the west, through Area 700 and into the Minnesota River. The terrain is generally flat with a few wetlands and hydric soils scattered in the southwest corner. There is a large wetland area on the southeast side of this area. Most of the catchment is currently in row crop production.

In the developed stage, it is proposed to manage Area 690 storm water runoff with the use of two sub-regional ponds: one in the southwest and one in the north; as well as the use of coordinated small on-site wet detention ponds as part of the individual developments. Direct discharge from impervious surfaces to wetlands is not allowed, so smaller ponds to treat the water before being discharged into the wetlands will be required. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of these recommended locations are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional ponds with outlets constructed to discharge to the wetland and ultimately discharge to the Minnesota River, offers storm water management for future development.
- The locations make use of the existing slopes to direct water to the ponds.

SS. Area 700

Area 700 is northwest of Highway 169. This area presently flows to the west, through some residential areas, and into the Minnesota River. The terrain is generally flat with a variety of soils scattered throughout. Most of the catchment is currently in row crop production, with some wooded areas.

In the developed stage, it is proposed to manage Area 700 storm water runoff with the use of a sub-regional pond in the central part of the area; as well as the use of coordinated small on-site wet detention ponds as part of the individual developments. In this case, the anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified. The downstream benefits of this recommended location are:

- The dampening of the developed property runoff to match pre-developed flow rate conditions.
- The large sub-regional pond with outlet constructed to ultimately discharge to the Minnesota River, offers storm water management for future development.
- The location makes use of the existing slopes to direct water to the pond.

TT. Area 710

Area 710 is northwest of Highway 169. This area presently flows to the northwest, underneath the railroad tracks, and into the Minnesota River. The terrain is generally sloping gently towards the river with a variety of soils scattered throughout. Along the north side of the catchment are ravines. Most of the catchment is currently in row crop production or wooded ravine.

In the developed stage, it is proposed to manage Area 710 storm water run off with the use of coordinated small on-site wet detention ponds as part of the individual developments. Direct discharge from impervious surfaces to the Minnesota River is not allowed, so smaller ponds to treat the water before being discharged into the river will be required. In this case, the

anticipated ultimate runoff from each developed parcel cannot be accurately evaluated until the actual land use is known and the runoff can be quantified.

## XI. Operations and Maintenance

As part of enforcing the City Ordinances, operations and maintenance is a way to protect and improve the City's valuable natural resources.

A. Storm Water Basins

Storm water basins represent a sizeable investment in the City's drainage system. General maintenance of these facilities can help insure proper performance and reduce the need for major repairs. Periodic inspections shall be performed to identify possible problems in and around the basin. Basins are currently inspected annually. Finally, water quality sampling can insure that storm water basins are operating correctly and can detect abnormal pollutant discharges within the watershed.

The most important part of the inspection of storm water basins is to insure the outlet of the basin can perform at design capacity. The area around the outlet shall be free and clear of debris, litter and heavy vegetation. Trash guards shall be installed and maintained over all outlets to prevent clogging of the downstream storm sewer. Trash guards must be inspected at least once a year, preferably in early spring, to remove debris that may clog the outlet. Emergency overflow outlets shall be clear of equipment or materials and properly protected against erosion.

Basin inlets shall be inspected for erosion. In cases where erosion occurs near an inlet, an energy dissipator or riprap material may be required. Sediment deposits or deltas may form at the inlet from poor erosion control practices upstream. This may occur during mass grading of sites within the drainage area. Large sediment deposits may reduce the ability of water to discharge from the storm sewer system during large storm events and may cause surcharging upstream.

The side slopes of basins must be kept well vegetated to prevent erosion and sediment deposition into the basin. Severe erosion along side slopes can decrease the quality of water discharging from the basin and require dredging of sediments from the basin. Noxious weeds may need to be periodically removed from around basins. Some basins in highly developed areas may require mowing. If mowing is performed, a buffer strip adjacent to the normal water level shall be maintained to provide filtration of runoff from side slopes and protection of wildlife habitat. The buffer strip width shall be based on the type of basin, but shall be a minimum of 16.5 feet.

Periodic inspection of storm water basins shall include checking for evidence of illicit dumping or discharges. The most common of these is dumping of yard waste into the pond. Signs may need to be posted prohibiting the dumping of yard waste in areas where this occurs. Oil sheens can also be present in areas where waste motor oil is dumped into upstream storm sewers. Skimmer devices placed at outlets of basins can help prevent oil spills from being transported downstream. Skimmer structures shall be periodically inspected for damage from freeze-thaw cycles. Inspections performed during dry weather periods shall check for flows at basin inlets. Dry weather flows can indicate illicit dumping or connections to the storm sewer system.

B. Sediment Removal

The removal of sediment deposits will likely be the most expensive portion of maintenance for storm water basins. The removal efficiencies of basins for water quality treatment can be significantly reduced if sediment is allowed to accumulate to excessive depths. As a general guideline for maintenance scheduling, ponds will require dredging every 15 to 20 years to

remove accumulated sediments. Some basins will require shorter or longer times between dredging based on the land use and rate of erosion within the drainage area. The first cleaning of a storm water basin is paid for by the developer, as stated in the developer's agreement with the City.

Sampling of the sediments in basins shall be conducted prior to disposal to detect possible high levels of harmful materials. If excessive hazardous waste levels are detected in sediment tests, disposal of material must be conducted under MPCA guidelines. If high levels are not detected, sediment disposal sites shall be located adjacent to the basin when possible. The material shall be disposed of in a location where it will be stable and not in contact with humans such as playgrounds or parks. Sediments shall be covered with topsoil and revegetated to prevent erosion of the material.

C. Open Channels

Overland routes constitute an important part of the surface water drainage system. Open channels are typically vegetated and occasionally lined with more substantial materials. The lined channels typically require little or no maintenance. Vegetated channels require periodic inspection and maintenance as high flows create erosion within the channel. Eroded channels will contribute to the water quality problems in downstream water bodies as the soil is continually swept away. If not maintained, the erosion of open channels will accelerate and the repair will become increasingly more costly.

D. Piping System

The storm sewer piping system constitutes a multi-million dollar investment for any City. A comprehensive maintenance program is recommended to maximize the life of the facilities and optimize capital expenditures. To accomplish this, the following periodic inspection and maintenance procedures are recommended.

- Inspect catch basin and manhole castings, clean and replace as necessary.
- Inspect catch basin and manhole rings and replace and/or regrout as necessary.
- Inspect catch basin and manhole structures and repair or replace as needed. Check pipe inverts, benches, steps (verify integrity for safety) and walls. Cracked, deteriorated and spalled areas need to be grouted, patched or replaced.
- Inspect storm sewer piping either manually or by television to assess pipe condition. Items to look for include root damage, deteriorated joints, leaky joints, excessive spalling, and sediment buildup. The piping system shall then be programmed for either cleaning, repair, or replacement as needed to ensure the integrity of the system.

E. Chloride Management (De-Icing Practices)

Minnesota receives approximately 54 inches of snow during a typical year. This requires a large amount of de-icing chemicals to be applied to roads and sidewalks each winter. The main chemical used for de-icing is salt or sodium chloride. The Twin Cities Metropolitan Area applies approximately 349,000 tons of road salt to its roads each winter ( Inventory of Road Salt Uses in the Minneapolis/St. Paul Metropolitan Area 2007) . Improper storage and overuse of salt will increase the chance of high chloride concentrations in runoff and ground water. High chloride concentrations can be toxic to fish, wildlife and vegetation.

Estimates indicate that 80 percent of the environmental damage caused from de-icing chemicals is a result of inadequate storage of the material (MPCA 1989). Therefore, proper storage of salt is critical in reducing the amount of chloride that is transported to the environment. The following procedures can be used as a guideline for de-icing storage practices.

