



City of Grand Rapids, MI

STORMWATER MASTER PLAN

May 2013

Updated January 20, 2014

STORMWATER MASTER PLAN

MAY 2013

Updated January 20, 2014

City of Grand Rapids, MI
Environmental Services Department
1300 Market Avenue
Grand Rapids, MI. 49503

Tt Project Number: 200-12737-12006 Task 001

P:\IER\12737\200-12737-12006\Docs\Reports\SWMP\SWMP 2013-06-12.docx

TABLE OF CONTENTS

1. INTRODUCTION	1
PURPOSE AND INTENT	1
BACKGROUND.....	1
System Planning Efforts	1
COMMUNITY OUTREACH	3
2. POLICY CONSIDERATIONS.....	5
FEDERAL PROGRAMS	5
Clean Water Act.....	5
National Pollutant Discharge Elimination System.....	5
STATE PROGRAMS.....	6
Natural Resources and Environmental Protection Act.....	6
Public Act 40 of 1956 – The Drain Code.....	6
Water Quality Standards	6
Permits	7
Total Maximum Daily Load (TMDL) Program.....	7
OTHER PROGRAMS.....	8
Green Grand Rapids Master Plan.....	8
Green Infrastructure Portfolio Standard Projects.....	8
The Sustainability Plan	9
Transformation Investment Plan.....	10
Interim Report of the Sustainable Streets Task Force.....	10
3. WATERSHED SUMMARY.....	11
INTRODUCTION.....	11
BUCK CREEK WATERSHED	12
COLDBROOK CREEK DISTRICT	13
COMSTOCK/SLIGH DISTRICT	14
GRACELAND-LACEY DISTRICT	14
GRAND RIVER DISTRICT	15
HOGADONE CREEK	15
INDIAN MILL CREEK.....	16
LAMBERTON CREEK	16
PALMER STREET DISTRICT	17
PLASTER CREEK DISTRICT.....	17
BURTON-BRETON BRANCH OF PLASTER CREEK	17
SILVER CREEK BRANCH OF PLASTER CREEK.....	18
WHISKEY CREEK BRANCH OF PLASTER CREEK	18
4. ASSET MANAGEMENT AND CAPITAL IMPROVEMENTS	21
DRAINAGE SYSTEM ASSETS	21
Open Channels and Roadside Ditches	22

Stream Crossings	22
Detention and Retention Basins.....	22
Pump Stations	22
Green Infrastructure.....	22
Combined Sewer Areas.....	25
ASSET MANAGEMENT	25
CAPITAL IMPROVEMENTS.....	27
5. STORMWATER ACTIVITIES.....	29
MS4 NPDES PERMIT	29
ILLICIT DISCHARGE ELIMINATION PROGRAM	31
EMPLOYEE/CONTRACTOR TRAINING	31
CONSTRUCTION STORMWATER RUNOFF CONTROL.....	31
POST-CONSTRUCTION STORMWATER CONTROLS	31
DOWNSPOUT DISCONNECTION.....	32
FOOTING DRAIN DISCONNECTION PROGRAM (FDDP) – PUBLIC PORTION.....	32
FOOTING DRAIN DISCONNECTION PROGRAM (FDDP) – PRIVATE PORTION	32
OPERATIONS AND MAINTENANCE	33
6. PLANNING FOR THE FUTURE	35
NEW PARADIGM.....	35
CLIMATE CHANGE.....	35
FEDERAL AND STATE STORMWATER REGULATIONS	36
FUNDING OPTIONS	37
Property Taxes/General Fund	38
User-Fee Based Funding (Stormwater Utilities).....	38
Special Assessments	39
Bonding for Capital Improvements	39
System Development Charges	39
Impact Fees	40
Developer Extension/Latecomer Fee	40
Plan Review, Development Inspections and Special User Fees	40
Federal and State Funding	40
<i>SAW Grants and Low-Interest Loans.....</i>	<i>40</i>
<i>Strategic Water Quality Initiatives Fund (SWQIF).....</i>	<i>41</i>
<i>S2 Grant Program.....</i>	<i>42</i>
<i>Other Grant Programs.....</i>	<i>42</i>
<i>USACE Planning Assistance to States</i>	<i>42</i>
Environmental Tax Shifting.....	42
INCENTIVIZING STORMWATER MANAGEMENT.....	43
7. RECOMMENDATIONS	45
MS4 PERMIT RELATED PROJECTS	45
PLANNING PROJECTS	45
POLICIES AND PROCEDURES	46

ASSET MANAGEMENT	46
CAPITAL PROJECTS	47
8. REFERENCES	49
APPENDIX A: HISTORIC MODELING STUDIES	51
BUCK CREEK WATERSHED (1991).....	51
COLDBROOK CREEK DISTRICT (1985)	51
COMSTOCK/SLIGH DISTRICT (1994)	52
GRACELAND-LACEY DISTRICT (1994)	53
GRAND RIVER DISTRICT (1989)	54
HOGADONE CREEK (1994).....	54
INDIAN MILL CREEK (1994)	56
LAMBERTON CREEK (1994)	57
PALMER STREET DISTRICT (1992).....	58
PLASTER CREEK DISTRICT (1991).....	59
BURTON-BRETON BRANCH OF PLASTER CREEK (1991).....	61
SILVER CREEK BRANCH OF PLASTER CREEK (1991)	62
WHISKEY CREEK BRANCH OF PLASTER CREEK (1991).....	63
WHISKEY CREEK BRANCH OF PLASTER CREEK (2004).....	64

LIST OF TABLES

Table 1-1 Summary of Historical Watershed Reports	2
Table 2-1 TMDL's for Major Waterbodies Flowing Through Grand Rapids	7
Table 3-1 Summary of Watershed and Drainage Studies	11
Table 3-2 Coldbrook Creek Modeling Results	13
Table 4-1 Stormwater Summary	21
Table 4-2 Green Infrastructure Inventory	23
Table 4-3 Asset Summary and Cost.....	26
Table 4-4 Level of Service Funding Requirements	27
Table 5-1 WMP Objectives and Measurable Milestones.....	29
Table 5-2 O&M Activities	33

LIST OF FIGURES

Figure 2-1 GIPS Pilot Areas.....	9
----------------------------------	---

ACRONYMS

AMP	Asset Management Plan
BMP	Best Management Practice
CIP	Capital Improvement Plan
CNT	Center for Neighborhood Technology
CMI	Clean Michigan Initiative – State Bound
CSDS	City Stormwater Drainage System
cfs	cubic feet per second
CN	Curve Number
CSO	Combined Sewer Overflow
CWA	Clean Water Act – Federal
ESD	Environmental Services Department
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
fps	feet per second
HSG	Hydrologic Soil Group
GIS	Geographic Information System
GR	Grand Rapids
GI	Green Infrastructure
GIPS	Green Infrastructure Portfolio Standard
LID	Low Impact Development
LGRWMP	Lower Grand River Watershed Management Plan
MARB	Market Avenue Retention Basin
MDEQ	Michigan Department of Environmental Quality
MDOT	Michigan Department of Transportation
MS4	Municipal Separate Storm Sewer System
NFI	Natural Features Inventory
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service (formerly Soil Conservation Service, SCS)
NREPA	Natural Resources and Environmental Protection Act
O&M	Operations and Maintenance
PEP	Public Education Plan
PPP	Public Participation Plan
PWSS	Public Water Supply System
RCP	Reinforced Concrete Pipe

ROW	Right-of-way
SCS	Soil Conservation Service (now the NRCS)
SDWA	Safe Drinking Water Act
SWMM	Storm Water Management Model
SWMP	Stormwater Master Plan
SWPPI	Stormwater Pollution Prevention Plan
SUSTAIN	System for Urban Stormwater Treatment and Analysis Integration Model
TOT	Time of Travel
TR-55	NRCS Technical Release No. 55, Urban Hydrology for Small Watersheds
TSS	Total Suspended Solids
TIP	Transformation Investment Plan
USACE	United States Army Corps of Engineers
WMEAC	West Michigan Environmental Action Council
WMP	Watershed Management Plan

EXECUTIVE SUMMARY

The character of stormwater management has, and continues to change. Originally stormwater systems were built just for conveyance, with a mindset of *get-it-out quick*. Now stormwater management is a component of a comprehensive integrated urban water resource. The new mantra is *slow it down, spread it out, and soak it in*. Contemporary stormwater management includes quantity and quality considerations, multiple-use facilities, riparian corridors, recreation, wetland preservation and groundwater recharge. The new approaches require a complete paradigm shift on how managing runoff from rain and snow is thought about.

The new paradigm has introduced a whole new array of issues that has resulted in basic changes in stormwater planning, design, operation and maintenance, construction, and financing. Stormwater managers now must find the resources to effectively satisfy the changes as well as the regulatory requirements.

The Stormwater Master Plan (SWMP) has many purposes but is primarily intended to establish standards with respect to the use and operation of the City's stormwater system; to mitigate flooding; reduce pollution and sedimentation of the system, adjacent properties and the environment; and to improve the water quality of our rivers, lakes and streams. Specifically, the objectives of the SWMP are to:

- 1) Protect human life, health and safety through stormwater management.
- 2) Effectively utilize public funds for flood and stormwater pollution control projects.
- 3) Minimize the need for rescue and relief efforts associated with flooding.
- 4) Reduce the level of pollutants discharged by the Grand Rapids Stormwater System.
- 5) Provide for the wise use and development of flood-prone areas so as to maximize beneficial use without increasing flood hazard potential and/ or degrading water quality.
- 6) Ensure a functional drainage system that will not result in excessive maintenance costs.
- 7) Encourage the use of best management practices to improve water quality.
- 8) Encourage the reduction of existing flooding problems in conjunction with new development.
- 9) Protect public and private property from the accumulation of mud, dirt, water, debris, and other materials.
- 10) Comply with Federal and State laws regarding stormwater discharges, floodplain management, and erosion and sediment control.

The SWMP is an update to the plan written in 1994. Since 1994, much has changed within the City and with regards to stormwater management. The City recently developed several plans and projects which have a stormwater related component. These are discussed in this Plan and include the following:

- Green Grand Rapids Master Plan (October 2011),
- Sustainability Plan (Amended June 2011),
- Transformation Investment Plan (2011),
- Interim Report of the Sustainable Streets Task Force (May 2012),
- Green Infrastructure Portfolio Standards Project (2012), and
- Stormwater Asset Management and Capital Improvement Plan (April 2013).

Over the years, numerous studies have been conducted on the various subwatershed and drainage areas in the City. These studies have resulted in identification of problems, both manmade and naturally occurring. Each of the major separate storm sewer districts has been studied. This SWMP provides a summary of the historical reports and the major findings of each report.

A 20-year citywide asset management and capital improvement plan have been developed for the public stormwater infrastructure system. The plan demonstrates how the City's goal of establishing and delivering certain levels of service may be achieved through effective and sustainable management of the

stormwater system. The details of the plan are provided in the Stormwater Asset Management and Capital Improvement Plan (2013) and briefly discussed in this Plan.

To support the management and maintenance of infrastructure and the new paradigm shift in stormwater management the following core recommendations are offered.

- Implement a standardized database to track and record permit activities.
- Conduct an evaluation of the public education activities and use the results to update the existing action plan.
- Develop implementation plans to meet the Total Maximum Daily Load (TMDL) water quality limits.
- Proactively leverage grant opportunities by developing a project plan for responding to notices of available grant funding.
- Conduct a conveyance capacity analysis of the drainage system to identifying system bottlenecks, address channel erosion problems, establish post construction allowable release rates, support green infrastructure evaluations; and support project planning efforts to secure funding.
- Conduct a green infrastructure opportunity assessment for the city.
- Develop stormwater control measure design standards for use on future infrastructure projects.
- Proactively plan for climate change.
- Develop a program to incentivize stormwater management on private property.
- Develop a compensatory mitigation program for losses of stormwater resources.
- Develop and adopt a suite of tools to assist with the design, life cycle costing and triple bottom line evaluation of stormwater control measures.

As the move into the new stormwater paradigm occurs it is also important to remember that the focus also needs to include minimizing costs and maximizing the results achieved through the investments made. Analysis of alternatives should include life cycle cost estimates and consideration for the triple bottom line (social, economic and environmental considerations). Stormwater management should also be thought of as a continuous improvement process. Meaning we should always strive to improve the stormwater infrastructure as well as the organizational systems, processes and skills.

1. INTRODUCTION

PURPOSE AND INTENT

The Stormwater Master Plan (SWMP) is primarily intended to establish standards with respect to the use and operation of the City's stormwater system, to mitigate flooding, reduce pollution and sedimentation of the system, adjacent properties and the environment and to improve the water quality of our rivers, lakes and streams. Specifically, the objectives of the SWMP are to:

- 1) Protect human life, health and safety through stormwater management.
- 2) Effectively utilize public funds for flood and stormwater pollution control projects.
- 3) Minimize the need for rescue and relief efforts associated with flooding.
- 4) Reduce the level of pollutants discharged by the Grand Rapids Stormwater System.
- 5) Provide for the wise use and development of flood-prone areas so as to maximize beneficial use without increasing flood hazard potential and/ or degrading water quality.
- 6) Ensure a functional drainage system that will not result in excessive maintenance costs.
- 7) Encourage the use of best management practices to improve water quality.
- 8) Encourage the reduction of existing flooding problems in conjunction with new development.
- 9) Protect public and private property from the accumulation of mud, dirt, water, debris, and other materials.
- 10) Comply with Federal and State laws regarding stormwater discharges, floodplain management, and erosion and sediment control.

BACKGROUND

The City of Grand Rapids has a significant investment in its stormwater management facilities, which are estimated to have a replacement value of approximately \$529 million. These facilities have been built over a long period of time and represent an important community asset. The existing facilities have been primarily constructed to provide drainage and management of stormwater flows that protect the life, health and safety of Grand Rapids residents. They provide a level of service (LOS) to the City that should not be allowed to deteriorate. To maintain the current investment and address future needs, a scheduled and proactive approach is required. The City is also required by the Federal Stormwater National Pollutant Discharge Elimination System (NPDES) Permit Program to implement a stormwater quality management program. There are six elements to the NPDES stormwater program that the City must implement to be in permit compliance. To maximize the effectiveness of the overall stormwater program, both the management of assets and the pollution control efforts should be addressed in a synchronized manner. Therefore, the NPDES actions dealing with stormwater quantity and quality will be integrated with routine operation and maintenance activities to manage the system to a very high level of service.

The City's stormwater system has been significantly modified through the implementation of the Combined Sewer Overflow (CSO) program. Through its CSO program, the City has gone from 59 in system overflow points in 1991 to just five remaining. This has been achieved through the combination of the separation of sanitary and storm sewers in CSO areas and the use of detentions basins such as the Market Avenue Retention Basin (MARB).

System Planning Efforts

A number of system planning efforts have been implemented which are reflected in this SWMP. The various efforts include:

- Watershed level evaluations and plans that identify problems, both natural and manmade, that are occurring for each of the major watershed districts of the City (Appendix A). Table 1-1 provides a summary of the historical reports.

- An operation and maintenance program for the stormwater system.
- An Asset Management Plan (AMP) that compiled available information on the age and condition on each of the systems components, such as storm sewers, catch basins and streams into a database.
- A Capital Improvement Plan (CIP) that builds off the Watershed Management Plans, AMP and NPDES requirements. This plan is intended to correct the backlog of existing problems and to provide improvements for the desired levels of service throughout the City.
- A Technical Reference Manual (TRM) that is aimed at reducing stormwater contributions from new development and redevelopment.

Table 1-1 Summary of Historical Watershed Reports

Watershed	Study Prepared By	Date	Report Title
Coldbrook Creek	Fishbeck, Thompson, Carr and Huber	1985	Stormwater Management Plan for Coldbrook Creek Drainage District
Grand River	Wade Trim	1989	The Grand River Floodwall / Embankment Study
Plaster	Grand Rapids Waste Water Treatment Report	1990	Silver Creek Drain Report
Buck and Plaster Creek	Camp, Dresser, and McKee	1991	Buck Creek and Plaster Creek Stormwater Management Master Plan
Palmer	Prein and Newhof, P.C.	1992	Palmer Drain Watershed Study
Plaster	Grand Valley State University	1992	Plaster Creek Stormwater Quality Study
Comstock/Sligh	McNamee, Porter and Seeley, Inc.	1994	Grand Rapids Comprehensive Stormwater Management Master Plan
Graceland-Lacey	McNamee, Porter and Seeley, Inc.	1994	Grand Rapids Comprehensive Stormwater Management Master Plan
Hogadone	McNamee, Porter and Seeley, Inc.	1994	Grand Rapids Comprehensive Stormwater Management Master Plan
Indian Mill Creek	McNamee, Porter and Seeley, Inc.	1994	Indian Mill. Creek Stormwater Management Plan
Lamberton Creek	McNamee, Porter and Seeley, Inc.	1994	Grand Rapids Comprehensive Stormwater Management Master Plan
Lamberton Creek	Spicer	2006	Hydraulic Analysis and Flood Plain Mapping of Lamberton Creek
Whiskey Creek	Black and Veatch	1999	Improvements to Whiskey Creek Watershed
Whiskey Creek	Black and Veatch	2004	Analysis of Whiskey Creek watershed

This SWMP summarizes and integrates these efforts both in order to make recommendations for the future management of the system. The SWMP, together with the TRM will ensure that the effects of stormwater on local waterways are mitigated to the maximum extent possible.

A number of reference materials were considered in the creation of this SWMP. These include: the Environmental Protection Agency’s (EPA) Planning for Sustainability, System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) Model, and the Integrated Municipal Stormwater and Wastewater Planning Approach Framework.

The SWMP is organized in the following manner. A summary of the policy environment is provided, followed by a description of the watersheds and stormwater system, an assessment of the stormwater system, findings and conclusions based on the current reality, development of a plan for the future management of the system, and recommendations for implementation.

COMMUNITY OUTREACH

Since 2009, the West Michigan Environmental Action Council (WMEAC) has been working with the City of Grand Rapids to educate and engage the public on stormwater issues. The process has been designed to aggressively reach out to the community, including property owners, community and business leaders, as well the general citizenry.

As the community based stormwater initiative ramped up WMEAC and the City of Grand Rapids has proactively reached out to the community with many smaller meetings. Meetings have occurred with the Grand Rapids (GR) Chamber, Kent Intermediate School District (ISD), GR Public Schools, Lotus Development, Meijer Inc., and Consumer's Energy, with many more invited and more meetings to come. Topics for the meetings included a description of the current infrastructure, perceptions of the current level of service, future needs and funding options.

Two surveys have been conducted, an informal survey of participants on their perception of the current level of service and a door to door survey conducted by Clean Water Action that solicited answers from interested citizens (therefore biased). Perceptions of the current level of service were that it was reactionary in nature, repairs were "as needed" and that the infrastructure was "wearing out". The 574 door to door surveys indicated that 85% of respondents were willing to spend between \$2 and \$12 dollars more per-month for improvements to the current level of service.

WMEAC is committed to continuing to partner with the City of Grand Rapids to assist with outreach and engagement of the public on stormwater issues. With regard to this SWMP, WMEAC has participated in the weekly progress meetings and represented the public interest in the development of the plan.

The SWMP will also be presented to City Commission and be subject to the required public commenting period before adoption is considered.

2. POLICY CONSIDERATIONS

Stormwater is a key component in the sustainable management of our natural resources, and as such, is included as part of many policy documents beyond those regulating its management. The following section summarizes the policy environment surrounding stormwater.

FEDERAL PROGRAMS

Clean Water Act

In November of 1972, Congress passed a comprehensive recodification and revision of federal water pollution control law, known as the *Federal Water Pollution Control Act Amendments of 1972* (more commonly known as the ‘Clean Water Act’ or (CWA), marking a distinct change in the philosophy of water pollution control in the United States. The Amendments contained requirements for water quality-based controls, with an emphasis on technology-based, or end-of-pipe, control strategies.

Since passage of the CWA, numerous international, federal, state (e.g. water quality standard updates), regional, and local programs have worked to enhance environmental conditions in the county, Great Lakes region, state, region, county, watershed, and subwatershed. These programs are discussed in detail elsewhere in the Watershed Management Plan (WMP), but some important programs are discussed briefly in the following sections.

