# City of Eagle Lake
# Comprehensive Infrastructure Planning Study
### June 2006

# Section 5 – Storm Water Management Plan

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# 1.0 PROJECT INTRODUCTION

This Storm Water Management Plan has been prepared to analyze the effects of continued growth around the City on the existing municipal storm drainage system and to ensure that the effects of growth are not detrimental to the area resources. This plan is also needed to recommend general development policies that are designed to reduce the potential of flooding and storm water pollution associated with the urbanization of the undeveloped lands surrounding the City.

To this end, we have mapped the various major watersheds and their subwatersheds within and around the City as a method of quantifying the effects of various rainfalls on the existing and proposed storm sewer systems. With this quantitative information, we have been able to size a combination of recommended storm water collection system pipes and retention pond sizes.

Most Minnesota cities have existing pipe networks that were originally designed to relieve ponding within the original platted city limits. When these systems were designed, the concern for the downstream properties was not a consideration. This is because the growth of these cities was relatively slow and the increase in the downstream flow rates was negligible. Now the urbanization of cities like Eagle Lake tends to be much more rapid. The effects of unmitigated rapid growth on the downstream systems can be devastating and can lead to legal action against the governing authority.

One of the best methods of mitigating the effects of urbanization is through the construction of storm water detention basins. Originally, these basins were designed like bathtubs in that they drained completely between rainfalls. They simply stored the excess runoff below levels where flood damage occurred until the outlet pipes could take the runoff away.

More recently, the water quality of urban storm water runoff has been a consideration. Numerous studies, most notably one by William Walker Jr. for the Vadnais Lake Area Water Management Area (1987), found that properly sized wet retention basins can effectively remove pollutants through the settling of suspended solids. When properly sized, these ponds can significantly reduce the contaminant levels, including phosphorus, commonly found in urban storm water runoff.

Typically, the most efficient and most economical retention basins serve larger areas. Hence, an effort has been made to locate regional retention ponds as opposed to smattering smaller basins throughout the City. However, topography and available space must provide optimum locations for regional ponds.

The only drawback with regional pond planning is in finding a funding mechanism to purchase the land needed and finding ways to have new development assist in their construction. A classic chicken and egg scenario results. Ideal planning of regional basins includes the purchase of the needed land while constructing the basin using funding generated from area charges on the new developments that generate the excess runoff. Typically, there is a shortage of available funding to plan regional basins ahead of growth. Accordingly, the regional ponding approach may need to parallel proposed developments until such time that pre-development funding is available.

This study attempts to consider the best fit scenario combining both regional and isolated localized development pond designs while constantly monitoring the ultimate effects on the affected downstream properties and resources. Please consider that this report is a planning tool, which must make assumptions relative to types of developments, trends in growth, planning and zoning. It is recommended that each new development be incorporated into the computerized model created for this report as part of the plan review process to ensure that the comprehensive models do not become outdated after the first few developments in and around the City.

Finally, we welcome your comments relative to this report, as it is intended for your use. Therefore, any input you can give relative to the goals and assumptions contained within this report will help us custom fit this report to meet your expectations and visions for Eagle Lake.

## 2.0 SUMMARY OF GOALS

The following goals for the City are:

### 2.1 Water Quality

Maintain or enhance the water quality of the surrounding wetlands and watercourses.

### 2.2 Runoff Management and Flood Control

Preserve, maintain and expand (where possible) the storm water storage and detention systems to control excessive runoff volumes and rates, prevent flooding, protect public health and safety, minimize public capital expenditures, and establish recommended ordinances to address minimum building floor elevations relative to the modeled 100-year flood elevations.

### 2.3 Wetlands

Consider the Minnesota Wetlands Conservation Act in attempting to limit the loss of wetlands and requiring mitigation of wetlands, where affected by growth, in accordance with state law.

### 2.4 Erosion and Sediment Control

Enforce the most recent extension of the 1987 Amendment to the Federal Water Quality Act which includes the NPDES Phase II requirements for Erosion and Sediment Control from Construction sites disturbing greater than 1 acre. This effort is anticipated to protect the existing capacity of the City's storm water management system by:

- Preventing sediment build-up.
- Preventing flooding.
- Maintaining the water quality of the runoff.
- Correcting existing erosion and sedimentation problems.

### 2.5 Groundwater

Protect the quality and quantity of groundwater resources.

### 2.6 Recreation and Habitat Management

Protect and enhance flora and fauna habitat and recreational opportunities.

### 2.7 Education and Public Involvement

Increase public awareness, understanding and involvement in water and natural resource management issues.

### 2.8 Financing

Minimize and fairly distribute public expenditures for plan implementation. The potential local funding mechanisms include:

- A storm water utility charge.
- Development charges.
- Collaborating/partnering with other entities.
- Unforeseen grant opportunities.

# 3.0 MODELING METHODOLOGY AND MAPPING

## 3.1 Hydrological Methodology

The general procedure used in the runoff modeling aspects of this analysis has been performed using the HydroCAD Modeling Software as developed by Applied Microsystems, Inc. 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. The SCS procedure is based on a standard rainfall hydrograph, which is modified by local parameters (i.e., rainfall, soil type, time to peak flow, etc.).

The general methodology used to model the existing flows from the larger agricultural watersheds was to calibrate the SCS peak hydrograph flow rates (as generated by the HydroCAD program) to match the flow rates predicted by the U.S.G.S. regression equations for the same area and probability of occurrence.

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. Retention storage studies are primarily concerned with flow volumes, which 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.

It is assumed that the volume of runoff presented by the SCS methodology is accurate, but that the detail necessary to account for all of the site specific nuances tend to make the estimating process questionable relative to the estimated flow rates. Given this, the SCS tailoring technique should be an effort to elongate the flow duration and dampen the peak flows generated. In keeping with this assumption, the SCS hydrographs were adjusted by increasing the time of concentration of the runoff while maintaining a minimum weighted SCS runoff curve number of 68. In this manner, representative existing system hydrographs were generated for key subwatersheds within each study area.

