Ox Creek Technical Update

An Addendum to the Paw Paw River Watershed Management Plan

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and
Southwest Michigan Planning Commission

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INTRODUCTION

Ox Creek is a warm water stream located in southwest Michigan. The creek flows through Benton Harbor where it joins the Paw Paw River. It originates in agricultural lands east of the city and drains an area of 13 square miles. The lower portion of the watershed is heavily influenced by urbanization and storm water. Ox Creek appears on Michigan's §303(d) list because it is not meeting the Other Indigenous Aquatic Life and Wildlife (OIALW) designated use which is indicated by poor macro-invertebrate community ratings. Sedimentation, siltation, total suspended solids (TSS), and flow regime alterations are causes of the impairment. Sources of impairment are stream bank modifications and storm water quality and quantity. A Total Maximum Daily Load (TMDL) was completed for Ox Creek in 2013.

The Ox Creek Watershed is all of the land that drains into Ox Creek. This includes wetlands, ponds, streams and other surface water bodies on this land and the groundwater are also part of the watershed. Water is a critical resource for recreation, irrigation, and increasing the value of adjacent real estate. These uses depend on good water quality, but they can also be a threat to it. The Ox Creek Watershed is identified as the highest priority urban area for implementation in the Paw Paw River Watershed Management Plan.

The Ox Creek Technical Update is intended provide specific information on green infrastructure site implementation to reduce pollutant load reductions and improve Ox Creek. The ultimate goal is to remove Ox Creek from Michigan's §303(d) list. The area of interest for this technical update is the 314acres of commercial/retail development along Pipestone Road and I-94 interchange referred to as the Orchards Mall area.

Figure 1. Ox Creek Watershed location

EXISTING CONDITIONS – Ox Creek Watershed

The Ox Creek watershed drains an area of 13 square miles. Ox Creek originates in predominately agricultural lands east of Benton Harbor. The Yore & Stoeffer Drain, situated to the south of Ox Creek's headwaters, is its largest tributary. Both Ox Creek and the Yore & Stoeffer Drain have been greatly altered and channelized in these upper reaches.

The Ox Creek watershed appears on Michigan's §303(d) list (Goodwin, et. al., 2012) as not meeting the OIALW designated use as a result of biological impairments. The listing includes Ox Creek, Yore & Stoeffer Drain, and its tributaries which total 16.8 miles.

In 2013 a TMDL was developed for Ox Creek to address biological impairments in the watershed. The macroinvertebrate community structure data coupled with qualitative habitat observations (Lipsey, 2007) indicate that siltation due to excess TSS loads is causing these impairments.

The causes have been identified as flow regime alterations, sedimentation/siltation, and solids (suspended/bedload). The sources are stream bank modifications/destabilization, impervious surface/parking lot runoff, and urban runoff/storm sewers. The TMDL document cites hydrology or flashiness problems, lack of biodiversity in benthic macroinvertebrates and results from TSS samplings as evidence.

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations [CFR], Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting water quality standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of water resources. The purpose of this TMDL is to identify the appropriate actions to achieve the biological (macroinvertebrate) community targets that will result in WQS attainment, specifically through reduction in total suspended solids (TSS) loadings from sources in the Ox Creek watershed.

Several segments of Ox Creek and its tributaries have been channelized or relocated to facilitate agricultural or commercial development. Level loggers were deployed on Ox Creek at Britain Avenue in 2007 by the Michigan Department of Environmental Quality (MDEQ). Level loggers record water levels during short time intervals and are used to examine the flashiness of a stream. The information showed that during storm events over the Ox Creek watershed, water levels can rise over four feet in a very short period of time.

Watershed Map

Ox Creek is in southwest Michigan in northern Berrien County. The following municipalities have land within the Ox Creek Watershed: Bainbridge Township, Sodus Township, Benton Charter Township and Benton Harbor City.

Table 1. Municipalities in the Ox Creek Watershed

Municipality	Acres in Ox Creek Watershed
Bainbridge Township	469
Sodus Township	496
Benton Charter Township	6,713
Benton Harbor City	914

There are two large transportation corridors that bisect the Ox Creek Watershed – I-94 and US31. Ox Creek flows into the Paw Paw River. Ox Creek is the last tributary of the Paw Paw River before it empties into the St Joseph River and then into Lake Michigan. The Ox Creek Watershed includes the following county drains:

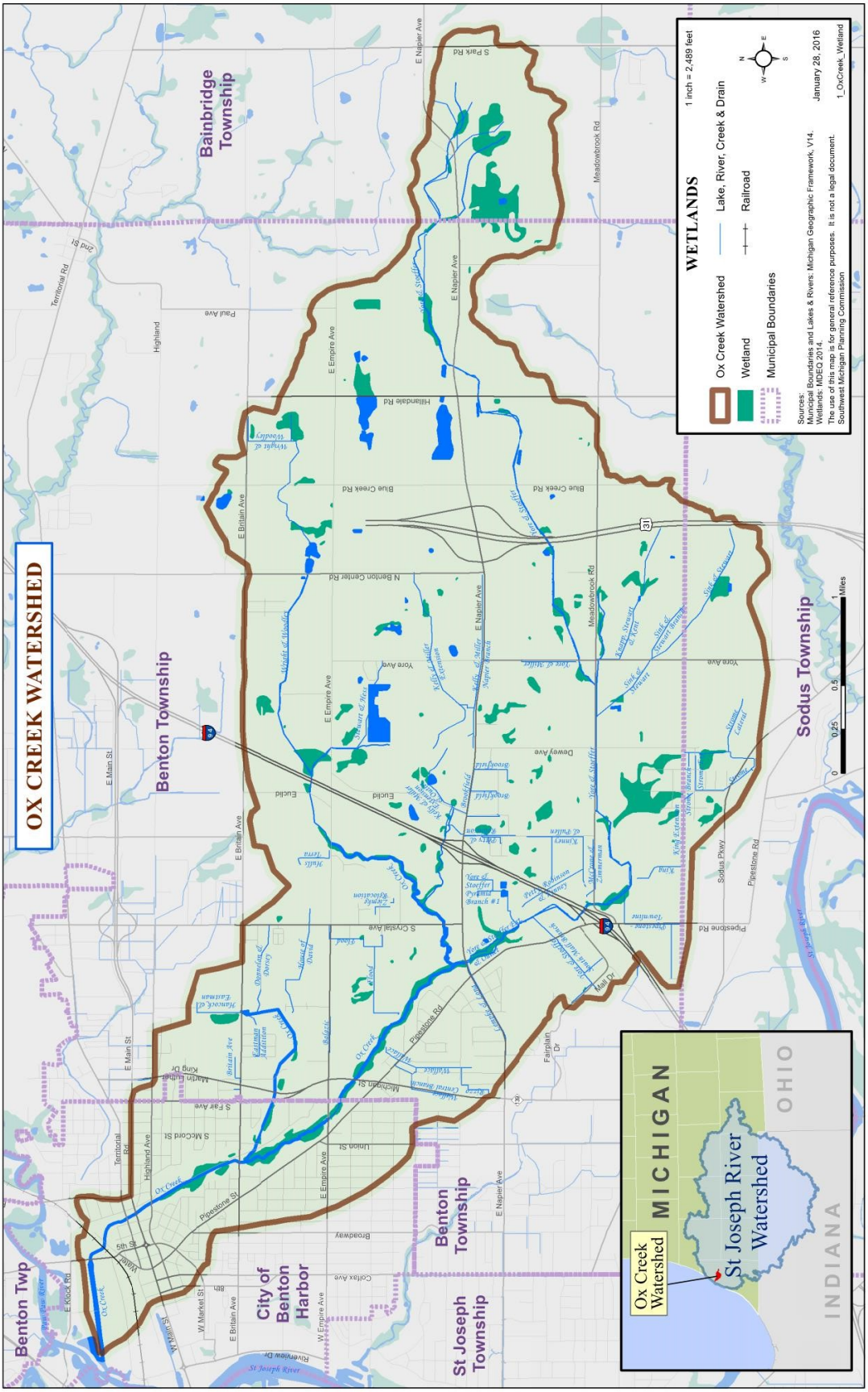
Table 2. County drains in the Ox Creek Watershed

Drain Name	Length (Miles)	Municipality
Yore & Stoeffer	7.77	Benton Charter Township
Wright & Woodley	3.25	Benton Charter Township
Yore & Stoeffer Extension & Outlet	2.83	Benton Charter Township
Kinney Consolidated	1.19	Benton Charter Township
Knapp, Stewart & Kent	1.07	Benton Charter Township
Brookfield	1.03	Benton Charter Township
Kelly & Miller	0.92	Benton Charter Township
Flood	0.91	Benton Charter Township
Stewart & Hess	0.91	Benton Charter Township
Kelly & Milller Extension & Outlet	0.83	Benton Charter Township
Pipestone – Townline	0.76	Benton Charter Township
Sink & Stewart	0.70	Benton Charter Township
House of David	0.69	Benton Charter Township
Lempke & Long	0.59	Benton Charter Township
Donnelan & Dorsey	0.56	Benton Charter Township
Yore & Stoeffer South Mall Branch	0.55	Benton Charter Township
Wallace	0.54	Benton Charter Township
Hancock & Eastman	0.45	Benton Charter Township
Wallace Central Branch	0.37	Benton Charter Township
Sink & Stewart Branch	0.36	Benton Charter Township
McCrone & Zimmerman	0.36	Benton Charter Township
Yore & Miller	0.32	Benton Charter Township
Rizzo	0.30	Benton Charter Township
Petty & Robinson	0.28	Benton Charter Township
Britain Avenue	0.28	Benton Charter Township
Hulls Terra	0.26	Benton Charter Township
Yore & Stoeffer Pyramid Branch	0.24	Benton Charter Township
Kelly & Miller Extension	0.23	Benton Charter Township
Ziemke Relocation	0.20	Benton Charter Township
Yore & Stoeffer Pyramid Branch #1	0.20	Benton Charter Township
Pleasant Gardens	0.20	Benton Charter Township

Drain Name	Length (Miles)	Municipality
Balazic	0.19	Benton Charter Township
Eastman Addition	0.18	Benton Charter Township
Rosedale & Lynch	0.17	Benton Charter Township
Yore & Stoeffer Mall Place Branch	0.16	Benton Charter Township
Handcock & Eastmen	0.14	Benton Charter Township
Petty, Robinson & Kinney	0.14	Benton Charter Township
Yore & Stoeffer South Mall Branch Lateral	0.14	Benton Charter Township
Kelly & Miller Branch	0.13	Benton Charter Township
Flood - Industrial Court Branch	0.12	Benton Charter Township
Brookfield South Branch	0.12	Benton Charter Township
Yore & Stoeffer Pyramid Branch 1984	0.11	Benton Charter Township
Yore & Stoeffer Pyramid Branch	0.08	Benton Charter Township
Pipestone - Townline Branch	0.06	Benton Charter Township
Britain Avenue Lateral	0.04	Benton Charter Township
Yore & Stoeffer Pyramid Branch #2	0.01	Benton Charter Township
Total	**30.95**	**Benton Charter Township**
Drain Name	**Length (Miles)**	**Municipality**
King	1.12	Sodus Township
Sink & Stewart	0.67	Sodus Township
Strome Extension	0.56	Sodus Township
Strome	0.42	Sodus Township
Strome Lateral	0.32	Sodus Township
Strome Branch	0.08	Sodus Township
Total	**3.18**	Sodus Township
Drain Name	**Length (Miles)**	
Yore & Stoeffer Extension	0.96	Bainbridge Township
Yore & Stoeffer Extension Branch	0.48	Bainbridge Township
Total	**1.43**	**Bainbridge Township**
Drain Name	**Length (Miles)**	
Handcock & Eastmen	0.38	City of Benton Harbor
Britain Avenue	0.11	City of Benton Harbor
Handcock & Eastmen	0.04	City of Benton Harbor
Total	**0.53**	**City of Benton Harbor**

The following map shows the boundaries of the entire Ox Creek Watershed.

Figure 2. Boundaries of the Ox Creek Watershed



Study Area – Existing Conditions

This technical update is focused within an area called the Lower Yore & Stoeffer unit, also known as subwatershed unit D in the approved TMDL for Ox Creek. The Lower Yore & Stoeffer unit D consists of the land area draining to the Yore & Stoeffer Drain between Meadowbrook Road and the confluence with Ox Creek near Napier Avenue. There are no point source or Part 201 facilities located in unit D. Two MS4 jurisdictions include lands in this unit, Benton Harbor City and Berrien County. Four active Part 213 facilities and four closed sites lie within unit D. Features of interest in this unit include the development around the I-94 interchange at Pipestone Road and the Orchards Mall area. This subwatershed unit contains a relatively large number of impervious surfaces, which clearly affects the hydrology of Ox Creek (see *Ox Creek TMDL Development – Linkage Analysis, July 26, 2012, page 99*). The following drains are located in the study area: Petty & Robinson; Yore & Stoeffer Pyramid Branch; Yore & Stoeffer Pyramid Branch 1984; Yore & Stoeffer Mall Place Branch; Yore & Stoeffer South Mall Branch; Yore & Stoeffer South Mall Branch Lateral; and the Yore & Stoeffer Extension & Outlet.

Specifically, this technical plan update focusses on prioritization for the Orchard Mall area which is **314 acres total, of which 95 acres (30%)** where the stormwater is treated (blue areas) and **219 acres (70%)** where stormwater is not treated.

Figure 3. Plan Focus Area

USDA Soil Type Map

Soil data was downloaded from the USDA portal and downloaded to GIS software. The data was symbolized in GIS software by the soil name. Soil Classifications found in the study area are as follows:

Brady Sandy Loam: Nearly level, somewhat poorly drained soil is on flat plains. Permeability is moderately rapid to very rapid and surface runoff is low. The available water capacity is moderate.

Cohoctah-Abscota Sandy Loams: Nearly level, poorly drained Cohoctah soil and the moderately well drained Abscota soil on flood plains and bottom lands of streams and rivers. Most areas are narrow, elongated flood plains in deeply dissected, upload drainageways. These soils are subject to flooding during most years. Permeability is moderately rapid to rapid. The available water capacity is high for the Cohoctah soil and low for the Abscota soil. Surface runoff is slow to very slow or ponded.

Gilford Sandy Loam: Nearly level, very poorly drained soil is in low flat areas. It is subject to frequent flooding. Permeability is moderately rapid and surface runoff is very slow. The available water capacity is moderate.

Kibbie Loam: Nearly level, somewhat poorly drained, sloping soils on convex areas or in drainageways. Permeability is moderate and surface runoff is slow. The available water capacity is high.

Martinsville Fine Sandy Loam: Well drained soil. Permeability is moderate and surface runoff is slow. The water capacity is moderate.

Metea Loamy Sand: Well drained soil. Permeability is very rapid to moderately slow and surface runoff is slow. The available water capacity is moderate

Oshtemo Sandy Loam: Well drained soil. Permeability is moderately rapid and surface runoff is slow. The available water capacity is moderate.

Oshtemo-Urban land Complex: Consists of nearly level and gently sloping, well-drained soils and urban land. Urban land is covered by streets, parking lots, driveways, buildings, sidewalks, and other structures that obscure or alter the soil so that identification is not suitable. Permeability is moderately-to-very rapid and surface runoff is slow. The available water capacity is moderate.

Sebewa Loam: Nearly level, poorly drained soil is in broad, flat, low areas. It is subject to frequent ponding. Permeability is moderately rapid and surface runoff is very low. The available water capacity is moderate.

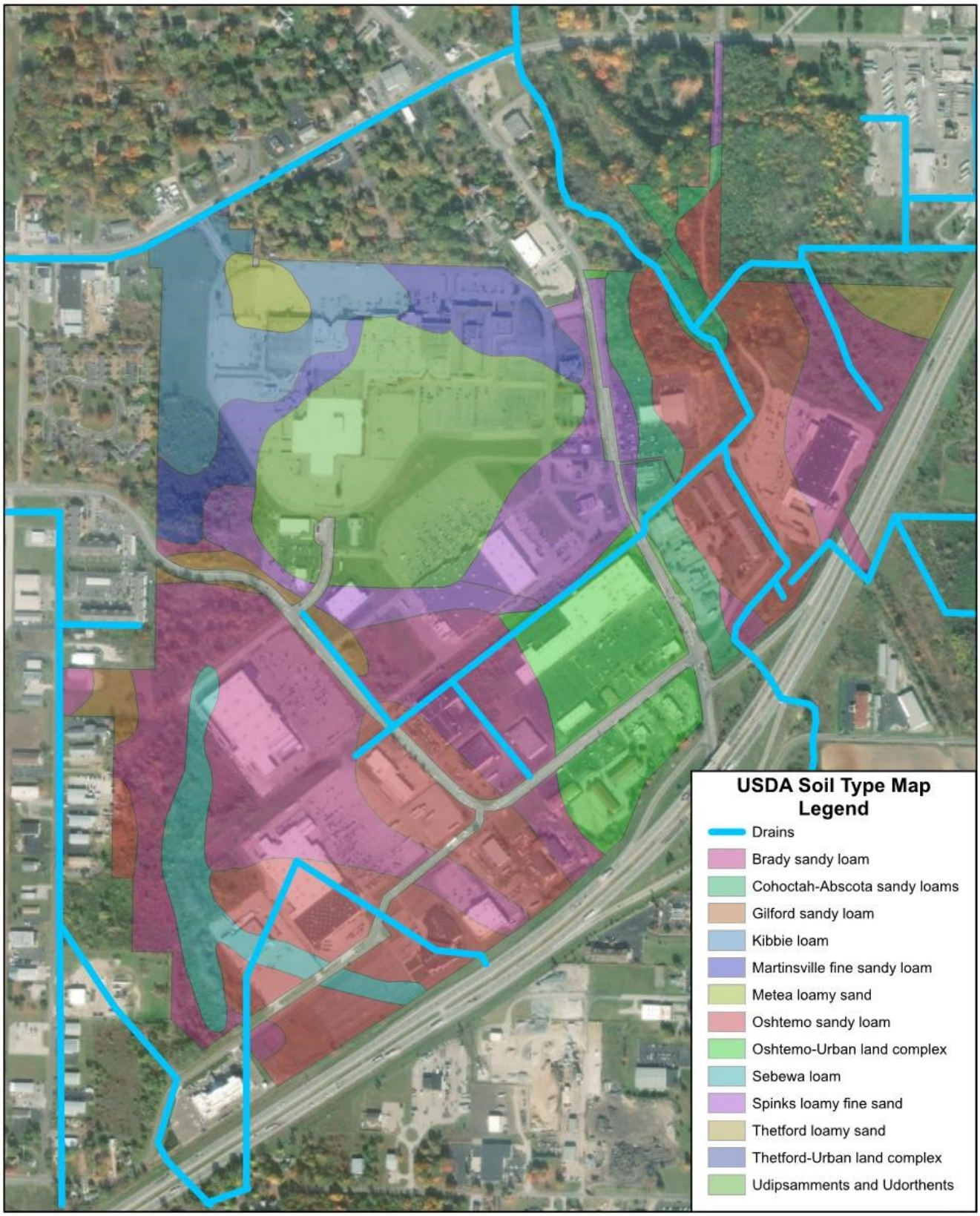
Spinks Loamy Fine Sand: Well-drained soil. Permeability is moderately rapid or rapid and surface runoff is slow. The available water capacity is low.

Thetford Loamy Sand: Nearly level, somewhat poorly drained soil is on plains. Permeability is moderately rapid and surface runoff is slow. The water capacity is low.

Thetford-Urban Land Complex: Nearly level, somewhat poorly drained soils and urban land. Some areas are artificially drained by sewer systems, gutters, drainage tiles, and surfaces ditches. If not drained, it has a water table at a depth of one foot during the wet season. Some low-lying areas are ponded because of runoff from adjacent, higher areas or because of high water table. Urban land is covered by streets, parking lots, driveways, buildings, sidewalks, and other structures that obscure or alter the soil so that identification is not suitable. Permeability is moderately rapid and surface runoff is slow. The available water capacity is low.

Udipsamments and Udorthents: The soil ranges from clay to sand and surface runoff is very rapid.

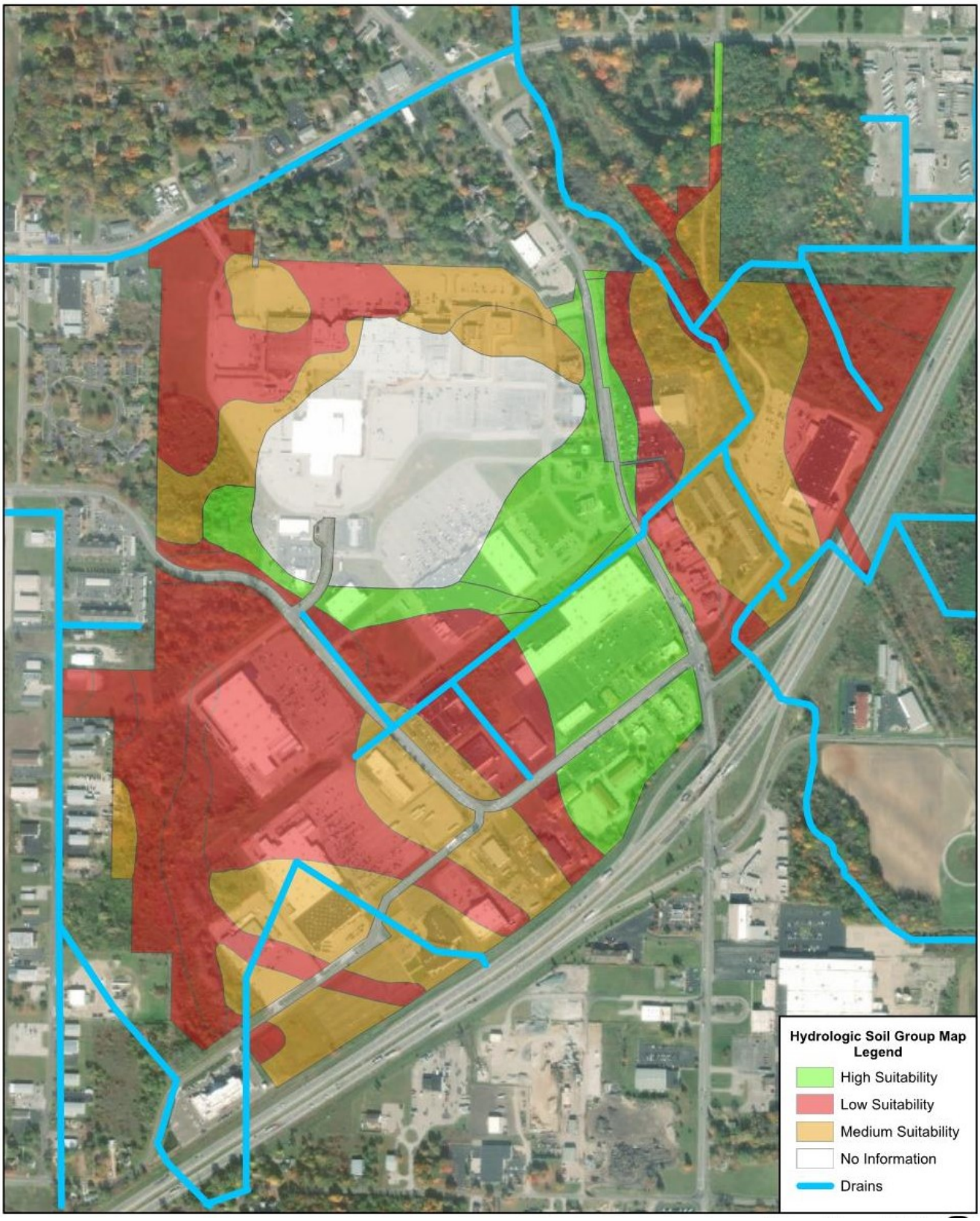
Figure 4. Plan Area Soil Types Map



Hydrologic Soil Group Map

Soil data was acquired from United States Department of Agriculture (USDA) portal (raw data shown in the USDA soil types map) and downloaded to geographic information system (GIS) software. Downloaded layers were separated out by soil type, grouped, and color coded by their soil classification (Type A, Type B, or Type C and Type D). The soils capacity for drainage range from Type A which drain the best down to Type D which drains the slowest. The map shows the suitability of areas for best management practices (BMPs) via color coding. Green shows the areas which have high suitability for locating BMPs (Type A soils), orange shows the parcels which have medium suitably for locating BMPs (Type B soils), and red shows the parcels which have low suitability for locating BMPs (Type C and Type D soils).