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System (NPDES) is a cornerstone of environmental protection at the federal level. When the NPDES was established in 1972 (under the Clean Water Act), only one third of our rivers, lakes, and coastal waters were considered fishable and swimmable. Today, approximately two thirds of our waters are healthy. This is due in no small part to the regulation of more than 50 categories of industry (including several hundred thousand businesses) and the nation’s network of more than 16,000 municipal sewage treatment systems. The NPDES permits that regulate discharges from these facilities have resulted in the prevention of billions of pounds of conventional pollutants (e.g. suspended solids) and millions of pounds of toxic pollutants (e.g. dissolved heavy metals) from being discharged into ‘waters of the United States’ (EPA, 2001).

In 1990, the EPA promulgated Phase I of the stormwater rules of the NPDES. This required municipal separate storm sewer systems (MS4s) in areas with 100,000 or more people to regulate the quality of stormwater discharges to waters of the United States. Grand Rapids has been a permitted Phase I (population is > 100,000) since the early 1990s. In 1999, the EPA promulgated Phase II of the NPDES stormwater rules. The Phase II requirements expand the coverage of MS4s to include those in urbanized areas (as defined by the U.S. Census) not previously covered under Phase I. Requirements for these programs have historically differed. It is anticipated that the Michigan Department of Environmental Quality (MDEQ) will merge the two programs and both Phase I and II communities will be subject to the same requirements moving forward.

Michigan is one of forty-five states and territories authorized to implement the NPDES program. In implementing the Phase I and II stormwater requirements, the MDEQ originally developed the NPDES Wastewater Discharge General Permit No. MIG610000 (Watershed General Permit) for covering Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s). This is one of a few instances where a watershed-based permitting approach has been used under the NPDES program. The MDEQ is in the process of moving away from the watershed based permit and to a jurisdictional-based approach. This approach involves communities working both individually and collaboratively to address stormwater discharges through: 1) Public Education and Outreach, 2) Public Participation / Involvement, 3) Illicit Discharge Detection and Elimination, 4) Construction Site Runoff Control, 5) Post- Construction

Runoff Control, and 6) Pollution Prevention / Good Housekeeping (see more in Section 9). In order to address these requirements GR, in partnership with its neighboring watershed communities has produced numerous documents aimed at articulating the intended course of actions. These include a Stormwater Pollution Prevention Initiative (SWPPI), the Public Education Plan (PEP), and the Public Participation Plan (PPP). Most these documents are in their second or third iteration.

In order for the City of Grand Rapids to be in compliance and have the proper enforcement authority to implement the six minimum measures mentioned above, the City adopted a comprehensive stormwater ordinance in 2001, which was revised in February of 2007.

STATE PROGRAMS

State programs that directly enforce and assist in compliance with federal and state stormwater regulations include the following MDEQ Water Division groups: Stormwater, Soil Erosion and Sedimentation Control, NPDES Permits, and Nonpoint Source Pollution. State-level funding programs that support stormwater related projects include: the State Revolving Fund, the Strategic Water Quality Initiative Fund, and the Clean Michigan Initiative.

Natural Resources and Environmental Protection Act

Act 451 of 1994, the Natural Resources and Environmental Protection Act (NREPA), is designed to protect the environment and natural resources of the state by: regulating pollutant discharges; regulating land, water, and resource use; and prescribing penalties and remedies for violations.

Notable parts of the act relating to stormwater include:

- Part 17 – Environmental Protection;
- Part 31 – Water Resources Protection;
- Part 41 – Sewerage Systems;
- Part 87 – Groundwater and Freshwater Protection;
- Part 91 – Soil Erosion & Sedimentation Control;
- Part 301 – Inland Lakes and Streams;
- Part 303 – Wetland Protection;
- Part 305 – Natural Rivers Act;
- Part 307 – Inland Lake Levels;
- Part 309 – Inland Lake Improvement;
- Part 315 – Dam Safety; and
- Part 323 – Shorelands Protection and Management.

Public Act 40 of 1956 – The Drain Code

The Drain Code sets forth procedures for the creation, maintenance and financing of county and inter-county drains in Michigan. It establishes the office and prescribes the duties and powers of the county drain commissioner. County drains are important to stormwater efforts because many of them are waters of the state, and most of them discharge directly or indirectly to waters of the state (Pratt, 2005). It should be noted that the new stormwater permit guidance clarifies that an open county drain that is a surface water of the state is not a component of an MS4.

Water Quality Standards

Under the auspices of the CWA and NREPA, the MDEQ defines water quality standards “to protect the Great Lakes, the connecting waters, and all other surface waters of the state” (MDEQ, 2006). State water quality standards can be found at: http://www.michigan.gov/deq/0,4561,7-135-3313_3686_3728-11265--00.html.

Permits

Despite the NPDES permitting process that covers stormwater-specific issues; other permits may be required for specific cases. Many state and federal permits are covered under the MDEQ/United States Army Corps of Engineers (USACE) Joint Permit Application package. The application covers activities relating to: wetlands, floodplains, marinas, dams, inland lakes and streams, great lakes bottomlands, critical dunes, and high-risk erosion areas. Other permits not included in the application include: the Sewerage System Construction Permit and the Groundwater Discharge Permit.

Total Maximum Daily Load (TMDL) Program

MDEQ regulations (as authorized by the EPA under the CWA section 303(d)) require that “when a lake or stream does not meet water quality standards, a study must be completed to determine the amount of a pollutant that can be put in a waterbody from point sources and nonpoint sources and still meet water quality standards, including a margin of safety” (MDEQ, 2006). Table 2-1 identifies applicable TMDLs. State enforcement of the TMDLs is through the NPDES permit program.

Table 2-1 TMDL’s for Major Waterbodies Flowing Through Grand Rapids

County	Waterbody	Parameter	Year	Problem Statement
Kent and Ottawa	Grand River	<i>E. coli</i>	2006	Recreational uses are impaired by elevated levels of pathogens. The affected reach is the Grand River near Johnson Park (in the vicinity of Walker) upstream to the Fulton Street crossing, including the unnamed tributary at Vets Drive in Johnson Park.
Kent	Plaster Creek	Biota	2002	Fish and macroinvertebrate communities are rated as poor. The affected reach is approximately 12 miles long from the confluence with the Grand River upstream to Dutton Park (Hanna Lake Avenue and 76 th Street).
Kent	Plaster Creek	<i>E. coli</i>	2002	Recreational uses are impaired by elevated levels of pathogens. The affected reach is approximately 12 miles long from the confluence with the Grand River upstream to Dutton Park (Hanna Lake Avenue and 76 th Street).
Kent	Unnamed Tributary to the Grand River	Biota	2005	This biota TMDL focuses on the stabilization and attenuation of extremes in existing flow regimes to improve and maintain a cold water designated fish community. The affected reach is from the Grand River confluence from the vicinity of Grand River Drive upstream to M-44, just north of Leonard Street. Note only the very upstream fringes of the watershed are within the City limits
Kent	Buck Creek	<i>E. coli</i>	2006	Recreational uses are impaired by elevated levels of pathogens. The affected reach is from the confluence with the Grand River upstream to 68 th Street. Note only the very upstream fringes of the watershed are with the City limits.

Previously identified as impaired water was an unnamed tributary to Mill Creek (assessment unit ID 040500060503-01). The draft 2012 Integrated Report (Sections 303(d), 305(b), and 314), delisted this waterbody.

OTHER PROGRAMS

The City of Grand Rapids has numerous sustainability initiatives that indirectly influence the management of stormwater. One example is the recent birth of the Rapids Restoration Initiative which aims at returning the historic rapids within the City to a more natural state. Other locally adopted policies are discussed below.

Green Grand Rapids Master Plan

The Green Grand Rapids Master Plan (2012) updates the citywide 2002 Master Plan with a focus on the importance of green infrastructure, sustainability and quality of life in maintaining the city's livability and competitive edge in attracting and retaining residents and businesses.

Grand Rapids adopted a revised stormwater management ordinance in 2007 that emphasizes the use of Low Impact Development (LID) Best Management Practices (BMP) to reduce the quantity, and improve the quality, of runoff on a site-by-site basis. Low impact development manages rain water where it falls by reducing impervious surface area to allow infiltration and by taking advantage of natural processes to store and treat stormwater to reduce flows and improve water quality before stormwater is released to sewers and, ultimately, the Grand River.

The design approach to all city streets should include improved stormwater management, wherever possible. These "green street" strategies manage stormwater at its source and include, for example, reducing paved area (by decreasing lane widths where possible) and using permeable pavement in alleys, and parking lanes. Landscape areas parallel to the curb, in curb bumpouts, traffic islands or medians can also be expanded and designed to capture and infiltrate runoff from streets and sidewalks; additional street tree plantings will clean and absorb rainfall (see Chapter 4.2.3 – Stormwater Management).

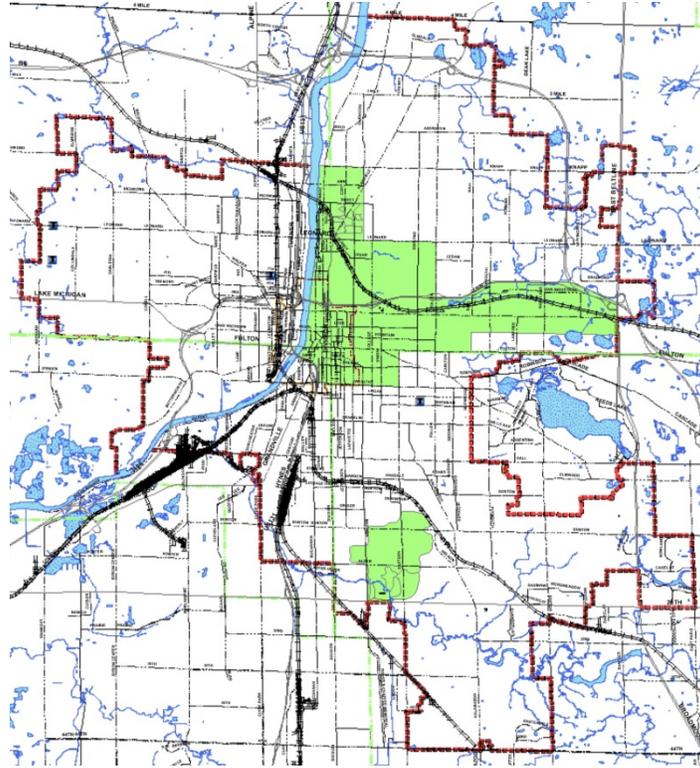
Requirements for pervious surface area (green space requirements) have been included in the City's updated zoning code (2007; amended 2008). Additional steps have been taken to educate developers, engineers and public officials about LID techniques through workshops and a map and driving tour (2006-07). The Grand Rapids-based WMEAC has also been conducting a community stormwater education project since 2002.

Green Infrastructure Portfolio Standard Projects

The Center for Neighborhood Technology (CNT) has developed an innovative stormwater green infrastructure "retrofit" program that incrementally, but substantially, reduces the volume of stormwater and pollutants entering the sewer system. In partnership with American Rivers and the Great Lakes and St. Lawrence Cities Initiative, CNT is working with the cities of Milwaukee and Grand Rapids to pilot this approach to scaling up green infrastructure (GI) in mature urban communities. A Green Infrastructure Portfolio Standard (GIPS) takes advantage of existing stormwater infrastructure and development procedures, providing for a systematic and cost-effective scale-up of GI practices.

The Grand Rapids GIPS pilot area no. 2 contains roughly 200 acres of residential, commercial, and industrial properties, in the northern portion of the northern shaded area shown in Figure 2-1. Within this area, the City is carrying out several projects to eliminate combined sewer overflows and a state-funded street resurfacing project. These are opportunities for the GIPS team to integrate green infrastructure practices into planned work. The area is primarily in one drainage area with a single outfall, which makes it easier to measure runoff and track progress in the reduction of both stormwater runoff volume and water pollution.

Figure 2-1 GIPS Pilot Areas



The Grand Rapids Environmental Services Department has identified several dozen green infrastructure projects within project area no. 2 to implement in the first year, which include street rain gardens with infiltration basins, porous pavement projects on public property, and a rain barrel program for residents. The Task Force is in the process of setting annual goals for runoff retention for the next 10 years. An annual goal, for example, could be that the installed green infrastructure retains an additional 1 percent of the runoff annually that occurs from a one-inch rainfall.

If Grand Rapids continues the GIPS program as currently planned and can secure funding for implementation, it will install enough green infrastructure to reduce the runoff from the project area by at least 20 percent in the next two decades, which will greatly assist in the reduction of the flooding and combined sewer overflows in the area that today result from typical storm events.

The Sustainability Plan

The Sustainability Plan FY 2011-2015 is a multi-year, adaptable document that is driven and influenced by other plans and strategies that may be developed throughout the duration of the Plan. Each department uses the Sustainability Plan as they plan their activities and justify their budget proposals. Management of stormwater, as recommended in the Sustainability Plan and in other City guidance documents is consistent with achieving the three Environmental Outcomes and their sub-targets as well some of the Social Outcomes sub-targets (Great Neighborhoods and Healthy Lifestyles and Healthy Environments). The most applicable outcomes and targets are provided below. Additional targets, for example *ENV 2.3 Target 1: Increase the percentage of tree canopy*, were not necessarily identified as a stormwater issue although may have some stormwater impacts or benefits.

ENV 2.2 - Outcome: Improve the quality of the Grand River and its tributaries. The Grand River is the city's single most precious natural resource. It provides a site for economic development and recreation, as well as important ecological processes that support fish populations, vegetation, wetlands, and birdlife. The Grand River and the areas surrounding it provide a natural method of stormwater containment during the spring thaw and significant rain events.

- *Target 1: Achieve 100% compliance with NPDES permit requirements annually.*
- *Target 2: Achieve water quality index of 70 or higher on Grand River annually.*
- *Target 3: Achieve 100% compliance with Stormwater Pollution Prevention Initiative (SWPPI), Public Education Program (PEP), and Illicit Discharge Elimination Program (IDEP) permits annually.*
- *Target 6: Increase the number and square footage of green roofs within the city by June 30, 2015.*
- *Target 7: Reduce stormwater discharge by at least 50,000 gallons per rain event by June 30, 2013.*
- *Target 9: At least 5% of reconstructed streets, alleys, and City parking lots to be constructed of pervious or porous pavement by June 30, 2015.*

Transformation Investment Plan

The Transformation Investment Plan (TIP) is intended to guide the City's efforts to fund the activities required to meet their numerous obligations and to provide a vibrant viable City. Future opportunities and actions undertaken, as recommended in this SWMP, are to be compatible and the TIP's tenants, especially for the Streets and Infrastructure and Transforming City Operations sections. The TIP can be found at <http://grcity.us/Transformation/Pages/Transformation-Investment-Plan.aspx> (last accessed Jan 2013).

Interim Report of the Sustainable Streets Task Force

Storm systems improvements should be considered when street upgrades occur in order to be consistent with the Sustainable Streets Task Force recommendations as well as other City policies. The Sustainable Streets Task Force made the following recommendations:

- A “window of opportunity” exists over the next four years when investment of \$1 in Heavy Maintenance/Light Rehab or Heavy Rehab will avoid a cost of \$5 – 7 in the future for more extensive (and disruptive) repairs. After 2015 street maintenance and replacement costs are anticipated to escalate exponentially because of deferred needs over time.
- Vital Streets investments should be a priority to provide accessibility to all and improve connectivity in our community. Pilot investments have demonstrated that the approach is viable, catalytic, and *sustainable*.

3. WATERSHED SUMMARY

INTRODUCTION

A number of studies have been conducted on the various subwatershed and drainage areas in the City of Grand Rapids. These studies have resulted in identification of problems, both manmade and naturally occurring. Most of these studies predate the prior SWMP, with only one study conducted subsequent to 1994. The following information provides an overview of problems identified and is important for future decision-making.

The City of Grand Rapids has been divided into watershed districts for the purpose of preparing watershed planning studies. Each of the major separate sewer districts has been studied; however, small areas on the fringes of the City limits which drain out of the City have not been studied individually. The municipal separate storm sewer system (MS4) collectively represents approximately 83 percent of the drainage area within the City. The combined sewer area was studied as part of a separate project and encompasses approximately 7.3 square miles. The watershed studies typically included developing a hydrologic and hydraulic model of the major stormwater system. These studies evaluated existing conditions and presented alternatives for problem areas.

Although the studies share many similarities, there are also a number of differences. No common study methodology or modeling technique was used. For example, the type of model selected, the level of detail considered, and the level of calibration and verification differ among all of the studies. Some studies included non-structural alternatives, but most focused only on structural alternatives to solve the identified problems. In addition, the driving force behind each study varied, and in some cases these studies focused on only specific problems.

Table 3-1 provides a summary of the subwatershed and drainage studies, when they were studied, and the project report title. In addition to studies of specific watershed districts, a drainage and erosion report was prepared for the entire city and the Grand River flood walls were studied.

Table 3-1 Summary of Watershed and Drainage Studies

Watershed District Name	Drainage Area (Acres)		Study Prepared By	Date	Report Title
	MS4	Total			
Coldbrook Creek	4,434	4,689	Fishbeck, Thompson, Carr and Huber	1985	Stormwater Management Plan for Coldbrook Creek Drainage District
Grand River	0	0	Wade Trim	1989	The Grand River Floodwall / Embankment Study
East Side Trunk	596	1,089	Black and Veatch	1990	Combined Sewer System Study
First Street	198	1,022	Black and Veatch	1990	Combined Sewer System Study
Front Street	216	360	Black and Veatch	1990	Combined Sewer System Study
Goodrich St.	46	702	Black and Veatch	1990	Combined Sewer System Study
Howland	0	183	Black and Veatch	1990	Combined Sewer System Study
Louis St.	58	376	Black and Veatch	1990	Combined Sewer System Study
Sweet	30	138	Black and Veatch	1990	Combined Sewer System Study
Valley Ave.**	1,153	1,404	Black and Veatch	1990	Combined Sewer System Study

Watershed District Name	Drainage Area (Acres)		Study Prepared By	Date	Report Title
	MS4	Total			
West Side	10	575	Black and Veatch	1990	Combined Sewer System Study
Plaster	7,668	8,441	Grand Rapids Waste Water Treatment Report	1990	Silver Creek Drain Report
Buck Creek	783	783	Camp, Dresser, and McKee	1991	Buck Creek and Plaster Creek Stormwater Management Master Plan
Plaster	7,668	8,441	Camp, Dresser, and McKee	1991	Buck Creek and Plaster Creek Stormwater Management Master Plan
Palmer	846	846	Prein and Newhof, P.C.	1992	Palmer Drain Watershed Study
Plaster	7,668	8,441	Grand Valley State University	1992	Plaster Creek Stormwater Quality Study
Comstock/Sligh	951	951	McNamee, Porter and Seeley, Inc.	1994	Grand Rapids Comprehensive Stormwater Management Master Plan
Graceland-Lacey	243	243	McNamee, Porter and Seeley, Inc.	1994	Grand Rapids Comprehensive Stormwater Management Master Plan
Hogadone	824	824	McNamee, Porter and Seeley, Inc.	1994	Grand Rapids Comprehensive Stormwater Management Master Plan
Indian Mill Creek	2,211	2,331	McNamee, Porter and Seeley, Inc.	1994	Indian Mill Creek Stormwater Management Plan
Lamberton Creek	2,465	2,465	McNamee, Porter and Seeley, Inc.	1994	Grand Rapids Comprehensive Stormwater Management Master Plan
Lamberton Creek		320	Spicer	2006	Hydraulic Analysis and Flood Plain Mapping of Lamberton Creek
Whiskey Creek		3,712	Black and Veatch	1999	Improvements to Whiskey Creek Watershed
Whiskey Creek		3,712	Black and Veatch	2004	Analysis of Whiskey Creek watershed
Totals	23,269	31,650			

MS4- Municipal Separate Storm Sewer System

SPECIAL NOTE: The City of Grand Rapids Engineering Dept. did a report titled "Drainage I Erosion Report" in 1987 that addressed drainage and erosion problems. The entire City was covered and discusses many problems that were identified in the above reports. The study was intended only as a preliminary report without in-depth study.

- Includes Silver Creek, Burton-Breton, Whiskey Creek supplemental studies.
- Only a portion of the Valley Avenue District was studied in the B&V report.