Once the existing system was calibrated, the agricultural areas were modeled again under fully developed conditions and superimposed onto the existing network so that the effects of continued growth could be studied. Retention basins were then designed and modeled to mitigate the effects of the continued development.

When discussing the drainage and flood control aspects of stormwater management, it is important to draw a distinction between Level of Service (LOS), and Level of Protection (LOP). LOS can be defined as the drainage system's capacity to convey stormwater runoff while preventing flooding of adjacent facilities that would interfere with their normal day-to-day function. In other words, stormwater runoff will be conveyed in street gutters and storm sewer pipes. LOP can be defined as the drainage system's capacity to convey stormwater runoff while preventing flooding that would cause damage to adjacent facilities and threaten the health and welfare of the public. This means that minor flooding may occur, however, overflow storm sewer systems, drainage swales, and ponds prevent flooding of homes and businesses. Typically, storm sewers are designed to accommodate the LOS design event, while ponds and overflow systems are designed to accommodate the LOP design event.

When discussing rainfall design events, it is also important to understand rainfall event terminology. Most individuals are familiar with terms such as "100-year storm", which refers to the recurrence interval, or return period of the storm. From a statistical standpoint, the "100-year storm" can be defined as a storm that on the average would be exceeded in severity only once every 100 years. However, a more accurate definition is to refer to this as a storm that has a 1-percent probability of occurring every year. This definition is referred to as the "annual probability of occurrence". Under this definition, the "100-year storm" would be referred to as the "1% chance storm".

Following is a table showing common recurrence interval storm definitions along with their corresponding annual occurrence definition and the rainfall depths associated with them:

**Table 5.1 – Rainfall Depths per Recurrence Interval**

| Recurrence Interval | Annual Probability of Occurrence | U.S. Weather Bureau's TP-40 Rainfall Depths |
|---|---|---|
| 2yr | 50% | 2.85 inches |
| 5yr | 20% | 3.66 inches |
| 10yr | 10% | 4.30 inches |
| 25yr | 4% | 4.92 inches |
| 50yr | 2% | 5.48 inches |
| 100yr | 1% | 6.12 inches |

For the purposes of this report, we will use the 10% chance storm (10-year storm) for the LOS design event, and the 1% chance storm (100-year storm) for the LOP design event.

## 3.2 General Procedures

The general procedure and scope of this Storm Water Management Plan (SWMP) includes the development of a design document to size and locate future storm sewers, retention 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 storm sewer design procedures. By necessity, the SWMP becomes a very technical document.

### 3.2.1 The following summarizes the major activities associated with plan development:

- The existing City utility and storm sewer mapping was researched to determine existing drainage patterns, culvert locations, and other pertinent drainage features.
- USGS topographic mapping was obtained and correlated with the existing storm sewer utility data to determine and model the existing drainage patterns. Although this is the best available data, the elevation contours on the USGS topographic maps are shown at 10-foot intervals. This leaves a

definite margin for error in the determination of the watershed limits and the parameters used in estimating storm water flows and high water elevations.

- A physical field inspection of key areas of concern was made using topographic mapping and storm sewer data. Field inspection was made to identify recent topography changes and delineate subtle watershed breaks not discernible from, or at variance with, the available topographic contour data. A field inspection was also made to verify culvert crossing and drain tile inlet locations.
- Each minor drainage area, flowing to a collection point, such as a manhole at a low intersection, an existing catch basin, an existing pond, or a natural agricultural low area, was identified and mapped on a master drainage area and topography drawing. Approximately 70 subwatershed catchments were identified as part of this project. This study includes approximately 6,900 acres of the developed and potential development areas around Eagle Lake plus an additional 23,000 acres that drains through the study area.
- All drainage areas were transferred to a GIS compatible computer mapping system. Drainage areas were computed for each subwatershed.
- Interior drainage areas were assigned to a major watershed
- Surface runoff and storm sewer design is dependent upon the permeability of existing surfaces. 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. Based on the subwatershed and route analysis, a proposed future storm sewer piping system was developed.

Preliminary basin sizing was based on the Guidelines recommended by:

- For each prospective retention basin site, SCS TR-20 and TR-55 methods were used to size basins for flood mitigation potential. "HydroCAD" software was used as a watershed modeling tool to assist in retention basin sizing and location.

- The design criteria described in Section 4.0 for this report.
- The Minnesota Pollution Control Agency (MPCA) *"Protecting Water Quality in Urban Areas."*
- The design criterion described in the MPCA General Permit for Authorization to Discharge Stormwater Associated With Construction Activity under NPDES Phase II.
- The Minnesota Board of Water and Soil Resources (BWSR) recommendations for wet retention basins and water quality enhancement.
- Upon final report acceptance, computer file copies of the retention basin "HydroCAD" calculations and mapping files will be generated and furnished to the City of Ealge Lake for use on future final designs.

## 3.3 GIS Mapping

To allow the greatest ease in the use of this report information, Bolton & Menk, Inc. has mapped all of the SWMP information in a GIS system. GIS, or Geographic Information System, is a computerized mapping tool that is becoming commonplace in municipalities across the nation. This tool allows City staff to view a map and query information relative to a location on a map by clicking with the mouse in the area of interest. The GIS database will then list the available information to help the operator find the needed data in a relatively short time. The GIS system is also advantages since the various maps used in the preparation of this plan can be layered to show the information desired on one page.

The map layers included in the GIS compatible system are as follows:

- Watershed Map–Outer Growth Area (Aerial) Figure No. 5.1
- Watershed Map–Outer Growth Area (Topo) Figure No. 5.2
- Watershed Map–Inner Growth Area (Aerial) Figure No. 5.3
- Watershed Map–Inner Growth Area (Topo) Figure No. 5.4
- Drainage Area Map (Aerial) Figure No. 5.5

- Drainage Area Map (Topo) Figure No. 5.6
- Proposed Ponding Improvements Map Figure No. 5.7
- Soil Classification Map Figure No. 5.8
- Hydrologic Soil Classification Map Figure No. 5.9
- National Wetlands Inventory Map Figure No. 5.10
- 100yr Highwater Elev. for Drainageways Figure No. 5.11
- Land Use Map Figure No. 5.12
- Current Storm Sewer System Map Figure No. 5.13
- County Ditches within Growth Area Figure No. 5.14

Reduced maps of each of these layers are attached in Appendix A. The Figure Numbers shown correspond to the numbers shown on the title block of each attached map. The end mapping product will have a significant long-term benefit for the City.

