STORMWATER SYSTEM
ASSET MANAGEMENT PLAN

For

CITY OF KEEGO HARBOR
OAKLAND COUNTY, MICHIGAN

EGLE SAW GRANT #1220-01

DECEMBER 2019

HRC JOB NO. 20130735

HUBBELL, ROTH & CLARK, INC
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CHAPTER 1: EXECUTIVE SUMMARY

1.0 INTRODUCTION

The City of Keego Harbor is developing an Asset Management Program ("Program") for its sanitary sewerage and treatment system and stormwater collection system. This report discusses the stormwater collection system program. In 2013, the City of Keego Harbor applied for and received a Stormwater, Wastewater and Asset Management (SAW) grant from the Michigan Department of Environment, Great Lakes, and Energy (EGLE), formerly MDEQ. This grant provides between 90% and 75% grant funding for costs related to developing asset management programs. The City of Keego Harbor requested $430,000 for the development of a Stormwater Asset Management Program and received a 90% match for the work included. The SAW program was established by the EGLE in order to help communities meet the new National Pollutant Discharge Elimination System (NPDES) requirements, as well as help utilities move toward financial sustainability. Outside funding sources for stormwater systems are typically not available, and therefore the EGLE is encouraging stormwater utilities to move toward becoming self-sustaining enterprises.

1.0.1 What is an Asset Management Program?

The *International Infrastructure Management Manual* defines the goal of asset management as meeting a required level of service in the most cost-effective way through the creation, acquisition, operation, maintenance, rehabilitation, and disposal of assets to provide for present and future customers.

An Asset Management Program includes a set of procedures to manage assets based on principles of life cycle costing implemented in a programmatic way. The intent of asset management is to ensure the long-term sustainability of the wastewater or stormwater utility. By helping a utility manager make better decisions on when it is most appropriate to repair, replace, or rehabilitate particular assets and by developing a long-term funding strategy, the utility can ensure its ability to deliver the required level of service perpetually.

Effective asset management implementation is comprehensive. It may involve integrating a number of tools along with other existing systems (accounting, financial reporting, purchasing and stores, payroll, etc.) to create a comprehensive information system that will support an integrated Asset Management Program. Properly practiced, it involves all parts of the organization and entails a living set of performance goals.

A good program is not "done" and put on a shelf, but rather provides a framework of tools that may be continuously used for decision making. It is an active, on-going process that provides information to managers in order to make sound decisions about their capital assets and allows decision makers to better identify and manage needed investments in their utility's infrastructure. The Program tools may be used for tasks such as to review and establish annual budgets, plan improvements, determine required staffing, and communicate performance with the public and regulatory agencies.

1.0.2 What is an Asset Management Plan?

An Asset Management Plan ("Plan") is a tool to help the utility implement its Asset Management Program. The purpose of this report is to provide a long-term Plan that will assist the OWNER in planning for the short and long-term needs of the wastewater and stormwater system, with a focus on the next 20 years. The goal of the Plan is to provide the City of Keego Harbor with the information required that will allow the organization to be able to continue to provide the desired level of service to the community at the lowest life cycle costs. This will be achieved by developing a strategic process to perform proactive maintenance and investment in the system, rather than reacting to failures.

The Plan consists of the five core components as described in the EGLE document, "Asset Management Guidance for Wastewater and Stormwater Systems." These include:

- Asset Inventory
- Critical Assets
- Level of Service
- Capital Improvement Planning
- Revenue Structure

1.1 SCOPE OF WORK

The scope of work for development of this Asset Management Plan included review of the stormwater system, and related structures and facilities.

Approximately 295 individual assets were examined and inventoried in the storm system. Each asset was categorized, had its condition and criticality assessed and was given a monetary value. In some cases, these determinations were made by review of record documents on file for the asset, while other assets included detailed field inspections. A capital improvement plan (CIP) was developed to plan for rehabilitation and/or replacement of assets, facilities and structures with useful lives of more than 20 years, and recommendations made for potential funding sources for these improvements.

A Geographic Information System (GIS) was utilized to manage the asset inventories for the system. System Level of Service goals and a Mission Statement were developed with staff input. A total of 1,500 system features were added to create the GIS database for the City of Keego Harbor. This includes discharge points, outfalls, leeching basins, Oakland County structures and pipes, culverts, and private systems.

1.2 RECOMMENDATIONS

The CIP provided in Appendix H should serve as a guide for the coming years. Because there is not a dedicated funding source for the stormwater system, an exact schedule of implementation and how funding will be made available (build up cash reserves, bond, grants, etc.) has not been included as part of the SAW grant efforts. If grants or other funding sources become available, the City can use this document as a reference to prepare grant applications or seek funding opportunities.

CHAPTER 2: UTILITY OVERVIEW

2.0 INTRODUCTION

The stormwater system is owned and operated by the City of Keego Harbor. There are other storm pipes located in the City that are under the jurisdiction of Oakland County Water Resources Commissioner (WRC) or Road Commission for Oakland County (RCOC), and privately-owned on private properties. The figure below provides an organization chart of the departmental and authorizing structure:

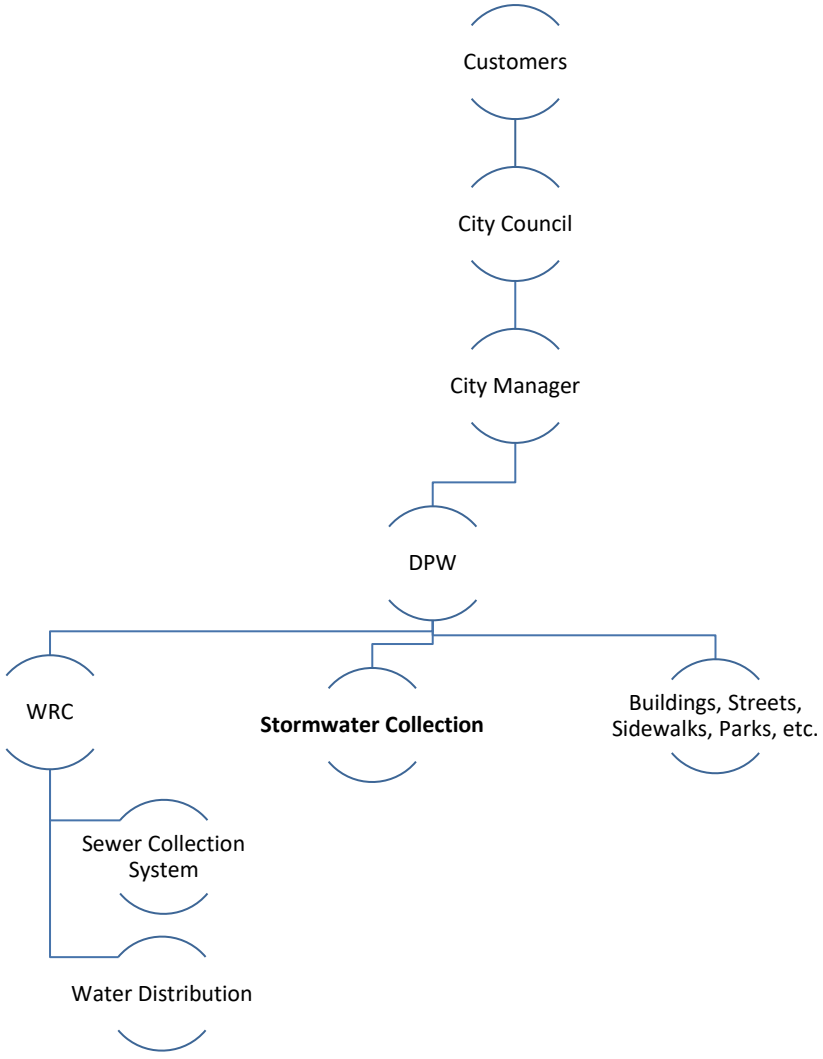

Figure 1: Organizational Chart

As indicated above, City-owned storm pipes fall under the jurisdiction of the City's Department of Public Works (DPW).

2.0.1 Mission Statement

A Mission Statement should be an overarching purpose for maintaining an Asset Management Program. It should consider the impacts to public health, the system's ability to comply with regulations, and financial stability if you do not manage utility resources. The following Mission Statement was developed to represent the purpose and goals of the storm system:

> *The City of Keego Harbor strives to cost effectively maintain its storm drainage system to reduce standing water and maintain the longevity of the roadways. The City tries to ensure the presence of standing water following rain events is limited to around 72 hours. The City will maintain an electronic map of the system used to inventory assets, record condition, and budget for capital improvements to ensure the system operates in a cost-effective manner. The City will endeavor to respond to residential inquiries related to ROW drainage within a reasonable time period during workdays and perform routine operation and maintenance tasks.*

It is noted that there is not a funding source from a specific customer base for the stormwater system. The City either budgets from the general fund or uses dedicated roadway funding to operate, maintain, and perform capital improvements to the storm system.

2.0.2 Asset Management Team

When forming an Asset Management Team, current and past municipal staff (officials, board members, clerks, accountants, and engineers), current and past utility staff (operators and other service workers), and any other stakeholders that can help in assembling the information and executing goals should be considered for inclusion.

Contact information for the personnel involved with development of this Plan is provided below. As implementation of the overall Asset Management Program continues, additional stakeholders will be involved for input and may be added to this list.

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2.1 SYSTEM DESCRIPTION

The City of Keego Harbor is located in the center of Oakland County and resides in Sections 1, 2, 11, and 12 of Township 2N R9E. The City is surrounded by the City of Sylvan to the east, Waterford Township to the north, the City of Orchard Lake Village to the west, and West Bloomfield Township to the south. The entire City covers an area of approximately 360 acres, of which 320 acres are land and 40 acres are water including Dollar Lake and portions of Cass Lake, Otter Lake, and Sylvan Lake. The majority of the land use in the City of Keego Harbor is single family residential area, with the remaining areas consisting of multiple family residential areas and commercial/office properties. The portions of the City along Cass Lake Road and Orchard Lake Road includes all the general and local businesses, multiple family residential, and office buildings. The surrounding areas are where majority of the single family residential neighborhoods reside.

Presently, the majority of the City is developed. The City's downtown area is located at the intersection of Cass Lake Road and Orchard Lake Road and extends along Orchard Lake Road in each direction (east and west) and along Cass Lake Road to the north.

The City of Keego Harbor's topography is flat with few elevation changes (USGS) ranging from 925' to 950' throughout the entire City, which primarily slopes towards the waterways.

2.1.1 Keego Stormwater System

The stormwater system includes the storm pipes, open drains and ditches, retention/detention ponds, manholes, inlets, leaching basins and catch basins that collect stormwater from the service areas and convey them to the outfalls. The open drain/ditch system includes culverts, open channels, check dams, and outfalls.

There are approximately 5,250 feet of 8 to 15-inch diameter City storm pipes, and 67 City structures in the system. In addition, there are approximately 23,500 feet of 8 to 60-inch diameter storm pipes and 197 structures that are owned and maintained by either WRC or RCOC. Any City-owned storm pipes that do not directly outlet to waterways within Keego Harbor, discharge directly into the WRC and RCOC owned systems. From there, the stormwater discharges to either Dollar Lake, Cass Lake, Otter Lake, or Sylvan Lake. Within the City limits there are 3 stormwater pumping stations. However, these are all on the County Drains and are owned and maintained by WRC.

A map showing the general system is provided in Figure 2.

Complete Storm Systems in Keego Harbor

Keego Harbor
- Structures
- Pipes
- Culvert
- Culvert Ends

Road Commission
- Structures
- Pipes

OCWRC
- Structures
- Pipes

Private
- Structure
- Pipe
- Culvert

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2.1.2 City Owned Properties

There are several City-owned properties that border Cass Lake and Dollar Lake, as well as parks that can and have been used for stormwater management. As part of the SAW grant effort, multiple City-owned properties were reviewed for potential stormwater management opportunities and to improve water quality of direct discharge to the lakes. Field verifications were completed on City-owned properties to inventory, delineate the boundaries and review the condition of these assets. Where feasible, conceptual stormwater improvement plans were developed to illustrate the stormwater management and water quality benefits that could potentially be implemented at these locations. An overview map of the City-owned properties with stormwater management concept plans with cost estimates are included as Appendix A.

CHAPTER 3: ASSET INVENTORY

3.0 INTRODUCTION

The first EGLE core component of asset management is the asset inventory. The goal of developing an inventory is to answer the following questions:

- What do I own?
- Where is it?
- What condition is it in?
- What is its remaining useful life?
- What is its value?

It is absolutely critical for a utility to understand what it owns in order to manage it effectively. Unfortunately, often records regarding what assets have been installed may be old, incomplete, inaccurate, and/or missing; and staff turnover in operations and management may limit the historical knowledge of system assets.

The key to any asset inventory is that the data is comprehensive, accessible, and secure. The inventory can start as a very basic list and the data quality can be increased over time as the system gathers more information. The basic inventory data will typically include an asset name or ID, type of asset, location, material or make/model number, nameplate data for equipment, original cost, etc. More robust inventories can be expanded with additional data or linked to work orders.

Some assets will be too small or inexpensive to include in the database. In these cases, the value of the time it takes to input and track the asset is greater than its actual value to the utility. Therefore, assets are listed as Major Maintenance Items (MMIs.) MMIs may be individual items (large equipment items such as pumps and process-specific equipment) and other MMIs may include a group of related items (air relief valves or yard hydrants), an entire system (building heating and ventilation systems) or unit processes (primary clarification.) The inventory is typically organized into logical groupings of assets that fit into a hierarchy of larger and larger groups that can be "rolled" up or down in terms of detail. Items grouped into larger categories or systems can share a single replacement value and a common replacement schedule.

The inventory must also include an estimate of the condition of the assets, the remaining useful life and value. Historical data and staff knowledge can be used at first to make a reasonable estimate to answer these questions, and then the data can be expanded and refined as actual field inspection of the assets is made.

It is important to recognize that asset inventory is an ongoing process. After the initial inventory is established, there must be a system in place in order to ensure the inventory remains up-to-date. New assets must be added, and when existing assets are repaired, replaced or decommissioned, the data for those existing assets must also be updated.

3.1 SYSTEM INVENTORY

3.1.1 Inventory Scope of Work and Method

Storm Drainage System

"Horizontal facilities" generally include the assets that form a collection or distribution system and are disbursed over a large area. Mobile lidar technology was utilized to locate stormwater drainage structures, ditches, and culverts. Structures were opened to verify connectivity and create a map of the system. Structures that could not be located using Lidar were field located with GPS.

The City of Keego Harbor mainly consists of roadside ditches in the neighborhood areas to contain and convey all the stormwater drainage. Over the years, residents have filled in their ditches, either to allow for easier mowing or to provide off-street parking adjacent to the road. Some residents installed pipe or culverts for drainage, but there was no consistency in pipe size or material from property frontage to property frontage. This made it difficult for these pipes to be maintained and ensure proper flow to outfall areas. Identifying the locations of the undocumented structures and pipes helped provide an overall view of where the inconsistency needs to be addressed.

The pipes, manholes, and other related structures were inventoried using the databases generated by the community's GIS. Each structure or pipe was given a unique asset ID in the database, and related information such as size, depth, slope, material of construction, etc. are provided where available. City culverts are defined as culverts crossing the roads. Any culverts that cross under privately-owned driveways, are considered private culverts. Tables showing the fields in the GIS for manholes and pipes are included in Appendix B. Table 1 below shows the inventory of assets:

Table 1: Asset Inventory Summary

Asset Group	Number of Assets	Total Length (feet)
8-inch	11	710
12-inch	66	4,340
15-inch	1	272
City Culverts	22	1,430
Outfall	14	N/A
Leaching Basin	2	N/A
Catch Basin	47	N/A
Manhole	20	N/A

Oakland County Drains:

WRC owns and operates three drains located in the City of Keego Harbor; the Schmid Drain, the Keego Harbor Drain, and the Beechmont Drain.

The Schmid Drain is separated into three sections; Branch A, Branch B, and Branch D. They were constructed around 2003. Schmid Drain Branch A is located along Cass Lake Road between Hensman and Orchard Lake. The drainage district boundary limit includes a 76.1 acre watershed. Schmid Drain Branch B is located along Cass Lake between Glenbroke and Stapleton Court. This Branch outlets to a pumping station at Magnolia by the Lakes South building, then discharges by means of forcemain to Sylvan Lake, west of Stapleton Drive. The drainage district boundary limit includes a 112.2 acre watershed. Schmid Drain Branch D is located in the green belt along North Cass Lake and begins at the pumping station located on Kessler Avenue and discharges to the canal that connects Otter Lake with Cass Lake on the border of Waterford Township by means of forcemain and gravity main. The drainage district boundary limit includes a 16.7 acre watershed.

The Keego Harbor Drain was constructed in 1990 and is located along Willow Beach Road. The Keego Harbor drainage district boundary limits include a 119 acre watershed. The drain begins on Summers Road between Fordham and Harbor Village Avenue and outlets to Dollar Lake, just north of Orchard Lake. The outlet of the drain contains a weir system that is used as a sedimentation basin for the stormwater before entering Dollar Lake.

The Beechmont Drain was constructed in 1989 and is located between Maddy Lane and Beechmont. The Beechmont drainage district boundary limits include a 57.2 acre watershed. The drain inlet collects stormwater overflow from the pond adjacent to City Hall and discharges to a pumping station just north of Wall Street. The pumping station has a total storage volume of 44,600 gallons and has two pumps with the available capacity of 12,500 gpm each. The Beechmont Drain pump station discharges into a canal on Sylvan Lake, east of Rustic Lane.

Review of Ordinances, Standards, and Details

After a review of the City's ordinance, standards, and details, it was noted that the City does not have specific documents related to stormwater management. As part of the grant, an ordinance was developed that primarily referenced the draft Regional Stormwater Standards Coordination Committee (RSSCC) ordinance that is being reviewed by EGLE and anticipated to be adopted, but also includes items specific to the City. If adopted, this ordinance will assist the City to ensure stormwater is not inappropriately discharged to neighboring properties, the quality of the stormwater discharged into the City's Lakes is maintained, that new developments handle increased stormwater volumes on site and that roadside ditches are restored and protected. The ordinance is included in Appendix C. More details on the adoption of this ordinance are included in Chapter 4.

3.2 CONDITION ASSESSMENT, REMAINING LIFE AND VALUE

Condition assessment can be completed in many different ways, depending on the budget and resources available. The simplest way is to assign a numerical ranking to each asset using the best record information available. If additional resources are available, a higher level of assessment could include physical inspection of some or all of the system assets. If only a portion will be physically inspected, priority should be given to those with the potential to be in the worst condition (the oldest, for example) or to the assets deemed most critical to maintaining service or preventing

catastrophic failure. If possible, detailed condition assessment should include a sample of each major asset grouping, such as a sample of each age or type of pipe in a system.

The overall condition of an asset may be summarized by rating it on a scale of 1 to 5, generally as described in the following:

Asset Condition	**Rating**
Unserviceable - Over 50% of asset requires replacement	5
Significant deterioration - significant renewal/upgrade required (20 -40%)	4
Moderate deterioration -Significant maintenance required (10 -20%)	3
Minor Deterioration - Minor maintenance required (5%)	2
New or Excellent Condition - Only normal maintenance required	1

All assets will eventually reach the end of their remaining useful lives. Some assets will reach this point sooner than other assets. There are many factors that will affect the useful life of an asset such as maintenance practices, type of materials, usage, and surrounding environment. Useful life will also vary over time; for example, a pump may originally have been assigned a useful life of 15 years, but with proper maintenance that useful life may extend to 20 years. Useful life should be reevaluated on a regular basis. Past experience, system knowledge, existing and future conditions, and maintenance practices will dictate ongoing changes/updates to the useful life.

The value of the asset is the cost to replace the asset after it has exhausted its useful life. Obtaining costs for the asset replacement is not easy. In some cases, the utility will use an estimate based on best practices; in other cases, the utility may rely on a consultant or manufacturer's catalogs and sales representatives. More reliable data can be added when available.

Storm Drain System

The condition of each pipe, manhole, and other asset in the collection system was estimated based on age, input from City staff, industry standards, review of record installation and repair data, and in some cases, detailed inspections. Detailed inspections were made following the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) and Manhole Assessment and Certification Program (MACP).

66 of the 68 City structures were inspected by MACP trained inspectors using a level 1 plus inspection and given an overall rating of good, fair, or poor. The data collected, including photos, is linked to each manhole structure or catch basin in the GIS system is included as Appendix B.

4,600 feet of the 5,540 (80%) feet of City-owned storm pipes were cleaned, televised, and scored using the PACP protocols by WRC. Structural and Operation and Maintenance quick scores were assigned for each pipe. Any storm pipes that were not televised were either in very poor condition or full of debris and could not be cleaned due to fear of complete failure and collapse. These areas

were added to the CIP to be rehabilitated or replaced. The PACP reports and videos are linked to the pipes in the GIS system and is included as Appendix B.

Future City Planning Maps

The City is relatively flat and experiences frequent ponding water during seasons with high precipitation. In order to assist the City with future planning, and to provide a better understanding of the intent of the system, a drainage district map was developed and is stored as a layer in the City's GIS. The drainage districts are separated into areas that drain to waterways or Keego Harbor storm systems and areas that drain to County-owned drain-pipes. Impervious areas and building footprints were also considered in each drainage district for future planning and development of Keego Harbor's storm system. Each of these layers were created into maps that are included as Appendix D.

Areas with Current Drainage Concerns

Six specific areas with water ponding concerns were investigated as part of the SAW grant. The Mobile lidar data collected from the asset inventory was processed to provide more detailed topographic information to help determine the cause of the standing water. Memos were developed for these areas including conceptual recommendations, cost estimation and a detailed site map. An overview map of these locations and the drainage concern memos are included as Appendix E.

Wetland Delineation Survey

Fran Leaf Park is owned by the City and located north of Brock Street on the north side of the canal off Cass Lake. This park was reviewed to determine areas in the Park which should be considered a wetland. The purpose of the wetland delineation was to determine areas within Fran Leak Park that can be improved upon and which are protected. The wetland delineation will help the City locate potential areas for stormwater management improvements and track the growth of the wetland. A report and map from the delineation survey are included as Appendix F.

CHAPTER 4: LEVEL OF SERVICE

4.0 INTRODUCTION

Level of Service (LOS) defines the way in which the utility stakeholders want the utility to perform over the long term. The LOS can include any technical, managerial, or financial components the utility desires. The LOS will become a fundamental part of how the utility is operated.

All utilities must operate within the state and federal regulations and requirements. In Michigan, these regulations are generally specified in facility's NPDES permit, but there are additional rules and regulations that will apply, such as compliance with MIOSHA. Although the local, state, and federal regulations may set bare minimum standards of operation in the LOS, these standards may not adequately address all areas of operation and should not be the sole factor of the LOS. Utilities should include many other factors to delineate important areas of the utility's operation.

Within the range of the minimum (regulations) and maximum (absolute capabilities of assets), there are numerous items a utility could include within its LOS. Items may be included so the utility can communicate its intentions with its customers, measure its performance, and determine critical assets. It is important for the utility to communicate with its customers to avoid confusion and a negative public image, and to build community support for financing the system. Communication should be used to manage expectations between the utility and the customer.

Defining the LOS also sets the goals for the utility. These goals allow the operations staff to have a better understanding of what is desired from them, and the management has a better understanding of how to use staff and other resources more efficiently and effectively. Periodic review of how the utility is meeting the LOS allows management to shift resources, if needed, from one task to another to meet all the goals most effectively. Understanding the desired LOS will help to prioritize and characterize the system's assets, as well as how to manage finances to reach the LOS goals.

There is a direct link between the LOS provided and the cost to the customer. A higher LOS usually costs more to provide than a lower service level. This direct link demands that the utility have an open dialogue with its customers regarding the LOS desired and the amount the customers are willing to pay for this LOS or increased services.

Similar to the overall Asset Management Plan that will change and adjust over time, the LOS may need to be adjusted from time to time. This adjustment may be required because the system may discover that it is too costly to operate the system at the levels previously defined. Or the adjustment may be necessary due to new rules or regulations that require a change in operation. Additionally, the customers may feel that they desire a different level of service. As with all components of asset management, LOS is an ongoing process and determining and detailing the level of service that the system is going to provide is a key step in asset management.

4.1 QUESTIONS TO CONSIDER

The following questions were discussed in developing the LOS for the system:

1) What is the LOS goal for health, safety, and security?
2) How often is the system out of compliance with regulations?
3) Are the operators properly certified?
4) How does the utility stay aware of and prepare for new regulations?
5) Do you share your LOS statement with your customers?
6) How do you track and respond to customer needs/complaints?
7) Can the current process be improved?
8) How quickly does the utility respond to customer issues?
9) Is maintenance being deferred to save money?
10) How much will the improvements cost and how will they be funded?
11) Are assets being properly maintained to insure they are in reliable working condition?
12) What areas within the system are most important to insure the best LOS possible?
13) When considering a preferred LOS, are asset age and life cycles, asset conditions, funding availability, etc. being factored in?
14) How often will the LOS statement be reviewed in order to capture changes such as funding availability (growth and decline), regulatory requirements, demand of customers (increases/decreases in customers), and physical deterioration of assets (addressing maintenance)?
15) Are O&M activities being maximized to meet the LOS goals?

4.2 SCOPE OF WORK

As part of the asset management planning, it was determined that there is a need for the City to define and communicate to residents a Level of Service for the storm drain system. Through drainage structure inspections, culvert inventories, and drain/pipe televising it was found that residential properties throughout the City have drainage pipes with illicit discharge connections to the City's system, culverts have been filled in or removed, and pipes have been abandoned or simply terminated into the ground.

There are also several surface water ponding concerns following rain events throughout the City. During the Spring of 2019, complaints were tracked from residents regarding these issues. Each of these issues has been investigated and documented in Appendix E. Solutions to some of these issues were addressed in the memos included in Appendix E and some were addressed in the Capital Improvement Plan in Appendix H. However, many of the surface water ponding concerns stem from the topographic features on the City and its location near the lake system.

The City's location between lakes, while appealing to residents to take advantage of the recreation and beauty of the water, lends itself to flat topography, high ground water, and slowly draining stormwater during and following rain events. Historically, stormwater was conveyed through the City's ditches and

culvert system. In many areas of the City, the ditches have been filled and replaced with functioning storm drains/culverts that are functioning properly. However, some ditches have been filled without another drainage solution, causing standing water to accumulate in driveways and roads following rain events.

In order to better define the level of service (LOS), the City decided to develop a mission statement and review and update its ordinances.

4.2.1 Mission Statement

A Mission Statement should be an overarching purpose for maintaining an Asset Management Program. It should consider the impacts to public health, the system's ability to comply with regulations, and financial stability if utility resources are not properly managed. The following Mission Statement was developed to represent the purpose and goals of the stormwater system:

> *The City of Keego Harbor strives to cost effectively maintain its storm drainage system to reduce standing water and maintain the longevity of the roadways. The City tries to ensure the presence of standing water following rain events is limited to around 72 hours. The City will maintain an electronic map of the system used to inventory assets, record condition, and budget for capital improvements to ensure the system operates in a cost-effective manner. The City will endeavor to respond to residential inquiries related to ROW drainage within a reasonable time period during workdays and perform routine operation and maintenance tasks.*

It is noted that there is not a funding source from a specific customer base for the stormwater system. The City either budgets from the general fund or uses dedicated roadway funding to operate, maintain, and perform capital improvements to the stormwater system.

4.2.2 Stormwater Goals

Goals for the Stormwater AMP based on the above mission statement are as follows:

1. Limit the presence of standing water following storm events to 72 hours.
2. Maintain a GIS map of the system including condition information.
3. Provide budget for Operation, Maintenance, and Improvements (OM&I).
4. Respond to residential inquiries regarding ROW drainage within a reasonable time.

The City can set additional goals as new issues arise.

4.2.3 Ordinance Reviews and Updates

The City ordinance included in Appendix C was discussed during the October 15th Council study session and well received by the public attendees and Council Members. It is anticipated that the ordinance will be adopted before the end of the year.

4.3 CONSIDERING CONNECTIONS

Majority of Keego Harbor's storm system connects downstream to systems owned by Oakland County through both the RCOC and WRC. These points have been identified and marked on the GIS database map as discharge points. As discussed, WRC owns and operates three drains in Keego Harbor where majority of the runoff from the City's drainage districts is discharged to; the Schmid Drain, Keego Harbor Drain, and Beechmont Drain. Within these drains, they also maintain three lift stations to control discharge to the waterways.

The City should consider its storm system holistically and be open to potentially coordinating efforts with Oakland County in order to increase efficiency and effectiveness of maintenance, repair, and capital costs. It should also be noted that the lake levels are not controlled by the City but have a large impact on the stormwater system in Keego Harbor.

There are also privately owned systems in the City that connect into the City's system that could be in need of repairs and should be coordinated for inspection. Any issues that are found within private systems should be addressed and coordinated for repairs.

CHAPTER 5: ASSET CRITICALITY

5.0 INTRODUCTION

Not all assets are equally important to the utility's operation. Some assets are highly critical to maintaining operations, and others are not critical at all. Certain assets or types of assets may be critical in one location, but not critical in another. For example, a pump station serving a very large commercial and residential area may be deemed more critical than a pump station servicing a small stormwater basin. A utility must examine its assets very carefully to determine which assets are critical and why.

In determining criticality, two questions are important. The first is how likely it is that the asset will fail; and second, what is the consequence of failure. Determining an asset's criticality will allow a utility to manage its risk and aid in determining where to spend operation and maintenance dollars and plan capital expenditures.

5.0.1 Probability of Failure (PoF)

To determine the Probability of Failure (PoF), a utility needs to look at a number of factors: asset age, condition of asset, failure history, historical knowledge, experiences with that type of asset in general, maintenance records, and knowledge regarding how that type of asset is likely to fail.

Description	Performance Rating	Failure of Individual Item	Type of Failure
Imminent	5	Likely to occur in the life of the item	Continuously experienced
Probable	4	Will occur several times in the life of an item	Will occur frequently
Occasional	3	Likely to occur sometime in the life of an item	Will occur a few times
Remote	2	Unlikely but possible to occur in the life of an item	Unlikely, but can reasonably be expected to occur
Improbable	1	So unlikely, it can be assumed occurrence may not be experienced	Unlikely to occur, but possible

5.0.2 Consequence of Failure (CoF)

To determine the Consequence of Failure (CoF), it is important to consider all of the possible costs of failure. These costs include: cost of repair; social cost associated with the loss of the asset; repair/replacement costs related to collateral damage caused by the failure; legal costs related to additional damage caused by the failure; environmental costs created by the failure; loss of business revenue to the community; and any other associated costs or asset losses. The consequence of failure can be high if any one of these costs is significant or the accumulation of several costs occurs with a failure.

Description	Performance Rating	Impact
Catastrophic disruption	5	Massive system failure, severe health affect, persistent and extensive damage
Major disruption	4	Major effect, major loss of system capacity, major health effects, major costs, important LOS compromised
Moderate disruption	3	Moderate effect, moderate loss of system capacity, moderate health effects, moderate costs, important LOS still achieved
Minor disruption	2	Minor effect, minor loss of system capacity, minor health effects, minor costs
Insignificant disruption	1	Slight effect, slight loss of system capacity, slight health effects

5.0.3 Business Risk Evaluation (BRE)

Assessing criticality requires an examination of the probability of failure and the consequence of failure as discussed above, as well as any redundancy provided in the system. Redundancy can significantly reduce risk. Redundancy refers to whether there are other assets that are able to provide the same service if failure occurs. If one part of a system fails and there is another part available immediately to take its place, then the risk of loss is reduced.

The assets that have the greatest probability of failure and the greatest consequences associated with the failure will be the assets that are the most critical. The Business Risk Evaluation (BRE) score takes into account the PoF, the CoF, shown below. Adjustments are then made to take into account any redundancy available that would mitigate the consequence of failure.

$$BRE = PoF \times CoF$$

Assets with greatest BRE scores are likely candidates for immediate rehabilitation or replacement. Assets with lower scores should to be analyzed to develop the best life cycle strategy. If an asset's potential modes of failure and risks of failure are understood, it is possible to leverage use of the asset for a longer period and ensure the useful life is maximized before investing in replacement.

Risk should be managed in any decision-making process. The utility should analyze and document acceptable risk tolerance for all critical assets. The condition of the asset will change over time as will the consequences related to failure. It will be necessary to periodically review the criticality analysis and make adjustments to account for changes in the probability and consequence of any asset failures. As with all the components of the Asset Management Program, the criticality analysis is an on-going process.

5.1 PROBABILITY OF FAILURE

Each of the assets was given a ranking from 1 to 5 for probability of failure. This ranking was based on the asset's current condition, the environment in which the asset functions, and the historical experience with

failure for that service. Appendix G includes tables showing how POF was calculated, a map of the POF values, and the number of structures and storm pipes assigned to each value.

5.2 CONSEQUENCE OF FAILURE

Each of the assets was given a ranking from 1 to 5 for consequence of failure. This ranking was based on the relative importance of the asset in the overall system, potential impacts to the surrounding area and downstream systems in failure, and historical experience. Appendix G includes tables showing how COF was calculated, a map of the COF values, and the number of structures and storm pipes assigned to each value.

5.3 BUSINESS RISK EVALUATION

The product of the POF and the COF resulted in the final business risk evaluation (BRE) score.

The City's GIS system includes fields for the POF, COF, and BRE ratings, as well as the scoring factors that were considered to perform these calculation as noted in the tables in Appendix G. The calculations were done in ArcMap using GIS modeling software. Maps of the BRE scores and numbers of structures and pipes with each score are included as Appendix G.

CHAPTER 6: O&M AND REVENUE STRUCTURE

6.0 INTRODUCTION

Developing an operation & maintenance (O&M) plan or manual is important for a City in order to maintain the quality and longevity of their stormwater system. Basic elements for developing a plan include maintenance schedules, inspection frequency & requirements, easements for maintenance and identifying a funding source. Maintenance of stormwater systems include; trash removal around catch basins, removal of sediment in structures using a vactor truck and keeping a log of the amount of sediment collected. Tracking O&M activities can be completed by utilizing GIS systems, which can assist in optimizing future cleaning efforts.

Typically, municipalities do not have their customer bases billed for stormwater services or allocate other dedicated funding sources. O&M and capital improvements are often funded through the general fund. The general fund should be discussed each year and be based on the regular yearly O&M costs while taking into account any necessary rehabilitation for the year.

6.1 OPERATION AND MAINTENANCE BUDGET

6.1.1 Annual Maintenance

An annual operation and maintenance budget should include the typical costs spent each year to operate the City stormwater infrastructure system and to perform normal maintenance activities. It does not include major capital improvements that are required to increase capacity or meet new regulatory requirements, or replacement of items with a useful life of more than 20 years, such as drains, structures, culverts, etc. This budget does include costs related to personnel, utility charges and energy use, chemicals, supplies, disposal costs, etc. The O&M budget should account for expected annual cost increases, such as increases in utility charges, wages and benefits, etc.

It is recommended that the storm system be cleaned and televised at least every 5 years. Anticipated costs to clean and televise the entire system is approximately $30,000.

6.1.2 Preventative Maintenance

Storm drain pipes, culverts and structures are typically run to failure with some preventative maintenance done to extend the useful life of the facility and to ensure safety for pedestrians and vehicles. Necessary preventative maintenance is typically funded using the City's general fund.

Below is table of O&M schedule tasks for specific asset items that should be performed by the City regularly.