Additional information on each of the individual watersheds studies is provided in Appendix A.

BUCK CREEK WATERSHED

The Buck Creek watershed was evaluated in the 1991 report, "Buck Creek and Plaster Creek Stormwater Management Master Plan." The following summary is based on that report.

The Buck Creek watershed encompasses approximately 51 square miles, of which about 1.3 square miles lie within the City of Grand Rapids. The rest of the watershed lies within portions of the cities of

Kentwood, Wyoming, and Grandville, and the townships of Dorr, Leighton, Byron, and Gaines. The portion of Buck Creek which lies within the City of Grand Rapids consists of the north branch of the Heyboer Drain. The land use within this area is residential, commercial and industrial.

The Buck Creek problem areas identified in the Buck and Plaster Creek Stormwater Management Master Plan did not lie within the City of Grand Rapids. The problems that were identified were along the main stem of Buck Creek and not its tributaries. The City's main obligation regarding the management of the watershed is to ensure that the 104 acres available for development in the Heyboer Drain are managed so as to mitigate impacts from construction and future hydraulic modifications to the drain. There are no other recommended actions to be undertaken by the City in the plan.

COLDBROOK CREEK DISTRICT

The Coldbrook Creek watershed was evaluated in the 1994 report, "Stormwater Management Plan for Coldbrook Creek Drainage District" which was prepared for the Kent County Drain Commissioner. The following summary is based on that report.

The Coldbrook Creek watershed encompasses approximately 7,500 acres in Grand Rapids, East Grand Rapids and Grand Rapids Township. There are four main branches: Carrier, North, South, and Reeds. Land use for Coldbrook Creek within the City of Grand Rapids is primarily residential. The prominent industrial area of the watershed is located in the North Branch. The remaining watershed lies in East Grand Rapids. Reeds and Fisk Lakes are significant storage areas within this watershed. The conveyance system in Carrier and Reeds Branches are primarily enclosed storm sewers, while the North and South Branches are open channels. Wetland areas exist in the North, South and Reeds Branches.

Table 3-2 is based on the findings of the Stormwater Management Plan for Coldbrook Creek Drainage District.. The "X" in Table 2-2 indicates the storm events in which structures are predicted to be affected and their location. The approximate number of structures affected for each problem area is also given.

Table 3-2 Coldbrook Creek Modeling Results

Problem Areas	Structures Affected	Design Storm Events					
		10-year		25-year		100-year	
		Existing	Future	Existing	Future	Existing	Future
Monroe at Coldbrook	20 Businesses		X	X	X	X	X
Coldbrook St. at Clancy	1 Business 12 Multi-Family Units	X	X	X	X	X	X
Monroe at Leonard	3 Businesses 5 Residences	X	X	X	X	X	X
Michigan St.	33 Businesses 59 Residences			X	X	X	X
Hope St. at Carlton and Evangeline St. at Fuller Ave.	2 Businesses 33 Residences					X	X

The report yielded the following conclusions:

- 1) The interior surface of the reinforced concrete structures is generally smooth with the exception of erosion along the invert.
- 2) The primary source of damage to the drain and obstruction to flow is due to the cut-in for utilities and catch basins.
- 3) Deterioration to the structural integrity of the drain was evident in the following general locations:

- a) Brick and masonry sections in which mortar had been removed due to erosion.
- b) Corrosion of the reinforcing steel in the concrete structures and subsequent spalling of the interior concrete surface.
- c) Rehabilitation has since been completed for the above locations mentioned in (a) and (b).

COMSTOCK/SLIGH DISTRICT

The Comstock/Sligh District was evaluated in the 1994 report, “Grand Rapids Comprehensive Stormwater Management Master Plan” which was prepared for the City of Grand Rapids. The following summary is based on that report.

The Comstock/Sligh District encompasses approximately 831 acres in north central Grand Rapids. The area is bounded by Fuller Avenue and the Grand River to the east and west and 3 Mile Road and Graceland Street to the north and south. The land use comprises primarily single-family residential with the Comstock area being high density and the Sligh area being medium density. Other land uses include commercial, institutional and open land. The terrain is nearly level to gently rolling. The minor system in this area is composed of two main storm sewers that follow Comstock and Sligh boulevards. The Sligh storm sewer connects with the Comstock storm sewer at the intersection of Monroe Avenue and Guild Street. The area is fully developed with no major land use changes expected.

No major flooding conditions have been reported within the Comstock-Sligh watershed. Conversations with the City of Grand Rapids and review of the Complaint File Compiled by the City Engineer's office reveal no regional flooding problems. Two localized flooding problems were identified within the watershed. The City has compensated a resident at the intersection of Comstock Boulevard and Foster Avenue to assist with alleviating basement flooding from street runoff. The second area of concern was flooding at the intersection of Hollywood Street and Fuller Avenue during intense rain events. This problem was alleviated by a new storm sewer in the area. Capacity constraints were identified in the model within the Comstock-Sligh watershed. Model results revealed that the storm sewer system capacities were only sufficient for the storm between the 2- and 10-year, 1-hour events.

GRACELAND-LACEY DISTRICT

The Graceland-Lacey District was evaluated in the 1994 report, “Grand Rapids Comprehensive Stormwater Management Master Plan” which was prepared for the City of Grand Rapids. The following summary is based on that report.

The Graceland-Lacey district encompasses approximately 198 acres in northeast Grand Rapids. The watershed is bounded by Monroe Avenue and Diamond Avenue on the east and west and Eleanor Street and Knapp Street on the north and south. The minor system is composed of two storm sewers that parallel each other along Knapp Street and Graceland Street. These two sewers join approximately 600 feet east of Plainfield along Graceland Street. The system then continues the remaining distance along Graceland Street to Monroe Avenue and then to the Grand River. The terrain is nearly level to gently rolling. The land use is primarily high-density, single-family residential with some institutional, commercial, and open space. The area is fully developed with no major land use changes expected.

The report indicated that no major flooding conditions have been reported within the Graceland-Lacey watershed. Conversations with the City of Grand Rapids' officials and review of the Complaint File compiled by the City Engineer's office reveal no major problems or complaints. The only complaint recorded in the Complaint File was a resident at 1960 Meadowfield Drive N.E. who reported yard and basement flooding during intense rain events. This problem was attributed to his home lying within a natural low spot. Shortfalls were identified within the storm sewer system during modeling. Results documented in the report showed that the storm sewer system is generally sized to handle a storm less than the 2-year, 1-hour event.

GRAND RIVER DISTRICT

The Grand River District was evaluated in the 1989 report, “Grand River Floodwall/Embankment Study” which was prepared for the City of Grand Rapids. The following summary is based on that report.

The Grand River flows through the City of Grand Rapids for approximately seven miles. The banks of the Grand River are a floodwall system which is a combination of earth embankments and concrete walls. There is a total of 70,100 feet of flood wall within the City of Grand Rapids. The east bank comprises 13,300 feet of concrete walls and 26,700 feet of embankment while the west bank includes 9,100 feet of concrete walls and 21,000 feet of embankment.

Estimated average annual damages from Grand River flooding in Grand Rapids are nearly one-million dollars. The major problems with the flood-wall include erosion, lack of freeboard for the 100-year elevation, structural integrity, and outfall conditions. Thirty-eight percent of the flood wall is below the 100-year flood elevation. The freeboard for the 100-year flood elevation is below one foot for 48 percent of the floodwall and below three feet for 68 percent of the floodwall, respectively. Twenty-nine percent of the concrete walls are structurally unsound. In addition, spall and crack repairs need to be performed on 20 and 60 percent of the concrete walls, respectively. Erosion of the earth embankments is evident on fourteen percent of the structures. The final problem is 83 sewer outlets that are deficient of backflow control devices. The total cost of fixing these deficiencies in 1988 dollars was estimated at \$6.4 million. Federal funds were mentioned as a possible funding source for this project.

A follow-up report was completed by Fishbeck, Thompson, Carr & Huber, Inc. in April 1995 titled “Grand River Floodwall and Embankment Improvements Implementation Plan.” Over the following six years, millions of dollars were invested in constructing the recommended improvements.

HOGADONE CREEK

The Hogadone Creek watershed was evaluated in the 1994 report, “Grand Rapids Comprehensive Stormwater Management Master Plan” which was prepared for the City of Grand Rapids. The following summary is based on that report.

The Hogadone Creek watershed encompasses approximately 1,400 acres and is located in the southwest corner of the City of Grand Rapids and the southeast portion of the City of Walker. The headwaters begin approximately 700 feet north of Seventh Street. The watershed continues south for three miles where it empties into the Grand River with an average width of approximately 0.8 miles. The land use of this area is primarily medium- to high-density residential with some institutional in the upper portions of the watershed with mainly agriculture, wetlands, forested, non-forested, industrial and extraction in the lower portions. The terrain is nearly level to gently rolling in the upper portions of the watershed and changes to rolling or strongly sloping in the lower sections. The main drainage of Hogadone Creek is primarily open channel with some enclosed sections. Several tributary storm systems enter the main drainage with the largest being from the Edison Park Sub-district. Mining exists in the watershed with Domtar Mines discharging flows into the system daily. Future development in the watershed was expected in the City of Grand Rapids south of Sterner Street to the City of (Grand Rapids/City of Walker border and north of Valley Forge Drive.

Several problems have been identified in the Hogadone Watershed through the review of the City's Drainage and Erosion Report and Complaint File compiled by the City Engineer's office. The first problem area is the Edison Park Subdistrict along with a portion of Lake Michigan Drive. The area experiences flooding of streets, the Holy Spirit Church, and portions of Grosse Point Estates. A study was performed by Vander Horst and Associates for this area and a plan was developed to rectify the situation. Construction began during the summer of 1993. The other problem area occurs upstream of Lake Michigan Drive along Oakleigh where the drainage behind homes overflows and floods yards. Basement flooding within this area during 1988 was noted from discussions with local residents during the

Stormwater Management Master Plan. High water velocities were noted in the channel downstream at Lake Michigan Drive during the monitoring program.

INDIAN MILL CREEK

The Indian Mill Creek watershed was evaluated in the 1994 report, “Indian Mill Creek Stormwater Management Plan” which was prepared for Alpine Charter Township, the City of Grand Rapids and the City of Walker. The following summary is based on that report.

The Indian Mill Creek Watershed encompasses approximately seventeen square miles in Kent County, Michigan. The watershed includes portions of Alpine Township, the City of Walker and the City of Grand Rapids. The main stem of Indian Mill Creek follows the northwest border of the City of Grand Rapids until it enters Grand Rapids and discharges south of Ann Street into the Grand River. The other portion of the Indian Mill Creek watershed which lies within the city limits is a tributary to Brandywine Creek, which converges with Indian Mill Creek upstream of Walker Avenue. The land use in the downstream portions of the main stem are composed of medium- to high-density residential, industrial and commercial areas while the Brandywine Creek area land use is composed of medium- to low-density residential with notable wetland and open space regions.

The Indian Mill Creek Watershed does not experience large-scale flooding problems compared with other watersheds of this size. McNamee, Porter and Seeley, Inc., however, identified several areas of concern within the watershed. The first area of concern lies within the Brandywine Creek Watershed. Modeling identified flooding problems upstream of Remembrance Road for the 10- and 100-year storm events. The other area of major importance within the City of Grand Rapids is the area from Garfield Avenue to the Grand River. Modeling results identified the potential for extensive flooding of this area for the 10- and 100-year storm events. Historically, the area from Garfield Avenue to the Grand River has experienced flooding problems as noted in the City of Grand Rapids Drainage and Erosion Report.

LAMBERTON CREEK

The Lamberton Creek watershed was evaluated in the 1994 report, “Grand Rapids Comprehensive Stormwater Management Master Plan” and the 2006 report, “Hydraulic Analysis and Flood Plain Mapping of Lamberton Creek.” The following summary is based on that report.

The Lamberton Creek Watershed is located in the northeast corner of the City of Grand Rapids, and Grand Rapids and Plainfield Townships. The watershed encompasses 4,100 acres and comprises several land uses. Medium- to high-density residential along with institutional and commercial occupy the downstream reaches of the watershed. The southern and eastern parts of the watershed comprise a combination of low-density residential, water, wetlands, forested areas, and agriculture. The northern sections include medium- to high-density residential with commercial and water. The basin is divided into four sub-basins: Wells and Plainfield occupy the north followed by the East and South branches. The terrain is level to gently rolling in the downstream areas and changes to rolling, undulating in the upstream sections. The drainage of Lamberton Creek is open channel. Several lakes, reservoirs and wetlands provide important retention throughout the watershed. The development of this watershed is expected in future years according to the City of Grand Rapids Planning Department's 1984 Land Use Plan.

No major watershed problems have been noted through the City's Complaint File compiled by the City Engineer's office. The problems that were identified included street flooding on Donol Street east of Fuller, and at the intersection of Knapp Street and Ball Avenue; erosion of property near Shadyside Drive and Lamberton Lake Drive, Leffingwell Avenue and Bradford Street, and Banbury Avenue and Ridgefield Street; and minor yard flooding near Chelsea Road and Ridgefield Street, and Rickman Avenue and North Park Street.

PALMER STREET DISTRICT

The Palmer Street drainage district was evaluated in the 1992 report, “Palmer Drain Watershed Study” which was prepared for the City of Grand Rapids. The following summary is based on that report.

The Palmer Street drainage district encompasses 911 acres composed primarily of single-family residential housing of medium density. This district is part of the older portion of Grand Rapids. Light commercial establishments exist on the major streets in the form of general stores and gas stations. Light industrial areas are present near the Grand River and in the southern portion of the watershed. The primary conveyance system is composed of enclosed storm sewers, except for one portion of open channel through the Kent County Country Club.

Previously known problems of the watershed, before the study was commissioned, include flooding of the country club along the swale passing through the golf course and on the west side next to the intersection of Dean Street and Plainfield Avenue, and localized street, yard and some basement flooding upstream of the country club. Underneath the swale passing through the golf course is a 15-inch storm sewer. The flooding locations upstream of the country club are Country Club Dr. and West Lane; Country Club Dr. and Sweet St.; Diamond Ave. and Sweet St.; and Herrick Ave north of Burke St.

According to the Storm Water Management Model (SWMM), the conveyance system upstream of the golf course has sufficient capacity for approximately the one-year storm. In addition, the country club experiences flooding yearly due to the undersized 15-inch storm sewer. No problems have been reported downstream of the country club, but the model reported that a 25-year storm would cause some local street flooding at Elmwood St. and Center Ave.

PLASTER CREEK DISTRICT

The Plaster Creek district was evaluated in the 1991 report, “Buck Creek and Plaster Creek Stormwater Management Master Plan” and the 1992 report “Plaster Creek Stormwater Quality Study.” The following summary is based on that report.

The Plaster Creek watershed encompasses approximately sixty square miles, thirteen of which lie within the City of Grand Rapids. The rest of the watershed includes portions of Kentwood, Wyoming, East Grand Rapids, Grand Rapids Township, Ada Township, Gaines Township, and Cascade Township. There are three main tributaries to Plaster Creek in Grand Rapids that have been individually studied: Burton-Breton, Silver Creek and Whiskey Creek. The watershed land use within Grand Rapids includes primarily industrial and commercial in the lower portion and commercial and residential in the middle and upper sections. Vertical drop along the main stem up to 44th street is approximately 106 feet. Some wetlands do exist within Grand Rapids; however, the majority are outside the city limits. Areas of the watershed developed before the 1970's have minimal detention with the exception of the Whiskey Creek Watershed.

There are no major flooding problems along the main stem of Plaster Creek through Grand Rapids. Most of the flooding that previously existed has been rectified through the construction of new bridges. The remaining minor flooding that occurs along the main stem does not affect a large amount of properties. Erosion problems along the main stem are occurring within the Ken-O-Sha Park area. The major problems that are present in the Plaster Creek watershed are within the tributaries of Silver Creek, Burton-Breton Branch, and Whiskey Creek. These will be addressed in following sections.

BURTON-BRETON BRANCH OF PLASTER CREEK

The Burton-Breton Branch of Plaster Creek was evaluated in the 1991 report, “Buck Creek and Plaster Creek Stormwater Management Master Plan” and the 1992 report, “Plaster Creek Stormwater Quality Study” which were prepared for the City of Grand Rapids. The following summary is based on that report.

The Burton-Breton watershed is a sub-basin of the Plaster Creek watershed. This watershed drains approximately 1,290 acres in southeast Grand Rapids and a small portion of southern East Grand Rapids. The vertical drop of the watershed is approximately eighty-five feet in its two-mile length. The watershed is characterized by a number of steep-sloped channels in areas of steep ravines. A few natural ponding areas exist within the watershed along with a recently built detention facility. The land use of this basin is largely residential with a mixture of some commercial and light industrial areas.

Flooding in the Burton-Breton branch occurs in three main areas: Annchester Drive-Okemos Drive, and Indian Trails Golf Course. The 10-year event causes flooding at Annchester and Indian Trails Golf Course. In addition to those previously mentioned, the 25-year event causes flooding to occur at Okemos Drive. The 100-year event causes problems for all these areas with increased damage. Erosion is a concern throughout the watershed due to steep slopes and high velocities. One area of specific concern is the reach downstream of 28th street. Two additional areas of concern are upstream of Okemos and Annchester Drives.

SILVER CREEK BRANCH OF PLASTER CREEK

The Silver Creek Branch of Plaster Creek was evaluated in the 1990 report, "Silver Creek Drain Report." The following summary is based on that report.

The Silver Creek watershed is a sub-basin of the Plaster Creek Watershed. This watershed drains approximately 3,160 acres on the south side of Grand Rapids. The vertical drop of the watershed is approximately one hundred and sixty feet. The primary drain for Silver Creek is an enclosed sewer. The land use consists of residential in the upper reaches, and light industrial, commercial, and residential in the middle and lower reaches. The upper portions of this watershed include parts of East Grand Rapids. The northern boundary of this watershed includes areas of combined systems.

There are four main areas of flooding along the Silver Creek Drain. The first area is in the northern section of the watershed and is located south of Franklin Street between Fuller Avenue and Eastern Avenue. Since this area is a combined area, it was not evaluated; however, this area does experience water backing up into streets and basements during intense rain events. However, since 1987 no basement flooding has been reported. The second and third areas of concern are along the main Silver Creek Drain from Kalamazoo Avenue and Ramona Street downstream to Eastern Avenue and along Crofton Street between Madison Avenue and Division Avenue, respectively. Both of these areas experience chronic flooding due to hydraulic overload problems in the drain. The fourth problem area exists in the lower section of the watershed and is described as the "Roosevelt Park Neighborhood." The flooding problems in this area include streets and homes.

WHISKEY CREEK BRANCH OF PLASTER CREEK

The Whiskey Creek Branch of Plaster Creek was evaluated in the 1999 report, "Improvements to Whiskey Creek Watershed" and the 2004 report, "Analysis of Whiskey Creek Watershed." The following summary is based on that report.

The Whiskey Creek watershed is a sub-basin of the Plaster Creek Watershed. This watershed drains approximately 1,240 acres in southeast Grand Rapids and northern Kentwood. The vertical drop of the watershed is approximately seventy-five feet. The watershed is characterized by open channel and seven man-made ponds / detention areas. A small area of wetlands exists on the Calvin College premises and is not planned to be developed. Land use is primarily residential, multi-family residential, and institutional with some commercial.

Black and Veatch identified several flooding problem areas throughout the Whiskey Creek Watershed; however, the frequency of these problems was not given. The following is a listing of the problem areas and the type of flooding that is occurring.

The hydraulic model results for existing condition show the following:

- 1) The 100-year flood elevation at Lake Eastbrook of 738.14-ft exceeds the 737.50-ft elevation established by MDNR.
- 2) The 100-year flood flow through the outfall weir is 471 cfs. Conveyance system downstream from the weir (up to 28th Street) has flow capacity of 640 cfs. Hence the downstream system can convey the 100-year flood flow. Please note that downstream of 28th Street to Plaster Creek, flood flows are documented in Flood Hazard Analyses Report for Plaster Creek.
- 3) Head loss through the culvert is quite excessive. For example, the culvert causes 3.03 feet rise in N. Lake Eastbrook level for the 100-year storm event.
- 4) Water level at 2041 Raybrook Avenue of 758.38-ft greatly exceeds the 754.0-ft elevation of the office building entrance door. The high flood elevation is partly due to inadequate detention storage being provided in the upstream 171 acre drainage area. Upstream area is served by 42-inch and 30-inch storm sewer at Burton Street/Morning Side.
- 5) Many of the commercial and residential buildings were constructed below the 100-year flood elevation.