Figure 5. Plan Area Soil Groups Map

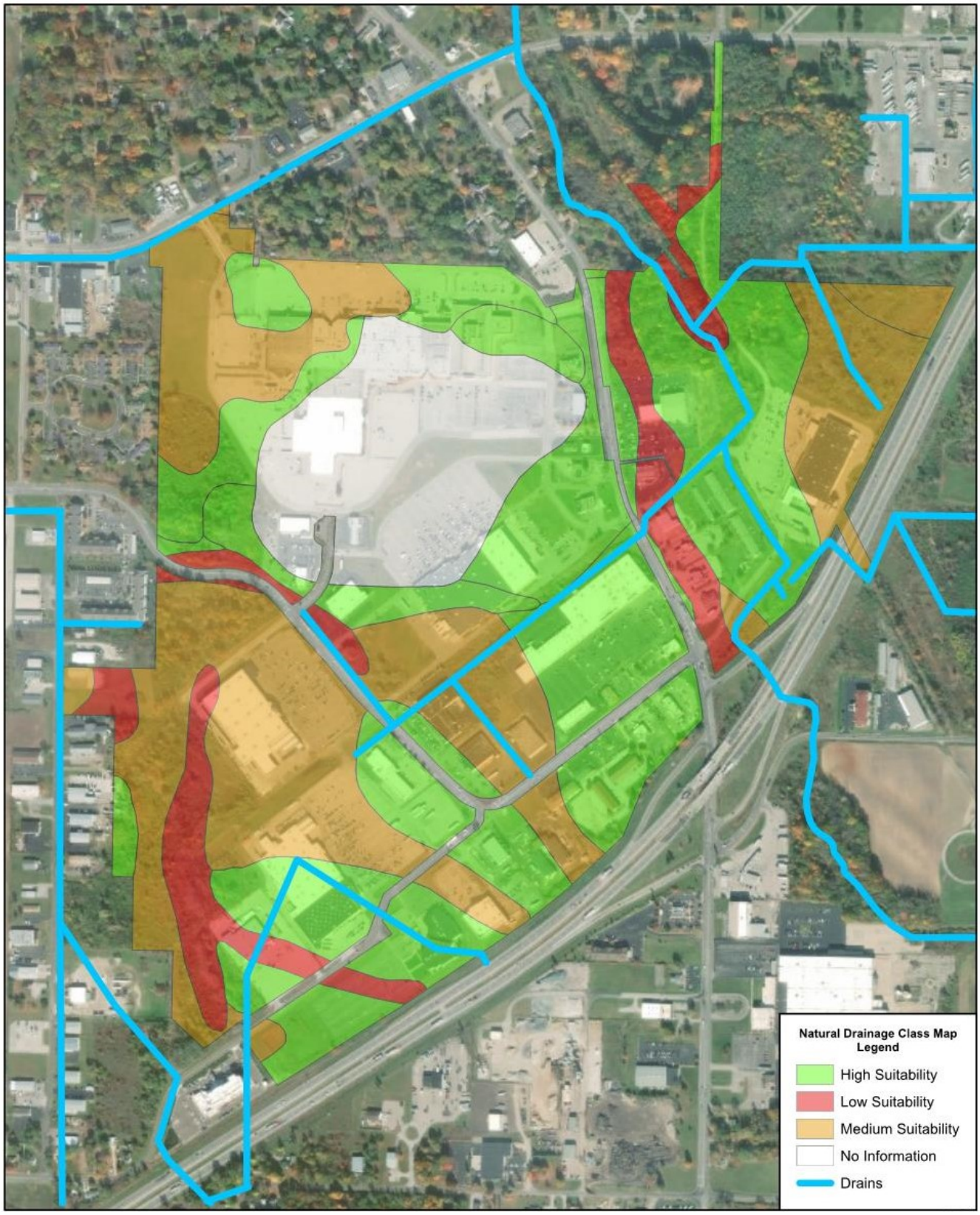


Natural Drainage Class Map

Soil data was acquired from the USDA portal and downloaded to GIS software. Downloaded layers are classified and separated by their drainage class.

Green shows the areas which have high suitability for locating BMPs (“Well Drained” and “Excessively Drained” soils), orange shows the areas which have medium suitably for locating BMPs (“Medium Drained” soils), and red shows the areas which have low suitability for locating BMPs (all drainage classes below “Medium Drained” soils).

Figure 6. Plan Area Natural Drainage Class Map



Site Slope Map

Slope data was downloaded from the US Geological Survey and downloaded to GIS. Slopes are shown in three classifications: 2-5% slope, 5-8% slope, and 0-2% slope.

Green shows the areas which have high suitability for locating BMPs (2-5% slope), orange shows the areas which have medium suitably for locating BMPs (5-8% slope), and red shows the areas which have low suitability for locating BMPs (0-2% slope and slopes above 8% grade).

Figure 7. Plan Area Site Slope Map

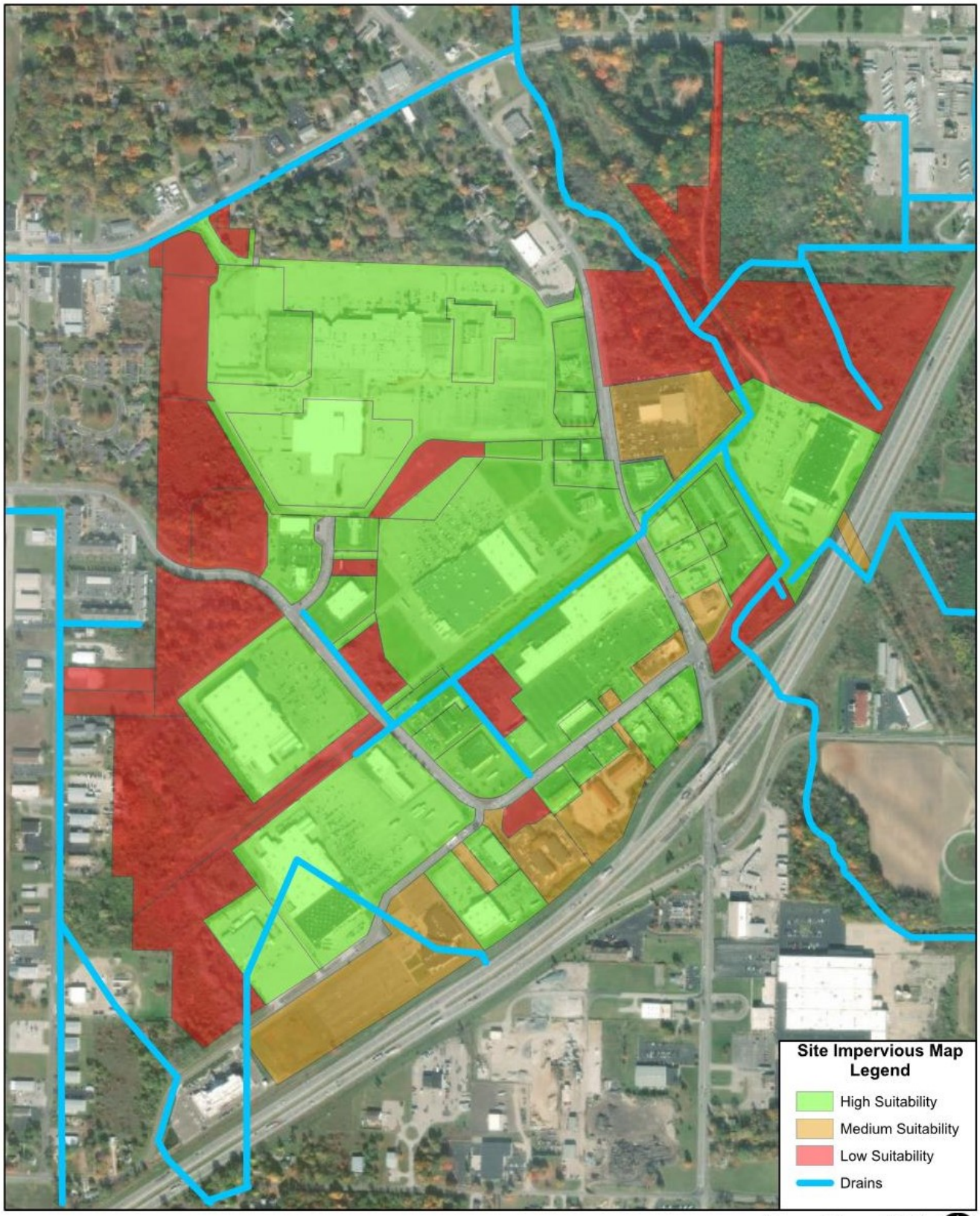
Site Impervious Map

Aerial images were used to identify areas within the subwatershed that are covered by pavement, buildings, or other features that are impervious surfaces and prevent runoff from entering the soil. The percent of each parcel's impervious surface compared to the total parcel size was calculated.

Parcels that have high impervious cover are considered highly suitable for BMP siting due to the large amount of water leaving the site without being treated before entering Ox Creek and its tributaries. Parcels with less impervious cover are considered less suitable for BMP siting due to more water being infiltrated or treated naturally before entering Ox Creek and its tributaries.

Green shows the parcels which have the highest suitability for locating BMPs (parcels with 66-100% impervious surface), orange shows the parcels which have medium suitably for locating BMPs (parcels with 33-66% impervious surface) and red shows the parcels which have the lowest suitability for locating BMPs (parcels with 0-33% impervious surface).

Figure 8. Plan Area Site Impervious Map

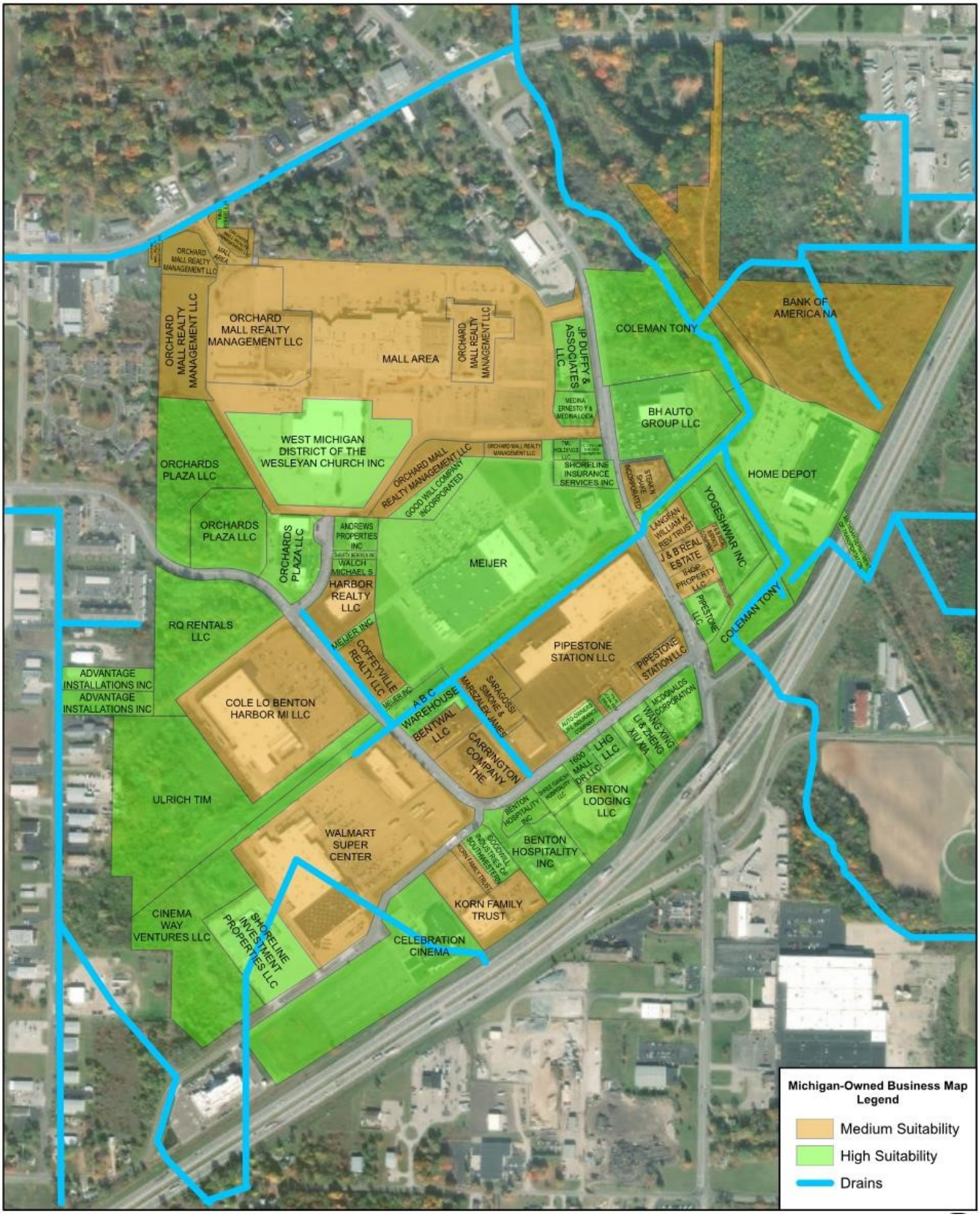


Michigan-owned Business Map

GIS parcel data was obtained from Berrien County. Within the GIS data there is information about where the business owner resides. This information was pulled from the parcels, and the parcels that have an owner with a Michigan address were selected. In addition to these Michigan owners, Wightman & Associates had a list of other partners with owners outside of Michigan that had expressed interest in the project that were also added to the selection.

Green shows the parcels which have high suitability for locating BMPs (Michigan land owners), orange shows the parcels which have medium suitably for locating BMPs (all other land owners).

Figure 9. Plan Area Michigan-owned Business Map



CURRENT ZONING SUMMARY – STUDY AREA

The entire study area is within Benton Charter Township. The following is a review of relevant parts of Benton Charter Township's zoning ordinance.

Parking Requirements

Benton Charter Township follows Euclidean zoning through their ordinance. Article 4 of Benton Charter Township's covers their parking requirements. Parking requirements are prescriptive based on building use and size. Since the study area is a commercial district, this report will focus upon those requirements.

Parking requirements for commercial developments are laid out in the zoning ordinance as a minimum number of spaces per square foot of building size. Uses such as theaters, hotels/motels and other uses with fixed seats or rooms have requirements listed per seat or room.

In general parking requirements range for one space per every 100, 150, or 200 square foot (SF) of building space. Restaurants and night clubs require one space for every 100 SF. Retail stores, supermarkets, and department stores require one space for every 150 SF. And regional shopping centers (multi-unit shopping centers over 100,000 SF) require one space for every 200 SF.

Joint Parking: The ordinance does allow for joint parking for uses in the same vicinity, where the total space requirement is the sum of the individual requirements at the same time of day. This allows for the joint requirements to be less than the total individual requirements if the peak needs for some uses occur at distinctly different times of day from the peaks of others.

Green Space Requirements

Green Space: No requirements for green or open space were found for commercial developments

Landscaping: No requirements for site or parking lot landscaping were found. One reference to screening between commercial parking and residential lots mentioned a hedge or natural landscape, uniformly trimmed, could be used to screen parking.

Stormwater Requirements

In general, no stormwater requirements were found in the Township's zoning. Stormwater regulations are handled through the Berrien County Drain Commissioner's office. As a result of this project, the County's stormwater guidelines are being updated to include more green infrastructure techniques.

Sidewalk Requirements

No regulations for sidewalks or pedestrian facilities in commercial districts or areas were found.

PUD Requirements

Planned Unit Developments: A planned unit development (PUD) is a zoning district unique to itself. It applies to an area of land as a single entity with several associated uses. It is a plan for lot size, bulk or type of dwelling, density, lot coverage, required open space, or uses that do not exist in a singular zoning district. Often times PUDs are used for large or mixed-use developments as a developer is able to create site specific zoning for the development during the process. No recommendations for parking, green or open space, sidewalks, landscaping, or stormwater were found in the Township's zoning ordinance relating to PUDs.

PARKING STUDY

This parking study was initiated to help understand parking supply and demand within the study area. Quantifying actual usage through a parking study is extremely valuable in understanding the true parking demand of an area because parking needs are often over-estimated.

Twelve parking lots within the study area were considered during this study: Best Buy, Walmart, Meijer, Jo-Ann, Target, Kohl's/Michaels, Harbor Freight Tools/Burlington, Family Farm & Home, Lowe's, Home Depot, Dunham's Sports/Pier 1 Imports, and JCPenney.

Knowing occupancy allows one to determine whether or not there is enough parking, occupancies of 85-90% or just below are ideal – the demand is being met without waste (Ref: Oneida City Parking Study).

The study of these twelve lots took place on Thanksgiving and the day after, known as Black Friday. The counts were taken between 5pm on 11/26/2015 and 10am on 11/27/2015. Ample parking was observed within all twelve lots, usually excessive parking was observed. Best Buy was the only lot observed to be at capacity. Overall, the most underutilized lots are JCPenney and Dunham's Sports/Pier 1 Imports while the most used lots are Best Buy, Walmart, and Meijer. However, even the most used lots were observed to provide abundant parking opportunity.

Within this study area, the parking supply exceeds parking demand with average occupancies of the lots at about 33%. It is important to provide parking to employees, residents and patrons, but excess parking is not only unnecessary but takes up valuable space and can create large expanses of impervious surfaces. These large swaths of impervious surfaces can create water quality issues downstream as well as create heat-island effect.

Table 3. Plan Area Parking Lots – Black Friday Occupancy

Parking Lot:	**Black Friday Occupancy:**
Best Buy	100%
Meijer	90%
Walmart	45%
Jo-Ann	40%
Target	25%
Kohl's/Michaels	20%
Harbor Freight Tools/Burlington	20%
Family Farm & Home	17%
Lowe's	13%
Home Depot	11%
Dunham's Sports/Pier 1 Imports	10%
JCPenney	8%
Average	**33%**

Parking supply and demand is most efficient with occupancies of 85-90%. At this amount the demand is being met without waste. Occupancies of 85-90% were only observed at two locations in this area: at 5.20 PM on 11/26/2015 the Best Buy lot was at 100% capacity and at 6.10 PM on 11/26/2015 the Walmart lot was at 90%. It should be noted that parking size should never be planned around peak events (for example, planning parking

size around the demand on Black Friday shopping day), these dates were used to study parking capacity to show the extremes and start a conversation about real parking needs in the area.

The following set of maps show the usage of parking lots in the study area to start the conversation about how much parking is needed at sites. The reduction in impervious surfaces such as parking lots is the easiest way to reduce the amount of stormwater runoff that is not being treated before reaching Ox Creek and its tributaries. In the next map, yellow highlights the 12 parking lots observed during the study. The following maps highlight in red the parking being utilized during the observed time.

Figure 10. Plan Area Parking Utilization

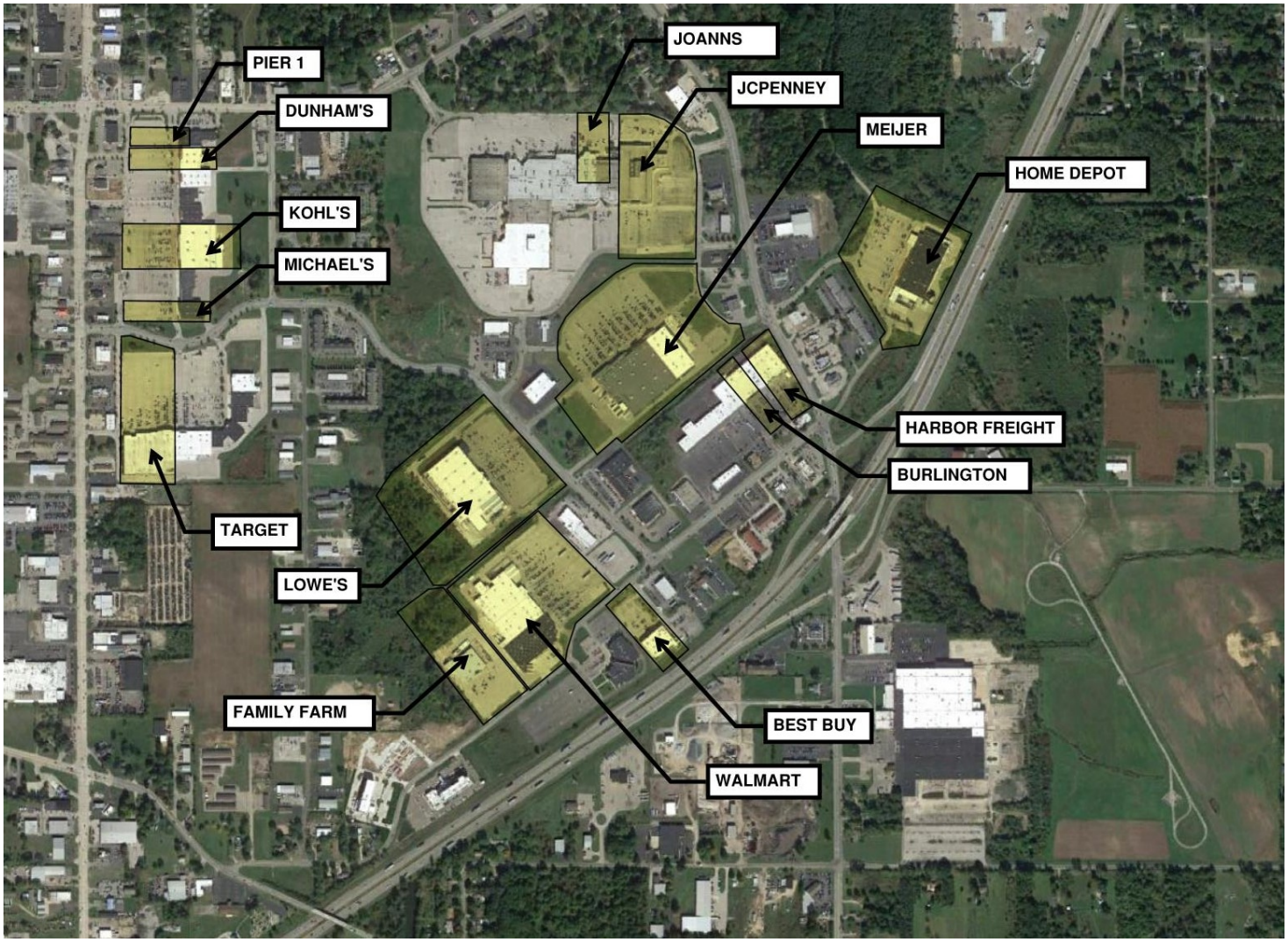
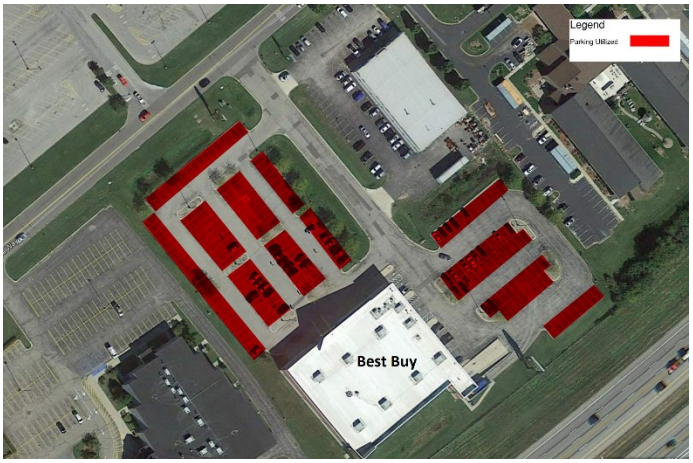
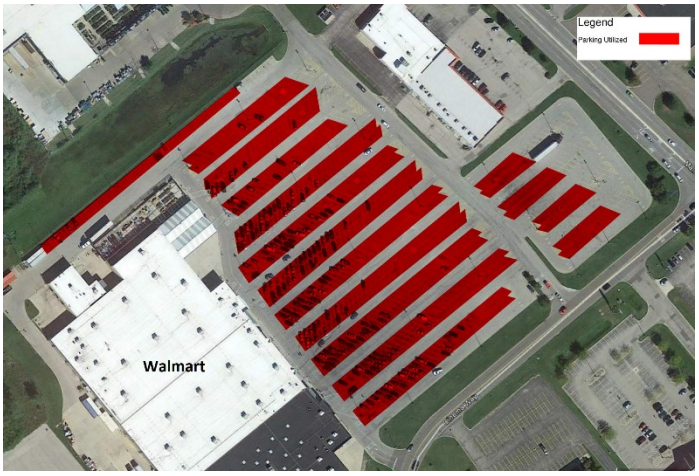
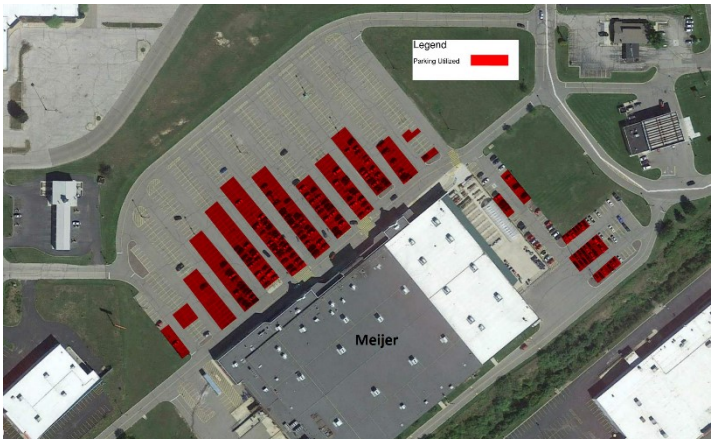
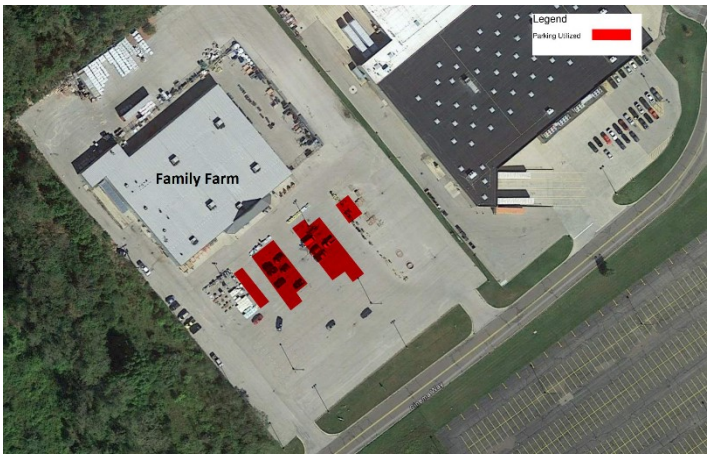