Table 2: O&M Schedule & Costs

Asset Type	# of Assets	O&M Schedule	O&M Costs
Leaching Basins	2	Clean/Vactor out twice a year – *Spring & Fall*	$2,000 (x 2)
Outfalls	14	Inspect & clear debris once a year – *Spring*	$2,000
City-Owned Culverts	22	Inspect & clean inlets once a year – *Fall*	$3,500 (x 1/2)
Catch Basins	47	Inspect & clean/vactor every 5 years	$47,000 (x 1/5)
		TOTAL YEARLY BUDGET	$17,500

6.2 STORMWATER SYSTEM VALUE

A valuation of the existing stormwater system assets that estimates replacement of the entire system is not feasible or necessary. It would be more feasible for the entire system to be lined using cured-in-place pipe (CIPP). The cost to rehabilitate the entire stormwater system using cured-in-place pipe (CIPP) lining is a more realistic way to value the existing system. The estimated cost to install a cured-in-place pipe liner in each City-owned storm drain pipe is approximately $650,000.

As part of the Stormwater Asset Management Program, the majority of the storm structures were able to be inspected well enough to determine a rehabilitation cost. The estimated cost to rehabilitate all of the City-Owned storm structures is approximately $34,400, which is included with the Storm Manhole CIP further discussed in Chapter 7. A replacement cost for the City-Owned storm structures was calculated based on structure diameter, depth and proximity to utilities, water, and roads. The estimated cost to replace all of the City-Owned storm structures is approximately $590,000.

6.3 REPLACEMENT FUND

It is helpful to maintain a replacement fund that identifies items owned by the utility. These operating pieces of equipment generally have a useful life of 20 years or less and contain moving parts. Replacement items will also appear in the asset inventory, but usually have a dedicated funding source due to their limited useful life and importance to the operation of the system. On an annual basis, replacement funds are set aside in a dedicated "Replacement Fund" and build up until needed.

The purpose of the Replacement Fund is to set aside money on an annual basis for items that will need to be replaced during the normal course of operating the system. Once a particular item fails, money is drawn from the Replacement Fund to replace the item in question without disrupting the existing budget.

The replacement cost is the cost to replace the item at failure or replacement time. The replacement cost is divided by the remaining useful life to calculate an annual contribution to the Replacement Fund for each item. The annual total amount for replacement will then be included in the budget as a line item. These items will be funded out of system revenues, so they must be accounted for in the annual budget and in the rates and charges.

It is noted that this process of determining valuation did not involve a determination of depreciation value for accounting purposes. The only purpose in this valuation determination was to determine the recommended amount of funds to set aside for yearly basic replacement and rehabilitation.

In most cases, it is not known which year in the next 20 that any given piece of equipment will need to be repaired/replaced. Thus, the 20 year cost budget is divided into 20 for a set aside dollar amount for the rates. This amount should be set aside each year, even if not spent, so that when the expected repair does occur, funds are available to do the work without the City borrowing money for the expense.

6.4 STORMWATER UTILITY FEE

The City recognized the need for and discussed the possibility of developing a stormwater utility fee to help with the costs to maintain, address the areas with frequent water ponding, and plan for capital improvements. Some of the work done through the grant would contribute to the development of a stormwater usage free including the drainage district map, impervious surface layer, and building footprint information. The City will continue to investigate this as an option.

If a storm water utility rate is established, the rate methodology is a tool to determine utility rates and charges that will provide sufficient revenues to cover operation, maintenance, replacement, capital improvement projects, and debt costs associated with the system.

A billable methodology would generate revenue through a commodity rate based on building footprints and impervious surfaces on the property. A readiness to serve or fixed charge methodology would generate revenues through a fixed unit such as a residential equivalent unit or meter equivalent unit. A fixed and variable methodology is a combined methodology and would generate revenues for fixed expenses through a fixed unit and generate revenues for variable expenses through a commodity rate.

The budget should consist of the actual budget line items as required by the State of Michigan Chart of Accounts and other accounting statutes, rules, regulations, and requirements applicable to municipal entities. Only those costs related to the stormwater system should be listed in the stormwater budget. Accurate budgeting will help track and control spending, ensure accountability, and improve the ability to anticipate expenses.

Once total expenses have been identified, rates and charges could be reviewed to determine how to provide sufficient revenues to cover expenses. If subsidies occur, then the users of the system are not paying for the true cost of service – someone else is making up the difference. While temporary subsidies are sometimes necessary to cover unexpected costs, continued use of subsidies will result in either significant rate increases in the future or a problematic deficit in the wastewater or stormwater budget.

CHAPTER 7: CAPITAL IMPROVEMENT PLAN

7.0 INTRODUCTION

A long-term Capital Improvement Plan (CIP) should look at the utility's needs for the future, typically over a period of at least 20 years, with greater emphasis on the first five years of the plan. It is understood that the specific expenditures and needs of the utility in the latter years are more speculative than the needs for the first 5 years; however, the inclusion of the needs for this longer time period will provide a better opportunity for the utility to ensure the system is evaluated in a comprehensive manner and improvement projects are coordinated. Capital improvement projects are projects that the utility has an extended period of time to plan for and are projects that usually cover high cost, non-recurring items.

There are several categories of capital improvements that must be considered, including:

- Capital Needs Related to Future/Upcoming Regulations
- Capital Needs Related to Major Asset Replacement
- Capital Needs Related to System Expansion
- Capital Needs Related to System Consolidation or Regionalization
- Capital Needs Related to Improved Technology

In order to fund any short or long-term project, the utility must first identify the desired project and its anticipated cost. Once costs have been identified, the utility could choose to begin to set money aside to fund future projects. The Capital Improvement Fund could be funded on an annual basis and the accumulated Capital Improvement Fund monies can be used to supplement bonding for the particular project, act as a down payment, or cover the entire cost of the project as determined by the utility.

The utility determines the estimated cost of each identified project and the intended date for project initiation. The clear identification of the project, its cost, and the intended timeframe provides the utility with a defensible presentation for setting aside and safeguarding funds for projects.

The following information is helpful when prioritizing and gaining support for a capital improvement project:

- Description of the project
- Brief statement regarding the need for the project
- Year project needed
- Is the year needed flexible or absolute
- Estimate of project cost
- How costs were estimated
- Funding source(s) considered/available for this type of project

Recommended CIP projects are listed below for the next 0-20 years. This CIP is generated from the most current CCTV defects and is separate from the Replacement Fund of the system. The CIP may change in future years when the system is re-televised and new CCTV defect data is available. A full CIP is included as Appendix H.

Capital Projects, 0 to 20 years total:

- Excavation: $36,000
- Pipe Open Cut: $13,700
- Pipe Spot Liner: $10,000
- Point Repair: $11,000
- Stabilize Culvert: $3,000
- *Pipe Heavy Clean, Pre CCTV, Post CCTV: $6,500
- Manhole Repair (Cover, Joints, Adjust, Uncover, etc.): $34,300

TOTAL STORM 0 to 20-year CIP **$114,500**

Table 3: 0 to 5-year Pipe and Manhole CIP

Item	Locations	Lineal Feet	Cost
Excavation	4	210	$ 24,000
Pipe Open Cut	4	50	$ 7,700
Pipe Spot Liner	3	10	$ 8,000
Point Repair	2	n/a	$ 11,000
Stabilize Culvert	3	n/a	$ 1,500
Heavy Clean, Pre-Post CCTV	14	810	$ 3,000
Manhole Repairs	16	n/a	$ 27,850
TOTAL 0 to 5 years			**$ 83,000**

Table 4: 5 to 20-year Pipe and Manhole CIP

Item	Locations	Lineal Feet	Cost
Excavation	2	70	$ 12,000
Pipe Open Cut	5	40	$ 6,000
Pipe Spot Liner	1	2	$ 2,000
Stabilize Culvert	3	n/a	$ 1,500
Heavy Clean, Pre-Post CCTV	12	1000	$ 3,500
Manhole Repairs	15	n/a	$ 6,500
TOTAL 5 to 20 years			**$ 31,500**

Table 5: Stormwater Improvements on City Property CIP

Item	Locations	Quantity	Cost
Bank Stabilization	3	470-ft	$ 18,500
Culvert Outlet Stabilization	2	60-sft	$ 7,000
Install Riprap	1	25-ft	$ 5,000
Swale Installation	2	1,500-sft	$ 12,000
Rain Garden Installation	1	430-sft	$ 11,500
Pervious Pavement	1	650-sft	$ 13,000

Install Storm Pipe	1	40-ft	$ 16,000
TOTAL COST			**$ 83,000**

7.1 ANTICIPATED SCHEDULE AND FUNDING

The CIP provided in Appendix H should serve as a guide for the coming years. If a larger project is undertaken in the area of the recommended repairs, manhole and pipe/culvert rehabilitation could be included in the project. The information in Appendix E, that addresses the drainage issue recommendations, and Appendix A, that addresses the stormwater management on city-owned properties, should also serve as guides for future planning. Included in Appendix A is a native plant list to also be used as a guide for both the City and residents. Because there is not a dedicated funding source for the stormwater CIP, an exact schedule of implementation and how funding will be made available (build up cash reserves, bond, grants) has not been included as part of the SAW grant efforts. As grants become available, the City can use this CIP document as a reference to prepare grant applications.

CHAPTER 8: CONCLUSION AND RECOMMENDATIONS

8.0 INTRODUCTION

The SAW program provided funding for a thorough review of the City's stormwater system. As discussed throughout this report, asset management is an ongoing process without an end date. Through the SAW program, the City was able to update its GIS system significantly, assess the condition of the majority of the system, and put in place processes to continue asset management activities into the future. Below is a summary of how the funding was used:

- Asset Inventory
    - Created a GIS database with location accuracy, ownership, and condition data.
    - Plans were scanned and linked to GIS for easier reference.
    - City owned properties & future stormwater management recommendations.
    - Purchase of DPW field tablet, 7 desktop computers, a printer/scanner/copier and software including GIS for inventory, record keeping, and day-to-day operations to manage the system.
- Condition Assessment/ Preventative Maintenance
    - Logged data of culverts.
    - Inspected 98% of manholes/catch basins.
    - Cleaned and televised 87% of storm pipes with observations added to the GIS.
- Criticality, LOS, CIP, Planning, and Misc.
    - Developed criticality scores for horizontal assets.
    - Estimated cost and timeline of future repairs.
    - Created DPW regular maintenance log for assets.
    - Developed a mission statement and level of service.
    - Updated City ordinances and MS4 permit.
    - Implemented a FOG educational program.

8.1 FOR SAW, REQUIRED REPORTING

A summary of this plan and a Certificate of Completion for the MDEQ's SAW Grant Program has been submitted to MDEQ separately and will be posted on MDEQ's website. The Certificate of Completion is also included in the Appendix I. This full plan and associated materials will be made available to the public upon request for 15 years following the December 2019 deadline, until December of 2034.

8.2 MS4 REPORTING

The City's stormwater system is required to maintain a MS4 Permit under the NPDES through EGLE because the system discharges to Waters of the State. The goal of the MS4 program is to reduce the discharge of pollutants to surface waters of the State. A MS4 is a system of drainage (including roads, storm drains, pipes, and ditches, etc.) that is not a combined sewer or part of a sewage treatment plant. During wet weather, pollutants are transported through MS4s to local water bodies.

While this AMP is not directly related to the City's MS4 permit, many of the deliverables will assist the City with compliance such as the updated system map and condition assessment data. Progress Reports are due biennially for the MS4 permit and cover the previous two-year span. Employee training, illicit discharge identification, pipe televising, catch basin cleaning, new outfall discovery, Best Management Practices (BMP) implementation, and public education materials are just a few of the aspects that need to be documented. The SAW effort will assist with the next Progress Report.

8.3 SUMMARY OF GOALS KEY PERFORMANCE INDICATORS

The following will be monitored and used to determine system performance include:

- Limit the presence of standing water following storm events to 72 hours & document in ArcGIS.
- Maintain the ArcGIS map of the system including condition information and improvements.
- Provide a budget for Operation, Maintenance, and Improvements (OM&I).
- Respond to residential inquiries regarding ROW drainage within a reasonable time.

8.4 FUTURE ASSET MANAGEMENT GOALS

Additional goals the community plans to address in the future include:

- Fulfill MS4 reporting obligations to meet stormwater discharge compliances.
- Follow an O&M schedule to maintain a clean stormwater system regularly.
- Develop a revenue structure for proper planning and O&M of stormwater infrastructure.
- Implement the recommended stormwater improvement plans on the City-owned properties.

Appendix A

City-Owned Property Maps

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

MAILING: PO Box 824
Bloomfield Hills, MI 48303-0824

SHIPPING: 555 Hulet Drive
Bloomfield Hills, MI 48302-0360

PHONE: 248-454-6300
WEBSITE: hrcengr.com

Memorandum

To: Jered Ottenwess

From: Hubbell, Roth, & Clark

Date: November 4, 2019

Subject: Stormwater Management on City-Owned Properties HRC Job No. 20130735

BACKGROUND

- Field verification was completed on the City-owned properties to inventory and review the condition of City-owned assets.
- Four City owned properties were further reviewed for purposes of stormwater management planning.
- The four properties that were reviewed are near waterways, Dollar Lake and Cass Lake, and are intended for:
  - Improving water quality of direct discharge to Dollar Lake and other waterways.
  - Potential stormwater management opportunities.

RECOMMENDATIONS

HRC proposes the following best management practices (BMPs) that could be implemented in order to address stormwater management on the City-owned properties. See attached map for markups on the proposed BMPs location.

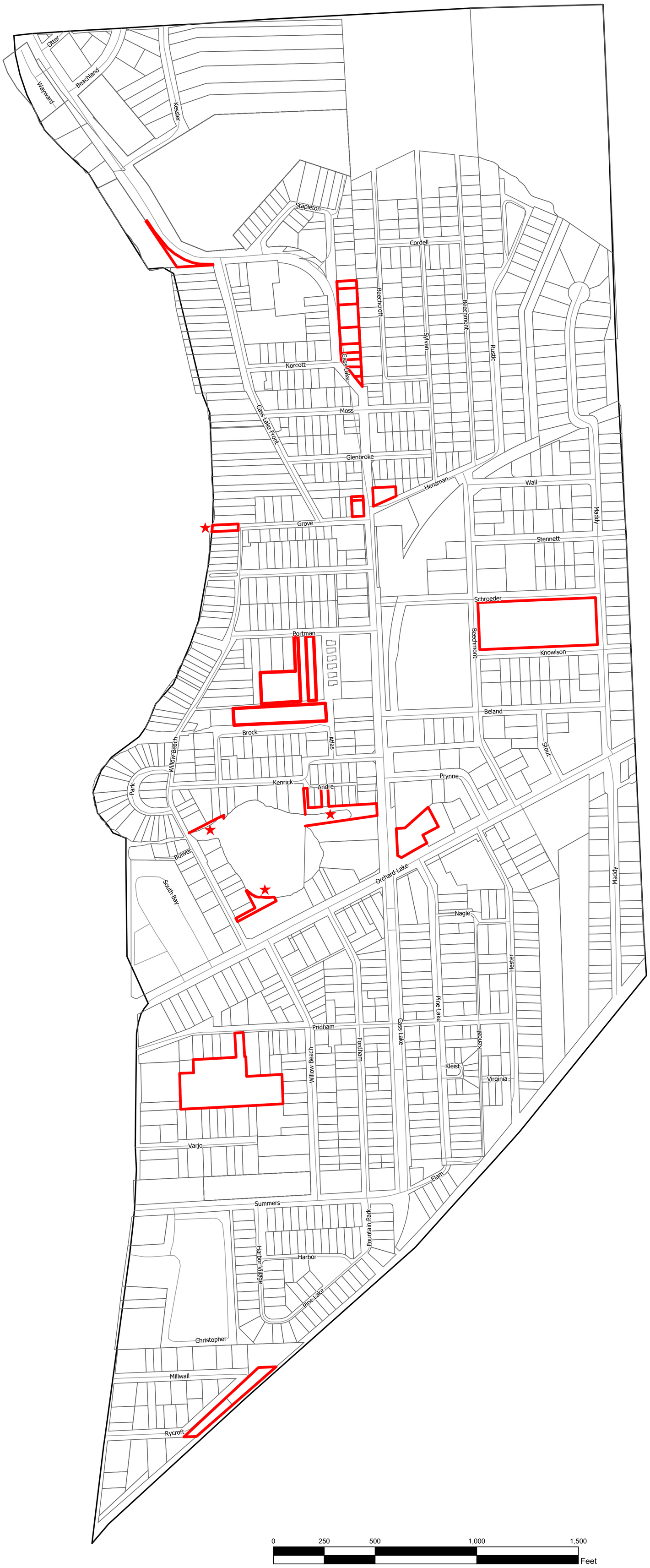
- **Bioretention or Bio-Infiltration**
  - **Definition**: Landscaped shallow basins filled with native, flowering plants and grasses through physical, chemical, and biological processes.
  - **Purpose**: Slow and treat on-site stormwater runoff.
  - **Examples**: Rain gardens, swales, curb-less parking lots islands, or tree box filters.
- **Pervious/Porous Pavement**
  - **Definition:** Designed pavement that allows water to percolate or infiltration stormwater through its surface to the soil below.
  - **Purpose:** Naturally filter out pollutants and forces water that normally runs off the pavement to infiltrate.
  - **Examples:** Grid pavers, poured-in-place asphalt and concrete, or modular pavers.
- **Subsurface Infiltration or Detention**
  - **Definition:** Underground structures used to temporarily detain and release stormwater.
  - **Purpose:** Manage stormwater runoff without occupying surface space or parking areas.
  - **Examples:** Underground storage vaults, stone storage, or plastic grid storage.
- **Slope Stabilization**
  - **Definition:** Method of adding a surface cover to slopes near waterways, excavating or regrading, adding support structures, and introducing stabilizing forces.
  - **Purpose:** Prevent unnecessary debris from entering waterways and assist with filtering stormwater runoff.

COST ESTIMATES

BMP Application	Cost Range	Per Unit
Rain Gardens	$3.00 - $4.00	SFT
Swales	$0.50 - $1.00	FT
Parking Lot Filter Strips	$2.50 - $5.00	CFT
Tree Box Filters	$7,000 - $10,000	PER BOX
Grid/Grass Pavers	$3.00 - $10.00	SFT
Poured-in-Place Permeable Pavement	$2.00 - $6.50	SFT
Modular Pavers	$4.00 - $6.00	SFT
Underground Storage Vault	$3.00 - $10.00	CFT
Plastic Grid Storage	$1.50 - $5.00	SYD
Slope Stabilization	*Varies depending on technology/ method.*	

Refer to EPA's Green Infrastructure Design Manual or SEMCOG's Green Infrastructure Vision Manual.

Keego Harbor Owned Parcels



Legend

- Parcels
- ★ Stormwater Management Recommendations

City of Keego Harbor

"Heart of the Lakes"

HRC

HUBBELL, ROTH & CLARK, INC

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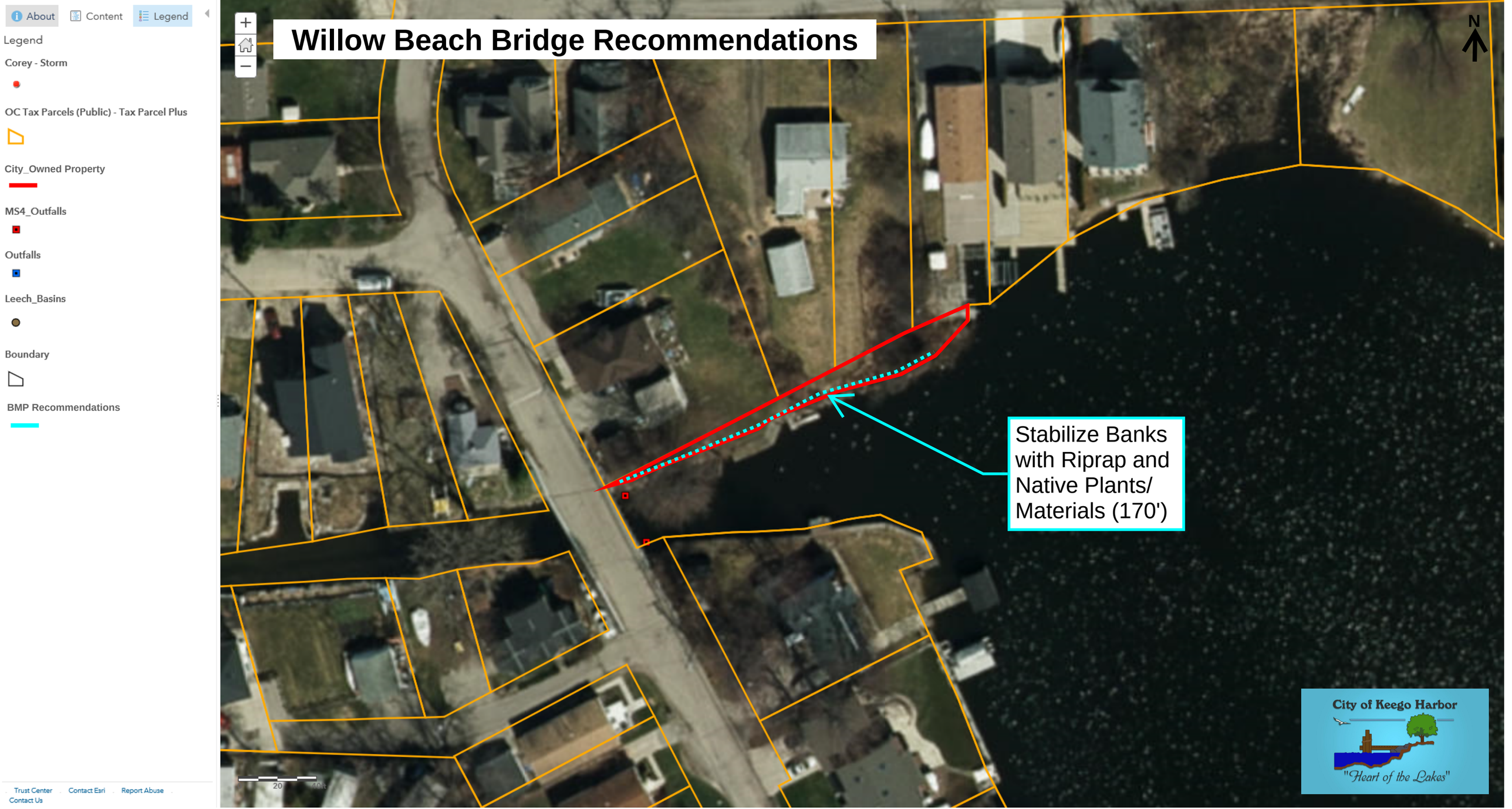
About
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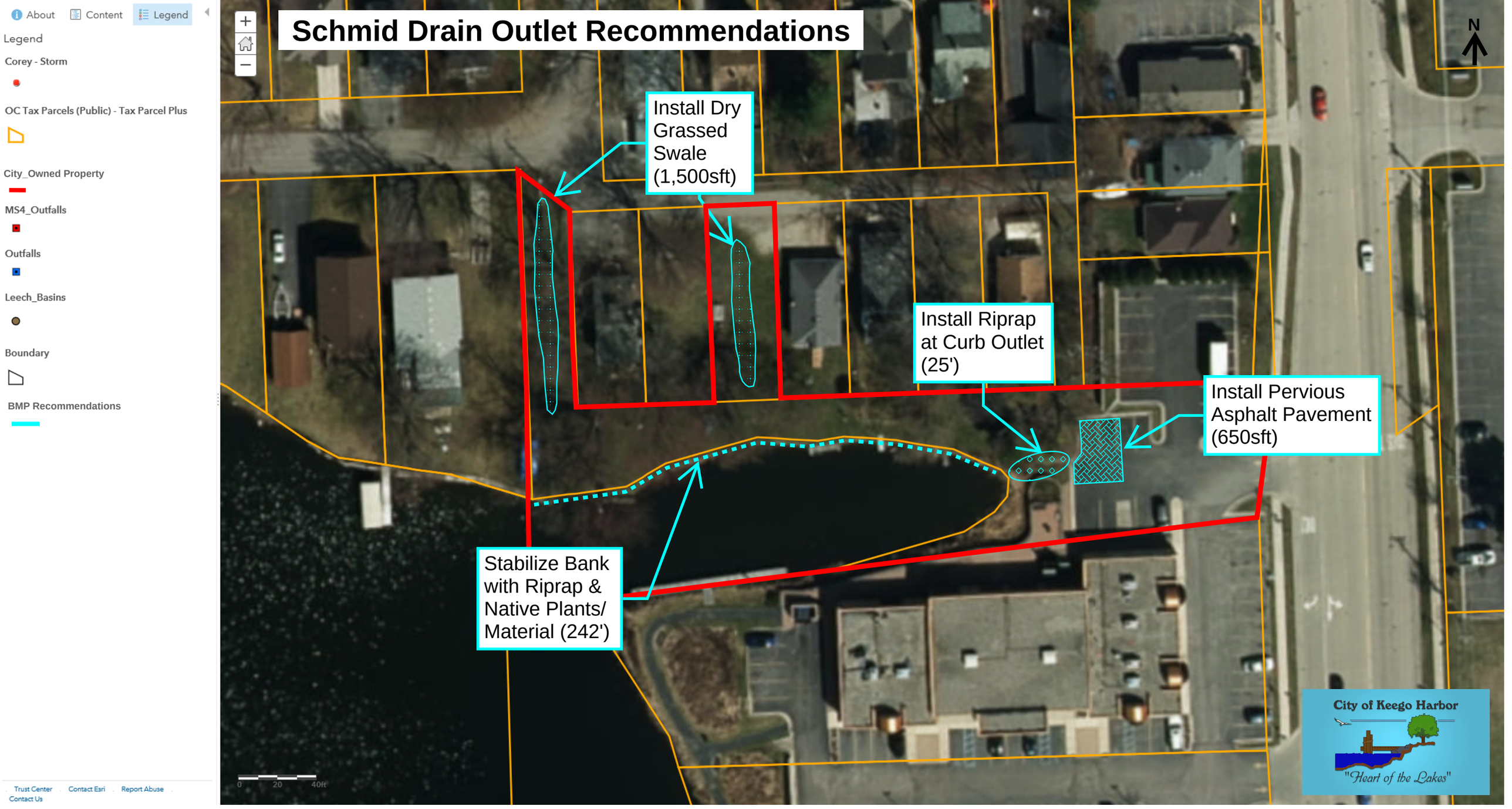
Legend
Legend
Corey - Storm
OC Tax Parcels (Public) - Tax Parcel Plus
City_Owned Property
MS4_Outfalls
Outfalls
Leech_Basins
Boundary
BMP Recommendations
Willow Beach Bridge Recommendations
N
Stabilize Banks with Riprap and Native Plants/ Materials (170')
City of Keego Harbor
"Heart of the Lakes"
Trust Center
Contact Esri
Report Abuse
Contact Us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Corey - Storm
OC Tax Parcels (Public) - Tax Parcel Plus
City_Owned Property
MS4_Outfalls
Outfalls
Leech_Basins
Boundary
BMP Recommendations
Schmid Drain Outlet Recommendations
Install Dry Grassed Swale (1,500sft)
Install Riprap at Curb Outlet (25')
Install Pervious Asphalt Pavement (650sft)
Stabilize Bank with Riprap & Native Plants/ Material (242')
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City of Keego Harbor
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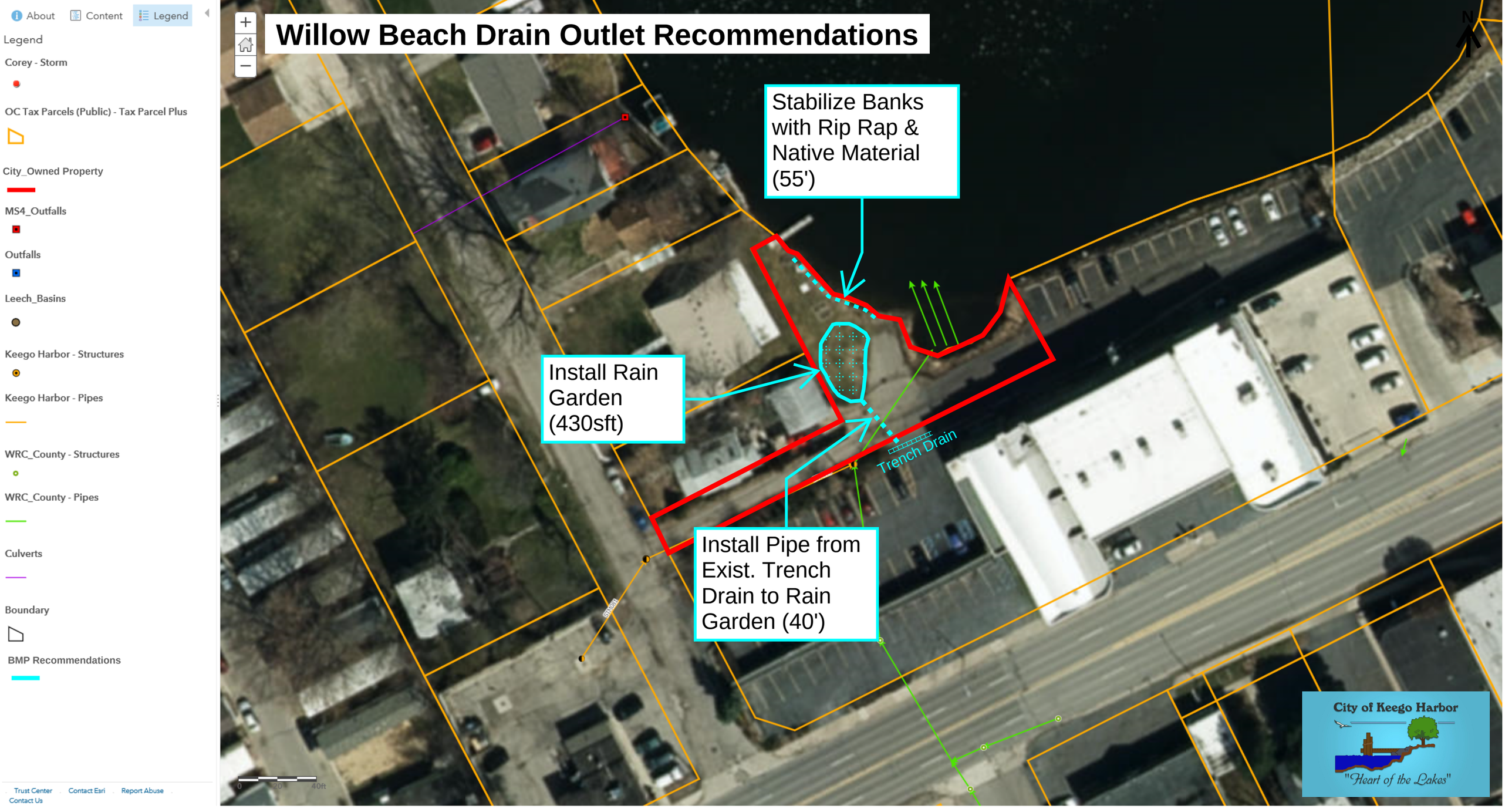
Trust Center
Contact Esri
Report Abuse
Contact Us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Keego Harbor - Pipes
WRC_County - Structures
WRC_County - Pipes
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Willow Beach Drain Outlet Recommendations
Stabilize Banks with Rip Rap & Native Material (55')
Install Rain Garden (430sft)
Install Pipe from Exist. Trench Drain to Rain Garden (40')
Trench Drain
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MS4_Outfalls
City_Owned Property
Leech_Basins
Keego Harbor - Structures
Keego Harbor - Pipes
WRC_County - Structures
WRC_County - Pipes
Culverts
Boundary
BMP Recommendations
Trust Center
Contact Esri
Report Abuse
Contact Us
Grove Street Park Recommendations
Stabilize Culvert Outlet with Geotextile Fabric & Aggregate
Stabilize Culvert Outlet with Geotextile Fabric & Aggregate
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Appendix B

GIS Data Dictionary and NASSCO Excerpts

Appendix B – GIS Data Dictionary

This Appendix is a detailed description of the GIS data fields developed for each of the Sewer Manhole and Sewer Pipe feature classes (GIS layers). There are two sets of data for each feature class: the Master Database and the Criticality Scoring data. Therefore, there are four parts to this document:

1. Structure Master Database
2. Structure Scoring
3. Pipe Master Database
4. Pipe Scoring

Many of the data fields were derived from the National Association of Sewer Services Companies (NASSCO) and from the years of field inspection experience of Hubbell, Roth & Clark, Inc. The fields derived from the NASSCO Version 7 manuals will have an underscore and number following the field name, which will refer to the field number for the MACP or PACP portion of the training manual (such as "_35"). The inspection fields listed are mostly part of the Level 1 NASSCO MACP inspection with additional fields developed by HRC, making it a Level 1 hybrid. Some of the additional fields are from the Level 2 inspection but not all Level 2 fields are included. The corresponding field definition from the NASSCO Version 7 manual is included with this Appendix. The user should refer to the underscored number after the field name to find the field number in the included manual pages for a further description of the field.

The pipes were inspected by both HRC (for pipe information visible in the manholes) and a CCTV Contractor. The CCTV contractor provided a separate shapefile that contains a layer mapping the laterals and defects found during the inspection. These defects along with the O&M and Structural Quick Scores were used to rate the condition or Probability of Failure of the pipes and develop a Capital Improvement Plan (CIP). Appendix C, *PACP Condition Grading System*, of the NASSCO Training Manual, which is included with this Appendix, explains the codes used to described defects and how the quick scores are derived.

The field names without an underscore and number are the fields developed by HRC and have a definition and explanation given below. The fields are intended to be used for statistics, counting, and overall summary for asset condition during the report phase of the SAW Grant project. The Rehabilitation Fields do not serve as stand-alone recommendations for Work-Orders or Contract Work but are intended to summarize the overall condition into typical construction procedures performed by construction companies. These can be used to generating SAW grant Capital Improvement Programs and cost estimates. The data provided in these fields was also intended to be used in collaboration with HRC's Civil Department projects (paving, water, sewer, etc.) in order to prioritize construction work where excavation is needed.

1. Structure Master Database

The following fields are from the structure inspections done by HRC.

Field Name	Explanation
Asset_ID_22	Refer to the NASSCO Version 7 Manual field number.
City_24	Refer to the NASSCO Version 7 Manual field number.