4. ASSET MANAGEMENT AND CAPITAL IMPROVEMENTS

DRAINAGE SYSTEM ASSETS

The stormwater drainage system is comprised of both manmade and natural systems, and includes both conveyance and storage components. The following list describes the various components that make up the drainage system:

- Pipes – gravity sewers and service laterals connecting to the catch basin inlets
- Structures
 - inlets such as catch basins which collect water from surface features (for example roads and parking lots) and convey it to an underground drainage system
 - outlets which are located at points where the underground drainage system discharges to open channels or other waterbodies and commonly include flared end sections, grates, and gates
 - junction chambers, such as manholes, which connect various parts of the underground drainage system together
- Culverts and bridges connecting open channel sections typically under roadways
- Open channels and roadside ditches
- Storage basins including detention and retention basins
- Pump stations and the pressurized pipes downstream of the pump stations
- Green infrastructure practices such as bioretention, pervious pavement and water harvesting systems

This stormwater master plan does not address riverine flood control components or issues. Assets commonly associated with river flood control include floodwalls, berms, levees, dams, and backflow preventers.

The City's stormwater system is typical of most large city systems in that about 40 to 45 percent of the system is over 50 years old or about half of the life expectancy for most of the manmade structures (based on the assumption that the average life of sewer is 100 years). Table 4-1 provides a summary of the system components.

Table 4-1 Stormwater Summary

System Component	Quantity
Gravity Mains	2,030,660 feet
Manholes	10,748 each
Laterals	514,583 feet
Catch Basins	17,054 each
Pressurized Mains	664 feet
Siphons	339 feet
Stream Crossings / Culverts	3,600 feet
Outfalls	356 each
Open Channels	39.6 mile
Ditches	72 mile
Detention Basins	5 each
Pump Stations	11 each
Green Infrastructure	13 each

The information presented below expounds on some of the asset groups. More detailed information is provided in the Asset Management Plan.

Open Channels and Roadside Ditches

There are a total of 39.6 miles of open channels identified in the City's Geographic Information System (GIS). There are additional open channels not included in this analysis which are under the jurisdiction of either the Kent County Drain Commissioner or the Michigan Department of Transportation.

In addition to the open channels, there are also roadside ditches used for stormwater drainage. Typical maintenance issues with roadside ditches include excessive vegetation, sediment accumulation, bank erosion, and debris accumulation. Shallow roadside ditches in residential areas also commonly have driveway culverts which can become buried and plugged if not maintained.

Stream Crossings

Stream crossings are structures that occur at the intersection of streams with roads and railroads. Due to the width of the stream and the potential for flooding (i.e. large upstream drainage area), some crossings only require culverts while other crossings would require full bridge structures. Often the responsibility of the crossing is correlated with the ownership of the road or railroad.

Detention and Retention Basins

The City has five detention basins under its jurisdiction. Many other basins within the city are privately owned or are the responsibility of the County Drain Office. The five City basins include:

- Woodlawn detention basin (1999)
- Kreiser Street detention basin (1993)
- Calvin Avenue detention basin (1994)
- Otsego detention basin (1995)
- Corduroy detention basin (1994)

Pump Stations

The City owns and operates a total of 11 stormwater pumping stations. The eight stations listed below are used during a major rainfall event to pump stormwater to the Grand River during periods where the river level is too high to allow free gravity discharge.

- Caledonia (1999)
- Palmer (1999)
- Indian Mill Creek (1999)
- Market Ave (2008)
- Wealthy (1996)
- Front/Scribner (1991)
- Ken-O-Sha (2006)
- Academy (2000), owned by the Kent County Drain Commissioner (KCDC) and maintained by the City.

These lift stations are critical components in that they provide flood relief in the system during high river levels so reliable operation is essential.

The remaining stormwater pump stations (Alpine (1973), MARB (1995) and Albany (2000)) are in operation regardless of the river level and are used to convey flows to nearby gravity systems for sites and areas that lack adequate grade for gravity drainage.

Green Infrastructure

The City has recently begun implementing green infrastructure as part of their stormwater system, and is poised to increase installations as part of the overall City Sustainability Plan. Green infrastructure is

designed to help reduce the volume of stormwater runoff and improve the quality of the water discharged to surface waters. A list of the green infrastructure projects within the City limits is provided in Table 4-2.

Table 4-2 Green Infrastructure Inventory

Green Infrastructure Project Name	Owner	Date Installed	Type
Environmental Services Engineering Parking Lot	City	3/1/2004	Permeable Pavement
Broadway Alley	City	2001	Permeable Pavement
Commerce Avenue Alley	City	Unknown	Permeable Pavement
Division Avenue Alley	City	Unknown	Permeable Pavement
Horton Avenue	City	Unknown	Permeable Pavement
Grand Rapids Community College	City	Unknown	Permeable Pavement
Leonard Street	City	Unknown	Hydrodynamic Device
Joe Taylor Park	City	10/1/2010	Subsurface Storage System
Rosalie Avenue	City	Unknown	Infiltration Swale; Hydrodynamic Device
Darwin Avenue	City	2011	Infiltration Basin
Amtrak Parking Lot	City	Unknown	Rain Garden; Permeable Pavement
River of Stars	City	9/1/2002	Rain Garden
Potters House School Rain Garden	City	5/1/2011	Rain Garden
River of Dreams	City	6/1/2008	Rain Garden
Grand Rapids Wastewater Treatment Plant	City	Unknown	Rain Garden; Native Landscaping
Turner Gateway	City	Unknown	Rain Garden; Native Landscaping
Roosevelt Park Riparian planting	City	4/1/2011	Naturalized Landscape
Grand Rapids Ballet	West MI Center for Arts and Technology	2007	Green Roof
Burton Street School		2008	Green Roof
Cathedral Square		2008	Green Roof
Grand Valley State University Mackinac Hall	Grand Valley State University	2008	Green Roof
Hauerstein Center at St. Mary's Hospital		2008	Green Roof
John Ball Park Zoo – Lion Exhibit	John Ball Park Zoo	2008	Green Roof

Green Infrastructure Project Name	Owner	Date Installed	Type
John Ball Park Zoo – Ape House	John Ball Park Zoo	2008	Green Roof
The Rapid (Interurban Transit Partnership)		2008	Green Roof
Van Andel Institute Expansion	Van Andel Institute	2009	Green Roof
Cesar E Chavez Elementary		2009	Green Roof
Grand Rapids Community College	GR Community College	2009	Green Roof
True North		2010	Green Roof
Druke Building		2010	Green Roof
The Rapid Garage Entry		2010	Green Roof
Western Commerce Parking Garage		2010	Green Roof
John Ball Park Zoo – Chimpanzee Exhibit	John Ball Park Zoo	2011	Green Roof
Spectrum Health Blodgett East Healing Garden		2011	Green Roof
The Rapid Bus Garage		2011	Green Roof
School of Grand Rapids Ballet Company		Unknown	Green Roof; Permeable Pavement
Mid Towne Village Subsurface Storage	Mid Towne Village, LLC	8/1/2010	Subsurface Storage System
Mid Towne Village Subsurface Storage	Mid Towne Village, LLC	8/1/2010	Subsurface Storage System
Fredrick Meijer Gardens and Sculpture Park	Frederick Meijer	1994	Rain Garden; Stormwater Wetland
East Hills Center		2005	Rain Garden; Green Roof
Fairmont Square		2007	Rain Garden; Stormwater Reuse; Permeable Pavement
GRCHS Rain Garden and Butterfly Garden	Grand Rapids Christian High School	5/1/2008	Rain Garden
DeVries Hall rain garden	Calvin College	5/1/2007	Rain Garden
Rain Garden at Christian Reformed Church Headquarters	Christian Reformed Church	10/1/2010	Rain Garden
Sylvan Learning Center		2005	Rain Garden
Hispanic Center of Western Michigan		2006	Rain Garden
Aquinata Hall, Dominican Center at Marywood		2004	Naturalized Landscape; Rain Garden
Native gardens and walking paths at Christian Reformed Church Headquarters	Christian Reformed Church	6/1/2012	Naturalized Landscape
Tree Planting at Christian Reformed Church Headquarters	Christian Reformed Church	7/1/2011	Naturalized Landscape

Combined Sewer Areas

Between 1991 and 1999 the City's west side sub-system combined sewer system (3.1 square miles) was separated at a cost of \$160M. Currently sewer separation in the City's east side sub-system combined sewer system (3.4 square miles) is underway. Expenditures to date are just over \$100M with \$20M in construction costs remaining. The East Side sub-system consists of approximately 23.8 square miles of sewer service area of which 21.0 square miles is a completely separated sanitary sewer system and the remaining approximately 2.8 square miles is a combined sewer system. The East Side sub-system includes the following areas:

- City of Grand Rapids (east and northeast portions of the City)
- The majority of Grand Rapids Charter Township (Customer Community)

The combined sewer portion of this subsystem is completely within the City of Grand Rapids and includes five (5) remaining in-system overflows. The City embarked on the East Side Sewer Improvements Program in 2001. The City's NPDES Permit mandates elimination of the remaining CSO outfalls by year end 2019. The sewer separation improvements include constructing new storm sewers and discharging that stormwater to the Grand River. The existing combined sewers will become sanitary sewers and will be rehabilitated or replaced as necessary. The combined sewer separation leading to outfall elimination is ongoing through 2019. The City plans to continue separating any remaining combined sewers following 2019 under its street reconstruction program.

Since combined sewers are considered part of the sanitary system replacement costs were not considered as part of the stormwater system. The sewer separation efforts have created extensive additional storm sewer assets that will need to be maintained.

ASSET MANAGEMENT

A 20-year citywide asset management plan was developed for the public stormwater infrastructure system. The plan demonstrates how the City's goal of establishing and delivering certain levels of service may be achieved through effective and sustainable management of the stormwater system. Having developed a proactive long-term plan to stormwater asset management, the City will have a sustainable system ensuring the well-being of the community, environment and future generations. The details of the plan are provided in the Stormwater Asset Management and Capital Improvement Plan (2013).

The general scope of the asset management plan consists of three major items:

- Assessment of the existing stormwater assets
- Evaluation of levels of service the stormwater asset will meet
- Summary of efforts necessary to meet the desired level of service

Following the completion of these items, a Capital Improvement Plan was developed which provides an additional level of detail for projects and activities required to meet the level of service identified in this report.

The current value of the stormwater drainage system is estimated at \$529 million. Ninety-five percent (95%) of the current investment in the drainage system is represented by the separate storm sewers, manholes and catch basins. The remaining five percent (5%) is attributable to the pump stations, force mains, siphons, culverts, basins and green infrastructure components. Table 4-3 summarizes the quantity and baseline costs of each stormwater asset. Many of the open channels are considered to be Waters of the State of Michigan and are under the jurisdiction of the Michigan Department of Environmental Quality as well as the Army Corp of Engineers. A baseline system value (current cost) is not listed for open channels based on the complexity of estimating the construction costs and because in most cases the channel was not manmade.

Table 4-3 Asset Summary and Cost

System Component	Quantity (unit)	Baseline System Value (Current Cost)	Baseline Future System Cost (Replacement Cost at Failure)
Gravity Mains	2,030,660 feet	\$365,757,000	\$933,842,000
Manholes	10,748 each	\$39,051,000	\$105,349,000
Laterals	514,583 feet	\$43,065,000	\$113,942,000
Catch Basins	17,054 each	\$55,910,000	\$136,594,000
Pressurized Mains	664 feet	\$131,000	\$505,000
Siphons	339 feet	\$250,000	\$618,000
Culverts	3,600 feet	\$1,649,000	\$3,530,000
Outfalls	356 each	\$1,669,000	\$3,530,000
Open Channels	39.6 mile	NA	\$2,570,000
Ditches	72 mile	\$5,703,000	\$1,223,000
Detention Basins	5 each	\$1,725,000	\$4,614,000
Pump Stations	11 each	\$12,051,000	\$26,236,000
Green Infrastructure	13 each	\$1,842,000	\$8,451,000
Integrated System Total		\$528,803,000	\$1,341,004,000

The asset model developed under the Asset Management Plan is primarily an age-based system when evaluating the risk and consequence of failure. The intent is to transition the model from an age-based system to a condition based system as additional investigation and assessment information is collected.

A major factor in the quality of community life is the quality of the community’s facilities, services and amenities. Level of service (LOS) is a measure of the amount and/or quality of the public facility which must be provided to meet that community’s basic needs and expectations. It is a reflection of the performance and reliability of the system. Increasing the reliability and performance presumes a greater level of investment. Three levels of service (LOS) beyond the existing operating procedures were analyzed. Each LOS is correlated to specific investments established for each asset group found in the system and are briefly summarized below.

- Level of Service A. Assumes complete system replacement at the end of the assets estimated effective life (100-years for sewers and manholes); a 10-year cycle for full system assessment; corrective maintenance on 50 percent of assets currently beyond their effective life; preventative maintenance on 10 percent of inspected assets; and 30 percent of the capital investment is attributed to green infrastructure practices.
- Level of Service B. Assumes extending the effective life of infrastructure by 50 percent through rehabilitation methods before complete system replacement (125-years for sewers and manholes); a 10-year cycle for system assessment on infrastructure over 50-years old; corrective maintenance on 30 percent of assets currently beyond their effective life; preventative maintenance on 10 percent of inspected assets; and 20 percent of the capital investment is attributed to green infrastructure practices.
- Level of Service C. Assumes doubling the effective life of infrastructure through rehabilitation methods before complete system replacement (150-years for sewers and manholes); a 10-year cycle for system assessment on infrastructure over 75-years old; corrective maintenance on 15 percent of assets currently beyond their effective life; preventative maintenance on 10 percent of inspected assets; and 10 percent of the capital investment is attributed to green infrastructure practices.

These criteria are based on standardized best practices that have been established by other municipalities, and were designed to meet regulatory requirements, goals for renewal, and operations and maintenance. It has yet to be tested and proven whether doubling the life expectancy of infrastructure can actually occur. Table 4-4 summarizes the annual funding requirements necessary to meet each level of service.

Table 4-4 Level of Service Funding Requirements

Level of Service	Annual Funding Requirement
A	\$22,868,000
B	\$14,726,000
C	\$10,377,000
Existing	\$3,597,000

CAPITAL IMPROVEMENTS

A 20-year capital improvement plan was developed using an assumed Level of Service B annual funding. The capital plan provides recommendations of priority areas where the funding should be spent on stormwater infrastructure over the next 20 years. The priority areas are based on a risk exposure analysis. Capital stormwater expenditures were aligned with planned spending by other City departments in order to maximize the City's investment dollars. The capital improvement plan is detailed in the Stormwater Asset Management and Capital Improvement Plan (2013).

5. STORMWATER ACTIVITIES

The City has committed to a triple bottom line approach to developing municipal services, which considers economic, environmental, and social criteria. Best practices and project opportunities within the stormwater system are identified to coordinate with the City's Sustainability Plan now and in the future.

MS4 NPDES PERMIT

The Lower Grand River Watershed Management Plan (LGRWMP) was 319 approved (2004) by MDEQ and the U.S. Environmental Protection Agency (USEPA) in August 2011. This plan was developed in-part to address deficiencies in the previous program outlined in a December 29, 2011 letter to all permittees. A 319 approved plan must meet stringent requirements composed of nine measures that must be met, including the setting of current pollutant load levels and the required reductions necessary to achieve ambient water quality standards. The WMP also includes objectives and actions that are relevant to the approved Total Maximum Daily Loads (TMDLs) within the watershed, listed in Table 2-1.

The Stormwater Pollution Prevention Initiative (SWPPI) includes commitments to address the objectives from the WMP that will mitigate impacts caused by stormwater runoff. These objectives are identified in Table 5-1 and include those that address the approved TMDLs and other water quality conditions within the Lower Grand River Watershed (LGRW) that may be affected by stormwater. Actions have been developed to meet each of these objectives and measurable milestones. The measureable milestones from the WMP are for one to five years and are to be used as a guide by the City to measure effectiveness of their commitments. Included are the public education categories so that activities that also meet these objectives and have evaluation measures are cross referenced. The complete details of the program are available in the LGRWMP.

Table 5-1 WMP Objectives and Measurable Milestones

Objectives from the 2012 WMP	Public Education Plan (PEP) Topics Considered for SWPPI Commitments (Specific activities identified in PEP)	WMP Measurable Milestones Considered for SWPPI Measures of Effectiveness
Encourage proper septic tank management	Public Education Topic No. 3 - Public Reporting of Illicit Discharges	<ul style="list-style-type: none"> • Number of septic systems repaired or replaced • Number of septic systems inspected • Number of identified and corrected illicit connections found in future Nonpoint Source (NPS) inspections • Number of identified areas needing cluster septic systems
Encourage septage ordinance	Not Applicable	<ul style="list-style-type: none"> • Development of draft septage ordinance
Implement vegetative buffering practices and restore and protect the stream buffer and canopy	Public Education Topic No. 6 - Management of Riparian Lands	<ul style="list-style-type: none"> • Miles of buffer/filter strips installed • Number of native plantings • Acres of riparian acres preserved • Number of people trained on the use of native vegetation • Number of people trained on reduced mowing • Adoption of buffer ordinances adopted by GR • Acres enrolled in conservation easements

Objectives from the 2012 WMP	Public Education Plan (PEP) Topics Considered for SWPPI Commitments (Specific activities identified in PEP)	WMP Measurable Milestones Considered for SWPPI Measures of Effectiveness
Implement Michigan Department of Natural Resources (MDNR) wildlife population management practices	Public Education Topic No. 4 - Personal Actions that can Impact the Watershed	<ul style="list-style-type: none"> • Number of problem sites identified through inventories of subwatersheds where control of geese and other wildlife populations is needed
Implement sanitary sewer maintenance practices	N/A	<ul style="list-style-type: none"> • Miles of sanitary sewer system repaired
Implement Low Impact Development (LID) practices to reduce imperviousness and increase infiltration	Public Education Topic No. 2 - Ultimate Stormwater Discharge Location and Potential Impacts	<ul style="list-style-type: none"> • Number of rain gardens installed • Number of rain barrels installed • Number of vegetated roofs installed • Acres of grassed waterways installed • Number of infiltration BMPs installed • Number of sites using pervious pavement
Implement watershed focused land-use planning	N/A	<ul style="list-style-type: none"> • To be determined
Implement proper soil erosion and sedimentation control techniques	N/A	<ul style="list-style-type: none"> • Number of construction sites inspected • Documentation of coordination with site manager so no Soil Erosion and Sedimentation Control (SESC) violations are issued
Implement channel and streambank stabilization, bio-engineering, and erosion control techniques	Public Education Topic No. 6 - Management of Riparian Lands	<ul style="list-style-type: none"> • Development of LID stormwater criteria in counties where none exists • Feet of streambank and shoreline protection at streambank erosion sites identified in NPS inventories • Completion of hydrologic and morphologic studies for 2 watershed management units • Adoption and implementation of watershed protection ordinances for communities in the watershed • Feet of channel restoration needed in critical areas in the watershed • Acres of buffer/filter strips installed using native plantings • Acres of riparian forest buffer installed • Number of people trained on the use of native vegetation • Number of people trained on reduced mowing
Implement turf management and proper fertilizer application practices	Public Education Topic No. 4 - Personal Actions that can Impact the Watershed	<ul style="list-style-type: none"> • Number of people trained on turf management practices • Number of training sessions on proper storage and disposal of chemicals and other Operations and Maintenance (O&M) materials

Other actions in the WMP, such as those directed to manage invasive species that do not directly relate to the operation and management of the storm sewer system are also not included in Table 5-1, but could be included in part of a permittees' overall stormwater management program.

ILLICIT DISCHARGE ELIMINATION PROGRAM

The City of Grand Rapids, along with all the other MS4 communities in the LGRW commit to implement and enforce a program to detect and eliminate illicit connections and discharges to MS4s. The IDEP was approved in 2003 and will be implemented until revised. The participating communities, including the City of Grand Rapids, are awaiting MDEQ approval of the 2013 IDEP.

