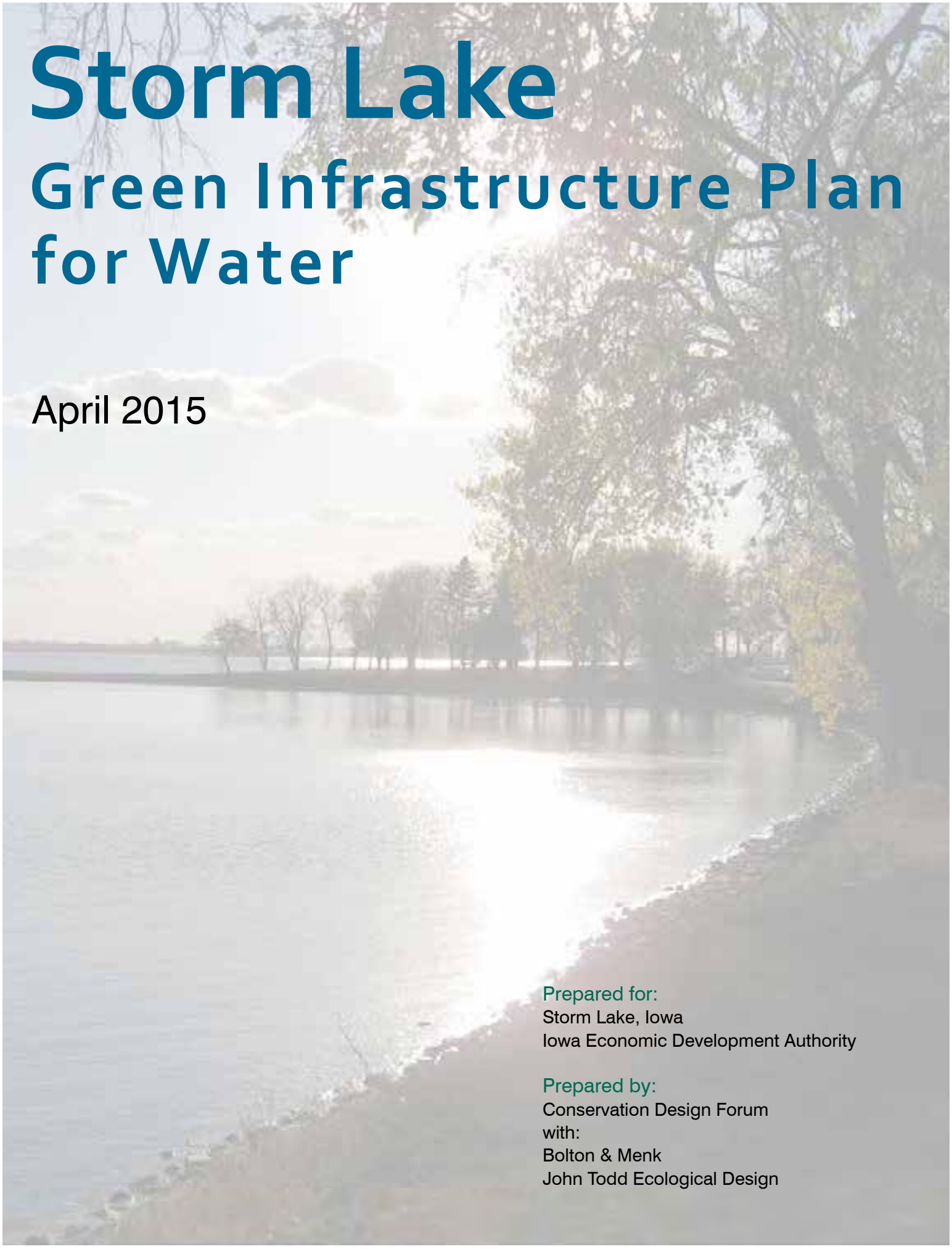
Storm Lake
Green Infrastructure Plan for Water

April 2015



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preamble

Preamble

There is a sea change underway about the way Iowans think about water. Led by policies and incentives largely through the Iowa Economic Development Authority (IEDA), the state is now home to some of the most innovative applications of high-performance green infrastructure practices in the nation. The City of Storm Lake has a long-term close relationship with water for obvious reasons, and seeks to benefit from these practices. In 2014, The City partnered with the IEDA to develop a plan to help guide the most appropriate and beneficial application of green infrastructure technology city-wide to achieve water quality enhancements and other benefits at a watershed scale. The result of this partnership is this Plan document, a comprehensive approach to the integrated application of green infrastructure practices to allow Storm Lake to be Iowa's first net-positive water community.

This Plan analyzes the overall water condition of the City, identifies key green infrastructure practices and strategies, and illustrates how they could be applied city-wide. An open, inclusive community process was utilized to learn what residents and business owners felt is most important to the future of Storm Lake, and to help shed light on the potential for green infrastructure solutions to address these and other priorities with the same effort. A series of discrete capital projects have been identified, defined, and prioritized as the most effective way to achieve the best possible health and vitality to Storm Lake, in a way that extracts the most value out of every dollar spent on public and private infrastructure, including roads, parks, parking lots, and landscapes.

The focus of this Plan and the green infrastructure strategies identified is to illustrate how to renovate public space and private properties with high-performance materials and systems that offer multiple benefits and values. These strategies integrate complete streets concepts and improved walkability and transportation choices with ecologically-based green infrastructure practices that address water, energy, and urban ecology.

Generally, green infrastructure in this sense refers to site systems, many of which include vegetation and a porous substrate as key elements to slow, cool, cleanse, and infiltrate rainwater. These systems include green roofs, permeable pavement, bio-retention/rain gardens, and urban trees. The key to maximizing the benefit and value of these systems is the appropriate adaptation and integration with other key priorities, as well as proper design, construction, and long-term maintenance.

Benefits to applying these strategies in Storm Lake include:

- Cleaner water entering Storm Lake
- Reduced flooding
- Cleaner air
- Improved urban ecology and biodiversity
- Increased recreational opportunities and connection to the shoreline
- Improved health and well-being
- Reduced energy use
- Higher property values
- Reduced long-term maintenance and operations costs for public infrastructure
- Overall improved performance and quality of life for residents, business owners, and visitors
- An environmentally sustainable community
- Reduced nutrients in downstream waters

The Plan is organized into the following ten sections:

1. **Introduction**
   Brief background on the Plan, including purpose, time frame, and planning priorities.

2. **Background Information**
   The context of Storm Lake, including some of the City's previous efforts and initiatives successfully adapting green infrastructure practices.

3. **Integrated Planning Process**
   An outline of the approach used for this study that can be readily adapted to other applications at a range of scales and contexts. Planning and design integration is the key to achieving the best possible results.

4. **Analysis of Existing Conditions**
   A summary of the water context of the City and Storm Lake, including stormwater modeling to predict and illustrate current flooding and water quality issues.

5. **Identification of Goals and Standards**
   Three water goals were established to set clear, measurable criteria for water quality and the volume and rate of stormwater runoff to achieve the community's overall environmental and quality-of-life objectives.

6. **Development of Green Infrastructure Plan**
   The heart of the Plan includes definitions, illustrations, and applications of green infrastructure that would be most beneficial to Storm Lake. A *Green Infrastructure Toolbox* includes recommended

high-performance green infrastructure strategies. Several *Land Use Templates* were developed to illustrate the integration of these tools in typical land use settings found in Storm Lake. The resulting performance (improved water quality and runoff reduction) was analyzed to help quantify the aggregated benefits at the site/neighborhood scale. Lastly, a set of recommended strategies for wastewater treatment using living technologies is included.

7. **Implementation Plan**
   This section identifies three phases of capital projects to achieve short-range, medium, and long-term performance objectives around water. These projects include public improvement (streets and parks) as well as private and institutional site enhancements and renovations. It maps out a clear path to accomplish the greatest levels of success with necessary expenditures in the short term as a strategy to attract long-term support and community investment.

8. **Recommendations and Next Steps**
   In order to maintain positive progress as funding is being secured for the first recommended capital projects, there are a number of identified activities the City can engage in immediately to maintain momentum and build enthusiasm for the Plan.

9. **Funding and Financing**
   A visionary plan such as this requires partnership and support from a broad array of local, regional, state and federal sources.

10. **Appendices**
    A number of the background studies and basis of analysis and recommendations are included here for reference.

The primary message expressed in this Plan is that every investment in community infrastructure is an opportunity to ***create long-term benefits and values through the integration of high-performance, ecologically-focused green infrastructure strategies*** in concert with necessary repair, upgrade and replacement of facilities, and the best planning and urban design principles. This Plan provides a practical approach for Storm Lake to capitalize upon the technologies and practices already available through green infrastructure to achieve multiple benefits over time as sites, streets, facilities, and neighborhoods are rebuilt and revitalized for the next century and beyond.

Storm Lake

1 introduction

a. Purpose

The Iowa Economic Development Authority (IEDA) has initiated a proactive approach to better manage water, wastewater, and stormwater throughout the state. Part of this approach includes developing a template for use in urban areas which details opportunities and methods for improved water management. The IEDA selected the City of Storm Lake to be the pilot for development of this integrated Green Infrastructure Plan for Water. IEDA has partnered with the City of Storm Lake by providing technical and financial assistance to develop the Plan, identify financial assistance opportunities, and promote the efforts of the greater Storm Lake community to demonstrate best practices in stormwater, drinking water, and wastewater infrastructure. The Plan is intended to place an emphasis on green infrastructure practices that mimic natural processes to restore natural hydrology, improve water quality and increase biodiversity. This approach has been found to provide multiple benefits in addition to water quality improvements and flood attenuation, and will maximize the value of every dollar invested in public and private capital improvements. To that end, this Plan will serve as a guide for Storm Lake to prioritize and continue the use of green infrastructure alternatives as it relates to storm, sanitary, and potable water solutions within the City. As a pilot, the Plan is meant to provide a template for emphasizing green infrastructure best practices to treat water as a resource, which the IEDA can bring to other communities to promote implementation throughout the state.

This approach has been found to provide multiple benefits in addition to water quality improvements and flood attenuation, and will maximize the value of every dollar invested in public and private capital improvements.

Putting the Resources Together

b. Timeline

The IEDA chose Storm Lake as a demonstration community in early 2014. The information and priorities presented in this Plan were used for 2015 fiscal year budgeting and for development of the 5-year capital improvement budget. Additionally, the report provides guidance on priority project areas throughout the City over the next several decades of development, redevelopment, and urban infrastructure management.

In the coming years, IEDA will use the process begun in Storm Lake as well as the lessons learned to encourage other communities to develop similar plans. The IEDA intends for this model process and template to serve as a resource for communities and an approach to leverage scarce federal funding to achieve greater, multifaceted community impacts. Communities will be encouraged to use this model as a resource when considering water-related projects and applying for Community Development Block Grant funding for water, wastewater, and stormwater projects. The examples in this Plan will be shared at meetings and conferences, and with the IEDA's funding partners at the Iowa Department of Natural Resources, the Department of Agriculture and Land Stewardship, and the USDA so they too may share this model approach to integrated water system planning with the communities they serve via financial and technical assistance.

c. Planning Priorities

- Green infrastructure is an innovative, highly effective approach to managing water which maximizes opportunities to mimic natural hydrology in the urban environment. It is a more distributed approach that manages water where it falls, rather than further downstream. Green infrastructure uses natural processes to cleanse, infiltrate, and evaporate water to retain resources (such as nutrients) where they are beneficial (in the landscape) rather than where they are detrimental (in the Lake).

- Green infrastructure implementation can also be a catalyst for community and economic development. There are many successful communities in Iowa, and other states, that are utilizing a comprehensive green infrastructure approach to revitalize their downtown commercial districts and other areas of the community. This allows opportunities for community engagement and education, and can stimulate renewed appreciation for the downtown area.

- With Storm Lake being a significant attraction to the City, the importance of water quality entering the Lake cannot be overstated. The improvement of water quality entering the Lake was a guiding principle through the development of this Plan.

- Reduction of flooding throughout the City is a priority for this Plan.

- This Plan is meant to serve as a case study and guidance document for green infrastructure planning in other communities. The Plan demonstrates a process that can be replicated and scaled to any size city.

- Reduction of nutrients in stormwater and wastewater is a priority for this Plan.

- This Plan will also help educate citizens about the water they rely on and how to improve its quality.

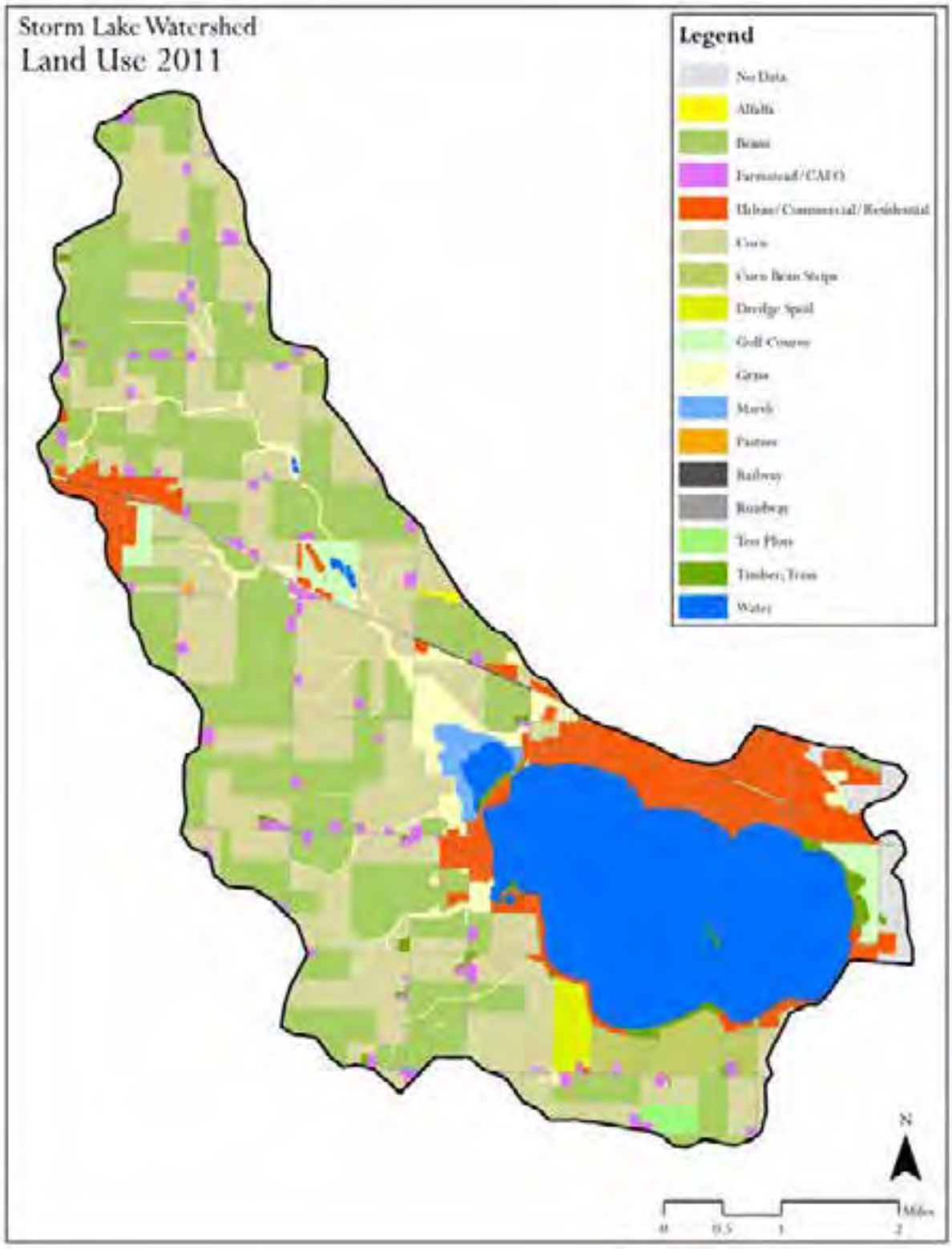
2 background information

a. Location & Growth

The City of Storm Lake is located in Buena Vista County in northwest Iowa, and sits at the north shore of Storm Lake, the fourth largest natural glacial lake in the state at 3,200 acres. The City has experienced steady growth since its settlement in the 1860's and 70's, with the 2010 census reporting a population of 10,600. The population is also rich in diversity, with 27 ethnic groups represented and 30 languages spoken.

Storm Lake Comprehensive Plan

Storm Lake boasts a diverse population consisting of 27 ethnic groups speaking 30 languages.



Storm Lake Watershed, Storm Lake Dredging Impacts Study

b. Previous Storm Lake Initiatives

The City has already put forth significant effort to reduce stormwater runoff and improve stormwater and wastewater quality.

Recent and Proposed Stormwater Projects

Aside from the recommendations in this Plan, Storm Lake has already implemented practices such as curb cut bioretention features along Rose Lane, a water quality basin at Radio Park, bioswales along Lakeshore Drive, the Vista Drive rain garden (the first rain garden in Iowa), rain gardens along Highway 7 near the golf course, permeable pavers at the marina, bioretention at the Reserves and 10th Street townhomes, and rain gardens on the McDonald's property. Other completed projects include stormwater retention and rain gardens at the High School, a stormwater retention basin in Drainage District 25, and a Little Storm Lake stormwater treatment system. The City also plans to install a bioretention treatment train along Expansion Boulevard and in the north central area, as well as one or more permeable paver streets in the near future.

(Top) Iowa's First Rain Garden

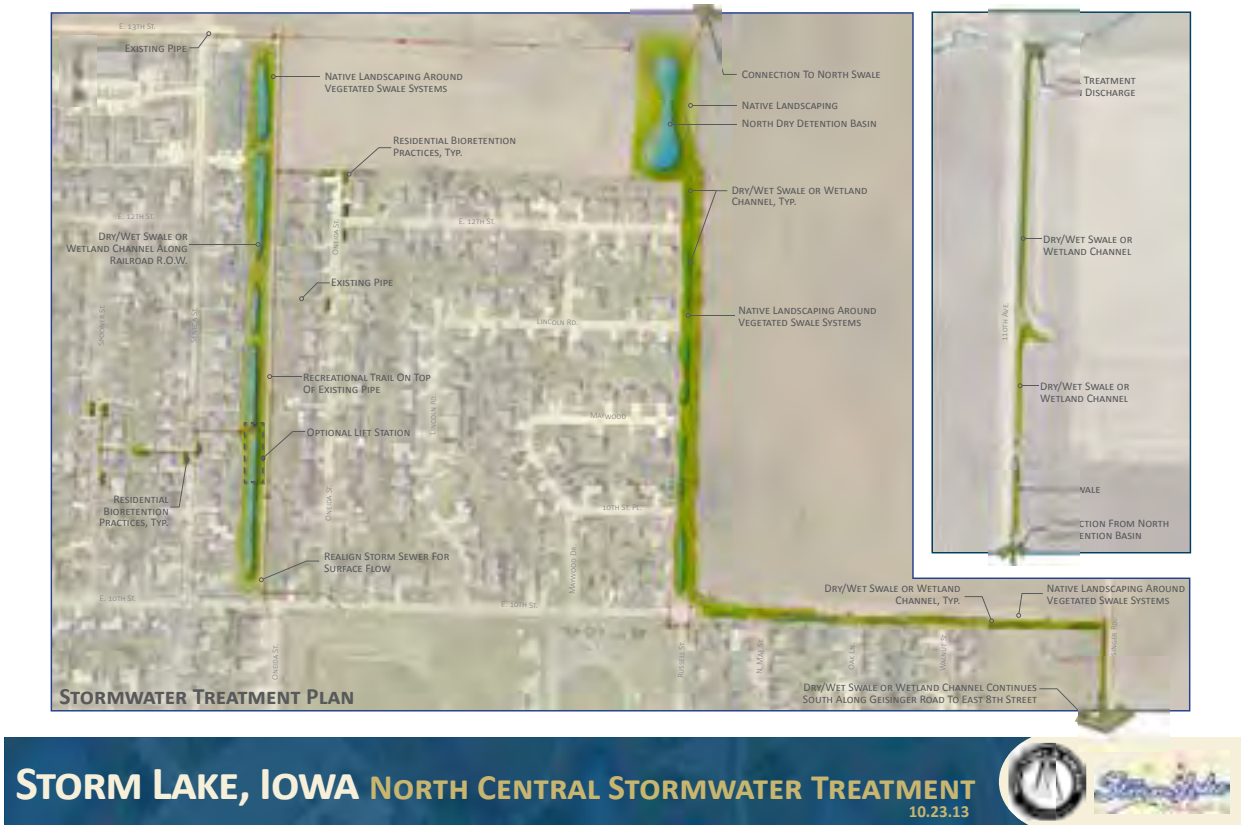
(Bottom) McDonald's Rain Garden

(Top) Lakeshore Drive Bioretention

(Bottom) Radio Park Water Quality Basin

Golf Course Ponds

Rose Lane Bioretention



North Central Stormwater Treatment

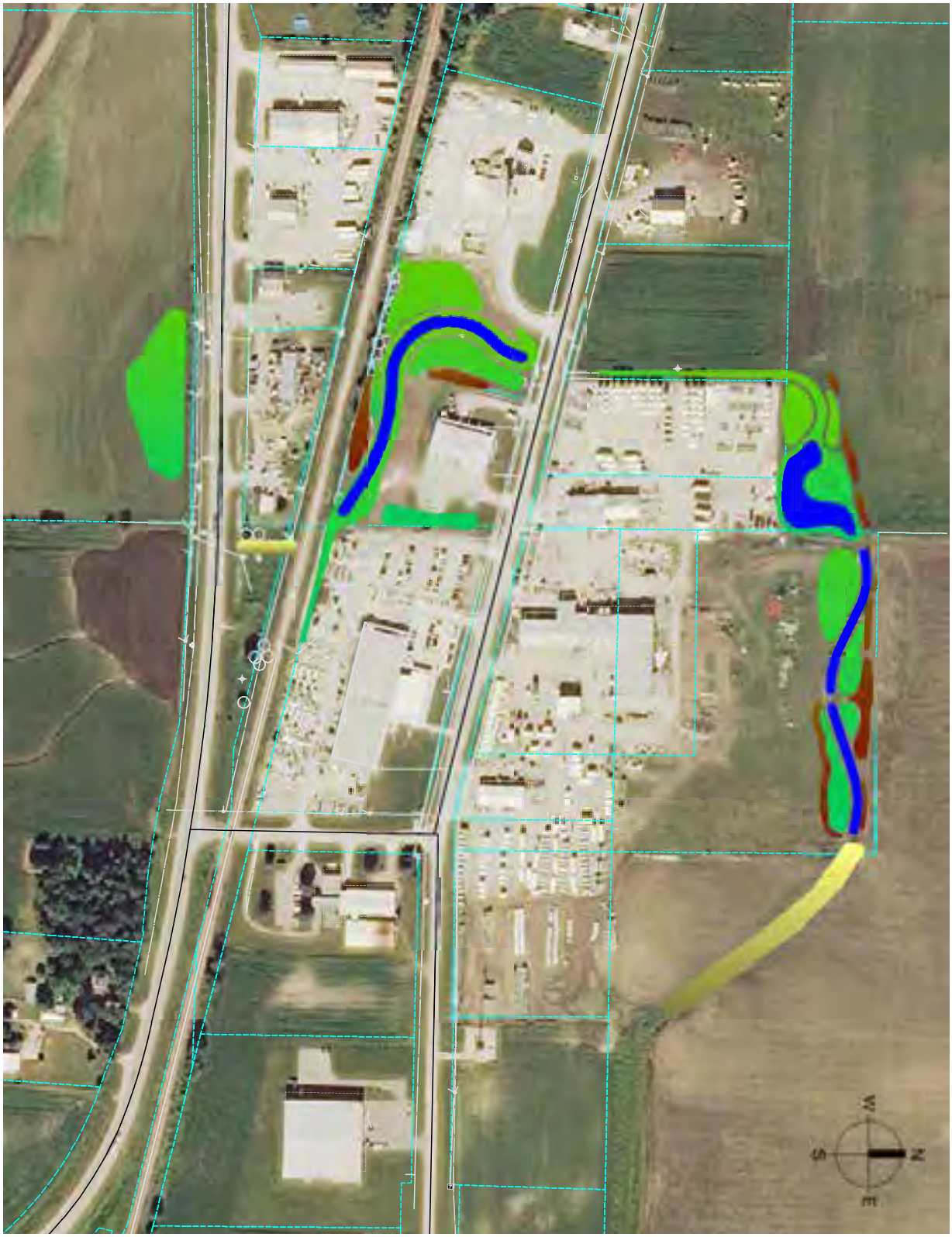
Recent Ordinance Adoption

Storm Lake has recently adopted a post-construction stormwater control ordinance (Appendix A) for new development and redevelopment in an effort to minimize increases in runoff volume and rate and non-point source pollution. The ordinance mirrors standards in the Iowa Stormwater Manual. There are also plans to adopt a Construction Erosion and Sediment Control Ordinance (Appendix B).

An Urban Tree Management Program has also been initiated, which has an integral role in stormwater management. Trees are important for absorbing water and nutrients, and they better the quality of life and enhance sustainability in a community.

System Modeling Effort

Another Storm Lake initiative has been development of hydrologic/hydraulic models for much of the City's storm sewer network. These models confirmed visible flooding and were used to develop alternatives to reduce localized flooding. An outcome of this modeling effort was the Expansion Boulevard project. The models were also used to evaluate some of the green infrastructure recommendations identified in this Plan.



Expansion Boulevard Project

Water and Wastewater Initiatives

Storm Lake is committed to improving potable water quantity and quality and wastewater treatment. The City is effectively combating nitrifying bacteria and reducing nitrite formation in the water distribution system with sodium chlorite. The City has initiated discussions with a significant industrial sewer user, Tyson Foods, to evaluate opportunities for joint environmental enhancement projects associated with the City and Tyson wastewater treatment facilities.

Bacteria Control

The City has adopted a stormwater quality ordinance that focuses on illicit discharges including biological and chemical substances. Specifically, the ordinance establishes bacteria concentration limits for stormwater runoff and discharge to storm sewers as an aggressive local regulatory approach to addressing lake water quality issues.

Watershed Initiatives

Storm Lake is participating in larger scale watershed initiatives to help reduce nutrients in downstream waters. An example of this is the City's selection by the Iowa League of Cities to be one of two communities to pilot a nutrient trading program. This effort is part of the Iowa Nutrient Reduction Strategy for reducing nitrogen and phosphorus loads to Iowa streams and the Gulf of Mexico.

Education

The City works regularly with Buena Vista University students to monitor lake water quality. The City has also developed a Discovery Center on Little Storm Lake to educate about wetlands and their value.

3 integrated planning process

Integrated Planning Process

The intent of the planning approach for this effort was to use a methodology that could be replicated in many communities, and scaled down to portions of the City or to smaller communities, or up to any size community. An *integrated* planning approach addresses a comprehensive set of community issues with a single effort. The process involved the following general steps:

An *integrated* planning approach addresses a comprehensive set of community issues with a single effort.

1. **Observation of physical conditions:** The City was toured to understand development patterns, topography, general street and infrastructure conditions, and other unique characteristics of the community. It also provided an opportunity for City officials to identify and communicate particular areas of concern and areas of pride to the consultant team.

2. **Review of existing policies and previous work:** The consultant team reviewed existing documents and participated in a workshop where City staff identified existing and past initiatives.

3. **Data collection:** Applicable data was collected. This included reports such as the Capital Improvement Plan, Watershed Management Plan, Comprehensive Plan, and documents such as recent ordinances.

4. **Analysis:** This effort included analysis of existing pollutant loading and flooding conditions. It also involved overlaying maps and data to further identify synergies among projects. For example, if a particular street experiences

frequent flooding and is also slated for near-term reconstruction, it would make economic sense to combine these projects and potentially reconstruct with permeable pavement. At the other end of the spectrum, a recently constructed street that does not have stormwater capacity would not be given such a high priority.

5. **Public input:** During the process, three public workshops were conducted.
   a. The first workshop was conducted at the beginning, prior to significant analysis. The purpose of the workshop was to introduce the project and the concept of green infrastructure and obtain input regarding community priorities. The first workshop was primarily attended by community and business leaders as well as State and local agency staff.

   b. The second workshop was conducted upon completion of the analysis of existing conditions of stormwater drainage and pollutant loading and identification of potential green infrastructure strategies that could be utilized in Storm Lake. This workshop was conducted during the day and was intended to obtain input from the same group as the first workshop.

   c. The third workshop was conducted in the evening after the second workshop and was intended to present the analysis and green infrastructure strategies to the residents of Storm Lake and obtain their input.

6. **Goals and standards development:** Target standards to control water quantity and quality were developed. These standards were based on discussions with City officials and review of national, state, and local policies and standards. This step included a second workshop to engage the public for their input.

7. **Plan development:** An implementation plan was developed to prioritize projects that would achieve the stated goals and standards.

4 analysis of existing conditions

a. Storm Lake

Storm Lake is a significant resource for the City, drawing tourists and providing recreational opportunities due to its natural beauty and significance in the landscape. However, the Lake is highly turbid, has high phosphorus loadings, and has been placed on the Section 303(d) list due "objectionable turbidity that is a combination of inorganic material and algae blooms," according to the 2012 Storm Lake Watershed Management Plan. After being placed on Iowa's Impaired Waters List, rehabilitation goals of a target total suspended solids (TSS) level of 20 mg/L, and a Secchi depth light transmittance of 2.3 feet were established. To help meet these goals, the City has undertaken a dredging program. Related to this effort, Iowa State University conducted a study documented in a report titled "Maximizing Ecosystem Benefits of the Storm Lake Dredging Program: An evaluation of dredging and potential management scenarios on wind-driven sediment resuspension and water quality of Storm Lake". This report concludes that the water quality goals can be met best by maintaining a diverse selection of management strategies, including lake stage increases, continued dredging, and wind fetch reduction. The City is continuing to dredge, and is looking into possible options for reducing wind fetch and reduce phosphorus and suspended solids. A study is underway to determine best practices to accomplish these goals. The use of alums, building islands, using restorers, and other remediation strategies are currently being considered.

Storm Lake is a significant resource for the City, drawing tourists and providing recreational opportunities due to its natural beauty and significance in the landscape.

Storm Lake Dredging Operation

b. Land Use

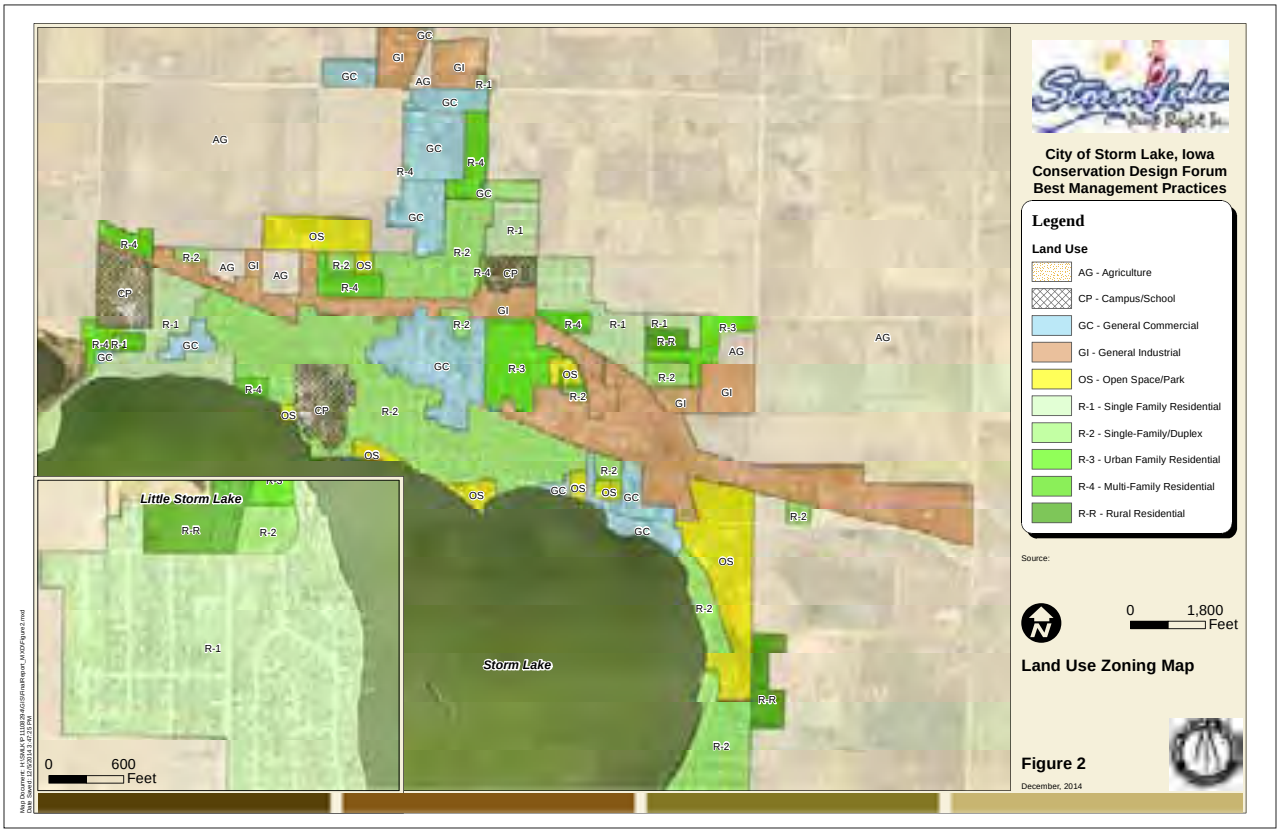
Figure 2 (Appendix C) , shown below, documents current and planned land use as derived from the City Zoning Map, as well as key areas that will be discussed in this Plan. The figure shows that railroad lines split the community into distinct areas. Primarily residential land use occurs adjacent to the Lake, bordered on the north by the Illinois Central railroad line. Residential also exists throughout the remainder of the community. North of the Illinois Central railroad line is the downtown area, concentrated with commercial use. Commercial use also occurs in the north central portion of town along Lake Avenue, north of 10th Street. A zone of industrial use exists in the southeast portion of town, and in the west along Milwaukee Avenue.

Land Use Zoning Type	Area (acres)
Agricultural†	64
Campus/School	130
General Commercial	343
General Industrial	612
Open Space/ Park	216
Residential	1129
Rural Residential	20

†Only agricultural land within city limits is summed

Land Use Zone Types and Areas

Figure 2: Land Use Zoning Map (Appendix C)



c. Water and Wastewater

The City's potable water supply is drawn from underground aquifers, including three wells drawing from the Dakota aquifer, one that taps the Jordan aquifer, and five wells connected to alluvial aquifers. The wells are included in a Wellhead Protection Plan with a 200 foot protection radius. The wells pump to the City's water treatment plant rated for 5.19 MGD. The well water supply has a significant ammonia concentration and the City has experienced issues with biological conversion of ammonia to nitrite in the water distribution system. To address this condition, the City recently installed a sodium chlorite disinfection system for effective control of nitrite formation in the distribution system. The well water supply also has a high hardness concentration. The hardness is reduced with lime softening. The lime softening process is more sustainable and has less environmental impacts than other water treatment alternatives such as:

- Ion exchange softening, which discharges sodium and chloride to the environment
- Membrane hardness reduction (reverse osmosis or ultrafiltration), which has greater power requirements than lime softening and uses 25% more water
- No hardness reduction, which would rely on individual home softeners that discharge sodium and chloride to the environment

The City operates a 2.0 MGD wastewater treatment facility, which discharges into Outlet Creek. Wastewater flow to this plant includes about 800,000 GPD from the Hillshire Brands turkey processing facility when in normal operation. Tyson Foods operates a pork processing facility and has its own 1.5 MGD plant next to the City's, and maintains a separate wastewater facility. The City's wastewater treatment plant is just finishing a major upgrade that will double the plant capacity. Improvements include two new aeration basins and two 150-foot clarifiers as part of a $20 million Federal Emergency Management Agency (FEMA) and Homeland Security grant. System-wide improvements include a new sanitary sewer around the west and south sides of the Lake, along with five new lift stations to help prevent basement flooding and bypass events, which have occurred in the past. The City invested an additional $7 million in the plant for improvements not related to capacity.

As part of a separately funded effort, the City will also be evaluating alternatives for reducing nitrogen and phosphorus discharges as required by the Iowa Nutrient Reduction Strategy. The next National Pollutant Discharge Elimination System (NPDES) discharge permit will require evaluation of nitrogen and phosphorus removal alternatives. The Iowa Nutrient Reduction Strategy includes a flexible approach to nutrient reduction at wastewater treatment facilities. The City will determine the economically and technically achievable approach for reducing nutrient discharge from the Storm Lake wastewater treatment facility.

The Iowa Nutrient Reduction Strategy includes goals of 66% nitrogen and 75% phosphorus reductions, and 10 mg/L total nitrogen and 1.0 mg/L total phosphorus effluent concentrations for facilities that treat domestic strength sewage. After receiving the renewed NPDES discharge permit, the City will conduct a two year study of nutrient reduction alternatives and submit a report to the Iowa Department of Natural Resources (IDNR). The report will include the City's proposed nutrient removal process and a proposed schedule for construction of any treatment facility modifications. The plan may include construction of modifications to the treatment facility or simple modifications to the operation of the existing facility.

After IDNR review and approval of the City's proposed plan for installing nutrient removal, the NPDES discharge permit will be amended to include a construction schedule for implementation of the plant and process modifications for nutrient removal. After the plant and/or process operation are modified, the process will be operated for a six month startup period followed by a 12 month process performance evaluation period. IDNR will then amend the NPDES discharge permit by adding average annual total nitrogen and phosphorus mass discharge limits that are based on the demonstrated process performance following the 12 month process evaluation period.

The City is participating in an Iowa League of Cities pilot nutrient water quality trading project. The League is developing a nutrient trading program framework for consideration by IDNR. The City may develop projects with nonpoint sources of nutrient discharge as part of the pilot project. Even though there are currently no nutrient water quality standards or stringent nutrient discharge limits on the City's wastewater treatment facility discharge, the City may develop nutrient reduction projects for future use as nutrient offsets or trading credits when more stringent nutrient limits are implemented. This "precompliance" trading concept has been developed in some other states, including the Ohio River Basin nutrient trading program.

d. Stormwater Modeling

This Plan includes stormwater modeling of most areas of the City, starting with previously created models for other projects, and new modeling for several other areas of the City. The model was calibrated to confirm surface flooding areas previously described by city officials, and was used to identify and quantify recurring flood patterns. Pollutant load estimates were developed based on land use and typical event mean concentrations (EMCs) (average concentrations of various pollutants for typical rainfall events) for the various land uses. Appendix C provides further details on the modeling and pollutant load estimation approach.

Stormwater Drainage and Flooding

Figure 3A (Appendix C), shown below, depicts model-predicted flooding for 2-, 10-, and 100-year rain events, with dark blue areas flooding most frequently. The map shows several problem areas, identified by number, but not necessarily representing priority:

1. Northwest corner of Northwestern Dr. and 5th St., and a portion of the Buena Vista Regional Medical Center parking lot
2. 9th and 10th Streets between Vestal St. and Michigan St.
3. Intersection of Ontario St. and 7th St., and surrounding neighborhood
4. Erie St. between 10th St. and 12th St.
5. Oneida St. between 4th St. and 6th St.
6. 4th St. between Russell St. and Skewis St.
7. Portions of the Hillshire Brands facility, including the intersection of Richland Dr. and Vilas Rd. and the southern property boundary
8. Intersection of Lakeshore Dr. and Flindt Dr., including Radio Park to the west and baseball fields to the east
9. 6th St. in the vicinity of the Hyland Dr. intersection
10. Early St. between Iowa St. and 4th St.
11. The abandoned railroad corridor east and west of Geisinger Rd., between Poplar Ln. and 5th St.
12. The western part of the agricultural field between Richland Dr. and Expansion Blvd.
13. 4th St. between Western Ave. and Barton St.
14. Northern portion of the intersection of Expansion Blvd. and Radio Rd.
15. Northwest corner of the Expansion Blvd. and Route 71, and into the agricultural field
16. Southern portion of the intersection of Expansion Blvd. and Radio Rd.
17. South side of Expansion Blvd. at the aggregate production facility, and the north side of Hwy. 7 between Radio Rd. and Gilbert St.
18. South side of Hwy. 7 between Radio Rd. and Gilbert St., and into the adjacent agricultural field
19. Southwest corner of the intersection of Hwy. 7 and Route 71, and into the adjacent agricultural field
20. Northwest corner of the intersection of Hwy. 7 and Route 71, and the southwest corner of intersection of Expansion Blvd. and Route 71
21. Prairie Ln., Meadow Ln., and Clover Ln. south of County Hwy. C63
22. Open field south of Emerald Dr., east of 85th Ave.
23. Emerald Dr. at the intersection of Parlina Ln., and to the south

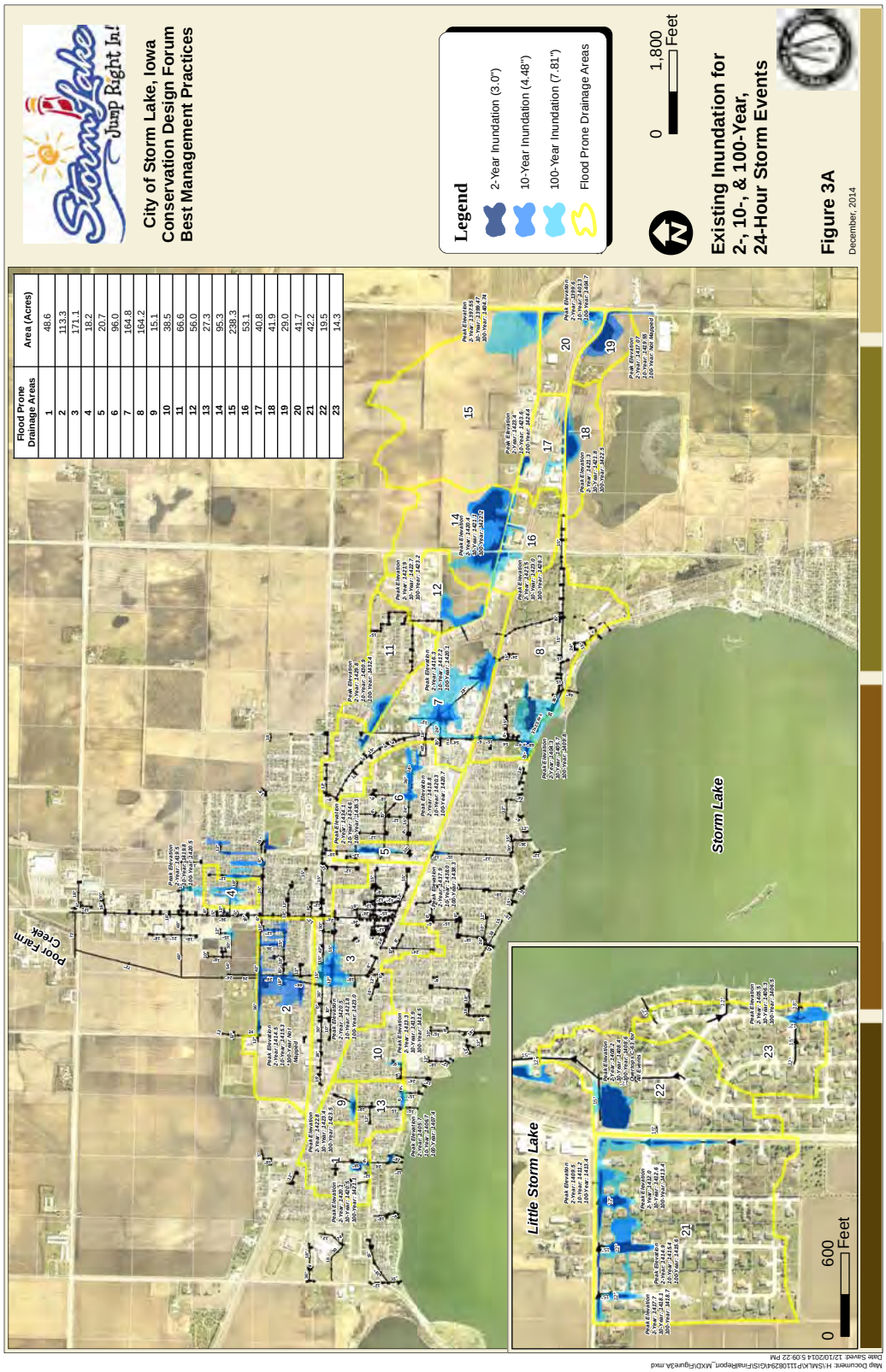


Figure 3A: Existing Inundation for 2-,10-, & 100-Year 24-Hour Storm Events (Appendix C)

d. Stormwater Modeling (cont.)