Field Name	Explanation
Street_23	Refer to the NASSCO Version 7 Manual field number.
Date_11	Refer to the NASSCO Version 7 Manual field number.
Surveyed_By_1	Refer to the NASSCO Version 7 Manual field number.
Certificate_Number_2	Refer to the NASSCO Version 7 Manual field number.
Weather_14	Refer to the NASSCO Version 7 Manual field number.
Purpose_of_Survey_17	Refer to the NASSCO Version 7 Manual field number.
Inspection_Level_18	Refer to the NASSCO Version 7 Manual field number.
Inspection_Status_19	Refer to the NASSCO Version 7 Manual field number.
MH_Use_29	Refer to the NASSCO Version 7 Manual field number.
Access_Type_30	Refer to the NASSCO Version 7 Manual field number.
Location_Code_25	Refer to the NASSCO Version 7 Manual field number.
Surface_Type_26	Refer to the NASSCO Version 7 Manual field number.
Rim_to_Grade_IN_35	Refer to the NASSCO Version 7 Manual field number.
Cover_Material_50	Refer to the NASSCO Version 7 Manual field number.
Cover_Type_45	Refer to the NASSCO Version 7 Manual field number.
Cover_Vent_Hole_Number_52	Refer to the NASSCO Version 7 Manual field number.
Cover_Shape_46	Refer to the NASSCO Version 7 Manual field number.
Cover_Size_IN_47	Refer to the NASSCO Version 7 Manual field number.
Cover_Size_Width_IN_49	Refer to the NASSCO Version 7 Manual field number.
Cover_Frame_Fit_55	Refer to the NASSCO Version 7 Manual field number.
Cover_Condition_56	Refer to the NASSCO Version 7 Manual field number.
Evidence_of_Surcharge_33	Refer to the NASSCO Version 7 Manual field number.
Cover_Insert_Type_57	Refer to the NASSCO Version 7 Manual field number.
Cover_Insert_Condition_58	Refer to the NASSCO Version 7 Manual field number.
Cover_Adj_Ring_Type_59	Refer to the NASSCO Version 7 Manual field number.
Cover_Adj_Ring_Material_60	Refer to the NASSCO Version 7 Manual field number.
Cover_Adj_Ring_Condition_61	Refer to the NASSCO Version 7 Manual field number.
Frame_Material_63	Refer to the NASSCO Version 7 Manual field number.
Frame_Condition_68	Refer to the NASSCO Version 7 Manual field number.
Frame_Offset_Dist_IN_70	Refer to the NASSCO Version 7 Manual field number.
Frame_Seal_Inflow_71	Refer to the NASSCO Version 7 Manual field number.
Frame_Seal_Condition_69	Refer to the NASSCO Version 7 Manual field number.
Chimney_Present_73	Refer to the NASSCO Version 7 Manual field number.
Chimney_Material_74	Refer to the NASSCO Version 7 Manual field number.
Chimney_InI_76	Refer to the NASSCO Version 7 Manual field number.
Chimney_Height_to_Rim_FT_78	Refer to the NASSCO Version 7 Manual field number.
Chimney_Condition_81	Refer to the NASSCO Version 7 Manual field number.
Cone_Type_82	Refer to the NASSCO Version 7 Manual field number.
Cone_Material_83	Refer to the NASSCO Version 7 Manual field number.
Cone_Condition_87	Refer to the NASSCO Version 7 Manual field number.

Field Name	Explanation
Wall_Diameter_FT_88	Refer to the NASSCO Version 7 Manual field number.
Wall_Material_90	Refer to the NASSCO Version 7 Manual field number.
Wall_Condition_94	Refer to the NASSCO Version 7 Manual field number.
Bench_Present_95	Refer to the NASSCO Version 7 Manual field number.
Bench_Condition_98	Refer to the NASSCO Version 7 Manual field number.
Channel_Installed_99	Refer to the NASSCO Version 7 Manual field number.
Channel_Material_100	Refer to the NASSCO Version 7 Manual field number.
Channel_Condition_103	Refer to the NASSCO Version 7 Manual field number.
Step_Number_104	Refer to the NASSCO Version 7 Manual field number.
Step_Material_105	Refer to the NASSCO Version 7 Manual field number.
Step_Condition	Added by HRC with further explanation below.
Sump_Present	Added by HRC with further explanation below.
Sump_Depth_FT	Added by HRC with further explanation below.
MH_Structural_Condition	Added by HRC with further explanation below.
Rehab_Status	Added by HRC with further explanation below.
Rehab_Structural	Added by HRC with further explanation below.
Rehab_II	Added by HRC with further explanation below.
Rehab_OM	Added by HRC with further explanation below.
Rehab_Notes	Added by HRC with further explanation below.
Problem_Observed	Added by HRC with further explanation below.
Comments	Comments by HRC inspection or GIS staff

This describes the un-numbered Rehabilitation Fields above, which were created by HRC.

Step_Condition – This describes the general (Good, Fair, Poor) condition of the steps leading down into the manhole
Sump_Present – This is a Yes/No indication of whether a sump is located in the structure. Normally just for catch basins.
Sump_Depth_FT – If a sump is present, this is the depth in feet of the sump.
MH_Structural_Condition – This describes the general overall condition of the manhole as observed by the inspector.

Rehab_Status

- No Action
  - Based on the visual interpretation of the MACP Inspector, the manhole does not require any corrective action of structural or maintenance issues.
- Emergency Repair
  - Based on the visual interpretation of the MACP Inspector, the structure has an immediate structural issue that poses immediate danger to the public, such as collapse, unstable adjustment section, active surcharging, or missing cover/holes.

- Repairs/Maintenance Needed
  - Based on the overall visual interpretation of the MACP inspector, the manhole structure requires repairs or maintenance as noted in previous fields. Such repairs may include routine mortar pointing, patch sealing, cleaning, chimney adjustment, or cover replacement.

Rehab_Structural

- Replace Cover_wrong cover label or broken
  - The Inspector has noted that the manhole Cover has been mislabeled with the wrong owner or wrong system type (i.e. water, electrical/traffic signal, etc) or the Cover requires replacement sue to cracks, corrosion, or inability to open.
- Joint Mortar_Seal
  - Based on the visual interpretation of the MACP Inspector, the Chimney/Adjustment Section requires proper pointing/sealing in order to eliminate infiltration or roots.
- Reset/Adjust Frame_veg/gvl –
  - Based on the visual interpretation of the MACP Inspector, the Frame requires resetting or adjustment to proper grade in grassy/vegetation surface types in order to correct the problem noted
- Reset/Adjust Frame_pave
  - Based on the visual interpretation of the MACP Inspector, the Frame requires resetting or adjustment to proper grade in pavement area (road, sidewalk, parking lot) in order to correct the problem noted
- Reconstruct Chimney_veg/gvl
  - Based on the visual interpretation of the MACP Inspector, the Chimney section requires reconstruction in grassy/vegetation surface types in order to correct the problem noted
- Reconstruct Chimney_pave
  - Based on the visual interpretation of the MACP Inspector, the Chimney section requires reconstruction in pavement surface types in order to correct the problem noted
- Reconstruct Manhole_veg/gvl
  - Based on the visual interpretation of the MACP Inspector, the Manhole Structure, (including wall and/or cone section) requires reconstruction/replacement in grassy/vegetation surface types in order to correct the problem noted. Conditions may include collapsed Wall, Severe Corrosion, Holes, or Cross Bores
- Reconstruct Manhole_pave
  - Based on the visual interpretation of the MACP Inspector, the Manhole Structure, (including wall and/or cone section) requires reconstruction/replacement in pavement surface types in order to correct the problem noted.. Conditions may include collapsed Wall, Severe Corrosion, Holes, or Cross Bores

Rehab_II

- Hardware_Bolts/gasket
  - This field was created to quickly identify manholes with missing hardware or gaskets. The rubber gasket or bolts were reported missing or damaged during inspection.
- Sealing Program
  - Based on the visual interpretation of the MACP Inspector, the Manhole structure has evidence of widespread infiltration
- Spray in Liner Candidate
  - Based on the visual interpretation of the MACP Inspector, the manhole structure has visual signs of corrosion from H2S or spalling brick material. This Field quickly identifies manholes that may have corrosion issues.

Rehab_OM

- Clean Manhole_Vactor
  - Based on the visual interpretation of the MACP Inspector, the manhole structure has heavy ragging of sanitary debris or calcium deposits, debris on bench or steps (i.e. clothes, garbage, septic waste, etc) and requires a High-Pressure Vactor Truck to clean
- Remove large Debris
  - The manhole has large debris in the bottom of the structure such as large rocks, construction debris, bricks, unusual objects, silt bags, soil, concrete, or gravel
- Flooding/Surcharge
  - The manhole is actively surcharging sanitary sewage or has backup above the crown of the pipe (note: for combined/sanitary structures only; does not include storm water structures with sumps)

Rehab Notes — Other Observations not applicable to the previous fields, such as manhole channel repairs, or unusual observations.

Problems_observed

- Yes: Some type of structural or maintenance concern was reported in previous Fields. Used for report running and statistics
- No: The visual interpretation of the MACP inspector did not observe any structural or maintenance concern

2. Structure Scoring

The following fields are for the structure scores related to the COF, POF, and BRE.

Field Name	Explanation
AssetID	Format indicating utility and type with added numbers to create a unique ID for each structure.
Access_Type	Type of structure only populated if an inspection was complete.
Wall_Diameter	Measure the diameter of the manhole structure observed during inspection
Wall_Material	Structure wall material observed during inspection such as concrete block, spray in liner, etc.
Outgoing_Pipe_Diameter	Diameter in inches of the outgoing pipe observed, incoming pipe diameter used if outgoing data unavailable
Outgoing_Pipe_Depth	Depth of the outgoing pipe observed, deepest invert in the structure given in decimal feet, such as (4.7ft), incoming pipe diameter used if outgoing data unavailable
MH_Structural_Condition	Good, fair, or poor as observed during inspection
MH_Year	Year the manhole was installed
COF	Score from 1.00 to 5.00, with 1 being least critical, rating the importance of the pipe to the system overall and the potential cost associated with repair or replacement
POF	Score from 1.00 to 5.00, with 1 being best, rating the condition of the pipe
BRE	POF x COF resulting in a score from 1 to 25, with 1 being the lowest risk
Surface_Type	Description of the surface type observed during inspection (or aerial observations) such as dirt/grass or asphalt.
DiameterRating	Score from 1 to 5, with 1 being smaller diameters, used as a factor to calculate COF score above, based on the diameter of the outgoing pipe. Incoming pipe diameter used if outgoing data unavailable.
DepthRating	Score from 1 to 5, with 1 being most shallow, as a factor to calculate COF score above, based on the depth of the outgoing pipe. Incoming pipe diameter used if outgoing data unavailable.
SurfaceTypeRating	Score from 1 to 5, with 1 being least expensive roadway, used as a factor to calculate COF score above.
NearWaterRating	Score of 1 or 5, with 5 being closest proximity to water, used as a factor to calculate COF score above.
ConditionRating	Score from 1 to 5, with 1 being best observed condition, used as a factor to calculate POF score above
MaterialRating	Score from 1 to 5, with 5 being the least durable material.
SoilScore	Score from 1 to 3, with 1 being least corrosive and stable soils, used as a factor to calculate POF score above.

Field Name	Explanation
MUSYM	Abbreviation for type of soil based on the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) maps
Map_Unit_N	Type of soils based on the US department of Agriculture (USDA)

3. Pipe Master Database

The following fields are for the Pipe Inspections done by both HRC (for pipe information visible in the manholes) and a CCTV Contractor.

Field Name	Explanation
Asset_ID	The unique feature identification number.
Install_Date	Determined/Estimated date of installation of storm pipe
Install_Date_Source	Method of verifying install date
Survery_By_1	From the NASSCO Version 7 manual.
Certificate_Number_2	From the NASSCO Version 7 manual.
Date	Date of inspection
Cardinal_Flow_Direction	Primary direction of flow in the pipe; N,S,E,or W
Type	From the NASSCO Version 7 manual field for Pipe Use.
US_Structure_ID	The Asset ID of the upstream structure
US_Diameter_IN	The diameter in inches of the pipe at the upstream structure
US_Material	The type of material of the pipe as observed from the upstream structure
US_Rim_to_Invert_FT	The distance, in feet, from the structure rim to the bottom invert of the pipe
Traps	If a trap exists, what kind: Elbow, Cover, Gate or Other
DS_Structure_ID	The Asset ID of the downstream structure
DS_Diameter_IN	The diameter in inches of the pipe at the downstream structure
DS_Material	The type of material of the pipe as observed from the downstream structure
DS_Rim_to_Invert_FT	The distance, in feet, from the structure rim to the bottom invert of the pipe
Drop_Present	This is a Yes/No indication of whether a second pipe, or drop pipe, is present, which allows the flow to enter the structure closer to the bottom of the structure
Lower_Drop_Invert_FT	If a drop is present, this is the depth in feet from the rim to the bottom of the drop pipe
Drop_Type	If a drop is present, this indicates if the pipe is inside the manhole or built into the wall of the structure
Is_Flow_Arrow_Correct	Yes/No confirmed at time of inspection
Data_Collected	This is a Yes/No indication of whether data was collected on the pipe.
Comments	This is a general comment field regarding any observations or issues not covered by other data fields

Field Name	Explanation
Shape_Length	This is the actual length of the line segment in the software which represents the pipe

4. Pipe Scoring

The following fields are for the Pipe scores related to the COF, POF, and BRE.

Field Name	Explanation
AssetID_22	Format indicating utility with added numbers to create a unique ID for each sewer run
Diameter	Diameter of the pipe observed.
Length	Length of the pipe as drawn in GIS, which could be inaccurate if the locations of manholes are incorrect. May differs from Plan Length.
Material	material of pipe observed
US_Manhole_ID	The Asset ID of the upstream structure
DS_Manhole_ID	The Asset ID of the downstream structure
OM_SCORE	Four digit or alpha-numeric NASSCO Operations & Maintenance score based on televising observations, such as roots, dirt in pipe, mineral deposits.
ST_SCORE	Four digit or alpha-numeric NASSCO structural score based on televising observations
Up_Depth	Measurement from rim to invert of the upstream manhole
Down_Depth	Measurement from rim to invert of the downstream manhole
COF	Score from 1.00 to 5.00, with 1 being least critical, rating the importance of the pipe to the system overall and the potential cost associated with repair or replacement
POF	Score from 1.00 to 5.00, with 1 being best, rating the condition of the pipe
BRE	POF x COF resulting in a score from 1 to 25, with 1 being the lowest risk
DiameterRating	Score from 1 to 5, with 1 being smaller diameters, used as a factor to calculate COF score above
DepthRating	Score from 1 to 5, with 1 being most shallow, used as a factor to calculate COF score above
RoadRating	Score from 1 to 5, with 1 = uncertified/private road and 5 being interstate freeway, used as a factor to calculate COF score above.
NearWaterRating	Score of 1 or 5, with 5 being closest proximity to water, used as a factor to calculate COF score above.
MaterialRating	Score from 1 to 5, with 5 being the least durable material.

Field Name	Explanation
SoilRating	Score from 1 to 3, with 1 being least corrosive and stable soils, used as a factor to calculate POF score above.
Flagged_COF_Score	COF scores that could not be determined using the COF model
MUSYM	Symbol for type of soil based on the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) maps

Attached:

NASSCO Version 7.0.3 Training Manual *Section 8 – Manhole Assessment Certification Program®, Part 2 – MACP Inspection Form, Parts 1 through 16, pages 8-22 to 8-93*, pertaining to the numbered data fields (such as "_35") throughout the GIS database.

NASSCO Version 7.0.3 Training Manual, *Appendix C, PACP Condition Grading System, pages C-1 to C-44*, pertaining to the PACP defects and scoring.

Appendix C

Stormwater Management Ordinance

ARTICLE XX. – STORMWATER MANAGEMENT

DIVISION X. – PURPOSES AND INTERPRETATION

Sec. XX. - Purposes.

The purposes of this article shall be:

(a) To protect public health, safety, and welfare by requiring stormwater management i.e. quantity and quality enhancements, whenever site improvements or developments are undertaken and existing stormwater features are to be expanded, modified, or altered.

(b) (c) To protect the public health, safety, and welfare by protecting existing man-made or natural stormwater management facilities.

(d) To promote the minimization or degradation of water resources by reducing and/or avoiding impacts on the hydrology of stormwater runoff.

(e) To establish regulations to prevent harmful effects of changes in the quantity and quality of surface water discharge into water bodies that are in the City of Keego Harbor or in downstream areas.

(f) To protect homeowner/property owners from neighboring runoff.

(g) To assure that stormwater runoff from development is controlled so that the water quality in watercourses, groundwater recharged by stormwater, and the habitat situated in areas impacted by stormwater are protected, and that siltation and pollution are minimized to the extent possible.

(h) To provide for cost-effective and functionally-effective stormwater management, and to reduce the need for future remedial projects.

(i) To minimize soil erosion and sedimentation.

(j) To ensure that all stormwater management facilities will be properly maintained.

(k) To eliminate stormwater connections to the separated sanitary sewer.

(l) To recognize private responsibility to incorporate stormwater management systems into the early stages of site planning and design.

(m) To assure compliance with state and federal law and regulations relating to water quality.

Sec. XX. - Construction of language.

The following rules of construction apply to the text of this article:

(a) Particulars provided by way of illustration or enumeration shall not control general language.

(b) Ambiguities, if any, shall be construed liberally in favor of protecting natural land and water resources.

(c) Words used in the present tense shall include the future, and words used in the singular number shall include the plural, and the plural the singular, unless the context clearly indicates the contrary.

(d) Terms not specifically defined in this article shall have the meaning customarily assigned to them.

(e) Considering that stormwater management in many cases requires sophisticated engineering design and improvements, some of the terms of this article are complex in nature. Effort has been made to simplify terms to the extent the subject matter permits. In addition, assistance and examples will be provided by or on behalf of the city as needed for the interpretation and understanding of this article.

Sec. 21-202. - Abrogation and conflict of authority.

Nothing in this article shall be interpreted to conflict with present or future state statutes in the same subject matter. Conflicting provisions of this article shall be abrogated to the extent of the conflict. The provisions of this article shall be construed, if possible, to be consistent with and in addition to relevant state regulations and statutes.

In their interpretation and application, the provisions of this article shall be held to be minimum requirements and shall be liberally construed in favor of achieving the objectives of this article, and shall not be deemed a limitation or repeal of any other powers granted by state statutes.

This article is not intended to repeal, abrogate or impair any existing easements, covenants, or deed restrictions. However, where this article imposes greater restrictions, the provisions of this article shall prevail. If there is another ordinance that is inconsistent, the terms of the ordinance that promotes the objectives of this article to the greatest extent shall apply.

Sec. XX. - Definition of terms.

The following terms, phrases, words and derivatives shall have the meaning defined below:

Accelerated soil erosion. The increased movement of soils that occurs as a result of the impact of development upon the flow of stormwater.

BMP or *best management practice.* BMPs are any structural, vegetative or managerial practice used to treat, prevent or reduce water pollution. Such practices include temporary seeding on exposed soils, detention and retention basins for stormwater control, and scheduling the implementation of all BMPs to ensure their effectiveness.

City. City of Keego Harbor.

City Council. Keego Harbor City Council.

Conveyance facility. A storm drain, either open channel or pipe, as defined in this article.

Detention basin. A structure or facility, natural or artificial, which stores stormwater on a temporary basis and releases it at a controlled rate. A detention basin may drain completely after a storm event, or it may be a pond with a fixed minimum water elevation between runoff events.

Development. Any change in grade, impervious surface area, or land cover that tends to alter stormwater impacts on non-residential properties will be held to Oakland County Water Resources Commissioner's Office (OCWRC) standards.

Discharge. Any addition or introduction of any pollutant, stormwater, or any other substance into the stormwater system or into the groundwater table.

Disturbed area. An area of land subjected to development.

Ditch. Defined depression of land that transports and directs the flow of stormwater usually along the side of a road.

Drainage system. All facilities, measures, areas, and structures which serve to convey, catch, hold, filter, store, and/or receive stormwater, either on a temporary or permanent basis.

Earth change. A human-made change in the natural cover or topography of land, including but not limited to cut and fill activities, which may result in or contribute to soil erosion or sedimentation of watercourses or wetlands.

Floodplain. The area of land typically adjacent to a continuous watercourse that is covered temporarily by water during given flood events recorded elevation per FEMA.

French drain. A below-ground drain consisting of a trench filled with gravel to permit movement of water through the gravel and into the ground. Perforated pipe may be used to enhance the efficiency of the system.

Grading plan. A sealed drawing or plan and accompanying text prepared by a registered professional engineer, surveyor or landscape architect which shows alterations of topography, alterations of watercourses, flow directions of stormwater runoff, and proposed stormwater management and measures, having as its purpose to ensure that the objectives of this article and the city's grading ordinance (chapter 7.5 of the City Code) are met.

Infiltration. The percolation of water into the ground, expressed in inches per hour.

Infiltration facility. A structure or designated area which allows runoff to seep gradually into the ground, e.g., French drains, seepage pits, infiltration trenches, dry well, or perforated pipe.

Maintenance agreement. A binding agreement that sets forth the terms, measures and conditions for the maintenance of stormwater management systems and facilities.

Nonerosive velocity. Stormwater flow rate/speed that does not cause accelerated soil erosion.

Offsite facility. All or part of a drainage system that is located partially or completely off the development site for which it serves.

Peak rate of discharge. The maximum rate of stormwater flow at a particular location following a storm event, as measured at a given point and time in cubic feet per second (cfs).

Person. Any individual, firm, partnership, association, corporation, company, or organization of any kind including school districts and government agencies conducting operations within the city.

Planning commission. Keego Harbor Planning Commission.

Ponding. Ponding is the unwanted pooling of water.

Private storm drain. A drainage system serving a platted subdivision or other development which has been designed and constructed and accepted to be operated and maintained by the property owner, business or homeowner’s association.

Public storm drain. A drainage system serving a platted subdivision or other development which has been designed and constructed and accepted to be operated and maintained by the City of Keego Harbor.

Receiving body of water. Any watercourse or wetland into which stormwaters are directed, either naturally or artificially.

Retention basin. A holding area for stormwater, either natural or manmade, which does not have an outlet to adjoining watercourses or wetlands. Water is removed from retention basins through infiltration and/or evaporation processes, and retention basins may or may not have a permanent pool of water.

Runoff. That part of precipitation which flows over the land.

Sediment. Mineral or organic particulate matter that has been removed from its site of origin by the processes of soil erosion, is in suspension in water, or is being transported.

Site improvement. Any change in grade, impervious surface area, or land cover on the site that tends to alter stormwater impacts. This term shall not include customary lawn maintenance or gardening.

Soil erosion. The wearing away of land by the action of wind, water, gravity or a combination thereof.

Soil erosion control measures. A structure, facility, barrier, berm, process, vegetative cover, basin, and/or other installations designed to control accelerated soil erosion. Temporary measures are installed to control soil erosion during construction or until soils in the contributing drainage area are stabilized. Permanent measures remain after the project is completed.

Storage facility. A basin, structure, or area, either natural or human made, which is capable of holding stormwater for the purpose of controlling or eliminating discharge from the site.

Stormwater discharge. The volume of water passing a given point at a given time expressed in cubic feet per second. Also referred to as "peak rate of discharge".

Storm drain. A conduit, pipe, ditch, swale, natural channel or manmade structure which serves to transport stormwater runoff. Storm drains may be either enclosed or open.

Stormwater management measure and facility. Any facility, structure, channel, area, process or measure which serves to control stormwater runoff in accordance with the purposes and standards of this article.

Stormwater management plan. Drawings and/or written information prepared by a registered professional engineer or registered landscape architect which describe the way in which accelerated soil erosion and/or stormwater flows are proposed to be controlled, both during and after construction, having as its purpose to ensure that the objectives of this article are met.

Stormwater management system. Entire existing or proposed stormwater conveyance and storage facilities and all appurtenances thereto.

Swale. Defined contour of land with gradual slopes that transports and directs the flow of stormwater. Also known as a shallow ditch. Generally, a swale is located between homes or through rear yards and is not within a public easement.

Watercourse. Any natural or manmade waterway or other body of water having reasonably well-defined banks. Rivers, streams, creeks and brooks and channels, whether continually or intermittently flowing, as well as lakes and ponds are watercourses for purposes of stormwater management.

Watershed. An area in which there is a common receiving body of water into which stormwater ultimately flows, otherwise known as a drainage area.

Wetlands. Land characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances does support, wetland vegetation or aquatic life and is commonly referred to as a bog, swamp or marsh, as defined by state law.

Sec. XX. – Standards for stormwater management plan approval.

All developments requiring a stormwater management plan shall comply with the Oakland County Water Resources Commissioner's Office stormwater standards to prevent flooding and protect water quality. The particular facilities and measures required on-site shall take into consideration the natural features, wetlands, and watercourses on the site; the potential for on-site and off-site adverse stormwater impacts, water pollution, and erosion; and the size of the site. Developments shall be held to OCWRC Standards; site improvements will require a grading plan and must comply with the following:

(a) Protecting existing stormwater management systems.

(1) Natural drainage courses such as ditches, swales, streams, creeks, lakes, etc. shall be protected from:

a. Increased discharge of pollutants or sedimentation;

b. Adverse impacts from increased water quantity or velocity;

c. Encroachments that could be otherwise avoided;

d. Improvements, such as enclosures, for purely aesthetic reasons.

(2) Existing stormwater management systems shall not be obstructed, blocked or their route otherwise altered without the submittal of a stormwater management plan in accordance with this article and the approval granted by the City.

(3) Regrading, such as cutting or filling, in a wetland is prohibited unless permitted by EGLE.

(4) Regrading, such as cutting and filling, in a floodplain may be completed as long as a 1:1 cut to fill ratio is maintained and no adverse impact to the floodplain is created. Regrading in the floodplain requires approval from the City based on engineering review and administrative consent unless otherwise indicated.

(5) Depositing soil, leaf, lawn, plant or other yard waste materials within an existing drainage facility shall be strictly prohibited.

(6) All stormwater management plans shall first take into account existing drainage and stormwater facilities and preserve and protect these features.

(b) *Discharge onto neighboring property*

(1) Site drainage or discharge originating from one property (including filling low-lying areas) is prohibited to flow onto another adjacent property, unless it is through an intended stormwater conveyance path through a right-of-way (ROW), such as a ditch, or protected by an easement. Increased site drainage must either be contained on site or drained to an intended conveyance path on the originating property.

(2) In the case of a violation, a solution shall be proposed by the discharging party within ten (10) business days to resolve the issue. The solution must be agreed upon by both parties and by the City for a resolution to occur. If an agreement is made, the discharging entity will have thirty (30) business days to implement the solution and resolve the issue.

(3) If any entity violates this provision or an agreement cannot be reached, the City will determine and implement a solution. A lien will be placed on the discharging party's

property for the cost of the solution. The property will be subject to a fine not exceeding $500.00.

(c) *Improving existing stormwater management systems.*

(1) Most existing stormwater conveyance paths, such as ditches and culverts, are located within county drainage districts or the City's public road ROW. The responsibility for routine maintenance (i.e., mowing, removing obstructions and debris, improving landscaping, etc.) lies with the adjacent property owner(s).

(2) Under the provisions herein, property owners adjacent to the stormwater facility may individually or in concert with other such property owners petition the City to establish a special assessment district (SAD) to evaluate, design, construct, administer, and finance an improvement to a stormwater management facility. The SAD will be facilitated in accordance with the provisions herein, state law, and the City Charter. The benefiting property owners will be assessed their portion of the project costs based on benefit. Typically, drainage area, percent impervious, capacity, or other means as determined by the City are used to determine benefit. The City may elect to contribute to the project costs based on a review of the petition and benefit to the City at large.

(3) Improvements to existing stormwater management systems can also be petitioned through the Oakland County Water Resources Drain Commissioner’s Office in accordance with Public Act 40 of 1956, the Drain Code of 1956, as set forth in MCL 280.1 et seq.

(4) Historically, drainage ditches have been filled in or regraded without approval or without an alternative drainage path constructed. The City has the right to require that drainage areas on or offsite be improved or restored as part of any site improvement or development.

(5) Design and construction provisions for improving existing stormwater management systems shall be as indicated herein.

(d) *Ditches and driveway culverts.*

(1) It is recognized that existing roadside ditches and driveway culverts are an integral part of the City's overall stormwater management system and are important to local drainage patterns.

(2) Typically, maintenance of roadside ditches and driveway culverts are the responsibility of the adjacent property owner. As such the property owner is responsible for maintaining the drainage pattern through these facilities, removing obstructions, mowing in the case of a grassed ditch, and replacing or repairing these facilities if deteriorated or damaged.

(3) Should a property owner wish to modify or replace a driveway culvert, a plan meeting the requirements of this article shall be prepared, submitted, and include the following specific items:

a. Size and material of the culvert to be replaced and at least the next two (2) culverts upstream and downstream from the subject property.

b. The existing and proposed inverts of the culvert to be replaced and at least the inverts of the nearest two (2) upstream and downstream culverts and any other piping near the proposed replacement.

c. Provisions for the replacement of the driveway including materials, cross sections, construction requirements, etc.

d. The existing and proposed width of the driveway and culvert.

e. Details of any culvert end treatments such as headwalls, end sections, bar grates, etc.

(4) Should a property owner wish to enclose an existing ditch and/or swale, a plan meeting the requirements of this article shall be prepared and submitted and include the following specific items:

a. Size and material of the culvert to be installed and at least the next two (2) culverts upstream and downstream from the subject property.

b. The proposed inverts of the culvert to be installed and at least the inverts of the nearest two (2) upstream and downstream culverts and any other piping near the proposed replacement.

c. A cross section of the ditch enclosure showing the existing ditch bottom, pipe invert, bedding, backfill and at least six (6) inches of fall from the existing edge of the road to a swale over the top of the culvert.

d. Drainage calculations showing the proposed culvert is sized adequately to convey the upstream drainage area.

e. Drainage calculations showing the downstream culverts are sized adequately to convey the upstream drainage area.

f. Location and details of at least two (2) inlets, catch basins or structures per property, to receive and inlet surface drainage into piping.

(5) Requests for enclosing ditches shall not be granted unless it can be demonstrated that:

a. The proposed enclosure is sized accordingly and can be extended for a future storm sewer;

b. The enclosure will not affect the subsurface drainage for the adjacent roadways; and

c. Surrounding properties will not adversely be affected.

(6) All design, construction and maintenance costs for driveway culverts and ditch enclosures will be the responsibility of the adjacent property owner. The City may request a surety bond or escrow deposit be placed with the City to guarantee the completion of the project.

(7) If a City-initiated roadway or drainage project requires the cleaning or repairing of a driveway culvert or ditch enclosure the City shall cause said cleaning, repair or enclosure to be done at the project's cost. All other cleaning or repairing to maintain flow shall be completed by the property owner or at the City's request in accordance with the provisions herein. Failure to comply with the City's request may result in the City completing the project. Costs will be assessed to the adjacent property owner(s) and a lien placed on the property if payment is not received.

(e) *Soil erosion control.*

(1) Cutting, filling and grading shall conform with the requirements of the grading ordinance and the soil erosion control permit issued by the Oakland County Water Resources Drain Commissioner's Office.

(2) All development and other earth changes shall be designed, constructed, and completed in such a manner that the exposed area of any disturbed land is limited to the shortest practical period of time. Proposed erosion control measures shall be submitted to the City of Keego Harbor for determination that such measures comply with the City of Keego Harbor regulations in the Zoning Ordinance that require property owners to obtain a grading permit, if relevant.

(3) Approved soil erosion control measures shall be installed and maintained between the disturbed area and any down gradient watercourses (including rivers, streams, creeks, lakes, ponds, and other watercourses), wetlands, roadways, and property lines.

(4) Sediment resulting from accelerated soil erosion shall be removed from runoff water before it leaves the site of the development.

(5) Temporary and permanent soil measures designed and constructed for the conveyance of water around, through, or away from the development or earth change area shall be designed to limit the water flow to a nonerosive velocity.

(6) Temporary soil erosion control measures shall be removed after permanent soil erosion control measures have been implemented and stabilized. All developments and earth change areas shall be stabilized with permanent erosion control measures.

(7) If inland lakes, ponds, rivers, creeks, wetlands, streams or other watercourses are located on or near the site, measures which trap sediment shall be provided. Straw bale berms may be used as temporary stormwater diversion structures but will not be considered sufficient by themselves for trapping sediment on-site. The use of temporary sediment basins, sediment traps, filter fabric, and rock filters in lieu of straw bale berms shall be employed as required as part of a permit. Other measures may be required if reasonably determined to be necessary to protect a watercourse or wetland.

(8) When it is not possible to permanently stabilize a disturbed area after an earth change has been completed or where significant earth change activity ceases, temporary soil erosion control measures shall be implemented within two (2) calendar days.

(9) Permanent soil erosion control measures for all slopes, channels, ditches, or any disturbed land area shall be completed within fifteen (15) calendar days after final grading or the final earth change has been completed. All temporary soil measures shall be maintained until permanent soil measures are implemented and stabilized.

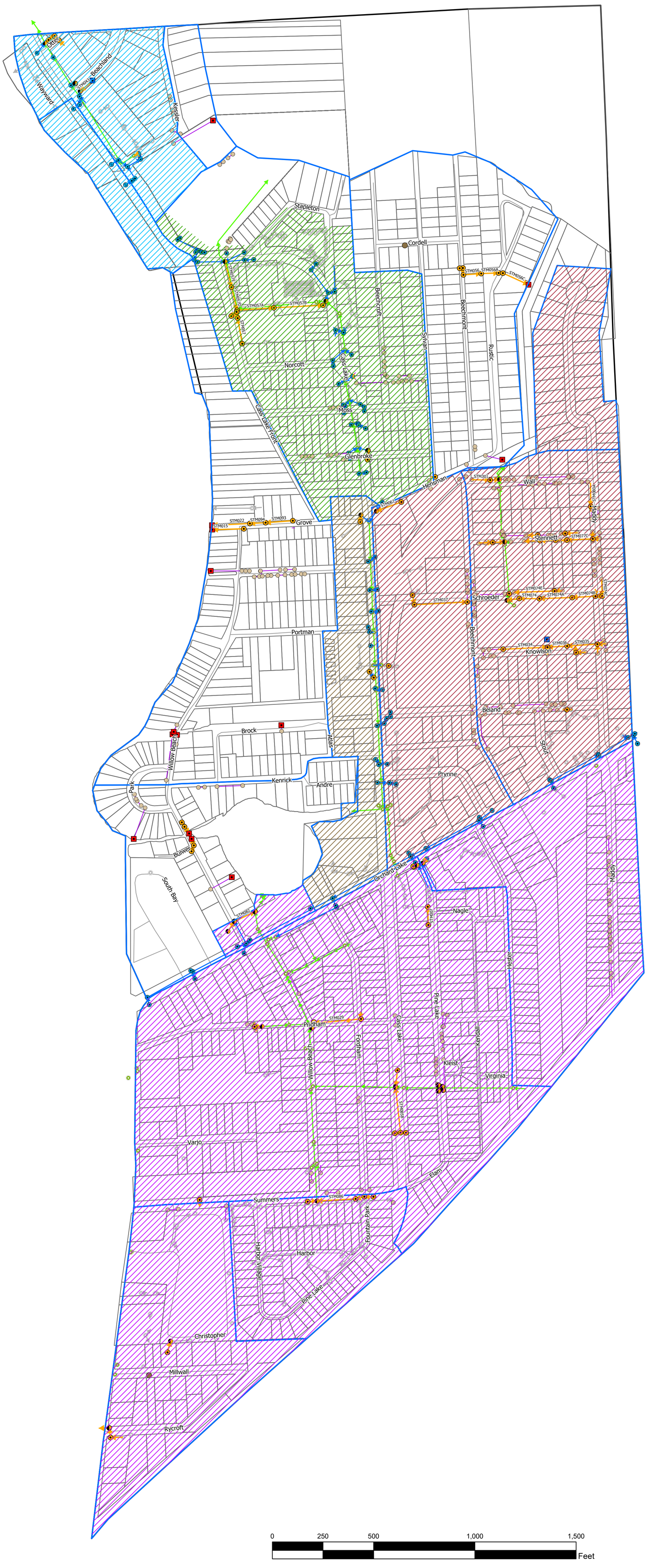
(10) Vegetated filter strips, twenty-five (25) feet in width, shall be created or retained along the edges of all lakes, creeks, streams, and other watercourses. As part of permit approval, the width of a particular filter strip may be reduced to the extent it is demonstrated that a portion of the width will serve no useful function, e.g., to the extent the grade is such that water flow will be away from the watercourse and the filter strip does not serve to protect wildlife habitat or other useful function.

(11) The city shall have the authority to issue stop-work orders for failure to comply with the requirements of this section, provided a proprietor shall be entitled to a hearing before the chief building inspector or his designee within three (3) business days to determine whether the stop-work order shall continue.