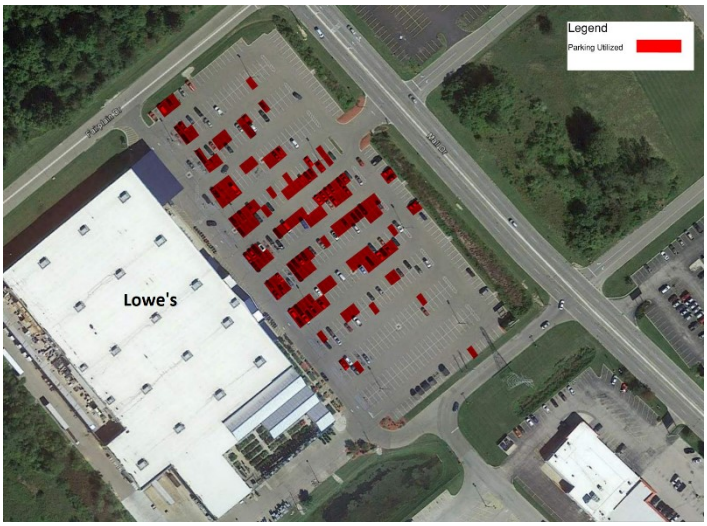
Figure 11. Plan Area Site-specific Parking Utilization



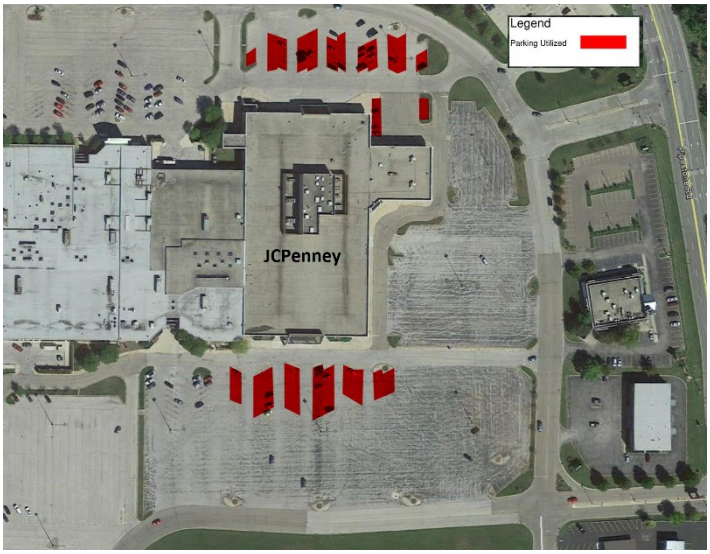





Legend
Parking Utilized
Family Farm


Legend
Parking Utilized
Lowe's


Legend
Parking Utilized
Home Depot
I-94
I-94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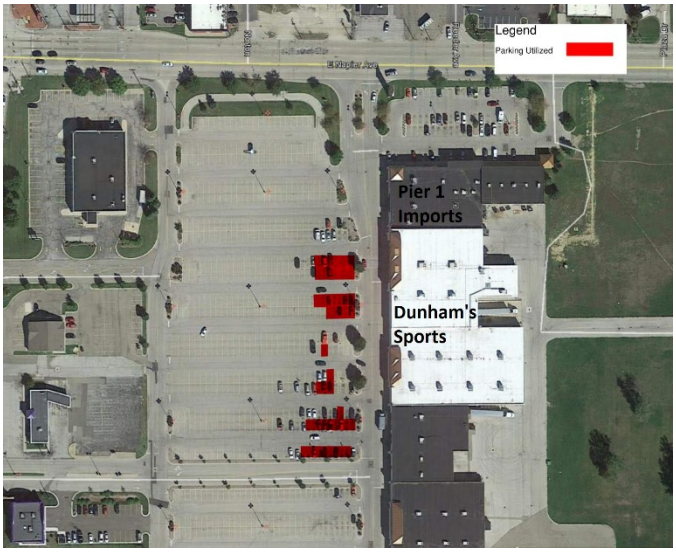
Parking Utilized
JCPenney


Legend
Parking Utilized
Pier 1
Imports
Dunham's
Sports

WIGHTMAN BMP IMPLEMENTATION

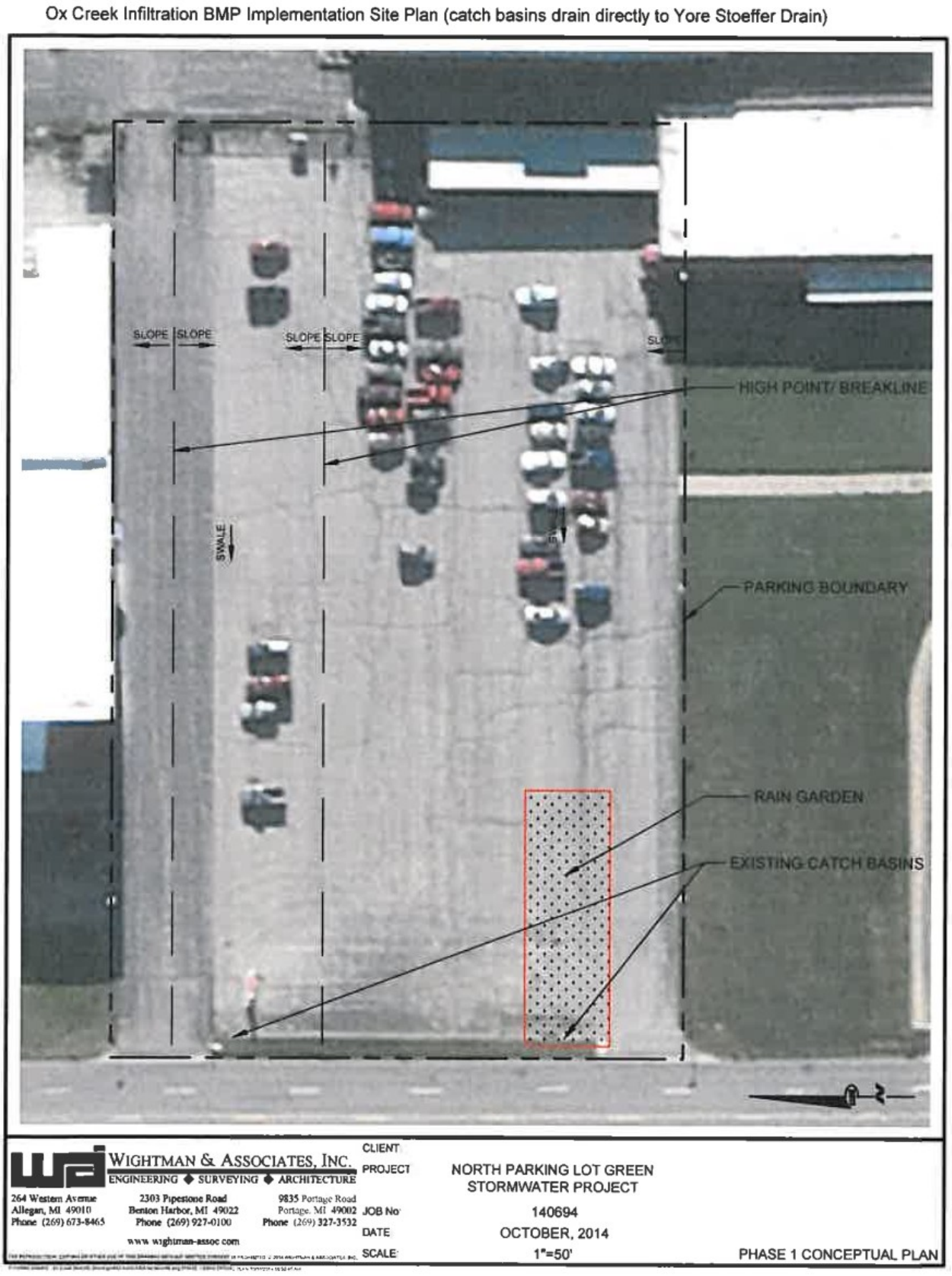
Wightman's Benton Harbor Office is located just southeast of the study area at 2303 Pipestone Rd, Benton Harbor, MI. According to the Paw Paw River Watershed Management Plan, the Wightman site is a high to medium priority area for implementation. This was the location of the first stormwater BMP near the study area.

Stormwater from the building flows into the Pipestone-Townline Drain pipe along Pipestone Road which then discharges into the Yore & Stoeffer Drain approximately 1,250 feet beyond the property. The location for the Rain Garden at Wightman's office was chosen for several reasons, but most importantly the area provides the most potential for treatment of stormwater from the parking lot. The parking lot chosen sheet flows into storm basins at the road's edge. Two-thirds of the lot flows into the southern basins and one-third of the lot to the northern basins; because of this, the rain garden was installed in the southern portion of this parking lot. The pavement slopes to a paved swale in the center of the parking lot then to the storm basin. By removing a portion of the pavement and installing engineered soils and plantings we can direct all of the water from this portion of the parking lot into the rain garden/bioretention area. Contributing area to the BMP is 2.5 acres.

The BMP Implementation project goals were to reduce unused parking to save in maintenance and decrease environmental footprint; reduce stormwater quality; slow the release of stormwater from the site to the Yore & Stoeffer Drain (reduce flashiness); cool the water before it reaches the drain; and remove suspended solids and other pollutants.

Figure 12. Rain Garden BMP Implementation – Wightman Offices

Figure 13. Infiltration BMP Implementation Site Plan



Soil borings were taken to ensure the designed bioretention area could infiltrate enough water.

Figure 14. Soil Boring Log – Pavement Borings for Rain Garden

SOIL BORING LOG

PROJECT: **Pavement Borings for Rain Garden**

CLIENT:

JOB NUMBER: 150383

DATE: December 22, 2015

City:	***Benton Harbor***	**County: Berrien**		**State:**	**Michigan**
Boring Location:	***85' East of Catch Basin***			**Boring Number:**	**PB-1**
Date Started:	***12/22/2015***	**Date Completed:** ***12/22/2015***		**Surface Elevation:**	**Top of Asphalt**
Weather:	***Cloudy / 50 F***	**Depth to water:** 59"	**Boring Method:**	Hand Auger	

Soil Layer Limits (ft)		**Soil Description**
0	5.25	Asphalt
5.25	9	Road gravel
9	14	Gray clayey fine sand
14	17	Gray / black sandy organic clay
27	32	Gray clayey fine sand
32	61	Brown clayey sand & gravel
61	86	Brown fine to coarse sand & gravel with a trace of silt/clay & layers of fine sand
86	93	Stiff gray clay
93		End of boring (too wet)

Technician Bryan J. Styburski

Bryan J., Styburski

SOIL BORING LOG

PROJECT: **Pavement Borings for Rain Garden**

CLIENT:

JOB NUMBER: 150383

DATE: December 22, 2015

City:	***Benton Harbor***	**County: Berrien**		**State:**	**Michigan**
Boring Location:	***24' East of Catch Basin***			**Boring Number:**	**PB-2**
Date Started:	***12/22/2015***	**Date Completed:** ***12/22/2015***		**Surface Elevation:**	**Top of Asphalt**
Weather:	***Cloudy / 50 F***	**Depth to water:** NA	**Boring Method:**		Hand Auger

Soil Layer Limits (ft)		**Soil Description**
0	5.5	Asphalt
5.5	12.5	Road Gravel
12.5	25	Gray clayey fine sand
25	34	Gray clayey fine to coarse sand & gravel
34	76	Brown clayey silt
76	88	Very stiff gray clay
88	120	Brown silty clay
120		End of boring

Technician Bryan J. Styburski

Bryan J., Styburski

Plant Species for Rain Garden/Bio-Retention Area

The following shows the plant species for rain garden/bioretention areas.

Table 4. Plant Species for Rain Garden/Bioetention Area

	BOTANICAL NAME	COMMON NAME
TREES		
	BETULA NIGRA 'HERITAGE'	HERITAGE RIVER BIRCH
	CERCIS CANADENSIS	EASTERN REDBUD
SHRUBS		
	ARONIA MELANOCARPA 'MORTON'	IROQUOIS BEAUTY BLACK CHOKEBERRY
	CEANOTHUS AMERICANUS	NEW JERSEY TEA
	CLETHRA ALNIFOLIA 'HUMMINGBIRD'	HUMMINGBIRD SUMMERSWEET
	CORNUS SERICEA 'ALLEMANS'	ALLEMAN'S RED TWIG DOGWOOD
	PHYSOCARPUS OPULIFOLIUS 'SMPOTW'	TINY WINE NINEBARK
GRASSES / SEDGES		
	CAREX BEBBII	BEBB'S OVAL SEDGE
	CAREX VULPINOIDEA	FOX SEDGE
	PANICUM VIRGATUM 'HEAVY METAL'	HEAVY METAL SWITCH GRASS
	PANICUM VIRGATUM 'SHENANDOAH'	SHENANDOAH RED SWITCH GRASS
	SCHIZACHYRIUM SCOPARIUM 'THE BLUES'	THE BLUES LITTLE BLUESTEM
	SORGHASTRUM NUTANS 'SIOUX BLUE'	SIOUX BLUE INDIAN GRASS
	SPOROBOLUS HETEROLEPIS	PRAIRIE DROPSEED
PERENNIALS		
	AMORPHA CANESCENS	LEAD PLANT
	AQUILEGIA CANADENSIS L.	RED COLUMBINE
	ASCLEPIAS TUBEROSA	BUTTERFLY MILKWEED
	ASTER LAEVIS	SMOOTH ASTER
	DALEA PURPUREA	PURPLE PRAIRIE CLOVER
	ECHINACEA PURPUREA 'MAGNUS'	MAGNUS PURPLE CONEFLOWER
	ERYNGIUM YUCCIFOLIUM	RATTLESNAKE MASTER
	EUTROCHIUM DUBIUM 'PHANTOM'	PHANTOM JOE PYE WEED
	GEUM TRIFLORUM	PRAIRIE SMOKE
	HYPERICUM PYRAMIDATUM 'ALBURY PURPLE'	ST. JOHN'S WORT
	IRIS VERSICOLOR	BLUE FLAG IRIS
	LIATRIS SPICATA 'KOBOLD'	KOBOLD SPIKE GAYFEATHER
	PERSICARIA BISTORTA 'SUPERBA'	BISTORT

RUDBECKIA FULGIDA 'GOLDSTRUM	GOLDSTRUM BLACK EYED SUSAN
SOLIDAGO SPECIOSA	SHOWY GOLDENROD

Figure 15. Rain Garden BMP Implementation: Before Picture

Figure 16. Rain Garden BMP Implementation: Site Rendering

Figure 17. Rain Garden BMP Implementation: After Pictures


Pardon our dust while we construct a rain garden that will improve the quality of stormwater runoff from our parking lot prior to entering the Ox Creek.
THIS PROJECT IS FUNDED IN PART THROUGH THE MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY'S NONPOINT SOURCE PROGRAM BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY.
THANK YOU TO OUR PROJECT PARTNERS AND SPONSORS
Sarett NATURE CENTER
DEQ
EPA United States Environmental Protection Agency

The following Table shows the estimated pollutant load reductions for the Wightman Rain Garden implementation.

Table 5. Estimated Pollutant Load Reductions

	Load before BMP (lbs/yr)		Load after BMP (lbs/yr)		Load Reduction (lbs/yr)
BOD	54.7		U		U
COD	471.8		U		U
TSS	893		366		527
LEAD	0.7		U		U
COPPER	0.1		0.0		0.1
ZINC	1.1		0.1		1.1
TDS	3,936.5		U		U
TN	14.5		7.4		7.1
TKN	8.2		U		U
DP	0.6		U		U
TP	1.2		0.4		0.8
CADMIUM	0.0		U		U

Note: U=undetected

PLANNING PROCESS

The Ox Creek Watershed Study incorporated public engagement throughout the planning process in a three-tiered approach: Steering Committee, business Stakeholders, and targeted meetings with local officials and agency staff. The Steering Committee is a group volunteers with environmental, economic development, and municipal perspectives who guided the over-arching metrics for success while providing review periodically throughout the project. Once the project team with the Steering Committee's input selected the project planning area, business stakeholders within the Ox Creek Watershed and Orchards Mall commercial area were engaged to provide feedback on areas that need improvement, what those areas should look like, and which areas should be preserved.

The following vision statement was developed from the identified objectives, advantages and opportunities described below.

Envision a **revitalized Orchards Mall area** with **mixed use development** and public **gathering spaces** as a gateway to Benton Harbor and St. Joseph and the **regional commercial/retail hub** of SW Michigan

ADVANTAGES

Improved roads to better accommodate all users – cars, pedestrians and bicyclists

The gateway nature of the area to the St. Joseph/Benton Harbor community

The major supermarket (Meijer)