Water Quality (Pollutant Loading)

Typical pollutant loadings were developed for each land use based on the amount of impervious cover and the nature of the land use. The numbers used in the analysis were based on typical values for urban areas around the Midwest, and are shown in Appendix C, Tables 1 and 2. Based on that analysis, Figures 4B, 5B, and 6B were developed that show the loading rates for key pollutants.

Total Suspended Solids (TSS) is the amount of sediment washed from the landscape. This pollutant is important because the sediment can be detrimental to the physical habitat conditions of lakes, streams, and wetlands and because the sediment caries many other pollutants with it, including heavy metals, nutrients, and petroleum-based hydrocarbons.

Phosphorus (Total Phosphorus – TP) and Nitrogen (Total Nitrogen – TN) are nutrients that are beneficial to the landscape in moderate amounts but can be very detrimental to lakes and ponds where they lead to excessive algae growth and are otherwise harmful to the ecology of these waterbodies.

Figures 4B, 5B, and 6B in Appendix C (and shown below) map the average annual loading rates for these pollutants based on the land use. In the case of TSS, the colors progress from darker blue to light to darker red as the average annual load increases. For TP and TN, the colors progress from light to dark as the pollutant load increases.

For green infrastructure practices that capture pollutant loads near their source, the unit area pollutant load maps below help to identify those land use areas where green infrastructure practices should be targeted to have the greatest pollutant load reduction benefit.

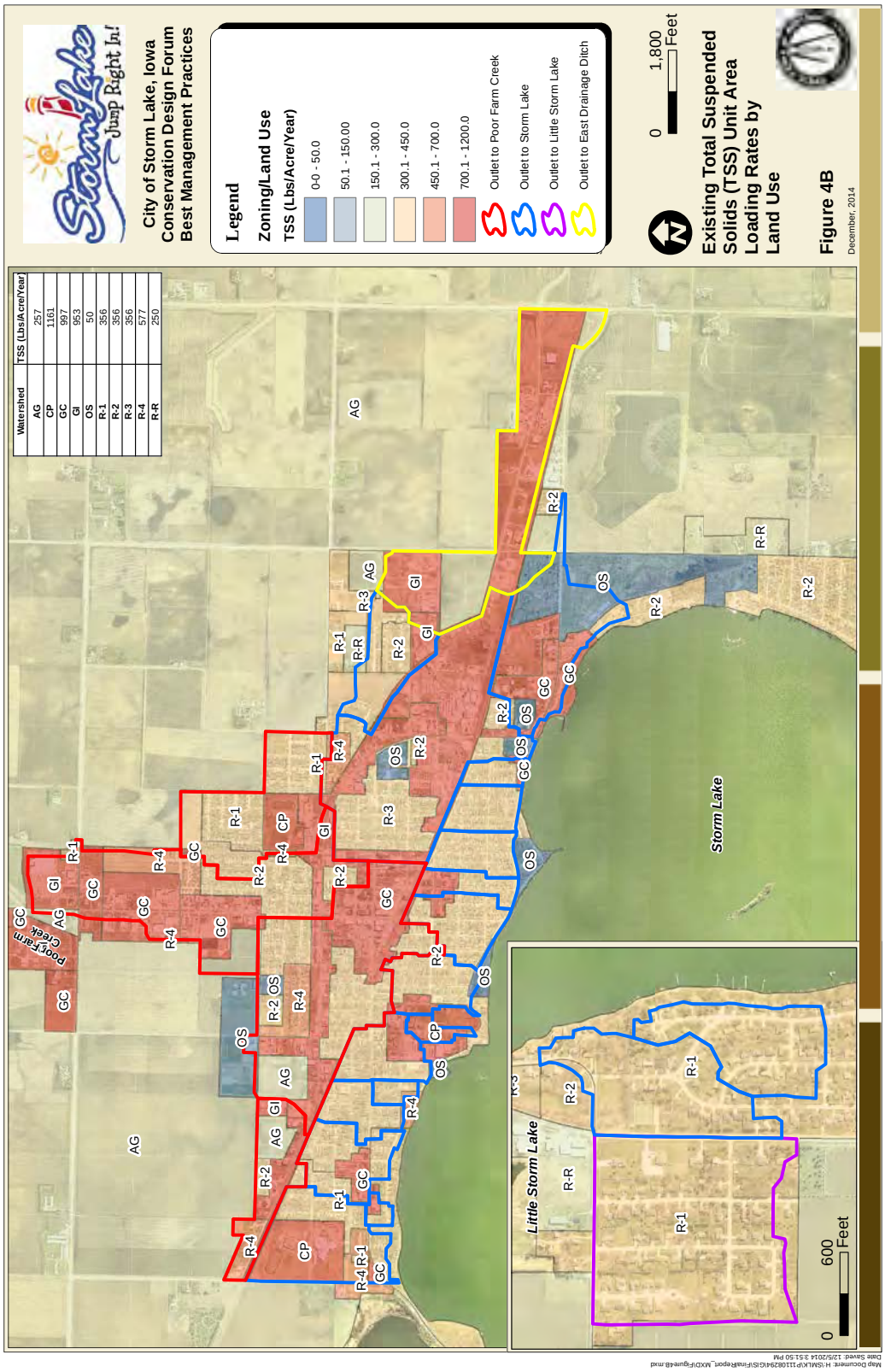


Figure 4B: Existing TSS Unit Area Loading Rates Map (Appendix C)

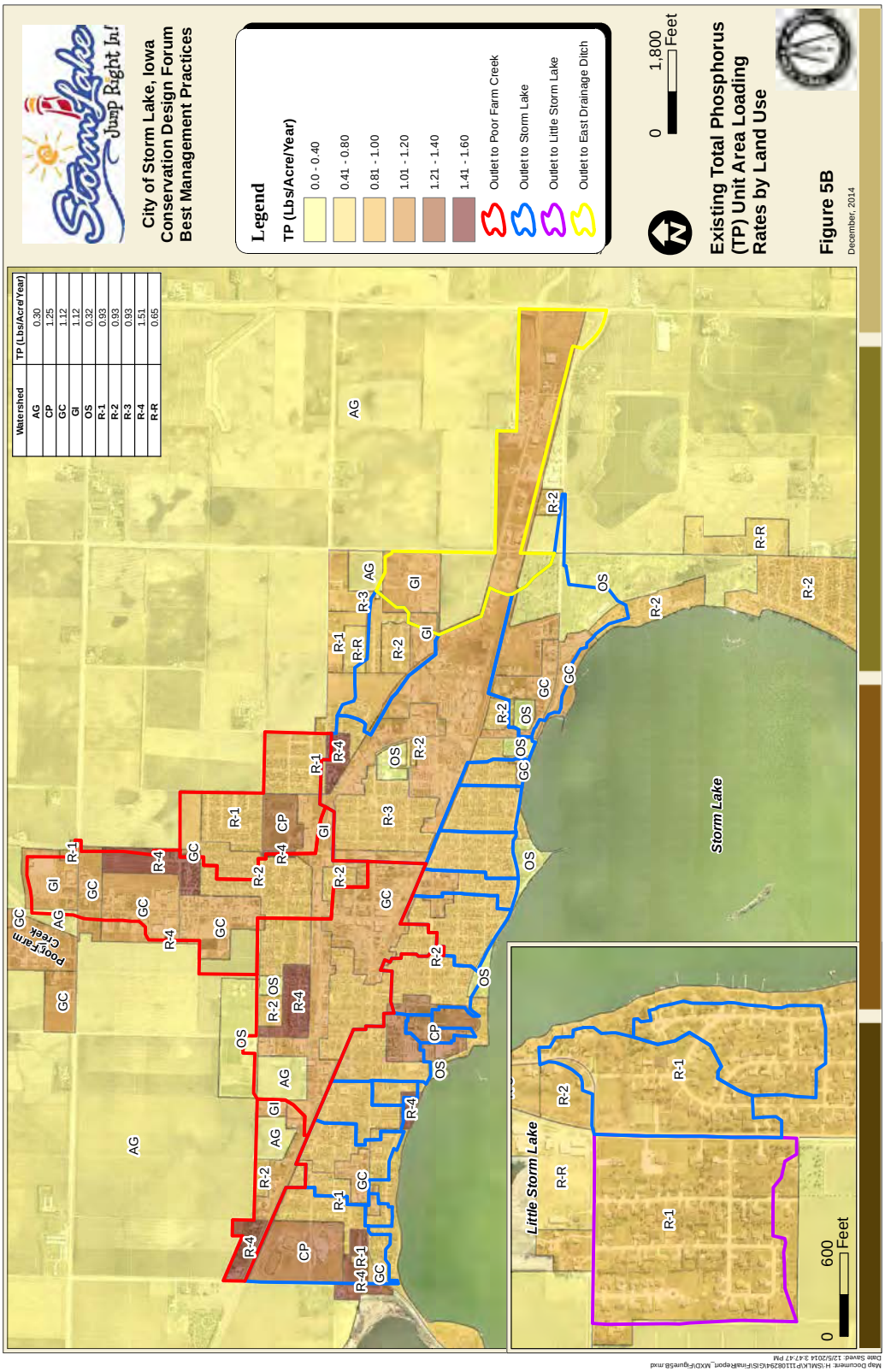


Figure 5B: Existing TP Unit Area Loading Rates Map (Appendix C)

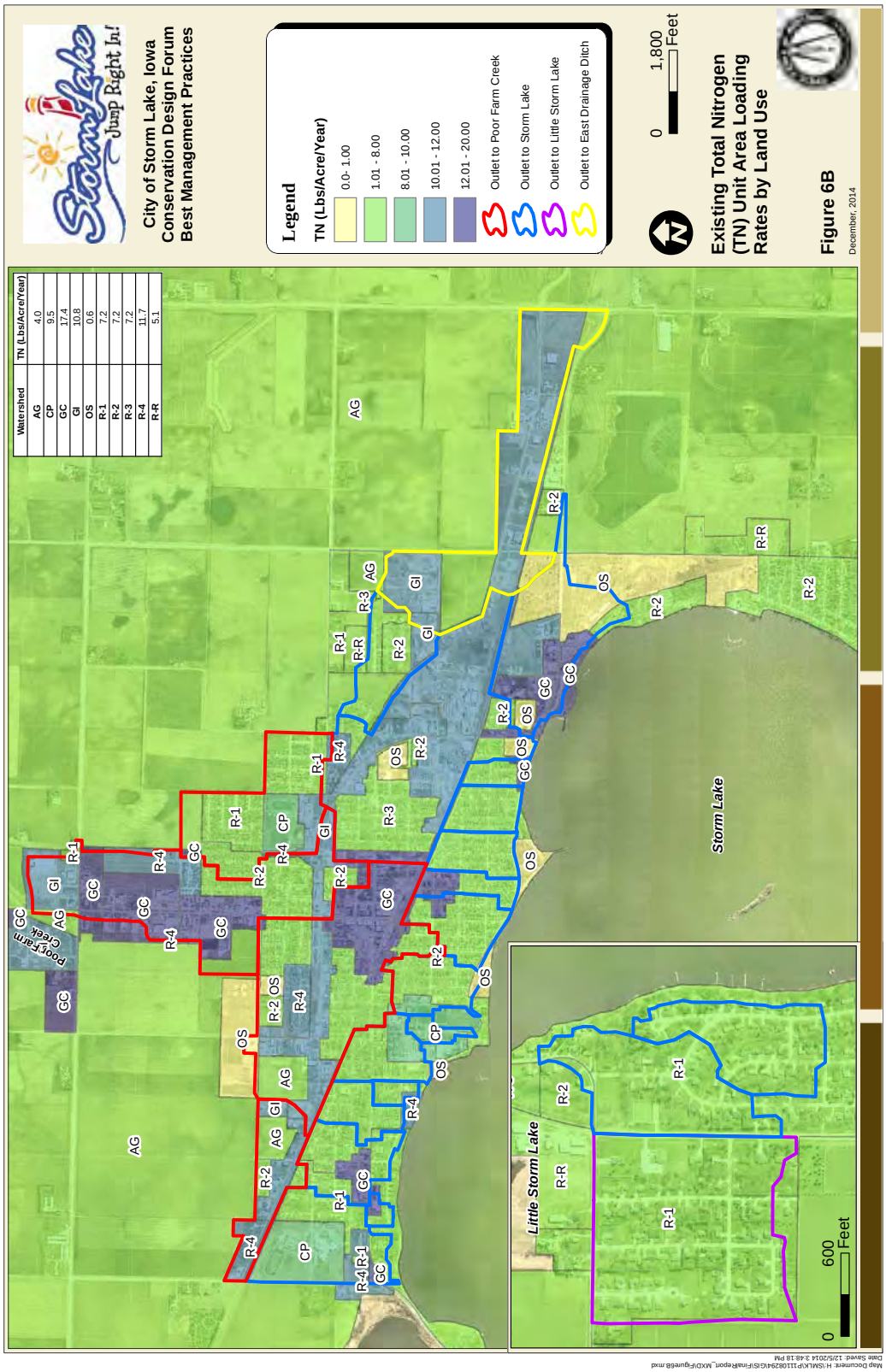


Figure 6B: Existing TN Unit Area Loading Rates Map (Appendix C)

e. Community Input

The project team solicited input from the community, including city officials, local industry and residents, and regulatory agencies, regarding goals and needs for water management best practices to consider in this Plan. The following is a summary of the community's priorities relative to water:

Stormwater

- Consider a goal of 10% or less directly connected impervious area within the watershed, and build this into street reconstruction policy or a more broad development ordinance.
- Potential for both voluntary and city-administered rain garden maintenance.
- Continue promoting the use of phosphorous-free fertilizer throughout the City to reduce TP loading.
- Consider creating maximums instead of minimums for parking requirements for new development to decrease impervious area.
- To help reduce E. coli bacteria in the Lake, consider a holding requirement for first flush.

Wastewater

- Consider further processing of biosolids from the City's and Tyson's wastewater treatment facilities to produce a higher quality fertilizer product for potential sale. Waste biogas from the Tyson anaerobic lagoons may be used as an economical fuel source for heat treatment and drying.
- Potential for participation in a nutrient trading program.
- Potential for nutrient removal from the City and Tyson wastewater plants by polishing ponds and/or wetlands.

5 identification of goals and standards

Identification of Goals and Standards

In developing performance goals for a green infrastructure strategy, precedent target goals of varied intensity were considered. There are voluntary stormwater standards for new development and redevelopment set forth by the U.S. Green Building Council's (USGBC) Leadership in Energy & Environmental Design (LEED) certifications, the Sustainable Sites Initiative (SITES), and the International Living Future Institute's Living Building Challenge. There are also policy and regulatory approaches at the national, state, and local government levels, such as the Iowa Stormwater Manual, the newly adopted Storm Lake Stormwater Ordinance, and the Storm Lake Watershed Management Plan. Emerging wastewater standards have been developed as part of the Iowa Nutrient Reduction Strategy and Gulf Hypoxia Task Force. For potable water, current and future City goals and objectives were considered. The development of this Plan was guided by these sources as well as performance goals that came out of conversations with the City and others in the community.

After consideration of the goals and standards set forth by various organizations and governmental agencies, it was determined that the target level of stormwater performance for the proposed plan should be the standards set forth by the Iowa Stormwater Manual and the City of Storm Lake's stormwater ordinance. While different in format than the standards of the USGBC and the SITES program, they are not inconsistent and projects constructed to the state and local standards would generally meet or exceed those and most federal standards. Utilizing the Iowa and Storm Lake standards also establishes

The identified standards are part of IEDA's *Iowa Green Streets Criteria*, which is helping to promote improved water, energy, and economic performance in communities throughout Iowa.

consistency from community to community and provides consistency between new development and targets for retrofitting. This standard is also part of IEDA's *Iowa Green Streets Criteria*, which is helping to promote improved water, energy, and economic performance in communities throughout Iowa. Objectives were developed for wastewater and water based on the City's goals and emerging standards.

Stormwater

The stormwater goals below are based on City goals and Iowa Green Streets criteria.

Goals

1. Water Quality: Reduce the sediment, nutrient, and bacteria load to Storm Lake and Poor Farm Creek from stormwater sources.
2. Stormwater Volume: Reduce the volume of stormwater runoff to better mimic natural hydrology. As in nature, the volume of runoff should be reflective of the soils present on the site.
3. Stormwater Rate: Runoff rates should be controlled to address both downstream flooding and erosion.
4. The relative importance of the water quality, stormwater volume and stormwater rate goals should reflect the conditions and constraints of the receiving manmade and natural systems.
5. Utilize green infrastructure practices based on natural processes integrated into the urban and rural environment to achieve the goals above.

Objectives

To achieve the goals stated above, the following performance standards are recommended:

1. 80% TSS removal for all events up to and including a 1.25" rainfall
2. Runoff volume retention based on Hydrologic Soil Group (HSG), as detailed in the Iowa Stormwater Management Manual
3. Runoff rate control
   - Channel Protection: Post-development 1-year discharge controlled to achieve a 24-hour detention time
   - Flood Protection: Allowable post-development 100-year discharge rate = 5-year pre-development rate

Although it is recommended that the green infrastructure strategies identified in this Plan be designed to meet the City stormwater ordinance standards as identified above, each project should be evaluated in the context of its location, including downstream areas. In some cases, alleviation of downstream drainage or flooding may dictate designs exceeding the City standards, where feasible. In other cases, an absence of flooding concerns may dictate that the rate control standards could be relaxed while retaining the standards for water quality and runoff volume control.

Wastewater

The City is in the process of renewing their NPDES permit which will include nitrogen and phosphorus load reduction requirements. In addition, the Gulf Hypoxia Task Force goal of 45% nutrient load reduction was considered.

Goals

1. Reduce nutrient discharges from wastewater facilities using the most economically and technically feasible strategies.
2. Reduce the net load of nutrients to zero using nutrient trading or offset concepts.
3. Eliminate non-beneficial export of biosolids and biogas from wastewater and other facilities.
4. Anticipate and address emerging contaminants of concern.

Objectives

1. Reduce wastewater nutrient discharge of nitrogen by 66% and discharge of phosphorus by 75%.
2. Reduce nutrient loading from nonpoint sources with constructed wetlands, tile drainage bio-reactors, and other agricultural best management practices to fully offset the remaining discharge of nitrogen and phosphorous from wastewater facilities.
3. Produce biosolids with a quality adequate for sale as a fertilizer and soil conditioning product; evaluate the use of biogas from Tyson anaerobic lagoons as a fuel in a heat treatment and/or drying facility.
4. Monitor emerging concerns and policy related to wastewater contaminants, including pharmaceutical residuals and endocrine disruptors.

Water

Goals

1. Reduce the discharge of lime softening sludge using revenue positive strategies.
2. Anticipate and identify emerging contaminants of concern and address them at their source.
3. Minimize impact of water supply treatment on downstream water quality.

Objectives

1. Process lime sludge to develop a saleable agricultural lime or calcium soil amendment; blend it with wastewater treatment facility biosolids to produce a fertilizer and soil amendment with added value of high calcium and buffering capacity.
2. Identify and plan for newly-regulated contaminants; monitor the development of policy related to water contaminants, including pharmaceutical residuals and endocrine disruptors. Develop strategies to address these contaminants through either source reduction or wastewater treatment technologies.
3. Reduce the hardness of finish water to reduce or eliminate the need for home and industrial ion exchange water softeners that discharge sodium and chloride to wastewater facilities. Sodium chloride that is harmful to aquatic life cannot be removed by wastewater treatment facilities.

6 development of green infrastructure plan

Development of Green Infrastructure Plan

The methodology used for development of this Plan considered progressively larger scales of strategies to meet the Plan goals. The terms used for the strategy scales are Toolbox, Template, and Scenario.

Green Infrastructure Toolbox

The first step in developing this Plan was to identify green infrastructure tools appropriate for accomplishing the performance goals and standards described above and applicable to Storm Lake.

Land Use Templates

The next step was to develop typical Land Use Templates based on current land use areas. Within a Template, multiple Toolbox items can be applied to function as a system to meet the recommended green infrastructure performance standards. The Templates below illustrate potential arrangements of Toolbox strategies for the given land use. However, the site specific conditions of every location will dictate unique arrangements for every project.

Implementation Scenarios

Finally, the community-wide benefits of implementing the green infrastructure tools and Templates can be analyzed for a range of Implementation Scenarios. Each Scenario reflects a different set of assumptions regarding individual green infrastructure practices, level of green infrastructure implementation within a Template, and targeted implementation of green infrastructure Templates. For this Plan, two Scenarios were developed as described in the Scenario section, below.

High-performance green infrastructure strategies are developed by combining a toolbox of practical applications with typical land use templates across the city, and considering time-based scenarios for implementing these approaches.

a. Green Infrastructure Toolbox

The tools identified to meet the performance standards outlined in this document include the following:

- Green Roofs
- Permeable Paving
- Street Trees
- Bioretention
- Naturalized Swales
- Naturalized Detention
- Cisterns
- Wastewater Discharge Reduction
- Onsite Wastewater Treatment

Each tool is described in terms of the benefits it provides, how it functions, and its estimated performance based on previous installations. There are also examples of each tool in use to provide context for how the tools might be used.

TOOL:
Green Roofs

Green Roof Benefits:

Vegetated roof system designed to capture, temporarily store, and evapotranspire rainwater on the top of roofs. Green roofs are generally planted with drought and wind tolerant vegetation. Green roofs can be designed as simple, lightweight systems primarily providing stormwater benefits or as more elaborate rooftop gardens providing outdoor space as well as stormwater benefits.

Chicago City Hall, Chicago, IL

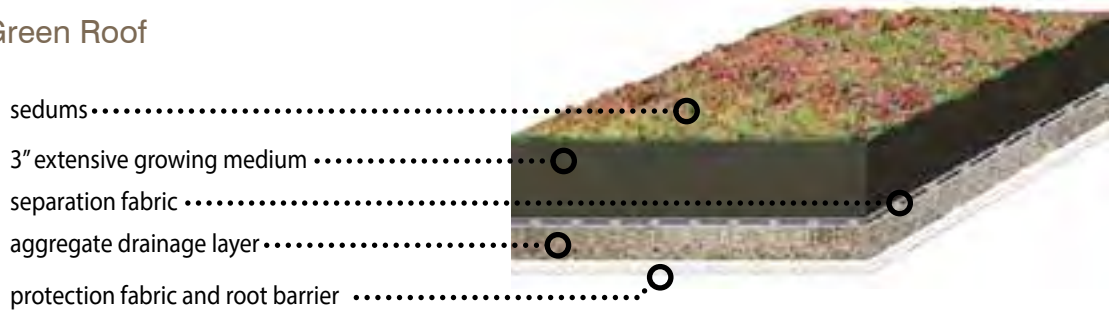
Estimated Performance

- 100% TSS removal
- 70% TP removal
- 60% TN removal
- 50% annual runoff volume reduction
- 35% volume reduction for 2-year event

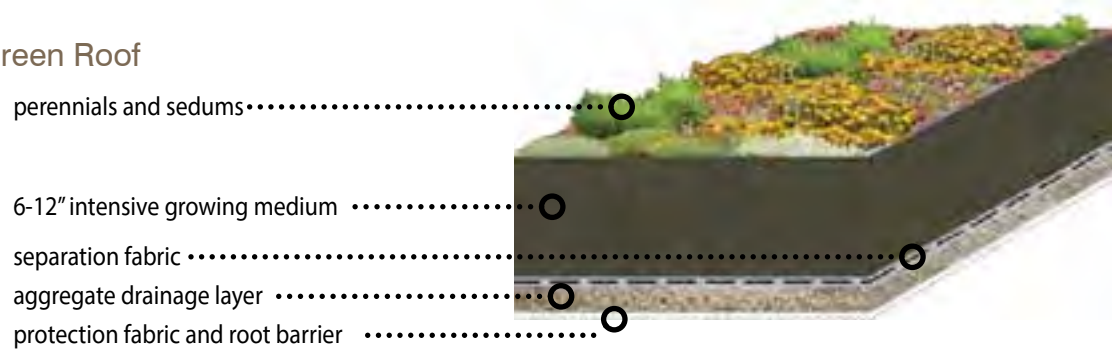
How Green Roofs Work:

Rather than allowing rainwater to immediately drain from a typical rooftop via downspouts, a green roof provides rainwater storage and rate attenuation in the soil medium and aggregate drainage area. As water slowly percolates through the soil layer, sedums and perennials can withdraw their required water intake and remove nutrients like phosphorus and nitrogen from the water. Water that isn't taken up by roots continues to the lower aggregate drainage area, where it is stored as it slowly discharges via perforated pipe to downspouts. To further improve phosphorus and nitrogen removal, annual removal of dead top growth of green roof vegetation should be performed. Nutrient and runoff reduction can also be improved through collection of excess storm runoff in cisterns or rain barrels and re-applying the runoff to the roof between storm events.

Extensive Green Roof



Intensive Green Roof



Green Roof Applications

Peggy Notebaert Nature Museum, Chicago, IL

Extensive Green Roof

Extensive Green Roofs can accommodate sedums for vegetation. The soil structure is about 3" thick.

Chicago City Hall Green Roof, Chicago, IL

Intensive Green Roof

Intensive green roofs have a deeper growing medium (typical 6-12") to allow perennials as well as sedums.

Iowa State College of Design, Ames, IA

Green Roofs for Stormwater Management

Green roofs help to treat and reduce rainfall where it falls, putting less of a demand on downstream stormwater management.

ASLA Headquarters, Washington D.C.

Green Roofs as Social Space

Green roofs can help beautify otherwise unusable rooftop space, making it an ideal social space.

TOOL:
Permeable Paving

Estimated Performance

- 88% TSS removal[1]
- 73% TP removal[1]
- 68% TN removal[1]
- 54% annual runoff volume reduction[1]
- 94% 100-year peak flow reduction[1]

Permeable Paving Benefits:

Permeable or perforated paving materials or pavers with spaces that allow for the infiltration of rainwater and transmission of water through an aggregate base to the subsoils. Runoff is temporarily stored in the base for infiltration into the subsoils and/or slow release to a bioswale or stormwater system. This reduces the volume of runoff, and also allows the water that does runoff to drop in temperature prior to lakes or streams to better protect the fish habitat.

How Permeable Pavers Work:

A permeable paving system allows rainwater to infiltrate beneath the top surface. Once below the surface, the water is temporarily stored in an open graded aggregate base. Some of this stored water will continue to infiltrate to native soils, depending on the soil type and conditions, and the remaining water will flow to a perforated pipe for eventual slow discharge into the storm system.

Estimated Performance:

The performance of a permeable paving system depends on its area, volume, drainage area, underlying soil permeability, and the design of the underdrain system. Properly sized permeable paving systems located in areas of permeable soils can be nearly 100% effective in reducing runoff rates and volumes and capture of urban runoff pollutants. However, the soils within Storm Lake have a high clay content and relatively low permeability. For the purposes of the Storm Lake analysis, the assumptions used are detailed in Appendix D.

← Voids between pavers to allow water to infiltrate into the gravel storage area below.

← Aggregate between pavers allows water to pass.

← A gravel storage layer is the base of the paver system. It provides structural strength to support cars and trucks. Rainwater is stored in the gravel layer and slowly released after a storm.

← Water contained in the gravel storage area will infiltrate into the existing soil. If clay soils are present, additional drains may be necessary.

[1] Expected performance data was developed assuming application of permeable paving over 50% of paved area. Site-appropriate design details should be implemented to encourage denitrification and phosphorus removal for lower permeability soil applications.

Permeable Paving Applications

JCI, Glendale, WI

Permeable Paving Parking Lot

Permeable Paving Parking lots can provide significant volume for stormwater infiltration due to their large footprint.

Charles City, IA

Permeable Paving Street

In addition to stored runoff, permeable parking streets in residential or downtown areas will add character.

Portland, OR

Permeable Paving Parking Lane

When its not feasible to install permeable pavers on an entire street, using them in parking lanes can still capture significant runoff volumes.

Permeable Alley

A traditional way to handle stormwater in a downtown area is to outlet downspouts into an alley. By installing permeable pavers in the alley, the roof runoff can be captured and treated rather than causing nuisance drainage problems and discharging to the storm system.

TOOL:
Street Trees

Carbon Cliff, IL

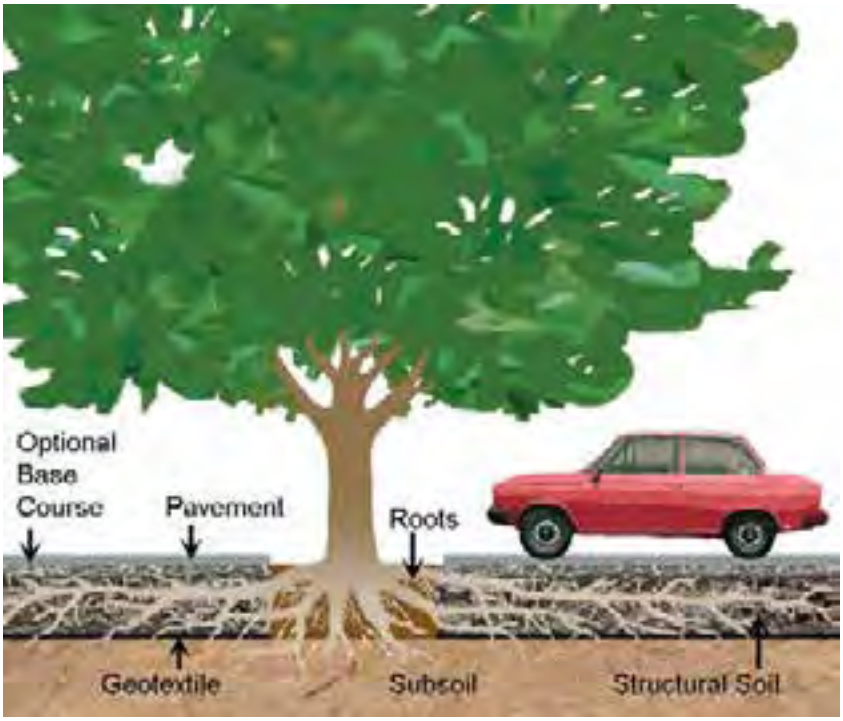
Street Tree Benefits:

Trees play a major role in stormwater management and overall community health. Broad tree canopies can intercept rain before it falls to the ground and allow for increased evapotranspiration, and elaborate root systems can draw up infiltrated water. Large canopies also create shade in otherwise paved locations. Trees also provide health benefits like increased air filtration and positive human responses to vegetation.

How Street Trees Work:

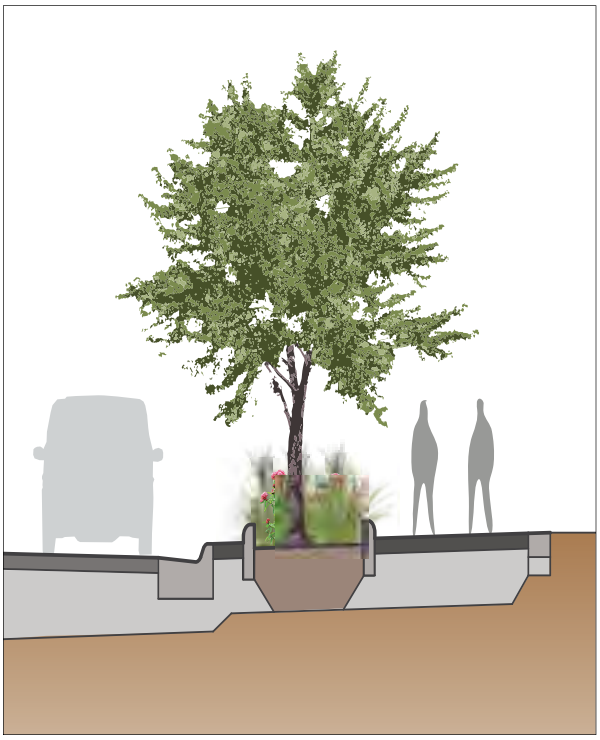
Trees can be planted along with many capital improvement projects within the parkway. In certain applications, such as limited right-of-way space, structural soils may be required to support trees. Structural soils are composed of small aggregate and clay soils. The rock provides structural support while the soil fills the void spaces and allows water to infiltrate and be stored, and root systems to thrive.

Street Tree Diagram:



Day, S.D, and S.B. Dickinson (Eds.) 2008. Managing Stormwater for Urban Sustainability using Trees and Structural Soils. Virginia Polytechnic Institute and State University, Blacksburg, VA, Pg. 2.

Street Tree Applications



NIRPC GI E.Chicago Booklet

Combining street trees with lower native plants or other vegetation can help maximize water captured by root systems. Layered vegetation also creates a more natural atmosphere.

Cornell University Structural Soil Report

Street trees can be installed in predominantly paved areas as necessary by using structural soils.

Carbon Cliff, IL

Street trees can be installed while maintaining plenty of sidewalk and courtesy walk space as required.

Charles City, IA

Over time, street trees will add significant shade and help cool walking paths and nearby seating areas.

TOOL: Bioretention

Bioretention Benefits:

A depression in the landscape that allows stormwater to be retained and filtered through soil for use by plants. During larger events, an underdrain will route water to storm sewer or other pathway. As with permeable paving, bioretention can reduce runoff volume, and also allows water that does runoff an opportunity to lower in temperature prior to discharge to a lake or stream.

How Bioretention Works:

Bioretention areas allow runoff from impervious surfaces into a depressional area with plants. Water can then filter through plant roots before slowly infiltrating to subgrade or entering the underdrain.

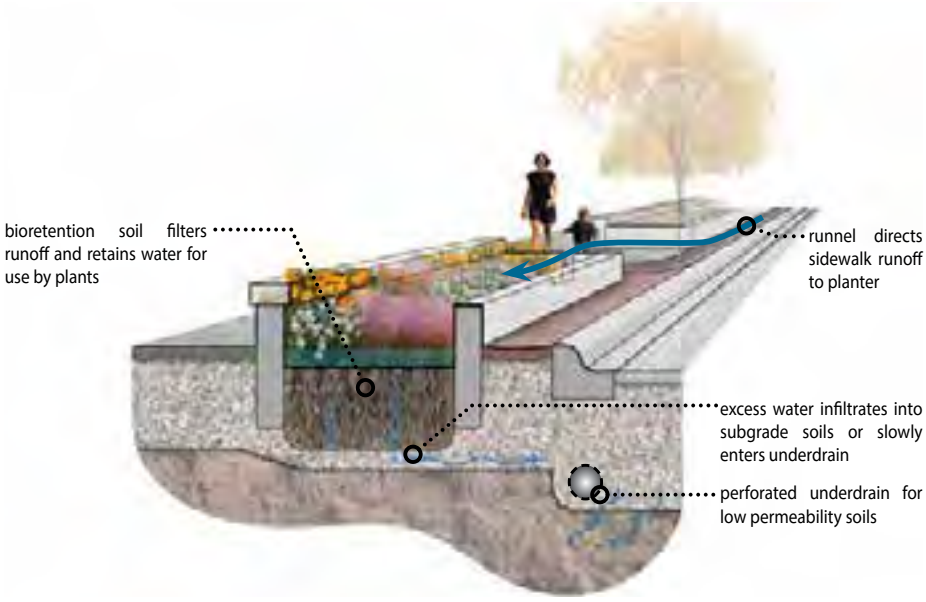
West Union, IA

Estimated Performance

- 89% TSS removal
- 63% TP removal
- 53% TN removal
- 26% annual runoff volume reduction
- 3% 100-year peak flow reduction

Estimated Performance:

The performance of bioretention systems depends on its area, volume, drainage area, underlying soil permeability, and the design of the underdrain system. Properly sized bioretention systems located in areas of permeable soils can be nearly 100% effective in reducing runoff rates and volumes and capture of urban runoff pollutants. However, the soils within Storm Lake have a high clay content and relatively low permeability. For the purposes of the Storm Lake analysis, the assumptions used are detailed in Appendix D. HydroCAD modeling along with typical Midwest rainfall frequency statistics were used to calculate the runoff volume and peak rate performance for bioretention.



Bioretention Applications

Morton Arboretum, Lisle, IL

Parking Lot Islands

Bioretention islands can capture runoff via curb cuts and filter water as it drains through soils. They also provide an opportunity to bring vegetation to beautify the area.

Parkways

Parkway bioretention practices can be installed and monitored by either a municipality or private property owners. They can be built to accommodate on street parking as well.

City of Boardman, OR

Medians and Boulevards

Medians and boulevards can be vegetated and amended with engineered soils to capture runoff from properly sloped streets. Medians can also help to slow traffic on neighborhood streets.

JCI, Glendale, WI

Rain Gardens

Rain gardens can be installed in most open areas with some amount of tributary drainage area. These installations with an engineered soil can be thriving communities of native plants with runoff storage capacity.

Bioretention Applications

West Union, IA

Bumpouts

Bumpouts can be highly functional features in downtown or residential areas. Their main focus is capturing runoff from streets and sidewalks for storage and filtration by plants or decorative aggregate. Secondary functions include opportunities to create protected parking spaces, slowing traffic, and shortening crosswalks.

West Union, IA

Planters

Planters, or tree boxes, can be installed flush with nearby grade, or built above grade with some sort of curb cut to allow water in. These can be planted with lower vegetation or trees to provide additional shade and potential cooling.

Highland Park, IL

Backyard Swales

Rather than removing runoff as quickly as possible from private property, backyard swales can still provide a conveyance route for runoff, but include benefits such as creating potential for runoff infiltration and adding native plants to the landscape.

TOOL:
Naturalized Swales

Naturalized Swale Benefits:

Similar to bioretention backyard swales, naturalizing a swale includes native plantings with extensive root structure to allow for water quality enhancement and a more diverse local ecosystem.

How Naturalized Swales Work:

These swales provide a flow path for runoff, but also serve as a filter for runoff by allowing for nutrient absorption before discharging to a downstream system. The plantings will slow water and also provide habitat for insects and small animals.

Estimated Performance

- 70% TSS removal
- 50% TP removal
- 40% TN removal
- 1% annual runoff volume reduction
- 10% 100-year peak flow reduction

Highland Park, IL

Estimated Performance:

Naturalized swales are primarily a conveyance feature that can also provide a water quality benefit. The performance of naturalized swales depends primarily on the velocity of the flow through the swale since settling is the primary pollutant removal mechanism. However, under conditions of permeable soils, volume reduction can also occur. Given the relatively tight clay soils in the Storm Lake area, and the lack of retention storage in the bottom of the swale, runoff volume reduction will be negligible. The list on this page details expected performance statistics for a naturalized swale. The values are generally based on information from the Minnesota Pollution Control Agency (MPCA) Minimal Impact Design Standards (MIDS) manual.

Poplar Creek Library, Streamwood, IL

West Union, IA

Design Considerations:

Naturalized swales can be implemented in open spaces to encourage native plants and infiltration. They also provide a means of conveyance to move water downstream during larger rain events.