The City adopted an ordinance in 2001 (and updated in 2007) to effectively prohibit illicit discharges into its MS4. The ordinance regulates the contribution of pollutants to the MS4, owned or operated by the City and prohibits illicit discharges, including the direct dumping or disposal of materials, into the MS4. It also establishes the authority to investigate, inspect, and monitor suspected illicit discharges into its MS4, as well as requires elimination of illicit discharges and connections.

EMPLOYEE/CONTRACTOR TRAINING

The City of Grand Rapids, along with the other communities in the LGRW ensure that training for staff and contractors associated with potential stormwater pollutant sources is part of their everyday activities. The procedures use Best Management Practice (BMP) guidance and training materials that are available from federal, state, or local agencies, or other organizations. Additional training topics are included to address more than pollution prevention & good housekeeping, such as construction site stormwater runoff, gravel road maintenance, LID, Illicit Discharge Elimination Plan (IDEP), and general stormwater education. The Municipal Training Committee prioritizes the training, identifies additional training opportunities, and organizes the activities to create a more robust training program to meet permit requirements.

CONSTRUCTION STORMWATER RUNOFF CONTROL

The MDEQ has determined that Part 91 of the Michigan Act and Michigan's Permit by Rule (Rule 323.2190) programs are "qualifying local programs" for the control of wet weather discharges from construction activities that result in a land disturbance of greater than or equal to one acre, or disturb less than one acre that is part of a larger common plan of development or sale. A "qualifying local program" provides control for soil erosion, offsite sedimentation, and other construction-related wastes, consistent with Federal stormwater control requirements for MS4 permittees. The Environmental Services Department is qualified as both an Authorized Public Agency (APA) and as a Municipal Enforcing Agency (MEA). The existing regulatory mechanisms for the City of Grand Rapids are Ordinance No. 2001-26, § 1 (July 21, 2001) and Ordinance No. 2007-13, § 1 (February 20, 2007).

POST-CONSTRUCTION STORMWATER CONTROLS

The City of Grand Rapids, along with the other permittees in the LGRW address post-construction stormwater runoff with controls on areas of new development and significant redevelopment that disturb one (1) acre or more, including projects less than one (1) acre that are part of a larger common plan of development or sale that discharge into a drainage system. The goal of this regulatory mechanism is to protect the designated uses in the receiving water from common impacts associated with urbanization.

The post-construction stormwater control measures ensure the BMPs for stormwater controls are being designed in the planning stages of developments. These can be vegetative, structural, or managerial BMPs that work together with regulatory mechanisms to prevent or minimize impacts on water quality.

Other regulatory mechanisms work with the stormwater controls to minimize impacts, such as Natural Features Inventories (NFI), wetlands ordinances, open space requirements, required reduction in volume of stormwater discharge, and urban growth boundaries.

Long-term O&M of the post-construction stormwater controls is also necessary to retain the desired level of water quality protection over time. The existing regulatory mechanisms for the City of Grand Rapids

are Ordinance No. 2001-26, § 1 (July 21, 2001) and Ordinance No. 2007-13, § 1 (February 20, 2007). Specifics can be found in Appendix 2E of the SWPPI.

DOWNSPOUT DISCONNECTION

The City completed a pilot downspout removal program in the Lewison/Carlton Area (568 homes) and Lafayette/Coldbrook Area (38 homes). This program consisted of investigating plumbing systems, determining corrective actions, implementing corrective actions, public education and participation. The positive results of the pilot program resulted in the release of a request for proposal by the City for similar work to be conducted in the East Leonard Heights and Maryland Estates neighborhoods in 2011 for the next Phase of the program. Systematic continuation of this program throughout the City will be conducted until all neighborhoods have been addressed is the goal.

FOOTING DRAIN DISCONNECTION PROGRAM (FDDP) – PUBLIC PORTION

The first portion of the next phase of this program included the installation of added stormwater infrastructure in the East Leonard Heights and Maryland Estates neighborhoods. Most of the added infrastructure was located in the right of way, following the curb line. This “behind the curb” piping was routed to the existing stormwater infrastructure and would pave the way for footing drain discharges to be rerouted from the sanitary sewer system to the stormwater system. Major modifications to the stormwater system in the Maryland Estates Target Area would be warranted for proper flow distribution.

FOOTING DRAIN DISCONNECTION PROGRAM (FDDP) – PRIVATE PORTION

In September of 2010, Article 12 “Footing Drain Disconnection Program” was added to Chapter 27, “City Sewage Disposal System” of the code of the City of Grand Rapids. This language was used as a basis for the workflow and design of the private portion of this program to eliminate illicit discharge of stormwater and groundwater into the sanitary sewer system and redirecting these flows into the enhanced stormwater system. The City utilized States Revolving Loans as an initial funding source for the inspections of plumbing systems and subsequent corrective actions that were needed to appropriately redirect discharges.

In August of 2011, following the completion of the public portion of the FDDP, the private portion of the FDDP in the East Leonard Heights (ELH) Target Area (438 homes) was able to proceed. The private portion of the FDDP work in the Maryland Estates (ME) Target Area (326 homes) began in October of 2012 following the completion of the public portion of the FDDP and stormwater system upgrades that were necessary to accommodate the influx of stormwater discharges. Each home in the Target Areas, as designated by the City Manager, is required to be inspected for illicit discharges to the sanitary sewer system by a plumbing contractor that is pre-qualified to perform inspections and subsequent disconnection work per the guidelines of the program.

Homes that are within a designated Target Area and do not participate in the FDDP by (1) not being inspected by a qualified contractor as part of the program or (2) not redirecting stormwater and/or groundwater discharges that are routed to the sanitary sewer system will be billed for the treatment of those illicit discharges at the Wastewater Treatment Plant.

In addition to rerouting illicit discharge of stormwater and groundwater from the sanitary sewer system, the FDDP provided an opportunity to interact in large group settings and one-on-one with the citizens residing in these areas. These interactions resulted in elevating the stormwater infrastructure knowledge base of these residents.

As of March 2013, the efforts of this project have redirected an estimated 15 million gallons of groundwater per year that were entering the sanitary sewer system.

OPERATIONS AND MAINTENANCE

Municipal operations cover a wide variety of activities and land uses that are potential sources of stormwater pollutants. These include, roadways; parking lots; transportation and equipment garages; fueling areas; warehouses; stockpiles of salt and other raw materials; open ditches and storm sewers; turf and landscaping for all municipal properties, including parks; and waste handling and disposal areas.

The City of Grand Rapids, along with all the other participating communities in the LGRW have developed and are implementing activities to ensure compliance with stormwater control, inspection and maintenance requirements, with the ultimate goal of minimizing pollutant runoff to the maximum extent practicable from municipal operations. Specific stormwater controls with inspection and maintenance schedules for the City of Grand Rapids are provided in Table 5-2.

Table 5-2 O&M Activities

Structure	Maintenance Goals
Stormwater Manholes	
Stormwater Catch basins	Clean 2,500 annually
Discharge Points	
Stormwater Laterals	
Stormwater Pressurized Mains	Bi-weekly inspection visit
Stormwater Lift Stations	Bi-weekly inspection visit
Stormwater Gravity Mains	
Infiltration Basins (underground)	10 year inspection cycle
Detention Basins	Maintain & inspect three times annually
Hydro Separators	Clean twice year
Siphons	Clean annually
Creek gates	Clean annually
Open Ditches	

Other LGRW communities have also developed and adopted O&M procedures for the following:

- Controls used for reducing or eliminating the discharges of water and pollutants from streets, roads and highways; parking lots, maintenance garages, and storage yards
- Procedures for the disposal of O&M waste from the MS4
- Procedures to ensure that flood management control projects, such as detention basins and dams, assess impacts on water quality of the receiving waters
- Controls used to reduce discharge of pesticides, herbicides, and fertilizers

The specific procedures adopted or commitments to adopt are included in Appendix 2C of the Grand Rapids SWPPI (http://www.ftch.com/images/LGRW%20Docs/SWPPI_GR_2012_04.pdf, last accessed Jan 2013).

6. PLANNING FOR THE FUTURE

Every family and business in Grand Rapids relies on the stormwater infrastructure to thrive. The stormwater infrastructure manages the rainwater runoff and water quality from the urbanized area. Creation of the stormwater system coincides with the urban development and dates back well over 100 years. Today, managing the system is a challenging task based on the public's desires, aging infrastructure, changing environmental regulations, and limited financial resources.

This chapter discusses new concepts in stormwater management that have been developed in the last 20 years and some of the issues that are driving change in stormwater management. Financing strategies are also discussed.

The American Society of Civil Engineers published the 2013 Report Card for American's Infrastructure in March 2013. The Report Card depicts the condition and performance of the nation's infrastructure in the familiar form of a school report card by assigning letter grades to each type of infrastructure. The 2013 Report Card gave America a cumulative GPA for infrastructure a D+. The grade for the nation's wastewater and stormwater systems was a D. The nation's capital investment needs in wastewater and stormwater are estimated at \$298 billion over the next 20 years; \$3.7 billion in Michigan alone. The degradation of the existing stormwater infrastructure did not happen overnight. Improvements to the system will likewise take time and will require continuous effort over a long period. Planning for the future is a critical first step.

NEW PARADIGM

The character of stormwater management has, and continues to change. Originally stormwater systems were built just for conveyance, with a mindset of *get-it-out quick*. Now stormwater management is a component of a comprehensive integrated urban water resource. The new mantra is *slow it down, spread it out, and soak it in*. Contemporary stormwater management includes quantity and quality considerations, multiple-use facilities, riparian corridors, recreation, wetland preservation and groundwater recharge. The new approaches require nothing short of a complete paradigm shift on how we think about managing runoff from rain and snow.

The new paradigm has introduced a whole new array of issues that has resulted in basic changes in stormwater planning, design, operation and maintenance, construction, and financing. Stormwater managers now must find the resources to effectively satisfy the changes as well as the regulatory requirements.

As the move into the new stormwater paradigm occurs, it is also important to remember that the focus also needs to be on minimizing costs and maximizing the results achieved through the investments made. Analysis of alternatives should include life cycle cost estimates and consideration for the triple bottom line (social, economic and environmental considerations). Stormwater management should also be thought of as a continuous improvement process. Meaning to always strive to improve the stormwater infrastructure as well as the organizational systems, processes and skills.

CLIMATE CHANGE

The climate of the Great Lakes is changing. Higher global temperatures change patterns of seasons and precipitation at Great Lakes regional and local levels. These uncertainties impact ecology, economy, and social well-being. It will also have a profound effect on stormwater infrastructure.

The following findings are taken from research conducted by Michigan State Universities Dr. Dave Lush and were presented at a 2011 Conference for local policy makers in the Saginaw Bay watershed. The impacts reported here pertaining specifically to urban areas and are subset of those reported. The impacts are relevant to the entire Great Lakes Basin.

The predicted impacts on urban areas are:

- 1) Increases in heavy rainstorms will likely cause more frequent and severe flooding in urbanized watersheds.
- 2) Erosion and recession rates due to heavier and earlier seasonal precipitation events and storm surges with less ice coverage will increase the risk of damage to homes, buildings, and other infrastructure.
- 3) The FEMA Flood Insurance Rate Maps for many riparian communities have likely underestimated the 100-year flood area because they have not accounted for the likely increases in the frequency and intensity of rain events.
- 4) Flooding, coastal erosion, and bluff failures are expected to increase road closures and result in more maintenance and repairs, while increases in heavy rainfall events could contribute to an increase in accidents and fatalities.
- 5) Lower water levels in the summer and fall may expand beaches and encourage public use, resulting in new conflicts over property rights.
- 6) Increases in storm and wave intensity and lower water levels are anticipated to result in higher infrastructure maintenance and dredging costs for commercial ports and recreational marinas.
- 7) Currently, there are 46 CSO communities in Michigan with 262 outfalls. Increases in the intensity and frequency of heavy rainstorms will likely increase the number and severity of untreated CSO releases.
- 8) The most common methods used to calculate storm runoff volume, peak rate of discharge, hydrographs and storage volumes required for floodwater reservoirs in the eastern U.S. are based on 24-hour rainfall data published by the National Weather Service in 1961! Even new stormwater systems are probably ill-prepared for the likely increases in the frequency and intensity of heavy rainstorms. For example, experts predict anywhere from a 20% to 60% increase in runoff by the end of the century (NOAA, 2012).
- 9) Reduced summer low flows in streams result in lower dissolved oxygen concentrations which could adversely impact:
 - a) BOD limits of existing NPDES permits for wastewater treatment facilities
 - b) existing or future TMDLs
- 10) Climate change will affect nearly all aspects of energy production, delivery, and consumption in the Great Lakes region.

FEDERAL AND STATE STORMWATER REGULATIONS

At the federal level, EPA has initiated a national rulemaking to strengthen the stormwater program. The proposed national rulemaking is considering the following key rulemaking actions (<http://cfpub.epa.gov/npdes/stormwater/rulemaking.cfm>, last accessed on 3/23/2013):

- *Develop performance standards from newly developed and redeveloped sites to better address stormwater management as projects are built;*
- *Explore options for expanding the protections of the municipal separate storm sewer systems (MS4) program;*
- *Evaluate options for establishing and implementing a municipal program to reduce discharges from existing development;*
- *Evaluate establishing a single set of minimum measures requirements for regulated MS4s. However, industrial requirements may only apply to regulated MS4s serving populations of 100,000 or more;*
- *Explore options for establishing specific requirements for transportation facilities;*

The current federal schedule calls for draft rules to be published by June 10, 2013 and final rules by December 10, 2014. Based on current events, the schedule for the rulemaking is expected to be delayed.

In an attempt to anticipate the direction the proposed stormwater rules may be headed, other recent legislation, rules and permits may be considered. The examples show a trend toward regulation on maintaining pre-development hydrologic conditions for the smaller storm events. Examples include:

- The Energy Independence and Security Act (2007). Section 438 Stormwater Runoff Requirements for Federal Development Projects. “*The sponsor ... shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow.*” Note this only applies to federal projects.
- West Virginia NPDES MS4 permit indicates that “*Site performance standards for all new and redevelopment that require, in combination or alone, management measures that infiltrate, evapotranspire and reuse of, at a minimum, the first 1 inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation.*”
- Ventura County MS4 Permit indicates that “*Permittees shall require that all New Development and Redevelopment projects identified in subpart 5.E.II control pollutants, pollutant loads, and runoff volume emanating from impervious surfaces through percolation, infiltration, storage, or evapotranspiration, by reducing the percentage of Effective Impervious Area to less than 5 percent of total project area.*”
- Ohio Big Darby Watershed Construction Stormwater Permit indicates that “*Groundwater Recharge Requirements: post-development groundwater recharge equals or exceeds the pre-development groundwater recharge.*”
- New Jersey Stormwater Rules indicate that “*Demonstrate through hydrologic and hydraulic analysis that the site and its stormwater management measures maintain 100 percent of the average annual preconstruction groundwater recharge volume for the site; or Demonstrate through hydrologic and hydraulic analysis that the increase of stormwater runoff volume from pre-construction to post-construction for the two year storm is infiltrated.*”

In Michigan, the 2008 general permit (later rescinded) included specific language on managing the *minimum treatment volume* (commonly taken as the 90 percent annual non-exceedance storm) and for the *channel protection criteria* (commonly associated with the 2-year 24-hour storm). The draft permit language currently being discussed within Michigan is very similar to the 2008 permit. The new draft permit language also discusses regulatory mechanisms when on-site standards cannot be met including: off-site mitigation and “payment in lieu” programs.

By all accounts the direction the state and federal stormwater programs are headed is toward increased regulation on post-development stormwater control measures. The focus appears to be on limiting post-development flows to not exceed pre-development flow conditions. This is seen as a long-term strategy for managing stormwater.

FUNDING OPTIONS

Analyzing methods for financial sustainability is a critical component of management planning. Sustainability means finding a way to implement the SWMP once it is complete. It also means that the plan is being continuously updated and improved to meeting local needs.

The construction, operation and maintenance of a municipal separate storm sewer system can involve significant expense, especially when regulatory requirements (existing and pending stormwater regulations), flooding concerns, water quality issues (including total maximum daily loads, or TMDLs) and population growth are factored in.

Property Taxes/General Fund

Many communities have funded stormwater management from property taxes paid into their general funds. However, there is great competition for municipal general fund dollars from other worthy municipal programs. Stormwater management improvements typically have a low priority, unless the municipality is reacting to a recent major storm or regulatory action. The total cost of stormwater management is not readily apparent because these costs are often spread among several general fund departmental budgets. As stormwater management costs increase, general fund budgets are often not increased to meet those needs. The sources of general revenues have little if any association with the origin of stormwater management demands and costs. For example property taxes are usually calculated based on the economic value of land and improvements, which have little direct relationship with stormwater runoff quantity or quality.

Because general revenues are derived primarily from taxes, tax-exempt properties do not support the cost, even though it can be shown that many of them, such as governmental properties, schools, colleges, and universities are major contributors of stormwater runoff.

User-Fee Based Funding (Stormwater Utilities)

Some communities include stormwater management costs as line items within their water or sanitary sewer enterprise system budgets. Water and sanitary sewer utilities charge customers user fees for services rendered. Many of these base their user fees on metered water flow. This is not equitable because a property's metered water flow is not proportional to stormwater runoff generated by the property. For example, a shopping center typically generates a significant amount of stormwater runoff (primarily from the impervious area of its buildings and parking lots), but may use a relatively small amount of potable water.

Over 1,300 communities' nationwide charge properties stormwater user fees by means of a user fee funded stormwater utility. A user fee funded stormwater utility includes a sustainable funding mechanism dedicated to recover a portion of, or all, the costs of stormwater infrastructure regulatory compliance, planning, maintenance, capital improvements, and repair and replacement. Stormwater user fees are charged to taxpaying and tax-exempt properties and are based on property area. User fee funded stormwater utilities address the shortcomings and inequities of funding stormwater management by property taxes or water/sanitary user fees. The average quarterly fee for a single family home is \$13.50, which usually covers regulatory and operation and maintenance costs. Some communities charge as little as \$2 per quarter, while others charge more than \$40 per quarter for a single family home.

A user fee funded stormwater utility operates similarly to an electric or water utility. The utility is administered and funded separately from the revenues in the City's general fund, ensuring a dedicated revenue source that can only be used to recover stormwater management program expenses.

When calculating user fees, be they water, sewer or stormwater, Michigan communities must comply with the three criteria guidance for valid user fees as established by the Michigan Supreme Court's December 28, 1998 ruling in the case of *Bolt v. City of Lansing* (the *Bolt Opinion*).

The *Bolt Opinion* established three criteria to determine whether the mathematical basis of a charge is a valid user fee or a tax. Pursuant to the *Bolt Opinion* to be a valid user fee the charge must:

- 1) Serve a regulatory as opposed to a revenue-raising purpose;
- 2) Be proportionate to the necessary cost of the service;
- 3) Allow property owners to voluntarily refuse or limit the use of the service.

In the case of stormwater user fees, these three criteria are addressed as follows. It is recommended that communities obtain a legal opinion as to whether the following approach would meet the three-criteria test.

- 1) **Regulatory purpose:** Communities must meet the federal and state regulatory requirements to manage stormwater. Stormwater user fees provide property owners access to (and reimburse the community for) the services the community provides to manage the community’s stormwater runoff which consists of the sum of the stormwater runoff from all property within the community’s legal boundaries. All fees collected are deposited in the community’s dedicated stormwater enterprise fund. That fund is restricted in purpose and none of the revenue generated from the user fees may be used to pay for any other community expenses.
- 2) **Proportionate to the necessary cost of service:** Services to manage stormwater runoff can include, but are not limited to, street sweeping, leaf pick-up, and catch basin cleaning. The total cost of services provided to manage stormwater runoff is allocated per property based on the relative amount of runoff generated by each property’s area. Thus, the user charge reflects the amount of stormwater runoff generated per property and consequently, the relative amount of stormwater services used by a property owner. For example, a ten acre shopping center generates significantly more stormwater runoff than a coffee shop and the cost to provide stormwater service for the shopping center is significantly more than what is required for the coffee shop. The area-based user fee charged to these properties takes this into account.
- 3) **Voluntarily refuse or limit use of service:** A user fee funded stormwater utility charge can be designed to allow property owners to voluntarily refuse or limit the use of the stormwater service by offering credits to those property owners who adopt approved stormwater best management practices such as rain gardens or on-site stormwater storage. Adopting these practices can reduce a stormwater utility bill by as much as 100% in some communities.