Hotels that are at capacity year-round

The connection to local waterways

Potential for obtaining grant funding

OPPORTUNITIES

Improve road safety

Manage water runoff

Revitalize the mall area

Increase perception of safety

Become a shopping destination

Attract mixed-use development

Build new townhomes

Expand green space

Restore fruit trees

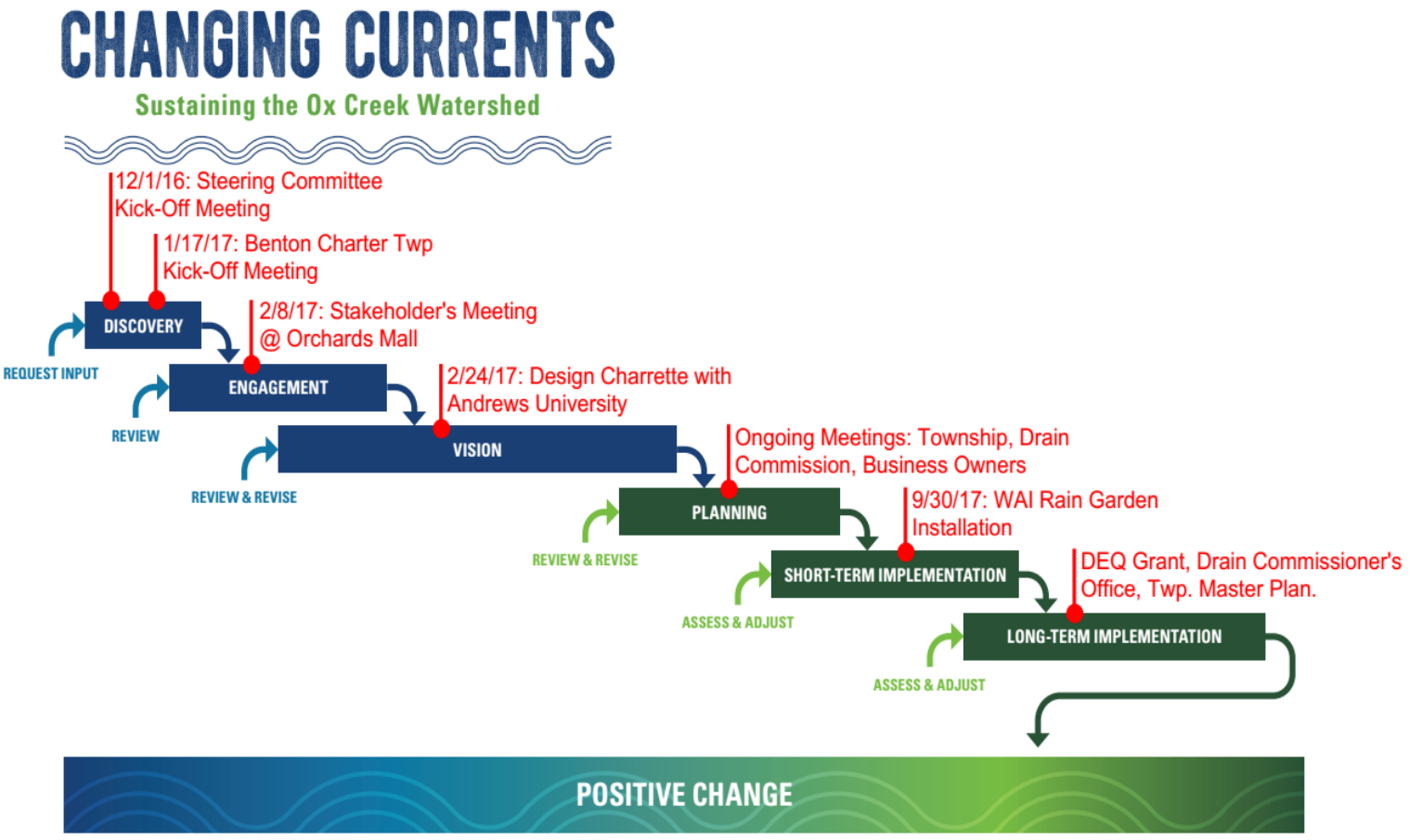
Create more parks and trails

Include accessibility by bike and on foot

Attract young professionals

Create outdoor market and gathering spaces

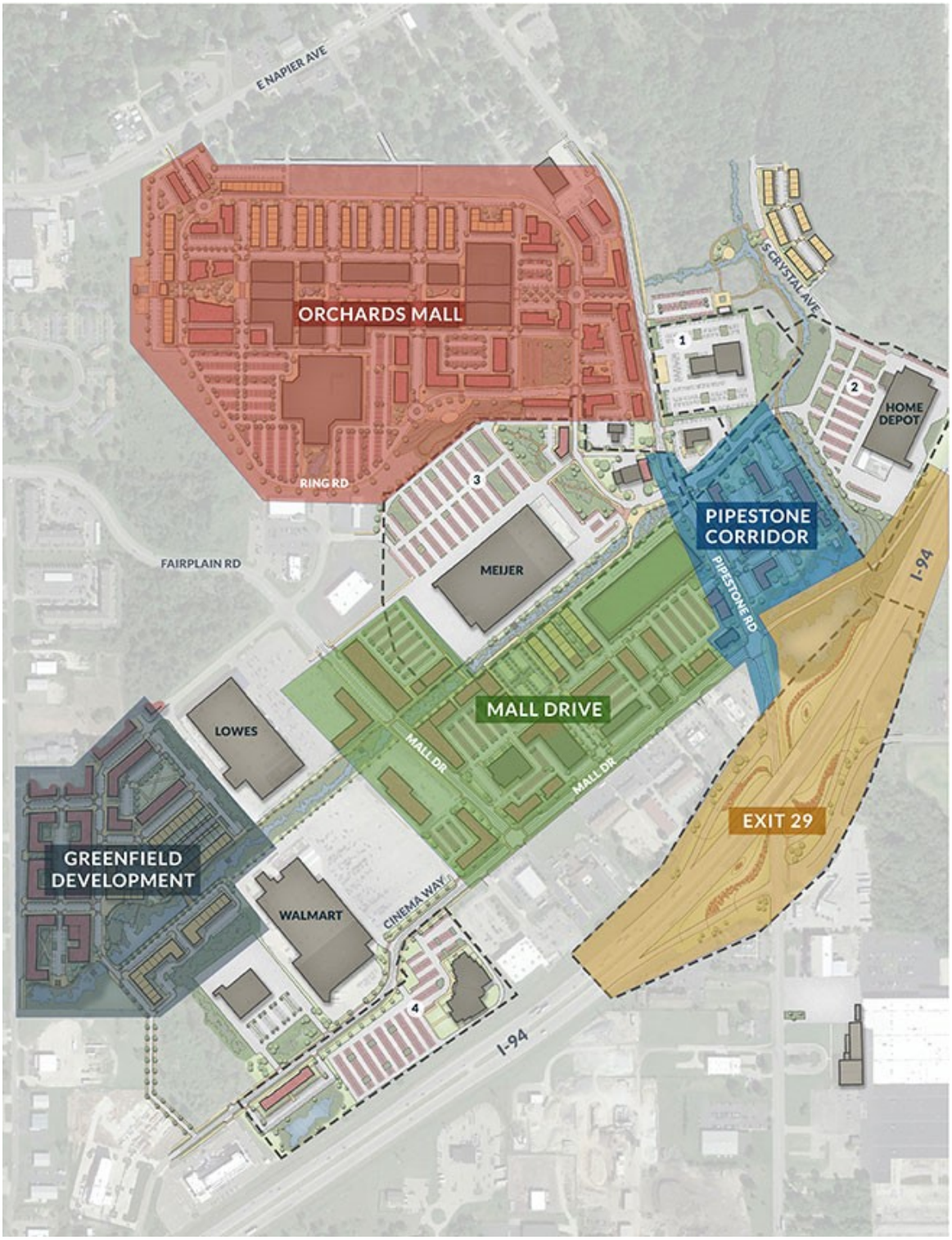
Andrews University architecture students with Wightman staff led a charrette-based design approach where municipal officials, County officials, MDOT, and commercial and economic developers worked directly with the students as they proposed and drew improvements. Once developed, these drawings were used for targeted meetings throughout the region to discuss issues/opportunities with the County Drain Commissioner, MDOT's planning department, and MDEQ staff to determine the feasibility and effectiveness of the proposed designs.



The plans were developed in five conceptual development zones: The Orchards Mall for redevelopment, the Greenfield Development for new development, Pipestone Corridor for safety and sense of arrival, the Mall Drive Corridor for suburban retrofit and infill development and the I-94/Pipestone Exit for improved water quality and non-motorized travel. The five planning areas depict how high-quality development and better multi-modal access can be a driving force for cleaner water through sustainable property management.

The following Figure shows the five conceptual development zones. The section titles below are color coded to match the relevant sections on this map.

Figure 18. Five Conceptual Development Zones



Orchards Mall

Throughout our engagement process groups were calling for a revitalized Orchards Mall that could become a regional destination. By opening up the central promenade and bringing in a ‘Main Street’ aesthetic, the mall not only becomes a whole new environment but also reduces impervious area for better storm water management, leading to better water quality. These water management techniques would also serve as amenities to mall patrons, providing more opportunities for rest and relaxation and visual softening with pools of water and greenery.

Mall Drive/Pipestone Plaza Park

Benton Charter Township residents and officials desired a signature location that incorporated the principles of Placemaking into a high-quality public space that could also anchor community events. High quality public space has multiple frontage types, and this park delivers with mixed use frontage, hospitality frontages that incorporate al fresco dining, and residential townhouse frontages. By also connecting to non-motorized facilities on Mall Drive and to the Ox Creek Regional Trail connecting to the Benton Harbor Arts District to the north this space becomes activated by diverse residents and visitors.

Exit 29/Pipestone Corridor

With MDOT beginning efforts to relocate Exit 29's westbound off-ramp the commercial district now has an opportunity to influence what that design could look like. Ox Creek has a tributary that runs beneath I-94 at this location, creating an ideal location for a series of large filtration ponds that will closely resemble natural wetlands. This will slow water down and filter out sediments while also providing a backdrop for a potential Township park. If realized, a three-mile trail could run adjacent to Ox Creek from this new trailhead park at Exit 29 all the way to the Benton Harbor Arts District. By connecting these two commercial districts residents of both the Township and the City will have an amenity to connect neighborhoods with high quality shopping and dining.

Greenfield Development

Behind Lowe's and Walmart sits unused scrubland that is adjacent to the new hotel district on Cinema Drive and directly under an electric utility easement. The challenges of this location are clear, but what if we could turn it into a high quality, connected development that provides commercial, mixed use, and residential purchase and lease opportunities? With providing an open water amenity next to activated public space creates a beautiful frontage opportunity for residential units. By providing public space along the entire waterway it now becomes an amenity to the entire development rather than the few that purchase property along it. This amenity will also showcase various storm water management techniques such as riparian buffer zones, large-scale bioswales with natural overflow drainage, restored wetlands, among others.

IMPLEMENTATION RECOMMENDATIONS for STUDY AREA

Structural BMPs

The descriptions of the Best Management Practices below are provided by The Low Impact Development Manual for Michigan. *http://www.swmpc.org/downloads/lidmanual.pdf*

Bioretention (Rain Garden): a method of managing stormwater by pooling water within a planting area and allowing the water to infiltrate the garden. They are shallow surface depressions planted with specially selected native vegetation to capture and treat stormwater runoff from impervious surfaces such as rooftops, streets and parking lots. In addition to managing runoff volume and reducing peak discharge rates, this process filters suspended solids and related pollutants from stormwater runoff.

Bioretention vegetation serves to filter (water quality) and transpire (water quantity) runoff, and enhance infiltration and groundwater recharge. Plants absorb pollutants while microbes associated with the plant roots and soil break them down. The soil medium filters out pollutants and allows storage and infiltrations of stormwater runoff, providing volume control. Bioretention can also control water volume, enhance site aesthetics and habitat as well as potential air quality and climate benefits. Depending on varying site conditions, bioretention can be designed to allow for complete infiltration, infiltration/filtration, and filtration.

Properly designed and installed bioretention areas require some regular maintenance, most occurring within the first year or two of establishment. Bioretention areas can decrease the cost for stormwater conveyance system on site; cost range is approximately $5-7/CF of storage to construct.

Benefits:

- Volume control and groundwater recharge
- Moderate peak rate control
- Filtration
- Versatile with broad applicability
- Enhance site aesthetics and habitat
- Potential air quality and climate benefits

Cost:

- Low/Med and Med. Adds less than 1% or up to 5% to total project cost
- Requires maintenance one to several times per year

Capture Reuse (Rain Barrel, Cistern, Manufactured Product): structures designed to intercept and store runoff from rooftops allow for its reuse, reducing volume and overall water quality impairment. Stormwater is contained in the structures and typically reused for irrigation or other water needs.

Typically, cisterns are used to supplement greywater needs (i.e., toilet flushing, or some other sanitary sewer use) though they can also be used for irrigation. Cisterns may be comprised of fiberglass, concrete, plastic, brick, or other materials and can be located either above or below ground. The storage capacity of cisterns can

range from 200 gallons to 10,000 gallons. Very large cisterns, essentially constructed like an underground parking level, can also be used.

Maintenance of cisterns includes flushing cisterns annually to remove sediment, brushing the inside of surfaces and thoroughly disinfect twice per year, and to avoid damage, drain container prior to winter, so that water is not allowed to freeze in devices. Cisterns are assumed to have a life span of 25 years; the cost range varies by manufacturer and material.

Benefits:

- Provides supplemental water supply
- Wide applicability reduces potable water use
- Related cost savings and environmental benefits

Cost:

- Low/Med and Low/Med/High. Adds less than 1% or more than 5% to total project cost depending on chosen structure
- Requires maintenance once per year or extensive maintenance (i.e., year-round maintenance) depending on chosen structure.

Pervious Pavement with Infiltration: an infiltration technique that combines stormwater infiltration, storage, and structural pavement consisting of a permeable surface underdrain by a storage reservoir.

A pervious pavement system consists of a porous surface course underlain by a storage reservoir placed on uncompacted subgrade to facilitate stormwater infiltration. The storage reservoir may consist of a stone bed of uniformly graded, clean, and washed course aggregate with a void space of approximately 40 percent or other pre-manufactured structural storage units. The pavement may consist of porous asphalt, pervious concrete, permeable paver blocks, or reinforced turf/gravel. Stormwater drains through the surface course where it is temporarily held in the voids of the stone bed, and then slowly infiltrates into the underlying, uncompacted soil mantle. When properly designed, pervious pavement systems provide effective management of stormwater volume and peak rates. The storage reservoir below the pavement surface can be sized to manage both direct runoff and runoff generated by adjacent areas, such as rooftops.

Properly installed and maintained pervious pavement has a significant life span. For example, existing systems that are more than 20 years old continue to function successfully. Because water drains through the surface course and into the subsurface bed, freeze/thaw cycles do not tend to adversely affect pervious pavement. The cost of pervious pavement has a range of pricing based on the selected material. Porous asphalt, with additives, is generally 15-25% higher in cost than standard asphalt on a unit area basis. Unit costs for pervious asphalt (without infiltration bed) range from about $4/SF to $5/SF. Pervious concrete as a material is generally more expensive than asphalt and requires more labor and expertise to install. Unit cost of a six-inch-thick pervious concrete (without infiltration bed) section is about $4/SF to $6/SF. Permeable paver blocks vary in cost depending on type and manufacturer.

Benefits:

- Volume control and groundwater recharge
- Moderate peak rate control
- Dual use for pavement and stormwater management

Cost:

- Med and High. Adds 1-5% to total project cost
- Requires extensive maintenance (i.e., year-round maintenance)

Riparian Buffer Restoration: area of land that exists between low, aquatic areas such as rivers, streams, lakes, and wetlands, and higher, dry upland areas such as forests, farms, cities, and suburbs.

A riparian buffer is a permanent restoration area of trees, shrubs, and herbaceous vegetation adjacent to a waterbody that serves to protect water quality and provide critical wildlife habitat. A riparian buffer can be designed to intercept surface runoff and subsurface flow from upland sources for the purpose of removing or buffering the effects of associated nutrients, sediment, organic matter, pesticides, or other pollutants prior to entry into surface waters and groundwater recharge areas. An effective riparian buffer restoration project should include stewardship guidelines to manage and maintain the site in perpetuity. The most critical period of riparian buffer establishment is canopy closure, which is typically the first three to five years after saplings are planted. Buffer boundaries should be well defined with clear signs or markers. During this time, the riparian buffer should be monitored four times annually (February, May, August, and November are recommended) and inspected after any severe storm. Maintenance measures that should be performed regularly include watering, mulching, weed and invasive plan control, and stable debris.

Installing a riparian buffer involves site preparation, planting, second-year reinforcement planting, and additional maintenance. Costs may fluctuate based on numerous variables including whether or not volunteer labor is used, and whether plantings and other supplies are donated or provided at a reduced cost.

Benefits:

- Water quality
- Ecological
- Aesthetic value, and low cost

Cost:

- Low/Med and Low. Adds less than 1% or up to 5% to total project cost
- Requires maintenance one time per year

Vegetated Roof: conventional rooftops that include a thin covering of vegetation allowing the roof to function more like a vegetated surface. Vegetated roofs involve growing plants on rooftops, thus replacing the vegetated footprint that was removed when the building was constructed. Vegetated roof covers are an "at source" measure for reducing the rate and volume of runoff released during rainfall events. The water retention and detention properties of vegetated roof covers can be enhanced through selection of the engineered media and plants. Depending on the plant material and planned usage for the roof area, modern vegetated roofs can be categorized as systems that are intensive, semi-intensive, or extensive.

Establishing plant material on rooftops provides numerous ecological and economic benefits including stormwater management, energy conservation, mitigation of the urban heat island effect, increased longevity of roofing membranes, as well as providing a more aesthetically pleasing environment to work and live. Direct

runoff from roofs is a contributor to pollutants in stormwater runoff. Vegetated roof covers can significantly reduce this source of pollution

Basic maintenance for extensive vegetated covers typically requires about 2-3 person-hours per 1,000 square feet, annually. Irrigation will be required as necessary during the plant establishment period and in times of drought. During the plant establishment period, 3-4 visits to conduct basic weeding, fertilization, and infill planting is recommended. The soluble nitrogen content (nitrate plus ammonium ion) of the soil should be adjusted to between 1-5 parts per million, based on soil test. Once plants are established, it is crucial to maintain the roof 1-2 times per year. Weeds and other unwanted plants on the entire roof, at the perimeters and at the upstands need to be removed. For grass and herb vegetation the organic buildup has to be removed once a year. Intensive vegetated roofs require higher maintenance and service throughout the year.

The construction cost of vegetated roof covers varies greatly, depending on factors such as: height of building, accessibility to the structure by large equipment such as cranes and trailers, depth and complexity of the assembly, remoteness of the project from sources of material supply, and size of the project. However, under 2007 market conditions (the time of original assessment), extensive vegetated covers for roof will typically range between $8 and $16 per square foot, including design, installation, and warranty service (not including waterproofing). Although vegetated roofs are relatively expensive compared to other BMP's in terms of stormwater management, they can have significant benefits which serve to reduce their life-cycle costs. For example, the longevity of the roof system maybe greatly increased. In addition, heating and cooling costs can be significantly reduced.

Benefits:

- Good stormwater volume control
- Heating and cooling energy benefits
- Increased lifespan of roof, heat island reduction
- Enhanced habitat value

Cost:

- High and Med. Adds more than 5% to total project cost
- Requires maintenance several times per year.

Vegetated Swale: a shallow storm water channel that is densely planted with a variety of grasses, shrubs, and/or trees designed to slow, filter, and infiltrate storm water runoff. Vegetated swales are broad, shallow, earthen channels designed to slow runoff, promote infiltration, and filter pollutants and sediments in the process of conveying runoff. Water is filtered through the soil to under drains and the swale is quickly dewatered, preventing standing water. Vegetated swales are an excellent alternative to conventional curb and gutter conveyance systems, because they provide pretreatment and can distribute stormwater flows to subsequent BMPs.

Maintenance of a vegetative swales includes the following: Irrigation will be necessary during plant establishment and may be needed in periods of little rain or drought. Vegetation should be established as soon as possible to prevent erosion and scour. Stabilize freshly seeded swales with appropriate temporary or permanent soil stabilization methods, such as erosion control matting or blankets. Erosion control for seeded swales should be required for at least the first 75 days following the first storm event after planting. If runoff velocities are high, consider sodding the swale or diverting runoff until vegetation is fully established. Annually

inspect and correct erosion problems, damage to vegetation, and sediment and debris accumulation. Annually mow and trim vegetation to ensure safety, aesthetics, proper swale operation, or to suppress weeds and invasive vegetation. Dispose of cuttings in a local composting facility; mow only when swale is dry to avoid rutting. Annually inspect for uniformity in cross-section and longitudinal slope; correct as needed. Inspect and correctly check dams when signs of altered water flow (channelization, obstructions, etc.) are identified.

Vegetated swales provide a cost-effective alternative to traditional curbs and gutters, including associated underground storm sewers. Cost can range from $4.50-$8.50 per linear foot for seeded swales and $15-$20 per linear foot for sodded swales

Benefits:

- Can replace curb and gutter for site drainage
- Significant cost savings
- Water quality
- Peak volume control with infiltration

Cost:

- Low/Med. Adds less than 1% or up to 5% to total project cost.
- Requires maintenance once to several times per year

PRIORITIZATION FOR IMPLEMENTATION

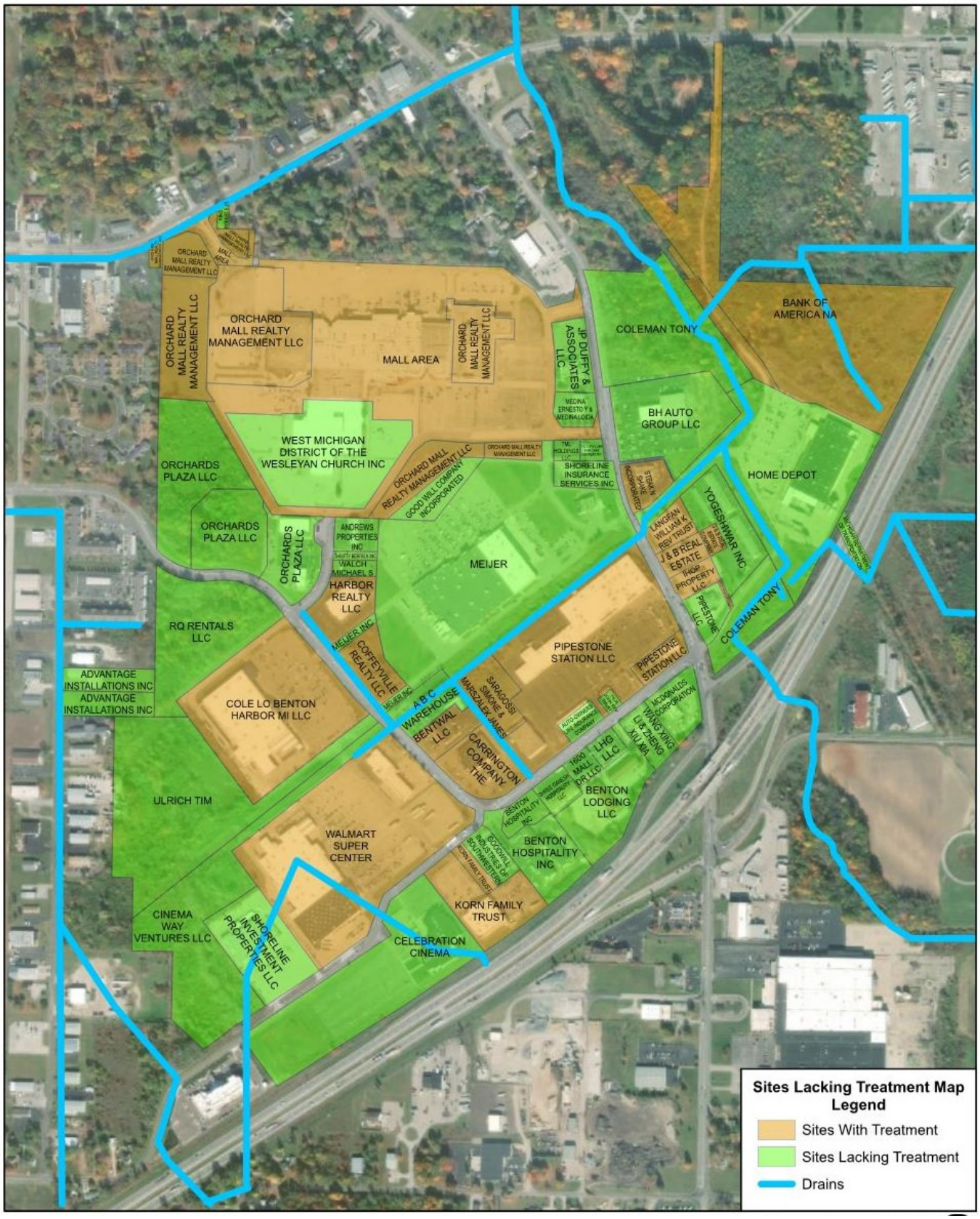
Identification of BMP Locations

A list of the most important site characteristics was compiled to determine which sites held the highest suitability for Green Infrastructure BMPS. These site characteristics were determined to be sites lacking treatment, sites with a high site percent imperviousness, and close proximity to the Yore & Stoeffer Drain. These maps can be seen on the following pages.

Sites Lacking Treatment Map

The study area was analyzed and sites within the area were researched to determine which are currently treating stormwater runoff before it enters the Yore & Stoeffer Drain and ultimately Ox Creek. This map shows the sites which currently have some type of stormwater treatment on site in yellow. The sites which do not currently have any water treatment are shown in green.