Appendix D

City Planning Maps

Drainage Districts in Keego Harbor



Legend

Keego Harbor
- Beechmont Phase 1 Drain
- Keego Harbor Phase 1 Drain
- Schmid Drain Branch A
- Schmid Drain Branch B
- Schmid Drain Branch D
- Drainage_Districts
- Discharge
- MS4_Outfalls
- Outfalls
- Leech_Basins
- Structures
- Pipes
- Culvert Ends
- Culverts

Road Commission
- Structures
- Pipes

OCWRC
- Structures
- Pipes

Private_Keego_Harbor
- Structures
- Pipes

City of Keego Harbor
"Heart of the Lakes"

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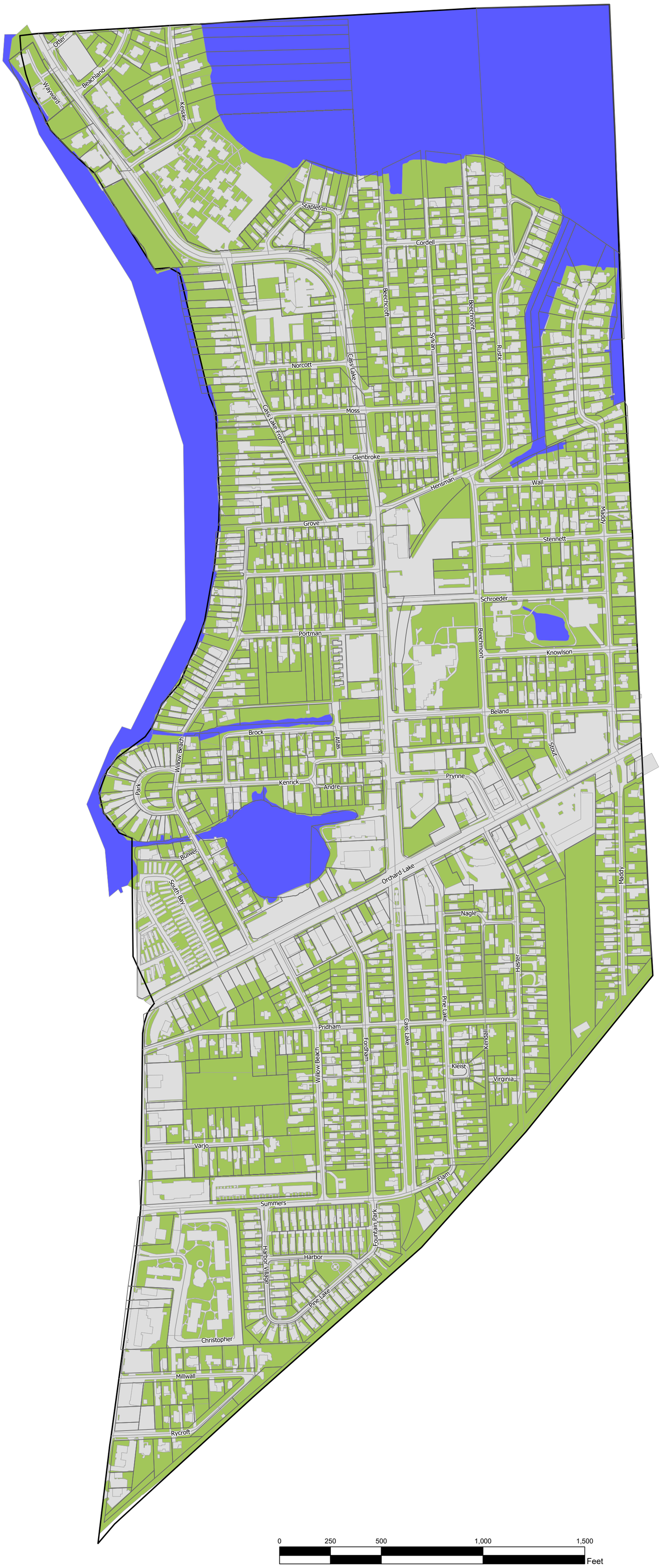
Y:\2013\07\20130735\03_Studies\Working\GIS\Keego_Harbor_SAW.aprx

Impervious Surfaces in Keego Harbor



Legend

- Impervious surface
- Pervious surface
- Water Area

City of Keego Harbor

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Building Footprints in Keego Harbor

Legend

Building Footprints

Year Built

- Unknown
- 1900-1919
- 1920-1939
- 1940-1959
- 1960-1969
- 1970-1979
- 1980-1989
- 1991-1999
- 2000-Present

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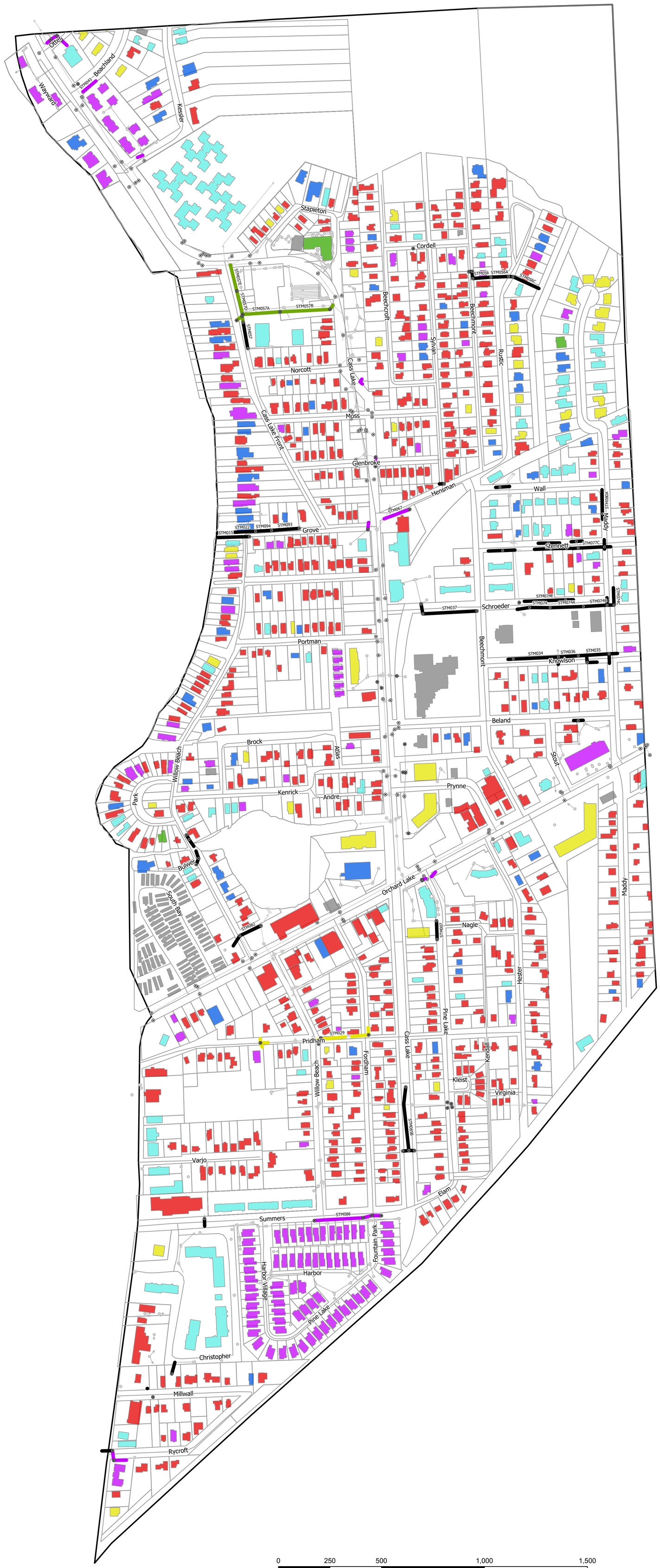
Age of Storm System in Keego Harbor



Legend

Keego Harbor

- Structures

Pipes

Install_Date

- 1980s
- 2000s
- 2010s
- <Null>

Building Footprints

YEAR_BUILT

- Pre 1960s
- 1960-1979
- 1980s
- 1990s
- 2000s
- 2010s
- Null
- Parcels
- Boundary

City of Keego Harbor

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Appendix E

Drainage Concern Area Memos

Drainage Issue Conceptual Recommendations

Legend

Drainage Memo Locations

City of Keego Harbor

"Heart of the Lakes"

HRC

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Bloomfield Hills, MI 48302-0360

PHONE: 248-454-6300
WEBSITE: hrcengr.com

Memorandum

To: Jered Ottenwess

From: Hubbell, Roth, & Clark

Date: September 30, 2019

Subject: 3201 Kenrick Street Drainage Issues HRC Job No. 20130735

The following memorandum has been developed for the purposes of documenting perceived surface water ponding and drainage issues in the city, providing conceptual recommendations for improvements, and developing budgetary costs for inclusion in the city's stormwater system capital improvement plan. This analysis is cursory in nature and will require more detailed design, survey, and geotechnical investigation to sufficiently address the concerns presented. The recommendations provided shall in no way constitute complete remediation of surface water ponding and drainage issues described.

Background

- Residents at 2140 Brock Street and 3201 Kenrick Street complained of standing water on the south side of Kenrick which they claim are due to the east end culvert being buried or collapsed.
- Residents also indicate that water ponds in the driveways on the north side of Kenrick Street at 2140 Brock Street during rain events.
    - Residents stated that this was worsened when the City filled the ditch in the right-of-way with gravel about 10 years ago at the corner of Kenrick and Brock.
- Elevations of the City streets and structures were collected from a Lidar Scan in March of 2017.

Site Visit Notes (April 5, 2019 and May 3, 2019)

- At the time of the field investigation on April 5, 2019, there was no standing water in the front yards of the homes on the north side of Kenrick Street.
- During a field visit again on May 3, 2019:
    - There was standing water in the driveways of 2141 Willow Beach and 2140 Brock Street on the north side of Kenrick Street.
    - The culvert at 3185 Kenrick Street on the south side of Kenrick Street was completed filled with debris and the water upstream of the culvert was stagnant.
    - The homeowner at 3243 Kenrick Street, on the south side of Kenrick, placed a sand berm along their fence to keep the storm water from draining into their yard.
- When walking along the extent of the culvert in front of 3185 Kenrick, 3175 Kenrick, and 3165 Kenrick, HRC staff were unable to find an outlet point.
    - This outlet point may be buried, not allowing the water to discharge into Dollar Lake.
    - These properties have recently repaved their driveways which may have contributed to the blockage of drainage.
- It appears that the elevations of the front yards are close in elevation to the wetland area off of Dollar Lake.

- Based on discussions with the City, it has been suggested that a culvert be installed in between the driveways of 2141 Willow Beach and 2140 Brock Street that crosses under Kenrick Street into the culvert on the south side of Kenrick in front of 3201 Kenrick Street , in order to discharge to Dollar Lake.
- Many of the properties along this road are below the road grade, so properly maintaining the ditches and culverts along Kenrick Street to the proper elevation is critical to prevent runoff from the road into properties.

Recommendations

- Regrade existing ditches to make them more defined and deeper to promote positive drainage to Dollar Lake
- Stabilize the sides of ditches with riprap and native vegetation to absorb some of the runoff from the road, especially in front of 3201 Kenrick Street since the property fence is so close to the edge of road.
- The end section of the culvert in front of 3185, 3175, and 3165 Kenrick Street should be cleared from debris and located.
    - WRC did not clean out this culvert because the driveway was new and they did not want to cause any sinkholes if the culvert was in poor condition.
- The projected cost for this is estimated to be approximately $15,000 to $20,000.

Some recommendations to the homeowners to address the drainage issues in their driveway:

- Regrade and repave the driveways so they slope towards the road or adjacent to the driveway.
- Install an asphalt wedge at the end of the driveways to keep water from pooling on the driveway.
- Plant salt tolerant, native vegetation adjacent to the driveways so the plants can absorb some of the runoff from the driveways.

Attachments

- Pictures from the site visits
- Site elevation map from the Lidar data collected in 2017 and site plan with notations

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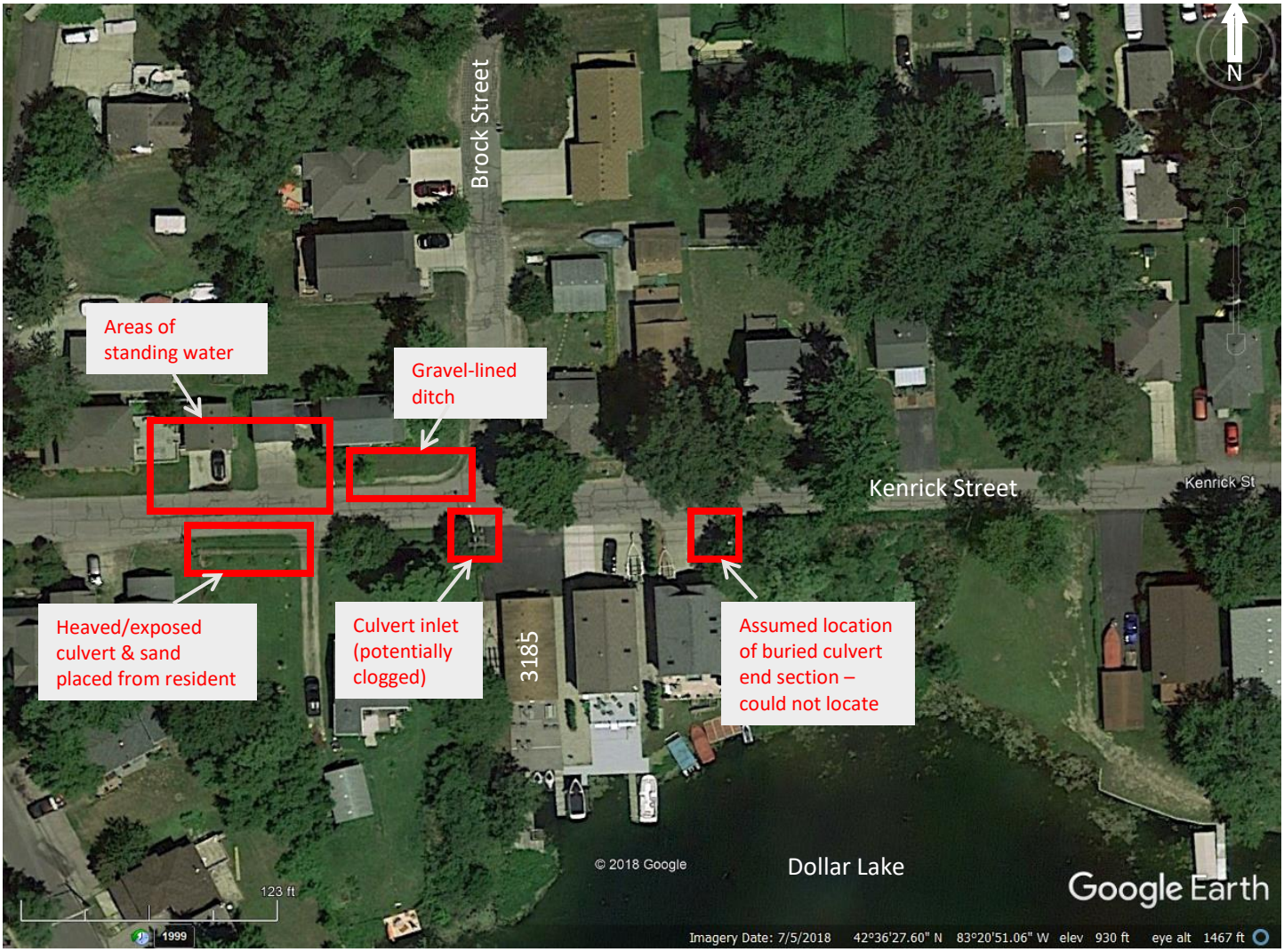
PHONE: 248-454-6300
WEBSITE: hrcengr.com

3201 Kenrick Street

Subject: Drainage Issue Pictures HRC Job No. 20130735



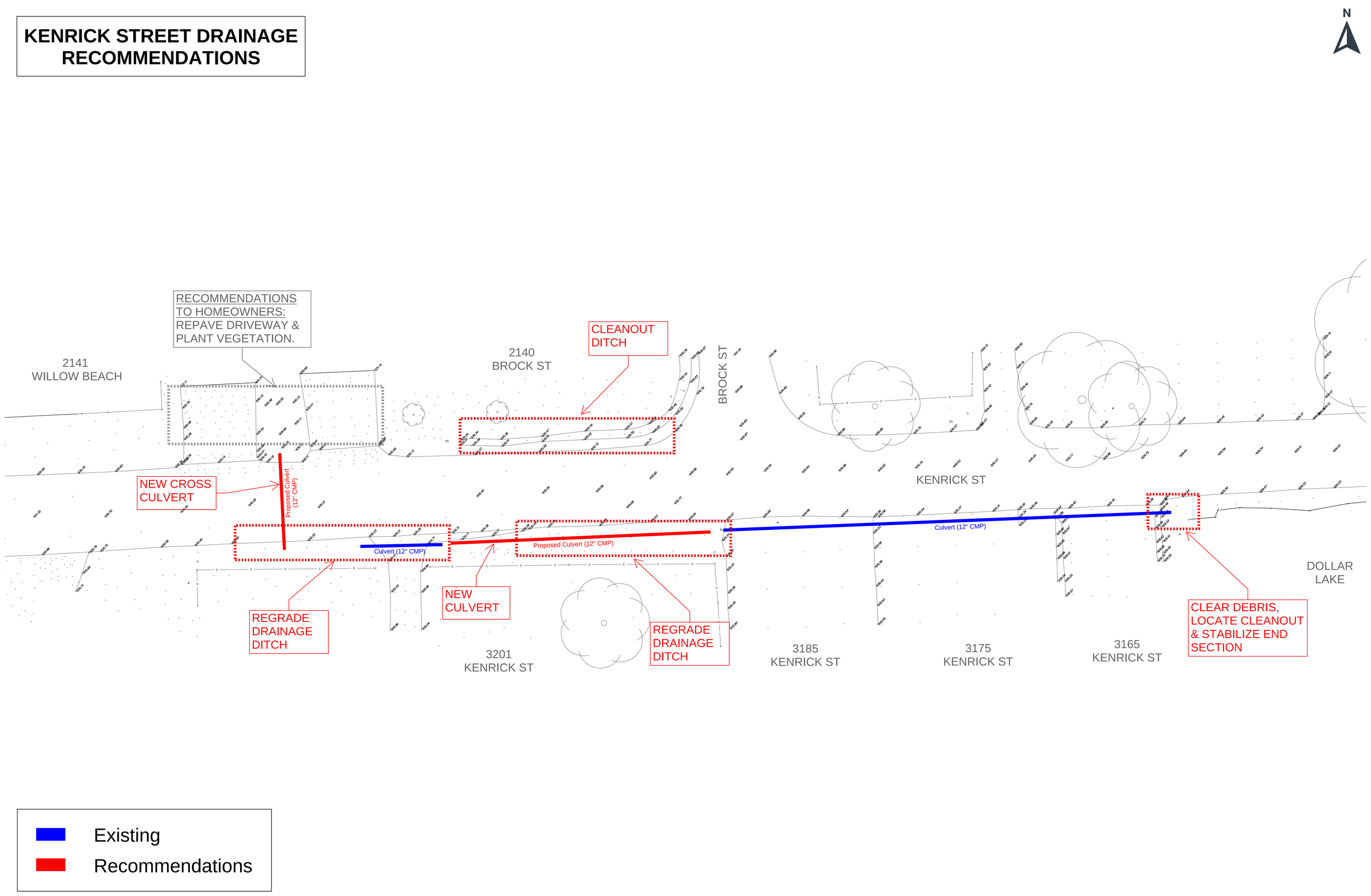
Google aerial view of Kenrick Street with markups of where complaints and drainage issues were passed along to the City.

Photo taken by HRC staff on May 3, 2019 of clogged culvert inlet and stagnate water at 3185 Kenrick Street.

Image taken by HRC staff on May 3, 2019 of standing water at driveways of 2141 Willow Beach Street and 2140 Brock Street.

Image taken by HRC staff on May 3, 2019 of the heaved culvert at 3201 Kenrick and the location where the homeowner of 3201 Kenrick placed a sand berm to prevent roadway runoff from draining to their property.

KENRICK STREET DRAINAGE RECOMMENDATIONS



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WEBSITE: hrcengr.com

Memorandum

To: Jered Ottenwess

From: Hubbell, Roth, & Clark

Date: November 4, 2019

Subject: Brock Street Drainage Issues HRC Job No. 20130735

The following memorandum has been developed for the purposes of documenting perceived surface water ponding and drainage issues in the city, providing conceptual recommendations for improvements, and developing budgetary costs for inclusion in the city's stormwater system capital improvement plan. This analysis is cursory in nature and will require more detailed design, survey, and geotechnical investigation to sufficiently address the concerns presented. The recommendations provided shall in no way constitute complete remediation of surface water ponding and drainage issues described.

Background

- Brock Street has a history of having standing water on the road.
  - Homeowners that live on Brock Street have previously made complaints due to the standing water and the poor road condition.
- The road has been patched and cracks have been sealed several times throughout the years.
- The canal also has a history of high water levels and eroding embankments that may lead to the encroaching water levels.
  - Efforts are currently being made to address the canal issues.
- Elevations of the City streets and structures were collected from a Lidar Scan in March of 2017.

Site Visit Notes (April 5, 2019)

- On April 5, 2019, the site was visited following a period of heavy rains and standing water was observed on the road. The wet area measured about 12 feet by 6 feet and was centered on the north side of Brock Street
  - There was also evidence of an area of standing water that crosses the entire roadway. This area measured about 20 feet by 40 feet and was centered on the north side of Brock Street.
- To assist in preventing water from the canal from backing up into the roadway, Corey Mills with the City's DPW made a small berm on the north side of the road, however, trenches were dug by others through the berm from the roadway to the canal.
- The road elevation looks to be very close to the elevation of the water level in the canal.
  - It was mentioned that the canal water level is about 1 foot lower than what it is normally.
- The pavement near the low area of the road appears to have been replaced more recently.
  - This newer portion of pavement extends about 100 feet to the east of the low point and just around the bend on the road to the west of the low point.
- Soil erosion and sedimentation control along the canal does not appear to be effective and is crucial for this area.

  - As water levels rise, erosion is more prone to occurring.
  - Since the road is so close to the shoreline, clay and dirt under the road may be washing away causing the road to sink lower. Stabilization will assist in addressing this issue.
- A Wetland Delineation Study was completed with a site visit taking place on September 13, 2019, identifying wetlands surrounding the canal as shown in the attached map. The full report is included with the City's Stormwater Asset Management Plan.

Recommendations

- Option 1:
  - Raise the road elevation in the low-lying area.
  - Check ground water level and install pumping manhole in road ROW where rainwater is prone to ponding to pump water from MH to canal.
  - Install a 12-inch concrete storm pipe from pumping MH to a catch basin in front of 3119 Brock Street.
  - Install a 6" finger drain from the catch basin.
  - Ensure the banks on the south side of the canal are stabilized with diverse, native vegetation appropriate for wet areas.
  - The projected cost for this solution is estimated to be around $45,000 - $50,000.
- Option 2:
  - Abandon Brock Street at the empty lot between 3103 and 3119 Brock Street to the turn in the road.
    - This allows most of the residents on Brock to still have access to their driveways.
    - Leaving a small section close to the road ROW for 3119 Brock St to access their driveway.
  - Fill in this area of Brock Street with pervious material such as grass or wetland plants & ensure the banks on the south side of the canal are stabilized with diverse, native vegetation appropriate for wet areas.
  - The projected cost for this solution is estimated to be around $45,000 - $50,000.
- Option 3:
  - Raise the road elevation in the low-lying area.
  - Install tiered geogrid base section where needed to stabilize subgrade.
  - Install Shoresox™ erosion control containment fabric 560-ft along the south side of the canal (see attached brochure or similar slope stabilization product design).
    - Additional slope stabilization details are attached as well.
  - Plant diverse, native vegetation appropriate for wet areas on top of the fabric.
  - The projected cost for this is estimated to be around $65,000 - $70,000.
- Option 4:
  - Raise the road elevation in area prone to flooding. Replace the asphalt with a permeable asphalt pavement on Brock Street to mitigate the runoff water while also keeping water from ponding in the road. Since this is a low-volume road, durability will be less of a concern (see attached brochure).
  - Ensure the banks on the south side of the canal are stabilized with diverse, native vegetation appropriate for wet areas.
  - The projected cost for this is estimated to be around $200,000 and a $1,000/year maintenance cost of vactoring the pavement.

Attachments

- Pictures from the site visits
- Site overview identifying the low points using elevation from the Lidar data collected in 2017
- Wetland Delineation map
- Porous Pavement & ShoreSox Erosion Control factsheet
- Site overview with markups for each recommended option

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PHONE: 248-454-6300
WEBSITE: hrcengr.com

Brock Street

Subject: Drainage Issue Pictures

HRC Job No. 20130735

Site photos taken by HRC staff on April 5, 2019 of the wet road and shoreline erosion along Brock Street.

Delhi Township
2101 Aurelius Rd.
Suite 2A
Holt, MI 48842
517-694-7760

Detroit
535 Griswold St.
Buhl Building, Ste 1650
Detroit, MI 48226
313-965-3330

Grand Rapids
801 Broadway NW
Suite 215
Grand Rapids, MI 49504
616-454-4286

Howell
105 W. Grand River
Howell, MI 48843
517-552-9199

Jackson
401 S. Mechanic St.
Suite B
Jackson, MI 49201
517-292-1295

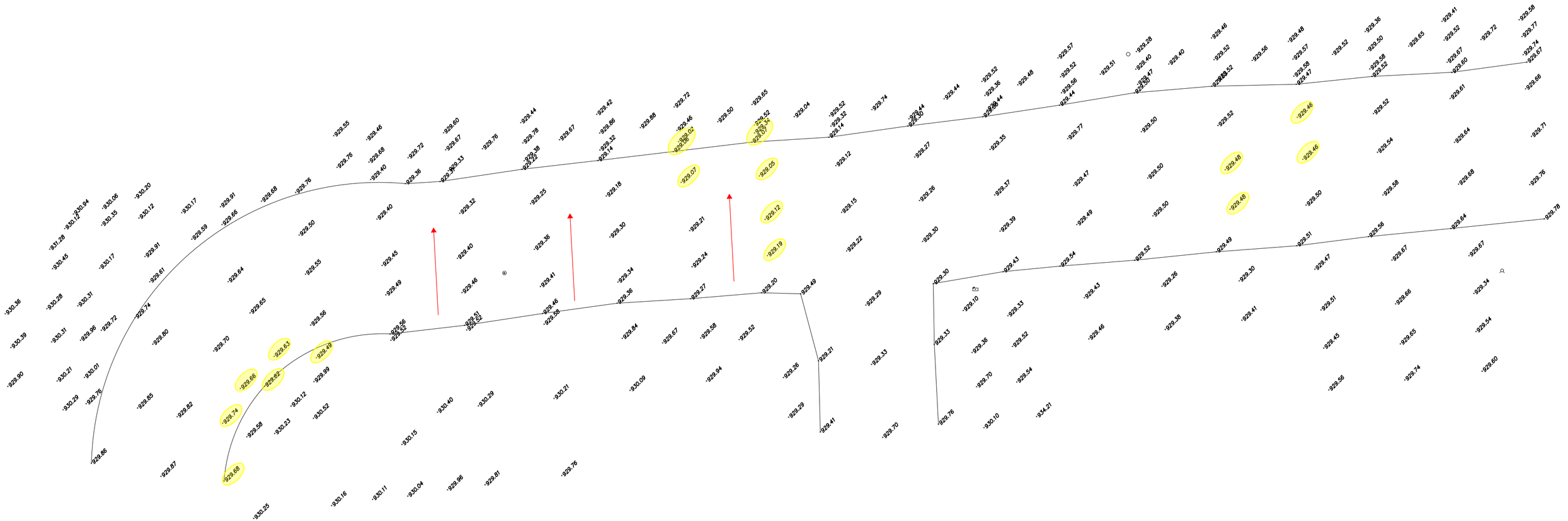
Kalamazoo
834 King Highway
Suite 107
Kalamazoo, MI 49001
269-665-2005

Lansing
215 S. Washington SQ
Suite D
Lansing, MI 48933
517-292-1488

August 2018 Google street view image of low-lying area in front of 3119 Brock Street that experiences frequent water ponding.

Brock Street

Low Areas



BROCK STREET DRAINAGE RECOMMENDATIONS

Option 1: Pumping Storm Drain

Stabilize Banks

Install CB

Pump water from MH to canal

Install Pumping MH in ROW

Install 12-inch Concrete Stm Pipe

Install 6" Finger Drain

Existing Culvert

3127

3119

3103

3095

Brock

Kenrick

Kenrick

Ames

0 20 40ft

SEMCOG, DigitalGlobe

POWERED BY esri

BROCK STREET DRAINAGE RECOMMENDATIONS

Option 2: Abandon End of Brock Street

Stabilize Banks

Abandon Section of Brock, Remove Pavt, & Install Plants

Extend Driveways

Existing Culvert

3127

3119

3103

3095

Brock

Akins

Kenrick

Kenrick

0 20 40ft

SEMCOG, DigitalGlobe

POWERED BY esri

BROCK STREET DRAINAGE RECOMMENDATIONS

Option 3: ShoreSox™ Erosion Control

Install Shoresox™
& native vegetation

Re-grade &
Re-pave

Existing Culvert

3127

3119

3103

3095

Brock

Atlas

Kenrick

0 20 40ft

SEMCOG, DigitalGlobe

POWERED BY esri

BROCK STREET DRAINAGE RECOMMENDATIONS

Option 4: Permeable Pavement

Stabilize Banks

Install Permeable Asphalt Pavement

Existing Culvert

3127

3119

3103

3095

Brock

Akins

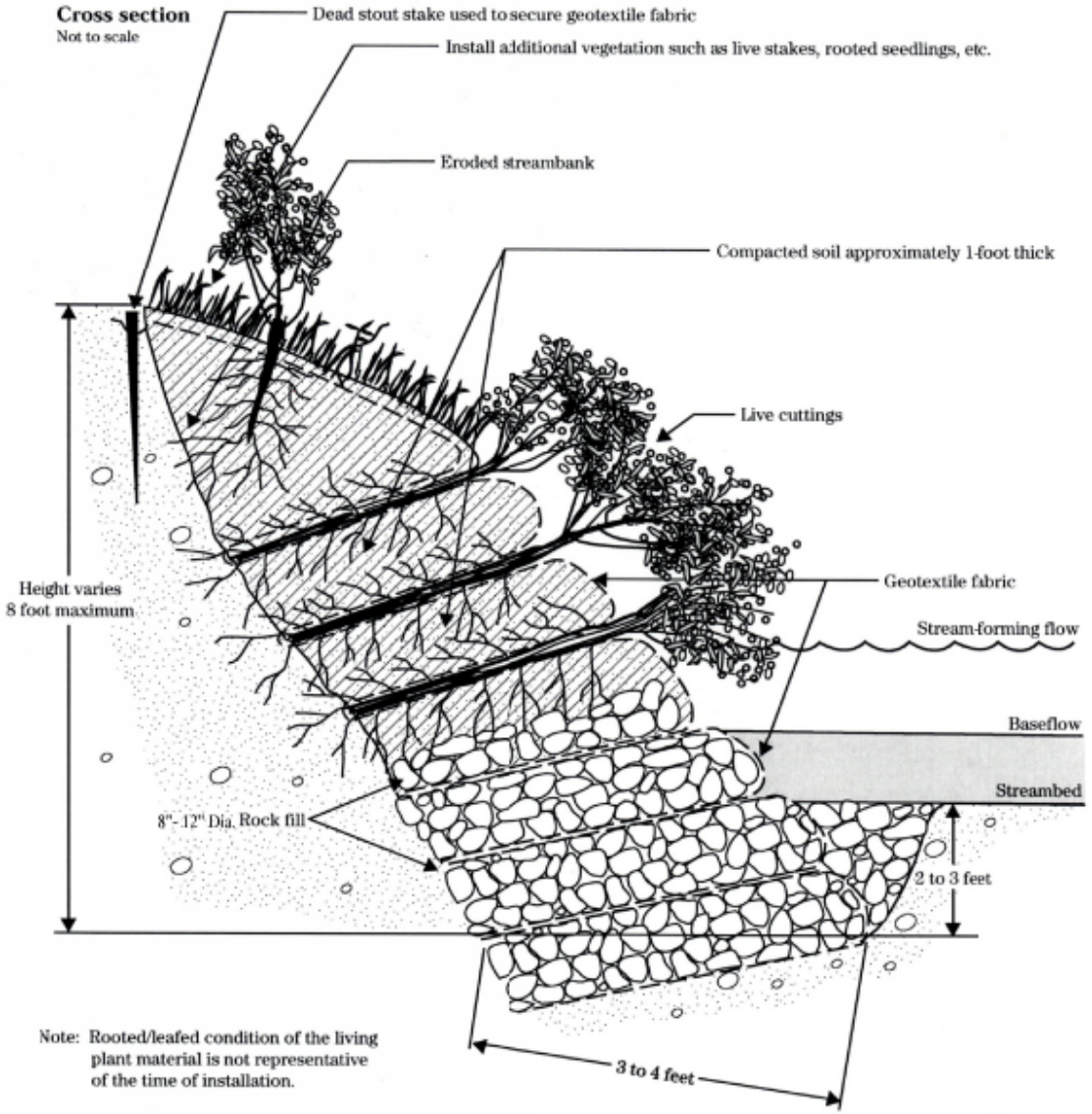
Kenrick

Kenrick

0 20 40ft

SEMCOG, DigitalGlobe

POWERED BY esri



VEGETATED REINFORCED SOIL SLOPES (VRSS)

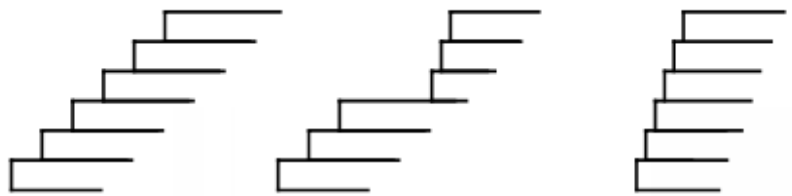
VEGETATED REINFORCED SOIL SLOPES (VRSS) ARE SYSTEMS USED TO VEGETATE EARTH FILL SLOPES. VRSS CONSIST OF 6-8 INCH LAYERS OF LIVE BRANCH CUTTINGS INTERSPERSED BETWEEN COIR FABRIC-ENCAPSULATED SOIL LIFTS. THE BRUSH CUTTINGS ARE PLACED IN AN OVERLAYING AND CRISS-CROSS PATTERN SO THAT THE TIPS OF THE CUTTINGS PROTRUDE FROM THE FACE OF THE FILL SLOPE. THE BASE OF THE STEMS EXTENDS TO THE BACK OF THE FILL SLOPE (TYPICALLY 5 FT BRANCHES DEPENDING ON VRSS DEPTH). EACH BRUSH LAYER IS COVERED WITH SOIL, LIGHTLY COMPACTED, AND WATERED BEFORE THE NEXT SOIL ENCAPSULATED LIFT IS CONSTRUCTED. ON TOP OF THE LIVE BRUSH LAYER, 1 FT HIGH LAYERS OF SOIL WRAPPED IN COIR NETTING OVER COIR BLANKET.

GENERAL NOTES:

1. INSTALL DOWNSTREAM SEDIMENT CONTROL MEASURES, IF REQUIRED, PRIOR TO ANY EARTH DISTURBANCE.

2. CUT AND REMOVE TREES AND SHRUBS DESIGNATED FOR REMOVAL, LEAVING THE ROOTWAD IN PLACE UNLESS OTHERWISE NOTED. PROTECT EXISTING TREES MARKED FOR PRESERVATION.