Special Assessments

If a stormwater construction project benefits only a portion of a municipality, it can be funded by fees assessed only to those properties within that area, which is called a special assessment district. Special assessments can be used to fund capital improvement and operation of stormwater systems. The assessment concept is predicated on apportioning costs based on the direct and special benefits received.

Bonding for Capital Improvements

Bonding is a common practice to fund and spread the cost of major capital improvement projects out over a number of years. Bonds are not a revenue source, but rather a method of borrowing money to fund expenditures. Debt service of bonds is commonly derived from general revenues, service fees, or special assessments. Two types of bonding are available, revenue bonding and general obligation bonding. General obligation bonding incurs a debt that has first standing with regard to public assets and is backed by the “full faith and credit” of the issuing agency. Revenue bonding is supported and ensured only by specified revenues, such as service fees or assessments.

System Development Charges

System development charges, also known as connection fees or tie-in charges are onetime fees commonly charged to new properties connecting to a water or sanitary sewer system. The objective is to buy into the infrastructure that has already been built for them, to pay their fair share of the infrastructure expansion necessary to serve them, or a combination of both. The amount of the new customer’s system development charge is typically calculated on the basis of the potential water demand that the new customer will place on the system. Stormwater system development charges can also be developed. However, the amount of a customer’s stormwater charge is typically tied to the area of the customer’s property. System development charges are user fees and therefore, in Michigan, should be designed to comply with the intent of the Bolt Opinion’s three-part valid user fee criteria.

Impact Fees

Impact fees have been adopted by government entities for a variety of public infrastructure components. They are based on the cost of mitigating development impacts of individual developments by building public off-site improvements where impacts can't be solved on-site.

Developer Extension/Latecomer Fee

Under the developer extension/latecomer fee concept, the initial developer is later compensated for providing the facilities by fees applied to subsequent developers that tap into or make use of the improvements. This fee is not a revenue mechanism, rather a means of apportioning capital costs among several properties as they are developed.

Plan Review, Development Inspections and Special User Fees

Fees for the performance of regulatory activities may be collected. This category of fees is related to special services provided to a limited group, as opposed to user fees that are generally applicable to utility customers. Such fees apportion the costs only among those who require the service or cause the need for the regulatory measure. Special fees may have other applications, such as a cost recovery mechanism that assigns certain expenses to a specific group. For example the inspection of a private detention system which may be ignored by property owners. Inspections may be necessary to ensure that systems are maintained and not altered from their approved design. Placing the cost of such inspections on the specific property owners through special fees relieves the general taxpayers or utility ratepayers of the expense. Special fees typically provide only small additional amounts of revenue.

Federal and State Funding

Federal and state funding for local stormwater management takes many forms including technical support, facility construction, cooperative programs, and grants and loans. Local governments make use of federal and state government funding for various purposes including stormwater management, flood control and water quality protection. Provided below is a sampling of available programs.

SAW Grants and Low-Interest Loans

New Michigan legislation has been enacted to enable stormwater management grants for various types of projects. The Michigan Department of Environmental Quality (MDEQ) has named this the "SAW" program with SAW standing for "Stormwater, Asset Management, and Wastewater". The grants are for sewage collection and treatment systems or stormwater or nonpoint source pollution control. There will be 90% grant/10% local match for \$1 million or less; 75% grant/25% local match for more than \$1 million and less than \$2 million.

The grant may be used to cover 100% of the costs if the municipality is: a disadvantaged community, in receivership, operating under an emergency manager or an emergency financial manager, or operating under a consent agreement.

Grants may be used for:

- 1) Development of an asset management program for a sewage collection and treatment system or a stormwater system. For sewage collection and treatment systems, the program must include the development of a funding structure and implementation schedule that provides sufficient resources to implement the asset management program.
- 2) Development of management plans for stormwater treatment.
- 3) Planning and design of a sewage treatment works project or stormwater treatment project defined as follows:
 - a) Sewage treatment works:
 - i) Treatment

- ii) Storage
 - iii) Collection
 - iv) Conveyance
 - v) Recycling
 - vi) Reclamation
 - vii) Combined sewer overflow correction
 - viii) Major rehabilitation of sewers
- b) Stormwater treatment (for stormwater that is conveyed by a storm sewer that is separate from a sanitary sewer):
- i) Treatment
 - ii) Storage
 - iii) Recycling
 - iv) Reclamation
- 11) Planning and design of construction activities designed to reduce nonpoint source pollution.
- 12) Project costs related to the testing and demonstration of innovative wastewater and stormwater technologies.

Grant recipients must proceed with the projects for which grant funding is provided within 3 years after the MDEQ approves the grant. For grants received for asset management programs related to sewage collection and treatment the grant recipient must demonstrate that significant progress has been made toward achieving the funding structure necessary to implement the asset management program. The grant recipient must repay the grant, with interest, if it is unable to, or decides not to, proceed with a construction project or begin implementation of an asset management program for which grant funding has been provided.

Eligible projects will be similar to federal Clean Water SRF program. There will be no priority ranking. That is, first come, first served. It is expected that there will be fewer program requirements (no Davis-Bacon, no Disadvantaged Business Enterprise).

The MDEQ has formed a task force to develop the application process for SAW grants and loans and expects to release the information in late summer 2013. Expenses for eligible work will be retroactive to January, 2013. \$450 million will be available.

Strategic Water Quality Initiatives Fund (SWQIF)

The MDEQ provides the following guidance on the key elements of this low-interest loan program as it might apply to Grand Rapids:

Projects to remove clear water [groundwater or stormwater infiltration/inflow (I/I)] from sanitary or combined sewer house leads can qualify for this program. The SWQIF loan can cover only the private property portions of such projects; companion work on facilities that will be publicly-owned, such as storm sewer connections, must be handled under a separate SRF loan. Furthermore, the public system work is eligible to the extent that is necessary to handle the private property clear water only. The first step towards obtaining a SWQIF and/or SRF loan is the submittal of a complete project plan to the DEQ Revolving Loan Section by July 1st for funding in the subsequent fiscal year. Clear water removal projects must be justified based upon one or both of the following: (1) the existence of chronic operational problems related to hydraulic overloading of the collection/treatment system during storm events, such as sewer surcharging, basement backups, combined and sanitary sewer overflows, or bypassing at the treatment plant; and/or (2) cost-effective clear water removal as determined by an I/I analysis and a sanitary sewer system evaluation (SSES). A traditional cost-effectiveness analysis must be done for house lead lining/replacement and footing drain disconnection (FDD) projects to show that the cost to remove I/I flow is less than the cost to transport and treat it, likely making some properties eligible for SWQIF-funded work and others ineligible.”

S2 Grant Program

The MDEQ provides the following guidance on the key elements of this grant program as it might apply to Grand Rapids:

In December 2010, legislation was signed to commit an additional \$40 million in S2 Grants. The grants are available to cover planning, design and user charge systems for potential State Revolving Fund (SRF) and Strategic Water Quality Initiatives Fund (SWQIF) applicants. The grants will cover 90 percent of eligible costs. Recipients are limited to \$1 million in total grant assistance including grant awards under the prior S2 Grant program.

As of January 30, 2013, approximately \$7.2 million was allocated of the \$40 million. Fourteen applications for a total of \$4 million are under review. Therefore, grant funds are still available but could be exhausted at any time.

Other Grant Programs

Many other grant programs are available covering a wide range of project types. For example the Michigan Nonpoint Source Program grants use funds from the Clean Water Act Section 319(h) and 205(j) categories as well as through the Clean Michigan Initiative. These grants focus on restoration of waterbodies impaired by nonpoint source pollution. Grants are also available through the Great Lakes Commission for sediment control; through the state for various monitoring programs; the Great Lakes Fisheries Trust for fish habitat restoration; the Natural Resources Conservation Service for conservation innovation; Michigan Coastal Zone Management Program for planning of water trails; the US Forest Service for restoring urban forests and reducing toxic substances in Brownfield Sites; Sustain Our Great Lakes for habitat restoration; the University of Michigan Water Center for restoration efforts; and many more. The point is there are a lot of grant opportunities. Most of the commonly available grants focus on an environmental aspect as oppose to funding replacement of pipes and manholes. Having The Lower Grand River Watershed Management Plan (LGRWMP) 319 approved makes the communities eligible for 319 funding.

A good strategy for tapping into available grant funds is to have a list of project ideas covering a wide range of topics kept up-to-date and ready at any time. In addition to the type of project, whether the project focus is on study, design, construction or monitoring is also important to note. Then when grant requests for proposals are published, available grant funding categories can be quickly paired with specific projects. Ideally projects should have a flexible implementation schedule as some grants can take an extended period of time to secure.

USACE Planning Assistance to States

Another funding mechanism is the Planning Assistance to States program through the USACE. This program allows the Corps of Engineers to provide states, local governments, and other non-federal entities assistance in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources. Typical studies are only planning level of detail and can encompass many types of studies dealing with water resources issues. The City of Lansing has used these funds to conduct ordinance reviews and updates, develop stormwater policies and procedure manual and technical reference manual, perform collection system investigations, develop standard operating procedure updates for stormwater, and conduct facility planning. Macomb County has mapped its drainage system in GIS, developed a field manual for woody debris management, and organized an economic sustainability conference.

Environmental Tax Shifting

Environmental Tax Shifting is a concept that has been proposed by the Friends of the Earth and other environmental groups to redirect tax code incentives in a direction that would support energy conservation and sustain the environment. In 2001 the Environmental League of Massachusetts published

a report prepared by the Tellus Institute titled, *Environmental Tax Shifting in Massachusetts*. This report discussed two creative proposals to change state tax policy to enhance stormwater management. One was a pay to pave tax that would be levied “on newly paved surfaces on a per-square foot basis.” The second was to eliminate the Massachusetts pesticide and fertilizer sales and use tax exemption. This would generate \$1.1 million in annual revenue in Massachusetts. The report stated that 28 other states also exempt pesticides and fertilizers from sales and use taxes.

INCENTIVIZING STORMWATER MANAGEMENT

Incentives are a creative way to encourage developers and private property owners to implement a program. Incentive mechanisms can be easy to implement and afford local decision makers the flexibility and creativity to tailor programs to specific priorities or to particular geographic areas. Examples of local incentive mechanisms include (USEPA 2009):

- **Stormwater Fee Discount:** Require a stormwater fee that is based on impervious surface area. If property owners reduce need for service by reducing impervious area and the volume of runoff discharged from the property, the municipality reduces the fee.
- **Development Incentives:** Offered to developers during the process of applying for development permits. Examples include: zoning upgrades, expedited permitting, reduced stormwater requirements and increases in floor area ratios.
- **Grants:** Provide direct funding to property owners and/or community groups for implementing a range of green infrastructure projects and practices.
- **Rebates & Installation Financing:** Provide funding, tax credits or reimbursements to property owners who install specific practices. Often focused on practices needed in certain areas or neighborhoods
- **Awards & Recognition Programs:** Provide marketing opportunities and public outreach for exemplary projects. May include monetary awards.

7. RECOMMENDATIONS

The following recommendations are offered. A budget range is suggested for each recommendation. Budget details for the asset management and capital improvement tasks are discussed in the Asset Management and Capital Improvement Plan (2013).

MS4 PERMIT RELATED PROJECTS

- Tracking Database. Develop and implement a database to track activities under the MS4 permit program. The database would be used to aid in the periodic reporting activities required under the permit. There are many database options to choose from, these range from pre-packaged software to a customized program. The pre-packaged software typically has some ability to be customized and costs approximately \$5,000 to \$10,000 with an annual licensing fee of a few thousand dollars per year.
- Public Education Evaluation and Updated Plan. Conduct a social survey to evaluate the success of the past public education efforts and to aid in future planning. Social monitoring should be conducted in a statistically significant way in accordance with the guidelines set by the MDEQ. The U.S. EPA Region 5 Social Indicators Work Group developed a step-by-step system (the Social Indicator Planning and Evaluation System, SIPES) for using social indicators to help plan, implement and evaluate nonpoint source outreach and education projects. Develop 5-year education plan for residents, business community and city staff. A budget of \$20,000 to \$50,000 is recommended.
- TMDL Implementation Plans. Development of TMDLs implementation plans is recommended. The purpose is to develop a specific action plan on how to proceed in identifying and removing pollutant sources in order to meet the TMDL requirements. Implementation planning commonly requires monitoring activities to locate the sources of pollutants. The use of modeling load reductions associated with the proposed improvements is often used to determine the efficacy of the plan. These implementation activities will help to achieve the TMDL target reductions and attain water quality standards resulting in a cleaner, healthier watershed. A budget of \$40,000 to \$75,000 per TMDL is recommended.

PLANNING PROJECTS

- Grant Planning. Develop and maintain a list of grant project ideas. For each project idea identify the project phase (study, design, construction, or monitoring), an estimated budget and common project partners who would be involved. Identify a list of commonly available grant programs of interest, eligibility requirements, and the approximate schedule. Review grant requests for proposals when they are published. A budget of \$30,000 to \$60,000 is recommended to initiate the process. Thereafter an annual budget of \$15,000 to \$25,000 per year is recommended for tracking and applying for grants. The annual budget estimate assumes preparing two grant applications per year.
- Conveyance Capacity Analysis. Conduct a conveyance capacity analysis of the stormwater drainage system. The analysis commonly involves data collection of system attributes (primarily geometric configuration and elevation information), hydrologic-hydraulic modeling, rainfall and runoff monitoring to calibrate the model, and then a system analysis. A comprehensive analysis for a complete system the size of Grand Rapids can range in cost from approximately \$800,000 to \$2 million. The cost is highly dependent on the specific objectives and level of detail. To defray costs, the analysis can be conducted on a watershed basis in a prioritized order. A capacity analysis can be used for multiple purposes such as:
 - identifying system bottlenecks resulting in local flooding or less than desirable level of service;

- supporting a study to address channel erosion problems and solutions;
- identifying post construction allowable release rates and timing to prevent streambank erosion and flooding concerns (note, this could be extended to include specific water quality concerns);
- support green infrastructure evaluations; and
- support project planning efforts to secure funding.
- **Green Infrastructure Opportunity Assessment.** The purpose of an opportunity assessment for green infrastructure is to identify locations where green infrastructure can work. These opportunities are divided into two groups for analysis purposes. The first group looks for locations of large discrete practices and is commonly done through a GIS analysis approach. The second group looks at distributed systems with an analysis focused on developing typical designs, standard details, unit life cycle costing and implementation strategies. The assessment should also identify opportunities to daylight creeks and streams that are currently enclosed in a pipe. The green infrastructure analysis should be coordinated with the TMDL and MS4 permit issues as well as other community sustainability issues. A budget of \$75,000 to \$150,000 is recommended.

POLICIES AND PROCEDURES

- **Stormwater Control Measures Design Standards.** Updates to the City's *Standard Construction Specifications* (1993) (aka the Red Book) are recommended to address various stormwater control measures including green infrastructure techniques. The updates should include development of standard design details along with construction specifications. The stormwater control measures should be coordinated with the Stormwater Technical Reference Manual and any tools used in the design process. A budget of \$75,000 to \$150,000 is recommended.
- **Planning for Climate Change.** Evaluate the state-of-the-art climate change information in order to recommend revised hydrologic design standards, e.g. the anticipated intensity, duration, and frequency for precipitation events. Update the Stormwater Technical Reference manual accordingly with the agreed upon revised standards. Include in the update, recommended methodologies to be used in the hydrologic calculation for stormwater projects. A budget of \$20,000 to \$40,000 is recommended.
- **Codes and Ordinance Review.** Review the codes and ordinances for protecting and improving water quality. *Note – American Rivers is currently working on this task with the EPA Water Quality Scorecard.*
- **Stormwater Incentives Program.** Develop incentive mechanism to encourage the use of green infrastructure practices on private property. Examples of incentive programs include grants, rebates, installation financing, awards, recognition programs, and development incentives such as zoning upgrades, expedited permitting, reduced stormwater requirements, and increases in floor area ratios. A budget of \$40,000 to \$100,000 is recommended.
- **Compensatory Mitigation for Stormwater.** Develop a compensatory mitigation program for stormwater with on-site mitigation, mitigation banking, and environmental credit trading approaches. A budget of \$40,000 to \$100,000 is recommended.
- **Stormwater Control Measures Design and Benefit Tools.** Develop and implement a suite of tools to provide consistent design to site development and street improvement projects. Companion tools would evaluate life cycle costing along with social, economic and environmental benefits. Benefit types would align with sustainability goal metrics. Include training opportunities for staff and local developers. A budget of \$25,000 to \$100,000 is recommended.

ASSET MANAGEMENT

Details of the asset management recommendations are provided in the Asset Management and Capital Improvement plan document (2013). A brief summary of the key recommendations is provided below.

- Condition Assessment. Implementation of the condition assessment activities are recommended as discussed in Level of Service B. The majority of the effort involves CCTV inspection of pipes older than 50-years over a 10-year period and assessment of 5 miles of open channel per year.
- Transition to Condition Based Asset Management. Document all condition assessment information in the IO toolset to transition the information from an age based approach to that of a condition based approach. Update base information and project prioritization annually in conjunction with fiscal year planning.
- IO Toolset Planning. Use the IO toolset as a means to assist in identifying, prioritizing and budgeting for future stormwater projects both explicitly and for projects planned by other City Departments.
- Data Management. Review and update data management strategy for stormwater assets. This involves the data attributes associated with the assets in the GIS.

CAPITAL PROJECTS

Details of the asset management recommendations are provided in the Asset Management and Capital Improvement plan document (2013). The key recommendation is to address the recommended capital projects identified in the Capital Improvement Plan.

8. REFERENCES

ASCE 2013, *2013 Report Card for America's Infrastructure*.

City of Grand Rapids 1994, *Stormwater Master Plan*, Environmental Services Department, City of Grand Rapids

City Grand Rapids 1994, *Stormwater Technical Management*, Environmental Services Department, City of Grand Rapids

City of Grand Rapids 2010, *Transformation Plan*, last accessed February 2013 at: <http://www.grcity.us/city-manager/Pages/Transformation-Journey.aspx>

City of Grand Rapids, 2010, Green Infrastructure Portfolio Standard Initiative, last accessed February 2013 at: <http://www.cnt.org/news/2012/04/02/the-nation%E2%80%99s-first-green-infrastructure-portfolio-standards/>

City of Grand Rapids, 2011, *Sustainability Plan*, last accessed February 2013 at: <http://grcity.us/enterprise-services/officeofenergyandsustainability/Documents/Sust%20Plan%20as%20amended%206-21-11.pdf>

City of Grand Rapids 2012, *Grand Rapids Master Plan Update*, last accessed February 2013 at: <http://grcity.us/design-and-development-services/Planning-Department/Pages/Master-Plan.aspx>

City of Grand Rapids 2012, *Grand Rapids Stormwater Pollution Preventions Initiative*, Environmental Services Department, City of Grand Rapids

Environmental Protection Agency (EPA) 2009, *SUSTAIN – A Framework for Placement of Best management Practices in Urban Watersheds to Protect Water Quality*, last accessed February 2013 at: <http://www.epa.gov/nscep/index.html>

Environmental Protection Agency (EPA) 2011, *Integrated Municipal Stormwater and Wastewater Planning Approach Framework*, last accessed February 2013 at: <http://cfpub.epa.gov/npdes/integratedplans.cfm>

Environmental Protection Agency (EPA) 2012, *Planning for Sustainability* (EPA-832-R-12-001), last accessed February 2013 at <http://water.epa.gov/infrastructure/sustain/upload/EPA-s-Planning-for-Sustainability-Handbook.pdf>

Grand Valley Metro Council, 2008 *Plaster Creek Watershed Management Plan*, last accessed February 2013 at: http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714_31581-127709--,00.html

Lower Grand River Organization of Watersheds 2011, *Lower Grand River Watershed Management Plan*, last accessed February 2013 at: <http://www.gvsu.edu/wri/isc/lower-grand-river-watershed-management-plan-draft-312.htm>

Lusch, David P., 2011 *Climate Change: Water Implications for Michigan Communities, Land systems and Agriculture*, last accessed February 2013 at: <http://expeng.anr.msu.edu/uploads/files/20/Climate%20Change%20Implications%20for%20MI%20by%20Dr.%20David%20Lusch.pdf>

Michigan Department of Environmental Quality 2012 *Water Quality and Pollution Control in Michigan 2012 Sections 303(d), 305(b), and 314 Integrated Report*.