Figure 19. Sites Lacking Treatment Map



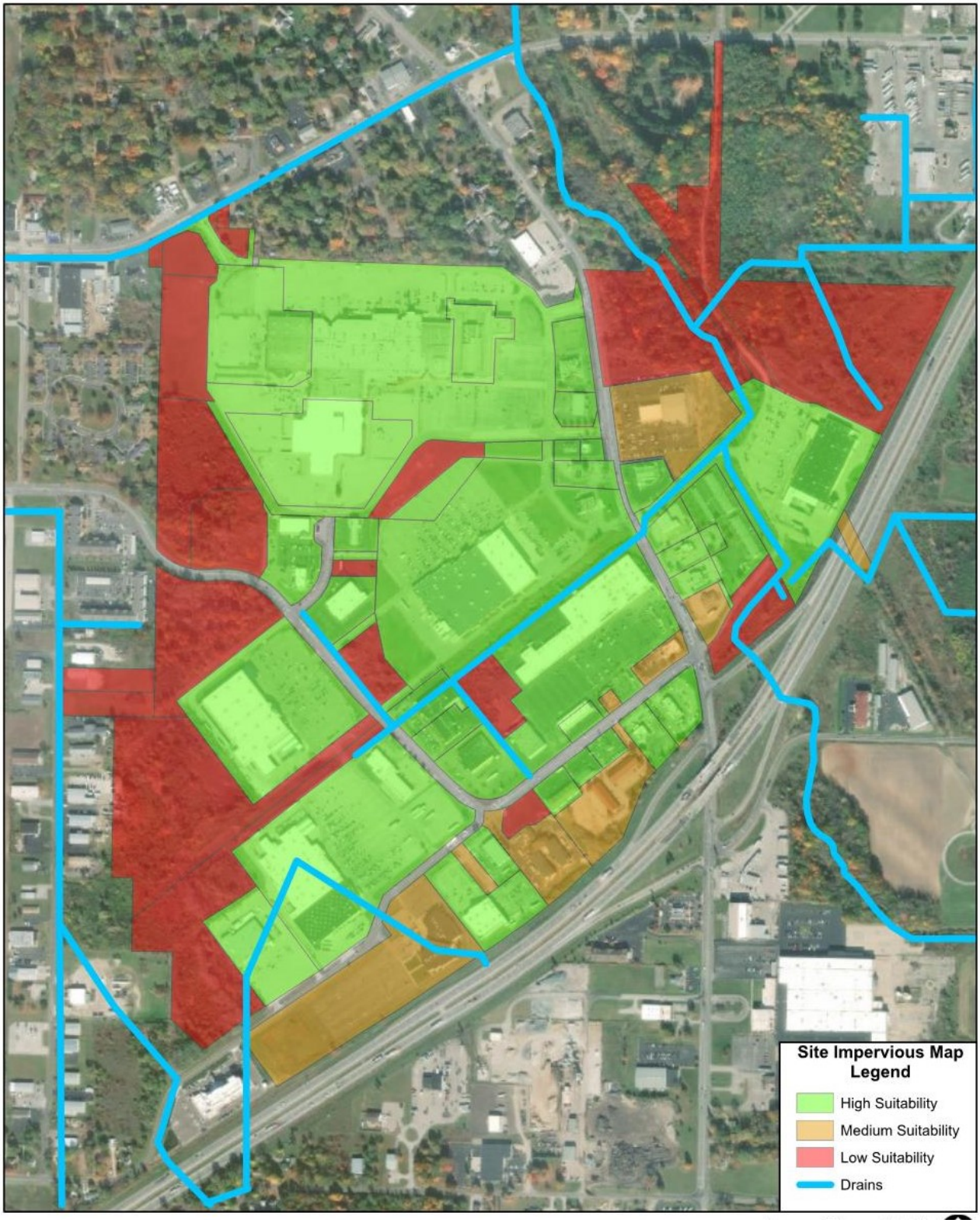
Site Impervious Map

Aerial images were used to identify areas within the subwatershed that are covered by pavement, buildings, or other features that are impervious surfaces and prevent runoff from entering the soil. The percent of each parcel's impervious surface compared to the total parcel size was calculated.

Parcels that have high impervious cover are considered highly suitable for BMP siting due to the large amount of water leaving the site without being cleaned before entering Ox Creek and its tributaries. Parcels with less impervious cover are considered less suitable for BMP siting due to more water being infiltrated or cleaned naturally before entering Ox Creek and its tributaries.

Green shows the parcels which have the highest suitability for locating BMPs (parcels with 66-100% impervious surface), orange shows the parcels which have medium suitably for locating BMPs (parcels with 33-66% impervious surface) and red shows the parcels which have the lowest suitability for locating BMPs (parcels with 0-33% impervious surface).

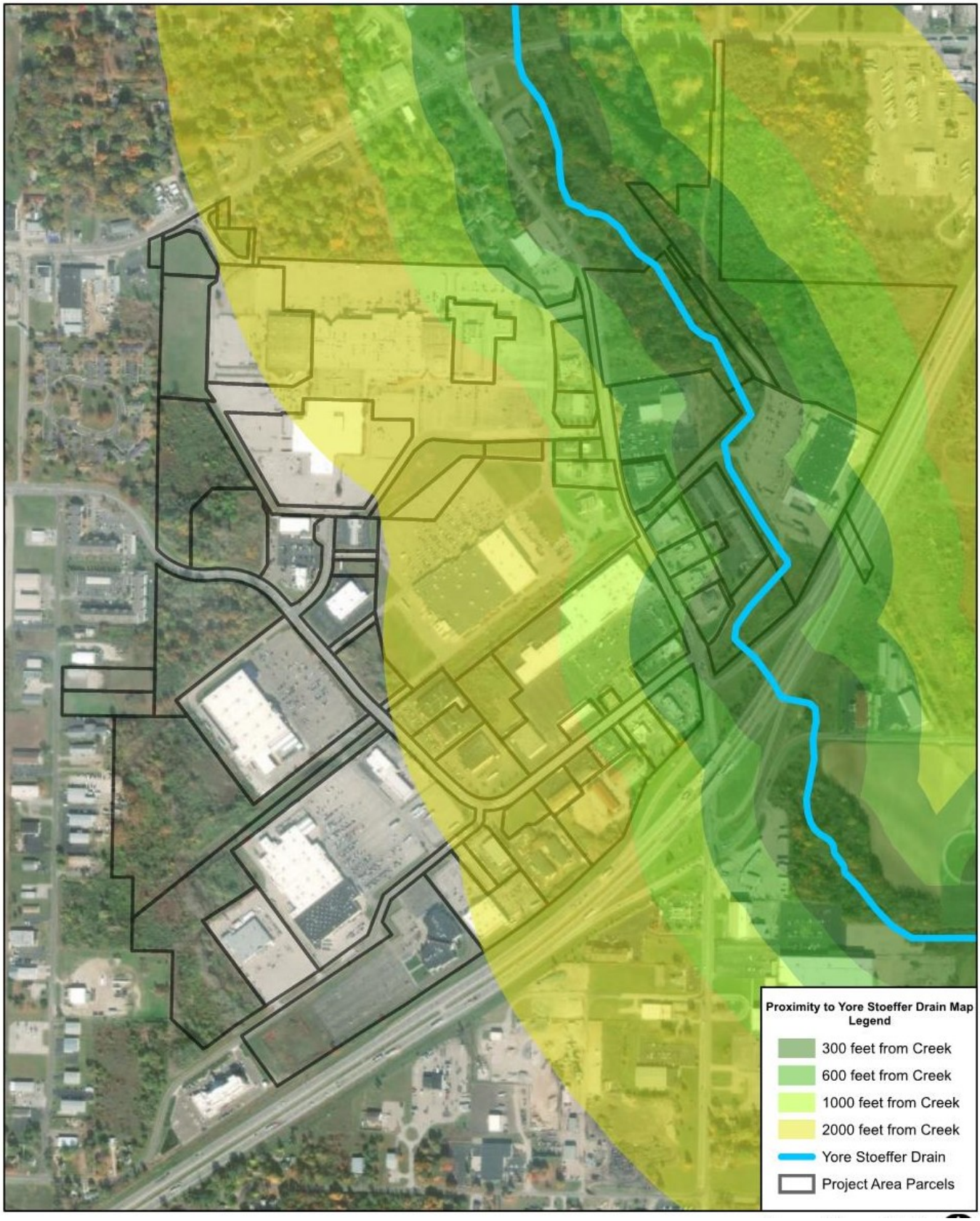
Figure 20. Site Impervious Map



Proximity to Yore & Stoeffer Drain Map

A buffer map was created to show the sites that are closest to the Yore & Stoeffer Drain. The yellow shows sites that are 2000' from the drain, light green shows sites that are 1000' from the drain, darker green shows sites that are 600'-300' from the drain. Sites that are closer to the drain are considered a higher priority because they have less physical space to clean the runoff water before it enters the drain.

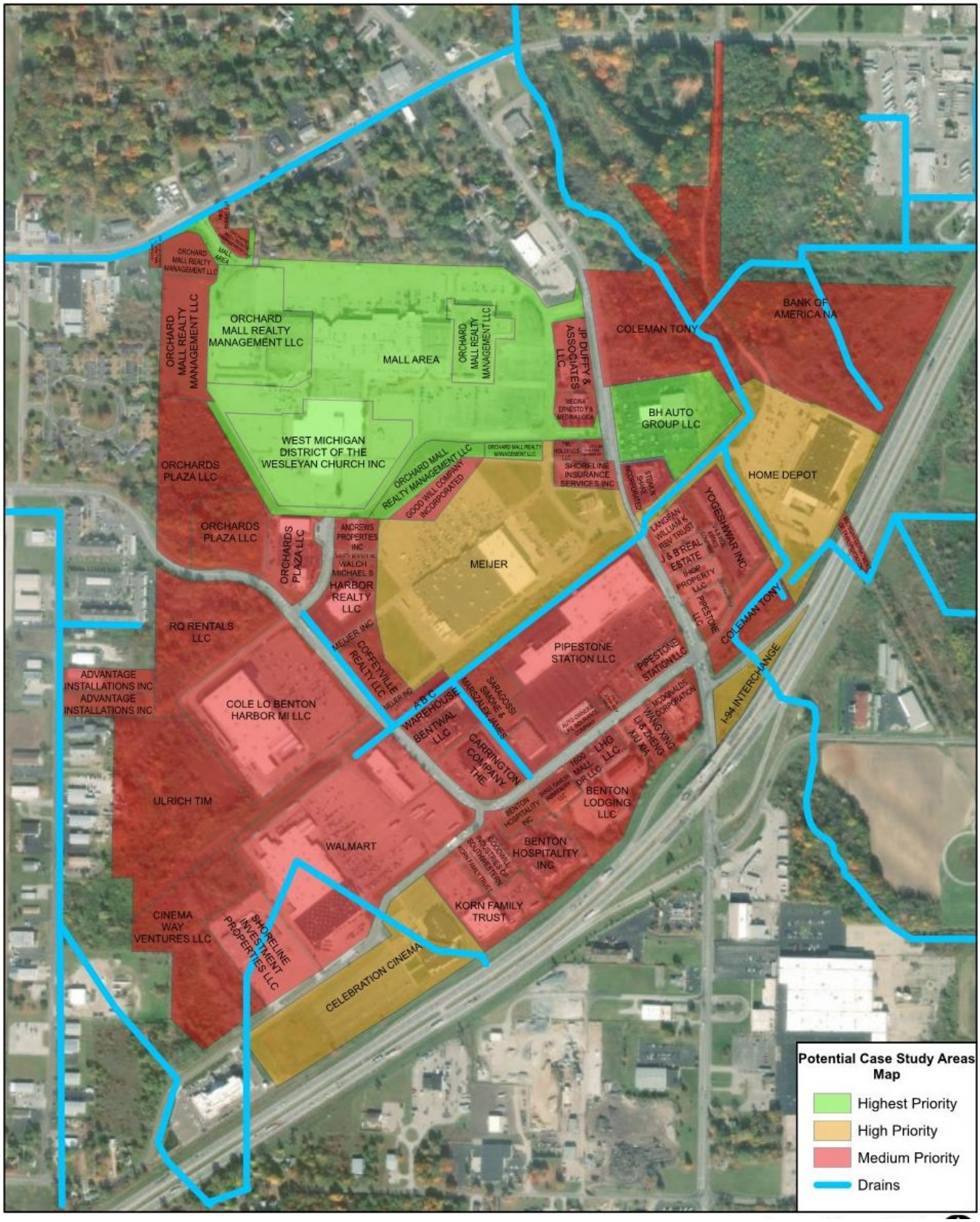
Figure 21. Proximity to Yore & Stoeffer Drain Map



Potential Implementation Areas Map

The potential implementation areas map was created to identify prioritization for implementation. High priority sites are shown in green and medium priority sites are shown in orange. This map is a combination of all previous maps to help choose the best places to site BMPs.

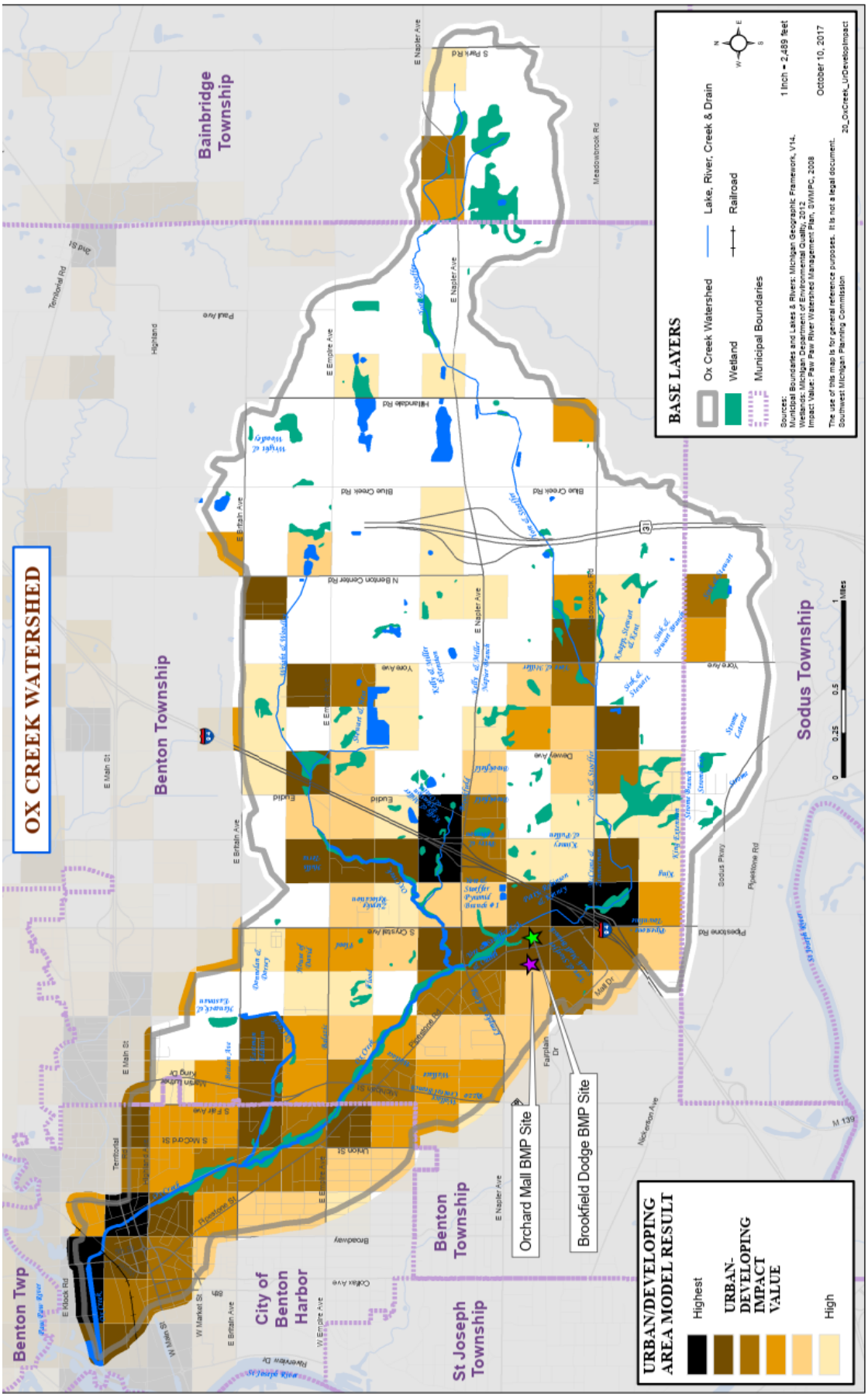
Figure 22. Potential Implementation Areas Map



HIGHEST PRIORITY RECOMMENDATIONS

The Brookfield Dodge and Orchards Mall site are the highest priority sites for implementation. For the cost/benefit evaluation: between these two sites, 54,600 SF of parking will be eliminated and the first flush from 44 acres will be treated. The total expected pollutant reduction from the BMP practices is 48,708 lbs/year of TSS, 345 lbs/year of Total Nitrogen and 27 lbs/year of Total Phosphorus. The total implementation costs are expected to be $1,000,000 which equates to $2,898 per pound of TSS reduction.

Figure 23. Urban/Developing Area Modeling Map



Brookfield Dodge LID BMP Treatment Train

Brookfield Dodge is located at 1845 Pipestone Road in Benton Harbor, the site is approximately 14 acres in size with approximately 290 parking stalls. The site is 64% impervious and 36% pervious.

The recommended BMPs for Brookfield Dodge are: bioretention (rain garden), capture reuse (cistern), pervious pavement with infiltration, riparian buffer restoration, vegetated roof, and vegetated swale. After meetings and discussions with Don Brookfield, economic and aesthetic constraints led to the recommended BMPs to be reduced to removing 8,000 SF of pavement and constructing four bioretention areas (rain gardens) and a vegetated swale.

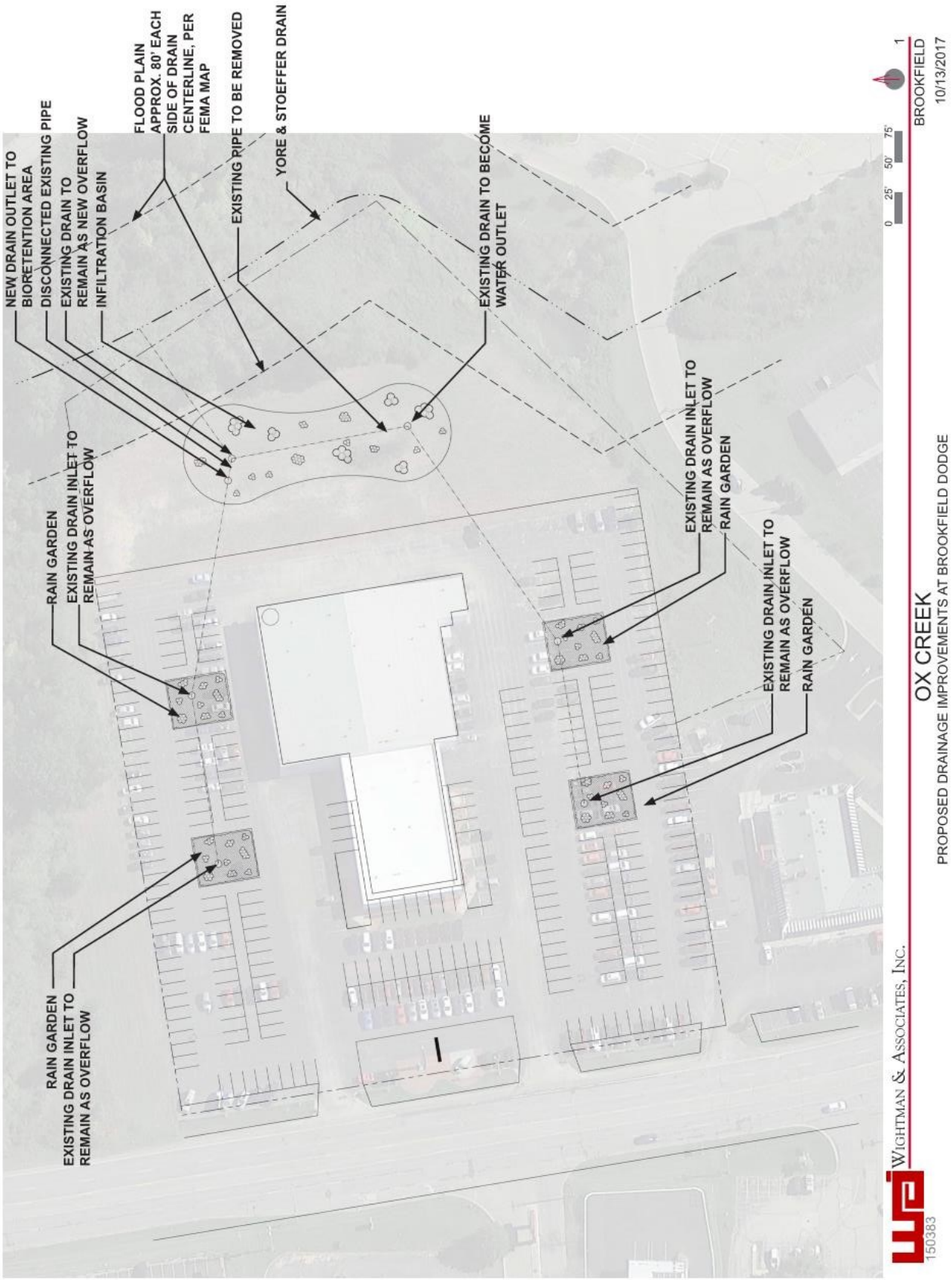
This project will remove 8,000 SF of pavement to install four bio retention areas (rain gardens) that will treat four acres of parking lot runoff and rooftop. Construct one 14,200 SF infiltration basin at the rear of the property along the Yore & Stoeffer Drain. The addition of the BMPs reduced the amount of impervious surface on the site by 2% and reduced the number of parking stalls by 13%. The expected implementation cost is $250,000 not including engineering.

Table 6. Bioretention and Infiltration Loads – Brookfield Dodge

	BIORETENTION			Infiltration Basin		
	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	378.6	U	U	378.6	U	U
COD	2,715.9	U	U	2,715.9	950.6	1,765.3
TSS	5,389	2,209	3,179	5,389	1,347	4,042
LEAD	4.6	U	U	4.6	1.6	3.0
COPPER	0.9	0.0	0.9	0.9	U	U
ZINC	7.2	0.4	6.9	7.2	2.5	4.7
TDS	14,718.8	U	U	14,718.8	U	U
TN	94.5	48.2	46.3	94.5	37.8	56.7
TKN	34.5	U	U	34.5	U	U
DP	3.2	U	U	3.2	U	U
TP	6.1	2.1	4.0	6.1	2.1	4.0
CADMIUM	0.0	U	U	0.0	U	U

Note: U=undetected

Figure 24. Proposed Drainage Improvements – Brookfield Dodge



Orchards Mall LID BMP Treatment Train

The study area of Orchards Mall is located at 1800 Pipestone Road in Benton Harbor; the area within the site is approximately 30 acres in size with approximately 624 parking stalls. The site is 92% impervious and 8% pervious.

The recommended BMPs for The Orchards Mall area are: oil/grit separator, dry detention, and grass swales.

The addition of the BMPs reduced the amount of impervious surface on the site area by 60% and reduced the number of parking stalls by 42%.

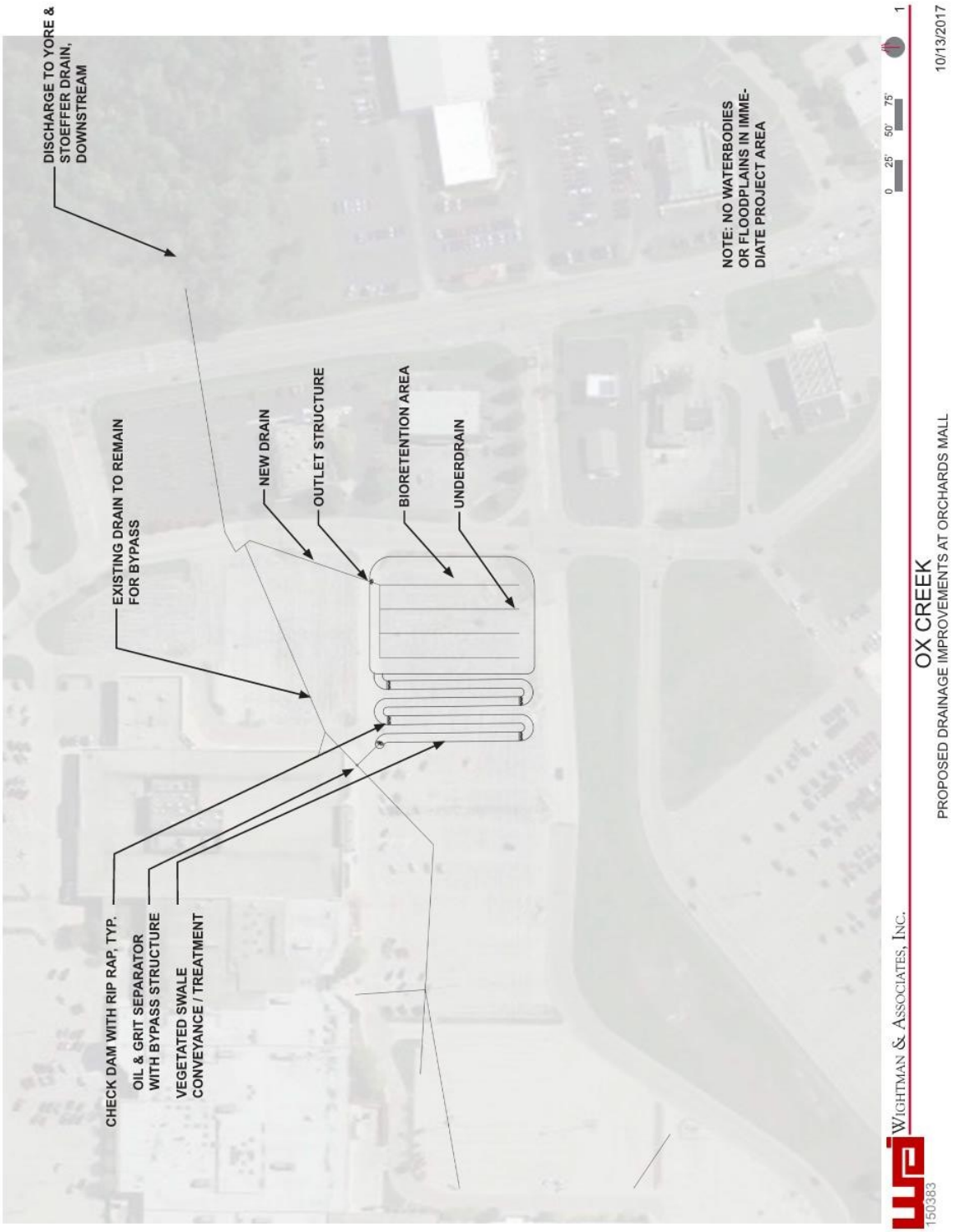
Install an oil/grit separator and replace a 46,000 SF of parking lot area with 11,200 SF of vegetated swales and 35,400 SF dry detention basin area to intercept stormwater and treat the first flush from 26 acres of parking lot and rooftop. The implementation cost is expected to be $750,000 not including engineering costs.