- Store de-icing material in waterproof sheds. If this is not possible, stockpiles shall be covered with polyethylene.
- Divert off-site runoff away from storage locations. Berms and shallow drainage swales may need to be constructed.
- Place stockpiles on impervious surfaces. Infiltration of runoff high in chloride content can pollute the ground water. Impervious surfaces also provide easier year-end cleanup of loading areas and will not become muddy during the spring.
- Contain runoff from stockpile locations. Runoff from stockpiles shall not be allowed to flow directly into streams or wetlands where environmental damage can occur.
- Road de-icing stockpiles shall not be located near municipal well areas or in other sensitive ground water areas.

Practices shall also be followed to reduce the amount of salt that is applied to roads. One method is to limit the amount of salt applied to low traffic areas and straight level areas. Streets shall be inspected for the need for de-icing prior to application. Equipment shall be maintained in good working order to evenly distribute salt on roadways and shall be properly calibrated to prevent excessive application. The City currently follows these practices.

F. Detection of Illicit Connections

In preparation for possible NPDES regulation changes, a program to detect illicit connections to the City's drainage system shall be implemented. This program would involve the inspection of storm sewer outfalls during dry weather periods to identify possible illegal dumping or connections to the storm sewer system. Inspection shall be prioritized by focusing on industrial and commercial areas, then extending to residential areas.

If dry weather flows are detected and illicit connections could be the source of the flow, a grab sample shall be collected for analysis to determine if pollutants are present. It is very important that all data collected under this program be saved in an organized fashion. This information will be valuable in future NPDES permitting requirements for the City.

## XII. Education

The successful implementation of the SWMP will require that the individuals and groups involved in the SWMP have a clear understanding of the objectives of the management policies. Informing the public of the SWMP components is the goal of the education program. Since all City residents, staff, elected officials, developers and consulting firms will be impacted by the SWMP, all of them need to be informed of the pertinent policies.

The target audiences for the education program can be broken into three main groups:

- City Staff
- City Residents
- Development Community

Each of these groups needs a thorough understanding of the major objectives and policies of the SWMP. In addition, each group will require extensive training in specific aspects of the SWMP pertaining to the manner in which they impact water quality.

For instance, City residents shall be informed about the negative aspects of excessive phosphorus fertilizer, while developers need a sound understanding of the use of the Best Management Practices (BMPs) to control erosion. The specific informational needs of each group and possible training mechanisms are discussed below.

A. City Staff

City Staff will have a wide range of plan implementation responsibilities including:

- Maintaining detention basin nutrient removal efficiencies;
- Implementing a spill response program;
- Enforcing SWMP policies and recommendations;
- Responding to public inquiries about the SWMP policies;
- Developing annual budgets to implement the SWMP; and,
- Planning coordination and delivery of education programs to the public, school groups and other organizations.

Training shall be provided on the proper methods of containing, neutralizing and disposing of spills of oil, gasoline, pesticides, and other hazardous material. The crucial factor to emphasize is that spilled materials shall not be washed into the storm sewer system. Oil adsorbent materials should be available for use in spill containment and clean up. The manufacturer can provide instructions for proper use of these materials.

B. City Residents

In order to obtain the necessary political and economic support for successful SWMP implementation, it will be vital to inform City residents about basic water quality concepts, the policies and recommendations in the SWMP, the progress of water quality improvements in Belle Plaine, and their role in improving water quality. The education program should also promote water conservation, provide information to the public on groundwater resources and encourage well water testing. Information on the value of wetlands and how to avoid impacting wetlands will also be provided. Efforts will be made to increase participation of citizen stakeholders in wetlands and wildlife management programs. The educational programs shall be made a high priority. The City will work with Scott WMO, DNR, University of Minnesota Extension Service, SWCD, and NRCS to provide these educational opportunities.

Initial education efforts shall focus on explaining the causes of water quality degradation and the manner in which the SWMP addresses these problems. Providing information to the public on how they can personally affect the quality of storm water runoff will be important in maintaining public support for the SWMP. This initial information can be presented to the public during the public hearing process on the ordinance changes, the City newsletter, City website, fliers in the water and sewer bills and press releases to local papers.

Periodic updates on water quality trends in the City, the progress of SWMP implementation, and information on specific improvement projects shall also be provided to the public. Again, the City newsletter and press releases to local papers are good methods to disseminate this information. In addition, City Staff shall take advantage of the opportunities provided by local service clubs and church groups to speak at meetings. Finally, special efforts shall be made to coordinate educational and environmental awareness programs with the school district. These programs shall focus on K through 12 science curricula as well as adult

community education. These groups are constantly in need of speakers and would probably welcome requests from the City to provide information on water quality in Belle Plaine.

C. Development Community

The SWMP will have a major impact on the development community. Therefore, informing developers and their consulting engineers of the SWMP requirements will be an important component of the education program. Efforts will be made to increase participation of developers who are stakeholders in wetlands and wildlife management programs.

In addition to a basic understanding of the overall SWMP policies, the development community will need a good understanding of the reasons for the development of the policies impacting their activities. Specifically, developers and consultants must understand the impact of development on:

- The standard design requirements for the conveyance system;
- The theory of storm water detention ponding, and the rationale behind the selection of runoff coefficients;
- General practices for erosion control;
- The value of wetlands;
- Water quality preservation practices; and,
- The economic and social value of maintaining high water quality for streams, wetlands and the Minnesota River.

Much of the necessary information can be disseminated to developers in an information packet during the preliminary plat stage. The information packet shall include storm water management requirements for new development, design requirements for storm water facilities and basic requirements of Best Management Practices (BMPs) for erosion control.

## XIII. Economic Considerations

As with all improvements, there is a cost associated with prudent storm water management. Implementation of a storm water development charge on an area wide basis and building the regional ponding system as a City funded project is probably the best and fairest method of ensuring that new developments are adequately studied, sized and coordinated properly.

Perhaps the most advantageous strategy is to choose a single cost over the entire study area. This would eliminate the contention by the more expensive area developers and landowners that they are being treated unfairly. However, this should be approached with caution, as simply choosing an average cost could result in the City of Belle Plaine financing the more expensive projects first. Accordingly, a thorough review with consideration of a reasonable contingency beyond the averages should be made with your financial consultant and planner.

Assessment rates for commercial and industrial areas are proportionately higher than for low-density residential areas. The higher rate is justified because these areas typically have a larger percentage of roofed and paved areas, which increase the amount of runoff. The velocity of runoff on impervious surfaces is also greater, which results in lower times of concentration, higher peak runoff rates, and larger required storm sewer pipe. The 2018 storm sewer area charges per acre for land uses are as follows:

- Residential - $2,850/ac
- Commercial - $3,100/ac
- Industrial - $3,450/ac

This storm sewer area charge is used to annually inspect and maintain the City's storm sewer system, including storm water ponds. See the implementation table in Section 13 of this report for the tasks and the associated funding.

## XIV. Summary and Recommendations

A. Summary

The Belle Plaine SWMP has a dual purpose: it will serve as a guide for the construction of storm drainage facilities and provide a basis for a consistent approach to the preservation of ravines, wetlands, streams and the Minnesota River. The following issues have been incorporated into this plan:

- Division of the City into major watersheds based on contour maps, grading plans and natural topography;
- Determination of storm water runoff under ultimate land use conditions;
- General layout and sizing of trunk storm sewers and open channels;
- Tributary areas, storage volumes, and high water levels of all required ponding areas;
- Recommendations for standard Operations and Maintenance procedures;
- Recommendations for specific construction site erosion control practices;
- Estimated construction and implementation costs of the SWMP;
- Recommendations for education of City residents, staff, and development community.