3. SEE SECTION 02227 - SOIL BIOENGINEERING FOR DETAILED INSTALLATION INSTRUCTIONS. INSTALL ALL SOIL FILL LIFTS USING SUITABLE MATERIAL TO 85-90% COMPACTION.

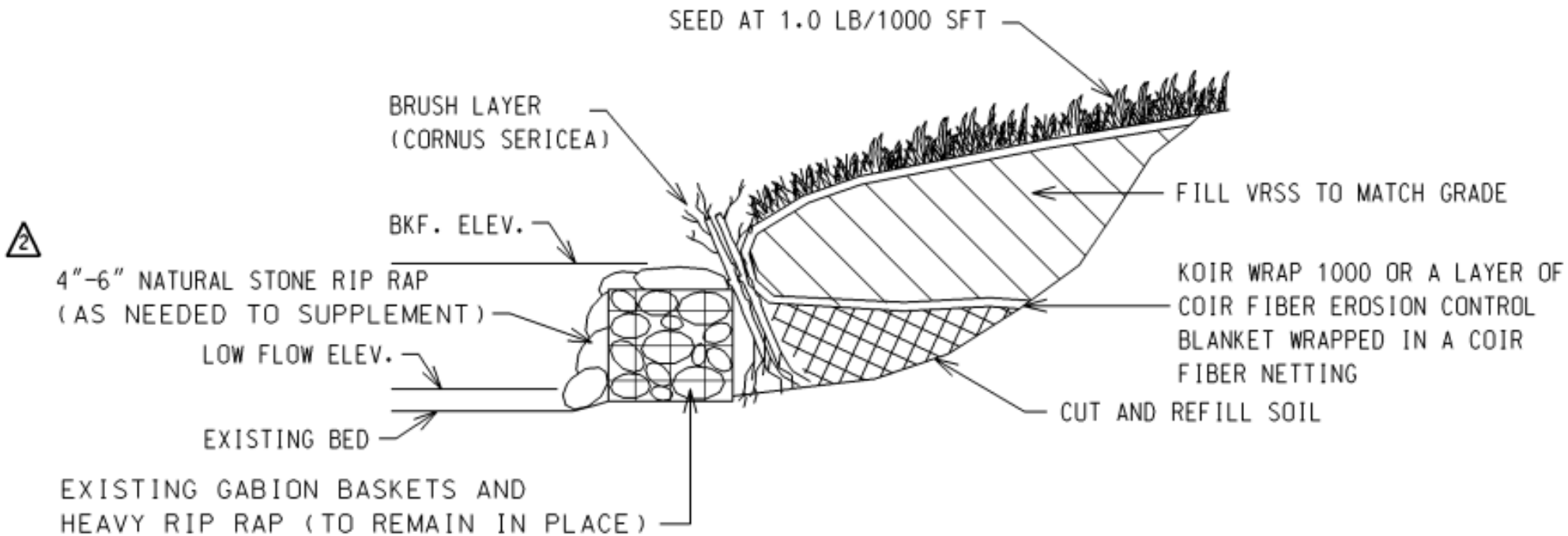


VEGETATED REINFORCED SOIL SLOPES (VRSS)

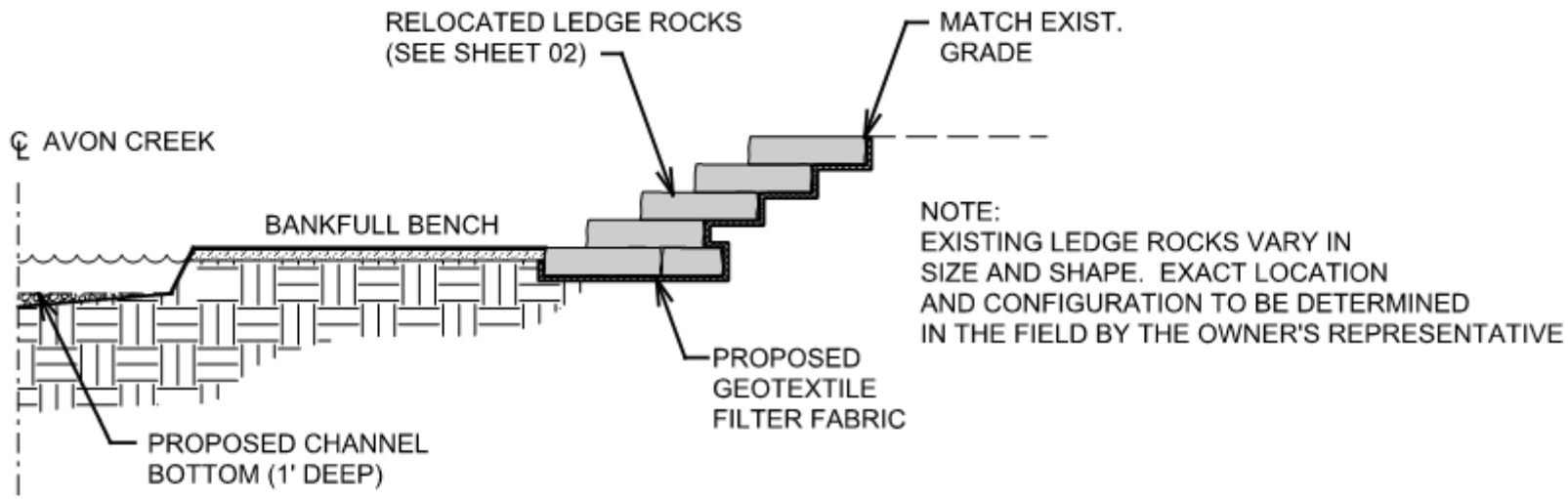
NOTE: ALL VRSS APPLICATIONS FOR THIS PROJECT USE A FLAT OR SLIGHTLY STEPPED CONFIGURATION.

VEGETATED REINFORCED SOIL SLOPES (VRSS)

NO SCALE

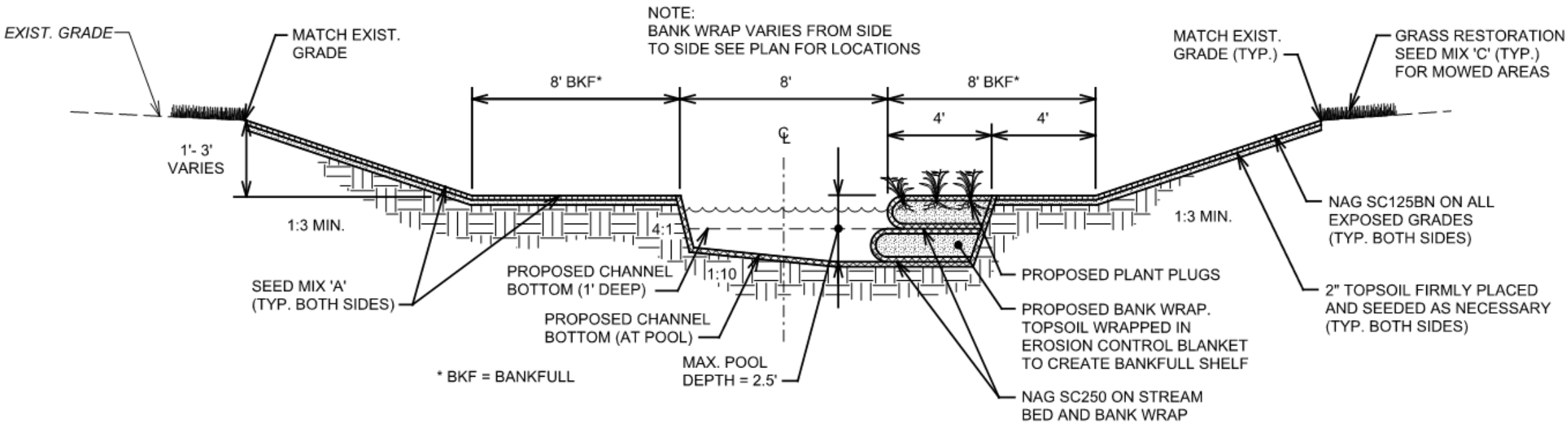


VEGETATED REINFORCED SLOPE STABILIZATION (VRSS) SYSTEM



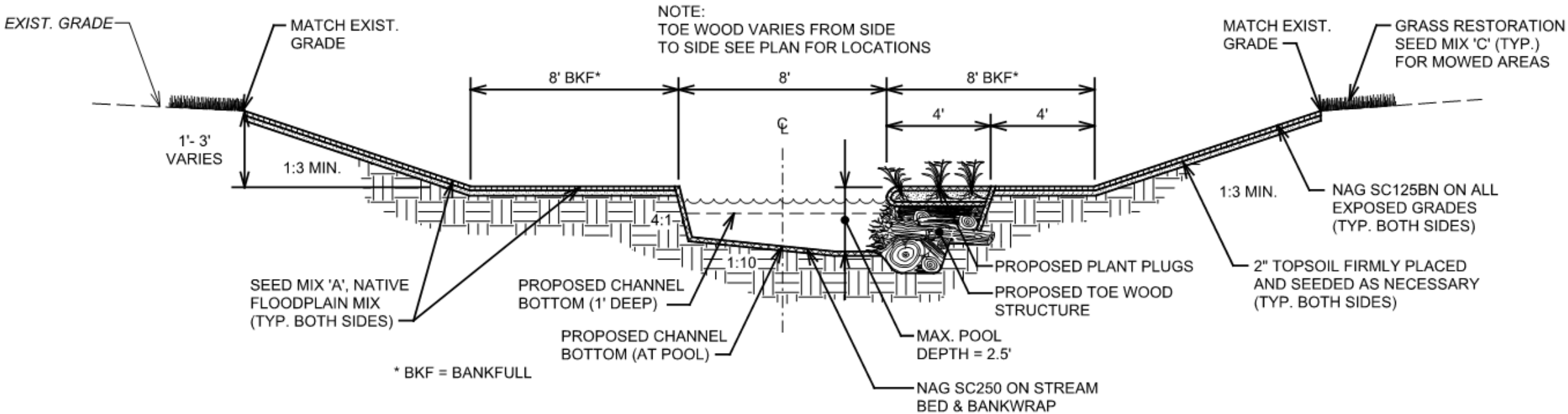
⑫ RELOCATED LEDGE ROCK DETAIL @ RIFFLE

NO SCALE



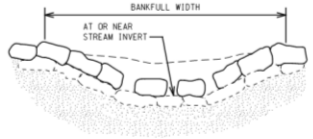
TYPICAL CHANNEL CROSS SECTION (BANK WRAP @ POOL)

NO SCALE



TYPICAL CHANNEL CROSS SECTION @ TOE WOOD

NO SCALE



SECTION A
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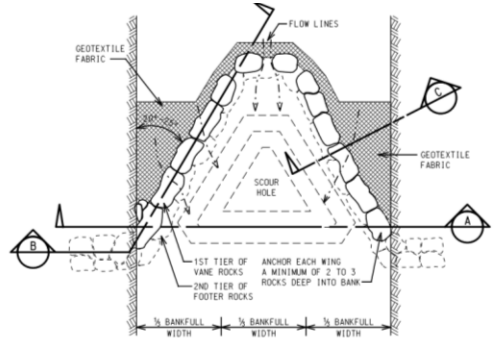
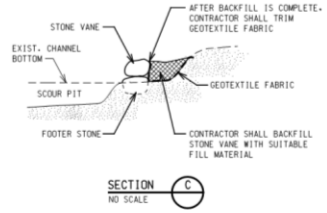


PLAN
NO SCALE



SECTION C
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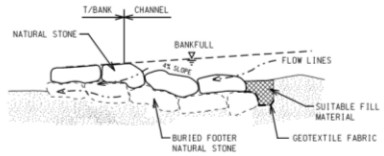
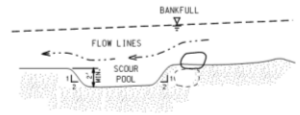


SECTION B
NO SCALE

ROCK CROSS VANE NOTES:

1. THE ANGLE OF THE ARMS WITH THE UPSTREAM BANK SHOULD BE APPROXIMATELY 20 TO 25 DEGREES. ALL FOOTER AND VANE ARM ROCKS SHOULD TOUCH ADJACENT ROCKS TO FORM A TIGHT FIT. VANE ARM ROCKS SHALL BE PLACED ON TOP OF ONE LAYER OF FOOTER ROCKS. THE VANE (UPPER LAYER OF) ROCKS SHALL BE SHINGLED UPSTREAM.
2. OVERALL MAXIMUM DROP CONTROLLED BY THE CROSS VANE SHALL NOT EXCEED TWO (2) FEET. TO PREVENT FLANKING, A FIVE (5) FOOT LONG STONE SILL SHALL BE INSTALLED PERPENDICULAR TO THE CHANNEL AT THE DOWNSTREAM TERMINUS OF EACH ARM.
3. COORDINATE THE CROSS VANE CONSTRUCTION WITH THE INSTALLATION OF EROSION CONTROL BLANKETS ON ALL STREAMBANK AND UPLAND AREAS TO INSURE THAT THEY ARE PROPERLY KEYED IN AT THE TOE OF THE BANK.
4. ALL STONE USED IN CROSS VANE CONSTRUCTION SHALL BE NATURAL STONE RANGING FROM 15 INCH TO 24 INCH IN ITS LEAST DIMENSION WITH THE RATIO OF MAXIMUM TO MINIMUM DIMENSION NOT EXCEEDING 2:1.

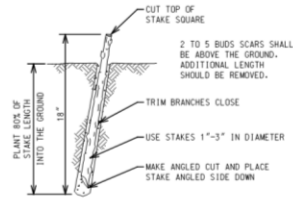


PROFILE OF CENTER OF ROCK CROSS VANE
NO SCALE

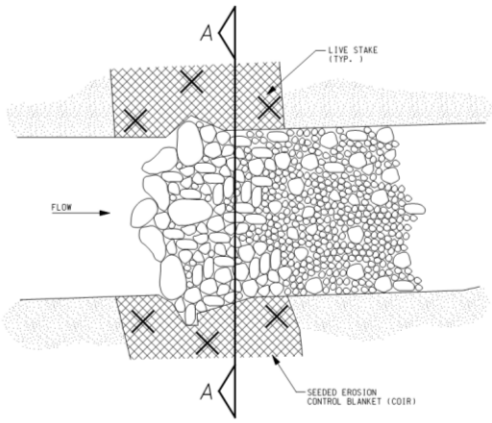
ROCK CROSS VANE DETAILS
NO SCALE

NOTES:

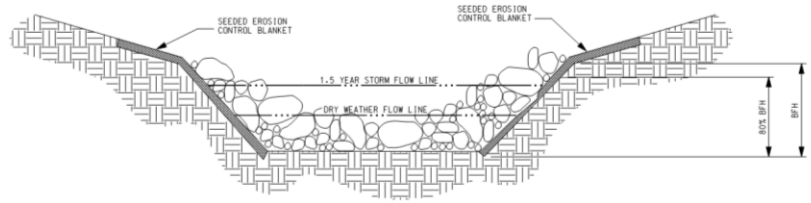
1. HARVEST AND PLANT STAKES DURING THE DORMANT SEASON.
2. USE HEALTHY, STRAIGHT AND LIVE WOOD AT LEAST 1 YEAR OLD.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE STAKES OR SPLIT ENDS DURING INSTALLATION. USE A PILOT BAR IN FIRM SOILS.
4. SOAK CUTTINGS FOR 24 HOURS (MIN.) PRIOR TO INSTALLATION.
5. TAMP THE SOIL AROUND THE STAKE.
6. PLANT STAKES 1'- 3' AWAY FROM EACH OTHER.



LIVE STAKING
NO SCALE



PLAN VIEW



CROSS SECTION VIEW A-A

*BFH = BANK FULL HEIGHT

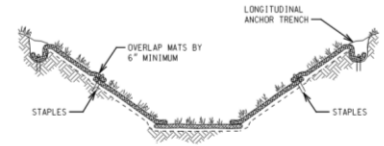
- EXISTING STONE

PROFILE VIEW

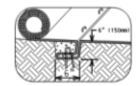
NOTES:

1. EXCAVATE A 12" TRENCH ALONG THE UPSTREAM EDGE OF THE RIFFLE.
2. USE 12" - 36" NATURAL OR EXISTING FIELD STONE ON THE UPSTREAM EDGE OF THE RIFFLE AT A 4:1 SLOPE TO DIRECT FLOW TO THE CENTER OF THE CHANNEL.
3. POSITION STONES IN A V-SHAPE TOWARD AT THE CREST OF THE CHANNEL. AND ARMOR THE BANKS WITH SMALLER COBBLE RANGING FROM 4"-10" IN DIAMETER TO PREVENT SUBSEQUENT BANK EROSION.
3. BE SURE TO ALLOW WATER TO SPILL OVER THE RIFFLE STRUCTURE DURING HIGH FLOW PERIODS.
4. TAPER OFF THE RIFFLE DOWNSTREAM AT A 40:1 SLOPE.
5. DIMENSIONS WILL VARY FOR EACH RIFFLE.

RIFFLE DETAILS
NO SCALE

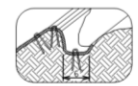


SECTION

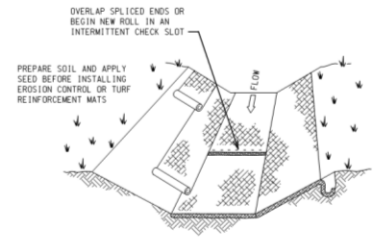


INTERMITTENT SLOT

TYPICAL INSTALLATION WITH EROSION CONTROL BLANKETS OR TURF REINFORCEMENT MATS



LONGITUDINAL TRENCH



PLAN

NOTES:

1. DEPTH OF CHANNEL TO BE SPECIFIED BY ENGINEER.
2. DESIGN VELOCITIES EXCEEDING 2 FT/SEC REQUIRE TEMPORARY BLANKETS OR SIMILAR LINERS TO PROTECT SEED AND SOIL UNTIL VEGETATION BECOMES ESTABLISHED.
3. GRASS LINED CHANNELS WITH DESIGN VELOCITIES EXCEEDING 6 FT/SEC SHOULD INCLUDE TURF REINFORCEMENT MATS.

SC-7 TURF REINFORCEMENT MAT
NO SCALE

Lake & Wetland MANAGEMENT

Featured Product:

SHORESOX Erosion Control™

Product and Erosion Control Knowledge From:

Lake and Wetland Management Inc.

Toll Free: (855) 888 – SOXX (7699)

www.shoresox.com - info@shoresox.com

Toll Free: (855) 888 – LAKE (5253)

www.lakeandwetland.com - office@lakeandwetland.com

The Problem: Soil Erosion

Over many decades, hillside erosion and the erosion of shorelines around our lakes, rivers, streams and oceans has led to severely degraded waterways and aquatic ecosystems, loss of profitable agricultural land and decreased water quality. The natural vegetation that once held the soil in-place is being lost, impacted by increased residential development, urban expansion, farming practices, and increased human activities on lakes, rivers and streams. Normally, vegetation provides a natural filtration effect that mitigates the velocity at which sediment can be carried to bodies of water, thereby protecting shorelines from erosion. And without vegetation that natural filtration system becomes ineffective.

Absent of healthy shorelines, pollutants such as nitrates, phosphates and other soluble and particulate matter are often able to flow into bodies of water unrestricted, filling them with silt, particulate matter and chemical contaminants. In fact, sediment accounts for more than two-thirds of all pollutants entering U.S. waterways. Studies estimate that the U.S. is losing soil at a rate that is 10 times faster than the rate of natural replenishment.

The combination of nutrients and particulate matter loading results in increased algae growth, starving the water of oxygen and allowing invasive species to flourish. This leads to an unhealthy body of water that not only destroys naturally occurring aquatic ecosystems, but also disrupts recreation and other uses of these altered bodies of water.

The Cost of Erosion

Erosion has a number of detrimental effects on the land and our economy. As sediment is lost to the bodies of water, aquatic habitats are impacted; degrading the natural environment, including fish, native aquatic plants, birds and waterfowl. This also reduces popular recreational opportunities such as fishing and hunting. Additionally, arable land is reduced and water quality is affected. This has direct and measurable economic impact measuring in the tens of billions of dollars (USDA, 2002). As stewards of these sensitive environments, it is our obligation to protect and preserve them for each other and for future generations.

The Shoresox Story

Founder, Daniel Schaaf, knew the problem of erosion could be solved in an environmentally responsible way. His interest in finding natural methods to deal with shoreline erosion quickly became his passion. Thus, the development of Shoresox began.

The search for an effective and environmentally responsible solution to shoreline erosion included research and development activities completed in compliance and coordination with offices of the Department of Natural Resources, Watershed Districts and Land and Water Offices. Over an 11-year period, research, product development and field-testing took place, with one objective… Find natural, degradable materials and product configurations that would not only halt and reverse shoreline erosion, but would completely conform to the guidelines of state and local governing agencies.

Daniel was very interested in providing a product that could be filled with unused plant materials that are native to the area. Originally, the material used to fill Shoresox was cornstalks. What was once discarded and plowed into the earth could now be harvested, processed and sold. Continuing in that same spirit today, Shoresox is filled with locally-sourced agricultural products and organic materials.

Erosion Control Best Management Practices (BMPs)

The primary goal of an erosion control device is to immediately arrest sediment loss. When evaluating erosion control solutions there are a number of key factors to consider, including whether or not a given solution will support the long-term establishment of proper upland and aquatic vegetation. For millions of years, proper vegetation development has been nature's most effective solution for erosion control.

The erosion control industry promotes a set of generally-accepted guidelines and considerations based on these factors, called Best Management Practices or BMPs. Today, most governing agencies and municipalities have formalized BMPs that must be adhered to whenever conducting erosion management or restoration activities, or to mitigate the risk of erosion during construction or related activities.

While not all-encompassing, consider these typical erosion control BMPs (taken from a formal BMP manual):

1. **Preserve existing vegetation.**
2. Divert upland run-off around exposed soil.
3. **Seed/mulch/cover bare soil immediately.**
4. **Use sediment barriers to trap soil in run-off.**
5. Protect slopes and channels from gullying.
6. **Install sediment traps and settling basins.**
7. **Preserve vegetation near all waterways.**

Additionally, when considering bioengineered erosion control solutions:

8. The erosion control device must provide strength and integrity to support newly established vegetation.
9. The device must wick and retain water and nutrients to effectively support the health of newly established vegetation.
10. The device must provide safe ingress and egress zones for wildlife and aquatic life.
11. The device must contain appropriate organic material to provide safe and effective biodegradability, without causing additional contamination to nearby waterways.
12. The device must provide filtration of unwanted nutrients and pollutants in order to protect the water quality.

From a structural durability perspective, an important consideration is the mechanism by which the erosion control device is secured to the earth. Devices must have secure attachments, and should include means to apply or add tension to the system, as necessary, in the event the device settles. Devices that do not allow periodic re-tensioning may settle prematurely, causing newly developed roots and plants to tear or separate from the device.

Finally, during these challenging economic times, we must also seek to maximize the cost-effectiveness of available erosion control solutions. Following the practices mentioned above can provide beautiful environmental restoration, without costly replacement or maintenance.

The Shoresox Brand Advantage

Shoresox is an innovative, fully-degradable erosion control solution that arrests hillside and shoreline erosion immediately while providing a foundation for vegetative restoration. By comparison to competitive products, Shoresox contains a number of un-paralleled key design features and benefits.

Containment Unit Design

The patented Shoresox containment system is made from a combination of biodegradable burlap fabric and heavy-duty, photodegradable mesh. This combination provides excellent water-retention properties as well as outstanding durability. The full degradation period is greater than five years, allowing ample time for vegetation to develop strong and secure root systems.

Subsurface Anchoring System

The patented Shoresox sub-surface anchoring system securely attaches the containment unit **directly to the firm soil** of the intact shoreline or hillside. Competitive shoreline products are typically fastened to the less-stable, water-saturated shore bottom, subjecting the fastening system to the forces of wave action, wind and ice-heaving, potentially loosening and destabilizing the product.

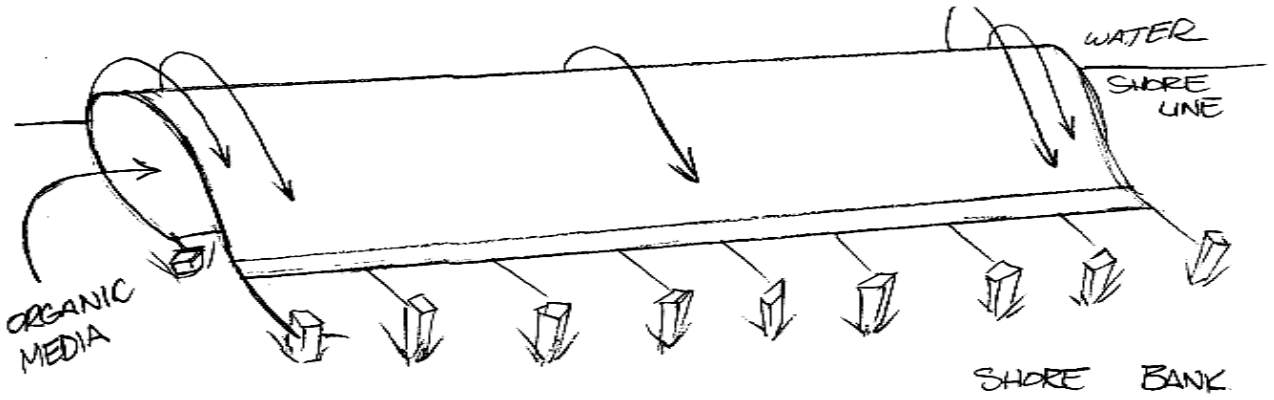
Safety

The patented sub-surface staking system used by Shoresox not only provides an exceptional means of securing the product to the earth, it also provides **unmatched safety** since there are no exposed stakes to pose a risk to humans and animals.

Ease-of-Use

Shoresox is simple to use and can be installed by almost anyone, without complex, destructive and costly equipment or machinery. Using common hand-tools, installation is completed as follows:

1. **Place** and partially secure the empty Shoresox containment system in its intended location.
2. **Fill** the containment system with locally-grown organic material.
3. **Roll** the Shoresox fabric over the organic filling to completely enclose the material.
4. **Secure** Shoresox to the firm soil of the shoreline or hillside using the patented anchoring system.



Shoresox Value

Value and Flexibility

Shoresox **maximizes overall value** by delivering a high-quality, flexible and cost-effective solution.

- A single Shoresox containment system provides the flexibility to cover an eroded area with a height ranging from just a few inches (~10 - 15 cm) up to approximately four feet (~1.2 m). Competitive products must be stacked in rows, or tiers, to achieve the same maximum level of coverage. Stacking multiplies the amount of product needed, leading to increased project cost.
- The cost of the Shoresox staking system is **included in our product pricing**, whereas many competitive products force you to purchase separate fastening systems to secure the product.
- The Shoresox containment system is shipped empty, providing **significant transportation savings** over our competitors. During installation, Shoresox is filled with locally-sourced organic materials. These organic materials may either be baled or loose, and either fresh or in a state of decomposition when used. Recommended filling materials include: oat straw, pine straw, barley straw, compactable (fertilizer-free) vegetation compost, etc.

Revegetation, Filtration and Buffering

Once filled and secured, native vegetation (upland and aquatic plants) can be planted through the mesh and fabric layers. And immediately after installation, Shoresox begins filtering and buffering run-off water, removing harmful contaminants and benefiting waterways and ecosystems. Shoresox can be used in conjunction with "hard-armoring" systems, such as stone rip-rapping, to provide this important advantage.

Shoresox is a modular system and is available in three different lengths, making it easy for customers to meet their projects' unique design needs. All containment systems have a width of 54 inches, effectively providing up to 4 square feet of coverage per linear foot of product.

Length (Lin. Feet)	Weight[1] (Pounds)	Ship. Wt.[2] (Pounds)
25	10.1	30.3
50	20.3	53.7
100	40.6	107.3

[1] Approximate weight of one unfilled Shoresox containment system, not including staking system components.

[2] Approximate shipping weight of one complete Shoresox system. Each complete system includes one containment system plus the anchoring system for securing the containment system to the ground (stakes plus rope). Actual weight may vary. Organic filling material, installation tools are not included.

Product Patent: Shoresox

A copy of the patent can be found in Appendix A. The patent registration was filed in March, 2009, and granted in December, 2011. The major claims of the patent define the use of an open or bag system to protect shorelines or hillsides from erosion. The patent also protects the use of the unique rope and staking system developed by Daniel Schaaf. This patent is specific to the area of erosion control and broad in its scope of application in that area. US Patent No. 8,070,387 B2. Date of Patent: December 6, 2011.

Traditional Shoreline Erosion Control Products

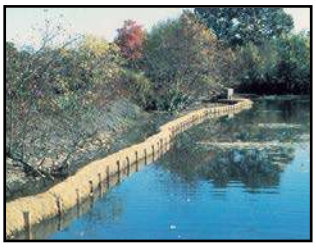
More detailed understanding of the detrimental effects of soil erosion on our economy and ecosystems has spawned a vast market for erosion control products. The wide range of products spans across multiple levels of application, cost and effectiveness. The traditional products that most closely compete with Shoresox include coconut coir (fiber) logs, wattles, geotextile socks, stone rip-rap and stone gabion walls.

Curlex® Bloc: A product of the American Excelsior company, the Curlex® Bloc is constructed of a geotextile fabric bag pre-filled with aspen wood fibers. The unit is placed into position and staked into the shore bed using stakes and rope.

Curlex® Blocs are currently available in 4' and 8' lengths and weigh between 14 – 18 pounds per linear foot.

Coconut "Coir" Logs: Coir fiber, fashioned into logs or blocks, is used based on the theory that it helps native plants grow and stabilize stream banks, slopes, wetlands, and hillside soils for long term erosion control. These pre-filled units are placed into position and staked into the shore bed or hillside using stakes and ropes.

Coir logs are typically available in 10' – 20' lengths and weigh between 2 – 20 pounds per linear foot, depending on the density of the material.



Geotextile Socks: Socks (tubes) of geotextile fabric are filled with materials such as sediment, soil, natural fibers, etc. They are available in both pre-filled and un-filled variations. Once filled, the units are placed into position and staked into the shore bed or hillside using only stakes.

Geotextile socks are available in a variety of lengths, including long, continuous lengths, and typically weigh between 7 – 19 pounds per linear foot, depending on diameter and filling material.

Straw Wattles: Wattles are open-mesh tubes filled with straw or compost. They are similar in design to coir logs, although they are much lighter and degrade more quickly than coir. Wattles are most often used along the contours of newly constructed or disturbed slopes to provide sediment loss control.

Wattles are available in variety of lengths, including long, continuous lengths, and typically weigh between 1.5 – 2 pounds per linear foot.

Stone Rip-Rap: Stone is one of the common methods used in attempts to control erosion along lakes, rivers and oceans. Typically, a geotextile fabric is first laid along the shoreline and then covered with stones or boulders.

Rip-rap installations are always custom-built, extremely labor-intensive, and most often necessitate the use of heavy equipment.

Stone Gabion Walls: Gabions are made by fashioning wire mesh "container" structures and then filling the containers with small to medium-sized stones. Many containers are usually necessary to complete a project.

Stone gabion installations are always custom-built, extremely labor-intensive, and often necessitate the use of heavy equipment.

Competitive Landscape: Shoreline and Hillside Erosion Control Products

We at Shoresox find ourselves with a strong competitive advantage among erosion control solution providers. While a number of "traditional" erosion control products exist on the market, none of them are as uniquely-suited to meet the needs and challenges of erosion control installers. Simply put, Shoresox addresses virtually every drawback and challenge associated with using traditional products. Shoresox provides a safe, effective, durable, easy-to-use, visually appealing and cost-effective solution. Even in comparison to our closest competitors, the unique features and benefits of the Shoresox system remain unrivaled.

- Where heavy, traditional products necessitate the use of costly and destructive equipment during installation, Shoresox provides a light-weight, portable and easy-to-use solution. And because no heavy equipment is needed, there is no collateral damage to the surrounding landscape and environment.
- Where the semi-rigid, traditional products are challenged to follow the contours of the earth, Shoresox provides a fully-flexible solution, easily contouring around tight curves, trees and boulders.
- When the substantial weight of traditional products also means substantial transportation costs, the light-weight Shoresox system can be shipped for a fraction of the cost.
- Where multiple "tiers" of traditional products are needed to provide substantial vertical coverage (thereby multiplying project costs), Shoresox provides a solution with up to four square feet of coverage per linear foot of length.
- Where traditional anchoring systems (attached to the shore "bed") can fail due to exposure to the physical forces of nature (wave action, ice-heaving, etc.), the patented Shoresox anchoring system is attached above the waterline, to the firm shore "bank," easily resisting nature's forces.
- Where the traditional anchoring systems utilize unsightly and dangerous exposed stakes, the Shoresox "subsurface" anchoring system is below-grade, and is Safe, Secure and Out-Of-Sight!
- While traditional products provide limited or no benefits for re-vegetation and run-off filtration, Shoresox has successfully, and repeatedly, demonstrated its ability to do both.
- Because Shoresox is shipped empty and filled with locally-sourced organic material, it supports the income stream for local farmers and eliminates the use of potentially invasive coconut coir fiber.

Not only does Shoresox beat traditional products in terms of safety, functionality, ease-of-use and durability, we also stack-up as one of the most value-packed products on the market. Shoresox is significantly less expensive than competitive products, especially when the comparison is based upon total available coverage.

Shoresox provides up to four square feet of coverage per linear foot of product. It takes two or three tiers of our competitors' products to provide the same level of coverage. And because erosion control devices are sold by the linear foot, creating tiers multiplies the cost of the project.

Our pricing is also in stark contrast to the cost of other common "hard-armoring" solutions, such as rip-rapping. Typical rip-rapping installations cost $75 - $130 per linear foot, and obtaining rip-rapping installation permits from the DNR/DEP is become increasingly difficult. A number of other hard-armoring solutions are available, with some costing hundreds of dollars per linear foot. Considering all of the benefits of the Shoresox system, including our exceptional pricing, Shoresox provides the most value of any product on the market.

Shoresox vs. the Competition

The following table provides a straight-forward comparison between Shoresox and the closest competitive products. The comparison criteria reflect the important considerations and Best Management Practices associated with the erosion control industry.

Comparison Criteria	Shoresox	Curlex® Bloc	Coir Logs	Geotextile Sock	Stone Rip-Rap	Stone Gabion
Subsurface anchoring	**Yes**	No	No	No	N/A	N/A
Attaches to firm shore bank	**Yes**	No	No	No	No	No
Degradable	**Yes**	Yes	Yes	No	No	No
Supports re-vegetation	**Yes**	Yes	Maybe	Maybe	No	No
Filters & buffers run-off	**Yes**	Maybe	No	No	No	No
Lightweight construction	**Yes**	No	No	Maybe	No	No
Broad single unit coverage	**Yes**	No	No	No	Yes	Yes
Shipped empty	**Yes**	No	No	Maybe	No	No
Filled with local material	**Yes**	No	No	Maybe	Maybe	Maybe
Heavy equipment needed	**No!**	Yes	Yes	Yes	Yes	Yes
Resists forces of nature	**Yes**	No	No	No	Maybe	Maybe

Key Client Base

General Contractors: Any construction firms that are involved with significant earth work use erosion control systems during the construction phase. And if any amount of shoreline is impacted or involved, they will be required to restore the shoreline to an acceptable level so that natural vegetation re-growth is possible.

Environmental Contractors: These companies source materials to be used for shoreline restoration after a project is finished. These projects often can require thousands of feet of shoreline restoration.