TOOL:
Naturalized Detention

Naturalized Detention Benefits:

Used to temporarily store runoff and release it at a rate allowed by ordinances. Native wetland and prairie vegetation improves water quality and habitat benefits. Naturalized detention basins can be designed as either shallow marsh systems with little or no open water or as open water ponds with a wetland fringe and prairie side slopes.

Estimated Performance

- 90% TSS removal
- 50% TP removal
- 40% TN removal
- 5% annual runoff volume reduction
- 95% 100-year peak flow reduction

JCI, Glendale, WI

How Naturalized Detention Works:

Naturalized detention areas use the same principle as traditional detention by holding runoff and allowing it to be released at an allowable rate. What makes naturalized detention different is its additional functions as water quality and natural habitat areas. Native plantings will filter pollutants from the runoff and also provide a habitat for many insects and small wildlife.

Estimated Performance:

The performance of detention basins depends on its area, volume, drainage area, the presence of a permanent pool, and the vegetation in the bottom (in the case of a dry bottom basin) and sides. Properly sized detention basins are extremely effective in reducing peak flows. However, very little volume reduction is achieved due to the typically large drainage area ratio. Naturalized basins with a permanent pool of water can also be relatively effective for pollutant removal relative to dry bottom basins. The list on this page details expected performance statistics for a naturalized, wet bottom detention basin adequately sized to control the 100-year event. The values are generally based on information from the MPCA MIDS manual.

Poplar Creek Library, Streamwood, IL

University Research Park, Madison, WI

Wet and Dry Detention Basins

Most stormwater ordinances require runoff rate controls, typically accomplished with detention basins. While effective for controlling release rates, they provide no volume reduction and limited pollutant removal capacity. Naturalized wet basins provide a waterscape with a pollutant removing buffer of native plants. Dry basins may provide volume reduction as well as pollutant reduction.

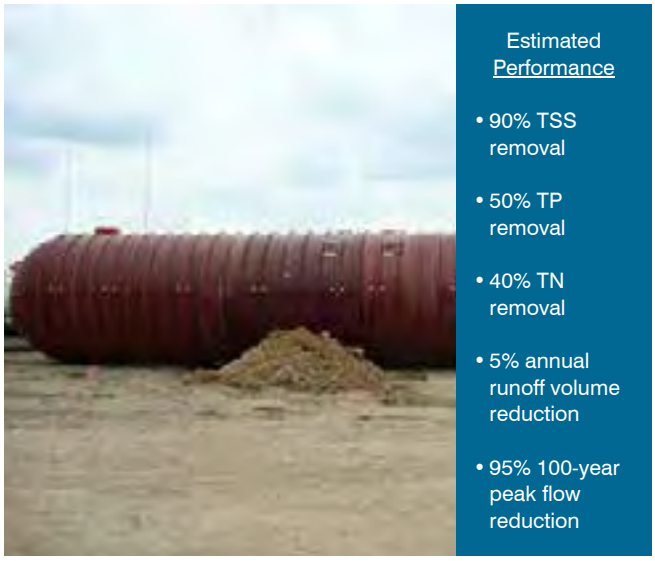
TOOL: Cisterns

Cistern Benefits:

A vessel used to capture and temporarily store rainwater for various uses, including greywater reuse and irrigation.

How Cisterns Work:

Cisterns capture water that would otherwise become runoff. The stored water is then typically pumped out to its reuse destination. If too much water becomes stored, the structure will allow water to overflow as runoff.



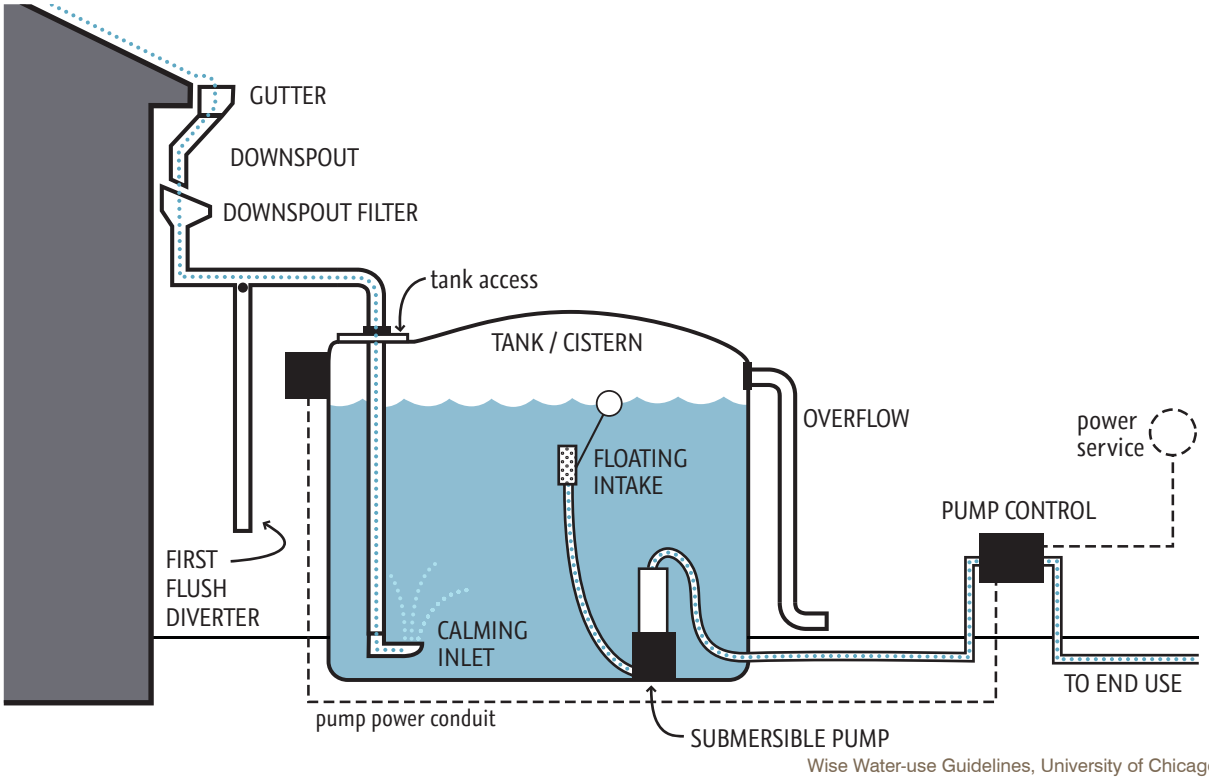
Estimated Performance

- 90% TSS removal
- 50% TP removal
- 40% TN removal
- 5% annual runoff volume reduction
- 95% 100-year peak flow reduction

30,000 Gallon Cistern, JCI, Glendale, WI

Estimated Performance:

Properly sized cisterns utilized as part of an automated irrigation system can virtually eliminate the need for potable water for irrigation. Further, annual runoff volumes can be reduced by amounts exceeding 40%. However, a cistern or rain barrel located at a residence that never uses the collected water will provide essentially no water conservation or runoff volume reduction benefits. Because of the highly variable nature of cistern systems, the Template and Scenario analyses that follow assumed no pollutant removal or runoff volume control benefits from cisterns.



Wise Water-use Guidelines, University of Chicago, IL

TOOL: Wastewater Discharge Reduction

Wastewater Discharge Reduction Benefits:

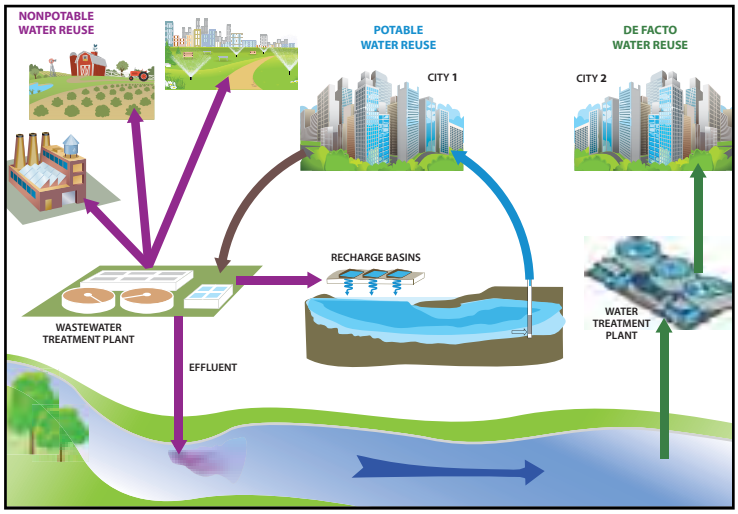
Reused water can be drawn from either treated wastewater or a grey water system. Recycling water from these sources helps to reduce demand on the potable water supply (an aquifer, lake, or river) and water treatment facility, and can reduce water use costs for high demand users. Water reuse can also help to reduce the total wastewater discharge volume from a facility, thereby reducing chemical use and sludge generation.

Mountain Forum

How Onsite Wastewater Discharge Reduction Works:

Depending on the wastewater source, water can be siphoned from the treatment process at different points for reuse elsewhere. In a grey water system the recycled water will be taken from sources with low organic content, such as drains from showers and laundry equipment. The water can be reused in a variety of applications including industrial cooling water, irrigation, and dust control.

Use of wastewater treatment facility effluent for golf course irrigation is regulated by IDNR with the following requirements: a minimum of 0.5 mg/L chlorine residual with a 15 minute contact time; prior to reuse, treated water must be held in a retention pond with a minimum detention time of 20 days; golf courses must post signs and notifications on score cards regarding oral contact with golf balls and tees, color code irrigation piping, and restrict public access to the courses. Reuse of treated water for other purposes is regulated by informal IDNR internal policies and project specific regulatory negotiations.



National Research Council
http://www.nap.edu/openbook.php?record_id=13514&page=7

Wastewater Discharge Reduction Applications

Los Angeles County, Department of Public Works

GarverUSA

International Water Management Institute

Weston Solutions

Cooling (top)

Treated wastewater can be used for industrial applications, particularly in process piping for cooling water.

Irrigation (left)

Irrigation of non-edible vegetation is an ideal use of treated wastewater.

TOOL: Onsite Wastewater Treatment

Onsite Wastewater Treatment Benefits:

Treating wastewater at its source has many benefits. It allows for a more targeted treatment process that is designed for the needs of the waste stream and reduces the loading on a downstream treatment plant. Onsite treatment can be more efficient than traditional centralized treatment, and offers the potential for a reusable byproduct. Onsite treatment of wastewater at industrial sites can help reduce sanitary piping and plant size. It also has the benefit of potential for reuse in other processes.

The Audubon Society's Corkscrew Swamp, Naples, FL

Wastewater from agricultural and food production is biodegradable and non-toxic but may be high in Biological Oxygen Demand and suspended solids. Wastewater from animal slaughterhouses may be contaminated with significant levels of antibiotics and pesticides that, if treated on site, can be kept out of a municipal waste stream.

How Onsite Wastewater Treatment Works:

Onsite treatment can take many forms, but typically makes use of a circulated water body, aeration and baffling, and plants for pollutant uptake and conversion.

Treating Concentrated Wastes:

For concentrated wastes, treatment may take the form of bio-reactors or anaerobic digesters. The biological digestion of concentrated, carbon rich effluent may provide a source of fuel and energy that offsets or even covers the cost of treatment. Treated water can be reused onsite as process water and help reduce the demand on municipal drinking water systems.

Residual solids produced by these processes may be higher quality than comparable residual left over from the treatment of municipal waste. Sludge generated from food wastes should be low in heavy metals and other contaminants that compromise the value of compost and fertilizer. This may allow for these waste residuals to be converted into a saleable product.

Neptunes Harvest in Gloucester, Massachusetts – Neptunes Harvest is a successful organic fertilizer product developed by Ocean Crest Seafood that composts fish wastes from the fishing industry.

MillerCoors Ethanol Plant in Golden, Colorado – MillerCoors produces 3 to 5 million gallons per year of ethanol from its brewing residual products.

Treating Dilute Wastes:

Onsite treatment of dilute wastes can be accomplished more simply near the source than if mixed with municipal wastewater. Wastewater such as contaminated runoff or vehicle wash water may require only minimal treatment before they can be safely reused for irrigation or process water. Treatment of dilute wastes may be efficiently accomplished through natural treatment methods including the retrofitting of stormwater ponds with enhanced ecological treatments.

Tyson Lagoon Restorers in Berlin, Maryland – Effluent from Tyson's poultry processing plant was frequently out of compliance with the Maryland EPA's regulatory requirements for discharge. Twelve restorers were installed on the nine million gallon lagoon, turning the lagoon into a thriving ecological environment and bringing Tyson into regulatory compliance for discharge into the Chincoteague Bay.

Additional Previous Projects:

Omega Center for Sustainable Living in Rhinebeck, New York – The Center was designed to meet the Living Building Challenge. The facility, integrated into public space within a campus building, treats up to 50,000 gallons per day of sewage from the nearby campus through an Eco-Machine and discharges treated effluent to groundwater.

The Audubon Society's Corkscrew Swamp in Naples, Florida – This site uses an Eco-Machine with solar aquatic cells and two wetlands to treat 10,000 gallons/day of wastewater from Corkscrew's visitor facilities.

Omega Center for Sustainable Living , Rhinebeck, NY

Tyson Lagoon Restorers, Berlin, MD

MillerCoors Ethanol Plant, Golden, CO

Tyson Lagoon Restorers, Berlin, MD

Omega Center for Sustainable Living, Rhinebeck, NY

b. Land Use Templates

Creating templates based on typical land use in the community helps to plan how multiple tools can be used together to achieve the performance goals. Four templates were used based on predominant land use throughout the city:

- Downtown Commercial
- Residential
- Campus
- Big Box Commercial / Industrial

Besides these templates, an open space land use was also considered. This includes park space and ball fields, and was used only for calculation purposes and is therefore not shown here.

Downtown Commercial Land Use Template

Downtown Commercial Land Use

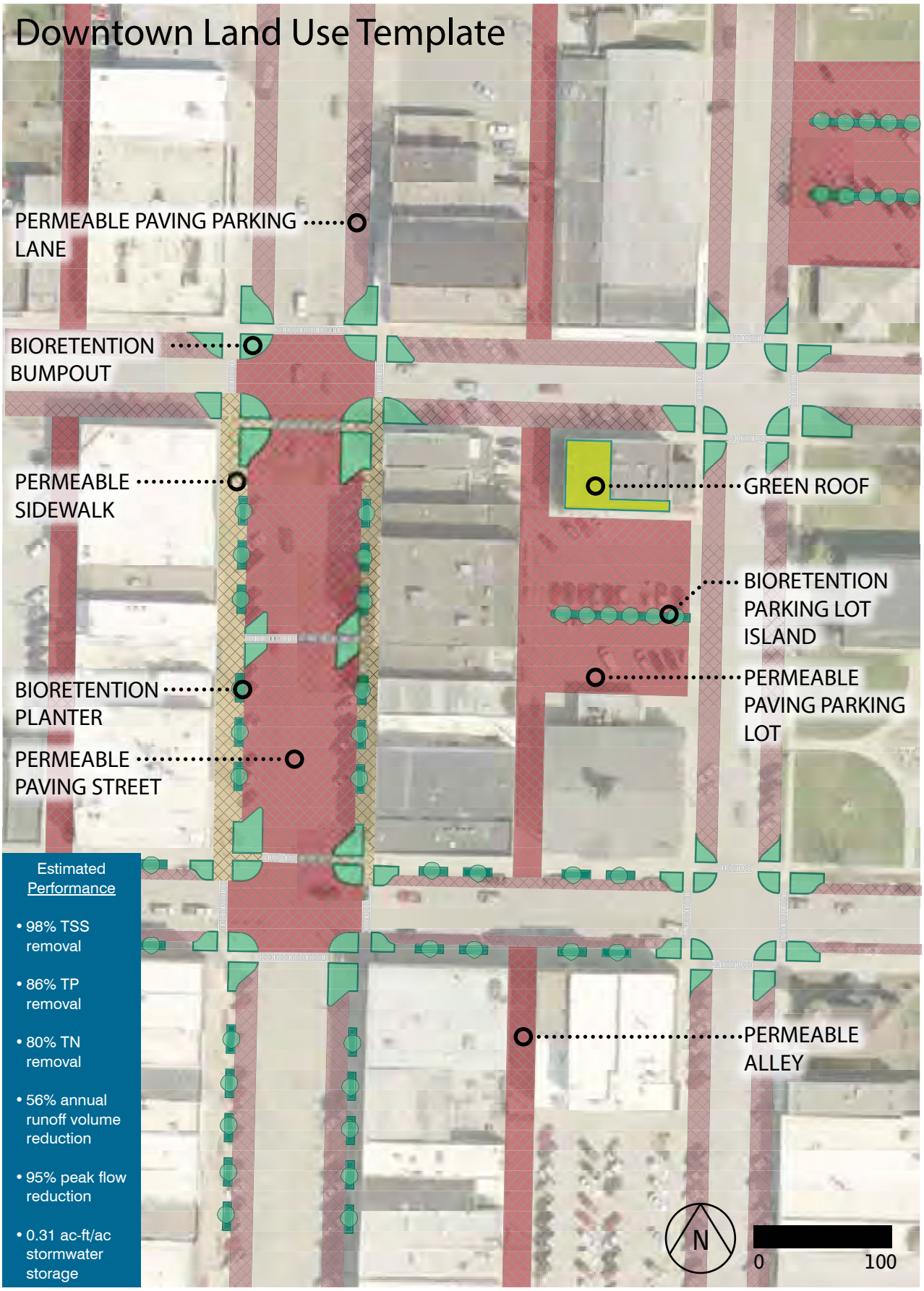
The downtown commercial district is a significant portion of land use in Storm Lake. It consists of a highly concentrated impervious area, where large amounts of storm runoff are directed to alleys and immediately into the storm sewer network in the street without control before discharge to Poor Farm Creek. In addition to the runoff quality and quantity benefits, green infrastructure in the downtown area can reignite interest in the local economy through improved landscape, pedestrian circulation, and sense of place as well as create learning opportunities and an attraction for community-minded businesses. Potential green infrastructure in the downtown commercial district includes permeable paving, bioretention bump outs and planters, green roofs, permeable alleys, and cisterns for landscape irrigation.

How the Tools are Used:

- **Bioretention Bumpout:** this feature will accomplish several benefits including additional planted area for stormwater filtration, protected parking areas along the street, and safer pedestrian crossings.
- **Bioretention Planter:** these features can be integrated into sidewalk areas to capture sidewalk runoff as well as screen parked vehicles and beautify the downtown area. If tree wells are installed, increased shade will help to cool the area in warm months.
- **Bioretention Parking Lot Islands:** Many lots already have concrete and/or vegetated islands to delineate parking areas. These features, where they exist, can easily be converted to bioretention areas and can often be incorporated where they don't exist to provide landscape to improve shading and soften large expanses of parking while also capturing and treating runoff.
- **Permeable Paving Street:** Particularly in a downtown area, a brick paver street can add character as well as runoff reduction benefits.
- **Permeable Paving Parking Lane:** In certain circumstances, it may make sense to only pave a portion of a road with pavers. Whether the road has diagonal, parallel, or perpendicular parking, permeable pavement will capture much of the runoff due to the crowned surface of the road.
- **Permeable Paving Parking Lot:** Resurfacing parking lots with pavers can dramatically reduce runoff volumes, depending on the footprint.
- **Permeable Sidewalk:** To capture water before it runs onto the street, pavers can be applied to the sidewalks as well. Permeable paving can reduce icing of the pedestrian surfaces, reducing the need for salt and other compounds that have significant negative water quality impacts as well as being detrimental to flooring materials interior to the local businesses.

Estimated Performance:

- Based on the Template shown, performance levels have been estimated for use in the Scenario analyses described in the next section.
- Although performance levels have been calculated to represent this Template, actual performance will depend on selected practices, level of implementation, soil permeability, and the chosen design rainfall event.
- The performance levels were largely calculated based on the methods of the MPCA MIDS manual for water quality and HydroCAD analysis for runoff volumes and rates based on similar projects.


Downtown Land Use Template
PERMEABLE PAVING PARKING LANE
BIORETENTION BUMPOUT
PERMEABLE SIDEWALK
GREEN ROOF
BIORETENTION PARKING LOT ISLAND
BIORETENTION PLANTER
PERMEABLE PAVING PARKING LOT
PERMEABLE PAVING STREET
PERMEABLE ALLEY
Estimated Performance
• 98% TSS removal
• 86% TP removal
• 80% TN removal
• 56% annual runoff volume reduction
• 95% peak flow reduction
• 0.31 ac-ft/ac stormwater storage
N
0
100

Residential Land Use Template

Residential Land Use

Residential areas make up the majority of the City's land use. Portions of the residential areas have extra wide rights-of-way and streets wider than necessary for local traffic. Where they exist, the extra wide streets and rights-of-way provide space for bioretention center medians, expanded parkways (between the walk and curb), and landscape bump outs. Within the paved areas, permeable paving can be used to address street runoff, address nuisance drainage problems, and reduce the load on the storm sewer system. Additionally, private property can make use of individual rain gardens and back lot line bioretention swales.

How the Tools are Used:

- **Bioretention Bumpout:** These can provide protected parking at intersections, improve pedestrian safety, and also treat and store runoff.
- **Parkway:** This area within the right-of-way can often be converted to rain gardens to address runoff from the front yards as well as the street. However, conflicts with existing mature street trees can often limit the feasibility of bioretention parkways. Bioretention parkways can either be maintained by the residents or the City.
- **Bioretention Median:** Creating a median in the residential street will help to slow traffic on overly wide streets and also provide for stormwater capture and beautification. Integration of bioretention medians will be feasible on only selected streets in Storm Lake.
- **Bioretention Backyard Swales and Rain Gardens:** Some backyard areas are particularly well suited for backyard bioretention swales that temporarily hold roof and driveway runoff. These features can also be used to address nuisance drainage problems where they exist.
- **Permeable Paving Street and Parking Lane:** Permeable paving through the entire street cross section can provide for a durable and long lasting pavement system as well as providing significant storage volume. Placing pavers along only the parking lane will still allow for most street runoff to be captured at a potentially lower cost.

Estimated Performance:

- Performance depends on selected practices, level of implementation, soil permeability, and the chosen design rainfall event.
- The performance levels were largely calculated based on the methods of the MPCA MIDS manual for water quality and HydroCAD analysis for runoff volumes and rates based on similar projects.


Residential Land Use Template
BIORETENTION BUMPOUT
BIORETENTION PARKWAY
PERMEABLE PAVING PARKING LANE
BIORETENTION MEDIAN
Bioretention Backyard Swale
Estimated Performance
• 88% TSS removal
• 68% TP removal
• 60% TN removal
• 49% annual runoff volume reduction
• 75% peak flow reduction
• 0.21 ac-ft/ac stormwater storage
N
0
100

Campus Land Use Template

Campus Land Use

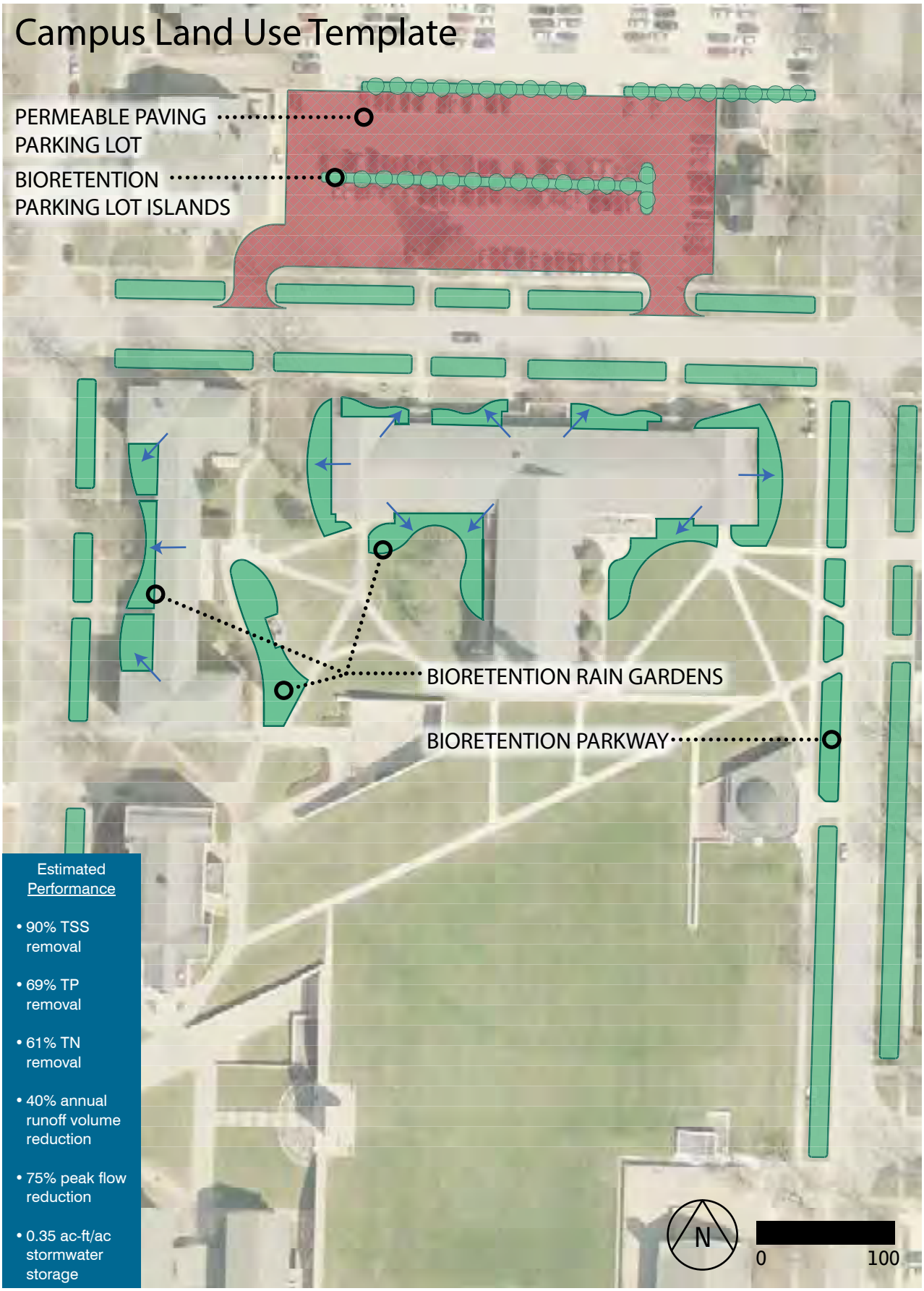
Campus areas typically contain large buildings surrounded by relatively large lawn and landscape, and shared parking areas where the campus contains multiple buildings. The large rooftops typically have downspouts directly connected to storm sewer, while large parking lots contribute large runoff volumes and stormwater pollutant loads. Potential green infrastructure tools include permeable paving parking lots, bioretention parking lot islands, rain gardens, naturalized detention, street trees, green roofs, and cisterns for non-potable uses. Within Storm Lake, the campus Template was used to represent the public school sites and Buena Vista University.

How the Tools are Used:

- **Bioretention Parkway:** These planted areas along the streets, combined with curb cuts, can be used to manage street, sidewalk, and other street side impervious runoff.
- **Bioretention Rain Garden:** Campus areas tend to have large lawn and landscape areas surrounding the buildings providing significant available space for the integration of rain gardens to manage roof runoff.
- **Permeable Paving Parking Lot:** Campus areas also tend to have large areas of impervious parking lot. Replacing these with permeable pavers can capture large amounts of runoff.
- **Bioretention Parking Lot Island:** By themselves or in combination with permeable pavers, bioretention islands can be used to manage parking lot runoff while also providing significant shading and other landscape beautification.

Estimated Performance:

- Performance depends on selected practices, level of implementation, soil permeability, and the chosen design rainfall event.
- The performance levels were largely calculated based on the methods of the MPCA MIDS manual for water quality and HydroCAD analysis for runoff volumes and rates based on similar projects.


Campus Land Use Template
PERMEABLE PAVING PARKING LOT
BIORETENTION PARKING LOT ISLANDS
BIORETENTION RAIN GARDENS
BIORETENTION PARKWAY
Estimated Performance
• 90% TSS removal
• 69% TP removal
• 61% TN removal
• 40% annual runoff volume reduction
• 75% peak flow reduction
• 0.35 ac-ft/ac stormwater storage
N
0
100

Big Box Commercial / Industrial Land Use Template

Big Box Commercial/Industrial Land Use

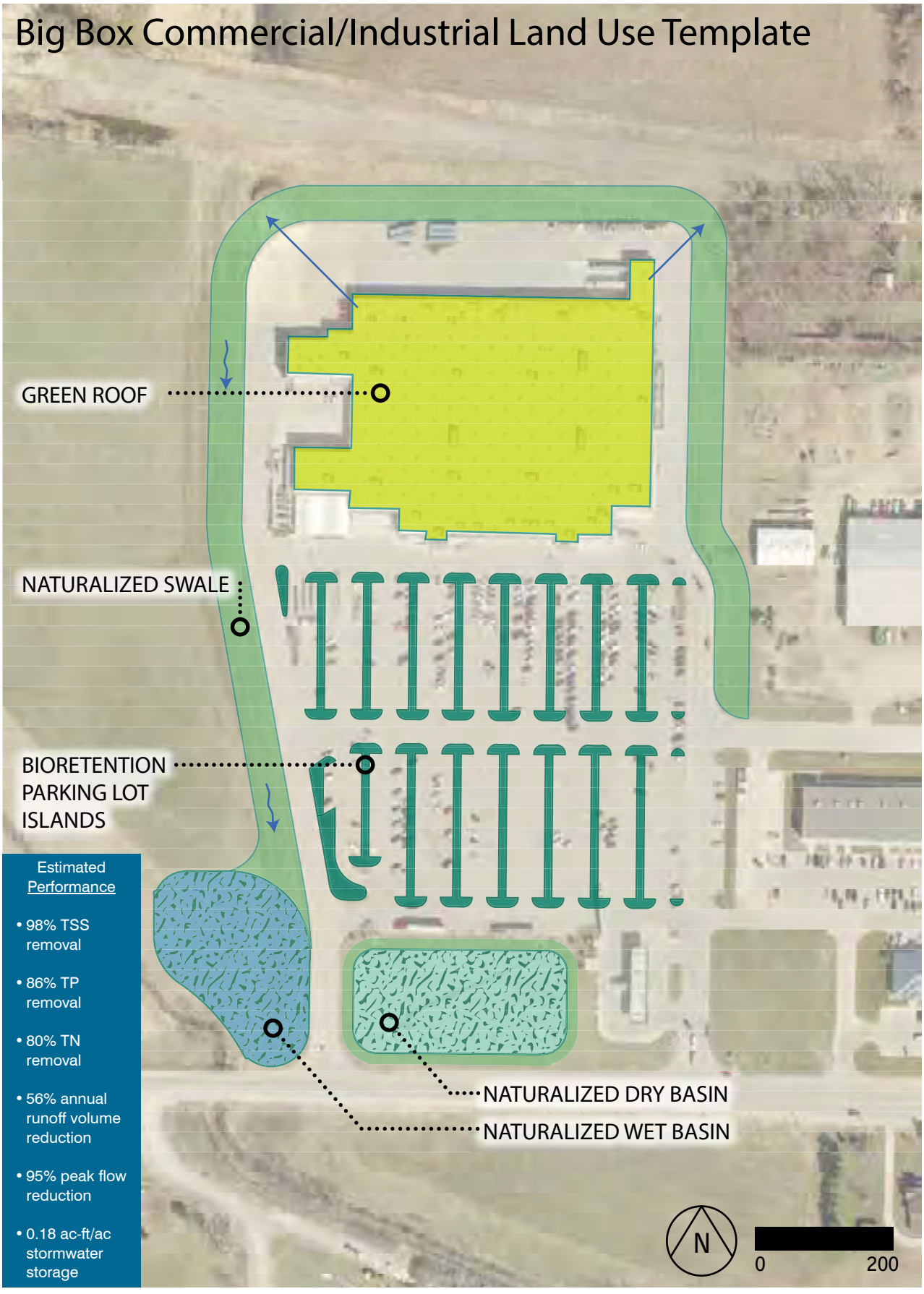
The big box Template land use is intended to represent typical suburban large lot commercial developments that include large roof and paved areas, and limited open space. Included in this land use type are big box retail land uses such as Walmart and larger industrial sites that are also composed of large buildings with large parking lots. Permeable paving parking, bioretention parking lot islands, green roofs, naturalized detention, and cisterns are potential Toolbox items for this land use.

How the Tools are Used:

- **Green Roof:** Both commercial and industrial land use areas tend to have large rooftops that produce significant amounts of rainwater runoff. These are prime opportunity areas for green roofs to slow the rate of runoff from the roof. In addition to stormwater runoff volume reduction, green roofs can provide significant heating and cooling benefits as well as improve views and potential outdoor space where roof areas are visually or physically accessible to building occupants.
- **Bioretention Parking Lot Areas:** Many commercial and industrial parking lots are large and completely impervious, producing large amounts of runoff. There are typically many parking spaces that are required by zoning code that could potentially be converted to bioretention islands where actual experience indicates that fewer parking spaces would be adequate.
- **Naturalized Detention:** Many existing parcels of this Template type already have detention areas. However, many are dry bottom basins that do not provide significant water quality benefits, particularly those that have low flow channels through the bottom. To achieve water quality benefits, dry bottom detention areas can be converted to naturalized detention.
- **Naturalized Swale:** Many sites of this size include edge-of-lot landscape that could be converted to naturalized swales to manage roof runoff and/or pavement runoff to slow the rate of water and improve water quality benefits.

Estimated Performance:

- Performance depends on selected practices, level of implementation, soil permeability, and the chosen design rainfall event.
- The performance levels were largely calculated based on the methods of the MPCA MIDS manual for water quality and HydroCAD analysis for runoff volumes and rates based on similar projects.


Big Box Commercial/Industrial Land Use Template
GREEN ROOF
NATURALIZED SWALE
BIORETENTION PARKING LOT ISLANDS
Estimated Performance
• 98% TSS removal
• 86% TP removal
• 80% TN removal
• 56% annual runoff volume reduction
• 95% peak flow reduction
• 0.18 ac-ft/ac stormwater storage
NATURALIZED DRY BASIN
NATURALIZED WET BASIN
N
0
200

c. Scenario Analysis

Under the scenario analysis, a range of assumptions can be made regarding the level of implementation of the green infrastructure Templates throughout the City. The scenario analysis assumes the levels of performance described in the Toolbox and Template sections of this Plan. Before the city-wide performance can be determined, the level of implementation of the Templates must be assumed.

Level of Implementation of Templates:
This portion of the scenario analysis looks at what proportion of the Template conditions will receive projects and are the areas of the community where implementation would be prioritized. Three levels of implementation were considered, as described below. These levels of implementation are further detailed with proposed projects in Section 7.

1. Near-Term Implementation
This level of implementation includes projects and areas that the City is already considering for green infrastructure implementation. Some projects are in the design phase, some are in construction, and others are planned for construction within the next one to two years. These are projects that should be incorporated into the City Capital Improvement Plans for the next two years.

2. Medium-Term
This level of implementation represents a moderate level of implementation that should be achievable over the next two to ten years, including the projects in the Near-Term Implementation. The projects identified are primarily focused on public projects, but projects on private property along with development and redevelopment will also contribute to achieving the goals of this Plan.

3. Long-Term Implementation (50-Year Plan)
This level of implementation assumes a complete implementation of the green infrastructure Templates throughout the City. The Scenario was developed as an aspirational plan that the City can work towards as municipal urban infrastructure projects are implemented and development and redevelopment projects occur. For the purposes of this document, this is referred to as the “50-year Plan”. The project team solicited input from the community, including city officials, local industry and residents, and regulatory agencies, regarding goals and needs for water management best practices to consider in this Plan.

d. Analysis Results

Full Implementation Plan (50-Year Plan)

Water Quality Analysis

Consistent with the 50-year Plan assumptions, the green infrastructure Templates and their associated pollutant load reductions were applied throughout the study area. The results are shown in Figures 7B, 8B, and 9B of Appendix C, and are also shown below. Comparing these figures to the figures presented in Section 4, Analysis of Existing Conditions, shows a dramatic reduction in pollutant load from existing conditions to proposed conditions with full implementation of green infrastructure. Comparing the Existing and Proposed TSS maps shows that the majority of the City that was in the orange and red ranges under existing conditions are reduced to the blue ranges throughout the City under the 50-year Plan. Similarly, comparing the Existing and Proposed TP maps shows that the TP load is reduced from the orange and brown ranges down to the yellow range throughout the City. Finally the TN loads are reduced from the blue range in many areas of the City (primarily commercial and industrial) to the green range throughout.