Table 7. Oil/Grit Separator, Dry Detention, and Grass Swales Loads – Orchards Mall

	Oil/Grit Seperator			Dry Detention			Grass Swale		
	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	2,173.5	U	U	2,173.5	1,586.6	586.8	2,173.5	1,521.4	652.0
COD	15,060.7	14,307.7	753.0	15,060.7	12,048.6	3,012.1	15,060.7	11,295.5	3,765.2
TSS	30,173	25,647	4,526	30,173	12,823	17,349	30,173	10,560	19,612
LEAD	26.3	22.4	4.0	26.3	13.2	13.2	26.3	7.9	18.4
COPPER	5.1	U	U	5.1	U	U	5.1	2.6	2.6
ZINC	40.9	38.9	2.0	40.9	32.7	8.2	40.9	16.4	24.5
TDS	72,363.1	U	U	72,363.1	U	U	72,363.1	U	U
TN	537.0	510.1	26.8	537.0	375.9	161.1	537.0	483.3	53.7
TKN	176.4	U	U	176.4	U	U	176.4	U	U
DP	17.6	U	U	17.6	U	U	17.6	U	U
TP	33.2	31.6	1.7	33.2	24.6	8.6	33.2	24.9	8.3
CADMIUM	0.2	U	U	0.2	U	U	0.2	0.1	0.1

Note: U=undetected

Figure 25. Proposed Drainage Improvements – Orchards Mall



SECOND HIGHEST PRIORITY SITES

I-94/Pipestone Interchange/Pipestone Corridor

The I-94/Pipestone Interchange is located at between the I-94 westbound off-ramp and Pipestone Road in Benton Harbor; the site is approximately 3 acres in size. The design for this area is still in progress with Michigan Department of Transportation, the Berrien County Drain Commissioner and Berrien County Road Department.

Figure 26. Planting Zone Descriptions – I-94/Pipestone Interchange/Pipestone Corridor

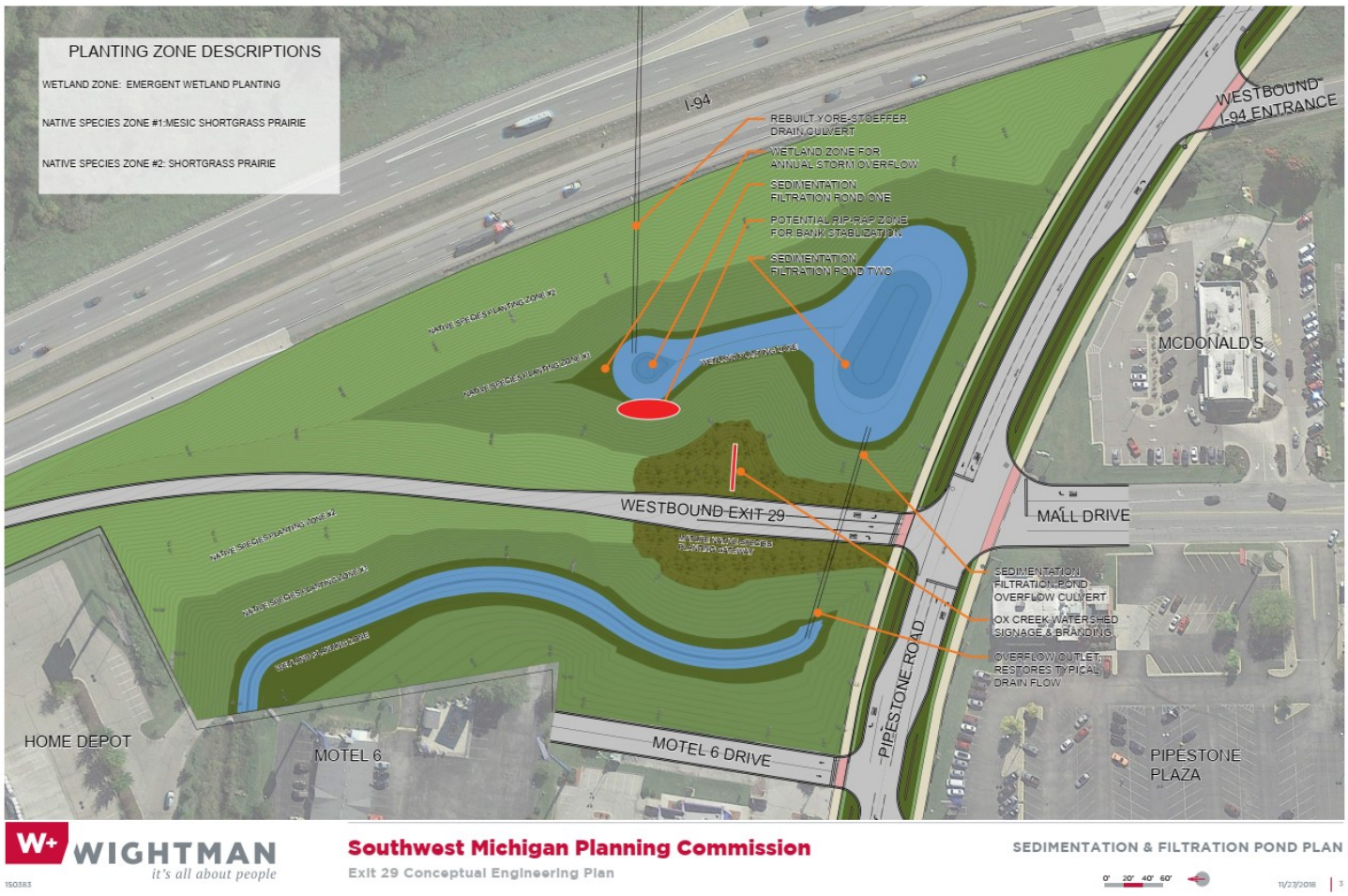


Figure 27. Pipestone Road – Infiltration Basin, Preliminary Estimate

PRELIMINARY ESTIMATE

PROJECT: **Pipestone Road - Infiltration Basin**

CLIENT: **Client Name**

DATE: November 27, 2018

This project will consist of the construction of a stormwater extended detention basin. Work will include the replacement of the culvert under I-94, installation of a culvert under the new off-ramp, earthwork to construct a new detention basin, reshaping of Ox Creek north of the off-ramp, placement of wetland plantings in the pond bottom and restoration of the side slopes with native vegetation.

1	L.S.	Mobilization, Max 10%	@	50,000.00	50,000.00
66,000	CYD	Excavation, Earth	@	3.25	214,500.00
50,000	CYD	Embankment	@	3.75	187,500.00
400	LFT	Culvert, 15'x9' Arch Pipe	@	425.00	170,000.00
250	LFT	Culvert, 12' x 8' Arch	@	350.00	87,500.00
1	L.S.	Outlet Control Structure	@	10,000.00	10,000.00
1	L.S.	Wetland Plantings (Pond Bottoms)	@	75,000.00	75,000.00
1	L.S.	Gateway Landscaping and Native Plantings	@	100,000.00	100,000.00
41,000	SYD	Native Plantings (slopes outside of pond bottom)	@	3.00	123,000.00
		SUBTOTAL ESTIMATED CONSTRUCTION COST			$ 1,017,500.00
		Construction Contingency		10%	101,800.00
		Design Engineering		9%	91,600.00
		Construction Engineering		12%	122,100.00
		TOTAL ESTIMATED PROJECT COST			**$ 1,333,000.00**

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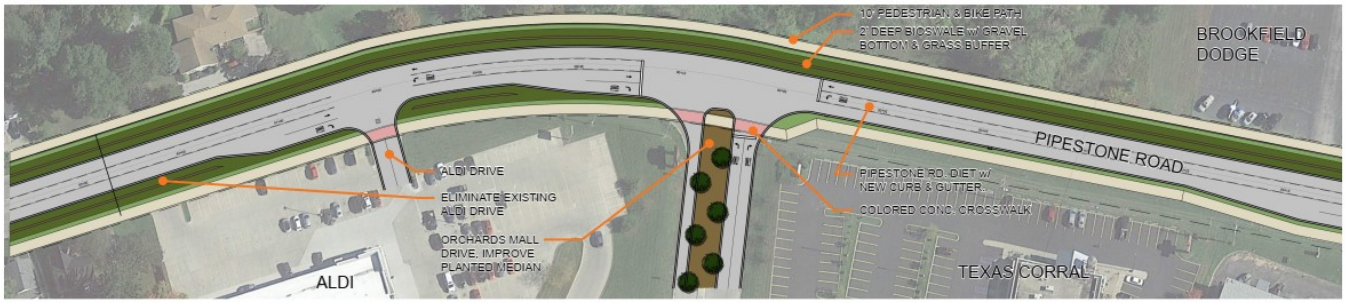
Figure 28. Pipestone Road – Bio-Swale Capacities



PIPESTONE ROAD RIGHT-OF-WAY
STORMWATER VOLUMES @ 1" OF RAIN

EXISTING ROAD DESIGN:	388,798 in/ft =	32,400 cft
PROPOSED ROAD DESIGN:	260,997 in/ft =	21,750 cft
TOTAL REDUCTION:		- 10,650 cft

PIPESTONE ROAD BIO-SWALE CAPACITIES

NORTHBOUND:	36,400 ft
SOUTHBOUND:	31,680 cft
TOTAL CAPACITY:	68,080 cft*

*ALMOST A 25 YEAR STORM

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150383

Southwest Michigan Planning Commission
Exit 29 Conceptual Engineering Plan

Pipestone Road Diet Plan
0' 20' 40' 60'
11/27/2018 | 1

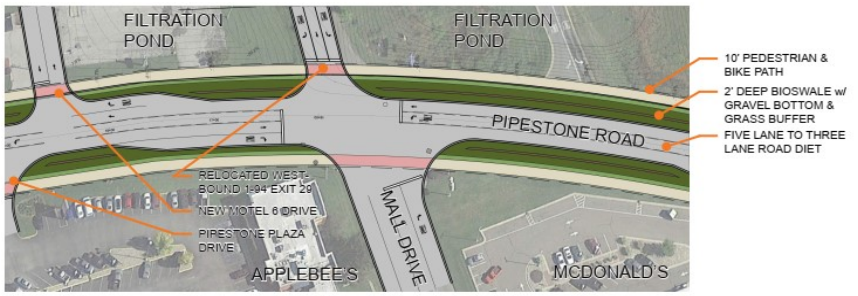

Figure 29. Pipestone Road Corridor Improvement – Preliminary Estimate

PRELIMINARY ESTIMATE

PROJECT: **Pipestone Road Corridor Improvements**

CLIENT: **Client Name**

DATE: November 14, 2018

The project would reconstruct Pipestone Road from Meadwobrook Road to the north driveway of Aldi, which is approx. 0.80 miles. The roadway would be reduced from 5-lanes to 3-lanes, with a two-way center left turn lane. The roadsurface will be 33 ft wide road with curb and gutter on each side and a 10 ft wide non-motorized pathway on each side of the roadway. The pavement section would consist of 8" of aggregate base, 4" of HMA, 4E3 (base/leveling), and 2" of HMA, 5E3 wearing surface. Also included in this estimate is a bioswale, misc signal modifications, pavement markings, traffic control and miscellaneous signage. Utility work (sewer, water, electric) is not included with the scope of this estimate.

1	L.S.	Mobilization, Max 10%	@	180,000.00	180,000.00
10,800	LFT	Curb and Gutter, Rem	@	5.00	54,000.00
200	SYD	Pavt, Rem	@	8.00	1,600.00
18,760	CYD	Excavation (Roadway)	@	4.00	75,040.00
5,000	CYD	Embankment	@	4.00	20,000.00
1,000	CYD	Subgrade Undercutting	@	15.00	15,000.00
9,415	CYD	Subbase, CIP	@	7.00	65,905.00
24,050	SYD	Aggregate Base 8"	@	6.25	150,312.50
6	EA	Dr Structure, 24 inch dia	@	1,500.00	9,000.00
14	EA	Dr Structure, 48 inch dia	@	2,000.00	28,000.00
700	LFT	Sewer, Cl E, 12 inch, Tr Det B	@	35.00	24,500.00
14	EA	Dr Structure Cover, Type (Beehive)	@	550.00	7,700.00
6	EA	Dr Structure Cover, Type K	@	750.00	4,500.00
5,330	TON	HMA, 4E3	@	65.00	346,450.00
2,675	TON	HMA, 5E3	@	70.00	187,250.00
29,100	SYD	HMA Surface, Rem	@	3.25	94,575.00
400	LFT	Driveway Opening, Conc, Det M	@	22.00	8,800.00
10,290	LFT	Curb and Gutter, Conc, Det C4	@	23.00	236,670.00
340	LFT	Spillway, Conc	@	45.00	15,300.00
450	LFT	Curb Ramp Opening	@	23.00	10,350.00
340	LFT	Detectable Warning Surface	@	50.00	17,000.00
5,100	SFT	Sidewalk Ramp, 6 inch	@	7.25	36,975.00
7,500	LFT	Shared Use Path, Grading	@	10.00	75,000.00
8,280	SFT	Shared Use Path, Concrete	@	30.00	248,400.00
1	L.S.	Permanent Signage	@	7,500.00	7,500.00
1	L.S.	Traffic Signal Modifications	@	15,000.00	15,000.00
13,125	LFT	Pavement Marking, 4" Yellow	@	0.50	6,562.50
1,200	LFT	Pavement Marking, 4" White	@	0.50	600.00
1,800	LFT	Pavement Marking, Stop Bars and Cross walks	@	8.00	14,400.00
40	EA	Pavement Marking, Arrow Symbols	@	150.00	6,000.00
1	L.S.	Trafic Control	@	25,000.00	25,000.00
4,000	LFT	Bioswale Grading	@	8.00	32,000.00

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PRELIMINARY ESTIMATE

40,000	SFT	Bioswale Vegetation/Plantings	@	2.50	100,000.00
75	STA	Restoration	@	400.00	30,000.00
		SUBTOTAL ESTIMATED CONSTRUCTION COST			$ 2,149,390.00
		Construction Contingency		10%	215,110.00
		Design Engineering		9%	193,500.00
		Construction Engineering		12%	258,000.00
		TOTAL ESTIMATED PROJECT COST			**$ 2,816,000.00**

Meijer

Meijer is located at 1920 Pipestone Road in Benton Harbor; the site is approximately 27 acres in size with approximately 940 parking stalls. The site is 67% impervious and 33% pervious.

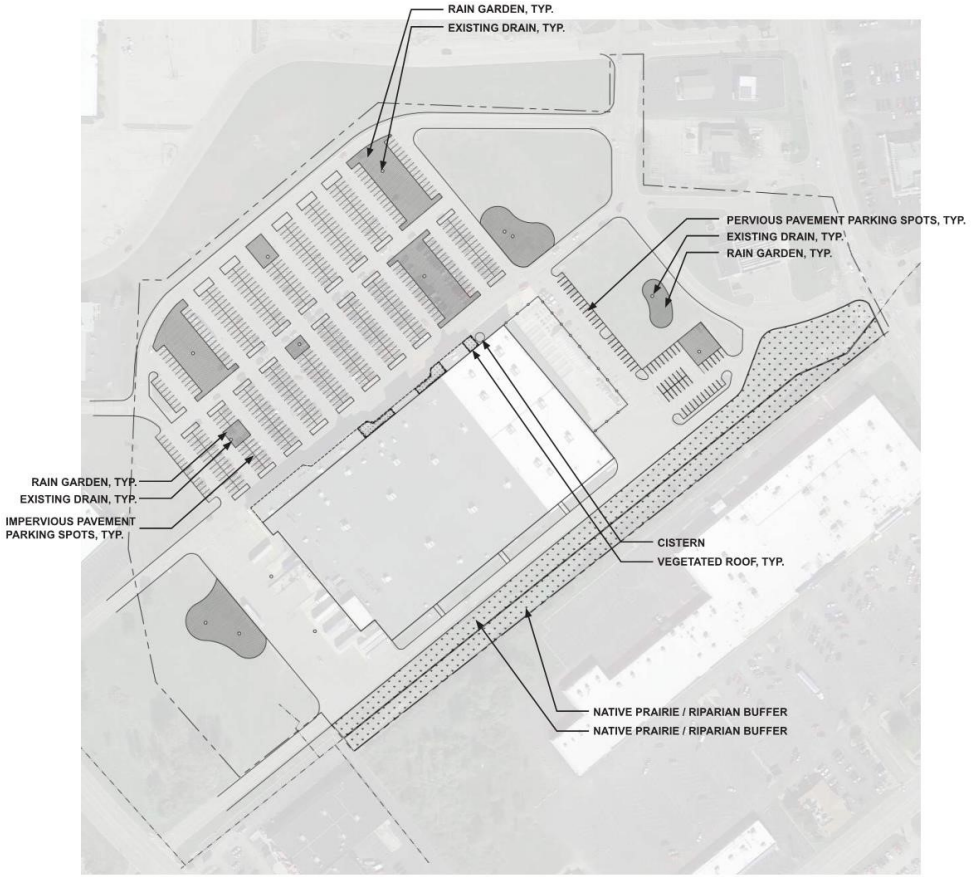
The recommended BMPs for Meijer are: bioretention (rain garden), capture reuse (cistern), pervious pavement with infiltration, riparian buffer restoration, vegetated roof, and vegetated swale.

The addition of the BMPs reduced the amount of impervious surface on the site by 7% and reduced the number of parking stalls by 43%.

Table 8. Green Roof, Bioretention, Pervious Pavement Loads – Meijer

	GREEN ROOF	BIORETENTION			PERVIOUS PAVEMENT		
	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	80	1,491.8	U	U	233.8	U	U
COD	555	10,337.0	U	U	1,619.8	324.0	1,295.8
TSS	1,111	20,709	8,491	12,218	3,245	325	2,921
LEAD	1	18.1	U	U	2.8	0.0	2.8
COPPER	0	3.5	0.1	3.4	0.6	U	U
ZINC	1	28.1	1.4	26.7	4.4	0.0	4.4
TDS	2,670	49,666.5	U	U	7,782.5	U	U
TN	19	368.6	188.0	180.6	57.8	8.7	49.1
TKN	7	121.1	U	U	19.0	U	U
DP	1	12.1	U	U	1.9	U	U
TP	1	22.8	8.0	14.8	3.6	1.3	2.3
CADMIUM	0	0.1	U	U	0.0	U	U

Note: U=undetected



TYPES OF STRUCTURAL BEST MANAGEMENT PRACTICES:

BIORETENTION (RAIN GARDEN): SHALLOW SURFACE DEPRESSIONS PLANTED WITH SPECIALLY SELECTED NATIVE VEGETATION TO CAPTURE AND TREAT STORM WATER RUNOFF FROM ROOFTOPS, STREETS, AND PARKING LOTS.
BENEFITS:
- VOLUME CONTROL AND GROUNDWATER RECHARGE,
- MODERATE PEAK RATE CONTROL,
- FILTRATION,
- VERSATILE WITH BROAD APPLICABILITY,
- ENHANCE SITE AESTHETICS AND HABITAT,
- AND POTENTIAL AIR QUALITY AND CLIMATE BENEFITS.

COST:
- LOW/MED & LOW/MED. ADDS LESS THAN 1% OR UP TO 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE - SEVERAL TIMES PER YEAR

CAPTURE REUSE (RAIN BARREL, CISTERN, MANUFACTURED PRODUCT): STRUCTURES DESIGNED TO INTERCEPT AND STORE RUNOFF FROM ROOFTOPS ALLOW FOR ITS REUSE, REDUCING VOLUME AND OVERALL WATER QUALITY IMPAIRMENT.
BENEFITS:
- PROVIDES SUPPLEMENTAL WATER SUPPLY,
- WIDE APPLICABILITY, REDUCES POTABLE WATER USE,
- AND RELATED COST SAVINGS AND ENVIRONMENTAL BENEFITS.

COST:
- LOW/MED/HIGH & LOW/MED/HIGH. ADDS LESS THAN 1% OR MORE THAN 5% TO TOTAL PROJECT COST DEPENDING ON CHOSEN
- STRUCTURE;
- REQUIRES MAINTENANCE ONE PER YEAR OR EXTENSIVE MAINTENANCE (I.E., YEAR-ROUND MAINTENANCE) DEPENDING ON CHOSEN STRUCTURE.

PERVIOUS PAVEMENT WITH INFILTRATION: AN INFILTRATION TECHNIQUE THAT COMBINES STORM WATER INFILTRATION, STORAGE, AND STRUCTURAL PAVEMENT CONSISTING OF A PERMEABLE SURFACE UNDERDRAIN BY A STORAGE RESERVOIR.
BENEFITS:
- VOLUME CONTROL AND GROUNDWATER RECHARGE,
- MODERATE PEAK RATE CONTROL,
- AND DUAL USE FOR PAVEMENT AND STORM WATER MANAGEMENT.

COST:
- MED & HIGH. ADDS 1-5% TO TOTAL PROJECT COST;
- REQUIRES EXTENSIVE MAINTENANCE (I.E., YEAR-ROUND MAINTENANCE).

RIPARIAN BUFFER RESTORATION: AREA OF LAND THAT EXISTS BETWEEN LOW, AQUATIC AREAS SUCH AS RIVERS, STREAMS, LAKES, AND WETLANDS, AND HIGHER, DRY UPLAND AREAS SUCH AS FORESTS, FARMS, CITIES, AND SUBURBS.
BENEFITS:
- WATER QUALITY,
- ECOLOGICAL
- AND AESTHETIC VALUE, AND LOW COST.

COST:
- LOW/MED & LOW. ADDS LESS THAN 1% OR UP TO 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE TIME PER YEAR

VEGETATED ROOF: CONVENTIONAL ROOFTOPS THAT INCLUDE A THIN COVERING OF VEGETATION ALLOWING THE ROOF TO FUNCTION MORE LIKE A VEGETATED SURFACE.
BENEFITS:
- GOOD STORM WATER VOLUME CONTROL,
- HEATING AND COOLING ENERGY BENEFITS,
- INCREASED LIFESPAN OF ROOF, HEAT ISLAND REDUCTION,
- AND ENHANCED HABITAT VALUE.

COST:
- HIGH & MED. ADDS MORE THAN 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE SEVERAL TIMES PER YEAR.