## 4.0 HYDROLOGIC PARAMETERS

### 4.1 Topography

Currently the best availavle topographic elevation mapping for the City of Eagle Lake is the USGS Quadrangle maps with 10-foot contour intervals. The relief for the area encompassed by the City Limits and the areas to the east and west are relatively flat with more pronounced grade in the southern portion of the growth area. These more noticeable grade changes are due to the proximity of the LeSueur River to the southern growth area and the tributaries that wind through our study area. For this study, we have modeled the City as having five major watersheds (East (E), WestCentral (W), North (N), Southwest (SW) and South (S) associated with the various directions of flow and/or means of routing. Figure Numbers 5.3 & 5.4 illustrate these 5 major watersheds. The collection zones throughout the growth area are more specifically described as:

#### 4.1.1 East Watershed

The East Watershed is separated into relatively flat ground with localized depressions on the north side of U.S. Hwy 14, and more rolling hills and ravines to the south. The east watershed encompasses approximately 1,500 acres within the growth area, but collects outer growth area runoff from more than 23,000 acres. 16,000 of these acres flow from Madison Lake/Jurisdictional County Ditch No.12 which drains into the study area from the east. The remaining 7,000 acres flows to the north side of the study area from Eagle Lake. This watershed is routed south beneath Hwy 14 where it flows adjacent to the northeast side of town. Figure Numbers 5.1 & 5.2 show the Outer Growth Area Watersheds. These large Watersheds have significant impacts on the east watershed including the 100 year high water elevation, developable property, locating regional ponds, locating future culvert crossings, subdivision layouts, and many other aspects of development.

### 4.1.2 North Watershed

The North Watershed is made up of approximately 50 acres. All of which is relatively flat. This watershed is made up of two small drainage areas that discharge north beneath U.S. Hwy 14 before flowing to Eagle Lake. From Eagle Lake storm runoff is eventually discharged south back through the City of Eagle Lake where it is incorporated into the East Watershed.

### 4.1.3 West Central Watershed

The West Central Watershed is made up of approximately 1,500 acres, 400 of which is currently developed or platted for development The upper half of the watershed is moderately flat, while the lower half has more rolling hills and low lands/wetlands. The drainage pattern of this watershed is from northwest to southeast. This watershed combines with the east watershed just southeast of the intersection of CR 27 and 211$^{th}$ Street. From here the flow continues south to the Le Sueur River.

### 4.1.4 Southwest Watershed

The Southwest Watershed is comprised of approximately 650 acres, which is currently all undeveloped. This watershed drains to a series of large depressions that are inner connected with a County Tile Line, Jurisdictional County Ditch No. 43. Storm water ponds in these depressions before the county tile line can catch up and attenuate the flows. The County tile line drains from northeast to southwest with multiple tile inlets to capture surface runoff.

### 4.1.5 South Watershed

The South Watershed consists of one drainage area 207 acres in size. The drainage area flows to the center of the catchment where it collects and is routed southeast out of the study area. The drainage area has moderately sloping terrain on the outer edges of the drainage boundary, with gentler sloping flats across it's interior.

## 4.2 Soils

Infiltration capacities of soils affect the amount of direct runoff resulting from rainfall. The higher the infiltration rate for a given soil, the lower the runoff potential. Conversely, soils with low infiltration rates produce high runoff volumes and high peak discharge rates.

For purposes of this report, we have chosen the Soil Conservation Service (SCS) method of classifying soils. The following is an excerpt from SCS Technical Release No. 55 (SCS TR-55) defining the four Hydrologic Soil Groups:

- Type A Soils - Sand, Loamy sand, or Sandy loam. Type A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.3 in/hr).
- Type B Soils - Silt loam or loam. Type B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15 to 0.30 in/hr).
- Type C Soils - Sandy Clay Loam. Type C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05 to 0.15 in/hr).
- Type D Soils - Clay loan, silty clay loam, sandy clay, silty clay, or clay. Type D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist of chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay

layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).

According to the Blue Earth County Soil Survey, the underlying soils in and around the City of Eagle Lake vary in classification from type B to D with noticeable type D soils in low lying wetland areas. See Figure Numbers 5.8 and 5.9 for Soil Classifications and Hydrologic Soil Classification Maps.

Of course, as the City develops and increases the percentage of impermeable surfaces associated with houses and pavement, the soil classification becomes less important. As this occurs, the recommended retention basin network will become a greater factor in the management of runoff.

## 4.3 Land Use

The City of Eagle Lake has developable space in most directions and is limited only by its close proximity to Eagle Lake, floodway corridors, and the area wetlands. See Figure No. 5.12 for the Land Use map in relation to watersheds.

Land use and zoning data is an important factor in estimating surface water runoff. The hard or impervious surface areas associated with each land use greatly affect the amount of runoff generated from an area. The greater the concentration of impervious surface, the more storm water that runs off and at a more rapid rate. Hence, commercial and industrial areas create more runoff than residential because they have more impervious surface. These differences in land use are directly correlated to the SCS runoff Curve Numbers which are used in our storm water models to describe the land use type. Curve numbers normally range from 30-98, with typical residential and industrial values of 84 and 94 respectively, depending on soil type. Please see the SCS RUNOFF CURVE NUMBERS table in Section 6 of this report for further reference.