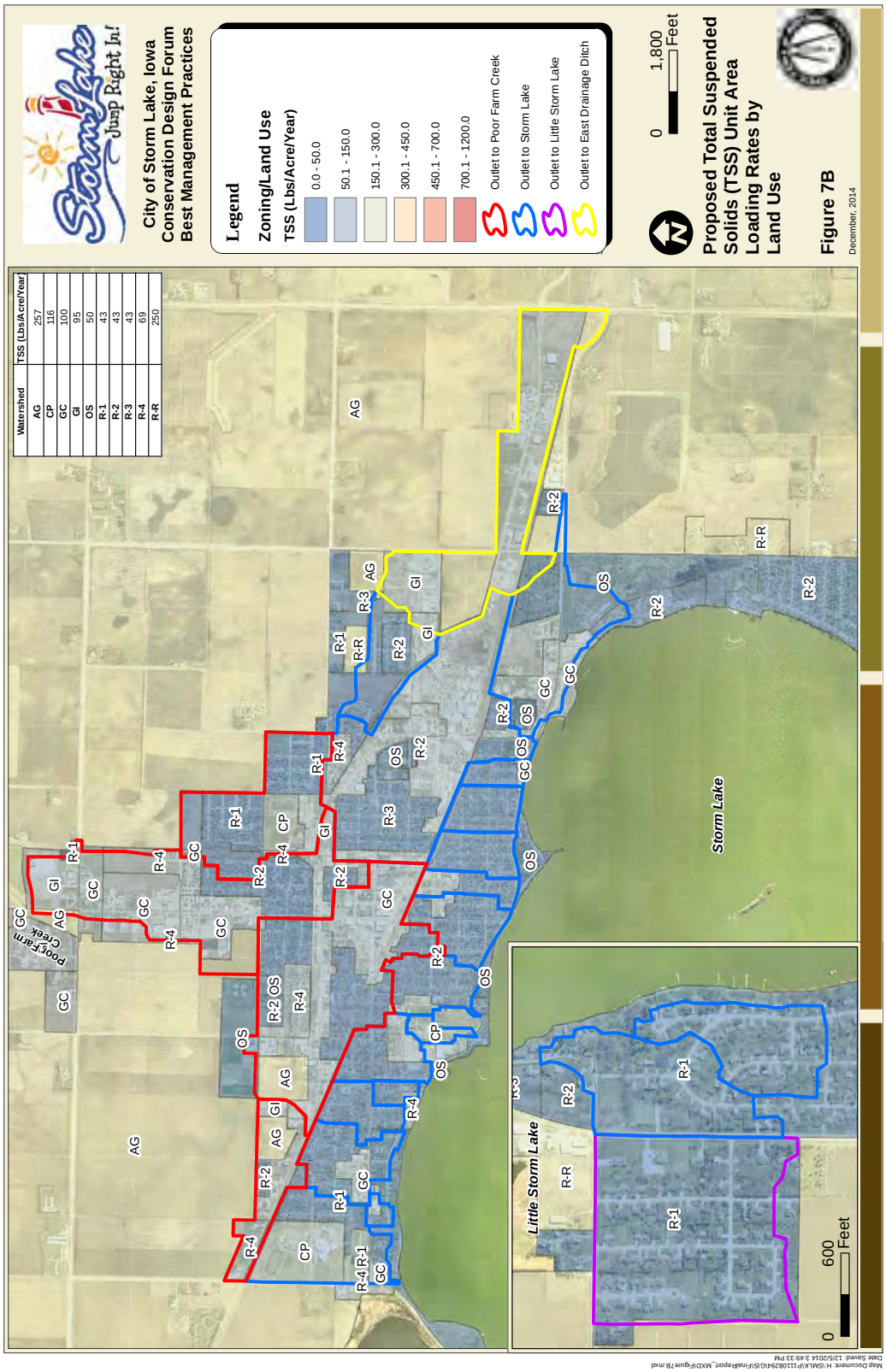


Figure 7b: Proposed TSS Unit Area Loading Rates Map (Appendix C)

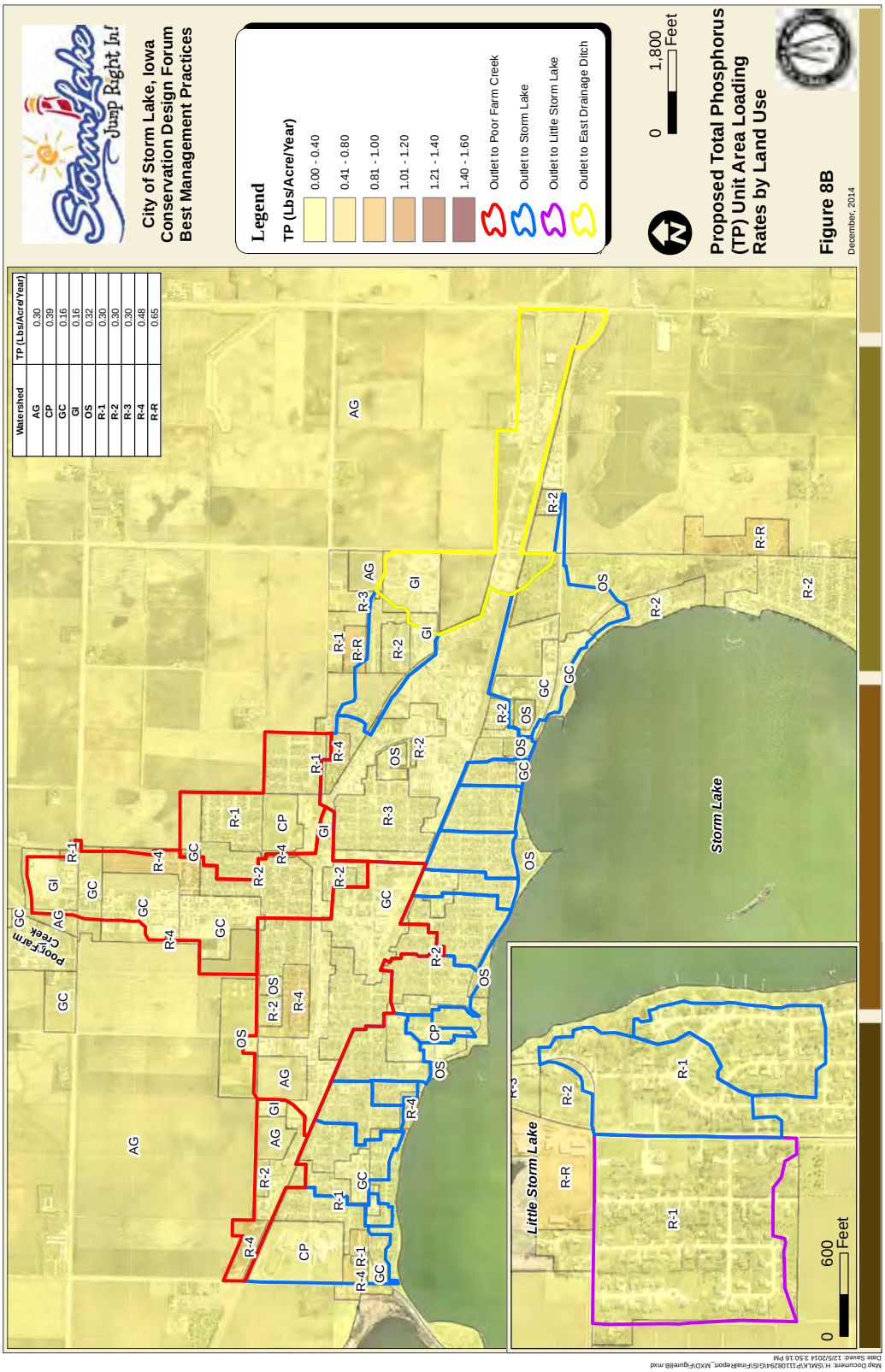


Figure 8b: Proposed TP Unit Area Loading Rates Map (Appendix C)

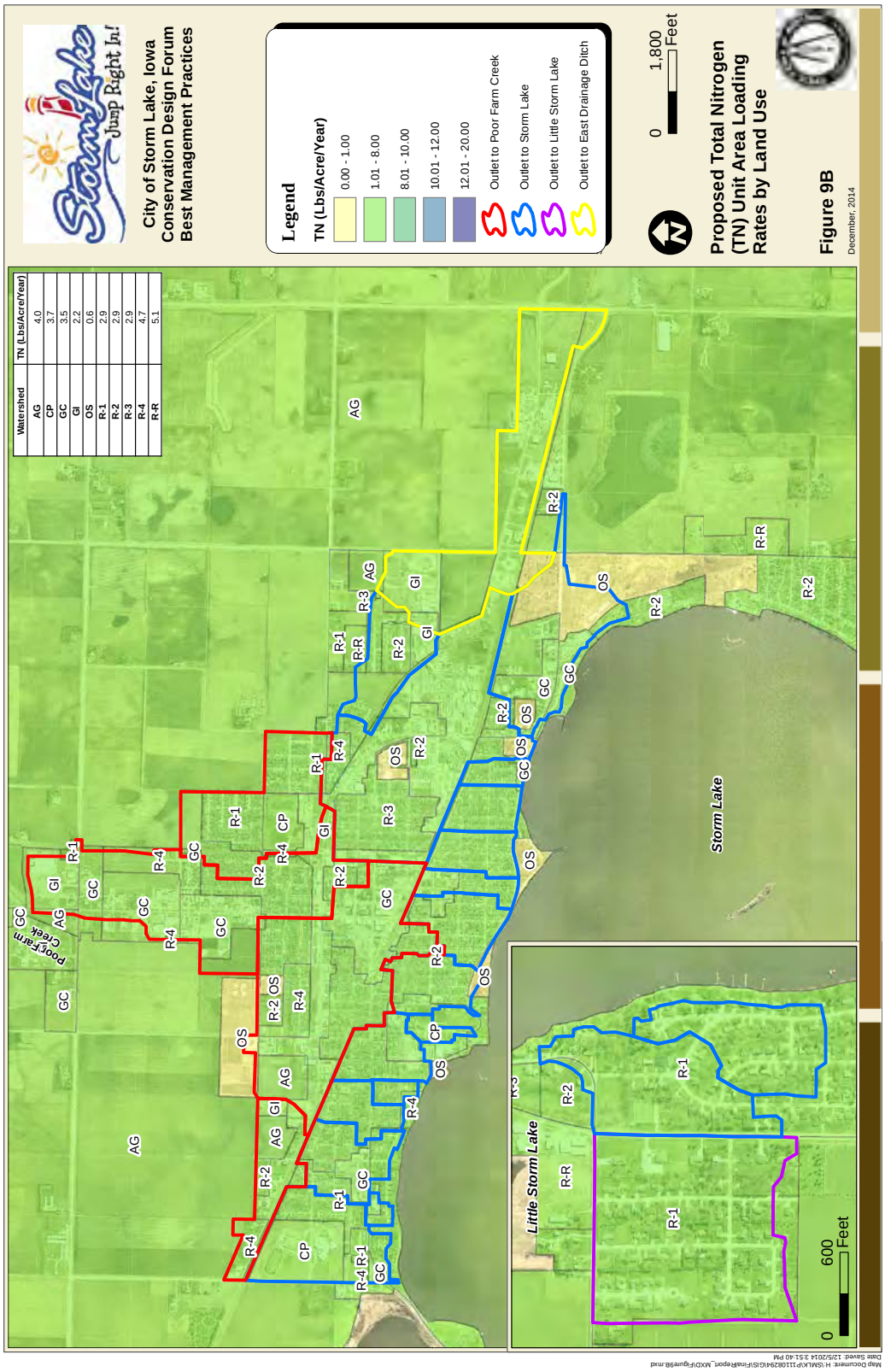


Figure 9b: Proposed TN Unit Area Loading Rates Map (Appendix C)

Full Implementation Plan (50-Year Plan) (Continued)

Flooding Assessment

The Stormwater Drainage and Flooding details in Section 4 of this Plan describe 23 areas of the City that experience regular flooding as indicated by the models. To assess the potential for green infrastructure to address the 23 flood problem areas, the flood volumes under existing conditions were compared to the potential available flood storage in the green infrastructure Templates within the tributary drainage areas, assuming full implementation of the Templates (the 50-year Plan). The following table shows the results of the flooding analysis of existing conditions in the "Flooding Details" columns. The volumes shown are the volumes of runoff exceeding the capacity of the existing stormwater system. This is an approximation of the volume that must be provided by green infrastructure to address the flooding.

The volumes in the "Green Infrastructure Implementation" columns show the volume that could be provided within green infrastructure in the contributing runoff area of each flood prone area if the templates were fully implemented (Long-term) and partially implemented (Medium-term). The last two columns show the proportion of the contributing area over which green infrastructure must be implemented to address the 10- and 100-year flood events for each flood prone area. These columns show that the green infrastructure would likely only need to be distributed over a portion of the contributing areas to achieve flood protection for most of the flood prone areas.

Flood Prone Areas and Potential Flood Protection

Flood Prone Areas (App. D - Fig. 3A)		Flooding Details						Green Infrastructure Implementation			
		10-Year Event			100-Year Event			Full (Long-term)	Moderate (Medium-term)	% Required for:	
Area	Drainage Area (Ac)	Depth (ft.)	Volume (Ac-ft)	Volume (ac-ft/ac)	Depth (ft.)	Volume (Ac-ft)	Volume (ac-ft/ac)	Volume Provided (ac-ft/ac)		10-year Protection	100-Year Protection
1	48.6	1.5	0.4	**0.01**	2.1	1.1	**0.02**	**0.20**	-	**4%**	**11%**
2	113.3	1.1	7.4	**0.07**	Not Mapped	Not Mapped	**N/A**	**0.14**	-	**47%**	**N/A**
3	171.0	2.6	5.1	**0.03**	3.8	16.0	**0.09**	**0.25**	**0.06**	**12%**	**38%**
4	18.2	0.7	0.5	**0.03**	1.4	2.0	**0.11**	**0.20**	-	**13%**	**54%**
5	20.7	0.8	0.5	**0.02**	1.5	1.8	**0.09**	**0.19**	-	**12%**	**44%**
6	96.0	1.6	2.9	**0.03**	2.0	4.6	**0.05**	**0.18**	**0.05**	**16%**	**26%**
7	164.8	1.8	4.1	**0.02**	4.7	53.4	**0.32**	**0.18**	-	**14%**	**177%**
8	164.2	2.3	4.9	**0.03**	6.4	49.9	**0.30**	**0.11**	**0.03**	**26%**	**266%**
9	15.1	1.7	0.4	**0.03**	1.8	0.5	**0.04**	**0.21**	-	**14%**	**17%**
10	38.5	0.8	0.1	**0.00**	1.3	0.2	**0.01**	**0.24**	-	**1%**	**2%**
11	66.6	1.7	1.8	**0.03**	3.2	6.6	**0.10**	**0.20**	**0.05**	**13%**	**49%**
12	56.0	1.9	3.8	**0.07**	2.4	6.3	**0.11**	**0.11**	-	**62%**	**104%**
13	27.3	1.5	0.3	**0.01**	2.2	0.9	**0.03**	**0.21**	-	**5%**	**15%**
14	95.3	3.6	41.1	**0.43**	4.1	52.3	**0.55**	**0.03**	-	**1458%**	**1855%**
15	238.3	3.5	2.9	**0.01**	8.7	85.9	**0.36**	**0.03**	-	**39%**	**1153%**
16	53.1	4.7	2.5	**0.05**	8.0	23.9	**0.45**	**0.12**	-	**39%**	**376%**
17	40.8	1.6	0.5	**0.01**	2.4	2.9	**0.07**	**0.13**	-	**10%**	**56%**
18	41.9	2.3	3.5	**0.08**	3.0	7.3	**0.17**	**0.00**	-	**N/A**	**N/A**
19	29.0	4.7	214.7	**7.40**	Not Mapped	Not Mapped	**N/A**	**0.00**	-	**N/A**	**N/A**
20	41.7	4.2	4.8	**0.12**	7.6	9.2	**0.22**	**0.14**	-	**82%**	**156%**
21	42.2	N/A	2.8	**0.07**	N/A	8.4	**0.20**	**0.21**	**0.11**	**31%**	**95%**
22	19.5	2.4	1.6	**0.08**	2.6	2.2	**0.11**	**0.21**	-	**39%**	**53%**
23	14.3	1.8	0.5	**0.03**	2.0	0.6	**0.04**	**0.21**	-	**15%**	**20%**

Note:

- Depths for Areas 14 - 20 obtained from modeling completed during EOR study of Enterprise Blvd.

Near- and Medium-Term Implementation Plan

This Scenario represents projects that are identified for Near-Term implementation within one to two years, as well as more Medium-Term (two to ten years) projects. Several criteria were used to determine what priority level should be put on a particular problem area. Criteria separating this Scenario from the Long-Term Scenario are the following:

- Areas with 1.5 ft flood depths or greater
- Areas with 1.0 ac-ft flood volumes or greater
- Areas that could achieve 10-year flood protection with less than 25% green infrastructure implementation across the drainage area
- Areas that could achieve 100-year flood protection with less than 50% green infrastructure implementation across the drainage area
- Other areas with a majority of non-agricultural land use types that do not meet the above criteria, but do have greater than 0.2 ac-ft/ac flood volumes

The flood prone areas that meet these criteria are shown under the “Moderate (Medium-term)” column in the table above. This column incudes implementation of both Near- and Medium-Term projects. The recommended projects in each of these areas are prioritized and discussed in more detail in the Implementation Prioritization section below. They are also shown in Figure 3B of Appendix C and below.

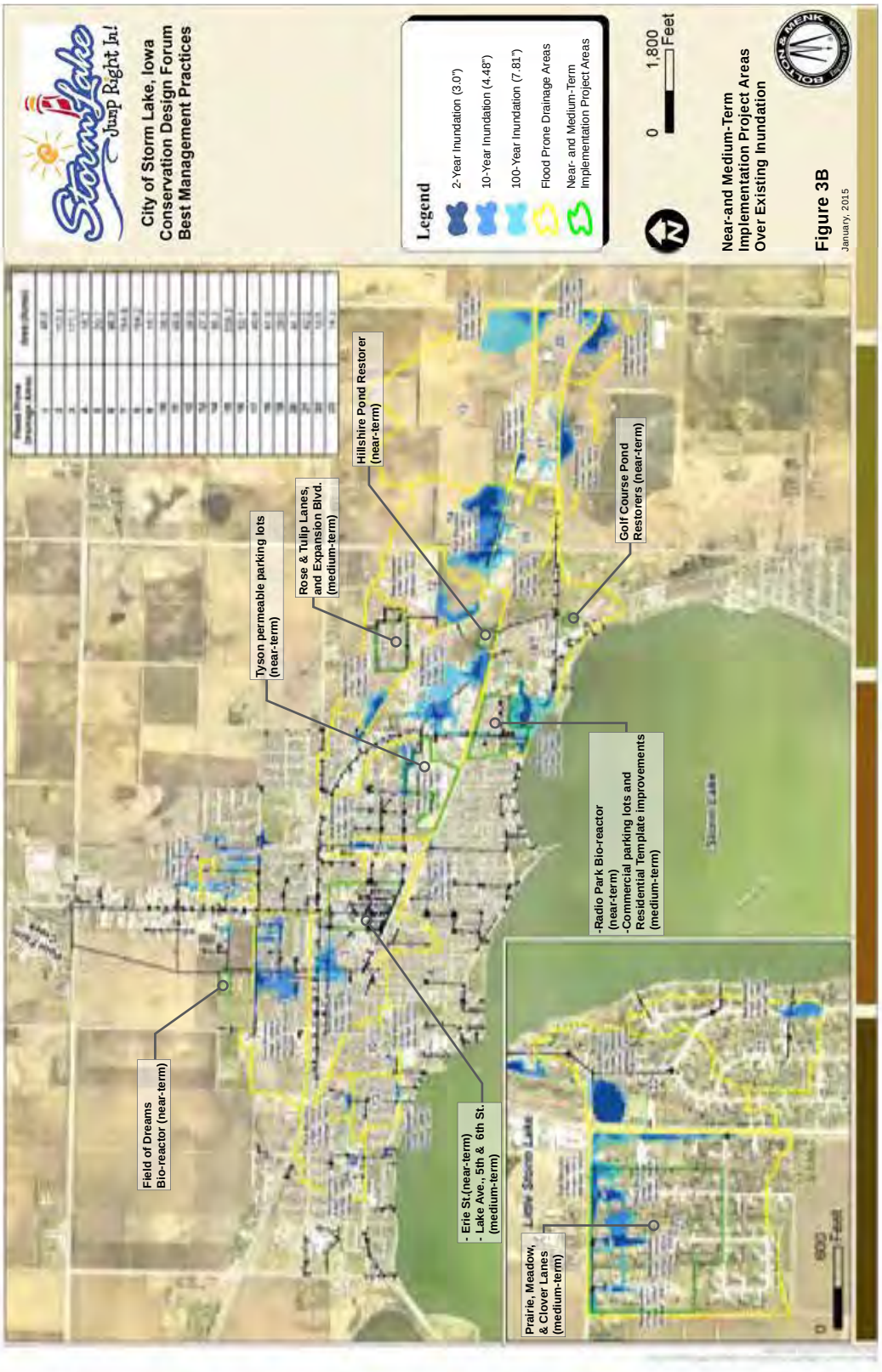


Figure 3b: Near- and Medium-Term Project Areas (Appendix C)

e. Water and Wastewater Integration

The following opportunities for green water and wastewater treatment infrastructure were identified to further improve water quality and provide other benefits. Several of these efforts are described in more detail in Appendix E.

Tyson/City Biosolids Processing Facility

The City and Tyson wastewater treatment facilities are adjacent to each other southeast of the City. Both wastewater treatment facilities include biological treatment processes that generate biosolids. The biosolids must be disposed off-site. Tyson currently stores biosolids in a lagoon and periodically dredges solids from the lagoon and land applies the liquid sludge to agricultural land. The City stabilizes the biosolids for pathogen reduction with aerobic digestion. The City then dewaters the biosolids with a rotary press, stores the dewatered biosolids in a covered bunker, and land applies the biosolids to agricultural land.

Tyson operates large, covered anaerobic lagoons that remove 90% of the raw wastewater organic matter (CBOD). The lagoons generate biogas as a byproduct of the anaerobic biological process. The biogas contains 60-65% methane (natural gas). Tyson cleans the gas by removing sulfide prior to flaring the biogas.

Tyson and the City should evaluate the feasibility for processing the City and Tyson biosolids into a marketable fertilizer and soil conditioner product. The biogas from the Tyson anaerobic lagoons should be evaluated as a fuel source for the biosolids heat stabilization and drying facility in a central biosolids processing facility. This project would provide the following environmental benefits:

- Reduced methane (greenhouse gas) emissions from the Tyson biosolids storage lagoon (biosolids would be processed as generated and not stored in a lagoon where anaerobic decomposition of biosolids generates methane gas and carbon dioxide).
- Reduced power consumption at City's aerobic digester (biosolids would be processed as generated and not stabilized and stored in the aerated digester tank).
- Provide for beneficial use of Tyson biogas in biosolids stabilization and drying.
- Eliminate carbon dioxide (greenhouse gas) emissions from City's aerobic digestion process.
- Eliminate Tyson fuel consumption and greenhouse gas emissions from dredging and liquid sludge transport trucks.
- Potential reduction in nitrogen and phosphorus loads to streams due to more consistent fertilizer product that will be applied at more controlled rates and using more efficient application methods than the current liquid sludge and dewatered biosolids application methods.

Wetlands Nutrient Removal Project

The City owns several acres of marginal value agricultural land adjacent to the Tyson wastewater treatment facility. It may be feasible to convert this land to a constructed wetland for use in nitrogen and phosphorus removal from the City and/or Tyson wastewater treatment facility effluent streams.

City Wet Weather Storage Lagoon Enhancement for Nutrient Removal

As further described in Appendix E, the existing lagoon can be modified with an ecological restorer and sediment biofiltration units to reduce algae rates, and therefore the load on the treatment plant.

Tyson Wastewater Lagoons Enhancement for Nutrient Removal

Similar to the City lagoon enhancement, Tyson's two older lagoons can be used to provide advanced treatment. This is described in Appendix E.

Water Treatment Plant Lime Sludge Processing

Currently, the City dewaters the lime softening sludge with a belt filter press and a contractor uses the dewatered sludge for agricultural purposes as substitute for agricultural lime. If the City and Tyson construct a biosolids processing facility, the dewatered lime sludge may be blended with the biosolids prior to drying for a value added fertilizer and soil conditioner product.

Other Project Concepts

Appendix E details several project concepts including active stormwater treatment at the Hillshire facility, use of the existing stormwater ponds at the golf course, and continued protection and enhancement of Lake Storm Lake.

Nutrient Water Quality Trading

The City is required to evaluate the feasibility for nitrogen and phosphorus (nutrient) removal at its wastewater treatment facility as part of its next NPDES permit as the IDNR implements the Iowa Nutrient Reduction Strategy. The City will evaluate alternative methods for removing nutrients. The current treatment plant upgrade project includes the ability to operate the process for some degree of nutrient removal. The City will submit a report to the IDNR two years after the NPDES permit is renewed. The report will include a schedule for installing plant improvements or revisions in plant operations for nutrient removal. The NPDES discharge permit will be revised to include average annual nutrient mass limits after 18 months of nutrient removal process operation. The discharge limits will be based on demonstrated process performance.

It should be feasible to operate the existing, upgraded activated sludge treatment process with minor modifications to achieve at least 50% total nitrogen and phosphorus removal. The minor modifications include installation of chemical feed equipment for chemical phosphorus removal and refined operation of the activated sludge process for biological denitrification.

The City will also evaluate the use of water quality trading with nonpoint sources as an alternative to treatment facility modifications. Water quality trading involves reducing nutrient loads from other sources such as agricultural land or other point sources in lieu of revising the treatment facility process for increased nutrient removal. The nutrient removal achieved from other sources would be "traded" with the City plant.

Iowa DNR does not currently have a water quality trading program. The Iowa Nutrient Reduction Strategy provides for nutrient trading. Although there are approximately 14 states with water quality trading programs, only a few states have active trading programs. The City is participating with the City of Dubuque in an Iowa League of Cities nutrient trading pilot project. This pilot project will evaluate the feasibility for nutrient trading and will develop a model trading program framework for potential implementation by the IDNR as a state wide trading program.

Nutrient trading provides the opportunity for the City to make or fund improvements for nonpoint source nutrient control on private land in the watershed as a more cost effective method for reducing nutrient loads to the receiving stream than costly plant modifications for nutrient removal. The trading concept will become a more essential alternative long-term as stringent numeric nutrient water quality (in-stream) standards are implemented. The City will evaluate the feasibility for making improvements in the watershed now for reducing nutrient loads and "bank" the benefits for potential future use as nutrient reduction credits when more stringent limits are implemented.

Innovative and Alternative Wastewater Treatment Processes

The City is reviewing emerging treatment technologies for potential cost effective and lower environmental impact "green" wastewater treatment. The evaluations include initial review of manufacturers' technical and sales information, site visits to operating installations of the technology, discussions with DNR staff, and pilot studies at Storm Lake. The City plans to conduct pilot study evaluations of technologies that indicate good potential. The following technologies have been and are being considered by City staff:

- Ecolotree Phyto reactor treatment of treatment plant effluent for nitrogen removal using trees.
- Northern Filter Media silicon quaternary ammonia coated granular filter media for bacteria and nitrogen removal from treatment plant effluent.
- EcoProducts granular media for phosphorus removal from treatment plant effluent, stormwater, and lake dredging pond decant water.
- John Todd Ecological Design Eco-Machine treatment of treatment plant effluent for nutrient removal using constructed wetlands and indoor greenhouse plants.
- John Todd Ecological Design Restorer treatment of stormwater for bacteria and nutrient removal, and treatment of the Lake for nutrient removal.

Water Reuse

Water reuse is not common in Iowa due to the moderate climate and abundant water resources. However, there are regional concerns regarding excessive water withdrawal from the Jordan Aquifer. The City could review opportunities for reuse of the wastewater treatment facility effluent. This would reduce the demand on the water supply aquifer and reduce water treatment plant chemical usage and lime sludge generation. Potential uses include industrial cooling water, golf course and City park irrigation, agricultural irrigation, landscape contractor and residential lawn irrigation, dust control, and nonpotable industrial use. The investment in infrastructure for distributing reclaimed water for use as lawn irrigation would be significant. The City could explore the regulatory requirements with IDNR and conduct a community survey of potential reclaimed water users.

7 implementation plan

a. Implementation Objectives

This section reiterates the fundamental water quality objectives of the Storm Lake Green Infrastructure Plan for Water, and identifies and prioritizes a comprehensive list of discrete projects and site improvements that over time will help Storm Lake realize a long-term vision for a more positive, healthy, and sustainable community. The key objectives this Implementation Plan addresses are:

- Reduce bacterial loads to Storm Lake to meet full body contact (swimming) standards and reduce the potential for beach closures
- Meet nutrient reduction standards for the City's and Tyson's wastewater facilities
- Reduce stormwater pollutant loads from urban runoff sources with a focus on Total Suspended Solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN)
- Reduce neighborhood flooding and nuisance drainage problems

These objectives fall into three Priority levels:

Priority 1: The highest priority and most immediate need is to reduce the bacterial loads to Storm Lake. The Priority 1 objective will generally be met through site specific projects to address site specific, high bacterial loading areas.

This section reiterates the fundamental water quality objectives of the Storm Lake Green Infrastructure Plan for Water, and identifies and prioritizes a comprehensive list of discrete projects and site improvements that over time will help Storm Lake realize a long-term vision for a more positive, healthy, and sustainable community.

Priority 2: The next highest priority is to meet State nutrient reduction standards. This priority is driven by State mandate as well as by programs that are already in place such as the nutrient trading pilot project that Storm Lake is participating in.

Priority 3: Reducing stormwater pollutant loads and reducing neighborhood flooding and drainage issues are of similar priority and fall into Priority 3. In terms of location, no priority was given to the Storm Lake watershed over the Poor Farm Creek watershed.

Due to the distributed nature of green infrastructure practices and the ability to integrate green infrastructure into other urban infrastructure improvements, addressing the Priority 3 improvements in the most cost effective manner involves a fundamentally different implementation strategy than Priority 1 and 2 objectives. While addressing the Priority 1 and 2 objectives will generally involve implementation of discrete projects, addressing the Priority 3 goals will be more programmatic in nature and more of a long-term process.

The Priority 3 goals should be implemented as part of a larger, long-term capital improvement plan as well as through private investment. In terms of location, improvements within high impervious land uses such as campus, downtown commercial, big box commercial/industrial, and multifamily residential will provide the greatest benefit in terms of pollutant load reduction to downstream waterbodies and peak flow control to address floodprone areas. Spatially, the improvements should be targeted toward the drainage areas of the floodprone locations.

b. Implementation Phasing

Phase 1 – Near-Term (1-2 years)

Near-Term project areas were chosen based on several factors. Each project will demonstrate improvements directly related to the prioritized implementation objectives described above. Projects were also included based on the City's most immediate needs such as necessary road construction, and immediate opportunities such as available grant funding for implementation. In addition, these projects can serve as pilot projects to evaluate performance and costs prior to larger scale implementation.

The indicated costs for each of the projects include estimated construction costs as well as engineering (10%) and contingency (15%). Greater detail on the construction cost estimates is provided in Appendix F.

Projects

- **Erie Street Reconstruction (Priority 3 project)**
  - Reconstruction of Erie Street between Milwaukee Ave. and 6th Street is recommended as a Near-Term project. This project aims to replace a deteriorating street while also providing volume and pollutant load reductions within the downtown district. Construction would include a permeable paver street and bioretention bumpouts and planters. It would also include reconstructing the City Hall parking lot and public parking area on the east side of the street with permeable pavers and parking lot bioretention areas.
  - The estimated construction budget for the Erie Street and parking lot work is $1,200,000. The cost includes demolition of the existing pavement and curb and gutter system and reconstruction of the street and parking lot with permeable paving in the parking lanes and bioretention planters throughout. The concept plan and cost details for this project are shown in Appendix G. This project would be funded by a combination of local, state, and federal funding, and grant applications are in progress as of December, 2014 to cover roughly half of the cost of improvements. The applicable grants are the Urban Conservation Water Quality Initiative Projects category (seeking $130,000), and the Housing and Urban Development's Community Development Block Grant (seeking $6,000).
  - The Erie Street project was included as a Phase 1 (Near-Term) project due to the availability of grant funds, an immediate need for pavement improvements, and to serve as a pilot for broader implementation of the Priority 3 green infrastructure projects.

- **Hillshire Brands Pond Restorers (Priority 1 project)**
  - It is recommended that a Restorer be designed and constructed at the existing Hillshire retention pond. Stormwater design plans for the rest of Hillshire's site have already been developed, so the Restorer construction would dovetail well with other work. The Restorers would integrate active circulation, micro-aeration, and baffling to treat the organic load and reduce pathogens.
  - The total engineering and construction cost for the restorer system is estimated to be $120,000. The cost is based on a budgeted amount of $60,000 for each Restorer, which includes planning, engineering and design, shipping, installation, planting, and labor. The cost is based

on a proposed Restorer layout of 27' long by 27' wide, as well as four 20' by 7' floating islands, a 13' by 13' Ecological Fluidized Bed, semi-buoyant media, and a solar power station for a 1.5 hp blower. This setup will circulate at least 100,000 gallons per day. It is anticipated that the installation of the Restorers will take place during currently planned construction on the existing pond and swales.

- This Priority 1 project has a high priority due to its potential to significantly reduce bacterial loads to Storm Lake and its ability to serve as a pilot for enhanced stormwater treatment with a focus on bacteria through retrofitting of more conventional stormwater ponds.

- **Tyson Foods Stormwater Upgrades (Priority 2 & 3 projects)**
  - It is recommended that the onsite employee parking and container storage lots be converted to permeable paving with bioretention islands to reduce drainage issues within Flood Prone Area 6 and help reduce pollutant loads. This impervious surface amounts to approximately 13.5 acres, which has the potential to store and slow the flow rate of a significant volume of runoff. While replacing the entire area with permeable pavers may not be feasible, it is recommended that the City work with Tyson to determine an appropriate phased approach.
  - It is also recommended that a small-scale stormwater runoff treatment option be evaluated for installation at the Tyson entrance at the intersection of Richland and Flindt Drives, in the existing mowed open space. Previous discussions with the City have indicated the existing storm sewer in the nearby unloading area flows to Tyson's treatment facility, which should be verified. This treatment would likely be a small greenhouse receiving a portion of the incoming stormwater runoff to treat bacteria loads before runoff reaches Radio Park.
  - The estimated total construction and engineering cost for reconstructing the parking lots is $8.76M, or approximately $650,000 per acre of improved parking lot. This cost includes removal and replacement of curbs, removal and hauling of existing asphalt and excavation (based on an 18" base), and installing permeable paving with bioretention.
  - As discussed above, the treatment greenhouse at Tyson's entrance needs further consideration. However, a planning-level cost estimate is $50,000.

- **Radio Park Detention and Bio-reactor System (Priority 1 & 2 project)**
  - The City is currently evaluating installation of a bio-reactor system to reduce nutrient loading to the Lake. The proposed bio-reactor system is a sub-surface installation relying on gravity flow through woodchips to reduce nitrogen, and possibly phosphorus loadings and bacteria. These bio-reactor systems are currently being researched and tested by Iowa State University. The Radio Park project would be a pilot for use in treating urban runoff. As part of the bio-reactor system, it is recommended that the City expand the detention volume of the existing Radio park basin by a factor of 1.5, based on estimated available space north of the existing detention area.

The runoff from upstream would first be directed to this expanded naturalized detention basin to act as pre-treatment and to moderate flow rates discharging to the bio-reactor that has limited hydraulic capacity and could be subject to clogging by urban runoff sediment loads.

- While still in the early planning stages, the estimated construction budget for the bio-reactor is $90,000. The City is currently applying to cover a portion of the cost ($45,000) with a grant from the Iowa Department of Agriculture's Urban Conservation Water Quality Initiative Projects category. Additionally, it is estimated the expansion of the existing detention area by a factor of roughly 1.5 would cost approximately $57,000.
- Radio Park has components of both Priorities 1 and 2. It falls under Priority 1 due to its potential for treating bacteria. It falls under Priority 2 due to its potential to provide significant treatment of nutrient runoff from a relatively large area of the City in a readily monitored location. The City may also be able to incorporate this project into its nutrient trading program. The project is included as a high priority project due to its potential to address two categories, due to its potential for grant funding, and due to its ability to serve as a pilot project for a new urban runoff treatment technology.

- **Golf Course Ponds (Priority 2 project)**
  - It is recommended the City evaluate and implement Restorers, or other integrated biological system in the golf course ponds to continue stormwater treatment prior to discharge to Storm Lake. The golf course ponds should receive pre-treated stormwater from the Hillshire pond mentioned above, and can further reduce nutrients entering the Lake by implementing a circulation system and rafted wetland plants and filtration wetlands.
  - The total engineering and construction cost for the restorer system is $120,000. The budgeted amount for each Restorer is $60,000, which includes planning, engineering and design, shipping, installation, planting, and labor. The cost is based on a proposed Restorer layout of 27' long by 27' wide, as well as four 20' by 7' floating islands, a 13' by 13' Ecological Fluidized Bed, semi-buoyant media, and a solar power station for a 1.5 hp blower. This setup will circulate at least 100,000 gallons per day. It is anticipated that the installation of the Restorers at the golf course ponds will not require earthwork modification or installation of major process piping.
  - This project is included as a high priority project due to its ability to serve as a pilot project for use of a Restorer system as a new urban runoff treatment technology for retrofitting existing detention ponds.

- **Field of Dreams Bio-reactor (Priority 2 project)**
  - The City is currently evaluating installation of a bio-reactor system within the City-owned property located north of the Field of Dreams along 10th & Vestal Streets. The proposed system would include two cells – one with wood chips and one with a new, locally produced product called EcoRock. The woodchip cell would provide primarily nitrogen removal and the EcoRock cell would provide

primarily Phosphorus removal. Monitoring should be included upstream of the cells, downstream of the cells, and between cells to evaluate the performance of the individual cells. Like with the Radio Park system, it is recommended that naturalized detention storage be provided upstream of the bio-reactor system to provide pretreatment of sediment loads and to moderate flow rates to the hydraulic capacity of the bio-reactor cells.

- Research is currently being conducted on the details and cost of the bio-reactor, which would provide treatment of just a portion of incoming flow due to available land. The first chamber would be an anoxic bio-reactor with wood chip media with a cost less than $10,000, completely installed. In addition, an allowance of $15,000 should be budgeted for monitoring work. This includes rental or purchase of flow and sampling equipment and installation of additional structures to use as monitoring points. The second chamber with EcoRock media would allow a flow rate of 500 GPM and have a volume of 500 cubic yards. The second chamber would be installed by EcoProducts, who would then retain ownership of the system.
- The Field of Dreams project falls under Priority 2 and was included as a high priority due to its ability to serve as a pilot, due to the participation by EcoProducts, and due to its potential to address nutrient loads as part of the City's nutrient trading program.

- **Additional planned projects that are further in the planning stages or near construction include the following:**
  - 10th Street and Russell Street reconstruction with permeable pavers
  - Expansion Boulevard Stormwater Project, projected to cost $1.4 million
  - North Central Stormwater project, projected to cost $2.1 million
  - Development of Storm Lake 3rd Addition subdivision, including permeable pavers, backyard swales, and bioretention areas
  - Water plant improvements and a new well at a cost of $2.5 million
  - School district and Regional Hospital expansion and remodeling projects which will include bioretention and rain gardens implementations

Estimated Costs for Phase 1 - Short-Term Projects (1-2 years)

Project/Improvement		Cost
Erie Street Reconstruction		$ 1,200,000
Hillshire Brands Pond Restorers		$ 120,000
Tyson Foods Stormwater Upgrades		$ 8,810,000
	Parking Lots Reconstruction	$ 8,760,000
	Treatment Greenhouse	$ 50,000
Radio Park Stormwater Upgrades		$ 147,000
	Bio-reactor	$ 90,000
	Additional Detention	$ 57,000
Golf Course Ponds Restorer		$ 120,000
Field of Dreams Bio-reactor		$ 130,000
	TOTAL	**$ 10,527,000**

Phase 2 – Medium-Term (2-10 years)

The Medium-Term projects are all Priority 3 green infrastructure projects. As indicated in Section 6, the distributed green infrastructure projects should be targeted towards areas with high impervious coverage and in areas that contribute runoff to the identified floodprone areas.

The estimated budgets for Medium-Term projects are based on average costs per linear foot of permeable paved road construction projects constructed in northeast Iowa and western Illinois (quad cities) in the last four years. These previously constructed projects are presented in the Budget Considerations section of Phase 3 below. The costs have been adjusted to include a contingency and engineering design fee. Due to the lack of similar projects in western Iowa to date, costs for early projects in Storm Lake may be higher than found in other parts of the State where more projects have been implemented.

Due to the very preliminary nature of these projects, it is recommended that further analysis be conducted to better define the performance of the proposed improvements to address the identified pollutant load and flood reduction benefits, and to refine the preliminary costs provided based on actual site conditions.

Projects

- **Flood Prone Area 3**
  - It is recommended the City continue green infrastructure development within the downtown area to help reduce high runoff and pollutant loads generated by this land use. This project would include reconstructing Lake Street between 7th and Railroad Streets with permeable paving as well as 5th and 6th Streets between Michigan and Cayuga Streets. The Downtown Template described previously should be used as a guide to implement other volume and pollutant reduction measures along the streets, such as permeable sidewalks, bioretention bumpouts, planters, and parking lot islands.
  - The estimated cost of permeable paving and associated improvements for 3 streets (Lake Avenue, 5th Street, and 6th Street) is $2.55M.
  - Flood Prone Area 3 was included due to the severity and frequency of flooding in this area.

- **Flood Prone Area 8**
  - This project prioritizes green infrastructure just upstream of the area's outlet to the Lake. The project area includes the commercial strip east of Flindt Drive; the residential neighborhood bordered by 3rd, Dorinda, Park, and Roberts Streets; and the neighborhood west of Flindt including 3rd, Kenzy, 1st, Hwy, and Park Streets. The commercial area across the street from Radio Park contributes large amounts of runoff and pollutants. The approach in this area would be to convert as much commercial parking lot area to permeable pavers as possible, and also add bioretention where possible. A significant benefit achieved in this particular location would be reducing loads to Radio Park. By accomplishing this and implementing the Near-Term Radio Park project described above, Radio Park can become a treatment zone more devoted to runoff from Tyson and upstream commercial areas.
  - In addition to the reductions from commercial land use, the green infrastructure development within the residential areas of this region will continue to reduce volume and loading to the Lake and help reduce flooding along Flindt and Lakeshore Drive during large events. The Residential Template described previously should be used to develop a suite of tools for the area, including permeable paver streets and bioretention practices.

- The estimated cost of permeable paving and associated improvements for 3 streets west of Flindt Drive (3rd Street, 1st Street, and Hwy Street)is $1.10M.
- The estimated cost of permeable paving and associated improvements for 3 streets east of Flindt Drive (3rd Street, Dorinda Street, and Roberts Street) is $1.08M.
- The estimated cost of permeable paving and associated improvements for 3-4 commercial lots east of Flindt Drive is $900,000.

- **Flood Prone Area 11**
  - This project area is within the residential neighborhood including Rose Lane and Tulip Lane, as well as Expansion Blvd. between those two streets. As mentioned in Section 2, this area has already been developed with parkway rain gardens. To continue adding flood storage volume from this multi- and single-family residential area, this project would pave a portion of the streets with permeable pavers, and add bioretention.
  - The estimated cost of permeable paving and associated improvements for 3 streets (Expansion Blvd., Tulip Lane, and Rose Lane) is $2.13M.

- **Flood Prone Area 21**
  - This residential neighborhood west of Storm Lake includes reconstruction of Prairie Lane as well as Meadow and Clover Lanes between 610th Street and Leona Drive. This area draining to Little Storm Lake should be considered as a permeable paver implementation area. Existing depressional area, or open lots, such as the southwest corner of 85th Avenue, could also be used as naturalized detention areas to increase flood storage capacity.
  - The estimated cost of permeable paving and associated improvements for 3 streets (Prairie Lane, Meadow Lane, and Clover Lane) is $1.94M.

- **Additional planned projects that the City has begun planning include the following:**
  - Implementation of bio-reactors in agricultural several areas (average cost of $10,000 - $15,000 each)
  - Redesign of old lime lagoons to wetlands to treat runoff from Abner Bell Road before entering Little Storm Lake
  - Downtown green space and permeable paver parking areas around the railroad track to treat downtown stormwater
  - Marina permeable paver parking lot
  - Bio-reactors in Drainage Districts 13 and 25 to help treat agricultural runoff as well as City storm water runoff using EcoRocks
  - Shoreline restoration along Storm Lake with native cultivars
  - Inclusion of green infrastructure in any city-led infrastructure improvement

Estimated Costs for Phase 2 - Medium-Term Projects (5-10 years)

Project/Improvement		Cost
Flood Prone Area 3	$	2,550,000
Flood Prone Area 8	$	3,090,000
Residential improvements west of Flindt Dr.	$	1,110,000
Residential improvements east of Flindt Dr.	$	1,080,000
Commercial lots east of Flindt Dr.	$	900,000
Flood Prone Area 11	$	2,130,000
Flood Prone Area 21	$	1,940,000
TOTAL	**$**	**9,710,000**

Phase 3 – Long-Term (50-year build-out)

Finally, implementation of green infrastructure should continue into the future and be integrated into other City documents such as the Comprehensive Plan and Capital Improvement Plan to ensure consistency in planning and implementation of public and private urban infrastructure improvements including new construction, redevelopment, and infill. By incorporating these practices into already planned construction and reconstruction, the cost of green infrastructure is reduced to the incremental cost, thereby reducing the total cost of implementing the Plan and improving utilization of valuable urban land. The Comprehensive Plan should also be updated every 10 years to include goals and projects in this Phase. As Near- and Medium-Term projects are implemented over the next 10 years, prioritization of the floodprone and highest pollutant load contributors should be reviewed on a regular basis to incorporate these projects in the Capital Improvement Plan.

Several specific Long-Term projects that the City is currently planning include the following:

- Rehabilitation of the dredge spoils site
- Sampling and analysis of Storm Lake water quality to improve clarity and reduce nutrients
- The City is working in partnership with IDNR to conduct further lake studies to find ways to complement the dredging operations with other treatments, reduce nutrient loading, establish aquatic vegetation, expand the fish variety, and improve water quality.
- Nutrient reduction from the WWTP
- The City is determining how to best dovetail their actions with the Iowa League of Cities and IDNR's efforts to develop nutrient trading programs. The City should monitor and take advantage of new and evolving programs that will help implement the recommendations or new strategies to achieve the goals.