VEGETATED SWALE: A SHALLOW STORM WATER CHANNEL THAT IS DENSELY PLANTED WITH A VARIETY OF GRASSES, SHRUBS, AND/OR TREES DESIGNED TO SLOW, FILTER, AND INFILTRATE STORM WATER RUNOFF.
BENEFITS:
- CAN REPLACE CURB AND GUTTER FOR SITE DRAINAGE
- AND PROVIDE SIGNIFICANT COST SAVINGS,
- WATER QUALITY,
- AND PEAK VOLUME CONTROL WITH INFILTRATION.

COST:
- LOW/MED & LOW/MED. ADDS LESS THAN 1% OR UP TO 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE - SEVERAL TIMES PER YEAR

WIGHTMAN & ASSOCIATES, INC.
150383

0" 100' 200' 300'

1

OX CREEK VISION PLAN
BEST MANAGEMENT PRACTICES CASE STUDY

MEIJER
07/11/2017

Figure 30. Ox Creek Vision Plan BMPs – Meijer

Figure 31. Meijer BMP Engineer's Estimate

ENGINEER'S ESTIMATE

PROJECT: **150383 - Meijer BMP**
CLIENT: **Meijer**
DATE: July 11, 2017

Install various BMPs and site amenties as shown on plan

Rain Garden at Existing Drains					
75,000	SFT	Rain Garden	@	$10.00	750,000.00
			Subtotal		$ 750,000.00
Pervious Pavement					
130,000	SFT	Pervious Concrete Pavement	@	7.00	910,000.00
14,500	SYD	Removal of Existing Asphalt & Base	@	3.00	43,500.00
14,500	SYD	Base Course, Open Graded, 12" depth	@	8.00	116,000.00
1	LS	Machine Grading	@	5,000.00	5,000.00
			Subtotal		$ 1,074,500.00
Riperian Buffer Native Planting					
12,750	SYD	Native Seeding	@	1.50	19,125.00
			Subtotal		$ 19,125.00
Vegetated Roof (tray system only)					
3,500	SFT	Vegetated Roof System	@	$25.00	87,500.00
			Subtotal		$ 87,500.00
Cistern (irrigation by others)					
1	LS	Cistern	@	$7,500.00	7,500.00
1	LS	Plumbing connections	@	3,000.00	3,000.00
			Subtotal		$ 10,500.00

SUBTOTAL ESTIMATED CONSTRUCTION COST		$ 1,941,625.00
Contingency	15%	291,243.75
TOTAL ESTIMATED PROJECT COST		**$ 2,232,868.75**

P:\BentonHarbor\150383 SWMPC - Ox Creek Study\A) Documents\A40 Budgets and Cost Estimates\Site Plans Cost Estimates\2017.07.11 Meijer Estimate.xlsx

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Home Depot

Home Depot is located at 2075 Pipestone Road in Benton Harbor; the site is 12 acres in size with approximately 475 parking stalls. The site is 79% impervious and 21% pervious.

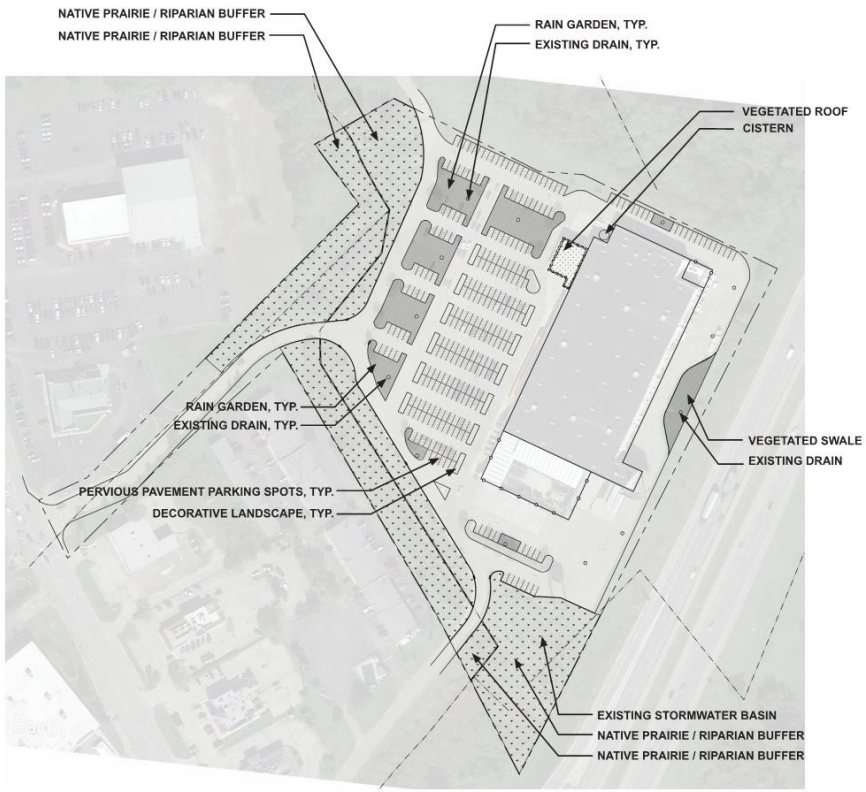
The recommended BMPs for Home Depot are: bioretention rain garden), capture reuse (cistern), pervious pavement with infiltration, riparian buffer restoration, vegetated roof, and vegetated swale.

The addition of the BMPs reduced the amount of impervious surface on the site by 9% and reduced the number of parking stalls by 39%.

Table 9. Green Roof, Bioretention, Pervious Pavement Loads – Home Depot

	GREEN ROOF	BIORETENTION			PERVIOUS PAVEMENT		
	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	81	820.3	U	U	111.4	U	U
COD	561	5,683.9	U	U	771.6	154.3	617.3
TSS	1,123	11,387	4,669	6,718	1,546	155	1,391
LEAD	1	9.9	U	U	1.3	0.0	1.3
COPPER	0	1.9	0.1	1.9	0.3	U	U
ZINC	2	15.4	0.8	14.7	2.1	0.0	2.1
TDS	2,698	27,309.5	U	U	3,707.3	U	U
TN	19	202.7	103.4	99.3	27.5	4.1	23.4
TKN	7	66.6	U	U	9.0	U	U
DP	1	6.7	U	U	0.9	U	U
TP	1	12.5	4.4	8.2	1.7	0.6	1.1
CADMIUM	0	0.1	U	U	0.0	U	U

Note: U=undetected



TYPES OF STRUCTURAL BEST MANAGEMENT PRACTICES:

BIORETENTION (RAIN GARDEN): SHALLOW SURFACE DEPRESSIONS PLANTED WITH SPECIALLY SELECTED NATIVE VEGETATION TO CAPTURE AND TREAT STORM WATER RUNOFF FROM ROOFTOPS, STREETS, AND PARKING LOTS.
BENEFITS:
- VOLUME CONTROL AND GROUNDWATER RECHARGE,
- MODERATE PEAK RATE CONTROL,
- FILTRATION,
- VERSATILE WITH BROAD APPLICABILITY,
- ENHANCE SITE AESTHETICS AND HABITAT,
- AND POTENTIAL AIR QUALITY AND CLIMATE BENEFITS.

COST:
- LOW/MED & LOW/MED. ADDS LESS THAN 1% OR UP TO 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE - SEVERAL TIMES PER YEAR

CAPTURE REUSE (RAIN BARREL, CISTERN, MANUFACTURED PRODUCT): STRUCTURES DESIGNED TO INTERCEPT AND STORE RUNOFF FROM ROOFTOPS ALLOW FOR ITS REUSE, REDUCING VOLUME AND OVERALL WATER QUALITY IMPAIRMENT.
BENEFITS:
- PROVIDES SUPPLEMENTAL WATER SUPPLY,
- WIDE APPLICABILITY, REDUCES POTABLE WATER USE,
- AND RELATED COST SAVINGS AND ENVIRONMENTAL BENEFITS.

COST:
- LOW/MED/HIGH & LOW/MED/HIGH. ADDS LESS THAN 1% OR MORE THAN 5% TO TOTAL PROJECT COST DEPENDING ON CHOSEN
- STRUCTURE;
- REQUIRES MAINTENANCE ONE PER YEAR OR EXTENSIVE MAINTENANCE (I.E., YEAR-ROUND MAINTENANCE) DEPENDING ON CHOSEN STRUCTURE.

PERVIOUS PAVEMENT WITH INFILTRATION: AN INFILTRATION TECHNIQUE THAT COMBINES STORM WATER INFILTRATION, STORAGE, AND STRUCTURAL PAVEMENT CONSISTING OF A PERMEABLE SURFACE UNDERDRAIN BY A STORAGE RESERVOIR.
BENEFITS:
- VOLUME CONTROL AND GROUNDWATER RECHARGE,
- MODERATE PEAK RATE CONTROL,
- AND DUAL USE FOR PAVEMENT AND STORM WATER MANAGEMENT.

COST:
- MED & HIGH. ADDS 1-5% TO TOTAL PROJECT COST;
- REQUIRES EXTENSIVE MAINTENANCE (I.E., YEAR-ROUND MAINTENANCE).

RIPARIAN BUFFER RESTORATION: AREA OF LAND THAT EXISTS BETWEEN LOW, AQUATIC AREAS SUCH AS RIVERS, STREAMS, LAKES, AND WETLANDS, AND HIGHER, DRY UPLAND AREAS SUCH AS FORESTS, FARMS, CITIES, AND SUBURBS.
BENEFITS:
- WATER QUALITY,
- ECOLOGICAL
- AND AESTHETIC VALUE, AND LOW COST.

COST:
- LOW/MED & LOW. ADDS LESS THAN 1% OR UP TO 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE TIME PER YEAR

VEGETATED ROOF: CONVENTIONAL ROOFTOPS THAT INCLUDE A THIN COVERING OF VEGETATION ALLOWING THE ROOF TO FUNCTION MORE LIKE A VEGETATED SURFACE.
BENEFITS:
- GOOD STORM WATER VOLUME CONTROL,
- HEATING AND COOLING ENERGY BENEFITS,
- INCREASED LIFESPAN OF ROOF, HEAT ISLAND REDUCTION,
- AND ENHANCED HABITAT VALUE.

COST:
- HIGH & MED. ADDS MORE THAN 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE SEVERAL TIMES PER YEAR.

VEGETATED SWALE: A SHALLOW STORM WATER CHANNEL THAT IS DENSELY PLANTED WITH A VARIETY OF GRASSES, SHRUBS, AND/OR TREES DESIGNED TO SLOW, FILTER, AND INFILTRATE STORM WATER RUNOFF.
BENEFITS:
- CAN REPLACE CURB AND GUTTER FOR SITE DRAINAGE
- AND PROVIDE SIGNIFICANT COST SAVINGS,
- WATER QUALITY,
- AND PEAK VOLUME CONTROL WITH INFILTRATION.

COST:
- LOW/MED & LOW/MED. ADDS LESS THAN 1% OR UP TO 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE - SEVERAL TIMES PER YEAR

0” 100’ 200’ 300’

1

WIGHTMAN & ASSOCIATES, INC.
150383

OX CREEK VISION PLAN
BEST MANAGEMENT PRACTICES CASE STUDY

HOME DEPOT
07/07/2017

Figure 32. Ox Creek Vision Plan BMPs – Home Depot

Figure 33. Home Depot BMP Engineer's Estimate

ENGINEER'S ESTIMATE

PROJECT: **150383 - Home Depot BMP**

CLIENT: **Home Depot**

DATE: July 7, 2017

Install various BMPs and site amenties as shown on plan

Rain Garden at Existing Drains						
30,000	SFT	Rain Garden		@	$10.00	300,000.00
			Subtotal			$ 300,000.00
Pervious Pavement						
60,000	SFT	Pervious Concrete Pavement		@	7.00	420,000.00
6,700	SYD	Removal of Existing Asphalt & Base		@	3.00	20,100.00
6,700	SYD	Base Course, Open Graded, 12" depth		@	8.00	53,600.00
1	LS	Machine Grading		@	2,500.00	2,500.00
			Subtotal			$ 496,200.00
Vegetative Swale / Riperian storage area						
10,000	SFT	Vegetative Swale		@	6.00	60,000.00
			Subtotal			$ 60,000.00
Riperian Buffer Native Planting						
19,500	SYD	Native Seeding		@	1.50	29,250.00
			Subtotal			$ 29,250.00
Vegetated Roof (tray system only)						
4,000	SFT	Vegetated Roof System		@	$25.00	100,000.00
			Subtotal			$ 100,000.00
Cistern (irrigation by others)						
1	LS	Cistern		@	$7,500.00	7,500.00
1	LS	Plumbing connections		@	3,000.00	3,000.00
			Subtotal			$ 10,500.00

SUBTOTAL ESTIMATED CONSTRUCTION COST		$ 995,950.00
Contingency	15%	149,392.50
TOTAL ESTIMATED PROJECT COST		**$ 1,145,342.50**

P:\BentonHarbor\150383 SWMPC - Ox Creek Study\A) Documents\A40 Budgets and Cost Estimates\Site Plans Cost Estimates\2017.07.07 Home Depot Estimate.xlsx

(269) 673-8465 — 264 WESTERN AVENUE, **ALLEGAN, MI**
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(269) 327-3532 — 9835 PORTAGE ROAD, **PORTAGE, MI**
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Celebration Cinema

Celebration Cinema is located at 1468 Cinema Way in Benton Harbor; the site is approximately 13 acres in size with approximately 650 parking stalls. The site is 48% impervious and 52% pervious.

The recommended BMPs for Celebration Cinema are: bioretention (rain garden), capture reuse (cistern), pervious pavement with infiltration, riparian buffer restoration, vegetated roof, and vegetated swale.

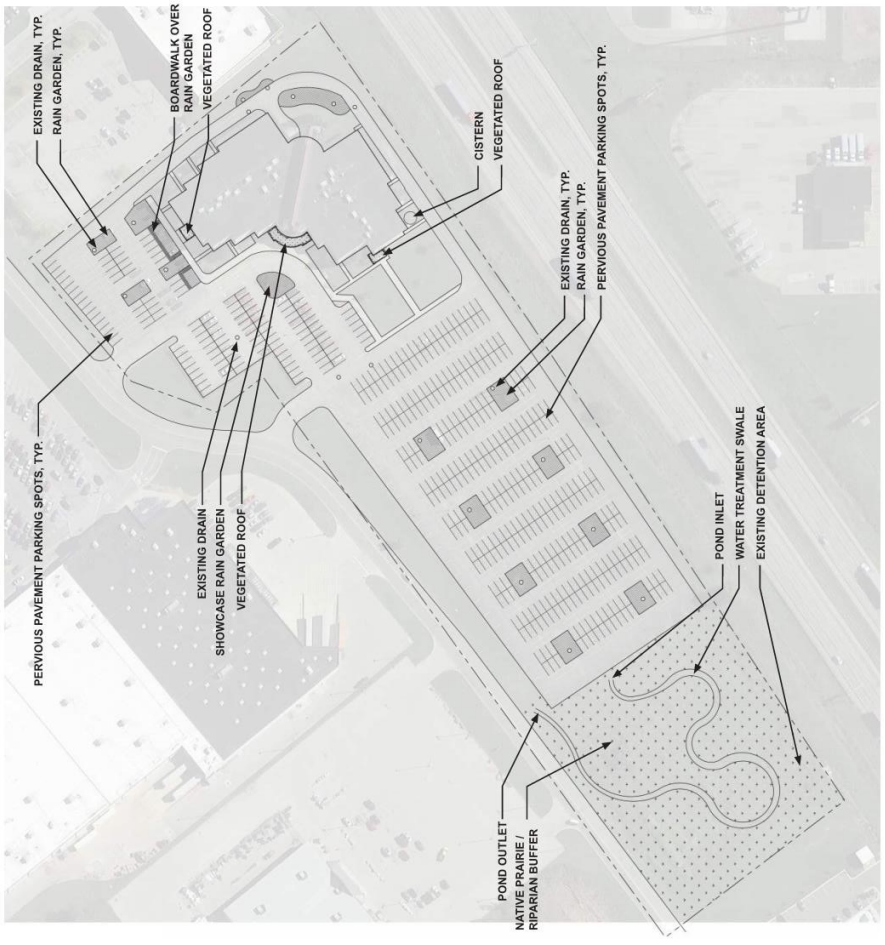
The addition of the BMPs reduced the amount of impervious surface on the site by 7% and reduced the number of parking stalls by 27%.

Table 10. Green Roof, Bioretention, Pervious Pavement Loads – Celebration Cinema

	GREEN ROOF	BIORETENTION			PERVIOUS PAVEMENT			GRASS SWALE		
	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)	Load before BMP (lbs/yr)	Load after BMP (lbs/yr)	Load Reduction (lbs/yr)
BOD	78	512.6	U	U	187.0	U	U	208.3	145.8	62.5
COD	538	3,551.7	U	U	1,295.8	259.2	1,036.6	1,443.1	1,082.3	360.8
TSS	1,075	7,115	2,917	4,198	2,596	260	2,336	2,891	1,012	1,879
LEAD	1	6.2	U	U	2.3	0.0	2.3	2.5	0.8	1.8
COPPER	0	1.2	0.0	1.2	0.4	U	U	0.5	0.2	0.2
ZINC	1	9.6	0.5	9.2	3.5	0.0	3.5	3.9	1.6	2.4
TDS	2,585	17,064.9	U	U	6,226.0	U	U	6,933.5	U	U
TN	19	126.6	64.6	62.0	46.2	6.9	39.3	51.5	46.3	5.1
TKN	6	41.6	U	U	15.2	U	U	16.9	U	U
DP	1	4.2	U	U	1.5	U	U	1.7	U	U
TP	1	7.8	2.7	5.1	2.9	1.0	1.9	3.2	2.4	0.8
CADMIUM	0	0.0	U	U	0.0	U	U	0.0	0.0	0.0

Note: U=undetected

Figure 34. Ox Creek Vision Plan BMPs – Celebration Cinema



TYPES OF STRUCTURAL BEST MANAGEMENT PRACTICES:

BIORETENTION (RAIN GARDEN): SHALLOW SURFACE DEPRESSIONS PLANTED WITH SPECIALLY SELECTED NATIVE VEGETATION TO CAPTURE AND TREAT STORM WATER RUNOFF FROM ROOFTOPS, STREETS, AND PARKING LOTS.
BENEFITS:
- VOLUME CONTROL AND GROUNDWATER RECHARGE.
- MODERATE PEAK RATE CONTROL.
- FILTRATION.
- VERSATILE WITH BROAD APPLICABILITY.
- ENHANCE SITE AESTHETICS AND HABITAT.
- AND POTENTIAL AIR QUALITY AND CLIMATE BENEFITS.

COST:
- LOW/MED & LOW/MED. ADDS LESS THAN 1%, OR UP TO 5%, TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE - SEVERAL TIMES PER YEAR

CAPTURE REUSE (RAIN BARREL, CISTERN, MANUFACTURED PRODUCT): STRUCTURES DESIGNED TO INTERCEPT AND STORE RUNOFF FROM ROOFTOPS ALLOW FOR ITS REUSE, REDUCING VOLUME AND OVERALL WATER QUALITY IMPAIRMENT.
BENEFITS:
- PROVIDES SUPPLEMENTAL WATER SUPPLY,
- WIDE APPLICABILITY, REDUCES POTABLE WATER USE,
- AND RELATED COST SAVINGS AND ENVIRONMENTAL BENEFITS.

COST:
- LOW/MED/HIGH & LOW/MED/HIGH. ADDS LESS THAN 1% OR MORE THAN 5% TO TOTAL PROJECT COST DEPENDING ON CHOSEN STRUCTURE;
- REQUIRES MAINTENANCE ONE PER YEAR OR EXTENSIVE MAINTENANCE (I.E., YEAR-ROUND MAINTENANCE) DEPENDING ON CHOSEN STRUCTURE.

PERVIOUS PAVEMENT WITH INFILTRATION: AN INFILTRATION TECHNIQUE THAT COMBINES STORM WATER INFILTRATION, STORAGE, AND STRUCTURAL PAVEMENT CONSISTING OF A PERMEABLE SURFACE UNDERDRAIN BY A STORAGE RESERVOIR.
BENEFITS:
- VOLUME CONTROL AND GROUNDWATER RECHARGE.
- MODERATE PEAK RATE CONTROL.
- AND DUAL USE FOR PAVEMENT AND STORM WATER MANAGEMENT.

COST:
- MED & HIGH. ADDS 1-5% TO TOTAL PROJECT COST;
- REQUIRES EXTENSIVE MAINTENANCE (I.E., YEAR-ROUND MAINTENANCE).

RIPARIAN BUFFER RESTORATION: AREA OF LAND THAT EXISTS BETWEEN LOW, AQUATIC AREAS SUCH AS RIVERS, STREAMS, LAKES, AND WETLANDS, AND HIGHER, DRY UPLAND AREAS SUCH AS FORESTS, FARMS, CITIES, AND SUBURBS.
BENEFITS:
- WATER QUALITY,
- ECOLOGICAL
- AND AESTHETIC VALUE, AND LOW COST.

COST:
- LOW/MED & LOW. ADDS LESS THAN 1%, OR UP TO 5%, TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE TIME PER YEAR

VEGETATED ROOF: CONVENTIONAL ROOFTOPS THAT INCLUDE A THIN COVERING OF VEGETATION ALLOWING THE ROOF TO FUNCTION MORE LIKE A VEGETATED SURFACE.
BENEFITS:
- GOOD STORM WATER VOLUME CONTROL,
- HEATING AND COOLING ENERGY BENEFITS,
- INCREASED LIFESPAN OF ROOF, HEAT ISLAND REDUCTION,
- AND ENHANCED HABITAT VALUE.

COST:
- HIGH & MED. ADDS MORE THAN 5% TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE SEVERAL TIMES PER YEAR.

VEGETATED SWALE: A SHALLOW STORM WATER CHANNEL THAT IS DENSELY PLANTED WITH A VARIETY OF GRASSES, SHRUBS, AND/OR TREES DESIGNED TO SLOW, FILTER, AND INFILTRATE STORM WATER RUNOFF.
BENEFITS:
- CAN REPLACE CURB AND GUTTER FOR SITE DRAINAGE
- AND PROVIDE SIGNIFICANT COST SAVINGS,
- WATER QUALITY,
- AND PEAK VOLUME CONTROL WITH INFILTRATION.

COST:
- LOW/MED & LOW/MED. ADDS LESS THAN 1%, OR UP TO 5%, TO TOTAL PROJECT COST;
- REQUIRES MAINTENANCE ONE - SEVERAL TIMES PER YEAR

0' 75' 150' 225'

WIGHTMAN & ASSOCIATES, INC.

OX CREEK VISION PLAN

BEST MANAGEMENT PRACTICES CASE STUDY

CELEBRATION CINEMA

07/10/2017

150383

Figure 35. Celebration Cinema BMP Engineer's Estimate

ENGINEER'S ESTIMATE

PROJECT: **150383 - Celebration Cinema BMP**
CLIENT: **Celebration Cinema**
DATE: July 10, 2017

Install various BMPs and site amenties as shown on plan

Rain Garden at Existing Drains						
15	EA	Rain Garden (1,200 SF)	@	$12,000.00		180,000.00
		Subtotal			$	180,000.00
Pervious Pavement						
90,000	SFT	Pervious Concrete Pavement	@	7.00		630,000.00
10,000	SYD	Removal of Existing Asphalt & Base	@	3.00		30,000.00
10,000	SYD	Base Course, Open Graded, 12" depth	@	8.00		80,000.00
1	LS	Machine Grading	@	2,500.00		2,500.00
		Subtotal			$	742,500.00
Vegetative Swale / Riperian storage area						
750	LFT	Grading flow channel	@	3.50		2,625.00
1	LS	Modify grate and rim of existing structures	@	2,000.00		2,000.00
110,000	SFT	Rain Garden Planting, seed	@	0.35		38,500.00
1	LS	Machine Grading	@	3,500.00		3,500.00
		Subtotal			$	46,625.00
Vegetated Roof (tray system only)						
2,500	SFT	Vegetated Roof System	@	$25.00		62,500.00
		Subtotal			$	62,500.00
Cistern (irrigation by others)						
1	LS	Cistern	@	$7,500.00		7,500.00
1	LS	Plumbing connections	@	3,000.00		3,000.00
		Subtotal			$	10,500.00
		SUBTOTAL ESTIMATED CONSTRUCTION COST			$	1,042,125.00
		Contingency		15%		156,318.75
		TOTAL ESTIMATED PROJECT COST			**$**	**1,198,443.75**

P:\BentonHarbor\150383 SWMPC - Ox Creek Study\A) Documents\A40 Budgets and Cost Estimates\Site Plans Cost Estimates\2017.07.11 Celebration Cinema Estimate.xlsx

(269) 673-8465 264 Western Avenue, **Allegan, MI**
(269) 927-0100 2303 Pipestone Road, **Benton Harbor, MI**
(269) 327-3532 9835 Portage Road, **Portage, MI**
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POTENTIAL FUNDING SOURCES

All of the following funding and implementation information has been compiled from multiple resources, please see Resources and References section at the end of this document for more information.