# 5.0 WATERSHED ASSESSMENT AND RECOMMENDED SOLUTIONS

## 5.1 Runoff Pollution Prevention Best Management Practices (BMP's)

In addition to the recommended Stormwater Treatment, Runoff Pollution Prevention BMP's should be considered both during and after construction. During construction, we recommend that the following BMP's be considered for implementation:

- Temporary Seeding
- Mulches and/or Erosion Control Blankets
- Silt Fence
- Inlet Protection
- Check Dams
- Rock Construction Entrance/Exit
- Bio-Rolls

Although these are temporary BMP's, it is important to include regular maintenance as a condition of their installation to insure effectiveness.

Following construction, we recommend that the following BMP's be considered for implementation:

### 5.1.1 Pavement Management

Includes street sweeping, alternative de-icers, modified sand or salt application rates, snow storage locations, etc.

### 5.1.2 BMP Maintenance

Includes sediment removal and disposal for regional and development ponds. Ponds should be checked visually every spring and should be surveyed every 5-10 years to assess sediment loading and need for dredging. Each pond should be placed in a maintenance schedule, which is updated yearly.

### 5.1.3 Animal Management

Includes leaving a vegetative buffer around retention ponds to discourage geese.

For a further description of these recommended BMP's, see the Metropolitan Council's "*Minnesota Urban Small Sites BMP Manual*".

## 5.2 Regional Ponding

The proposed regional basins are highlighted on the Proposed Ponding Improvements map (Figure No. 5.7). Basins have been generally located in strategic low areas around the community to allow for future development (generally residential). They are intended to protect downstream properties from increased runoff rates and volume, which new development creates, and to enhance water quality. Proposed individual development ponds were not shown because of the multiple site layout(s) and options that could exist.

Key design criteria have been noted on Figure No. 5.7 and are documented in greater detail in the design computations. Upstream basins have been sized to accommodate ultimate watershed development. 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, recommended ordinance, MPCA and BWSR requirements).

The National Wetlands Inventory maps were also reviewed in an effort to site the proposed basins in areas where wetlands are not anticipated. However, field delineation review is recommended prior to detailed design of any proposed basin to ensure there are no conflicts.

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

Preliminary locations of development detention basins are based on available open space and hydraulic requirements. See Figure No. 5.7 for the Proposed Regional Pond Locations. Cursory consideration has been given to land use, development potential, boundary lines, etc. Many of the recommended retention sites are already prone to flooding and would require substantial fill if development were to occur in these locations.

If flood protection and/or water quality improvements are needed in the older, more densely developed portions of the community, such as the originally platted areas, open space for retention basin development would be extremely limited. Throughout most of these previously developed drainage areas, new retention 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 to manage flow and/or flow through skimmer structures to improve the storm water quality and convey it to an area suited for storm water retention.

Further consideration should be given to future development in order to maintain viable and safe flood routing. With this in mind, the proposed ultimate network makes every attempt to utilize the natural drainage routes.

Similarly, the regional basins 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 not need to be a symmetrical depression designed only 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 pipe.

## 5.3 Watershed Specific Assessment and Recommendations

The following is a brief description of the various major watershed areas studied. At present, the descriptions are limited to the potential growth areas around the City of Eagle Lake. The delineated areas and pond numbers described correspond to the numbers shown in the Watershed and Drainage Area Figure Numbers 5.3 through 5.7. The drainage study area has been divided into five separate drainage districts [East (E), North (N), West Central (W), Southwest (SW) and South (S)].

### 5.3.1 Existing System

At present, the existing stormwater management system is performing adequately, with the exception of a low lying area near the north end of Linda Drive. The area is prone to flooding due to the lack of a stormwater outlet. In previous discussions and letters, we have identified the need for a 1-acre stormwater detention pond. Also identified was the need for a 36-inch stormwater pipe outfall for the pond draining to the wetland east of the Prairie Run subdivision. An additional area of concern is drainage along Plainview Street, north of LeSueur Avenue. This area drains west along the north side of the tennis courts and ponds north of the school property. It has been proposed to extend a storm sewer to this area to relieve the drainage problems. It has also been proposed to extend Linda Drive to connect with CSAH 17. The approximate construction cost for these stormwater and street improvements has been estimated at $500,000 to $600,000. This project has been included in the City's Capital Improvement Project for 2007 construction.

### 5.3.2 East Watershed (E)

The majority of the watershed is comprised of wetlands, agricultural land, and a portion within the existing City limits of Eagle Lake. As previously stated this watershed encompasses approximately 1,500 acres within the growth area, but collects outer growth area runoff from more than 23,000 acres. 16,000 of the 23,000 acres flows from Madison Lake and its contributing watersheds through a private ditch. The private ditch flows into the southeast side of the growth area. The remaining 7,000acres flows into the north side of the study area from Eagle Lake. With this amount of area, and in turn runoff flowing through the east watershed, it will be virtually impossible to establish inline regional ponding along the drainageway. Due to NPDES phase II requirements the MPCA would require that the volume of water below the normal water level of any pond be sized to accommodate all water flowing into it. For this reason developments with land on both sides of the drainageways will need to construct at least one detention basin on each side to treat all storm runoff from the development. Although this hampers the use of an inline regional pond, it does not hamper the use of a regional area for ponding. We may not be able to have a single pond, but it is possible to have multiple ponds straddling a creek to create the advantages of regional ponding.

Although regional ponding is the recommended practice for storm water management, it will not be conducive to all areas of the east watershed due to topography and drainage patterns. Please see Figure No. 5.7 for the proposed regional pond locations. Even though some areas do not set up perfectly for regional ponding it is still recommended to collect as much development at as few locations as possible to conserve land and funding resources. This should be a goal for all developments.

With these major drainage corridors flowing though the east watershed, it will be extremely important to maintain their natural features and flood carrying capacity. Alterations to the drainage ways should be kept to a minimum. This also includes new culvert crossings. Any new crossings, with the exception of full span bridges, create energy loss which cause upstream flows to rise. As mentioned this energy loss can be minimized by full span bridges or extremely large box culverts which are both costly. Some rising of stream flow may be allowed due to an agreement with the affected property owners, an easement agreement, or if the increase in water surface elevation has no adverse affect or increase for potential property damage. This issue will need to be evaluated on a case by case basis. Recommended ordinances and current FEMA regulations will also help preserve the natural flood carrying capacity of the drainage corridors. See Section 6 for recommended policies and Figure No. 5.11 for the 100 year highwater elevation of Eagle Lake's major drainageways.