Budget Considerations

Before costs for individual Long-Term projects can be developed, further analysis will be required to determine the scope of each project and which green infrastructure alternatives will serve a particular location the best, given the overall objectives. To aid in overall budgeting and planning, the cost data below provides details for similar improvements at four different projects, two in Iowa, and two in Illinois, from 2010 to 2014.

- **Charles City Phase 1**
  - Located in Charles City, IA
  - Completed in 2010
  - Included demolition & disposal of existing asphalt & concrete paving and base, 2 feet of open graded stone base, permeable paving surface, parkway turf bioretention strips, new curb and gutter, water main replacement, water and sanitary service replacement, removal and replacement of driveway aprons and parkway service walks.
  - 4,310 linear feet of permeable paving street (112,000 sf)
  - 6,100 linear feet of parkway bioretention
  - Winning bid: 2.79M ($647/lf or $25/sf of permeable paving area)

- **Charles City Phase 2**
  - Located in Charles City, IA
  - Completed in 2012
  - Included demolition and disposal of existing asphalt & concrete paving and base, 2 feet of open graded stone base, permeable paving surface, parkway turf bioretention strips, new curb and gutter, water main replacement, water and sanitary service replacement, removal and replacement of driveway aprons and parkway service walks.
  - 2,800 linear feet of permeable paving street (86,000 sf)

- 3,900 linear feet of parkway bioretention
- Winning bid: $1.89M ($675/lf or $22/sf of permeable paving area)

- **Carbon Cliff Phase 1**
  - Located in Carbon Cliff, IL
  - Completed in 2011
  - 1,380 linear feet of full width permeable paving street (35,325 sf)
  - Included demolition & disposal of existing asphalt paving and base, 2 feet of open graded stone base, permeable paving surface, parkway infiltration trenches, new curb and gutter, removal and replacement of sidewalk, removal and replacement of driveway aprons, storm sewer to manage offsite runoff, sump pump discharge management system, pavement drainage, 1,000 feet of swale, street trees.
  - Winning bid: $0.83M, complete ($600/lf or $24/sf of permeable paving area)

- **Carbon Cliff Phase 2**
  - Located in Carbon Cliff, IL
  - Completed in 2013
  - Included demolition & disposal of existing asphalt paving and base, 2 feet of open graded stone base, permeable paving surface, parkway infiltration trenches, new curb and gutter, removal and replacement of sidewalk, sump pump discharge management system, pavement drainage, street trees.
  - 2,200 linear feet of permeable paving street (56,900 sf)
  - 3,100 linear feet of infiltration trench
  - 10.4 acre drainage area
  - Winning bid: $1.25M ($570/lf or $22/sf of permeable paving area)

8 recommendations and next steps

Recommendations and Next Steps

- It is recommended the City move forward with evaluation, design, and construction of the Near-Term projects listed in Section 7. In particular, the City should capitalize on currently available grant funding to implement these projects and demonstrate need and effectiveness. Following verification of improvements, the City should continue to move projects currently in the Medium-Term priority to the Near-Term, and into the Capital Improvement Plan budget.

- The City has already been active in developing updated ordinances for stormwater and construction site erosion and sediment control. The Capital Improvement Plan contains a line item for continued updates to the stormwater ordinance, which should be expanded to include recommendations presented in this document. This includes reviewing the disturbance thresholds below which the ordinance standards don't apply and ensuring that the ordinance requires management of all impervious cover on site and not only new impervious cover. In general, the City should ensure any ordinance does not prohibit recommendations in this Plan.

- It is important that the City integrates this Plan with the Capital Improvement Plan and Comprehensive Plan. Near-Term and Medium-Term projects should be added to the CIP regularly to ensure they are completed. Likewise, the Comprehensive Plan should be informed by this Plan and updated roughly every 10 years to ensure alignment and a clear community vision for implementation of green infrastructure for stormwater, wastewater, and water.

Creating a healthy, sustainable community requires action. These next steps help to generate and maintain momentum.

8. recommendations and next steps

- The City has adopted a stormwater utility ordinance that collects fees for direct or indirect connections to the City stormwater system. Currently, residential properties are charged a flat rate and non-residential properties are charged based on impervious area. It is recommended the stormwater utility fee remain high enough to accomplish two functions:

    1. The fee should generate sufficient funding to help accomplish the goals outlined in this Plan.
    2. The fee should encourage users to implement stormwater practices outlined in this Plan by allowing for reduction or elimination of the fee.

- The City is already considering how to coordinate with adjacent agriculture to implement the goals in the document. In particular, opportunities exist with nutrient trading, the sale of wastewater plant sludge, and potential water reuse for irrigation. While this study focused on priorities within the City, the large areas of agricultural land surrounding the City provide ample opportunity to improve water quality and implement best practices. The City is partnering with the Conservation District, Iowa Department of Agriculture and Land Stewardship, and Iowa Soy Bean Association to improve water quality.

  As discussed in the Analysis of Existing Conditions section, the City should move forward with a two year study of nutrient reduction alternatives, followed by implementation and evaluation of proposed modifications.

- The Iowa Economic Development Authority should work with other communities in the State to develop similar Green Infrastructure plans that can be efficiently incorporated into Capital Improvement Plans and Comprehensive Plans to improve the quality of the State's urban waters.

- The City collaborates with life sciences students and staff at Buena Vista University. The City and College work cooperatively on water quality monitoring and lake water quality evaluation projects. The cooperative arrangement provides educational opportunities for students and staff and allows the City to conduct water quality studies at reasonable costs.

  The City should also work collaboratively with the University to implement the Campus Template concepts, and any of these projects implemented within Storm Lake provide an opportunity for the University's programs and students to monitor and build into the science curriculum.

- Storm Lake is in the process of creating an Urban Tree Management Program, and it is recommended the City continue with this initiative. This program, or the formation of an advisory committee, would underscore the importance of the role of trees in this Plan and the community. The committee would also help to inform policies that ensure proper maintenance and potential planting requirements for development.

- A significant amount of the potential green infrastructure opportunities exist on private property, including both residential and non-residential. Further, even the recommended public green infrastructure is targeted to the street right-of-way system and therefore highly visible to the public. Although public meetings were conducted during development of this Plan, it will be important to sustain a continued outreach program to increase the visibility of this Plan and instill a shared vision throughout the community. For these reasons, it is recommended that a comprehensive public education and outreach plan be developed that includes:

    - Periodic public meetings
    - Newsletters
    - Press releases and community tours as projects are initiated and constructed

- Participation in Statewide conferences and workshops to reach a broader audience and enhance community pride in these efforts
- Prepare materials for residents and businesses located within project areas to assist them in understanding the purpose and function of the projects and to enlist their efforts in managing and stewarding the green infrastructure landscapes and other elements of the Plan

9 funding and financing

Funding and Financing

As with most infrastructure, leveraging of multiple funding sources and utilizing strategic partners is necessary to implement community-wide green infrastructure. Storm Lake has already partnered with Iowa Department of Natural Resources, Iowa Economic Development Authority, Iowa Department of Agriculture and Land Stewardship, Iowa League of Cities, Soil and Water Conservation District, Iowa Nutrient Reduction Center, Iowa Clean Water Alliance, Raccoon River Watershed Association, and the Lake Preservation Association on a number of projects and studies. The following paragraphs discuss several funding mechanisms available to communities.

Community Generated Funds

The most direct way for communities to fund green infrastructure projects is through internal funding sources. These can include the following:

- **Stormwater Utility:** Stormwater utilities are becoming increasingly popular throughout the nation. Stormwater utilities provide both a revenue source to implement and maintain public assets and an opportunity to encourage private investment through utility credits. Most stormwater utilities are structured such that their fees are based on impervious cover. A utility credit program allows land owners to reduce or eliminate their utility fee by implementing green infrastructure practices that meet City standards on their property. However, for the utility credit to be an effective incentive, the fee per acre must be sufficiently high that there is an adequate return on investment for the landowner.

Many funding opportunities exist for Green Infrastructure projects, both from within the community and from state, federal, and private sources. There are also innovative mechanisms to generate local funds.

- **Fee in Lieu:** In some instances a developer may not have available land to implement proper stormwater control measures. The City's ordinance allows a developer to pay a fee in lieu, which can generate revenue for compensating stormwater management to be developed by the City. While this can be effective, it is important to use the money for stormwater solutions in the vicinity of the development. This will achieve the goal of managing stormwater where the rain falls, instead of further downstream where the problems can become exacerbated.
- **Funding Programs:** An example program is the 1% for Open Space program in Gunnison County, Colorado (*http://www.onepercentforopenspace.org/*). This program has raised nearly $2 million to conserve open space, and is completely funded by local businesses collecting a voluntary 1% donation on gross sales of products from customers. Funds are then put in high-interest accounts until applications for its use are submitted. Programs like this can encourage local businesses to play a role in developing green infrastructure. It also provides an opportunity for residents and tourists to preserve what they appreciate about their community.

Grants and Financing for Private Development

There are a number of strategies for encouraging and/or requiring implementation of green infrastructure Tool and Template improvements on private property. These strategies include:

- **Stormwater Ordinance Enforcement:** A community's first opportunity to ensure implementation of green infrastructure is a stormwater ordinance with strict water quality, retention, and release rate standards that apply to development and redevelopment projects of virtually all sizes. The standards should apply to all impervious cover and not just the increase in impervious cover.
- **Development Bonuses:** To avoid incentivizing greenfield development over redevelopment and infill development through enforcement of the stormwater ordinance, communities should consider development incentives such as TIF districts, sales tax sharing, waiving of utility connection fees, density bonuses and other measures to encourage infill and redevelopment projects that tend to place less burden on city services and improve land utilization within the city.
- **Stormwater Grant or Revolving Loan Program:** Utilizing funds from a Stormwater Utility or other sources, communities should consider an incentive program to encourage implementation of green infrastructure practices on private property. The incentives could be in the form of outright grants that cover a portion of the proposed improvements. The incentives could also be in the form of a loan whereby the city finances all or a portion of the improvements and the landowner pays back the loan through continued fee payments until the loan is paid in full. Thereafter, the utility fee credit would control.
- Each of the incentives described above could be structured to encourage implementation in areas of a community that would most benefit from the improvements such as areas that contribute runoff to floodprone areas.

Grants and Financing for Public Development

Many improvements illustrated in a green infrastructure plan like this will occur in the public right-of-way and should therefore be integrated with other proposed public improvements such as pavement reconstruction, major underground utility projects, and streetscape projects. To help offset costs, there are two primary categories for funding this work:

- **Public Funds:**
  - **Clean Water Act Section 319** (*http://www.iowadnr.gov/Environment/WaterQuality/WatershedImprovement/ResourcesforLocalGroups/ImplementationGrants.aspx*): This annual appropriation of EPA funding to states is meant primarily for implementation of Watershed Based Plans within impaired watersheds. A limited amount of funds are also available for projects not located within an impaired watershed. The IDNR administers the state's allocated funding, and for a project to be funded, it must be outlined in a Watershed Based Plan. Possible projects include urban runoff management activities such as technical assistance, monitoring, implementation of BMPs for pollutant reduction and runoff control, development of stormwater runoff regulatory guidelines, and stormwater projects occurring outside any NPDES permit area or which don't directly implement a NPDES permit.
  - **Clean Water State Revolving Fund** (*http://www.iowasrf.com/program/other_water_quality_programs/storm_water_management_best_practices.cfm*): This low interest loan program offered by the EPA and administered by IDNR focuses on nonpoint source pollution control. A portion of the allocated funds are set aside for implementation of stormwater management best practices.
  - **Federal Highway Administration Transportation Enhancement Activities Funding** (*http://www.fhwa.dot.gov/environment/transportation_enhancements/teas.cfm*): Applications for funding under this program must demonstrate a relationship to surface transportation. The funding category applicable to this Plan includes landscaping and other scenic beautification. In particular, emphasis is placed on removal of invasive species; planting natives; and overall landscaping including street furniture, lighting, and gateways along highways, streets, and waterfronts.
  - **Department of Housing Community Development Block Grant Program** (*http://www.iowaeconomicdevelopment.com/Community/CDBG*): These funds are made available by HUD, and administered through the IEDA, or a local government designated as a HUD entitlement area. Funds can be used to support water and sewer facilities as well as public buildings.
  - **Department of Housing and Urban Development Sustainable Communities Regional Planning Grants Program** (*http://portal.hud.gov/hudportal/HUD?src=/program_offices/economic_resilience/sustainable_communities_regional_planning_grants*): This program supports locally-led collaborations focusing on integrating housing, economic development, and infrastructure improvements.

- **Department of Agriculture Water and Environmental Programs** (*http://www.rurdev.usda.gov/UWEP_HomePage.html*): These programs include various types of grants and direct loans for rural development of water, wastewater, and stormwater facilities and infrastructure.
- **Iowa Department of Agriculture and Land Stewardship Stormwater BMP Loans** (*http://www.iowaagriculture.gov/FieldServices/stormwaterBMPloans.asp*): These loans are meant to fund voluntary implementation of BMP practices within the Iowa Stormwater Management Manual, such as infiltration practices, detention basins, pond and wetland systems, grassed waterways, and permeable pavement systems.
- **Iowa Department of Agriculture and Land Stewardship Urban Water Quality Initiative Grant** (*http://www.iowaagriculture.gov/press/2014press/press10312014.asp*): This recent grant aims to install stormwater practices to capture and infiltrate stormwater.

- **Private Funds:** There are also philanthropic funding sources and foundations that can provide funding for public capital improvements.

A appendix

Storm Lake Stormwater Control Ordinance

CITY OF STORM LAKE, IOWA

POST-CONSTRUCTION STORMWATER CONTROL ORDINANCE

159.01 FINDINGS OF FACT.

1. The U.S. EPA's National Pollutant Discharge Elimination System ("NPDES") permit program ("Program") administered by the Iowa Department of Natural Resources ("IDNR") requires that cities meeting certain demographic and environmental impact criteria obtain from the IDNR an NPDES permit for the discharge of stormwater from a Municipal Separate Storm Sewer System ("MS4") ("MS4 Permit"). The City of Storm Lake is subject to the Program and is required to obtain, and has obtained, an MS4 Permit; the City's MS4 Permit is on file at the office of the City Clerk and is available for public inspection during regular office hours.

2. As a condition of the City's MS4 Permit, the City is obliged to adopt and enforce a POST-CONSTRUCTION STORMWATER CONTROL ordinance.

3. No State or Federal funds have been made available to assist the City in administering and enforcing the Program. Accordingly, the City shall fund its operations under this chapter entirely by charges imposed on the owners or developers of properties which are made subject to the Program by virtue of State and Federal law, and/or other sources of funding established by a separate ordinance.

4. Land development and associated increases in impervious cover alter the hydrologic response of local watersheds and increase stormwater runoff rates and volumes, flooding, stream channel erosion, and sediment transport and deposition; this stormwater runoff contributes to increased quantities of water-borne pollutants; and stormwater runoff, soil erosion, and non-point source pollution can be controlled and minimized through the regulation of stormwater runoff from development sites.

5. Therefore, the City of Storm Lake establishes this set of City stormwater requirements to provide reasonable guidance for the regulation of stormwater runoff for the purpose of protecting local water resources from degradation. It is determined that the regulation of stormwater runoff discharges from land development and other construction activities in order to control and minimize increases in stormwater runoff rates and volumes, soil erosion, stream channel erosion, and non-point source pollution associated with stormwater runoff is in the public interest and will prevent threats to public health, safety, and property damage.

6. The "Iowa Stormwater Management Manual" published collaboratively by the Iowa Department of Natural Resources and The Center for Transportation Research and Education at Iowa State University establishes guidelines consisting of unified sizing criteria, stormwater management designs and specifications and Best Management Practices (BMP). City hereby finds and declares that the guidelines provided for in the Iowa Stormwater Management Manual, and in future editions thereof, should be and are hereby adopted as the stormwater management standards of the City. Any BMP installation that complies with the provisions of the Iowa Stormwater Management Manual, or future editions thereof, at the time of installation shall be deemed to have been installed in accordance with this ordinance.

159.02 PURPOSE. The purpose of this chapter is to adopt as the City's standards and sizing criteria and BMPs to address said standards the Guidelines, Sizing Criteria, and BMPs proposed by the Iowa Stormwater Management Manual and as specifically identified above (hereinafter collectively "City stormwater requirements") in order to protect and safeguard the general health, safety, and welfare of the public within this jurisdiction. This chapter seeks to meet that purpose through the following objectives:

1. Minimize increases in stormwater runoff from development within the City limits and fringe area in order to reduce flooding, siltation, increases in stream temperature, and stream bank erosion and maintain the integrity of stream channels;

2. Minimize increases in non-point source pollution caused by stormwater runoff from development which would otherwise degrade local water quality;

3. Minimize the total annual volume of surface water runoff which flows from any specific development project site after completion to not exceed the pre-development hydrologic regime to the maximum extent practicable; and

4. Reduce stormwater runoff rates and volumes, soil erosion, and non-point source pollution, wherever possible, through establishment of appropriate minimum stormwater management

standards and BMPs and to ensure that BMPs are properly maintained and pose no threat to public safety.

159.03 APPLICABILITY.

1. This chapter is applicable to all subdivision or site plan applications meeting the minimum square foot applicability criteria of item 2 of this section, unless eligible for an exemption or granted a waiver by the City under Section 159.07 of this chapter. This chapter also applies to land disturbance activities that are smaller than the minimum square foot applicability criteria specified in subsection 2 if such activities are part of a larger common plan of development that meets the minimum square foot applicability criteria specified in subsection 2, even though multiple separate and distinct land development activities may take place at different times on different schedules. In addition, all plans must also be reviewed by City of Storm Lake officials to ensure that established water quality standards will be maintained during and after development of the site and that post-construction runoff levels are consistent with any local and regional watershed plans.

2. City stormwater requirements must be met for development to be approved. City stormwater requirements apply to any development disturbing one acre (43,560 square feet) or more of land, and to any development disturbing less than one acre if the amount of impervious cover created exceeds 5,000 square feet. The following activities are exempt from this chapter:

    A. Any logging and agricultural activity which is consistent with an approved soil conservation plan or a timber management plan prepared or approved by the appropriate agency, as applicable.

    B. Additions or modifications to existing single-family structures.

    C. Developments that do not disturb more than one acre of land provided they are not part of a larger common development plan.

    D. Repairs to any stormwater BMPs deemed necessary by City.

3. When a site development plan is submitted that qualifies as a development, as defined in this chapter, decisions on permitting any appropriate on-site BMPs shall be guided by the Iowa Stormwater Management Manual. Issuance of a Construction Site Runoff Permit (CSR Permit) will be granted to development or redevelopment projects after review and approval of the site development plan by the City.

4. The site shall be designed using the Better Site Design process. Better Site Design involves techniques applied early in the design process to preserve natural areas, reduce impervious cover, distribute runoff and use pervious areas to more effectively treat stormwater runoff. Site design should address open space protection, impervious cover minimization, and runoff distribution and minimization, and runoff utilization through considerations such as:

    A. Open space protection and restoration

        (1) Conservation of existing natural areas (upland and wetland)

        (2) Reforestation

(3) Re-establishment of prairies

(4) Restoration of wetlands

(5) Establishment or protection of stream, shoreline and wetland buffers

(6) Re-establishment of native vegetation into the landscape

B. Reduction of impervious cover

(1) Reduce new impervious through redevelopment of existing sites and use of existing roadways, trails etc.

(2) Minimize street width, parking space size, driveway length, sidewalk width

(3) Reduce impervious surface footprint (e.g. two story buildings, parking ramp)

C. Distribution and minimization of runoff

(1) Utilize vegetated areas for stormwater treatment (e.g. parking lot islands, vegetated areas along property boundaries, front and rear yards, building landscaping)

(2) Direct impervious surface runoff to vegetated areas or to designed treatment areas (roofs, parking, driveways drain to pervious areas, not directly to stormsewer or other conveyances)

(3) Encourage infiltration and soil storage of runoff through grass channels, soil compost amendment, vegetated swales, raingardens, etc.

(4) Plant vegetation that does not require irrigation beyond natural rainfall and runoff from the site

D. Runoff utilization

(1) Capture and store runoff for use for irrigation in areas where irrigation is necessary

Information on the Better Site Design Process is available at www.cwp.org.

159.04 COMPATIBILITY WITH OTHER REQUIREMENTS.

1. It is intended that this chapter be construed to be consistent with existing City Code.

2. The requirements of this chapter should be considered minimum requirements, and where any provision of this chapter imposes restrictions different from those imposed by any other chapter, rule or regulation, or other provision of law, whichever provisions are more restrictive or impose higher protective standards for human health or the environment shall be considered to take precedence.

159.05 PERMIT PROCEDURES AND REQUIREMENTS.

1. Permit Required. No landowner or developer shall receive any of the building, grading, or other land development permits required for land disturbance activities without first meeting the requirements of this chapter prior to commencing the proposed activity.

2. Pre-application Meeting

    A. Prior to the development of plans, the applicant shall request a pre-application meeting which will be facilitated by the City between the applicant, City staff, and staff of partner agencies as applicable. The meeting shall be **mandatory** prior to submission of a permit application. The purposes of the meeting are: to understand the general parameters of the proposed project; and to convey the requirements of meeting the provisions of this and other applicable ordinances.

3. Application Requirements.

    A. Unless specifically exempted by this chapter, any landowner or developer desiring a permit for a land disturbance activity shall submit to the City a permit application on a form provided for that purpose.

    B. Unless otherwise exempted by this chapter, a permit application must be accompanied by the following in order that the permit application be considered:

        (1) A copy of the stormwater management concept plan;

        (2) A copy of the maintenance agreement; and

        (3) A non-refundable permit review fee.

        Materials shall be submitted in pdf format for ease of distribution and review.

    C. The stormwater management concept plan and maintenance agreement shall be prepared to meet the requirements of this chapter, and fees shall be those established by the City by separate resolution.

4. Application Procedure.

    A. Applications for land disturbance activity permits must be filed for review with the office of the Building and Planning Department on any regular business day.

    B. The City shall make a determination regarding the completeness of a permit application within ten (10) business days of the receipt of the application and notify the applicant in writing if the application is not complete include the reasons the application was deemed incomplete.

    C. Within fifteen (15) business days of the receipt of a complete permit application, including all documents as required by this chapter, City shall inform the applicant whether the application, plan, and maintenance agreement are approved or disapproved by the enforcement officer.

D. If the permit application, stormwater management concept plan, or maintenance agreement are disapproved, the applicant may revise the stormwater management concept plan or agreement. If additional information is submitted, the City shall have 15 business days from the date the additional information is received to inform the applicant that the stormwater management concept plan and maintenance agreement are either approved or disapproved.

E. If the permit application, stormwater management final plan, and maintenance agreement are approved by City, all appropriate land disturbance activity permits shall be issued.

5. Permit Duration. Permits issued under this section shall be valid from the date of issuance through the date City notifies the permit holder that all stormwater BMPs have passed the final inspection required under permit conditions.

6. Application Review Fees. The fee for review of any land development application shall be based on the amount of land to be disturbed at the site; the fee structure shall be established by City, and said fees shall be paid prior to the issuance of any applicable City permits. All such revenue shall be credited to a City budgetary category to support the administration of this chapter.

159.06 STORMWATER STANDARDS.

1. The following general criteria shall be incorporated into the site design for stormwater runoff to protect surface and ground water and other natural resources and other private and public property:

A. Reduce impacts on water

B. Decrease runoff volume

C. Increase infiltration (groundwater recharge)

D. Decrease flow frequency, duration, and peak runoff rates

E. Reduce time to peak flows by increasing the time of concentration to and through storm sewers

F. Store stormwater runoff on-site

G. Maintain existing flow patterns

H. Avoid natural channel and steep slope erosion as well as protect in stream habitats and channels.

I. Decrease erosion and sedimentation

J. Preserve vegetation

K. Preserve and replace existing topsoil in an uncompacted manner

2. The site design shall provide on-site treatment during construction and post-construction to ensure no increase in offsite peak discharge for the 1-year, 24-hour storm event (2.61 inches), the 5-year, 24-hour storm event (3.75 inches), and the 100-year, 24-hour storm event (7.81 inches).

3. The site design shall provide on-site water quality treatment for the runoff resulting from a rainfall depth of 1.25 inches over the post-construction site area in order to reduce average annual post-development total suspended solids loadings by at least 80%.

4. The site design shall retain on-site for recharge, a portion of the water quality treatment volume calculated as a soil specific recharge factor multiplied by the volumetric runoff coefficient multiplied by the area and all divided by 12. The soil specific recharge factor is given as 0.51 for Hydrologic Soil Group (HSG) A soils, 0.34 for HSG B soils, 0.17 for HSG C soils, and 0.08 for HSG D soils. The volumetric runoff coefficient is calculated as 0.05 + 0.009 multiplied by the site impervious percentage. See the Iowa Stormwater Management Manual for additional clarification on the calculation.

5. Applicant shall fully attempt to comply with the standards in one through three above. For areas of the site where there is no feasible way to achieve the recharge requirement, other options may be considered by the City. Options considered and presented shall examine the merits of relocating project elements to address varying soil conditions and other constraints across the site. If full compliance is not possible, the following flexible treatment options shall be used:

    A. Applicant shall document the flexible treatment options sequence starting with Alternative #1. If Alternative #1 cannot be met, then Alternative #2 shall be analyzed. If Alternative #2 cannot be met than Alternative #3 shall be met. When all of the conditions are fulfilled within an alternative, this sequence is completed.

    B. Recharge techniques considered shall include infiltration, reuse & rainwater harvesting, and canopy interception & evapotranspiration and/or additional techniques included in the Iowa Stormwater Management Manual.

    C. Higher priority shall be given to BMPs that include volume reduction. Secondary preference is to employ filtration techniques, followed by rate control BMPs.

    D. Factors to be considered for each alternative will include:

        (1) Shallow bedrock

        (2) High groundwater

        (3) Hotspots or contaminated soils

        (4) Poor soils (infiltration rates that are too low or too high, problematic urban soils)

        (5) Excessive cost

E. Alternative #1: Applicant attempts to comply with the following conditions:

(1) Achieve at least 0.625" volume reduction, and

(2) Remove 75% of the annual TP (Total Phosphorous) load, and

(3) Options considered and presented shall examine the merits of relocating project elements to address, varying soil conditions and other constraints across the site.

F. Alternative #2: Applicant attempts to comply with the following conditions:

(1) Achieve volume reduction to the maximum extent practicable, and

(2) Remove 60% of the annual TP load, and

(3) Options considered and presented shall examine the merits of relocating project elements to address, varying soil conditions and other constraints across the site.

G. Alternative #3: Off-site Treatment. Off-site mitigation, as outlined in Section 159.07 Waivers, of the required treatment volume that cannot be provided onsite can be used to protect receiving waters.

6. To protect channels, the site shall be designed to infiltrate or provide 24 hour extended detention of the channel protection volume, defined as the 1 year, 24 hour storm per NOAA Atlas 14.

7. The site shall be designed to prevent the post development rate of runoff from exceeding the pre-development rate of runoff for a five year to 100 year storm, 24 hour storm to not exceed runoff rates equivalent to the five year predevelopment storm event per NOAA Atlas 14.

8. The site shall be designed to provide an emergency spillway and designated overflow route for the 100 year, 24 hour storm as defined by the Iowa Stormwater Management Manual. The spillway and overflow route must be able to safely pass overflows through the structure without creating damaging conditions downstream of the facility.

9. Existing topsoil must be preserved on site to be uniformly applied in an uncompacted manner to a minimum depth of four inches.

10. The site shall be designed to provide vegetated buffers for water quality protection adjacent to receiving channels and waters. Buffers shall commence at the "ordinary high water mark", or at the delineated boundary of the waterbody. Buffer widths are based on a 0-10% slope* between the activity and the water body as determined by land use and are as follows;

Residential	35 feet
Industrial	50 feet
Mid/High Density Residential & Commercial	50 feet

*Buffer width shall increase 2 feet for each percent increase in slope above 10%.

A. Access shall be provided on each side of the buffer for maintenance.

B. The applicant shall maintain the buffer for the first year after completion of the project.

C. Impervious surfaces shall not be allowed in the buffer area.

D. Fences and structures shall not be allowed in the buffer area.

E. Where land disturbing construction activity occurs within a buffer area, and where no impervious surface is present, adequate approved native vegetative cover of 70% shall be established and maintained. The native vegetative cover shall be sufficient to provide for bank stability from upslope overland flow areas under sheet flow conditions. Non-vegetative materials, such as rock riprap, may be employed on the bank as necessary to prevent erosion, such as on steep slopes of where high velocity flows occur.

F. BMP's such as filter strips, swales, or wet detention basins may be located in the buffer area.

159.07 WAIVERS. Every applicant shall provide for stormwater management as required by this chapter, unless a written request is filed to waive implementation of BMPs, in whole or in part, and such waiver is granted. Requests to waive implementation of BMPs in whole or in part shall be submitted to City for approval.

1. A waiver of BMPs required by this chapter may be granted provided that at least one of the following conditions is established by the applicant based on authoritative written evidence satisfactory to City:

    A. The proposed development is not likely to impair attainment of the objectives of this chapter.

    B. Alternative minimum requirements for on-site management of stormwater have been established in a stormwater management final plan that has been approved by City and fully implemented.

    C. Provisions are made to manage stormwater by an off-site facility within the same watershed. The off-site facility is required to be in place, to be designed and adequately sized to provide a level of stormwater control that is equal to or greater than that which would be afforded by on-site practices, and there is, in the City's sole judgment, a responsible entity legally obligated to monitor the performance of and maintain the efficiency of stormwater BMPs in accordance with a written and recorded maintenance agreement.

    D. In instances where one of the above conditions is established, the applicant must further establish by authoritative written evidence satisfactory to City that the partial waiver will not result in any of the following impacts to downstream waterways:

        (1) Deterioration of existing culverts, bridges, dams, and other structures; or

        (2) Degradation of biological functions or habitat; or

        (3) Accelerated stream bank or streambed erosion or siltation; or

(4) Increased threat of flood damage to public health, life, property.

2. If the City finds that a waiver is appropriate because implementation of on-site stormwater BMPs is not feasible due to the natural or existing physical characteristics of a site, or that one of the conditions specified in subsection 1 above cannot be established to a certainty, or that any one or more of the impacts to downstream waterways specified above cannot be entirely averted, the applicant shall execute a binding written agreement to accomplish one or more of the following mitigation measures selected by City:

    A. The purchase and donation of privately owned lands, or the grant of an easement to be dedicated for preservation and/or reconstruction of native ecosystems of lands strategically located in the watershed consistent with the purposes of this chapter, of a sufficient quantity to enable City or others to achieve City stormwater requirements with respect to a number of cubic feet of annual stormwater equivalent to the estimated number of cubic feet of annual stormwater that will not achieve City stormwater requirements as a consequence of the waiver.

    B. The creation of one or more stormwater BMPs on previously developed properties, public or private, that currently lack stormwater BMPs, having a capacity to achieve City stormwater requirements with respect to a number of cubic feet of annual stormwater equivalent to the estimated number of cubic feet of annual stormwater that will not achieve City stormwater requirements as a consequence of the waiver.

    C. Monetary contributions (fee in lieu) to fund stormwater management activities as identified in the City of Storm Lake's Comprehensive Stormwater Management Plan such as research and studies (e.g., regional wetland delineation studies, stream monitoring studies for water quality and macroinvertebrates, stream flow monitoring, threatened and endangered species studies, hydrologic studies, monitoring of stormwater BMPs, and stream corridor stabilization practices). The monetary contribution required shall be in accordance with a fee schedule (unless the developer and the City agree on a greater alternate contribution) established by City, based on the estimated cost savings to the developer resulting from the waiver and the estimated future costs to City to achieve City stormwater requirements with respect to a number of cubic feet of annual stormwater equivalent to the estimated number of cubic feet of annual stormwater that will not achieve City stormwater requirements as a consequence of the waiver. All of the monetary contributions shall be credited to an appropriate capital improvements program project, and shall be made by the developer prior to the issuance of any building permit for the development.

    D. Dedication of land or granting of an easement by the applicant of a value equivalent to the cost to City of the construction of an off-site stormwater management facility sufficient to achieve City stormwater requirements with respect to a number of cubic feet of annual stormwater equivalent to the estimated number of cubic feet of annual stormwater that will not achieve City stormwater requirements as a consequence of the waiver. The agreement shall be entered into by the applicant and City prior to the recording of plats or, if no record plat is required, prior to the issuance of the building permit.

E. Factors that may generate waivers:

(1) Shallow Bedrock

(2) High Groundwater

(3) Hotspots or contaminated soils

(4) Excessive Cost

159.08 APPROVAL OF STORMWATER MANAGEMENT CONCEPT PLAN. No application for development will be accepted unless it includes a stormwater management concept plan detailing in concept how runoff and associated water quality impacts resulting from the development will be controlled or managed. The stormwater management concept plan shall:

1. Be prepared by a licensed professional engineer or landscape architect or individual credentialed in a manner satisfactory to the City.

2. Indicate whether stormwater will be managed on site or off site and, if on site, the general location and type of practices, with clear citations to the Iowa Stormwater Management Manual.

3. Include a signed and dated certification under penalty of perjury by the preparer of the stormwater management concept plan that it complies with all requirements of this chapter, meets the design requirements outlined in the Iowa Stormwater Management Manual and is designed to achieve City stormwater requirements, and that the City is entitled to rely upon the certification as due diligence on the part of City.

4. Include sufficient information (e.g., maps, hydrologic calculations, etc.) to evaluate the environmental characteristics of the project site, the potential impacts of all proposed development of the site, both present and future, on the water resources, and the effectiveness and acceptability of the stormwater BMPs proposed for managing stormwater generated at the project site. The intent of this conceptual planning process is to determine the type of stormwater BMPs necessary for the proposed project, and ensure adequate planning for management of stormwater runoff from future development. To accomplish this goal, the following information shall also be included in the stormwater management concept plan:

A. A USDA soils map identifying soil types, hydrologic soil groups and hydric soils. Soil borings will be required where infiltration practices are proposed.

B. A map (or maps) indicating the location of existing and proposed buildings, roads, parking areas, utilities, structural stormwater management and sediment and erosion BMPs. The map(s) will also clearly show proposed land use with tabulation of the percentage of surface area to be adapted to various uses; drainage patterns; locations of utilities, roads, and easements; and the limits of clearing and grading. A written description of the site plan and justification of proposed changes in natural conditions may also be required. A copy of the current SWPPP may satisfy this requirement.

C. Sufficient engineering analysis to show that the proposed BMPs are capable of achieving City stormwater requirements for the site in compliance with this chapter.

D. A written or graphic inventory of the natural resources at the site and surrounding area as it exists prior to the commencement of the project and a description of the watershed and its relation to the project site. This description should include a discussion of forest cover, topography, wetlands, and other native vegetative areas on the site. Particular attention should be paid to environmentally sensitive areas that provide particular opportunities or constraints for development.

E. A written description of the required maintenance burden for any proposed BMPs.

F. The City may also require a concept plan to consider the maximum development potential of a site under existing zoning, regardless of whether the applicant presently intends to develop the site to its maximum potential.

G. For development occurring on a previously developed site, an applicant shall be required to include within the stormwater management concept plan BMPs for controlling existing stormwater runoff discharges from the site in accordance with this chapter.

5. The stormwater management concept plan shall be referred for comment to all other interested agencies, and any comments must be addressed in a stormwater management final plan.

159.09 APPROVAL OF STORMWATER MANAGEMENT FINAL PLAN. No building, grading, or sediment control permit shall be issued until a satisfactory stormwater management final plan (or a waiver thereof) shall have undergone a review and been approved by the City after determining that the plan or waiver is consistent with the requirements of this chapter. After review of the stormwater management concept plan, and modifications to that plan as deemed necessary by City, a stormwater management final plan must be submitted to the City for approval. The stormwater management final plan, in addition to the information included in the stormwater management concept plan, shall:

1. Be prepared by a licensed professional engineer or landscape architect or individual credentialed in a manner satisfactory to the City.

2. Indicate whether stormwater will be managed on site or off site and, if on site, the general location and type of practices, with clear citations to the Iowa Stormwater Management Manual.

3. Include a signed and dated certification under penalty of perjury by the preparer of the stormwater management final plan that it complies with all requirements of this chapter and the Iowa Stormwater Management Manual, meets the submittal requirements outlined in the Iowa Stormwater Management Manual designed to achieve City stormwater requirements, and that City is entitled to rely upon the certification as due diligence on the part of City.

4. The stormwater management final plan shall also include:

A. A detailed summary of how and why the stormwater management final plan differs, if at all, from the stormwater management concept plan previously submitted.

B. Contact information, including but not limited to the name, address, and telephone number of all persons having a legal interest in the property and the tax reference number and parcel number of the property or properties affected.

C. Topographic base map, consisting of a 1" = 200' topographic base map, of the site which extends a minimum of 300 feet beyond the limits of the proposed development and indicates existing surface water drainage including streams, ponds, culverts, ditches, and wetlands; current land use including all existing structures; locations of utilities, roads, and easements; and significant natural and manmade features not otherwise shown.

D. Hydrologic and hydraulic design calculations for the pre-development and post-development conditions for the design storms specified in the Iowa Stormwater Management Manual. Such calculations shall include:

(1) description of the design storm frequency, intensity and duration;

(2) time of concentration;

(3) soil curve numbers or runoff coefficients;

(4) peak runoff rates and total runoff volumes for each watershed area;

(5) infiltration rates, where applicable;

(6) culvert capacities;

(7) flow velocities;

(8) data on the increase in rate and volume of runoff for the design storms referenced as referenced in the NOAA Atlas 14, Volumes 8 and 9 (April 2013); and

(9) documentation of sources for all computation methods and field test results.

E. If a stormwater BMP depends on the hydrologic properties of soils (e.g., infiltration basins), then a soils report shall be submitted. The soils report shall be based on on-site boring logs or soil pit profiles. The number and location of required soil borings or soil sites shall be determined based on what is needed to determine the suitability and distribution of soil types present at the location of the BMP. Borings shall be a minimum of 5’ below the subgrade of the practice for small practices and 20’ below the subgrade of large infiltration basins.

F. A maintenance and repair plan for all stormwater BMPs including detailed maintenance and repair procedures to ensure their continued efficient function. These plans will identify the parts or components of a stormwater BMP that need to be maintained and the equipment and skills or training necessary. Provisions for the periodic review and evaluation of the effectiveness of the maintenance program and the need for revisions or additional maintenance procedures shall be included in the plan.

G. A detailed landscaping plan for management of vegetation at the site after construction is finished, including who will be responsible for the maintenance of vegetation at the site and what practices will be employed to ensure that adequate vegetative cover is preserved. This plan must be prepared by a registered landscape architect, landscape designer, or by an individual credentialed in a manner satisfactory to the City.

H. Proof of permanent recorded maintenance easements that will ensure access to all stormwater BMPs at the site for the purpose of inspection and repair. These easements will be recorded with the stormwater management final plan and will remain in effect even with transfer of title to the property.

I. Proof of a recorded maintenance agreement binding on all subsequent owners of land served by stormwater BMPs to ensure maintenance and repair in accordance with the specifications of this chapter.

J. Copies of all existing Stormwater Pollution Prevention Plans (SWPPP's) current as of the date of submission of the stormwater management final plan for all construction activities related to implementing any on-site stormwater BMPs.

K. Proof that the applicant has acquired all other applicable environmental permits for the site, or that no other such permits are required, prior to submission of the stormwater management final plan to the City.

159.10 PERFORMANCE SECURITY OR BOND.

1. The City shall require the submittal of an installation performance security or bond prior to issuance of a permit in order to ensure that the stormwater BMPs are installed by the permit holder as required by the approved stormwater management final plan.

2. The amount of the installation performance security or bond shall be the total estimated construction cost of the stormwater BMPs approved under the permit, plus 25%. The installation performance security or bond shall contain forfeiture provisions for failure to complete work specified in the stormwater management final plan.

3. The installation performance security or bond shall be released in full only upon submission of "as-built plans" of all stormwater BMPs specified in the stormwater management final plan and written certification by a professional engineer that the stormwater BMPs have been installed in accordance with the approved stormwater management final plan and other applicable provisions of this chapter. The City will make a final inspection of stormwater BMPs to ensure compliance with the approved stormwater management final plan and the provisions of this chapter. Provisions for a partial pro rata release of the installation performance security or bond based on the completion of various development stages can be made at the discretion of City.

4. The installation performance security or bond shall inure only to the benefit of the City for purposes of completing, modifying, or correcting the stormwater BMPs to comply with this chapter.

159.11 CONSTRUCTION INSPECTION.

1. The applicant must notify the City in advance before the commencement of construction. Regular inspections of construction of the stormwater BMPs shall be conducted by City or City's designated representative. Inspections will be conducted before any land disturbing activity begins, at the time of footing inspections, at the completion of the project; and prior to the release of financial securities. All inspections shall be documented and written reports prepared that contain the following information:

A. The date and location of the inspection; and

B. Whether construction is in compliance with the approved stormwater management concept plan; and

C. Variations, if any, from the approved stormwater management concept plan.

2. If any violations are found, the applicant shall be notified in writing of the nature of the violation and the required corrective actions. No additional work shall proceed until any violations are corrected and all work previously completed has received approval by City.

3. After construction is completed, applicants are required to submit actual "as-built" drawings satisfactory to City for any stormwater BMPs located on site. The drawings must show the final design specifications for all stormwater BMPs and must be certified by a professional engineer. A final inspection by City is required before the release of the installation performance security or bond can occur.