Federal Funding

Local governments have the opportunity to draw upon a wide range of funding sources, revenue models, and financing strategies to support green infrastructure programs. Investing in green infrastructure can cost-effectively help communities manage stormwater while also producing significant co-benefits.

Federal programs can provide significant funding for local green infrastructure programs. Federal funding can come in the form of competitive grants or formula programs that local governments are already likely to be receiving. Grant funding may provide a local government with the resources to implement green infrastructure projects. However, federal grants can be highly competitive, may require lengthy application, are limited in size and scope, and often are awarded on a one-time basis. Many federal grants require a funding match from state or local sources for some percentage of the awarded funds. Some funding sources also prohibit the use of grant funding for operations and maintenance expenses.

Clean Water State Revolving Fund: One important source of financing for water infrastructure projects is the Clean Water State Revolving Fund (CWSRF). The federal government provides grants to capitalize state CWSRF programs. States contribute a 20% funding match and administer and operate the programs. The state programs function as infrastructure banks: repaid principal and interest from loans is returned to the state program, allowing the state to finance new projects. States have significant flexibility over CWSRF program administration, and can provide several forms of financial assistance to local governments, including:

- Direct loans: CWSRF can provide financing for a project and offer interest rates at or below market rates;
- Debt purchasing or refinancing: CWSRF can be used to purchase a community's stormwater infrastructure debt to relieve unfavorable loan terms; projects may be refinanced using CWRF funds;
- Loan guarantees and insurance: CWSRF funding can be used to increase access to private credit markets or lower a jurisdiction's private borrowing costs;
- Additional subsidization: Under certain conditions and federal appropriation levels, additional subsidization in the form of loan forgiveness or grants may be available.

States can use the CWSRF to fund the capital costs of both gray and green infrastructure, but CWSRF funding cannot be used for operations and maintenance expenses.

Water Pollution Control Revolving Fund (Clean Water State Revolving Fund-CWSRF) Loans: Purpose is to assist municipalities in addressing water quality problems identified in watershed management plan such as wastewater treatment system improvements, stormwater treatment projects, and nonpoint source (NPS) pollution control projects. CWSRF funds capital costs only (planning, design, construction), not operation and maintenance costs. The loan is provided by U.S. Environmental Protection Agency (EPA) with MDEQ. Plan must address water quality benefits and the capacity to repay loan. Examples of municipalities' investments in green infrastructure include: land conservation, reforestation, tree boxes, cisterns and rain barrels, downspout disconnections, wetland restoration, parks and greenways, rain gardens and bio infiltration practices, permeable pavements and green roofs.

Clean Water Act 319: Purpose is to provide funding to implement NPS activities identified in DEQ and USEPA-approved watershed management plans. Implementation activities must address specific sources of NPS pollution identified by Michigan's Nonpoint Source Program Plan. This plan's vision is to protect high quality waters from NPS threats and restore waters impaired by NPS pollution or causes. Eligible agencies include county or local units of government, state agencies and non-profit organizations.

Transportation Alternatives Program: The Transportation Alternatives Program (TAP) is a competitive grant program that uses federal transportation funds designated by Congress for specific activities that enhance the intermodal transportation system and provide safe alternative transportation options. TAP will fund water quality projects that: will have a positive effect on important watersheds or water bodies with sensitive fisheries or that are not attaining state water quality standards; include monitoring after implementation or projections of water quality improvement; are consistent with a local watershed management plan; and include an inspection and maintenance schedule.

State Funding

Michigan has multiple loan and grant programs that may be used to fund green infrastructure projects and programs. Michigan Community Development Block Grant Program are of the most relevant for Benton Charter Township.

Michigan Community Development Block Grant Program: There are three different sub-grants within this program, two of the three would work for Benton Charter Township. 1) Downtown Infrastructure Grant which is used to upgrade existing infrastructure systems in a traditional downtown and 2) Infrastructure Capacity Enhancement Grant which funds public works projects that upgrade existing public infrastructure systems either by replacing deteriorating or obsolete systems or by adding capacity to existing systems.

Grants are provided by Michigan Economic Development Corporation (MEDC) on behalf of Michigan Strategic Fund (MSF). Low to moderate income municipalities that are implementing new infrastructure to improve economic development, downtown development and housing projects may apply. Population of small cities, township, and villages needs to be less than 50,000 to apply and be non-urban counties. Advantages include job creation, increased economic activity and increased property values. Additionally, green infrastructure can increase property values by mitigating flooding, improving neighborhood aesthetics, and providing other co-benefits.

Clean Michigan Initiative: provides funding to implement the physical improvements in approved watershed management plans intended to restore impaired waters and protect high quality waters. Practices must address specific sources of NPS pollution identified by Michigan's Nonpoint Source Program Plan. Physical improvements are structural and vegetative BMPs. Eligible agencies include county or local units of government, state agencies and non-profit organizations.

Private Funding

Communities may also explore innovative strategies to leverage limited municipal funds to attract private capital. One approach that is common to infrastructure projects but has been limited in green infrastructure stormwater management is the use of public-private partnerships.

Public-Private Partnerships (P3s): A contractual agreement between a public agency and one or more private sector partners that allows for the private sector participation in the financing, planning, design, construction,

and maintenance of stormwater facilities. Advantages include reduction in costs to government, significantly leverages public funding and government resources, ensures adequate and dedicated funding, improved operations and management, and shared risk. A P3 may allow a local government to make significant upfront capital investments without straining its municipal debt limit, by leveraging limited public funds to attract private capital. Commonly cited benefits of P3s include more cost effective and faster program implementation, due to potential economies of scale and technical expertise that a private-sector partner can provide. Disadvantages includes perceived loss of public control and the assumption that private financing is more expensive and belief that contract negotiations are difficult. Prior to establishing a P3, local governments should conduct meaningful stakeholder and community outreach to ensure that the goals of the P3 and terms of the contract agreement align with community interests and achieve community objectives.

Local Funding

Local governments have multiple options for using local funding to pay for green infrastructure projects. If resources are sufficient, local governments can include green infrastructure programs and projects in capital budgets. If local governments want a dedicated source of funds just for green infrastructure and stormwater management, municipal and stormwater utility fees may also provide an important source of revenue.

Municipal Budget/Taxes/General Funds: Many local governments fund green infrastructure and stormwater management programs through the general fund, which in most local governments is primarily funded through income and property taxes. Advantages are that a local government using funds from general tax revenue for green infrastructure will not need to set up new revenue collection and appropriation systems. Disadvantages are that funding for green infrastructure programs may not be stable year-to-year if other spending obligations are seen as higher priorities. Additionally, the use of general funds could be seen as inequitable, because some property owners that contribute to stormwater runoff (such as public facilities, universities, and churches) may be exempt from the income or property taxes used to fund the program.

Stormwater Utility Fees: Generates its revenue through user fees and the revenues from the stormwater charges will go into a separate fund that might be used only for stormwater services. Local governments may choose to assess stormwater utility fees as a reliable means of paying for green infrastructure programs. The advantage of this is that it provides a dedicated funding stream with sustainable and predictable revenue over time. A stormwater utility fee may be seen as a more equitable way to pay for stormwater management, compared to general funds, because local governments or utilities may be able to raise money in a way that is directly related to a property's stormwater impacts. Many local governments allow property owners to offset stormwater user fees or earn incentives and credits by managing stormwater onsite through BMPs such as reducing impervious surface area. The Cities of Lansing and Jackson, MI have had stormwater utilities deemed unconstitutional by the Michigan Supreme Court because they classify the fee as a tax. The court has outlined specific criteria for distinguishing between a fee and a tax. Several Michigan cities have successfully adopted a stormwater utility, including Berkley, New Baltimore, Marquette and Ann Arbor. Additionally, the Michigan Legislature has introduced bills in 2016 and 2017 to allow local governments to more easily adopt stormwater utilities. Additional advantages are improved watershed stewardship, addresses existing stormwater issues, and provides dedicated revenue for stormwater management through equitable measurements and billing, similar to the commonly used metering for drinking water and wastewater. Disadvantages of establishing utility fees include that they may face regulatory and legal limitations, including sometimes approval of a legislative body. While these requirements vary by state, they can include procedural questions (e.g., whether a vote by the local elected body or the voters is necessary) and substantive questions (e.g., whether the fee is structured in such a way as to fairly relate to the amount of impervious surface on a particular property). Establishing and assessing

a utility fee requires upfront administrative costs, including a feasibility study, stakeholder outreach, and fee structure design and implementation, and perception by the public of a "tax on rain."

Permit Fees: Local governments can assess permit fees to provide additional revenue for green infrastructure programs. Advantages are that the fees allow local governments to raise revenue directly from any proposed development or construction that might worsen stormwater impacts. Disadvantages are that assessed fees may not provide sufficient funding for full program implementation, and likely would need to be combined with additional funding sources. Additionally, fees may not be a consistent source of revenue, as they may decrease during a time of slow construction.

Bond Financing: Bonds are not a true revenue source but are means of borrowing money. "Green" bonds are a new source of funding dedicated to environmentally friendly projects, including clean water projects. Green bonds are not significantly different in structure than bonds used for other purposes but are used to finance environmentally beneficial activities. Because green bonds must be used for environmentally beneficial projects, they may attract the interest of investors interested in environmental issues, as well as traditional investors. This increased interest may in the future reduce borrowing costs (compared to traditional bonds) for governments raising funds through bond issuance. Local governments and municipal utilities may be able to finance capital spending through the issuance of municipal bonds. For infrastructure that requires significant upfront capital investment but will operate for a number of years, bond financing allows a local government to pay for a project over the entire life of the infrastructure because the debt is repaid gradually over time. Municipal bonds can be issued as: General obligation bonds, secured by the full faith and credit of a local government; or Revenue bonds, secured by a future revenue stream (e.g., a stormwater fee). While local governments and utilities can raise funds in the private bond market, municipal bonds often provide capital at a lower interest rate. Advantages include existing sources available for stormwater-related funding, can support construction-ready projects, and can provide steady funding stream over the period of the bond. Disadvantages includes one-time source of funds, requires individual approval for each issuance, requires full repayment, possible interest charges, requires dedicated repayment revenue stream, may require design-level documents to be prepared in advance, likely requires voter approval, can have high transaction costs relative to requested amount, and may require significant administrative preparation to issue.

Loans: Low-interest loans may be secured but are generally used for planning and capital project. Advantages include existing sources available for stormwater-related funding and offers low- or no-interest financing. Disadvantages include one-time source of funds and requires full repayment.

Tax Increment Financing (TIF): is a method of financing a project or development in a designated geographic area based on the anticipated increase in property tax that will be generated by the project. The revenue generated by a TIF is the property tax assessed on the increase in property value of a designated district following a development project, compared to the baseline property value prior to the development project. Local governments can use tax increment financing for large capital projects (such as green infrastructure installation) or incremental, longer-term spending. Advantages of tax increment financing includes allowing a development or infrastructure project to "self-finance" – the increase in assessed property value caused by the development is used to repay the cost of the property development. This process allows a local government to finance a capital project without raising property tax rates or exceeding its debt limit. State-specific statutory and regulatory requirements regulate the type of projects permitted and administrative procedures required for tax increment financing, such as requirements to pass local ordinances. Additionally, TIFs have received significant criticism and opposition due to the potential of TIF financing to divert property tax revenue from other municipal needs, such as school funding.

Corridor Improvement Authority (CIA): Allows the use of TIF to make capital improvements within an established commercial district. It allows communities that already have Downtown Development Authorities (DDAs) to extend similar benefits to aging commercial corridors outside the DDA district or that extend through more than one municipality. CIAs are authorized by the legislation of 2005 PA 280. This act specifically allows TIF to be used for commercial and economic growth in commercial districts in cities, villages and townships. Local units can use taxes arising from increased property values through TIF to pay for improvement to the commercial areas along arterial or collector streets and roads. This act is designed to rehabilitate, renovate and prevent the deterioration of established commercial business districts not eligible under the DDA Act. The district must be adjacent to a road classified as an arterial or collector road by the Federal Highway Administration and contain at least 10 contiguous parcels or five contiguous acres with more than half of the existing ground floor square footage classified as commercial property. Corridor improvement may include improvements to the land, as well as constructing, rehabilitating, preserving, equipping or maintaining buildings within the development district for public or private use. These improvements may be financed initially through bonding, which may be repaid from the enhanced property tax revenue stream, special assessments and fees.

INSTITUTIONAL BMPS

There are many different types of tools that can be used to influence the implementation of green infrastructure. These tools vary in their ability to influence new construction versus existing development and in influencing public versus private property. It is recommended that multiple tools are used together to encourage green infrastructure.

Regulatory Approaches – Zoning Code

Regulatory tools include requirements set in zoning or building codes or stormwater retention ordinances, mandating action by private property owners. In many jurisdictions, stormwater retention ordinances establish retention requirements and then lay the foundation for other regulations that mandate green infrastructure as a specific set of practices to meet those retention requirements.

Regulatory tools, because of their inherent nature as requirements (as opposed to options or incentives), get surer results than programs that rely solely on capital improvement projects on publicly owned lands or voluntary measures for private land. Private property owners must meet regulatory requirements to obtain a permit and, therefore, they must change their landscaping and building practices to comply. As a result, regulatory approaches may result in some political pushback. Many of the regulatory tools below may be more palatable to local developers if some flexibility is built into the system. Last, because of the nature of regulatory requirements of things mandated in laws such as zoning codes or other ordinances, many of these strategies may require legal changes to incorporate those requirements into that particular legal framework. These legal changes can be administratively complicated and time-consuming.

Zoning Codes: can create green infrastructure requirements for new construction and sometimes substantial renovations. Zoning codes are particularly suited to tailoring those requirements to particular land uses such as industrial, residential, etc., and for addressing the entire site under development, including landscaping. Zoning requirements can either set retention requirements that property owners can meet by choosing green infrastructure practices themselves or can count particular green infrastructure practices that qualify to meet the regulatory requirement.

Overlay Zones: are additional zoning districts that are laid over the top of two or more zoning districts. This is usually done to introduce an additional standard(s) or regulation(s) along some feature. For example, an overlay zone could require additional buffer, or setbacks from a body of water than for areas of the same zoning. Overlay zones for areas within specific watersheds that had specific needs could be created to require measures to improve, buffer, or additionally clean water beyond the baseline required in the zoning district.

Parking Requirements: The parking and landscape ordinance for City of Southfield, MI has been done so that it promotes green infrastructure; those incentives are detailed below. The City of Southfield provides a bike rack and bike parking credit, which promotes non-motorized transit, and to reduce impervious surfaces the city is encouraging alternate means of transportation. For every bike rack which accommodates four bikes, one off-street parking space, up to a maximum of 5% of total required parking may be credited by the city planner. Exceeding the minimum parking space requirements by more than 20% shall only be allowed with approval by the City. Parking spaces are conservative at 9’ x 18’ in size. Reduction in space size for compact cars can be accomplished with approval from the City. The code requires 10% of the total parking area to be landscaped in

the interior of the parking area if the parking area has 20 parking spaces or more. They encourage large continuous landscape by requiring that landscaped areas be at least 8' x 150' in size. The City of Southfield requires a stormwater infiltration plan that includes a plan showing the contributing drainage area, land use, slope, seasonal high groundwater elevation in areas where practice is proposed; design calculations; detailed planting plan; construction details and sequencing plan; and a maintenance plan. Lastly, the City recommends and references both the Low Impact Development (LID) and SEMCOG manuals which encourages designers to do the same.

LID Guidelines in Zoning/Site Plan Review: These are both beneficial times to require or encourage LID techniques and improve water quality. Often zoning ordinances or building codes either do not allow for LID practices or make them difficult. This creates a barrier to implementation. Most construction projects and developers want known methods with quick turnarounds. If LID techniques can be suggested in the zoning ordinance and encouraged this helps potential developers to more readily consider and include these techniques. Some communities even fast track review of projects with LID features. Another way to encourage LID features is to have a preliminary site plan review with a developer. At this meeting schematic plans can be reviewed, and the municipal reviewer can suggest alterations to the site plan that may improve the site's natural systems. These early reviews are key to implementing LID features because if the site plan review does not occur until plans are completed, owners are less likely to change their plans.

Green Landscaping Requirements: Municipalities can create additional incentives for stormwater BMPs by implementing permit requirements that encourage increased quantity and quality of planted areas within affected zones. This requirement provides developers and designers with flexibility in meeting development standards through mechanisms that are complementary to other stormwater management programs within the zone.

Cool Roof Exemptions: A municipality may provide exemptions, or waivers, for an existing cool roof requirement when a green roof is installed. This allows for cost-effective stormwater and environmental management while increasing energy efficiency and reducing energy costs.

Stormwater Ordinances/Water Quality/Stormwater Regulations: Stormwater Ordinances can directly require green infrastructure practices or can serve as a foundational regulation to encourage green infrastructure to meet retention requirements. Stormwater ordinances can link these practices to reductions in stormwater fees (see Incentive-based Approaches) or can simply require retention and/or green infrastructure practices. Like zoning and building codes, stormwater ordinances best reach new construction projects, although they can impact existing buildings when those buildings are undergoing substantial renovation.

Incentive-based Approaches

While mandates are the most certain method to change behavior, both financial and development incentives for green infrastructure can be important tools as well. Incentive programs are a great tool for promoting voluntary BMP implementation. Both types of incentives can stand alone or can accompany mandates; unlike mandates, incentives can influence stormwater management practices on property that is not otherwise subject to zoning or building code requirements (i.e., existing development not planned for renovation). They therefore can be a critical tool for highly-developed municipalities to spur change on private property.

Financial Incentives: Subsidies, grants, and rebates are examples of financial incentives. Financial incentives "can make the initial capital costs needed to install green infrastructure seem less daunting to private property owners, while tax incentives can reduce costs to property owners over time. Developing a financial incentive strategy may also require local governments to choose between subsidizing many properties with small amounts of money, or few properties with a larger amount of money. Local governments may also want to consider whether to take a "first-come, first-serve" approach to those subsidies, or to be strategic about targeting funds to particular watersheds, neighborhoods, or land-use types that are the highest priority.

Recognition Incentives: Include awards and recognition programs which provide flags, signs or placards to property owners identifying their property as environmentally friendly. Municipalities may also increase implementation of stormwater BMPs by offering grant awards for recognizing unique efforts that reduce impacts on the storm sewer system. This not only encourages participation, but also establishes partnerships by working with public and private sector to strive towards the common goal of improving water quality and reduction stormwater runoff.

Technical Assistance Incentives: Providing assessments, landscape design pallets and other resources.

EVALUATION

The overall goal is to remove Ox Creek and its tributaries from the 303(d) list. The implementation efforts will be evaluated by calculating pollutant loads and comparing to the target loads in the approved TMDL. Further, MDEQ will continue to do benthic macroinvertebrate sampling to see if assessment scores improve over time. Lastly, TSS sampling may be conducted in the future to see if TSS targets are being met after BMP implementation.

Evaluation measures will include the number of landowners implementing BMPs, the acres or linear feet of BMPs installed, the pollutants (sediment, nutrients, flow) reduced, and ultimately the delisting of Ox Creek from the 303(d) list. The MDEQ spreadsheets will be used to document pollutant load reductions for urban BMPs at the site level. All information/education activities will be evaluated by recording the number of participants, number of one-on-one visits and increased interest in urban BMP implementation.

REFERENCES & RESOURCES

General Ox Creek Watershed Information

Ox Creek TMDL Development – Watershed Characterization and Source Assessment Report, http://www.swmpc.org/downloads/ox_creek_tmdl_development_watershed_characterization_and_source_assessment_report_march_2010.pdf

Ox Creek TMDL Development – Linkage Analysis, http://www.swmpc.org/downloads/ox_creek_tmdl_development_linkage_analysis_july_2012_1.pdf

Funding Information

Funding Stormwater Management. Strategies to support stormwater management at the municipal level, https://www3.epa.gov/region1/npdes/charlesriver/pdfs/MAPCSWFundingResourceGuide.pdf

Funding Stormwater Programs, https://www3.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

An Internet Guide to Financing Stormwater Management, https://cues.rutgers.edu/meadowlands-district-stormwater/pdfs/Doc18_Internet%20guide%20to%20financing%20stormwater%20management.pdf

Getting to Green: Paying for Green Infrastructure. Financing Options and Resources for Local Decision-Makers, https://www.epa.gov/sites/production/files/2015-02/documents/gi_financing_options_12-2014_4.pdf

PAYING FOR STORMWATER CONTROLS AND PROGRAM MANAGEMENT, https://www3.epa.gov/npdes/pubs/region3_factsheet_funding.pdf

GUIDANCE FOR MUNICIPAL STORMWATER FUNDING, https://www.epa.gov/sites/production/files/2015-10/documents/guidance-manual-version-2x-2.pdf
Community Based Public-Private Partnerships (CBP3s) and Alternative Market-Based Tools for Integrated

Green Stormwater Infrastructure, https://www.epa.gov/sites/production/files/2015-12/documents/gi_cb_p3_guide_epa_r3_final_042115_508.pdf

Financing Green Infrastructure in Michigan, https://www.michigan.gov/documents/deq/Financing_Green_Infrastructure_in_Michigan_455013_7.pdf

Implementation Information

Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers, https://semcog.org/Reports/LID/files/assets/basic-html/page-1.html

Guidebook of Best Management Practices for Michigan Watersheds Reprinted October 1998, http://www.cicacenter.org/pdf/MIBMPGuidebook.pdf

Using Smart Growth Techniques as Stormwater Best Management Practices, https://www.epa.gov/sites/production/files/2014-04/documents/stormwater-best-management-practices.pdf

Incentive Policies to Promote the Use of Enhanced Stormwater BMPs in New Residential Developments, https://ageconsearch.umn.edu/bitstream/56541/2/Stormwater%20BMP%20Southern%20Paper%202010%20Final.pdf

Utility Operations BMP Implementation Guidebook, http://cuwcc.org/Portals/0/Document%20Library/Resources/BMP%20Resources/BMP%201%20Utility%20Operations/Guidebook/UtilityOperationsGuidebook.pdf

Incentive Programs, http://www.stormwater.allianceforthebay.org/riverwise-communities-manual/incentive-programs

Stormwater Incentives Grant Manual, https://www.phila.gov/water/wu/Stormwater%20Grant%20Resources/StormwaterGrantsManual.pdf

Using Rainwater to Grow Livable Communities - Regulatory and Incentive Systems, http://www.werf.org/liveablecommunities/pdf/regulatory.pdf

Using Rainwater to Grow Livable Communities - Using Incentive Programs to Promote Stormwater BMPs, http://www.werf.org/liveablecommunities/toolbox/incentives.htm

Commercial, Institutional, and Industrial BMP Implementation Guidebook, http://calwep.org/Search-Results?Search=CIIGuidebook.pdf