The primary function of an urban storm drainage system is to minimize economic loss and inconvenience due to periodic flooding of streets and other low-lying areas. Adequately designed storm drainage facilities provide flood control, minimize hazards and inconvenience associated with flooding, and protect or enhance water quality. The SWMP takes the entire drainage basin with future saturation development into consideration.

Wet water quality ponds upstream of dry regional infiltration basins (where possible) will help control the rate and the volume of storm water runoff. To provide flood protection for adjacent property, the design storm interval for ponding areas is a 100-year storm as compared to a 10-year storm for design of storm sewer piping. Any new residential, commercial, industrial and other habitable structures shall be constructed with the following low floor elevation: Elevation of the lowest opening of a structure shall be a minimum of 2 feet above the Emergency Overflow, or 1 foot above the HWL of the nearby pond or waterbody, whichever is higher. The area of a pond's HWL plus 1 foot of freeboard shall be contained entirely within an outlot that is owned and maintained by the City.

The numerous natural depressions found throughout Belle Plaine have been incorporated into the SWMP as ponding areas. The effective use of ponding areas enables the installation of outflow sewers with reduced capacities since the design storm duration is effectively increased over the total time required to fill and empty the ponding reservoirs. Storm sewers represent a sizable investment for the community and this investment can be more efficiently utilized by ponding storm water in designated ponding areas and allowing smaller diameter pipes to be used as outfall lines.

Equally as important as flood control and cost considerations, is the use of ponding areas to:

- Improve water quality;
- Return storm water to the groundwater table;

- Increase water amenities in developments for aesthetic, recreational and wildlife purposes.

For water quality ponds, the wet volume is the most important consideration. The area and depth of the ponds may differ from the values presented here, but the wet volume must be provided so that the prescribed pollutant loading of the system is not exceeded.

Amenity aspects are maximized by careful planning in the initial development of any residential or industrial area and by integrating the ponding system into an overall comprehensive SWMP.

The wildlife aspects of the ponding areas shall be maximized in design and the proper location of the trail system will allow good access to these areas for wildlife observation.

It is extremely important that each area be re-evaluated at the time of final design to confirm the criteria used in this study and to make any changes that a proposed development may dictate. Special consideration must be given to areas that develop differently than shown in the Comprehensive SWMP, especially when a higher runoff coefficient is likely to result from development.

All storm sewer facilities, especially those conveying large quantities of water at high velocities, shall be designed with efficient hydraulic characteristics. Special attention shall be given during final design to those lines that have extreme slopes and create high hydraulic heads.

The Best Management Practices (BMPs) recommended by the MPCA shall be followed wherever necessary.

B. Recommendations

The following recommendations are presented for the City Council's consideration based upon the data compiled in this report:

- The SWMP as presented herein be adopted by the City of Belle Plaine.
- Standard review procedures be established to ensure all development within the City is in compliance with proper erosion control practices.
- Detailed hydrologic analysis be required during final design of all ponding areas.
- Final high water levels governing building elevations adjacent to ponding areas and floodplains be established as development occurs or when drainage facilities are constructed.
- Overflow routes be established and maintained to provide relief during extreme storm conditions, which exceed design conditions.
- A storm water maintenance program be enforced to ensure the successful operation of the drainage system.
- The erosion and sedimentation control criteria for new developments be enforced.
- An education program for City residents, staff, and development community be implemented.
- Amendments to the plan be adopted and implemented as warranted by future standards or regulations.
- That the plan be updated in the year 2020 or earlier if needed.

The existing storm sewer system of the City of Belle Plaine is not adequate to handle the continued development around the presently developed area. If development continues, the

existing system will need major improvement and enlargements to effectively serve the community without excessive flooding. The proposed regional ponding scenario presents one method of accommodating the present growth of Belle Plaine. However, this report and the proposed ponding scenario is not necessarily the only method of accomplishing the goal of comprehensive storm water management.

Given this, it is imperative that this plan is updated on a regular basis to ensure that any adjustments in area developments continue to be coordinated. In addition, the proposed storm water development charges shall be updated annually to ensure that the associated City costs are fully financed. In this manner, the plan can maintain its usefulness as a current document.

Finally, the EPA has initiated the NPDES Phase II requirements whereby cities with populations in excess of 10,000 people are required to apply for a Phase II permit. Some additional cities that are actually under 10,000 in population are also included. Given that the Minnesota River watershed has been specifically targeted for cleanup, it is probable that Belle Plaine will eventually be included on the list of cities needing a permit. One of the requirements of the NPDES permitting process is the existence of a storm water management plan.

As stated earlier, this report is predominantly based on information obtained from available topographic data, field verification of the watershed areas, and discussions with City staff relative to the historical flooding areas. Since the modeled existing system closely matches that described by observation, we feel that this plan has significant benefit as a planning and design tool. However, the quality and accuracy of this report could be further validated with more detailed survey data in the growth areas around the City.

We request that City staff and interested parties carefully review the accompanying information. With projects of this magnitude and the amount of data analyzed and developed, there will undoubtedly be some oversights, typographic errors, calculation errors, etc. Our final review and quality control process is on-going and, prior to final publication of maps and computer files, additional quality control reviews will be completed.

We wish to thank the City of Belle Plaine and City staff for their support in this project. We look forward to meeting with the Council and other interested citizens to answer any questions regarding the project and the recommended improvements.

C. Implementation of Recommendations

A Capital Improvement Program, or CIP, already exists and is updated on a 5 year period. The CIP includes projects to implement the recommendations in this SWMP. "Capital Improvement Program" means an itemized program for at least a five year prospective period, and any amendments to it, subject to at least biennial review, setting forth the schedule, timing, and details of specific contemplated capital improvements by year, together with their estimated cost, the need for each improvement, financial sources, and the financial effect that the improvements will have on the local government unit or watershed management organization.

The following is an implementation process list of the recommended actions, timing, responsible party, and the cost or funding source which are presented for the City Council's consideration based upon the data compiled in this report. Actions are listed in order of priority, from highest to lowest.

**Table 9 - Implementation Process List Of The Recommended Actions**

| | | | |
|---|---|---|---|
| Maintain and implement Capital Improvement Program | On-going, updated on a 5 year period | City of Belle Plaine | Storm water area charge and monthly storm water utility fee |