4. Landscaping and stabilization shall be accomplished to prevent violation of City stormwater requirements or impairment of BMPs. In addition, a landscaping plan must be submitted with the final as-built drawings describing the vegetative stabilization and management techniques to be used at a site after construction is completed. This plan will explain not only how the site will be stabilized after construction, but who will be responsible for the maintenance of vegetation at the site and what practices will be employed to ensure that adequate vegetative cover is preserved. This plan must be prepared by a registered landscape architect, landscape designer, or by and individual credentialed in a manner acceptable to the City.

159.12 MAINTENANCE AND REPAIR OF STORMWATER BMPS. The applicant or owner of every site or an assignee qualified pursuant to Section 159.12 shall be responsible for providing as built drawings at the completion of the project and maintaining as-built stormwater BMPs in an effective state as determined in the sole judgment of City for 10 years from and after completion of construction.

1. Maintenance and Repair Easement. Prior to the issuance of any permit for development involving any stormwater BMP, the applicant or owner of the site must execute a maintenance and repair easement agreement that shall be binding on all subsequent owners of land served by the stormwater BMP. The agreement shall provide for access to the BMP and the land it serves at reasonable times for periodic inspection by City or City's designee and for regular or special assessments of property owners to ensure that the BMP is maintained in proper working condition to meet City stormwater requirements. The easement agreement shall be recorded by City at the expense of the permit holder or property owners.

2. Maintenance Covenants.

A. Maintenance of all stormwater BMPs shall be ensured through the creation of a formal maintenance covenant that must be approved by the City and recorded prior to the stormwater management final plan approval. As part of the covenant, a schedule shall be developed for when and how often maintenance will occur to ensure proper function of the stormwater BMPs. The covenant shall also include plans for periodic inspections to ensure proper performance of the BMPs between scheduled cleanouts.

B. The City, in lieu of a maintenance covenant, may at its discretion, accept dedication of any existing or future stormwater BMP to include City responsibility for maintenance

and repair, provided that: the maintenance and repair of such element will not impose an undue burden on other City taxpayers who enjoy little if any benefit from the BMP; the BMP meets all the requirements of this chapter; and the dedication includes adequate and perpetual access and sufficient area, by easement or otherwise, for inspection and regular maintenance.

3. Requirements for Maintenance Covenants. All stormwater BMPs must undergo, at the minimum, an annual inspection to document maintenance and repair needs and ensure compliance with the requirements of this chapter and accomplishment of its purposes. These needs may include (but are not limited to) removal of sediment build up, litter, and other debris from all stormwater treatment and conveyance facilities including ponds, infiltration basins, raingardens, catch basins, inlets, and drainage pipes, grass cutting and vegetation removal, and necessary replacement of landscape vegetation. Any maintenance or repair needs detected must be corrected by the developer or entity responsible under a written maintenance agreement in a timely manner, as determined by City, and the inspection and maintenance requirement may be increased as deemed necessary to ensure proper functioning of the stormwater BMPs.

4. Inspection of Stormwater BMPs. Inspection programs may be established on any reasonable basis, including but not limited to: routine inspections; random inspections; inspections based upon complaints or other notice of possible violations; inspection of drainage basins or areas identified as higher than typical sources of sediment or other contaminants or pollutants; inspections of businesses or industries of a type associated with higher than usual discharges of contaminants or pollutants or with discharges of a type which are more likely than the typical discharge to cause violations of State or Federal water or sediment quality standards or the NPDES stormwater permit; and joint inspections with other agencies inspecting under environmental or safety laws. Inspections may include but are not limited to: reviewing maintenance and repair records; sampling discharges, surface water, groundwater, and material or water in stormwater BMPs, and evaluating the condition of stormwater BMPs.

5. Right of Entry for Inspection. When any new stormwater BMP is installed on private property, or when any new connection is made between private property and a public stormwater management facility, sanitary sewer or combined sewer, the property owner shall grant to City the right to enter the property at reasonable times and in a reasonable manner for the purpose of inspection. This includes the right to enter a property when City has a reasonable basis to believe that a violation of this chapter is occurring or has occurred, and to enter when necessary for abatement of a public nuisance or correction of a violation of this chapter.

6. Records of Installation and Maintenance and Repair Activities. Parties responsible for the operation and maintenance of stormwater BMPs shall submit to the City Engineer an annual maintenance and inspection report including all records of the installation and of all maintenance and repairs conducted. At the completion of the 5^{th} year, an updated as built drawing will be required. The responsible parties shall retain the records for at least five (5) years or longer if the City Inspector deems it necessary. These records shall be made available to City during inspection of the facility and at other reasonable times upon request.

7. Failure to Maintain Stormwater BMPs. If a responsible party fails or refuses to meet the requirements of the maintenance covenant or any provision of this chapter, the City, after reasonable notice, may correct a violation by performing all necessary work to place the BMP in proper working condition. In the event that the stormwater BMP becomes a danger to public safety or public health, the City shall notify the party responsible for maintenance of the stormwater BMP in writing. Upon receipt of that notice, the responsible person shall have thirty

(30) days to effect maintenance and repair of the stormwater BMP in an approved manner. After proper notice, the City may assess, jointly and severally, the owners of the stormwater BMP or the property owners or the parties responsible for maintenance under any applicable written agreement for the cost of repair work and any penalties; and the cost of the work shall be a lien on the property, or prorated against the beneficial users of the property, and may be placed on the tax bill and collected as ordinary taxes.

159.13 ENFORCEMENT AND PENALTIES.

1. Violation of any provision of this chapter may be enforced by civil action including an action for injunctive relief. In any civil enforcement action, administrative or judicial, the City shall be entitled to recover its attorneys' fees and costs from a person who is determined by a court of competent jurisdiction to have violated this chapter.

2. The City may issue a stop work order for violation of any provision of this chapter. The stop work order shall remain in effect until the violation is corrected and a subsequent inspection completed.

3. Violation of any provision of this chapter may also be enforced as a municipal infraction within the meaning of Section 364.22 of the Code of Iowa, pursuant to Chapter 4 of this Code of Ordinances.

4. Enforcement pursuant to this section shall be undertaken by City upon the advice and consent of the City Attorney or other counsel employed by City.

5. Any violator may be required to restore land to its undisturbed condition. In the event that restoration is not undertaken within a reasonable time after notice, the City may take necessary corrective action, the cost of which shall become a lien upon the property until paid.

6. Occupancy permits shall not be granted until all stormwater BMPs have been inspected and approved by City.

159.14 APPEAL. Administrative decisions by City staff and enforcement actions may be appealed by the developer or property owner to the City Council pursuant to the following rules:

1. The appeal must be filed in writing with the City Clerk within five (5) business days of the decision or enforcement action.

2. The written appeal shall specify in detail the action appealed from, the errors allegedly made by the enforcement officer giving rise to the appeal, a written summary of all oral and written testimony the applicant intends to introduce at the hearing, including the names and addresses of all witnesses the applicant intends to call, copies of all documents the applicant intends to introduce at the hearing, and the relief requested.

3. The enforcement officer shall specify in writing the reasons for the enforcement action, a written summary of all oral and written testimony the enforcement officer intends to introduce at the hearing, including the names and addresses of all witnesses the enforcement officer intends to call, and copies of all documents the enforcement officer intends to introduce at the hearing.

4. The City Clerk shall notify the applicant and the enforcement officer by ordinary mail and shall give public notice, in accordance with Chapter 21 of the Code of Iowa, of the date, time, and

place for the regular or special meeting of the City Council at which the hearing on the appeal shall occur. The hearing shall be scheduled for a date not less than four (4) or more than twenty (20) days after the filing of the appeal. The rules of evidence and procedure and the standard of proof to be applied shall be the same as provided by Chapter 17A, Code of Iowa. The applicant may be represented by counsel at the applicant's expense. The enforcement officer may be represented by the City Attorney or by an attorney designated by the City Council at City expense.

5. The decision of the City Council shall be rendered in writing and may be appealed to the Iowa District Court.

159.15 DEFINITIONS. Terms in this chapter, other than those defined below, shall have the meanings set out in the Iowa Stormwater Management Manual .

1. "Applicant" means a property owner or agent of a property owner who has filed an application for a stormwater management permit.

2. "Best Management Practice (BMP)" is a technique, measure, or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner. BMPs can be either Non Structural (planning, watershed management, practice design, etc.) or Structural (Engineered and constructed) systems that are used to treat the stormwater.

3. "Buffer" is a vegetative area, including trees, shrubs, and herbaceous vegetation, that exists or is established to protect a stream system, lake, or reservoir area. Alteration of the natural area is strictly limited.

4. "Building" means any structure, either temporary or permanent, having walls and a roof, designed for the shelter of any person, animal, or property, and occupying more than 100 square feet of area.

5. "City stormwater requirements" means the standards, sizing criteria, BMPs and other requirements established in this chapter.

6. "Dedication" means the deliberate appropriation of property by its owner for general public use.

7. "Developer" means a person, persons, or entity who undertakes land disturbance activities.

8. "Development" or "Redevelopment means either:

    A. Land disturbance activity exceeding one acre (43,560 square feet) on land previously vacant of buildings or largely free of previous land disturbance activity other than traditional agricultural activities; or

    B. Land disturbance activity exceeding one acre (43,560 square feet) in areas where existing land use is high density commercial, industrial, institutional or multi-family residential (a.k.a. "redevelopment").

9. "Drainage easement" means a legal right granted by a landowner to a grantee allowing the use of private land for stormwater management purposes. Public easements shall be maintained by

the City of Storm Lake. Private easements shall be maintained by the private owners of the project.

10. "Enforcement officer" means that person designated by the City having responsibility for administration and enforcement of this chapter.

11. "Excessive Cost" means Practice cost greater than an amount as set by resolution of the City Council per impervious acre.

12. "Fee in lieu" means a payment of money in place of achieving or exceeding all or part of City stormwater requirements.

13. Infiltration Based Practices means that at a minimum the water quality volume moves through the soil media to provide filtration.

14. "Iowa Stormwater Management Manual" means the current Iowa Stormwater Management Manual publication, by whatever name, as amended from time to time by Iowa Department of Natural Resources in collaboration with Iowa Stormwater Education Program and other partners that recommends Stormwater Management Guidelines and Uniform Sizing Criteria and BMPs designed to address said Guidelines.

15. "Land disturbance activity" means any activity which changes the volume or peak flow discharge rate of rainfall runoff from the land surface. This may include the grading, digging, cutting, scraping, or excavating of soil, placement of fill materials, paving, construction, substantial removal of vegetation, or any activity which bares soil or rock or involves the diversion or piping of any natural or man-made watercourse.

16. "Landowner" means the legal or beneficial owner of land, including those holding the right to purchase or lease the land, or any other person holding proprietary rights in the land.

17. "Maintenance agreement" means a legally recorded document that acts as a property deed restriction, and which provides for long-term maintenance of stormwater BMPs.

18. "Native Vegetation" refers to vegetation originating naturally in this region of the state. Native vegetation is not to be confused with all existing vegetation.

19. "Predevelopment Condition " shall be considered the greater of the rainfall at which direct runoff begins using the curve number for a meadow in good condition, or the 1-year, 24-hour storm event per the Iowa Stormwater Management Manual.

20. "Stormwater management" means the use of BMPs that are designed in accordance with City stormwater requirements to reduce stormwater runoff pollutant loads, discharge volumes, peak flow discharge rates, and detrimental changes in stream temperature that affect water quality and habitat.

21. "Stormwater Pollution Prevention Plan" (SWPPP) means a plan that is designed to minimize the accelerated erosion, sediment, and other pollutant runoff at a site during construction activities.

22. "TP (Total Phosphorous) means the total concentration of all forms of phosphorus found in a water sample.

B appendix

Storm Lake Construction Site Erosion and Sediment Control Ordinance

CHAPTER 160

CONSTRUCTION SITE EROSION AND SEDIMENT CONTROL

160.01 FINDINGS.

1. The U.S. EPA's National Pollutant Discharge Elimination System ("NPDES") permit program ("Program") administered by the Iowa Department of Natural Resources ("IDNR") requires that certain individuals engaged in construction activities ("applicants") submit an application to the IDNR for a State NPDES General Permit #2. Notwithstanding any provision of this chapter, every applicant bears final and cmplete responsibility for compliance with a State NPDES General Permit #2 and a City COSESCO Permit and any other requirement of State or Federal law or administrative rule.

2. The City is obliged to undertake responsibility for administration and enforcement of the Program by adopting a CONSTRUCTION SITE EROSION AND SEDIMENT CONTROL ("COSESCO") ordinance designed to achieve the following objectives:

    A. Any applicant required by law or administrative rule to apply to the IDNR for a State NPDES General Permit #2 shall also be required to obtain from the City a COSESCO permit ("City COSESCO Permit") in addition to and not in lieu of the State NPDES General Permit #2; and

    B. The City shall have responsibility for inspection, monitoring and enforcement procedures to promote applicants' compliance with State NPDES General Permits #2 and City COSESCO Permits.

3. No State or Federal funds have been made available to assist the City in administering and enforcing the Program. Accordingly, the City shall fund its application, inspection, monitoring and enforcement responsibilities entirely by fees imposed on the owners of properties which are made subject to the Program by virtue of State and Federal law, and/or other sources of funding established by a separate ordinance.

4. Terms used in this chapter shall have the meanings specified in the Program.

160.02 PURPOSE

The general purpose of this ordinance is to establish regulatory requirements for land development and land disturbing activities aimed at minimizing the threats to public health, safety, public and private property and natural resources within the community from construction site erosion. Specific purposes are to establish performance standards that will provide a single, consistent set of performance standards that apply to all developments and will protect public and private property and receiving waters from damage resulting from erosion and sediment in stormwater runoff.

160.03 APPLICABILITY

1. All persons required by law or administrative rule to obtain a State NPDES General Permit #2 from the IDNR are required to obtain a City COSESCO Permit and prepare a Stormwater Pollution Prevention Plan (SWPPP).

2. All persons are required to obtain a City COSESCO Permit and prepare an Erosion and Sediment Control Plan (ESC) if proposing a land disturbance activity that will:

    A. Disturb a total land surface area of between 3,000 square feet and one acre, or

    B. Excavate and/or fill a volume in excess of 50 cubic yards of material, or

    C. Lay, repair, replace, or enlarge an underground utility, pipe or other facility, or disturb a road ditch, grass swale or other open channel for a distance of 300 feet or more.

160.04 APPLICATION PROCEDURE.

1. The applicant shall request a pre-application meeting which will be facilitated by the City between the applicant, City staff, and staff of partner agencies as applicable. The meeting shall be mandatory prior to submission of a permit application. The purposes of the meeting are: to understand the general parameters of the proposed project; and to convey the requirements of meeting the provisions of this and other applicable ordinances.

2. The City shall make a determination regarding the completeness of a City COSESCO Permit application within ten (10) business days of the receipt of the application and notify the applicant in writing if the application is not complete including the reasons the application was deemed incomplete.

3. The applicant shall not commence any construction activity subject to this ordinance until a City COSESCO Permit has been authorized by the City. A complete review of the permit application shall be done within fifteen (15) business days of the receipt of a complete permit application from the applicant. The City will work with the necessary state, county, and local

agencies to complete its review. The City shall review all information in the permit application including proposed stormwater practices, hydrologic models, and design methodologies and certify compliance with this ordinance. Applications for City COSESCO Permits shall be made on forms approved by the City which may be obtained from the office of the City Clerk.

4. An applicant for a City COSESCO Permit shall pay fees as follows:

    A. An application fee at the time of application in the amount of $0.00.

    B. For each inspection required by this chapter, the applicant shall pay an inspection fee in the amount of $0.00.

    C. Failure of the applicant to pay an inspection fee within thirty (30) days of billing shall constitute a violation of this chapter.

    D. The applicant will also be responsible for any outside consultant fees incurred by the City in enforcing this chapter.

5. An applicant in possession of a State NPDES General Permit #2 issued by the IDNR shall immediately submit to the City full copies of the materials described below as a basis for the City to determine whether to issue a City COSESCO Permit:

    A. Applicant's plans, specifications, and supporting materials previously submitted to the IDNR in support of applicant's application for the State NPDES General Permit #2;

    B. Applicant's authorizations issued pursuant to applicant's State NPDES General Permit #2; and

    C. A Stormwater Pollution Prevention Plan ("SWPPP") prepared in accordance with this chapter.

6. Every SWPPP submitted to the City in support of an application for a City COSESCO Permit shall:

    A. Comply with all current minimum mandatory requirements for SWPPPs promulgated by the IDNR in connection with issuance of a State NPDES General Permit #2;

    B. If the applicant is required by law to file a Joint Application Form, PROTECTING IOWA WATERS, IOWA DEPARTMENT OF NATURAL RESOURCES AND U.S. ARMY CORPS OF ENGINEERS, comply with all mandatory minimum requirements pertaining to such applications;

    C. Comply with all other applicable State or Federal permit requirements in existence at the time of application;

    D. Be prepared by a licensed professional engineer or landscape architect or a professional in erosion and sediment control credentialed in a manner acceptable to the City; and

E. Include within the SWPPP a signed and dated certification by the NPDES General Permit #2 permit holder that the SWPPP complies with all requirements of this chapter and the applicant's NPDES General Permit #2.

7. In addition to the SWPPP requirements stated in subsection 5 of this section, which constitute minimum mandatory requirements imposed by the Program, every SWPPP submitted to the City in support of an application for a City COSESCO Permit shall comply with Iowa Stormwater Management Manual standard design criteria, including but not limited to design, location, and phased implementation of effective, practicable stormwater pollution prevention measures, and shall also:

   A. Identify the nature of the construction activity and the potential for sediment and other pollutant discharges from the site.

   B. Calculate the predicted erosion and estimated sediment yield for the construction site using the USDA Revised Universal Soil Loss Equation.

   C. Limit total off-site annual aggregate sediment yield for exposed areas to an equivalent amount resulting from sheet and rill erosion equal to an annual, cumulative soil loss rate not to exceed the standard established from time to time by Soil and Water Conservation Districts; erosion rates can exceed soil loss limits as long as sediment yield does not exceed that expected from allowable erosion rates.

   D. Assure that all stockpiles of soil or other materials subject to erosion by wind or water are covered, vegetated, or otherwise effectively protected from erosion and sedimentation in accordance with the amount of time the material will be on site and the manner of its proposed use; no stockpiling is allowed in the street.

   E. Identify measures and procedures to reasonably minimize site soil compaction and provide soil quality restoration as specified.

   F. Assure that all temporary erosion and sediment controls shall not be removed until the City has determined that the site has been permanently stabilized.

   G. Assure that all disturbed sites be permanently stabilized with 70% perennial cover as measured by the USDA line transect method.

   H. Identify methods to prevent sediment damage to adjacent properties and sensitive environmental areas such as water bodies, plant communities, rare, threatened, and/or endangered species habitats, wildlife corridors, greenways, etc.

   I. Provide for design and construction methods to stabilize steep or long continuous slopes.

   J. Include measures to control the quantity and quality of stormwater leaving a site before, during, and after construction.

   K. Provide for stabilization of all waterways and outlets.

   L. Protect storm sewer infrastructure from sediment loading/plugging.

   M. Specify precautions to be taken to contain sediment when working in or crossing water bodies.

N. Assure stabilization of disturbed areas, including utility construction areas, as soon as possible.

O. Protect outlying roads from sediment and mud from construction site activities, including tracking.

P. Provide for disposal of collected sediment and floating debris.

Q. Assure that, when working near water bodies , the specific practices itemized immediately below are utilized:

(1) During Construction.

(a) All exposed soil areas with a slope of 3:1 or steeper, which have a continuous positive slope to a receiving water, should have temporary erosion protection or permanent cover within three days after the area is no longer actively being worked; all other slopes that have a continuous positive slope to a receiving water should have temporary erosion protection or permanent cover within seven days after the area is no longer actively being worked.

(b) Temporary sediment basin requirements should be used for common drainage locations that serve an area with five or more acres disturbed at one time.

(2) Buffer Zone. Provide for the maintenance at all times of an undisturbed buffer zone consisting of not less than 100 linear feet from a receiving water. Exceptions from this for areas such as water crossings or limited water access are allowed if the applicant fully documents in the SWPPP the circumstances and reasons that the buffer encroachment is necessary; all potential water quality, scenic and other environmental impacts of these exceptions should be minimized and documented in the SWPPP for the project.

8. Every Erosion and Sediment Control Plan (ESC) Submitted to the City in support of a City COSESCO Permit shall:

A. Phase construction to minimize duration of exposed soil areas.

B. Provide temporary and permanent erosion prevention, sediment control, stormwater runoff, and soil stabilization BMPs along with procedures to establish additional temporary BMPs as necessary for the site conditions during construction.

C. Provide final stabilization of all exposed soil areas.

D. Incorporate the following into the site design for erosion and sediment control:

(1) Minimize disturbance of natural soil cover and vegetation

(2) Minimize, in area and duration, exposed soil and unstable soil conditions

(3) Protect receiving water bodies, wetlands and storm sewer inlets

(4) Protect adjacent properties from sediment deposition

(5) Minimize off-site sediment transport on trucks and equipment

(6) Minimize work in and adjacent to waterbodies and wetlands

(7) Maintain stable slopes

(8) Avoid steep slopes and the need for high cuts and fills

(9) Minimize disturbance to the surrounding soils, root systems and trunks of trees adjacent to site activity that are intended to be left standing

(10) Minimize the compaction of site soils

E. Identify the:

(1) Elevations, sections, profiles, and details as needed to describe all natural and artificial features of the project.

(2) 100-year flood elevation with and without the floodway, flood fringe, and/or general flood boundary, if available.

(3) Normal water level, high water level, and emergency overflow elevations for the site and all associated ponding systems.

(4) Locations of all stormwater management practices, infiltration areas, and areas not to be disturbed during construction.

(5) Location, size, and approximate grade of proposed public sewer and water mains.

(6) Construction phasing including a map and calculations as necessary of areas of grubbing, clearing, tree removal, grading, excavation, fill and other disturbance; areas of soil or earth material storage; quantities of soil or earth material to be removed, placed, stored or otherwise moved on site, delineated limits of disturbance, and final stabilization methods.

(7) Locations of planned temporary and permanent erosion prevention, sediment control, stormwater runoff, and soil stabilization BMPs.

9. Issuance by the City of a City COSESCO Permit shall be a condition precedent for the issuance of a City building permit or site plan approval.

10. For so long as a construction site is subject to a State NPDES General Permit #2 or a City COSESCO Permit, the applicant shall provide the City with current information, as follows:

A. The name, address, and telephone number of the person on site designated by the owner who is knowledgeable and experienced in erosion and sediment control and who will oversee compliance with the State NPDES General Permit #2 and the City COSESCO Permit;

B. The names, addresses, and telephone numbers of the contractors and/or subcontractors that will implement each erosion and sediment control measure identified in the SWPPP or ESC.

Applicant's failure to provide current information shall constitute a violation of this chapter.

11. Developers can transfer State NPDES General Permit #2 and the City COSESCO Permit responsibility to homebuilders, new lot owners, contractors, and subcontractors. Transferees must agree to the transfer in writing, must agree to fulfill all obligations of the SWPPP or ESC, the State NPDES General Permit #2 (if applicable), and the City COSESCO Permit. Absent such written confirmation of transfer of obligations, the developer remains responsible for compliance on any lot that has been sold. A developer shall notify the City of any application to the DNR for release of any property from a General Permit #2 pursuant to Iowa Administrative Code 567, 64.6(6) or any similar successor provision.

12. Before work under the permit is deemed complete, the permittee must submit as-builts and a maintenance plan demonstrating at the time of final stabilization that the stormwater facilities conform to design specifications.

13. Application for termination of a City COSESCO Permit shall be made by contacting the City Inspector.

160.05 INSPECTION PROCEDURES.

1. All inspections required under this chapter shall be conducted by the Public Works Director, City Engineer, City Inspector, a subcontractor credentialed in a manner satisfactory to the City, or other appropriate designee, hereinafter referred to as the "enforcement officer."

2. The City shall conduct inspections on a regular basis to ensure that both stormwater and erosion and sediment control measures are properly installed and maintained prior to construction, during construction, and at the completion of the project. Mandatory inspections are required as follows:

   A. Before any land disturbing activity begins;

   B. At the time of footing inspections;

   C. At the completion of the project; and

   D. Prior to the release of financial securities.

3. Applicant shall notify the City prior to commencing land disturbing activity, at the time of footing inspections and when all measures required by applicant's SWPPP have been accomplished on-site, whereupon the City shall conduct an inspection for the purpose of determining compliance with this chapter, and shall within two (2) business days thereafter report to the applicant either that compliance appears to have been achieved, or that compliance has not been achieved, in which case the City shall provide a bill of particulars identifying the conditions of noncompliance. The applicant shall immediately commence corrective action and shall complete such corrective action within twenty-four (24) hours of receiving the City's bill of particulars. For good cause shown, the City may extend the deadline for taking corrective action. Failure to take corrective action in a timely manner shall constitute a violation of this chapter.

4. Construction shall not occur on the site at any time when the City has identified conditions of noncompliance.

5. Construction activities undertaken by an applicant prior to resolution of all discrepancies specified in the bill of particulars shall constitute a violation of this chapter.

6. The City shall not be responsible for the direct or indirect consequences to the applicant or to third parties for noncompliant conditions undetected by inspection.

160.06 MONITORING PROCEDURES.

1. Upon issuance of a City COSESCO Permit, an applicant has an absolute duty to monitor site conditions and to report to the enforcement officer any change of circumstances or site conditions which the applicant knows or should know pose a risk of stormwater discharge in a manner inconsistent with applicant's SWPPP, State NPDES General Permit #2 and/or City COSESCO Permit.

    A. Such report shall be made by the applicant to the enforcement officer immediately but in any event within twenty-four (24) hours of the change of circumstances or site conditions.

    B. Failure to make a timely report shall constitute a violation of this chapter.

2. Any third party may also report to the City site conditions which the third party reasonably believes pose a risk of stormwater discharge in a manner inconsistent with applicant's SWPPP, State NPDES General Permit #2, and/or City COSESCO Permit.

3. Upon receiving a report pursuant to the previous subsections, the enforcement officer shall conduct an inspection of the site as soon as reasonably possible and thereafter shall provide the applicant with a bill of particulars identifying the conditions of noncompliance. The applicant shall immediately commence corrective action and shall complete such corrective action within 24 hours of receiving the City's bill of particulars. For good cause shown, the City may extend the deadline for completing corrective action. Failure to take corrective action in a timely manner shall constitute a violation of this chapter, whereupon the enforcement officer shall immediately commence enforcement actions specified in Section 160.06 below.

4. Unless a report is made to the enforcement officer pursuant to the previous subsections, the enforcement officer may conduct unannounced inspections during the course of construction to monitor compliance with the State NPDES General Permit #2 and the City COSESCO Permit. If the inspection discloses any significant noncompliance, the enforcement officer shall provide the applicant with a bill of particulars identifying the conditions of noncompliance. The applicant shall immediately commence corrective action and shall complete such corrective action within 24 hours of receiving the City's bill of particulars. For good cause shown, the City may extend the deadline for completing corrective action. Failure to take corrective action in a timely manner shall constitute a violation of this chapter, whereupon the enforcement officer shall immediately commence enforcement actions specified in Section 160.06 below.

5. The City shall not be responsible for the direct or indirect consequences to the applicant or to third parties for noncompliant conditions undetected by inspection.

160.07 ENFORCEMENT.

1. Violation of any provision of this chapter may be enforced by civil action including an action for injunctive relief. In any civil enforcement action, administrative or judicial, the City shall be entitled to recover its attorneys' fees and costs from a person who is determined by a court of competent jurisdiction to have violated this chapter.

2. Violation of any provision of this chapter may also be enforced as a municipal infraction within the meaning of Section 364.22 of the Code of Iowa, pursuant to Chapter 4 of this Code of Ordinances.

3. Enforcement pursuant to this section shall be undertaken by the enforcement officer upon the advice and consent of the City Attorney.

4. In cases where cooperation for inspections is withheld, construction stop work orders shall be issued by the City until stormwater and erosion and sediment control measures meet the requirements of this ordinance. An inspection must follow before work can resume.

5. If stormwater and/or erosion and sediment control management measures malfunction and breach the perimeter of the site, enter streets, other public areas, or a receiving water, the applicant shall immediately develop a cleanup and restoration plan, obtain the right-of-way from the adjoining property owner, and implement the cleanup and restoration plan within 48 hours of obtaining permission. If in the discretion of the City, the applicant does not repair the damage caused by the stormwater runoff the City can complete the remedial work required and charge the cost to the applicant. If payment is not made within thirty days, payment will be made from the applicant's financial securities.

6. The City can take any combination of the following actions in the event of a failure by applicant to meet the terms of this ordinance:

    A. Withhold inspections or issuance of certificates or approvals;

    B. Revoke any permit issued by the City to the applicant;

    C. Conduct remedial or corrective action on the development site or adjacent site affected by the failure;

    D. Charge applicant for all costs associated with correcting the failure or remediating damage from the failure; If payment is not made within thirty days, payment will be made from the applicant's financial securities;

    E. Bring other actions against the applicant to recover costs of remediation or meeting the terms of this ordinance; and

    F. Any person, firm or corporation failing to comply with or violating any of these regulations, shall be deemed guilty of a misdemeanor and be subject to a fine or imprisonment or both. Each day that a separate violation exists shall constitute a separate offense.

160.08 FAILURE TO COMPLY. Failure to comply with this chapter constitutes a municipal infraction. The property owner is responsible to ensure that this chapter is observed.

160.09 APPEAL. Administrative decisions by City staff and enforcement actions of the enforcement officer may be appealed by the applicant to the City Council pursuant to the following rules:

1. The appeal must be filed in writing with the City Clerk within five (5) business days of the decision or enforcement action.

2. The written appeal shall specify in detail the action appealed from, the errors allegedly made by the enforcement officer giving rise to the appeal, a written summary of all oral and written testimony the applicant intends to introduce at the hearing, including the names and addresses of all witnesses the applicant intends to call, copies of all documents the applicant intends to introduce at the hearing, and the relief requested.

3. The enforcement officer shall specify in writing the reasons for the enforcement action, a written summary of all oral and written testimony the enforcement officer intends to introduce at the hearing, including the names and addresses of all witnesses the enforcement officer intends to call, and copies of all documents the enforcement officer intends to introduce at the hearing.

4. The City Clerk shall notify the applicant and the enforcement officer by registered mail, and shall give public notice, in accordance with Chapter 21 of the Code of Iowa, of the date, time, and place for the regular or special meeting of the City Council at which the hearing on the appeal shall occur. The hearing shall be scheduled for a date not less than four (4) or more than twenty (20) days after the filing of the appeal. The rules of evidence and procedure, and the standard of proof to be applied, shall be the same as provided by Chapter 17A, Code of Iowa. The applicant may be represented by counsel at the applicant's expense. The enforcement officer may be represented by the City Attorney or by an attorney designated by the City Council at City expense.

The decision of the City Council shall be rendered in writing and may be appealed to the Iowa District Court.

160.10 FINANCIAL SECURITIES

1. The City shall require financial securities from the applicant in an amount sufficient to cover the entirety of the estimated costs of permitted and remedial work based on the final design as established in a set finance security schedule determine by the City.

2. Financial securities shall not be released until all permitted and remedial work is completed

3. Financial securities may be used by the City to complete work not completed by the applicant

4. The form of the financial securities shall be one or a combination of the following to be determine by the City:

    A. Cash Deposit – The first $5000 of the financial security for erosion and sediment control shall be by cash deposit to the City. The cash will be held by the City in a separate account.

    B. Securing Deposit – Deposit, either with the City, a responsible escrow agent or trust company and the option of the City, either:

(1) An irrevocable letter of credit or negotiable bonds of the kind approved for securing deposits of public money or other instruments of credit from one or more financial institutions, subject to regulation by state and federal government wherin said financial institution pledges funds are on deposit and guaranteed for payment;

(2) Cash in U.S. Currency; or

(3) Other forms of securities (e.g. disbursing agreement) as approved by the City

5. The security shall save the City free and harmless from all suits or claims for damages resulting from the negligent grading removal, placement or storage of rock, sand, gravel, soil or other like material within the City.

6. If at any time during the course of the work the amount falls below 50% of the required deposit, the applicant shall make another deposit in the amount necessary to restore the cash deposit to the required amount. If the applicant does not bring the financial security back up the to required amount within seven (7) days after notification by the City that the amount has fallen below 50% of the required amount the City may:

   A. Withhold the scheduling of inspections and/or the issuance of a Certificate of Occupancy.

   B. Revoke any permit issued by the City to the applicant for the site in question or any other of the applicant's sites within the City's jurisdiction.

7. The City may access financial security for remediation actions if any of the conditions listed below exist. The City shall use the security to finance remedial work undertaken by the City, or a private contractor under contract to the City , to reimburse the City for all direct costs incurred in the process of remedial work including, but not limited to, staff time and attorney's fees.

   A. Abandonment – The applicant ceases land disturbing activities and/or filling and abandons the work site prior to completion of the grading plan.

   B. Failure to Implement the SWPPP or ESC Plan – The applicant fails to conform to the grading plan and/or the SWPPP as approved by the City.

   C. Failure to Perform – The techniques utilized under the SWPPP or ESC Plan fail within one year of installation.

   D. Failure to Reimburse the City – The applicant fails to reimburse the City for corrective action taken.

8. When more than one-third of the applicant's maximum exposed soil area achieves final stabilization, the City can reduce the total required amount of the financial security by one-third. When more than two-thirds of the applicant's maximum exposed soil area achieves final stabilization, the City can reduce the total required amount of the financial security to two-thirds of the initial amount. This reduction in financial security will be determined by the City

9. The security deposited with the City for faithful performance of the SWPPP or ESC Plan and any related remedial work shall be released one full year after the completion of the

installation of all stormwater pollution control measures as shown on the SWPPP or ESC Plan

160.11 RIGHT OF ENTRY The issuance of a permit constitutes a right-of-entry for the City or its contractor to enter upon the construction site. The applicant shall allow the City and their authorized representative upon presentation of credentials to:

1. Enter upon the permitted site for the purpose of obtaining information, examination of records, conducting investigations or surveys;

2. Bring such equipment upon the permitted site as is necessary to conduct such surveys and investigation;

3. Examine and copy any books, papers, records or memoranda pertaining to activities or records required to be kept under the terms and conditions of the permit;

4. Inspect the stormwater pollution control measures;

5. Sample and monitor any items or activities pertaining to stormwater pollution control measures; and

6. Correct deficiencies in stormwater and erosion and sediment control measures

160.12 DEFINITIONS

1. "Applicant" means a property owner or agent of a property owner who has filed an application for a construction site erosion and sediment control permit.

2. "Developer" means a person who undertakes land disturbance activities.

3. "Development" means activity land disturbance activity on land previously vacant of buildings or largely free of previous land disturbance activity other than traditional agricultural activities; or on land where existing land use is high density commercial, industrial, institutional or multi-family residential (a.k.a. "redevelopment").

4. "Enforcement officer" means that person designated by the City having responsibility for administration and enforcement of this chapter.

5. "Land disturbance activity" means any activity which changes the volume or peak flow discharge rate of rainfall runoff from the land surface. This may include the grading, digging, cutting, scraping, or excavating of soil, placement of fill materials, paving, construction, substantial removal of vegetation, or any activity which bares soil or rock or involves the diversion or piping of any natural or man-made watercourse.

6. "Stormwater Pollution Prevention Plan" (SWPPP) means a plan that is designed to minimize the accelerated erosion and sediment runoff at a site during construction activities.

7. "Iowa Stormwater Management Manual" means the current Iowa Stormwater Management Manual publication, by whatever name, as amended from time to time by Iowa Department of Natural Resources in collaboration with The Center for Transportation Research at Iowa State University, that recommends Stormwater Management Guidelines and Uniform Sizing Criteria and BMPs designed to address said Guidelines.

C appendix

Stormwater Modeling Report and Figures – Bolton and Menk, Inc.

City of Storm Lake, Iowa

Conservation Design Forum

Best Management Practices

Water Quality Modeling

To model water quality for the City of Storm Lake, Iowa, Geographic Information System (GIS) techniques were used to give consistent results for the areas modeled. The Simple Method, which estimates pollutant loads from various land uses, was used to model stormwater quality. This method requires key watershed characteristic inputs including land use, drainage area, impervious percentage, pollutant concentrations and annual precipitation. The Simple Method uses these parameters to quantify the pollutant load generated by each watershed. The stormwater pollutants quantified using this method are Total Suspended Solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN). The Simple Method equation, pollutant concentrations and land uses modeled in this study are listed as follows.

The Simple Method Equations

$$Loading\left(\frac{\frac{Lbs}{Acre}}{year}\right) = 0.226 * R * C$$

R = Annual runoff (inches)
C = Pollutant Concentration (mg/l)
0.226 = Unit conversion factor

$$R = P * Pj * Rv$$

P = Average annual rainfall (inches), 29.12" for the City of Storm Lake, Iowa
Pj = Fraction of annual rainfall events that produce runoff (90%)
Rv = Runoff Coefficient

$$Rv = 0.05 + 0.009 * I$$

I = Impervious fraction (ex: 90%, I = 90)

Table 1: Pollutant Concentrations

Event Mean Concentrations			
Land Use	**TSS (mg/L)**	**TP (mg/L)**	**TN (mg/L)**
Agriculture	456	0.53	7.1
Campus	391	0.42	3.2
Commercial	206	0.23	3.6
Industrial	230	0.27	2.6
Open Space	60	0.39	0.7
Residential	153	0.4	3.1

Table 2: Land Use Impervious % and Pollutant Loading per Acre

Land Use Designation	Zoning Symbol	Impervious %	Runoff Coefficient	TSS		TP		TN	
				EMC (mg/L)	Loading (Lbs/Ac/Yr)	EMC (mg/L)	Loading (Lbs/Ac/Yr)	EMC (mg/L)	Loading (Lbs/Ac/Yr)
Agriculture	AG	5.00%	0.095	456	257	0.53	0.30	7.1	4.0
Campus/School	CP	50.00%	0.5	391	1161	0.42	1.25	3.2	9.5
General Commerical	GC	85.00%	0.815	206	997	0.23	1.11	3.6	17.4
General Industrial District	GI	72.00%	0.698	230	954	0.27	1.12	2.6	10.8
Open Space	OS	10.00%	0.14	60	50	0.39	0.32	0.7	0.6
Single Residential District	R-1	38.00%	0.392	153	356	0.40	0.93	3.1	7.2
Single Family & Duplex Development	R-2	38.00%	0.392	153	356	0.40	0.93	3.1	7.2
Urban Family Residential District	R-3	38.00%	0.392	153	356	0.40	0.93	3.1	7.2
Multi-Family Residential District	R-4	65.00%	0.635	153	577	0.40	1.51	3.1	11.7
Rural Residential District	R-R	25.00%	0.275	153	250	0.40	0.65	3.1	5.1

Using GIS techniques for stormwater quality modeling allows the entire city to be modeled efficiently and consistently at a sub watershed scale. The land use dataset is based on zoning GIS data provided by the City. It has been modified to reflect actual land use as verified by aerial photography. GIS allows each individual land use to be broken into subcomponents within each watershed, quantifies the pollutant loading based on the land use, and then summarizes the pollutant loading for all land uses within each respective watershed. This method limits user error during calculations and provides consistent results on a citywide basis.

For the water quality modeling, watersheds are delineated for each individual storm sewer system outlet. Figure 1 shows the delineated watersheds used for the water quality modeling. No pollutant loading was modeled outside of city limits. The goal of this study is to quantify pollutant loading at individual source locations rather than total loading to receiving waters. Delineating watersheds to each respective storm sewer system provides output data that will allow the impact of potential future Best Management Practices (BMPs) to be easily quantified.

Figures 4A – 6B show a graphically shaded representation of the existing pollutants for each watershed within the City of Storm Lake. The pollutant loading and watershed area are linearly related, thus the larger the drainage area, the larger the pollutant loading. The figures show that the high impervious areas associated with commercial and industrial land uses generate higher pollutant concentrations.

Using the data shown on Figures 4A – 6B, plans can be developed to improve stormwater quality within each respective watershed. Stormwater quality improvements can be made by treating and/or reducing the amount of stormwater runoff that leaves a site. Ways to reduce the runoff volume include reducing the impervious surface through the use of BMPs such as porous pavement/pavers, green roofs, and low-impact development plans. Landscape plans that include rain gardens, infiltration basins and infiltration trenches also reduce runoff volumes. Stormwater reuse is another technique that can reduce runoff volume and improve stormwater quality. Reuse or rainwater harvesting typically includes storing rainfall and roof runoff to provide water for industrial processes and landscape irrigation systems. Where volume reduction techniques are not practical, other treatment methods including filters, iron enhanced sand filters, bio-filters, sedimentation ponds, and proprietary treatment devices and/or processes can be used to remove target pollutants.

Pollutant removal rates were modeled on a city wide basis assuming all storm water would be treated within City limits prior to discharge. Figures 7A – 9B, show what the pollutant loading will be on a sub-watershed basis and by the unit loading rate per land use. By applying stormwater treatment BMPs to high impervious areas, pollutant loading for these areas can be reduced to values similar to those generated from pervious surfaces such as grassed areas and open prairies. The reduction in pollutant loading from urban areas will have a positive impact on all receiving waters. Table 3 shows the removal rates assumed for each pollutant per land use.

Table 3: Pollutant Removal Rates per Land Use

Removal Rates			
Land Use	**TSS (mg/L)**	**TP (mg/L)**	**TN (mg/L)**
Agriculture	0.00%	0.00%	0.00%
Campus	90.00%	69.00%	61.00%
Commercial	90.00%	86.00%	80.00%
Industrial	90.00%	86.00%	80.00%
Open Space	0.00%	0.00%	0.00%
Residential	88.00%	68.00%	60.00%

Hydrologic and Hydraulic Modeling

A hydrologic and hydraulic model of the City of Storm Lake was developed using Autodesk's Storm and Sanity Analysis (SSA) 2014, which utilizes the Soil Conservation Service (SCS) Technical Release Nos. 20 & 55 (TR-20 & TR-55) hydrologic methodology to route watershed runoff through the existing stormwater collection system using a rainfall hydrograph. SSA and the TR-20/55 method was chosen because it models storage volumes and ponding durations for various storms. Also, SCS methods were developed to specifically model watersheds of this size.