Landscape Contractors: These contractors will be involved with shoreline projects when their clients have waterfront properties.

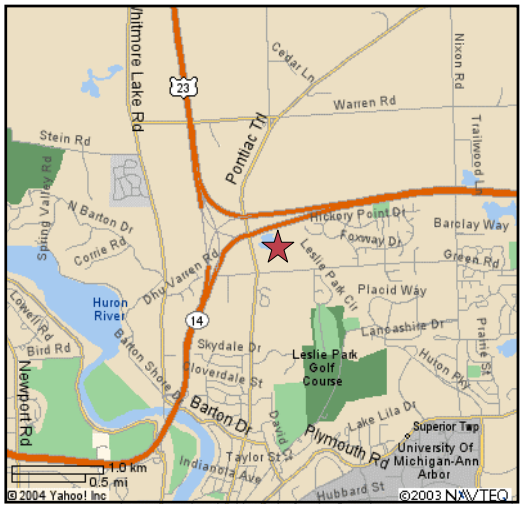
Golf Course Superintendents: Golf courses often have significant lengths of shoreline that are highly susceptible to erosion, particularly given the amount of water applied for turf maintenance. They are also keenly interested in maintaining shorelines that conform to the surrounding landscape and allow natural vegetation to guard against erosion.

Home Owners: Residential properties that have shorelines, in many cases, are devoid of buffer zones that help protect against erosion. Most watershed districts are now requiring increased efforts by shoreline property owners to mitigate erosion and make efforts to re-introduce native plants.

Before and After Shoresox Installation

Porous Pavement

Porous pavement, an alternative to conventional impervious pavement, has many water quality benefits such as storm water infiltration and ground water recharge. Porous asphalt and pervious concrete are two types of porous pavement which have been installed locally.



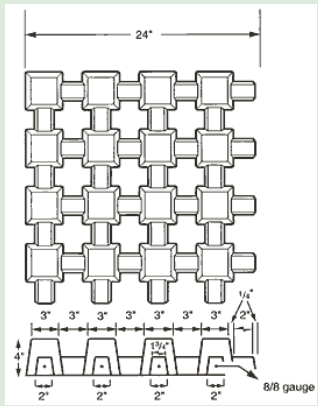
Olson Park

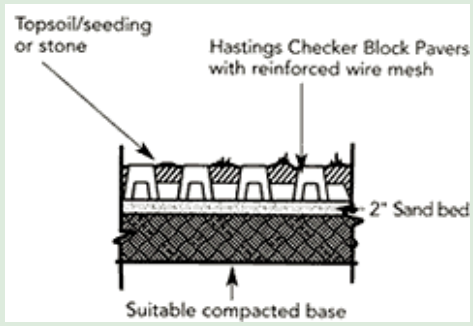
Considerations:

- Suitable in areas with high soil permeability of 3"/hr. or more, a slope of 3% or less and 3' or more above high water table.
- Ideal for areas with low volume or overflow parking.
- The additional cost of porous pavement installation can be offset by a reduction in storm water piping, structures, and detention basin required for conventional pavement.
- Maintenance costs for porous pavement can be 30% less expensive than conventional pavement.
- Detailed specifications on soil erosion, sediment control and system installation, as well as thorough construction oversight are necessary for proper performance and reduced risk of failure.

Olson Park

Location:	Pontiac Trail and Dhu Varren Rd. Ann Arbor
Engineer:	Ayers, Lewis Norris & May, Inc.
Size:	6400 SF
Installation Date:	2003-04
Material:	Hastings Checker Block Pavers
Installation Cost:	$9.00/SF including materials and installation



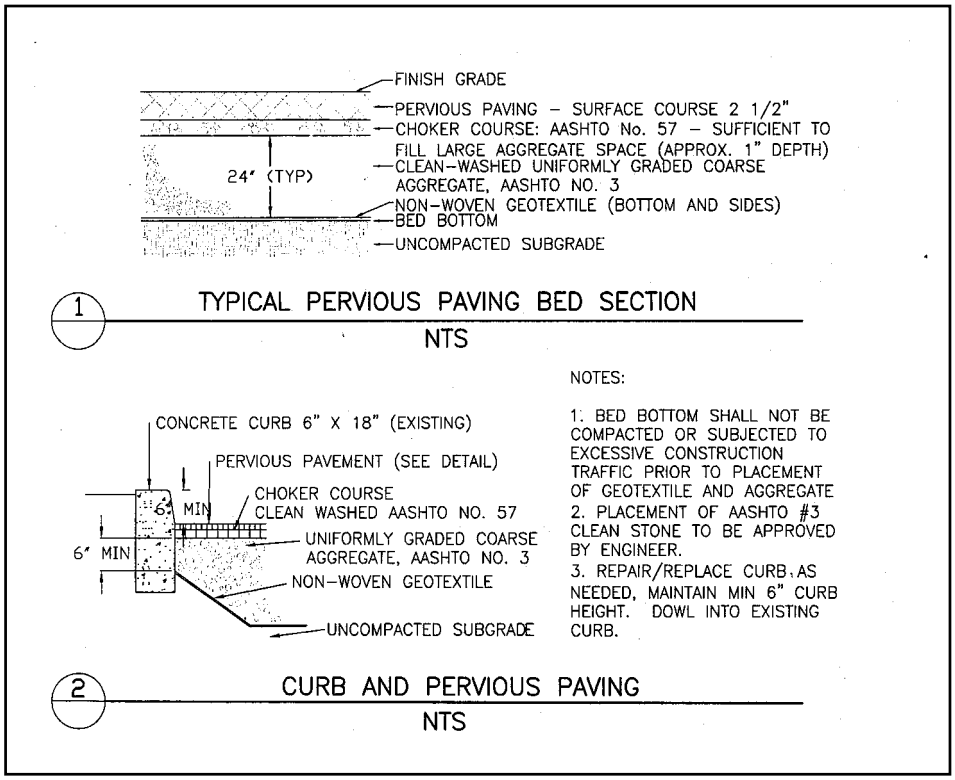


Michigan's Nonpoint Source Program

Office of the Washtenaw County Drain Commissioner, Janis Bobrin. Funded by the United States Environmental Protection Agency; administered by the Michigan Department of Environmental Quality.

For more information, contact Harry Sheehan at (734)222-6851
www.ewashtenaw.org/government/drain_commissioner/dc_lid html

★ University of Michigan W-16 Parking Lot



University of Michigan W-16 Parking Lot

Location: Thompson St., Madison St. & Packard St. Ann Arbor

Credit: University of Michigan Plant Services Division

Size: 1,533 SY

Installation Date: 2002

Material: Porous Asphalt

Installation Cost: $80,000 including construction fence/traffic control, removing existing inlet, 2x2 concrete inlet with frame and covers, removing existing asphalt, excavating and removing soil/subgrade preparation, furnishing and installing geotextile fabric, inlet protection, 8" dia. Perforated HDPE, AASHTO No. 3 course aggregate, 1" choker course, furnishing and installing porous asphalt, curb removal and replacement, bituminous waterstop, 6" sleeves, parking lot striping

Porous asphalt consists of a 2.5" asphalt top course with a lower concentration of fine aggregates in the mix than conventional pavement. This allows water to percolate through the voids down through the choker course, and then through a 24" stone drainage bed that also provides a structural base for the pavement. The storm water then infiltrates evenly over the bed bottom area into the soil.

With minimum maintenance, porous asphalt can function efficiently for well over 20 years. The primary goal of porous pavement maintenance is to prevent clogging of the pavement surface with sediment. This can be ensured by adhering to the following:

- Vacuum sweep the surface twice per year
- Perform initial and annual inspections
- Do not seal coat surface
- Do not apply sand or cinders on or adjacent to pavement
- Snow plow with the blade set slightly higher than usual

Resources

For more information about porous pavement:

Low Impact Development Center
www.lowimpactdevelopment.org/

USEPA Storm Water Fact Sheets
www.epa.gov/owm/mtb/porouspa.pdf

Michigan Department Of Environmental Quality
www.deq.state.mi.us/documents/deq-swq-nps-pap.pdf

Sustainable Building Sourcebook
www.greenbuilder.com/sourcebook/PerviousMaterials.html

US Department Of Transportation
www.fhwa.dot.gov/environment/ultraurb/3fs15.htm

International Stormwater Best Management Practices Database
www.bmpdatabase.org

Pollutant Removal*

Phosphorus	60-71%
Total Suspended Solids	82-95%

* USEPA Storm Water Technology Fact Sheet: Porous Pavement

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

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Bloomfield Hills, MI 48303-0824

SHIPPING: 555 Hulet Drive
Bloomfield Hills, MI 48302-0360

PHONE: 248-454-6300
WEBSITE: hrcengr.com

Memorandum

To: Jered Ottenwess

From: Hubbell, Roth, & Clark

Date: September 16, 2019

Subject: City Hall Drainage HRC Job No. 20130735

The following memorandum has been devolved for the purposes of documenting perceived surface water ponding and drainage issues in the city, providing conceptual recommendations for improvements, and developing budgetary costs for inclusion in the city's stormwater system capital improvement plan. This analysis is cursory in nature and will require more detailed design, survey, and geotechnical investigation to sufficiently address the concerns presented. The recommendations provided shall in no way constitute complete remediation of surface water ponding and drainage issues described.

Background

- The City has noticed excess amounts of stormwater ponding along the west side of Beechmont Road.
- The City also noted that the county beehive, MH014, on the north side of Schroeder clogs frequently and the area surrounding the beehive has eroded away.
    - The City believe this is a safety issue for residents walked alongside the road.
- Elevations of the City streets and structures were collected from a Lidar Scan in March of 2017.

Site Visit Notes (May 3, 2019 and July 30, 2019)

- Upon further investigation, the direction of flow from the pipes on the south side of Schroeder appears to flow east towards Beechmont.
    - This storm pipe is discharging all the runoff from that section of Schroeder to the location where the ponding is occurring along Beechmont.
- The culverts that run on the southwest side of Schroeder and under Beechmont are defective and corroded
- The elevation of this area is relatively flat.
    - The lowest point is on Schroeder, east of Beechmont.
- The manhole at the corner of Beechmont and Schroeder, MH244, is always filled with water.
    - According to the Lidar Scan, the manhole is at a higher elevation that the surrounding grade, which may be contributing to the ponding rainwater in front of the manhole.
- All stormwater on these roads should be draining to county manhole MH016 and eventually drain to Sylvan Lake.
    - All culverts should be verified that they are flowing in the correct direction.

Recommendations

- In order to allow water to get to MH244 at the southwest corner of Beechmont and Schroeder, the manhole should be lowered, replaced with a beehive cover, and have a deeper sump.
    - The inverts should be measured for all the pipes in this manhole to ensure that the outgoing pipe to the east is lower than the incoming pipes from the north and west.
- In addition, the existing culverts and ditches along either side of Beechmont should be regraded to ensure that the slope is flowing north.
    - Native vegetation can be planted alongside the ditches on Beechmont to assist with soaking up runoff from the road and stabilizing the embankments.
- The county beehive, MH014, on Schroeder should be raised closer to grade, the embankment surrounding the manhole should be stabilized with vegetation, and the ditches should be filled in to match the grade of the beehive.
- The culvert that runs under Beechmont is corroded and may need to be replaced during this rehabilitation project.
    - This was not televised during the SAW grant but looking at the inside picture of MH244, it is in poor condition.
- The Keego owned pipe, STM076, next to MH016 is in poor condition and is part of the 0-5 year CIP. This work should be coordinated to be replaced at the same time as the above.
- The projected cost for this solution is estimated to be approximately $50,000-$60,000.

Attachments

- Pictures from the site visits
- Site plan with notations developed using elevations from the Lidar data collected in 2017

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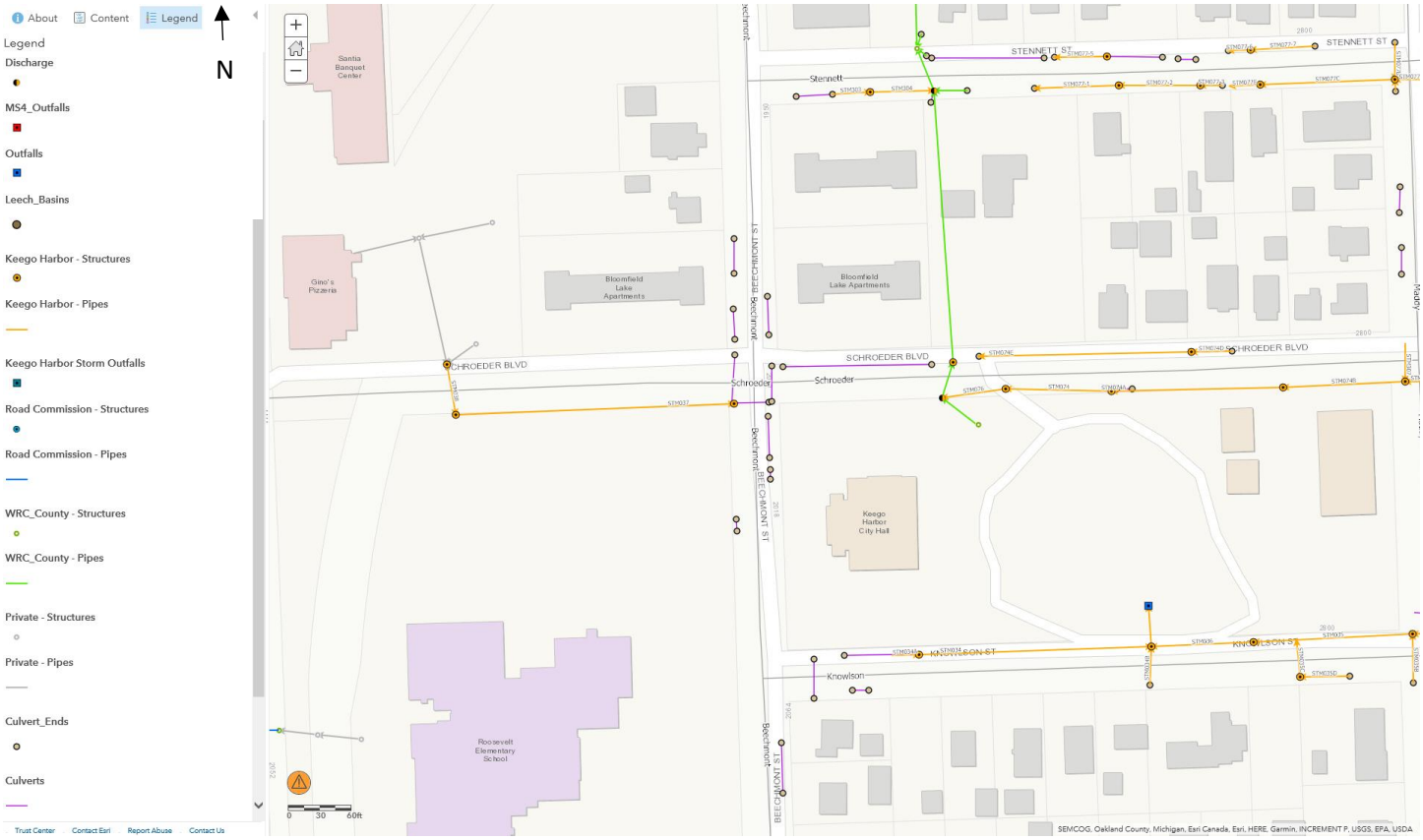
Bloomfield Hills, MI 48302-0360

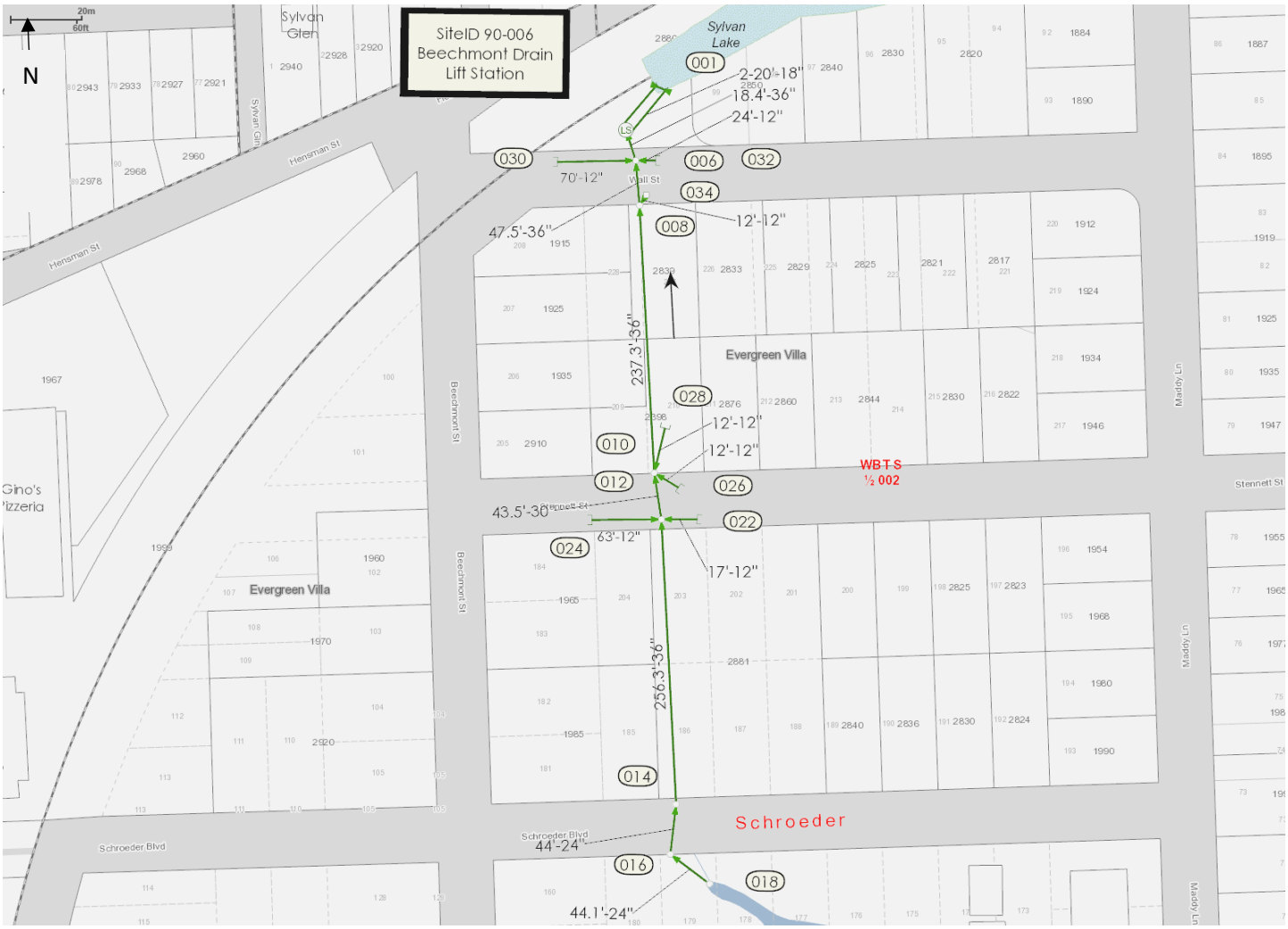
PHONE: 248-454-6300
WEBSITE: hrcengr.com

City Hall

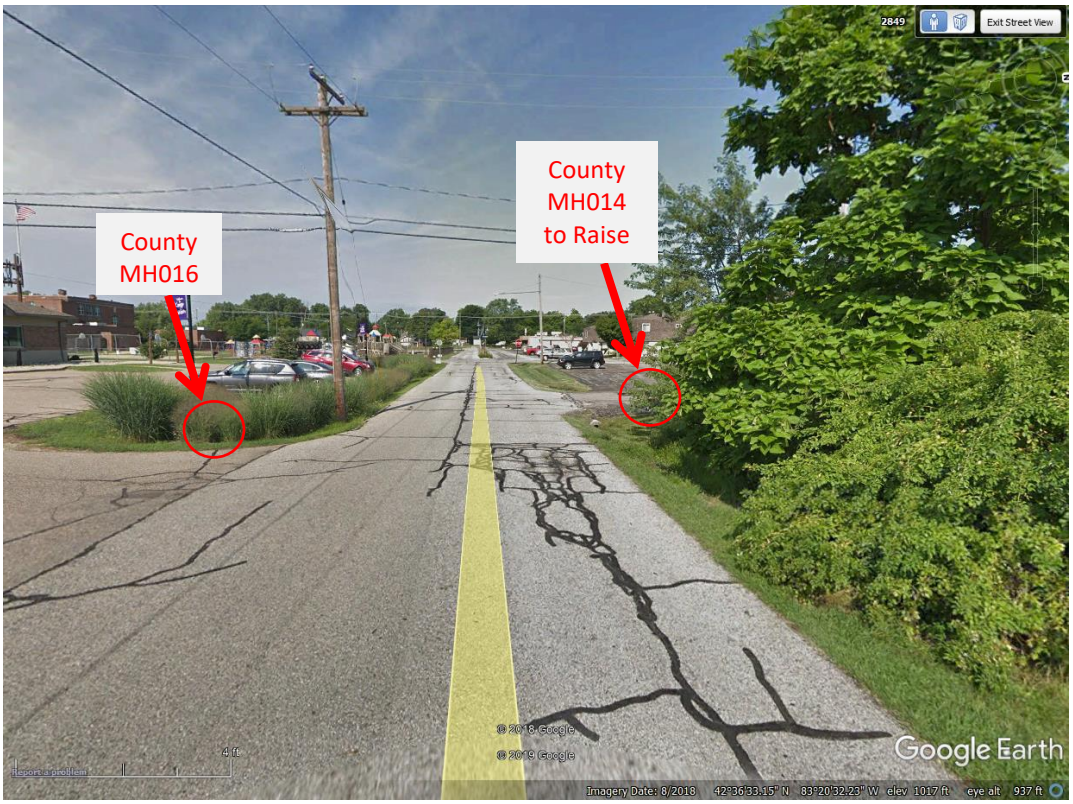
Subject: Drainage Issue Pictures HRC Job No. 20130735



HRC's ArcGIS Map of the existing pipes at the intersection of Schroeder and Beechmont.



Oakland County's GIS Map of their Beechmont Drain, showing the storm drain taking the overflow from the pond and discharging to the Sylvan Lake lift station.



Google street view image taken in August 2018 of Schroeder Blvd., facing west and showing the location of the manhole recommended to repair.

Google street view image taken in August 2018 of Schroeder Blvd., facing east and showing the location of the repair recommendations to existing manhole and culvert.

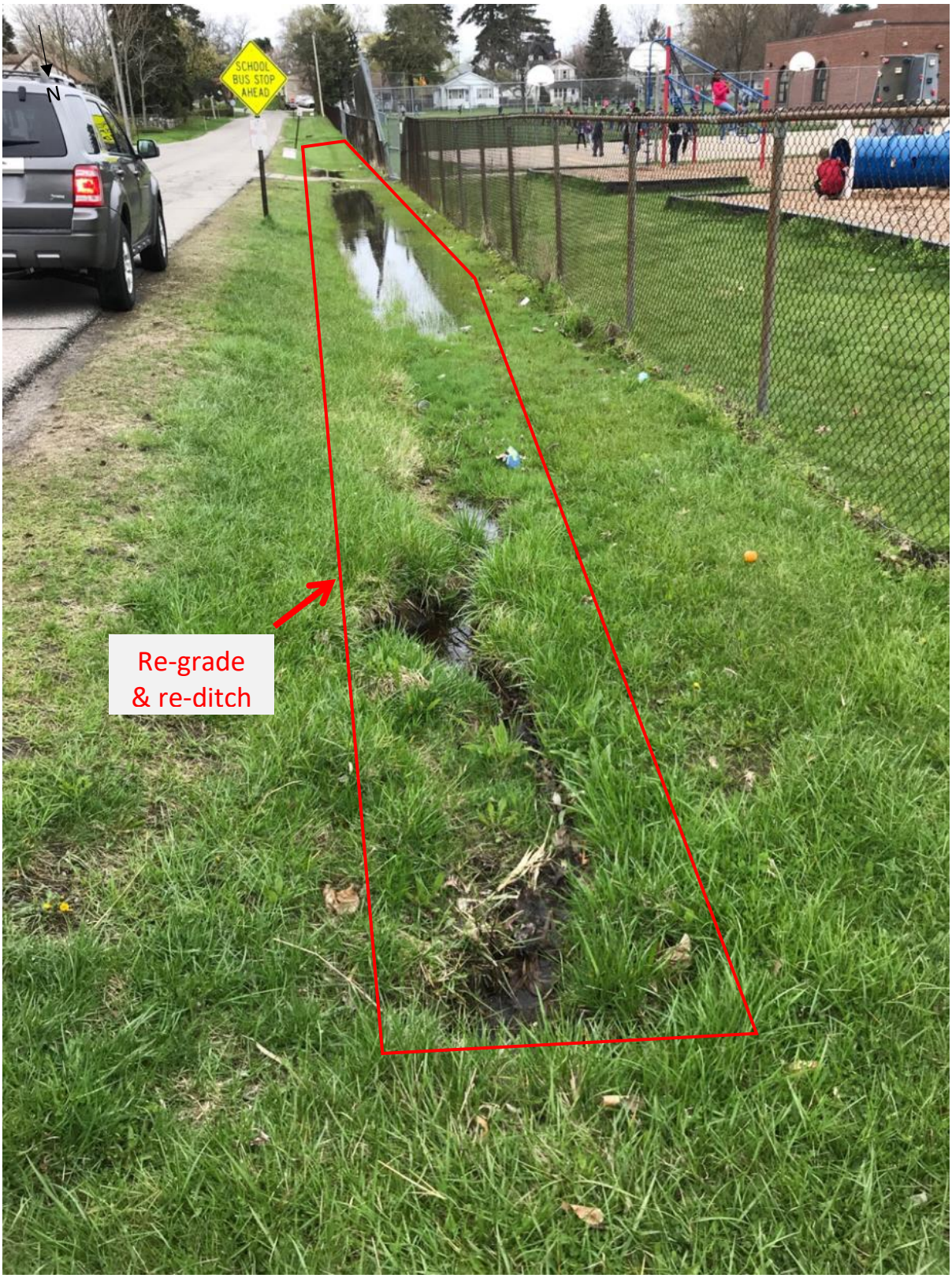
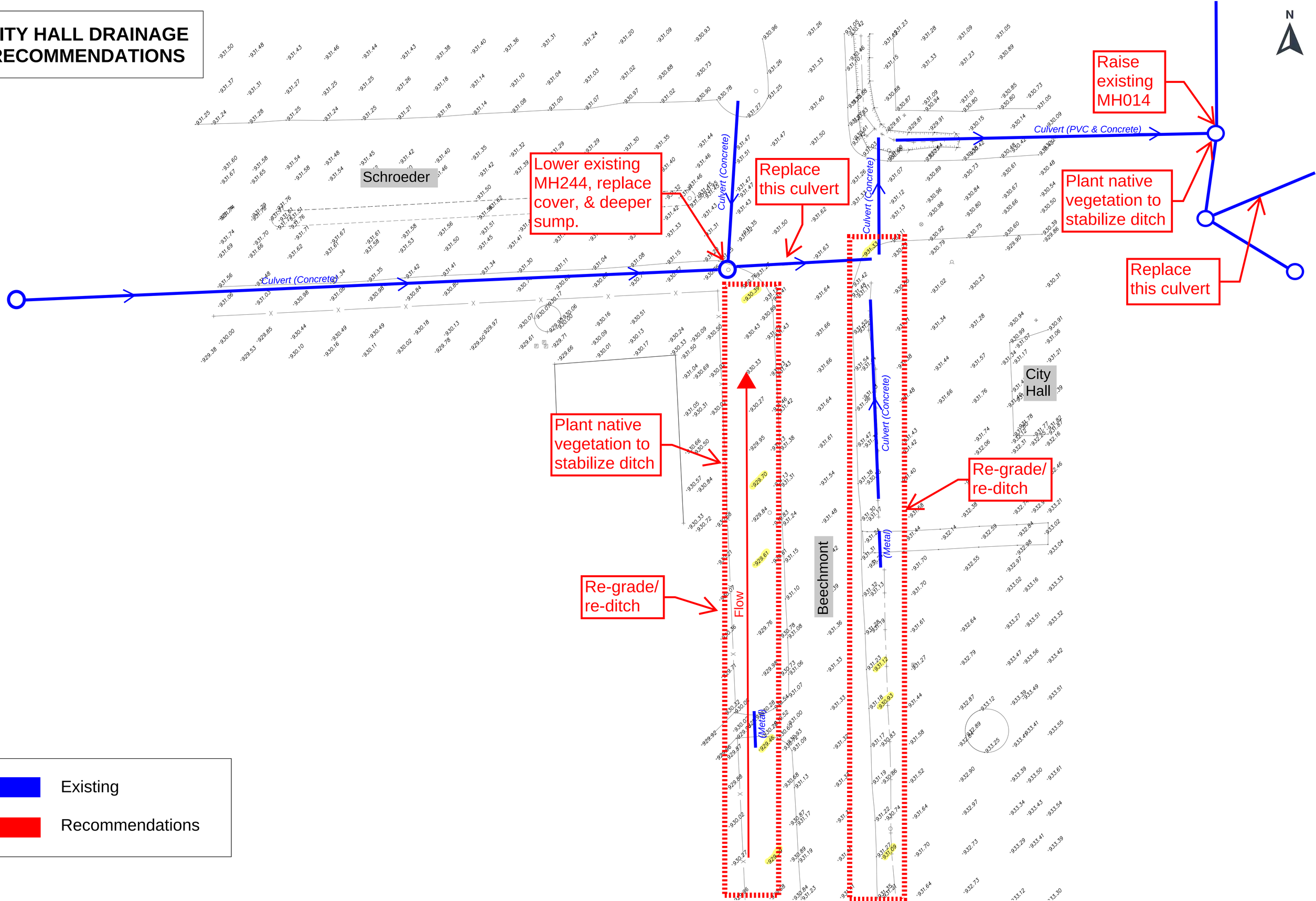


Photo taken by HRC staff on May 3, 2019 of the overgrown ditch along Beechmont Road, south of Schroeder.

Photo taken by HRC staff on May 3, 2019 of stagnant water in the ditch along Beechmont, south of Schroeder, that's prevent flow from entering the manhole.

Photo taken by HRC staff on May 3, 2019 showing the inside of the manhole (MH244) at the corner of Beechmont and Schroeder.

CITY HALL DRAINAGE RECOMMENDATIONS



Existing

Recommendations

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

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Memorandum

To: Jered Ottenwess

From: Hubbell, Roth, & Clark

Date: September 5, 2019

Subject: 1615 Maddy Lane Drainage HRC Job No. 20130735

The following memorandum has been developed for the purposes of documenting perceived surface water ponding and drainage issues in the city, providing conceptual recommendations for improvements, and developing budgetary costs for inclusion in the city's stormwater system capital improvement plan. This analysis is cursory in nature and will require more detailed design, survey, and geotechnical investigation to sufficiently address the concerns presented. The recommendations provided shall in no way constitute complete remediation of surface water ponding and drainage issues described.

Background 2017 March

- The homeowner has complained of water accumulating at the end of their driveway.
- The homeowner installed a new piping to drain the existing trench drain between the end of the driveway and the roadway.
    - This trench drain outlets to a drainpipe that runs along the South side of the home to the canal behind the home. However, the drainpipe does not drain to the cancel, but is conveyed to an underground level spreader on the backside of the seawall. Refer to the attached pictures.
- Maddy Lane was re-surfaced was in 2009 during which a drainage study was not incorporated.
- Elevations of the City streets and structures were collected from a Lidar Scan in March of 2017.

Site Visit Notes (July 30, 2019)

- The driveway appears to lay significantly lower than Maddy Lane and slopes towards the house and canal behind his house.
- The existing drainage system on Maddy Lane, North of Wall Street consists of ditches that have been filled in or culverts that have been buried or removed.
- The top of the seawall in the backyard of 1615 Maddy was approximately 1.5-ft higher than the water-level at the end of July.
    - Homeowner stated that he frequently requests that the County adjust the dam to lower the lake water level because it gets very high in the spring.

Recommendations

HRC proposes the following ideas to address the drainage issues:

- Option 1: The following were recommendations made by HRC staff in 2015, which are still applicable.

  - Add a drainage basin in the backyard with a 6-inch perforated underdrain at the bottom of the proposed swale (1'-2' below).
  - The underdrain should be tied into the trench drain at the base of the driveway to provide an adequate outlet for the trench drain (piping already completed).
  - Install a sump pump in the plastic drainage structure to pump the collected water over the seawall into the lake when necessary.
  - The projected cost for this project is estimated to be about $5,000-$6,000.
- Option 2: Re-establish ditch and culvert drainage system along Maddy Lane North of Wall Street
  - Install ditches in front yard areas along homes on Maddy Lane
  - Install culverts beneath all driveways and repave drive approaches
  - Install piped outlet(s) through seawall(s) at the low point(s) in the stormwater drainage system.
  - The projected cost for this project is estimated to be about $20,000-25,000 .

Attachments

- Pictures from the homeowner and site visits
- Site plan with notations developed using elevations from the Lidar data collected in 2017
- Previous memo discussing this drainage issues dated 6/30/2015

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

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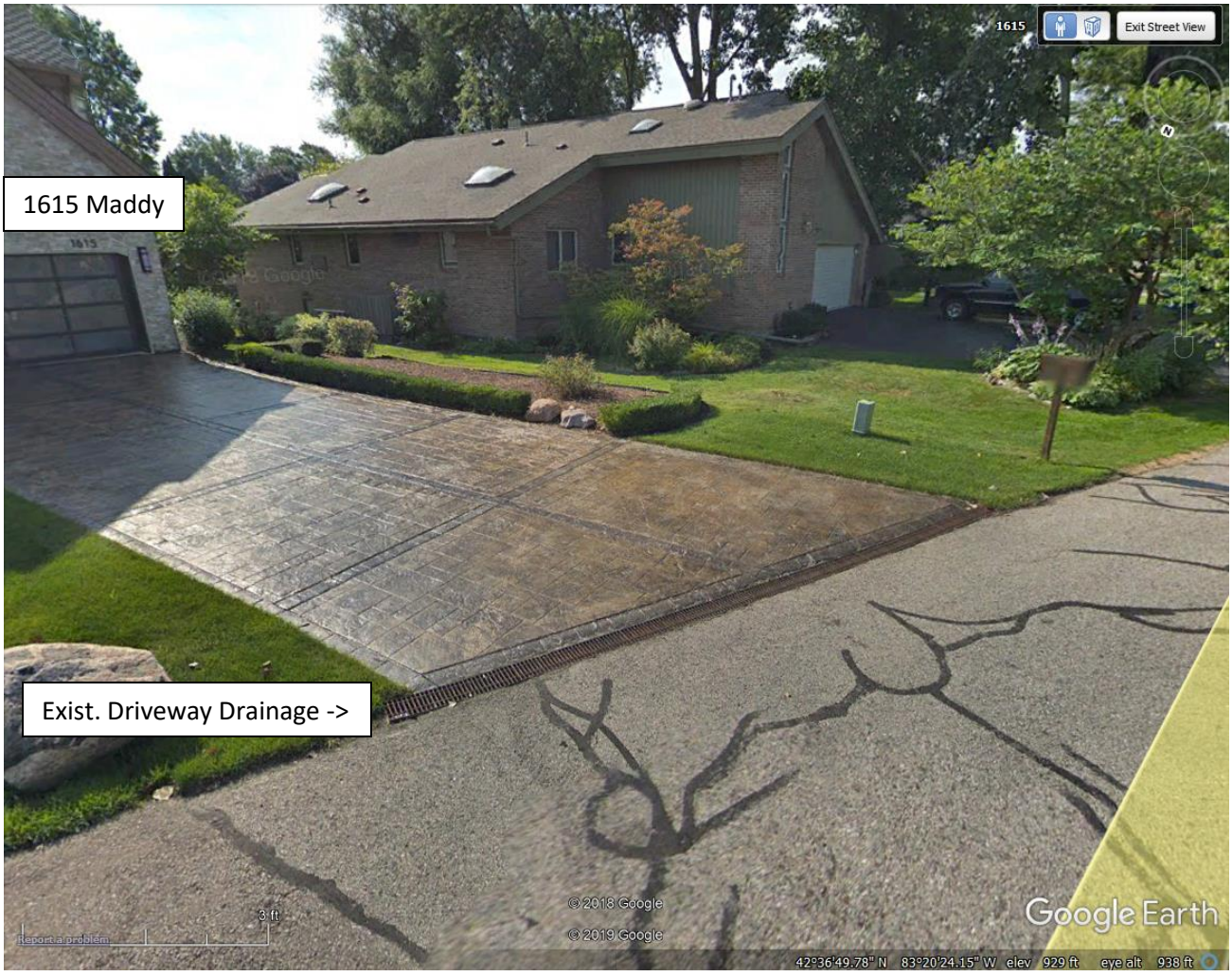
1615 Maddy Lane

Subject: Drainage Issue Pictures HRC Job No. 20130735



Google Earth Image from August 2018 of homeowner's house and driveway drainage.