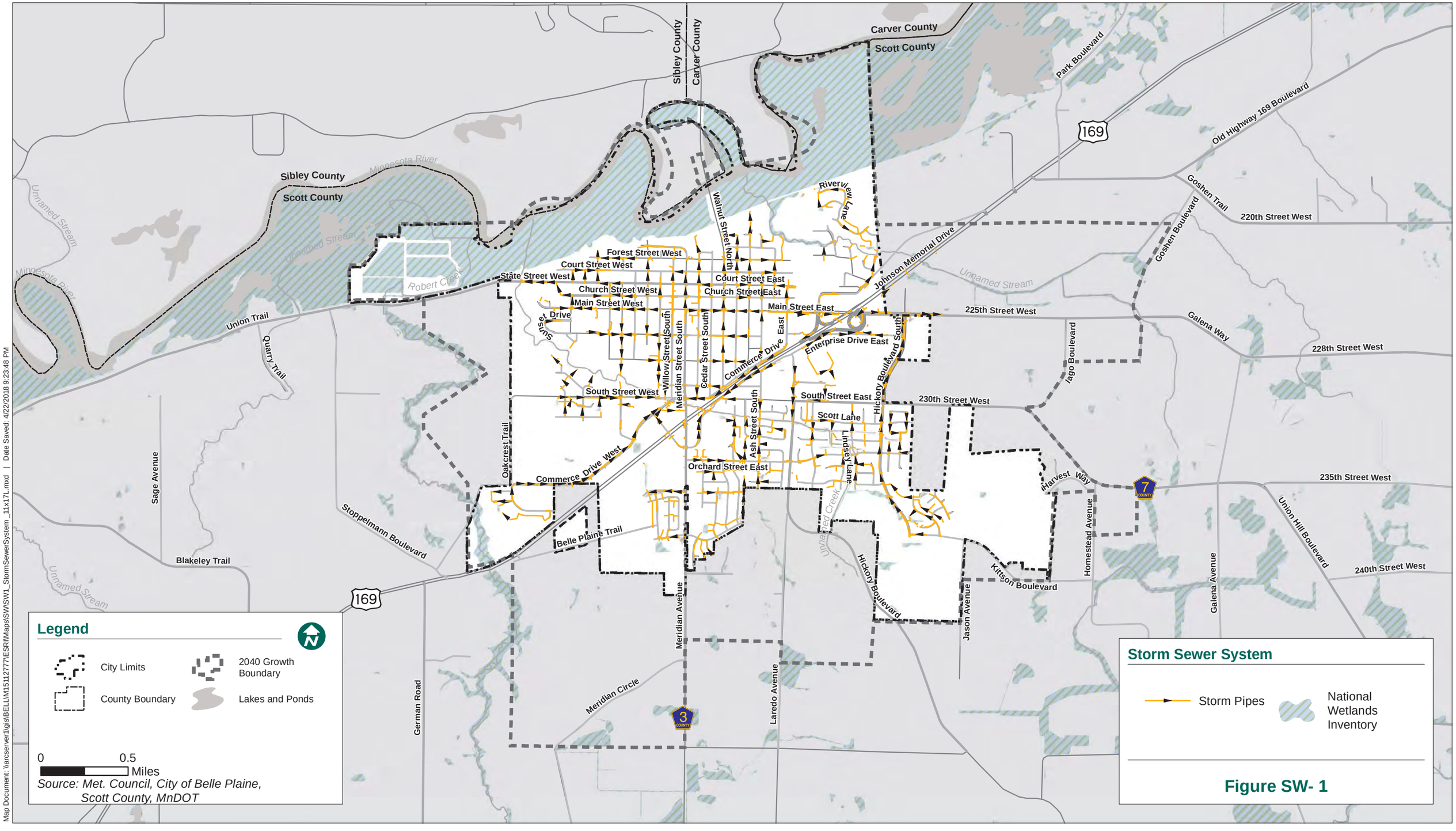
| Table 9 - Implementation Process List Of The Recommended Actions | | | |
|---|---|---|---|
| A storm water maintenance program be enforced to ensure the successful operation of the drainage system. | On-going | City of Belle Plaine | Storm water area charge and monthly storm water utility fee |
| Corrective actions for storm water problem areas | On-going, as problems come up | City of Belle Plaine | Storm water area charge and monthly storm water utility fee |
| The erosion and sedimentation control criteria for new developments be enforced. | On-going, as developments are submitted to the City for approval | City of Belle Plaine | Funding by developer's fees and building permits |
| Low impact development/better site design for new developments be encouraged. | On-going, as developments are submitted to the City for approval | City of Belle Plaine | Developers |
| Conceptual ponding areas be established as development occurs and made a part of the storm water management system. | On-going, as developments are submitted to the City for approval<br>Right of first refusal purchasing at time of sale of property | City of Belle Plaine | Cost sharing with Scott County |
| Standard review procedures be established to ensure all development within the City is in compliance with proper erosion control practices. | Currently in place. Update as necessary. | City of Belle Plaine | Funding by developer's fees and building permits |
| Detailed hydrologic analysis be required during final design of all ponding areas. | Currently in place. Update as necessary. | City of Belle Plaine | Funding by developer's fees and building permits |
| Final high water levels governing building elevations adjacent to ponding areas and floodplains be established as development occurs or when drainage facilities are constructed. | On-going | City of Belle Plaine | Funding by developer's fees and building permits |
| Overflow routes be established and maintained to provide relief during extreme storm conditions, which exceed design conditions. | On-going, as developments are submitted to the City for approval | City of Belle Plaine | Developers |
| An education program for City residents, staff, and development community be implemented. | On-going | City of Belle Plaine | City of Belle Plaine, with help from Scott WMO, DNR, University of Minnesota Extension Service, SWCD, NRCS |

| Table 9 - Implementation Process List Of The Recommended Actions | | | |
|---|---|---|---|
| Amendments to the SWMP be adopted and implemented and the SWMP be updated. | As warranted by future standards or regulations – by 2020 or earlier if needed | City of Belle Plaine | Storm water area charge and monthly storm water utility fee |
| Regulate construction and land uses along the bluff, to prevent erosion. | On-going, as developments are submitted to the City for approval | City of Belle Plaine | Funding by developer's fees and building permits |
| Encourage property owners to retain any areas of native vegetation, to plant species native to the area, protect and improve wildlife habitat and maintain the historic ecological role and appearance of the blufflands along the river. The existing housing developments along bluffs have addressed retention of native vegetation in one of two ways: platting of the property in an outlot and deeding that to the City or through a conservation easement. | On-going, as developments are submitted to the City for approval | City of Belle Plaine | Cost sharing with the County |
| Develop an implementation strategy for Lower MN River TMDL/WRAPS Study. | Once TMDL is formulated | City of Belle Plaine, working with Scott WMO | Scott WMO, BWSR, DNR, etc. |
| Blaha Ravine Improvements to provide treatment and rate control via a rock filtration weir at the upstream end of the ravine and to ravine stabilization. The drainage area to this ravine includes 83 acres of area that discharges via Blaha Ravine to the Minnesota River without rate control or water quality treatment. | When funding is available | City of Belle Plaine, working with Scott WMO | Scott WMO, BWSR |
| Phase II of Chestnut Ravine Improvements to provide treatment and rate control at the bottom ravine downstream of the Phase I improvements completed in 2012. Phase I included ravine repair and storm sewer outlet in Chestnut Street north Forest Street. The drainage area for this ravine includes 155 acres that discharges via Chestnut Ravine to the Minnesota River with limited rate control or water quality treatment. | When funding is available | City of Belle Plaine, working with Scott WMO | Scott WMO, BWSR |

# Appendix A: Figures

# Figure SW- 1 - Storm Sewer System

April 2018

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# Figure SW-2 - Watershed Districts