For this study, the 2-, 10-, & 100-Year (3.0", 4.5", and 7.8", respectively), 24-hour rainfall events were modeled. These rainfall events have respective probabilities of occurring of 50%, 10%, and 1% in any given year. The rainfall depths used for each respective event correspond to the recently published Atlas-14 rainfall depths for Storm Lake.

Storm sewer GIS data obtained from the City was used to develop a hydraulic model of the pipe network. Publically available Light Detection and Ranging (LiDAR) aerial survey data was used to delineate watersheds, develop the surface runoff patterns, and estimate storage volumes in flood prone areas.

The Canadian National Railroad line generally splits the City into two separate watersheds. Stormwater north of the tracks tends to drain toward Poor Farm Creek, one mile north of the railroad tracks. Poor Farm Creek flows to the northeast and discharges to North Raccoon River. Stormwater south of the railroad tracks tends to drain toward Storm Lake. Storm Lake outlets to the southeast via Outlet Creek which ultimately discharges to the North Raccoon River. The industrial park on the east side of the City drains toward an unnamed ditch that eventually discharges to the North Raccoon River.

The results generated by the hydrologic and hydraulic modeling are shown in Figure 3A. Several low areas in predominately impervious (industrial and commercial) land use have significant flooding. Storm sewer throughout the City was most likely designed for less than a 10-year event, so localized flash flooding is expected for precipitation depths exceeding 3-inches. In general, the best approaches to improve local flooding includes adding storage with detention, volume reduction BMPs and/or increasing the pipe sizes. Since most of the flood prone areas are fully developed, adding storage associated with traditional stormwater detention may not be feasible due to land acquisition costs. Because of this area limitation, the low impact development BMPs described in this report are recommended as part of any reconstruction effort. These volume reduction BMPs are designed to reduce runoff volume and will reduce the need for extensive traditional detention storage.

List of Figures

Watershed	Area (Acres)
1	108.8
2	7.3
3	60.4
4	35.2
5	10.6
6	49.3
7	11.8
8	48.9
9	53.2
10	25.8
11	37.6
12	34.7
13	16.7
14	261.2
15	309.5
16	136.2
17	69.1
18	145.2
19	66.6
20	284.4
21	42.2
22	19.5
23	14.3
24	223.2

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

- Watershed Outlet Location
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

Source:

0 1,800 Feet

Storm Sewer Outfall Drainage Boundaries

Figure 1

December, 2014

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City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

Land Use

- AG - Agriculture
- CP - Campus/School
- GC - General Commercial
- GI - General Industrial
- OS - Open Space/Park
- R-1 - Single Family Residential
- R-2 - Single-Family/Duplex
- R-3 - Urban Family Residential
- R-4 - Multi-Family Residential
- R-R - Rural Residential

Source:

0 1,800 Feet

Land Use Zoning Map

Figure 2

December, 2014

Little Storm Lake

Storm Lake

0 600 Feet

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Flood Prone Drainage Areas	Area (Acres)
1	48.6
2	113.3
3	171.1
4	18.2
5	20.7
6	96.0
7	164.8
8	164.2
9	15.1
10	38.5
11	66.6
12	56.0
13	27.3
14	95.3
15	238.3
16	53.1
17	40.8
18	41.9
19	29.0
20	41.7
21	42.2
22	19.5
23	14.3

Poor Farm Creek

Peak Elevation
2-Year: 1419.5
10-Year: 1419.8
100-Year: 1420.5

Peak Elevation
2-Year: 1414.5
10-Year: 1415.3
*100-Year Not Mapped

Peak Elevation
2-Year: 1422.8
10-Year: 1423.4
100-Year: 1423.5

Peak Elevation
2-Year: 1420.1
10-Year: 1420.5
100-Year: 1421.1

Peak Elevation
2-Year: 1420.5
10-Year: 1421.8
100-Year: 1423.0

Peak Elevation
2-Year: 1434.1
10-Year: 1434.6
100-Year: 1435.3

Peak Elevation
2-Year: 1429.8
10-Year: 1430.9
100-Year: 1432.4

Peak Elevation
2-Year: 1421.9
10-Year: 1422.7
100-Year: 1423.2

Peak Elevation
2-Year: 1413.3
10-Year: 1413.9
100-Year: 1414.5

Peak Elevation
2-Year: 1405.7
10-Year: 1406.7
100-Year: 1407.4

Peak Elevation
2-Year: 1418.8
10-Year: 1420.3
100-Year: 1420.7

Peak Elevation
2-Year: 1437.9
10-Year: 1438.0
100-Year: 1438.3

Peak Elevation
2-Year: 1416.3
10-Year: 1417.2
100-Year: 1420.1

Peak Elevation
2-Year: 1420.4
10-Year: 1421.1
100-Year: 1422.2

Peak Elevation
2-Year: 1397.55
10-Year: 1399.47
100-Year: 1404.74

Peak Elevation
2-Year: 1423.4
10-Year: 1423.6
100-Year: 1424.4

Peak Elevation
2-Year: 1421.5
10-Year: 1423.0
100-Year: 1426.3

Peak Elevation
2-Year: 1404.3
10-Year: 1405.7
100-Year: 1409.8

Peak Elevation
2-Year: 1421.3
10-Year: 1421.8
100-Year: 1422.5

Peak Elevation
2-Year: 1399.6
10-Year: 1401.3
100-Year: 1404.7

Peak Elevation
2-Year: 1417.07
10-Year: 1419.55
100-Year: Not Mapped

Storm Lake

Little Storm Lake

Peak Elevation
2-Year: 1409.5
10-Year: 1411.2
100-Year: 1413.4

Peak Elevation
2-Year: 1408.2
10-Year: 1408.4
100-Year: 1408.6
Overtops C-63 for All Events

Peak Elevation
2-Year: 1417.7
10-Year: 1418.1
100-Year: 1418.7

Peak Elevation
2-Year: 1414.9
10-Year: 1415.4
100-Year: 1415.6

Peak Elevation
2-Year: 1412.0
10-Year: 1412.6
100-Year: 1413.4

Peak Elevation
2-Year: 1405.5
10-Year: 1406.3
100-Year: 1406.5

0 600 Feet

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

- 2-Year Inundation (3.0")
- 10-Year Inundation (4.48")
- 100-Year Inundation (7.81")
- Flood Prone Drainage Areas

0 1,800 Feet

Existing Inundation for 2-, 10-, & 100-Year, 24-Hour Storm Events

Figure 3A

December, 2014

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Flood Prone Drainage Areas	Area (Acres)
1	48.6
2	113.3
3	171.1
4	18.2
5	20.7
6	96.0
7	164.8
8	164.2
9	15.1
10	38.5
11	66.6
12	56.0
13	27.3
14	95.3
15	238.3
16	53.1
17	40.8
18	41.9
19	29.0
20	41.7
21	42.2
22	19.5
23	14.3

Field of Dreams
Bio-reactor (near-term)

Poor Farm Creek

Tyson permeable parking lots
(near-term)

Rose & Tulip Lanes,
and Expansion Blvd.
(medium-term)

Hillshire Pond Restorer
(near-term)

- Erie St.(near-term)
- Lake Ave., 5th & 6th St.
(medium-term)

Prairie, Meadow,
& Clover Lanes
(medium-term)

Little Storm Lake

-Radio Park Bio-reactor
(near-term)
-Commercial parking lots and
Residential Template improvements
(medium-term)

Storm Lake

Golf Course Pond
Restorers (near-term)

0 600 Feet

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

- 2-Year Inundation (3.0”)
- 10-Year Inundation (4.48”)
- 100-Year Inundation (7.81”)
- Flood Prone Drainage Areas
- Near- and Medium-Term Implementation Project Areas

N

0 1,800 Feet

Near-and Medium-Term Implementation Project Areas Over Existing Inundation

Figure 3B

January, 2015

Watershed	TSS (Tons/Year)
1	44.25
2	2.12
3	14.98
4	6.32
5	2.02
6	14.48
7	6.69
8	11.75
9	11.41
10	8.00
11	6.93
12	6.70
13	4.10
14	97.97
15	110.02
16	37.78
17	22.11
18	39.43
19	16.12
20	93.39
21	7.51
22	3.48
23	2.54
24	87.7

Storm Lake
Jump Right In!

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

TSS (Tons/Year)

- 0.0 - 4.0
- 4.1 - 7.0
- 7.1 - 12.0
- 12.0 - 18.0
- 18.1 - 50.0
- 50.0 - 125.0
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

Poor Farm Creek

Little Storm Lake

Storm Lake

0 600 Feet

0 1,800 Feet

Existing Total Suspended Solids (TSS) Pollutant Loading Rates by Drainage Boundary

Figure 4A

December, 2014

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Watershed	TSS (Lbs/Acre/Year)
AG	257
CP	1161
GC	997
GI	953
OS	50
R-1	356
R-2	356
R-3	356
R-4	577
R-R	250

Poor Farm Creek

Little Storm Lake

Storm Lake

0 600 Feet

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

Zoning/Land Use

TSS (Lbs/Acre/Year)

- 0-0 - 50.0
- 50.1 - 150.00
- 150.1 - 300.0
- 300.1 - 450.0
- 450.1 - 700.0
- 700.1 - 1200.0
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

0 1,800 Feet

Existing Total Suspended Solids (TSS) Unit Area Loading Rates by Land Use

Figure 4B

December, 2014

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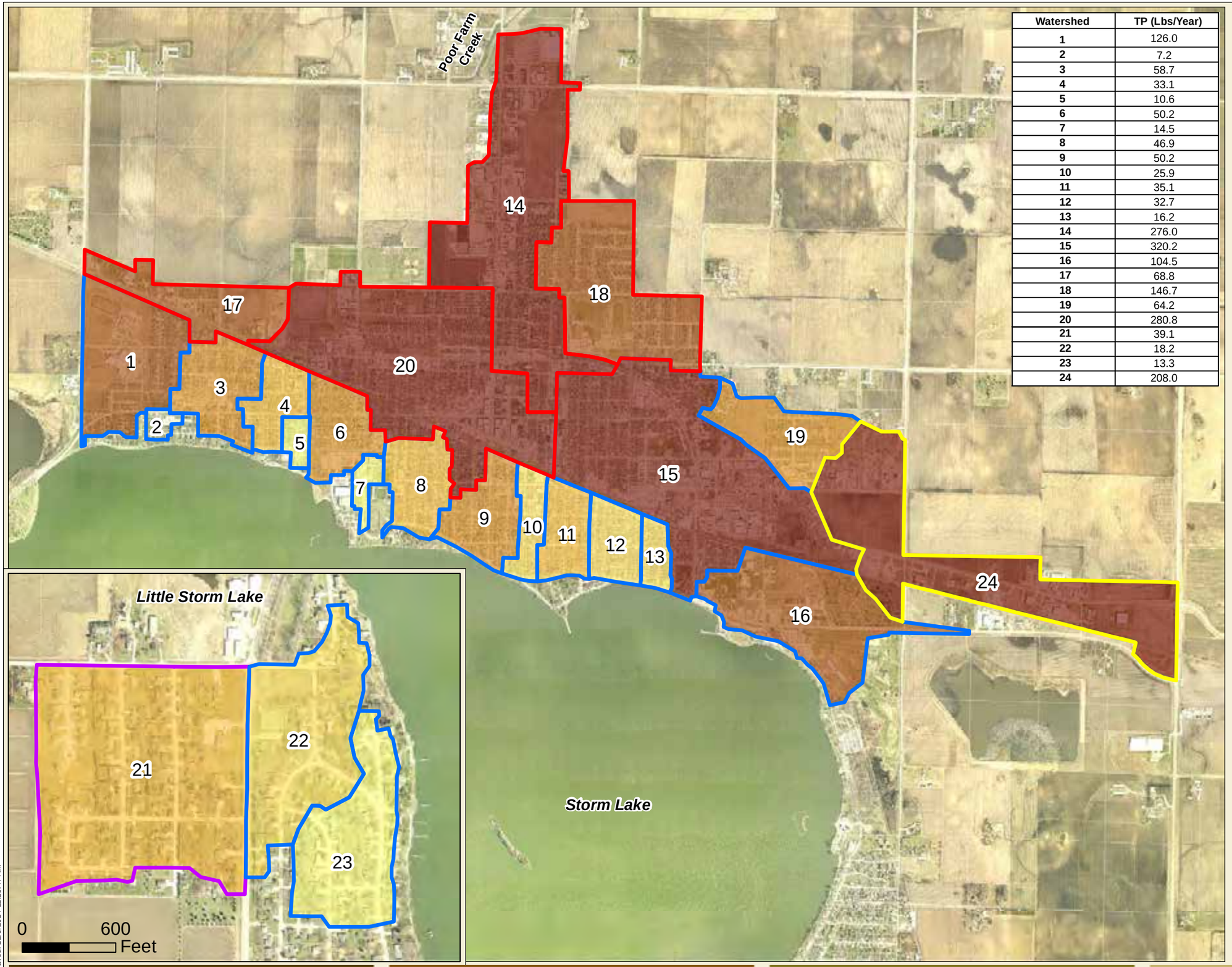

Watershed	TP (Lbs/Year)
1	126.0
2	7.2
3	58.7
4	33.1
5	10.6
6	50.2
7	14.5
8	46.9
9	50.2
10	25.9
11	35.1
12	32.7
13	16.2
14	276.0
15	320.2
16	104.5
17	68.8
18	146.7
19	64.2
20	280.8
21	39.1
22	18.2
23	13.3
24	208.0

Storm Lake
Jump Right In!

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

TP (Lbs/Year)

- 0.0- 15.0
- 15.1 - 33.0
- 33.1 - 48.00
- 48.11 - 66.0
- 66.1- 150.0
- 150.1 - 325.0
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

N

0 1,800 Feet

Existing Total Phosphorus (TP) Pollutant Loading Rates by Drainage Boundary

Figure 5A

December, 2014

BOLTON & MENK

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Watershed	TP (Lbs/Acre/Year)
AG	0.30
CP	1.25
GC	1.12
GI	1.12
OS	0.32
R-1	0.93
R-2	0.93
R-3	0.93
R-4	1.51
R-R	0.65

Poor Farm Creek

Little Storm Lake

Storm Lake

0 600 Feet

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

TP (Lbs/Acre/Year)

- 0.0 - 0.40
- 0.41 - 0.80
- 0.81 - 1.00
- 1.01 - 1.20
- 1.21 - 1.40
- 1.41 - 1.60
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

0 1,800 Feet

Existing Total Phosphorus (TP) Unit Area Loading Rates by Land Use

Figure 5B

December, 2014

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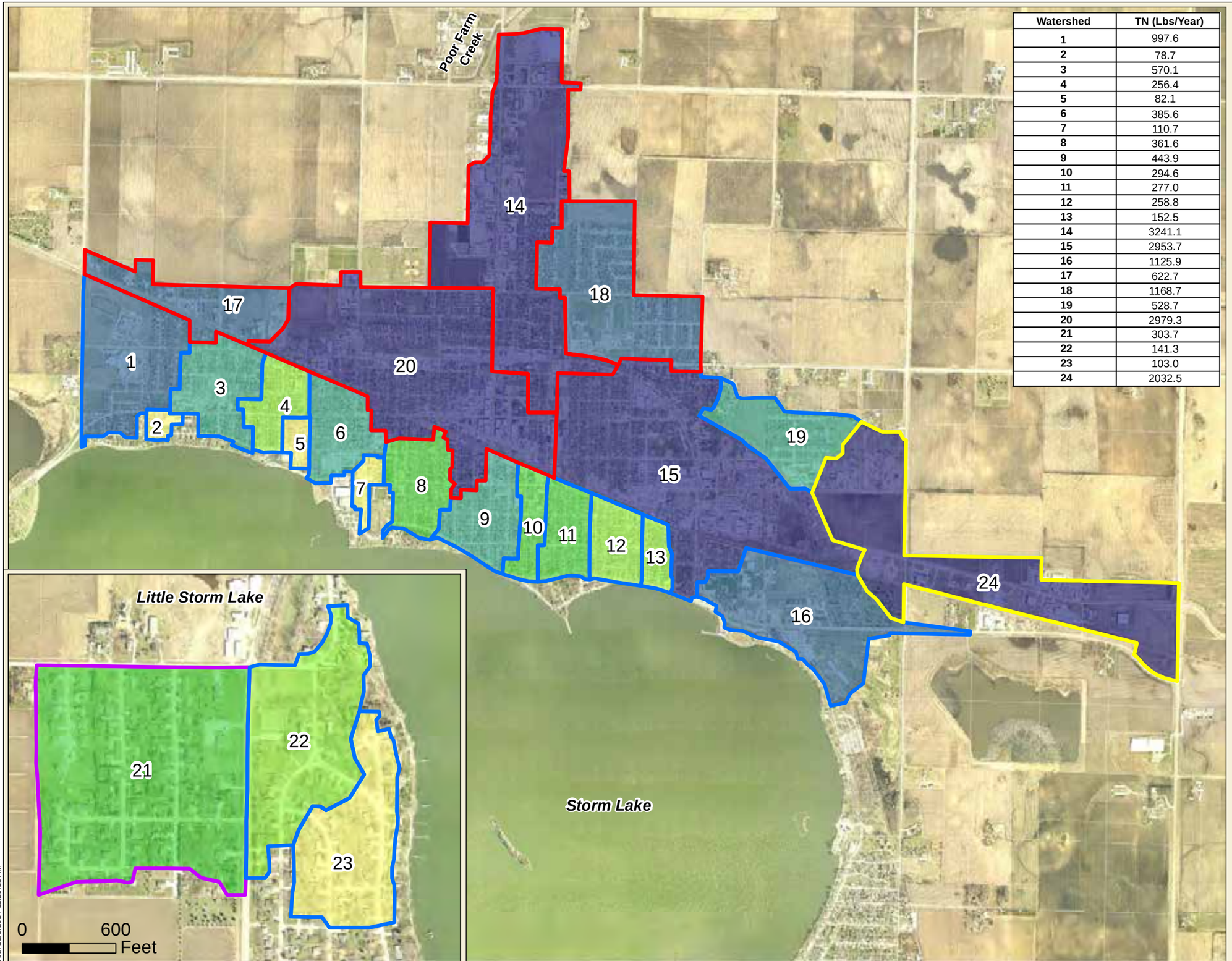

Watershed	TN (Lbs/Year)
1	997.6
2	78.7
3	570.1
4	256.4
5	82.1
6	385.6
7	110.7
8	361.6
9	443.9
10	294.6
11	277.0
12	258.8
13	152.5
14	3241.1
15	2953.7
16	1125.9
17	622.7
18	1168.7
19	528.7
20	2979.3
21	303.7
22	141.3
23	103.0
24	2032.5

Storm Lake
Jump Right In!

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

TN (Lbs/Year)

- 0.0 - 130.0
- 130.1 - 260.0
- 260.1 - 370.0
- 370.1 - 600.0
- 600.1 - 1200.0
- 1200.1 - 3400.0
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

N

0 1,800 Feet

Existing Total Nitrogen (TN) Pollutant Loading Rates by Drainage Boundary

Figure 6A

December, 2014

Bolton & Menk

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Watershed	TN (Lbs/Acre/Year)
AG	4.0
CP	9.5
GC	17.4
GI	10.8
OS	0.6
R-1	7.2
R-2	7.2
R-3	7.2
R-4	11.7
R-R	5.1

Storm Lake
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Best Management Practices

Legend

TN (Lbs/Acre/Year)

- 0.0- 1.00
- 1.01 - 8.00
- 8.01 - 10.00
- 10.01 - 12.00
- 12.01 - 20.00
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

0 1,800 Feet

Existing Total Nitrogen (TN) Unit Area Loading Rates by Land Use

Figure 6B

December, 2014

Map Document: H:\SML\KP\111082941GIS\FinalReport_MXD\Figure6B.mxd
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Watershed	TSS (Tons/Year)
1	4.75
2	0.23
3	1.67
4	0.76
5	0.24
6	1.58
7	0.67
8	1.36
9	1.33
10	0.86
11	0.83
12	0.79
13	0.46
14	12.43
15	11.76
16	5.44
17	4.19
18	4.37
19	1.96
20	12.71
21	0.93
22	0.42
23	0.30
24	14.1

Poor Farm Creek

Little Storm Lake

Storm Lake

0 600 Feet

0 1,800 Feet

City of Storm Lake, Iowa
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Legend

TSS (Tons/Year)

- 0.0 - 4.0
- 4.1 - 7.0
- 7.1 - 12.0
- 12.1 - 18.0
- 18.1 - 50.0
- 50.0 - 125.0
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

Proposed Total Suspended Solids (TSS) Pollutant Loading Rates by Drainage Boundary

Figure 7A

December, 2014

Map Document: H:\SMLK\P1110829\4GIS\FinalReport_MXD\Figure7A.mxd
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Watershed	TSS (Lbs/Acre/Year)
AG	257
CP	116
GC	100
GI	95
OS	50
R-1	43
R-2	43
R-3	43
R-4	69
R-R	250

Poor Farm Creek

Little Storm Lake

Storm Lake

0 600 Feet

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Zoning/Land Use

TSS (Lbs/Acre/Year)

- 0.0 - 50.0
- 50.1 - 150.0
- 150.1 - 300.0
- 300.1 - 450.0
- 450.1 - 700.0
- 700.1 - 1200.0
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

0 1,800 Feet

Proposed Total Suspended Solids (TSS) Unit Area Loading Rates by Land Use

Figure 7B

December, 2014

Map Document: H:\SMLK\P111\08294\GIS\FinalReport_MXD\Figure7B.mxd
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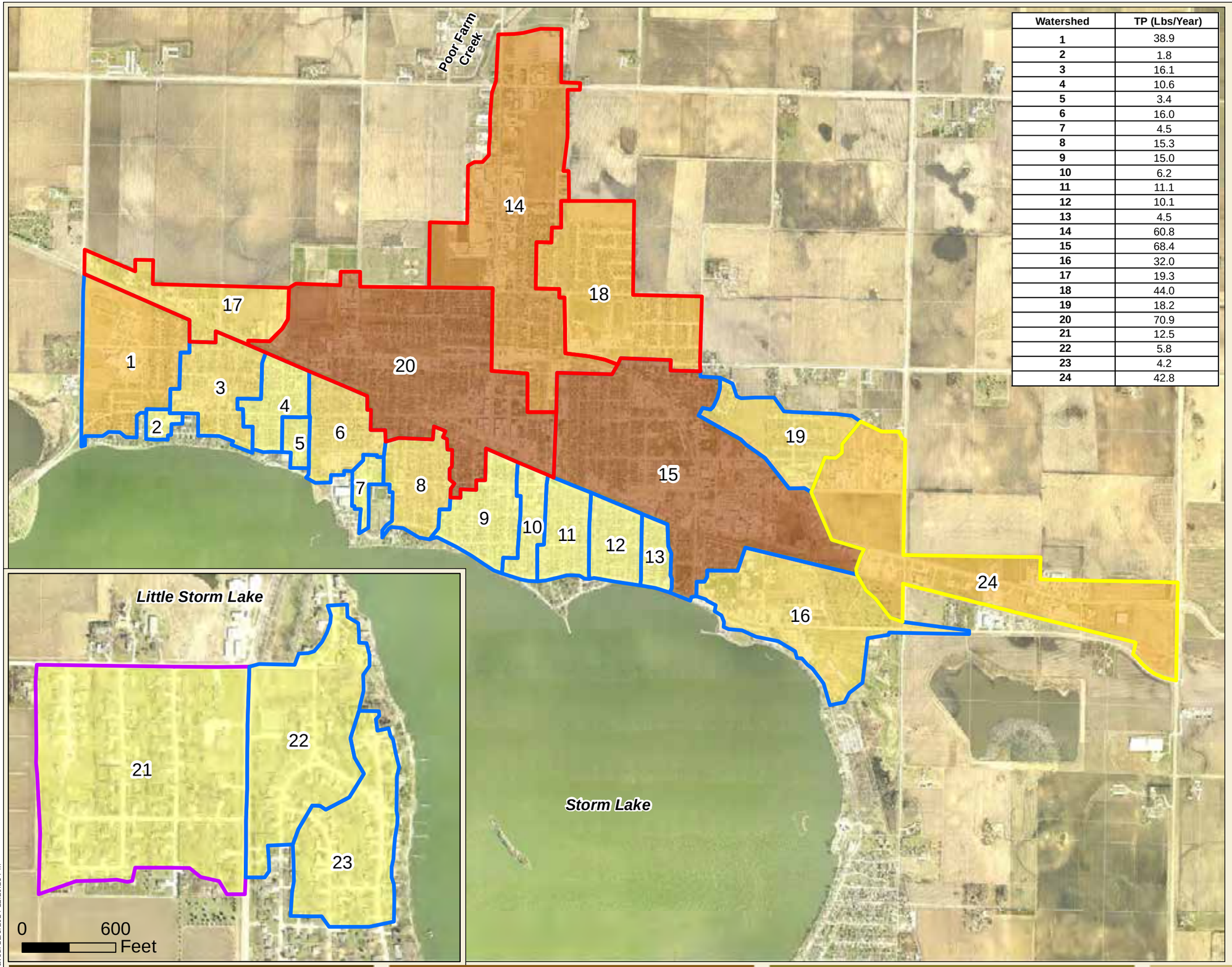

Watershed	TP (Lbs/Year)
1	38.9
2	1.8
3	16.1
4	10.6
5	3.4
6	16.0
7	4.5
8	15.3
9	15.0
10	6.2
11	11.1
12	10.1
13	4.5
14	60.8
15	68.4
16	32.0
17	19.3
18	44.0
19	18.2
20	70.9
21	12.5
22	5.8
23	4.2
24	42.8

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Best Management Practices

Legend

TP (Lbs/Year)

- 0 - 15.0
- 15.1 - 33.0
- 33.1 - 48.0
- 48.1 - 66.0
- 66.1 - 150.0
- 150.1 - 325.0
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

N

0 1,800 Feet

Proposed Total Phosphorus (TP) Pollutant Loading Rates by Drainage Boundary

Figure 8A

December, 2014

BOLTON & MENK

Map Document: H:\SMLK\P111\08294\GIS\FinalReport_MXD\Figure8A.mxd
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Watershed	TP (Lbs/Acre/Year)
AG	0.30
CP	0.39
GC	0.16
GI	0.16
OS	0.32
R-1	0.30
R-2	0.30
R-3	0.30
R-4	0.48
R-R	0.65

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Legend

TP (Lbs/Acre/Year)

- 0.00 - 0.40
- 0.41 - 0.80
- 0.81 - 1.00
- 1.01 - 1.20
- 1.21 - 1.40
- 1.40 - 1.60
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

0 1,800 Feet

Proposed Total Phosphorus (TP) Unit Area Loading Rates by Land Use

Figure 8B

December, 2014

Poor Farm Creek

Storm Lake

Little Storm Lake

0 600 Feet

Map Document: H:\SMLK\P1110829\4\GIS\FinalReport_MXD\Figure8B.mxd
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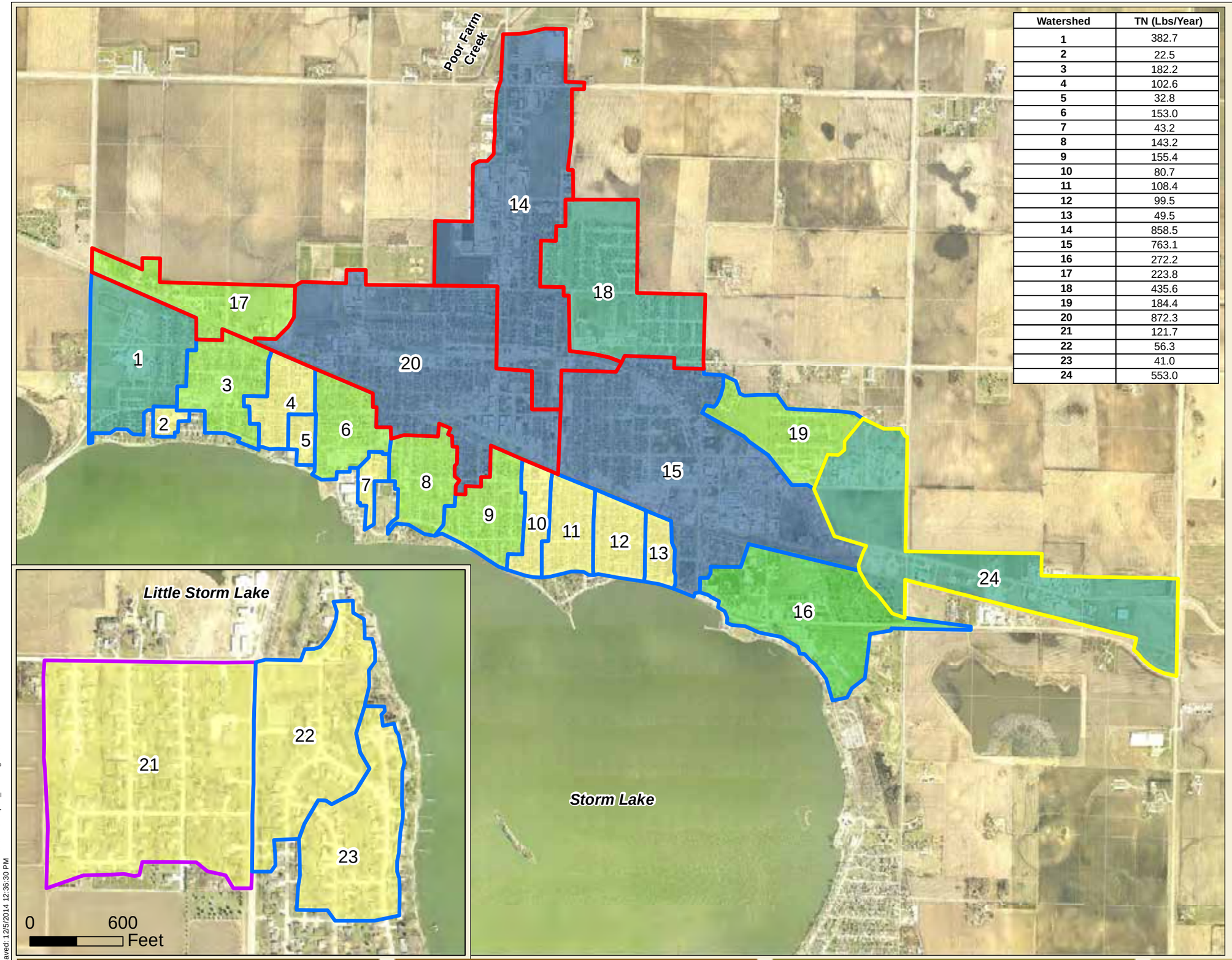

Watershed	TN (Lbs/Year)
1	382.7
2	22.5
3	182.2
4	102.6
5	32.8
6	153.0
7	43.2
8	143.2
9	155.4
10	80.7
11	108.4
12	99.5
13	49.5
14	858.5
15	763.1
16	272.2
17	223.8
18	435.6
19	184.4
20	872.3
21	121.7
22	56.3
23	41.0
24	553.0

Storm Lake
Jump Right In!

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

TN (Lbs/Year)

- 0.0 - 130.0
- 130.1 - 260.0
- 260.1 - 370.0
- 370.1 - 600.0
- 600.1 - 1200.0
- 1200.1 - 3400.0
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

N

0 1,800 Feet

Proposed Total Nitrogen (TN) Pollutant Loading Rates by Drainage Boundary

Figure 9A

December, 2014

Map Document: H:\SMLK\P1110829 4\GIS\FinalReport_MXD\Figure9A.mxd
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Watershed	TN (Lbs/Acre/Year)
AG	4.0
CP	3.7
GC	3.5
GI	2.2
OS	0.6
R-1	2.9
R-2	2.9
R-3	2.9
R-4	4.7
R-R	5.1

Poor Farm Creek

Little Storm Lake

Storm Lake

0 600 Feet

City of Storm Lake, Iowa
Conservation Design Forum
Best Management Practices

Legend

TN (Lbs/Acre/Year)

- 0.00 - 1.00
- 1.01 - 8.00
- 8.01 - 10.00
- 10.01 - 12.00
- 12.01 - 20.00
- Outlet to Poor Farm Creek
- Outlet to Storm Lake
- Outlet to Little Storm Lake
- Outlet to East Drainage Ditch

0 1,800 Feet

Proposed Total Nitrogen (TN) Unit Area Loading Rates by Land Use

Figure 9B

December, 2014

Map Document: H:\SMLK\P1110\08294\GIS\FinalReport_MXD\Figure9B.mxd
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D appendix

Assumptions for Estimating Green Infrastructure Performance

Assumptions for Estimating Green Infrastructure Performance

The assumptions detailed below were used to estimate performance for each toolbox item or land use template described in the Plan.

A. Green Infrastructure Toolbox

Permeable Paving

- Permeability Rate: A permeability rate of 0.05 inches per hour for the compacted soil beneath the permeable paving.
- Area Ratio: For the performance numbers reported below, two different assumptions were made. In one case, it was assumed that the entire paving area was permeable paving. In the second case it was assumed that only half the paving area was permeable (such as if the parking lanes of a street were permeable but the driving lanes were impermeable).
- Retention storage: It was assumed that the retention volume below the underdrain of the permeable paving system would be designed to drain within six hours.
- Detention Storage: It was assumed that sufficient storage for at least 36 hours of detention time would be provided during the 100-year event.
- The methods and assumptions in the Minnesota Pollution Control Agency Minimum Impact Design Standards (MPCA MIDS) manual and calculator along with the assumptions above were used to

calculate the water quality performance values listed below.

- HydroCAD modeling along with typical Midwest rainfall frequency statistics were used to calculate the runoff volume and peak rate performance for permeable paving.
- Modeled reductions:
  - 31% volume reduction for 2-year event
  - 93% 2-year peak flow reduction

Bioretention

- Permeability Rate: A permeability rate of 0.10 inches per hour for uncompacted soils beneath bioretention systems. This is higher than was assumed for permeable paving since compaction of subgrade soils is required to provide suitable pavement structure and minimize future settlement.
- Area Ratio: For the performance numbers reported below, it was assumed that the bioretention area was at least 15% of the total drainage area to the feature and that the drainage area was 100% impervious.
- Retention storage: It was assumed that the retention volume below the underdrain of the bioretention system would be designed to drain within 24 hours.
- Detention Storage: It was assumed that sufficient storage for approximately 24 hours of detention time would be provided during the 100-year event. This volume is in addition to the retention volume
- The methods and assumptions in the MPCA MIDS manual and calculator, along with the assumptions above, were used to calculate the water quality performance values listed below.
- Modeled reductions:
  - 11% volume reduction for 2-year event
  - 76% 2-year peak flow reduction.

Naturalized Swales

- Modeled reductions:
  - 0% volume reduction for 2-year event
  - 95% 2-year peak flow reduction

Naturalized Detention/Stormwater Park

- Modeled reductions:
  - 0% volume reduction for 2-year event
  - 10% 2-year peak flow reduction

B. Land Use Templates

Downtown Commercial

- Modeled reductions:
  - 41% volume reduction for 2-year event

Residential

- Modeled reductions:
  - 34% volume reduction for 2-year event

Campus

- Modeled reductions:
  - 25% volume reduction for 2-year event

Big Box Commercial/Industrial

- Modeled reductions:
  - 41% volume reduction for 2-year event

E appendix

Wastewater Improvement Recommendations Report – John Todd Ecological Design

John Todd Ecological Design
sustainable water management
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TECHNICAL MEMORANDUM

FOR THE CITY OF STORM LAKE, IOWA

Prepared by Max Rome, John Todd, Lauren Valle

John Todd Ecological Design

October 16, 2014

TABLE OF CONTENTS

BACKGROUND

The city and its sewage

Storm Lake is a town of 10,000 by the 2010 US census. However according to the IRS, the WWTP incoming flow, and the school district student population, the actual number is closer to 14,000. The city comprises four square miles wrapped above the northwestern corner of its eponymous water body. In the Town of Storm Lake there are more than 30 languages spoken. The city is home to the Buena Vista University and to a well-regarded and prosperous regional hospital. Storm Lake is also home to two large meat-processing plants, one of which manages their own wastewater. Storm water monitoring data suggests that E. Coli-rich material is flushed off of their parking lots causing local contamination.

Tyson foods operates a large hog slaughterhouse and has its own 1.5 MGD waste water treatment plant. Hillshire processes turkeys for sausage and sliced deli meat. The company processes forty truckloads averaging 37,000 turkeys each day. This plant has recently suffered a major fire and is operating at a reduced level until it is rebuilt. Hillshire has an onsite pretreatment facility consisting of a 1 MG equalization tank and an equal sized moving bed biological reactor, MBBR. Pretreated waste is pumped to the municipal treatment facility.

The municipal and Tyson WWTP are located adjacent to each other and are downstream and southeast of the lake. These WWTPs do not discharge into the lake but instead into its natural drainage, Outlet Creek. Except for the discharge from the WWTPs Outlet Creek would run dry for much of the year.

Site visit and meetings

On August 26th and 27th Max Rome, a representative of JTED, joined Tom Price and Jeff Guerrero with CDF, Gregory Sindt and Neil Guess with Bolton & Menk, and Jeff Geerts with IEDA, for meetings with city officials including James Patrick and community leaders. We were able to tour a few important sites and discussed solutions to eliminating and mitigating the effects of pathogen-contaminated runoff entering municipal storm sewers and draining into the lake.

POTENTIAL APPLICATIONS FOR ECOLOGICAL DESIGN

The flow of water and nutrients through the storm sewers and wastewater treatment systems of Storm Lake present a range of opportunities for ecological design and engineering. A combination of low impact design and enhanced ecological treatment within detention ponds can help protect the health and recreational value of Storm Lake. Meanwhile ecological treatment within the storage lagoons at the wastewater treatment facilities has the potential to create operational savings and enhance treatment. The following are recommendations for ecologically based treatment solutions.

Overview of the Todd Ecological Restorer Technology

Baima Canal Restorer, China

Restorers, which grew out of the Eco-Machine® technology, are floating systems that support planted ecologies, media to support microbial films, and an aeration system that provides active aeration and water circulation. The award-winning technology has been used for the remediation of nutrient-enriched fresh water

and saltwater ponds, the upgrade of wastewater treatment lagoons and the treatment of sewage in canals.

Restorers combine the benefits and processes of aeration, circulation, phosphorus inactivation, filtration, nitrification, de-nitrification, pathogen removal and sediment digestion. These processes, though initiated from a floating Restorer, take place not only on-board but also in the water column as well as in the sediments.

Aeration and circulation is achieved by airlift pumping of water from the bottom upward and throughout the Restorer's media and biota. Initially, the water is pulled through a sediment filter and then circulates through plant roots. An air compressor and diffuser-based system are employed for water movement. Oxygenation of sediment surfaces reduces the release of phosphates, iron and manganese.

Biological mechanisms for pathogen reduction

Many of the storm water issues facing the city and lake relate to the presence of pathogenic organisms. Hillshire has gone so far as to consider the future use of chemical or ultra violet disinfection. In our view a more holistic approach will better serve the city and prove more effective.

In ecological treatment pathogen reduction is a function of predation, natural die-off, adsorption and sedimentation. Pathogenic organisms that persist and thrive in a septic environment are rapidly eliminated in an enhanced and oxygenated clean water environment.

During JTED's decades of experience building wastewater treatment systems we have seen that reduction in pathogens is a function of maintaining a diverse and healthy aerobic environment and maximizing contact time between contaminated water and surfaces for attached bacterial growth and filter feeding organisms.

For rapid reduction in concentrations of pathogens the following conditions should be met:

1. Reduce Biological Oxygen Demand (BOD) to <25 mg/l
2. A dissolved oxygen level above 3 mg/l

3. Ample contact time with a diversity of pathogen consuming protozoa and higher animals
4. Retention times within the system that exceed 24 hours

In general, longer retention times ensure a more complete die off of pathogenic organisms. Through the use of baffles, floating plant racks and targeted micro-aeration, existing and planned ponds can be modified for pathogen reduction.

TREATMENT OPTIONS:

1: Active storm water treatment for Hillshire

The Hillshire processing plant washes down its birds on a year-round basis. Much of this is done in enclosed areas and the wash process involves disinfectant. However, during rain storms huge spikes in E. Coli counts are observed as a result of pathogen rich material from avian detritus, feathers and feces washing off of the parking lots. Disinfection may be of limited efficacy as organic material accumulates in gutters and bio-swales creating septic conditions. Inspection of their rain gardens reveals significant standing water as well as saturated mulch, all potential breeding grounds for E. Coli. In September, 2014, storm water and manhole sampling revealed E. Coli levels in the range of 1,723 to 78,000 MPN/100 ml.

As part of a redesigned parking area, Hillshire will be updating their rain gardens which outlet to a settling pond in the southeast corner of the property. It is essential that all storm water pass through this pond before entering the storm sewers. A Restorer with active circulation, micro-aeration, and baffling can ensure treatment of the organic load and in reducing pathogen levels. During storm events a permeable, gravel-based wetland can be used to protect the lake. Pathogenic organisms are strongly correlated to TSS (total suspended solids), so rough filtration and adsorption processes can improve water clarity.

The Hillshire treatment pond should drain to the city's existing storm water ponds that flow through the golf course before entering the lake. Active storm water treatment, including floating Restorers, baffled flow, enhanced circulation, aeration, and sediment filtration will cost approximately $330,000 for 1000 linear feet of treatment. These systems can be circular, oval, square, rectangular, or

ribbon-like depending on pond size, depth and shape. A single system will treat up to five acres of nutrient enriched waters, provided that a 24-hour retention time is achieved.