Delhi Township
2101 Aurelius Rd.
Suite 2A
Holt, MI 48842
517-694-7760

Detroit
535 Griswold St.
Buhl Building, Ste 1650
Detroit, MI 48226
313-965-3330

Grand Rapids
801 Broadway NW
Suite 215
Grand Rapids, MI 49504
616-454-4286

Howell
105 W. Grand River
Howell, MI 48843
517-552-9199

Jackson
401 S. Mechanic St.
Suite B
Jackson, MI 49201
517-292-1295

Kalamazoo
834 King Highway
Suite 107
Kalamazoo, MI 49001
269-665-2005

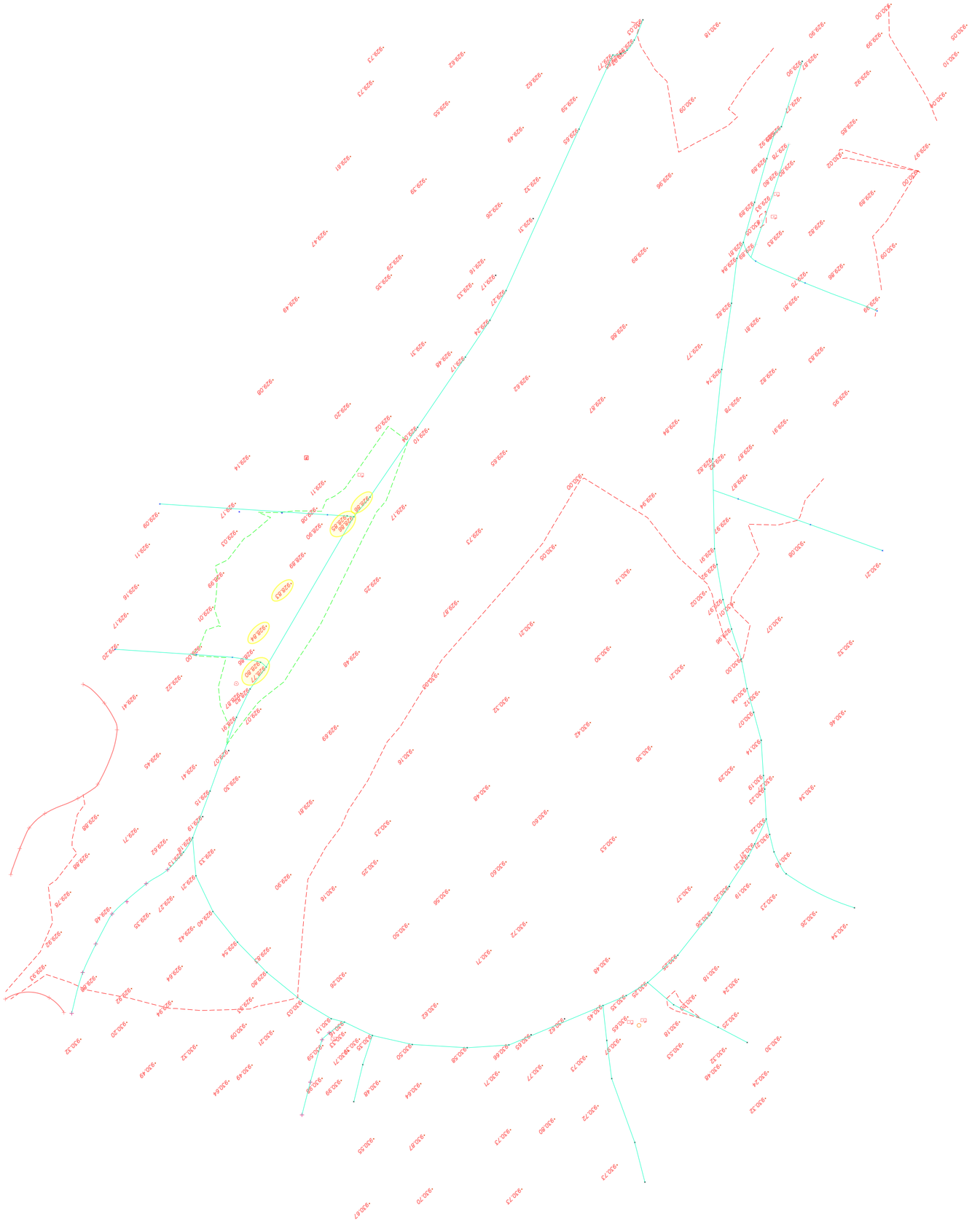
Lansing
215 S. Washington SQ
Suite D
Lansing, MI 48933
517-292-1488

Homeowner's images of installing footing drainage from May 5, 2019.

Homeowner's images of flooding in their driveway from May 7, 2019.

Elevation comparison of driveway compared to the road from July 30, 2019, taken by HRC staff.

Sylvan Lake water-level at the seawall on July 30, 2019, taken by HRC staff.



Memorandum

To: Ms. Linda Voll

From: Bradley Shepler, P.E., CCCA, LEED AP BD+C

Date: July 1, 2015

Subject: 1635 Maddy Lane HRC Job No. 20150482
Recommended Stormwater Drainage Improvements

Per your request, we have completed an investigation of the stormwater drainage concerns at the subject property. Our staff completed a simple topographic survey around the property utilizing GPS points to create a terrain model of the property. Utilizing the spot elevations provided by the survey, it appears that the elevations at the road and at the seawall are higher than areas within the property. This prevents water from draining to the lake and causes ponding along the property lines (specifically the south property line) and near the driveway at the subject property.

To help alleviate these drainage concerns, we have developed the following recommended improvements (ranked in order of which we feel is least effective to most effective) and have attached conceptual exhibits of each alternative;

1) Regrade the swale between 1635 Maddy Lane and 1615 Maddy Lane to provide clear conveyance of stormwater from the road to the backyard and install a plastic (High Density Polyethylene (HDPE) or Polyvinyl Chloride (PVC)) drainage basin to collect the water. Install a sump pump in this plastic drainage structure to pump the collected water over the seawall and into the lake. (Concept #1)
2) Improve the property and add a drainage basin in the back yard similar to Concept #1 but add a 6-inch perforated underdrain at the bottom of the proposed swale (approximately 1' to 2' below bottom of swale). This 6-inch underdrain should be tied into the existing trench drain at the base of the driveway to provide an adequate outlet for the trench drain. (Concept #2)
3) Install two (2) plastic drainage basins, one in the front yard and one in the back yard. Connect these basins with a 8" to 12" perforated drain pipe. Connect the front yard drainage basin to the existing trench drain at the base of the driveway with a 6-inch underdrain pipe. Install a sump pump in the backyard plastic drainage structure to pump the collected water over the seawall and into the lake. (Concept #3)

Below are a few considerations for the above recommended improvements:

1) All plastic structures and pipes should be perforated, encased in pea gravel and wrapped with a geotextile fabric to prevent soil infiltration.
2) The float for the sump pump in the backyard drainage basin (designated as FCB #1 on the exhibits) should be set just above the normal ground water elevation so that it is only used when stormwater surcharges the structure.
3) If the grades work out, consider punching a gravity flow pipe (PVC Schedule 40 or similar) through the seawall from FCB#1 to handle initial drainage and small storms.
4) Sump pump should be disconnected during the winter months and stored in an appropriate environment in accordance with the manufacturer's recommendations.

Note:

(1) INSTALL SUMP PUMP WITHIN FCB #1
SET SUMP PUMP FLOAT ABOVE NORMAL GROUNDWATER ELEVATION

(2) CONSIDER GRAVITY FLOW PIPE FROM FCB #1 THROUGH SEAWALL AS WELL

Unit 0 5 10 20 40
Feet/Inches

City of Keego Harbor
"Heart of the Lakes"

HRC 100 YEARS CONSULTING ENGINEERS SINCE 1911
555 HULET DRIVE
BLOOMFIELD HILLS, MICH.
P.O. BOX 824
48303-0824

1635 MADDY LANE, KEEGO HARBOR, MI
STORMWATER DRAINAGE IMPROVEMENTS
CONCEPT #1

JOB NO. 20150482
DATE JUNE 2015
FIGURE NO. 1

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Note:

(1) INSTALL SUMP PUMP WITHIN FCB #1
SET SUMP PUMP FLOAT ABOVE NORMAL GROUNDWATER ELEVATION

(2) CONSIDER GRAVITY FLOW PIPE FROM FCB #1 THROUGH SEAWALL AS WELL

0 5 10 20 40
Unit
Feet/Inches

City of Keego Harbor
"Heart of the Lakes"

HRC 100 YEARS
CONSULTING ENGINEERS SINCE 1915
555 HULET DRIVE
BLOOMFIELD HILLS, MICH.
P.O. BOX 824
48303-0824

1635 MADDY LANE, KEEGO HARBOR, MI
STORMWATER DRAINAGE IMPROVEMENTS
CONCEPT #2

JOB NO. 20150482
DATE JUNE 2015
FIGURE NO. 2

Note:

(1) INSTALL SUMP PUMP WITHIN FCB #1
SET SUMP PUMP FLOAT ABOVE NORMAL GROUNDWATER ELEVATION

(2) CONSIDER GRAVITY FLOW PIPE FROM FCB #1 THROUGH SEAWALL AS WELL

0 5 10 20 40
Unit
Feet/Inches

City of Keego Harbor
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HRC 100 YEARS CONSULTING ENGINEERS SINCE 1915
555 HULET DRIVE
BLOOMFIELD HILLS, MICH.
P.O. BOX 824
48303-0824

1635 MADDY LANE, KEEGO HARBOR, MI
STORMWATER DRAINAGE IMPROVEMENTS
CONCEPT #3

JOB NO. 20150482
DATE JUNE 2015

FIGURE NO. 3

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Memorandum

To: Jered Ottenwess

From: Hubbell, Roth, & Clark

Date: November 1, 2019

Subject: South Maddy Lane Drainage HRC Job No. 20130735

The following memorandum has been developed for the purposes of documenting perceived surface water ponding and drainage issues in the city, providing conceptual recommendations for improvements, and developing budgetary costs for inclusion in the city's stormwater system capital improvement plan. This analysis is cursory in nature and will require more detailed design, survey, and geotechnical investigation to sufficiently address the concerns presented. The recommendations provided shall in no way constitute complete remediation of surface water ponding and drainage issues described.

Background

- Keego Harbor's DPW reported water backing up on the South end of Maddy Lane where the street dead ends.
- There are several culverts in the easement on the west side of Maddy and a manhole that discharges to the stream that runs along the West Bloomfield Trail.
- Elevations of the City streets and structures were collected from a Lidar Scan in March of 2017.

Site Visit Notes (July 30, 2019)

- During the site visit by an HRC employee, there was no visible standing water on the dead-end street.
- However, there was evidence of the stream possibly surcharging from the presence of dirt on the road.
- The manhole at the south end of the street was completely full of water and did not seem to be serving any purpose since it appeared to be at the same level as the nearby stream.
- Also, the culverts that run along the side of the road were clogged with grass and had no defined ditches to help move the stormwater to the stream.
- The road appears to be low-lying, especially in comparison to the stream level.

Recommendations

- If this section of Maddy Lane is planned to be repaved soon, the road should be raised and the ditches on the west side of the street should be more defined around the existing culverts.
- Additional culverts and ditches should be installed on the east side of the street.
- Efforts should be made to stabilize the surrounding area of the stream and the access path to the West Bloomfield Trail.
- Costs would be minimal in conjunction with a repaving project.

Attachments

- Pictures from site visit
- Site plan recommendations with notations

HUBBELL, ROTH & CLARK, INC
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South Maddy Lane

Subject: Drainage Issue Pictures

HRC Job No. 20130735

Google Street View of dead-end street where stormwater ponding occurs.

Delhi Township
2101 Aurelius Rd.
Suite 2A
Holt, MI 48842
517-694-7760

Detroit
535 Griswold St.
Buhl Building, Ste 1650
Detroit, MI 48226
313-965-3330

Grand Rapids
801 Broadway NW
Suite 215
Grand Rapids, MI 49504
616-454-4286

Howell
105 W. Grand River
Howell, MI 48843
517-552-9199

Jackson
401 S. Mechanic St.
Suite B
Jackson, MI 49201
517-292-1295

Kalamazoo
834 King Highway
Suite 107
Kalamazoo, MI 49001
269-665-2005

Lansing
215 S. Washington SQ
Suite D
Lansing, MI 48933
517-292-1488

Buried culvert and ditches.

Location of the manhole at the end of Maddy Ln that discharges to the stream.

Inside image of the manhole at the end of Maddy Ln that is regularly filled with water as the outgoing pipe is below the water level in the stream.


About
Content
Legend
Legend
Keego_Harbor - Structures
Keego_Harbor - Pipes
Road Commission - Structures
Road Commission - Pipes
WRC_County - Structures
WRC_County - Pipes
Private_Keego_Harbor - Structures
Private_Keego_Harbor - Pipes
Keego Harbor Storm Outfalls
DrivewayCulverts - Driveway Culvert Form
DrivewayCulverts - Culverts_New
Boundary
MADDY LANE DRAINAGE RECOMMENDATIONS
Maddy Ln
2270
2285
2290
2297
2304
2313
2320
2340
RAISE ROAD GRADE
DEFINE DITCHES
ADD DITCHES
DEFINE DITCHES
Trail Access Path
STABILIZE PATH & STREAM BANK
Stream
West Bloomfield Trail
N

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

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SHIPPING: 555 Hulet Drive
Bloomfield Hills, MI 48302-0360

PHONE: 248-454-6300
WEBSITE: hrcengr.com

Memorandum

To: Jered Ottenwess

From: Hubbell, Roth, & Clark

Date: September 5, 2019

Subject: 2229 Willow Beach Drainage HRC Job No. 20130735

The following memorandum has been developed for the purposes of documenting perceived surface water ponding and drainage issues in the city, providing conceptual recommendations for improvements, and developing budgetary costs for inclusion in the city's stormwater system capital improvement plan. This analysis is cursory in nature and will require more detailed design, survey, and geotechnical investigation to sufficiently address the concerns presented. The recommendations provided shall in no way constitute complete remediation of surface water ponding and drainage issues described.

Background

- The homeowner has complained of water ponding in their driveway, their yard, and in the road.
- Willow Beach Road was repaved in this area in 2017 (HRC job #20170705).
- A 12" CMP culvert was installed during the road repaving job in 2017 under Willow Beach in this area that outlets to Dollar Lake with an inlet on the west side of Willow Beach. Minutes from that project discussing the intention and further recommendations for this culvert are attached.
- Elevations of the City streets and structures were collected from a Lidar Scan in March of 2017.

Site Visit Notes (May 3, 2019 and July 30, 2019)

- The 12" corrugated drainpipe changes from a 12" CMP beneath the west side of Willow Beach to a 4" PVC at the outlet on the property 2243 Willow Beach.
    - The culvert continuously clogs at the inlet and water pools on both sides of Willow Beach.
    - Slits have been cut on the east side of Willow Beach into the top of the pipe to allow drainage of water sheeting off the road to the east.
- The culvert outlet through the seawall behind 2243 Willow Beach into Dollar Lake is completely submerged and partially covered with rocks.
- The homeowner informed the City that the soil under the road has been eroding due to the pooling.
- The culvert inlet on the west side of Willow Beach Road continuously clogs with dirt and overgrown plants.
    - The City DPW visited the site after the homeowner's notice and cleared the debris and soil around the culvert opening and set a milk crate on top of the opening to prevent debris from clogging the pipe.
- Due to the driveway sitting lower than the road elevation, the homeowners at 2229 Willow Beach and 2243 Willow Beach repaved their driveway during the summer of 2019 to raise the elevation.

Recommendations

- Add a field catch basin structure over the top of the existing culvert in the low-lying area in front of 2229 Willow Beach.
- A field catch basin structure should be placed over the culvert opening on the West side of Willow Beach
    - Finger drains should be extended North and South from this structure parallel to the road and approximately 6-feet from the edge of road
- The location of where the pipe changes sizes should be identified:
    - Pipe should be replaced with a 12" pipe from this point to Dollar Lake or
    - A structure should be placed in this location to improve maintenance.
- The projected cost for this is in the range of $8,000 – $10,000.

Attachments

- Pictures from the homeowner and site visits
- Site plan with notations
- Meeting Minutes from 2017

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

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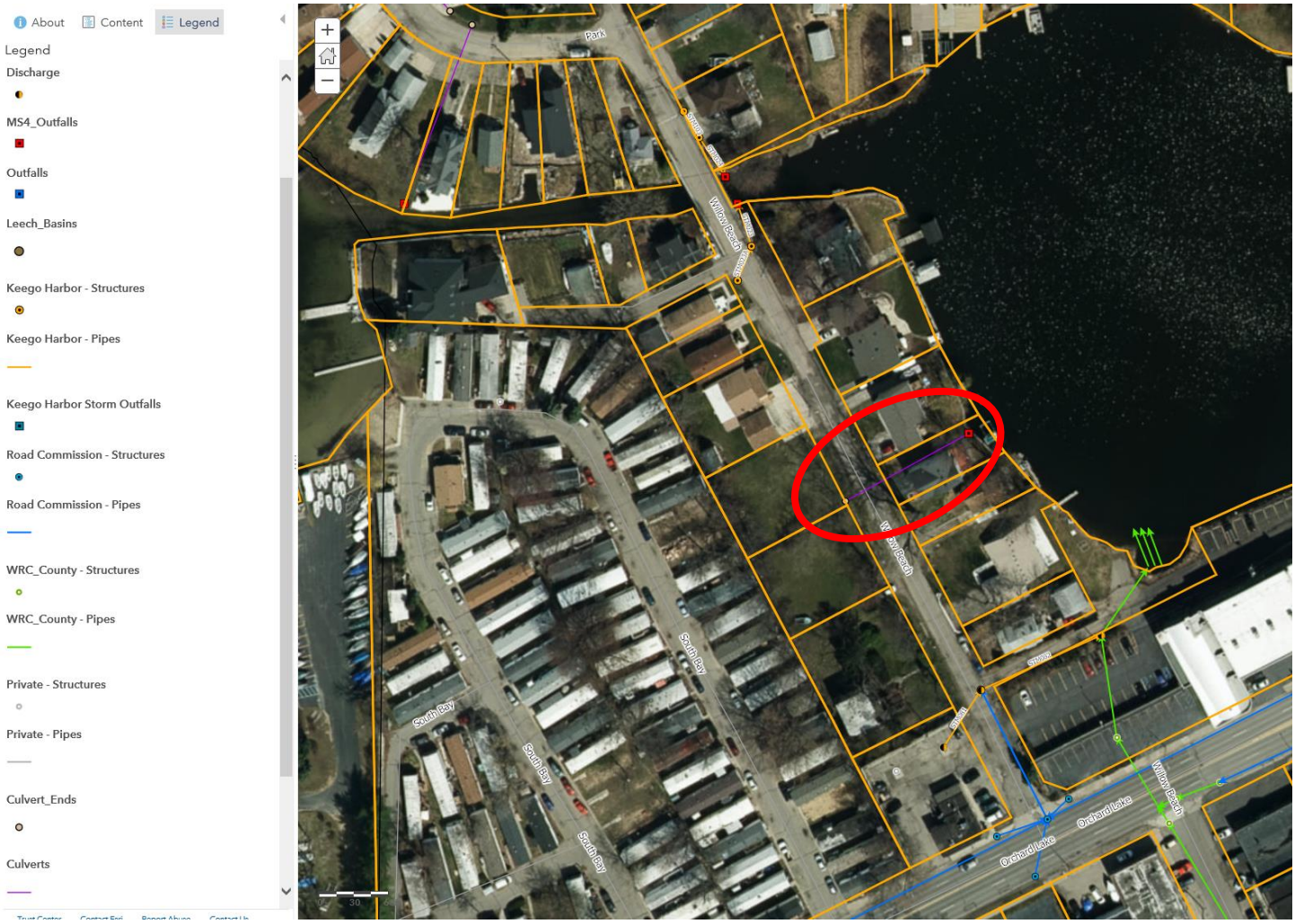
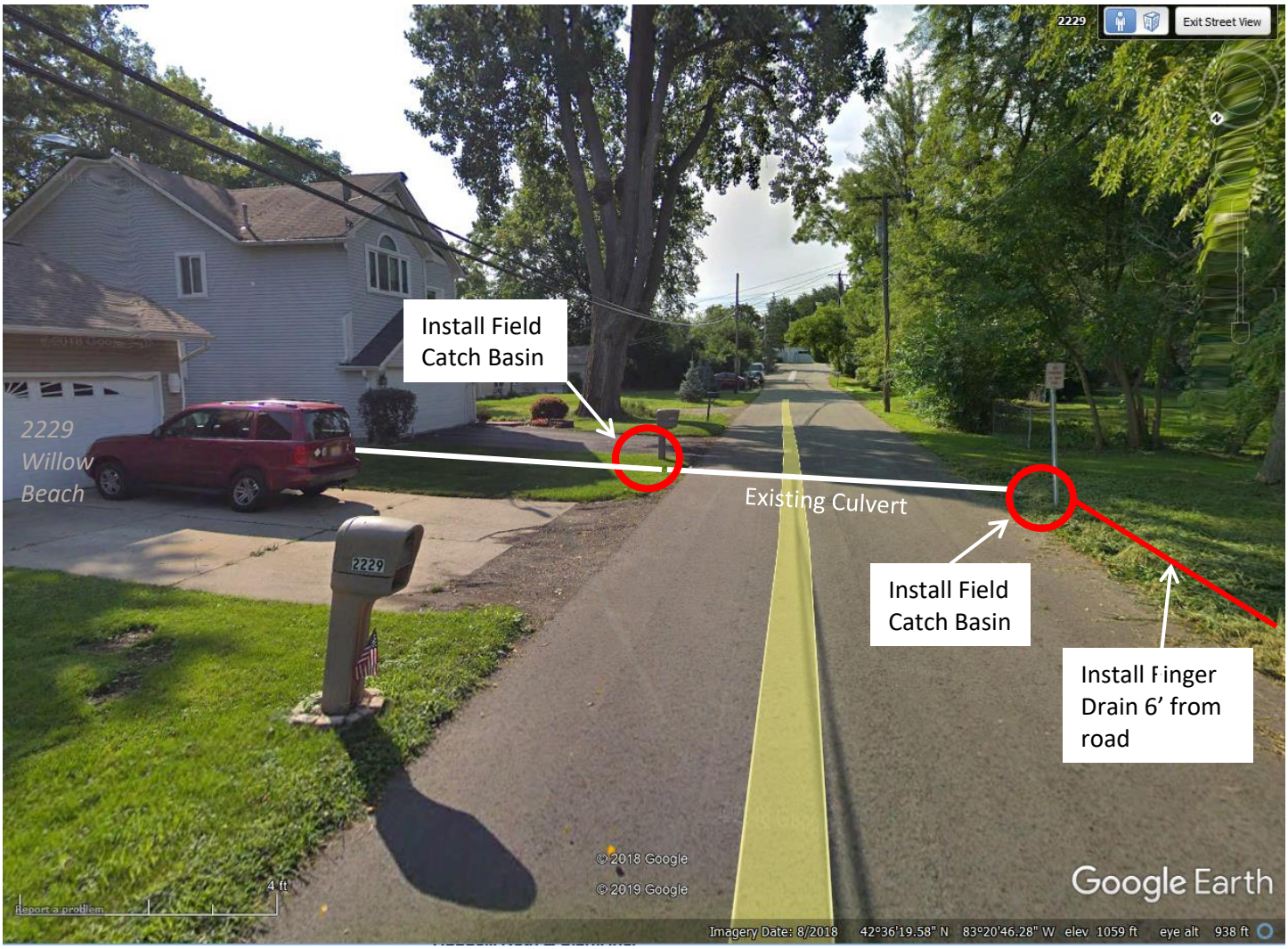
WEBSITE: hrcengr.com

2229 Willow Beach

Subject: Drainage Issue Pictures HRC Job No. 20130735



ArcGIS map overview of culvert location.



Google Earth Image from August 2018 with suggested improvements.

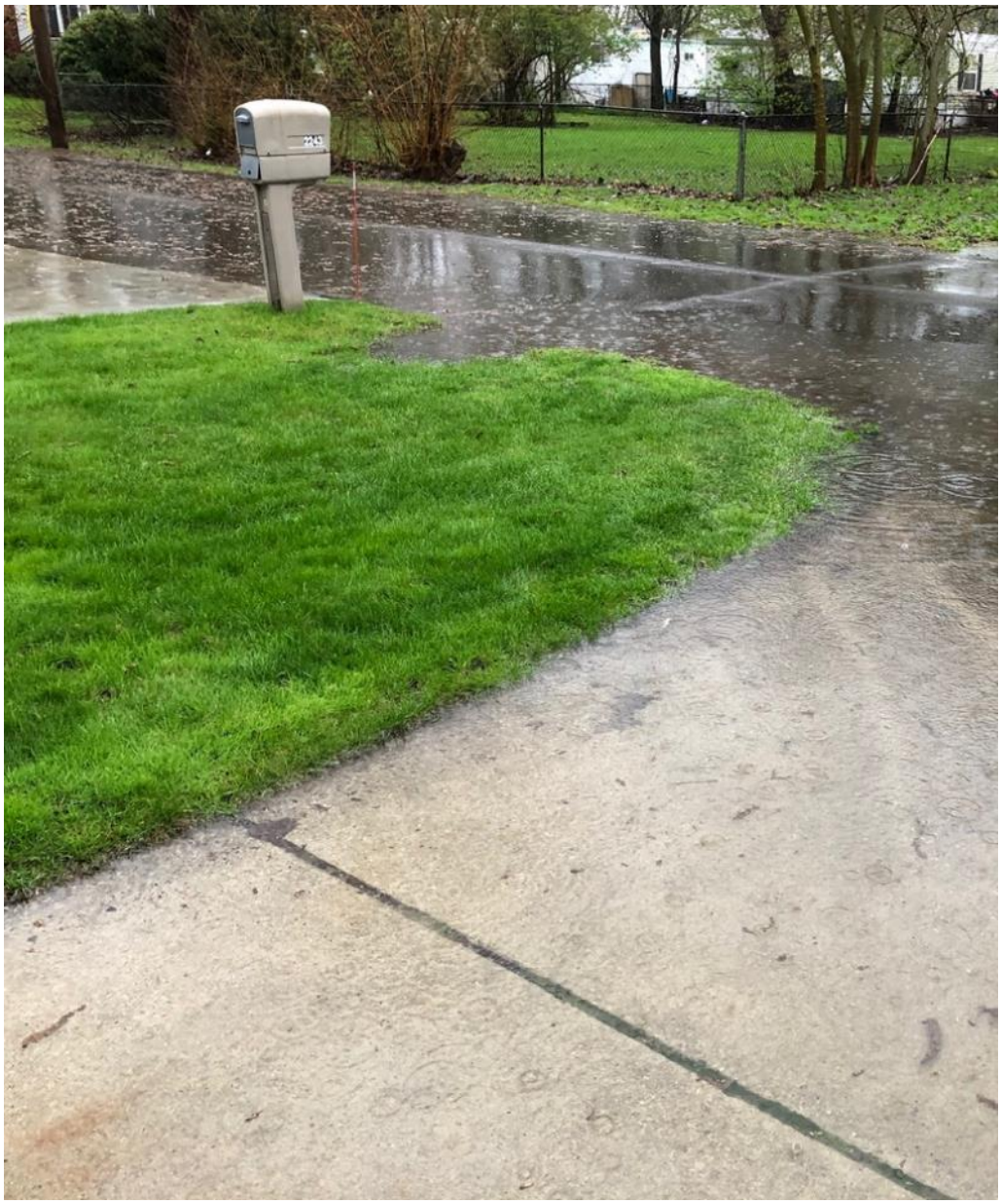


Photo from homeowner at 2229 Willow Beach St from May, 2019 of the flooded driveway and street.

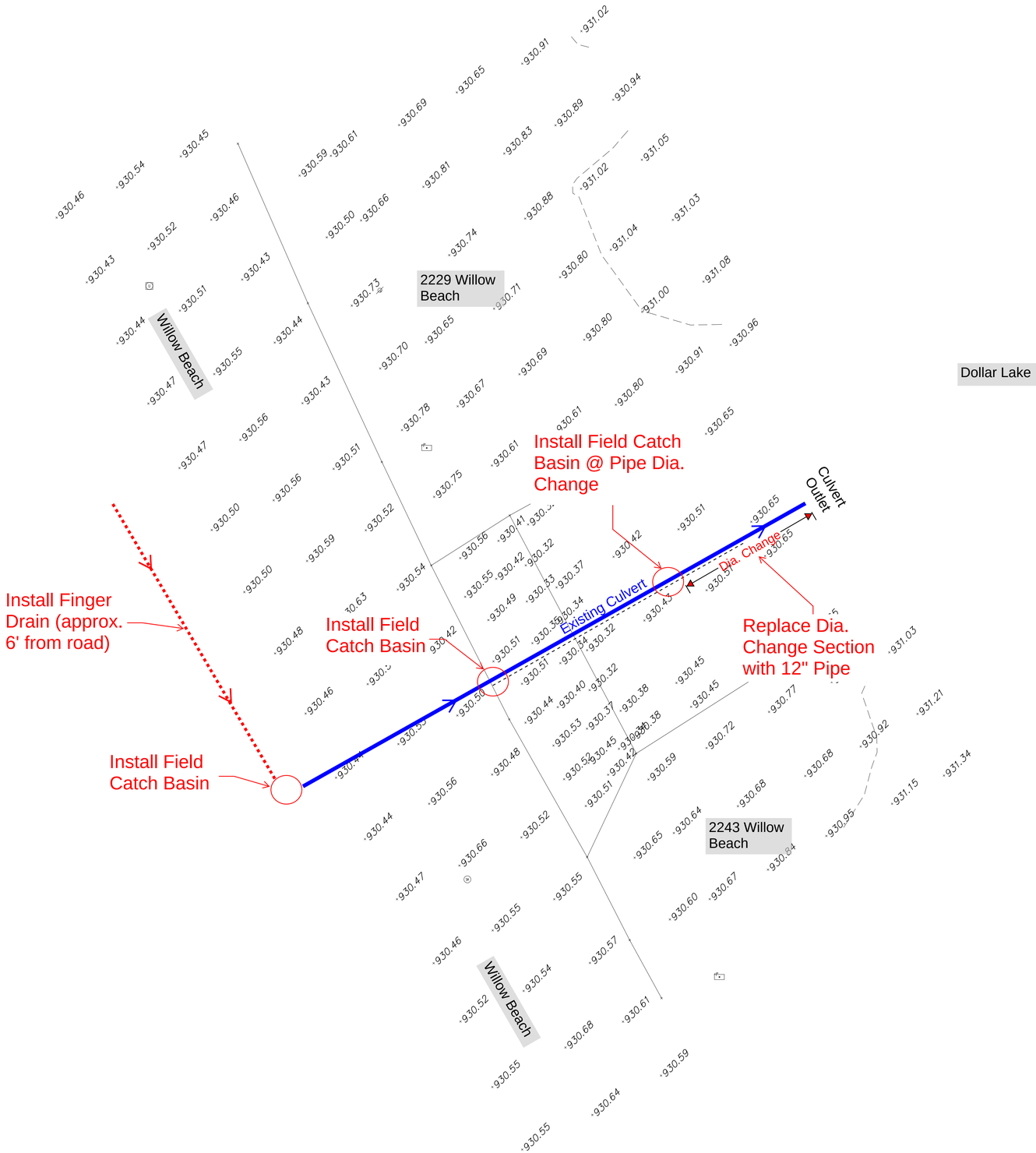
Taken by HRC staff on May 22, 2019 facing north showing Willow Beach with less flooding after rain event

Comparison of Vegetative Growth around Inlet of the Culvert:	
	
Taken by HRC staff on May 22, 2019 showing the inlet on the west side of Willow Beach.	Taken by HRC staff on July 30, 2019 showing the inlet on the west side of Willow Beach.

Photo taken by HRC staff the exposed drain and slit created to allow flow into the pipe from July 30, 2019. Location where field catch basin is recommended to be installed.

Photo taken by HRC staff of culvert outlet through the seawall into Sylvan Lake.

WILLOW BEACH DRAINAGE RECOMMENDATIONS



Existing

Recommendations

Appendix F

Wetland Delineation Survey

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

MAILING: PO Box 824
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Memorandum

To: The City of Keego Harbor

Attn: Jered Ottenwess, City Manager

From: Hubbell, Roth, & Clark

Date: September 30, 2019

Subject: Fran Leaf Park HRC Job No. 20130735
Wetland Delineation, Keego Harbor, MI

Dear Mr. Ottenwess,

Thank you for allowing Hubbell, Roth and Clark, Inc. (HRC) the opportunity to work with you on this project. Pursuant to your request, we conducted a wetland evaluation for the parcels of property that makes up Fran Leaf Park. The intent of this letter is to provide a report on the character of the parcel's wetlands and an opinion as to the possible jurisdiction of the Michigan Department of Environment, Great Lakes and Energy (MDEGLE) over these wetlands.

Background

The methods used to conduct this wetland evaluation are consistent with our understanding of the procedures and general practices used by the MDEGLE. The MDEGLE currently utilizes the wetland delineation protocols as specified in the US Army Corps of Engineers 1987 manual including regional supplements. This determination included review of in-office information including the Oakland County Soil Survey, the National Wetland Inventory mapping and online resources. An on-site evaluation including flagging of the wetland boundaries was conducted on September 13, 2019.

Wetland Delineation Summary

The subject parcels are located at the end of Atlas Street, in the City of Keego Harbor. The delineation area is approximately 2.0 acres in size; bounded by residential neighborhoods on the north, east and west and a canal leading to Cass Lake on the south. The southern half of the property contains a park with mowed turf grass, playground equipment, picnic tables and a small shelter structure. The northern half of the parcels are mostly mowed lawns with scattered trees. There are two areas that are not maintained and are mostly wetland.

Five wetlands lines were flagged and are shown on the attached map. These five lines demark three specific wetland areas.