### 5.3.3 North Watershed (N)

The north watershed is comprised of two small watersheds that drain north beneath U.S. Hwy 14 and into Eagle Lake. Eagle Lake then discharges back south beneath Hwy 14 and into the east watershed. The drainage areas within this watershed should be served by development ponds. Special care should be taken during the design and review process of these areas because of their proximity to Eagle Lake. It is recommended to double the MPCA Water Quality Treatment Volume from 0.5 inches over the new impervious area to 1.0 inch. The Water Quality Volume, as defined by the MPCA, is the volume of storm water created by a new project that is required to be treated in a permanent storm water management system, usually a treatment basin, as required by the NPDES Storm-Water permit. Increasing the amount of treated runoff will help insure Eagle Lake is preserved as an amenity for recreation and for the plants and animals that utilize the lake.

### 5.3.4 West Central Watershed (W)

The West Central Watershed is comprised of approximately 1,500 acres and is for the most part self contained with very little runoff from area outside the study boundary. This watershed is split into an upper and lower half by existing development which lies at the midpoint of the watershed. The upper half is dominated by relatively flat land utilized for agriculture with a multitude of wetlands. Of the nine drainage areas in the upper portion, only drainage area W317 sets up for regional ponding. The remainder of the drainage areas are either laden with wetlands, too small to support regional ponds, or are outside our growth area. Since drainage area W317 has contributing area outside its boundaries, it is recommended the regional pond for this area be split. This will ensure that the existing drainage way is maintained and that the ponds won't have to be oversized to accommodate offsite drainage. Please see Figure No.5.7 for the approximate location along the west side of 598$^{th}$ Avenue.

In conjunction with the regional pond in area W317, it is recommended to set aside a greenway corridor along the drainageway from 598$^{th}$ Avenue west 1,650 feet to where the drainage ditch splits. The greenway corridor would serve the following purposes:

- It will preserve flood capacity for the upstream watershed.
- This drainage way, through the corridor, would serve as the storm water conveyance system as opposed to more costly piping.
- This corridor can double as a recreational area for parks, sports fields, walking and biking trails, etc.

The lower portion of the West Central Watershed is dominated by two large drainage areas. These two drainage areas area labeled W339 and W340. Within these areas lay a large semi-connected wetland complex that is approximately 1000 feet by 3000 feet in size. The size and location of this wetland limits the use of regional ponding. This portion of the West Central Watershed is more conducively set up for development ponds where topography allows.

### 5.3.5 Southwest Watershed (SW)

The southwest watershed is comprised of approximately 650 acres, which is currently all undeveloped. This watershed drains to a series of large depressions that are inner connected with a County Tile Line, Jurisdictional County Ditch No. 43. During large rainfall events storm runoff ponds in these depressions before the county tile line is able to attenuate the flows and draw down the ponded water. Drainage areas SW101, SW102, SW104, and SW105 drain into, what is like a bath tub with a small drain and high side walls. If this drain were to plug there would be no outlet until water ponded to an elevation of approximately 997.00. This would mean 9 feet of ponding across this vast depression. To model an area such as this, with no Emergency Overflow (EOF), we have run back to back 100year rainfall events to establish a ponding elevation. The approximate ponding elevation for this area is 994.0 feet. Please see Figure No. 5.11 for the estimated ponding boundaries and location. The area below this contour should not be filled or built in, to protect homes, property, and to keep the High Water Elevation from rising.

To maintain the 100yr HWL it is recommended to consider the land below the 994.0 contour as green space for recreational use and periodic ponding. All new developments will need to treat their storm water runoff for quality prior to discharging into the depression, but not for rate control, since this large depression already accomplishes that.

Drainage area SW103 will work much the same way, since it drains to a depression without an apparent EOF. This drainage area is part of the same tiling system as the rest of the southwest watershed system, but is isolated via overland drainage. It is also recommended that all land below the 999.0 contour be considered green space for recreational use and storm water retention. The approximate boundary of this ponding is illustrated on Figure No. 5.11. Rate control will not be required for developments around this drainage area just water quality treatment.

Close attention should be placed on any development occurring in this watershed. For any increase in runoff volume, without reciprocating action, will raise the high water level.

If more developable land within this region is needed, there is opportunity to lower the highwater elevation by excavating a pond along County Road 86. Constructing a pond would increase storage volume and in turn decrease pond bounce. Type, location, size, and rate of development will dictate the viability of this option.

Please review the recommended policies portion of the report, which will discuss more ordinances and regulations affiliated with these two depression.

### 5.3.6 South Watershed (S)

The south watershed is a single drainage area that flows from northwest to southeast. Once storm water reaches the southeast boundary of the watershed it continues south between natural rolling ridges before flowing into a private ditch. Here it maintains it's course south and eventually runs beneath CR 27 and finally into the LeSueur River. The watershed is currently utilized for agricultural use and appears well drained. This watershed could be set up with one regional pond, but more realistically would have at least two basins to accommodate development phasing. It should be noted that the downstream regional pond is currently outside the study area. Please see Figure No. 5.7 for regional pond locations.

# 6.0 RECOMMENDED ORDINANCES AND POLICIES

## 6.1 Recommended Ordinances

**6.1.1** The post development runoff from all new subdivisions shall be limited to the rates estimated to be generated by the existing conditions for the 2-year, 10-year, and 100-year, 24 hour rainfall events (2.85, 4.30, and 6.12 inch respective rainfall depths). These rainfall amounts should be considered minimums. For a more complete list, please see the Recurrence Interval Table in Section 3.1.7 of this report.