2: Municipal and golf course storm water ponds

Restorer, Four Seasons Resort, Kona, Hawaii

The municipality maintains a series of storm water ponds, a featured component in the golf course design. They are intended to protect the lake from nutrients and suspended solids. In our opinion these ponds would benefit from enhanced treatment technologies. Water quality does improve as the ponds approach the lake, but additional ecologically engineered systems are recommended. Basic Restorers, with increased water circulation and rafted wetland plants, combined with shore-side constructed wetlands are recommended. These simple interventions will enhance the health of the ponds, reduce nutrients entering Storm Lake and can reduce or eliminate algal blooms.

In conjunction with these interventions we recommended that the golf course re-examine its use of fertilizers and pesticides, both of which contribute to loading on the pond and have a deleterious effect on the health of the lake. The National Audubon Society offers a certification program for golf courses to become a certified Audubon Cooperative Sanctuary that helps golf courses protect their natural areas and wildlife habitats that should be considered as a viable option.

3: Municipal WWTP

The municipal plant is currently undergoing a major upgrade. Upgrades to the facility include modification of the activated sludge basins, the installation of new clarifiers and a new belt press. The plant treats wastewater to a very high standard with BOD and TSS in the effluent below 5 mg/l. Based on conversations with the operator, the main challenge comes from dealing with huge quantities of storm water entering the city sewer through infiltration and inflow. This storm water can swell the demand within the lagoons by up to sixteen times from ~1.5 MGD to over 24 MGD. This water is stored in a large lagoon that is drawn down over the course of the summer and processed through the WWTP. During the long draw-down period the lagoon, due to its stagnant and high nutrient laden water acts as algae production "factory". Problems arise when this visibly green lagoon water is fed back into the WWTP, including creating difficult-to-maintain optimal dissolved oxygen levels within the activated sludge basin.

Green infrastructure storm water measures within the city will mitigate flooding and should help reduce inflow and infiltration into the sanitary sewer system, but until fully implemented, the City of Storm Lake can expect this issue to persist. Ecological treatment can be installed within this lagoon to address its problems, including stagnation, nutrient levels and resulting operational difficulties. A Restorer combined with sediment biofiltration units in the lagoon would go a long way towards managing the current problems. The combination of shading and high rate microbial activities in the Restorer units reduces algae's reproductive rates. This in turn will reduce the load on the WWTP. It is possible that a combination of treatment approaches will sufficiently treat the stored water and allow for the direct discharge into Outlet Creek.

4: Tyson WWTP

Tyson Restorer-based treatment system, Berlin, Maryland

The Tyson WWTP included two older lagoons formerly used for primary treatment. In a previous JTED project in Berlin, Maryland, we used the lagoons to provide advanced treatment. Releasing effluent of a much higher quality and brought the company into compliance in a cost effective manner. The retrofit of a 20 million gallon lagoon used for the treatment of 1.25 MGD of slaughterhouse waste employed a large Restorer to achieve advanced treatment within a 16 day retention time. A summary of the water quality results are provided below. The project was implemented between October of 2000 and November of 2001 at a cost of $1.75 million.

Summary of Treatment for Entire System at Tyson Foods over First Year				
	Influent	Effluent	Target Effluent	% Reduction
TSS	80	4.3	26.5	95%
Ammonia	15	0.8	1.2	94%
Nitrate	1.3	9.8	10.0	35%***
COD	490	22	-	95%
Total Phosphorus	10.9	0.5	0.5	96%
BOD derived* summer	418	16	7.5	96%
BOD derived* winter	275	21	23.0	92%
BOD actual**	267	12		95%

All mean data excludes outliers greater than 2 standard deviations from mean.

Based on estimated BOD:COD ratio at influent and effluent. Only COD data was monitored weekl N = 60 (influent), 92 (effluent) over 12 months

**BOD actual represents mean data analyzed as BOD, N = 13 over 4 months*

***Percent denitrification of total nitrogen load to the system (including ammonia)*

5: Storm Lake protection and enhancement

Storm Lake is a relatively shallow lake, with an average depth of 8.7 feet and a maximum depth of 21.1 feet (Iowa State, 2013). Storm Lake serves as one of Iowa's two most important walleye fisheries. During the spring Walleye are gill netted and stripped of fertile eggs. These eggs are reared in state hatcheries and are used to seed ponds throughout the rest of the state.

As a result of wind driven sediment re-suspension, the lake is quite turbid. The Storm Lake Watershed Management Plan reports secchi depths ranging from 6 inches to 2.5 feet in 2010 and 2011 with the majority of the readings less than 10 inches. Additionally, the WMP places the trophic status of the lake in 2011 at eutrophic to hyper-eutrophic. During the day, dredging barges move across the lake, which part of a huge and expensive 20-year dredging project. The Iowa State report indicates that remaining sediments in dredged areas are lighter and therefore more subject to re-suspension and less prone to settle than sediments in areas not dredged. It goes on to suggest that increasing the lake level by six to 12 inches and/or decreasing the fetch of the lake would be more effective at meeting turbidity goals than the current dredging plan.

In addition to sediments, the WMP reports high levels of phosphorous in the water column and the Iowa State report indicates a strong correlation between suspended sediment levels and phosphorous levels in the water column. Thus, if

suspended sediment levels can be reduced, phosphorous levels should also be reduced. Conversely, if light penetration is increased due to reduced turbidity levels, the turbidity problem could be replaced with excessive aquatic weed growth if phosphorous levels are not sufficiently reduced.

In addition to the current dredging operations, the city, which takes great pride in its aquatic amenity, is considering the addition of alum or aluminum salts to help clear the lake of suspended sediments. This would be a significant undertaking on a lake the size of Storm Lake and is not recommended.

Given the above, it is clear that other restorative ecological interventions should also be explored. Restorer Eco-Machines are a suitable solution on every level: water quality, water clarity, refugia for beneficial aquatic organisms, bio-diversity, sediment deposition, as well as its overall ecological health. Restorers would provide additional fish habitat and enhance the use of the parks and the lake.

The cost of Lake Restorer projects will vary with their size and ambition. A modest scale Restorer project, for example one thousand linear feet in size, with a bottom based biofiltration unit, would have a demonstrable effect of water quality within a confined area. It would be most appropriate near the swimming beach adjacent to the waterpark. Such a Restorer could be built with a floating walkway that could serve double duty for fishing, boating, swimming and educational activities. A Restorer designed to withstand storm conditions and winter ice would cost in the neighborhood of 500,000 dollars.

IN CONCLUSION

There exist a range of cost-effective soft and hard ecological technologies that, in combination, will function to improve water quality in the community of Storm Lake. This would include the lake itself, its storm water management systems, the food processing industries, the municipal wastewater treatment plant and by extension, to the surrounding landscape itself.

F appendix

Green Infrastructure Construction Costs

Green Infrastructure vs. Conventional Reconstruction Costs for Carbon Cliff, Illinois

The figure on the next page is an example cost comparison for road and stormwater reconstruction of several street blocks in Carbon Cliff, Illinois. Conventional (gray) costs include asphalt paving, curb & gutter, and replacement of the storm sewer system. The proposed green infrastructure approach included permeable paving on all streets, which provides additional benefits of reduced runoff rates and volumes, improved water quality, a smaller storm system, reduced street ponding, and increased pavement longevity.

Roadway	McClure Project Cost	CDF Project Costs	% Difference	Absolute Difference
1st Avenue	$ 1,112,884	$ 1,402,744	26%	$289,860
1st Street	$ 452,790	$ 565,587	25%	$112,797
2nd Street	$ 341,517	$ 535,350	57%	$193,833
3rd Street	$ 414,325	$ 574,052	39%	$159,727
4th Street	$ 304,742	$ 437,104	43%	$132,362
5th Street	$ 314,692	$ 502,605	60%	$187,913
6th Street	$ 235,997	$ 391,192	66%	$155,195
Denhardt Avenue	$ 118,947	$ 185,372	56%	$66,425
Jay Street	$ 96,586	$ 154,860	60%	$58,274
Lily Avenue	$ 201,273	$ 245,351	22%	$44,078
Sinclair Boulevard	$ 320,485	$ 530,472	66%	$209,987
State Street	$ 374,482	$ 557,400	49%	$182,918
Total Cost	$ 4,288,720	$ 6,082,087	42%	$1,793,367

Civil Engineer:
Conservation Design Forum
375 West First Street
Elmhurst, Illinois 60126
630.559.2000 Phone
630.559.2030 Fax
www.cdfinc.com

Client:
Village of Carbon Cliff
106 1st Avenue
Carbon Cliff, IL 61239
309.792.8235 Phone

FIG 5 - COST COMPARISON

CARBON CLIFF STORMWATER MANAGEMENT

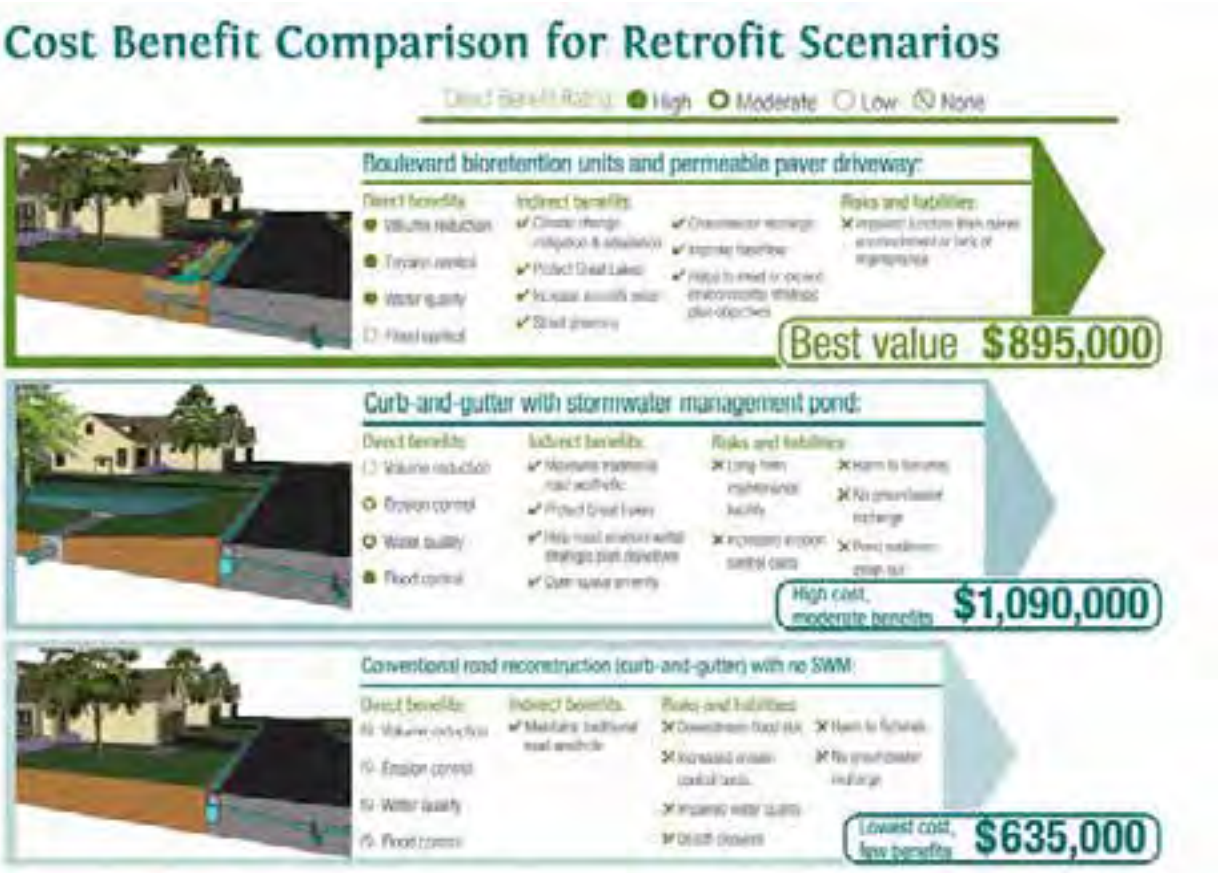
DATE	REVISIONS

DATE	08/21/2009
PROJECT NO.	09014.00
DRAWN BY	ATB
CHECKED BY	XXX

FIG-5

Green Infrastructure Cost Comparisons by Credit Valley Conservation

Credit Valley Conservation in Ontario, Canada has recently developed several documents to help communities and landowners implement green infrastructure as a means of effective asset management. Included in these documents is a Cost Benefit Comparison for Retrofit Scenarios within the right-of-way to help visualize the value associated with different levels of implementation. While this figure below is helpful as an example, it will be important for any community considering implementation of green infrastructure to first develop a list of priority benefits by location before determining the best value approach. For instance, an area that has regular structural damage from flooding will likely place a high value on green infrastructure that maximizes storage capacity, and potentially a lesser value on green infrastructure with primarily water quality benefits.



Credit Valley Conservation

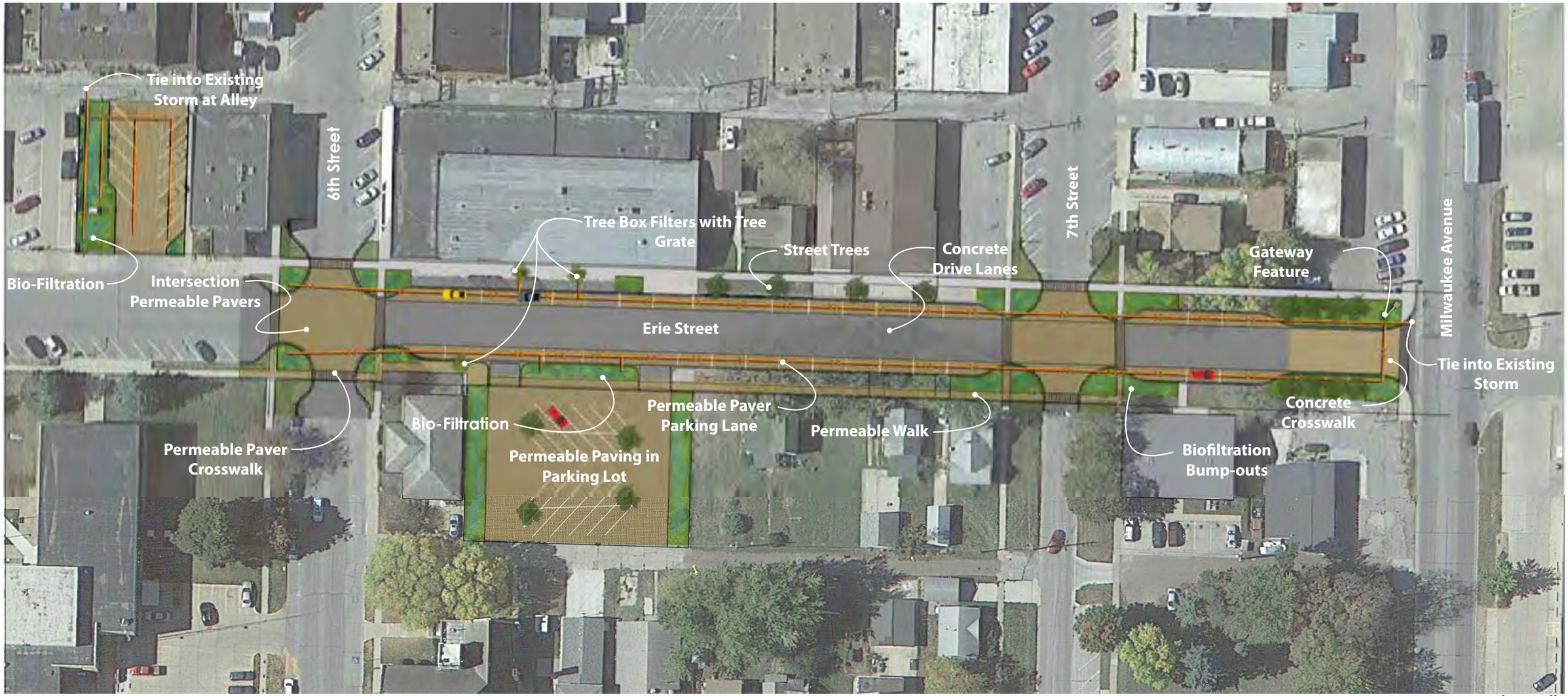
Credit Valley Conservation also developed a comparison of construction costs for various projects in Canada and the U.S. Additional information on how these costs were obtained can be found at *http://www.creditvalleyca.ca/low-impact-development/low-impact-development-support/stormwater-management-lid-guidance-documents/.*

Project	Project Type	Road Length	LID Practice	Construction Costs			Cost savings
				Conventional design	LID	Cost difference	
Lakeview Project, Mississauga, ON	ROW Retrofit	285 m	• Bioretention • Permeable pavers	$1,080,000*	$885,000	$195,000	18%
Elm Drive Project, Mississauga, ON	ROW Retrofit	210 m	• Bioretention • Permeable pavers	$850,000	$585,000	$265,000	10%
Hogg's Hollow Project, Toronto, ON	ROW Retrofit	267 m	• Perforated pipe	$646,000	$719,000	-$73,000	-11%
Crown Streets, BC	ROW Retrofit	335 m	• Bioretention • Vegetative landscaping	$364,000	$396,000	$-32,000	9%
Boulder Hills - Roadway, sidewalk & driveway, NH	New ROW	275 m	• Permeable asphalt	$4,289,000	$4,340,000	$49,000	1%
2nd Avenue, SEA Street Retrofit, Seattle, WA	ROW Retrofit	200 m	• Bioretention • Reduced impervious area • Swale	$869,000	$652,000	$217,000	25%
* Assumes construction of end-of-pipe facility to provide equivalent level of stormwater treatment							

Credit Valley Conservation

G appendix

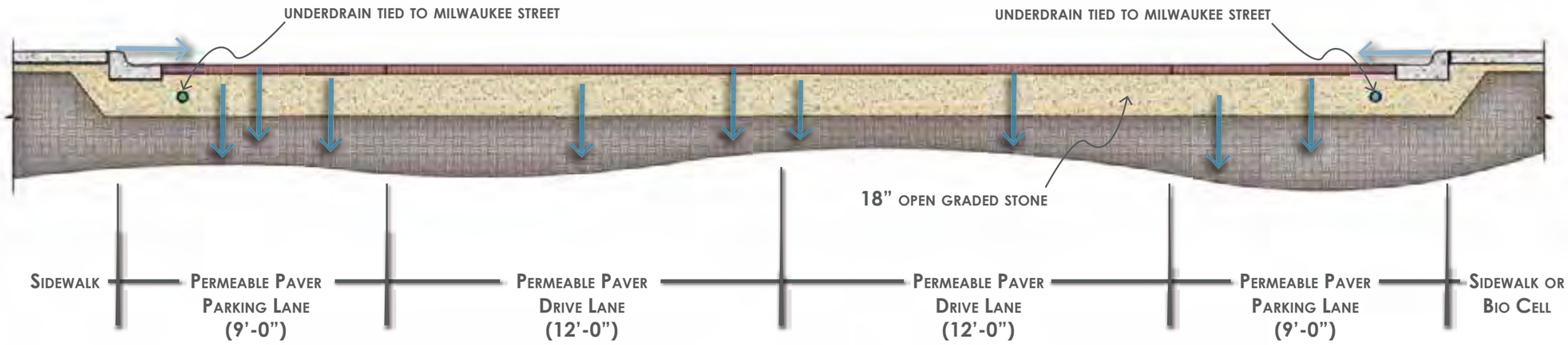
Erie Street Concept Plan and Cost Estimate



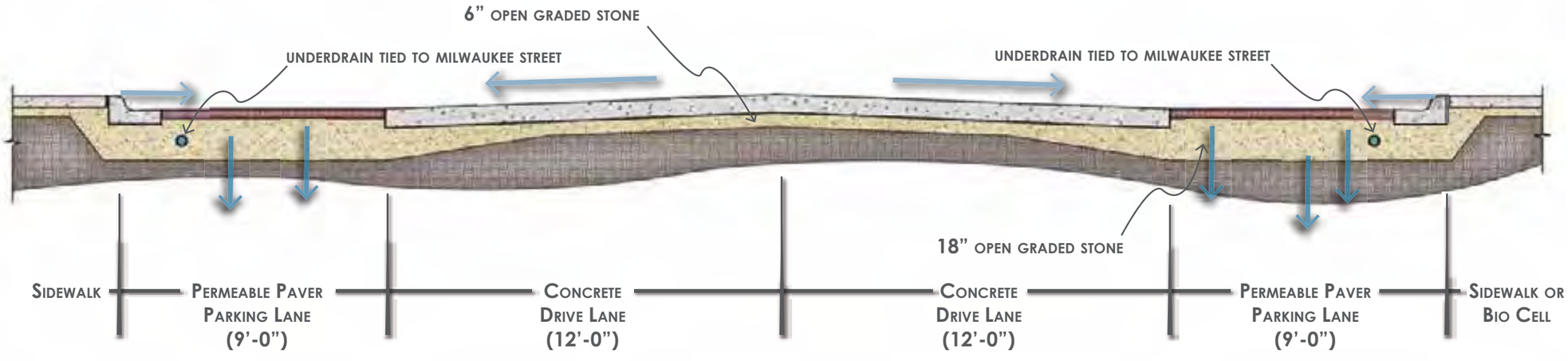
Storm Lake, Iowa

Erie Street Reconstruction

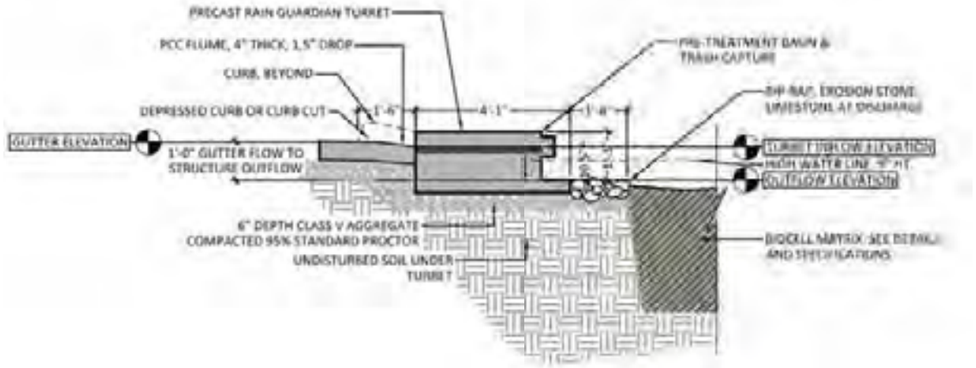
Concept Plan | October 2014



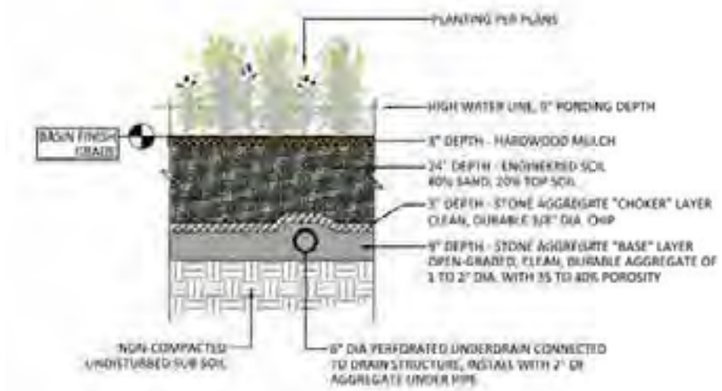
TYPICAL SECTION: ERIE STREET WITH PERMEABLE PAVER ROADWAY



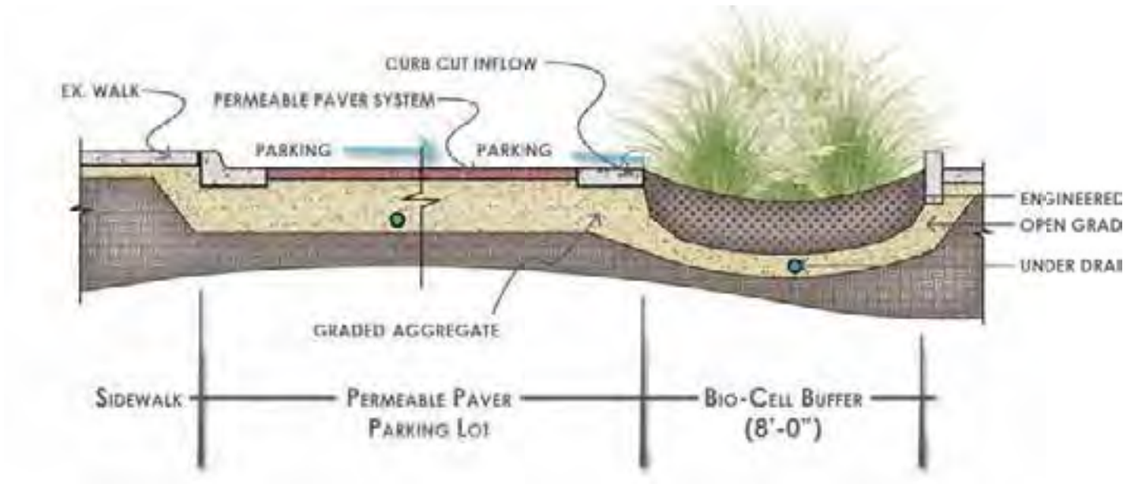
TYPICAL SECTION: ERIE STREET WITH CONCRETE ROADWAY



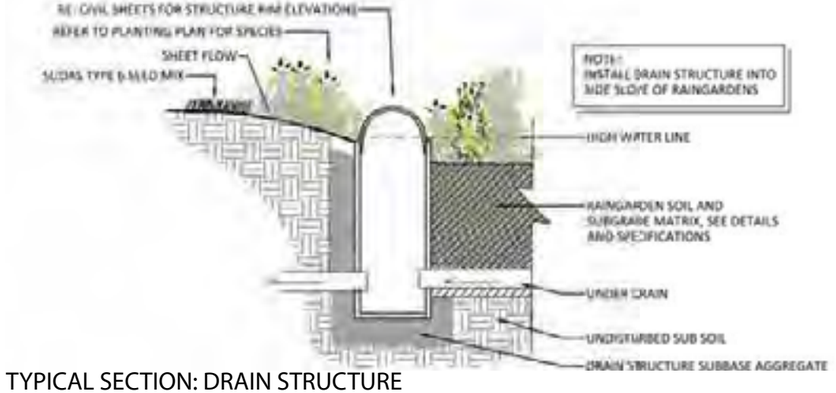
TYPICAL SECTION: RAINGARDEN INLET STRUCTURE WITH PCC FLUME
SCALE: NTS



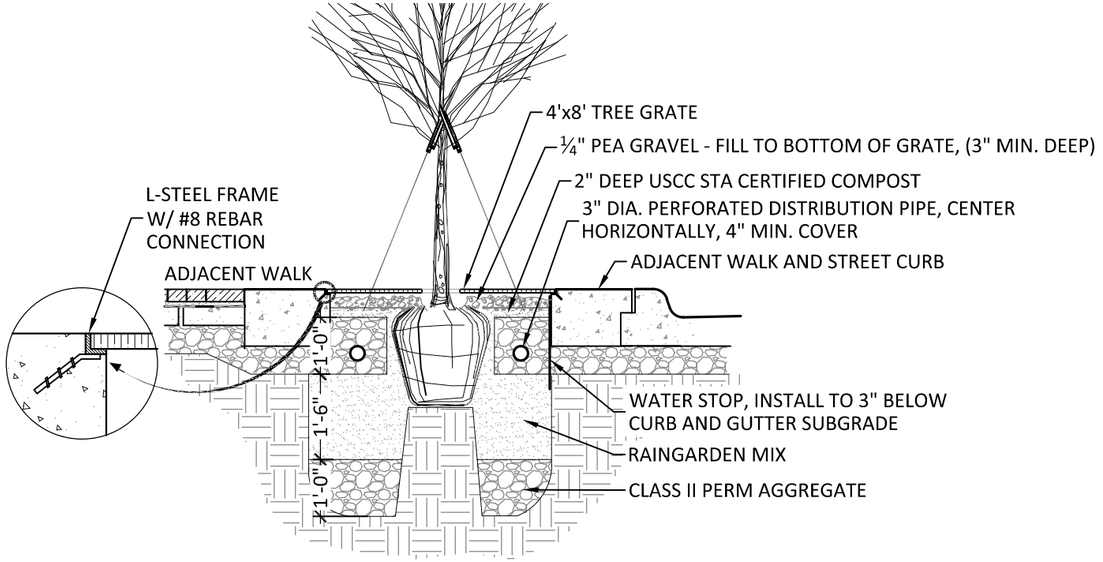
TYPICAL SECTION: RAINGARDEN SOIL AND SUBGRADE MATRIX
SCALE: NTS



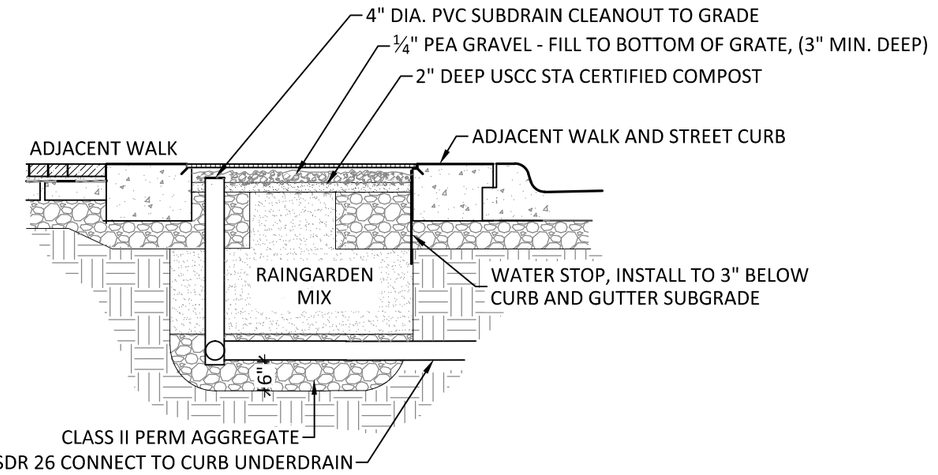
TYPICAL SECTION: ERIE STREET PARKING LOT WITH BIO-CELL
SCALE: NTS



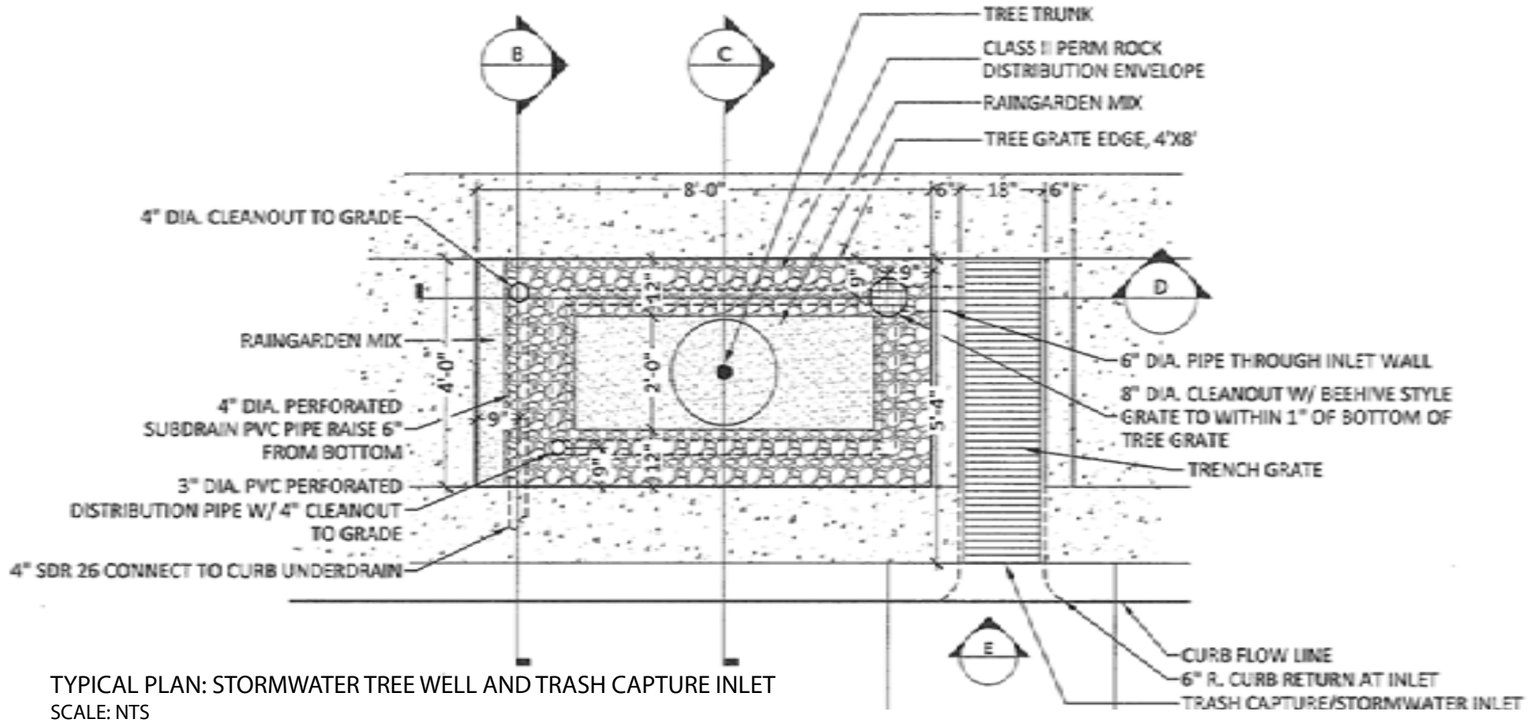
TYPICAL SECTION: DRAIN STRUCTURE
SCALE: NTS



TYPICAL SECTION: STORMWATER TREE GRATE THROUGH TREE
SCALE: 3/8" = 1'-0"



TYPICAL SECTION: STORMWATER SUBDRAIN
SCALE: 3/8" = 1'-0"



TYPICAL PLAN: STORMWATER TREE WELL AND TRASH CAPTURE INLET
SCALE: NTS

City of Storm Lake
Erie Street Reconstruction - 2014
Storm Lake, Iowa

Line No.	Description	Unit	Quantity	Engineer's Estimate Unit Price	Engineer's Estimate Amount
1	TRAFFIC CONTROL	LS	1	$15,000.00	$15,000.00
2	MOBILIZATION	LS	1	$40,500.00	$40,500.00
	Roadway - Milwaukee Ave through 7th Street Intersection				
3	EXCAVATION, CLASS 13	CY	500	$8.00	$4,000.00
4	SUBGRADE PREPARATION	SY	370	$2.50	$925.00
5	BASE, ASTM NO. 57 STONE	TN	95	$30.00	$2,850.00
6	SUBBASE, 0207 - 3" Ballast	TN	380	$30.00	$11,400.00
7	EXPLORATORY EXCAVATION, UTILITY POTHOLE	EA	2	$100.00	$200.00
8	STORM SEWER, TRENCHED, N-2000, 12"	LF	600	$40.00	$24,000.00
9	SUBDRAIN, TYPE 1, 6"	LF	150	$20.00	$3,000.00
10	INTAKE TYPE SW-501	EA	2	$2,500.00	$5,000.00
11	INTAKE - NYLOPLAST FOR BIOCELLS	EA	6	$500.00	$3,000.00
12	INTAKE ADJUSTMENT, MINOR	EA	1	$1,000.00	$1,000.00
13	CONNECTION TO EXISTING INTAKE	EA	2	$500.00	$1,000.00
14	PAVEMENT, PCC, 7"	SY	380	$45.00	$17,100.00
15	PERMEABLE PAVEMENT PAVERS	SY	880	$50.00	$44,000.00
16	CURB AND GUTTER, 6" STD. 30" WIDE	LF	750	$20.00	$15,000.00
17	REMOVAL OF SIDEWALK	SY	280	$8.00	$2,240.00
18	REMOVAL OF DRIVEWAY	SY	250	$8.00	$2,000.00
19	SIDEWALK, PCC, 4"	SY	230	$50.00	$11,500.00
20	SIDEWALK, PERMEABLE PAVERS	SY	50	$70.00	$3,500.00
21	PERMEABLE PAVER BASE	TN	5.5	$25.00	$137.50
22	SIDEWALK PAVER EDGE RESTRAINT	LF	90	$8.00	$720.00
23	DETECTABLE WARNING	SF	120	$25.00	$3,000.00
24	DRIVEWAY, PCC, 6"	SY	100	$45.00	$4,500.00
25	PAVEMENT REMOVAL	SY	2650	$8.00	$21,200.00
26	CONVENTIONAL SEEDING, FERTILIZING, AND MULCHING	AC	0.5	$3,000.00	$1,500.00
27	STREET TREES	EA	8	$500.00	$4,000.00
28	BIOFILTRATION	SF	3315	$10.00	$33,150.00
29	DECORATIVE LED LIGHTING	EA	6	$4,500.00	$27,000.00
	SUBTOTAL				**$246,922.50**
	Roadway - Through 6th Street Intersection				
30	EXCAVATION, CLASS 13	CY	650	$8.00	$5,200.00
31	SUBGRADE PREPARATION	SY	1237	$2.50	$3,092.50
32	BASE, ASTM NO. 57 STONE	TN	135	$30.00	$4,050.00
33	SUBBASE, 0207 - 3" Ballast	TN	540	$30.00	$16,200.00
34	EXPLORATORY EXCAVATION, UTILITY POTHOLE	EA	4	$100.00	$400.00
35	STORM SEWER, TRENCHED, N-2000, 12"	LF	950	$40.00	$38,000.00
36	SUBDRAIN, TYPE 1, 6"	LF	185	$20.00	$3,700.00
37	INTAKE TYPE SW-501	EA	4	$2,500.00	$10,000.00
38	INTAKE - NYLOPLAST FOR BIOCELLS	EA	6	$500.00	$3,000.00
39	INTAKE ADJUSTMENT, MINOR	EA	1	$1,000.00	$1,000.00
40	CONNECTION TO EXISTING INTAKE	EA	2	$500.00	$1,000.00
41	PAVEMENT, PCC, 7"	SY	1250	$45.00	$56,250.00
42	PERMEABLE PAVEMENT PAVERS	SY	1200	$50.00	$60,000.00
43	CURB AND GUTTER, 6" STD. 30" WIDE	LF	2100	$20.00	$42,000.00
44	REMOVAL OF SIDEWALK	SY	830	$8.00	$6,640.00
45	REMOVAL OF DRIVEWAY	SY	55	$8.00	$440.00
46	SIDEWALK, PCC, 4"	SY	300	$50.00	$15,000.00
47	SIDEWALK, PERMEABLE PAVERS	SY	535	$70.00	$37,450.00
48	SIDEWALK PERMEABLE PAVER BASE	TN	60	$25.00	$1,500.00
49	PAVER EDGE RESTRAINT	LF	925	$8.00	$7,400.00
50	DETECTABLE WARNING	SF	80	$25.00	$2,000.00
51	DRIVEWAY, PCC, 6"	SY	55	$45.00	$2,475.00
52	PAVEMENT REMOVAL	SY	3000	$8.00	$24,000.00
53	CONVENTIONAL SEEDING, FERTILIZING, AND MULCHING	AC	1.0	$3,000.00	$3,000.00
54	TREE BOX FILTERS WITH TREE GRATE (TREE INCLUDED)	EA	3.0	$4,500.00	$13,500.00
55	BIOFILTRATION	SF	2275	$10.00	$22,750.00
56	DECORATIVE LED LIGHTING	EA	14	$4,500.00	$63,000.00
	Subtotal				**$380,047.50**
	Parking Lot 1 - City Hall				
57	PAVEMENT REMOVAL	SY	800	$8.00	$6,400.00
58	EXCAVATION, CLASS 13	CY	260	$8.00	$2,080.00
59	BASE, ASTM NO. 57 STONE	TN	60	$30.00	$1,800.00
60	SUBBASE, 0207 - 3" Ballast	TN	240	$30.00	$7,200.00
61	SUBDRAIN, TYPE 1, 6"	LF	300	$20.00	$6,000.00
62	PERMEABLE PAVEMENT PAVERS	SY	520	$50.00	$26,000.00
63	CURB AND GUTTER, 6" STD. 30" WIDE	LF	200	$20.00	$4,000.00
64	INTAKE - NYLOPLAST FOR BIOCELLS	EA	2	$500.00	$1,000.00
65	BIOFILTRATION	SF	2160	$10.00	$21,600.00
	Subtotal				**$76,080.00**
	Parking Lot 2 - Bank				
66	PAVEMENT REMOVAL	SY	1800	$8.00	$14,400.00
67	EXCAVATION, CLASS 13	CY	678	$5.00	$3,390.00
68	BASE, ASTM NO. 57 STONE	TN	152	$25.00	$3,800.00
69	SUBBASE, 0207 - 3" Ballast	TN	608	$25.00	$15,200.00
70	SUBDRAIN, TYPE 1, 6"	LF	600	$20.00	$12,000.00
71	PERMEABLE PAVEMENT PAVERS	SY	1360	$45.00	$61,200.00
72	CURB AND GUTTER, 6" STD. 30" WIDE	LF	275	$20.00	$5,500.00
73	INTAKE - NYLOPLAST FOR BIOCELLS	EA	2	$500.00	$1,000.00
74	BIOFILTRATION	SF	2830	$10.00	$28,300.00
	Subtotal				**$144,790.00**
	TOTAL				**$903,340.00**

12-Nov-14

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Storm Lake Green Infrastructure Plan for Water

April 2015

City of Storm Lake, Iowa
Iowa Economic Development Authority