- Wetland line A demarks the very narrow wetland (A) along the canal banks.
- Wetland B is a small forested wetland on the west side of the parcel demarked by line B.
- Wetland line C, D and E all demark the same wetland C.
    - Wetland C is mostly a forested system with an open emergent component.

All Wetlands had permanent water more than 1 foot deep, but part of each wetlands had only a few inches of seasonal water. The most common tree species in the wetlands were Cottonwoods, Red Ash, American Elm, Willow, Silver Maple, and Buckthorn. The most common species in the upland areas were turf grass (Blue, Fescue and Rye). The two wetlands B and C were separate systems isolated from the canal.

MDEGLE Jurisdiction/Regulatory Discussion

Part 303 Wetlands Protection of PA 451, 1994 defines wetland as "…land characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances, does support, wetland vegetation or aquatic life, and it commonly referred to as a bog, swamp, or marsh…". Wetland areas in Oakland County are regulated by the MDEGLE if they are categorized as being greater than five acres in size; have a physical connection to or are located within 500 feet of an inland lake, river, stream or pond; or, have a physical connection to or are located within 1,000 feet of the Great Lakes or Lake St. Clair. A stream is defined as having definite banks, a bed, and visible evidence of a continued flow or continued occurrence of water.

All three of the wetlands that were flagged would appear to be regulated by the MDEGLE since they are located within 500 feet of the canal (or are adjacent to the canal) which would be considered part of Cass Lake.

A permit must be obtained from the MDEGLE prior to conducting most filling, dredging and/or draining activities or maintaining a use of a regulated wetland.

Please be advised the information provided in this report is merely a preliminary opinion. The ultimate decision on wetland boundary locations and jurisdiction thereof rests with the MDEGLE and, in some cases, the Federal government. Therefore, there may be adjustments to boundaries based upon review of a regulatory agency. An agency determination can vary, depending on various factors including, but not limited to, experience of the agency representative making the determination and the season of the year. In addition, the physical characteristics of the site can change with time, depending on the weather, vegetation patterns, drainage, activities on adjacent parcels, or other events. Wetland evaluations performed outside the growing season from late-October until late-April may not be consistent with the official MDEGLE wetland assessment program and therefore are subject to increased potential for change than those performed during the growing season. Any of these factors can change the nature/extent of wetlands on the site. We recommend the MDEGLE be requested to confirm our wetland boundaries and jurisdictional opinion. This report does not address any local ordinances that may apply to this site.

Thank you for the opportunity to provide this wetland evaluation. If you have any questions or require any additional information, please contact the undersigned.

Very truly yours,

HUBBELL, ROTH & CLARK, INC.
Derek J. Stratelak, PWS
Professional Wetland Scientist

Attachment

- *Fran Leaf Park Delineation Map*

pc: HRC; HD,MC, File

Wetland Survey Map

Legend

- Wetland Flag
- Wetland Line
- Wetlands on Keego Harbor Property
- Keego Harbor Owned Parcels
- Parcels

City of Keego Harbor

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Appendix G

Pipe and Structure Criticality Analysis

Keego Harbor Storm Pipe Criticality Rating Criteria

November 8, 2019

Outgoing Pipe Diameter	Diameter Rating	Pipe Count	Percent of Pipes
8"	1	11	14.3%
12"	2	65	84.4%
15"	3	1	1.3%
30"	4	0	0.0%
> 30"	5	0	0.0%
No Value	2	0	0.0%
		77	100.0%

COF Variable	Weight
Pipe Diameter	25.0%
Road Type	25.0%
Depth	10.0%
Water	40.0%
	100.0%

Depth	Depth Rating	Pipe Count	Percent of Pipes
<= 3'	1	65	84.4%
> 3' and <= 5'	2	11	14.3%
> 5' and <= 7'	3	1	1.3%
> 7' and <= 9'	4	0	0.0%
> 9'	5	0	0.0%
No Value	3	0	0.0%
		77	100.0%

COF Rating	Pipe Count
1	46
2	8
3	23
4	0
5	0
	77

Road Type	Road Type Rating	Pipe Count	Percent of Pipes
Not in road	1	20	26.0%
Subdivision/local	2	57	74.0%
Collectors/Minor Arterials	3	0	0.0%
Principal Arterials	4	0	0.0%
Freeways/Interstates	5	0	0.0%
		77	100.0%

Wetlands	Water Rating	Pipe Count	Percent of Pipes
> 200'	1	46	59.7%
<= 200	5	31	40.3%
		77	100.0%

OM Score	OM Score	Pipe Count	Percent of Pipes
1	1	4	5.2%
2	2	1	1.3%
3	3	2	2.6%
4	4	0	0.0%
5	5	0	0.0%
Null, 0	0	70	90.9%
		77	100.0%

POF Variable	Weight
ST score	50%
OM Score	30%
Material	10%
Soil Type	10%
	100%

Structural Score	Structural Score	Pipe Count	Percent of Pipes
1	1	1	1.3%
2	2	3	3.9%
3	3	14	18.2%
4	4	5	6.5%
5	5	15	19.5%
Null, 0	0	39	50.6%
		77	100.0%

POF Rating	Pipe Count
1	39
2	19
3	18
4	1
5	0
	77

BRE Rating	Pipe Count
<= 5	57
> 5 and <= 10	15
> 10 and <= 15	5
> 15 and <= 20	0
> 20 and <= 25	0
	77

Material	Material Rating	Pipe Count	Percent of Pipes
Clay, RCP	1	32	41.6%
PE, PP, Concrete	2	3	3.9%
Unknown	3	1	1.3%
CMP	4	41	53.2%
	5	0	0.0%
		77	100.0%

Soil Type	Soil Rating	Pipe Count	Percent of Pipes
Sand with or without Loam	1	0	0.0%
Urban Land	2	49	2.7%
Loam	3	4	0.2%
Undulating	4	22	1.2%
Muck and Water	5	2	0.1%
		77	4.2%

Keego Harbor Storm Manhole Criticality Rating Criteria

November 8, 2019

Outgoing Pipe Diameter	Diameter Rating	MH Count	Percent of MHs
8"	1	7	9.3%
12"	2	67	89.3%
15"	3	1	1.3%
No Value	2	0	0.0%
		75	100.0%

COF Variable	Weight
Pipe Diameter	24.0%
Road Type	14.0%
Depth	14.0%
Surface	14.0%
Water	34.0%
	100.0%

Depth	Depth Rating	MH Count	Percent of MHs
<= 3'	1	33	44.0%
> 3' and <= 5'	2	10	13.3%
> 5' and <= 7'	3	13	17.3%
No Value	3	19	25.3%
		75	100.0%

COF Rating	MH Count
1	45
2	21
3	9
4	0
5	0
	75

Surface Type	Surface Type Rating	MH Count	Percent of MHs
Grass, Dirt	1	30	40.0%
Berm, Gravel, Other	3	6	8.0%
Asphalt, Pavement	5	39	52.0%
		75	100.0%

Road Type	Road Type Rating	MH Count	Percent of MHs
Not in road	1	30	40.0%
Subdivision/local	2	45	60.0%
Collectors/Minor Arterials	3	0	0.0%
Principal Arterials	4	0	0.0%
Freeways/Interstates	5	0	0.0%
		75	100.0%

Wetlands	Water Rating	MH Count	Percent of MHs
> 200'	1	54	72.0%
<= 200	5	21	28.0%
		75	100.0%

Condition	Condition Rating	MH Count	Percent of MHs
Good, New	1	51	68.0%
Fair, Other	3	17	22.7%
Poor	5	7	9.3%
		75	100.0%

POF Variable	Weight
Condition	85%
Material	10%
Soil Type	5%
	100%

Material	Material Rating	MH Count	Percent of MHs
Concrete	1	28	37.3%
Block, Other or UNKN	2	30	40.0%
Brick	3	17	22.7%
		75	100.0%

POF Rating	MH Count
1	51
2	17
3	7
4	0
5	0
	75

Soil Type	Soil Rating	MH Count	Percent of MHs
Sand with or without Loam	1	1	1.3%
Urban Land	2	55	73.3%
Loam	3	4	5.3%
Undulating	4	15	20.0%
Muck and Water	5	0	0.0%
		75	100.0%

BRE Rating	MH Count
<= 5	47
> 5 and <= 10	25
> 10 and <= 15	2
> 15 and <= 20	1
> 20 and <= 25	0
	75

BRE Model
Keego Harbor

Model

BRE

- 0 - <=5 (47)
- >5 - <=10 (25)
- >10 - <=15 (2)
- >15 - <=20 (1)
- >20 - 25 (0)

BRE

- 0 - <=5 (57)
- >5 - <=10 (15)
- >10 - <=15 (5)
- >15 - <=20 (0)
- >20 - 25 (0)

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COF Model
Keego Harbor

Model

COF

- 1 (45)
- 2 (21)
- 3 (9)
- 4 (0)
- 5 (0)

COF

- 1 (46)
- 2 (8)
- 3 (23)
- 4 (0)
- 5 (0)

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POF Model
Keego Harbor

Model

POF

- 1 (51)
- 2 (17)
- 3 (7)
- 4 (0)
- 5 (0)

POF

- 1 (39)
- 2 (19)
- 3 (18)
- 4 (1)
- 5 (0)

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Appendix H

Capital Improvement Plan

November 2019

KEEGO HARBOR STORM SYSTEM
0-20-YEAR CAPITAL IMPROVEMENT PROJECTS
PROPOSED PIPE REPAIRS

Job #: 20130735

Asset ID	CIP Year	Street	Surface Type	Pipe Material	Dia.	Length Surveyed	Structural Rating	O&M Rating	Excavation (LS)	Excavation ($)	Open Cut (LF)	Open Cut ($)	Spot Liner (LF)	Spot Liner ($)	Point Repair (Ea)	Point Repair ($)	Stabilize Culvert (Ea)	Stabilize Culvert ($)	Clean, Pre/ Post CCTV ($/LF)	Repair Cost	Repair Type	Severe Rated 5 Defects
STM029	0-5	Pridham	Asphalt	CP/Clay	8	67.6	513A	0		$ -	10	$ 1,300.00		$ -	1	$ 4,000.00		$ -	3	**$ 5,502.80**	Point Repair	Hole @ 67.6'
STM029A	0-5	Pridham	Asphalt/Grass	CMP/PVC	12	31.6	0	0		$ -		$ -		$ -	1	$ 7,000.00		$ -	4	**$ 7,126.40**	Point Repair	
STM015	0-5	Grove St	Asphalt/Grass	CMP	12	82.9	4431	0	1	$ 6,000.00		$ -		$ -		$ -	1	$ 450.00	4	**$ 6,781.60**	Excavate/Replace	Hole SV @ 13-20', Deformed @ 22'
STM022	0-5	Grove St	Grass	CP	12	188.9	0	1100		$ -		$ -		$ -		$ -	1	$ 450.00	4	**$ 1,205.60**	Stabilize Culvert	
STM034b	0-5	Knowlson	Asphalt	CMP	12	28	5134	0		$ -		$ -	4	$ 3,500.00		$ -		$ -	4	**$ 4,512.00**	Spot Line (road)	Deformed @ 13' DS
STM056a	0-5	Beechmont	Grass	CMP	12	66.6	533A	0	1	$ 6,000.00		$ -		$ -		$ -		$ -	4	**$ 6,266.40**	Excavate/Replace	Hole @ 9 & 20' US, Deformed @ 38'
STM058	0-5	Cass Lk Front	Asphalt	CP	10	29.1	4236	0		$ -		$ -	4	$ 2,900.00		$ -		$ -	3.5	**$ 3,901.85**	Spot Line (road)	
STM043	0-5	Beachland	Grass/Asphalt	RCP	12	78.8	0	0		$ -		$ -		$ -		$ -	1	$ 450.00	4	**$ 765.20**	Stabilize Culvert	
STM074d	0-5	Schroeder	Grass/Driveway	CMP	12	38.1	5233	0		$ -	10	$ 1,600.00		$ -		$ -		$ -	4	**$ 1,752.40**	Open Cut	Hole @ 6.9' (10')
STM076	0-5	Schroeder	Grass/Driveway	CMP	12	21.6	5200	0	1	$ 6,000.00		$ -		$ -		$ -		$ -	4	**$ 6,086.40**	Excavate/Replace	Deformed DS @ 3.7', Hole US @ 18'
STM077b	0-5	Maddy Ln	Asphalt	CMP	12	40.7	5838	0	1	$ 6,000.00		$ -		$ -		$ -		$ -	4	**$ 6,162.80**	Excavate/Replace	Hole US @ 0' (40')
STM303	0-5	Stennett	Grass/Driveway	CMP	12	42.9	5139	0		$ -	10	$ 1,600.00		$ -		$ -		$ -	4	**$ 1,771.60**	Open Cut	Collapse US @ 42.9'
STM035D	0-5	KNOWLSON	Grass/Driveway	CMP	12	39.1	5334	0		$ -	20	$ 3,200.00		$ -		$ -		$ -	4	**$ 3,356.40**	Open Cut	Hole @ 21.8-39.1' US
STM035B	0-5	KNOWLSON	Asphalt	CMP	12	55.8	5139	0		$ -		$ -	2	$ 1,750.00		$ -		$ -	4	**$ 2,873.20**	Spot Line (road)	Deformed @ 55.8 US (MH)
STM024	5-20	Willow Beach	Grass	RCP	12	27.7	0	0		$ -		$ -		$ -		$ -	1	$ 450.00	4	**$ 560.80**	Stabilize Culvert	
STM034a	5-20	Knowlson	Grass	CMP	12	69.4	3A00	0		$ -		$ -		$ -		$ -	1	$ 450.00	4	**$ 727.60**	Stabilize Culvert	
STM035a	5-20	Knowlson	Asphalt	CMP	12	37.9	3500	0		$ -		$ -		$ -		$ -	1	$ 450.00	4	**$ 601.60**	Stabilize Culvert	
STM037	5-20	Schroeder	Grass	RCP	15	279.9	412D	0		$ -	2	$ 360.00		$ -		$ -		$ -	4.5	**$ 1,619.55**	Open Cut	
STM074b	5-20	Schroeder	Grass/Driveway	CMP	12	127	0	0		$ -		$ -		$ -		$ -		$ -	4	**$ 1,160.00**	CCTV	
STM074b	5-20	Schroeder	Asphalt	CMP	12	30.3	5143	0		$ -		$ -	2	$ 1,750.00		$ -		$ -	4	**$ 2,771.20**	Spot Line (road)	Hole @ 7.5'
STM074e	5-20	Schroeder	Grass/Driveway	CMP	12	226.9	3500	1200		$ -	2	$ 320.00		$ -		$ -		$ -	4	**$ 1,227.60**	Open Cut	
STM077a	5-20	Maddy Ln	Asphalt	CMP	12	50.9	5439	0	1	$ 6,000.00		$ -		$ -		$ -		$ -	4	**$ 6,203.60**	Excavate/Replace	Hole US @ 11' (20')
STM085	5-20	Cass Lake	Grass/Asphalt	CP	8	30.2	5100	0		$ -	20	$ 2,600.00		$ -		$ -		$ -	3	**$ 2,690.60**	Open Cut	
STM301	5-20	Wall	Grass	CMP	12	21.2	5333	0		$ -	15	$ 2,400.00		$ -		$ -		$ -	4	**$ 2,484.80**	Open Cut	Hole US @ 6.4' (15')
STM305	5-20	Beechmont	Asphalt	CMP	12	16.4	5333	0	1	$ 6,000.00		$ -		$ -		$ -		$ -	4	**$ 6,065.60**	Excavate/Replace	Hole US @ 0' (14.5')
STM093	5-20	GROVE	Grass/Driveway	RCP	12	130.8	4121	3218		$ -	4	$ 640.00		$ -		$ -		$ -	4	**$ 1,163.20**	Open Cut	

TOTAL CIP COST =	**$**	**85,340.80**
0-5 Year CIP COST =	**$**	**58,064.65**
5-10 Year CIP COST =	**$**	**27,276.15**

* Total costs do not include allowance for contingencies and engineering costs.

Pipe CIP Locations in Keego Harbor

CIP

- Pipes Years 0-5
- Pipes Years 5-20

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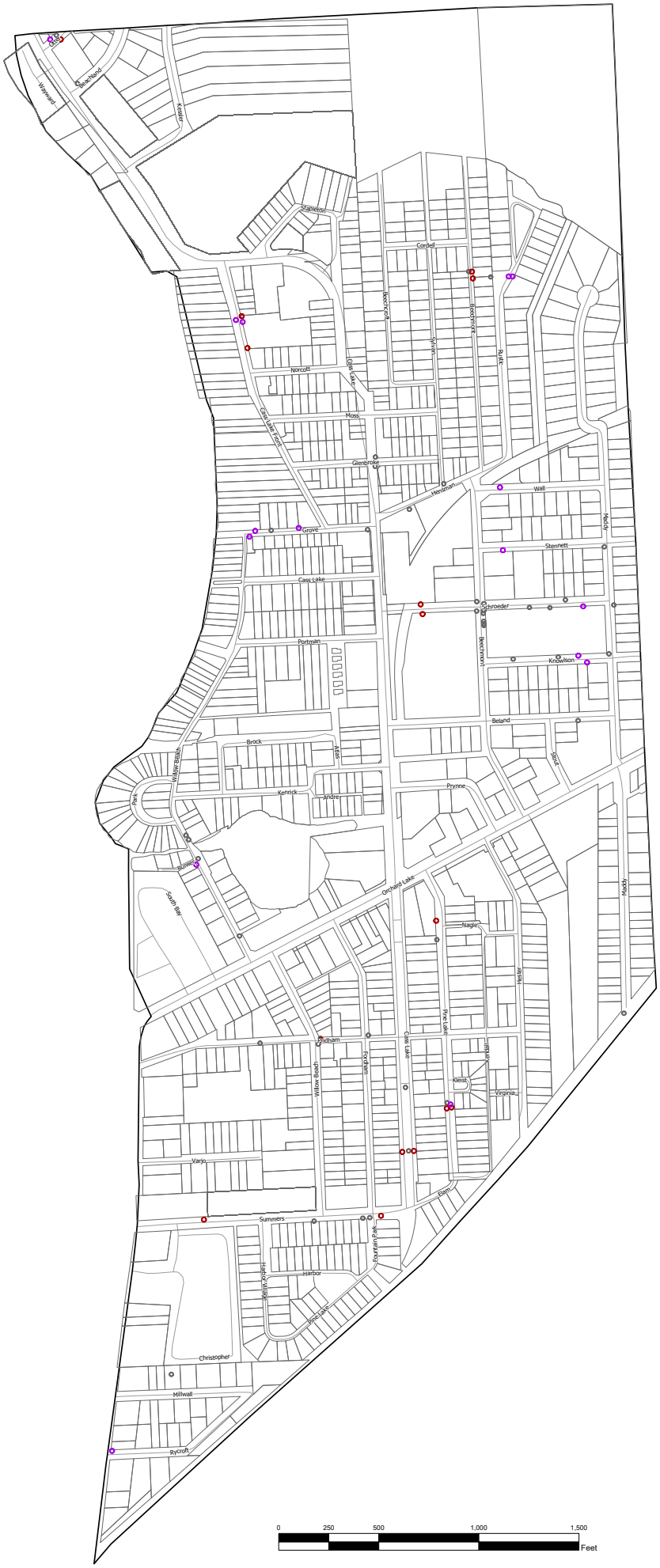
KEEGO HARBOR STORM SYSTEM
0-20-YEAR CAPITAL IMPROVEMENT PROJECTS
PROPOSED MANHOLE REPAIRS

MH ID	CIP Year	ADDRESS	SURFACE	INSPECTION DATE	DIA. (in)	COVER	DEFECTS	PROPOSED REPAIR(S)	REHAB. COST*
MH279	**0-5**	3425 Orchard Lake	Asphalt	6/18/2018	22	Flat Inlet Grate	•Cover Oversized •Wall Cracked •Heavy Debris	Install F/C (Pavt), Cementitious Wall Grout & Vactor (Regular O&M)	$ 3,000.00
MH243	**0-5**	1747 Rustic Lane	GrassDirt	6/4/2019	26	Beehive Dome	•Wall Defective •Manhole Below Grade (5")	Replace MH (Grass, Depth = 4')	$ 5,000.00
MH003	**0-5**	2025 Beechmont	GrassDirt	5/14/2019	22	Flat Inlet Grate	•Missing Frame Seal •Manhole Below Grade (-3")	Cementitious Frame Seal & Raise Manhole 3"	$ 900.00
MH216	**0-5**	1751 Cass Lake	GrassDirt	5/9/2019	34	Beehive Dome	•Manhole Below Grade (-6")	Raise Manhole 6"	$ 650.00
MH200	**0-5**	1478 Otter	GrassDirt	6/4/2019	34	Beehive Dome	•Frame Missing & Undersized •Manhole Not at Grade (-7")	Replace F/C (Grass) & Raise Manhole 7"	$ 1,850.00
MH240	**0-5**	1965 Beechmont	GrassDirt	6/18/2018	22	Flat Inlet Grate	•Cover Oversized •Frame Broken	Replace F/C (Grass)	$ 1,200.00
MH256	**0-5**	2025 Beechmont	GrassDirt	6/12/2018	24	Flat Inlet Grate	•Frame Missing	Install F/C (Grass)	$ 1,200.00
MH067	**0-5**	2066 Maddy	GrassDirt	6/12/2018	24	Flat Inlet Grate	•Frame Missing	Install F/C (Grass)	$ 1,200.00
MH217	**0-5**	1754 Cass Lake Front	Brick/Driveway	6/14/2018	22	Vented	•Frame Missing & Undersized •Wall Defective	Install F/C (Pavt) & Cementitious Wall Grout	$ 2,000.00
MH226	**0-5**	3070 Grove	GrassDirt	6/13/2018	34	Beehive Dome	•Cover Cracked •Manhole Below Grade (-5")	Replace Cover & Raise Manhole 5"	$ 1,150.00
MH088	**0-5**	2210 Willow Beach	Gravel	6/14/2018	34	Beehive Dome	•Wall Defective •Frame Missing	Structural Lining (Depth=2') & Install F/C (Gravel)	$ 1,900.00
MH105	**0-5**	2445 Pine Lake	GrassDirt	6/12/2018	24	Flat Inlet Grate	•Wall Defective •Heavy Roots	Structural Lining (Depth=6') (Possibly WRC ownership)	$ 2,100.00
MH228	**0-5**	3130 Grove	Landscaping	6/13/2018	22	Flat Inlet Grate	•Lanscaping Debris	Vactor (Regular O&M)	$ 1,500.00
MH229	**0-5**	3129 Grove	ConcretePavt	6/13/2018	24	Flat Inlet Grate	•Heavy Debris	Vactor (Regular O&M) (May Abandon Line)	$ 1,000.00
MH238	**0-5**	1915 Beechmont	GrassDirt	6/13/2018	24	Flat Inlet Grate	•Frame Missing •Heavy Debris	Install F/C (Grass) & Vactor (Regular O&M)	$ 2,200.00
MH246	**0-5**	1747 Rustic Lane	Asphalt	6/4/2019	22	Flat Inlet Grate	•Regular Heavy Debris	Vactor (Regular O&M)	$ 1,000.00
								0-5 Year Costs	**$ 27,850.00**
MH056	**5-20**	1999 Cass Lake	ConcretePavt	6/8/2018	26	Flat Inlet Grate	•Frame Seal Cracked •Wall Cracked	Cementitious Frame Seal Cementitious Wall Grout	$ 750.00
MH245	**5-20**	2065 Cass Lake	Asphalt	6/8/2018	22	Vented	•Chimney Defective •Wall & Cone Cracked	Chimney Repair, Point Grout Cementitious Wall Grout	$ 750.00
MH250	**5-20**	1741 Beechmont	Asphalt	6/11/2018	22	Vented	•Seal Mortar Missing •Cone Defective	Cementitious Frame Seal Cementitious Cone Grout	$ 750.00
MH106	**5-20**	2445 Pine Lake	Asphalt	6/12/2018	22	Flat Inlet Grate	•Frame Seal Cracked	Cementitious Frame Seal (Possible WRC ownership)	$ 250.00
MH107	**5-20**	2452 Pine Lake	Asphalt	6/12/2018	24	Flat Inlet Grate	•Frame Seal Cracked	Cementitious Frame Seal (Possibly WRC ownership)	$ 250.00
MH093	**5-20**	2965 Orchard Lake	ConcretePavt	6/12/2018	26	Flat Inlet Grate	•Frame Seal Cracked	Cementitious Frame Seal	$ 250.00
MH099	**5-20**	2399 Willow Beach	ConcretePavt	6/18/2018	23	Vented	•Wall Cracked	Cementitious Wall Grout	$ 500.00
MH109	**5-20**	2480 Pine Lake	Asphalt	6/18/2018	22	Vented	•Wall Cracked	Cementitious Wall Grout	$ 500.00
MH110	**5-20**	2476 Cass Lake	Asphalt	6/18/2018	22	Flat Inlet Grate	•Wall Defective	Cementitious Wall Grout	$ 500.00
MH114	**5-20**	3325 Orchard Lake	ConcretePavt	6/18/2018	22	Flat Inlet Grate	•Wall Cracked	Cementitious Frame Seal	$ 250.00
MH202	**5-20**	1537 Cass Lake	ConcretePavt	6/11/2018	22	Flat Inlet Grate	•Chimney Defective	Chimney Repair, Point Grout	$ 250.00
MH218	**5-20**	1751 Cass Lake Front	GrassDirt	6/14/2018	24	Beehive Dome	•Wall Cracked	Cementitious Wall Grout	$ 500.00
MH219	**5-20**	1751 Cass Lake Front	GrassDirt	6/14/2018	22	Vented	•Gap in Frame Seal	Cementitious Frame Seal	$ 250.00
MH249	**5-20**	1731 Beechmont	Asphalt	6/11/2018	18	Curb Inlet Grate	•Wall Defective	Cementitious Wall Grout	$ 500.00
MH273	**5-20**	2066 Fountain Park	ConcretePavt	3/29/2019	22	Curb Inlet Grate	•Chimney Defective	Chimney Repair, Point Grout	$ 250.00
								5-20 Year Costs	**$ 6,500.00**
								TOTAL CONSTRUCTION COSTS	**$ 34,350.00**

* Total cost does not include allowance for contrigencies and engineering costs.

Manhole CIP Locations in Keego Harbor



CIP

- MHs Years 0-5
- MHs Years 5-20

City of Keego Harbor
"Heart of the Lakes"

HRC
HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

Y:\2013\07\20130703\03_Studies\Working\GIS\Keego_Harbor_SAW.aprx

Appendix I

EGLE Deliverable & Certificate of Completion

HUBBELL, ROTH & CLARK, INC
CONSULTING ENGINEERS SINCE 1915

MEMORANDUM

To: Michigan Department of Environment, Great Lakes, & Energy (EGLE)
Revolving Loan Section
Attention: Jonathan Berman

From: Hubbell, Roth and Clark, Inc.

CC: City of Keego Harbor

Date: November 15, 2019

Re: City of Keego Harbor
MDEQ Stormwater, Asset Management and Wastewater (SAW) Grant #1220-01
Summary of Stormwater Asset Management Plan

The following is a summary of the work completed under the MDEQ SAW Grant work performed by the City of Keego Harbor. It includes a summary of the project scope, results and findings of activities covered by the grant, grant amount spent and match amount, and contact information. It has been prepared as required under Section 603 of Public Act 84 of 2015, and follows recent MDEQ guidance.

GRANTEE INFORMATION

City of Keego Harbor
2025 Beechmont Street
Keego Harbor, Michigan 48320

SAW Grant Project #1220-01

Project Grant Amount: $430,000

Applicant Match Amount $43,000

City of Keego Harbor
Jered Ottenwess, City Manager
248-682-1930
manager@keegoharbor.org

Hubbell, Roth, & Clark
Karyn Stickel, P.E.
248-454-6300
kstickel@hrcengr.com

EXECUTIVE SUMMARY

The City of Keego Harbor applied for and received a grant to further develop an Asset Management Plan (AMP) for its sanitary system through the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Stormwater, Wastewater and Asset Management (SAW) program. Because the SAW program was funded through monies appropriated for water quality, other related infrastructure systems, such as drinking water, were not eligible for funding through the grant, but are considered in analysis and recommendations where appropriate.

The City of Keego Harbor owns, operates and maintains their storm system and has various tools to manage the assets, including a GIS geodatabase, condition assessment methods, and an operating and capital improvement project plan. These tools are used to guide the short and long-term strategies to operate the various systems in a sustainable manner that meets the required level of service, with a focus on prioritizing assets that are most critical and being cost-effective. The funding strategy is also evaluated annually which includes a review of the fund balances and anticipated future funding needs.

As required by the program, this full plan and associated materials will be made available to the public for review at City Hall upon request for 15 years following the December 2019 deadline.

The following is a summary of the AMP, as required by the grant, which includes a brief discussion of the five major AMP components, a list of the plan's major identified assets, and contact information for the grant.

STORMWATER INVENTORY

City of Keego Harbor currently uses its new Geographic Information System (GIS) geodatabase as the primary means to inventory and map the assets in the system. The geodatabase includes key attributes associated with each asset, such as size, material, along with other information as needed for a given asset type. The geodatabase also includes attributes owned and maintained by other entities including Oakland County Water Recourses Commissioner (WRC), Oakland County Road Commission (RCOC), and privately-owned assets.

Condition assessment tools and protocols were developed to allow for efficient and consistent recording of asset condition. For stormwater assets, the NASSCO-compliant inspection information was collected during drain televising. The data is stored in the GIS system database and will be used to develop inspection work orders to continue to evaluate and maintain assets, such as manholes and drains.

As part of the grant, the GIS geodatabase inventory was reviewed for completeness and to ensure critical attributes were populated. Approximately 4,400 lineal feet of City storm pipe underwent condition assessment via cleaning and televising. Approximately 66 City manholes and other related structures were evaluated using the NASSCO inspection protocol.

CRITICALITY OF ASSETS

The City of Keego Harbor developed a baseline Probability of Failure (POF) and Consequence of Failure (COF) factors that were added to the GIS attributes, and were used to estimate the overall risk of the horizontal assets (storm drains and associated structures.)

Both the POF and COF were scored on a scale of 1 to 5, with 1 being the lowest probability or consequence of failure, and 5 corresponding to the highest probability or consequence of failure. The Business Risk Evaluation (BRE or Risk) score is the product of the POF score and the COF score (POF times COF equals Risk,) and has a scale of 1 to 25. Higher BRE scores identify the assets with the greatest overall risk.

The POF and COF for horizontal assets are determined using scoring values developed uniquely for each asset type. The POF and COF scores for each asset type are calculated using attribute data from the GIS geodatabase, inspection data from the recent cleaning and televising, and NASSCO PACP and MACP ratings. The primary attribute for determining the POF of storm gravity mains was the PACP Structural Quick Score. The PACP Maintenance Quick Score and age are also incorporated into the POF rating. Where PACP scores were not available, the POF score was based on the age-based assumed condition.

The COF for mains was determined based on asset depth, size, proximity flood zones, and proximity to roads and intersections.

LEVEL OF SERVICE DETERMINATION

At the strategic level, the Level of Service (LOS) identifies the long-term goals and strategies of the organization. An overall example of LOS goals matrix was developed to consider the goals and strategies of the City of Keego Harbor.

The City of Keego Harbor strategic example Level of Service Goals included:

- Limit the presence of standing water following storm events to 48 hours.
- Maintain a GIS map of the system including condition information.
- Provide budget for Operation, Maintenance, and Improvements (OM&I).
- Respond to residential inquiries regarding ROW drainage within a reasonable time.

At the tactical level, the LOS focuses on the prioritization in the medium-term and identification of factors and indicators related to performance, cost, risk, and failure probability. The Probability of Failure and Consequence of Failure scoring matrices used in the criticality and risk analysis were developed using the strategic LOS guidance.

At the operational level, the LOS is related to procedures and information related to the short-term, day-to-day operation. Performance can be measured at the asset level using work orders to collect data, and annual reporting of measurable to develop goals with operational staff.

REVENUE STRUCTURE

The annual operation and maintenance budget includes the typical costs spent each year to operate the system and to perform normal maintenance activities. This baseline O&M budget does not include major capital improvements that are required to increase capacity, meet new regulatory requirements, or replace items that have failed or reached the end of their useful service life.

The City does not charge a stormwater utility rate; therefore, the revenue structure was not reviewed for the AMP. Improvements to the storm water system, when needed, are primarily funding through the general or road maintenance funds.

CAPITAL IMPROVEMENT PLAN

A list of capital improvement projects was developed for the City of Keego Harbor's stormwater system, using recommendations from the asset inspection process, and considerations of other system needs.

The recommended projects are summarized below. Projects listed for implementation in the 0 to 5 year range include cost estimates prepared on data available at the study/feasibility level. Projects in the 5 to 20 year range are based on broad concepts only and costs are based on cost curves and other general tools. All projects are listed for financial and resource planning purposes only. Changes to project inclusion, scope, cost and/or timing are expected as resources are allocated and changes occur in prioritization, regulations, technology, cost and other data becomes available.

Capital Projects, 0 to 5 years:

- Excavation – $24,000
- Pipe Open Cut – $7,700
- Pipe Spot Liner – $8,000
- Point Repair – $11,000
- Stabilize Culvert – $1,500
- Heavy Clean, Pre-Post CCTV – $3,000
- Manhole Repairs – $27,850

Capital Projects, 5 to 20 years:

- Excavation – $12,000
- Pipe Open Cut – $6,000
- Pipe Spot Liner – $2,000
- Stabilize Culvert – $1,500
- Heavy Clean, Pre-Post CCTV – $3,500
- Manhole Repairs – $6,500

Stormwater Management Improvements on City Properties:

- Bank Stabilization – $18,500
- Culvert Outlet Stabilization – $7,000
- Install Riprap – $5,000
- Swale Installation – $12,000
- Rain Garden Installation – $11,500
- Pervious Pavement – $13,000
- Install New Storm Pipe – $16,000

RECOMMENDATIONS

In order to keep this AMP sustainable into the future, the review process will be undertaken annually to review existing recommendations, status of current projects, and forecasted needs against available reserves and anticipated funding. The asset information will be regularly updated to incorporate any new GIS and operational and condition data. The information can be reviewed to update recommended

treatment and replacement strategies, and capital projects. The updated recommendations will be reviewed on a regular basis as part of the annual process to ensure the availability of required funds for the projects.

LIST OF MAJOR ASSETS

The Owner's major assets include:

- 5,500 feet of 8-inch to 30-inch storm pipes
- 22 culverts
- 14 outfalls
- 2 leaching basins
- 47 catch basins
- 20 storm manholes

EGLE

Department of Environment, Great Lakes, and Energy (EGLE)
SAW Grant
Stormwater Asset Management Plan
Certification of Project Completeness

Completion Due Date: December 31, 2019
(no later than 3 years from executed grant date)

The City of Keego Harbor certifies that all stormwater asset management plan (SWAMP) activities specified in SAW Grant No. 1220-01 have been completed and the SWAMP, prepared with the assistance of SAW Grant funding, is being maintained. Part 52 of the Natural Resources and Environmental Protection Act, 1994, PA 451, as amended, requires implementation of the SWAMP within 3 years of the executed grant (Section 5204e(3)).

Attached to this certification is a summary of the SWAMP that identifies major assets. Copies of the SWAMP and/or other materials prepared through SAW Grant funding will be made available to EGLE or the public upon request by contacting:

JERED OTTENWESS	at 248-682-1930	MANAGER@KEEGOHARBOR.ORG
Name	Phone Number	Email

Jered Ottenwess 12-16-19

Signature of Authorized Representative (Original Signature Required) Date

Jered Ottenwess, City Manager
Print Name and Title of Authorized Representative