**6.1.2** All hydrological analysis shall be computed using SCS TR 20 or SCS TR 55 methodology.

**6.1.3** SCS runoff curve numbers (CN) shall follow the values established in the following table.

**Table 5.2 – Recommended SCS Runoff Curve Numbers (CN)**

| Landuse Type | Hydrologic Soil Classification | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Low Density Residential | 80 | 83 | 86 | 90 |
| Medium Density Residential | 82 | 85 | 88 | 91 |
| Limited High Density Residential | 85 | 88 | 90 | 92 |
| High Density Residential | 85 | 88 | 90 | 92 |
| Commercial | 89 | 92 | 94 | 95 |
| Light Industrial | 88 | 90 | 92 | 94 |
| Heavy Industrial | 90 | 92 | 94 | 96 |
| Park | 45 | 65 | 74 | 80 |
| Public/Semi-Public | 55 | 68 | 74 | 80 |
| Existing Stormwater Ponds | 98 | 98 | 98 | 98 |
| Agricultural | 64 | 72 | 76 | 80 |
| Grasslands | 30 | 58 | 71 | 78 |

These values should be considered maximum values in existing hydrological models and minimum values in proposed.

**6.1.4** Post development runoff rates shall be controlled using wet retention basins that are designed with the following requirements:

- The permanent pool depth should be at least 4 feet and no more than 10 feet.
- All ponds should meet or exceed all design requirements set forth by Minnesota's NPDES/SDS General Storm-Water Permit for Construction Activity, which is administered by the MPCA.
- The pond should have a safety bench extending from the edge of the water into the pond a minimum distance of 10 feet with a maximum slope of 10:1 (i.e., the pond should be no greater than 1 foot in depth within 10 feet of the shoreline.
- The maximum pond slopes above the safety bench should be no greater than 4:1 (horizontal to vertical) and no greater than 3:1 (horizontal to vertical) below the safety bench.
- The pond outlet structure shall not be closer than 50% of the pond length from the pond inlet to prevent short-circuiting.
- The pond outlet structure shall be designed to skim and prevent floating debris from leaving the pond.
- All pond shall be designed with an armored Emergency Overflow (EOF).
- All ponds shall be designed to….

  …maintain 1 foot of freeboard from the 100yr frequency post development bounce elevation to the top of the pond.

  …contain the 100yr post-development bounce elevation beneath the EOF.

  …contain the entire pond within a platted outlot owned by the City. An entire pond is defined as 1 foot above the EOF.
- Wetland impacts should be minimized at all times.
- All wetlands should have a 20' vegetative buffer.

- All wetlands, along with their 20' vegetative buffer, shall be placed in outlots.
- Lowest opening of all homes shall be no lower than 2' above the elevation of the 100year frequency flood, or 1' above the 100year back to back frequency flood for isolated depressions without EOFs.
- Lowest openings of all homes shall be no lower than 1' above EOFs.
- Construction entrances/exists shall be placed at all construction site access points.
- Garage floor elevations for residential houses shall be not less than eighteen (18) inches and not more than thirty-six (36) inches above the grade of the crown of the street. Exceptions to this standard may be approved by the zoning administrator for special circumstances such as increased setback, site topography, flooding potential and the like, provided that proper site and area drainage is maintained and the elevation of the structure is in keeping with the character of the area.

## 6.2 General Recommendations

A general recommendation for the undeveloped areas around Eagle Lake is to require the developers to submit a storm water management plan as part of any future plats in the vicinity. We have reviewed hydrologic information for new developments in the past, but without a formal list of required submittal information. Below is an outline of the required submittal information for a general storm water management plan. Additional site specific information may be required to properly evaluate the site.

**HYDROLOGICAL REVIEW CHECKLIST**

Maps
- Site Location Map
  - Preferably on a USGS Topographical Quadrangle Map showing nearest tributaries
- FEMA/FIRM Map
- Existing Drainage Map
  - On-site contours to be at a minimum of 2-ft intervals; off-site contours to be at a minimum of 10-ft contours
  - Show delineated drainage areas as defined in the existing hydrological model
- Proposed Drainage Map
  - On-site contours to be at a minimum of 2-ft intervals, Off-site contours to be at a minimum of 10-ft contours.
  - Show delineated drainage areas as defined in the proposed hydrological model.
- Wetland Map
  - Outline existing wetlands (with setbacks) and label delineated areas.
  - Show all proposed changes to wetlands (destruction and proposed wetlands.)

Plans and Reports
- Existing Hydrological Model (must use SCS methodology)
  - Provide the modeling results from the 2-yr, 10-yr, and 100-yr rainfall events. (Please note that wetlands must be modeled if present.)
- Proposed Hydrological Model (must use SCS methodology)
  - Provide the modeling results of the 2-yr, 10-yr, 100-yr, and 10" rainfall events. (Please note that wetlands must be modeled if present.)
  - Provide details of the pond outlet structures.
  - Provide a profile view of all ponds (with side slopes, etc.)
  - Note that ponds should have one foot of freeboard on the 100-year storm before utilizing the emergency overflow.
  - Provide a table contrasting existing and proposed off-site discharge
- Wetland Delineation Report
  - Submit Wetland Delineation and Mitigation Report (if applicable.)
- Storm Water Pollution Prevention Plan (SWPPP)
- Erosion Control Plan
- Storm Sewer Plan
- Using a 10yr frequency storm, provide a drawing of the storm sewer layout with pipe sizes and grades as well as the calculations used to determine pipe sizing.

It is recommended that this information be placed in the City ordinances as required submittal information for a pre- and final plat. Review and implementation of comments and questions should come at the developers expensive.

Even though developments may meet the requirement of throttling back flows to meet the pre-development rates, a development may release a greater amount of volume that may or may not adversely create downstream impacts. Another scenario may be that a multitude of small, piece meal, developments are constructed with retention ponds that may elongated peak flows that could coincide creating a larger rate of flow than previously seen. Because of this, we recommend that any subdivision/development ordinance reserve the right of the City, to require more restrictive outflow conditions, to ensure the City retains the ability to implement comprehensive improvements associated with piecemeal developments and volume concerns. Having this ordinance, along with maintaining the comprehensive storm water model and requiring hydrological reviews, will help ensure that downstream properties are not adversely affected.