San Diego Municipal Stormwater Co-Permittees 2003, *A Framework for Assessing the Effectiveness of Jurisdictional Urban Runoff Management Programs*, City of San Diego.

Michigan State University Institute of Water Research, *Social Indicators Data Management and Analysis Tool* (SIDMA). <http://www.iwr.msu.edu/sidma/>

USEPA. 2009. *Managing Wet Weather with Green Infrastructure Municipal Handbook Incentive Mechanisms*.

Western Michigan Environmental Action Council 2012, *Community-Based Stormwater Initiative*, last accessed February 2013 at: <http://thewmeacblog.org/2012/06/06/community-based-storm-water-stakeholder-meeting-produces-recommendations/>

APPENDIX A: HISTORIC MODELING STUDIES

BUCK CREEK WATERSHED (1991)

In 1991 Camp, Dresser, and McKee (CDM) completed the Buck Creek and Plaster Creek Stormwater Management Master Plan for the Kent County Drain Commissioner. The study included both a rainfall analysis of the area and models of the Buck and Plaster Creeks' systems. The results of the rainfall analysis using the PRECIP model included development of an IDF curve. SWMM Runoff and Extran blocks were used for the hydrologic and hydraulic modeling, respectively. Buck Creek was divided into 4 sub-basins with an average size of 427 acres. Existing and future simulations were performed using 24-hour SCS Type II rainfall hyetographs and TP-40 rainfall volumes for the 2-, 10-, 15-, 25-, 50-, and 100-year events. Calibration of the model utilized flow monitoring data collected during May 25 and June 3, 1989. Model results were verified using historical data from USGS and comparison with the Flood Insurance Study. The 25-year storm was adopted for a design criteria standard.

COLDBROOK CREEK DISTRICT (1985)

Background

In 1985 Fishbeck, Thompson, Carr, and Huber, Inc., completed the Stormwater Management Plan for Coldbrook Creek Drainage District. The ILLUDAS computer model was used for the analysis. Cold Brook Creek watershed was broken into a total of sixty-one sub-basins ranging in size from 1 to 127 acres. No continuous monitoring of the drainage district was performed for the study. Calibration of the model was based upon historical records of localized flooding at Coldbrook Street and Monroe Street during the May 16, 1974 storm along with the assumption that the remainder of the system was at peak capacity. In addition, flows from East Grand Rapids were taken from a TR-20 analysis completed in a previous study. Following calibration, the model was run for the 10-, 25-, and 100-year storm frequencies with durations of 1 to 24 hours for both existing and future land development. In conjunction with the hydraulic analysis, an inspection of the trunk sewer was conducted to evaluate structural integrity.

Alternatives

The evaluation of available structural and nonstructural improvement alternatives considered cost-effectiveness, implementation and environmental impact. The Coldbrook Creek study considered the following alternatives:

- 1) Retention basins: wetland areas used for temporary impoundment of stormwater.
- 2) Detention Basins: essentially dry areas for temporary impoundment of stormwater.
 - a) Regional: stormwater management for hundreds of acres.
 - b) On site: small basins constructed in conjunction with development.
- 13) Relief storm sewers.
- 14) No Action.

Coldbrook Creek District (1985) Recommendations

Recommended Alternative	Cost (1985 Dollars)	Status
<i>Structural Improvements Recommended</i>		
Regional Detention Basins		
Highland Park at College Ave.	\$26,668	Completed in 1989
Carrier Creek at College Ave.	\$31,532	Bid in 1993
Aquinas College	\$28,000	Targeted Completion 2013
Regional Retention Basin at Corduroy Pond	\$257,798	Completed in 1994
Relief Storm Sewer at Plainfield Ave.	\$178,000	Not Needed-Streets provide overland flood route
Storm Sewer Maintenance		
Plainfield Ave Trunk Sewer	\$35,600	Completed 1989
Michigan St. at Fuller	\$21,400	Completed 1989
Investigation of Condition	\$10,000	Completed 1989
<i>Non-Structural Improvements Recommended</i>		
Identification of 100-year Floodplain	\$0 – USGS study	Completed in 2011/12
Wetland Protection	NA	Unknown
Flood Insurance	NA	Completed in 2011/12

NA: No costs were given for the implementation of these alternatives.

COMSTOCK/SLIGH DISTRICT (1994)

Background

The Comstock/Sligh District encompasses approximately 831 acres in north central Grand Rapids. The area is bounded by Fuller Avenue and the Grand River to the east and west and 3 Mile Road and Graceland Street to the north and south. The land use comprises primarily single-family residential with the Comstock area being high density and the Sligh area being medium density. Other land uses include commercial, institutional and open land. The terrain is nearly level to gently rolling. The minor system in this area is composed of two main storm sewers that follow Comstock and Sligh Boulevards. The Sligh storm sewer connects with the Comstock storm sewer at the intersection of Monroe Avenue and Guild Street. The area is fully developed with no major land use changes expected.

AlternativesDo Nothing

Based on the results observed from the modeling efforts and historical records, the first alternative for this watershed is to leave the sewer system as is. Although the model predicts significantly undersized sewers, the estimated water depth in the major drainage system is relatively small. This finding is supported by the lack of reported historical flooding problems.

Provide Storm Relief Sewers

New storm sewers could be constructed to convey the 10-year 24-hour storm event. As a preliminary estimate of the new sewers which would be needed to convey the 10-year 24-hour storm, the model was run to simulate these conditions and to automatically resize the surcharged sewers as needed. Refinements were not made to size sewers on a reach by reach basis, taking into account changes in grade, storage ponds, etc. A preliminary estimate of cost of approximately \$8.5 million would be necessary to provide a sewer system capable of conveying a 10-year 24-hour storm.

Recommendations

Based upon the model results, available topographic maps and historical flooding records, no significant problems were identified in the Comstock-Sligh watershed. It is recognized that the minor drainage system (the sewer system) is undersized for the 10-year storm event, yet the major drainage system (roads and streets) can successfully accommodate the additional flow with depths typically less than 4 inches. Although flooding problems were not identified by this analysis, the potential for localized flooding does exist. In the event that problems occur, the recommendation is to consider non-structural alternatives first, and only after these have been tried to resort to the structural alternatives.

To better define localized flooding problems, base flood plain and floodway mapping is recommended. This would enable the City to properly manage both the quality and quantity aspects of stormwater runoff within the watershed. For example, affected properties with estimated damage could be identified. The public could be educated about what to expect during severe storms. The City could look at the option of acquiring property in the flood plain and setting aside blue-green space. Increasing infiltration and reducing directly connected impervious areas are also encouraged.

Water quality improvements should be enacted whenever possible. For this watershed emphasis should be on the residential/ commercial BMPs, concentrating on the illicit connection removal program, flood management requirements, and the public education program.

GRACELAND-LACEY DISTRICT (1994)

Background

A watershed study was performed by McNamee, Porter, and Seeley, Inc., in 1993. The EPA SWMM model was used to hydrologically and hydraulically model the watershed with the Runoff and the Transport block, respectively. Flow data were collected by an in-stream monitor at Monroe Avenue and Graceland Street while rainfall data were taken from the Grand Rapids Wastewater Treatment Plant rain gauges.

Alternatives

Do Nothing

Based on the results observed from the modeling efforts and historical records, the first alternative for this watershed is to leave the sewer system as is. Although the model predicts significantly undersized sewers, the estimated water depth in the major drainage system is relatively small. This finding is supported by the lack of reported historical flooding problems.

Infiltration Detention or Retention Pond

The Kent Country Club, on the south edge of the district, appears to be a suitable site for this type of structure. The structure could be used to reduce peak flows from an area north and east of the club. In cooperation with the club, the City might be able to disguise the structure as a golf course water hole hazard. Placement of rip-rap near the inlet could trap sediments which could reduce the water quality in the pond. Another potential site for a pond would be Riverside School.

Provide Storm Relief Sewers

New storm sewers could be constructed to convey the 10-year 24-hour storm event. As a preliminary estimate of the new sewers which would be needed to convey the 10-year 24-hour storm, the model was run to simulate these conditions and to automatically resize the surcharged sewers as needed. Refinements were not made to size sewers on a reach by reach basis, taking into account changes in grade, storage ponds, etc. A preliminary estimate of cost of approximately \$2.5 million would be necessary to provide a sewer system capable of conveying a 10-year 24-hour storm.

Recommendations

Based upon the model results, available topographic maps and historical flooding records, no significant problems were identified in the Graceland-Lacey watershed. It is recognized that the minor drainage system (the sewer system) is undersized for the 10-year storm event, yet the major drainage system (roads and streets) can successfully accommodate the additional flow with depths typically less than 2 inches. Although flooding problems were not identified by this analysis, the potential for localized flooding does exist. In the event that problems occur, the recommendation is to consider non-structural alternatives first, and only after these have been tried resort to the structural alternatives.

To better define localized flooding problems, base flood plain and floodway mapping is recommended. This would enable the City to properly manage both the quality and quantity aspects of stormwater runoff within the watershed. For example, affected properties with estimated damage could be identified. The public could be educated about what to expect during severe storms. The City could look at the option of acquiring property in the flood plain and setting aside blue-green space. Increasing infiltration and reducing directly connected impervious areas should also be encouraged.

Water quality improvements should be enacted whenever possible. For this watershed the emphasis should be on the residential/ commercial BMPs, concentrating on the illicit connection removal program, flood management requirements, and the public education program.

GRAND RIVER DISTRICT (1989)

The Grand River Floodwall/Embankment Study was completed by Wade-Trim/ Associates in March of 1989. The purpose of this study was to identify and assess the structural integrity of the walls, stability of the embankments, outlet conditions of tributary creeks and storm sewers, degree of scour or undermining of floodwall footings, height of the walls and embankments in relation to flood levels, and slope condition and erosion of embankments, and to recommend the most cost-effective improvements to be implemented. Extensive inspection of the floodwall was performed. Non-destructive methods were used to test for compressive strength on concrete walls while soil borings were taken on the embankments. Surveys were performed by boat and by ground. The Flood Insurance Study was used to determine 100-year flood levels. (There are now more recent flood insurance maps that have been considered for this report).

Quality parameters of the Grand River are monitored monthly through a program established by the Grand Rapids WWTP. This program not only monitors the Grand River, but also some local tributaries within and outside Grand Rapids. Stormwater quality issues are addressed under the NPDES section. The remaining summary focuses on the floodwalls and their importance in the Grand River through the City of Grand Rapids.

A follow-up report was completed by Fishbeck, Thompson, Carr & Huber, Inc. in April 1995 titled "Grand River Floodwall and Embankment Improvements Implementation Plan." Over the following six years, millions of dollars were invested in constructing the recommended improvements.

HOGADONE CREEK (1994)

Background

A watershed study was performed by McNamee, Porter, and Seeley, Inc., in 1994. The EPA SWMM model was used to hydrologically and hydraulically model the watershed with the Runoff and the Transport block, respectively. The basin was divided into twenty-one sub-basins ranging in size from 40 to 136 acres. A variety of simulations were performed that ranged between a typical rain event and the 100-year event for periods ranging from 1 hour to 24 hours. Volumes were taken from TP-40 while distributions were of SCS Type II. Flow and rainfall calibration data for the model were collected during

the period of August to November 1992. Flow data were collected by three in-stream monitors, two approximately 3,330 feet south of Lake Michigan Drive on the Grand Rapids and Walker border, and one just south of Butterworth Drive. Rainfall data was taken from the Grand Rapids Wastewater Treatment Plant rain gauges.

Alternatives

Do Nothing

Based on the results observed from the modeling efforts and historical records, the first alternative for this watershed is to leave the stormwater system as is. Although the model predicts undersized culverts and ponding occurring in residential neighborhoods, the estimated resulting flooding is viewed mostly as an inconvenience. This finding is supported by the limited number of serious reported historical flooding problems.

New Culverts and Storm Sewers

New culverts and storm sewers could be constructed to convey the 10-year 24-hour storm event. This would alleviate the ponding problems described previously. The converse side to this would be the increased flow rates, as a result of no flow restrictions, may adversely impact the natural channel by increasing stream velocities and hence increase the potential for stream bank erosion.

Recommendations

The recommendation for this watershed is to leave the stormwater system as is as long as the flooding problems remain as an inconvenience. This recommendation is based on the predicted model results which indicated that homes and other structures are not flooding at this time, and the limited number of reported historical flooding problems.

The predictions for future development indicate minimal growth and hence minimal impact on the creek flows are anticipated. However, restrictions should be placed to ensure that future development does not take away any natural detention and/ or storage areas, otherwise flows downstream will be increased. The restrictions should be in the form of a stream buffer, limiting the allowable flow rate from new development, and providing energy dissipaters on all outfalls of storm sewers dumping into the creek to prevent localized scour.

To better define localized flooding problems, base flood plain and floodway mapping is recommended. This would enable the City to properly manage both the quality and quantity aspects of stormwater runoff within the watershed. For example, affected properties with estimated damage could be identified. The public could be educated about what to expect during severe storms. The City could look at the option of acquiring property in the flood plain and setting aside blue-green space. Increasing infiltration and reducing directly connected impervious areas should also be encouraged. Up-to-date maps depicting detailed contours and current development status are essential to accurate flood plain mapping.

Water quality improvements should be enacted whenever possible. For this watershed the emphasis should be on the residential/commercial BMPs, concentrating on the illicit connection removal program, flood management requirements, and the public education program.

Currently Hogadone Creek is suffering from stream bank erosion. Although this problem is not currently causing damage to private property, the erosion is severe enough to topple adjacent trees and is causing increased suspended solids in the creek which results in a negative impact on the biological life of the stream. The problem will persist if left unattended and will worsen if flows are increased in the creek. The creek stream banks need to be stabilized to stop the current erosion and adequate measures need to be in place to prevent increased stream flows in the future. Stream bank stabilization may be achieved through the use of plant plugs, plant carpets, fiber rolls, check dams, or rip-rap.

The designation of a stream buffer on each side of the stream channel and the prevention of any development within the designated buffer would provide a minimum strip of land to filter pollutants, attenuate overland flow and protect the stream. The minimum width of the buffer strip should be 50 feet. The stream buffer further expands to include flood plains, steep slopes, wetlands and open space areas to form a contiguous system.

No clearing and grading should be permitted on slopes in excess of 25% to prevent soil erosion of the steep slopes. These areas may be tied into the stream buffer system, or may exist as isolated open space reserves.

INDIAN MILL CREEK (1994)

Background

McNamee, Porter and Seeley completed the Indian Mill Creek Watershed Stormwater Management Plan Report in February of 1994 for the City of Grand Rapids, City of Walker, Alpine Charter Township and the Kent County Drain Commissioner. XP-SWMM Runoff and Extran blocks were used for hydrologic and hydraulic modeling, respectively. The 11,000-acre watershed was divided into 101 sub-basins ranging from 46 to 165 acres. Existing and future simulations were performed using 24-hour SCS Type II rainfall hyetographs and TP-40 rainfall volumes for storms ranging from a typical event to the 100-year event for periods of 1 to 24 hours. Calibration of the model utilized data from three in-stream flow monitors and rainfall data from a variety of sources including a five-minute recording rain gauge in the middle of the watershed. Monitoring data was collected from April 27 to July 6, 1993.

Alternatives

Several alternatives were presented for both the Brandywine Creek and main stem Indian Mill Creek flooding problems. Those identified for the Brandywine Creek are listed below:

- Cleaning of the reach between Milo Street and Benning Avenue
- Relief sewers in the region of Leonard Street
- Further study of this portion of the Indian Mill Creek Watershed with more detailed up-to-date data.

Indian Mill Creek proposed alternatives are listed below:

- Dredge the lower portion of the Indian Mill Creek main stem to MDNR specifications.
- Further channelization of the main stem of Indian Mill Creek upstream of the original 1905 constructed channelization.
- Regional detention at Walker Avenue.

Recommendations

The final specific recommendations for the Indian Mill Creek Watershed study are listed below.

- The recommendation is made that a regional cleaning of all the county drains in Alpine Township within the Indian Mill Creek Watershed not be made.
- In Brandywine Creek, cleaning and/ or providing a relief sewer would not solve the flooding problems upstream of Remembrance Road. Cleaning of the channel between Benning Avenue and Milo Street is recommended as routine maintenance to maintain the flow channel. It is recommended that new detailed topographic information be obtained and a more detailed hydrologic and hydraulic model be developed for this region. After completion of detailed mapping and modeling, at least the following should be investigated:
 - delineation of the floodplain and floodway,
 - definition of the extent of affected properties and estimated damages,

- building publicly owned detention basins, and
 - the option of acquiring property in the floodplain and setting aside blue-green space.
- The channel improvements approved by the Michigan Department of Natural Resources in the lower reaches of Indian Mill Creek should be undertaken as soon as possible.
- A routine maintenance program in all communities should be developed and implemented to maintain current characteristics of channels to avoid future major expensive and remedial measures. The anticipated program would cycle every 4 to 8 years, except in the lower reaches where more frequent cleaning may be necessary.
- All three communities should adopt a formal on-site detention policy for new development.
 - A standard county-wide policy should be adopted unless a specific hydrologic/hydraulic study is performed.
 - The 25-year, 24-hour storm should be used as the standard storm to size all detention/retention basins with outflows not to exceed 0.13 cfs/acre.
 - Basins should be designed to convey up to the 100-year, 24-hour storm through an emergency spillway.
- All three communities should limit or prevent development within the 100-year floodplain. Rights to floodplain areas should be acquired by the communities where possible, by title or permanent easement, or other available methods.
- All three communities should establish a water quality program in conjunction with the Kent County Drain Commissioner, patterned after the City of Grand Rapids' NPDES program.
- Encourage continued use of the Soil Conservation Service programs for reducing erosion from farmlands.

LAMBERTON CREEK (1994)

Background

A watershed study was performed by McNamee, Porter, and Seeley, Inc., in 1993. The EPA SWMM model was used to hydrologically and hydraulically model the watershed with the Runoff and the Transport block, respectively. The basin was divided into fifty-six sub-basins ranging in size from 8.5 acres to 148 acres. A variety of simulations were performed that ranged between a typical rain event and the 100-year event for periods ranging from 1 hour to 24 hours. Volumes were taken from TP-40 while distributions were of SCS Type II. Flow and rainfall data for the model were collected during the period of August to November of 1992. Flow data were collected by five in-stream monitors. Two flow monitors were installed above and below Lamberton Lake; one monitor was installed on the South Branch of Lamberton Creek at 3 Mile Road; and the final two monitors were installed on the main stem at Cheney Avenue and just downstream of the Veteran's Cemetery Pond. Rainfall data were taken from the Grand Rapids Wastewater Treatment Plant rain gauges.

Alternatives

Do Nothing

Based on the results observed from the modeling efforts and historical records, the first alternative for this watershed is to leave the stormwater system as is. Although the model predicts undersized culverts and ponding occurring in residential neighborhoods, the estimated resulting flooding is viewed mostly as an inconvenience. This finding is supported by the limited number of serious reported historical flooding problems.

New Culverts and Storm Sewers

New culverts and storm sewers could be constructed to convey the 10-year 24-hour storm event. This would alleviate the ponding problems described previously. The converse side to this would be the

increased flow rates, as a result of no flow restrictions, may adversely impact the natural channel by increasing stream velocities and hence increase the potential for stream bank erosion.

Recommendations

The recommendation for this watershed is to leave the stormwater system as is as long as the flooding problems remain as an inconvenience. This recommendation is based on the predicted model results which indicated that homes and other structures are not flooding at this time, and the limited number of reported historical flooding problems.

The predictions for future development indicate that projected growth will have minimal impact on the creek flows. However, restrictions should be placed to ensure that future development does not take away any natural detention and/or storage areas, otherwise flows downstream would be increased. The restrictions should be in the form of a stream buffer, limiting the allowable flow rate from new development, and providing energy dissipaters on all outfalls of storm sewers dumping into the creek to prevent localized scour.