April 2018

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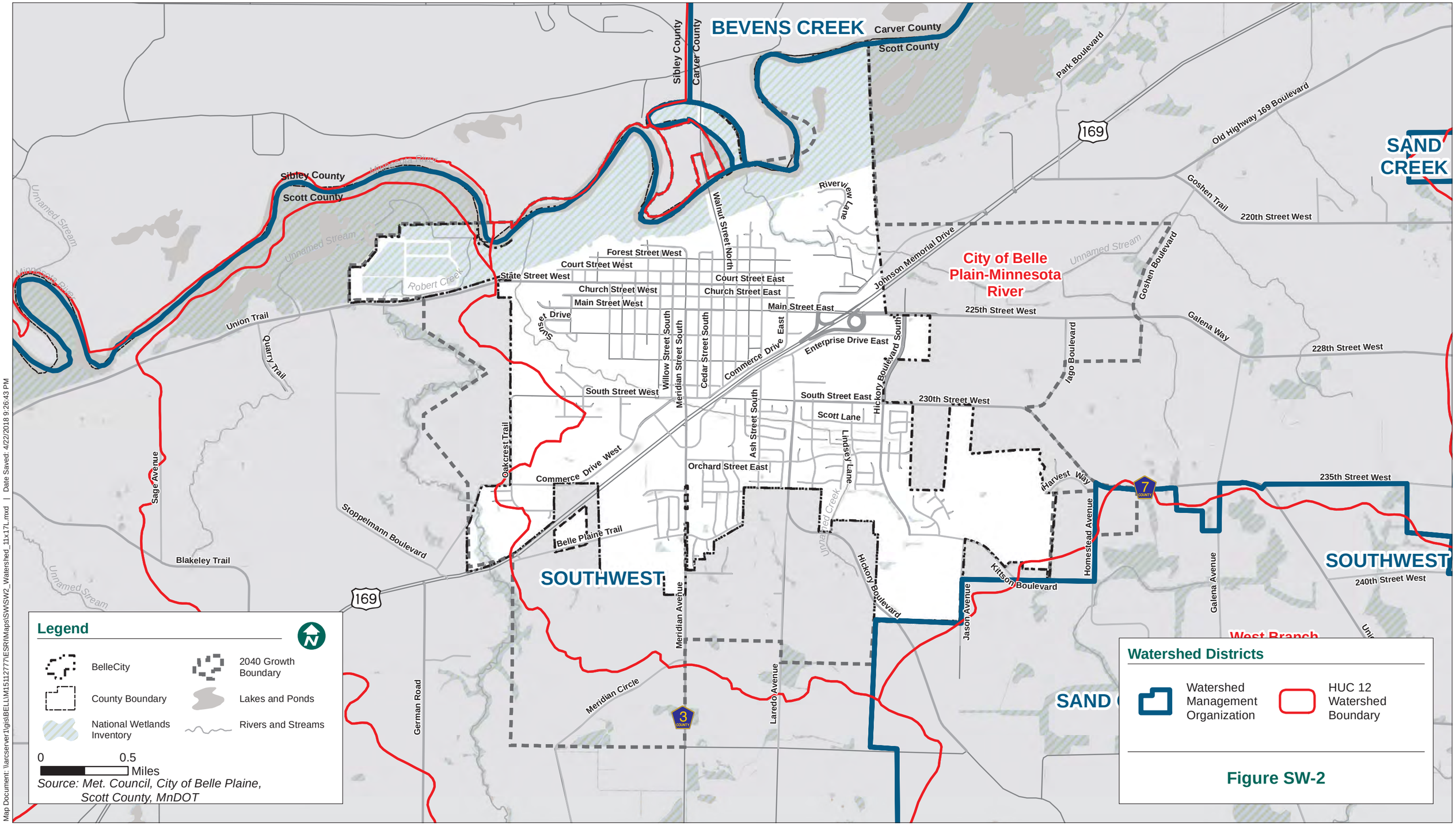


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# Figure SW-3 - Hydrologic Soils

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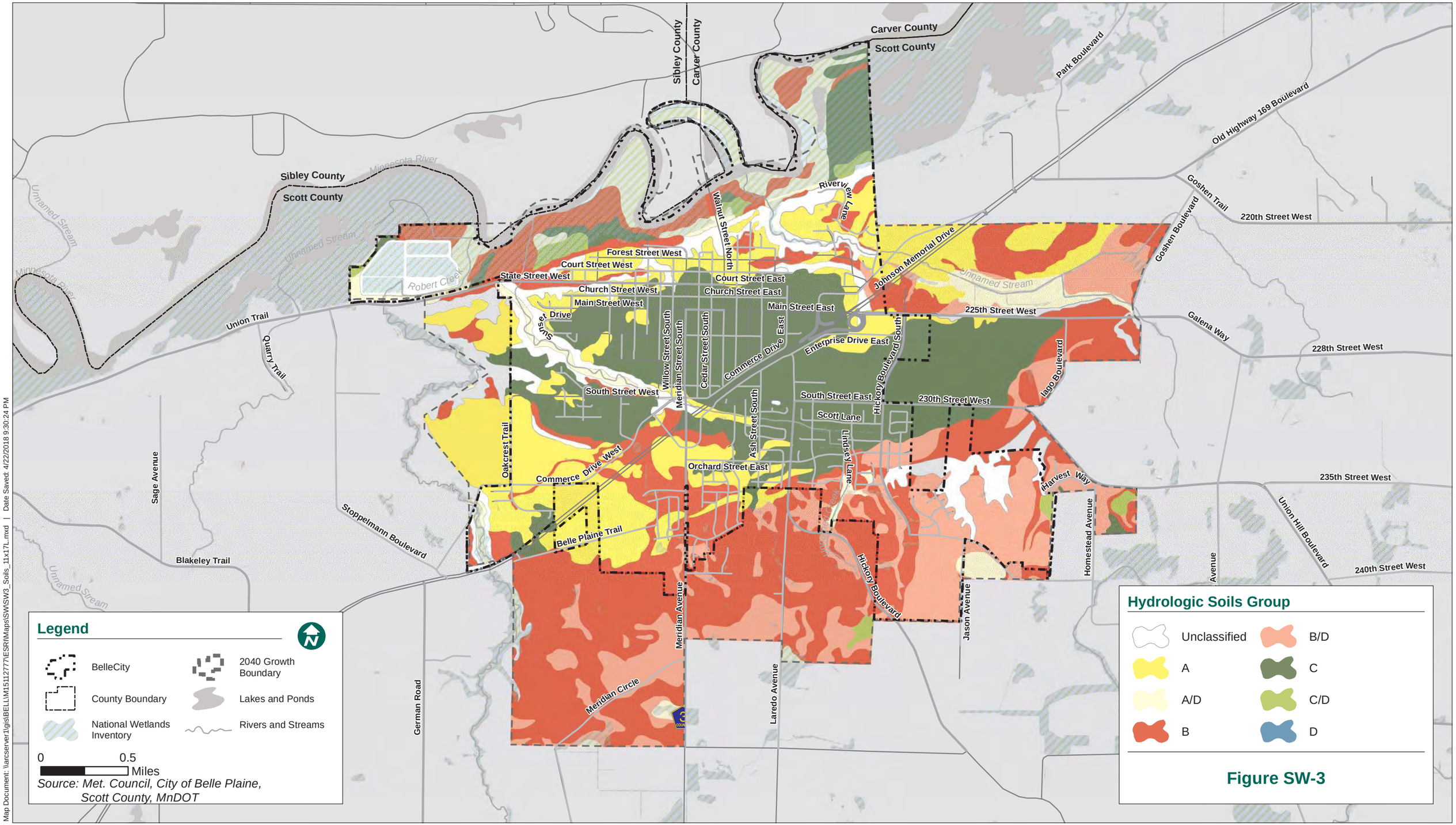


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# Figure SW-4 - Natural Areas, Open Spaces, & RSEA