## 6.3 Recommended Citywide Policy

In addition to the recommended ordinances controlling new developments, there are also several general considerations that can be implemented on a Citywide basis. They include the following:

**6.3.1** Implementation of regional storm water basin approach – Regional storm water facilities can reduce discharge rates and act as surge basins for larger storm events and accommodate large drainage areas when properly designed and located in a watershed. Even though it is not always possible to implement regional ponding, it is recommend that the City's Storm Water Management Policy be to strive for regional ponding as the first option.

**6.3.2** Buffer Areas - The establishment of buffer areas along existing and future drainage ways, wetlands, and streams to provide filtration of sediments and pollutants in storm water runoff and stabilize stream banks against erosion.

**6.3.3** Preservation of Existing Wetlands - Existing wetlands provide natural water quality ponding for storm water runoff. Wetland impacts should be mitigated to provide replacement of water quality functions within the watershed. If wetland banking is accepted outside the area, perhaps an increase in water quality ponding is warranted.

**6.3.4** Areas with moderate to highly erodible soils may require permanent BMPs. Proposed developments within areas containing highly erosive soil units should include permanent BMPs to minimize chronic erosion problems. Additional conservation practices may be required at the discretion of City staff.

**6.3.5** All permanent storm water management devices should be owned, operated, and maintained by the City. At a minimum the City should have permission and/or an easement to operate and maintain all permanent storm water management devices. The downfall of not having the right to operate and maintain these areas is that these areas will never be monitored, maintained, or updated. Another pitfall is that these areas may be altered from their original design to better fit an individuals needs as opposed to the needs of the community. Permanent storm water management devices include, but are not limited to, detention, retention, and treatment basins, infiltration/filtration basins, grit chambers, grassed swales, ditches, wetlands, and regional ponds. All permanent devices that are not currently under the jurisdiction of the City, either by ownership or easement, should eventually be. Having jurisdiction on all permanent devices will enable the City to inspect, operate, and maintain storm water management on a City wide basis.

## 7.0 COSTS AND FUNDING

### 7.1 Costs

As with all improvements, there is a cost associated with prudent storm water management. To that end, we have prepared a cursory estimate of the costs for:

- The mainline storm sewer pipe construction to deliver the runoff to each regional pond.
- The actual pond construction.
- The turf restoration.
- The piped outfall construction.
- A 10 percent contingency factor.
- Estimated engineering services.

The costs associated with each growth area as well as the average costs over all of the proposed development areas has been tabulated and averaged to determine a recommended city-wide development charge ranging from $1,500 to $2,000 per acre of new development. The rates for this charge could be associated with the zoning, usage, and the estimated amount of impervious surface.

As with all estimates of this nature, they are based on current construction costs and should be adjusted annually to account for inflation, bonding costs, legal costs, interest costs, etc. Land acquisition costs should also be added to any area development charge.

## 7.2 Funding

For this report we recommend two forms of funding for storm water management and maintenance. These two forms of funding are a storm water utility and/or a storm water development charge. Information regarding these funding options is as follows.

### 7.2.1 Storm Water Development Charge

Many cities are beginning to use a storm water development charge. This is a charge that asks new developments to pay a fee on a per-acre-developed basis. The fee is usually based on the cost of conveyance piping to the various regional ponds as well as a prorated share in the land purchase and construction of the regional basin. Of course, this assumes the City has already arranged for the purchase of the land where the regional basin is planned. Once again, securing a first right of refusal agreement seems to be the best option to secure the land rights in the vicinity of the proposed regional ponds without the need to make the up front expenditure.

It is recommended that the City consider the establishment of a storm water development charge to be applied to developing areas within the three study areas. The city attorney should be consulted as to the legal process for creating and implementing the storm water development charge.

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. As can be seen from the table, the costs can vary throughout the system depending on the area and topography of the development.

**Table 5.3 - Projected Regional Pond Costs**

| POND LABEL | PROPOSED STORM SEWER MAINLINE STUB (10YR) (IN) | LENGTH (FT) | UNIT PRICE ($/FT) | SUBTOTAL | POND VOLUME (CY) | $/CY ASSUMED $3.00 SUBTOTAL | DOES NOT INCLUDE LAND ACQUISITION IF REQUIRED **TOTAL** | AREA SERVED (ACRES) | $/ACRE |
|---|---|---|---|---|---|---|---|---|---|
| 102Da | 60 | 1000 | $160 | $160,000 | 52756 | $158,268 | $318,268 | 110 | $2,893 |
| 102Db | 48 | 750 | $100 | $75,000 | 22425 | $67,276 | $142,276 | 50.3 | $2,829 |
| 102Dc | 60 | 1600 | $160 | $256,000 | 20167 | $60,500 | $316,500 | 100 | $3,165 |
| 201Da | 54 | 900 | $130 | $117,000 | 49852 | $149,556 | $266,556 | 94 | $2,836 |
| 201Db | 60 | 1100 | $160 | $176,000 | 59371 | $178,112 | $354,112 | 114 | $3,106 |
| 317DEV | 84 | 1500 | $310 | $465,000 | 131809 | $395,428 | $860,428 | 311 | $2,767 |
| 501DEV | 78 | 1600 | $270 | $432,000 | 137779 | $413,336 | $845,336 | 219 | $3,860 |
| 502DEV | 72 | 1100 | $230 | $253,000 | 98736 | $296,208 | $549,208 | 168 | $3,269 |
| 515Da | 42 | 500 | $70 | $35,000 | 22748 | $68,244 | $103,244 | 40.9 | $2,524 |
| 515Db | 54 | 1000 | $130 | $130,000 | 47916 | $143,748 | $273,748 | 93 | $2,944 |
| 518DEV | 78 | 1700 | $270 | $459,000 | 141973 | $425,920 | $884,920 | 277 | $3,195 |

**AVERAGE COST PER ACRE = $3,035**

The average cost per acre of $3,035 is an average cost if the City were to fund, build, and maintain the pond. It should be noted that the average cost per acre is slightly higher than the recommended development charge of $1500 to $2000. This is because the City will not be the responsible party for construction and funding every storm water pond. Although the City is not funding every pond, the City will retain some sort of ownership or responsibility for maintaining the these ponds, as well as the storm sewer infrastructure, which should necessitate a fee.