To better define localized flooding problems, base flood plain and floodway mapping is recommended. This would enable the City to properly manage both the quality and quantity aspects of stormwater runoff within the watershed. For example, affected properties with estimated damage could be identified. The public could be educated about what to expect during severe storms. The City could look at the option of acquiring property in the flood plain and setting aside blue-green space. Increasing infiltration and reducing directly connected impervious areas are also encouraged. Up-to-date maps depicting detailed contours and current development status are essential to accurate flood plain mapping.

Water quality improvements should be enacted whenever possible. For this watershed the emphasis should be on the residential/ commercial BMPs, concentrating on the illicit connection removal program, flood management requirements, and the public education program.

The designation of a stream buffer on each side of the stream channel and the prevention of any development within the designated buffer would provide a minimum strip of land to filter pollutants, attenuate overland flow and protect the stream. The minimum width of the buffer strip should be 50 feet. The stream buffer further expands to include flood plains, steep slopes, wetlands and open space areas to form a contiguous system.

No clearing and grading should be permitted on slopes in excess of 25% to prevent soil erosion of the steep slopes. These areas may be tied into the stream buffer system, or may exist as isolated open space reserves.

PALMER STREET DISTRICT (1992)

Background

A watershed study was performed by Prein & Newhof, P.C. and Camp, Dresser and McKee in 1992. Yearly flooding of the Kent County Country Club was the motivation for the study. The EPA SWMM model was used to hydrologically and hydraulically model the watershed. Upstream of the country club the runoff block was used, downstream the Extran block. No monitoring of the drainage district was performed specifically for the study. Calibration was achieved by utilizing the calibration parameters developed from the Plaster and Buck Creeks model in conjunction with observations at the country club. The SWMM model used seventeen subcatchments ranging in size from 1 to 150 acres with a percent imperviousness ranging from 0 to 35%. Design storms utilized for this study were taken from the Plaster and Buck Creeks study and included 1-, 10- and 25-year, 24-hour storms using the SCS Type II distribution.

Alternatives

Problems upstream of the country club were not addressed. Three alternatives were proposed for the flooding problem on the golf course. Common to all three alternatives is the inclusion of increased detention area on the west side of the golf course at the intersection of Dean Street and Plainfield Avenue. The golf course has several existing ponds through which the swale runs. Two options are presented for each alternative as to whether or not to keep the golf course ponds. The proposed alternatives are:

- 1) Open Channel- Rebuild the existing swale to provide capacity for a 10-year storm event. Estimated Cost:
 - a) keep ponds \$420,000
 - b) remove ponds \$390,000
- 2) 48-inch Storm Sewer-Construct a 48-inch storm sewer under the swale. The 48-inch sewer would provide capacity for a 1-year storm; greater flows would go into the swale. Estimated Costs:
 - a) keep ponds \$510,000
 - b) remove ponds \$500,000
- 3) 60-inch Storm Sewer-Construct a 60-inch storm sewer under the swale. The 60-inch sewer would provide capacity for the 10-year storm; greater flows would go into the swale. Estimated costs:
 - a) keep ponds \$650,000
 - b) remove ponds \$660,000

In addition, it was proposed to construct a relief sewer downstream of the golf course near Elmwood Street and Center A venue. The purpose of the relief sewer would be to reduce the necessary detention in alternatives (2) and (3), and to eliminate the need for the detention in alternative (1). The estimated cost for the relief sewer is \$95,000. The cost of the relief sewer would be in addition to the estimated cost for each of the alternatives.

Recommendations

The 60-inch storm sewer alternative was selected and implemented in 1995/1996.

PLASTER CREEK DISTRICT (1991)

Background

In 1991 Camp, Dresser, and McKee (CDM) completed the Buck Creek and Plaster Creek Stormwater Management Master Plan for the Kent County Drain Commissioner. The study included both a rainfall analysis of the area and models of the Buck Creek and Plaster Creek systems. The results of the rainfall analysis using the PRECIP model included development of an IDF curve. SWMM Runoff and Extran blocks were used for the hydrologic and hydraulic modeling, respectively. Plaster Creek was divided into 127 sub-basins with an average size of 320 acres. Existing and future simulations were performed using 24-hour SCS Type II rainfall hyetographs and TP-40 rainfall volumes for the 2-, 10-, 15-, 25-, 50-, and 100-year events. Calibration was performed through data collected from in-stream monitors during the events of May 25 and June 3, 1989. Model verification was obtained by using historical data from USGS and comparison with the Flood Insurance Study. The 25-year storm was used to evaluate reasonable upper limits of manageable flooding conditions.

In addition to the CDM report, Grand Valley State University (GVSU) and the City of Grand Rapids have published two separate water quality reports that pertain to the watershed. The Plaster Creek Stormwater Quality Study was published by GVSU Water Resources Institute in October of 1992. The purpose of this report was to assess the relationship between the water quality of Plaster Creek and the delivery of stormwater runoff from the watershed. The City of Grand Rapids WWTP and the West Michigan Environmental Council published the Silver Creek Drain Report in November of 1990. The goal of this study was to inspect the drain, document connections, and identify sources of pollutants entering the

drain. While the findings of these reports are pertinent to the water quality issues of the watershed, the remainder of this summary will focus on water quantity issues presented in the COM report.

Alternatives

In accordance with the Master Plan for Plaster Creek, CDM developed specific management strategies for controlling the runoff from newly developed areas and/ or existing developed areas to ensure that no increases in flood stage along Buck and Plaster Creeks; main stem occurred under ultimate development conditions. The following is a list and description of the proposed alternatives to control runoff from future development. Some of the alternatives presented are relevant to both Buck Creek and Plaster Creek Watersheds; therefore, some of the alternatives presented here are reiterated from the Buck Creek Watershed Section.

- Alternative 1.-Regional and On-site Detention for Developable Land: 10-Year Peak Release Rate. This alternative reduces ultimate land use discharges by imposing an existing 10-year, 24-hour storm peak release rate to each tributary serving developable sub-basins.
- Alternative 2.-On-site Detention for Developable Land: 2-Year Peak Release Rate. The second alternative limits ultimate land use discharges from each developable sub-basin by imposing an existing 2-year, 24-hour storm peak release rate.
- Alternative 3.-On-site Detention for Developable Land: No Increase in Main Stem Stage. This alternative was the most conservative and allowed for no increase in stage along the main stem under ultimate land use conditions. Control for this alternative would be set at one-eighth the existing 2-year peak release rate for Plaster Creek.
- Alternative 4.-On-site Detention for Developable Land: No Significant Impacts. This alternative is less stringent than the above alternative in that it allows for modest increases in stage for the main stem that have no significant impacts. The release rate for this alternative is based upon one-fourth of the existing 2-year peak flows for Plaster Creek.
- Alternative 5.-On-site Detention for Break-Even Land: No Significant Impacts. This alternative provides detention in all locations, regardless of developed or undeveloped status, upstream of the "Break-Even" point. CDM defined the "Break-Even" point as "the location within the watershed where the addition of detention upstream will result in a reduction in the stage along the main stem of the stream." Control for this alternative was set for two-thirds of the 2-year peak discharge for Plaster Creek.
- Alternative 6.-On-site Detention for Developable: Average Release Rates. This alternative is similar to Alternative Four; however, the release rate for each sub-basin is equal to the area-weighted average peak release rates determined for Alternative Four. The single area-weighted average was developed to simplify regulation of detention pond design.

Recommendations

Alternative 6 was the recommended alternative for the Master Plan. Alternative 6 with specifics is listed below:

- Detention must be considered for all new development above the break-even point. The peak aggregate discharge rate for sub-basins above the break-even point is .13 cfs/acre.
- "Quasi-regional" detention for aggregating detention required from several developments is recommended. Channel and conduit improvements from the developments to this detention must be provided.
- The amount of detention to be provided for new development must be at 0.5 acre-feet/acre of developed impervious area.
- The area of the detention facility must be included in the total impervious area for any development.

- A standard detention storage rate of 0.1 acre-feet/acre of development may be used for single family residential development.
- A standard detention storage rate of 0.2 acre-feet/acre of development may be used for multi-family residential and mobile home residential land uses.
- Other land uses must calculate the required detention storage based on 0.5 acre-feet/ acre of actual impervious area planned for the development.
- Regional detention for control of the main stem flooding is not recommended.
- To provide for water quality improvement, it is recommended that all new detention provide extended 12-hour dry detention for the runoff from the average rainfall event, which has been found to be .21 inches.
- The first phase of development must include provisions for sufficient detention for the completed development.
- A standard stormwater ordinance should be enacted for Buck and Plaster Creeks' watersheds with mandated standards included.
- The 100-year floodplain established by the Federal Emergency Management Agency should be used to limit development adjacent to the stream, where available.
- Rights to floodplain areas should be acquired by the Chapter 20 Drainage Board, where possible, by title or permanent easement, or other available methods.
- Assuming the primary use of existing wetland area is for flood detention, the use of the wetland area for detention by individual developments is recommended as long as its other uses are not adversely impacted by this additional use.
- Existing capacity problems within the Silver Creek Sub-watershed to Plaster Creek should be corrected by placement of new open detention storage basin adjacent to the existing Silver Creek Drain.
- High velocities and the resulting localized flooding and erosional problems within the Burton-Breton sub-watershed to Plaster Creek should be addressed through a series of drain checks , limited flood-proofing, and a capacity constraint removal.
- Existing flooding problems adjacent to existing detention basins within the Whiskey Creek sub-watershed to Plaster Creek should be managed through the addition of more "quasi-regional" detention and removal of some capacity constraints.

The cost of this project was estimated at \$5,070/ acre for development. The total developable area in Plaster Creek was approximated at 16,700 acres.

BURTON-BRETON BRANCH OF PLASTER CREEK (1991)

Background

The Burton-Breton branch was studied as a part of the 1991 Camp, Dresser and McKee (CDM) Buck Creek and Plaster Creek Stormwater Management Master Plan for the Kent County Drain Commissioner. SWMM Runoff and Extran blocks were used for the modeling of the watershed. Model calibration was performed from in-stream flow monitors during the events on May 25 and June 3, 1989. The models were run for 10-year, 25-year, and 100-year events.

Alternatives

The alternatives evaluated for the Burton-Breton branch included three options and are as follows:

- Replace deficient culverts at Okemos Drive, Annchester Drive and 28th Street.
- The addition of new detention in the watershed.
- Drain checks along the course of the stream to reduce velocities for erosion control.

Recommendations

Camp, Dresser, and McKee made the following recommendations for the Burton-Breton branch:

- No restriction device should be installed in the detention basin outlet under Breton Avenue. The preceding statement is based upon original design specifications; however, further investigation by the City indicates a potential benefit for the installation of a restriction device at this location.
- Leave in place the 4x4 culvert under 28th Street.
- Notify Grand Central Plaza of their location in the 100-year floodplain.
- Culverts at Okemos and Annchester Drives be constructed to handle the 25-year flows. Recommend flood-proofing measures for structures in the vicinity of these culverts to reduce flood damages due to possible backwater conditions.

SILVER CREEK BRANCH OF PLASTER CREEK (1991)

Background

The Silver Creek branch was studied as a part of the 1991 Camp, Dresser, and McKee (CDM) Buck Creek and Plaster Creek Stormwater Management Master Plan for the Kent County Drain Commissioner. SWMM Runoff and Extran blocks were used for modeling the watershed. Calibration of the model utilized data from field flow information and a flow monitor installed in the drain. The event used to calibrate the model occurred on August 4, 1989.

Alternatives

The following alternatives for Silver Creek are those developed by CDM in their Plaster Creek Master Plan in 1991. CDM developed six alternatives for the main area and two for the "Roosevelt Park Neighborhood." The first main area alternative dealt with a relief sewer and the other five considered detention alternatives. The detention alternatives looked at the use of six possible detention areas: Ostego and Farmers Market between Crofton and Garden Streets east of Division Avenue; South Field bounded by Cottage Grove and Crofton Streets on the north and south, and Madison and Jefferson Avenues on the east and west; Berkley, West of Blain Avenue between Ramona and Dickinson Streets; Calvin within the vicinity of Calvin Avenue and Adams Street; and Kreiser, north of Kreiser Street within the vicinity of Hall and Plymouth Streets. The first three detention alternatives included the combined areas while the other two did not. In addition, alternatives D and E (in Table 2-3) made provisions for the increased flow from possible improvements taking place in East Grand Rapids (EGR) for the 10- and 25-year events.

Summary of Silver Creek Alternatives for 1991 Plaster Creek Master Plan

Alternative	Detention Basins	CSO Area Included	Cost
Relief Storm Sewer for 25-Year Event		Unknown	\$8.5 million*
Alternative A for 100-Year Event	South Field Otsego Farmer's Market Berkley Calvin	Yes	\$5.4 million
Alternative B for 25-Year Event	South Field Otsego Berkley Calvin	Yes	\$3.0 million
Alternative C for 15-Year Event	South Field Berkley Calvin	Yes	\$2.3 million
Alternative D for 25-Year Event Additional Capacity	South Field Otsego Berkley Calvin	No	\$3.4 million
Alternative E for 25-Year Event with EGR improvements.	South Field Otsego Berkley Calvin Kreiser	No	Not Given

*Estimate of pipe cost only. Does not include costs associated with property acquisition, environmental issues, and tunneling efforts.

The alternatives developed for the "Roosevelt Park Neighborhood" of Silver Creek dealt with the installation of a relief sewer to solve the flooding problems.

Recommendations

The recommended alternative for the main area of Silver Creek was Alternative D with the constraint that if East Grand Rapids does make improvements, the Kreiser basin should be built. The recommended alternative for the Roosevelt Park neighborhood comprises a new relief sewer system for Naylor Street, High Street, and Cordelia Street, no changes to Vries Street, and abandoning the sewer section between Cordelia and Vries Streets.

WHISKEY CREEK BRANCH OF PLASTER CREEK (1991)

The Whiskey Creek branch was studied as a part of the 1991 Camp, Dresser, and McKee (COM) Buck Creek and Plaster Creek Stormwater Management Master Plan for the Kent County Drain Commissioner. SWMM Runoff and Extran blocks were used for modeling of the watershed. Model calibration was performed by using the same hydrologic and hydraulic parameters used in the Plaster Creek Master Plan. No monitored flow data were available for this model. Models were run for the 10-, 25-, and 100-year events.

Alternatives

Several alternatives were developed to cope with the above flooding problems. These alternatives include increasing capacity in a restraining culvert and additional storage throughout the watershed.

The proposed alternatives are as follows:

- Enlarge the culvert between Lake Eastbrook and North Lake Eastbrook under Camelot Drive to reduce levels in North Lake Eastbrook.
- Establish detention basins within the watershed along with the culvert enlargement. The first basin, known as the Raybrook Basin, would be located just west of the intersection of Burton and the East Beltline. The second basin, known as the Valleywood Basin, would be located to the

north of Woodland Mall and west of the East Beltline. These basins were designed to provide peak rate control to .14 cfs/acre under the 25-year design storm conditions.

- Flood-proofing areas around Lake Eastbrook, North Lake Eastbrook, and behind the office building on Raybrook.

Recommendations

Construction plans and documentation have been prepared by the City of Grand Rapids Engineering Department. The project is expected to be bid in winter or spring of 1994. The original design by CDM has been modified by the City. Design modifications included removal of COM's relief sewer along Century Avenue and replacing it with storm sewer along easements between High, Cordelia, and Vries Streets.

Whiskey Creek Branch of Plaster Creek Recommended Alternative and Its Current Status

Recommended Alternative	Cost	Status
Culvert Enlargement between Lake Eastbrook and North Lake Eastbrook	\$120,000	Not Selected
Installation of two "quasi-regional" detention facilities. One 36 acre-ft pond and one 15 acre-ft pond.	\$1,700,000*	Unknown
Modification of the Burton Ridge overflow to allow for the maximum predicted flood stages without any flow bypassing around the structure.	\$20,000	Unknown
Flood-proofing for the apartments to the north of Lake Eastbrook. <i>Does not include the price of land acquisition.</i>	\$16,000-\$52,000	Unknown

The above alternative does not correct the flooding problems mentioned on Woodcliff and at Radcliff Village apartments. These problems were identified to be caused by inadequate drainage pathways. In addition, the problems at Eastbrook Mall appear to be related to infiltration /inflow problems within the sanitary collection system.

WHISKEY CREEK BRANCH OF PLASTER CREEK (2004)

Background

A September 22, 1988 rain event flooded a number of apartment and office complexes overlooking Lake Eastbrook and N. Lake Eastbrook and an office complex at 2041 Raybrook, SE. Measured data shows the lake levels rose high enough to flood the low lying walkout patios of these apartment and office complexes. No known reported flooding has occurred between September 1988 and end of 1998.

Lake Eastbrook, N. Lake Eastbrook and property at 2041 Raybrook, SE are within Whiskey Creek watershed. The watershed was previously analyzed in 1990 by Camp Dresser McKee (CDM).

The CDM study recommended replacing the existing culvert joining the two lakes with a larger culvert, constructing two detention basins and flood-proofing affected properties - all at an estimated project cost of \$2 Million in 1999 dollars. The detention basin sites specified may no longer available due to subsequent land development.

Purpose

To resolve the wide variation in cost and effectiveness of improvements specified in the two studies, the City of Kentwood and the City of Grand Rapids jointly retained Black & Veatch to examine the flooding problems, resolve discrepancy between the two studies and to propose an implementation plan utilizing the most cost effective alternative(s).

The Black & Veatch study:

- developed a computer model to analyze the September 22, 1988 flooding event
- performed model calibration/verification by obtaining and analyzing measured lake levels for corresponding rain events during the study period
- evaluated the following alternatives:
 - detention basin location and size
 - resize culvert connecting the two lakes
 - lower outfall weir
 - modify outfall channel
 - combination of above
 - flood-proofing
 - procure flood insurance
- resolved discrepancy between CDM and Calvin College studies
- provided recommendations

Model Development and Calibration

Whiskey Creek has 1053.2 acre watershed and for modeling purposes was subdivided into 31 subcatchments. Computer program XP-SWMMTM was used to model the system and stormwater runoff from 31 subcatchments is analyzed by the SCS method in the Runoff block.

The Extran block analyzes stormwater conveyance through storm sewers, culverts, and natural channels; stormwater discharge rates through existing detention basins; overflow through existing weirs; and hydrological routing of flood flows through the two lakes (Lake Eastbrook and N. Lake Eastbrook), and ponds (Springbrook Manor, Burton Ridge, Corporation, and Seminary ponds).

For the XP-SWMMTM model calibration, measured rain data at the nearby Kent County Airport and lake levels measured by the City for the September 22, 1988 flooding events were used. The calibration results indicated that XP-SWMMTM with the inclusion of outfall discharge channel compared very well.

The outfall channel creates a backwater effect and submerges the outfall weir. The effects were considered and appears reasonable when it is realized that 197 cfs is being conveyed through two culverts and a very long (630') and flat (0.016% slope) natural channel only 4.5' deep [734.5 (weir crest) — 730 (channel invert) = 4.5'].

Findings

It is believed that one of the reasons that CDM's study under predicts flood stage (737.7 compared to 738.16 by XP-SWMMTM) and over predicts allowable discharge (of 418 cfs compared to 225 cfs by XP-SWMMTM) to Plaster Creek could be because the CDM study did not include the backwater effects created by outfall discharge channel previously discussed.

Recommendations

The following recommendations were made:

- 1) Construct an 8' (H) x 10' (W) culvert to replace the existing 91" (H) x 58" (W) culvert between Lake Eastbrook and N. Lake Eastbrook. The larger culvert will have lower head loss and therefore keep N. Lake Eastbrook level low enough to mitigate flooding of Heartland Village Apartment units. This improvement alternative should cost approximately \$0.5 million in project cost.
- 2) Since detention storage is not a viable alternative, flood-proofing of low lying structures is recommended. Since the structures were built low, flood-proofing should be constructed and maintained by the property owners at their costs.

- 3) Begin efforts to have flood insurance study (FIS) done by Federal Emergency Management Agency (FEMA). The FIS will help obtain insurance through the Federal Flood Insurance Fund (FIF) and all pay-outs would come from FIF and not the insurance company.