April 2018

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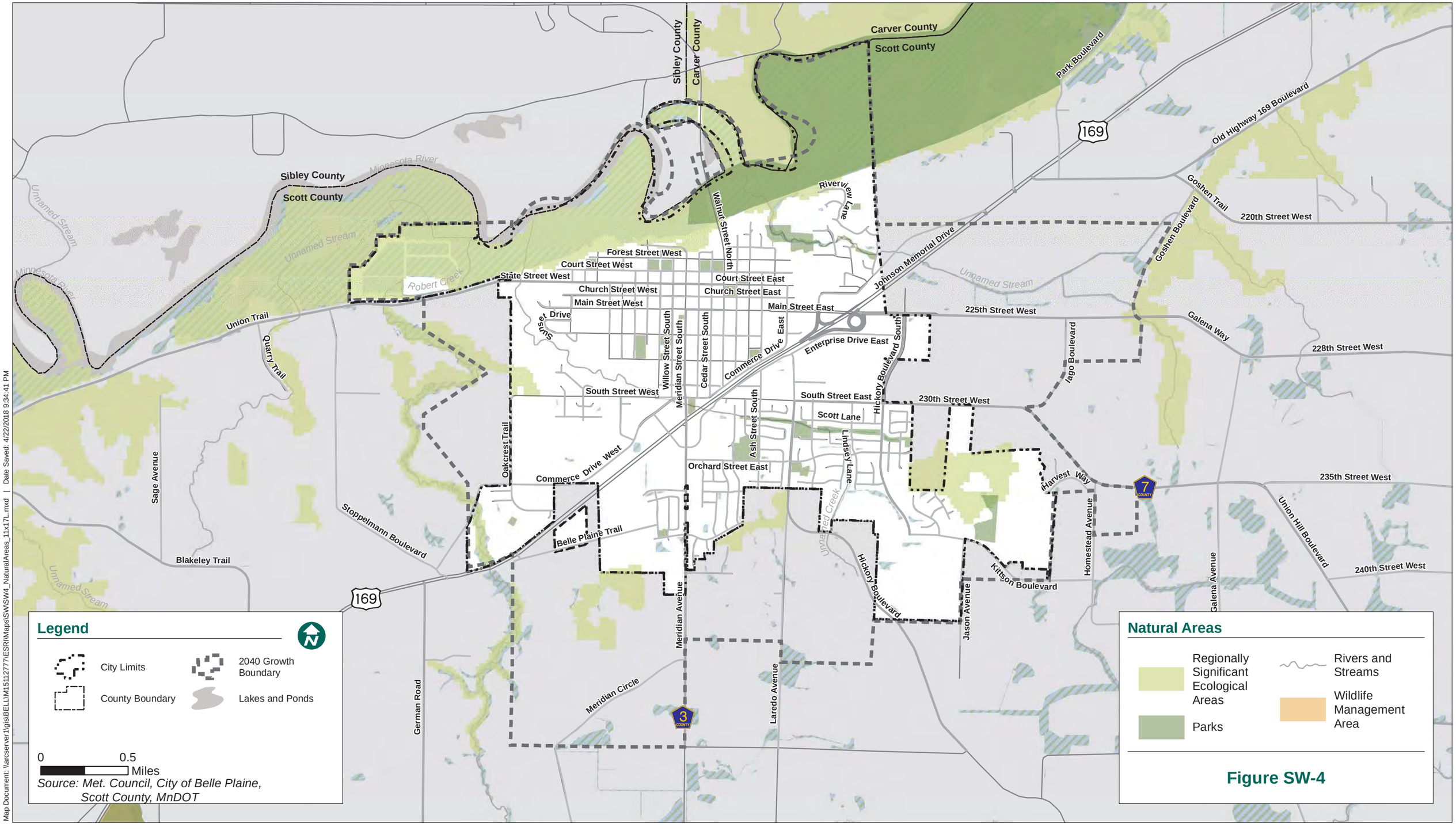


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# Figure SW-5 - Wetlands

December 2018

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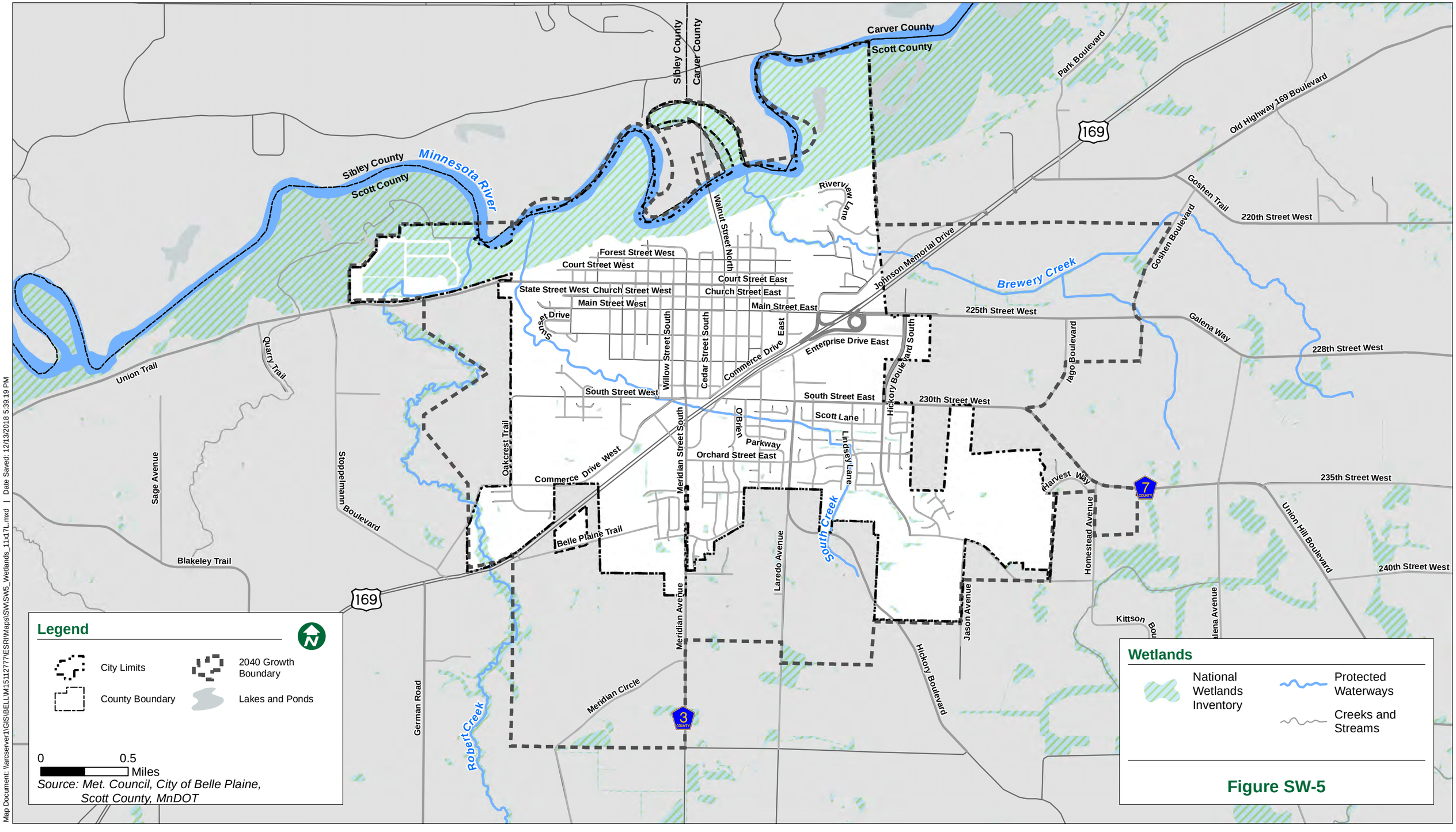