One drawback with regional pond planning is in finding funding to purchase the land needed and finding ways to have new development assist in their construction. A classic chicken and egg scenario results. Ideal planning of regional basins includes the purchase of the needed land and constructing the basin using funds generated from area charges on the new developments generating the excess runoff. The problem occurs because the purchase rights for the needed regional pond land should be secured before the development occurs. Hence, development fees are collected after the fact. This is where storm water utilities can be useful.

### 7.2.2 Storm Water Utility

Storm water utilities are currently being implemented by cities of all sizes. The primary reason for this is the difficulty associated with other forms of assessing benefit. In cities without storm water utilities, distribution of costs is typically done by one of the following methods:

- Direct assessment to those in a contributing watershed.
- Establishing a watershed district for the distribution of improvements within the district.
- Eliminating storm water assessments altogether and using general funds to finance storm sewer improvements.

Although direct assessments can work, there are scenarios where assessments are distributed unfairly. For example, a city may embark on a large storm sewer project in phases over a significant number of years. Storm sewer improvements are best started on the downstream end of the project so that there is an adequate outlet for the ensuing improvements. The problem is that the benefiting watershed shrinks with each extension. The result is that the uppermost parts of the watershed pay for all phases of the improvements while the downstream land owners may pay for only the first improvement phase. Further, there may be no increase in property value associated with the improvement, which puts the viability of the assessments in jeopardy.

Because of the inequities associated with using a direct assessment process, many cities have opted to define a watershed district and to uniformly assess the entire district for each improvements. Under this scenario, an improvement hearing is required for each improvement phase. The problem is that once the downstream portion is fixed, the downstream parcel owners are no longer interested in paying for upstream improvements. They may even argue that the proposed upstream improvements will deliver more water to their area.

Using the general fund is a reliable alternative, but it means that a city's mil rate must be set high enough to accommodate the need. Also, the mil rates are based on property values and not on the amount of runoff generated.

Storm water system maintenance is also a significant issue that is typically financed through the city's general fund. If assessments are planned for maintenance, it involves a public hearing. It would also be difficult to prove benefit.

Maintenance costs are steadily increasing and are anticipated to increase even more through new developments. The new construction storm water permits encourage water quality ponds where more than one acre of new impervious surfacing is created. All of these ponds will need to be maintained to ensure that sediment removal is occurring as designed. Eventually the collected sediment will need to be removed adding cost to maintaining the storm sewer system.

A storm water utility is the most logical method of accommodating these needs. This is because it works similar to a water utility in that there is a monthly charge and a consistent funding stream. Most cities work to allocate the fees in a consistent manner that gives credits for private ponds and increases charges for larger areas of impervious surfaces. The easiest way to do this is by looking at the zoning regulations and charging various parcels based on parcel size, zoning and/or percent of impervious surfaces. When done in this manner, the parcels generating the runoff are the ones financing the storm sewer reconstruction improvements and the maintenance of the existing system. Some cities even finance their street sweeping program with the storm water utility funds.

The reason most cities are opting for this form of financing is best summarized as follows:

- The billing plan can be weighted more fairly.  That is, parcels generating the highest runoff pay the highest fees.
- The rates are fairly uniform for the typical residential lot.
- The revenue stream is more consistent and can be used to finance a revenue bond.
- Once an ordinance is passed, the hearings are over relative to storm water financing.

To implement a storm water utility a city needs to develop a utility rate schedule that is fair, but does not stifle the business sector of the community.  Then, as with most ordinances, the process includes publication and calling a hearing for public consideration and input prior to implementation.

Bolton & Menk, Inc. has experience in developing rate schedules that meet each cities special needs and in assisting municipalities in the implementation.  We typically recommend working with a special committee in a workshop setting which may include the consultant, the Clerk, the PUC/storm water superintendent and volunteers from the Council and/or PUC to:

- Develop a reasonable annual budget that includes maintenance, equipment and anticipated capital improvements.
- Formulate a fair and reasonable rate schedule.
- Develop a billing spreadsheet from the county assessor's information.

When these are complete, the resolution calling for a hearing can be made. Bolton & Menk is available to assist in generating the needed spreadsheet, developing a storm sewer capitol improvement plan, and showing the various alternative rate schedules that have proven successful in other cities.

## 8.0 CONCLUSION

As mentioned in the report the existing storm water management system is currently working sufficiently. Regardless of the adequacy of the existing storm sewer system, continued development could occupy the available outlet capacity and cause downstream flooding and possibly upstream backwater flooding. If development continues, the updates to the existing storm water management system will need to be considered as part of this continued development to ensure that coordinated flow controls are designed on a watershed-wide basis. The proposed pond network and the incorporation of regional ponding, where possible, presents one method of accommodating the present growth of Eagle Lake. Each proposed development will need to be looked at on a case by case scenario and evaluated for the Best Management Practices that will work for a given area and land use.

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 funding alternatives including storm water development charges and/or implementing a storm water utility could ensure that the associated City costs are fully financed.

As stated earlier, this report is largely based on the USGS topographic quadrangle maps with a 10-foot contour interval, field verification of the watershed areas, and discussions with City Residents 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. If more detailed topographic and elevation data becomes available (i.e., aerial photographical contours from the county or continued development contour data), we suggest that this plan be revisited to include the new information. In this manner, the plan can maintain its usefulness as a current document.

It is also recommended that the City thoroughly investigate the suggested ordinances to determine what regulations best fit the goals of the City. Through the implementation of storm water ordinaces, the city will be able to set a standard of expectations that can be utilized as a minimum requirement for protecting existing and proposed personal property.

# FIGURES