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# 2040 Comprehensive Plan

Belle Plaine, MN

# Figure SW-6 - FEMA Floodplain

April 2018

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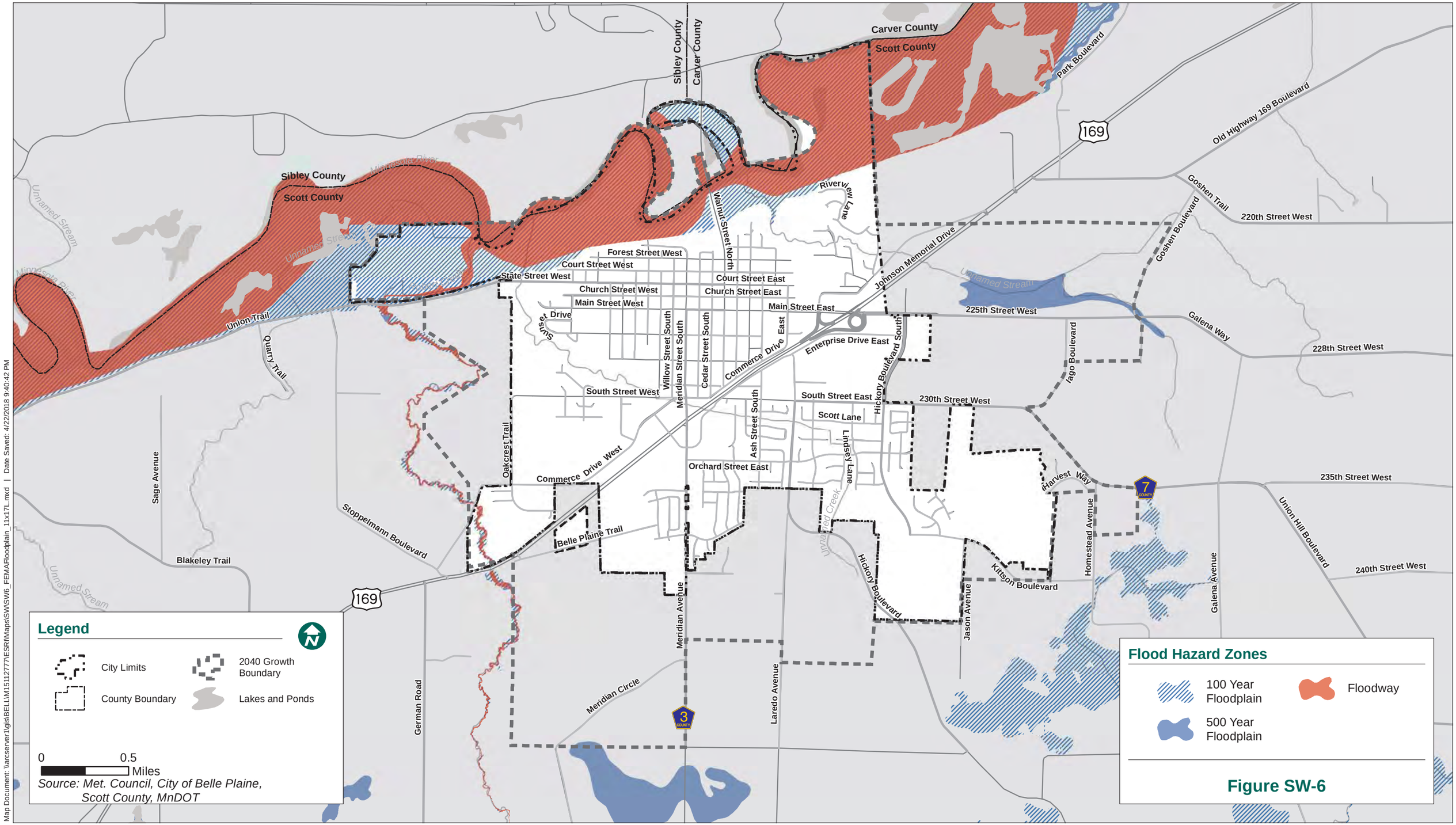


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# Figure SW-7 - Minnesota Land Cover Classification

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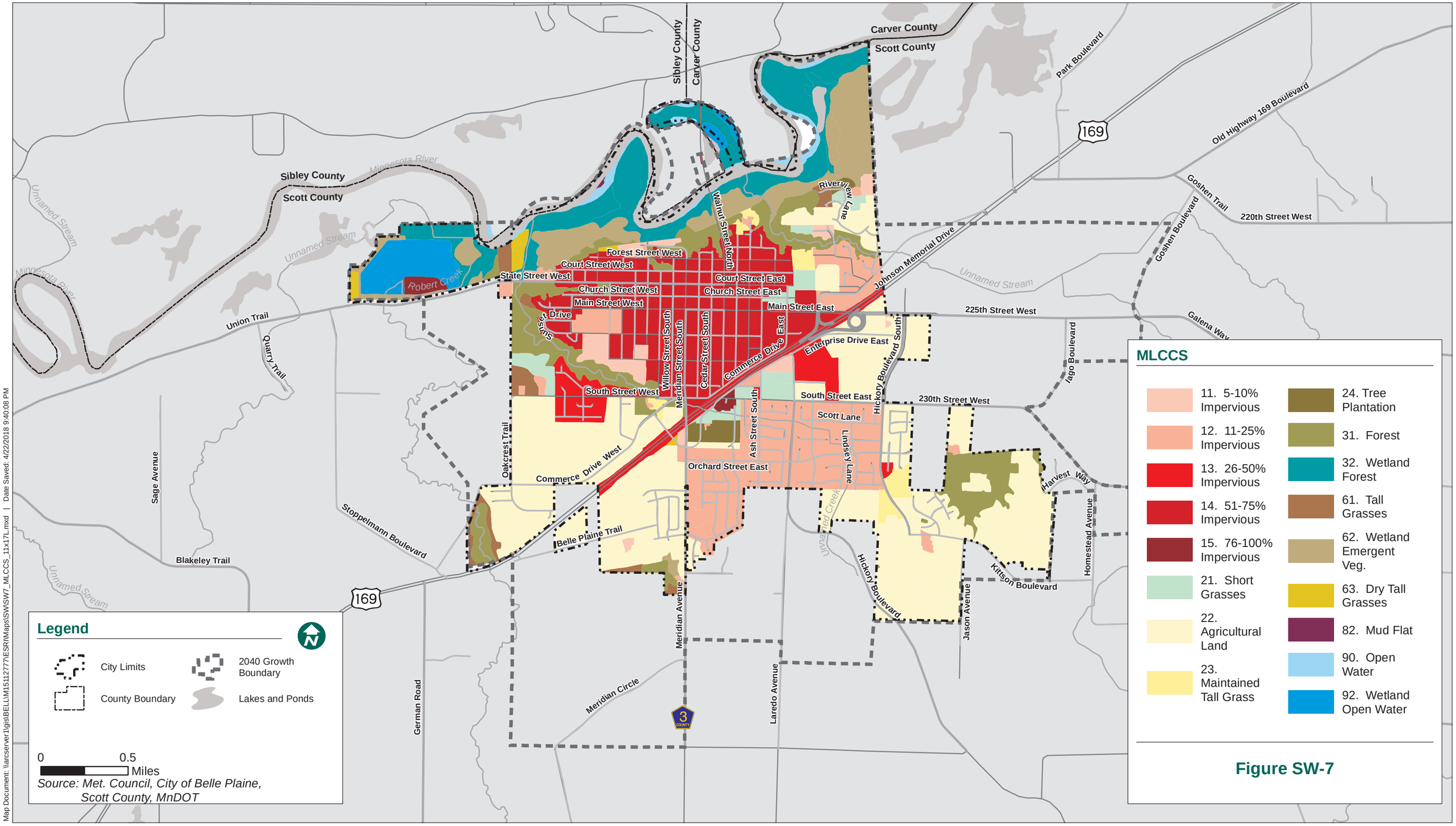


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# Figure SW-8 - Impaired Waters

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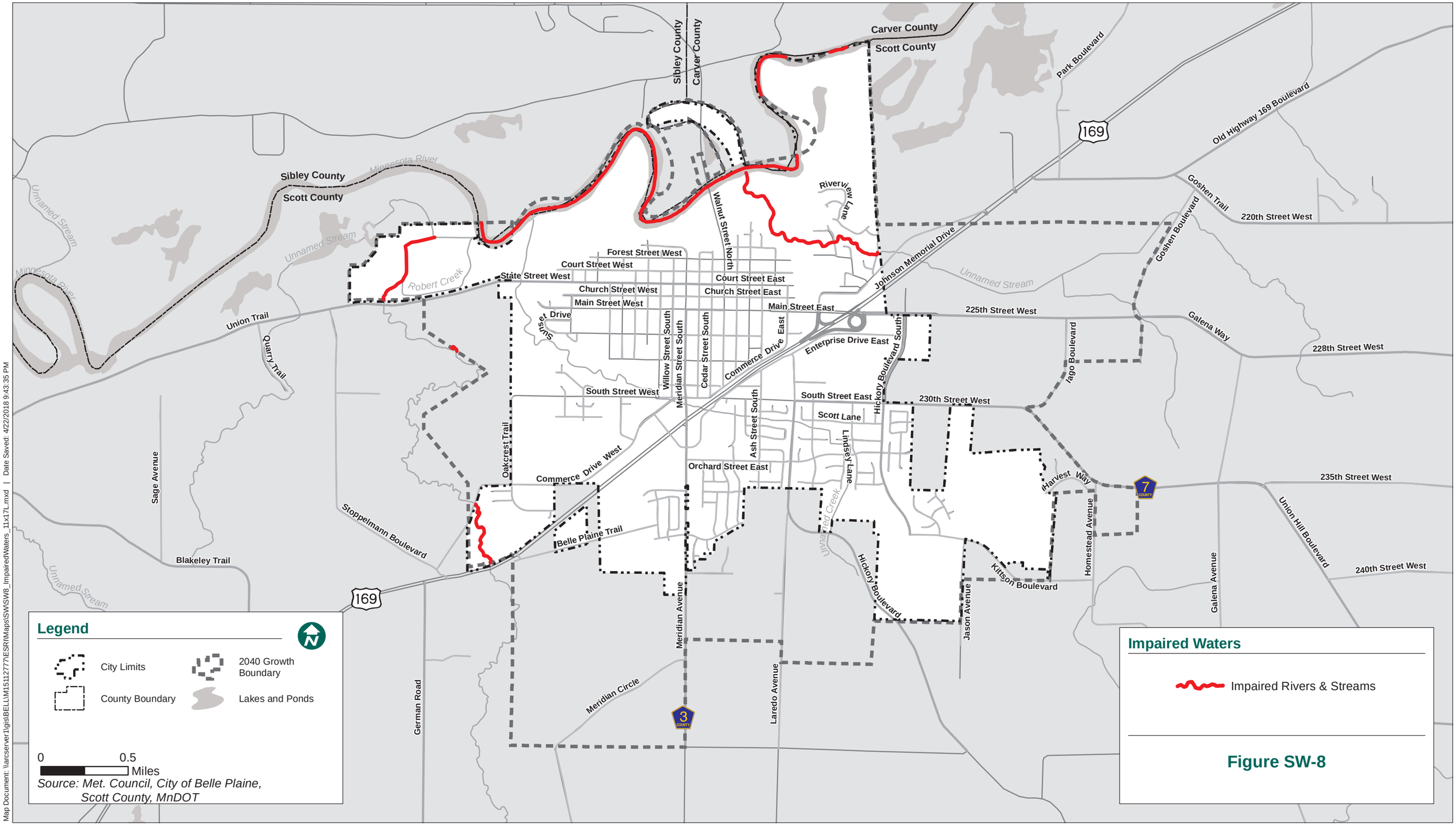


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# Figure SW-9 - Study Area

April 2018

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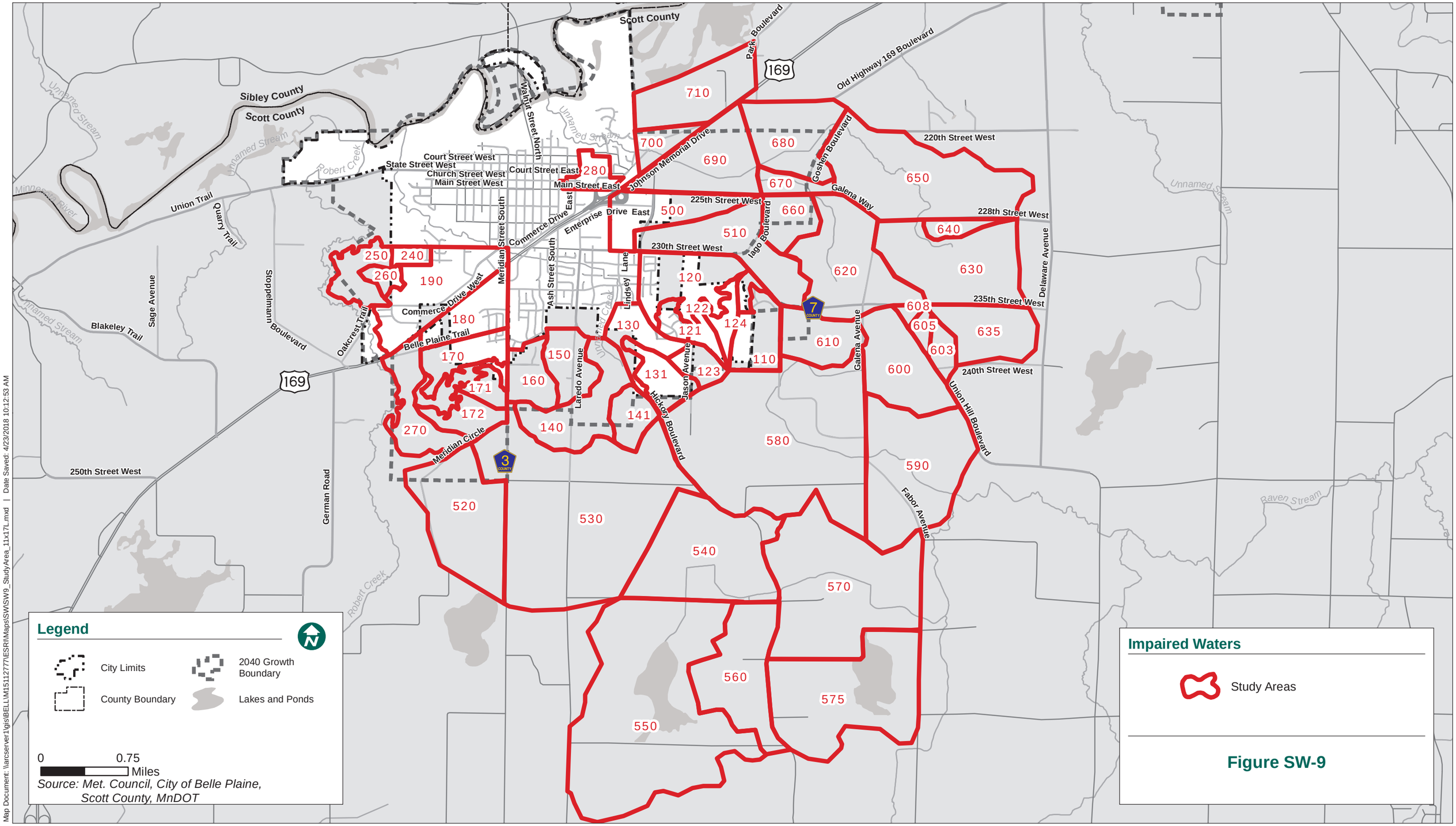


## Legend

- City Limits
- County Boundary
- 2040 Growth Boundary
- Lakes and Ponds

0 0.75 Miles

*Source: Met. Council, City of Belle Plaine, Scott County, MnDOT*

## Impaired Waters

- Study Areas

**Figure SW-9**

Map Document: \\arcserver1\gis\BELL\M1511277\ESRI\Maps\SWS\W9_StudyArea_11x17L.mxd | Date Saved: 4/23/2018 10:12:53 AM

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